GEF

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February 05, 2009

Dear Council Member:

The World Bank, as the Implementing Agency for the project entitled ***China: Thermal Power Efficiency***, has submitted the attached proposed project document for CEO endorsement prior to final approval of the project document in accordance with World Bank procedures.

The Secretariat has reviewed the project document. It is consistent with the proposal approved by Council in November 2007 and the proposed project remains consistent with the Instrument and GEF policies and procedures. The attached explanation prepared by World Bank satisfactorily details how Council's comments and those of the STAP have been addressed.

If by March 05, 2009, I have not received requests from at least four Council Members to have the proposed project reviewed at a Council meeting because in the Member's view the project is not consistent with the Instrument or GEF policies and procedures, I will complete the Secretariat's assessment with a view to endorsing the proposed project document.

We have today posted the proposed project document on the GEF website at www.TheGEF.org. If you do not have access to the Web, you may request the local field office of UNDP or the World Bank to download the document for you. Alternatively, you may request a copy of the document from the Secretariat. If you make such a request, please confirm for us your current mailing address.

Sincerely,

Robert K Dixon for

Monique Barbut
Chief Executive Officer and Chairperson

Attachment: Project Document

Copy to: Country Operational Focal Point
GEF Agencies
STAP
Trustee

REQUEST FOR CEO ENDORSEMENT/APPROVAL

PROJECT TYPE: Full-sized Project
THE GEF TRUST FUND

Submission Date: January 13, 2009
Re-submission Date:

PART I: PROJECT INFORMATION

GEFSEC PROJECT ID: 2952
GEF AGENCY PROJECT ID: P098654
COUNTRY(IES): China
PROJECT TITLE: China Thermal Power Efficiency
GEF AGENCY(IES): World Bank
OTHER EXECUTING PARTNER(S): Ministry of Finance (MOF)
GEF FOCAL AREA(S): Climate Change
GEF-4 STRATEGIC PROGRAM(S):
Retrofitting of Existing Power Plants;
Promoting Industrial Energy Efficiency
NAME OF PARENT PROGRAM/UMBRELLA PROJECT: NA

Expected Calendar	
Milestones	**Dates**
Work Program (for FSP)	Sep. 2007
GEF Agency Approval	Mar 2009
Implementation Start	April 2009
Mid-term Review (if planned)	Mar 2011
Implementation Completion	June 2013

A. PROJECT FRAMEWORK (Expand table as necessary)

Project Objective: to reduce coal consumption and GHG emission per unit of electricity production in Shanxi Province, Shandong Province and Guangdong Province in China.

Project Components	Indicate whether Investment, TA, or STA**	Expected Outcomes	Expected Outputs	GEF Financing*		Co-financing*		Total ($)
				($)	%	($)	%	
1. Mechanisms to Support the Closure of Inefficient Small Coal-fired Generation Units	TA and Investment	• reduced coal consumption and GHG emission per unit of electricity production in Shanxi and Shandong Provinces	• Closure of 2,910 MW of inefficient small coal-fired power generation units • Reduced share of generation capacity by less efficient coal-fired units in Shandong and Shanxi provinces	9.5	18.1	26.9	81.9	36.4
2. Demonstration of Power Plant Efficiency Improvement	Investment and TA	• reduced coal consumption and GHG emission per unit of electricity production in Shanxi and Shandong Provinces	• Improved efficiency of coal-fired power and heat supply at targeted plants in Shandong and Shanxi Provinces	3.59	6.4	52.77	93.6	56.36
3. Transition to Efficient Generation Dispatch	TA and Investment	• reduced coal consumption and GHG emission per unit of electricity production in	• Pilot operation of Efficient Fuel Saving Dispatch (ESD) • Operation of dispatch	4.07	55.8	3.23	44.2	7.30

		Guangdong Province • Changed from existing dispatch practices to efficient fuel saving dispatch in Guangdong provincial grid	simulation system • Report on assessment of ESD pilots in five provinces					
4. Technical Assistance for Project Implementation	TA	• smooth project implementation.	• Consulting services for project implementation.	1.27	68.4	0.59	31.6	1.85
5. Project Management				0.41	21.3	1.51	78.7	1.92
6. Unallocated Contingencies for Exchange Rate Changes				0.86	16.9	4.25	83.1	5.11
Total Project Costs				19.70	18.1	89.26	81.9	108.96

* List the $ by project components. The percentage is the share of GEF and Co-financing respectively to the total amount for the component.

** TA = Technical Assistance; STA = Scientific & technical analysis.

B. FINANCING PLAN SUMMARY FOR THE PROJECT ($)

	*Project Preparation**	*Project*	*Agency Fee*	*Total at CEO Endorsement*	*For the record: Total at PIF*
GEF	0.35	19.70	1.97	21.67	19.70
Co-financing		89.26		89.26	89.26
Total	0.35	108.96	1.97	108.96	108.96

***** Please include the previously approved PDFs and PPG, if any. Indicate the amount already approved as footnote here and if the GEF funding is from GEF-3. Provide the status of implementation and use of fund for the project preparation grant in Annex D.

C. SOURCES OF CONFIRMED CO-FINANCING, including co-financing for project preparation for both the PDFs and PPG.

(expand the table line items as necessary)

Name of co-financier (source)	*Classification*	*Type*	*Amount ($)*	*%**
Beneficiary enterprises	Beneficiaries	Equity/hard loan In-kind	62.52 2.74	18.4 8.5
Government of China (GoC)	National / local governments	Grant In-kind	16.44 7.56	70.0 3.1
Total Co-financing			89.26	100%

* Percentage of each co-financier's contribution at CEO endorsement to total co-financing

D. GEF RESOURCES REQUESTED BY FOCAL AREA(S), AGENCY(IES) OR COUNTRY(IES)

It is a single focal area, single country and single GEF Agency project.

E. PROJECT MANAGEMENT BUDGET/COST

Cost Items	*Total Estimated person weeks*	*GEF ($)*	*Other sources ($)*	*Project total ($)*
*Local consultants**	SOE for translation	105,000	29,000	134,000
*International consultants**				
*Office facilities, equipment, vehicles and communications***		272,000	1,276,000	1,548,000
*Travel***		32,000	203,000	234,000
Total		408,000	1,507,000	1,916,000

* Provide detailed information regarding the consultants in Annex C.

** Provide detailed information and justification for these line items.

Office facilities, equipment, vehicles and communications**

		Total (US$m)	**GEF (US$m)**	**Co-financing (US$m)**
5A	**National PMO**			
5A1	Office equipment	0.114	0.029	0.086
5A2	Office rental	0.129	0.071	0.057
5A3	Operational cost	0.276	0.042	0.235
	Subtotal	**0.519**	**0.1417**	**0.378**
5B	**Shandong PMO**			
5B1	Office equipment	0.114	0.043	0.071
5B2	Office rental	0.143		0.143
5B3	Operational cost	0.126	0.022	0.104
	SD subtotal	**0.384**	**0.064966**	**0.319**
5C	**Shanxi PEO/PCO**			
5C1	Office equipment	0.114	0.043	0.071
5C2	Office rental	0.143		0.143
5C3	Operational cost	0.189	0.022	0.167
	SX subtotal	**0.446**	**0.064966**	**0.381**
5D	**Guangdong - PMO**			
5D1	Office equipment	0.071		0.071
5D2	Office rental	0.086		0.086
5D3	Operational cost	0.042		0.042
	GD subtotal	**0.199**		**0.199**
	Total	**1.548**	**0.272**	**1.276**
		100.0%	17.6%	82.4%

Note: PMO – Project Management Office; PEO – Project Executive Office; PCO – Project Coordination Office.

***GEF grant - Travel**:** *GEF grant for staff of the 4 PMOs to travel to individual project sites for supervision together with Bank's supervision missions over the 4 years of project implementation. Each PMO: 4 travels/year (2 persons for 2 travels); US$500/travel.*

***Co-financing for travels:** additional travel needed for project implementation, supervision, monitoring and evaluation.*

		Total (US$m)	**GEF (US$m)**	**Co-financing (US$m)**
5A5	**National PMO** - Travel	0.102	0.015	0.087
5B5	**Shandong PMO** - Travel	0.047	0.008	0.039
5C5	**Shanxi PEO/PCO** - Travel	0.070	0.008	0.062
5D5	**Guangdong PMO** - Travel	0.015		0.015

Total	**0.234** 100.0%	**0.032** 13.6%	**0.203** 86.4%

F. CONSULTANTS WORKING FOR TECHNICAL ASSISTANCE COMPONENTS:

Component	*Estimated person weeks*	*GEF($mn)*	*Other sources ($mn)*	*Project total ($mn)*
*Local consultants**	1,515	3.818	3.250	7.068
*International consultants**	228	1.492	0.586	2.078
Total	1,743	5.310	3.836	9.146

* Provide detailed information regarding the consultants in Annex C.

G. DESCRIBE THE BUDGETED M&E PLAN:

Project implementation monitoring will be carried out through normal review of procurement, Financial Management Reports (FMRs), annual audits of the project accounts, periodic progress reports, external monitoring reports, and regular supervision missions by the World Bank.

Comprehensive M&E will be implemented for the project in accordance with GEF M&E Guidelines. The agreed indicators, baseline values and responsibility for data collection and monitoring are described in Annex 3. Monitoring of interim outcome indicators will be carried out through periodic progress reports from the IAs, external monitoring reports from consultants and the Bank's supervision missions. Technical assistance designed under the project will ensure sufficient capacity in data collection, monitoring, reporting and outcome evaluations.

The M&E results will provide critical input to the central government agencies for decisions on adjustments of national policies and regulations and set up of benchmarks and good practices for replication to the rest of the country. The evaluation of results and impact of various pilot programs will be managed by the central government agencies to ensure ownership and replication. Financial resources are allocated to support the evaluation and replication under the project.

A mid-term review will be carried during the project implementation to assess the effectiveness of the project design and realism of the project development objectives. The review results will be used for adjustments, if needed, of project design and implementation arrangement.

PART II: PROJECT JUSTIFICATION

A. DESCRIBE THE PROJECT RATIONALE AND THE EXPECTED MEASURABLE GLOBAL ENVIRONMENTAL BENEFITS:

By completion of implementation, the Project is expected to result in a cumulative direct emission reduction of about 26.1 million tons of Carbon dioxide (CO_2) and indirect emission reduction of 425.9 million tones.

Growing Energy Demand and GHG Emissions. China is the world's second largest energy user. Since 1990 energy consumption has been increasing on average at 5.8% per year, growing from 987 million tons of coal equivalent (tce) in 1990 to about 2.46 billion tce in 2006[1]. China's greenhouse gas (GHG) emissions are now comparable to the United States. This is due mostly to the consumption of coal for electricity production. CO_2 emissions in China are projected to double over the next decade and as a result China will experience the largest absolute growth in these emissions over this period.

[1] China Statistic Year Book 2007

Therefore, efforts to curb CO_2 emissions resulting from the generation of electricity are of paramount importance to the Climate Change Agenda.

Predominance of Coal in China's Energy Mix. China's rising energy demand has been met largely by domestic coal. Coal consumption reached about 1.7 billion tce in 2006, accounting for 69% of the country's total energy consumption. Various projections show that coal will still constitute 60% or more of China's primary energy consumption by 2020[2].

Coal has also been the predominant source of electricity generation in China. Thermal power generation capacity reached 484 GW in 2006, amounting to about 78% of the 622 GW total installed capacity and generating 83% of the 2,834 TWh total electricity output in China. Of this thermal generation capacity, 422 GW was coal-fired, accounting for about half of the country's 2006 total coal consumption. The Government of China (GOC) is seeking to diversify generation resources, mainly through scaling-up renewable energy and nuclear power. However, even with this diversification policy, coal will remain the prevailing fuel source for the foreseeable future.

Significant Environmental Consequences. The rapid expansion of installed thermal power generation capacity and its primary reliance on coal has contributed significantly to adverse environmental impacts in China. Emissions of sulfur dioxide (SO_2), CO_2 and nitrogen oxides (NO_X) from burning bituminous coal cause serious atmospheric pollution and are partially responsible for ground level ozone (smog), acid rain, poor surface water quality and climate change.

Low Efficiency of Coal-fired Power Generation. China's coal-fired power plants consume considerably more coal per kWh of electricity supplied than the international average. In 2006 coal-fired generation in China consumed an average 366 gce/kWh compared to a 300 gce/kWh benchmark in Japan or Europe [3]. The main factors contributing to China's low power generation efficiency are:

(a) ***Large share of generation by inefficient small*** [4] ***units.*** In 2006, coal-fired power generating units of 100 MW and below had a combined installed capacity of 115 GW. This was equal to more than 27% of the total coal-fired power generation capacity in China. With a typical heat-rate of between 400 and 800 gce/kWh, these small units significantly underperform in comparison to medium and large size coal-fired generation units. For example 200 MW units consume about 360 gce/kWh, while units 300 MW and larger consume between 325 and 335 gce/kWh[5]. Notwithstanding the much higher coal consumption, these inefficient small thermal units, under the existing generation dispatch practices, have similar utilization factors [6] to the larger, more efficient units.

(b) ***Generation dispatch not optimized for achieving maximum efficiency.*** Unlike most other electricity systems in the world, Chinese power generation dispatch practices do not favor more efficient or lower variable cost generation[7]. Instead, all thermal units are scheduled to operate for a similar number of hours per year, regardless of efficiency or fuel consumption cost. The underlying cause of this practice is the regulated energy-only generation prices[8] for electricity supplied to grid companies. The energy-only price for a coal-fired generation investment project is approved based on an annual operational hour assumption, usually around 5000 hours. On a year-ahead basis, each generation unit is planned with a proportional allocation of the energy required to supply the demand forecast, leading to similar annual operational hours. Throughout the year, the dispatch center

[2] Sustainable Energy in China: The Closing Window of Opportunity, World Bank, 2007
[3] With units of 6 MW and bigger
[4] Refers to units of 100 MW and smaller
[5] Conclusions of a sample survey carried out by Chinese government authorities in 2007
[6] Utilization factor = annual energy generated/(available capacity x number of hours in the year)
[7] International practice of merit order dispatch schedules available thermal generation units to minimize total generation variable costs (mainly fuel costs).
[8] The grid company pays a generator only for the energy (kWh) injected to the grid.

schedules generation in accordance with the operational hours target assigned to each unit. This causes significantly greater average coal consumption per MWh of electricity production than if the dispatch had prioritized the more efficient coal-fired generation units.

(c) ***Small combined heat and power units operating for power generation only.*** Small units for combined heat and power (CHP) supply operate at a higher overall efficiency when providing both power and heat. For this and other reasons, small CHP units supplying heat are exempt from government-mandated closure, if these units comply with a specified ratio of heat-to-power[9] generation over the course of a year. However, operation for power generation only must be restricted accordingly. The small CHP units that do not comply with the required annual ratio of heat-to-power are liable to be closed down. Nonetheless, despite government regulations, many small CHP units in China continue to operate solely for power generation even when more coal-efficient capacity is available for substitutive generation, since the regulatory entities and system dispatchers do not have effective measures to monitor the heat supply by the CHP units. An effective monitoring system of heat supply by the small CHP units would facilitate enforcement of government regulations and lead to improvements in the overall system efficiency in power generations.

(d) ***Old mid-sized coal-fired units operating at relatively high coal consumption rate.*** Mid-sized coal-fired generation units built in the 1990s are operating at coal consumption rates higher than the rates of units with newer technologies and have significant potential for efficiency improvement during their generation life expectancy through rehabilitation and retrofit. These potential gains could be achieved through: (i) rehabilitation and retrofit of more than 100 sets of 200 to 300 MW units built in the 1990s; (ii) conversion of more than 81 sets of 300 MW units in northern China from solely power generation into CHP operation[10]; and (iii) waste heat recovery from the cooling systems of condensing-type power generation units for district heating.

B. DESCRIBE THE CONSISTENCY OF THE PROJECT WITH NATIONAL PRIORITIES/PLANS:

The proposed Project is requested by the GOC to assist the implementation of its strategy in improving efficiency and reducing coal consumption in China, especially in the thermal power sector. The GOC has endorsed the project as one of its climate change assistance priorities under the GEF-4 and again under the GEF-5.

Government Strategies. Chinese authorities at the highest levels have recognized that a business-as-usual approach in the energy sector will lead to unacceptable environmental consequences and strain the coal supply chain on an unprecedented scale. The Government initiatives intended to improve efficiency and reduce coal consumption in China are contained in its 11th Five Year Plan (2006-2010), issued in early 2006 that calls for a 20% reduction of energy consumption per unit output of gross domestic product (GDP) by 2010; and in the Medium and Long Term Energy Conservation Plan issued in 2004 by the National Development and Reform Commission (NDRC), which targets a reduction of energy intensity from 2.68 tce per RMB 10,000 of GDP output in 2002 to 2.25 tce by 2010 and 1.54 tce by 2020.

Specific GOC strategies to improve coal-fired thermal power generation efficiency include: (i) closure of inefficient small coal-fired units and the addition of new high-efficiency large-sized thermal units[11]; (ii) introduction of efficient generation dispatch, known as the Efficient Fuel Saving Dispatch (ESD); (iii)

[9] State Council Document [2000]1268: Heat-to-Power Ratio over the year (GJ: kWh*(3600 GJ/kWh)) x 100% must be equal to or above 100% for units smaller than 50 MW and 50% for units between 50 to 200 MW

[10] A 2006 survey commissioned by NDRC and conducted by the China Electric Power Engineering Consultants Group Corporation identified 81 units of 300 MW power-only condensing turbine power plants that were within a 15 km of cities with substantial industrial and district heat demand.

[11] Most of new units added in 2008 are 600 MW and larger, with super-critical and ultra-super-critical technologies.

adoption of new clean coal technologies such as integrated gasification combined cycle (IGCC); (iv) investment in energy efficient systems and the rehabilitation of existing generation units; and (v) scale-up of renewable power generation.

The GOC's strategy for reducing the capacity share of inefficient small coal-fired generation units seeks to close down 50 GW of these units by 2010. Plant closure goals for 2010 were negotiated in 2007 and NDRC signed agreements with 30 provincial governments and 7 major power companies for their closure goals. Early results have been favorable, with 14.38 GW of small units closed by the end of 2007, exceeding the national 2007 target of 10 GW. However, most of the units closed belonged to large power generation companies which have the financial, institutional and technical capacity to address the financial and social impact of such closures. Those units remaining to be closed in 2009 and 2010 are smaller and mostly owned by municipal and county level small power companies. These companies are less likely to be able to address the financial and social impact of closure in the allotted time without additional financial support.

Another element of the GOC's strategy for improving thermal power sector efficiency is the replacement of existing dispatch practices with the ESD[12]. This requires generation dispatch to follow a merit order of units, determined by their efficiency and emission levels. The ESD will commence with pilots in 5 selected provinces, with the intention later of being implemented nationally. The change in dispatch practice will significantly reduce coal consumption for power generation. However, this will also have a critical impact on the financial viability of less efficient units (due to the reduction in generation), rendering these units unable to recover fixed costs at current generation tariffs. Additionally, the ESD pilot requires new technical regulations on access, disclosure and verification of generation efficiency data that to date has not been available at dispatch centers or used for dispatch. Although the start up of the pilot was scheduled to commence by early 2008, it has been delayed until adequate regulation and financial compensation mechanisms are implemented to address the associated technical and financial barriers.

C. DESCRIBE THE CONSISTENCY OF THE PROJECT WITH GEF STRATEGIES AND STRATEGIC PROGRAMS:

The Project is consistent with the strategic objective of the GEF Interim strategy - *Summary of Negotiations on the Fourth Replenishment of the GEF Trust Fund, dated August 25, 2006*. The Project will support the retrofit of power plants, included under that strategy.

D. OUTLINE THE COORDINATION WITH OTHER RELATED INITIATIVES:

The project has been developed and will be implemented in close coordination with the on-going energy efficiency related international assistance program in China, thereby maximizing knowledge-sharing and incorporating lessons learned into the project design. The First and Second China Energy Conservation projects focus on promoting energy efficiency through the development of energy service company industry in China. The project management office which managed these two projects will also provide implementation support for the project.

The project will coordinate with and take advantage of efforts under the China Energy Efficiency Financing Project recently approved by the Bank and the GOC and the United Nation Development Program (UNDP) GEF China: End-Use Energy Efficiency Project. The former has funded a technical assistance to the Establishment of the National Energy Conservation Center and the latter has a component, Capacity Building and Training for Provincial Energy Conservation Centers, under implementation. The UNDP project also will provide substantive energy audit training to selected

[12] A simulation study conducted for one provincial power grid as part of the project preparation work shows that the ESD could reduce coal consumption by about 2.2 million tce per year in that province during the period 2007-2011.

provincial energy conservation centers. In addition, the project will coordinate with the International Finance Corporation (IFC)/GEF China Utility-Based Energy Efficiency Project and the projects focusing on energy efficiency improvement financed by other agencies, such as the French Development Agency.

E. **DESCRIBE THE INCREMENTAL REASONING OF THE PROJECT:**

Please see the Annex 15 of the Project Appraisal Document for a detailed description of the incremental cost analysis.

F. INDICATE RISKS, INCLUDING CLIMATE CHANGE RISKS, THAT MIGHT PREVENT THE PROJECT OBJECTIVE(S) FROM BEING ACHIEVED AND OUTLINE RISK MANAGEMENT MEASURES:

Risks	*Risk mitigation measures*	*Risk rating with mitigation*
To project development objective		
Weakening of government commitment to promote energy efficiency in thermal power sector	• Improved energy efficiency has been set as one of the highest priorities of the 11th Five-Year Plan and reaffirmed by officials at the highest level of the government • The GOC has issued regulations and signed agreements for the closure of inefficient small units and launched the ESD pilot during the project preparation	Low
Weak enforcement capacity of the provincial governments	• Technical assistance designed under the project to strengthen the related provincial governments' capacity of monitoring and enforcing related energy conservation and environmental policies, regulations & standards • Strong support by the Bank's Task Team throughout the preparation and implementation stages	Modest
To component results		
Component 1: Government funds for MCSU not in place	• Agreement for funding reached before project implementation • GEF Grant ear-marked for MCSU disbursement only when government funds made available	Modest
Payment under the MCSU not fully made to affected plants or not used for intended purposes	• Preparation and approval of an MCSU Operational Manual is a condition for disbursement of funds for output-based payment • Clear and detailed requirements on use of funds, disbursement procedures, FM, auditing, and reporting laid down in the Operational Manual • Annual auditing and periodic reporting by IAs • Close FM supervision by MOF/National PMO and the Bank's Task Team	Modest
Closure of small units impeded due to affected interests of local governments and social impacts	• Provincial governments' commitment to closure defined in the agreements with the central government • MCSU to support mitigation of social impacts • Technical assistance to facilitate generation of additional revenues under existing government policies to complement the MCSU	Modest
Compliance with government's policies regarding satisfactory settlement of workers affected by the closure of small units	• Government's policies instructing satisfactory settlement of workers affected by the closure of small units are in place at the central, provincial and municipal levels and are systematic, comprehensive and adequate • These government policies include adequate financing and institutional arrangements for implementation and monitoring • Additional financial resources, as output-based payments, will be provided to the targeted owners of small units under the MCSU as an incentive to the closure and compliance with the government policies • An independent third-party monitor will be engaged to check compliance to governments' policies • Compliance to the government staff settlement policies is a condition for the disbursement of the output-based payment	Modest
Compliance to the Environmental Management Framework (EMF) during the process of closure	• An independent third-party monitoring will be engaged to check compliance to the EMF • Compliance to the EMF is a condition for the disbursement of the output-based payments	Low

Component 2: echnical risk of not achieving expected efficiency gains Inadequate safeguard management	• Design of turbine rehabilitation activities by original suppliers • Technical due diligence and support by both international and local consultants in project design, implementation and supervision • EMPs and RPFs prepared, agreed and budgeted by power plants • Hiring experience environmental and social specialist for implementation and monitoring • Close support and supervision by the Bank's Task Team	Low Low
Component 3: ESD not implemented in the pilot province due to the complementary policies and regulations to address associated financial impacts and technical requirements not in place Delays in ESD implementation due to affected interests of generation and grid companies	• Support to central government agencies and GDGP to prepare regulations and implement (i) a financial compensation mechanism supporting the pilot ESD; and (ii) detailed requirements on information disclosure required for the pilot implementation of ESD • Strong support by international consultants and the Bank's Task Team throughout the implementation stage • Technical assistance to develop adequate financial compensation mechanisms to address financial impacts due to change in dispatch practices	Low High
Component 1-3: Successful experience in pilot provinces not replicated in other provinces	• Efforts to reach consensus and legal agreements with central government agencies for the replication before project implementation • Central government agencies to be responsible and take the lead of impact assessment and replication • Support to central and provincial government agencies to build capacity for replication	Modest
Overall risk rating		**Modest**

G. EXPLAIN HOW COST-EFFECTIVENESS IS REFLECTED IN THE PROJECT DESIGN:

The direct CO_2 emission reductions impacts and the project budget are brought together in Table below. These results suggest that the Project is a very cost effective source of CO_2 reductions. Total project-wide cumulative CO_2 emission reductions are 26.1 million tons direct and 425.9 million tons indirect. The average cost of direct CO_2 emission reductions across all the components and including the "overhead" components such as M&E and Incremental Operating Cost was US$ 3.98 per ton. When expressed as per unit of indirect impacts, the costs would be much lower, only 24 cents per ton. The proportion of the incremental cost shared by GEF is about US$0.72 per ton for direct CO_2 emission reductions and about US$ 0.04 per ton for indirect reductions.

Project Components	GEF Funding	Total Funding	Cumulative Direct CO_2 Reductions	Cumulative Indirect CO_2 Reductions	Cost of Direct CO_2 Impacts	Cost of Total (Indirect + Direct) CO_2 Impacts
	(US$m)	(US$m)	(10^6 t)	(10^6 t)	($/t)	($/t)
1A: Pilot Implementation of MCSU	5.79	21.54	5.7	30.95	3.78	0.70
1B: Set-up of CHP On-line Monitoring Systems	2.00	11.81	N.A.	N.A.	N.A.	N.A.
1C: TA to Trading of Emission Allowances	1.00	1.93	N.A.	N.A.	N.A.	N.A.
1D: M&E	0.71	1.14	N.A.	N.A.	N.A.	N.A.
Component 1 Subtotal	**9.50**	**36.42**	**5.70**	**30.95**	**6.39**	**1.18**
2 A: Conversion for CHP at Huangtai	1.14	27.34	9.46	86.04	2.89	0.32
2 B: Waste Heat Recovery at Beijiao	1.14	22.75	3.23	220.00	7.04	0.10
2 C: Efficiency Impr. Retrofit at Yangguang	1.10	5.87	2.22	13.9	2.65	0.42
2D: TA to Capacity Building / Replication	0.22	0.40				
Component 2 Subtotal	**3.60**	**56.36**	**14.91**	**319.94**	**3.78**	**0.18**
3A: Guangdong Provincial ESD Pilot	2.62	5.15	5.5	75	0.94	0.07

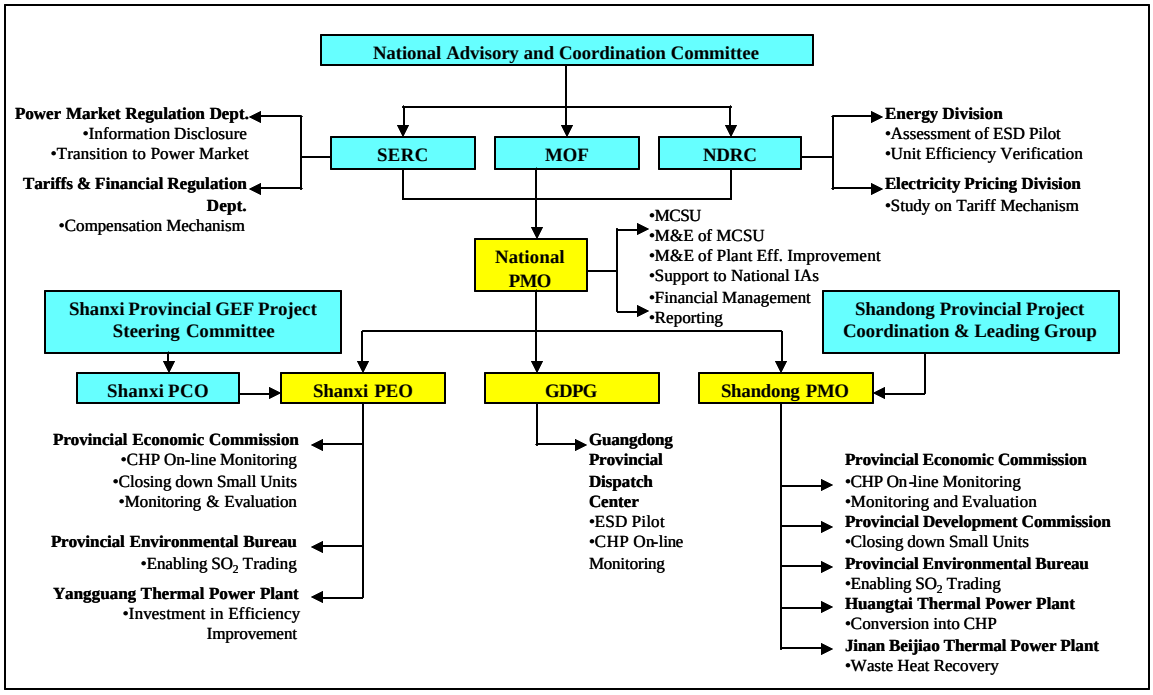
3B: National Policy Development and Capacity Building	1.45	2.15	N.A.	N.A.	N.A.	N.A.
Component 3 Subtotal	**4.07**	**7.30**	**5.50**	**75.00**	**1.33**	**0.10**
Component 4 Subtotal	**1.27**	**1.85**	**N.A.**	**N.A.**	**N.A.**	**N.A.**
Component 5 Subtotal	**0.41**	**1.92**	**N.A.**	**N.A.**	**N.A.**	**N.A.**
GEF PROJECT TOTAL	**18.84**	**103.85**	**26.110**	**425.890**	**3.98**	**0.24**
Cost to GEF					**0.72**	**0.04**

PART III: INSTITUTIONAL COORDINATION AND SUPPORT

A. PROJECT IMPLEMENTATION ARRANGEMENT:

(a) Partnership arrangements. The GEF will finance about 18.1 % of the total project cost, estimated at US$ 108.96 million. The remaining 81.9 % will be co-financed by central government agencies including the Ministry of Finance (MOF), NDRC, State Electricity Regulation Commission (SERC) and Shandong and Shanxi Provincial Governments with budget allocations and in-kind contributions, Guangdong Power Grid Corporation (GDGP)[13] in Guangdong and three power plants in Shandong and Shanxi with loans from bcal banks (see Annex 5). USAID supported the energy audits of the three power plants under Component 2 during the project preparation and has agreed to continue its support for the introduction of international technologies and experience in plant efficie ncy improvement during the project implementation. The agency will finance international consulting services and workshops.

(b) Institutional and implementation arrangements. The project implementation will be carried out over four years by the central and provincial government agencies, GDGP in Guangdong and three power plants in Shandong and Shanxi. The institutional arrangements for project implementation have followed the normal functions of the government agencies and project entities (see Figure below). Project management/coordination offices have been created at both national and provincial levels so as to allow internal and external coordination, operational and logistical support to the project implementation, M&E and reporting, without major interruption to each IA's normal operating functions.



[13] A subsidiary of China Southern Grid Corporation.

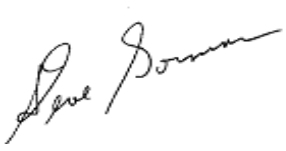
According to the institutional and implementation arrangements illustrated in the Figure above, all implementing agencies have comparative advantages and sufficient technical capacities to manage their respective project activities. However, the capacity assessments conducted by the Bank's Task Team indicated that the newly created project management/coordination units did not possess the capacity to provide the necessary operational support to the various implementing agencies in procurement, financial management and safeguard management.

PART IV: EXPLAIN THE ALIGNMENT OF PROJECT DESIGN WITH THE ORIGINAL PIF:

Compared to the work program submission, the design of project components and activities remain the same, but following changes have been made:

Changes	Work Program Submission	Proposed Project
1. Project Development Objective	to reduce coal consumption and GHG emission per unit of electricity production in China	to reduce coal consumption and GHG emission per unit of electricity production in Shanxi Province, Shandong Province and Guangdong Province in China
2. Expected GHG emission reductions	90 million tone country wide (upon replication) when compared with the 2005 baseline	26.1 million tones direct in the three pilot provinces and 425.9 million tones indirect, when compared with the 2006 baseline, which gives more conservative reductions then the 2005 baseline does
3. Co-financing	US$107.8 million	US$89.26 million, based on refined cost estimations

PART V: AGENCY(IES) CERTIFICATION

This request has been prepared in accordance with GEF policies and procedures and meets the GEF criteria for CEO Endorsement.	
 *Steve Gorman* GEF Agency Coordinator	Mahesh Sharma Project Contact Person
Date: *January 15, 2009*	Tel. 202-458-7339, Email:msharma1@worldbank.org

ANNEX A: PROJECT RESULTS FRAMEWORK

CHINA: GEF China Thermal Power Efficiency Project

PDO/Global Environmental Objective	Project Outcome Indicators	Use of Project Outcome Information
GEF Operational Programs: promoting retrofitting of power plants, grandfathered under the GEF Interim Strategy		
• Reduce coal consumption and GHG emission per unit of coal-fired electricity production in Shandong, Shanxi and Guangdong Provinces	• Average coal consumption and GHG emission per unit of coal-fired electricity output (gce/kWh) in Shandong, Shanxi and Guangdong Provinces	**YR1-3:** Determine if policies and regulations need to be adjusted; **YR4:** Feed into government's power sector efficiency strategy
Intermediate Outcomes	**Outcome Indicators**	**Use of Intermediate Outcome Information**
Outcome 1 • Reduced share of generation capacity by less efficient coal-fired units in Shandong and Shanxi Provinces	**Outcome 1** • Cumulative capacity of small thermal unit closed down in Shandong and Shanxi Provinces • Operation of CHP On-line Monitoring Systems in Shandong and Shanxi Provinces	**Outcome 1** **YR1-3:** Test effectiveness of financial incentive output- based mechanism **YR3-4:** Inform adjustments of policies and incentive output based mechanism
Outcome 2 • Improved efficiency of coal-fired power and heat supply at targeted plants	**Outcome 2** • Thermal efficiency of targeted plants/units • Annual coal savings and GHG emission reduction from targeted plants/units	**Outcome 2** **YR1-4:** Establish financially successful cases, benchmarks and best practices
Outcome 3 • Changed from existing dispatch practices to fuel efficient generation dispatch in Guangdong provincial grid	**Outcome 3** • Pilot operation of ESD • Operation of dispatch simulation system • Report on assessment of ESD pilots	**Outcome 3** **YR1-3:** Test effectiveness of approach and regulations on generation dispatch **YR4:** Inform improvements to efficient generation dispatch for replication

NOTE: PDO – PROJECT DEVELOPMENT OBJECTIVE.

		Target Values				Data Collection and Reporting		
Outcome Indicators	**Baseline (2007)**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Frequency and Reports**	**Data Collection Instruments**	**Resp. for Data Collection**
Reduction in average coal consumption per unit of coal-fired electricity output in selected provinces	SX: 373 gce/kWh SD: 382 gce/kWh GD: 342 gce/kWh	SX: 370 SD: 378 GD: 342	SX: 364 SD: 374 GD: 337	SX: 361 SD: 371 GD: 335	SX: 357 SD: 369 GD: 332	Annually; Project Progress Report	Provincial Government Statistics	SX: PEO SD: PMO GD: GDGP
Reduction of GHG emission per unit of coal-fried electricity output in selected provinces	SX:1,020 $kgCO_2$/MWh SD:1,045 $kgCO_2$/MWh GD: 935 $kgCO_2$/MWh	SX: 1,012 SD: 1,034 GD: 935	SX: 996 SD: 1,023 GD: 922	SX: 987 SD: 1,015 GD: 916	SX: 977 SD: 1,009 GD: 908	Annually; Project Progress Report	Provincial Government Statistics	SX: PEO SD: PMO GD: GDGP
Results Indicators for each Component								
Component 1: (i) Cumulative capacity of small thermal units closed down (ii) CHP on-line Monitoring System operational	SX: 1007 MW SD: 1717 MW SX: no SD: no	SX:1543 SD:2717	SX:2065 SD:3517 SX: yes SD: yes	SX:2870 SD:4300 SX: yes SD: yes	SX: yes SD: yes	Semi-annually; Project Progress Report	Verification by NDRC	SX: PEO SD: PMO
Component 2: (i) Increase in thermal efficiency of targeted plants/units (ii) Annual coal savings and GHG emission reduction from targeted plants / units	<u>Thermal efficiency</u> YG: 35.3% HT: 40.3% BJ: 57.0% <u>Coal savings / GHG emission reduction</u> YG: 0.0 million tce / 0.0 million tone HT: 0.0 million tce / 0.0 million tone BJ: 0.0 million tce / 0.0 million tone		<u>Efficiency</u> YG: 35.8% HT: 44.4% BJ: 66.8% <u>Savings / reduction</u> YG: 0.04 / 0.11 HT: 0.17 / 0.47 BJ: 0.06 / 0.16	<u>Efficiency</u> YG: 35.8% HT: 44.4% BJ: 66.8% <u>Savings / reduction</u> YG: 0.04 / 0.11 HT: 0.17 / 0.47 BJ: 0.06 / 0.16	<u>Efficiency</u> YG: 35.8% HT: 44.4% BJ: 66.8% <u>Savings / reduction</u> YG: 0.04 / 0.11 HT: 0.17 / 0.47 BJ: 0.06 / 0.16	Semi-annually; Project Progress Report	Measurements at power plants	YG & SX PEO, HT & SD PMO, BJ & SD PMO

Component 3: (i) Operation of dispatch simulation system (ii) Implementation of information disclosure (iii) Pilot implementation of the Financial Compensation Mechanism (iv) Pilot operation of ESD system (v) Report on assessment of the ESD pilot in all the five pilot provinces	Pilot ESD system developed by GDGP, no simulation system operational No detailed requirements on information disclosure No financial compensation mechanism	Simulation system, information disclosure system & comp. mechanism agreed by NDRC	Operation of the simulation system, information disclosure system & financial comp. mechanism and pilot ESD system	Report on assessment of pilot programs in all the five pilot provinces, including GD, and recommendations on improvements		Semi-annually; Project Progress Report	M&E by IAs	GDGP & National PMO (NDRC)
Component 4: Performance of procurement, FM and other project management activities	Satisfactory performance for project preparation activities	Ensuring smooth project implementation				Semi-annually; Project Progress Report	M&E by IAs; external auditors	All PMOs/PEO GDGP
Component 5: Use of incremental operating budget	Satisfactory performance in use of PPG Grand	Ensuring compliance with the project Financial Management Manual				Semi-annually; Project Progress Report	M&E by IAs; external auditors	All PMOs/PEO GDGP

Note: **SX** – Shanxi Province; **SD** – Shandong Province; **GD** – Guangdong Province
YG – Shanxi Yangguang Thermal Power Plant; **HT**- Shandong Huangtai Thermal Power Plant; **BJ** – Shandong Jinan Beijiao Thermal Power Plan.

ANNEX B: RESPONSES TO PROJECT REVIEWS (from GEF Secretariat and GEF Agencies, and Responses to Comments from Council at work program inclusion and the Convention Secretariat and STAP at PIF)

A. Response to GEF Secretariat and GEF Agencies Review

COMMENTS FROM FRANCE

1. The project aims at phasing out small inefficient coal-fired plants and replacing them by more efficient, larger units.

2. **Opinion: favourable with the following remark:** Considering the length of the PIF, it is surprising to find mistakes such as the one concerning the amount of co financing in chapter B – indicative financing plan summary for the projects. According the chapter A, co financing amounts to 143 800 000 USD rather than 2 320 000 USD as indicated in B.

Response: modified.

COMMENTS FROM SWITZERLAND

Overall Comments

3. The proposed project aims at reducing GHG emissions from low efficiency, smaller coal-fired thermal power stations by developing a policy framework for phasing out inefficient small units and by improving the efficiency of larger units. The objective of the proposed project is well in line with China's National Climate Change Plan published in June 2007 and therefore supported from implementation. Enhancement of energy efficiency in the power sector is a key objective of the Govt of China, supported, besides climate change objectives, by the generally increasing cost of energy, including coal.

4. However the project seems, assessed by the outcome indicators, overambitious for the set timeframe and the resources available. The budget for technical assistance to project implementation is rather small. Hence the project would have to largely rely on Chinese expertise. Chinese experts qualified in this field are typically overloaded by other ambitious goal set by GoC. The capacity of the environment division of the Bank's Beijing office is rather limited and already strongly engaged in implementation of the Bank's Carbon business in China.

Response: the project development objective and the expected outcome are downgraded from aiming to the entire country to targeting the three pilot provinces, given the timeframe and resources available. Since the closure of small coal-fired units and part of the associated legal, financial and social issues are unique in China, relying on local services supported by key international services to bring in international experiences and different perspectives would best fit the project needs. For safeguard work, consulting services could be outsourced from within China while resources of Bank's Beijing Office could be used for strategic guidance.

Questions, Concerns and Challenges for the further Project Preparation

5. Assuming that rehabilitation of one 100MW CHP plant would improve the efficiency by 0.2kg CO2/kWh, one such rehabilitation would reduce GHG emissions by 100,000t CO2/year approximately. Over 20 years of remaining lifetime one rehabilitation project would yield some 2MtCO2 of emission reduction. To achieve the overall targeted 90MtCO2 emission reduction, 45 100 MW plants would need to be rehabilitated during project lifetime up to 2012, which seems to be very ambitious. This assessment is considering that there are technology/engineering/best practice issues to be resolved in plant rehabilitation with this time span as well as administrative capacity being built to operate a trading system at province level. Phase-out of small units, which would have a limited lifespan (less than 20 years) hardly save more than 1-2MtCO2 by plant and hence do also not appear to be "low hanging fruits". If the targeted emission reduction of 90MtCO2 is set in relation to the GEF investment of $19.7 million, abatement costs result of 0.2$/tCO2. It seems rather unrealistic to assume that policy measures are more than 10 times more efficient (by foreign investment) than CDM projects. The current CER floor price operated by China stands at 10$/tCO2.

Response: The GHG emission reduction impact has been revised. Total project-wide cumulative CO_2 emission reductions are estimated at 26.1 million tons direct 425.9 million tons indirect. The emission reduction would come from (i) replacing 2.9 GW of small coal-fired units with 300 MW and 600 MW units; (ii) retrofitting existing plants for efficiency improvement; and (iii) adoption of efficient generation dispatch.

The 26.1 million tons of emission reduction is set in relation to the GEF investment of $19.7 million together with co-financing of US$ 89.26 million from the government and beneficiary enterprises.

One province not included in the Project was tested by simulation dispatch system and would achieve an average annual coal savings of 2.0 to 2.5 million tones of coal savings over 2009-2014 just by switching to fuel efficient system dispatch. The Project will support the on-going pilot fuel efficient dispatch in 1 of the 5 pilot provinces and replication to all the 31 provinces / municipalities covered by the State Grid and China Southern Power Grid.

The 90Mt CO_2 emission reduction was a rough estimation, at the concept stage, of the expected output of the three initiatives.

6. To compare: China will at best be in a position to build one modern integrated gasification combined cycle (IGCC) plant, which could apply the recently approved CDM methodology by 2012. While working further in project preparation the direct objectives to be achieved by the project team up to 2012, in particular being specific with regard to targeted provinces, should be worked out more specifically compared to the assumed long-tern policy gains which may or may not be realized in full depending on a number of co-founding factors difficult to forecast in China.

Response: the directive objectives were revised, more specific and realistic with the resources and timeframe available.

7. In order to remove barriers effectively, the "how" in dealing with those barriers should be more explicitly addressed in the further stages of project preparation. Targets should not be set too ambitiously for the target's sake. Very ambitious targets may not really be helpful in enhancing implementation quality in a dialogue between the implementing agency and the Chinese partners.

Response: Yes, The proposed Project is less ambitious and the "how" in dealing with the barriers is more explicitly addressed, as presented in the Project Appraisal Document.

Conclusions and Recommendations

8. To take into consideration the questions and concerns addressed above in course of further project preparation.

Response: addressed with due consideration in the project preparation.

COMMENTS FROM THE UNITED STATES

9. We believe this is a very important project with significant potential in terms of replication. It is quite consistent with the goals of the Asia Pacific Partnership for Clean Development and Climate. We do see three issues that should be addressed or clarified, and would appreciate the opportunity to discuss there issues with the World Bank.

10. First, we have questions about how benefits are calculated and their presentation. The table on page 4 indicates 90 million tons of CO2 equivalent reductions between 2006 and 2012, which is presented to be the result of the $163.5M project investment. The 90 million tons is based on an expected increase in gross generation efficiency for the entire set of units – going from 367 gce/kWh down to 355 gce/kWh. (This means the dispatched power averaged across the entire fleet is getting on average about 3.26% more efficiently generated.) However, the other assumption is that the

power generated will grow from 2600TWh to 3300 TWh, an increase of 27% in those 6 years. How is the 90 million ton reduction calculated?

Response: the emission reduction was re-calculated once the detailed design of various components was completed. Total project-wide cumulative CO_2 emissions reductions are estimated at 26.1 million tons direct 425.9 million tons indirect. See more detailed information on response to Question 5 above and the Annex 15 of the Project Appraisal Document.

11. We also suggest that the benefits from the different components separated out, into two parts: (a) the benefits of component #2, improvement of the efficiency of existing units; and (b) the benefits of component #3, improved dispatch.

Response: benefits from each activity under Component 1, 2 and 3 are separately presented above and in the Project Appraisal Document.

12. Second, we see a potential contradiction between the components regarding (a) fiscal policies and incentives to phase out inefficient producers; and (b) moving to economic dispatch. On page 4, the discussion of component under (i) mentions "development of effective policies and regulations providing a mixture of mandatory and incentive measures to phase inefficient small coal-fired power generation units;". If indeed the system moves to economic dispatch, specific measures to phase out inefficient units will not be needed. The merit order of the dispatch is likely to render the inefficient units uneconomic and they will therefore need to close, if economic dispatch determines their fate. If the issue is one of timing, i.e., the adoption of economic dispatch is likely to take more time than is desirable for inefficient units to continue operating, then special policies to encourage their exit may be needed. The project document should address this issue.

Response: (i) yes timing as stated in the question is one of the factor; (ii) phasing out small units is a major initiative of the government, targeting a more efficient generation mix along with the fast expansion of the generation system in China; (iii) closure of small units are selective in terms of timing and system requirements; and (iv) there are various government special policies to address the technical, financial and social issues associated with the closure of small units. The policies are briefed in the Project Appraisal Document.

13. Third, it is also not clear how much of the $9 million under component #1 will be spent on developing policies and "incentives" and how much for implementing monitoring systems. Will any GEF funding be used to provide incentives for firms to exit? We don't believe this is the case, but would appreciate confirmation.

Response: The objective, process and procedures of using the GEF funds for Component 1 are described in great detail in the Project Appraisal Document and have obtained a special clearance from the Bank management due the related risks (see Annex D). The GEF funding will not be used to provide incentives for firm to exist.

B. Responses to Comments from Council at Work Program Inclusion

C. Response to STAP Scientific and Technical Screening

1. The STAP review screening comments received at work program inclusion have been taken into account in the preparation of the Project Appraisal Document, especially the Component Descriptions and the Incremental Cost Analysis. Specific responses are detailed below:

2. **Comment:** As regards the scientific validity of global environmental benefits, "the GEB appears to be based on China's need to help it de-commission or renovate old inefficient power plants. If this is done, energy efficiency will be achieved. To strengthen this argument further, it would be useful to include some projections of greenhouse gas production in the electricity sector with and without the project."

Response: The Incremental Cost Analysis (Annex 15 of project Appraisal Document) cites projections from the IEA of Chinese power sector CO_2 emissions. Power sector CO_2 emissions were 2,500 million t in 2005 and forecast to grow to 3,600 million t in 2010. This is the Business-as-Usual scenario. In the GEF alternative the cumulative direct and indirect emissions reductions resulting from the project could reach 575 million t over ten years, over 55 million t per year and almost a 2% impact on total 2010 power sector CO_2 emissions. These energy savings and GHG emissions reductions were estimated in accordance with recently-updated GEF guidelines for climate change projects.[14]

3. **Comment:** As regards the explicit inclusion of a scientific control, "there is no control situation identified against which to compare project impact."

Response: The control situation is the Business-as-Usual scenario, in line with GEF guidelines on incremental cost analysis.[15] The Business-as-Usual scenario is described in detail in the Incremental Cost Analysis and varies according to each component of the project. Generally speaking the Business-as-Usual scenario involves slow but unsteady progress in implementing key reforms, such as efficient fuel dispatch and enforcement of regulations regarding cogeneration facilities and a flow of investment to new power plants to the exclusion of retrofitting older power plants. The Business-as-Usual scenario in the aggregate is represented by the Reference Scenario in WEO 2007.

4. **Comment:** As regards the scientific validity of the incremental reasoning, "the argument on global environmental benefits needs to be strengthened further".

Response: The incremental reasoning behind GEF support of the project is detailed in the Incremental Cost Analysis (Annex 15 of Project Appraisal Document). Barriers are impeding the accelerated adoption of three major efficiency-improvement initiatives for existing generators – accelerated closure and operational restrictions for small inefficient coal-fired generation units and CHPs, efficiency retrofitting of mid-sized coal fired generation units, and introduction of efficient fuel saving dispatch. The incremental reasoning is that with GEF intervention these barriers can be overcome more quickly and completely, with the efficiency improvement initiatives becoming effective sooner and more completely. Further elaboration on the incremental reasoning in support of each component is provided in the Annex 15 of this Project Appraisal Document.

[14] Manual For Calculating GHG Benefits Of GEF Projects: Energy Efficiency And Renewable Energy Projects, prepared for the GEF Council, Washington, DC, February 21, 2008.

[15] *Operational Guidelines for the Application of the Incremental Cost Principle* (GEF/C.31/12, May 14, 2007),

ANNEX C: CONSULTANTS TO BE HIRED FOR THE PROJECT

Position Titles	*$/ person week*	*Estimated person weeks*	*Tasks to be performed*
For Project Management			
Local			
interpreters	$1000/week $60/1000 Chinese Characters	80 weeks 900,000 characters	To be paid on SOE – statement of Expenditures: translation of project documents, progress reports, training materials etc., and interpretation of meetings, trainings, workshops and international consulting services. Both interpretation and translation
International			Not expected
For Technical Assistance			
Local			
Firm			Preparation of MCSU (Mechanism for Closing down Small Coal-fired Units) Fund Operational Manual
Firm			(i) Assessment the adequacy and effectiveness of the MCSU; and (ii) support to replication of MCSU to other provinces
Firm (s)			(i) preparation standardized methodologies and procedures for thermal power plant energy auditing; (ii) assessment of efficiency improvement and coal saving through the investment projects at the three thermal power plant and support to replication; and (iii) methodologies for verification of unit's efficiency
Firms			Multiple contracts: (i) External monitoring of safeguard performance; (ii) preparation of external monitoring reports.
Firms			Multiple contracts for Shandong and Shanxi Provinces: (i) feasibility study SO2 trading platform to facilitate closing of small coal-fired units; (ii) design and implementation of the trading platform
Firm			Shanxi: feasibility study and system design for CHP on-line monitoring system; (ii) supervision of installation and commissioning
Firms			Multiple contracts for Shandong, Shanxi and Guangdong: procurement agent for activities in Shandong
Firm			(i) Assessment of the ESD pilot in all the five piloting provinces; (ii) knowledge dissemination and consultations through workshops and publications; and (iii) recommendations for policy and regulation adjustments for improved efficient generation dispatch
Firm			Study on tariff mechanism: in the context of (i) ESD with compensation mechanism; (ii) transition to power market and economic dispatch based on variable cost of generation
System dispatch expert	2000	40	(i) Regulations for information disclosure associated with the generation dispatch; (ii) advice on impacts of changed generation dispatches
Power economist	3000	50	(i) Financial impacts of changed generation dispatch; (ii) national policies to mitigate financial impacts on plant owners due to changed generation dispatch: (iii) compensation mechanism for ESD
Project managers	500	48 x 3	National PMO, Shandong PMO, Shanxi PEO: Management and coordination for project implementation over the project duration

Technical expert	400	48	National PMO: support the project management
Accountants	400	24 x 3	Part-time positions for accounting, financial management, organizing of auditing, disbursements, financial reporting associated with the three Designated Accounts over the project duration
Procurement specialists	400	48 x3	National PMO, Shandong PMO, Shanxi PEO: procurement and contract management
Secretary	300	48	National PMO: support to PMO administration, logistic support, document management and archiving
International			
Firm			Training
Firm			Supervise, guidance, or advice on (i) preparation standardized methodologies and procedures for thermal power plant energy auditing; (ii) assessment of efficiency improvement and coal saving through the investment projects at the three thermal power plant and support to replication; and (iii) methodologies for verification of unit's efficiency
SO2 trading expert	5000	20	Supervise, guidance, or advice on (i) feasibility of SO2 trading bulletin system; (ii) rules and regulations on trading
System Dispatch Expert	5600	25	Supervise, guidance, or advice on (i) development of information disclosure required by the ESD; (ii) development of compensation mechanism required by the ESD; (iii) design, development and operation of a simulation system for improved Guangdong Provincial Grid dispatch; (iv) assessment of ESD pilot in the five provinces; (v) policy and regulation adjustments for improved efficient generation dispatch
Power economist	7000	40	Supervise, guidance, or advice on (i) study on tariff mechanism; (ii) fiscal policies for efficiency improvement; (iii) financial impacts of changed generation dispatch and development national policies to mitigate financial impacts on plant owners due to ESD/changed generation dispatch - compensation mechanism for ESD.

ANNEX D: STATUS OF IMPLEMENTATION OF PROJECT PREPARATION ACTIVITIES AND THE USE OF FUNDS

A. EXPLAIN IF THE PPG OBJECTIVE HAS BEEN ACHIEVED THROUGH THE PPG ACTIVITIES UNDERTAKEN.

The PPG-financed activities have been successfully completed on time, except for the Executive Director consultant for the management of the National PMO, which has gone beyond the original closing date of the PPG. The project preparation and the Board Date were delayed due to additional time required to process the Project-supported certain types of expenditures that pose particular risks (see section B below).

The outputs of the PPG-financed activates have provided necessary inputs to the preparation of the proposed Project.

B. DESCRIBE IF ANY FINDINGS THAT MIGHT AFFECT THE PROJECT DESIGN OR ANY CONCERNS ON PROJECT IMPLEMENTATION.

The GOC has initiated a program to close down 50 GW of inefficient small coal-fired power generation units (mostly 50 MW or smaller) by 2010 to improve efficiency and reduce overall unit coal requirements for power generation in China. The PPG-financed social economic survey on closure of small coal-fired units suggested additional financial support to small power generation companies would be needed to achieve the targeted

closure on schedule. The proposed Project will finance partially (25%) of the pilot financial incentive Mechanism for the Closure of Small Coal-fired Units (MCSU) in China, which is intended to help power plant owners recover a portion of costs associated with closing their small coal-fired units, which may include severance payments for laid-off workers.

The proposed pilot MCSU to be partially financed by the GEF Grant proceeds under the Component 1 of the proposed project will provide an output-based payment to the affected plant owners for each MW of capacity closed in two of the three pilot provinces as an incentive to support the closure of small coal-fired units on time. The MCSU pilot targets exclusively those small power companies which need additional financial support to close their small units on time. Based on lessons learned from the MCSU, this mechanism will be replicated in other provinces and scaled up to achieve the ambitious target of the inefficient coal plant closing program.

The proposed MCSU pilot will provide output-based payments for each MW of targeted small units closed upon completion of the closure. A total of 2,910 MW are targeted for closure with the output-based payment support. About 2.4 workers per MW or 6,900 workers in total would be affected and may be laid-off. Arrangement for settlement of the affected workers is in place and has been reviewed and found acceptable by the Bank. A third-party independent monitor is to be hired to monitor and assess the settlement and other social mitigation measures for affected workers. Satisfactory settlement of affected workers is one of the conditions agreed with the Bank for disbursement of the output-based payment.

Following the OP/BP 6.00 on Bank Financing, which requires RVP approval for certain types of expenditures that pose particular risks, the RVP's clearance for the financing of the pilot MCSU was obtained in December 2008.

C. PROVIDE DETAILED FUNDING AMOUNT OF THE PPG ACTIVITIES AND THEIR IMPLEMTATION STATUS IN THE TABLE BELOW:

Project Preparation Activities Approved	*Implementation Status*	*GEF Amount ($)*				*Co-financing ($)*
		Amount Approved	*Amount Spent To-date*	*Amount Committed*	*Uncommitted Amount**	
Activities						
1. Preparation of the Component 1	Completed	90,000	200,030	210,530		0
2. Preparation of Component 2	Completed	110,000	2,000	2,000		128,571
3. Preparation of Component 3	Completed	50,000	35,400	53,800		21,429
4. Technical Assistance to PMU in Project Preparation	Completed	35,000	54,476	54,476		57,143
5. Development of a comprehensive monitoring framework	Completed	20,000	23,759	23,759		24,143
6. PPG management cost*	Completed	45,000	34,335	34,335		355,286
Total		**350,000**	**350,000**	**378,900**		**586,571**

* Uncommitted amount should be returned to the GEF Trust Fund. Please indicate expected date of refund transaction to Trustee.

** Co-financing in cash from Central and Provincial Governments and beneficiary companies for project preparation.

Document of
The World Bank

FOR OFFICIAL USE ONLY

Report No:

PROJECT APPRAISAL DOCUMENT

ON A

PROPOSED GRANT FROM THE
GLOBAL ENVIRONMENT FACILITY (GEF) TRUST FUND

IN THE AMOUNT OF US$ 19.7 MILLION

TO THE

PEOPLE'S REPUBLIC OF CHINA

FOR A

GEF CHINA THERMAL POWER EFFICIENCY PROJECT

December 31, 2008

CURRENCY EQUIVALENTS

(Exchange Rate Effective December 31, 2008)

Currency Unit	=	US$
RMB 7.0	=	US$1.0
US$	=	SDR1.0

FISCAL YEAR

January 1 – December 31

ABBREVIATIONS AND ACRONYMS

CO_2	Carbon Dioxide
CPS	Country Partnership Strategy
CRESP	China Renewable Energy Scale-up Project
ECD	Economic Construction Department
ESD	Efficient Fuel Saving Dispatch
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EMP	Environmental Management Plan
EPB	Environmental Protection Bureau
ESMAP	Energy Sector Management Assistance Programme
FIRR	Financial Internal Rate of Return
FM	Financial Management
FMM	Financial Management Manual
GDGP	Guangdong Power Grid Corporation
GDP	Gross Domestic Product
GEF	Global Environmental facility
GOC	Government of China
GHG	Greenhouse Gas
GJ	Gigajoule
GNP	Gross National Product
GW	Gigawatt
GWh	Gigawatt-hour
ha	Hectare
ICB	International Competitive Bidding
IEA	International Energy Agency
IFC	International Finance Corporation
kWh	Kilowatt-hour
M&E	Monitoring and Evaluation
MOF	Ministry Of Finance
MVA	Megavolt Ampere
MWh	Megawatt-hour
NDRC	National Development and Reform Commission
NO_X	Nitrogen Oxide
O&M	Operational and Maintenance
PCO	Project Coordination Office
PEO	Project Executive Office
PM_{10}	Particulate Matter (particles of 10 micrometers or less)
PMO	Project Management Office
RPF	Resettlement Policy Framework
SDFB	Shandong Provincial Finance Bureau
SERC	State Electricity Regulatory Commission
SXFB	Shanxi Provincial Finance Bureau
SO_2	Sulfur Dioxide
SOE	Statement of Expenditure
Tce	Tons of Coal Equivalent
TWh	Terawatt-hour
TSP	Total Suspended Particulate
UNDP	United Nation Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
VSD	Variable Speed Drive

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CHINA
GEF China Thermal Power Efficiency Project

CONTENTS

I. STRATEGIC CONTEXT AND RATIONALE

A. Country and sector issues

1. **Growing Energy Demand and GHG Emissions.** China is the world's second largest energy user. Since 1990 energy consumption has been increasing on average at 5.8% per year, growing from 987 million tons of coal equivalent (tce) in 1990 to about 2.46 billion tce in 2006[1]. China's greenhouse gas (GHG) emissions are now comparable to the United States. This is due mostly to the consumption of coal for electricity production. Carbon dioxide (CO_2) emissions in China are projected to double over the next decade and as a result China will experience the largest absolute growth in these emissions over this period. Therefore, efforts to curb CO_2 emissions resulting from the generation of electricity are of paramount importance to the Climate Change Agenda.

2. **Predominance of Coal in China's Energy Mix.** China's rising energy demand has been met largely by domestic coal. Coal consumption reached about 1.7 billion tce in 2006, accounting for 69% of the country's total energy consumption. Various projections show that coal will still constitute 60% or more of China's primary energy consumption by 2020[2].

3. Coal has also been the predominant source of electricity generation in China. Thermal power generation capacity reached 484 GW in 2006, amounting to about 78% of the 622 GW total installed capacity and generating 83% of the 2,834 TWh total electricity output in China. Of this thermal generation capacity, 422 GW was coal-fired, accounting for about half of the country's 2006 total coal consumption. The Government of China (GOC) is seeking to diversify generation resources, mainly through scaling-up renewable energy and nuclear power. However, even with this diversification policy, coal will remain the prevailing fuel source for the foreseeable future.

4. **Significant Environmental Consequences.** The rapid expansion of installed thermal power generation capacity and its primary reliance on coal has contributed significantly to adverse environmental impacts in China. Emissions of sulfur dioxide (SO_2), CO_2 and nitrogen oxides (NO_X) from burning bituminous coal cause serious atmospheric pollution and are partially responsible for ground level ozone (smog), acid rain, poor surface water quality and climate change.

5. **Low Efficiency of Coal-fired Power Generation.** China's coal-fired power plants consume considerably more coal per kWh of electricity supplied than the international average. In 2006 coal-fired generation in China consumed an average 366 gce/kWh compared to a 300 gce/kWh benchmark in Japan or Europe[3]. The main factors contributing to China's low power generation efficiency are:

> (a) ***Large share of generation by inefficient small[4] units.*** In 2006, coal-fired power generating units of 100 MW and below had a combined installed capacity of 115 GW. This was equal to more than 27% of the total coal-fired power generation capacity in China. With a typical heat-rate of between 400 and 800 gce/kWh, these small units significantly underperform in comparison to medium and large size coal-fired generation units. For

[1] China Statistic Year Book 2007
[2] Sustainable Energy in China: The Closing Window of Opportunity, World Bank, 2007
[3] With units of 6 MW and bigger
[4] Refers to units of 100 MW and smaller

example 200 MW units consume about 360 gce/kWh, while units 300 MW and larger consume between 325 and 335 gce/kWh[5]. Notwithstanding the much higher coal consumption, these inefficient small thermal units, under the existing generation dispatch practices, have similar utilization factors[6] to the larger, more efficient units.

(b) ***Generation dispatch not optimized for achieving maximum efficiency.*** Unlike most other electricity systems in the world, Chinese power generation dispatch practices do not favor more efficient or lower variable cost generation[7]. Instead, all thermal units are scheduled to operate for a similar number of hours per year, regardless of efficiency or fuel consumption cost. The underlying cause of this practice is the regulated energy-only generation prices[8] for electricity supplied to grid companies. The energy-only price for a coal-fired generation investment project is approved based on an annual operational hour assumption, usually around 5000 hours. On a year-ahead basis, each generation unit is planned with a proportional allocation of the energy required to supply the demand forecast, leading to similar annual operational hours. Throughout the year, the dispatch center schedules generation in accordance with the operational hours target assigned to each unit. This causes significantly greater average coal consumption per MWh of electricity production than if the dispatch had prioritized the more efficient coal-fired generation units.

(c) ***Small combined heat and power units operating for power generation only.*** Small units for combined heat and power (CHP) supply operate at a higher overall efficiency when providing both power and heat. For this and other reasons, small CHP units supplying heat are exempt from government-mandated closure, if these units comply with a specified ratio of heat-to-power[9] generation over the course of a year. However, operation for power generation only must be restricted accordingly. The small CHP units that do not comply with the required annual ratio of heat-to-power are liable to be closed down. Nonetheless, despite government regulations, many small CHP units in China continue to operate solely for power generation even when more coal-efficient capacity is available for substitutive generation, since the regulatory entities and system dispatchers do not have effective measures to monitor the heat supply by the CHP units. An effective monitoring system of heat supply by the small CHP units would facilitate enforcement of government regulations and lead to improvements in the overall system efficiency in power generations.

(d) ***Old mid-sized coal-fired units operating at relatively high coal consumption rate.*** Mid-sized coal-fired generation units built in the 1990s are operating at coal consumption rates higher than the rates of units with newer technologies and have significant potential for efficiency improvement during their generation life expectancy through rehabilitation and retrofit. These potential gains could be achieved through: (i) rehabilitation and retrofit of more than 100 sets of 200 to 300 MW units built in the 1990s; (ii) conversion of more than 81

[5] Conclusions of a sample survey carried out by Chinese government authorities in 2007

[6] Utilization factor = annual energy generated/(available capacity x number of hours in the year)

[7] International practice of merit order dispatch schedules available thermal generation units to minimize total generation variable costs (mainly fuel costs).

[8] The grid company pays a generator only for the energy (kWh) injected to the grid.

[9] State Council Document [2000]1268: Heat-to-Power Ratio over the year (GJ: kWh*(3600 GJ/kWh)) x 100% must be equal to or above 100% for units smaller than 50 MW and 50% for units between 50 to 200 MW

sets of 300 MW units in northern China from solely power generation into CHP operation[10]; and (iii) waste heat recovery from the cooling systems of condensing-type power generation units for district heating.

6. **Government Strategies.** Chinese authorities at the highest levels have recognized that a business-as-usual approach in the energy sector will lead to unacceptable environmental consequences and strain the coal supply chain on an unprecedented scale. The Government initiatives intended to improve efficiency and reduce coal consumption in China are contained in its 11th Five Year Plan (2006-2010), issued in early 2006 that calls for a 20% reduction of energy consumption per unit output of gross domestic product (GDP) by 2010; and in the Medium and Long Term Energy Conservation Plan issued in 2004 by the National Development and Reform Commission (NDRC), which targets a reduction of energy intensity from 2.68 tce per RMB 10,000 of GDP output in 2002 to 2.25 tce by 2010 and 1.54 tce by 2020.

7. Specific GOC strategies to improve coal-fired thermal power generation efficiency include: (i) closure of inefficient small coal-fired units and the addition of new high-efficiency large-sized thermal units[11]; (ii) introduction of efficient generation dispatch, known as the Efficient Fuel Saving Dispatch (ESD); (iii) adoption of new clean coal technologies such as integrated gasification combined cycle (IGCC); (iv) investment in energy efficient systems and the rehabilitation of existing generation units; and (v) scale-up of renewable power generation.

8. The GOC's strategy for reducing the capacity share of inefficient small coal-fired generation units seeks to close down 50 GW of these units by 2010. Plant closure goals for 2010 were negotiated in 2007 and NDRC signed agreements with 30 provincial governments and 7 major power companies for their closure goals. Early results have been favorable, with 14.38 GW of small units closed by the end of 2007, exceeding the national 2007 target of 10 GW. However, most of the units closed belonged to large power generation companies which have the financial, institutional and technical capacity to address the financial and social impact of such closures. Those units remaining to be closed in 2009 and 2010 are smaller and mostly owned by municipal and county level small power companies. These companies are less likely to be able to address the financial and social impact of closure in the allotted time without additional financial support.

9. Another element of the GOC's strategy for improving thermal power sector efficiency is the replacement of existing dispatch practices with the ESD[12]. This requires generation dispatch to follow a merit order of units, determined by their efficiency and emission levels. The ESD will commence with pilots in 5 selected provinces, with the intention later of being implemented nationally. The change in dispatch practice will significantly reduce coal consumption for power generation. However, this will also have a critical impact on the financial viability of less efficient units (due to the reduction in generation), rendering these units unable to recover fixed costs at current generation tariffs. Additionally, the ESD pilot requires new technical regulations on access, disclosure and verification of generation efficiency data that to date has not been available at dispatch centers or used for dispatch. Although the start up of the pilot was scheduled to commence

[10] A 2006 survey commissioned by NDRC and conducted by the China Electric Power Engineering Consultants Group Corporation identified 81 units of 300 MW power-only condensing turbine power plants that were within a 15 km of cities with substantial industrial and district heat demand.

[11] Most of new units added in 2008 are 600 MW and larger, with super-critical and ultra-super-critical technologies.

[12] A simulation study conducted for one provincial power grid as part of the project preparation work shows that the ESD could reduce coal consumption by about 2.2 million tce per year in that province during the period 2007-2011.

by early 2008, it has been delayed until adequate regulation and financial compensation mechanisms are implemented to address the associated technical and financial barriers.

B. Rationale for Bank involvement

10. Continued progress on improving coal-fired power generation efficiency is vital if the GOC's plan for a 20% reduction in GDP energy intensity by 2010 is to be realized. The success of the power sector efficiency strategy is closely linked to the removal of the key barriers identified above. Drawing from its international experience and knowledge of similar undertakings, the Bank is well positioned to assist in resolving the policy and technical issues associated with the GOC's sector strategy.

11. The Bank has assisted Russia and Poland in closing small mines. The experience acquired in addressing the social and financial barriers related to the mine closure could be applied in China. The Bank has also supported thermal power plant rehabilitation in many countries and has accumulated significant expertise in the planning and implementation of such projects. Project examples include: (i) the rehabilitation of the Elbistan thermal power plant in Turkey, consisting of four 320 MW units consuming local lignite; (ii) the Thermal Power Plant Rehabilitation Program in India, involving three power plants with a total of 640 MW capacity; and (iii) an Energy Sector Management Assistance Programme (ESMAP) study assessing the potential for rehabilitation or retirement of coal-fired power plants in Ukraine.

12. The proposed project continues and expands the Bank's support of the Government with its efforts to develop policies that will help achieve environmental sustainability of the energy sector. These efforts have included lending projects, analytical and advisory activities and economic and sector work (see Annex 2). More recently the Bank has been working with the Government on the development of a new investment framework which will promote clean energy and energy efficiency by combining carbon finance, Global Environment Facility (GEF) funds and the newly established Climate Investment Funds into lending operations. The GOC has requested this GEF project, and considers that it will provide a good opportunity to benefit from the Bank's experience in its efforts to improve the power sector efficiency in China.

C. Higher level objectives to which the project contributes

13. **Consistent with the Bank's new Country Partnership Strategy.** The project will directly support Pillar 3 of the Bank's new Country Partnership Strategy (CPS) for China (2006–2010) by managing resource scarcity and addressing key resource and environmental constraints to China's future growth. Demonstrating more efficient ways of using coal, creating a more competitive electric power market and addressing climate change as the means to build a resource-efficient society, are explicitly stated objectives of the CPS. These objectives are also fully aligned with a major, and long-standing, GOC objective of reducing energy intensity and the resulting negative impact of coal use.

14. **Consistent with the Bank Climate Change Strategy.** The Bank is finalizing its *Strategic Framework on Climate Change and Development for the World Bank Group (SFCCD)*. Within the SFCCD, the Bank attaches great importance to partnerships and is taking specific steps to enhance coordination and/or collaboration among the United Nation agencies, GEF, multilateral development banks, bilateral donors, the private sector, research institutions and civil society groups. The Bank's operational response to climate change focuses on six key areas: (i) integrating

climate actions in development strategy; (ii) mobilizing concessional and innovative finance; (iii) facilitating the development of innovative market mechanisms; (iv) leveraging private sector finance; (v) increasing support to technology acceleration; and (vi) stepping-up policy research, knowledge and capacity building. This project is consistent with the SFCCD, as it will integrate actions in both the reform and development of power sector policies. This includes the closure of inefficient small units, facilitating the pilot implementation and transition to efficient generation dispatch practices, supporting the development of power generation efficiency technology in China and enhancing energy efficiency policy research, best practices establishment, knowledge sharing and capacity building. This would be achieved through collaboration among government agencies, utilities, power companies, research institutions, GEF, international donors and the Bank.

15. **Consistent with the Bank's Strategy in Promoting Carbon Reduction.** The Bank, as the trustee of various Carbon Funds, is also a world leader in mitigating climate change. The Bank has achieved this by market-based GHG emission reduction purchase transactions through the Clean Development Mechanism under the Kyoto Protocol under the United Nations Framework Convention on Climate Change (UNFCCC). Since ratifying the Kyoto Protocol, China now has a strong interest in benefiting from the Bank and GEF support and from carbon finance. The Bank has already approved the Project Idea Note for one of the three sub-projects under the Component 2 of the project – *Waste Heat Recovery at Beijiao Thermal Power Plant in Shandong*. There are strong financial and technical barriers to investment in projects for the recovery of heat dispipated in plant cooling systems. The expected carbon finance from sales of carbon credits produced by emission reductions will help to off-set the cost of investment in these new improved technologies, and perhaps more importantly, will demonstrate their viability. A practical success story will help to encourage public/private enterprises to invest in heat recovery from similar plants for district heating in small and mid-sized municipalities in China.

16. **Consistent with the Strategic Objective of the GEF Interim Strategy** (*Summary of Negotiations on the Fourth Replenishment of the GEF Trust Fund, dated August 25, 2006)*. The project will support the retrofit of power plants, included under that strategy.

II. PROJECT DESCRIPTION

A. Lending Instrument, Financing Arrangements and Other Approaches

17. The total project cost is estimated US$ is estimated US$ 108.96 million. The project will be financed with a GEF Grant of US$ 19.7 million, complemented by counterpart funding from the central and provincial governments, power plants and commercial loans from local banks in a total amount of US$ 89.26 million (see Annex 4).

Table 5.1: Cost Estimation by Types of Activities

		Total	GEF	CPF	Total	GEF	CPF
			(US$m)			(RMB Ym)	
1	MCSU – capitalization	20.00	5.00	15.00	140.00	35.00	105.00
2	Goods	72.56	7.53	65.03	507.93	52.68	455.24
3	Services	9.29	5.83	3.46	65.03	40.78	24.25
4	Project management cost	1.92	0.41	1.51	13.41	2.86	10.55
	Total Base Cost	**103.77**	**18.76**	**85.01**	**726.36**	**131.32**	**595.04**
5	Contingency for exchange rate	5.19	0.94	4.25			
	Total Cost	**108.95**	**19.70**	**89.26**	**726.36**	**131.32**	**595.04**

Financing Requirement	**108.95**	**19.70**	**89.26**	**726.36**	**131.32**	**595.04**

Note: CPF – Counterpart Fund

B. Project development objective and key indicators

18. The project development objective is to reduce coal consumption and GHG emission per unit of electricity production in Shanxi Province, Shandong Province and Guangdong Province in China, through (i) mitigating the financial barriers of closing inefficient small-sized coal-fired units; (ii) demonstrating the viability of investments in efficiency improvements in existing mid-sized thermal units; and (iii) developing effective regulations to implement the pilot ESD programs and conducting studies to support the transition to efficient generation dispatch. The project will support pilot programs and demonstration sub-projects in three provinces that have significant potential for power sector efficiency improvements – Shanxi, Shandong and Guangdong.

19. Key performance indicators include: (i) average efficiency of and GHG emission from coal-fired electricity generation in Shandong, Shanxi and Guangdong provinces; (ii) Cumulative capacity of small coal-fired power generation units closed in Shandong and Shanxi; (iii) thermal efficiency of and GHG emission reduction from the units #1-4 of Yangguang Thermal Power Plant in Shanxi; (iv) thermal efficiency of and GHG emission reduction from the units #7-8 at Huangtai Thermal Power Plant in Shandong; and (v) thermal efficiency of and GHG emission reduction from the units #2-5 at Jinan Beijiao Thermal Power Plant in Shandong (see Annex 3).

C. Project components

20. The project has five components: (i) mechanisms to support the closure of inefficient small coal-fired generation units; (ii) demonstration of power plant efficiency improvements; (iii) transition to efficient generation dispatch; (iv) technical assistance for project implementation; and (v) project management (see Annex 4).

21. **Component 1: Mechanisms to Support the Closure of Inefficient Small Coal-fired Generation Units** (GEF Grant US$ 9.50 million and counterpart funds US$ 26.92 million). This component will support the closure of inefficient small thermal units and GHG emission reduction in Shandong (4,300 MW) and Shanxi (2,870 MW), by 2010. Both provinces have adequate capacity reserve and committed investment in new generation capacities, which will ensure reliable power and heat supply along with the closure. The capacity of small units to be closed exceeds, by 300 MW and 200 MW respectively, the current provincial targets agreed with the NDRC. Out of the total target, the GEF Project is expected to support the closure of 2,910 MW in 2009 and 2010 (1583 MW in Shandong and 1327 MW in Shanxi). The component will support: (i) the establishment and pilot operation of a transparent and effective financial incentive mechanism for the closure of small units (MCSU). This will assist the small county and municipal power companies in Shanxi and Shandong to recover part of the costs of closure, mainly the cost of addressing the social impact of the closure; (ii) establishing CHP On-line Monitoring Systems to facilitate enforcement of government regulations for CHP unit operation; (iii) establishment of bulletin systems to enable the trading of emission allowances entitled by small units closed on schedule. These revenues can be complementary to the MCSU to partially offset closure costs; and (iv) monitoring and evaluation (M&E) and knowledge sharing to facilitate replication of successful experiences in other provinces of China.

22. **Component 2: Demonstration of Power Plant Efficiency Improvement** (GEF Grant US$ 3.51 million and counterpart funds US$ 52.77 million). This component will demonstrate plant efficiency improvement and GHG emission reduction through three different types of investment activities: (i) conversion of mid-sized power generation only units into CHP units, at Huangtai Thermal Power Plant in Shandong; (ii) waste heat recovery at thermal power units and utilization for district heating, at Jinan Beijiao Thermal Power Plant in Shandong; and (iii) improvement of power generation efficiency resulting from plant energy audit recommendations, at Yangguang Thermal Power Plant in Shanxi. Each project has been designed to improve the efficiency of power and heat supply during the remaining life expectancy of the generation units. The thermal efficiency baseline and target values of these demonstration projects are presented in Annexes 3 and 4. To ensure successful demonstration, sustainability and replication, support will also be provided for: (i) monitoring and assessment of the effectiveness of the three demonstrative projects, knowledge sharing and publications; and (ii) establishment of standard plant energy audit procedures and processes for identification and assessment of efficiency improvement investment activities and best practices of plant operation and maintenance (O&M).

23. **Component 3: Transition to Efficient Generation Dispatch** (GEF Grant US$ 4.07 million and counterpart funds US$ 3.23 million). This component will reduce system-wide coal consumption and GHG emission for power generation by supporting the transition from current system dispatch practices to an efficient generation dispatch optimized for coal savings. Firstly, support will be provided for the pilot implementation of ESD in Guangdong Provincial Power Grid, including: (i) development or improvement of the detailed regulations required to commence the piloting. This will cover; regulations for ESD financial compensation mechanisms, methodology and procedures for monitoring thermal efficiency and emission levels of units required to prepare the ESD merit order, and procedures for information disclosure to improve the ESD transparency and monitoring; and (ii) a simulation system to test improvements in the Guangdong Provincial Power Grid. Subsequently, the component will provide continued support for the improvement of the approach and regulations for generation dispatch and replication to other provinces. This will include: (i) a comprehensive assessment of the pilot ESD in all of the five pilot provinces after their first 12 months of operation, to identify recommendations on further improvement of the dispatch approach and regulations; (ii) key studies on generation pricing and tariff reform to phase out the ESD financial compensation mechanisms and to make the development of power markets compatible with the transition to efficient generation dispatch; and (iii) knowledge sharing and consensus building to support the improvement of the dispatch approach, regulations and replication.

24. **Component 4: Technical Assistance for Project Implementation** (GEF Grant US$ 1.27 million and counterpart funds US$ 0.59 million). This component will support the hiring of international and local consultants for operational management, technical advisory, procurement and financial management (FM) at various implementing agencies (IA) to support project implementation, M&E and replication of successful experience and practices (see Annex 4).

25. **Component 5: Project Management** (GEF Grant US$ 0.41 million and counterpart funds US$ 1.51 million). This component will provide budget support for the incremental operating costs of various IAs resulting from the project implementation (see Annex 4).

D. Lessons learned reflected in the project design

26. Key lessons learned during Bank supported mine closure projects in Russia and Poland are relevant for this project and include: (i) financial resources must be available to address the social impact of closure; and (ii) financial aid must reach the target groups. These lessons have been incorporated in the design of the MCSU under Component 1, regarding the institutional arrangement for disbursement and monitoring of the MCSU. The Bank has supported several power sector reform projects in China. Key lessons learned are that the ownership and commitment of central government agencies and the major power companies, consensus building and a gradual approach are essential to the success of changes in power sector practices. Both Components 1 and 3 fully take these lessons into account. International experience and best practice for plant rehabilitation have been incorporated in the design of the investment projects for plant efficiency improvement under Component 2. An example of this is from Turkey where lignite power rehabilitation projects have been supported. The methodology of screening and determining the scope of rehabilitation through a standard energy audit has been introduced during the project preparation and the project design was based on audit recommendations. In India, similar ongoing rehabilitation projects supported by the GEF, IBRD, ESMAP and Policy and Human Resource Development Fund of Japan suggest the same experience. The Turkey and India projects prove that good O&M practice is cost effective in enhancing plant efficiency and has been incorporated into the project design.

E. Alternatives considered and reasons for rejection

27. Initially, support was considered solely for the retrofit of power plants to improve efficiency. However, based on extensive consultation and field surveys conducted during the project preparation, the project focus was enlarged to support other key GOC initiatives that have significant sector-wide impact on efficiency improvement – closure of inefficient small coal-fired units and transitioning to efficient generation dispatch – to ensure achievement of the project development objective.

28. To achieve improvements in plant efficiency, the emphasis was initially placed on assisting plant owners to rehabilitate old 300 MW units by focusing on the turbines and auxiliary systems as well as technology transfer support to local equipment manufacturers for the manufacturing of highly efficient and reliable power plant auxiliary equipment. However the planned support to local manufacturers was dropped as it was believed that technology development would be more effective if it was market-driven.

29. For closure of small units, the options considered included assistance to resolve the associated technical issues, but during project assessment it was discovered that the grid companies have adequate capacity. Project design then focused on support for enforcement of government regulations and incentive mechanisms to address related social and financial barriers, targeting the most difficult small units that are unlikely to be fully closed by 2010 without this additional support.

30. For transition to efficient generation dispatch, initial consideration was given to funding the pilot ESD systems in two of the five pilot provinces. To facilitate successful replication and to scale up the impact, the project support was changed to preparing detailed regulations required to start the ESD piloting, testing the improvement of the ESD to maximize coal savings and assisting in replication. This includes a system for detailed dispatch simulation in one province to test the improvement in parallel to the actual pilot implementation of ESD, and a comprehensive assessment of the ESD pilot in all the five provinces. Additionally the project will undertake key

studies to support the transition to efficient generation dispatch and power market development in the medium and long term.

III. IMPLEMENTATION

A. Partnership arrangements (if applicable)

31. The GEF will finance about 18.1 % of the total project cost, estimated at US$ 108.96 million. The remaining 81.9 % will be co-financed by central government agencies including the Ministry of Finance (MOF), NDRC, State Electricity Regulation Commission (SERC) and Shandong and Shanxi Provincial Governments with budget allocations and in-kind contributions, Guangdong Power Grid Corporation (GDGP)[13] in Guangdong and three power plants in Shandong and Shanxi with loans from local banks (see Annex 5). USAID supported the energy audits of the three power plants under Component 2 during the project preparation and has agreed to continue its support for the introduction of international technologies and experience in plant efficiency improvement during the project implementation. The agency will finance international consulting services and workshops.

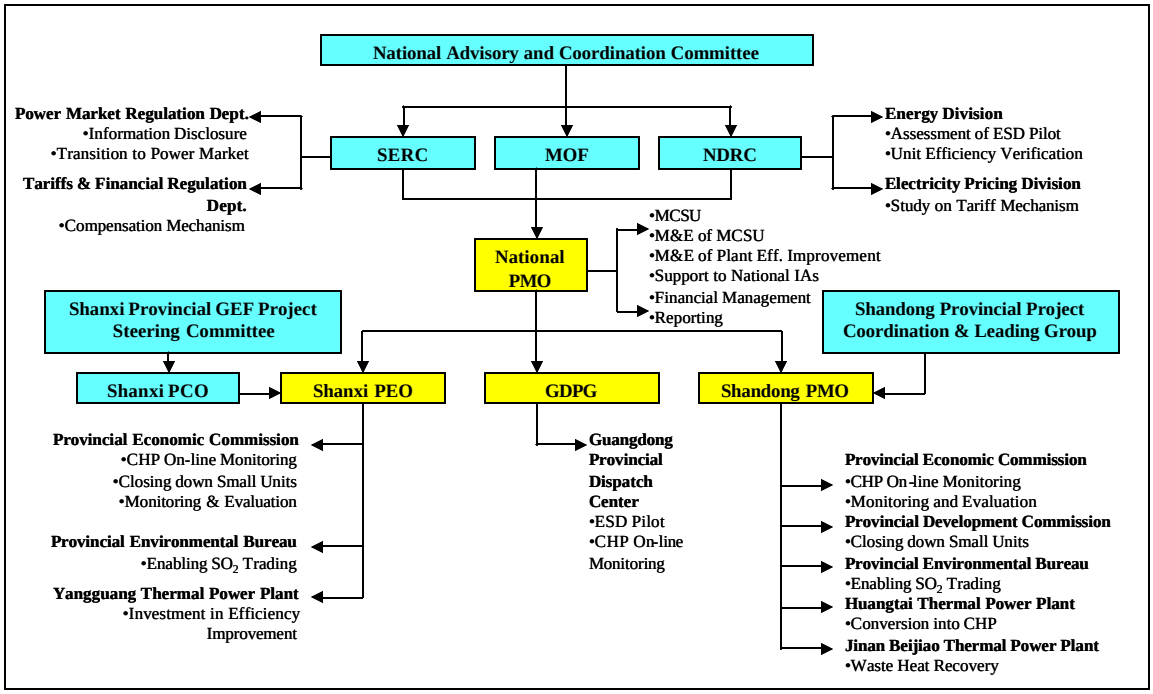
B. Institutional and implementation arrangements

32. The project implementation will be carried out over four years by the central and provincial government agencies, GDGP in Guangdong and three power plants in Shandong and Shanxi. The institutional arrangements for project implementation have followed the normal functions of the government agencies and project entities (see Figure 1). Project management/coordination units have been created at both national and provincial levels so as to allow internal and external coordination, operational and logistical support to the project implementation, M&E and reporting, without major interruption to each IA's normal operating functions (see Annex 6).

33. According to the institutional and implementation arrangements illustrated in Figure 1 below, all IAs have comparative advantages and sufficient technical capacities to manage their respective project activities. However, the capacity assessments conducted by the Bank's Task Team indicated that the newly created project management/coordination offices did not possess the capacity to provide the necessary operational support to the various IAs in procurement (see Annex 8), financial management (see Annex 7) and safeguard management (see Annex 10). See Section IV for the major conclusions of the capacity assessments and actions for capacity enhancement.

[13] A subsidiary of China Southern Grid Corporation.

Figure 1: Institutional Arrangement for Project Implementation



C. Monitoring and evaluation of outcomes/results

34. Project implementation monitoring will be carried out through normal review of procurement, Financial Management Reports (FMRs), annual audits of the project accounts, periodic progress reports, external monitoring reports, and regular supervision missions by the World Bank.

35. Comprehensive M&E will be implemented for the project in accordance with GEF M&E Guidelines. The agreed indicators, baseline values and responsibility for data collection and monitoring are described in Annex 3. Monitoring of interim outcome indicators will be carried out through periodic progress reports from the IAs, external monitoring reports from consultants and the Bank's supervision missions. Technical assistance designed under the project will ensure sufficient capacity in data collection, monitoring, reporting and outcome evaluations.

36. The M&E results will provide critical input to the central government agencies for decisions on adjustments of national policies and regulations and set up of benchmarks and good practices for replication to the rest of the country. The evaluation of results and impact of various pilot programs will be managed by the central government agencies to ensure ownership and replication. Financial resources are allocated to support the evaluation and replication under the project.

37. A mid-term review will be carried during the project implementation to assess the effectiveness of the project design and realism of the project development objectives. The review results will be used for adjustments, if needed, of project design and implementation arrangement.

D. Sustainability and replicability

38. **Sustainability.** The project activities have been designed to increase operational efficiency and thus reduce the operational cost of power generation, contributing to the sustainability of the

power sector. There are clear indications of GOC ownership and commitment to closing down small units and implementing fuel efficient generation dispatch to reduce coal consumption in electricity production. The central government has issued several new sector regulations during the project preparation, signed agreements on closure targets with the provincial governments and major power companies and issued in 2007 the ESD principles and called for a ESD pilot in 5 selected provinces. The project-supported activities are complementary to the GOC's own initiatives.

39. The investment projects for plant efficiency improvement will lower operation costs and increase financial viability, consequently enhancing the financial sustainability of the thermal power plants. The project will also support the improvement of plant O&M practices which are critical to maintain the efficiency levels after the project completion.

40. **Replicability.** The GOC is strongly committed to scale up the impact of coal saving in the power sector. The GOC has adopted a phased approach to lower the energy intensity in power generation by issuing new sector policies and regulations on the closure of small units, issuing the ESD regulations to initiate the transition to efficient dispatch and piloting the ESD in selected provinces to test their effectiveness. The project will utilize international experience and contribute to the government's own initiatives, including technical assistance for assessment of the pilot programs and their replication.

41. The potential for replication of successful project experience is substantial. Many provinces are facing similar challenges in addressing the financial and social impacts of closing inefficient small units. The central government intends to continue the closure of the remaining less efficient small thermal units during 2010 to 2015. Replication of efficient generation dispatch practices to other provinces in China is part of the central government's current strategy and the provinces are expecting to benefit from the experience and lessons of the ESD pilot. The GOC and independent evaluations have confirmed that: (i) there are about 100 sets of 200-300 MW units, constructed in the 1990s, which could have their efficiency improved by up to 10% through dedicated investment activities; and (ii) there are over 81 sets of 300 MW units in northern China that have the potential to be transformed into CHP. When financially viable, waste heat recovery would be applicable to most of the coal-fired condensing type units in northern China where use of the recovered heat is needed locally.

42. The assessment of the MCSU and ESD pilot will lead to recommendations for improvements to central government policies and regulations to support replication. Assessment of plant efficiency improvement projects will demonstrate cases that are financially viable and also provide recommendations on standardized methodology and procedures for identification of the scope, implementation and M&E of efficiency improvement investments. This is vital to achieving effective replication of efficiency improvements to other power plants. Domestic commercial bank financial intermediaries, supported under the on-going China Energy Efficiency Financing Project, are keen to develop and sustain viable commercial energy conservation lending businesses. These would substantially increase investment in industrial energy conservation. In 2008, the MOF increased its current budget of US$ 3.2 billion to US$ 4.0 billion for energy saving and emission reduction investment project incentives. It is keen to identify and promote appropriate energy efficient industrial technologies. At the request of MOF, the Bank is providing technical assistance on the use of this current budget for project identification and appraisal, determination of subsidy levels and evaluation of impacts on energy efficiency improvement and emission reduction.

E. Critical risks and possible controversial aspects

Risks	*Risk mitigation measures*	*Risk rating with mitigation*
To project development objective		
Weakening of government commitment to promote energy efficiency in thermal power sector	• Improved energy efficiency has been set as one of the highest priorities of the 11th Five-Year Plan and reaffirmed by officials at the highest level of the government • The GOC has issued regulations and signed agreements for the closure of inefficient small units and launched the ESD pilot during the project preparation	Low
Weak enforcement capacity of the provincial governments	• Technical assistance designed under the project to strengthen the related provincial governments' capacity of monitoring and enforcing related energy conservation and environmental policies, regulations & standards • Strong support by the Bank's Task Team throughout the preparation and implementation stages	Modest
To component results		
Component 1: Government funds for MCSU not in place	• Agreement for funding reached before project implementation • GEF Grant ear-marked for MCSU disbursement only when government funds made available	Modest
Payment under the MCSU not fully made to affected plants or not used for intended purposes	• Preparation and approval of an MCSU Operational Manual is a condition for disbursement of funds for output-based payment • Clear and detailed requirements on use of funds, disbursement procedures, FM, auditing, and reporting laid down in the Operational Manual • Annual auditing and periodic reporting by IAs • Close FM supervision by MOF/National PMO and the Bank's Task Team	Modest
Closure of small units impeded due to affected interests of local governments and social impacts	• Provincial governments' commitment to closure defined in the agreements with the central government • MCSU to support mitigation of social impacts • Technical assistance to facilitate generation of additional revenues under existing government policies to complement the MCSU	Modest
Compliance with government's policies regarding satisfactory settlement of workers affected by the closure of small units	• Government's policies instructing satisfactory settlement of workers affected by the closure of small units are in place at the central, provincial and municipal levels and are systematic, comprehensive and adequate • These government policies include adequate financing and institutional arrangements for implementation and monitoring • Additional financial resources, as output-based payments, will be provided to the targeted owners of small units under the MCSU as an incentive to the closure and compliance with the government policies • An independent third-party monitor will be engaged to check compliance to governments' policies • Compliance to the government staff settlement policies is a condition for the disbursement of the output-based payment	Modest
Compliance to the Environmental Management Framework (EMF) during the process of closure	• An independent third-party monitoring will be engaged to check compliance to the EMF • Compliance to the EMF is a condition for the disbursement of the output-based payments	Low
Component 2: Technical risk of not achieving expected efficiency gains	• Design of turbine rehabilitation activities by original suppliers • Technical due diligence and support by both international and local consultants in project design, implementation and supervision	Low
Inadequate safeguard management	• EMPs and RPFs prepared, agreed and budgeted by power plants • Hiring experience environmental and social specialist for implementation and monitoring • Close support and supervision by the Bank's Task Team	Low

Component 3: ESD not implemented in the pilot province due to the complementary policies and regulations to address associated financial impacts and technical requirements not in place Delays in ESD implementation due to affected interests of generation and grid companies	• Support to central government agencies and GDGP to prepare regulations and implement (i) a financial compensation mechanism supporting the pilot ESD; and (ii) detailed requirements on information disclosure required for the pilot implementation of ESD • Strong support by international consultants and the Bank's Task Team throughout the implementation stage • Technical assistance to develop adequate financial compensation mechanisms to address financial impacts due to change in dispatch practices	Low High
Component 1-3: Successful experience in pilot provinces not replicated in other provinces	• Efforts to reach consensus and legal agreements with central government agencies for the replication before project implementation • Central government agencies to be responsible and take the lead of impact assessment and replication • Support to central and provincial government agencies to build capacity for replication	Modest
Overall risk rating		**Modest**

F. Loan/credit conditions and covenants

43. The following financial and environment covenants have been incorporated into the grant agreement:

(i) Compliance with the MCSU Operational Manual (see section below);

(ii) Satisfactory implementation of the Environment Management Plans (EMP), Environment Management Framework (EMF), Resettlement Policy Frameworks (RPF) and Resettlement Plan; and

(iii) Compliance with the Financial Management Manuel.

IV. APPRAISAL SUMMARY

A. Economic and financial analyses

44. **Summary of Economic Analysis:** The main economic benefits of this project are the direct economic gain of coal saving due to energy efficiency improvement and avoided local and global environmental damage costs of pollution emissions reduction. A cost-benefit analysis was performed for power plant efficiency improvement investments in Component 2 to examine their economic viability. The economic internal rate of return (EIRR) of the rehabilitation projects at Huangtai, Jinan Beijiao and Yangguang Thermal Power Plants are 20.4%, 26.8% and 78.7%, respectively. The variation is due primarily to the difference in the energy efficiency gains by technology. The EIRRs of all the three projects are above the hurdle level acceptable to the GOC – the 10% discount rate for investment projects recommended by NDRC in 2002. Sensitivity analysis, with 10% increase in capital investment costs and 10% decrease in coal saving, further shows that the economic returns are robust (see Annex 9).

Power Plant with Investment Projects	EIRR base	Fixed cost increased by 10%	Coal saving reduced by 10%	Combined
Huangtai	20.4%	17.6%	13.7%	11.3%
Jinan Beijiao	26.8%	24.3%	24.5%	22.2%
Yangguang	78.7%	71.5%	72.8%	66.2%

Aggregate EIRR	30.5%	27.5%	26.3%	23.7%

45. Because of the lack of the details about implementation plans and incurred costs by the local parties, it is impossible to carry out the cost-benefit analysis for components 1 and 3. The potential economic gains of the MCSU and the pilot ESD, however, were estimated in order to justify the use of the GEF Grant to create the incentive mechanisms to help overcome the implementation barriers and to initiate the transition to efficient generation dispatch. The estimates show that the economic gains of coal savings of the MCSU-supported closure of small units and the pilot ESD would be significant and can well justify economically the GEF involvement. (see Annex 9).

46. **Summary of Financial Analysis:** Financial analysis indicates that all three investment projects for plant efficiency improvement in Component 2 are financially viable, with the financial internal rate of return (FIRR) ranging between 23.7% and 88.7%. Results of the sensitivity analysis also show the strong financial performance of each project. The conclusions are summarized in the table below (see details in Annex 9).

Projects	FIRR base case	Investment cost increased by 10%	Efficiency gain reduced by 10%	Combined
Huangtai	23.7%	21.5%	17.5%	15.8%
Jinan Beijiao	17.0%	15.3%	14.7%	13.1%
Yangguang	88.7%	75.7%	74.4%	63.4%

B. Technical

47. **Mechanism to Support Closure of Small Units.** A sample social economic survey was carried out during project preparation to identify the major barriers related to the closing of small units. Accordingly, the MCSU has been designed based on findings of the survey (see Annex 1). Government funds will top up the GEF Grant to provide adequate financial resources to the pilot implementation of the output-based MCSU to help the two pilot provinces, Shandong and Shanxi, achieve the targeted closure of inefficient small coal-fired units by 2010 (see Annex 7). Experience and lessons learned in China and other countries, in which the Bank-supported mine closure programs faced similar financial and social issues, were considered in the design of the MCSU pilot.

48. **Investments for Power Plant Efficiency Improvement.** The technical proposals have adopted proven measures and audit methodologies according to international standards. The IAs have adequate technical capacity for project implementation. Technical capacity within China and abroad for equipment manufacturing, design and implementation of these projects is also adequate. International experience and best practice for plant rehabilitation and O&M have been used in project design and preparation and will be employed during implementation, M&E and replication.

49. **Transition to Efficient Generation Dispatch.** International experience and best practice will be used for the development and implementation of a dispatch optimization model, to run off-line in parallel with the on-line pilot ESD model developed by GDGP in accordance with the current government regulations. It will be operated to test potential improvements to the ESD pilot. Dispatch optimization models for minimizing variable cost and fuel consumption are well proven and widely used internationally, though are still not used in China. Guangdong Provincial Power Grid Dispatch Center has extensive grid operation experience and adequate capacity to manage the

development and operation of the off-line simulation model. For the off-line optimization model and assessment of the pilot ESD, international dispatch experts will be hired to guide the modeling and suggest possible improvement using proven practices.

C. Fiduciary

50. **Procurement.** The project will follow applicable Bank procurement guidelines and procedures. The Bank's procurement capacity assessment rates the overall procurement risk as "average".

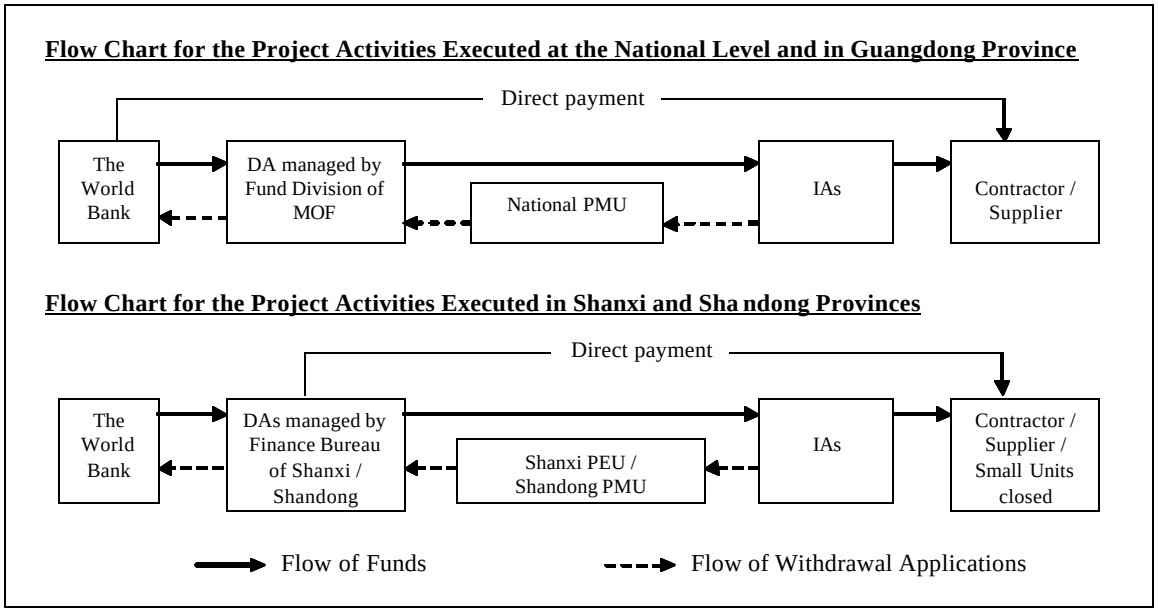
51. Procurement plans have been prepared by various IAs in compliance with the Government's and Bank's procurement guidelines and requirements and will be updated periodically during the project implementation. The IAs will be responsible for carrying out the procurement of GEF Grant-supported contracts in line with the procurement plans. The National Project Management Office (PMO) will support all the central government IAs and GDGP in procurement of GEF Grant-supported activities. Shanxi Provincial Project Execution Office (PEO) and Shandong Provincial PMO will support procurement for all GEF Grant-supported activities in their respective provinces.

52. To enhance the procurement capacity of the national PMO, the GEF Project Preparation Grant (PPG) has been used to hire a procurement specialist at the National PMO. The specialist, who has completed training on the Bank's procurement process and procedures, has also managed all PPG-supported services and goods procured during project preparation. The specialist will continue to manage procurement during project implementation. Due to their limited experience of Bank-financed procurement, each of the provincial PMO/PEO will hire a Tendering Agent (firm) which is experienced in Bank-financed procurement. The PEO and PMO will also hire a procurement specialist to manage the Tendering Agent and coordinate with the National PMO and the Bank. Procurement training for Bank-financed projects will be provided to all the IAs by the Bank's Task Team before commencement of project implementation.

53. The Bank's Task Team will provide procurement guidance and support whenever needed, carry out the required reviews and clearances with due diligence during the procurement process and will conduct close procurement supervision throughout project implementation.

54. **Funds Flow.** The GEF Grant will be provided to MOF under a grant agreement. A Designated Account (DA) will be set up within the Fund Division, International Department of MOF to manage the GEF Grant. MOF will disburse the grant proceeds either to various IAs or suppliers/contractors directly from the DA under sub-grant agreements. A separate DA will be set up in Shandong Provincial Finance Bureau (SDFB) and Shanxi Provincial Finance Bureau (SXFB) respectively to manage the GEF Grant proceeds transferred to the separate DAs, including the ear-marked contributions to the MCSU. MOF budget allocations for the MCSU will be disbursed to the Provincial Governments through normal government budget distribution channels. After the targeted small units are closed and compliance with associated social and environmental requirements verified, proceeds of the Grant ear-marked for the output-based payment to the closure of small units will be disbursed directly to various power plants in line with a MCSU Operational Manual. A detailed MCSU Operational Manual will be developed in the first year of project implementation following the table of contents agreed during project preparation (see Annex 7). The agreed funds flow and institutional arrangements for FM, disbursement, monitoring and reporting are shown in Figure 2 below.

Figure 2: Withdrawal Application and Funds Flow



55. **Financial Management.** In line with the funds flow illustrated above, the FM under the project will follow relevant Government and Bank requirements. The Bank's FM capacity assessment rates the overall FM risk as "average".

56. At the national level, the Fund Division of MOF will execute the DA's FM and, together with the National PMO, will be responsible for FM and disbursement for activities implemented by the central government agencies and GDGP. The National PMO will support the FM in bookkeeping, accounting, assisting the Central Government IAs and GDGP in preparation of statements of expenditure (SOE) and withdrawal applications, supporting the Fund Division in disbursements processing, financial monitoring, external auditing and reporting. At the provincial level, SDFB and SXFB will be responsible for the FM and disbursement of the DAs at the two provinces and, together with the Provincial PMO/PEO, will be responsible for FM and disbursement for activities implemented by the provincial government agencies, the three power plants and the output-based payments to local power companies according to the capacity of small units closed. The Shanxi Provincial PEO and Shandong Provincial PMO will work in a similar manner as the National PMO in FM for all the project activities in their respective provinces. The Financial Departments of GDGP will be responsible for FM associated with the ESD pilot in Guangdong. For financial management monitoring, the MOF, SDFB and SXFB will be responsible for auditing and FM reporting. The National PMO, Shandong Provincial PMO and Shanxi Provincial PEO will prepare and submit to the Bank FMRs periodically as agreed and audit reports within six months after the end of each fiscal year of the government. FMR standard format was prepared during project preparation.

57. The Fund Division of MOF, SDFB and SXFB have adequate experience and capacity in performing their responsibilities stated above as they have been managing a number of DAs of Bank-financed projects. The National PMO will hire an experienced part-time accountant throughout the project duration for FM. Shanxi PEO and Shandong PMO will each hire a qualified and experienced part-time accountant for the supporting FM functions which are similar to those of the accountant at the National PMO. The Financial Department of GDGP has adequate FM

capacity. Training on FM and disbursement for Bank-financed projects will be provided to all the IAs by the FM specialist and disbursement specialist of the Task Team to all the IAs prior to project implementation.

58. The Bank's Task Team will provide guidance and support to the FM whenever needed, carry out required reviews and clearances with due diligence and will conduct close FM supervision throughout the project implementation.

D. Social

59. The project is expected to achieve a positive social impact in the project areas and China in general. The project will result in coal savings and GHG emission reduction. It will have a positive social impact by increasing the coverage of heat supply, reducing air pollution, avoiding other environmental damage associated with coal use and will improve the quality of life for people in the project areas. The investment activities under Component 1 and 2 will also bring some negative social impacts, while negative social impacts from other components of the project are not envisaged. .

60. **Component 1 Closure of Small Generation.** Closure of small coal-fired units to be supported by the pilot MCSU will lead to cases of plant workers losing their jobs. To ensure settlement of affected workers is properly addressed during the closure process, the central, provincial and local governments have issued a number of policies and regulations (see detailed review of these policies and regulations in the project file). The policies and regulations focus on proper settlement of affected workers and include definition of responsibility, preparation of settlement plan for affected workers, process for consultation, institutional arrangement for implementation and supervision and measures to channel additional financial resources to the affected power plants. The policies and regulations are systematic and comprehensive. Compliance with these policies and regulations would lead to satisfactory settlement of affected workers.

61. MCSU pilot under Component 1 has been designed to test the effectiveness and adequacy of the output-based payment as additional financial incentives to the targeted plant owners to close down on schedule small coal-fired generation units in Shandong and Shanxi Provinces. This will help the plant owners recover part of the cost of closure, including the cost of settlement of affected workers. Compliance to the current government policies and regulations regarding settlement of affected workers will be specified in the MCSU Operational Manual as a condition for approval of the output-based payment per MW closed. The pilot provinces, eligibility criteria for selection of beneficiary power plants and targeted small units, proposed rate of the output-based payment per MW closed, procedures and process for verification of the closure and disbursement of the output-based payment, fund flow, financial management and auditing, institutional arrangements for implementation, supervision, monitoring and verification, financing plan, detailed social and environmental compliance requirements and arrangement for impact assessment and replication have been agreed among all the parties involved and will be specified in details in the MCSU Operation Manual is to be finalized at the beginning of the project implementation and is subject to review and approval by MOF and the Bank.

62. **Component 2.** The plant efficiency improvement projects involve civil works in the case of Huangtai and Jinan Beijiao Thermal power plants. The project activities at ***Yangguang Thermal Power Plant*** in Taiyuan City, Shanxi Province do not entail civil works outside the plant, and therefore the Bank's social safeguard policies are not applicable.

63. The project activities at ***Huangtai Thermal Power Plants*** in Jinan City, Shandong Province will include construction of a heat exchange station and installation of district heating pipes outside the plants in urban and peri-urban areas. As a result of the project, a secondary branch pipes will be planned and implemented in line with the expected future demand growth. The direct adverse social impact, as identified by the field social surveys and interviews conducted in late 2007 by a consulting firm experienced in Bank-financed projects, is mainly due to temporary disturbance with the installation of heat supply trunk pipelines along existing roads requiring no land acquisition, as well as land acquisition (1,300 m^2) for construction of the exchange station.

64. Other impacts linked to the project activities at Huangtai are associated with the construction of a 9-kilometer new road, along which trunk pipes for heat supply by Huangtai will be installed. The road construction had already commenced, and more than 50% of land acquisition and associated resettlement work had been completed prior to the Bank's involvement in the project. The field social surveys concluded that the resettlement completed for the road construction had followed applicable laws and regulations and the affected communities, households and enterprises were satisfied. It has been agreed that the residual resettlement work will follow the same compensation rates, settlement standards, procedures and management methods as the portion already implemented (see Annex 10).

65. Applying relevant domestic laws and Bank's safeguard policies and procedures, a Resettlement Plan for the trunk heat pipes and heat exchange station and a RPF for the future secondary branch heat pipes have been prepared.

66. The project activities at ***Jinan Beijiao Thermal Power Plant*** will include retrofitting the turbines and cooling system within the plant facilities and heat supply pipes outside the plant. The direct adverse social impact, as identified by the field social surveys in November 2007, is mainly due to temporary disturbance with the installation of heat supply pipelines along existing roads. The detailed routing of the pipes will be determined in late years of project implementation. No land acquisition is required for these project activities. Applying relevant domestic laws and Bank's safeguard policies and procedures, a RPF for the heat supply pipeline project has been prepared.

67. All these documents were prepared in both Chinese and English languages. The Chinese versions were disclosed via an announcement in local newspapers and the English versions at the World Bank InfoShop, at the same time in January 2008.

68. As the power plants have limited capacity, qualified social specialists will be hired by each plant to support the implementation of the RPFs and Resettlement Plan. Safeguards training will be provided to the power plant staff before and during the project implementation.

69. A third-party agent will be engaged for external monitoring of activities under both Component 1 and 2. The social specialists of the Task Team will provide timely support as needed and carry out regular supervision with due diligence throughout the project implementation.

E. Environment

70. While the project is expected to bring significant global and local environmental benefits by reducing coal consumption in the power sector in China, the project activities supported by Component 1 and 2 will also result in some negative environmental impacts. The project is

classified as a "Category B" project according to the magnitude of the environmental issues involved, the coverage area and the nature of the project activities.

71. **Component 1 Closure of Small Generation.** The closure of small coal-fired units to be supported by the pilot MCSU will bring significant environmental benefits in coal consumption and emission reductions[14]. It will also bring negative impacts, which may include noise and dust during the dismantling process and pollutions due to improper treatment of wastes. No serious adverse or irreversible environmental impacts were envisaged from the dismantling. Since specific units to be closed and supported by the pilot MCSU in the two pilot provinces, Shandong and Shanxi, cannot be identified until mid 2009, an EMF has been prepared to provide guidance on identification of potential negative impacts, preparation of mitigation measures and arrangements for implementation, supervision and internal and external monitoring. Compliance with this EMF will be specified in the MCSU Operational Manual as a condition for approval of the output-based payment under the MCSU (see Annex 4).

72. The draft final EMF, containing basic information on Component 1 project activities, in both Chinese and English versions, has been disclosed at Shandong Provincial PMO, Shanxi Provincial PEO, EA Institutes in the two provinces, as well as the World Bank InfoShop in November 2008.

73. **Component 2.** The EIA shows that the investment activities will result in significant benefits to the natural and socio-economic environment in the project areas as well as global environmental benefits, including avoided coal handling and combustion due to efficiency improvement in power generation as well as the dismantling of distributed coal-fire boilers and with consequent reductions in emissions of PM_{10}, SO_X, NO_X and CO_2. No serious adverse or irreversible environmental impacts were envisaged. All adverse environmental impacts identified are limited and can be avoided or mitigated to acceptable levels, provided the mitigation measures developed in the EMPs are properly implemented (see Annex 10).

74. Environmental assessment (EA) documents, including Environmental Impact Assessment (EIA), Environment Management Plan (EMP) and Environmental Audit Report were prepared for each power plant efficiency improvement project in Component 2, in accordance with the relevant Chinese national requirements and the Bank's safeguard policies and procedures. The EA documents have covered: (i) baseline environmental and socio-economic conditions; (ii) alternatives considered under the project design; (iii) environmental auditing and public consultation; (iv) potential impacts, mitigation measures and monitoring; and (v) information disclosure. As the power plants have limited capacity, qualified environmental specialists will be hired by each plant to support implementation of the EMPs. Safeguards training will be provided to the power plant staff before and during the project implementation.

75. Basic information on Component 2 project activities, major anticipated adverse and positive impacts and mitigation measures have been disclosed to the public through bulletins, posters, as well as local newspapers. The draft final EIA reports, EMPs and Environment Audit Reports, in both Chinese and English versions, have also been disclosed at the PMOs/PEO, power plants, EA Institutes, as well as the World Bank InfoShop in January 2008.

76. A third-party agent will be engaged for external monitoring of project activities under both components. The environmental specialists of the Task Team will provide timely support as needed

[14] Units to be closed cannot be installed in other provinces, as regulations only allow installing generation of size 300 MW or more.

for ongoing safeguard management and to carry out regular supervision with due diligence throughout the project implementation.

F. Safeguard Policies

77. The Bank's safeguard policies are not applicable for most of the project activities except for the plant efficiency improvement projects under the Component 2, for which the Bank's Safeguard Policies of Environment Assessment (OP/BP 4.01) and Involuntary Resettlement (OP/BP 4.12) are triggered.

Safeguard Policies Triggered	Yes	No
Environmental Assessment (OP/BP 4.01)	X	
Natural Habitats (OP/BP 4.04)		X
Forests (OP/BP 4.36)		X
Pest Management (OP 4.09)		X
Physical Cultural Resources (OP/BP 4.11)		X
Indigenous Peoples (OP/BP 4.10)		X
Involuntary Resettlement (OP/BP 4.12)	X	
Safety of Dams (OP/BP 4.37)		X
Projects on International Waterways (OP/BP 7.50)		X
Projects in Disputed Areas (OP/BP 7.60)		X

G. Policy Exceptions and Readiness

78. The project is in compliance with the GOC, Bank and GEF policies and procedures without exceptions.

79. In compliance with OP/BP 6.00 on Bank Financing, Bank Management approval is obtained on [date] for the MCSU output-based payment, which may partially be used by the beneficiary plant owners for severance payment to plant workers to be laid off due to the Project-supported closure of inefficient small coal-fired power generation units.

80. The project meets readiness criteria for implementation. For ***Component 1***, the pilot provinces, eligibility criteria for selection of beneficiary power plants and targeted small units, proposed rate of the output-based payment per MW closed, procedures and process for verification of the closure and disbursement of the output-based payment, fund flow, financial management and auditing, institutional arrangements for implementation, supervision, monitoring and verification, financing plan, detailed social and environmental compliance requirements and arrangement for impact assessment and replication have been agreed with various government agencies based on the findings of the social economic survey completed during the project preparation. These will be specified in details in the MCSU Operational Manual, for which a table of content has been prepared and agreed with various government agencies involved (see Annex 4). For the on-line CHP monitoring system, detailed system design has been completed, bidding documents drafted and a simulation system developed for Shandong Province during the project preparation. A detailed project proposal, including the draft terms of reference for study on SO_2 emission allowance trading has been prepared for Shandong Province. For ***Component 2***, a detailed procurement plan has been prepared by the IAs and agreed with the Bank. A tender agent has been hired by Shandong PMO and the procurement for the two power plants in the province is underway

following the Bank's Procurement Guidelines. Most of the contracts for investment activities to be co-financed by the GEF Grant will be completed in late 2008 or early 2009. Retroactive financing with the GEF Grant proceeds will be needed. For ***Component 3***, the GDGP has prepared a detailed procurement plan and agreed with the Bank. A detailed simulation and optimization model has been developed for Guangdong Power Grid, during the project preparation, to examine the potential coal savings and environmental benefits of efficient generation dispatch. Above activities are on the critical path of the project implementation schedule and are either under implementation to be compatible with the fast transition and changes in the power sector and the plans of the power plants for major overhauls, or ready for implementation. The National PMO, Shandong Provincial PMO, Shanxi Provincial PEO and project task teams of the various IAs in Shandong, Shanxi and Guangdong provinces have been established worked effectively for the project preparation. The institutional arrangement will continue to function for project implementation. Counterpart financing has been agreed.

Annex 1: Country and Sector or Program Background

CHINA: GEF China Thermal Power Efficiency Project

1. China, with a total population of more than 1.32 billion, has achieved rapid economic development. Its GDP, which reached RMB 24,669 trillion in 2007[15], has grown at an average of 9.7% over the past two decades.

A. Energy Sector Overview

2. **Energy Production and Consumption.** Reflecting the fast growth of the economy, energy consumption in China has increased from 987 million tce in 1990 to about 2.46 billion tce in 2006. China has made remarkable progress in developing its energy resources during the last two decades and is now the second largest producer of commercial energy in the world. In 2006, the total commercial energy production reached 2.21 billion tce, an increase of 7.4% over that of 2005, including coal production of 1.7 billion tce (Table 1.1).

Table 1.1: Total Production of Energy and Its Composition

Year	Total Energy Production (million tce)	As Percentage of Total Energy Production				
		Coal		Crude Oil (%)	Natural Gas (%)	Hydro, Nuclear and Wind Power (%)
		(%)	(million tce)			
1990	1,039.22	74.2	771	19.0	2.0	4.8
2002	1,438.10	72.3	1,040	16.6	3.0	8.1
2003	1,638.42	75.1	1,230	14.8	2.8	7.3
2004	1,873.41	76.0	1,424	13.4	2.9	7.7
2005	2,058.76	76.5	1,575	12.6	3.2	7.7
2006	2,210.56	76.7	1,695	11.9	3.5	7.9

Source: China Statistic Year Book 2007

3. China is also the world's second largest energy user. On average, energy consumption in the country has increased at 5.8% annually since 1990, a rate more than three times faster than the world's average annual increase and is showing no sign of abating. In 2006, China's total energy consumption was about 2.46 billion tce, an increase of 9.6% over 2005 (Table 1.2). Coal consumption reached 1.7 billion tce in 2006, accounting for about 69.4% of the total.

Table 1.2: Total Consumption of Energy and Its Composition

Year	Total Energy Consumption (million tce)	As Percentage of Total Energy Consumption				
		Coal		Crude Oil (%)	Natural Gas (%)	Hydro/Nuclear/ Wind Power (%)
		(%)	(million tce)			
1990	987.03	76.2	752	16.6	2.1	5.1
2002	1,517.97	66.3	1,006	23.4	2.6	7.7
2003	1,749.90	68.4	1,197	22.2	2.6	6.8
2004	2,032.27	68.0	1,382	22.3	2.6	7.1
2005	2,246.82	69.1	1,553	21.0	2.8	7.1
2006	2,462.7	69.4	1,709	20.4	3.0	7.2

Source: China Statistic Year Book 2007

[15] Source: National Bureau of Statistics of China.

4. Based on a number of forecasts, primary energy demand in 2020 will vary between 2.5 and 3.2 billion tce. The high or low figure depends on many factors, but primarily on whether effective energy conservation policies and measures can be implemented. In view of the energy resources available in China, coal is expected to continue the dominance of energy composition. The participation other cleaner energy resources will depend on how successfully China can exploit hydropower, renewable energy, natural gas and coal bed methane. Even with an aggressive fuel diversification policy, coal is expected to remain the dominant energy source for the foreseeable future. All projections show that coal will still account for 60% or more of China's primary energy consumption in 2020[16].

5. **Predominance of Coal in China's Energy Mix.** China's rising energy demand has been met largely by domestic coal. Coal consumption reached about 1.7 billion tce in 2006, which accounted for 69% of the country's total energy consumption. The Government is carrying out aggressive plans to diversify energy resources, mainly through scaling-up renewable energy and nuclear power. Even with this diversification policy, coal will remain the dominant fuel source for the foreseeable future.

6. **Environmental Consequences.** The increased generation of coal-based energy is both a corollary of economic growth and a major source of pollution. Rising coal consumption in China has contributed to increasingly serious environmental damage, both at the local and global level. In particular, the combustion of bituminous coal is causing serious atmospheric pollution from air-borne particulates, especially emissions of SO_2 and CO_2. SO_2, which transforms into sulfate small particles, is affecting buildings, cultural heritage and crop production, as well as human health. Currently China's SO_2 emission is the highest in the world. The former State Environmental Protection Agency stated that a total of 25.5 million tons of SO_2 was emitted in 2005, with coal combustion accounting for over 90%.

7. According to a report by the World Health Organization, seven of the world's ten most polluted cities are in China and it is estimated that air pollution in major urban areas contributes to 178,000 premature deaths and 346,000 respiratory hospital admissions per year, of which SO_2 is a major contributor. About one-third of China's territory, mainly the densely populated and industrial southern region, has been affected by acid rain. Economic losses from pollution are conservatively estimated to be between 3% and 7% of GDP.

B. Institutional Arrangements and Regulation of the Power Sector in China

8. **Power Sector Structure and Generation Ownership.** Since the mid-1980s, the GOC has started to move the power sector away from a centrally administrated electricity industry toward a market-oriented industry.

9. To promote effective generation competition, the GOC initiated the separation of generation assets from transmission in 2002. Five large generation companies (Huaneng, Datang, Huadian, Guodian and China Power) and two grid companies (State Grid, China Southern Grid Corporation) were created from the former State Power Company. Separation of generation assets from transmission has not yet been fully completed. Both grid companies still retain ownership of generation facilities, mainly pumped storage units for reserve ancillary services and peaking. The

[16] Sustainable Energy in China: The Closing Window of Opportunity, World Bank, 2007

remaining generation capacity that is not owned by the five large generation companies or the grid companies is owned by local government corporations, quasi-private and private companies.

10. For power transmission and distribution, the State Grid Company operates the grid covering 26 provinces, autonomous regions and major cities directly under the jurisdiction of the Central Government. This accounts for 88% of the country's territory. The China Southern Grid Corporation operates the grid covering five provinces in southern China. The grid companies are responsible for grid expansion planning, development and operation of the power grids, power generation dispatch, wholesale power purchase and resell ate regulated tariffs, and the development and operation of regional power markets. The grids under both companies are integrated with transmission lines of various voltage levels.

11. Under the two grid companies, each province has a Provincial Grid Company that typically owns and dispatches the transmission network and all or most of the distribution network within the boundaries of the province. There are various organizations for the distribution services. In most areas, distribution is fully integrated with the provincial grid companies. In other cases, particularly in rural areas, distribution is carried out by local county-owned power companies that operate their distribution system and dispatch and buy generation connected to its network (i.e. generation not dispatched by the Provincial Grid Company). These local power companies sometimes also build their own power plants, mainly small hydro, to meet local demand.

12. **Regulation of the Power Sector in China.** Regulation of the power sector in China is divided between the NDRC and SERC. NDRC is responsible for several regulatory functions including pricing methodologies, transmission projects and new power plant approvals. SERC is responsible for the design and oversight of generation markets. SERC also provides inputs to NDRC on pricing and market reform issues.

C. Key Energy Sector Issues in China

13. **Fast Growing Demand.** China has been extremely successful in the past two decades in increasing its energy supply to meet the need of a fast growing economy. However, China faces many great challenges in the next 20 years to be able to supply the energy needed to quadruple its GDP and build a stable and prosperous society by 2020. Despite rapid demand growth, China's per capita energy consumption is still at less than one fifth of the Organization for Economic Cooperation and Development countries' average, and accordingly has significant scope to expand along with the economy.

14. **Predominance of Coal in Power Generation.** Coal has also been the predominant source of electricity generation in China. By the end of 2006, China's installed capacity for electricity generation exceeded 622 GW and electricity generation reached 2,834 TWh. Among the generation facilities, 484 GW or 78% consisted of thermal power units, generating 83% of the total electricity output. Coal-fired generation capacity amounted 422 GW, accounting for about 50% of the total coal consumption in China.

15. **Low Efficiency of Coal-fired Power Generation.** China's coal-fired power plants consume considerably more coal per kWh of electricity supplied than the international average. In 2006 coal-fired generation in China required an average 366 gce/kWh (units = 6MW) compared to a 300 gce/kWh benchmark in Japan or Europe. The main factors contributing to China's low power generation efficiency are: (i) large share of generation by inefficient small units; (ii) generation

dispatch is not optimized for achieving maximum efficiency; (iii) small CHP units which are operating for power generation only; and (iv) old mid-sized coal-fired units operating at a relatively high coal consumption rate.

16. ***Large share of generation by inefficient small units.*** In 2006 there were 115 GW of coal-fired generation units sized 100 MW and below, accounting for more than 27% of the total coal-fired generation capacity in China. With a typical heat-rate between 400 and 800 gce/kWh, these small units significantly underperform compared to medium and large sized coal-fired generation units in China. For example 200 MW units consume about 360 gce/kWh, while 300 MW and larger units consume 325 to 355 gce/kWh[17] (see Table 1.3 below).

Table 1.3: Installed Capacity and Average Efficiency of Coal-Fired Generation in China

Year	2002			2006		
Coal-fired Generation	**Gross Heat-rate (gce/kWh)**	**CO_2 Emission Rate (kg/MWh)**	**Installed Capacity (GW)**	**Gross Heat-rate (gce/kWh)**	**CO_2 Emission Rate (kg/MWh)**	**Installed Capacity (GW)**
Total/Average	**357**	**977**	**249**	**367**	**1,004**	**422**
600 MW ? Unit Size	328	897	18	326	892	82
300 MW? Unit Size <600 MW	326 - 350	892 - 357	95	325 - 355	889 - 971	154
100 MW? Unit Size <300 MW	340 - 390	930 - 1,067	82	340 - 390	930 - 1,067	113
6 MW? Unit Size <100 MW	400 - 800	1,094 - 2,188	54	400 - 800	1,094 - 2,188	72
Unit Size <6 MW	na	na	na	na	na	na

Note: na – not available

17. ***Generation dispatch not optimized for achieving maximum efficiency.*** The overall low efficiency of coal-fired power generation in China is also attributable to its generation dispatch practice. Unlike most other electricity systems in the world, Chinese power generation dispatch practices do not favor more efficient or lower variable cost generation units[18]. Instead, all thermal generation units are scheduled to operate for a similar number of hours per year, regardless of their efficiency or fuel consumption costs. The underlying cause of this practice is the regulated energy-only generation prices for electricity that is supplied to grid companies. The energy-only price for a coal-fired generation investment project is approved based on an assumption of annual operating hours. This is usually around 5000 hours. On a year-ahead basis, each generation unit in operation receives a proportional allocation of the demand forecast, thus leading to a similar number of annual operational hours. Throughout the year, the dispatcher follows the operational hours target allocated to each unit to schedule generation and operate the system. Actual operational hours at the end of the year may vary depending on demand, but the difference between forecasted and actual demand tends to be allocated proportionally to ensure that all units end with a similar deviation to the allocated annual operational hours. The result is significantly greater average coal consumption per MWh of electricity production than if the dispatch had prioritized more efficient coal-fired generation.

18. Although, historically, each thermal unit was allocated the same number of annual operational hours independent of efficiency, in recent years there has been a trend towards increasing the

[17] Conclusions of a survey conducted by government agencies in 2007.

[18] International practice of merit order dispatch is to dispatch available generation units from higher to lower variable costs, subject to system security constraints.

operational hours that are allocated to larger coal-fired units equipped with flue-gas desulfurization systems. However, results show that the difference between operational hours of efficient and inefficient coal-fired units still remains limited, usually less than 10%.

(i) *Generation Pricing Practice.* The principles of generation tariff in China have been evolving over the past years. This has progressed from ensuring cost recovery plus a rate of return on investment to, in some cases, benchmark provincial generation tariffs differentiated by unit size and technology[19]. However, generation has always been based on an "energy-only" tariff approach, in which generators are paid for the energy injected to the grid ("on-grid generation tariff")[20]. Currently, the thermal generation tariff is set during the investment approval process, and is based on generation benchmark prices and an assumption of energy to be generated[21]. This energy-only generation tariff system has created a barrier to improving efficiency as changing dispatch practices would result in revenue reduction of the less efficient units, in some cases not sufficient to recover fixed costs. Compensation mechanisms are to be implemented with the ESD pilot to address financial impacts on generation companies, as a transitional measure until new generation pricing practice is developed and implemented.

(ii) *Grid Company Pricing.* A change in dispatch practices could also affect the power purchase costs and the regulated tariffs at which the grid companies sell power to their customers and the risks they face as wholesale purchasers. Once a provincially dispatched generator starts commercial operation, the grid company must buy the energy supplied to the grid at the approved tariff ("on-grid tariff"). End customers retail tariffs of the grid company are set annually and include a pass-through of forecasted power purchase cost. This annual power purchase cost is estimated based on a year-ahead planning, typically together with the approval of the operational hours of the units to be dispatched. Each power plant and even each unit in the same plant may have a different on-grid tariff. A generation unit with low efficiency may have a lower tariff than a more efficient unit, leading to an increase in power purchase cost of the grid company and also in retail tariffs if the energy generated by the more efficient, but also more expensive, unit is increased. Deviations between forecasted and actual power purchase costs due to efficient dispatch may affect cost recovery of the grid company, as annual retail tariffs are not adjusted when generation purchase costs change.

(iii) *Trading of Operational Hours.* The annual operational hours allocated to each generation unit represents the "right" to generate the corresponding energy during the year. In recent years, the GOC has encouraged, and some provinces have initiated, the trading of operational hours among generators as a step in the transition to a more efficient dispatch without negatively affecting generators' revenues or grid companies' purchase costs. This trading has allowed substituting operational hours of an inefficient unit with an efficient unit, while maintaining the on-grid tariff of the substituted generation. This means that because the price at which the grid company buys the

[19] This practice results in the same or similar generation tariff for the same type/technology and size of units commissioned around the same time in the same province.

[20] There are some exceptions, e.g. pumped storage owned by the provincial grid company providing peaking and reliability ancillary services for system operation.

[21] There has been an implicit link, though not explicitly set in regulations, between the practice of operational hour allocation and the energy assumption in setting the energy-only generation tariffs.

energy does not change, there is no negative impact in retail tariffs or in grid companies power purchase cost recovery. The trading is a win-win financial net result for generation, where the substituted unit benefits from a payment for the allocated operational hours without burning fossil fuel (typically, coal), and the substitution efficient unit benefits from selling more energy at a price higher than its variable production cost, paid by the substituted generation[22]. In summary, this trading has developed due to the value of fossil fuel savings, as the same energy is generated with more efficient generation, while burning less fuel. However, voluntary trading of operational hours cannot achieve the full improvement expected from establishing a centralized efficient dispatch practice as proposed in the new ESD regulations.

(iv) *Efficiency Monitoring and Information Disclosure.* There has been no clear regulation on system and generation information that has to or can be disclosed by the provincial grid company and most generation data tends to be considered confidential. This practice needs to change so as to implement the ESD because the Provincial Economic Commission will require data on the efficiency and emission levels of units to be able to prepare the merit order tables for dispatch thermal generation. In addition, system and generation data disclosure and clear procedures and methodology for the verification, monitoring and reporting of the thermal units' efficiency and emissions become essential to the pilot ESD to ensure transparency, fairness and predictability to power generation companies and investors and for the achievement of maximized coal savings and GHG emission reduction. Standard methodologies and procedures for measuring and verifying thermal unit efficiency, as well as regulations on the scope of information disclosure need to be developed.

19. ***Small CHP units operating for power generation only.*** Small CHP units operate at high overall efficiency when providing both power and heat. For this and other reasons, small CHP units supplying heat are exempt from the government-mandated closure. However these units should supply a specified ratio of heat-to-power[23] supply during the year. The small CHP units that do not supply the required ratio of heat-to-power over the year shall be closed down. Nonetheless, despite government regulations, many small CHP units in China continue to operate solely for power generation even when more coal-efficient capacity is available for substitutive generation. This occurs because the regulatory entities and system dispatcher do not have effective measures for timely monitoring of the heat supply by the CHP units. A CHP on-line monitoring system will serve as an essential tool for monitoring the heat supply and for dispatch of the CHP units under the ESD[24]. This will support the enforcement of government regulations and thereby improve efficiency.

20. ***Old mid-sized coal-fired units operating at relatively high coal consumption rate.*** The mid-sized coal-fired units built in the 1990s are operating at coal consumption rates higher than units with new technology. These older units have the potential to improve their efficiency through rehabilitation and retrofit. Associated O&M also needs to be improved to sustain the efficiency

[22] In most provinces, the trading has been between thermal units. However, in Sichuan Province the trading has targeted maximizing hydro generation by transferring thermal operational hours to hydro units with surplus energy to avoid or minimize spilling.

[23] State Council Document [2000]1268: Heat-to-Power Ratio over the year (GJ: kWh*(3600 GJ/kWh)) x 100% must equal to or above 100% for units smaller than 50 MW, 50% for units between 50 to 200 MW

[24] Under the issued policy for ESD, a CHP unit's merit order list in the dispatch depends on whether or not the unit is actually providing heat. The ESD regulations require CHP to be equipped with heat supply on-line monitoring.

levels. The EU-funded technical assistance project to Improve Efficiency and Reduce Environmental Impact for Fossil Fuel Fired Power Plants within China completed in May 2005 confirmed that additional efficiency gains and emission reductions could be achieved during generation life expectancy if advanced technologies were applied in these areas. This potential could be achieved through (i) rehabilitation of more than 100 sets of 200 to 300 MW units built in the 1990s; (ii) conversion of more than 81 sets of 300 MW units in northern China from solely power generation into CHP operation; and (iii) recovery of heat wasted in the condensing and cooling systems of condensing-type power generation units for use in district heating. This would replace distributed coal-fired boilers.

E. Government Strategy for Efficiency Improvement

21. **Participation in International Efforts to Address Climate Change.** China has actively participated in international efforts to address global challenges, including climate change and degradation of land and biodiversity. China played an important role during the negotiation of the UNFCCC. On behalf of the Government, the Prime Minister signed the UNFCCC during the United Nation Conference on Environment and Development in 1992 and China was one of the first countries to ratify the Convention in 1993. China ratified the Kyoto Protocol in 2002.

22. **Plans and Target for Coal Consumption Reduction.** Chinese authorities at the highest levels have recognized that a business-as-usual approach in the energy sector will lead to unacceptable environmental consequences and strain the resource supply chain on an unprecedented scale. The Government initiatives intended to improve efficiency and reduce coal consumption in China are contained in its 11th Five Year Plan (2006-2010), issued in early 2006, which calls for reduction of energy consumption per unit output of GDP by 20% by 2010. The Medium and Long Term Energy Conservation Plan, issued in 2004 by NDRC, requires reduction of energy intensity from 2.68 tce per 10 thousand of GDP output in 2002 to 2.25 tce by 2010 and 1.54 tce by 2020.

23. The 11th Five Year Plan incorporates major objectives of energy conservation. These include: (i) significant increase in overall energy efficiency, both in major industries and for major products; (ii) building robust energy conservation systems including supportive laws and standards, policy, technical services, inspection and management; and (iii) emphasizing a new, market-oriented growth model that is also more energy efficient and environmentally friendly. This constitutes a multi-pronged energy strategy aimed at improving the efficiency of the energy sector, bringing energy intensity in line with international good practice, developing clean coal technologies and relying more on market-based approaches to meet the objective of sustainable development.

24. **Actions to Address the Low Efficiency of Coal-fired Power Generation.** Specific strategies of the GOC to improve the efficiency of coal-fired power generation include: (i) closing down inefficient small coal-fired units; (ii) pilot and later replication of efficient fuel saving generation dispatch, known as the ESD; (iii) adoption of new clean coal technologies such as IGCC; (iv) investment in energy efficient systems and rehabilitation of existing generation units; and (v) scale-up of renewable power generation.

25. ***Closing Down Inefficient Small Units.*** The GOC's strategy for reducing the capacity share of small generation units seeks to close down 50 GW of the small inefficient coal-fired units by 2010. Provincial closure goals until 2010 have been negotiated and in 2007 NDRC signed agreements with 30 provincial governments and 7 major power companies on the closure goals. Early results have been promising, with 14.38 GW of small units closed by the end of 2007, exceeding the

national annual target of 10 GW. However, most of the units closed belonged to large power generation companies which have the financial, institutional and technical capacity to address the financial and social impact of such closures. The units remaining to be closed in 2009 and 2010 are smaller in size and mostly owned by municipal and county level small power companies, who are less likely to be able to address the financial and social impact and close these units in the time allotted without additional financial support. The major financial and social difficulties associated with closure and faced by the small power companies include[25]:

(i) *Impact on Plant Staff Employment*. The resulting unemployment of plant staff poses the most difficult barrier to the closure of small units. Small power companies do not have the required technical and financial capacity to build the large units (of at least 300 MW)[26] necessary to replace the small units and re-employ the affected staff for operation. Neither do they have other businesses or the ability to provide additional training support for re-employment of staff;

(ii) *Debt Repayment*. Some small thermal units to be closed down still have heavy debt, partially due to the regulated low generation tariffs they have been receiving since commissioning. The closure of these small units will result in lost revenue needed to repay the debt.

26. To provide financial support to the closure, regulations entitle the small units closed down by 2010 on schedule with continued tradable operational hours for a period of up to three years after the closure. Additionally, every unit of 6 MW and larger in Shandong province has a tradable SO_2 emission allowance up to 2010. Currently there is room for the SO_2 emission allowance to be traded and used either by large existing or new efficient generation units. There is also scope for trading of operational hours under the existing dispatch practice. Both Shandong and Shanxi have implemented a platform in the Provincial Grid Companies to facilitate trading of operational hours among different generation companies owning generation units under their dispatch. However, small companies with a power plant at municipal or county level are outside the provincial grid company dispatch and thus unable to trade their operational hours after closure. There has been until now no trading of SO_2 emission allowances in both provinces due to the lack of legal, institutional and technical enabling environment as well as uncertainty about the value of the SO_2 emission allowance.

27. ***Pilot Efficient Fuel Saving Dispatch.*** In 2007, the GOC called for pilot implementation of the principles for a new efficient dispatch practice – the ESD[27] – in five pilot provinces, namely Henan, Jiangsu, Guangdong, Sichuan and Guizhou. The objective of the pilot ESD is to dispatch generation to minimize fossil fuel consumption, reduce emissions and prioritize renewable energy and other clean energy resources. The GOC requires the ESD pilot to include: (i) preparation of detailed rules for system dispatch; (ii) preparation, by the Provincial Economic Commission, of merit order tables of thermal units in each province for the grid company dispatch center to follow; (iii) financial compensation to small units closed in line with government policies; (iv) preparation and implementation of a Financial Compensation Mechanism to address the financial impact to

[25] See details in the GEF PPG financed Social Economic Survey for Closing down Small Units in Shandong, Shanxi, Henan and Guangdong Provinces, November, 2007.

[26] With the purpose of facilitating closure of small units, government regulations issued give priority to the approval of new larger coal-fired generation capacity by owners of the small unit capacity closed.

[27] A simulation study conducted as part of the project preparation work shows that energy saving dispatch in one provincial power grid alone could reduce 2.2 million tce per year during the period 2007-2011.

power generation and to ensure sufficient peaking, frequency control and system reserve capacity for system reliability; (v) equipping all coal-fired units with flue-gas monitoring systems, installation of on-line real-time heat supply monitoring system at all CHP units and establishment of data communication between the dispatch center and environmental regulatory agency; and (vi) verification and confirmation of coal-fired units' efficiency levels. However, the pilot implementation of ESD has been delayed due to the following major difficulties:

(i) *The required Financial Compensation Mechanism not in place.* Under the current energy-only generation tariffs, the ESD pilot would lead to significant financial impact. Generation units that are more efficient will benefit from increased generation while less efficient units will see their revenues reduced. The Financial Compensation Mechanism to be implemented under the ESD pilot is expected to address the financial impact to generators and ensure, among other things, the availability of sufficient generation reserve for system reliability and security of supply. The ESD could also affect the intended financial support to cover costs of small units closed on schedule by the year 2010, since the practice of allocation and trading of operational hours would cease to exist.

(ii) *New technical regulations on verification, access and disclosure of key data not in place.* The regulations are essential for providing key data required for the pilot ESD, such as unit efficiency and emission level; and

(iii) *Inadequate monitoring of CHP units' real-time operation.* Under ESD, the dispatch merit order of CHP will depend on whether or not it is supplying heat. However, systems to monitor on line their heat supply are not in place.

28. ***Increasing Financial Resources for Energy Efficiency Improvement.*** The GOC has budgeted US$ 3.2 billion in 2007 to support activities to improve energy efficiency and reduce pollutant emissions. Of this, US$ 947.2 million was earmarked as grants to encourage major energy-efficient projects and was to be disbursed based on the value of energy savings. The MOF budget would be doubled in 2008 and could be channeled to promote investment in thermal power plant efficiency improvement.

29. ***Adoption of Key Environmental Standards for Power Plants.*** The 11th Five-Year Plan sets a target to reduce the country's 2005 level of SO_2 emission by 10% by the year 2010. The revised Standards on Emissions of Air Pollutants from Coal-Fired Plants (GB 13223-2003) limit the SO_2 emission of new power plants to below 400 mg per Nm^3. New financial incentives, such as tariff premium for plants with Flue Gas Desulfurization installation have also been implemented. In addition there are also fines, including an SO_2 emission fee of RMB 633 /ton as well as heavy penalties for noncompliance of emission caps. The enforcement is being strengthened with measures such as installation of on-line flue gas monitoring systems at power plants.

30. To achieve the national SO_2 emission control target, the former State Environmental Protection Agency had signed binding SO_2 emission control targets with the seven largest SO_2 emission provinces (including Shandong) and the major power generation companies. Government regulations also require that construction of new generation units must obtain SO_2 emission allowances and have encouraged power companies to trade their SO_2 emission allowances. A further step taken in pioneering provinces, including Shandong, is to cap SO_2 emission up to 2010 to each generation unit of 6 MW or larger. This has created an environment for the small coal-fired

units to be closed in order to trade their SO_2 emission allowances to large operational or new units, and thus obtain complementary financial resources to cover the costs of closure.

Annex 2: Major Related Projects Financed by the Bank and/or other Agencies

CHINA: GEF China Thermal Power Efficiency Project

Sector Issue	Project	IEG rating	Latest Supervision (ISR) Ratings (Bank/GEF-financed projects only)	
Bank/GEF-financed			**Implementation Progress (IP)**	**Development Objective (DO)**
Energy-efficiency and environmental improvements	Heat Reform and Building Energy Efficiency	NA	S	S
	Energy Conservation Project	S	S	S
	Energy Conservation Project Phase II	NA	S	S
	Efficient Industrial Boilers	S	S	S
	Second Shandong Environment Project	NA	S	S
	China Energy Efficiency Financing Project	NA	S	S
Dispatch of the provincial grid	Economic and Sector Work: China-Generation Pricing, Trading & Dispatch	NA	NA	NA
SO_2 emissions in the heat and power sector; and capacity of monitoring and enforcement of SO_2 emissions reduction program	Shandong Flue Gas Desulfurization Project	NA	S	S
Other Development Agencies				
Building and industry energy efficiency and environmental improvements	UNDP China: End-Use Energy Efficiency Project	NA	NA	NA
Lighting efficiency and energy saving	UNDP: Barrier Removal for Efficient Lighting Products and Systems	NA	NA	NA

Note: IEG Rating/IP/DO Ratings: S (Satisfactory), U (Unsatisfactory), HU (Highly Unsatisfactory), NA (Not Applicable); *IEG – the Independent Evaluation Group of the World Bank; ISR – Implementation Status Report*

1. The project has been developed and will be implemented in close coordination with the on-going energy efficiency related international assistance program in China, thereby maximizing knowledge-sharing and incorporating lessons learned into the project design. The First and Second China Energy Conservation projects focus on promoting energy efficiency through the development of energy service company industry in China. The project management office which managed these two projects will also provide implementation support for the project.

2. The project will coordinate with and take advantage of efforts under the China Energy Efficiency Financing Project recently approved by the Bank and the GOC and the United Nation Development Program (UNDP) GEF China: End-Use Energy Efficiency Project. The former has funded a technical assistance to the Establishment of the National Energy Conservation Center and the latter has a component, Capacity Building and Training for Provincial Energy Conservation Centers, under implementation. The UNDP project also will provide substantive energy audit training to selected provincial energy conservation centers. In addition, the project will coordinate with the International Finance Corporation (IFC)/GEF China Utility-Based Energy Efficiency Project and the projects focusing on energy efficiency improvement financed by other agencies, such as the French Development Agency.

Annex 3: Results Framework and Monitoring

CHINA: GEF China Thermal Power Efficiency Project

PDO/Global Environmental Objective	Project Outcome Indicators	Use of Project Outcome Information
GEF Operational Programs: promoting retrofitting of power plants, grandfathered under the GEF Interim Strategy		
• Reduce coal consumption and GHG emission per unit of coal-fired electricity production in Shandong, Shanxi and Guangdong Provinces	• Average coal consumption and GHG emission per unit of coal-fired electricity output (gce/kWh) in Shandong, Shanxi and Guangdong Provinces	**YR1-3:** Determine if policies and regulations need to be adjusted; **YR4:** Feed into government's power sector efficiency strategy
Intermediate Outcomes	**Outcome Indicators**	**Use of Intermediate Outcome Information**
Outcome 1 • Reduced share of generation capacity by less efficient coal-fired units in Shandong and Shanxi Provinces	**Outcome 1** • Cumulative capacity of small thermal unit closed down in Shandong and Shanxi provinces • Operation of CHP On-line Monitoring Systems in Shandong and Shanxi Provinces	**Outcome 1** **YR1-3:** Test effectiveness of financial incentive output- based mechanism **YR3-4:** Inform adjustments of policies and incentive output based mechanism
Outcome 2 • Improved efficiency of coal-fired power and heat supply at targeted plants	**Outcome 2** • Thermal efficiency of targeted plants/units • Annual coal savings and GHG emission reduction from targeted plants/units	**Outcome 2** **YR1-4:** Establish financially successful cases, benchmarks and best practices
Outcome 3 • Changed from existing dispatch practices to fuel efficient generation dispatch in Guangdong Provincial Power Grid	**Outcome 3** • Pilot operation of ESD • Operation of dispatch simulation system • Report on assessment of ESD pilots	**Outcome 3** **YR1-3:** Test effectiveness of approach and regulations on generation dispatch **YR4:** Inform improvements to efficient generation dispatch for replication

Note: PDO – Project Development Objective.

Arrangements for Results Monitoring

		Target Values				Data Collection and Reporting		
Outcome Indicators	**Baseline (2007)**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Frequency and Reports**	**Data Collection Instruments**	**Resp. for Data Collection**
Reduction in average coal consumption per unit of coal-fired electricity output in selected provinces	SX: 373 gce/kWh SD: 382 gce/kWh GD: 342 gce/kWh	SX: 370 SD: 378 GD: 342	SX: 364 SD: 374 GD: 337	SX: 361 SD: 371 GD: 335	SX: 357 SD: 369 GD: 332	Annually; Project Progress Report	Provincial Government Statistics	SX: PEO SD: PMO GD: GDGP
Reduction of GHG emission per unit of coal-fried electricity output in selected provinces	SX:1,020 kgCO_2/MWh SD:1,045 kgCO_2/MWh GD: 935 kgCO_2/MWh	SX: 1,012 SD: 1,034 GD: 935	SX: 996 SD: 1,023 GD: 922	SX: 987 SD: 1,015 GD: 916	SX: 977 SD: 1,009 GD: 908	Annually; Project Progress Report	Provincial Government Statistics	SX: PEO SD: PMO GD: GDGP
Results Indicators for each Component								
Component 1: (i) Cumulative capacity of small thermal units closed down (ii) CHP on-line Monitoring System operational	SX: 1007 MW SD: 1717 MW SX: no SD: no	SX:1543 SD:2717	SX:2065 SD:3517 SX: yes SD: yes	SX:2870 SD:4300 SX: yes SD: yes	SX: yes SD: yes	Semi-annually; Project Progress Report	Verification by NDRC	SX: PEO SD: PMO
Component 2: (i) Increase in thermal efficiency of targeted plants/units (ii) Annual coal savings and GHG emission reduction from targeted plants / units	Thermal efficiency YG: 35.3% HT: 40.3% BJ: 57.0% Coal savings / GHG emission reduction YG: 0.0 million tce / 0.0 million tone HT: 0.0 million tce / 0.0 million tone BJ: 0.0 million tce / 0.0 million tone		Efficiency YG: 35.8% HT: 44.4% BJ: 66.8% Savings / reduction YG: 0.04 / 0.11 HT: 0.17 / 0.47 BJ: 0.06 / 0.16	Efficiency YG: 35.8% HT: 44.4% BJ: 66.8% Savings / reduction YG: 0.04 / 0.11 HT: 0.17 / 0.47 BJ: 0.06 / 0.16	Efficiency YG: 35.8% HT: 44.4% BJ: 66.8% Savings / reduction YG: 0.04 / 0.11 HT: 0.17 / 0.47 BJ: 0.06 / 0.16	Semi-annually; Project Progress Report	Measurements at power plants	YG & SX PEO, HT & SD PMO, BJ & SD PMO

Component 3: (i) Operation of dispatch simulation system (ii) Implementation of information disclosure (iii) Pilot implementation of the Financial Compensation Mechanism (iv) Pilot operation of ESD system (v) Report on assessment of the ESD pilot in all the five pilot provinces	Pilot ESD system developed by GDGP, no simulation system operational No detailed requirements on information disclosure No financial compensation mechanism	Simulation system, information disclosure system & comp. mechanism agreed by NDRC	Operation of the simulation system, information disclosure system & financial comp. mechanism and pilot ESD system	Report on assessment of pilot programs in all the five pilot provinces, including GD, and recommendations on improvements		Semi-annually; Project Progress Report	M&E by IAs	GDGP & National PMO (NDRC)
Component 4: Performance of procurement, FM and other project management activities	Satisfactory performance for project preparation activities	Ensuring smooth project implementation				Semi-annually; Project Progress Report	M&E by IAs; external auditors	All PMOs/PEO GDGP
Component 5: Use of incremental operating budget	Satisfactory performance in use of PPG Grand	Ensuring compliance with the project Financial Management Manual				Semi-annually; Project Progress Report	M&E by IAs; external auditors	All PMOs/PEO GDGP

Note: **SX** – Shanxi Province; **SD** – Shandong Province; **GD** – Guangdong Province
YG – Shanxi Yangguang Thermal Power Plant; **HT**- Shandong Huangtai Thermal Power Plant; **BJ** – Shandong Jinan Beijiao Thermal Power Plan.

Annex 4: Detailed Project Description

CHINA: GEF China Thermal Power Efficiency Project

A. Background.

1. **Project Development Objectives.** The project development objective is to reduce coal consumption and GHG emission per unit of electricity production in Shanxi Province, Shandong Province and Guangdong Province in China. To achieve these objectives the project is designed to address the major factors that have caused the low efficiency of coal-fired power generation in China (see Annex 1).

2. **Selection of Pilot Provinces.** Shandong, Shanxi and Guangdong provinces were selected as pilot provinces because their power generation relies heavily on coal use and both Shandong and Shanxi have sufficient reserve to proceed with the closing of small units without affecting supply reliability. In both ***Shanxi*** and ***Shandong Provinces***, the installed power generation capacity is mostly coal-fired. Both provinces have a significant share of small generation units, making up 27.8% and 36.2% of their total capacity respectively. The provinces have agreed with NDRC to close down 2,671 and 4,000 MW of small units respectively by 2010 and are facing all the issues of closure as discussed in Annex 1. Additionally, Shandong is one of the leading developed economies in the country while Shanxi is one of the western provinces receiving central government subsidies for poverty reduction. This will allow the project-supported MCSU to be tested under different economic conditions. Both provinces are located in northern China and have significant potential for efficiency improvement through conversion of units from power generation only into CHP operation as well as recovery of residual heat from power plants to replace distributed coal-fired boilers for district heating. ***Guangdong Province*** is one of the five provinces selected by the central government for piloting the ESD and the provincial grid has a mix of coal, hydro, wind, nuclear, gas, oil and pumped storage capacities. More importantly, GDGP, which is responsible for dispatch of the Guangdong Provincial Power Grid, are open to new approaches in system dispatch and, during the project preparation, demonstrated clear understanding of the system dispatch issues and strong ownership and commitment to explore efficiency improvement through system dispatch.

3. ***Guangdong Provincial Power Grid.*** By the end of 2006, the generation capacity dispatched by the Guangdong Provincial Power Company was mainly coal-fired (66%) plus a mix of nuclear (10%), hydro (2%) and other thermal, such as natural gas, liquefied natural gas and fuel oil (21%). Demand is forecasted to grow 11% in 2008 and then 10% per annum until 2010. Of the total 246 TWh energy supplied by the Provincial Grid Company in 2006, nearly 26% was imported from other provinces and the Three Gorges Hydropower Project, 71% was produced by thermal units (of which almost 57% was coal-fired) and 1% was produced by hydropower plants in the province.

Table 4.1: Guangdong Provincially Dispatched Generation in 2006

2006	No. of Unit	Capacity (MW)	Output (GWh)
Coal-fired	97	26,175	139,073.7
Gas (natural gas and liquefied natural gas)	25	5,530	954.3
Fuel Oil	20	2,960	4,799.4
Nuclear	4	3,948	30,976.6
Hydro	16	875	3,296.7
Sub Total Provincial Generation	**162**	**39,488**	**179,100.7**
Imports			**66,707.0**
Total			**245,807.7**

4. ***Shanxi Province.*** By the end of 2006, the total installed capacity and power generation in Shanxi reached 27.5 GW and 152.6 TWh. Of this 26.7 GW (97.1%) and 150.3 TWh (98.4%) were derived from thermal power capacity and generation. Small thermal units reached 5.8 GW (21.6%) and generated 33.9 TWh (28.7%) in 2006. The average coal consumption rate for power generation in the province was 373 gce/kWh in 2006, higher than the national average of 366 gce/kWh. Within the provincial grid, the coal consumption rate of units sized 100 MW or smaller averaged 465 gce/kWh in 2006. The closure target of 2,671 MW represents 10% of the 2006 total installed capacity of the province.

Table 4.2: Shanxi Power Generation in 2006

		No. of Unit	Capacity (MW)	Average Heat-rate (gce/kWh)	Operation Hour (h)	Output (GWh
1.	**Provincial Grid**					
	Hydro		790.02	--	3,021	2,387
	Thermal		19,961.25	382	5,797	115,717
	In which: thermal units=100MW		5,765.25	**465**	5,878	33,886
	Sub-Total		**20,751.27**	--	--	**118,104**
1.1	**Municipal Grid Dispatching**					
	Hydro		122.02	--	1,800	220
	Thermal (all units=100 MW)		2,496.25	**513**	4,903	12,240
	Sub-Total		**2,618.27**	**--**	**--**	**12,459**
1.2	**Provincial Grid Dispatching**					
	Hydro		668.00	--	3,244	2,167
	Thermal		17,465.00	368	5,925	103,477
	In which: thermal units =100MW	50	3,269.00	438	5,764	21,647
	Sub-Total		**18,133.00**			**105,644**
2.	**Others /1**					
	Hydro		-	--	--	--
	Thermal (>100MW)		6,700	**343**	5,155	34,537
	Sub-Total		**6,700**			**34,537**
3.	**Province**					
	Hydro/Wind		790.02	--	3,021	2,387
	Thermal		26,661.25	**373**	5,636	150,254
	Total		**27,451.27**	**--**	**--**	**152,640**

Note: **/1** units located within the province but dispatched from outside the province.
Source: Shanxi Provincial Economic Commission.

5. ***Shandong Province.*** By the end of 2006, the total installed capacity and power generation in Shandong reached 51.8 GW and 235.1 TWh, of which 51.1 GW (98.7%) and 234.8 TWh (99.9%) were thermal power capacity and generation. Small thermal units reached 18.8 GW (36.2%) and generated 88.3 TWh (37.5%) in 2006. The average coal consumption rate for power generation in the province was 382 gce/kWh in 2006, higher than the national average of 366 gce/kWh. Within the provincial grid, the coal consumption rate of units sized 100 MW or smaller averaged 431 gce/kWh in 2006. The closure target of 4,000 MW agreed with NDRC represented 7.7% of the 2006 total installed capacity of the province, which will keep growing to meet the forecasted demand growth with timely and sufficient investment in new and larger scale generation units to replace the closed capacity and ensure sufficient system reserve.

Table 4.3: Shandong Power Generation in 2006

		No. of Unit	Capacity (MW)	Average heat-rate (gce/kWh)	Operation Hour (h)	Output (GWh)
1.	**Provincial Grid**					
	Hydro/wind	242	672	--	--	313.3
	Thermal	578	41,246	**367**	4,480	184,770.7
	in which: thermal units =100MW	534	8,897	411	4,299	38,243.1
	Sub-Total	**820**	**41,918**	--	--	**185,084.0**
1.1	**Municipal Grid Dispatching**					
	Hydro	116	52	--	2,960.60	153.1
	Thermal	478	5,793	**431**	4,365	25,289.0
	in which: thermal units =100MW	478	5,793	431	4,365	25,289.0
	Sub-Total	**594**	**5,845**	--	--	**25,442.1**
1.2	**Provincial Grid Dispatching**					
	Wind	126	621	--	258.03	160.2
	Thermal	100	35,452	**357**	4,498	159,481.8
	in which: thermal units =100MW	56	3,104	371	4,174	12,954.1
	Sub-Total	**226**	**36,073**	--	--	**159,641.9**
2.	**Others**					
	Thermal (all units =100MW)	**541**	**9,860**	**436**	**5,073**	**50,011.5**
3.	**Province**					
	Hydro/Wind	242	672	--	--	313.3
	Thermal	1,119	51,104	**382**	4,594	234,782.2
	Total	**1,361**	**51,777**	--	--	**235,095.5**

Source: Shandong Provincial Economic Commission.

B. Project Description

6. The project has five components: (i) mechanisms to support the closure of inefficient small coal-fired units; (ii) demonstration of power plant efficiency improvement; (iii) transition to efficient generation dispatch; (iv) technical assistance for project implementation; and (v) project management.

7. **Component 1: Mechanisms to Support the Closure of Inefficient Small Coal-fired Units.** The objective of this activity is to establish a transparent and effective output-based financial incentive mechanism, the MCSU, to support small generation companies in closing down inefficient small units and reducing GHG emission. The component will support: (i) establishment and pilot operation of the MCSU; (ii) set up of CHP On-line Monitoring Systems; (iii) development of bulletin systems to enable the trading of pollutant emission allowances; and (iv) M&E, knowledge sharing and replication of successful experiences.

8. ***Activity A. Pilot Implementation of MCSU.*** This activity will provide technical assistance and grant support for the establishment and pilot operation of the MCSU in Shandong and Shanxi provinces. The GEF Grant will contribute to the MCSU to top up the government budget for output-based payment per MW closed for the owners of the closed small units according to the amount of capacity closed down. This will be calculated on a US$ / MW basis and will target exclusively the small coal-fired units that are not provincially dispatched and that are owned by

small county / municipality companies, in line with the eligibility criteria defined in the MCSU Operational Manual.

(i) *Capitalization of the MCSU.* The sources of the MCSU include: (i) GEF Grant of US$ 5 million ear-marked for capitalization of the MCSU; and (ii) MOF and provincial government budget allocations for closing down small units, matching the GEF Grant with a ratio of at least 3:1. Based on the findings of the survey conducted in 2007[28], this amount of resources will be adequate for the MCSU to provide the minimum financial support required to address the financial and social barriers created when closing down the targeted small units in Shandong and Shanxi (see sections below and Attachment 1).

(ii) *MCSU Pilot Operation*. The project will provide technical assistance to both the central and provincial government agencies in preparation of the MCSU Operational Manuals, MCSU pilot operation and M&E. The principles for provision of output-based mechanism under the MCSU were discussed and agreed during the project preparation and outlined in the table of contents of the MCSU Operational Manual (see Attachment 1).

(iii) *Assessment of the MCSU and Replication.* This activity will provide technical assistance to the MOF in monitoring the MCSU pilot operation. It will also assess the effectiveness of the financial incentive mechanism in facilitating closing down the targeted inefficient thermal units to support improvements and replication of the incentive output based mechanism using the Government's own financial resources.

9. ***Activity B. Set-up of CHP On-line Monitoring System.*** This activity will provide technical and financial support to Shanxi and Shandong provinces on a feasibility study, planning and design and implementation of CHP heat supply on-line monitoring systems, support of verification of small CHP to be closed down, as well as dispatching and monitoring the operation of CHP units.

(i) *Shanxi - CHP On-line Monitoring System.* There were 70 sets of CHP units of 100 MW or smaller dispatched by the Shanxi Provincial Grid for power generation in 2006. The CHP On-line Monitoring System will include real-time heat supply data acquisition at the units, data transmission through the existing dispatch data exchange channels and the CDMA wireless network, computer systems for on-line monitoring at the dispatch center of the provincial grid, and integration of the on-line heat supply data with the generation dispatch system. The power plants will finance and install the heat supply data acquisition elements at each CHP unit in accordance with the latest government regulations. The project will support consulting services and computer systems required for on-line monitoring of the heat supply by these CHP units at the Provincial Grid Dispatch Center, including: (i) feasibility study and system configuration; (ii) detailed system design; and (iii) implementation, including hardware, standard system software, application software development, modification of existing data communication links to power plants and integration of the on-line monitoring with the dispatch system. The project will also support hardware and software for the Provincial Economic Commissions to access the selected CHP operation data to support enforcement of government regulations on CHP units.

[28] The GEF PPG financed Social Economic Survey for Closing down Small Units in Shandong, Shanxi and Henan Provinces, November 2007.

(ii) *Shandong - CHP On-line Monitoring System.* There were 27 CHP plants with 83 CHP units, totaling 10.79 GW, on the Shandong Provincial Grid in 2006. The project will support the Provincial Dispatch Center and the Provincial Economic Commission to bring these CHP units under on-line monitoring. This system is similar to the one described above. The detailed system planning and design for monitoring the 83 CHP units and the development of a simulation system have been completed by the Provincial Dispatch Center during the project preparation with the GEF PPG and the Government's own resources. The GEF Project will support the implementation of the on-line monitoring system implementation. Based on the experiences of the project supported on-line monitoring system, the Provincial Economic Commission will finance and implement a follow-up project to bring all the remaining CHP units (more than 500 sets) in the province under its on-line monitoring.

10. ***Activity C. Study and Support for Trading of Emission Allowances.*** This activity will support pilot programs in Shandong and Shanxi to facilitate trading of the SO_2 emission allowance entitled by the small coal-fired units closed, or to be closed down, before 2010, so as to generate additional revenues that can complement the MCSU to partially off-set the cost of closure.

(i) *Bulletin System for Trading of SO_2 Emission Allowance.* This will support, in the two provinces: (i) a study on practical government rules and procedures to facilitate the trading by small inefficient thermal units of their SO_2 emission allowance; and (ii) feasibility study, implementation and pilot operation of a bulletin system, which will facilitate the trading of SO_2 emission allowance;

(ii) *Assessment of SO_2 Emission Allowance Trading.* It includes technical assistance to the National PMO in assessment of the effectiveness and efficiency of the pilot SO_2 emission allowance trading and its impact on the closure of small units in the two provinces. The findings of the assessment will be used for improvement of the SO_2 emission allowance trading to be replicated in other provinces.

11. ***Activity D. Monitoring and Evaluation.*** This activity will provide technical assistance dedicated to the M&E of the output and impacts of activities under the Component 1 in line with the indicators and data collection arrangement specified in the GEF M&E Framework (see Annex 3). The technical assistance will focus on: (i) measurement, collection and verification of data; (ii) evaluation of the impact on coal savings and GHG emission reduction; (iii) reporting; and (iv) training for capacity building on data collection and impact assessment.

12. ***Expected Outputs.*** This pilot program will support Shandong and Shanxi not only to achieve their agreed 2010 targets of closure targets (4,000 MW and 2,670 MW) on schedule but also to exceed their targets by 300 MW and 200 MW respectively.

Table 4.4: Target and Schedule of Closing down Small Units in Shanxi and Shandong

Unit: MW

		2010 Target	2007	2008	2009	2010	Additional by 2010
1	Shanxi	2,670	1,007	536	622	505	200
2	Shandong	4,000	1,717	1000	800	483	300

13. **Component 2: Demonstration of Power Plant Efficiency Improvement.** This component will demonstrate plant efficiency improvement and GHG emission reduction through three different types of investment activities: (i) conversion of mid-sized units for power generation only into CHP units; (ii) waste heat recovery at thermal power units and utilization for district heating; and (iii) efficiency improvement at plants for power generation only following recommendations provided by plant energy auditing. To ensure successful demonstration, sustainability and replication, it will also support (iv) monitoring and assessment of the effectiveness of the three demonstrative efficiency improvement projects, knowledge sharing and publications; and (v) establishment of the standard procedures and processes of plant energy auditing for identification and assessment of efficiency improvement investment activities and best practices of plant O&M. This component will support the following demonstrative activities:

14. ***Activity A. Conversion for CHP Operation at Huangtai.*** The project will support conversion of the two 330 MW units at Huangtai Thermal Power Plant in Shandong from power generation only into CHP operation to improve their overall thermal efficiency and to replace the heat supply from the two 110 MW CHP units and distributed boilers to be used for district heating and consequently, to reduce GHG emissions.

15. The plant has an installed capacity of 2 x 110 MW (#5 & #6) and 2 x 330 MW (#7 & #8). The two 110 MW units are CHP units, operating at an average annual heat-rate of 405 gce/kWh in 2007. The 330 MW units are for power generation only and operated at an average heat-rate of 348 and 353 gce/kWh respectively in 2007. The plan for efficiency improvement at the plant is as follows:

(i) conversion of #7 & #8 units into CHP operation during 2007-2009 to allow closure of #5 - #6 units and 77 distributed small boilers for district heating;

(ii) building two sets of 300 MW CHP units, one in 2009 and one in 2010 to meet both power and heat supply; and

(iii) construction during 2008-2010.of a master heat-exchange station and network for heat supply.

16. Both the #7 & #8 units are condensing type units. Heat supply by the #7 & #8 units will be sufficient to replace the #5 - #6 and 77 distributed boilers for heat supply, with an additional 440 ton/h of heat available to meet future load growth. Based on the project design carried out by a local institute and reviewed and verified by a plant energy audit conducted by Xi'an Thermal Power Research Institute in November 2007 under the supervision of the USAID-supported international consultant, the following activities will be implemented for efficiency improvement under the project and the GEF Grant will co-finance 3.9% of the total cost estimated US$ 27.3 million:

(i) Retrofit of the two turbines and addition of a steam extraction system to each of the turbines for heat supply (0.65-0.90 MPa, 304ºC - 346ºC, 400 ton/h);

(ii) Construction of a master heat-exchange station within the plant; and

(iii) the trunk pipeline to connect to existing distribution networks outside the power plant.

17. ***Activity B: Waste Heat Recovery at Jinan Beijiao.*** The project will support the retrofit work at Jinan Beijiao Thermal Power Plant in Shandong to recover heat wasted in the condensing and

cooling process of the CHP units #2 and #5, 12 MW and 50 MW respectively, to improve thermal efficiency and replace the heat supply by distributed boilers for district heating and consequently, to reduce GHG emission.

18. The Power Plant has an installed capacity of 91 MW and four boilers at a total capacity of 630 t/h, with an annual energy output of 356 GWh and heat of 5.8 million GJ. The units in the plant include: (i) unit #1: back-pressure type (relatively high efficiency), 12 MW, commissioned in 1993; (ii) unit # 2: condensing type (relatively low efficiency), 12 MW, commissioned in 1993; (iii) unit #3: back-pressure type (relatively high efficiency), 12 MW, commissioned in 1993; and (iv) unit #5: condensing type (relatively low efficiency), 50 MW, commissioned in 2006.

19. All four units are CHP units, with steam extraction for supplying an industrial load of 36 large and medium enterprises and district heating of 4.6 million m^2, through a steam pipeline network, which is operating with 23 % losses. A new load of 1.06 million m^2 is subscribed for heat supply by the thermal plant and an additional 2.1 million m^2 is expected to be added by the year 2010. To meet the additional heat load, one option is to build another two boilers, with 240 t/h unit capacity at heat efficiency of 75%, plus one 50 MW CHP unit at the plant. Another option is to build only one boiler and refurbish the two existing condensing type units, #2 and #5, to collect the heat lost in their cooling system to replace one boiler for heat supply with hot water circulation. In addition, a master heat-exchange station will be built within the plant facility to back up the heat supply by the hot water circulation system of #2 and #5 units for a load area within a 3 km radius. The heat-exchange station will use the steam extracted from the plant to heat up circulation water to back up the #2 and #5 units for heat supply in case the units are out of operation during heat supply seasons.

20. Based on the project design carried out by a local institute and reviewed and verified through a plant energy audit conducted by Xi'an Thermal Power Research Institute in November 2007 under the supervision of the USAID-supported international consultant, the following activities would be carried out for efficiency improvement under the project and the GEF Grant will co-finance 4.8% of the total cost estimated US$ 22.7 million:

(i) Retrofit of the #2 and #5 turbines and generators, to recover the heat lost in their condensing and cooling systems for heat supply by hot water (60/45 ºC);

(ii) Rehabilitation of the steam pipelines outside for heat supply by hot water circulation;

(iii) Construction of a master heat-exchange station (60/45 ºC) within the plant facility with a capacity for district heating to an area of 2.0 million m^2 within a 3 km radius:
- capacity for heat supply: 2.0 million m^2, at 0.06 kW/m^2 (120 MW total load);
- hot water (60/45 ºC): 1600 t/h from unit #2 and 9,000 t/h from unit #5; and
- steam for water heating: 0.98 MPa, 300ºC, 31.5 t/h.

21. The overall thermal efficiency of the thermal power plant is above 30% at the present and more than 60% of heat energy was lost mainly at the condensers and cooling systems. Upon completion of the retrofit project, most of the heat energy currently wasted will be recovered to provide heating for an area of 2.16 million m^2. The pipeline losses will also be reduced from the existing 23% with steam to 5% with hot water circulation.

22. ***Activity C. Efficiency Improvement Retrofit at Yangguang.*** This activity will support the demonstrative retrofit at Yangguang following the recommendations of a standard energy audit to improve the overall thermal efficiency of its units #1 - 4 in electricity generation and supply and reduce GHG emissions from the thermal power plant.

23. The plant has an installed capacity of 4 x 300 MW. All the four units are CHP units, generating power while supplying heat to an area of 1.5 million m^2. Based on recommendations of the energy audit conducted by a local institute and reviewed and verified by Xi'an Thermal Power Research Institute in November 2007 under the supervision of the USAID-supported international consultant, the following activities will be carried out to improve the efficiency under the project and the GEF Grant will co-finance 17% of the total cost estimated US$ 5.9 million:

(i) Energy audit for preparation of the project (completed during the project preparation);

(ii) Retrofit of #1-4 turbine blade and shaft seal;

(iii) Installation of 4 sets of variable speed drives (VSD) for the primary fan of #1 and #2 boilers which requires the VSD to have reliability of 12,000 hours of operation without failure (locally manufactured VSD is unable to meet this requirement); and

(iv) Installation and calibration of monitoring elements to enhance plant efficiency monitoring to facilitate coal saving and GHG emission reduction impact assessment.

24. ***Expected Outputs.*** By the project completion, the expected improvement of thermal efficiency of the units involved are summarized below (see Annex 15 for annual coal savings and GHG emission reductions):

Table 4.5: Thermal Efficiency Improvement at Power Plants in Shanxi and Shandong

	Business-as-Usual Case			GEF Alternative		
Physical Description	**Capacity (MW)**	**Thermal Efficiency***	**Heat-rate** (gce/kWh)**	**Capacity (MW)**	**Thermal Efficiency**	**Heat-rate (gce/kWh)**
A) Conversion for CHP Operation at Huangtai Thermal Power Plant						
Unit # 5	110	47.59%	405	Closed Down	--	--
Unit # 6	110	51.75%	405	Closed Down	--	--
Unit # 7	300	34.85%	356.2	330	41.54%	356.2
Unit # 8	300	34.04%	364.7	330	52.10%	364.7
Distributed Boilers	77 sets	75.00%	--	Closed Down	--	--
B) Waste Heat Recovery at Jinan Beijiao Thermal Power Plant						
Unit # 2	12	51.15%	456	12	66.81%	961
Unit #5	50	45.67%	381	50	65.71%	589
Package Boilers	2x240t/h	75%	--	1X240t/h	75.00%	--
C) Investment for Efficiency Improvement at Yangguang Thermal Power Plant						
Units # 1-4	1200	35.27%	352	1200	35.77%	347

Note: * thermal efficiency: (power output + heat output)/heating value of coal consumed

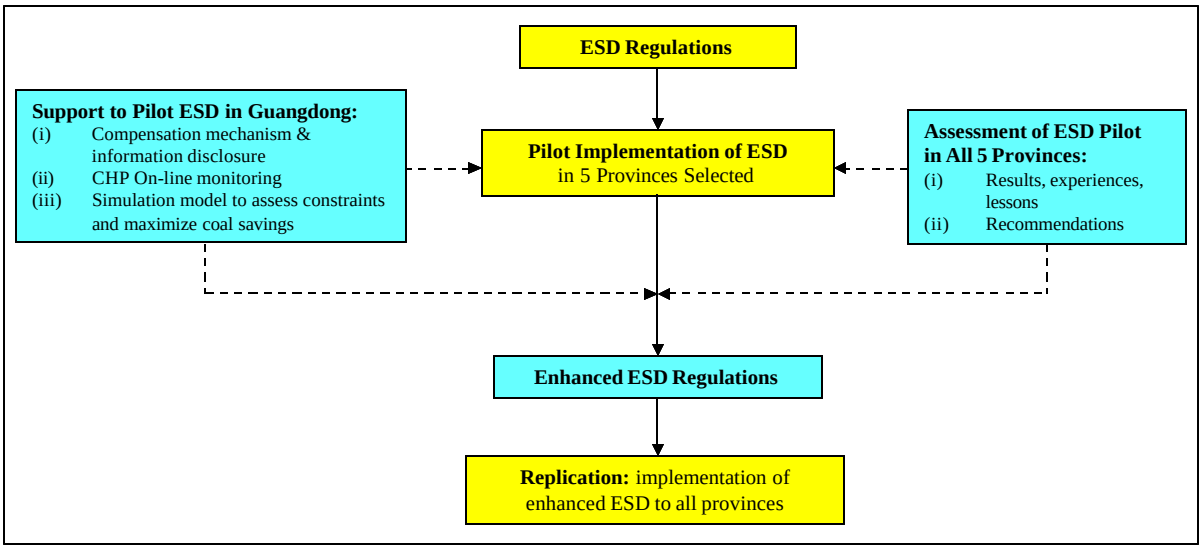
** Heat Rate: total coal consumed/power output (coal consumption not allocated to heat production, which is "free")

Unit Conversions: 1 kWh =0.0036 GJ; 1 tce=29 million GJ

25. **Component 3: Transition to Efficient Generation Dispatch.** This component will reduce provincial grid fuel consumption for power generation by supporting the transition from the existing

system dispatch practices to an efficient generation dispatch that maximizes coal savings and GHG emission reduction. Firstly, the component will support the pilot implementation of ESD in Guangdong Province. This will include: (i) development or improvement of the detailed regulations required to start the ESD pilot. This covers ESD financial compensation mechanisms to mitigate financial impacts, procedures and methodology to monitor and verify thermal efficiency and emission levels of units for preparation of the merit order of dispatch and procedures for information disclosure to improve transparency and monitoring; and (ii) a simulation system to test improvements during the pilot ESD in Guangdong Provincial Power Grid. Subsequently, the component will support improving the efficiency of approach and regulations for generation dispatch and replication to other provinces. The continued support will include: (i) a comprehensive assessment of the ESD pilot after the first 12 months in all the five provinces, including identification of recommendations on improvement of the dispatch approach and regulations; (ii) key studies on generation pricing and tariff reform under efficient system dispatch, to phase out the ESD financial compensation mechanisms and make the development of power markets consistent with efficient generation dispatch; and (iii) knowledge sharing and consensus building to support the improvement of the dispatch approach and regulations and replication. (Figure 4.1 illustrates the stages necessary for an improved generation dispatch in China.)

Figure 4.1: Process for Implementation of ESD in China



26. ***Activity A: ESD Pilot in Guangdong Provincial Power Grid.*** The project will support the following activities for the ESD pilot in Guangdong:

(i) *Regulations to Start ESD Pilot.* This technical assistance will support NDRC and SERC to develop or finalize the pending regulations critical for the ESD pilot implementation and GDGP to implement these regulations together with the ESD pilot in Guangdong Provincial Power Grid, including (i) the compensation mechanism to mitigate the financial impacts of ESD, including compensation to small units closed in accordance with the State Council Document #[2007]2; (ii) the regulations on information disclosure principles and procedures; and (iii) transparent procedures and standard methodology to monitor and verify the efficiency of thermal units' and the emission levels required to prepare the merit order for the dispatch of the coal-fired units in Guangdong.

(ii) *CHP On-line Monitoring System*. There are four CHP plants dispatched by Guangdong Provincial Power Grid Dispatch Center. This activity will support implementation of a CHP heat supply on-line monitoring system to support the verification, dispatch and monitoring of the CHP units operation in accordance with the ESD regulations. The real-time heat-supply data acquisition elements at the individual CHP unit will be financed and established by the power plants in accordance with the latest government regulations. The project will support the implementation at the provincial dispatch side, including system hardware, standard system software, application software development, modification of existing data communication links to power plants and integration of the on-line monitoring with the system dispatch at the Provincial Grid Dispatch Center.

(iii) *Generation Dispatch Simulation System.* A generation dispatch simulation system will be developed and run off-line for 12 months during the ESD pilot to simulate and test improvements to the dispatch of generation in Guangdong Provincial Power Grid. The simulation will optimize the generation dispatch to achieve maximum coal savings and GHG emission reduction within system security constraints. The results will be documented and compared with the actual results of the ESD Pilot to identify areas of the ESD regulations for improvement. The project will finance the required hardware and software of the simulations system and consulting services for assessment and reporting.

(iv) *Information Disclosure.* A system will be developed for information disclosure in Guangdong in line with the information disclosure principles and procedures endorsed by the central government agencies.

27. ***Activity B: Assessment of ESD Pilot and Replication.*** This activity will support a joint team of international and local consultants to assess the effectiveness of the ESD pilot in coal savings and GHG emission reduction in all the five pilot provinces selected by the Government. The simulation system in Guangdong and the assessment of the other four ESD pilot programs will provide practical results and lessons learned to identify improvements to the dispatch approach and regulations, and to support the transition to efficient dispatch in other provinces in China to maximize the fossil fuel savings. Required capacity building for the replication will be provided under this activity.

28. ***Expected Outputs.*** During project preparation, technical assistance was provided, with the GEF PPG, to simulate the ESD in Guangdong Provincial Power Grid and assess the impacts. Using data provided by Guangdong Grid Company, including demand forecasts and new generation investment, the simulation showed that inefficient oil fired thermal generation would be replaced by efficient coal generation and the efficiency of coal-fired generation would increase. Also with the ESD pilot implementation, the average heat-rate for power generation in the grid would be improved from 342 gce/kWh in 2007 to 332 gce/kWh in 2010[29].

[29] A simulation study conducted for one provincial power grid as part of the project preparation work shows that the ESD could reduce 2.2 million tce per year within that provincial grid during the period 2007-2011.

Table 4.6: Simulation Results of Efficiency Gain from ESD Pilot in Guangdong Provincial Power Grid

	Guangdong Generation Dispatch	Unit	2007	2008	2009	2010
1	Total output	GWh	195,342	210,129	241,495	273,536
2	Output by coal-fired	GWh	141,491	183,189	208,745	241,300
3	Average heat-rate without ESD	gce/kWh	342	340	338	335
4	Average GHG emission rate without ESD	$kgCO_2$/MWh	935	930	925	916
5	Average heat-rate with ESD	gce/kWh	--	337	335	332
6	Average GHG emission rate with ESD	$kgCO_2$/MWh		922	916	908
7	**Coal Savings**	**1,000 tce**		**550**	**626**	**724**
8	**GHG Emission Reduction**	**1,000 ton**		**1,503**	**1,713**	**1,980**

29. **Component 4: Technical Assistance for Project Implementation**. This component will support the hiring of international and local consultants to support various IAs for the project implementation, M&E as well as the replication of successful experience and practices.

30. ***Activity A: Technical Assistance to National PMO*.** This activity will assist the National PMO to perform its functions and responsibilities as described in Annex 6, to ensure smooth project implementation.

(i) *Project Management*. An Executive Director will be hired by the National PMO for the duration of the GEF Project implementation. The Executive Director will be responsible for the management and coordination of the project team in the PMO to ensure smooth implementation for the project. Funded by the GEF PPG, an Executive Director was hired by the PMO during the project preparation period. This arrangement contributed to the successful completion of the project preparation activities.

(ii) *Procurement.* An individual procurement consultant will be hired by the National PMO, throughout the duration of the project implementation. The consultant will be responsible for managing procurement for various activities directly managed by the National PMO, overseeing, coordinating and supporting the procurement managed by other IAs at both the national and provincial levels and supporting the contract management after the procurement.

(iii) *Technical Advisor.* Technical expert(s) will be hired when needed by the National PMO to support the National PMO with the required technical expertise to perform its functions and responsibilities.

(iv) *FM.* A part-time accountant will be hired throughout the duration of the project implementation for FM of the project. The consultant will be responsible for accounting, supporting the Fund Division of MOF in the GEF DA management, processing disbursement, supervising and guiding the FM at the provincial level, organizing auditing and preparing FMRs consolidated for the entire GEF Project.

(v) *Office Secretary.* An office secretary will be hired throughout the duration of the project implementation to provide administrative and logistic support to the operation of the National PMO.

(vi) *Training.* Training programs covering procurement, FM, disbursement and project management in accordance with World Bank policies and procedures will be organized for capacity building of the project team at the National PMO.

31. ***Activity B: Technical Assistance to Shanxi Provincial PEO.*** This activity will assist the Shanxi Provincial PEO to perform its functions and responsibilities as described in Annex 6, to ensure smooth implementation of project activities in Shanxi Province.

(i) *Project Management.* A government official was appointed as the PEO Director responsible for managing and coordinating the implementation of various project activities in Shanxi Province. A project management consultant will be hired for the duration of the GEF Project implementation to support the PEO Director in management and coordination of the project implementation.

(ii) *Procurement.* An individual procurement consultant will be hired by the Provincial PEO throughout the duration of the GEF Project implementation. The procurement consultant will be responsible for managing the procurement directly managed by the Provincial PEO, and overseeing, coordinating and supporting the procurement managed by other IAs in the province and supporting the contract execution after the procurement.

(iii) *FM.* A part-time accountant will be hired for FM associated with the project activities in Shanxi. The accountant will be responsible for accounting, processing of applications for disbursement and supervision of the FM at other IAs in the provinces, organizing auditing and preparing FMRs for all the project activities in the province.

(iv) *Training.* Training programs covering procurement, FM, disbursement in accordance with World Bank policies and procedures will be organized for various IAs in Shanxi in combination with similar training at the national level.

32. ***Activity C: Technical Assistance to Shandong Provincial PMO.*** This activity will assist the Shandong Provincial PMO to perform its functions and responsibilities as described in Annex 6, to ensure smooth implementation of project activities in Shandong province.

(i) *Project Management.* A government official was appointed as the PMO Director responsible for managing and coordinating the implementation of various project activities in Shandong Province. A project management consultant will be hired for the duration of the GEF Project implementation to support the PMO Director in management and coordination of the project implementation.

(ii) *Procurement.* An individual procurement consultant will be hired by the provincial PMO throughout the duration of the GEF Project implementation. The consultant will be responsible for managing the procurement directly managed by the Provincial PMO, overseeing, coordinating and supporting the procurement managed by other IAs in the province and supporting the contract management after the procurement.

(iii) *FM.* An accountant will be hired by the provincial PMO for FM associated with the project activities in Shandong. The accountant will be responsible for accounting,

processing disbursement applications, supervising and guiding the FM at other IAs in the province, organizing auditing and preparing FMRs for all the project activities

(iv) *Training.* Training programs covering procurement, FM, disbursement in accordance with World Bank policies and procedures will be organized for various IAs in Shandong in combination with similar training at the national level.

33. ***Activity D: Technical Assistance to GDGP Project Team.*** This activity will assist GDGP to ensure smooth implementation of the ESD pilot in Guangdong Provincial Power Grid and associated studies and assessment.

(i) *Project Management.* A project management consultant will be hired for the duration of the ESD pilot implementation to support the Guangdong Provincial Power Grid Dispatch Center in management and coordination of the project implementation.

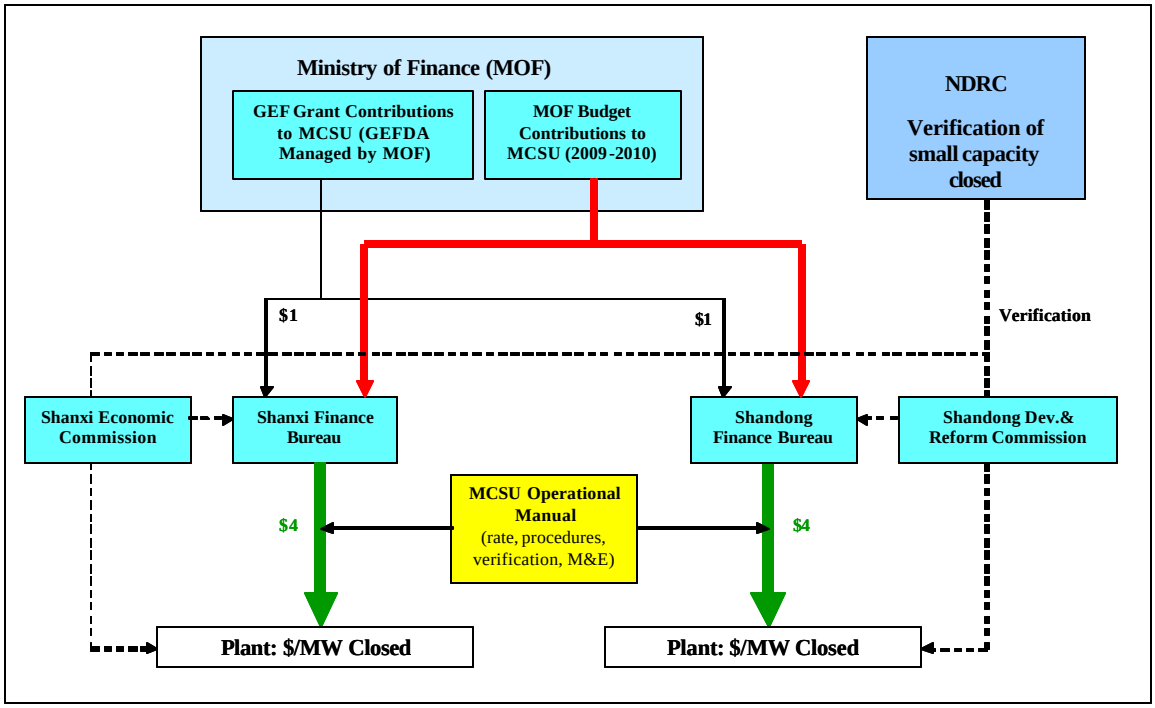
(ii) *Training.* Training programs will be organized for capacity building of GDGP for efficient generation dispatch, focusing on study and introduction of international experience and best practices. Training programs covering procurement, FM and disbursement in line with the Bank policies and procedures will be organized for the project team of GDGP in combination with similar training at the national level.

34. **Component 5: Project Management**. This component will provide budget support for incremental operating costs of various IAs for the project implementation.

Attachment 1 Pilot Operation of MCSU

1. ***Flow of Funds under the MCSU.*** See Figure 7.1 for the flow of funds under the pilot MCSU operation.

Figure 7.1: Flow of MCSU Financial Support



2. ***MCSU Operational Manual.*** The contents for the MCSU Operational Manual were prepared based on the principles for the MCSU as discussed and agreed during the project preparation. The MCSU will become operational upon completion of the Operational Manual and approval by MOF and the Bank. The contents of the Operational Manual shall cover the following:

A) <u>Institutional arrangement</u>

(i) Shanxi PEO and Shandong PMO will be responsible for preparation of the lists of small units to be supported by the MCSU in 2009 and 2010
(ii) National PMO will confirm the lists for 2009 and 2010 after endorsement by relevant central government authorities
(iii) SDFB and SXFB will be responsible for the disbursement of MCSU from the DAs
(iv) NDRC will be responsible for verification of closure of the small units capacity.
(v) An independent third-party monitor will be responsible for external monitoring of compliance to the EMF for Closure of Small Unit
(vi) An independent third-party monitor will be responsible for external monitoring of compliance to the existing governments' policies and regulations regarding settlement of workers affected by the closure of small units

B) <u>Targeted Closure and Time line</u>

(i) Targeted units: small units which are not provincially dispatched and which are owned by generation companies at municipal and county levels

(ii) Time line: small units to be closed between 2009 to 2010
(iii) Shanxi Province: units of 1,127 MW as part of the government targeted 2,670 MW and 200 MW additional, by 2010
(iv) Shandong Province: units of 1,283 MW as part of the government targeted 4,000 MW and 300 MW additional, by 2010

C) Source of Funds

(i) GEF Grant; and
(ii) Government funds (MOF, Shanxi and Shandong provincial governments), not less than three times of the GEF Grant contribution

D) Use of Funds

(i) Provincial PMO to coordinate provincial government agencies to merge the GEF Grant and Government matching funds and for disbursement to be in line with the relevant requirements and procedures specified in the GEF Project MCSU Operational Manual
(ii) Output-based payment per MW closed to be disbursed 100% to affected plant owners

E) Rate of Output-Based Payment.

The rate has been determined as US$ 6,800 per MW closed. This rate is proposed based on the 2007 field survey results (see sections below). The rates are subject to adjustment during the project implementation and will be specified in the MCSU Operation Manual for approval by MOF.

(i) Total rate per MW closed (GEF Grant and Government matching funds) may vary depending on issues and conditions of plants with units to be closed
(ii) There will be a fixed GEF Grant rate per MW closed ($/MW) in each province
(iii) Government matching funds to be no less than three times the fixed GEF Grant contribution; to top up the total payment

F) Procedures for Processing

(i) Provincial PMO/PEO to submit the lists of the small units that are to be closed between 2009 and 2010 for support by MCSU
(ii) National PMO confirms the lists once they have been endorsed by the relevant central government agencies (MOF and NDRC)
(iii) MOF makes budget allocation at beginning of the fiscal year to the provincial Government(s)
(iv) MOF transfers the ear-marked GEF Grant to the secondary DA at the provincial levels in line with the schedule of closure of the small units in the lists
    - Annually, or semi-annually, or quarterly
(v) Plants to close small units
(vi) Plants to prepare output-based payment application form for submission to the Provincial PEO/PMO and Provincial agencies to be responsible for closing small units
    - Simple and straightforward template to be prepared
(vii) Provincial PEO/PMO to coordinate for verification of closed small unit capacity by Shandong and Shanxi, which will then issue a letter of verification

(viii) The independent external monitor engaged to verify the compliance with (i) the EMF for the Closure of Small Unit; and (ii) the existing governments' policies and regulations on settlement of workers affected by the closure of small units, and issue a written letter of verification of compliance

(ix) Provincial PEO/PMO to coordinate with the responsible agencies to disburse GEF Grant and Government matching funds to the plant in line with requirements and procedures specified in the GEF Project MCSU Operational Manual

- affected plant owners to provide an official receipt of the output-based payment

G) Monitoring & Evaluation.

The Operational Manual shall include a framework to monitor

(i) Performance indicators for outputs and impact assessment

(ii) Funds disbursed (GEF Grant and Government budget)

- Receipts of affected plants

(iii) List of units closed (including owner, location, unit capacity, efficiency and operational hours before closure)

(iv) Reporting: Progress Report

- Preparation of progress report by Provincial PEO/PMO
- Quarterly, or semi-annually

3. ***Rate of the Output-based Payment for Closed Capacity under MCSU.*** The standard rate of output-based payment under the MCSU was estimated based on findings of the 2007 field surveys, which provided survey data to estimate an average number of staff loosing job per MW closed and their average annual income, including salaries and benefits. The survey data suggests on average 2.4 workers may lose jobs for each MW closed and an output-based payment of about US$ 6,800 per MW closed would bee needed, for the target small units in about 2,910 MW. The rate will be reviewed, revised if necessary, during the project implementation. In a specific case when more affected worker are need to be settled and the unified rate of payment is insufficient, the local government will provide extra financial resources to ensure satisfactory settlement of the affected workers.

A) Value of Closed Capacity.

Average annual values of closed capacity in Shandong and Shanxi are estimated at US$ 32,400 to US$ 68,000/MW based on the following assumptions:

(i) operational hours per year of the closed capacity: 5000 – 6000 hours

(ii) heat-rate difference between the closed and replacement capacity: 108 – 161 gce/kWh (replacement by 300 MW unit at 352 gce/kWh)

(iii) coal savings per year: 540 – 966 ton/MW

(iv) coal price: US$ 60 – 70/tons (RMB 420 – 500/tons), the higher the coal price the higher the value of the closed capacity

B) The Output-based Payment Rate per MW closed.

Average rate was estimated based on standardized number of staff that may loose job per MW closed, and typical salary and benefits in small power plants. The Output-Based

Payment rate for the NCSU support estimated during project preparation is ***US$ 6,787/MW***, with the following standard results from the survey and assumptions for compensation:

(i) staff/MW: 2.4; wage 25,770 Yuan/year; benefits: 19% of wage [30]; total income 30,668 Yuan/year

(ii) compensation: 12 month of benefits; 7 months of wage

Table. Survey Data and Estimation of Output-Based Payment Rate of MCSU

	Plant	Capacity (MW)		Staff			Annual Income	
		Total	Closure	total	laid off	person/MW	(Yuan)	
	Shandong							
1	Huangtai	1,025	365	2508	627	1.72	37,000	25% laid off
2	Baiyanghe	440	150	945	378	2.52	38,000	40% laid off
3	Jining	595	325	1638	819	2.52	48,888	50% laid off
4	Dazong	120	120	480	480	4.00	12,000	100% laid off
5	Jisan	X * 6	na	na	na	na	na	
	Sub-Total		**960**		**2,304**			
	Average					**2.40**	**36,182**	
	Shanxi							
1	Taiyuan Iron & Steel	76	76		0	0		0% laid off
2	Niangziguan	400	400	715	501	1.25	26,000	60% laid off
3	Huozhou	406	406	2673	1871	4.61	26,000	70% laid off
4	Puxian Electric	18	-	316				
5	Chunguang	18	18	2673			na	70% laid off
6	Bagong	48	48	900	0	0	na	0% laid off
7	Datong Thermal	304	100	800	350	3.50	na	350 staff laid off
8	Datong energy	100	100	2613			31,000	55% laid off
	Sub-Total		**1,148**		**2,722**			
	Average					**2.37**	**26,000**	
	Total		**2,108**		**5,026**			
	Average					**2.38**	30,668	
	MCSU Pilot							
1	Targeted Closure		**2,910**		**6,938**	**2.38**	**30,668**	incl. 20% benefits
2	Rate in US$/MW		6,787	for 7 months' salary, 12 months benefits				
3	Total Financing Requirement		19,751,197	total financing requirements for targeted closure				

C) Targeted Capacity of Closure.

Targeted units and capacity: units within the target of 2,910 MW to be closed in 2009 and 2010, including 300 MW additional in Shandong and 200 MW additional in Shanxi Provinces.

Table 7.1 Targeted closure of small thermal units in Shandong and Shanxi Provinces

Province	Unit	Target	Progress and Plan			
		2006-10	2006-07	2008	2009	2010
Shandong	MW	4,000	1,717	1,000	800	483 + 300
Shanxi	MW	2,670	1,007	536	622	505 + 200
Closure capacity to be directly supported by the MCSU					**2,910**	

[30] Findings of the GEF PPG financed Social Economic Survey for Closing down Small Units in Shandong, Shanxi, Henan and Guangdong Provinces, November 2007.

D) Resource requirement and proposed source of financing

(i) Resource requirement: about US$ 20 million with the output-based payment rate of US$ US$ 6,787 per MW closed, for 2,910 MW to be closed

(ii) Financing: US$ 20 million, with GEF Grant of US$ 5 million and Government budget at least US$ 15 million or more

Annex 5: Project Costs

CHINA: GEF China Thermal Power Efficiency Project

Table 5.1: Cost Estimation by Types of Activities

		Total	GEF (US$m)	CPF	Total	GEF (RMB Ym)	CPF
1	MCSU – capitalization	20.00	5.00	15.00	140.00	35.00	105.00
2	Goods	72.64	7.61	65.03	508.49	53.24	455.24
3	Services	9.29	5.83	3.46	65.03	40.78	24.25
4	Project management cost	1.92	0.41	1.51	13.41	2.86	10.55
	Total Base Cost	**103.85**	**18.84**	**85.01**	**726.92**	**131.88**	**595.04**
5	Contingency for exchange rate	5.11	0.86	4.25			
	Total Cost	**108.96**	**19.70**	**89.26**	**726.92**	**131.88**	**595.04**
	Financing Requirement	**108.96**	**19.70**	**89.26**	**726.92**	**131.88**	**595.04**

Note: CPF – Counterpart Fund

Table 5.2: Cost Estimation for Activities by Implementing Agencies

		Total	GEF (US$m)	CPF	Total	GEF (RMB Ym)	CPF
1	Technical Assistance to MOF/National PMO	17.68	6.61	11.07	123.76	46.26	77.50
2	Technical Assistance to NDRC	1.57	1.07	0.50	11.00	7.50	3.50
3	Technical Assistance to SERC	0.58	0.38	0.20	4.05	2.65	1.40
4	Shandong Province	61.95	4.59	57.36	433.68	32.14	401.54
5	Shanxi Province	16.42	3.42	13.00	114.94	23.92	91.02
6	Guangdong province	5.64	2.77	2.87	39.49	19.41	20.08
	Total Base Cost	**103.85**	**18.84**	**85.01**	**726.92**	**131.88**	**595.04**
7	Contingency for exchange rate	5.11	0.86	4.25			
	Total Cost	**108.96**	**19.70**	**89.26**	**726.92**	**131.88**	**595.04**
	Financing Requirement	**108.96**	**19.70**	**89.26**	**726.92**	**131.88**	**595.04**

Note: 1. Technical assistance to MOF/National PMO including budget of US$5 million earmarked for the MCSU.
2. Contingency is estimated at about 5%.

Table 5.3: Cost Estimation for Component 1

		Total	GEF (US$m)	CPF	Total	GEF (RMB Ym)	CPF
1A	**Technical Assistance to MOF**						
1A1	Capitalization to MCSU	15.000	5.000	10.000	105.000	35.000	70.000
1A2	Technical Assistance for MCSU						
	- Preparation of MCSU Operational Manual	0.100	0.057	0.043	0.700	0.400	0.300
	- Verification of Units Closed	0.143	-	0.143	1.000	-	1.000
	- Auditing (project)	0.029	-	0.029	0.200	-	0.200
		0.271	0.057	0.214	1.900	0.400	1.500
1A3	Assessment of MCSU & Replication	0.414	0.357	0.057	2.900	2.500	0.400
1A4	Assessment of SO_2 Trading & Replication	0.343	0.286	0.057	2.400	2.000	0.400
	Sub-total	**16.029**	**5.700**	**10.329**	**112.200**	**39.900**	**72.300**
1B	**Shandong - Pilot Program**						
1B1	Provincial MCSU						
	- Capitalization to Provincial MCSU	2.000		2.000	14.000		14.000
	- Preparation of MCSU Operational Manual	0.086	0.043	0.043	0.600	0.300	0.300
	- Verification of Units Closed	0.143		0.143	1.000		1.000
	- Auditing (project)	0.029	0.000	0.029	0.200	0.000	0.200
		2.257	**0.043**	**2.214**	**15.800**	**0.300**	**15.500**
1B2	Trading of SO_2 Emission Allowance						
	- Feasibility Study & Design	0.314	0.171	0.143	2.200	1.200	1.000
	- Supply and Installation	0.471	0.186	0.286	3.300	1.300	2.000
	- Knowledge Sharing and Training	0.214	0.143	0.071	1.500	1.000	0.500
		1.000	**0.500**	**0.500**	**7.000**	**3.500**	**3.500**
1B3	CHP On-line Monitoring						
	- 1st Stage - HW/SW	2.580	1.000	1.580	18.061	7.000	11.061
	- 2nd Stage - HW/SW	4.583	-	4.583	32.082	-	32.082
		7.163	**1.000**	**6.163**	**50.143**	**7.000**	**43.143**
1B4	Monitoring & Evaluation						
	- Services	0.429	0.286	0.143	3.000	2.000	1.000
	- Goods	0.143	0.071	0.071	1.000	0.500	0.500
		0.571	**0.357**	**0.214**	**4.000**	**2.500**	**1.500**
	Sub-total	**10.992**	**1.900**	**9.092**	**76.943**	**13.300**	**63.643**
1C	**Shanxi - Pilot Program**						
1C1	Provincial MCSU						
	- Capitalization to Provincial MCSU	3.000		3.000	21.000		21.000
	- Preparation of MCSU Operational Manual	0.086	0.043	0.043	0.600	0.300	0.300
	- Verification of Units Closed	0.143		0.143	1.000		1.000
	- Auditing (project)	0.029	0.000	0.029	0.200	0.000	0.200
		3.257	**0.043**	**3.214**	22.800	0.300	22.500
1C2	CHP On-line Monitoring						
	- Planning and Design	0.357	0.286	0.071	2.500	2.000	0.500
	- HW/SW	4.286	0.714	3.571	30.000	5.000	25.000
		4.643	**1.000**	**3.643**	32.500	7.000	25.500
1C3	Trading of SO_2 Emission Allowance						
	- Feasibility Study & Design	0.243	0.171	0.071	1.700	1.200	0.500
	- Supply and Installation	0.471	0.186	0.286	3.300	1.300	2.000
	- Knowledge Sharing and Training	0.214	0.143	0.071	1.500	1.000	0.500
		0.929	**0.500**	**0.429**	6.500	3.500	3.000
1C4	Monitoring & Evaluation						
	- Services	0.429	0.286	0.143	3.000	2.000	1.000
	- Goods	0.143	0.071	0.071	1.000	0.500	0.500
		0.571	**0.357**	**0.214**	4.000	2.500	1.500
	Sub-total	**9.400**	**1.900**	**7.500**	**65.800**	**13.300**	**52.500**
	Total - Component 1	**36.420**	**9.500**	**26.920**	**254.943**	**66.500**	**188.443**
		100.0%	26.1%	73.9%	100.0%	26.1%	73.9%

Table 5.4: Cost Estimation for Component 2

		Total	GEF (US$m)	CPF	Total	GEF (RMB Ym)	CPF
2A	**Technical Assistance to National PMO for Best Practice & Procedure**						
2A1	Energy Audit for Rehabilitation	0.199	0.128	0.071	1.394	0.894	0.500
2A2	Plant O&M	0.121	0.049	0.071	0.844	0.344	0.500
2A3	Assessment & Replication	0.079	0.043	0.036	0.550	0.300	0.250
	Sub-total	**0.398**	**0.220**	**0.179**	**2.788**	**1.538**	**1.250**
2B	**Shandong – Huangtai Thermal Power Plant**						
2B1	Retrofit of #7 Turbine	1.947	0.924	1.023	13.630	6.470	7.160
2B2	Retrofit of #8 Turbine	1.947		1.947	13.630		13.630
2B3	Master Heat Supply Station	4.950	0.183	4.767	34.650	1.280	33.370
2B4	Pipeline Network	15.583		15.583	109.080		109.080
2B5	Miscellaneous Works & Materials	2.814		2.814	19.700		19.700
2B6	Technical Assistance to Assessment	0.100	0.029	0.071	0.700	0.200	0.500
	Sub-total	**27.341**	**1.136**	**26.206**	**191.390**	**7.950**	**183.440**
2C1	**Shandong – Jinan Beijiao Thermal Power Plant**						
2C1	#2 & #5 turbine retrofit						
	- Goods	0.714		0.714	5.000		5.000
	- Civil works & installation	0.131		0.131	0.920		0.920
2C2	Extraction system						
	- Goods	1.180	1.117	0.063	8.260	7.820	0.440
	- Installation	0.161		0.161	1.130		1.130
	- Civil works	0.074		0.074	0.520		0.520
2C3	Pipeline network	15.671		15.671	109.700		109.700
2C4	Miscellaneous works & materials	4.721		4.721	33.050		33.050
2C5	Technical Assistance to Assessment	0.093	0.021	0.071	0.650	0.150	0.500
	Sub-total	**22.747**	**1.139**	**21.609**	**159.230**	**7.970**	**151.260**
2D	**Shanxi – Yangguang Thermal Power Plant**						
2D1	Replacement of Turbine Seals	1.489	0.286	1.203	10.420	2.000	8.420
2D2	Installation of 4 VSDs	2.286	0.571	1.714	16.000	4.000	12.000
2D3	Thermal Efficiency Monitoring						
	- Goods	0.171	0.143	0.029	1.200	1.000	0.200
	- Services	0.114	0.071	0.043	0.800	0.500	0.300
		0.286	0.214	0.071	2.000	1.500	0.500
2D4	Heat-exchange Station and Network	1.714		1.714	12.000		12.000
2D5	Technical Assistance to Assessment	0.100	0.029	0.071	0.700	0.200	0.500
	Sub-total	**5.874**	**1.100**	**4.774**	**41.120**	**7.700**	**33.420**
	Total - Component 2	**56.361**	**3.594**	**52.767**	**394.528**	**25.158**	**369.370**
		100.0%	6.4%	93.6%	100.0%	6.4%	93.6%

Table 5.5: Cost Estimation for Component 3

		Total	GEF (US$m)	CPF	Total	GEF (RMB Ym)	CPF
3.A	**Pilot of ESD in Guangdong**						
3A1	Simulation Modeling						
	- Model Development	0.290	0.190	0.100	2.030	1.330	0.700
	- Supervision and Assessment	0.092	0.063	0.029	0.642	0.442	0.200
		0.382	0.253	0.129	2.672	1.772	0.900
3A2	Simulation System - SW/HW						
	- System Design	0.200	0.100	0.100	1.400	0.700	0.700
	- SW	0.580	0.580	-	4.060	4.060	-
	- HW & Equipment	1.343	1.201	0.143	9.404	8.404	1.000
		2.123	1.881	0.243	14.864	13.164	1.700
3A3	CHP On-line Monitoring						
	- SW	0.030	0.030	-	0.210	0.210	-
	- Hw	1.914	0.200	1.714	13.400	1.400	12.000
		1.944	0.230	1.714	13.610	1.610	12.000
3A4	Information Disclosure System						
	- SW	0.100	0.100		0.700	0.700	
	- HW & Equipment	0.440	0.043	0.397	3.080	0.300	2.780
		0.540	0.143	0.397	3.780	1.000	2.780
3A5	Technical Assistance to Procurement	0.057	0.043	0.014	0.401	0.301	0.100
3A6	M&E						
	- Assessment and Reporting	0.086	0.072	0.014	0.601	0.501	0.100
	- Auditing	0.014	-	0.014	0.100	-	0.100
		0.100	0.072	0.029	0.701	0.501	0.200
	Sub-total	**5.147**	**2.621**	**2.526**	**36.028**	**18.348**	**17.680**
3B	**Technical Assistance to Replication – Policy and Regulation**						
	SERC						
3B1	Compensation Mechanism for ESD Pilot	0.082	0.054	0.029	0.577	0.377	0.200
3B2	Information Disclosure for ESD Pilot	0.073	0.044	0.029	0.509	0.309	0.200
3B3	Study on Combination of ESD & Power Market						
	- Study and Draft Report	0.190	0.119	0.071	1.331	0.831	0.500
	- Stakeholder Consultation	0.100	0.057	0.043	0.700	0.400	0.300
	- Finalization of Report	0.133	0.105	0.029	0.933	0.733	0.200
		0.424	0.281	0.143	2.965	1.965	1.000
	Sub-total	**0.579**	**0.379**	**0.200**	**4.051**	**2.651**	**1.400**
	NDRC						
3B4	Assessment of ESD in five Pilot Provinces						
	- Review and Draft Report	0.479	0.336	0.143	3.352	2.352	1.000
	- Stakeholder Consultation	0.114	0.071	0.043	0.800	0.500	0.300
	- Finalization of Report	0.235	0.206	0.029	1.642	1.442	0.200
		0.828	0.613	0.214	5.794	4.294	1.500
3B5	Study on Pricing and Tariff Reform						
	- Review and Draft Report	0.254	0.111	0.143	1.777	0.777	1.000
	- Stakeholder Consultation	0.082	0.039	0.043	0.574	0.274	0.300
	- Finalization of Report	0.136	0.108	0.029	0.953	0.753	0.200
		0.472	0.258	0.214	3.303	1.803	1.500
3B6	Efficiency Revivification	0.158	0.129	0.029	1.105	0.905	0.200
3B7	Knowledge Sharing	0.114	0.071	0.043	0.800	0.500	0.300
	Sub-total	**1.572**	**1.072**	**0.500**	**11.002**	**7.502**	**3.500**
	Total - Component 3	**7.297**	**4.071**	**3.226**	**51.080**	**28.500**	**22.580**
		100.0%	55.8%	44.2%	100.0%	55.8%	44.2%

Table 5.6: Cost Estimation for Component 4

		Total	GEF (US$m)	CPF	Total	GEF (RMB Ym)	CPF
4A	**TA To National PMO**						
4A1	Project Management - Individual	0.144	0.144	-	1.008	1.008	-
4A2	Technical Expert(s)	0.115	0.115	-	0.806	0.806	-
4A3	Procurement - Individual	0.043	0.043	-	0.302	0.302	-
4A4	FM - Individual	0.048	0.048	-	0.336	0.336	-
4A5	Secretary	0.034	0.034	-	0.235	0.235	-
4A6	Training	0.200	0.100	0.100	1.400	0.700	0.700
	Sub-Total	**0.584**	**0.484**	**0.100**	**4.088**	**3.388**	**0.700**
4B	**TA To Shandong PMO**						
4B1	Procurement Agent - Firm	0.113	0.113	-	0.788	0.788	-
4B2	Project Management - Individual	0.041	0.041	-	0.288	0.288	-
4B3	Accountant - Individual	0.021	0.021	-	0.144	0.144	-
4B4	Procurement - Individual	0.041	0.041	-	0.288	0.288	-
4B5	Training	0.200	0.100	0.100	1.400	0.700	0.700
	Sub-Total	**0.415**	**0.315**	**0.100**	**2.908**	**2.208**	**0.700**
4C	**TA To Shanxi PEO/PCO**						
4C1	Procurement Agent - Firm	0.071	0.071	-	0.500	0.500	-
4C2	Project Management (PCO) - Individual	0.041	0.041	-	0.288	0.288	-
4C3	Project Management (PEO) - Individual	0.041	0.041	-	0.288	0.288	-
4C4	Accountant - Individual	0.021	0.021	-	0.144	0.144	-
4C5	Procurement - Individual	0.041	0.041	-	0.288	0.288	-
4C6	Training	0.386	0.100	0.286	2.700	0.700	2.000
	Sub-Total	**0.601**	**0.315**	**0.286**	**4.208**	**2.208**	**2.000**
4D	**Guangdong – PMO**						
4D1	Project Management - Individual	0.051	0.051	-	0.360	0.360	-
4D2	Training	0.200	0.100	0.100	1.400	0.700	0.700
	Sub-total	**0.251**	**0.151**	**0.100**	**1.760**	**1.060**	**0.700**
	Total - Component 4	**1.852**	**1.266**	**0.586**	**12.964**	**8.864**	**4.100**
		100.0%	68.4%	31.6%	100.0%	68.4%	31.6%

Table 5.7: Cost Estimation for Component 5

		Total	GEF (US$m)	CPF	Total	GEF (RMB Ym)	CPF
5A	**National PMO**						
	Incremental Operating Cost						
5A1	Office Equipment	0.114	0.029	0.086	0.800	0.200	0.600
5A2	Office Rental	0.129	0.071	0.057	0.900	0.500	0.400
5A3	Operational Cost	0.379	0.057	0.321	2.650	0.400	2.250
5A4	Interpreter/Translation - SOE	0.048	0.048	-	0.335	0.335	-
	Sub-total	**0.669**	**0.205**	**0.464**	**4.685**	**1.435**	**3.250**
5B	**Shandong PMO**						
	Incremental Operating Cost						
5B1	Office Equipment	0.114	0.043	0.071	0.800	0.300	0.500
5B2	Office Rental	0.143	-	0.143	1.000	-	1.000
5B3	Operational Cost	0.173	0.030	0.143	1.212	0.212	1.000
5B4	Interpretation/Translation - SOE	0.029	0.029	-	0.200	0.200	-
	Sub-Total	**0.459**	**0.102**	**0.357**	**3.212**	**0.712**	**2.500**
5C	**Shanxi PEO/PCO**						
	Incremental Operating Cost						
5C1	Office Equipment	0.114	0.043	0.071	0.800	0.300	0.500
5C2	Office Rental	0.143	-	0.143	1.000	-	1.000
5C3	Operational Cost	0.259	0.030	0.229	1.812	0.212	1.600
5C4	Interpretation/Translation - SOE	0.029	0.029	-	0.200	0.200	-
	Sub-Total	**0.545**	**0.102**	**0.443**	**3.812**	**0.712**	**3.100**
5D	**Guangdong – PMO**						
	Incremental Operating Cost						
5D1	Office Equipment	0.071	-	0.071	0.500	-	0.500
5D2	Office Rental	0.086	-	0.086	0.600	-	0.600
5D3	Operational Cost	0.057	-	0.057	0.400	-	0.400
5D4	Interpretation/Translation - SOE	0.029	-	0.029	0.200	-	0.200
	Sub-total	**0.243**	-	**0.243**	**1.700**	-	**1.700**
	Total - Component 5	**1.916**	**0.408**	**1.507**	**13.409**	**2.859**	**10.550**
		100.0%	21.3%	78.7%	100.0%	21.3%	78.7%

Note: Costs in Table 5.3 to 5.7 exclude contingencies.

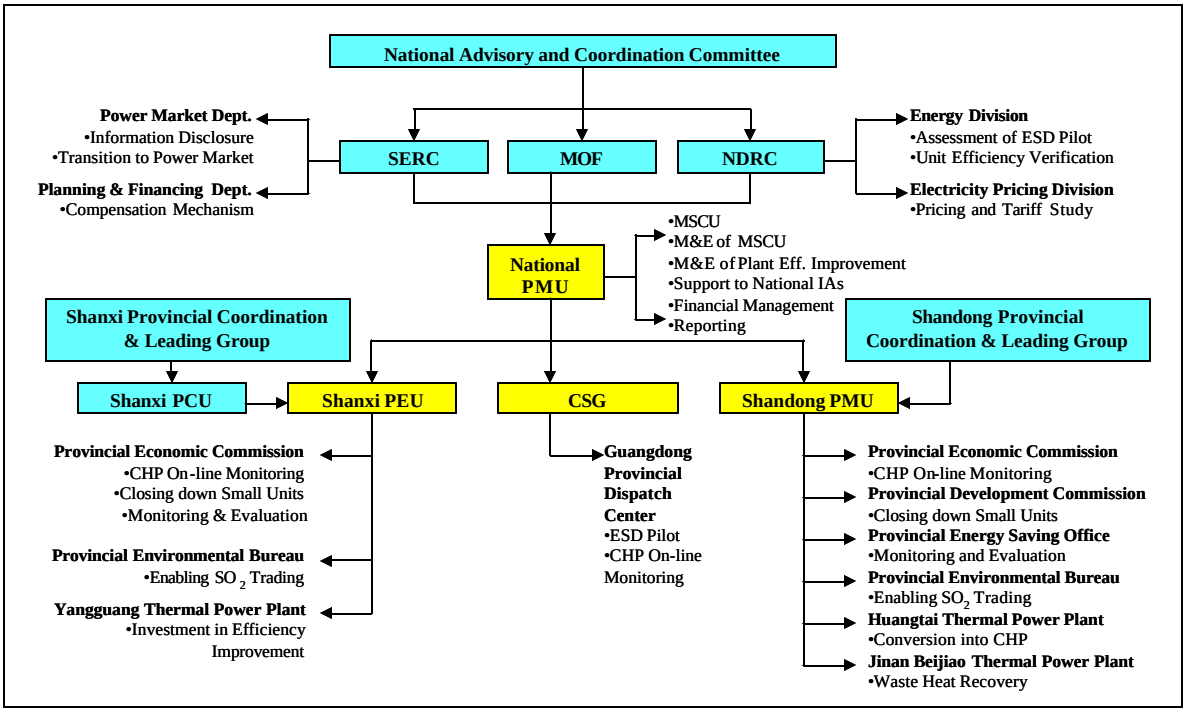
Annex 6: Implementation Arrangements

CHINA: GEF China Thermal Power Efficiency Project

A. Implementing Agencies

1. The project implementation will be carried out over four years by the central government agencies and provincial government agencies, a power company (GDGP) Guangdong and three power plants in Shandong and Shanxi provinces. The institutional arrangement for implementation of various project activities as illustrated in the figure below. It has been based on the existing functions and responsibilities of the various government agencies, GDGP and the three power plants involved as the IAs. Project management or coordination units were created under the GEF Project at both national and provincial levels mainly for coordination internally and externally and for operational and logistical support on implementation, monitoring and reporting of various project activities, without causing major interruption of the IA's normal functions and responsibilities.

Figure 6.1: Institutional Arrangement for Project Implementation



2. **Implementing Agencies.** The GEF Project will be implemented by the IAs including central government agencies, provincial government agencies and power companies and plants in three provinces. To minimize any additional burden, the implementation arrangements were designed based on existing GOC administrative arrangements, as these are considered to be functioning and effective. The project will only add to the existing organization and administrative arrangements the necessary operational support or internal and external coordination functions.

3. A National PMO was established within MOF to coordinate the project implementation and provide operational support to all IAs. For operational and logistic support to various IAs at the

provincial level, a Provincial Project Execution Unit (PEO) was set up within the Provincial Economic Commission for management and/or coordination of all the project activities in Shanxi Province and a Provincial Coordination Office (PCO) was established within the SXFB to support the PEO for internal coordination within the provincial government. A Provincial PMO was set up in SDFB for management and/or coordination of all the project activities in Shandong Province. The Dispatch Center of Guangdong Grid Company have formulated a project team for the implementation of the pilot ESD programs, with technical and FM support from the function departments of Guangdong Provincial Power Grid Company and GDGP.

4. ***National PMO.*** The National PMO within MOF has been operational since 2007 when the project preparation was initiated. The PMO will support the central government agencies including MOF, NDRC and SERC in implementation of activities managed by these agencies and with overall coordination and monitoring of the activities that are to be implemented by the provincial government agencies as well as power plants in Shandong and Shanxi Provinces and by GDGP in Guangdong Province. Its responsibilities include:

(i) Supporting the central government agencies in implementation of the project activities, including procurement (preparing terms of reference and bidding documents) and contract execution, FM and disbursement;

(ii) Overseeing and coordinating the implementation of activities managed by the provincial government agencies, power plants and GDGP;

(iii) Implementing activities directly managed by the PMO, including technical assistance to assessment of the MCSU, replication of successful plant efficiency improvement experience, training programs on procurement, FM and disbursement for the GEF Grant supported activities;

(iv) Supporting the administration of the GEF DA and conducting FM and disbursement covering all GEF Project-supported activities;

(v) Coordinating among all the IAs and with the Task Team of the Bank and supporting the Bank's supervision of the project implementation;

(vi) Monitoring the progress and outputs of project implementation and supporting the central government agencies in preparation of progress reports, collecting progress information and reports from various IAs in the selected provinces and preparing consolidated project progress reports in line with the requirements of the legal documents; and

(vii) Preparing the project completion report upon project completion.

5. The National PMO is staffed with an MOF official as the PMO Director and also with officials from the NDRC, SERC and MOF as Deputy Directors. A local consultant has been hired as the Executive Director of the National PMO, responsible for daily operation of the PMO. The PMO have hired a team of consultants to perform its functions and responsibilities described above, including a procurement specialist, an account, technical expert(s) and an office secretary. This team has been working on the project preparation since early 2007 and has also received training on the Bank's procedures and requirements for procurement and FM. The team has worked effectively

and has ensured the completion of the project preparation activities on time. This team will continue to work at the National PMO for project implementation.

6. ***National Advisory and Coordination Committee.*** An Advisory and Coordination Committee consisting of high-level officials from MOF, NDRC and SERC was set up at the project preparation stage. The Committee will continue its role for strategic decision making and coordination as needed during the project implementation.

B. Implementation of activities managed by central government agencies

7. MOF, NDRC and SERC will be responsible for implementation of various technical assistance activities under the GEF Project, in line with their current functions and responsibility.

8. ***MOF.*** As the counterpart of the Bank and focal point for GEF projects in China, MOF will sign the grant agreement with the Bank on behalf of the GOC, and the sub-grant agreement with various beneficiaries in Shandong, Shanxi and Guangdong. Through the National PMO, the Energy Division of the Economic Construction Department (ECD) will be responsible for the overall coordination to ensure smooth implementation of all activities at both central and provincial levels. The Fund Division of the International Department will be responsible for managing the DA, including associated FM, disbursement, auditing and monitoring, with operational support of the accountant hired by the National PMO.

9. Through the National PMO, the Energy Division will also lead the implementation of several project-supported activities, including review and approval of the MCSU Operational Manuals and monitoring of the MCSU pilot operation together with the Fund Division. It will also lead the assessment of the effectiveness of this financial incentive mechanism and associated knowledge sharing and replication to scale-up impacts. It will also lead the assessment of the plant efficiency improvement projects to provide inputs on use of its energy saving and emission reduction budget.

10. ***NDRC.*** Supported by the National PMO, the NDRC is responsible for implementation of relevant technical assistance activities for the pilot ESD and closure of the small units supported by the GEF Project, in coordination with other central government agencies. The deputy director of the Energy Division is also the deputy director of the National PMO.

11. To support NDRC in regulation of the closure of the small units and piloting the ESD, the Energy Division and the Electricity Pricing Division of NDRC will lead some of the key studies and activities supported by the GEF Project. These include:

(i) assessment of the pilot ESD programs in all the five pilot provinces, with recommendations on the improvements to the approach and regulations of the ESD

(ii) study on tariff mechanisms; and

(iii) sharing knowledge and experience accumulated under the GEF Project and preparation for replication to scale up impacts.

12. The Energy Division will also support other key studies and / or activities managed by SERC which are critical to support the ESD pilot (see section below). It will also be responsible for

coordination with Shanxi Provincial Economic Commission and Shandong Provincial Development and Reform Commission on the pilot programs for closing down small units, including verification of the small unit capacity closed. It will also be responsible for coordination with GDGP on the pilot ESD in Guangdong Provincial Power Grid.

13. ***SERC.*** Supported by the National PMO, the SERC will lead some of the key studies to develop effective regulations required to initiate the pilot ESD, including:

(i) financial compensation mechanism associated with the pilot ESD;

(ii) detailed requirements on information disclosure associated with the pilot ESD; and

(iii) development of the power markets compatible with the transition to efficient generation dispatch.

14. SERC will also support NDRC in managing the pilot implementation of ESD in Guangdong Provincial Power Grid, and with the associated assessment of the ESD pilot programs in the five pilot provinces.

15. A project team, consisting of officials from the International Cooperation, Planning and Financing and Power Market Departments of SERC will be formed for coordination and implementation of the relevant activities under the GEF Project in accordance with their existing functions and responsibilities.

C. Implementation of Activities in Shandong Province

16. ***Shandong Provincial PMO.*** A Project Coordination and Leading Group, consisting of high-level government officials from the Shandong Provincial Government including the SDFB, Economic Commission, Development and Reform Commission, Jinan Branch of SERC, Environment Bureau and Shandong Provincial Power Company was set up during the project preparation stage and will continue its role of strategic decision and coordination when needed for the project implementation. A Provincial PMO was established for the implementation of the GEF Project. The PMO resides within the SDFB and is staffed with three officials from the SDFB.

17. Similar to the functions of the National PMO, the Provincial PMO will be responsible for:

(i) coordinating and monitoring the implementation of all the project-supported activities in Shandong province;

(ii) supporting the provincial government agencies and the two power plants in implementation of the relevant project activities (see sections below); and

(iii) FM, disbursement, M&E and reporting.

18. To support functioning of the Provincial PMO, three local individual consultants, one for project management, procurement/contract management and FM respectively, will be hired throughout the project duration. A Tendering Agent (firm) will be hired to conduct the procurement work for all activities supported by the GEF Project in Shandong.

19. ***Provincial Finance Bureau*** will be responsible for management and operation of the MCSU in Shandong in close coordination with the Provincial Development and Reform Commission. It will have the support of the Provincial PMO in procurement, FM, disbursement and M&E.

20. ***Provincial Economic Commission*** will be responsible for the implementation of the CHP On-line Monitoring System, in close cooperation with the Provincial Grid Company and with the support of the Provincial PMO in procurement and disbursement.

21. ***Provincial Environment Bureau*** will implement the technical assistance to enable SO_2 emission allowance trading to support the closure of small thermal units in Shandong, with the support of the Provincial PMO in procurement and disbursement.

22. ***Huangtai Thermal Power Plan*** will implement the demonstrative project for conversion units into CHP operation, with support of the Provincial PMO in procurement and disbursement.

23. ***Jinan Beijiao Thermal Power Plant*** will implement the demonstrative waste heat recovery project, with the support of the Provincial PMO in procurement and disbursement.

D. Implementation of Activities in Shanxi Province

24. ***Shanxi Provincial PCO/PEO.*** A Project Steering Committee, consisting of high-level government officials from the Shanxi Provincial Government including the SXFB, Economic Commission, Development and Reform Commission and Shanxi Provincial Power Company was set up during the project preparation stage, with functions similar to those of the Leading Group in Shandong. A PCO was set up within the SXFB with the participation of representative of all the related agencies to coordinate among all relevant parities to support project implementation. A PEO was set up in the Provincial Economic Commission for implementation of the project activities.

25. The Provincial PCO will be responsible for:

(i) coordination with the National PMO and provincial agencies;

(ii) support of the SXFB in management and operation of the MCSU, in close coordination with the Provincial Economic Commission and the PEO; and

(iii) FM, disbursement, auditing and financial monitoring.

26. The Provincial PEO will be responsible for:

(i) implementing the CHP On-line Monitoring System;

(ii) overseeing and coordinating the implementation of all other project activities in Shanxi province (see sections below), except for the MCSU management; and

(iii) monitoring and progress reporting.

27. Local individual consultants for project management, procurement/contract management and FM respectively will be hired throughout the project duration to support the PCO and PEO. A

Tendering Agent (firm) will be hired by the PEO to conduct the procurement work for all activities supported by the GEF Project in Shanxi.

28. ***Provincial Finance Bureau*** will be responsible for management and operation of the MCSU in Shanxi, in close coordination with the Provincial Economic Commission and with administrative and operational support of the provincial PCO and PEO.

29. ***Provincial Economic Commission*** will be responsible for the closure of inefficient small units and the implementation of CHP On-line Monitoring System, in close cooperation with the Provincial Grid Company and with support of the Provincial PEO (within the Commission) and PCO.

30. ***Provincial Environment Bureau*** will implement the technical assistance necessary for SO_2 trading to support the closure of small thermal units in Shanxi, with operational support of the Provincial PEO/PCO in procurement and disbursement.

31. ***Yangguang Thermal Power Plant*** will implement the demonstration investment project for plant efficiency improvement, with operational support of the Provincial PEO/PCO in procurement and disbursement.

E. Implementation of Pilot ESD in Guangdong Province

32. ***International Department of GDGP.*** The department will be responsible for: (i) monitoring the implementation of the project-supported pilot ESD in Guangdong; and (ii) coordinating with the National PMO and the Bank for project implementation, M&E and reporting.

33. ***Guangdong Provincial Power Grid Dispatch Center.*** The Dispatching Center of GDGP will be responsible for implementation of the pilot ESD program in Guangdong Provincial Power Grid and associated FM, auditing, M&E and reporting associated with the GEF Project-supported pilot ESD.

34. To further enhance the capacity of the Dispatch Center, one local individual consultant will be hired to support the project management. A Tendering Agent (firm or individuals) will be hired to conduct the GEF-financed procurement work.

35. Experienced consultants (firms) will be hired to develop a dispatch simulation model and recognized experts on system dispatch, both local and international, will be hired to review and assess the simulation model, supervise the simulation and evaluate the simulation results.

F. Monitoring and Evaluation of Outcomes/Results

36. Monitoring of project activities and evaluation of outputs and impacts of the project will serve a dual function. First, it will facilitate tracking progress toward project objectives. Second, it will facilitate learning, improvements and generation of knowledge necessary for the replication of those pilot and demonstration programs in other provinces in China.

37. Project results monitoring will include: (i) collection of data for the key performance indicators (see Annex 3); and (ii) preparation of project progress reports. The National PMO will be responsible for overall M&E of the project implementation progress as well as preparation of the

consolidated project progress reports. Similarly, the Shandong PMO, Shanxi PEO and GDGP will collect data in line with the monitoring framework set in the Annex 3 and also prepare regular progress reports for their respective project activities. The national government agencies, SERC, NDRC and MOF, will prepare progress reports for their respective technical assistance activities.

38. The Bank's Task Team will supervise the implementation of the project with due regard to the project objectives and expected outputs and outcomes. Bank missions will visit China at least twice a year for this purpose.

Annex 7: Financial Management and Disbursement Arrangements

CHINA: GEF China Thermal Power Efficiency Project

1. **Introduction.** The Bank has conducted an assessment of the adequacy of the project financial management system. The assessment, based on relevant Bank's guidelines issued by the Financial Management Sector Board on November 3, 2005, has concluded that the project meets the minimum Bank FM requirements as stipulated in BP/OP 10.02. In the FMS' opinion, the project will maintain adequate financial management arrangement acceptable to the Bank and, as part of the overall arrangements that the Recipient has in place for implementing the project, will provide reasonable assurance that the proceeds of the GEF Grant will be used for the intended purposes. Financial management risk is the risk that the grant proceeds will not be used for the intended purposes and is a combination of country, sector and project specific risk factors. Taking into account the risk mitigation measures for the project, the FM risk is rated, during the appraisal stage as, Modest.

2. Funding sources for the project include GEF and counterpart funds. The GEF proceeds will flow from the Bank into three segregated project DAs to be set up at and managed by ECD of MOF, SDFB and SXFB, then to various IAs and finally to contractors or suppliers. For implementation relating to Guangdong Province, ECD of MOF will directly disburse funds from the DA managed by itself to Guangdong State Grid Company since there is only one implementing agency there. The GEF Grant Agreement will be signed between the Bank and the People's Republic of China through the MOF and then the sub-grant agreements will be signed between MOF and the provinces.

3. No outstanding audits or audit issues exist with any one of the IAs involved in the project.

4. **Country Issues.** To date, China Financial Accounting Assessment has not been performed, though dialogue with the GOC in respect of the assessment exercise has been initiated. However, based on observations and given the experience with Bank-financed projects in China over the past few years, substantial improvement in public expenditures, accounting and auditing has been noted and further improvement is expected in the next few years. This is a gradual progress and as the economic reform programs further unfold, the GOC has come to realize the importance of establishing and maintaining an efficient and effective market mechanism to ensure transparency and accountability and minimize potential fraud and corruption.

5. With the unique arrangement of the GOC, funds of Bank-financed projects, particularly Bank loans, are controlled and monitored by the MOF and its extension, i.e. finance bureaus at provincial, municipal/prefecture and county levels. However, project activities are usually carried out by implementing entities of the industry or sector. As a result this arrangement requires close coordination between the multi-level funding management and the project implementation arrangement to ensure smooth project implementation.

6. **Summary of Project Description.** The project development objective is to reduce coal consumption per unit of electricity production in Shanxi Province, Shandong Province and Guangdong Province in China. The project has five components: (i) mechanisms to support the closure of inefficient small coal-fired generation units; (ii) demonstration of power plant efficiency improvements; (iii) transition to efficient generation dispatch; (iv) technical assistance to project implementation; and (v) project management (see Annex 4).

A. Audit Arrangements

7. The project financial statements will be audited in accordance with standards acceptable to the Bank. In line with other Bank-financed projects in China, the project will be audited in accordance with International Auditing Standards and the Government Auditing Standards of the People's Republic of China. The Audit Service Center of China National Audit Office for Foreign Loan and Assistance Projects (central and Guangdong portion), Shandong Provincial Audit Office (Shandong portion) and Shanxi Provincial Audit Office (Shanxi portion) have been identified as auditors for the project. The Bank currently accepts audit reports issued by CNAO or provincial/regional audit bureaus/offices for which CNAO is ultimately responsible. Annual audit reports, covering project financial statements for the GEF Grant funds only, will be due to the Bank within 6 months after the end of each calendar year as stipulated in the GEF Grant Agreement. The responsible agency and timing for the submission of audit reports are summarized as follows:

Audit Report	Submitted by	Due date
Project financial statements – Central and Guangdong part	National PMO	June 30 of each calendar year
Project financial statements – Shandong part	SDFB	June 30 of each calendar year
Project financial statements – Shanxi part	SXFB	June 30 of each calendar year

B. Risk Assessment and Mitigation.

8. The following risks with corresponding mitigating measures have been identified during the assessment:

Risk	Risk Rating Before Mitigating Measures	Incorporated Risk Mitigating Measures	Risk Rating After Mitigating Measures	Conditions of Negotiations, Board or Effectiveness
Inherent Risk				
Country level	Modest	Annual audit will reduce the risk of project funds not used for intended purposes. For those areas where the government system can not be used, Bank's specific requirements will govern and be incorporated into the project FM system. Project supervision missions, in a risk-based approach, will review the FM during the project implementation to minimize FM risk.	Modest	
Entity Level	Substantial	Although most of the IAs do not have prior experience with the Bank financed projects, the guidance and supervision from the National PMO, SDFB and SXFB can, to some extent, mitigate this weakness since they are experienced in FM for Bank-financed projects. A well designed training session will be provided to all the IAs during project launch workshop and initial project implementation.	Modest	
Project Level	Substantial	The project will be implemented by over 10 IAs including central and provincial government agencies, a power company and 3 plants in 3 provinces. The project activities are geographically dispersed, and most of the IAs not experienced in the disbursement and FM of the Bank-financed projects. To mitigate risks, proper financial control procedures will be designed and documented in a Financial Management	Modest	Financial Management Manual is a condition for negotiation.

		Manual.		
Control Risk				
Budgeting	Modest	The task team will work with each PMO to improve their budgeting, execution and monitoring.	Modest	
Accounting	Modest	Accounting policies and procedures for the GEF fund are already in place. The Task Team will check at the initial implementation stage to ensure the accounting system is correctly set up. The team will keep checking by regular supervision missions.	Modest	
Internal Control	Substantial	Different forms of internal controls, not specifically for the project activities, already exist at all IAs. The FMM to be prepared and issued to all IAs will uniformly align their FM arrangement, disbursement requirements and internal control procedures.	Modest	
Funds Flow	Modest	Three segregated DAs will be opened and managed by ECD of MOF, SDFB and SXFB, which can ensure timely disbursement.	Modest	
Financial Reporting	Modest	The format and content of financial statements have been stipulated by MOF and the project will follow. The ECD of MOF will be responsible for preparing the project financial statements for the activities by the central government IAs and Guangdong Provincial Power Grid Company; and SDFB and SXFB for the activities in their respective provinces.	Low	
Auditing	Modest	The three external auditors for the project have extensive experience with Bank-financed projects.	Low	
Overall Risk	**Modest**		**Modest**	

9. Taking account of the measures and the arrangements for mitigating the risks, the overall FM risk-rating of this project at the appraisal stage is rated modest.

C. Disbursement Arrangements

10. Four disbursement methods: (i) advance; (ii) reimbursement; (iii) direct payment; and (iv) special commitment will be used for the project. Supporting documents required for Bank disbursement under different disbursement methods will be documented in the Disbursement Letter to be issued by the Bank.

11. The three segregated DAs denominated in US dollar amounts will be established at a commercial bank acceptable to the Bank. One will be managed by the ECD of MOF for activities executed by the Central Government IAs and GDGP and the other two will be managed by SDFB and SXFB for the activities executed in their respective province. The ceiling of the DAs will be specified in the Disbursement Letter to be issue by the Bank.

12. Applications for requesting advance into the DA can be submitted to the Bank at any time provided the outstanding advances do not exceed the established ceiling in the Disbursement Letter.

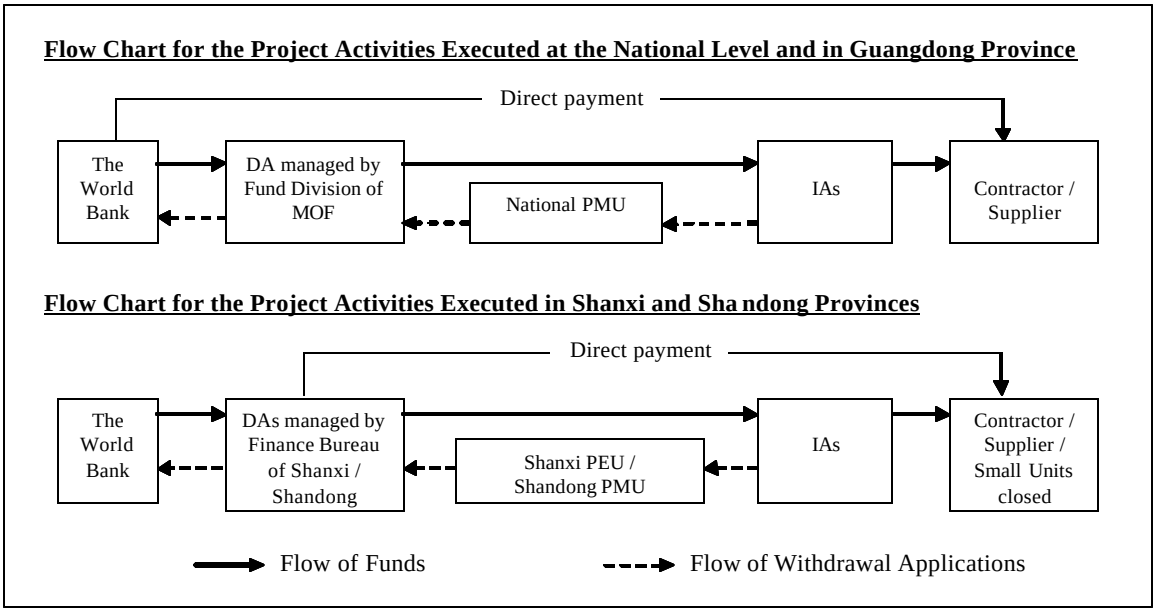
a) For contract amounts subject to the Bank prior review indicated in the table below, the list of payments against the contracts, and records evidencing eligible expenditures, e.g., copies of receipts, supplier invoices, will be furnished as

supporting documentation to request for disbursement and reporting eligible expenditures paid from the DA.

Expenditure Category	Contracts More than US$ Equivalent
Goods	200,000
Firm Consultant	100,000
Individual Consultant	All for the project management

b) For expenditures against contract amounts below the amounts indicated in the above table, SOE will be furnished as supporting documentation to request for disbursement and reporting eligible expenditures paid from the DA.

13. The ECD of MOF, SDFB and SXFB will be directly responsible for the management, maintenance and reconciliation of the DAs. Supporting documents required for Bank disbursements will be prepared by IAs and submitted through the respective PMOs/PEO to the ECD of MOF, SDFB and SXFB for verification and consolidation before sending to the Bank for disbursement processing. The flow of funds and withdrawal applications for the grant is as follows:



14. The GEF Grant would be disbursed against eligible expenditures as in the following table.

Category	Amount of the Grant Allocated (in US$ million) (Taxes Inclusive)	Percentage of Expenditures to be financed
1. Central Government Agencies and GDGP		100%
1.1 Works, Goods , Consulting Services and Training	US$5,626,543	
1.2 Operating Cost of National PMO	US$205,000	
2. Shandong Province		
2.1 MCSU Payment	US$2,000,000	
2.2 Works, Goods , Consulting Services and Training	US$4,409,715	
2.3 Operating Cost of Shandong PMO	US$101,714	
3. Shanxi Province		
3.1 Works, Goods , Consulting Services and Training	US$3,315,429	

3.2 MCSU Payment	US$3,000,000	
3.3 Operating Cost of Shanxi PEO/PCO	US$101,714	
4. Contingency	US$939,885	
Total	**US$19,700,000**	**100%**

15. According to the current project implementation plan, a certain amount of project expenditures will incurred prior to the signing of the GEF Grant Agreement. To facilitate the timely project execution, the Bank may allow retroactive financing under this project – the Bank may reimburse the Recipient from the grant proceeds for payments that the Recipient has made for eligible expenditures before the GEF Grant Agreement date. The Withdrawal of Proceeds section of the Grant Agreement will specify the date from which expenditures are covered and the amount.

16. To facilitate the disbursement and monitoring of output based financial incentive for closure of small units, the MCSU Operation Manual will be prepared and become operational upon completion and approval by MOF and the Bank. The MCSU Operation Manual will cover the institutional arrangement, rate of GEF compensation per MW closed (US$/MW), processing procedures and required supporting documents to apply for disbursement of the output-based payment under the MCSU. The SDFB and SXFB will be responsible for the disbursement of funds under the MCSU from DAs managed by them according to the processing procedures and the rate of GEF contribution to the output-based payment per MW closed specified in the MCSU Operational Manual. The disbursement of MCSU is suggested to be supported by the following documents:

(i) A list of small units to be closed and targeted by the MCSU pilot, from the provincial PMO/PEO;
(ii) Confirmation from national PMO that the list is endorsed by relevant central government authorities;
(iii) Written verification letter issued by NDRC on the closure of small generation unit(s) included in the approved list;
(iv) Documentation proving compliance with applicable social and environmental requirements as specified in the MCSU Operational Manual.

D. Financial Management and Reporting Arrangements

17. **Strengths.** SDFB and SXFB have experience with project FM and disbursement for the Bank-financed projects. They are familiar with the management of the DA, operating accounts and withdrawal applications procedures for Bank-financed projects.

18. **Weaknesses and Action Plan.** Since most of the IAs do not have experience in Bank-financed projects, a well designed training course on project disbursement and FM will be conducted during the launch workshop and project implementation. In addition, a Financial Management Manual (FMM) will be prepared by the ECD of MOF to uniformly align the project FM policies and procedures for all the IAs, including the PMOs and PEO, which will also implement the technical assistant activities and manage the incremental operating cost. The following action plan for addressing this weakness has been identified:

Significant weaknesses	Actions	Responsible Person	Completion Date
No uniform project FM policies and requirements in	FMM to be drafted by MOF, reviewed by the Bank and finalized and issued to all the	ECD of MOF	Before project negotiation

place for the whole project.	IAs including the PMOs and PEO.		

19. **Implementing Agencies.** The project implementation will be carried out over four years by the central and provincial government agencies, GDGP in Guangdong and three power plants in Shandong and Shanxi. The institutional arrangement for implementation of various project activities is described in details in Annex 6.

20. **Budgeting**. The cost table has been prepared for the project and each IA will prepare its annual implementing plan. The budgeting system of each IA shall be well maintained and monitored, and the Task Team will work with the IAs to improve their budgeting systems during the project implementation.

21. **Accounting.** The administration, accounting and reporting of the project will be set up in accordance with the Circular #13: "Accounting Regulations for World Bank Financed Projects" issued in January 2000 by MOF. The circular provides in-depth instructions of accounting treatment of project activities and covers: (i) chart of account; (ii) detailed accounting instructions for each project account; (iii) standard set of project financial statements; and (iv) instructions on the preparation of project financial statements.

22. The standard set of project financial statements mentioned above has been agreed between the Bank and MOF and applied to all Bank projects appraised after July 1, 1998 and includes: (i) Balance sheet of the project; (ii) Statement of implementation of grant agreement; (iii) Statement of designated account; and (iv) Notes to the financial statements.

23. Project accounting records will be managed, monitored and maintained by the ECD of MOF for project activities executed by the central government IAs and GDGP, and by SDFB and SXFB for activities in their respective province. Original supporting documents will be retained by each PMO or the PEO with copies provided to the ECD of MOF or SDFB or SXFB. Financial statements will be prepared by the ECD of MOF for the activities executed at the national level and in Guangdong, and by SDFB and SXFB for the activities executed in Shandong and Shanxi respectively.

24. Accountants with adequate qualification and work experience in FM are critical to success of project FM. The Task Team has reviewed and confirmed that the staff identified for the FM positions at the National PMO, SDFB and SXFB are qualified and have appropriate work experience to perform their work and duties.

25. The FMM will be prepared by the ECD of MOF to provide detailed guidelines on FM including internal controls, accounting procedures, fund and asset management, withdrawal application procedures, financial reporting and auditing arrangement to ensure consistent quality of accounting work.

26. The ECD of MOF, SDFB and SXFB will individually decide the use of computerized FM information system or manual entries to record and maintain the project accounting books. The Task Team will monitor the accounting process especially during the initial stage to ensure complete and accurate financial information be provided in a timely manner.

27. **Internal Control and Internal Auditing.** The internal control for the project will follow the accounting policy, procedures and regulations issued by MOF and the project specific FMM issued by the National PMO.

28. There is no formal independent internal audit function at all IAs. However, this will not have a significant impact on FM as the monitoring by the PMOs, SXFB, SDFB, MOF, supervision by the Bank missions, and the annual external audits are arranged so as to ensure appropriate FM by various IAs even without efficient internal control and audit.

29. **Financial Reporting.** The format and content of the project financial statements represent the standard project financial reporting package agreed between the Bank and MOF and have been discussed and agreed among all the parties concerned. The ECD of MOF, SDFB and SXFB will prepare relevant project financial statements and submit these to the Bank for review and comment on a regular basis. In line with MOF's and updated Bank's regulations, the interim un-audited project financial statements should be submitted as part of a progress report to the Bank on a semi-annual basis (prior to August 15 and February 15 of the following year).

30. **Financial Covenants.** No specific financial covenants are applicable to the project except for those standard financial covenants such as project audit and interim financial reports.

31. **Supervision Plan.** The supervision plan for this project will be based on the FM risk rating, which will be evaluated on a regular basis by the Task Team.

Annex 8: Procurement Arrangements

CHINA: GEF China Thermal Power Efficiency Project

A. General

1. Procurement for the project activities would be carried out in accordance with the Bank's latest "Guidelines: Selection and Employment of Consultants by World Bank Borrowers" (current version May 2004, revised October, 2006) and "Guidelines: Procurement under IBRD Loans and IDA Credits" (current version May 2004, revised October, 2006); and the provisions stipulated in the legal agreement [31]. The general description of various items under different expenditure categories can be found in the Procurement Plan. For each contract to be financed by the GEF Grant proceeds, the different procurement methods, estimated costs, prior review requirements and time frame are agreed between the Recipient and the Bank's Task Team in the Procurement Plan. The Procurement Plan will be updated annually or as required to reflect the actual project implementation needs and improvements in institutional capacity.

2. **Procurement of Works.** Not Applicable

3. **Procurement of Goods.** For procurement of equipment, materials and information system, the international competitive bidding (ICB) shall be followed for each contract estimated at more than US$ 500,000 using the Bank's Standard Bidding Documents for procurement of Goods and IT Information System, national competitive bidding (NCB) for each contract estimated more than US$ 100,000 and less than US$ 500,000 using MOF's MBD dated May 1997 agreed with the Bank, and the Shopping procedures for each contract less than US$ 100,000.

4. **Procurement of Non-consulting Services.** Not applicable.

5. **Selection of Consultants.** For selection of consultants, the procurement will follow the Quality and Cost based Selection or Quality Based Selection procedures for all contracts estimated above US$ 200,000 and Selection Based on Consultant's Qualification for all contracts below US$ 200,000 for firm consultants, as well as Individual Consultant procedures for individual consultants. Short lists for consulting services estimated to cost less than US$ 300,000 equivalent per contract can be composed entirely of national consultants in accordance with the provisions of paragraph 2.7 of the Consultant Guidelines. Consultants that are Universities and Government Research Institutions will be selected in accordance with the provisions of paragraphs 1.11(c) and 2.8 of the Consultant Guidelines. Single Source Selection may apply, subject to prior approval by the Bank, when justified. The Banks latest Standard Request for Proposal shall be used. The current version is: Standard Request for Proposal, Selection of Consultants, December 2008.

6. **Operational Costs.** The PMOs, PEO and PCO at both the national and provincial levels will rent offices, hire consultants for interpretation and translation, and procure services, goods equipment and materials for the operation of the project offices using the GEF Grant proceeds allocated for project management cost. The procurement shall follow the Bank's guidelines for procurement of goods and services.

[31] Including the GEF Grant Agreement between the GOC and the Bank and the sub-grant agreements between MOF and the provinces

7. **Others.** Training will be provided for capacity building to the staff of the agencies involved in the project management and implementation.

B. Procurement Capacity Assessment

8. Procurement activities will be carried out by various IAs including National PMO in MOF, Provincial PMOs/PEO in Shandong and Shanxi, GDGP in Guangdong, Shanxi Yangguang Thermal Power Plant, Shandong Huangtai Thermal Power Plant and Shandong Jinan Beijiao Thermal Power Plant. The National PMO will be responsible for the reporting of procurement activities and updating the procurement plan for the Bank review in accordance with the precepts of the grant agreements.

9. An assessment of the capacity of the IAs for procurement actions under the project was carried out by the Bank Task Team in November 2007. Based on the information provided to the Bank, the assessment reviewed the organizational structure for the project implementation and the interaction between the project's staff who are responsible for procurement in the National PMO and the IAs in the provinces.

10. The capacity of the IAs for procurement management will be enhanced by hiring experienced procurement agents and consultants and also by training. The provisions in the legal agreements for the procurement, Bank prior review and post review on the procurement activities will ensure that the Bank's policies and procedures will be followed. The risk has been rated as average.

11. The issues/risks concerning the procurement for project implementation have been reviewed and documented in the procurement capacity assessment report, including the agreed corrective measures:

Table 8.1: Action Plan for Procurement Capacity Enhancement

No	Proposed Action Plan	Due Date
1	Shanxi PEO and Shandong PMO to hire experienced procurement agents and consultants to work on the procurement	Before negotiations
2	All PMOs/PEO to appoint experienced staff dedicated for procurement activities as needed; and adequate qualified procurement staff at each PMO or PEO be in place	Before negotiations
3	PMOs/PEO to organize periodically, or send staff out for, procurement training activities; on-the-job training to be conducted for all staff working on the procurement; the National PMO organized the first training on procurement to all PMOs/PEO involved by the Bank procurement specialist in 02/2009	From time to time as planned
4	Procurement Plan and terms of reference to be drafted for the first year contracts under the project and revised according to Bank's comments	Before negotiations
5	To publish General Procurement Notice on UNDB online and dgMarket	Before any procurement

C. Procurement Plan

12. A Procurement Plan was prepared by the Recipient for project implementation and was agreed between the Recipient and the Task Team during the project preparation. It is available at the National PMO in Beijing, China. It will also be available in the project's database and in the Bank's website of ImageBank. The Procurement Plan will be updated in agreement with the Task Team annually or as required to reflect the actual project implementation needs and improvements in institutional capacity.

13. See Table 8.2 for the agreed prior review thresholds for the project.

Table 8.2: Threshold for Prior Review of Contract

	Threshold for Procurement Method			Threshold for Prior Review
Goods	**ICB**	**NCB**	**Shopping**	>US$ 200,000 and all DC
	>US$ 500,000	<US$500,000 and >US$100,000	<US$100,000	
Consultant Services	**QCBS/QBS**	**CQS**	**IC**	>US$ 100,000 for firm and all SSS
	>US$ 200,000	<US$ 200,000	Any value	

Notes:

ICB: International Competitive Bidding
NCB: National Competitive Bidding
DC: Direct Contracting
QCBS: Quality and Cost Based Selection
QBS: Quality Based Selection
CQS: Selection Based on Consultant's Qualifications
IC: Individual Consultants
SSS: Single Source Selection

14. In addition, the Bank will review all terms of references and the procurement of the first contract under each category by each PMO/PEO.

15. The procurement method thresholds for the project will be:

Table 8.3: Procurement Method for GEF Financed Contract

Procurement Method	Civil Works	Goods	Consultant services
ICB	NA	500K	>300K (short list to contain not more than 2 firms from any country) <300K (shortlist may include only national consultants)
NCB, advertisement in a national newspaper	NA	>300K	
NCB, advertisement in a provincial newspaper	NA	<300K	Firm >200K: QCBS/QBS <200K: CQS IC
Shopping	NA	<100K	
Single Source	NA	DC when justified	SSS when justified

16. Advertisement: In addition to a national newspaper, all Procurement Notices for consultant contracts above US$ 200,000 for firms shall be advertised on UNDB on-line and dgMarket. The advertisement for Expression of Interest for selection of consulting firms shall be in a national newspaper regardless of the contract value.

17. Proposal evaluation and contract award shall be published in accordance with paragraphs 2.28, 3.8 and 3.13 of the Guidelines for consultant services.

D. Frequency of Procurement Supervision

18. The Bank will monitor the procurement closely through its prior review procedures, regular supervision missions and procurement post-review missions. In addition to the prior review and supervision, the capacity assessment of the IAs has recommended supervision missions to visit the

field to carry out post review of procurement actions every 6 months if there are post review contracts procured during the period.

19. Contract package in the Procurement Plan prepared by Recipient and approved by the Bank is as follows:

Procurement Plan for the Contracts under GEF China Thermal Power Efficiency Project

Table 8.4: Shanxi Province – Contract Package for Provincial PEO

No.	Contract No.	Contract name	Cost Estimates (US$ 1000)	GEF Fund (US$ 1000)	Procurement methods	Prior or post review	Contract signing (Year)	Contract duration (months)
Component 1 – Mechanisms to Support Closing down Inefficient Small Thermal Units								
1.	SX/CHP1	CHP On-line Monitoring System - Planning	143	143	CQS	Prior	2008	6
2.	SX/CHP2	CHP On-line Monitoring System - Design	143	143	CQS	Prior	2009	3
3.	SX/CHP3	CHP On-line Monitoring System - Supply & Installation	4,286	714	ICB	Prior	2010	6
		Sub-total	4,643	1,000				
4.	SX/Trade1	Emission Allowance Trading - FS, Planning & Design	171	171	CQS	Prior	2008	6
5.	SX/Trade2	Emission Allowance Trading - Supply & Installation	186	186	NCB	Post	2009	3
6.	SX/Trade3	Emission Allowance Trading - Knowledge Sharing & Training	143	143	CQS, SOE	Prior	2010	6
		Sub-total	500	500				
7.	SX/M&E1	Monitoring & Evaluation - Services	286	286	QCBS	Prior	2008	6
8.	SX/M&E2	Monitoring & Evaluation - Equipment	71	71	Shopping	Post	2008	6
		Sub-total	357	357				
9.	SX/CSUF1	MCSU - Capitalization	12,000	3,000	by Manual			
10.	SX/CSUF2	MCSU - Operational Manual	43	43	CQS	post	2009	6
		Sub-total	**12,043**	**3,043**				
		Total Component 1 – Shanxi	**17,543**	**4,900**				
Component 4 – Technical Assistance to Project Implementation								
11.	SX/PA	Procurement Agent - Firm	102	102	CQS	Prior	2008	48
12.	SX/PM1	Project Manager in PCO - IC, 4 Years	41	41	IC	Prior	2008	48
13.	SX/PM2	Project Manager in PEO - IC, 4 Years	41	41	IC	Post	2008	48
14.	SX/PS	Procurement Specialist in PEO - IC, 4 Years	41	41	IC	Post	2008	48
15.	SX/I&T	Interpretation and Translation - SOE	29	29	SOE	Post	2008	48
16.	SX/FMS	FM Specialist In PEO - IC, Part Time in 4 Years	21	21	IC	Post	2008	24
17.	SX/OE	Office Equipment - Multiple Contracts	43	43	Shopping	Post	2008	2
18.	SX/TR	Training	386	100	CQS, SOE	Post	2008	48
		Total Component 4 – Shanxi	**704**	**417**				
		Total Components 1 and 4 – Shanxi	**18,247**	**5,317 /1**				

Note: /1 including US$ 3.00 million ear-marked as capitalization to the MCSU.

Table 8.5: Shanxi Province – Contract Package for Yangguang Thermal Power Plant

No.	Contract No.	Contract name	Cost Estimates (US$ 1000)	GEF Fund (US$ 1000)	Procurement methods	Prior or post review	Contract signing (Year)	Contract duration (months)
Component 2 – Demonstration of Power Plant Efficiency Improvement								
19.	SX/YG1	Replacement of Steam Shaft Sealing For No.4 Turbine	1,489	286	DC	prior	2008	6
20.	SX/YG2	VSD (2 Set) for Primary Blower of No.2 Boiler	1,143	571	ICB	prior	2008	6
21.	SX/YG3	System for Plant Efficiency Verification - Goods	143	143	NCB	post	2009	12
22.	SX/YG4	System for Plant Efficiency Verification - Services	71	71	CQS	post	2009	12
23.	SX/YG5	Assessment – Energy Auditing after Retrofit	29	29	CQS	post	2009	12
		Total Component 2 – Shanxi	**2,875**	**1,100**				
		Total Components 1, 2 and 4 Shanxi	**21,122**	**6,417**				

Table 8.6: Shandong Province – Contract Package for Provincial PMO

No.	Contract No.	Contract name	Cost Estimates (US$ 1000)	GEF Fund (US$ 1000)	Procurement methods	Prior or post review	Contract signing (Year)	Contract duration (months)
Component 1 – Mechanisms to Support Closing down Inefficient Small Thermal Units								
24.	SD/CHP1	CHP On-line Monitoring System - Supply & Installation	2,580	1,000	ICB	Prior	2010	6
		Sub-Total	**2,580**	**1,000**				
25.	SD/Trade1	Emission Allowance Trading - FS, Planning & Design	171	171	CQS	Prior	2008	6
26.	SD/Trade2	Emission Allowance Trading - Supply & Installation	186	186	NCB	Post	2009	3
27.	SD/Trade3	Emission Allowance Trading - Knowledge Sharing & Training	143	143	CQS, SOE	post	2010	6
		Sub-Total	500	500				
28.	SD/M&E1	Monitoring & Evaluation - Services	286	286	QCBS	Prior	2008	6
29.	SD/M&E2	Monitoring & Evaluation - Equipment	71	71	Shopping	Post	2008	6
		Sub-Total	357	357				
30.	SD/CSUF1	MCSU - Capitalization	8,000	2,000	by Manual			
31.	SD/CSUF2	MCSU - Operational Manual	43	43	CQS	Post	2009	3
		Total Component 1 – Shandong	**7,900**	**2,043**				
Component 4 – Technical Assistance to Project Implementation								
32.	SD/PA	Procurement Agent - Firm	143	143	CQS	Prior	2008	48
33.	SD/PM	Project Manager In PMO - IC, 4 Years	41	41	IC	Prior	2008	48
34.	SD/PS	Procurement Specialist in PMO - IC, 4 Years	41	41	IC	Post	2008	48
35.	SD/I&T	Interpretation and Translation - SOE	29	29	SOE	Post	2008	48
36.	SD/FMS	FM Specialist in PMO - IC, Part Time in 4 Years	21	21	IC	Post	2008	24

No.	Contract No.	Contract name	Cost Estimates (US$ 1000)	GEF Fund (US$ 1000)	Procurement methods	Prior or post review	Contract signing (Year)	Contract duration (months)
37.	SD/OE	Office Equipment - Multiple Contracts	43	43	Shopping	Post	2008	2
38.	SD/TR	Training (multiple contracts)	200	100	CQS, SOE	Post	2008	48
		Total Component 4 – Shandong	**518**	**418**				
		Total Components 1 and 4 – Shandong	**11,998**	**4,318 /2**				

Note: /2 including US$ 2.00 million ear-marked as capitalization to the MCSU.

Table 8.7: Shandong Province – Contract Package for Huangtai Thermal Power Plant

No.	Contract No.	Contract name	Cost Estimates (US$ 1000)	GEF Fund (US$ 1000)	Procurement methods	Prior or post review	Contract signing (Year)	Contract duration (months)
Component 2 – Demonstration of Power Plant Efficiency Improvement								
39.	SD/HT1	Retrofit of No.7 Turbine for Steam Extraction – Goods (valve)	470	470	DC	prior	2008	3
40.	SD/HT2	Retrofit of No.7 Turbine for Steam Extraction – Goods (vane and cover)	238	238	DC	prior	2009	4
41.	SD/HT3	Retrofit of No.7 Turbine for Steam Extraction – Goods (VSD)	70	70	Shopping	prior	2008	4
42.	SD/HT4	Retrofit of No.7 Turbine for Steam Extraction – Goods (de-oxygen units)	70	70	Shopping	prior	2008	4
43.	SD/HT5	Retrofit of No.7 Turbine for Steam Extraction – Goods (temperature reducer)	26	26	Shopping	prior	2008	4
44.	SD/HT6	Retrofit of No.7 Turbine for Steam Extraction – Goods (pump)	50	50	Shopping	prior	2008	4
45.	SD/HT7	Retrofit of No.7 Turbine for Steam Extraction – Service (Master heat exchange station design)	143	143	CQS	prior	2009	4
46.	SD/HT8	Retrofit of No.7 Turbine for Steam Extraction – Services (energy saving auditing)	29	29	CQS	post	2009	4
		Total Component 2 – Shandong Huangtai	**1,096**	**1,096**				

Table 8.8: Shandong Province – Contract Package Jinan Beijiao Thermal Power Plant

No.	Contract No.	Contract name	Cost Estimates (US$ 1000)	GEF Fund (US$ 1000)	Procurement methods	Prior or post review	Contract signing (Year)	Contract duration (months)
Component 2 – Demonstration of Power Plant Efficiency Improvement								
47.	SD/BJ1-1	Retrofit of No.2 Turbine (12MW) and No.5 Turbine (50 MW) – Goods (pump, valve and pipes for master heat-exchange station)	470	470	ICB	prior	2008	6
48.	SD/BJ1-2	Retrofit of No.2 Turbine (12MW) and No.5 Turbine (50 MW) – Goods (heat exchangers for master heat-exchange station)	423	423		prior	2008	6
49.	SD/BJ1-3	Retrofit of No.2 Turbine (12MW) and No.5 Turbine (50 MW) – Goods (electric and thermal control for master heat-exchange station)	177	177		prior	2008	6
50.	SD/BJ2	Retrofit of No.7 Turbine for Steam Extraction – Services (energy saving auditing)	29	29	CQS	post	2009	4
		Total Component 2 – Shandong Jinan Beijiao	**1,099**	**1,099**				
		Total Components 1, 2 and 4 – Shandong	**14,336**	**6,513**				

Table 8.9: Guangdong Province – Contract Package for Guangdong Provincial Power Grid

No.	Contract No.	Contract name	Cost Estimates (US$ 1000)	GEF Fund (US$ 1000)	Procurement methods	Prior or post review	Contract signing (Year)	Contract duration (months)
Component 3 – Transition to Efficient generation dispatch								
51.	GD/ESD1	ESD - Simulation Model Development	190	190	QCBS	prior	2009	6
52.	GD/ESD2	ESD Simulation – Supervision and Assessment	60	60	CQS	post	2009	4
53.	GD/ESD3	ESD Simulation – System Design	100	100	SSS	prior	2009	3
54.	GD/ESD4	ESD Simulation – System Soft Ware Development	580	580	QCBS	prior	2009	6
55.	GD/ESD5	ESD Simulation System – Hardware and Equipment	1,200	1,200	ICB	prior	2009	6
		Subtotal	**2,130**	**2,130**				
56.	GD/CHP1	CHP On-line Monitoring – SW Development	30	30	SSS	prior	2009	6
		Subtotal	**30**	**30**				
57.	GD/INF1	Information Disclosure System – SW Development	100	100	CQS	prior	2009	3
58.	GD/INF2	Information Disclosure System – HW and Equipment	444	44	NCB	prior	2009	3
		Subtotal	**544**	**144**				
59.	GD/PA	Procurement Agent - Firm	42	42	CQS	post	2009	12
60.	GD/M&E1	Technical assistance to Assessment and Evaluation	74	74	CQS	post	2009	3
		Total Component 3 – Guangdong	**2,820**	**2,420**				
Component 4 – Technical Assistance to Project Implementation								
61.	GD/PM	Project Management – IC, 3 Years	50	50	IC	prior	2008	36
62.	GD/TR	Training (multiple contracts)	200	100	CQS, SOE	Post	2008	36
		Total Component 4 – Guangdong	**250**	**150**				
		Total 3 and 4 – Guangdong	**3,070**	**2,570**				

Table 8.10: National Agencies – Contract Package for National Agencies and National PMO

No.	Contract No.	Contract name	Cost Estimates (US$ 1000)	GEF Fund (US$ 1000)	Procurement methods	Prior or post review	Contract signing (Year)	Contract duration (months)
NDRC – Technical Assistance for Project Implementation and Replication (Component 3)								
63.	NDRC/ESD1	Assessment of ESD Pilot in the 5 Pilot Provinces (multiple contracts)	613	613	QCBS/CQS, IC	Prior / post	2009	12
64.	NDRC/TRF	Study of Pricing and Tariff Mechanism (multiple contracts)	258	258	QCBS/CQS, IC	Prior / post	2009	24
65.	NDRC/EFF	Unit Efficiency Verification Procedure & Methodology (multiple contracts)	130	130	CQS, IC	Prior / post	2009	12
66.	NDRC/REP	Knowledge Sharing And Replication (multiple contracts)	71	71	CQS, IC	post	2009	8
		Sub-total	**1,072**	**1,072**				
SERC – Technical Assistance for Project Implementation and Replication (Component 3)								
67.	SERC/ESD1	ESD – Financial Compensation Mechanism	54	54	CQS	post	2009	12
68.	SERC/ESD2	ESD – Information Disclosure	44	44	CQS	post	2009	6
69.	SERC/PMK1	Study on ESD and Power Market Development (multiple contracts)	281	281	QCBS/CQS, IC	Prior / post	2009	6
		Sub-total	**379**	**379**				
MOF – Technical Assistance for Project Implementation and Replication (Component 1)								
70.	MOF/CSUF1	MCSU – Operational Manual Development	57	57	CQS	post	2008	3
71.	MOF/CSUF2	Assessment of MCSU & Replication (multiple contracts)	357	357	QCBS/CQS, IC	Prior / post	2009	4
72.	MOF/Trade1	Assessment of SO_2 Emission Allowance Trading & Replication (multiple contracts)	286	286	CQS, IC	Prior / post	2009	6
73.		**Sub-total**	**700**	**700**				
National PMO – Technical Assistance for Project Implementation and Replication (Component 2)								
74.	NPMO/ REP1	Standard Procedures For Plant Energy Audit	57	57	CQS, IC	Post	2008	6
75.	NPMO/ REP2	Best Practice For Plant O&M (multiple contracts)	357	357	QCBS/CQS, IC	prior	2009	12
76.	NPMO/ REP3	Demonstration Project For Plant Efficiency Improvement - Assessment & Replication	286	286	CQS, SOE	Prior / post	2009	6
		Sub-total Replication	354	354				
77.	NPMO/PM1	Project Management – IC, 4 Years	144	144	IC	Prior	2008	48
78.	NPMO/PM1	Technical Experts – Two ICs, 4 Years	115	115	ICs	Post	2008	48
79.	NPMO/PS	Procurement Specialist – IC, 4 Years	43	43	IC	Post	2008	48

No.	Contract No.	Contract name	Cost Estimates (US$ 1000)	GEF Fund (US$ 1000)	Procurement methods	Prior or post review	Contract signing (Year)	Contract duration (months)
80.	NPMO/FMS	FM Specialist – IC, 4 Years	48	48	IC	Post	2008	48
81.	NPMO/SE	Secretary – IC, 4 Years	34	34	IC	Post	2008	60
82.	NPMO/I&T	Interpretation And Translation (multiple contracts)	41	41	IC, SOE	Post	2008	60
83.	NPMO/TR	Training (multiple contracts)	100	100	CQS, SOE	Post	2008	60
84.	NPMO/OE	Office Equipment	30	30	Shopping	Post	2008	2
		Sub-total Project Implementation	**555**	**555**				
		Total – National Agencies and PMO	**3,060**	**3,060**				

Annex 9: Economic and Financial Analysis

CHINA: GEF China Thermal Power Efficiency Project

1. To achieve the project objective of reducing coal consumption per unit of coal-fired electricity production in China, the project supports the establishment of incentive mechanisms, demonstration projects, and technical assistance through providing grants to a set of carefully selected energy efficiency improvement activities which include the closure of inefficient small coal-fired generation units (Component 1), three power plant efficiency improvement pilot projects (Component 2), and transition to efficient generation dispatch (Component 3) as well as technical assistance and project management strengthening components.

A. Economic Analysis

2. To provide the economic justification for the GEF involvement, economic analysis was conducted for main components to demonstrate the economic benefits. In particular, the cost-benefit analysis approach was employed for each of the three power plants selected for demonstration of efficiency improvement projects at the power plant level. The scales of potential economic gains of the mechanisms for the closure of small units (MCSU) and the transition to efficient dispatch were also estimated in order to justify the use of the GEF grants to create the incentive mechanisms and develop regulations to help overcome the implementation barriers. The results of the economic analysis are summarized below.

Identification of Economic Benefits and Costs

3. Based on the analysis of project alternatives discussed in the previous section, the economic analysis was conducted for the selected option of investment under Component 2 and compared with the business-as-usual scenarios, under which the efficiency improvement activities would not occur. Economic benefits and costs, both direct and external, of the investments for power plant efficiency improvement were identified and then quantified as much as possible.

4. The main economic benefit of this project is the direct economic gain of coal saving due to energy efficiency improvement. Because coal-burning generates local (fine particulates), regional (SO_2) and global (CO_2) pollution, external benefits are the avoided local and regional environmental damage costs of SO_2, particulates and NO_X emissions reduction, as well as the global benefit of CO_2 emissions reduction.

5. For example, the investment activities at Huangtai and Jinan Beijiao plants for supply of both electricity and heat, direct benefits include the coal savings and GHG emission reduction due to the GEF Project-supported activities when compared with the business-as-usual scenarios, for production of the same amount of power and heat. In Yangguang where the investment activity will be solely for increased efficiency of electricity production, direct benefit would come from the reduction in production inputs due to increased efficiency in power production after the project completion and the reduction in operations and maintenance cost. The annual benefit is measured with coal savings and GHG emission reduction for the same output of electricity with and without the investment activity.

6. The direct costs of the investment projects are associated with fixed capital investments and incremental O&M costs incurred by the projects. Capital investments include the construction cost and the costs of purchasing and installing equipment or software. For the projects at Huangtai and Jinan Beijiao which will generate additional heat supply, the fixed investment needed for the construction of off-site heat supply pipeline network and the incremental consumption of electricity are also included. There are no incremental external costs as the investments generate no by-products that are environmentally harmful.

General Assumptions and Key Data Used.

7. The economic analysis assumes that market prices for the main elements of costs and benefits (such as coal and electricity) do not vary much from their economic values. Therefore, shadow prices and conversion factors were not applied. The discount rate normally accepted in the Bank-financed projects in China is 10% for investment projects recommended by NDRC in 2002. The economic benefits and costs, including contingencies, are valued at base year 2007 price levels and are net of inflation, duties and taxes. To be conservative, no increase in real terms of prices or tariffs is assumed while estimating economic benefits over time. The duration of the project construction is all assumed within one year in 2008-2009. (Usually turbine rehabilitation requires only a few months). The duration of the project operation is assumed to be 20 years, i.e., from 2009 to 2028, except for Huangtai which has units which are relatively old.

8. Valuing the local and global environmental benefits of energy efficiency improvement in the analysis is a challenge because to date no plant-specific or province-specific analysis has ever been done. The benefit transfer approach is adopted by applying the estimated unit cost of the main local air pollutant (SO_2) obtained elsewhere to the power plants of the project. For valuing the global benefit, the Chinese floor price of US$ 10 per ton of certified CO_2 emission reduction is used to approximate the global benefit per ton of CO_2 emission reduced (see details in the sections below).

9. Valuing Environmental Benefits. It is difficult to value the environmental benefits of reducing the SO_2, particulates, NO_x and CO_2 emissions because these benefits may include avoided damage on human health, species, buildings, farming and forestry which are difficult to quantify.

10. SO_2 is a primary contributor to acid rain which causes breathing and lung problems in human beings especially in children, the elderly and people with asthma. It has also been widely observed that acid rain causes damage to natural ecological systems (such as forests and river system), agricultural production, property, etc. The project directly contributes to SO_2 emissions reduction.

11. There have been a number of studies that have attempted to quantify the environmental costs of SO_2 in monetary terms in China. The study results were used in economic valuation of previous Bank-supported energy projects, for examples the China Renewable Energy Scale-up Program (CRESP) and the Shandong Power Plant Flue Gas Desulfurization Project. The unit costs of Total Suspended Particulate (TSP), SO_2 and NO_x for Shandong Province are shown in the table below. A significant portion of the environmental damage costs of power generation in Shandong are from damages which originate in other, nearby provinces, and are therefore a consequence of atmospheric transport.

Table 9.1: Damage costs of Emissions in Shandong (at 1999 price levels)

	Total damage Cost /1	Damage cost in	Percentage of damage

			Shandong	costs in Shandong
	US$/ton	Y/ton	US$/ton	%
TSP	1,332	10,656	270	20.3%
SO_2	311	2,488	54	17.5%
NO_X	335	2,680	69	20.7%

/1 Including damage costs in Shandong, Hebei, Henan, Beijing, Tianjin and Jiangsu
Source: World Bank, *CRESP Economic Analysis*, Vol.1, 2002.

12. The analysis of SO_2 damage by region conducted in 1999 for China long- and mid-term energy strategy indicated unit estimates much higher than CRESP's US$ 311 per ton.

Table 9.2: SO_2 Damage Estimation by Region in China

RMB Y/ton

	North	Northeast	West	Southeast	South	East	Middle
Low	2500	2800	1300	1500	3900	3300	1700
High	3000	3000	1500	6000	8000	8000	6000

Source: Zhou Fengqi and Zhou Dadi, *et al*., *China Long- and Mid-Term Energy Strategy*, China Planning Press, 1999.

13. A World Bank study on acid rain in Hunan Province also derived the damage cost for SO_2 (shown below). These amounts are based on estimates of crop and forest damage due to decreased yields and human health effects based on both the human capital approach and the willingness-to-pay approach. The damage cost is about 20% greater than CRESP's value.

Table 9.3: SO_2 Damage Estimation for Hunan Province

RMB/ton

	1995	2000	2005	2010	2015	2020
Y/ton	2384	3,022	3,912	4,884	5,736	6,595
Annual rate of increase		4.9%	5.3%	4.5%	3.3%	2.8%
CRESP (Table 1.3)		2,488				

Source: World Bank/ESMAP, *China: Air Pollution and Acid Rain Control: The case of Shijiazhuang City and the Changsha Triangle Area*, October 2003.

14. Compared with the estimates of other studies on environmental impacts of SO_2 in China, the CRESP estimate of SO_2 damage is lower and more conservative. The CRESP estimate has taken into account the location of the damage cost reductions, so the beneficiaries are identified more clearly in the analysis. The values show that a significant portion of the damage costs of power generation in a province like Shandong and Shanxi is incurred in nearby provinces as a consequence of atmospheric transport (particularly in Hebei, Henan, Beijing, Tianjin and Jiangsu). Only about less than 20% of the damage cost is within the provinces themselves. For the project economic analysis, the CRESP unit cost of US$ 311 per ton of SO_2 (1999 price) is adopted.

15. The cost value should increase over time because damage costs increase as per capita GDP increases. Shandong and Shanxi presently have high annual GDP growth rates (15% and 12.6%, respectively, in 2005) so an annual increase in unit damage costs hypothesized in the Hunan study are quite conservative, especially for Shandong, even given that 15% GDP growth rates are very unlikely to be sustained over the entire project lifetime. In Shandong Power Plant Flue Gas Desulfurization Project, it was assumed that the baseline damage cost estimates escalate by a constant 3.5% per year for SO_2. The same escalator is used in the economic analysis of this project, which provides US$ 410 per ton of SO_2 for the project base year of 2008.

16. The air pollution damage from particulates and NO_X are more local and location-related. Since the project supported power plants are away from high population density areas, the avoided local environmental damage related to particulates and NO_X is not taken into account to avoid double-accounting or over-estimating local air pollution costs. The local environmental benefits and as a result the EIRR projected for each power plant, are likely to be the lower bound values.

17. For global environmental benefits, it is even more difficult to predict and estimate the physical and economic loss due to CO_2 emissions by the power plants involved. But since China is actively participating in Clean Development Mechanism under the Kyoto Protocol, the Chinese floor price of certified CO_2 reduction is used in the approximation of the global environmental value of per ton CO_2 reduction. The current price is US$ 10 per ton of CO_2, which is used in the analysis.

Economic Evaluation by Power Plant

18. A main component at the provincial level is to support the demonstration of technologies and practices of thermal power plant retrofit and CHP conversion which not only gain maximum efficiency improvement but which are also economically and financially viable. The cost-benefit analysis was carried out for the investment of each selected power plant to assess its economic rationality. The results of the analysis were presented below.

19. Conversion for CHP Operation at Huangtai Thermal Power Plant**.** This investment of converting the power generation only units at Huangtai Thermal Power Plant into CHP operation will modify both its # 7 and # 8 units (2 x 300 MW) into 330 MW CHP units to produce heat which will substitute the heat supply by its two smaller CHP units (Unit # 5 and unit # 6 of 110 MW each) and 77 sets of boilers for district heating. After the conversion, the plant will save about 0.17 million tce per year to produce the same amount of electricity and heat (see Annexes 4 and Annex 15).

20. The project activities include: (i) retrofit of the #7 and #8 turbines, including associated auxiliary equipment and materials; (ii) construction of a head heat exchange station and associated rehabilitation of energy sources for the head heat exchange station; (iii) pipeline works within the plant facilities; and (iv) construction of extra pipeline works outside the plant facility, by another heat supply company.

21. The conversion for CHP operations will be the first project for units sized above 300 MW in the country. It is planned that project, including all the associated heat networks, will be completed by the end of 2008. The expected project life is 10 years (up to 2018) due to the age of the turbines at Huangtai. The total cost of the investment project is RMB 191.1 million or US$ 27.3 million equivalent. After the conversion, incremental annual O&M cost is estimated at 2% of the project investment cost and the project will supply heat of 4.89 million GJ per year. The EIRR of the project activities is projected at 20.4% as shown in Table 9.4 below.

Table 9.4: Economic Analysis of Huangtai Thermal Power Plant in Shandong

			NPV @ 10%	[0] 2008	[1] 2009	[2] 2010	[3] 2011	[4] 2012	[5] 2013	[6] 2014	[7] 2015	...2018
Economic cost at plant level												
Capital investment	191.1	[Ym]		102.4	88.73							
Incremental O&M cost (2% of investment cost)		[Ym]		0.0	2.05	3.82	3.82	3.82	3.82	3.82	3.82	3.82
Incremental Electricity Consumption for Heat Production		[Ym]		0.0	48.70	96.15	96.15	96.15	96.15	96.15	96.15	96.15
Total economic cost		[Ym]		102.38	139.47	99.97	99.97	99.97	99.97	99.97	99.97	99.97
Economic benefits at plant level												
Net saving of coal consumption to meet same power/heat supply due to increased efficiency		[Ton]			85000	170000	170000	170000	170000	170000	170000	170000
		[Ym]			51.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00
Total economic benefits at plant level					51.00	102.00	102.00	102.00	102.00	102.00	102.00	102.00
Local environmental benefits of SO2 reduction												
Damage cost escalator over year	3.5%											
Unit damage cost	311	[$/ton]		410	424	439	454	470	486	503	521	578
		[Y/ton]		2867	2967	3071	3178	3290	3405	3524	3647	4044
Avoided SO2 emissions		[tons/year]			1919	3838	3838	3838	3838	3838	3838	3838
Value of environmental benefits of SO2 reduction		[Ym]			5.7	11.8	12.2	12.6	13.1	13.5	14.0	15.5
Total local environmental benefits		[Ym]	67.9	0	5.7	11.8	12.2	12.6	13.1	13.5	14.0	15.5
Global environmental benefits of CO2 reduction												
Reduction in CO2 emissions		[Ton]			232461	464922	464922	464922	464922	464922	464922	464922
CO2 price per ton certified emission reduction	10	[$/ton CO2]										
		[$]			2324611	4649221	4649221	4649221	4649221	4649221	4649221	4649221
		[Ym]			16.3	32.5	32.5	32.5	32.5	32.5	32.5	32.5
Total global benefits		[Ym]	168.3	0.0	16.3	32.5	32.5	32.5	32.5	32.5	32.5	32.5
Total economic benefits		[Ym]	763.9	0.0	73.0	146.3	146.7	147.2	147.6	148.1	148.5	150.1
Net economic flows		[Ym]	79.8	-102.4	-66.5	46.4	46.8	47.2	47.6	48.1	48.6	50.1
EIRR		[%]	**20.4%**									

Note: This table is truncated on the right-hand side due to space limitation.

22. Waste Heat Recovery at Jinan Beijiao Thermal Power Plant. This plant is supplying heat to the northern part of Jinan City (the capital of the province). Currently it has two CHP units – #2 (12 MW) and #5 (50 MW) servicing an area of 4.6 million m^2. A new load of 1.06 million m^2 has already been subscribed for its heat supply and a total of 2.10 million m^2 new area is expected to be supplied with heat by the retrofit project by the year 2011, plus one set of 240 t/h boiler, or otherwise to be supplied by two sets of 240 t/h boilers. The retrofit work at #2 and #5 units is to recover the residual heat dissipated in the cooling towers for heat supply with circulation of the cooling water, avoiding construction of one 240 t/h boiler.

23. The rehabilitation project will have the following four investment activities:

(a) retrofit work at the #2 and #5 units (condensing type);

(b) construction of a master heat-exchange station (60/45ºC) within the plant facility for heat supply to an area of 2.0 million m^2, with hot circulation water;

(c) expansion of the required pipeline network for the hot water heat supply, including the eastern part of the network of 28.1 km and the western part of the network of 22.2 km.

24. It is estimated that about 0.06 million tce can be saved per annum under the assumption of generating the same amounts of heat and power (see Annex 4 and 15). The total investment cost for the rehabilitation project is RMB 158.97 million or US$ 22.7 million equivalent. Incremental annual O&M cost is assumed to be 2% of the investment costs in following project years. The expected project life is 20 years. The EIRR of the rehabilitation activity is projected at 26.8% as shown in the table below.

Table 9.5: Economic Analysis of Jinan Beijiao Thermal Power Plant in Shandong

			NPV @ 10%	*[0] 2008*	*[1] 2009*	*[2] 2010*	*[3] 2011*	*[4] 2012*	*[5] 2013*	*[6] 2014*	*[7] 2015*	*[12] ...2020*	*[17] ...2025*	*[20] ...2028*
Economic cost at plant level														
Capital investment	158.97	[Ym]		159.0										
Incremental O&M cost (2% of investment cost)		[Ym]		0.0	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
Incremental Electricity Consumption for Heat Production		[Ym]		0.0	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Total economic cost		[Ym]		159.0	10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.6
Economic benefits at plant level														
Coal saving to meet same power/heat supply due to increased efficiency		[Ton]			60000	60000	60000	60000	60000	60000	60000	60000	60000	60000
		[Ym]			36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
Total economic benefits for plant					36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
Local environmental benefits of SO2 reduction														
Damage cost escalator over year	3.5%													
Unit damage cost	311	[$/ton]		410	424	439	454	470	486	503	521	619	735	815
		[Y/ton]		2867	2967	3071	3178	3290	3405	3524	3647	4332	5145	5704
Avoided SO2 emissions		[tons/year]			1798	1798	1798	1798	1798	1798	1798	1798	1798	1798
Value of environmental benefits of SO2 reduction		[Ym]			5.3	5.5	5.7	5.9	6.1	6.3	6.6	7.8	9.3	10.3
Total local environmental benefits		[Ym]	52.5	0.0	5.3	5.5	5.7	5.9	6.1	6.3	6.6	7.8	9.3	10.3
Global environmental benefits of CO2 reduction														
Reduction in CO2 emissions		[Ton]			164090	164090	164090	164090	164090	164090	164090	164090	164090	164090
CO2 price per ton certified emission reduction	10	[$/ton CO2]												
		[$]			1640902	1640902	1640902	1640902	1640902	1640902	1640902	1640902	1640902	1640902
		[Ym]			11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5
Total global benefits		[Ym]	97.8		11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5
Total economic benefits		[Ym]	420.1	0.0	52.8	53.0	53.2	53.4	53.6	53.8	54.0	55.3	56.7	57.7
Net economic flows		[Ym]	193.3	-159.0	42.2	42.4	42.6	42.8	43.0	43.2	43.4	44.6	46.1	47.1
EIRR		[%]	**26.8%**											

Note: This table is truncated. The expected project life is 20 years.

25. Investment for Efficiency Improvement at Yangguang Thermal Power Plant. The Plant has four 300 MW units which combust anthracite and which uses double arch firing boilers. The proposed rehabilitation activities include the followings:

(a) rehabilitation of # 4 unit turbine blade seals;

(b) installation of VSDs to the two primary fans of each boiler; and

(c) installation of necessary instruments for measuring the losses and development of software for efficiency verification through the measurements.

26. The total investment will be RMB 41.1 million or US$ 5.9 million equivalent. The expected project life is 20 years. Incremental annual O&M cost is assumed to be 2% of the investment costs in following project years. Coal savings would reach 0.04 million tce per year for the same amount of electricity due to increased efficiency and reduced plant service power consumption. The EIRR for the rehabilitation project is projected at 78.1% as shown in the table below.

Table 9.6: Economic Analysis of Yangguang Thermal Power Plant in Shanxi

			NPV @ 10%	*[0] 2008*	*[1] 2009*	*[2] 2010*	*[3] 2011*	*[4] 2012*	*[10] ...2018*	*[15] ...2023*	*[20] ...2028*
Economic cost at plant level											
Capital investment	41.09	[Ym]		41.09							
Incremental O&M cost (2% of investment cost)		[Ym]		0.0	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Total economic cost		[Ym]		41.1	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Direct economic benefits at plant level											
Reduction in coal consumption to produce same amount of power output		[Ton]			40000	40000	40000	40000	40000	40000	40000
		[Ym]			24.0	24.0	24.0	24.0	24.0	24.0	24.0
Total direct economic benefits for plant					24.0	24.0	24.0	24.0	24.0	24.0	24.0
Local environmental benefits of SO2 reduction											
Damage cost escalator over year	3.5%										
Unit damage cost	311	[$/ton]		410	424	439	454	470	578	686	815
		[Y/ton]		2867	2967	3071	3178	3290	4044	4803	5704
Avoided SO2 emissions		[tons/year]			480	480	480	480	480	480	480
Value of environmental benefits of SO2 reduction		[Ym]			1.4	1.5	1.5	1.6	1.9	2.3	2.7
Total local environmental benefits		[Ym]	14.0	0.0	1.4	1.5	1.5	1.6	1.9	2.3	2.7
Global environmental benefits of CO2 reduction											
Reduction in CO2 emissions		[Ton]			109393	109393	109393	109393	109393	109393	109393
CO2 price per ton certified emission reduction	10	[$/ton CO2]									
		[$]			1093934	1093934	1093934	1093934	1093934	1093934	1093934
		[Ym]			7.7	7.7	7.7	7.7	7.7	7.7	7.7
Total global benefits		[Ym]	59.3	0.0	7.7	7.7	7.7	7.7	7.7	7.7	7.7
Total economic benefits		[Ym]	259.0	0.0	33.1	33.1	33.2	33.2	33.6	34.0	34.4
Net economic flows		[Ym]	215.3	-41.1	32.3	32.3	32.4	32.4	32.8	33.1	33.6
EIRR		[%]	**78.7%**								

Note: This table is truncated on the right-hand side.

27. Overall Evaluation and Sensitivity Analysis of the Power Plant Efficiency Improvement Component. The EIRR by power plant and the aggregate EIRR of the three power plants are shown in the table below. The aggregate project EIRR is 30.5%, taking into account the economic benefits of the energy efficiency improvement investments at the plant, local and global levels. The economic returns reflect the high economic benefits from saving in coal consumption, plus local and global environmental benefits associated with SO_2 and CO_2 reduction, respectively.

Table 9.7: Summary of EIRR

Power Plant with Investment Projects	Huangtai	Jinan Beijiao	Yangguang	Average
EIRR	20.4%	26.8%	78.7%	30.5%

28. The EIRR of individual investment project varies from 20.4% in Huangtai to 78.7% of Yangguang. The variation is due primarily to the difference in capital costs and the energy efficiency gain of coal consumption by different technologies. The levels of sulfur and carbon content as well as the prices of coal at each power plant also contribute to the difference. All of these sub-projects have their EIRR above the hurdle level acceptable to the GOC, i.e., the 10% discount rate for investment projects recommended by NDRC in 2002. Therefore, the retrofit projects, are economically justified for investment.

29. To further test the robustness of the analysis, a sensitivity analysis was conducted. Even though the conservative values of coal reduction and environmental benefits have been used in the economic analysis, the sensitivity analysis further increased capital costs by 10% and/or decreased the coal savings / GHG emission reduction by 10%. The results, as shown in the table below, suggest a robust EIRR. The combined scenarios still yielded an aggregate EIRR of 23.7%. Therefore, the rehabilitation project is sound despite the possible variation in coal efficiency and investment cost.

Table 9.8: Results of Sensitivity Analysis

Power Plant with Investment Projects	EIRR base	Fixed cost increased by 10%	Coal saving reduced by 10%	Combined
Huangtai	20.4%	17.6%	13.7%	11.3%
Jinan Beijiao	26.8%	24.3%	24.5%	22.2%
Yangguang	78.7%	71.5%	72.8%	66.2%
Aggregate EIRR	30.5%	27.5%	26.3%	23.7%

30. Impact on the Poor. The analysis also reviewed potential impacts on households, including low income groups. This was reviewed in two ways - changes in air quality and consumer prices for heat and power. The environmental and social impacts assessment concluded that the projects will bring positive impact to local residents, including the poor and that there is no negative impact on the poor.

Economic Justification for MCSU

31. The MCSU component will use the GEF grant to establish the incentive mechanisms to support the closure of inefficient small coal-fired generation units. Because of the lack of the details about the list of small units to be closed down and its incurred costs in two pilot provinces, it is impossible to carry out the cost-benefit analysis. However, the economic gains of coal savings due to closing the inefficient small units and fully using up the existing capacity of larger more efficient units could be significant. A rough estimate indicates that replacing small units with more efficient 300 MW units could save 108-161 gce/kWh or 540-966 ton per MW per year. The targeted closure of small units is 4,000 and 2,670 in Shandong and Shanxi Provinces, respectively, in 2006-10. Therefore, the total of potential coal saving could be in the range of 3.6-6.4 million tons per years. The associated cost saving and avoided local and global environmental costs are tremendous and can well justify the GEF involvement economically.

Economic Justification for ESD

32. With the ESD pilot implementation, the average heat-rate for power generation in the Guangdong Provincial Power Grid would be improved from 342 gce/kWh in 2007 to 332 gce/kWh in 2010, with a total reduction in coal consumption of about 2.2 million tce per year. Therefore, the economic benefits, both savings in coal consumption and avoided environmental costs, are large, which make the GEF involvement economically attractive.

B. Financial Analysis

33. **Conversion for CHP Operation at Huangtai Thermal Power Plant.** Financial analysis has been carried for the investment project at Huangtai to assess its financial viability.

34. ***Assumptions.*** A base case financial projection scenario was developed for Huangtai CHP conversion project, for the period of 2007-2031, with the following major assumptions:

(i) the exchange rate: US$ 1 = RMB 7
(ii) the total cost of the project is estimated at about RMB 191.10 million , including RMB 13.65 million for the retrofit of #8 unit's turbine and heat extraction system in FY 2007 and RMB 177.45 million for the retrofit of #7 unit's turbine and heat extraction system, master heat supply station, pipeline network, miscellaneous material and technical assistance to assessment costs and contingencies in 2008-2009;
(iii) heat price: RMB 32.46 /GJ; energy price: RMB 0.3434 /KWh;
(iv) incremental heat supply from 2009-2031: 4,890,000GJ/year;
(v) energy supply decrease during 2009-2031: 280GWh/year, due to extraction of steam for heat supply; and
(vi) the government tax rate: 25%, including value added tax.

35. Based on the above assumptions, the financial internal rate of return (FIRR) is projected at 23.73%. The detailed cash flow is shown in Table 9.9.

Table 9.9: FIRR for Huangtai Project

Year	Investment ('000 RMB)	Incremental O&M ('000 RMB)	Incremental Heat Revenue ('000 RMB)	Incremental Power Revenue ('000 RMB)	Total Incremental Revenue ('000 RMB)	Net Benefit
2007	13,650	0	0	0	0	(13,650)
2008	88,725	0	0	0	0	(88,725)
2009	88,725	0	79,365	(48,076)	23,467	(65,258)
2010		0	158,729	(96,152)	46,933	46,933
2011		0	158,729	(96,152)	46,933	46,933
2012		0	158,729	(96,152)	46,933	46,933
2013		0	158,729	(96,152)	46,933	46,933
2014		0	158,729	(96,152)	46,933	46,933
2015		0	158,729	(96,152)	46,933	46,933
2016		0	158,729	(96,152)	46,933	46,933
2017		0	158,729	(96,152)	46,933	46,933
2018		0	158,729	(96,152)	46,933	46,933

2019		0	158,729	(96,152)	46,933	46,933
2020		0	158,729	(96,152)	46,933	46,933
2021		0	158,729	(96,152)	46,933	46,933
2022		0	158,729	(96,152)	46,933	46,933
2023		0	158,729	(96,152)	46,933	46,933
2024		0	158,729	(96,152)	46,933	46,933
2025		0	158,729	(96,152)	46,933	46,933
2026		0	158,729	(96,152)	46,933	46,933
2027		0	158,729	(96,152)	46,933	46,933
2028		0	158,729	(96,152)	46,933	46,933
2029		0	158,729	(96,152)	46,933	46,933
2030		0	158,729	(96,152)	46,933	46,933
2031		0	158,729	(96,152)	46,933	46,933
Financial Internal Rate of Return						**23.73%**

36. **Waste Heat Recovery at Jinan Beijiao Thermal Power Plant.** Financial analysis has been carried out for the investment project at Jinan Beijiao to assess its financial viability.

37. ***Assumptions.*** A base case scenario for the period of FY2008-2031 was developed for Jinan Beijiao's projections with the following major assumptions:

(i) the exchange rate: US$1 = RMB 7 ;
(ii) the total cost of the rehabilitation is estimated at about RMB 158.97 million (US$ 22.71 million) for #2 and #5 turbine rehabilitation, extraction system, pipeline network, miscellaneous works and materials and technical assistance to assessment costs and contingencies in FY08;
(iii) heat price: RMB 28.73 /GJ; energy price: RMB 0.35 /KWh;
(iv) incremental heat supply from FY 2009-2031: 1,545,600 GJ/year;
(v) energy supply decrease during FY2009-2031: by 21.27 GWh/year, due to the increase of turbine backpressure for heat supply; and
(vi) the government tax rate: 25%, including value added tax.

38. Based on above assumptions, the FIRR is projected at 16.96%.

Table 9.10: FIRR for Jinan Beijiao Project

Year	Investment ('000 RMB)	Incremental O&M ('000 RMB)	Incremental Heat Revenue ('000 RMB)	Incremental Power Revenue ('000 RMB)	Total Incremental Revenue ('000 RMB)	Net Benefit
2008	158,970	0	0	0	0	(158,970)
2009		0	44,405	(7,445)	27,720	27,720
2010		0	44,405	(7,445)	27,720	27,720
2011		0	44,405	(7,445)	27,720	27,720
2012		0	44,405	(7,445)	27,720	27,720
2013		0	44,405	(7,445)	27,720	27,720
2014		0	44,405	(7,445)	27,720	27,720
2015		0	44,405	(7,445)	27,720	27,720
2016		0	44,405	(7,445)	27,720	27,720

2017		0	44,405	(7,445)	27,720	27,720
2018		0	44,405	(7,445)	27,720	27,720
2019		0	44,405	(7,445)	27,720	27,720
2020		0	44,405	(7,445)	27,720	27,720
2021		0	44,405	(7,445)	27,720	27,720
2022		0	44,405	(7,445)	27,720	27,720
2023		0	44,405	(7,445)	27,720	27,720
2024		0	44,405	(7,445)	27,720	27,720
2025		0	44,405	(7,445)	27,720	27,720
2026		0	44,405	(7,445)	27,720	27,720
2027		0	44,405	(7,445)	27,720	27,720
2028		0	44,405	(7,445)	27,720	27,720
2029		0	44,405	(7,445)	27,720	27,720
2030		0	44,405	(7,445)	27,720	27,720
2031		0	44,405	(7,445)	27,720	27,720
Financial Internal Rate of Return						**16.96%**

39. **Investment for Efficiency Improvement at Yangguang Thermal Power Plant.** Financial analysis has been carried out for the investment project at Jinan Beijiao to assess its financial viability.

40. ***Assumptions.*** A base case scenario for the period of 2008-2027 was developed for Yangguang's projections with the following major assumptions:

(i) the exchange rate: US$ 1 = RMB 7;
(ii) the total cost of the rehabilitation project is estimated at about RMB 41.09 million , with investment in 2008;
(iii) the project life: 5 year for the turbine blade and shaft seal and 20 years for the VSD rehabilitation;
(iv) the cumulative heat-rate gain: 2.7gce/kWh in 2008 (50% of potential); 5.4 gce/kWh during 2009-2012 (100%); 2.9gce/kWh in 2013 (when one turbine seal, contributing 2.5 gce/kWh reaches its life expectancy); and 0.4gce/kWh from 2014-2027 (the heat-rate gain of the VSD addition);
(v) annual energy output: 8,106 GWh; and
(vi) coal price: RMB 600 /ton.

41. Based on above assumptions, the FIRR is projected at 88.69%.

Table 9.11: FIRR for Yangguang Project

Year	Investment ('000 RMB)	Incremental O&M ('000 RMB)	Cumulative Efficiency Gain (gce/kWh)	Standard Coal Saving ('000 ton)	Fuel Saving ('000 RMB)	Net Benefit ('000 RMB)
2008	41,090	0	2.7	21.89	13,132	(27,958)
2009		0	5.4	43.77	26,263	26,263
2010		0	5.4	43.77	26,263	26,263
2011		0	5.4	43.77	26,263	26,263
2012		0	5.4	43.77	26,263	26,263

2013		0	2.9	23.51	14,104	14,104
2014		0	0.4	3.24	1,945	1,945
2015		0	0.4	3.24	1,945	1,945
2016		0	0.4	3.24	1,945	1,945
2017		0	0.4	3.24	1,945	1,945
2018		0	0.4	3.24	1,945	1,945
2019		0	0.4	3.24	1,945	1,945
2020		0	0.4	3.24	1,945	1,945
2021		0	0.4	3.24	1,945	1,945
2022		0	0.4	3.24	1,945	1,945
2023		0	0.4	3.24	1,945	1,945
2024		0	0.4	3.24	1,945	1,945
2025		0	0.4	3.24	1,945	1,945
2026		0	0.4	3.24	1,945	1,945
2027		0	0.4	3.24	1,945	1,945
Financial Internal Rate of Return						**88.69%**

42. ***Summary of Financial Analysis*:** Financial analysis was performed for each of the three rehabilitation demonstration projects to examine their financial viability. The FIRRs of the investment projects at Huangtai, Beijiao and Yangguang thermal power plants are projected at 23.73 %, 16.96 % and 88.69% respectively. Sensitivity analysis (see Table 9.12), with 10% increase in fixed investment and 10% decreased in efficiency gain, also shows favorable financial return.

Table 9.12: FIRR Sensitivity Analysis

Projects	FIRR base case	Investment cost increased by 10%	Efficiency gain reduced by 10%	Combined
Huangtai	23.73%	21.54%	17.51%	15.77%
Jinan Beijiao	16.96%	15.25%	14.69%	13.13%
Yangguang	88.69%	75.65%	74.39%	63.40%

Annex 10: Safeguard Policy Issues

CHINA: GEF China Thermal Power Efficiency Project

A. Environment

1. While the project is expected to bring significant global and local environmental benefits by reducing coal consumption in the power sector in China, the project activities supported by Component 1 and 2 will also result in some negative environmental impacts. The project is classified as a "Category B" project according to the magnitude of the environmental issues involved, the coverage area and the nature of the project activities. The Bank's environmental safeguard policies are not applicable to the activities under other components of the GEF Project

2. **Component 1 Closing Down of Inefficient Small Coal-fired Units.** The closure of small coal-fired units to be supported by the pilot MCSU will bring significant environmental benefits in coal consumption and emission reductions[32]. It will also bring negative impacts, which may include noise and dust during the dismantling process and pollutions due to improper treatment of wastes. Site-specific impacts may also be resulted in the cases of dismantling transformers, radioactive instruments if any and outgoing transmission lines and restoring the plant sites. However, closure of small coal-fired units to be supported with the MCSU pilot will be selected through an environmental screening process to ensure that the closure to be supported by the MCSU pilot will not entail serious adverse or irreversible environmental impacts. To address the potential environmental impacts, an EMF was prepared and reviewed by the Bank.

3. ***EMF.*** Since specific units to be closed and supported by the pilot MCSU in the two pilot provinces, Shandong and Shanxi, cannot be identified until mid 2009, an EMF has been prepared to provide guidance on identification of potential negative impacts, preparation of mitigation measures and arrangements for implementation, supervision and internal and external monitoring. Compliance with this EMF will be specified in the MCSU Operational Manual as a condition for approval of the output-based payment under the MCSU (see Annex 4).

4. ***Information Dissemination.*** The draft final EMF, containing basic information on Component 1 project activities, in both Chinese and English versions, has been disclosed at Shandong Provincial PMO, Shanxi Provincial PEO, EA Institutes in the two provinces, as well as the World Bank InfoShop in November 2008.

5. ***Funding and Implementation of the EMF*** will be part of the bidding document and contract for any dismantling work. Cost of the implementation will be part of the contract price. Compliance to the EMF is a contractual obligation of the contractor(s) for dismantling the small units.

6. ***Monitoring and Reporting.*** The contractors for dismantling of the small units and the plant owners will carry out internal monitoring as specified in the EMF. Local government environmental agencies will check, as part of their normal functions, the environmental conditions during the dismantling and take necessary actions to ensure compliance to the existing government regulations and requirements. A third-party agent will be engaged for external monitoring of project activities under this component. The environmental specialists of the Task Team will provide timely support

[32] Units to be closed cannot be installed in other provinces, as regulations only allow installing generation of size 300 MW or more.

as needed for ongoing safeguard management and to carry out regular supervision with due diligence throughout the project implementation.

7. ***Reporting.*** The contractor for dismantling and the plant owner are responsible for preparation of internal monitoring reports. External monitoring reports will be prepared by the third-party monitor. All reports will be prepared and submitted to the Bank on a regular basis as specified in the EMF.

8. **Component 2. Investment for Plant Efficiency Improvement.** Shandong University prepared the EIA, EMP and Environmental Audit Report for the project activities at Huangtai Thermal Power Plant, while the Shandong Academy of Environmental Protection Science Research and Design and China Academy of Radiation Protection Research prepared the EIA, EMP and Environmental Audit Report for the project activities at Jinan Beijiao Thermal Power Plant in Shandong and Yangguang Thermal Power Plant in Shanxi. The EA Documents were prepared in accordance with Chinese national requirements as well as World Bank Safeguard Policies and Procedures, namely OP/BP 4.01, Pollution Prevention and Abatement Handbook: "Thermal Power: Rehabilitation of Existing Plants" and the "Environmental Assessment Sourcebook Update: Environmental Auditing". The EA documents have covered the baseline environmental conditions as well as socio-economic conditions, alternatives considered as part of feasibility studies for each component of the project, potential impacts and mitigation measures, environmental management and monitoring plan, environmental auditing, public consultation and information disclosure.

9. ***Environmental Benefits.*** The EA identified and assessed, quantitatively to the extent possible, the project benefits and impacts to the natural and social environment. The EA concluded that the project will lead to significant positive impacts to the natural and socioeconomic environments in the project areas. The project as a whole is substantially positive in environmental terms, with the benefits greatly outweighing the negative impacts. The main benefits of the project include: reduced coal consumption, increased efficiency of coal use and reduced emissions of pollutants such as PM_{10}, CO_2, SO_X and NO_X. Therefore there will be improved environmental quality of the surrounding areas and the quality of life for local communities. The project will not have significant negative environmental impacts which cannot be effectively mitigated to acceptable levels and the project is designed to save coal use and minimize adverse impacts to the physical environment. To maximize environmental benefits and minimize potential negative impacts, a stand-alone EMP was prepared for each project under Component 2. All adverse environmental impacts can be avoided and mitigated to acceptable levels, provided the mitigation measures developed in the EMPs are properly implemented.

10. ***Potential Environmental Impacts/Risks and Mitigation Measures.*** Project components will potentially cause a variety of short-term construction and long-term operational impacts. A series of mitigation measures have been planned accordingly to reduce these impacts to acceptable levels during construction and operation phase. Mitigation monitoring procedures have been established and the organizations responsible for monitoring have been designated.

11. ***Construction phase:*** Project activities would likely have a variety of short-term impacts during construction, such as noise, dust, traffic, solid wastes, wastewater, resettlement and temporary land occupancy issues etc. These concerns are relatively minor and measures to reduce them to acceptable levels, as well as to monitor their effective implementation, have been discussed and detailed in the EIA and EMP.

12. ***Operations phase:*** the main environmental issues are the management of wastewater, noise, solid wastes and waste gases. Appropriate mitigation measures such as normative operation management and operation responsibility mechanisms were established and detailed in the EMP.

13. ***Alternative Analysis.*** Various alternatives have been identified, evaluated and compared during the EA with the objective to avoid or otherwise minimize potential adverse environmental and social impacts and to maximize environmental benefits. The EA teams have worked closely with the project planners/owners as well as the feasibility study teams to compare and evaluate alternatives. Optimal alternatives were selected based either on the avoidance of adverse social and environmental impacts or ensuring least possible such impact. Selection was also based on other economic, technical and financial considerations for the least cost solutions. A "no project" scenario was also considered as an alternative by each investment project under the Component 2.

14. ***Environmental Management Plan.*** To ensure the maximization of environmental benefits as well as avoidance, minimization or mitigation of potentially negative environmental impacts, a separate and stand-alone EMP was prepared for each of the three projects. The EMPs cover policy bases and applicable environmental standards, environmental management and supervision systems, mitigation measures, environmental monitoring plans, institutional arrangements, capacity building and estimated costs for the mitigation measures and monitoring programs for both the construction and operation phases. An EMP table was also designed for each project. This table summarized potential impacts, mitigation measures, implementation schedule, implementation agency and supervision agency, monitoring indicators, frequency and location, and EMP budget for the construction and operation phases. In addition, these EMPs will be attached to the engineering bid documents and a penalty clause will be added to the contracts to address non-compliance with the EMP. The contracts will also include an appropriate clause regarding the procedures to be followed in the event of chance finds of culturally significant artifacts or sites.

15. ***Supervision and reporting.*** The Bank will supervise the project's environmental aspects twice a year. Semi-annual progress reports from the PMO/PEO will include a section or chapter on the EMP, along with any revision proposed to the EMP to achieve its objectives.

16. ***Capacity Building***. To ensure that the above measures and plans are implemented efficiently the EMP has included training programs for managerial and technical personnel from project proponents and operational units, contractors and construction supervisors. Mandatory environmental training for contractors and construction supervision engineers will be held prior to the commencement of construction. The training will cover basic knowledge of environmental protection, environmental standards and pollution control, contents of respective EIAs and the requirements of the EMPs, environmental M&E and reporting requirements.

17. ***Funding Arrangements.*** The costs associated with EMP measures for both the construction and operation phases are included in the project cost estimates. Component-specific costs are detailed in the EMP, including costs for periodically monitoring waste-gas emission, wastewater and noise levels by certified environmental monitoring stations.

18. ***Monitoring***. An environmental monitoring program for the construction and operation phases has been designed in the EA/EMP. The monitoring program covers waste gas emission, wastewater, noise level etc., with specifics on parameters, frequencies, time, locations, responsible agencies and estimated costs. The monitoring program also specifies the reporting and response procedures to

ensure that appropriate actions are taken in response to the findings of the monitoring. Professional monitoring units, using standard methods recognized by regulatory authorities, will be contracted to monitor the parameters specified in the EMP. Professional monitoring units will also review overall compliance status. Environmental monitoring will provide key information in a timely manner, especially those on environmental impacts and mitigation, to the Recipient and the Bank to evaluate the success of environmental management. Compliance monitoring determines compliance status and provides the basis for further mitigation, if non-compliance is detected.

19. ***Public consultations***: In addition to the consultation conducted to obtain inputs into project design, two rounds of public consultations have been conducted for each power plant. The first round was conducted during the EA preparation stage to canvass the public's opinion about the project. The second round of public consultation was conducted after the draft EA reports had been prepared to explain the EA findings, the intended mitigation measures, the EMP and to confirm public acceptance and satisfaction. All the concerns raised in the two rounds of public consultation were addressed in the EA/EMP and passed on to the project owner for incorporation into the next step of project design and implementation. As a result, it was found that the project has strong public support in terms of its significant economic, environmental and social benefits.

20. ***Information dissemination:*** The project's basic information, major anticipated adverse and positive impacts and mitigation measures have been disclosed to the public through bulletins, posters, as well as local newspapers. Each of the municipalities with authority over the project areas has disclosed information regarding the availability of the relevant draft EA documents, and how to access them through local newspapers (Jinan Time Newspaper, Yangguang Daily). The draft final EIA reports, EMPs and Environment Auditing Report have also been made available at the PMOs, project owners, EA Institutes and on the websites in each of the project provinces. Table 10.1 below summarizes the information disclosure activities that have been held in each project location.

Table 10.1: Disclosure of Environment Safeguard Documents

No.	Name of project	EIA (Yes/No)	EMP (Yes/No)	EAR (Yes/No)	Chinese/ English	Date of submission	date of disclosure	location of disclosure
1	Shandong Huangtai Thermal Power Plant subproject	Y	Y	Y	C/E	C/2007-01-07 E/2008-01-07	C/2007-07-21 E/2008-01-12	C/Jinan Time Newspaper; Shandong PMO; EA Institute; www.luneng.com E/World Bank InfoShop
2	Shandong Beijiao Thermal Power Plant	Y	Y	Y	C/E	C/2008-01-07 E/2008-01-10	C/2007-12-22 E/2008-01-12	C/Jinan Time Newspaper; Shandong PMO; EA Institute; www.saes.com.cn E/World Bank InfoShop
3	Shanxi Yangguang Power Generation Company Ltd	Y	Y	Y	C/E	C/2007-01-11 E/2008-01-11	C/2007-11-09 E/2008-01-12	C/YANGQUAN Daily; Shanxi PEO;EA Institute; www.yq.gov.cn E/World Bank InfoShop

B. Social

21. The project is expected to achieve a positive social impact in the project areas and China in general. The project will result in coal savings and GHG emission reduction. It will have a positive social impact by increasing the coverage of heat supply, reducing air pollution, avoiding other environmental damage associated with coal use and will improve the quality of life for people in the project areas.

22. The Bank's social safeguard policies are not applicable to most of the project activities as they will not involve land acquisition and major civil works except for the investment projects for plant efficiency improvement under Component 2.

23. **Component 2** involves three thermal power plants in Shanxi and Shandong provinces. Of these the Jinan Beijiao and Huangtai plants in Jinan, Shandong Province have triggered resettlement while the Yangguang plant in Taiyuan, Shanxi has not because it will not entail land acquisition and resettlement.

24. The project activities at Jinan Beijiao plant will have temporary resettlement impacts during the installation of its 28 km heat supply pipes in urban and peri-urban areas. The heat exchange station will be built within the existing plant facility.

25. The project activities at Huangtai plant will entail land acquisition of 1,300 m^2 outside the plant area for construction of a heat exchange station. The heat supply from the plant to the exchange station requires construction of 9 km trunk pipes, along a road which is under construction, without additional land acquisition. Branch pipes may extend to both sides along the trunk pipes in the future if loads increase.

26. ***Resettlement Impacts.*** These two power plants hired Eastern Hydropower Design Institute, which is experienced in Bank-financed projects, to assist with the project preparation. The direct adverse social impacts, as identified by the consultant during its field surveys and interviews in late 2007, are mainly due to temporary disturbance along the heat supply pipelines during the construction period and the land acquisition for the heat exchange station of Huangtai. The impact of the construction of a heat exchange station within the existing plant facility is limited.

27. Other impacts linked to the project are associated with the construction of the road, along which the 9 km of trunk pipes for heat supply by Huangtai plant have already been installed. The linkage impacts include the acquisition of 44 ha of land, including 23 ha of farmland and demolition of 79 houses, affecting 225 households with 702 people. In addition, 8 small enterprises were partially affected. Resettlement due to road construction was already under way prior to the Bank's involvement in the project and land acquisition for 23.9 ha (54%) has been completed, 160 (71%) affected persons were resettled and 1 (13%) enterprise compensated.

28. No minority communities are present in the project area; therefore the Bank's Safeguard Policy OP 4.10 on Indigenous People is not triggered.

29. ***Resettlement Measures.*** Following relevant Bank policies and procedures for involuntary resettlement, the power plants have prepared resettlement documents with the assistance of the consultant. The documents include a RPF for Jinan Beijiao Thermal Power Plant to be applied in the planning and implementation of its pipe installation; (ii) a RPF for Huangtai Thermal Power Plant covering its future associated branch pipe planning and installation; and (iii) a Resettlement Plan for Huangtai covering a thorough review of the ongoing resettlement for its trunk pipes and the heat exchange station to be constructed under the project. The Bank's suggestions and comments were incorporated into the documents.

30. The RPFs require that any resettlement impact found during the project construction will be investigated, compensated, restored and managed. The RPFs have also presented a management system for project resettlement and this system, including external monitors, will be set up prior to project commencement.

31. In the Resettlement Plan for the trunk pipe, the resettlement that had already been implemented was reviewed and the remaining portion of the resettlement was planned. The resettlement that had been implemented had an impact on 79 households, 24 ha of land area and one enterprise. The 160 people who lost their land were compensated in cash and resettled, with social insurance as well as training by the local governments. The affected households have received the entitlement of replacement houses in downtown area with at least 40 m^2 per capita and are waiting to move into their new houses, which are currently under construction. The affected enterprise was paid in cash as per agreements reached. The 2007 surveys and interviews by the consultant concluded that the resettlement completed for the constructed road had followed the applicable laws and regulations and the affected communities, households and enterprise were satisfied. It has been agreed that the residual resettlement work, including land acquisition of 11.1 ha (55%), resettlement of 65 affected persons (29%) and treatment of the 7 affected enterprises (87%), will follow the same compensation rates, settlement standards, procedures and management methods as the portion already implemented. The Resettlement Plan for Huangtai Plant confirmed that a proper resettlement management system is in place for the ongoing resettlement.

32. ***Consultation and Information Disclosure.*** Consultations with the stakeholders, including the affected persons, local community leaders and governments provided information for preparation of the RPFs and Resettlement plan and are documented in detail in these reports. The RPFs also stipulate the agreed public participation and consultation mechanism in details for the remaining resettlement work during the pipe layout planning, technical design and construction process and the development of compensation and resettlement packages.

33. The first versions of the aforementioned documents were completed in October 2007 and were finalized in January 2008 after review by the Task Team. The final Chinese versions were submitted to the Bank's Beijing Office in January 2008 and disclosed in local newspapers in January 2008, and the English versions were sent to the World Bank InfoShop in January 2008.

34. **Component 1.** While Component 1 will not entail land acquisition and people resettlement, it may also result in negative social impact, in addition to its significant social benefits, if the existing government policies and regulations regarding settlement of the affected workers who may lose their jobs due to the closure of small coal-fired units are not fully implemented. Social due diligence work conducted during the project preparation and to be conducted during the project implementation is described below.

35. In China, more than 50% of coal consumption is for power generation. The on-going closure of inefficient small (50 MW or less) coal-fired power generation units with replacement by large and efficient ones is one of the critical measures for improving efficiency and saving coal consumption for power generation and reducing environmental pollution in China. It is part of the Central Government's initiatives for building a "resource-saving and environmentally friendly" society.

36. In January 2007, China State Council issued a ***Notice on Speeding up Closure of Small Thermal Plant*** to deploy the closure throughout the nation, targeting 50 GW small units by 2010. Subsequently, National Development and Reform Commission (NDRC) has negotiated and signed agreements with 30 provincial governments and 7 major power companies for their closure goals by 2010.

37. By the end of 2007, 14.38 GW (143.8% of the 2007 closure target—10GW—in the country) of small units were closed down, meanwhile, addition of large thermal units (300 MW and above) ensured no major interruption in power supply. Units closed are generally low-hanging fruit belonging to the top five power generation companies (in terms of installed capacity), provincial investment companies and/or state-owned enterprises, which contributed to 10.52 GW closed, accounting for 73% of the total capacity closed in 2007.

38. As agreed with NDRC, Shandong and Shanxi Provinces will close 4,000 MW and 2,670 MW respectively by 2010. The provincial governments are responsible for planning and supervising the closure. By the end of 2007, 1,717 MW and 1,007 MW have been closed in Shandong and Shanxi respectively. But when the closure is proceeded to small units owned by small power companies, in 2009 and 2010, additional financial support to these small companies would be needed to ensure of the targeted closure on schedule [33]

39. The GEF Project will support a pilot of an effective incentive Mechanism for Closing down the Small Coal-fired Units (MCSU) in Shandong and Shanxi Provinces, to channel additional financial resources for the small plant owners to address potential impacts of the closure. The MCSU pilot under the GEF Project aims to facilitating closure of 2,910 MW out of the planned closure in both Shandong and Shanxi, during 2009 to 2010.

[33] Conclusions of the Social Economic Survey supported by the GEF Project Preparation Grant and completed in November 2007, with a full report in the project file.

40. ***Potential Social Issues***. There is no doubt that the closure of inefficient small coal-fired power generation units will save coal for power generation and have long term and significant positive social and environment impacts. In the meanwhile, it also entails adverse social and environmental issues, such as impact on employment of the workers who are attached to the affected power plants and noise, dust and wastes that may be generated during the process of dismantling of these small units.

41. *Workers Affected by the Closure of Small Units.* Partial workers may face the risk of laid-off due to the closure of small units. The closure completed in 2007 throughout the country involved 152,000 persons, including retirees, and was providing jobs to 110,000 (7.6 workers per MW closed). In Shanxi Province, the targeted closure 2,670 MW by 2010 are providing jobs to about 11,000 plant employees, 4.1 person/MW [34]. However, only part of the workers lost jobs since the Governments have issued various complementary policies and regulations to mitigate social impacts of the closure (see sections below). In order to measure the barriers and social impacts of the closure, a Social Economic Survey covering 13 plants in Shandong and Shanxi and 2 plants in Henan Provinces, was completed in November 2007 with funding of the GEF PPG. The survey indicated that about 2.4 person per MW closed in Shandong and Shanxi would possible lose jobs and need help on re-employment (See Attachment 1 on detailed information of the survey).

42. ***Government Policies for Settlement of Affected Workers***. Consequent social impacts are the major barrier to the closure of inefficient small coal-fired units. To mitigate the impacts, the governments at various levels have issued regulations and policies, from incentive generation to specific requirements for settlement of affected workers. These regulations and policies include:

(a) *Policy at the state level*

43. The *State Council Document No.[2007]2* issued in 2007 for the closure of small units:

- requiring closing down of coal-fired generation units of (i) 50 MW and below; (ii) 100 MW with more than 20 years of operation; (iii) units that are 10% less efficient than the provincial (districts, cities) average efficiency level or 15% less efficient than the national average efficiency level; and (iv) units that cannot meet environmental emission criteria;
- giving priority to approval for building new and larger scale units (300 MW and above) that will replace the capacity of the closed small units;
- requiring proper resettlement of staff who will lose jobs due to the closing down of small units;
- creating revenues to owners of small units closed on schedule, allowing:
    - for 3 years, continued allocation of operational hours after closure to those small units that are scheduled for closing down during the 11th

[34] Data from Shanxi Provincial Government

Fiver Year Plan period (2006-2010) and are closed on schedule, and enabling the trading or transferring of those allocated operational hours to large and efficient units;
- trading of pollution allowances for the small units closed on schedule; and
- sale of water usage rights entitled by the closed small units/power plants.

44. *State Council Notice on Speeding up Closure of Small Thermal Power Plant* issued on January 12, 2007, which requires:

- provincial government shall properly resettle the workers and resolve debts, and ensure social stability;
- based on relevant domestic regulations, development of settlement plan for affected worker to ensure adequate settlement of the workers who lose job;
- plant to be partly closed shall provide the workers new internal position;
- for plant to be fully closed, issues such as compensation and social insurance for the affected workers shall be well handled according to relevant government regulations;
- new power plant or existing power plant expansion shall place priority in hiring the affected workers;
- the local governments shall be responsible for settlement of affected workers.

- In August 2007, NDRC established that approval of new capacity proposed by a generation company is conditional upon that company having closed its small thermal units as planned. In order to have new project approved, larger power companies are merging small power companies or by the capacity closed to obtain the required closure capacity.

(b) Policy at the provincial level – examples of Shanxi and Shandong Provinces

45. *Shanxi Provincial Precepts on Closure of Small Thermal Plant* issued by **Shanxi** Provincial Government on May 18, 2007 clearly states or indicates that:

- governments at various levels shall prepare detailed implementation plan for closing down of small units and the plan has to include adequate measures to ensure proper settlement of affected workers, to address the impacts of the closure and to ensure social stability;
- expansion with 3,500 MW new capacity to replace the 2,670 MW to be closed by 2010
- application for approval of new plants or existing plant expansion projects in the window of the 3,500 MW must be accompanied with the agreement reached with the owners of the small units to be closed and local governments on settlement of the workers affected by the closure;
- encourage restructuring, merge and acquisition of small units to be closed for construction of new plants or existing plant expansion projects;

- new plants or existing plant expansion shall place priority on hiring the workers who will lose job due the closure;
- provide compensation to enterprise fully closed and provide social insurance to affected workers in line with relevant government policies;
- small units will have operational hours up to 3 years after closure and can sell these operational hours to large units to obtain financial revenues;
- small units can sell their emission allowances, including SO_2, NOx and dust to large units to obtain financial revenues;
- transfer land title of small power plant after closure for financial revenues.

46. More specific principle for settlement of affected workers stated in this provincial government document:

- plant to be partly closed must provide new jobs to the affected workers within the plant or within the power generation company;
- for enterprise' self-generation plant to be fully closed, the affected workers shall be settled within the enterprise;
- for closure of an entire plant, affected workers shall be settled within the other enterprises, or with other public service positions, or self-employment,
- for closure of an entire plant owned by a company, affected worker shall be settled within the company;
- new power plant or expansion of an existing plant shall hire the workers affected by the closure of small units and the number of the affected workers employed is a condition for approval of the new plant or expansion projects
- plant to be closed shall prepare detailed settlement plan for affected workers including retirees; the plan shall be reviewed and approved by plant staff assembly and shall be submitted to the local government's Employment Assurance Department for review and approval;
- the Employment Assurance Department of the Provincial Government shall be responsible for preparation of the package of settlement measures, social insurance and re-employment arrangement for the affected, an for review and approval of the detailed settlement plan for affected workers submitted by each plant to be closed.

47. It also specified institutional arrangement and specific responsibility of each government agencies for implementation, supervision and supporting of the closure, as follows:

- *Provincial Leading Group* – headed by a vice-governor with participation of one representative from each of the following provincial government agencies
- *Provincial Development Commission* – implementation
- *Provincial Commission for Disciplines and Supervision* – supervision and monitoring
- *Provincial Finance Bureau* – budgetary and taxation support

- *Provincial Employment Assurance Department* – planning for re-employment and social insurance of affected worker and review and approval settlement plan of affected plants;
- *Provincial State Land Resources Department* – plan and support transferring of land title (of small power plants for revenue generation)
- *Provincial Environmental Protection Bureau* – support trading of pollutant emission allowances and supervision;
- *another 5 provincial agencies* – ensure closure on time, including planning, new capacity and network contraction to ensure un-interpreted supply, tariff and so on.

48. *Guidance on Speeding up Closure of Small Thermal Plant* issued by **Shandong** Provincial Government on August 24, 2007, which stipulates:

- governments at various levels should balance the closure and social stability through properly addressing the settlement of affected workers, asset treatment and debts;
- pertinent government authorities and each municipal government should make plan and take effective measures to use various resources like the land resources for creation new employment and settlement of the affected workers;
- closely tie the construction of new and large capacity units [35] and strictly follow the review and approval requirements and process of new capacity projects.

(c) Policy at the municipal level.

49. In addition, most of municipal governments also have similar but more detailed and specific regulations on the closure of the small units within their respective municipality. One example of the Implementation Plan issued by the Xinzhou Municipal Government, Shanxi Province is as follows:

50. ***Xinzhou Implementation Plan for Closure of Small Thermal Plant*** issued by **Xinzhou** Municipal Government on October 23, 2007, states that

- using construction of large capacity units as an opportunity for closing down small units and the new plant/units shall first hire the workers who lost their jobs due to the closure of small units;
- companies with partial units to be closed shall provide employment for workers affected by the unit closure;
- for closure of entire plant, compensations to enterprise and social insurance for workers affected shall be in place in line with relevant government

[35] Approval of new units project is contingent to replacement of certain amount of existing small coal-fired units

regulations; the revenues from selling the residual assets and transferring of land titles shall be first used for settlement of affected workers;

- the plant to be closed must prepare specific plan for settlement of affected workers and the plan shall cover: workers information, their employment status, settlement package, measures for re-employment, social insurance arrangement, retirement management, etc. The scheme needs to be agreed by worker representatives meeting and be reviewed and approved by the local government Employment Assurance Bureau;
- each county/city/district government and relevant departments shall take proper measures to ensure social stability.

- It also includes specific regulations regarding land title transfer and treatment of the residual assets of plant to be closed;
- It also re-affirm the principles for settlement of affected workers stated in the Shanxi Provincial Government document - *Shanxi Provincial Precepts on Closure of Small Thermal Plant.*

51. **Policy to Channel Financial Resources to Affected Plants**. Financial resources available to small power plant is critical for settlement of affected workers. The governments also issued policies and regulations to channel financial resources to the affected plants, including:

52. ***Revenues from Trading of Operational Hours and Pollutant Emission Allowances.*** The major objective of the government policies for the allocation and trading of operational hours and pollutant emission allowances is to provide key financial incentives to the small units to cover costs of closing down, to achieve system efficiency and emission reductions. Small units that were, or will be, closed down on schedule are entitled to continued operational hours, for a period of up to three years, after the closing down. Trading of operational hours are very active in Shanxi, Shandong, Henan and Sichuan provinces.

53. Moreover, in Shandong province, every unit of 6 MW and larger has SO_2 emission allowances up to 2010; and total provincial total SO_2 emission allowances up to 2010 is strictly capped – which means new project will have to obtain/buy SO_2 emission allowances from other existing units, e.g. small units closed.

54. ***Government Budgetary Support.*** The state Council document clear stated that the local governments are responsible for proper settlement of affected workers. Therefore, the local governments work together with the affected power plants on settlement of affected workers, and provide budget allocations, as needed, for training on re-employment. MOF has mobilized

55. ***In Summary,*** small power companies could generate revenues from the closure of small units, providing financial resources to address issues associated with the mandatory closure. Financial resources would mainly come from the following sources:

- Financing directly from central and local governments' budget;
- Revenues from the transfer of land entitled by the closed plant for commercial uses;
- Income from selling the "closed small unit capacity" to other power companies plants that need the "closed capacity" for approval of investment projects on new capacity;
- Income from selling other rights or allowances entitle even after the closure, such as generation hours, SO_2 emission allowances, other pollutant discharge allowance, water use right.

56. **Evaluation of the Settlement of Affected Workers.** Te government policies make provisions for settling affected workers in the following ways:

- Re-employment within the enterprise which owns the small units closed
- Re-employment by new power plants or existing power plants with expansion approved in linkage to small units closed
- New position provided by governments in public service sectors
- Training for re-employment and self employment
- Basic living assurance
- Unemployment insurance plus pension

57. The government regulations and policies for addressing the social impacts of closure of small thermal units are in place and are systematic and comprehensive, with adequate policies for channeling financial resources towards affected plants and institutional arrangement for consultation to affected workers, preparation of settlement plans and implementation, supervision and verification.

58. Compliance to these regulations and policies would lead to proper settlement of workers affected by the closure. This has been proven by the closure of 10.52 GW small units belonged to the top five power generation companies (in terms of installed capacity) and provincial investment companies and/or state-owned enterprises, which have the required institutional, technical and financial capacity to fully benefit from these government policies and can relatively easily settle the affected worked with internal job opportunities and adequate compensation package.

59. China's coal-fired generation capacity expansion is fast, from 422 GW in 2006 to 485 GW in 2007 after reduction of closed capacity. This fast expansion will require more plant operation and maintenance workforce and set favorable conditions for re-employment of the closure-affected worker.

60. However, the government policies and regulations to generate financial incentives to the closure of small units may not bring sufficient resources to the affected small and county-level power companies. These companies have less capacity to re-employ affected workers, or to sell their operational hours and pollutant emission/discharge allowances to larger companies to pay adequate compensations to

affected workers. Therefore, additional support will be needed to the settlement of the affected workers of these plants.

61. **Adequacy of Additional Support to the Targeted Closure by the GEF Project.** The pilot MCSU (financial incentive Mechanism to for Closure of Small Units) is designed for testing the adequacy and effectiveness of the additional financial support needed to achieve the closure of the targeted small units owned by the small power companies in Shandong and Shanxi, for 2,910 MW of small units in 2009 and 2010.

62. ***To ensure adequacy of additional financial support*** to the targeted closure, the Social Economic Survey was conducted in 2007 to provide basic information for design of the MCSU. According to the survey data, about 6,938 workers, 2.4 person per MW closed, would possibly lose jobs due to the targeted closure.

63. The output-based payments under the MCSU are at about 8-month total income of the affected workers. A total of US$20 million would required. Financing sources include US$ 5 million of GEF Grant Proceeds plus government top-up funds at least 3 times (US$15 million). In case the actual workers affected by the targeted closure exceeds the estimation of 2.4 person/MW, it was agreed that Governments would provide additional top-up funds or take necessary measures to ensure proper settlement of the affected workers.

64. ***To ensure compliance to the government policies*** for settlement of affected workers and management of social risks, the MCSU pilot will focus on checking compliance to the relevant government regulations and policies for settlement of affected workers during the closure of the targeted. Measures under the MCSU pilot include:

(i) Compliance to relevant government regulations and policies regarding settlement of affected workers will be covenanted in the MCSU Operational Manual as a condition for fund disbursement;

(ii) An independent monitor will be hired to check the compliance;

(iii) The MCSU Operational Manual will include: (a) criteria for identification of eligible plants to be supported; (b) requirements and process for checking compliance to relevant government regulations and policies regarding settlement of affected workers; (c) institutional arrangement (e.g. an independent monitor) for supervision, monitoring, verification and reporting of the compliance; and (d) conditions for disbursement of the output-based financial aid; and

(iv) The MCSU Operational Manual is subject to the MOF and Bank's review and approval, before the MCSU can become operational.

Table 10.1 Estimation of Financing Resources needed for MCSU to Support Closure of 2,910 MW of Small Coal-fired Units in Shandong and Shanxi Provinces

	Plant	Capacity (MW)		Staff			Annual Income (Yuan)	Remarks	
		Total	Closure	Total	Laid off	Person/MW			
	Shandong								
1	Huangtai	1,025	365	2508	627	1.72	37,000	25% laid off	
2	Baiyanghe	440	150	945	378	2.52	38,000	40% laid off	
3	Jining	595	325	1638	819	2.52	48,888	50% laid off	
4	Dazong	120	120	480	480	4.00	12,000	100% laid off	
5	Jisan	X * 6	na	na	na	na	na		
	Sub-Total		960		2,304				
	Average					2.40	36,182		
	Shanxi								
1	Taiyuan Iron & Steel	76	76		0	0		0% laid off	Self-generation, settlement of affected staff within enterprise; building 300 MW units
2	Niangziguan	400	400	715	501	1.25	26,000	60% laid off	building 2 x 600 MW units
3	Huozhou	406	406	2673	1871	4.61	26,000	70% laid off	building 2 x 600 MW units
4	Puxian Electric	18	-	316					not to be closed due to use coal wastes as fuel
5	Chunguang	18	18	2673			na	70% laid off	building 2 x 50 MW and 2 x 200 MW CHP
6	Bagong	48	48	900	0	0	na	0% laid off	China Electric Investment Corp to settle affected workers
7	Datong Thermal	304	100	800	350	3.50	na	350 staff laid off	
8	Datong energy	100	100	2613			31,000	55% laid off	building 2 x 300 MW
	Sub-Total		1,148		2,722				
	Average					2.37	26,000		
	Total		**2,108**		**5,026**				
	Average					**2.38**	30,668		
	MCSU-Supported		**2,910**		**6,938**	**2.38**	**30,668**		
	MCSU - Total Financing Requirement			**USD 20,262,965**					**With payments equal to about 8 months income s**

Annex 11: Project Preparation and Supervision

CHINA: GEF China Thermal Power Efficiency Project

1. Project Preparation Timeline:

	Planned	Actual
Project Concept Note review		11/28/2006
Initial Project Information Document to PIC		10/02/2007
Initial ISDS to PIC		11/21/2007
Appraisal	04/02/2008	
Negotiations	04/21/2008	
Board/RVP approval	05/22/2008	
Planned date of effectiveness		
Planned date of mid-term review		
Planned closing date		

2. Key institutions responsible for preparation of the project:

(i) MOF;
(ii) NDRC;
(iii) SERC;
(iv) Shandong Provincial Government;
(v) Shandong Huangtai Thermal Power Plant;
(vi) Shandong Jinan Beijiao Thermal Power Plant
(vii) Shanxi Provincial Government;
(viii) Shanxi Yangguang Thermal Power Plant; and
(ix) GDGP/Guangdong Grid Dispatch Center

3. Bank staff and consultants who worked on the project included:

Name	Title	Unit
Jie Tang	Senior Energy Specialist/Task Team Leader	EASTE
Ranjit Lamech	Sector Leader/Energy	EASTE
Beatriz Arizu de Jablonski	Senior Energy Specialist	EASTE
Defne Gencer	Consultant/Energy Specialist	EASTE
Masaki Takahashi	Senior Power Engineer	ETWEN
Stavros Tavoulareas	Consultant/Thermal Power Engineer	EASTE
Haixia Li	Financial Management Specialist	EAPCO
Dawei Yang	Procurement Specialist	EAPCO
Jian Xie	Senior Environmental Specialist	EASRE
Grayson Heffner	Consultant/Energy Efficiency Specialist	EASTE
Qing Wang	Environmental Specialist	EASRE
Yan Li	Consultant/Economist	FEU
Yu Huang	Consultant/Financial Specialist	EASTE
Songling Yao	Social Development Specialist	EASCS
Youxuan Zhu	Consultant/resettlement Specialist	EASTE
Yiren Feng	Environmental Specialist	EASCS
Mei Wang	Senior Counsel	LEGES
Teresita Ortega	Program Assistant	EASTE
Perry Lee Radford	Program Assistant	EASTE
Noureddine Berrah	Consultant/Energy Policy & Regulation	EASTE

4. Bank funds expended to date on project preparation:

a.	Bank Budget:	US$369,854
b.	Trust funds:	US$24,760
c.	Sub-Total:	US$394,615
d.	PPG (Recipient executed)	US$350,000
e.	**Total:**	**US$735,573**

5. Estimated Approval and Supervision costs:

a.	Remaining costs to approval:	US$52,000
b.	Estimated annual supervision cost:	US$70,000

Annex 12: Documents in the Project File

CHINA: GEF China Thermal Power Efficiency Project

1. Report on Social Economic Survey for Closing Down Small Units in Shandong, Shanxi, Henan and Guangdong Province, November 2007.
2. Efficient Dispatch and Generation Trading to Reduce Coal Consumption in China – Final Report, Mercados - Energy Markets International, 25 June 2007
3. Simulation of Fuel-efficient Dispatch in Guangdong Provincial Power Grid and Estimate of Coal Savings
4. Feasibility and Detailed Design Report of CHP On-line Monitoring System in Shandong Province
5. Design Report for Rehabilitation of Shandong Huangtai Thermal Power Plant
6. Evaluation Report on Heat Supply Rehabilitation Program of Shandong Huangtai Power Plant, Xi'an Thermal Power Research Institute Co. Ltd., April 2008
7. Evaluation Report on Heat Supply Rehabilitation Program of Shandong Beijiao Plant, Xi'an Thermal Power Research Institute Co. Ltd., April 2008
8. Environmental Impact Assessment for Rehabilitation of Shandong Huangtai Thermal Power Plant, Shandong University, January 2008
9. Environmental Audit Report for Rehabilitation of Shandong Huangtai Thermal Power Plant, Shandong University, January 2008
10. Environmental Management Plan for Rehabilitation of Shandong Huangtai Thermal Power Plant, Shandong University, January 2008
11. Design report for Rehabilitation of Shandong Jinan Beijiao Thermal Power Plant
12. Environmental Impact Assessment for Rehabilitation of Shandong Beijiao Thermal Power Plant, Shandong Academy of Environmental Protection Science Research and Design, January 2008
13. Environmental Management Plan for Rehabilitation of Shandong Beijiao Thermal Power Plant, Shandong Academy of Environmental Protection Science Research and Design, January 2008
14. Resettlement Policy Framework for the Heat Supply Pipeline of Jinan Beijiao Thermal Power Plant
15. Resettlement Policy Framework for the Branch Heat Pipes of Huangtai Thermal Power Plant
16. Resettlement Plan for the Trunk Heat Pipes of Huangtai Thermal Power Plant.
17. Design Report for Rehabilitation of Shanxi Yangguang Thermal Power Plant
18. Environmental Impact Assessment for Rehabilitation of Shanxi Yangguang Thermal Power Plant
19. Financial Management Capacity Assessment Report, the World Bank, June 2008
20. Procurement Management Capacity Assessment Report, the World Bank, September 2008

Annex 13: Statement of Loans and Credits

CHINA: GEF China Thermal Power Efficiency Project

			Original Amount in US$ Millions						Difference between expected and actual disbursements	
Project ID	FY	Purpose	IBRD	IDA	SF	GEF	Cancel.	Undisb.	Orig.	Frm. Rev'd
P093963	2008	CN-Guiyang Transport	100.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00
P088964	2007	CN-Guangxi Integrated Forestry Dev	100.00	0.00	0.00	0.00	0.00	68.09	-28.41	0.00
P083322	2007	CN-SICHUAN URBAN DEV	180.00	0.00	0.00	0.00	0.00	170.70	38.20	0.00
P086515	2007	CN-3rd National Railway	200.00	0.00	0.00	0.00	0.00	200.00	24.00	0.00
P077752	2007	CN-SHANDONG ENVMT 2	147.00	0.00	0.00	0.00	0.00	118.81	-20.69	0.00
P091020	2007	CN-Fujian Highway Sector Investment	320.00	0.00	0.00	0.00	0.00	320.00	52.50	0.00
P096285	2007	CN-MSE Finance	100.00	0.00	0.00	0.00	0.00	100.00	100.00	0.00
P075613	2007	CN-Shaanxi Ankang Road Development	300.00	0.00	0.00	0.00	0.00	290.00	15.27	0.00
P095315	2007	CN-W. Region Rural Water & Sanitation	25.00	0.00	0.00	0.00	0.00	25.00	0.00	0.00
P081776	2007	CN-GUANGDONG/PRD2	96.00	0.00	0.00	0.00	0.00	96.00	7.00	0.00
P092618	2007	CN-LIAONING MED CITIES INFRAS 2	173.00	0.00	0.00	0.00	0.00	173.00	0.00	0.00
P085124	2006	CN-Ecnomic Reform Implementation	20.00	0.00	0.00	0.00	0.00	18.44	5.94	0.00
P085333	2006	CN-5th Inland Waterways	100.00	0.00	0.00	0.00	0.00	60.28	26.78	0.00
P070519	2006	CN-Fuzhou Nantai Island Peri-Urban Dev	100.00	0.00	0.00	0.00	0.00	98.25	24.50	0.00
P075732	2006	CN-SHANGHAI URBAN APL2	180.00	0.00	0.00	0.00	0.00	144.90	24.90	0.00
P084742	2006	CN-IAIL III	200.00	0.00	0.00	0.00	0.00	93.01	-0.22	0.00
P086629	2006	CN-Heilongjiang Dairy	100.00	0.00	0.00	0.00	0.00	91.76	22.26	5.00
P099992	2006	CN-Liaoning Medium Cities Infrastructure	218.00	0.00	0.00	0.00	0.00	169.77	-19.48	0.00
P096158	2006	CN-Renewable Energy II (CRESP II)	86.33	0.00	0.00	0.00	0.00	71.95	33.66	0.00
P093906	2006	CN-3rd Jiangxi Hwy	200.00	0.00	0.00	0.00	0.00	128.52	-21.48	0.00
P081348	2006	CN-HENAN TOWNS WATER	150.00	0.00	0.00	0.00	0.00	139.63	19.63	0.00
P081255	2006	CN-Changjiang/Pearl River Watershed Reha	100.00	0.00	0.00	0.00	0.00	94.02	19.02	0.00
P081346	2005	CN-LIUZHOU ENVIRONMENT MGMT	100.00	0.00	0.00	0.00	0.00	52.46	-3.29	0.00
P081161	2005	CN-CHONGQING SMALL CITIES	180.00	0.00	0.00	0.00	0.00	140.06	42.46	0.00
P075730	2005	CN-HUNAN URBAN DEV	172.00	0.00	0.00	0.00	0.00	150.20	56.70	0.00
P071094	2005	CN - Poor Rural Communities Development	100.00	0.00	0.00	0.00	0.00	69.14	44.74	0.00
P086505	2005	CN-NINGBO WATER & ENVMT	130.00	0.00	0.00	0.00	0.00	80.73	-4.77	0.00
P069862	2005	CN - Agricultural Technology Transfer	100.00	0.00	0.00	0.00	0.00	68.43	32.13	0.00
P068752	2005	CN-Inner Mongolia Highway & Trade Corrid	100.00	0.00	0.00	0.00	0.00	23.59	-22.66	0.00
P067828	2005	CN-Renewable Energy Scale-up Program	87.00	0.00	0.00	0.00	10.00	2.40	9.90	0.00
P057933	2005	CN-TAI BASIN URBAN ENVMT	61.00	0.00	0.00	0.00	0.00	26.33	15.48	0.00
P065035	2004	CN-Gansu & Xinjiang Pastoral Development	66.27	0.00	0.00	0.00	0.00	13.89	5.61	0.00
P065463	2004	CN-Jiangxi Integrated Agric. Modern.	100.00	0.00	0.00	0.00	0.00	51.18	31.85	0.00
P066955	2004	CN-ZHEJIANG URBAN ENVMT	133.00	0.00	0.00	0.00	0.00	80.52	40.59	0.00
P069852	2004	CN-Wuhan Urban Transport	200.00	0.00	0.00	0.00	1.00	50.22	49.84	0.00
P073002	2004	CN-Basic Education in Western Areas	100.00	0.00	0.00	0.00	0.00	28.35	26.18	0.00
P075728	2004	CN-GUANGDONG/PRD UR ENVMT	128.00	0.00	0.00	0.00	0.64	68.38	31.82	0.00
P081749	2004	CN-Hubei Shiman Highway	200.00	0.00	0.00	0.00	1.00	9.19	-4.81	0.00
P077137	2004	CN-4th Inland Waterways	91.00	0.00	0.00	0.00	0.46	46.45	31.41	30.91

P040599	2003	CN-TIANJIN URB DEV II	150.00	0.00	0.00	0.00	0.00	121.69	85.30	2.93
P068058	2003	CN-Yixing Pumped Storage Project	145.00	0.00	0.00	0.00	0.00	42.27	33.37	0.00
P076714	2003	CN-2nd Anhui Hwy	250.00	0.00	0.00	0.00	0.00	11.16	-1.34	0.00
P070191	2003	CN-SHANGHAI URB ENVMT APL1	200.00	0.00	0.00	0.00	0.00	70.08	44.56	0.00
P058847	2003	CN-3rd Xinjiang Hwy Project	150.00	0.00	0.00	0.00	0.00	12.25	12.25	0.00
P064729	2002	CN-Sustainable Forestry Development	93.90	0.00	0.00	0.00	0.00	8.14	2.36	0.00
P068049	2002	CN-Hubei Hydropower Dev in Poor Areas	105.00	0.00	0.00	0.00	0.00	9.88	9.18	0.00
P071147	2002	CN-Tuberculosis Control Project	104.00	0.00	0.00	0.00	0.00	38.61	28.63	0.00
P047345	2001	CN-HUAI RIVER POLLUTION CONTROL	105.50	0.00	0.00	0.00	0.00	6.62	6.62	-3.16
P051859	2001	CN-LIAO RIVER BASIN	100.00	0.00	0.00	0.00	0.00	8.48	8.48	0.00
P056596	2001	CN-Shijiazhuang Urban Transport	100.00	0.00	0.00	0.00	0.00	30.86	30.86	0.00
P049436	2000	CN-CHONGQING URBAN ENVMT	200.00	0.00	0.00	0.00	29.50	43.85	73.35	2.54
P064730	2000	CN-Yangtze Dike Strengthening	210.00	0.00	0.00	0.00	0.00	58.99	58.99	49.32
P045910	2000	CN-HEBEI URBAN ENVIRONMENT	150.00	0.00	0.00	0.00	0.00	27.83	27.83	8.32
P042109	2000	CN-BEIJING ENVIRONMENT II	349.00	0.00	0.00	25.00	28.02	138.40	166.43	12.52
P051856	1999	CN-Accounting Reform & Development	27.40	5.60	0.00	0.00	0.00	5.23	5.02	5.07
P042299	1999	CN-Tec Coop Credit IV	10.00	35.00	0.00	0.00	5.84	9.59	12.82	0.00
P036953	1999	CN-Health IX	10.00	50.00	0.00	0.00	0.40	5.01	3.15	3.15
P003507	1996	Ertan II Hydroelectric Project	400.00	0.00	0.00	0.00	0.15	33.33	5.78	0.00
		Total:	8,103.40	90.60	0.00	25.00	77.01	4,415.92	1,320.20	116.60

CHINA
STATEMENT OF IFC's
Held and Disbursed Portfolio
In Millions of US Dollars

		Committed				Disbursed			
		IFC				IFC			
FY Approval	Company	Loan	Equity	Quasi	Partic.	Loan	Equity	Quasi	Partic.
2002	ASIMCO	0.00	10.00	0.00	0.00	0.00	10.00	0.00	0.00
2006	ASIMCO	0.00	0.00	4.12	0.00	0.00	0.00	3.61	0.00
2005	BCCB	0.00	59.21	0.00	0.00	0.00	59.03	0.00	0.00
2003	BCIB	0.00	0.00	12.04	0.00	0.00	0.00	0.00	0.00
2006	BUFH	8.14	0.00	0.00	0.00	8.14	0.00	0.00	0.00
2005	Babei	0.00	5.00	0.00	0.00	0.00	5.00	0.00	0.00
	Babei Necktie	11.00	0.00	0.00	6.00	8.94	0.00	0.00	4.88
1999	Bank of Shanghai	0.00	21.76	0.00	0.00	0.00	21.76	0.00	0.00
2000	Bank of Shanghai	0.00	3.84	0.00	0.00	0.00	3.84	0.00	0.00
2002	Bank of Shanghai	0.00	24.67	0.00	0.00	0.00	24.67	0.00	0.00
2005	BioChina	0.00	3.70	0.00	0.00	0.00	3.13	0.00	0.00
2002	CDH China Fund	0.00	2.02	0.00	0.00	0.00	0.00	0.00	0.00
2005	CDH China II	0.00	17.99	0.00	0.00	0.00	11.38	0.00	0.00
2006	CDH Venture	0.00	20.00	0.00	0.00	0.00	0.51	0.00	0.00
2005	CT Holdings	0.00	0.00	40.00	0.00	0.00	0.00	0.00	0.00
2004	CUNA Mutual	0.00	10.53	0.00	0.00	0.00	0.00	0.00	0.00
2006	Capital Today	0.00	25.00	0.00	0.00	0.00	0.32	0.00	0.00
2005	Changyu Group	0.00	18.07	0.00	0.00	0.00	18.07	0.00	0.00

1998	Chengdu Huarong	3.36	3.20	0.00	3.13	3.36	3.20	0.00	3.13
2004	China Green Ener	20.00	0.00	0.00	0.00	15.00	0.00	0.00	0.00
2004	China Re Life	0.00	0.27	0.00	0.00	0.00	0.27	0.00	0.00
1994	China Walden Mgt	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00
2006	Chinasoft	0.00	0.00	15.00	0.00	0.00	0.00	10.00	0.00
2004	Colony China	0.00	15.31	0.00	0.00	0.00	9.29	0.00	0.00
2004	Colony China GP	0.00	0.84	0.00	0.00	0.00	0.49	0.00	0.00
2006	Conch	81.50	40.93	0.00	0.00	81.50	0.00	0.00	0.00
2006	Dagang NewSpring	25.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2002	Darong	10.00	0.24	0.00	8.00	6.67	0.24	0.00	5.33
2006	Deqingyuan	0.00	2.85	0.00	0.00	0.00	2.85	0.00	0.00
1994	Dynamic Fund	0.00	2.21	0.00	0.00	0.00	2.01	0.00	0.00
2007	Epure	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
2004	Fenglin	17.64	0.00	6.00	13.47	13.64	0.00	6.00	12.53
2006	Fenglin HJ MDF	0.23	0.00	0.00	3.27	0.00	0.00	0.00	0.00
2005	Five Star	0.00	0.00	7.00	0.00	0.00	0.00	0.00	0.00
2006	GDIH	50.85	0.00	0.00	0.00	50.85	0.00	0.00	0.00
2003	Great Infotech	0.00	1.73	0.00	0.00	0.00	1.03	0.00	0.00
2006	Hangzhou RCB	0.00	10.85	0.00	0.00	0.00	0.00	0.00	0.00
2005	HiSoft Tech	0.00	4.00	0.00	0.00	0.00	3.00	0.00	0.00
2006	HiSoft Tech	0.00	4.34	0.00	0.00	0.00	1.74	0.00	0.00
2004	IB	0.00	52.18	0.00	0.00	0.00	52.18	0.00	0.00
2004	Jiangxi Chenming	40.00	12.90	0.00	18.76	40.00	12.90	0.00	18.76
2006	Launch Tech	0.00	8.35	0.00	0.00	0.00	8.33	0.00	0.00
2001	Maanshan Carbon	5.25	2.00	0.00	0.00	5.25	2.00	0.00	0.00
2005	Maanshan Carbon	11.00	1.00	0.00	0.00	5.00	1.00	0.00	0.00
2005	Minsheng	15.75	0.00	0.00	0.00	7.00	0.00	0.00	0.00
2006	Minsheng & IB	25.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2001	Minsheng Bank	0.00	23.50	0.00	0.00	0.00	23.50	0.00	0.00
2005	Minsheng Bank	0.00	2.80	0.00	0.00	0.00	2.79	0.00	0.00
2001	NCCB	0.00	8.94	0.00	0.00	0.00	8.82	0.00	0.00
1996	Nanjing Kumho	0.00	3.81	0.00	0.00	0.00	3.81	0.00	0.00
2004	Nanjing Kumho	31.38	2.23	0.00	0.00	31.38	2.23	0.00	0.00
2006	Neophotonics	0.00	0.00	10.00	0.00	0.00	0.00	10.00	0.00
2001	New China Life	0.00	5.83	0.00	0.00	0.00	5.83	0.00	0.00
2005	New Hope	0.00	0.00	45.00	0.00	0.00	0.00	0.00	0.00
1995	Newbridge Inv.	0.00	0.22	0.00	0.00	0.00	0.22	0.00	0.00
2005	North Andre	8.00	6.74	0.00	0.00	0.00	4.25	0.00	0.00
2003	PSAM	0.00	2.01	0.00	0.00	0.00	0.00	0.00	0.00
	RAK China	13.00	0.00	0.00	0.00	13.00	0.00	0.00	0.00
2006	Renaissance Sec	0.00	0.00	20.04	0.00	0.00	0.00	0.00	0.00
2006	Rongde	0.00	35.00	0.00	0.00	0.00	31.38	0.00	0.00
	SAC HK Holding	0.00	1.60	0.00	0.00	0.00	1.00	0.00	0.00
2003	SAIC	12.00	0.00	0.00	0.00	12.00	0.00	0.00	0.00
2006	SBCVC	0.00	20.00	0.00	0.00	0.00	2.00	0.00	0.00
2000	SEAF SSIF	0.00	3.74	0.00	0.00	0.00	3.37	0.00	0.00
	SH Keji IT	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2004	SHCT	38.18	0.00	0.00	28.64	29.04	0.00	0.00	21.78
2004	SIBFI	0.14	0.07	0.00	0.00	0.00	0.07	0.00	0.00
1998	Shanghai Krupp	19.25	0.00	0.00	36.75	19.25	0.00	0.00	36.75

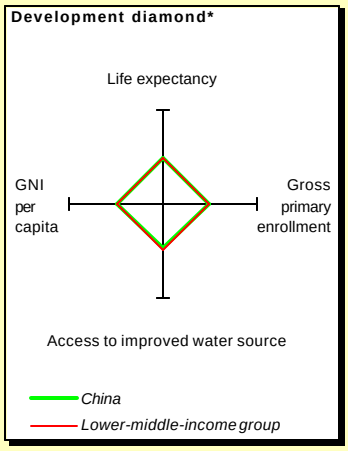
2006	Shanshui Group	50.00	5.50	2.20	0.00	50.00	5.50	0.00	0.00
1999	Shanxi	12.61	0.00	0.00	0.00	12.61	0.00	0.00	0.00
	SinoSpring	0.00	0.00	20.00	0.00	0.00	0.00	0.00	0.00
	Stora Enso	20.83	0.00	0.00	4.17	11.00	0.00	0.00	0.00
2005	Stora Enso	29.17	0.00	0.00	20.83	0.00	0.00	0.00	0.00
2006	Stora Enso	50.00	0.00	0.00	175.00	0.00	0.00	0.00	0.00
2006	TBK	4.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00
2006	VeriSilicon	0.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00
	Wanjie High-Tech	9.89	0.00	0.00	0.00	9.89	0.00	0.00	0.00
2004	Wumart	0.00	1.62	0.00	0.00	0.00	1.62	0.00	0.00
2003	XACB	0.00	17.95	0.00	0.00	0.00	0.64	0.00	0.00
2004	Xinao Gas	25.00	10.00	0.00	0.00	25.00	10.00	0.00	0.00
2006	Zhejiang Glass	50.00	24.96	0.00	18.00	0.00	0.00	0.00	0.00
2003	Zhengye-ADC	10.43	0.00	0.00	4.87	10.43	0.00	0.00	4.87
2002	Zhong Chen	0.00	4.78	0.00	0.00	0.00	4.78	0.00	0.00
2006	Zhongda_Yanjin	21.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total portfolio:	733.58	577.30	181.40	340.89	470.95	371.06	29.61	108.03

		Approvals Pending Commitment			
FY Approval	Company	Loan	Equity	Quasi	Partic.
2002	SML	0.00	0.00	0.00	0.00
2004	NCFL	0.00	0.00	0.02	0.00
2007	Xinao CTC	0.04	0.01	0.00	0.14
2004	China Green	0.00	0.00	0.01	0.00
2006	Launch Tech	0.01	0.00	0.00	0.00
2005	MS Shipping	0.00	0.01	0.00	0.00
2003	Peak Pacific 2	0.00	0.01	0.00	0.00
	Total pending commitment:	0.05	0.03	0.03	0.14

Annex 14: Country at a Glance

CHINA: GEF China Thermal Power Efficiency Project

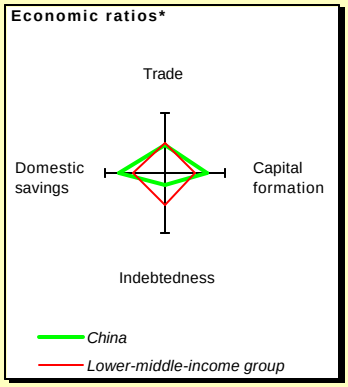
POVERTY and SOCIAL	China	East Asia & Pacific	Lower-middle-income
2006			
Population, mid-year *(millions)*	1,311.8	1,900	2,276
GNI per capita *(Atlas method, US$)*	2,000	1,863	2,037
GNI *(Atlas method, US$ billions)*	2,623.6	3,539	4,635
Average annual growth, 2000-06			
Population *(%)*	0.6	0.9	0.9
Labor force *(%)*	1.0	1.3	1.4
Most recent estimate (latest year available, 2000-06)			
Poverty *(% of population below national poverty line)*	..	..	..
Urban population *(% of total population)*	41	42	47
Life expectancy at birth *(years)*	72	71	71
Infant mortality *(per 1,000 live births)*	23	26	31
Child malnutrition *(% of children under 5)*	8	15	13
Access to an improved water source *(% of population)*	77	79	81
Literacy *(% of population age 15+)*	91	91	89
Gross primary enrollment *(% of school-age population)*	113	114	113
Male	113	115	117
Female	112	113	114



KEY ECONOMIC RATIOS and LONG-TERM TRENDS

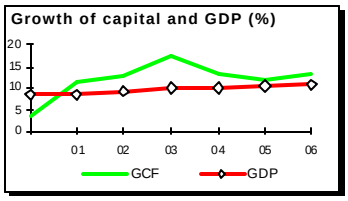
	1986	1996	2005	2006
GDP *(US$ billions)*	295.7	856.1	2,243.9	2,644.7
Gross capital formation/GDP	38.6	40.4	43.9	44.6
Exports of goods and services/GDP	11.8	20.1	37.3	40.1
Gross domestic savings/GDP	35.8	42.5	49.4	52.5
Gross national savings/GDP	35.9	41.3	51.0	54.1
Current account balance/GDP	-2.8	0.8	7.2	9.4
Interest payments/GDP	0.2	0.5	0.1	..
Total debt/GDP	8.0	15.0	12.6	..
Total debt service/exports	8.2	8.7	3.0	..
Present value of debt/GDP	.	.	12.3	..
Present value of debt/exports	.	.	30.6	..

	1986-96	1996-06	2005	2006	2006-10
(average annual growth)					
GDP	10.1	9.0	10.4	10.7	10.6
GDP per capita	8.6	8.2	9.7	10.1	9.9
Exports of goods and services	10.0	21.8	24.3	23.3	17.4



STRUCTURE of the ECONOMY

	1986	1996	2005	2006
(% of GDP)				
Agriculture	27.1	19.5	12.5	11.7
Industry	44.0	47.5	47.5	48.4
Manufacturing	35.2	33.5	33.5	..
Services	28.9	33.0	39.9	39.9
Household final consumption expenditure	49.3	43.5	36.1	33.2
General gov't final consumption expenditure	14.9	14.0	14.5	14.3
Imports of goods and services	14.7	18.0	31.7	32.2



	1986-96	1996-06	2005	2006
(average annual growth)				
Agriculture	4.3	3.5	5.2	5.0
Industry	13.5	10.1	11.7	12.5
Manufacturing	12.8	10.2	12.1	..
Services	9.4	9.8	10.5	10.3
Household final consumption expenditure	10.9	7.8	5.8	6.3
General gov't final consumption expenditure	10.4	9.5	11.6	10.9
Gross capital formation	11.9	10.2	11.6	13.2
Imports of goods and services	11.9	18.5	11.4	14.3

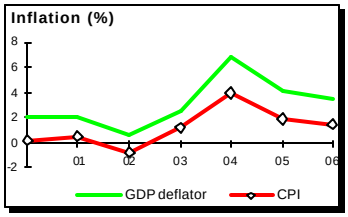
Note: 2006 data are preliminary estimates.

This table was produced from the Development Economics LDB database.

* The diamonds show four key indicators in the country (in bold) compared with its income-group average. If data are missing, the diamond will be incomplete.

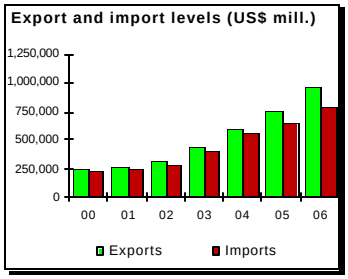
PRICES and GOVERNMENT FINANCE

	1986	1996	2005	2006
Domestic prices				
(% change)				
Consumer prices	..	8.3	1.8	1.5
Implicit GDP deflator	4.6	6.4	4.2	3.6
Government finance				
(% of GDP, includes current grants)				
Current revenue	0.0	10.5	17.2	18.4
Current budget balance	-17.7	0.2	2.4	3.0
Overall surplus/deficit	-24.8	-1.4	-1.3	-0.7



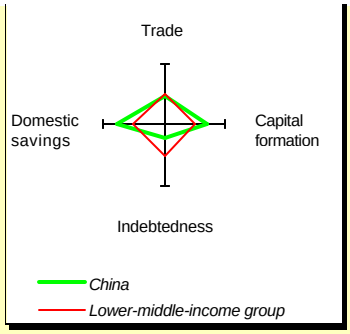
TRADE

	1986	1996	2005	2006
(US$ millions)				
Total exports (fob)	30,942	151,048	761,999	969,073
Food	4,448	10,231	22,481	25,722
Mineral fuels, lubricants, and related materials	3,683	5,931	17,621	17,776
Manufactures	19,670	129,123	712,960	916,147
Total imports (cif)	42,904	138,833	660,118	791,614
Food	1,625	5,672	9,388	9,997
Fuel and energy	504	6,877	63,957	89,002
Capital goods	16,781	54,763	290,628	357,107
Export price index *(2000=100)*	59	122	104	107
Import price index *(2000=100)*	76	108	118	124
Terms of trade *(2000=100)*	77	113	88	87



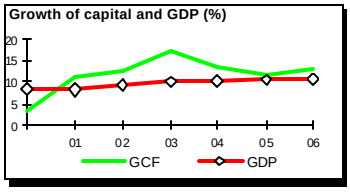
Gross capital formation/GDP	38.6	40.4	43.9	44.6
Exports of goods and services/GDP	11.8	20.1	37.3	40.1
Gross domestic savings/GDP	35.8	42.5	49.4	52.5
Gross national savings/GDP	35.9	41.3	51.0	54.1
Current account balance/GDP	-2.8	0.8	7.2	9.4
Interest payments/GDP	0.2	0.5	0.1	..
Total debt/GDP	8.0	15.0	12.6	..
Total debt service/exports	8.2	8.7	3.0	..
Present value of debt/GDP	..	..	12.3	..
Present value of debt/exports	..	..	30.6	..

	1986-96	1996-06	2005	2006	2006-10
(average annual growth)					
GDP	10.1	9.0	10.4	10.7	10.6
GDP per capita	8.6	8.2	9.7	10.1	9.9
Exports of goods and services	10.0	21.8	24.3	23.3	17.4

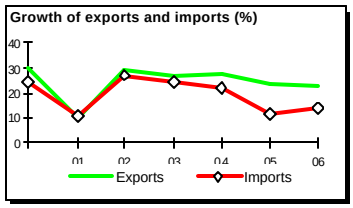


STRUCTURE of the ECONOMY

	1986	1996	2005	2006
(% of GDP)				
Agriculture	27.1	19.5	12.5	11.7
Industry	44.0	47.5	47.5	48.4
Manufacturing	35.2	33.5	33.5	..
Services	28.9	33.0	39.9	39.9
Household final consumption expenditure	49.3	43.5	36.1	33.2
General gov't final consumption expenditure	14.9	14.0	14.5	14.3
Imports of goods and services	14.7	18.0	31.7	32.2



	1986-96	1996-06	2005	2006
(average annual growth)				
Agriculture	4.3	3.5	5.2	5.0
Industry	13.5	10.1	11.7	12.5
Manufacturing	12.8	10.2	12.1	..
Services	9.4	9.8	10.5	10.3
Household final consumption expenditure	10.9	7.8	5.8	6.3
General gov't final consumption expenditure	10.4	9.5	11.6	10.9
Gross capital formation	11.9	10.2	11.6	13.2
Imports of goods and services	11.9	18.5	11.4	14.3



Note: 2006 data are preliminary estimates.
This table was produced from the Development Economics LDB database.

Annex 15: Incremental Cost Analysis

CHINA: GEF China Thermal Power Efficiency Project

INTRODUCTION

1. China's coal-fired power plants consume considerably more coal per kWh of electricity supplied than the international average. In 2006 coal-fired generation in China required an average 366 gce/kWh (units = 6MW) compared to a 300 gce/kWh benchmark in Japan or Europe. The main factors contributing to China's low power generation efficiency are: (i) a large share of the generation is by inefficient small units; (ii) generation dispatch is not optimized to achieving maximum efficiency; (iii) small CHP units operating for power generation only; and (iv) old mid-sized coal-fired units operating at relatively high coal consumption rate (see Annex 1).

2. This project will address these factors and improve the thermal efficiency of the coal-fired power generation in China by supporting pilot programs in Shanxi, Shandong, and Guangdong Provinces, and replicating successful experiences and practices throughout China. The project has five components: (i) mechanisms to support the closure of inefficient small coal-fired units; (ii) demonstration of power plant efficiency improvement; (iii) transition to efficient generation dispatch; (iv) technical assistance for project implementation; and (v) project management (see Annex 4).

A. Business-as-Usual Scenario

3. China has the second-largest power sector in the world. Installed capacity grew from 572 GW at the end of 2005 to 622 GW at the end of 2006 to over 700 GW by the close of 2007. China's power sector consumes about 50% of its total coal consumption, and coal-fired generation comprised 83% of the power produced. The International Energy Agency (IEA) forecasts that generation will continue to be added at a rate of 7.8% over the next eight years, slowing to 3.1% thereafter.[36] Coal-fired generation capacity additions are forecasted at 4.9% annually through 2015, accounting for 70 % of new additions. New orders of coal-fired power plants are mostly for high-efficiency super-critical units as well as some ultra-super-critical units. IGCC plants are also currently under planning and preparation as well. The new additions, combined with retirements and the forced closure of inefficient small units, are expected to meet the energy need with improved average coal-fired generation efficiency in China. Despite these improvements, the power sector's share of total coal consumption and GHG emissions will increase from 49% in 2005 to 52% in 2015 (see Table 15.1).

Table 15.1 Energy Related CO_2 Emission by Sector in the Reference Scenario

Unit: million ton/year

Year	1990	2005	2010	2015	2030
Power	652	2,500	3,589	4,450	6,202
Industry	800	1,430	2,014	2,186	2,373
Transport	121	337	486	664	1,255
Residential & Services	479	468	550	622	1,255
Other	191	365	585	709	903
Total	2,244	5,101	7,223	8,632	11,448

Source: World Energy Outlook 2007, International Energy Agency

[36] *World Energy Outlook 2007*, International Energy Agency

4. ***Business-as-Usual: Mechanism to Support Closing down Inefficient Small Thermal Units.*** The GOC has an active program focused on closing down inefficient small coal-fired power generation units. NDRC has targeted 50 GW of these small units (out of an estimated 115 GW total) for closure by 2010. The main instruments for achieving this objective include:

- State Council Document No. 2 (2007), which requires closure of all coal-fired units smaller than 50 MW, all coal-fired power units smaller than 100 MW and 20 years old or older, and all other coal-fired generation units which are more than 10% less efficient than the provincial average or more than 15% less efficient than the national average[37];

- Legal agreements between NDRC and 30 provincial governments and seven major power generation corporations that allocate the 50 GW national closure target; and

- A new NDRC policy linking approval of new capacity proposed by generation companies to closure of small thermal units.

5. Although the issued documents and agreements provide a basic framework for closing down small coal-fired power plants, effective implementation faces financial and social barriers, since the complementary capacity building and financial support needed to address these barriers are not in place (see Annex 1). The business-as-usual scenario for closing down small coal-fired units would be provincial and municipal authorities reaching their respective goals, but only at the very end of 2010 and accompanied by social and economic stress within affected communities.

6. Small CHP units are either restricted for power generation only[38] or to be closed to save coal consumption (see Annex 1). However, in the absence of a monitoring system it is difficult to enforce the closure or to ensure compliance with the dispatch restrictions. As there are delays in funding and implementation of the monitoring of CHP units, then the business-as-usual scenario will continue unrestricted (year-round) rather than having restricted operation for power generation by small CHP units when not serving district heating demand.

7. There is no platform for trading of SO_2 emission allowances to generate revenues complementary to the MCSU (see Annex 1). The business as usual scenario for this activity is little trading development outside the provinces affected by the Government's focus on closing down inefficient small coal-fired units.

8. ***Business-as-Usual: Demonstration of Power Plant Efficiency Improvement.*** There are few economic incentives which encourage investment in retrofitting coal-fired plants for efficiency improvements. Most new investment flows to constructing new power plants, where the incremental revenues are greater, the risk is negligible, and financing models are well established. Presently there are no obligations, few incentives, and no successful business cases for efficiency gain through (i) conversion of mid-sized units for power generation only into CHP units; (ii) waste heat recovery at thermal power units and utilization for district heating; and (iii) efficiency improvement at plants for power generation only following recommendations provided by plant energy auditing.

[37] As of end-2006 the national average coal consumption rate was 366 gce/kWh for units 6 MW or bigger. The provincial average rates were 373 and 382 gce/kWh for Shanxi and Shandong respectively.

[38] State Council Document [2000]1268: Heat-to-Power Ratio over the year (GJ: kWh*(3600 GJ/kWh)) x 100% must be equal to or above 100% for units smaller than 50 MW, 50% for units between 50 to 200 MW.

9. The business-as-usual scenario sees minimal resources flowing to retrofitting coal-fired plants for efficiency improvement. In the business-as-usual scenario the significant opportunities for cost-effective thermal efficiency improvements identified by NDRC are largely unrealized (see Annex 1). The other aspect of the business-as-usual scenario is the lost opportunity to coordinate conversion of mid-sized units into CHP operation and waste heat recovery retrofits to fill in the heat supply gaps caused by closure of inefficient small CHP units, or to substitute heat supplies by distributed boilers.

10. ***Business-as-Usual: Transition to Efficient Generation Dispatch.*** Change from the current system dispatch practices to the ESD will significantly save coal consumption for power generation. However, this change in dispatch practice will lead to significant financial impact on generation companies and will require improvement in fairness, transparency and monitoring of the system dispatch. Implementation of the ESD pilot in five pilot provinces has been delayed due to the lack of financial compensation mechanisms to address the financial impact and also the absence of other technical regulations required to pilot the ESD. Without technical assistance to support the development of the required regulations to pilot the ESD and to improve the dispatch approach for replication based on experience in both China and abroad, ESD pilot implementation will be further delayed, the transitioning to efficient generation dispatch will proceed slowly and cautiously, and the potential in coal-savings from improved generation dispatch will not be achieved.

B. Global Environment Benefits

11. The overall thermal efficiency of coal-fired power production in China will improve as new high-efficiency supercritical and ultra-supercritical power plants are added. Thermal efficiency can be further improved by policies and investments which are focused on existing power and CHP plants. Regulations such as State Council Document No. 2 provide the basis for closing down or restricting the operations of inefficient small thermal generation units. Other regulations to transition to efficient dispatch have long-term potential if effective technical and financial regulations are put in place. Growing heat demand and broader availability of rehabilitation technologies will eventually lead to more investment flowing to conversion of mid-sized power units into CHP units, waste heat recovery retrofits for condensing type power plants and efficiency refurbishment retrofits for mid-sized power plants built during the 1980s and 1990s. Any strategy or intervention that serves to accelerate these developments beyond the business-as-usual trajectory will have significant immediate, medium and long-term global environmental benefits. This is the strategy behind the China Thermal Power Efficiency Project – to accelerate the implementation of policies and investments focused on improving the operations and efficiency of existing power plants and the overall system.

12. ***Global Environmental Benefits: Mechanism to Support Closing down Inefficient Small Coal-fired Units.*** GEF-financed interventions with technical assistance, financial support and investment in monitoring systems will be targeted to closure of inefficient small units in Shanxi and Shandong. These two provinces contain almost one-quarter of the small thermal power units in China. In these provinces alone the closure of targeted inefficient small units could save as much as 7 million tons of coal equivalent consumption and reduce CO_2 emission by over 25 million tons per year. Replication of the financial support and monitoring systems could accelerate the closure of the remaining 65 GW inefficient small units not covered by the current closure plan and could quadruple these figures. In addition, on-line monitoring of the 3,000 MW of CHP units for district heating in Shandong and Shanxi will enable the provincial system dispatchers to minimize the energy generated by less efficient CHP units when not supplying heat, so as to further reduce CO_2 emissions in the two provinces.

13. ***Global Environmental Benefits: Demonstration of Power Plant Efficiency Improvement.*** Shanxi and Shandong provinces would also be the target of GEF-financed demonstrations of thermal efficiency improvements in 100-350 MW power plants constructed between ten and twenty-five years ago. There are an estimated 150 units in this size and age range throughout China. The waste heat recovery and conversion of power units into CHP operation will provide a potential solution which would allow the closure of inefficient small CHP units and distributed boilers.

Table 15.2: Global Environmental Benefits of Refurbishment and Retrofit for Efficiency Improvement and Waste Heat Recovery

Representative Market Description	Efficiency Improvement Strategy	Estimated Market Size
Small, inefficient CHP units and distributed boilers co-located with mid-sized, middle-aged power-only condensing turbine units in northern China	Close down inefficient small CHP units and distributed boilers for district heating, and retrofit mid-sized power-only units for CHP operation to replace the lost heat supply capacity and improve overall thermal efficiency	24 GW of pure-power condensing-type mid-sized units in northern China
Middle-aged, inefficient small CHP units providing heat and power	Refurbish for waste heat recovery to improve overall thermal efficiency and increasing heat supply capacity to replace boilers for heating	215 complexes under 100 MW in northern China
Mid-sized, middle-aged power generation units	Retrofit for improved power generation efficiency following recommendations of standard energy auditing	30 GW throughout China

14. ***Global Environmental Benefits: Transition to Efficient Generation Dispatch.*** This component will reduce system-wide coal consumption for power generation by accelerating the transition from current system dispatch practices to an efficient generation dispatch that maximizes coal savings and GHG emission reduction. The GEF intervention will support the ESD pilot implementation in one of the five pilot provinces designated by the Government, as well as simulation systems and assessments to further improve the dispatch approach and adapt regulations to accelerate the replication to other provinces (see Annex 4).

15. Simulation studies performed for two provincial grids documented significant global environmental benefits of moving to the ESD practice. Compared to current practices, implementation of ESD could save 730,000 tce of coal and 2.1 million tons of CO_2 emissions per year in Guangdong Provincial Power Grid and 2.2 million tce of coal and 6.4 million tons of CO_2 emissions per year in Shandong, starting in 2010. This represents a 1.0% and 3.2% reduction in coal consumption for power generation in the two provinces respectively.[39] Accelerated replication to transition to efficient generation dispatch that minimizes fuel consumption to all provinces (without capacity constraints) could reduce CO_2 emissions by as much as 75 million tons per year[40].

C. Incremental Reasoning and the Role of the GEF

[39] Shandong study: Efficient Dispatch and Generation Trading to Reduce Coal Consumption in China – Final Report, Mercados - Energy Markets International, 25 June 2007

[40] Based on a 2.1% reduction in IEA forecast 2010 CO_2 emissions from the power sector.

16. Realizing the global environmental benefits of improved thermal efficiency in the targeted provinces and eventually throughout China, requires overcoming an array of well-entrenched institutional and technical barriers. These barriers include: (i) regulatory environment lacking adequate incentives or support mechanisms; (ii) low monitoring capacity; (iii) lack of technical capacity and understanding regarding the potential for power efficiency improvements; (iv) difficulty in coordinating power sector policy and incentives at the municipal, provincial, and national levels; and (v) weak enforcement of existing government directives and regulations. In the "business as usual" scenario these barriers are eventually overcome, but only after years of trial and error and gradual improvement and scaling-up. The incremental reasoning behind this project is that GEF intervention will help overcome these barriers more quickly and comprehensively.

17. ***Incremental Reasoning: Mechanism to Support Closing down Inefficient Small Coal-fired Units.*** Closing down inefficient small coal-fired units will save coal consumption for power generation by reducing the share of less efficient capacity. Four complementary GEF-financed interventions will help overcome barriers (see Annex 1) to closing down or otherwise restricting the operations of small power and CHP plants in the selected provinces. The GEF support will ensure achievement of the 2006-2010 closure targets in Shandong and Shanxi that would otherwise be very difficult to attain on time as well as accelerate the closure of additional small units beyond the 2010 provincial closure targets.

18. *Pilot Implementation of Mechanism for Closing Small Units (MCSU).* A GEF-financed intervention will provide technical assistance and financing, including direct output-based payment per MW closed to local owners of small units to create financial incentives to closure of inefficient small units in Shandong and Shanxi. The MCSU mechanism is expected to help meet the 2009-2010 closure targets in the two provinces and close down an additional 300 MW in Shandong and 200 MW in Shanxi. If successful, the MCSU mechanism could be replicated to help address the barriers to the closure of remaining 65 GW of small inefficient coal fired generation, including when applicable small CHP units, throughout China.

19. *CHP On-line Monitoring Systems.* A GEF-financed intervention will support implementation of on-line monitoring systems for CHP units in Shanxi and Shandong. The on-line systems will be used to monitor the heat and power generation by the small CHP units, to identify units to be closed if they are not supplying the required ratio of heat-to-power and also to implement future transitions to efficient dispatch[41].

20. *Bulletin Systems for Trading of Emission Allowances.* The GEF will support development and trial implementation of a simple bulletin system to facilitate the trading of pollutant emission allowances of small units closed down, as allowed in State Council Document No. 2. This subcomponent will have indirect impacts as it will help accelerate the closure of small power units over the course of the 11th Five Year Plan.

21. *Monitoring and Evaluation.* The GEF will provide technical assistance to support data reporting, measurement and verification of results, impacts and outcomes evaluation, and capacity building. This activity will help ensure the effectiveness and replicability of the other interventions.

[41] Under the issued policy for ESD, CHP merit order list in the dispatch depends on whether or not the unit is actually providing heat. The dispatch regulations require CHP to be equipped with heat on-line monitoring.

22. ***Incremental Reasoning: Demonstration of Power Plant Efficiency Improvement.*** Conversion of mid-sized (300 MW) units from power generation only to CHP operation and recovery of wasted heat of condensing-type CHP units for hot water supplied district heating are new in China. Among the barriers to this efficiency-focused improvement are lack of familiarity with the technologies required, perception of higher risk and potentially lower returns than investing in new capacities, and the lack of technical capacity to develop and optimize projects that can maximize cost-effective efficiency gain.

23. This intervention shares the same incremental reasoning as many other GEF projects – that small investments in demonstrating new technologies and practices can leverage much larger investments by reducing risk, overcoming technical barriers and creating good practices that are replicable by others. The demonstration projects will result in modest direct CO_2 emission reductions but potentially much larger indirect reductions as the thermal efficiency improvement technologies and practice are replicated throughout China.

24. The GEF will co-finance three distinct thermal efficiency investment pilot projects – converting 330 MW units into CHP operation at Huangtai Power Plant, waste heat recovery at Jinan Beijiao Power Plant, and power-only efficiency improvement at Yangguang Power Plant. These three power plants were selected to represent generic thermal efficiency retrofitting opportunities to be found within China's fleet of mid-sized, middle-aged power plants (See Annex 1). The projects will demonstrate that retrofitting focused on energy efficiency will result in cost effective thermal energy efficiency improvements and, in the case of waste-heat recovery retrofits, will create a new source of heat supply capable of serving industrial and district heating needs.

25. *Conversion for CHP Operation at Shandong Huangtai Power Plant*. The project will demonstrate the benefits of retrofitting the 330 MW condensing-type power-only units (#7 & 8) for CHP operation to supply both power and heat at a higher overall thermal efficiency (see Figure 15.1 and Annex 4). Heat extraction from Units # 7 & # 8 after the retrofitting will provide sufficient heat supply to replace the output of the closed Units # 5 & # 6 in the same plant, along with the 77 distributed boilers. The thermal efficiency of the #7 & 8 units will increase and coal requirements for comparable levels of power and heat production will be reduced by 0.17 million tons per year starting 2009.

Figure 15.1: Shandong Huangtai Thermal Power Plant Characteristics before and after Conversion into CHP Operation

	Coal Inputs million tce	**Asset Mix**	**Energy Outputs** GWh and millions GJ
1. Business as Usual:	**1.91**	Unit # 5 and 6 Units # 7 and 8 before refurbishment 77 sets of distributed package boilers **Thermal Efficiency = 40.34%**	**Power: 4843.7** **Heat: 4.89**
2. GEF Alternative:	**1.74**	Units # 7 and 8 after refurbishment Supplemental grid power purchases **Thermal Efficiency = 44.36%**	**Power 4843.7** **Heat 4.89**
3. Coal Savings:	**0.17**		

26. Huangtai Power Plant demonstration project has considerable replication opportunities due to the large potential for low-pressure steam waste heat recovery from condensing turbines used in power plants and the current lack of experience in China in retrofitting these units for CHP operation.[42] A 2006 survey commissioned by NDRC and conducted by the China Electric Power Engineering Consultants Group Corporation identified 81 units of 300 MW power-only condensing turbine power plants that were within 15 km of cities with substantial industrial and district heat demand.

27. *Waste Heat Recovery at Jinan Beijiao Power Plant*. The investment project will demonstrate how to recover and utilize the heat wasted in the cooling system of condensing-type power generation units to significantly save coal consumption (see Figure 15.2 and Annex 4). The wasted heat recovered and network losses reduced (from 23% to 7%) will serve heat demand that would otherwise have to be met by construction of a 240 t/h boilers[43]. The overall thermal efficiency of Jinan Beijiao Power Plant will be increased and overall fuel inputs to produce the same amount of power and heat outputs will be reduced by 0.06 million tons of coal per year starting in 2009.

Figure 15.2: Jinan Beijiao Thermal Power Plant Characteristics Before and after Refurbishment

`	**Coal Inputs** million tce	**Asset Mix**	**Energy Outputs** GWh and millions GJ
1. Business as Usual:	**0.40**	Unit # 2 and 5 before refurbishment 2 Package Boilers @ 75% efficiency **Thermal Efficiency = 57.03%**	**Power: 427.87** **Heat: 5.13**
2. GEF Alternative:	**0.34**	Unit # 2 and 5 after refurbishment 1 Package Boiler @ 75 % efficiency Supplemental grid power purchases **Thermal Efficiency = 66.81%**	**Power: 427.87** **Heat: 5.13**
3. Coal Savings:	**0.06**		

28. There are a large number of similar facilities located throughout northern China. As mentioned above there are 70 sets of CHP units in Shanxi provincial grid and another 83 CHP units in Shandong provincial grid. In addition, there are more than 500 CHP units in the small towns and cities which mostly supply district heating in Shandong alone. This efficiency improvement strategy is applicable to those facilities providing district heating.

29. *Investment for Power Generation Efficiency Improvement at Yangguang Power Plant*. The project will demonstrate how mid-sized, middle-aged coal-fired units can be refurbished following the recommendations of a standard energy auditing to improve thermal efficiency without any change in power production (see Annex 4). Energy audits and pre-feasibility studies for Yangguang's four 330 MW power generation units showed that thermal efficiency gains could be achieved through refurbishment of the turbine rotors' blades, replacement of main shaft seals, installation of high-

[42] Evaluation Report on Heat Supply Rehabilitation Program of Shandong Huangtai Power Plant, Xi'an Thermal Power Research Institute Co. Ltd. for the GEF China Thermal Power Efficiency Project, April 2008

[43] Evaluation Report on Heat Supply Rehabilitation Program of Shandong Beijiao Plant, Xi'an Thermal Power Research Institute Co. Ltd. for the GEF China Thermal Power Efficiency Project, April 2008

reliability VSDs for primary fans of boilers, and adding a system for on-line monitoring of instantaneous heat rates.

30. The four units will operate in the same way and produce the same power outputs before and after refurbishment, but with improved heat rate for power production. This modest change will save 0.04 million tons of coal per year. The process is highly replicable throughout China's 24 GW fleet of 300 MW power generation units.

Figure 15.3: Yangguang Thermal Power Plant Characteristics Before and after Refurbishment

	Coal Inputs million tce	**Asset Mix**	**Energy Outputs** GWh and millions GJ
1. Business as Usual:	**2.85**	Unit # 1-4 before refurbishment **Thermal Efficiency = 35.27%**	**Power: 8106** **Heat: 0.00**
2. GEF Alternative:	**2.81**	Unit #s 1-4 after refurbishment Refubishment of turbine blades/seals Installation of 4 sets of VSDs **Thermal Efficiency = 35.77%**	**Power 8106** **Heat 0.00**
3. Coal Savings:	**0.04**		

31. ***Incremental Reasoning: Transition to Efficient Generation Dispatch.*** Current dispatch practices in China are focused on distributing load supply among available generation, independent of efficiency. State Council Document No. 53 and NDRC Document No. 3523 for the ESD initiate the transition to new dispatch practices that prioritize fuel savings and efficiency (see Annex 1). However, there are major barriers which must be overcome to start effective implementation of ESD pilot: These are (i) the lack of the Financial Compensation Mechanism to address the financial impact of change in dispatch practice on generation assets owners, due to the energy-only generation tariffs; and (ii) the lack of regulations for information disclosure required for transparent implementation and monitoring of the ESD.

32. The incremental reasoning for GEF support is that investment in support of developing and piloting this new generation dispatch practice in China and especially at the provincial level will accelerate the transition to a dispatch practice that maximizes coal savings and GHG emission reduction. This will also result in the leveraging very large global environmental benefits. The GEF would support pilot implementation of ESD in Guangdong Provincial Power Grid, including developing regulations required to start the ESD pilot implementation, as well as studies to improve the dispatch practice needed to accelerate the replication of improved dispatch approach country wide.

33. Since the Guangdong ESD pilot will provide impetus for scaling-up coal savings dispatch practices throughout China, the GEF intervention at the national level will help resolve the complex interactions between the financial impact on generation companies, the change of dispatch practice and the transition to more effective coal-saving dispatch.

34. ***Results Framework for the China GEF Thermal Power Efficiency Project.*** Table 15.3 provides an overall Results Framework which summarizes the Business-as-Usual case, the proposed GEF Alternative, and the nature of the GEF intervention.

Table 15.3: Results Framework for the China GEF Thermal Power Efficiency Project

	Business as Usual	GEF Alternative	GEF Intervention
Component 1: Mechanisms to Support Closing down Inefficient Small Coal-fired Units			
1A: Technical Assistance and Capitalization to MCSU	A program without fiscal assistance and incentives results in long delays in enforcement and heavy local economic impacts	Development and application of a comprehensive assistance program that becomes a model for reaching and exceeding the short-term 50 GW small units closure target and the longer-term goal of closing all remaining inefficient small units.	The GEF provides technical assistance to the formation and initial operations of the financial incentive mechanism (MCSU), including development of MCSU Operational Manual, studies and pilot operation of the MCSU for output based payment per MW closed to the asset owner.
1B: CHP On-Line Monitoring System	Inability to effectively monitor compliance with Government regulations for closure or restrictions on small CHP units	Near-term installation of real-time monitoring of CHP units dispatched by the provincial grid in line with relevant government policies and daily reporting of results to the Provincial Economic Commission for monitoring and enforcement.	The GEF co-finances the first-stage system, including system design and implementation of the first stage Supervisory Control and Data Acquisition system at selected CHP, telemetry to and systems for the provincial grid dispatch centers and economic commissions.
1C: Bulletin System for Trading of Emissions Allowances	Although national and provincial authorities have established basic regulations for emissions trading, value of SO_2 remains unknown and there is no trading platform.	To facilitate highly-replicable emissions trading bulletin systems as a platform that enables an additional revenue stream for owners of small generation units targeted for closure in two pilot provinces.	The GEF project provides technical assistance to prepare and pilot implementation of a simple bulletin system as a platform for trading of SO_2 emission allowance of small coal-fired units targeted for closure in the piloting provinces.
Component 2: Demonstration of Power Plant Efficiency Improvement			
2A: Conversion for CHP Operation at Huangtai	Heat supply gap created by closure of inefficient small CHP units provided by inefficient distributed boilers	Retrofit of mid-sized, middle-aged units for CHP operation closes heat supply gap, replaces distributed small boilers, and increases overall thermal efficiency of the power plant.	GEF co-finances certain critical elements of the retrofit which are directly tied to thermal efficiency improvements, such as the improved turbine and heat extraction system.
2B: Waste Heat Recovery at Jinan Beijiao	Continued operation of older inefficient CHP units and distributed boilers	Refurbishment of condensing-type units for waste heat recovery and district heating network for reduction of network losses increase overall efficiency.	GEF co-finances certain critical elements of the refurbishment which are directly tied to thermal efficiency improvements, such as the new systems for wasted heat recovery and utilization.
2C: Investment for Efficiency Improvement at Yangguang	Continued operation at 35 % power efficiency	Improvement of power efficiency to 36% with selective refurbishment investment activities.	GEF co-finances certain critical elements of the refurbishment which are directly tied to thermal efficiency improvements, such as turbine blade & shaft seal replacement, installation of VSD and an efficiency monitoring system (HW/SW)
Component 3: Transition to Efficient Generation Dispatch			

3A: ESD Pilot in Guangdong – simulation system to improve ESD	ESD based on merit order table may result in lower coal savings and GHG emission reduction than taking into consideration variable efficiency depending on generation output level	Guangdong Provincial Power Grid will receive sufficient assistance and systems to test in parallel improvements to dispatch practice to maximize coal savings and GHG emission reduction.	GEF co-finances the provincial pilot efforts and ensures that Guangdong dispatch center benefits from international experience in dispatch practices and models to improve the effectiveness of the dispatch
3A: ESD Pilot in Guangdong – regulation to start ESD pilot	Slow progress in developing required technical regulations and financial compensation mechanisms for the ESD pilot and generation pricing not harmonized with efficient dispatch practice	Development and implementation of technical regulations and compensation schemes for the ESD pilot and technical assistance to advance tariff reform, making accelerated transition to efficient generation dispatch possible.	GEF supports national level efforts to resolve financial impacts on generation assets owners due to the change in dispatch practice and technical regulations to accelerate the ESD pilot in Guangdong and other pilot provinces.
3B: Assessment of ESD Pilot and Replication	Assessment and adjustment of the ESD regulations for replication benefit from Chinese experience only	International dispatch experts and local power sector experts to assess the ESD pilot programs and identify improvements in regulations for effective replication to other provinces.	GEF support ties the pilot ESD results to regulatory developments and ensures the efficient generation dispatch is improved to maximize coal savings and GHG emission reduction when replicated throughout the country.

G. Role of Co-financing

35. Incremental costs and co-financing for the GEF Project are shown in Table 15.4. The GEF will provide 18.1% of the total project cost. GEF financing will be restricted to technical assistance, capacity building, partial capitalization to top up government funds for the MCSU (at a ratio of 1:3) and strategic capital investment in certain subcomponents.

Table 15.4: Incremental Cost for China Thermal Power Efficiency Project

Project Components	Counterpart Financing	GEF Funding	Estimated Total
	(US$m)	(US$m)	(US$m)
Component 1 – Mechanisms to Support Closing down Inefficient Small Coal-fired Units			
1A: Pilot Implementation of MCSU	15.757	5.786	21.543
1B: Set up of CHP On-Line Monitoring Systems	9.806	2.000	11.806
1C: Bulletin System for Trading of Emission Allowances	0.929	1.000	1.929
1D: Monitoring and Evaluation	0.429	0.714	1.143
Sub-total	**26.920** (73.9%)	**9.500** (26.1%)	**36.420** (100%)
Component 2 – Demonstration of Power Plant Efficiency Improvement			
2A: Conversion for CHP Operation at Huangtai	26.206	1.096	27.301
2B: Waste Heat Recovery at Jinan Beijiao	21.609	1.099	22.707
2C: Investment for Efficiency Improvement at Yangguang	4.774	1.100	5.874
2D: Technical Assistance to Capacity Building and Replication	0.179	0.220	0.398
Sub-total	**52.767** (93.8%)	**3.514** (6.2%)	**56.281** (100%)
Component 3 – Transition to Efficient Generation Dispatch			
3A: Guangdong Provincial ESD Pilot	2.526	2.621	5.147
3B: National Policy Development and Capacity Building	0.700	1.450	2.150
Sub-total	**3.226** (44.2%)	**4.071** (55.8%)	**7.297** (100%)
Component 4 – Technical Assistance to Project Implementation			

Sub-total	**0.586** (31.6%)	**1.266** (68.4%)	**1.852** (100%)
Component 5 – Project Management			
Sub-total	**1.507** (78.7%)	**0.408** (21.3%)	**1.916** (100%)
TOTAL	**85.01** (81.9%)	**18.76** (18.1%)	**103.77** (100%)

Note: excluding contingency

H. Detailed GHG Incremental Benefits and Benefit Cost Calculations

36. Coal savings and GHG emissions reductions resulting from the GEF Project are estimated in accordance with recently-updated GEF guidelines[44].

37. ***GHG Benefits and Incremental Costs: Mechanism to Support Closing down Inefficient Small Coal-fired Units.*** This component has four activities: (i) Pilot Implementation of MCSU; (ii) Set up of CHP On-line Monitoring Systems; (iii) Bulletin Systems for Trading of Emission Allowances; and (iv) M&E (see Annex 4). This component has the largest coal savings and the largest emission reduction impacts.

38. *Pilot Implementation of MCSU.* The establishment and pilot operation of the MCSU directly result in closure of an incremental 7.5% of small coal-fired units (300 MW in Shandong and 200 MW in Shanxi) beyond the closure targets agreed with NDRC. This subcomponent will also indirectly contribute to meeting the scheduled goals for these two provinces in 2009-2010. It may also contribute in the future to closing the remaining 65 GW of inefficient small coal-fired units after 2010, but the impact of this contribution is difficult to quantify. These assumptions yield an estimated direct CO_2 emissions reduction of 5.7 million metric tons over six years (2009-2014) and additional indirect CO_2 emissions reductions of 31 million metric tons over the same period (See Table 15.5)

Table 15.5: Mechanism to Support Closing Down Inefficient Small Thermal Units Direct and Indirect GHG Impact[45]

	Cumulative Impact	**Annual Impacts**					
	(6 years)	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Shanxi Direct CO2 Savings (10^6 te)	2.27		0.25	0.50	0.50	0.50	0.50
Shanxi Indirect CO2 Savings (10^6 te)	14.42	0.78	2.21	2.84	2.84	2.84	2.84
Shandong Direct CO2 Savings (10^6 te)	3.43		0.39	0.76	0.76	0.76	0.76
Shandong Indirect CO2 Savings (10^6 te)	16.58	1.01	2.63	3.24	3.24	3.24	3.24
Direct Total CO2 Savings (10^6 te)	**5.70**						
Indirect Total CO2 Savings (10^6 te)	**30.95**						

39. *CHP On-line Monitoring Systems.* This activity can indirectly deliver coal savings and CO_2 emission reductions to the extent that the systems are used by provincial dispatchers and regulators as a compliance tool. The monitoring system would allow the provincial regulators to identify and close inefficient small CHP units or otherwise the provincial dispatcher to restrict the operation of CHP units

[44] Manual For Calculating GHG Benefits Of GEF Projects: Energy Efficiency And Renewable Energy Projects, prepared for the GEF Council, Washington, DC, February 21, 2008.

[45] Assumes 5878 hours per year for all generators, power production at 465 gce/kWh by capacity to be closed is replaced by grid purchases at 348 gce/kWh and that capacity is closed at steady monthly intervals over the year

to generating electricity only when required to supply heat and subsequently, increase the operation of more-efficient generation capacity available.

40. The indirect impact of on-line CHP monitoring can be estimated by counting the capacity closed or by comparing current operating hours to the number of hours when district heating is required. Although likely to be substantial, the impacts are not counted here because of the possibility of double-counting impacts across the various activities of Component 1.

41. *Bulletin Systems for Trading of SO_2 Emission Allowances.* This activity will not have any direct impact on coal savings or CO_2 emission reductions. However, it will contribute to meeting the small unit closure goals of Shandong and Shanxi by possibly creating additional revenues to the MCSU to cover partial costs of the closure. However, separating out the indirect impacts of this component from the other components is not possible.

42. *Monitoring & Evaluation.* This activity *per se* does not have any direct or indirect impact on fuel savings or CO_2 emissions reductions, but will ensure achievement of the expected outcomes of other interventions.

43. ***GHG Benefits and Costs: Demonstration of Power Plant Efficiency Improvement.*** Demonstration projects have CO_2 emissions impacts resulting directly from the project investment and also indirectly based on how effective the GEF Project is in leveraging new investment. The three thermal efficiency improvement demonstration projects will have modest direct impacts from the project investment itself but potentially much large indirect impact as the investment practices and technologies are scaled-up and replicated throughout China.

44. Table 15.6 summarizes the direct and indirect GHG emissions reduction benefits for the three demonstration projects, based on the coal savings of each project and the replication potential as shown in Table 15.2. The indirect GHG emissions reductions are estimated by extrapolating direct CO_2 emissions impacts of the demonstration projects to the estimated market potential on a lifetime CO_2/MW basis. A "top-down" approach using a 25% market potential is assumed[46].

Table 15.6: Direct and Indirect GHG Impacts
Demonstration of Power Plant Efficiency Improvement

Demonstration Project	Annual Coal Savings (10^6 tce)	Annual CO_2 Emission Impacts (10^6 t)	Lifetime Direct CO_2 Emissions Impacts (10^6 t)	Indirect CO_2 Emissions Impacts (10^6 t)[47]

[46] Market potential can be estimated with either a "top down" or "bottom up" approach. The "bottom-up" approach is generally preferred, as it requires more detailed information and an expert judgment about the potential market and the likely pace at which the specific technology demonstrated is likely to be adopted by others. If such knowledge is available, the direct impacts of the demonstration project can be scaled-up to estimate the indirect impacts as a result of successful replication. The "top down" approach assesses indirect impacts by estimating the combined technical and economic market potential for a technology within a 10 year period of the demonstration project's lifetime. This can be a very inexact estimate, as many different technologies will vie for any large market, and the likelihood of the demonstration technology capturing a large market share will be low.

[47] The calculation is: (direct lifetime CO_2 impacts/MW of pilot project size)*(total size of the MW power plant fleet in that size and age category, per Table 15.2)*(25 % market share)

1. Conversion for CHP Operation at Huangtai	0.17	0.47	9.46	86.04
2. Waste Heat Recovery at Jinan Beijiao	0.06	0.16	3.23	220.00
3. Efficiency Improvement Retrofit at Yangguang	0.04	0.11	2.22	13.90
Total	**0.27**	**0.74**	**14.91**	**319.94**

45. ***GHG Benefits and Costs: Transition to Efficient Generation Dispatch.*** GEF support to pilot ESD in China will have direct and indirect global environmental benefits. A simulation of the Guangdong Provincial Power Grid estimated to have direct benefits of 1.9 million tons of coal savings during the three years of ESD pilot with an average of 0.72 million tons coal saving per year (see Annex 4), or 5.5 million cumulative tons of direct CO_2 savings. Indirect benefits as a result of accelerated transition to efficient generation dispatch nationwide could be as much as 75 million tons of CO_2 through 2015, based on a 0.5 % reduction in IEA forecast 2010 CO_2 emissions from the power sector.

46. ***GHG Benefits and Costs: Transition to Efficient Generation Dispatch.*** This activity *per se* does not have any direct or indirect impacts on fuel savings or CO_2 emissions reductions, but will ensure achievement of the expected outcomes of other interventions.

H. Cost of CO_2 Emission Reduction

47. The direct CO_2 emission reductions impacts and the project budget are brought together in Table 15.7. These results suggest that the GEF Project is a very cost effective source of CO_2 reductions. The average cost of direct CO_2 impacts across all the components and including the "overhead" components such as M&E was US$ 3.98 per ton. When expressed as per unit of indirect impacts, the costs would be much lower, only 24 cents per ton. Total project-wide cumulative CO_2 impacts are 26.1 million tons direct and 425.9 million tons indirect.

Table 15.7: Cost of GHG Emission Impacts

Project Components	GEF Funding (US$m)	Total Funding (US$m)	Cumulative Direct CO_2 Reductions (10^6 t)	Cumulative Indirect CO_2 Reductions (10^6 t)	Cost of Direct CO_2 Impacts ($/t)	Cost of Total (Indirect + Direct) CO_2 Impacts ($/t)
1A: Pilot Implementation of MCSU	5.79	21.54	5.7	30.95	3.78	0.70
1B: Set-up of CHP On-line Monitoring Systems	2.00	11.81	N.A.	N.A.	N.A.	N.A.
1C: Study and Support for Trading of Emission Allowances	1.00	1.93	N.A.	N.A.	N.A.	N.A.
1D: M&E	0.71	1.14	N.A.	N.A.	N.A.	N.A.
Component 1 Subtotal	**9.50**	**36.42**	**5.70**	**30.95**	**6.39**	**1.18**
2 A: Conversion for CHP operation at Huangtai	1.14	27.34	9.46	86.04	2.89	0.32
2 B: Waste Heat Recovery Demonstration Beijiao	1.14	22.75	3.23	220.00	7.04	0.10
2 C: Efficiency Improvement Retrofit at Yangguang	1.10	5.87	2.22	13.9	2.65	0.42
2D: Technical Assistance to Capacity Building / Replication	0.22	0.40				
Component 2 Subtotal	**3.60**	**56.36**	**14.91**	**319.94**	**3.78**	**0.18**
3A: Guangdong Provincial ESD Pilot	2.62	5.15	5.5	75	0.94	0.07
3B: National Policy Development and Capacity Building	1.45	2.15	N.A.	N.A.	N.A.	N.A.

Component 3 Subtotal	**4.07**	**7.30**	**5.50**	**75.00**	**1.33**	**0.10**
Component 4 Subtotal	**1.27**	**1.85**	**N.A.**	**N.A.**	**N.A.**	**N.A.**
Component 5 Subtotal	**0.41**	**1.92**	**N.A.**	**N.A.**	**N.A.**	**N.A.**
GEF PROJECT TOTAL	**18.84**	**103.85**	**26.110**	**425.890**	**3.98**	**0.24**

Annex 16: STAP Scientific and Technical Screening

CHINA: GEF China Thermal Power Efficiency Project

STAP Scientific and Technical screening of the Project Identification Form (PIF)

Date of screening: September 27, 2007 Screener: Douglas Taylor, STAP Secretary

Panel member validation by: Michael Stocking

I. PIF Information *(Paste here from the PIF)*

Full size project GEF Trust Fund

GEFSEC PROJECT ID:

GEF AGENCY PROJECT ID: P098654

COUNTRY(IES): China

PROJECT TITLE: China Thermal Power Efficiency

GEF AGENCY(IES): World Bank, (select), (select)

OTHER EXECUTING PARTNER(S): Ministry of Finance, China

GEF FOCAL AREA (S): Climate Change,(select), (select)

GEF-4 STRATEGIC PROGRAM(S): Strategic Objective of promoting retrofitting power plants (***Summary of Negotiations on the Fourth Replenishment of the GEF Trust Funds, dated August 25, 2006***)

NAME OF PARENT PROGRAM/UMBRELLA PROJECT:

II. STAP PIF Screening (based on Part I A Project Framework and Part II Questions of the PIF)

Background logical consistency informing STAP's scientific and technical screening:

1. Is the Project Objective consistent with the Problem/Issue? YES ☒ NO ☐ PARTIAL ☐
   - If "No" or "Partial" explain:
2. Are the expected outcomes consistent with the Problem/Issue? YES ☒ NO ☐ PARTIAL ☐
   - If "No" or "Partial" explain:
3. Global environmental benefits scientifically valid? YES ☐ NO ☒ UNKNOWN ☐
   - If "No" or "Unknown" explain: The GEB appear to be based on China's need to help it de-commission, or renovate old efficient power plants. If this is done, energy efficiency will be achieved. To strengthen this argument further, it would be useful to include some projections of greenhouse gas production in the electricity sector with and without the project.

Relevant Scientific and Technical issues contained in proponent responses to Questions A to H

4. Problem definition scientifically valid? YES ☒ NO ☐ UNKNOWN ☐
   - If "No" or Unknown" explain:
5. Proposed intervention scientifically justified? YES ☒ NO ☐ UNKNOWN ☐
   - If "No" or Unknown" explain:
6. Methodology proposed:
   - Is there a scientifically valid baseline? YES ☒ NO ☐ UNKNOWN ☐
   - Is a scientific control explicitly included? YES ☐ NO ☒ UNKNOWN ☐ N/A ☐
   - Is there scientific or technical innovation? YES ☒ NO ☐ UNKNOWN ☐
   - Is the methodology replicable? YES ☒ NO ☐ UNKNOWN ☐

   - If any of the above are marked "No" or "Unknown" explain: There is no control situation identified against which to compare project impact
7. Is the incremental reasoning scientifically valid? YES ☐ NO ☐ UNKNOWN ☒
   - If "No" or "Unknown" explain: The argument on global environment benefits needs to be strengthened further.
8. Are the risk statements scientifically valid and comprehensive? YES ☒ NO ☐ UNKNOWN ☐
   If "No" explain:

III. STAP Advisory Response *(see next page for explanation)*

9. Based on this PIF screening, STAP recommends the following action to the GEF Secretariat and GEF Agency (ies): **No objection, but follow-up action required**

IV. Further guidance from STAP

10. STAP has no objection to the approval of this proposal. However, STAP requests that the proponent strengthens the global environment benefit scenario, and provide a full analysis of whether the energy efficiency gains might not be achieved spontaneously through "natural selection" based upon cost-efficiency considerations and market forces.

A. RESPONSE TO STAP SCIENTIFIC AND TECHNICAL SCREENING:

1. The STAP review screening comments received at work program inclusion have been taken into account in the preparation of the Project Appraisal Document, especially the Component Descriptions and the Incremental Cost Analysis. Specific responses are detailed below:

2. **Comment:** As regards the scientific validity of global environmental benefits, "the GEB appears to be based on China's need to help it de-commission or renovate old inefficient power plants. If this is done, energy efficiency will be achieved. To strengthen this argument further, it would be useful to include some projections of greenhouse gas production in the electricity sector with and without the project."

3. **Response:** The Incremental Cost Analysis (Annex 15) cites projections from the IEA of Chinese power sector CO_2 emissions. Power sector CO_2 emissions were 2,500 million t in 2005 and forecast to grow to 3,600 million t in 2010. This is the Business-as-Usual scenario. In the GEF alternative the cumulative direct and indirect emissions reductions resulting from the project could reach 575 million t over ten years, over 55 million t per year and almost a 2% impact on total 2010 power sector CO_2 emissions. These energy savings and GHG emissions reductions were estimated in accordance with recently-updated GEF guidelines for climate change projects.[48]

4. **Comment:** As regards the explicit inclusion of a scientific control, "there is no control situation identified against which to compare project impact."

5. **Response:** The control situation is the Business-as-Usual scenario, in line with GEF guidelines on incremental cost analysis.[49] The Business-as-Usual scenario is described in detail in the Incremental Cost Analysis and varies according to each component of the project. Generally speaking the Business-as-Usual scenario involves slow but unsteady progress in implementing key reforms, such as efficient fuel dispatch and enforcement of regulations regarding cogeneration facilities and a flow of investment to new power plants to the exclusion of retrofitting older power plants. The Business-as-Usual scenario in the aggregate is represented by the Reference Scenario in WEO 2007.

6. **Comment:** As regards the scientific validity of the incremental reasoning, "the argument on global environmental benefits needs to be strengthened further".

7. **Response:** The incremental reasoning behind GEF support of the project is detailed in the Incremental Cost Analysis (Annex 15). Barriers are impeding the accelerated adoption of three major efficiency-improvement initiatives for existing generators – accelerated closure and operational restrictions for small inefficient coal-fired generation units and CHPs, efficiency retrofitting of mid-sized coal fired generation units, and introduction of efficient fuel saving dispatch. The incremental reasoning is that with GEF intervention these barriers can be overcome more quickly and completely, with the efficiency improvement initiatives becoming effective sooner and more completely. Further elaboration on the incremental reasoning in support of each component is provided in the Annex 15 of this Project Appraisal Document.

[48] Manual For Calculating GHG Benefits Of GEF Projects: Energy Efficiency And Renewable Energy Projects, prepared for the GEF Council, Washington, DC, February 21, 2008.
[49] *Operational Guidelines for the Application of the Incremental Cost Principle* (GEF/C.31/12, May 14, 2007),

Annex 17: Maps

CHINA: GEF China Thermal Power Efficiency Project