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The World Bank

Report No: ICR00003274

IMPLEMENTATION COMPLETION AND RESULTS REPORT
(TF-94204)

ON A

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

THERMAL POWER EFFICIENCY PROJECT

February 25, 2015

Energy & Extractives Global Practice
East Asia and Pacific Region

CURRENCY EQUIVALENTS

(Exchange Rate Effective October 25, 2014)

Currency Unit = US$
RMB 1.00 = US$ 0.16
US$ 1.00 = RMB 6.12

FISCAL YEAR
January 1 – December 31

ABBREVIATIONS AND ACRONYMS

CAPEX	Capital Expenditure	kWh	Kilowatt hour
CHP	Combined Heat and Power	M&E	Monitoring & Evaluation
CO_2	Carbon Dioxide	MCSU	Mechanism for the Closure of Small Units
CPS	Country Partnership Strategy	MEP	Ministry of Environmental Protection
EE	Energy Efficiency	MOF	Ministry of Finance
EIRR	Economic Internal Rate of Return	MWh	Megawatt hour
EMP	Environmental Management Plan	mtce	Million tons of coal equivalent
EPB	Environmental Protection Bureau	NDRC	National Development and Reform Commission
ESD	Energy Saving Dispatch	NEA	National Energy Administration
FIRR	Financial Internal Rate of Return	Nm^3	Normal cubic meter
FYP	Five Year Plan	NPMO	National Project Management Office
gce	Grams of Coal Equivalent	O&M	Operation and Maintenance
GDP	Gross Domestic Product	OMS	Operation and Management System
GEF	Global Environment Facility	PDO	Project Development Objective
GEO	Global Environment Objective	PMO	Project Management Office
GHG	Greenhouse Gas	PMU	Project Management Unit
GOC	Government of China	RMB	Renminbi Yuan (Chinese currency)
GW	Gigawatt	SERC	State Electricity Regulatory Commission
IAs	Implementing Agencies	SO_2	Sulfur Dioxide
ICR	Implementation Completion and Results	tce	Tons of Coal Equivalent
IGCC	Integrated Gasification Combined Cycle	TWh	Terawatt Hour

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China
GEF Thermal Power Efficiency Project (P098654)

CONTENTS

Data Sheet

A. Basic Information			
Country:	China	Project Name:	Thermal Power Efficiency
Project ID:	P098654	L/C/TF Number(s):	TF-94204
ICR Date:	02/20/2015	ICR Type:	Core ICR
Lending Instrument:	SIL	Borrower:	People's Republic of China
Original Total Commitment:	USD 19.70M	Disbursed Amount:	USD 19.54M
Revised Amount:	USD 19.54M		
Environmental Category: B		**Global Focal Area: C**	
Implementing Agencies: Shanxi Project Management Unit Shandong Project Management Unit Guangdong Power Grid Corporation National Project Management Office			
Cofinanciers and Other External Partners:			

B. Key Dates				
Process	**Date**	**Process**	**Original Date**	**Revised / Actual Date(s)**
Concept Review:	11/28/2006	Effectiveness:	08/13/2009	09/15/2009
Appraisal:	12/04/2008	Restructuring(s):		12/05/2012 01/16/2013 12/11/2013
Approval:	05/05/2009	Mid-term Review:	03/12/2012	02/17/2012
		Closing:	12/31/2012	06/30/2014

C. Ratings Summary	
C.1 Performance Rating by ICR	
Outcomes:	Satisfactory
Risk to Global Environment Outcome	Moderate
Bank Performance:	Moderately Satisfactory
Borrower Performance:	Moderately Satisfactory

C.2 Detailed Ratings of Bank and Borrower Performance			
Bank	**Ratings**	**Borrower**	**Ratings**
Quality at Entry:	Satisfactory	Government:	Highly Satisfactory

Quality of Supervision:	Moderately Satisfactory	Implementing Agency/Agencies:	Moderately Satisfactory
Overall Bank Performance:	Moderately Satisfactory	**Overall Borrower Performance:**	Moderately Satisfactory

C.3 Quality at Entry and Implementation Performance Indicators			
Implementation Performance	**Indicators**	**QAG Assessments (if any)**	**Rating**
Potential Problem Project at any time (Yes/No):	No	Quality at Entry (QEA):	None
Problem Project at any time (Yes/No):	Yes	Quality of Supervision (QSA):	None
GEO rating before Closing/Inactive status	Satisfactory		

D. Sector and Theme Codes

	Original	**Actual**
Sector Code (as % of total Bank financing)		
Energy efficiency in Heat and Power	39	39
Public administration- Energy and mining	61	61
Theme Code (as % of total Bank financing)		
Climate change	47	47
Environmental policies and institutions	11	11
Pollution management and environmental health	26	26
Rural services and infrastructure	16	16

E. Bank Staff

Positions	**At ICR**	**At Approval**
Vice President:	Axel van Trotsenburg	James W. Adams
Country Director:	Bert Hofman	David R. Dollar
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F. Results Framework Analysis

Global Environment Objectives (GEO) and Key Indicators (as approved)

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.

Revised Global Environment Objectives (as approved by original approving authority) and Key Indicators and reasons/justifications

The GEO was not revised.

(a) GEO Indicator(s)

Indicator	Baseline Value	Original Target Values (from approval documents)	Formally Revised Target Values	Actual Value Achieved at Completion or Target Years
Indicator 1 :	Reduction in average coal consumption per unit of coal-fired electricity output in selected provinces			
Value (quantitative or Qualitative)	Shanxi: 373 gce/kWh; Shandong: 382 gce/kWh; Guangdong: 342 gce/kWh	Shanxi: 357 gce/kWh; Shandong: 369 gce/kWh; Guangdong: 332 gce/kWh	Shanxi: 354 gce/kWh; Shandong: 366 gce/kWh; Guangdong: 330 gce/kWh	Shanxi 347 gce/kWh; Shandong: 332 gce/kWh; Guangdong: 299 gce/kWh
Date achieved	12/31/2007	12/31/2012	12/31/2013	12/31/2013
Comments (incl. % achievement)	Target exceeded in all three provinces. The actual amounts of coal consumption reduction per kWh exceeded the targets by 37%, 212%, and 258% in Shanxi, Shandong and Guangdong Province respectively.			
Indicator 2 :	Reduction of GHG emissions per unit of coal-fired electricity output in selected provinces			
Value (quantitative or Qualitative)	Shanxi: 1020 kg CO2/MWh; Shandong: 1045 kgCO2/MWh; Guangdong: 935 kgCO2/MWh	Shanxi: 977 kg CO2/MWh; Shandong: 1009 kgCO2/MWh; Guangdong: 908 kgCO2/MWh	Shanxi: 970 kg CO2/MWh; Shandong: 1002 kgCO2/MWh; Guangdong: 900 kgCO2/MWh	Shanxi: 951 kg CO2/MWh; Shandong: 909 kgCO2/MWh; Guangdong: 815 kgCO2/MWh
Date achieved	12/31/2007	12/31/2012	12/31/2013	12/31/2013
Comments (incl. % achievement)	Target exceeded in all three provinces. The actual amounts of GHG emission reduction per MWh exceed the targets by 38%, 216% and 242% in Shanxi, Shandong and Guangdong Province respectively.			

(b) Intermediate Outcome Indicator(s)

Indicator	Baseline Value	Original Target Values (from approval documents)	Formally Revised Target Values	Actual Value Achieved at Completion or Target Years
Indicator 1 :	Cumulative capacity of small thermal units closed down			
Value (quantitative or Qualitative)	Shanxi: 1007 MW; Shandong: 1717 MW	Shanxi: 2870 MW; Shandong: 4300 MW	Shanxi: - Shandong: 4300MW	Shanxi: - Shandong: 7733MW
Date achieved	12/31/2007	12/31/2011	12/31/2011	12/31/2011
Comments (incl. % achievement)	Fully achieved. The actual closed capacity in Shandong province was 80% higher than the original target. The target in Shanxi province was not reported as the sub-component was cancelled.			
Indicator 2 :	CHP on-line monitoring system operational			
Value (quantitative or Qualitative)	Shanxi: no Shandong: no	Shanxi: yes Shandong: yes	Shanxi: - Shandong: yes	Shanxi: - Shandong: yes
Date achieved	12/31/2007	12/31/2012	12/31/2012	12/31/2012
Comments (incl. % achievement)	Achieved. The target in Shanxi province was not reported as the sub-component was cancelled.			
Indicator 3 :	Increase in thermal efficiency of targeted plants/units			
Value (quantitative or Qualitative)	Yangguang (YG): 35.3%; Huangtai (HT): 40.3%; Beijiao (BJ): 57.0%	YG: 35.8%; HT: 44.4%; BJ: 66.8%	YG: 35.8%; HT: 44.4%; BJ: 66.8%; Weihai (WH): 77.9%; Wuxiang (WX): 38.4%; Taiyi (TY): 40.9%	YG: 39.49%; HT: 56.4%; BJ: 77.8%; WH: 72.84%; WX: 39.5%; TY: 41.26%
Date achieved	12/31/2007	12/31/2012	12/31/2013	12/31/2013
Comments (incl. % achievement)	Target exceeded in five out of six supported plants.			
Indicator 4 :	Annual coal savings and GHG emission reduction from targeted plants/units			
Value (quantitative or Qualitative)	Yangguang (YG): 0 mtce/0 mtons; Hunagtai (HT): 0 mtce/0 mtons; Beijiao (BJ): 0 mtce/0 mtons	YG: 0.04 mtce/0.11 mtons; HT: 0.17 mtce/0.47 mtons; BJ: 0.06 mtce/0.16 mtons	YG: 0.04 mtce/0.11 mtons; HT: 0.17 mtce/0.47 mtons; BJ: 0.06 mtce/0.16 mtons; WH: 0.007 mtce/0.017 mtons;	YG: 0.0664 mtce/0.1661 mtons; HT: 0.064 mtce/0.16 mtons; BJ: 0.03 mtce/0.069 mtons; WH: 0.0064 mtce/0.0155 mtons; WX: 0.01738 mtce/0.038 mtons; TY: 0.0041 mtce/0.012 mtons

			WX: 0.014 mtce/0.031 mtons; TY: 0.008 mtce/0.023 mtons	
Date achieved	12/31/2007	12/31/2012	12/31/2013	12/31/2013
Comments (incl. % achievement)	The actual coal savings/GHG emission reductions of four supported power plants, out of total six plants, did not meet the targets. This was mainly caused by less operation hours than planned for these plants.			
Indicator 5 :	Operation of dispatch simulation system			
Value (quantitative or Qualitative)	No	Yes		Yes
Date achieved	12/31/2007	12/31/2012		12/31/2012
Comments (incl. % achievement)	Achieved.			
Indicator 6 :	Implementation of information disclosure policy			
Value (quantitative or Qualitative)	No.	Yes		Yes
Date achieved	12/31/2007	12/31/2012		12/31/2012
Comments (incl. % achievement)	The target was achieved in the target province (Guangdong).			
Indicator 7 :	Pilot implementation of financial compensation mechanism			
Value (quantitative or Qualitative)	No.	Yes.		Yes
Date achieved	12/31/2007	12/31/2012		12/31/2012
Comments (incl. % achievement)	An equivalent financial compensation mechanism was established in Guangdong province, where the affected small units by the pilot ESD dispatch was compensated by its auxiliary service (see section 3.2).			
Indicator 8 :	Pilot operation of ESD system			
Value (quantitative or Qualitative)	No	Yes		Yes
Date achieved	12/31/2007	12/31/2012		12/31/2012
Comments (incl. % achievement)	Achieved. The ESD system has been operated in Guangdong province since 2008 and the ESD simulation supported under the project was operational in 2012.			
Indicator 9 :	Report on assessment of the ESD pilot in all five pilot provinces.			
Value (quantitative or Qualitative)	No.	Yes		Yes
Date achieved	12/31/2007	12/31/2012		12/31/2012
Comments	Achieved. The assessment was completed in 2011 and the report was provided to			

(incl. % achievement)	both MOF and National Energy Administration for their reference.			
Indicator 10 :	Performance of procurement, FM and other project management activities			
Value (quantitative or Qualitative)	Satisfactory performance for project preparation activities	Ensuring smooth project implementation		Three project restructuring were completed to adjust project component and extend the project closing date by 1.5 years. 99.2% of GEF grant was disbursed.
Date achieved	12/31/2007	12/31/2012		12/31/2013
Comments (incl. % achievement)	Achieved. Procurement, FM and project implementation was rated MS-S throughout the period of implementation. Grant was successfully disbursed and project outcomes achieved.			
Indicator 11 :	Use of incremental operating budget			
Value (quantitative or Qualitative)	Satisfactory performance in use of PPG Grant	Ensuring compliance with the project Financial Management Manual		The FM Manual was followed though financial records and documents in one PMU needed to be improved.
Date achieved	12/31/2007	12/31/2012		12/31/2013
Comments (incl. % achievement)	Achieved. Incremental operating budget was successfully utilized by the PMO/PMUs to coordinate the project implementation following the agreed FM Manual.			

G. Ratings of Project Performance in ISRs

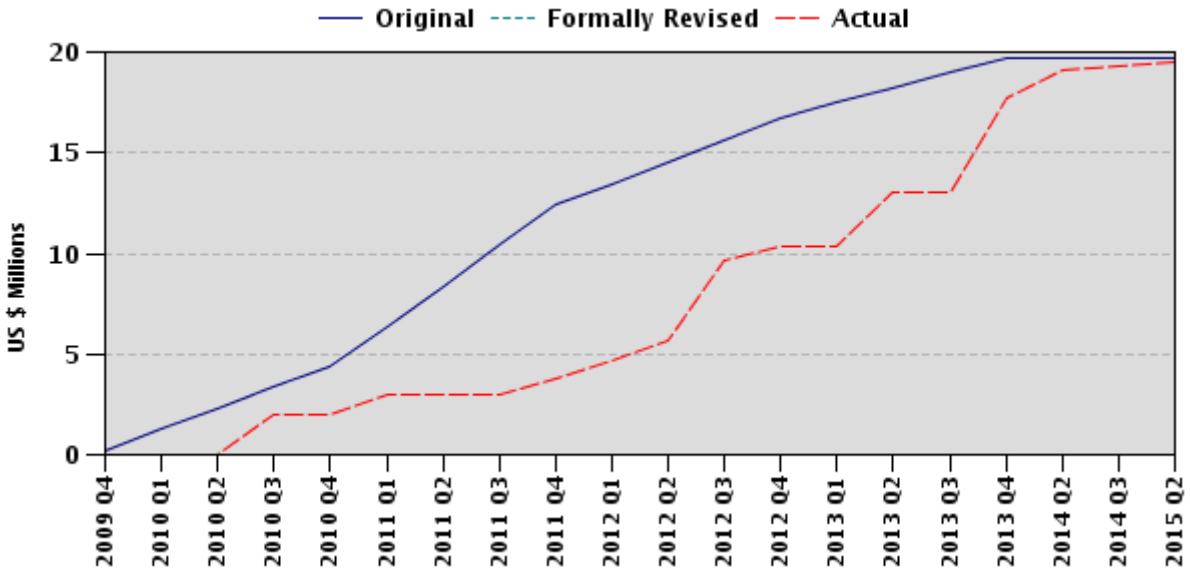
No.	Date ISR Archived	GEO	IP	Actual Disbursements (USD millions)
1	04/29/2010	Moderately Satisfactory	Moderately Satisfactory	2.00
2	06/27/2011	Moderately Satisfactory	Moderately Satisfactory	3.83
3	04/10/2012	Moderately Satisfactory	Moderately Unsatisfactory	9.67
4	11/12/2012	Satisfactory	Moderately Satisfactory	11.33
5	05/24/2013	Satisfactory	Moderately Satisfactory	16.35
6	12/04/2013	Satisfactory	Moderately Satisfactory	18.12
7	06/24/2014	Satisfactory	Moderately Satisfactory	19.29

H. Restructuring (if any)

Restructuring Date(s)	Board Approved GEO Change	ISR Ratings at Restructuring		Amount Disbursed at Restructuring in USD millions	Reason for Restructuring & Key Changes Made
		GEO	IP		
12/05/2012		S	MS	11.33	Level II restructuring. The project closing date was extended from December 31, 2012 to December 31, 2013, in order to allow the project implementing agencies to complete the planned project activities and achieve the project development objective. An updated project implementation plan to accelerate the project implementation was agreed with the Bank team, aiming to increase the total disbursement to 71% by December 31, 2012, 87% by June 30, 2013 and 100% by December 31, 2013.
01/16/2013		S	MS	13.02	Level I restructuring. The request of MOF covered both the first restructuring in December 2012 and January 2013. As the original closing date was December 31, 2012, the restructuring was divided into two restructuring to allow adequate time for internal processing. The 2nd restructuring included following changes to the Project: (1) amend the intermediate output indicators; (2) adjust the project components; and (3) adjust the implementation arrangement to include new implementing agencies. The adjustment of the project components included: (1) the scope of Part A of the Project was reduced due to cancellation of two activities (closure of small power plants and CHP online monitoring system in Shanxi province); and

Restructuring Date(s)	Board Approved GEO Change	ISR Ratings at Restructuring		Amount Disbursed at Restructuring in USD millions	Reason for Restructuring & Key Changes Made
		GEO	IP		
					(2) the scope of Part B of the Project was expanded to include the rehabilitations of three additional power plants, including: Weihai power plant in Shandong province, Wuxiang Power Plant and Taiyuan No. 1 Power Plant in Shanxi province. As a result, part of the GEF grant was reallocated from Part A to Part B of the Project.
12/11/2013		S	MS	18.12	Level II restructuring. The project closing date was extended from December 31, 2013 to June 30, 2014 per request of MOF, in order to complete the pending national level studies and maximize the influence of the Project. An action plan to implement the project in the extension period was agreed with the Bank team.

I. Disbursement Profile



1. Project Context, Global Environment Objectives and Design

1.1 Context at Appraisal

1. ***Predominance of Coal in China's Energy Mix.*** When the project was conceived in 2006, China was the world's second largest energy user. Since 1990, energy consumption had been increasing on average at 5.8% per year. China's rising energy demand had 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 showed that coal would still constitute 60% or more of China's primary energy consumption by 2020.

2. Coal had been the dominant source of electricity generation in China. Thermal power generation capacity reached 484 GW in 2006, accounting for 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 rapid expansion of installed thermal power generation capacity and its primary reliance on coal had contributed significantly to adverse environmental impacts in China.

3. ***Low Efficiency of Coal-fired Power Generation.*** China's coal-fired power plants consumed 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. The main factors contributing to China's low power generation efficiency were: (i) China's large share of generation by inefficient small units; (ii) generation dispatch not optimized for achieving maximum efficiency; (iii) small Combined Heat and Power (CHP) units operating for power generation only; and (iv) old mid-sized coal-fired units operating at relatively high coal consumption rate.

4. ***Government Strategies.*** Chinese authorities at the highest levels had recognized that a business-as-usual approach in the energy sector would 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 were contained in its 1lth Five Year Plan (2006-2010), issued in early 2006 that called 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 targeted 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.

5. Specific GOC strategies to improve coal-fired thermal power generation efficiency included: (i) closure of inefficient small coal-fired units and the addition of new high-efficiency large-sized thermal units; (ii) introduction of efficient generation dispatch, known as the Energy 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.

6. The GOC's strategy for reducing the capacity share of inefficient small coal-fired generation units sought 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 seven major power companies for their closure goals. Early results had 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 had 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 were smaller and mostly owned by municipal and county level small power companies. These companies were less likely to be able to address the financial and social impacts of closure in the allotted time without additional financial support.

7. Another element of the GOC's strategy for improving thermal power sector efficiency was the replacement of existing dispatch practices with the ESD. This required generation dispatch to follow a merit order of units, determined by their efficiency and emission levels. The ESD would commence with pilots in five selected provinces, with the intention later of being implemented nationally. The change in dispatch practice would significantly reduce coal consumption for power generation. However, this would 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 required new technical regulations on access, disclosure and verification of generation efficiency data that to date had not been available at dispatch centers or used for dispatch. Although the startup of the pilot was scheduled to commence by early 2008, it had been delayed until adequate regulation and financial compensation mechanisms were implemented to address the associated technical and financial barriers.

8. ***Rationale for Bank involvement.*** Continued progress on improving coal-fired power generation efficiency was vital if the GOC's planned for a 20% reduction in GDP energy intensity by 2010 was to be realized. Drawing from its international experience and knowledge of similar undertakings, the Bank was well positioned to assist in resolving the policy and technical issues associated with the GOC's sector strategy.

9. The proposed project continued and expanded the Bank's support of the Government's efforts to develop policies that would help achieve environmental sustainability of the energy sector. These efforts had included lending projects, analytical and advisory activities and economic and sector work. More recently the Bank had been working with the Government on the development of a new investment framework which would 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 had requested this GEF project, and considered that it

would provide a good opportunity to benefit from the Bank's experience in its efforts to improve the power sector efficiency in China.

1.2 Original Global Environment Objectives (GEO) and Key Indicators

10. The project development objective (PDO) was to reduce coal consumption and greenhouse gas (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 as well as conducting studies to support transition to efficient generation dispatch.

11. Key performance indicators included: (i) average efficiency and GHG emissions 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 and GHG emission reduction from the units #1-4 of Yangguang Thermal Power Plant in Shanxi; (iv) thermal efficiency and GHG emission reduction from the units #7-8 at Huangtai Thermal Power Plant in Shandong; and (v) thermal efficiency and GHG emission reduction from the units #5-6 of Jinan Beijiao Thermal Power Plant in Shandong.

1.3 Revised GEO and Key Indicators, and reasons/justification

12. The GEO is the same as the PDO for the Project, and the PDO was not revised.

13. The PDO level indicators were not changed. However, the intermediate outcome indicators were revised to adapt to the changes in project sub-components, as a result of a level I and two level II project restructurings. The changes to the intermediate outcome indicators are summarized below:

(i) Removal of one sub-indicator—cumulative capacity of small-coal fired power generation units closed in Shanxi province—as the sub-component was dropped; and

(ii) Addition of the thermal efficiency improvement and GHG emission reductions for three newly-added power plants under Component 2 (Guodian Taiyi and Wuxiang Hexin plants in Shanxi and Weihai Botong power plant in Shandong).

1.4 Main Beneficiaries

14. The target beneficiaries were not described explicitly in the PAD. Based on the description of the project components in the PAD, the main beneficiaries of the Project included government agencies, owners of associated power plants, and three provincial

power grid companies (Shandong, Shanxi, and Guangdong). Overall, the actual main beneficiaries of the project included:

(i) Project implementing agencies (IAs) for a total of 15 power plants (6 for rehabilitation and nine for closure) and two provincial grid companies: (a) the rehabilitations were implemented in six coal-fired power plants owned by Huangtai Thermal Power Co., Ltd (in Shandong); Jinan Beijiao Thermal Power Co. Ltd (Shandong); Weihai Botong Heat and Power Co., Ltd (Shandong); Yangguang Thermal Power Co., Ltd (Shanxi); Wuxiang Hexin Power Generation Co., Ltd. (Shanxi); and Guodian Taiyi Power Generation Co., Ltd. (Shanxi); (b) the closure of small power plants were implemented in nine power plants in Shandong owned by six companies, namely Feicheng Company, Dongyue Company, Taishan Yangguang Company, Laiwu Xingyuang Company, Taishan Paper Manufacture Company, and Yichou Cement Company; and (c) both Shandong and Guangdong power grid companies;

(ii) National government agencies (MOF, National Energy Administration (NEA), State Electricity Regulatory Commission (SERC) and Ministry of Environmental Protection (MEP)), and both Shandong and Shanxi provincial government agencies (Financial Bureau, Environmental Protection Bureau (EPB), and Economic and IT Commissions); and

(iii) Investors of coal-fired power plants who benefited from the dissemination activities included in the Project.

1.5 Original Components

15. The project had 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.

16. **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 was planned to 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 had adequate capacity reserve and committed investment in new generation capacities, which would ensure reliable power and heat supply along with the closure. The capacity of small units to be closed exceeded, by 300 MW and 200 MW respectively, the current provincial targets agreed with the NDRC. Out of the total target, the GEF project was expected to support the closure of 2,910 MW in 2009 and 2010 (1583 MW in Shandong and 1327 MW in Shanxi). The component would support the establishment and pilot operation of a transparent and effective financial incentive mechanism for the closure of small units (MCSU). This would 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; establishing CHP On-line Monitoring Systems to facilitate enforcement of government regulations for CHP unit operation; and establishment of bulletin systems to enable the trading of emission allowances entitled by small units closed on schedule. These revenues could be complementary to the MCSU to partially offset the closure costs; and monitoring and evaluation (M&E) and knowledge sharing to facilitate replication of successful experiences in other provinces of China.

17. **Component 2: Demonstration of Power Plant Efficiency Improvement** (GEF Grant US$3.59 million and counterpart funds US$52.77 million). This component was planned to 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 had been designed to improve the efficiency of power and heat supply during the remaining life expectancy of the generation units. To ensure successful demonstration, sustainability and replication, support would 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).

18. **Component 3: Transition to Efficient Generation Dispatch** (GEF Grant US$4.07 million and counterpart funds US$3.23 million). This component was planned to 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 would be provided for the pilot implementation of ESD in Guangdong Provincial Power Grid, including development or improvement of the detailed regulations required to commence the piloting. This would 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 a simulation system to test improvements in the Guangdong Provincial Power Grid. Subsequently, the component would provide continued support for the improvement of the approach and regulations for generation dispatch and replication to other provinces. This included: (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.

19. **Component 4: Technical Assistance for Project Implementation** (GEF Grant US$1.27 million and counterpart funds US$0.59 million). This component was planned to 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.

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

1.6 Revised Components

21. Project components were not revised but sub-components were changed for Component 1 and 2 as the results of three project restructurings.

22. The changes made for Component 1 and 2 were as follows:

- Sub-component *"support to closure of small coal-fired units"* was canceled in Shanxi and reduced in size in Shandong because both provincial governments accelerated the closure of small coal-fired units for 2006-2010. Substantial financial incentives (more than expected by the Bank team at appraisal) were provided by both provincial and central governments to the affected power companies. The anticipated social risk caused by the closure of small units (mainly loss of jobs and financial losses for the investors) were mitigated.

- Sub-component *"establishment of a CHP online monitoring in Shanxi"* was canceled as the Shanxi provincial government decided not to establish such a monitoring system as the amount of existing CHP units had been reduced substantially after most of the small coal-fired units were closed.

- Sub-component "*support to the establishment of electronic bulletin systems for emission allowances of closed small coal-fired units in Shandong and Shanxi*" was modified to support the pilot emission trading systems in both Shandong and Shanxi province. The provincial EPBs in both provinces ramped up their efforts to promote the emission trading systems to meet the stricter targets of pollutants emission reduction imposed by the central government.

- Component 2 was expanded from supporting the innovative rehabilitations of three power plants to six power plants. To further showcase the commercial viability of selected innovative rehabilitation technologies, three additional thermal plants were selected for the pilot technology demonstration. The power plants were selected based on the demonstration technology for rehabilitation, environmental and social impacts, as well as sustainability and replication

potential in the province and country, to maximize the value added by the available GEF grant resources.

1.7 Other significant changes

23. The project closing date was extended twice from the original December 31, 2012 to June 30, 2014, through two Level II project restructurings.

24. The GEF grant was reallocated to cover the changes of Component 1 and 2, as summarized in Table 1 below:

Table 1. Change of Disbursement Categories

Category of expenditure		**Amount of the Grant Allocated (US$)**	
Original	**Revised**	**Original**	**Revised in Jan. 2013**
(1) Recipient's Respective Part of the Project:			
(a) Goods, non-consulting services, consultants' services (including for audits), and Training	No changes	**2,856,543**	**3,716,428**
(b) Operating Costs		205,000	205,000
(2) Goods, non-consulting services, consultants' services (including for audits), and Training for GDPG's Respective Part of the Project	No changes	2,770,000	2,770,000
(3) Shandong Province's Respective Part of the Project:			
(a) Goods, non-consulting services, consultants' services (including for audits), and Training	No changes	**4,489,715**	**4,959,715**
(b) Operating Costs		101,714	101,714
(c) MCSU Grants		**2,000,000**	**1,530,000**
(4) Shanxi Province's Respective Part of the Project:			
(a) Goods, non-consulting services, consultants' services (including for audits), and Training	Category (4).c was deleted	**3,315,429**	**6,374,858**
(b) Operating Costs		**101,714**	**42,285**
(c) MCSU Grant		**3,000,000**	

(5) Unallocated	deleted	**859,885**	
TOTAL AMOUNT		19,700,000	19,700,000

2. Key Factors Affecting Implementation and Outcomes

2.1 Project Preparation, Design and Quality at Entry

25. ***The background analysis for the project design (Section 1.1) was sound and adequately identified the issues and barriers to be addressed***. Sector analysis together with consultations with key stakeholders in the sector had positioned the project at the right entry points. Taking into account the prevailing context in China during project preparation, the three specific strategies of the GOC in improving efficiency of coal-fired power generation were analyzed: (i) closing down inefficient small coal-fired units; (ii) investment in rehabilitation of existing generation units; and (iii) support for the pilot and later replication of ESD.

26. The project was expected to support the Government of China in meeting its energy intensity target by addressing key barriers/issues prevailing in China's power sector. The removal of those barriers and issues is essential to the success of China's power sector energy efficiency strategy and reducing the reliance of power generation on coal. The Bank's prior experience with small mine closures, the rehabilitation of thermal power plants, and power sector reform put it in a good position to support the GOC in achieving its objectives.

27. In addition, the project directly supported Pillar 3 of the Bank's Country Strategy Partnership for China (2006-2010), the Bank Climate Change Strategy, and the Bank's strategy in promoting carbon reduction. It was also consistent with the Strategic Objective of the GEF Interim Strategy under which the retrofit of power plants was supported.

28. ***The project design was generally sound***. The objective of the project was highly aligned with China's energy intensity reduction target. The project targeted three strategic areas that could significantly contribute to the achievement of the government's national target for its 11th FYP. The GEF project was prepared to align its support to address the various identified technical, financial, and social barriers in the three areas. In addition, the design of the project also incorporated a combination of lessons emerging from international experience related to the rehabilitation of thermal power plants and lessons from earlier Bank operations related to mine closures and power sector reform in China and other countries (such as Russia and Poland).

29. The first component (1) of the GEF project was designed to leverage the GEF grant to facilitate the closure process in Shanxi and Shandong. It aimed at setting a national example of sound social and financial management for the closure of small thermal units. However, in hindsight, the design underestimated the government's commitment to these closures during the 11th FYP, and overestimated the GEF resource

required to reach the target of this component. This was due to the fact that GOC raised its compensation standards and provided more-than-expected social protection measures to resettle workers affected by the closures during the project implementation period, and the expected major social risks related to the closures were thus largely mitigated. As a result, the project was restructured to reallocate the GEF grant to support more innovative rehabilitation technologies under Component 2 to meet the same project objective.

30. The second component (2) on power plant rehabilitation was well designed. It showcased a holistic approach to improve the efficiency of thermal plants by (i) using energy audits to identify areas for efficiency improvement, (ii) piloting leading energy-saving technologies, and (iii) promoting best practice for plant operation and maintenance. The piloting technologies were competitively selected based on energy saving potential and potential of replication. Knowledge dissemination was given a priority in the project design to bring about demonstration effect.

31. The design of the third component (3) was well thought-through as it aimed to address a number of technical and financial barriers that could have led to delays or failures for the pilot ESD. While the pilot ESD simulation system helped identify optimal dispatch rules to improve the operation of the existing ESD in Guangdong, the upstream policy studies targeted key policy gaps for sustaining ESD and for its national roll-out.

32. ***There were clear indications of strong GOC ownership and commitment*** to improving the thermal efficiency of the power sector. The central government had issued several new sector regulations during project preparation and signed agreements on closure targets with the provincial governments and major power companies. Its commitment to the closures was also reflected in the accelerated work by the Shanxi provincial government, which led to the cancellation of subcomponents for Shanxi under Component 1.

33. In 2007, the central government issued the ESD principles and called for an ESD pilot in five selected provinces. The activities supported under the GEF project were complementary to the GOC's own initiatives.

34. ***Most risks were adequately identified and rated.*** The overall rating of risk to achieving the PDO was modest at appraisal. Table 2 summarizes the risks envisaged at appraisal along with a brief review of them at ICR.

Table 2. Summary of risks envisaged at appraisal and at ICR

Category	*Risks Envisaged at Appraisal*	*Review of Risk at ICR*
Central/Provincial Government	• Weak commitment to thermal efficiency improvement in China • Weak enforcement capacity of the provincial governments	Not materialized
Component 1	• Government funds for the Mechanism for the	Not

	Closure of Small Units (MCSU) not in place • MCSU payments not made to the affected plants or not used for intended purposes • Closure of small units impeded due to affected interests of local governments and social impacts • Compliance with government's policies regarding satisfactory settlement of workers affected by the closure of small units • Environmental and social compliance risks	materialized
Component 2	• Technical risks of demonstrated technologies • Inadequate safeguards management	Not materialized
Component 3	• ESD not implemented in pilot provinces • ESD implementation delayed	Not materialized
Component 1-3	• Successful experience of component 1-3 in pilot provinces not replicated in other provinces	Not materialized
Component 1-5	• Weak capacity of project implementing agencies and PMO/PMUs • Unfamiliarity with Bank requirements	Materialized

35. Most of the risks envisaged at appraisal did not materialize. These include weak government enforcement capacity and risks associated with the closures and delayed ESD implementation, which were rated as either modest or high at appraisal.

36. Some of the risks materialized but did not hamper the PDO. For component 1, the preparation of the operational manual to guide the closure of small thermal units was delayed and support under component 1 was reduced. The manual, however, was later used as an input by MOF to issue a national policy. For component 3, the study on financial compensation regulation under the ESD did not lead to the issuance of an anticipated national policy, as the issuance of this policy is strongly linked to several ongoing power sector reforms (e.g., pricing reform), which are outside the control of the Bank and the Project. The weak capacity of some project implementing agencies and unfamiliarity with Bank requirements also hampered the project implementation and resulted in extension of the project closing date by one and half years.

2.2 Implementation

37. The project implementation in the three provinces followed generally the planned schedule and the planned targets were achieved:

(i) Project targets under Component 1, Closure of Small Units, were achieved in both Shandong and Shanxi province much earlier than expected due to the strong government commitments. The achievement reduced the need of GEF grant to support the closure of small units under Component 1. Timely project restructuring was made to reallocate the GEF grant to support more innovative rehabilitation technologies under Component 2 to achieve the same project objective.

(ii) The implementation of Component 2, Demonstration of Power Plant Efficiency Improvement, was implemented as planned and the expected results were achieved. With the project restructuring, additional activities were supported under the component to finance the rehabilitation of three additional power plants and demonstrate the EE potential of the identified technologies.

(iii) The planned activities under Component 3, Transition to Energy Saving Dispatch, were all completed with some delays. This was caused by unfamiliarity of Bank's procedures of the PMU and inadequate communication among different parties at the early stage of project implementation. With the enhanced project supervision by the Bank team, the issue was addressed and the implementation of the Component was accelerated.

38. The project was once rated as Moderately Unsatisfactory due to the slow disbursement, though this issue was resolved with the completion of project restructurings, enhanced project supervision and capacity building of the NPMO and PMUs. The main factors caused the project at risk included mainly:

(i) Slower than anticipated project implementation was highly linked to weak project management capacity of the NPMO/PMUs. At the outset of project implementation, the weak project management capacity of the NPMO/PMUs was mainly due to their lack of experience with GEF/Bank projects. This issue was addressed by the Bank's intensified supervision. The results were encouraging as the commitment and disbursement rates of the GEF grant climbed up markedly. During middle and later stages of the project, implementation suffered from frequent staff turnover in Shandong PMU (once every one or two years) and key personnel (executive director) changes in the NPMO. The frequent and key staff changes weakened management capacity of the NPMO and the Shandong PMU, which in turn prevented the project from being rated fully satisfactory on implementation progress.

(ii) Insufficient communication between the Bank team and NPMO/PMUs adversely affected project progress during early stages of implementation. The NPMO/PMUs were new to the GEF project and needed proper guidance from the World Bank to implement the project. The issue was addressed quickly with the intervention of the Bank management together with more enhanced and flexible supervision adopted by the Bank team.

39. Intensified project supervision was adopted to accelerate the project implementation. Following the first mission, an intensified supervision strategy was adopted by the Bank team to speed up implementation. In addition to the bi-annual supervision missions, the Bank team conducted frequent missions to meet the clients' needs, in particular during 2011-2012. The missions provided timely, flexible and

adaptive guidance to the NPMO/PMUs to strengthen their procurement and financial management capacities, and enhanced their coordination for dissemination of project outputs at the national level. Considerable progress was achieved and total disbursement went up from negligible in the 2nd quarter of 2010 to around 65 percent in the 2nd quarter of 2013.

40. The Project underwent three restructurings – two level II restructuring to extend the project closing date by a total of 1.5 years (from December 31, 2012 to June 30, 2014) and one level I restructuring to change the project component 1 and 2 and reallocate the GEF grant in January 2013. No changes to the PDO or GEO were made.

2.3 Monitoring and Evaluation (M&E) Design, Implementation and Utilization

41. ***M&E design.*** The GEF project was designed to reduce coal consumption and GHG emission per unit of electricity production in Shanxi province, Shandong province, and Guangdong province in China. Therefore, the two quantitative PDO level indicators selected for the project were fully aligned with the PDO and designed as reduction in average coal consumption per kWh output (coal-fired units) and reduction of GHG emission per kWh output (coal-fired units) in the three provinces. During the project restructuring, the PDO level indicators were kept unchanged, while the intermediate indicators were modified (see Section 1.3).

42. ***M&E implementation.*** To measure progress towards the targets of the original indicators, the required data were collected semiannually by the provincial PMUs and assessments were documented in project progress reports. All required data and information were collected when the provincial statistical data was available; the annual statistical data for the provinces normally is available to the public in the second half of the following year. The quality and reliability of the data used in the ICR is consistent with agreed methodologies.

43. **M&E utilization.** All PDO level indicators exceeded their original targets and intermediate indicator targets were mostly met, with minor shortcomings. The satisfactory results of the project were broadly communicated to a wide range of stakeholders, in particular in the case of the thermal plant rehabilitation components. The significant demonstration effect, via extensive dissemination activities, led to a wide replication of the GEF-supported energy-saving technologies, resulting in greater energy savings on a much broader geographic scale. The selected demonstration technologies, including conversion of power plants to combined heat and power generation in Huangtai plant, utilization of waste heat in Beijiao plant, and application of variable frequency control technology in Yangguang plant, have been widely utilized in the power sector in China; the later-on demonstration of peaking cooling technology in Wuxiang plant and installation of phased heat exchanger to recover waste heat in Taiyi plant were also listed as recommended technologies in Shanxi province to meet the provincial EE target in power sector in 2014.

44. At the national level, the achievement of satisfactory energy-saving results, along with targeted policy studies, contributed to the issuance of several national policies on EE in thermal plants such as *Adminstrative Measures on Fiscal Incentives on Energy-saving Technologies*, issued by MOF and NDRC in 2011, and *Notice on Undertaking Comprehensive Upgrading of Coal-fired Power Plants*, issued by MOF and NDRC in 2012.

2.4 Safeguard and Fiduciary Compliance

Safeguards

45. **Environmental**. The Environmental Assessment safeguards policy was triggered and the project was classified as a "Category B" project. Environmental Management Plans (EMPs) were prepared for the nine closed small power plants and the six existing plants for rehabilitation following an approved Environmental Management Framework. Overall environmental performance of all concerned thermal power plants was satisfactory. Environmental monitoring of noise, dust, waste water, and solid waste during project implementation was carried out regularly to ensure EMPs were followed. The monitoring data showed that the plants fully complied with relevant environmental standards and met the standards set in the Environmental Management Plan.

46. **Social**. The Involuntary Resettlement safeguards policy was triggered. The implementation of involuntary resettlement was rated satisfactory as the approved Resettlement Plan Framework and resettlement plans associated with the nine closed small power plants had been followed. The support to the closure of the nine small thermal plants was completed in June 2013. Adequate compensation and social protection measures for settlement of affected workers were provided. The post evaluation activity did not identify any remaining social issues.

Fiduciary

47. **Procurement**. Procurement performance was rated as satisfactory. Procurement was carried out generally in accordance with Bank procurement policies and procedures. No major issues were encountered. However, the prior and post review identified some minor procurement issues. In 2010-2011, some individual consultants and suppliers experienced delayed payments. In addition, the Shandong PMU was found to insufficiently maintain the record of procurement documents. Furthermore, Shandong PMU procured some contracts not in line with the agreed procurement plan. The above-mentioned issues were successfully addressed with proactive actions by Bank team.

48. **Financial management**. Financial management performance under all three components was moderately satisfactory. The financial reports were submitted timely generally and all audited financial reports were unqualified. Several minor issues were identified during the project implementation. These issues included (i) implementing agencies (in all three provinces) initially did not follow MOF Circular #13 to set up a

separate project ledger; (ii) the NPMO and Shanxi PMU initially did not carry out project accounting and financial reporting in accordance with MOF Circular #13; (iii) Shanxi PMU charged operating expenditures to the Designated Account (although small amounts, this is an ineligible expenditure per grant agreement); (iv) supporting documents for disbursement related to the closure of the small coal-fired plants in Shandong were insufficient to ensure the fund was used for its intended purpose; (v) record keeping of original supporting documents and accounting records was not well maintained by the Shandong PMU; and (vi) a second RMB account, in addition to the Designated Account, was created by Shandong Provincial Financial Bureau, which was not allowed without the Bank's permit. The Bank team provided several trainings and the above-mentioned issues were addressed.

2.5 Post-completion Operation/Next Phase

49. This section discusses the sustainability and replicability of Project interventions.

50. **Sustainability.** The project supported closure of small power plants and demonstrated rehabilitation of coal-fired thermal power plants to improve their efficiencies, as well as the associated studies and dissemination activities. The policies derived from these activities, including (i) national fiscal incentives to phase out inefficient capacity during the 12th FYP (2011-2015), (ii) fiscal incentives to promote further rehabilitation to upgrade existing coal-fired thermal power plants, and (iii) dissemination materials to summarize the good practices of power plant rehabilitations, contributed to the continuous actions in power sector in China to close inefficient power plant and improve the efficiencies of existing coal-fired power plants after the project closure.

51. The ESD system in Guangdong province is kept operation after the closure of the Project. The ESD simulation system has been used to improve the real-time ESD operation in the province.

52. The National PMO got trained through the implementation of the Project, and has worked with the Bank team in preparing another GEF project – GEF Establish M&V System for Energy Efficiency in China Project.

53. **Replicability.** The project was focused in three provinces, but the good practices and experience learned from the Project were disseminated to wider audiences (both government agencies and power enterprises) through the dissemination activities under the Project. The power plants supported under the Project were visited frequently as show cases of the good practices in improving the efficiency of coal-fired power plants, then replicated across the country. The innovative technologies were replicated, such as conversion of power plant to combined heat and power plants, utilization of waste heat for heating or power purpose, and application of variable frequency control technology.

54. A sub-component under Component 1 was to support the pilot SO2 emission trading in both Shanxi and Shandong province, including the design and trial operation of

the pilot trading system. This work served as a key test towards the national pollutants emission trading scheme, and led to the issuance of *Guidance Note on Further Promotion of Paid Use of Pollutants Emission Allowance and Pilot Trade* by the State Council in 2014, in which the experience collected under the Project was expanded to more provinces.

3. Assessment of Outcomes

3.1 Relevance of Objectives, Design and Implementation

55. The objectives of the GEF project—reductions of coal consumption and GHG emissions per unit of coal-fired electricity production—not only are still highly relevant, but also have become essential as China continues to move aggressively in energy conservation, climate change mitigation, and pollution control during its 12th FYP period (2011-2015). As part of its 12th FYP, the GOC is targeting to further reduce energy intensity by 16 percent at the end of 2015, relative to the 2010 level.

56. The project's design and implementation remain highly relevant as closure of inefficient coal-fired units, thermal plant rehabilitation, and pollutants emission control are still considered high priorities in China's 12th FYP (2011-2015). For this 12th FYP period, GOC planned to (i) close another 20 GW of inefficient thermal generation units by 2015; (ii) encourage energy efficient rehabilitation related to CHP, variable frequency motors, and waste heat recovery (also the focus of rehabilitation supported by the GEF project); (iii) reduce SO_2 emissions by 8 percent from the 2010 level; and (iv) reduce coal consumption per unit of coal-fired electricity production to 325 gce/kWh, a reduction of 8 percent compared to the 2010 level.

57. The project's objective and design remain consistent with the Country Partnership Strategy (CPS, FY2013-2016) for China. The China CPS supports shifting to a sustainable energy path as one of the supporting pillars. It is also in line with the WBG energy sector strategy, designed to help client countries secure an affordable, reliable, and sustainable energy supply needed to end extreme poverty and promote shared prosperity. Therefore, the relevance of objectives and design is rated as Satisfactory.

3.2 Achievement of Global Environmental Objectives

58. The PDO and GEO of the GEF project are the same: to reduce coal consumption and GHG emissions per unit of electricity production in Shanxi province, Shandong province, and Guangdong province in China.

59. The GEF project contributed to the achievement of the PDO through (i) *closing down inefficient small coal-fired units*. The small generation units had a high coal consumption rate per electricity output and the project clearly contributed to the closure of small units in Shandong province; (ii) *demonstrating the viability of energy-saving technologies in thermal plants*. The project directly supported the rehabilitation of six

coal-fired power plants and widely disseminated the knowledge for replication; and (iii) *supporting the transition to energy-saving dispatch in Guangdong*.

60. All PDO level indicators well exceeded the original targets in all three provinces.

- The average coal consumption per unit of coal-fired electricity output in three provinces was reduced to a level below the project target level. In Shanxi, it was reduced from 373 to 347 gce/kWh, while the project target was 354 gce/kWh; in Shandong, it went down from 382 to 332 gce/kWh (project target was 366 gce/kWh); and in Guangdong it was reduced from 342 to 299 gce/kWh, while the target was 330 gce/kWh.

- GHG emissions per unit of coal-fired electricity output in the three provinces also dropped to levels below the project target. In Shanxi, it was reduced from 1,020 to 951 $kgCO_2$/MWh, while the target was 970 $kgCO_2$/MWh; in Shandong, it went down from 1,045 to 909 $kgCO_2$/MWh, while the target was 1,002 $kgCO_2$/MWh; and in Guangdong it was reduced from 935 to 815 $kgCO_2$/MWh, with a target of 900 $kgCO_2$/MWh.

61. Achievements in intermediate outcomes were also satisfactory. The GEF project prepared a transparent financial incentive mechanism to guide the closure of small thermal power plants. The mechanism provided technical inputs to the issuance of a national policy, *Central Government Fiscal Incentives to Phase out Inefficient Capacity,* which was issued by MOF in 2011 and guides the further closure of 20 GW in inefficient capacity during the 12th FYP period.

62. The project also demonstrated the commercial viability of six rehabilitation technologies and brought about significant demonstration effect. Most of the technologies have become standard industry practice in today's thermal plant rehabilitation. Two technical studies, which complemented the demonstration project, contributed to the issuance of two national policies regarding plant rehabilitation in China, i.e. *Administrative Measures on Fiscal Incentives on Energy-saving Technologies* issued jointly by MOF and NDRC in 2011, and *Notice on Undertaking a Comprehensive Upgrading of Coal-fired Power Plants* issued jointly by MOF and NDRC in 2012.

63. The ESD simulation system developed under the Project and the associated equivalent financial compensation mechanism (the generation from the less efficient power plants was reduced but these plants were compensated from their provision of additional auxiliary service) became an essential tool to improve the actual ESD dispatch rule in Guangdong. The system is expected to continue to play an important role because the ESD model will likely be continued under the 13th FYP in Guangdong.

64. Based on the evidence of the results of the project, the efficacy of the operation is rated as Satisfactory.

3.3 Efficiency

65. The economic internal rates of return (EIRRs) and financial internal rates of return (FIRRs) were recalculated based on the same methodology applied at appraisal, using actual costs and benefits. The EIRRs were estimated using a cost benefit analysis, while the FIRRs were estimated through a cash flow analysis. Costs included investment and O&M cost, while the economic benefits included coal savings and environmental benefits. The results of the calculation at ICR and appraisal are summarized in Table 3 and detailed in Annex 3. Based on the results of the project and anticipated risks associated with the demonstration of pilot technologies, the efficiency of the operation is rated as Satisfactory.

66. For Huangtai, Beijiao, and Yangguang thermal power plants, the EIRRs and FIRRs are all higher at ICR compared to appraisal because actual capital expenditures were significantly below the levels anticipated at appraisal. In addition, Yangguang thermal plant saved more coal than estimated at appraisal, resulting in greater savings from the reduction of coal expenditure.

67. For Wuxiang, Taiyi, and Weihai thermal power plants, the EIRRs and FIRRs are all lower at ICR compared to appraisal/restructuring stage because of the decrease in coal price, which has reduced the benefit of the coal savings. In addition, the actual coal savings for both Taiyi and Weihai power plants were lower than expected.

Table 3. EIRRs and FIRRs at ICR and Appraisal

Project	**EIRR**		**FIRR**		**Brief Explanation**
	ICR	**Appraisal**	**ICR**	**Appraisal**	
Beijiao Thermal Power Plant	76.8 %	26.7 %	91.79 %	16.96 %	- significantly lower capital expenditure (CAPEX) - lower incremental electricity consumption for heat
Huangtai Thermal Power Plant	176.2%	20.4 %	186.77 %	23.73 %	- significantly lower CAPEX
Yangguang Thermal Power Plant	85.7 %	78.7 %	90.91 %	88.69 %	- lower CAPEX - more coal savings
Wuxiang Hexin Power Plant	20.8 %	25.1%	11.9 %	13.0%	- higher CAPEX - lower coal price
Taiyi Thermal Power Plant	11.3 %	16.4%	5.3 %	7.7%	- lower coal price - less coal savings
Weihai Thermal Power Plant	31.2 %	32.8%	20.1 %	25.4%	- lower coal price - lower CAPEX

3.4 Justification of Overall Outcome Rating

Rating: Satisfactory

68. The GEF project successfully implemented three targeted interventions that were in line with government priorities during the 11th FYP. Those targeted areas of interventions remain priorities on the government energy conservation agenda for the 12th FYP.

69. All PDO level indicators well exceeded the original targets in all three provinces and achievements in intermediate outcomes were also satisfactory. In summary, the GEF project played an important role in the thermal efficiency improvement in the three provinces and also promoted the efficiency improvement at the national level through its support to the national policy development and dissemination activities. At the project closing, all three major components have been implemented satisfactorily and the PDO/GEO has been achieved and surpassed. All the PDO/GEO indicators have well exceeded their original targets. Therefore, based on a Satisfactory rating for the relevance of objectives and design, Satisfactory rating for efficacy and Satisfactory rating for efficiency, the overall Satisfactory outcome rating is justified.

3.5 Overarching Themes, Other Outcomes and Impacts

(a) Poverty Impacts, Gender Aspects, and Social Development

70. **Social Development.** The closure of small units involved the envisaged unemployment of substantial amount of workers, and this issue was paid high attention in both the project design and implementation. Total affected workers amounted to 1,160 from the nine closed power plants under Component 1 of the project. Following the MCSU manual, the resettlement of the affected workers were handled and monitored. All affected workers got their new job as staff in other power plants or associated business operated by the original owners of the closed power plants after training. Third-party monitoring was arranged and monitoring report was prepared for each power plant. The findings showed that the social issue was handled satisfactorily.

(b) Institutional Change/Strengthening

71. The GEF project has substantially strengthened the institutional capacity of the following key stakeholders:

- *Government Agencies (MOF, NEA, SERC)*: The project has improved the capacity of government agencies in developing an enabling legal, policy, and regulatory environment related to thermal power efficiency through introduction of international experience and dissemination of valuable experience from the GEF project.

- *Thermal power plants (Shanxi and Shandong):* By piloting leading energy-saving technologies, the project successfully raised awareness among the six thermal

generation companies of the energy saving potential of EE measures. At least three companies have used their own funds to continue with EE retrofit following the GEF project. In addition, the project also improved the plants' technical capacity in implementing EE measures.

- *Thermal power industry:* Through a variety of dissemination activities on the successful rehabilitation experience of the thermal plants and through seminars/workshops on the plants' standard energy audit procedure and O&M best practices, the GEF project has brought about remarkable demonstration effects. The demonstration effects have raised awareness in EE and improved the technical capacity of thermal power plants, mainly in Shanxi and Shandong, in implementing EE retrofits.

- *Guangdong Power Grid Corporation:* The GEF project has strengthened the technical capacity of the Guangdong Power Grid Corporation in improving and optimizing energy-saving dispatch in Guangdong. This was accomplished by financing the development of the ESD simulation system, an information disclosure system, and the CHP online monitoring system.

- *Shandong Power Grid Company:* The GEF project has enhanced the technical capacity of Shandong Power Grid Company to enforce government policy on monitoring heat supply from CHP plants and support the provincial government authority in allocating planned generation for CHP plants based on their heat supply data.

- *Provincial Environmental Protection Bureaus (EPBs in Shanxi and Shandong:* The project directly contributed to the development and strengthening of technical capacity of Shanxi and Shandong EPBs in designing and operating SO_2 emission allowance trading systems. It also enhanced EPB capacity in effectively regulating and controlling total pollutants emissions at the provincial level. The project indirectly developed and improved the technical capacity of EPBs of other provinces via study tours and seminars on the experience in Shanxi and Shandong.

(c) Other Unintended Outcomes and Impacts

72. In the project design, one activity under Component 1 was to study and support for trading of emission allowances, specifically (i) bulletin system for trading of SO2 emission allowance for those small units to be closed, and (ii) assessment of SO2 emission allowance trading. During the project implementation, the Bank team noted that the SO2 emission allowance trading had been moved more advanced than planned. Per discussion with both province government agencies, the activity was adjusted to support the design and trial operation of the SO2 trading system in both provinces. The achievement was satisfactory and the SO2 emission trading scheme in Shanxi ranked the top among all pilot provinces. This work served as a key test towards the national pollutants emission trading scheme, and led to the issuance of *Guidance Note on Further*

Promotion of Paid Use of Pollutants Emission Allowance and Pilot Trade by the State Council in 2014.

3.6 Summary of Findings of Beneficiary Survey and/or Stakeholder Workshops

73. Based on the speech made by high-level government officials in the closing workshop and consultation with the IAs during the ICR mission, all parties commended the significant contributions of the project to the achievement of China's national target of energy intensity reduction, and also highlighted that the GEF project successfully targeted the three strategic areas in line with government priorities for energy conservation in the 11th and 12th FYPs. The IAs also mentioned that their participation raised their awareness of the energy-saving potential of rehabilitation technologies while they appreciated the Bank's support, and some of them also expressed intentions to continue collaboration with the Bank to further improve their plants' thermal efficiency.

4. Assessment of Risk to Development Outcome

Rating: Low to Moderate

74. The overall risk to sustaining the development outcome of the GEF project is low-to-moderate.

75. The government of China set a national target to close down 50 GW of inefficient small thermal units during 2006-2010. This target was surpassed by 25% at the end of 2010. The anticipated social and financial risks associated with the closures were largely mitigated as the central and provincial governments raised their compensation standards and provided sufficient social protection measures to resettle affected workers. Moving from the 11th FYP (2006-10) to the 12th FYP (2011-2015), the central government planned to close down another 20 GW of inefficient capacity, an indication of sustained government commitment to the optimization of the country's power generation mix. Thus, the risk to the development outcome of component 1 is low.

76. The GEF project piloted six EE retrofit technologies, demonstrated their commercial viability, and supported the issuance of national policies on thermal plant rehabilitation. It provided a holistic approach to efficiency improvements in thermal plants. The project brought about significant demonstration effects as the supported retrofit technologies are currently widely used in thermal plant rehabilitation. During the 12th FYP, thermal plant rehabilitation continues to be a top government priority. The strong government commitment to its energy intensity target ensures that thermal efficiency rehabilitation in power plants will continue on an increasing scale. As a result, the risk to the development outcome of component 2 is low.

77. Guangdong piloted ESD operation under the 11th FYP and continued it under the 12th. ESD operations are also very likely to be continued into the 13th FYP. The continuation of the ESD policy in Guangdong will sustain the important role of the ESD simulation system in improving and optimizing the actual ESD dispatch rules. The risk to the development outcome of component 3 is low.

78. The risk to the development outcome of component 3 at the national level, however, is moderate, as the decision whether to roll out ESD at the national level has not yet been made. The project supported a comprehensive evaluation of ESD pilots in five provinces. The results showed that the overall contribution of ESD to coal consumption reduction per kWh (as measured before and after the ESD pilot operation) is *moderate*, with the ESD contribution varying among provinces in a range from 0.7 gce/kWh in Guizhou to 3.98 gce/kWh in Sichuan (1.0 gce/kWh in Guangdong).

79. The GEF project also supported a number of policy studies to create an enabling environment for ESD, in particular addressing the compensation mechanisms for less efficient thermal plants that would suffer financial loss under the ESD. However, none of the policy studies have led to the issuance of national policies or regulations. This is because issuance of those policies or regulations is strongly linked to much broader power sector reforms, including pricing reform. The uncertainties in other key sector reforms may slow down the promotion of ESD at the national level.

80. Based on the above analysis, it is concluded that the overall risk to sustaining the development outcome of the GEF project is low to moderate.

5. Assessment of Bank and Borrower Performance

5.1 Bank

(a) Bank Performance in Ensuring Quality at Entry

Rating: Satisfactory

81. The Bank's support for the project was built upon a solid rationale and Bank performance in ensuring quality at Entry is considered satisfactory. The background analysis was sound and enabled the project to be positioned in line with key aspects of the government's plan for improving sector efficiency.

82. The design was generally appropriate. The project concept was well aligned with the government's top priorities for energy conservation and emission reductions in its 11th FYP. These areas continue to be the priorities during the 12th FYP. Lessons learned from previous Bank-financed projects in mine closures and rehabilitation of thermal power plants in a number of countries were taken into account during the project preparation. Problems encountered during the implementation were identified and solutions were proactively sought and implemented to enhance the probability of success for the project. However it should also be noted that the allocation of GEF grant for each component could be re-balanced as the resource required for Component 1, Closure of Small Units, was overestimated in the project design though it was adjusted through project restructuring.

(b) Quality of Supervision

(including of fiduciary and safeguards policies)

Rating: Moderately Satisfactory

83. The overall performance of Bank's supervision of the GEF project was moderately satisfactory. Intensive and flexible project supervision was adopted during the major part of the project implementation period when an earlier stage inadequate communication was notified by the Bank management and prompt action was taken in the Bank side.

84. Following the first supervision mission, intensified supervision was adopted by the Bank team and close communications with the NPMO/PMUs were established to speed up project implementation. In between the formal biannual supervision missions, the Bank organized a number of technical assistance missions to provide timely guidance and financial management and procurement trainings to the NPMO/PMUs whenever necessary. The NPMO gradually improved its management effectiveness and enhanced its coordination with provincial PMUs. The PMUs also developed adequate management capacity. As a result, project commitment and disbursement rates rapidly increased.

85. The Bank team also showed flexibility and willingness to make timely adjustments to adapt the project to the shifting provincial priorities. This is evident from the project restructuring, in which cancellation of the sub-component for the closure of small thermal units in Shanxi (a result of the rapid progress made by the provincial government) and the resources earmarked for the closure were re-allocated to other emerging government priorities, including the pollutants emission allowance trading system and innovative rehabilitation demonstration of an additional three thermal power plants. These changes kept the project objective achievable during the whole project implementation period.

(c) Justification of Rating for Overall Bank Performance
Rating: Moderately Satisfactory

86. The Bank team concentrated on development effectiveness and sustainability of thermal efficiency of the power sector. The team also demonstrated flexibility to meet the client's demand during project implementation, provided intensive guidance and trainings to the NPMO/PMUs, and made best efforts to provide timely solutions to major issues encountered though the communication with the PMO/PMUs could be improved at the early stage of the project implementation. Overall, the Bank performance is rated as moderately satisfactory.

5.2 Borrower

(a) Government Performance
Rating: Highly Satisfactory

87. The GOC showed strong commitment to and ownership of thermal efficiency improvements in the power sector. From 2006-2010, China achieved a stunning 19.1 percent energy efficiency improvement; 76 GW of small inefficient coal-fired units were closed down, an increase of 50 percent compared to the original target of 50 GW of closures. Sufficient fiscal incentives were provided to support EE rehabilitation of

medium- and large-size thermal units in the 11th FYP. The rehabilitation of thermal plants continues to be a top priority during the 12th FYP. In addition, ESD was successfully piloted in five provinces. An evaluation was carried out to distill lessons learned, which has provided recommendations for the further improvement of ESD operations.

88. During project implementation, government officials requested the GEF project for a range of analytical and advisory studies as inputs to the government's EE policies and regulations in the power sector. Both deputy director generals of the International Department and the Economic and Construction Department (both at MOF) attended the project closing workshop and acknowledged the remarkable contributions of the GEF project to China's thermal efficiency improvement in the power sector.

(b) Implementing Agency or Agencies Performance
Rating: Moderately to Highly Satisfactory

89. Overall performance of implementing agencies is rated as satisfactory. Individual IA performance, however, varies.

90. The performance of the six thermal power companies is rated as highly satisfactory. The six thermal power companies mobilized sufficient funds of their own to ensure the timely completion of their rehabilitation. The companies also have adequate technical capacity to ensure the successful completion of their rehabilitation.

91. The performance of the Shanxi EPB is rated as highly satisfactory. Shanxi EPB played a strong leadership role in advancing the agenda for SO_2 emission allowance trading at the provincial level and the trading volume has been growing since the inception of the trading system. The Shanxi model has become a good example for other provinces to follow.

92. The performance of the Shanxi PMU and Guangdong PMU is rated as satisfactory. Despite a lack of experience with Bank projects at an early stage of the project, the PMUs quickly improved their project management capacity. Shanxi PMU successfully coordinated project implementation with Shanxi EPB and the three thermal power plants. The progress of project implementation at the later stage of implementation was satisfactory. In addition, Guangdong PMU had adequate capacity to manage the project. The provincial PMU satisfactorily delivered the project on time and within budget.

93. The performance of the NPMO is rated as moderately satisfactory. The NPMO could have performed better in disseminating the knowledge and experience associated with thermal efficiency improvement at the national level. This would have increased the project's impact on the issuance of the national policies. In addition, activities at the national level suffered from a key personnel change, which slowed down project progress and directly led to the third project restructuring to extend the closing date by half year.

94. The performance of Shandong PMU is rated as moderately satisfactory. Similar to Shanxi PMU, Shandong PMU also suffered from a lack of capacity to manage Bank projects at project outset. Although Shandong PMU gradually improved its management

capacity, capacity remained weak due to frequent staff turnover and project implementation was slowed down. On the other hand, Shandong PMU performed well in closing down nine thermal plants in Shandong. The post-evaluation report showed no unresolved issues associated with the closures.

95. The performance of the owners of the nine closed small power plants, namely Feicheng Company (Dafeng, Caozhuang plants), Dongyue Company (Yangzhuang, Guozhuang, Taoyang plants), Taishan Yangguang Company (Laiwu plant), Laiwu Xingyuang Company, Taishan Paper Manufacture Company, and Yichou Cement Company (Luozhuang plant), is rated as satisfactory, as the plants were closed effectively. Evaluations of both the environmental and social safeguards were satisfactory.

96. The performance of Shandong EPB is rated as moderately satisfactory. The Shandong EPB completed the establishment of a SO_2 emission allowance trading system in Weifang city and made efforts to disseminate its experience. However, only virtual trading transactions occurred in the secondary market in Weifang city.

97. The performance of Shandong Power Grid Company is rated as satisfactory. The corporation completed the establishment of the CHP online monitoring system on time and effectively used the monitoring data to inform its discussion with the relevant government authorities on the scheduling of the power dispatch with CHP plants in Shandong.

(c) Justification of Rating for Overall Borrower Performance
Rating: Moderately Satisfactory

98. Despite the difficulties encountered during the project implementation, especially at early stages of the project, the borrower and implementing agencies showed strong commitment to thermal efficiency improvement in the power sector and took full ownership of the project. All government agencies and grant beneficiaries allocated the needed efforts and resources to deliver the project outputs and surpass its target indicators though the overall project implementation period was extended by one and half years. The Borrower's performance is therefore rated as moderately satisfactory.

6. Lessons Learned

99. **Strong government commitment.** Strong government commitment is critical for project success, and the GOC has shown strong ownership of the promotion of energy conservation to reduce overall energy intensity. This strong commitment has led to sufficient legal, policy, and regulatory frameworks to create an enabling environment for thermal efficiency improvement in the power sector. During the 11^{th} FYP, the central government set the ambitious target to close inefficient small thermal units to optimize the power mix, provided financial compensation for plant thermal efficiency rehabilitation, and piloted ESD in five provinces. The resulting financial and non-financial incentives, along with the enabling environment for thermal efficiency enhancement, contributed to the success of the GEF project.

100. **Project design aligned with country priorities.** The GEF project targeted three strategic areas that were identified by the GOC in pursuing its energy conservation objective. During the11th FYP, the central government created an enabling environment for the implementation of the GEF project. Relevant government authorities and implementing agencies were highly motivated to implement the GEF project as it was aligned with country priorities. This made it easier to disseminate the outputs, including guidelines, tools and knowledge, to a much broader range of stakeholders due to the project's high relevance to national priorities.

101. **Strong technical and financial capacity of implementing agencies.** The results of the plant thermal efficiency improvement component are considered highly satisfactory because the measured results indicators well exceed the original targets. The successful demonstration of rehabilitation is largely attributable to the strong technical capacity of the six thermal power plants. In addition to the GEF grant, sufficient counterpart funds were set aside by the thermal power companies to ensure the timely completion of the rehabilitation. This experience illustrates that strong technical capacity and good financial standing of the involved thermal power generation companies is essential for effective and efficient plant rehabilitation.

102. **Significant demonstration effect of rehabilitation as a result of the proper selection of technology (based on its competitiveness and replication potential) and extensive dissemination activities.** The GEF project achieved a significant demonstration effect as the six thermal plants collectively hosted more than 30 study tours for staff from other thermal plants located both inside and outside their respective provinces. This is an indication of the strong interest by the other thermal power plants, which regarded the rehabilitation technologies highly relevant to their operations. To ensure that the GEF-supported technologies had this high relevance, the Bank team selected technologies competitively based on cost-effectiveness and replication potential. Following the successful demonstration, the GEF project undertook extensive dissemination activities of various forms to widely convey the experience to a broad range of stakeholders. The achieved demonstration effect is critical to guarantee a satisfactory outcome of the project. As a result, several demonstrated technologies (CHP, waste heat utilization, variable frequency control, etc.) have been turned into standard industrial practices.

103. **Attribution of PDO Indicators.** Although the two PDO level indicators (electricity supply efficiency in gce/kWh and GHG emission factors in ton CO_2/MWh) are appropriate for measuring the success of the aggregated efficiency improvements and GHG impacts in the power sector in the three provinces, additional indicators would have provided more precise measurement of the output of the project to enhance attribution, as the size of the GEF project was quite small compared to the size of the sector in the three provinces. The additional indicators could be selected as weighted electricity supply efficiency (in gce/kWh), total energy savings contributed by the GEF project directly (tce), avoided GHG emissions (ton CO_2), or a weighted emission factor (ton CO_2/MWh).

104. **Flexibility is required to adapt project implementation to evolving government priorities.** The government of China was moving fast with the closure of small coal-fired units during its 11th FYP. The rapid government interventions, along with the project delay at the outset of the project, necessitated a revision to the sub-components to adapt to the fast closures. The flexibility of the Bank team led to satisfactory results. This flexible approach can be particularly helpful in countries where project ownership is particularly strong.

105. **Capacity building for PMO/PMUs and IAs through close communication between the Bank team and client agencies is an indispensable part of project design and implementation, especially for those agencies new to the Bank projects.** The capacity building is especially important at the early stage of project implementation in order to enable the IAs to start the project implementation quickly, as well as building the trust between the Bank team and IAs.

7. Comments on Issues Raised by Borrower/Implementing Agencies/Partners

(a) Borrower/implementing agencies

106. The borrower's contribution to the ICR was shared with the World Bank in June 2014 and is summarized in Annex 7. It provides a summary of the key outputs and outcomes of the project, implementation status of each project component, and assessment of the experience and lessons. These inputs have been incorporated into the ICR.

107. The draft final ICR was also circulated to the Ministry of Finance and implementing agencies (coordinated by the national PMO) for comments in January 2015. It was considered to reflect fairly large project results in accordance with the tasks initially established. The results mentioned and conclusions presented demonstrate that the project has achieved its objectives, though the national PMO proposed to rate its performance as Satisfactory rather than Moderately Satisfactory.

(b) Cofinanciers

Not applicable.

(c) Other partners and stakeholders

Not applicable.

Annex 1. Project Costs and Financing

(a) Project Cost by Component (in USD Million equivalent)

Components	Appraisal Estimate (USD millions)	Actual/Latest Estimate (USD millions)	Percentage of Appraisal
1. Mechanisms to Support the Closure of Inefficient Small Coal-fired Generation Units	**36.42**	**37.269**	**102.3%**
a). Technical Assistance to MOF	16.029	1.219	7.6%
b). Shandong Pilot Program	10.992	34.58	314.6%
c). Shanxi Pilot Program	9.4	1.47	15.6%
2. Demonstration of Power Plant Efficiency Improvement	**56.361**	**51.256**	**90.9%**
a). TA to NPMO for Best Practice & Procedure	0.398	0.376	94.5%
b). Rehabilitation of Thermal Power Plants	55.963	50.88	90.9%
3. Transition to Efficient Generation Dispatch	**7.297**	**4.637**	**63.6%**
a). Pilot of ESD in Guangdong	5.147	3.27	63.5%
b). Technical Assistance to Replication	1.572	1.367	87.0%
4. Technical Assistance to Project Implementation	**1.852**	**1.5**	**81.0%**
5. Project Management	**1.916**	**1.7**	**88.7%**
Contingencies	**5.11**	**-**	
Total	**108.96**	**96.36**	**88.4%**

(b) GEF Grant Contribution (in USD millions) by Component (Table A1.2)

Components	Appraisal Estimate (USD millions)	Actual/Latest Estimate (USD millions)	Percentage of Appraisal
1. Mechanisms to Support the Closure of Inefficient Small Coal-fired Generation Units	9.5	5.909	62.2%
2. Demonstration of Power Plant Efficiency Improvement	3.594	7.604	211.6%

3. Transition to Efficient Generation Dispatch	4.071	4.137	101.6%
4. Technical Assistance to Project Implementation	1.266	1.55	122.4%
5. Project Management	0.408	0.34	83.3%
Contingency for Exchange Rate	0.86	-	
Total GEF Grant Contribution	**19.7**	**19.54**	**99.2%**

(c) GEF Grant Contribution (in USD millions) by Types of Activities (Table A1.3)

Components	Appraisal Estimate (USD millions)	Actual/Latest Estimate (USD millions)	Percentage of Appraisal
MCSU – Capitalization	5.0	1.53	30.6%
Goods and Works	7.61	9.04	118.8%
Services	5.83	8.63	148.0%
Project Management Cost	0.41	0.34	82.9%
Contingency for Exchange Rate	0.86	-	
Total GEF Grant Contribution	**19.7**	**19.54**	99.2%

(d) Financing (Table A1.4)

Source of Funds	Type of Cofinancing	Appraisal Estimate (USD millions)	Actual/Latest Estimate (USD millions)	Percentage of Appraisal
Borrower	Grant	15.50	25.52	164.6%
Global Environment Facility (GEF)	Grant	19.70	19.54	99.2%
Sub-borrower(s)	Equity	73.76	51.30	69.5%
Total		108.96	96.36	88.4%

Annex 2. Outputs by Component

1. The GEF project consisted of three major components: (i) Component 1: Mechanisms to Support the Closure of Inefficient Small Coal-fired Generation Units; (ii) Component 2: Demonstration of Power Plant Efficiency Improvement; and (iii) Component 3: Transition to Efficient Generation Dispatch. Table A2.1 presents the structure of the GEF project, listing the various components and subcomponents.

Table A2.1. Structure of GEF project sub-components

Component	**Sub-component**
Mechanisms to Support the Closure of Inefficient Small Coal-fired Generation Units	Closure of nine small coal-fired plants (Shandong)
	CHP online monitoring system (Shandong)
	SO_2 emission allowance trading component (Shandong)
	SO_2 emission allowance trading component (Shanxi)
Demonstration of Power Plant Efficiency Improvement	Wet peak cooling technology by Wuxiang Hexin thermal plant (Shanxi)
	Integrated plant efficiency rehabilitation at Yangguang thermal plant (Shanxi)
	Branch console phase change heat exchanger at Taiyi thermal plant (Shanxi)
	Waste Heat Recovery at Jinan Beijiao Thermal Plant (Shandong)
	Conversion for CHP operation at Huangtai thermal plant (Shandong)
	Conversion to high voltage variable speed drive at Weihai Botong thermal plant (Shandong)
Transition to Efficient Generation Dispatch	ESD simulation system (Guangdong)
	CHP online monitoring system (Guangdong)
	Information disclosure system (Guangdong)

Component 1: Mechanisms to Support the Closure of Inefficient Small Coal-fired Generation Units

Closure of nine small coal-fired plants in Shandong

2. The closure of nine coal-fired plants (225 MW in total) was successfully completed. Results of a post-completion survey show that the closure was well implemented. The social and financial impacts of the closure on those that were affected by it were largely mitigated by the provision of vocational trainings and the delivery of sufficient financial compensations.

CHP online monitoring system (Shandong State Grids)

3. The CHP online monitoring system played an important role in helping Shandong government authorities enforce their regulations for CHP plants. The system was put into operation in 2007 and continues to undergo improvements. At the end of 2012, the Shandong Provincial Economic and IT Commission issued a regulation to improve the accuracy of data collected by the plants. The provincial authorities have thus far invested over RMB 12 million, including RMB 6 million in 2014 alone, to strengthen the functions and features of the CHP online monitoring system.

4. The CHP online monitoring system has also expanded its coverage to include 136 base-load units and 548 backup units in Shandong. State Grid set a target to implement CHP online monitoring within all its power grids by the end of 2014.

5. The technical design and specification of the Shandong CHP online monitoring system provided inputs to the State Grids' technical specification of the CHP online monitoring system.

SO_2 emission allowance trading component (Shanxi) by Shanxi Environmental Protection Bureau

6. The project supported the design, development, and operation of the Shanxi SO_2 emission allowance trading system by strengthening trading design and planning frameworks, and financing the development and installation of corresponding hardware and software.

7. The test operation of the SO_2 emission allowance trading system occurred in 2011, with official operation starting in 2012. Since the system's inception, emission trading has intensified. The number of transactions in the first 9 months of 2014 (Jan.-Sept.) reached 360, an increase of 33 percent compared to the 2013 level and 87 percent compared to 2012. The transaction volume during the first 9 months of 2014 amounted to RMB 500 million, 2.3 times the 2013 level (RMB 212 million) and nearly 6 times the 2012 volume (RMB 84 million).

8. Two salient trends have emerged: (i) transactions among binding companies dominate the secondary market; the transaction volume accounted for 39 percent of the total in 2012, climbing to 73 percent of the total in 2013, and hovering around 70 percent in 2014; and (ii) the transaction scope was broadened to cover city-level companies. From 2012 to June 2014, transactions were limited to provincial level companies, but since July 2014 emission trading has included city-level companies.

9. The demonstration effect of this sub-component is remarkable because of the successful operation of the emissions trading system, as evidenced by the intensified trading transactions over the year. Thus far, more than 20 provinces have organized study tours to Shanxi and four provinces have followed the Shanxi practice to establish independent emission allowance trading centers to manage emission control. About 10 provinces adopted an "IC Card" mechanism that was pioneered by Shanxi province to regulate total pollutants emissions.

10. Going forward, the pollutants emission allowance trading system will play a more important role in regulating pollutants emissions due to (i) tightened emission regulations in the new Environmental Protection Law to be effective in January 2015, and (ii) new additions of thermal capacity. Shanxi provincial authorities are aiming to add a total 21 GW of thermal capacity with low-calorific value coals as fuel and already have approved 90 percent of the target. The new capacity additions will produce more polluting emissions, creating a huge burden on the existing provincial emission control agenda.

SO_2 emission allowance trading component (Shandong) by Shandong Environmental Protection Bureau

11. The planning, design, and system establishment of the SO_2 emission allowance trading system in Weifang city in Shandong Province were completed. Continued and ongoing efforts are made to disseminate the experience. Since the establishment of the trading system at the end of 2012, the Weifang government has been allocating quota to the local enterprises in the primary market, with results publicly disclosed. Actual transactions in the secondary market, however, have been put on hold as a national policy for a pollutants emission allowance trading system is not available.

12. This situation, however, is expected to change soon, as a result of the central government's issuance of a relevant national policy in July 2014, providing a clear market signal. Following this new policy, the Shandong provincial authorities have been developing supporting policies at the provincial level to promote the trading.

13. This move sets the stage for upcoming transactions in the secondary market in Weifang. The pilot trading system supported by the GEF grant is expected to play a leading role in pollutants emission allowance trading not only in Weifang but across Shandong province.

Component 2: Demonstration of Power Plant Efficiency Improvement

Peak Cooling Technology by Wuxiang Hexin Thermal Plant

14. Prior to 2011, thermal power plants in water-scarce regions such as Shanxi, Inner Mongolia, Hebei, and Shaanxi often used direct air-cooling technology. This technology, however, was found to result in sub-loading in the summer when ambient temperature is high, causing uneconomic generation under high back pressure. The peak cooling technology employed by Wuxiang Hexin Power Generation Co., Ltd can solve the sub-loading issue by enhancing the load-bearing capacity of generators in the summer, thus improving the thermal efficiency of the power plant.

15. The pilot project was the first to demonstrate the use of peak cooling technology in summer for thermal plants situated in water-deficient regions. Despite an increase in water consumption, the post-retrofit total water consumption remains below the limit set by the government. The pilot's successful operation corroborated the technical and

economic feasibility of the application of such technology in China's northern part where water resources are limited. In addition, the project provided valuable experience in solving the sub-load issues that confronted direct air-cooling generators in the summer. The project sets an example for other similar thermal plants that adopt the direct air-cooling technology, in particular in water-deficient regions.

16. Project experience has been disseminated by the NPMO via various seminars and at the Green Expo; the plant also organized a number of inter- and intra-provincial study tours to showcase the pilot project. The dissemination activates brought about significant demonstration effect. Thus far, six thermal plants in Shanxi and three in other provinces have either started a peak cooling project or are formulating their retrofit plan.

Integrated Plant Efficiency Rehabilitation at Shanxi Yangguang Thermal Plant

17. The project at Yangguang thermal plant showcased the practice of plant efficiency rehabilitation based on the recommendations of a standard plant energy audit. The project also demonstrated three efficiency-enhancing retrofit technologies that were relatively new at the outset of the project.

18. The three efficiency-improving technologies include (i) high-voltage variable-frequency speed control system for primary fan of boilers; (ii) vapor seal retrofit of turbine blade and shaft; and (iii) adoption of a real-time plant efficiency monitoring system.

19. The company applied a patented vapor seal retrofit technology on the #4 generator. The post-retrofit operation began in March 2008. The retrofit achieved its intended objective: the unit efficiency rose from 35.3% to 39.5% relative to the pre-retrofit level, while coal consumption of a single unit declined by 4-5 g/kWh, according to a test report by the China Electric Power Research Institute. A number of dissemination and promotional activities were carried out by both NPMO and the company. This technology now has been used for 300 MW thermal units across the country.

20. In 2007-2008, high-voltage variable-frequency speed control systems for large thermal units were rarely seen due to their perceived technical risks. Demonstration of this technology in 2008 would have created significant demonstration effect, but the retrofit work was delayed until 2012 because its implementation was contingent upon another retrofit activity that was technically challenging. As a result, the demonstration effect for this technology was significantly reduced.

21. According to Yangguang company, the real-time plant efficiency monitoring system allows the plant to manage its thermal units more efficiently because of the early identification of issues and the software's intelligent function contributing to a timely resolution of those issues. According to the Shanxi PMU, the monitoring software has now been adopted by 70% of thermal power plants in Shanxi.

Waste Heat Recovery (Phased Heat Exchanger) at Taiyi Thermal Plant

22. The project at Taiyi thermal plant is the first project to demonstrate the application of a phased heat exchanger to recover waste heat from thermal power plants. The demonstrated technology is a major innovation as it successfully solves a number of technical issues facing the traditional phase-change heat transfer technology used in many plants. The technology reliably controls the wall temperature of the side gas heaters during the entire process, from unit start-up to close-down, and thus ensures a safe and efficient recycling of the heat of waste gas. The technology was jointly developed by the Guodian Taiyi Power Generation Co., Ltd. and the Process Engineering Institute of the Chinese Academy of Sciences.

23. The project supported the recycling of the waste heat from boiler #4 using this technology. The post-retrofit operation satisfactorily achieved its intended objectives, including an efficiency improvement in terms of a reduction of 2.24 gce/kWh of coal consumption for power generation, and annual reductions of 241.3 tons of SO_2 emissions; 178.4 tons of NOx emissions; 11,502 tons of CO_2 emissions; and 1,749 tons of ash emissions.

24. NPMO and the company have undertaken a number of activities to disseminate the successful results of the pilot, including workshops, seminars, and study tours. Already five thermal plants in Shanxi have either started to implement this technology or have already adopted it. In addition, NEA organized an evaluation panel to assess and evaluate this innovative technology. The technology was also recently included in the "National Near-zero Emission Technology Catalogue 2014" as one of the leading technologies to be promoted at the national level.

Waste Heat Recovery at Jinan Beijiao Thermal Plant

25. In 2008, recovery of heat wasted in the condensing and cooling process of CHP units and the use of circulating water for district heat supply were not common practice in thermal plants, but the GEF practice at the Jinan Beijiao thermal plant has shown its commercial viability. The GEF grant co-financed the transformation of condensers and circulating water systems of units #2 and # 5, the construction of the heat transfer station in the plant area, and the transformation of the urban heat supply network. The retrofit was completed at the end of 2009.

26. The retrofit project achieved good social benefits. It helped expand the heat supply area by 2 million square meters and improved the stability and efficiency of the heat supply network's operation by transforming it from a steam network to a water network.

27. The project also achieved economic benefits. Thermal efficiency was significantly enhanced, going from 57% (prior) to 77% (post) for unit #2, and to 78.57% in unit #5. Actual coal savings for the winter heating season amounted to 0.03 million tce per annum,

exceeding the target of 0.02 million tce per annum. GHG emissions were reduced by 0.069 million tons per year, surpassing the target of 0.053 million tons per year.

28. Early completion of the project brought about significant demonstration effect. Staff from about 14 to 16 other thermal plants visited the Beijiao thermal plant to learn from the plant's experience. The rehabilitation technology supported under the project is now widely used in the rehabilitation of thermal plants.

29. In addition, the social and economic benefits from the project have spurred a great interest at the Beijiao thermal plant to continue to explore and implement other energy efficient technologies beyond the technical scope of this project. The Beijiao thermal plant recently collaborated with the Energy Institute of Tsinghua University to evaluate the technical and financial viability of flue gas heat recovery technology to further enhance the thermal efficiency of the plant.

Conversion into CHP Operation at Huangtai Thermal Plant

30. The conversion of power generation only units into CHP operation was an innovative process in 2007-2008. The GEF grant was used to support this rehabilitation with the clear objective to initiate a wide replication of this conversion across the country via the pilot demonstration. The conversion at Huangtai thermal plant was completed in 2008.

31. The project achieved its intended objective. Thermal efficiency of the plant increased from 40.3% (prior) to 56.4% (post). Annual coal savings amounted to about 64,000 tons and associated GHG emission reductions reached about 160,000 tons.

32. The project created significant demonstration effect due to the successful and early completion of the rehabilitation. Nationally, about 40-50 thermal units (300 MW/600 MW) have adopted Huangtai's technical design to convert to CHP operation in their thermal plants.

33. The positive feedback and economic benefits have led Huangtai thermal plant to continue its thermal efficiency retrofit. So far the plant has invested over RMB 120 million in a retrofit of the heat supply for unit #8. The work is expected to be completed in late 2014.

Integrated Rehabilitation at Weihai Botong Thermal Plant

34. This project supported a suite of rehabilitation technologies, covering (i) an upgrade of the efficiency of four boilers by increasing steam temperature; (ii) retrofit of the turbine flow path; and (iii) the installation of 13 high voltage variable speed drives. The boiler retrofit was completed for two boilers while the remaining work for the other two boilers is to be completed soon. After the first batch of 11 variable speed drives was installed in November 2012, the encouraging results led to the installation of an additional two variable speed drives. The retrofit for the turbine flow path was ongoing

and expected to be completed in 2014. The post-retrofit thermal efficiency in 2013 amounted to 72.84 %, a bit lower than the target indicator (74.14%). With the completion of the retrofit for the turbine flow path in the plant, the thermal efficiency would be expected to achieve the target.

Component 3: Transition to Efficient Generation Dispatch

ESD Simulation System

35. The ESD simulation system has been put into operation since its establishment. According to staff of the Guangdong Power Grid Corporation, the ESD simulation system has been an effective analytical instrument to identify gaps between actual and ideal ESD operations. The system is also helpful in pinpointing underlying factors that contribute to the gaps, with results of the gap analysis used to improve the actual ESD dispatch operation, monthly or quarterly, to exploit the full potential of the ESD.

36. In addition, to quantify the incremental energy saving potential of the Guangdong power grid, an assessment report was recently produced based on the 2013 actual dispatch data. The report provided strong analytical underpinning to the sustained improvement of energy-saving dispatch in the province.

37. As a result of the sustained improvements, this sub-component has achieved its intended objective. It is also confirmed that the energy-saving dispatch will continue to be the dispatch model in Guangdong, which means that the effectiveness and usefulness of the ESD simulation system supported by the GEF grant will be sustained.

CHP Online Monitoring System

38. The Guangdong CHP online monitoring system has been in operation since its establishment in 2011. Since then, its coverage has been expanding. In 2011 only four CHP plants were connected to the monitoring system; this number is expected to increase to 17 at the end of 2014, covering all existing CHP plants in Guangdong. Going forward, it will be mandatory for all new CHP plants to be commissioned to be connected to the CHP monitoring system.

39. The CHP monitoring system has been effectively collecting real-time operational data from the CHP plants in Guangdong and results of the data analysis are used to inform policy decisions on power dispatch between China Southern Grids and relevant provincial authorities. As such, this sub-component has achieved its intended outcome.

Information Disclosure System

40. An information disclosure system was established based on actual ESD operation in Guangdong. The system provides an open platform for data collection, analysis, exchange, inquiry, and management. Guangdong Power Grid Corporation is developing a brand new Operation and Management System (OMS). Once this system is established,

the existing information disclosure system will be integrated into the OMS and perform its functions using the OMS platform.

41. The project indicators were illustrated in table A2.2 below.

Table A2.2. Project Indicators

Outcome Indicators	**Baseline (2007)**	**Target Value at Appraisal Year 4 (2012)**	**Target Value at Appraisal Year 5 (2013)**	**Actual Value at ICR (Year 5)**
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: 357 SD: 369 GD: 332	SX: 354 SD: 366 GD: 330	SX: 347 SD:332 GD: 299
Reduction of GHG emissions per unit of coal-fired electricity output in selected provinces	SX: 1,020 $kgCO_2/MWh$ SD: 1,045 $kgCO_2/MWh$ GD: 935 $kgCO_2/MWh$	SX: 977 SD: 1,009 GD: 908	SX: 970 SD: 1,002 GD: 900	SX:951 SD:909 GD:815
Component 1: (i) Cumulative capacity of small thermal units closed down (ii) CHP on-line monitoring system operational	SD: 1717 MW	SD: 4300MW (2011) SD: yes	 SD: yes	SD: 7733 MW (2011) SD: yes

Component 2: (i) Increase in thermal efficiency of targeted plants/units (ii) Annual coal savings and GHG emission reductions from targeted plants / units	Thermal efficiency YG: 35.3% HT: 40.3% BJ: 57.0% WH: WX: TY: Coal savings / GHG emission reduction YG: 0.0 million tce / 0.0 million tons HT: 0.0 million tce / 0.0 million tons BJ: 0.0 million tce / 0.0 million tons WH: 0.0 million tce / 0.0 million tons WX: 0.0 million tce / 0.0 million tons TY: 0.0 million tce /0.0 million tons	Efficiency YG: 35.8% HT: 44.4% BJ: 66.8% WH: WX: TY: YG: 0.04 / 0.11 HT: 0.17 / 0.47 BJ: 0.06 / 0.16 WH: 0.00 / 0.00 WX: 0.014 / 0.031 TY: 0.00 / 0.00	Efficiency YG: 35.8% HT: 44.4% BJ: 66.8% WH: 77.9% WX: 38.4% TY: 40.9% YG: 0.04 / 0.11 HT: 0.17 / 0.47 BJ: 0.06 / 0.16 WH: 0.007 / 0.017 WX: 0.014 / 0.031 TY: 0.008 / 0.023	Efficiency YG: 39.49% HT: 56.4% BJ: 77.8% WH: 72.84% WX: 39.5% TY: 41.26% YG: 0.0664 / 0.1661 HT: 0.0640 / 0.1600 BJ: 0.030 / 0.069 WH: 0.0064 / 0.0155 WX: 0.01738 / 0.038 TY: 0.0041 / 0.012
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 five pilot provinces	Pilot ESD system developed by Guangdong Power Grid Company, no simulation system operational No detailed requirements on information disclosure No financial compensation mechanism	Operation of simulation system, information disclosure system and financial comp. mechanism, and pilot ESD system Report on assessment of pilot programs in all five pilot provinces, including GD, and recommendations for improvement		Pilot ESD in implementation; simulation system in operation; information disclosure system and financial comp. mechanism developed Report available on assessment of pilot programs in five pilot provinces

Component 4: Performance of procurement, FM and other project management	Satisfactory performance for project preparation activities	Ensuring smooth project implementation	Ensuring smooth project implementation	Smooth project implementation
Component 5: Use of incremental operating budget	Satisfactory performance in use of PPG Grant	Ensuring compliance with the project Financial Management Manual	Ensuring compliance with the project Financial Management Manual	Compliance with the project Financial Management Manual

Note: SD=Shandong; SX=Shanxi; GD=Guangdong; YG=Yangguang thermal plant (Shanxi); HT=Huangtai thermal plant (Shandong); BJ: Beijiao Thermal Plant (Shandong); WH=Weihai Botong thermal plant (Shandong); WX=Wuxiang Hexin thermal plant (Shanxi); and TY=Taiyi thermal plant (Shanxi).

Annex 3. Economic and Financial Analysis
(Including assumptions in the analysis)

Economic Analysis

1. Economic analyses of investment sub-components were conducted at appraisal to justify their economic viability. This applied to the sub-components for the first three power plants including: (i) Jinan Beijiao thermal power plant, (ii) Huangtai thermal power plant in Shandong, and (iii) Yangguang thermal power plant in Shanxi. Rehabilitation of three more power plants was added during the project restructuring. Cost-benefit analyses were carried out to estimate the EIRRs of the six sub-projects. Using the same methodology, i.e., cost-benefit analysis, the EIRRs were recalculated at the time of ICR.

2. **Jinan Beijiao Thermal Power Plant:** At ICR, the EIRR was recalculated at 76.8 percent, tripling the estimate made during project preparation (26.7 percent). The increase is mainly caused by: (i) significantly lower CAPEX, as capital investment decreased from RMB 159 million at appraisal to RMB 23.6 million at ICR; and (ii) lower incremental costs of electricity consumption for heat. The increase is partially offset by lower than estimated coal-savings and consequently lower environmental and global benefits.

3. **Huangtai Thermal Power Plant:** The EIRR at ICR was recalculated at 176.2 percent, significantly higher than the estimated EIRR during project preparation (20.4 percent). The increase in EIRR is mainly caused by significantly lower CAPEX, as capital investment decreased from RMB 191 million at appraisal to RMB 21.6 million at ICR. The increase is partially offset by lower than estimated coal-savings and consequently lower environmental and global benefits.

4. **Yangguang Thermal Power Plant:** The EIRR at ICR was recalculated at 85.7 percent, higher than the estimated EIRR at project preparation (78.7 percent). The increase is mainly a result of a (i) CAPEX at ICR about 5 percent lower than at appraisal, and (ii) more coal savings achieved at ICR compared to the savings anticipated at appraisal.

5. Using the same methodology, the EIRRs at ICR for Wuxiang Hexin plant, Taiyi Power Plant, and Weihai Botong plant were calculated at 20.8, 11.3, and 31.2 percent respectively, all three below the estimated EIRRs at restructuring, which respectively were 25.1, 16.4, and 32.8 percent. This is mainly a result of the decrease in coal price, which has led to a reduction in the coal saving benefit. In addition, the actual coal savings for both Taiyi and Weihai power plants were lower than expected.

Financial Analysis

6. The financial analyses of the six investment subcomponents were carried out using the same methodology adopted during the project preparation, namely cash flow analysis, and the FIRRs were recalculated. It was found that:

- At Jinan Beijiao Thermal Power Plant, the FIRR of rehabilitation was recalculated at 91.79 percent, significantly higher than the estimated FIRR at project appraisal (16.96 percent).
- At Huangtai Thermal Power Plant, the FIRR of retrofit was recalculated at 186.77 percent, significantly higher than the estimated FIRR at project appraisal (23.73 percent).
- At Yangguang Thermal Power Plant, the FIRR of retrofit was recalculated at 90.91 percent, slightly higher than the estimated FIRR at project appraisal (88.69 percent).
- At Wuxiang Hexin, Taiyi, and Weihai Botong plants, the FIRRs of rehabilitation were calculated at 11.9, 5.3, and 20.1 percent respectively, lower than the estimated FIRRs at project restructuring, which had been 13.0, 7.7, and 25.4 percent respectively.

Summary

7. The EIRRs and FIRRs for the six investment subcomponents are summarized in table A3.1.

Table A3.1. Overview of project EIRRs and FIRRs

Project	**EIRR**		**FIRR**		**Brief Explanation**
	ICR	**Appraisal**	**ICR**	**Appraisal**	
Beijiao Thermal Power Plant	76.8 %	26.7 %	91.79 %	16.96 %	- significantly lower capital expenditure (CAPEX) - lower incremental electricity consumption for heat
Huangtai Thermal Power Plant	176.2%	20.4 %	186.77 %	23.73 %	- significantly lower CAPEX
Yangguang Thermal Power Plant	85.7 %	78.7 %	90.91 %	88.69 %	- lower CAPEX - more coal savings
Wuxiang Hexin Power Plant	20.8 %	25.1%	11.9 %	13.0%	- higher CAPEX - lower coal price
Taiyi Thermal Power Plant	11.3 %	16.4%	5.3 %	7.7%	- lower coal price - less coal savings
Weihai Thermal Power Plant	31.2 %	32.8%	20.1 %	25.4%	- lower coal price - lower CAPEX

Annex 4. Bank Lending and Implementation Support/Supervision Processes

(a) Task Team members

Names	Title	Unit	Responsibility/ Specialty
Lending			
Jie Tang	Senior Energy Specialist	EASTE	Task Team Leader
Ranjit Lamech	Sector Leader	EASTE	Energy policy and regulation
Beatriz Arizu de Jablonski	Senior Energy Specialist	EASTE	Power Engineering
Define Gencer	Energy Specialist (consultant)	EASTE	Energy analyst
Masaki Takahashi	Senior Power Engineer	ETWEN	Power Engineering
Stavros Tavoulareas	Thermal Power Engineer (consultant)	EASTE	Power Engineering
Haixia Li	Financial Management Specialist	EAPCO	Financial Management
Dawei Yang	Procurement Specialist	EAPCO	Procurement
Jian Xie	Senior Environmental Specialist	EASRE	Environmental safeguards
Grayson Heffner	Energy Efficiency Specialist (Consultant)	EASTE	Energy Efficiency
Qing Wang	Environment Specialist	EASRE	Environmental safeguards
Yan Li	Economist (consultant)	FEU	Financial analysis
Yu Huang	Financial Specialist (consultant)	EASTE	Financial analysis
Songling Yao	Social Development Specialist	EASCS	Social safeguards
Youxuan Zhu	Resettlement Specialist (consultant)	EASTE	Social safeguards
Yiren Feng	Environmental Specialist	EASCS	Environmental safeguards
Mei Wang	Senior Counsel	LEGES	Legal
Teresita Ortega	Program Assistant	EASTE	Team Assistant
Perry Lee Radford	Program Assistant	EASTE	Team Assistant
Noureddine Berrah	Energy (consultant)	EASTE	Energy policy and regulation
Supervision/ICR			
Ximing Peng	Senior Energy Specialist	GEEDR	Task Team

			Leader, Power Engineer
Songling Yao	Senior Social Development Specialist	GSURR	Social Safeguards
Yiren Feng	Senior Environmental Specialist	GENDR	Environmental Safeguards
Fang Zhang	Financial Management Specialist	GGODR	Financial Management
Yunlong Liu	Procurement Specialist		Procurement
Beatriz Arizu de Jablonski	Consultant	GEEDR	Power Engineering
Mei Wang	Senior Counsel		Legal
Dan Xie	Program Assistant		Team Assistant
Sameena Dost	Senior Counsel		Legal
Kun Cao	Program Assistant		Team Assistant
Zhou Yu	Finance Officer		Disbursements
Lin Wang	Financial Specialist	Non Bank Staff	Financial Analysis

(b) Staff Time and Cost

Stage of Project Cycle	Staff Time and Cost (Bank Budget Only)	
	No. of staff weeks	USD Thousands (including travel and consultant costs)
Lending		
FY06	3.75	38.44
FY07	20.23	135.92
FY08	31.13	187.20
FY09	12.66	77.79
Total:	**67.77**	**439.35**
Supervision/ICR		
FY09		4.88
FY10	14.09	64.40
FY11	16.93	62.11
FY12	15.63	51.17
FY13	9.88	49.10
FY14	10.9	36.44
FY15	5.9	39.92
Total:	**73.33**	**308.01**

Annex 5. Beneficiary Survey Results

1. The Bank team collected feedback from a variety of project beneficiaries at a project closing workshop and during a follow-up ICR mission in October 2014. This Annex presents a summary of the feedback. Although the summary of beneficiary feedback does not constitute a beneficiary survey, it is still valuable as it provides interesting insights into the perspectives of a wide range of stakeholders involved with the GEF project.

Summary of Findings of Beneficiary Survey and/or Stakeholder Workshops

2. Feedback from a variety of project beneficiaries was collected at a closing workshop and during a follow-up ICR mission, providing insights into the perspectives of a wide range of project beneficiaries. The feedback can be summarized as follows:

- *Closing workshop:* High level government officials attended the project closing workshop and commended the project for its significant contributions to the achievement of China's national target of energy intensity reduction. They also highlighted that the GEF project successfully targeted three strategic areas in line with government priorities for energy conservation in the 11^{th} and 12^{th} FYPs.

- *Follow-up ICR mission*: the six thermal power plants, two provincial grid companies, and involved government agencies in both Shandong and Shanxi expressed their appreciation for the GEF support. They stressed that a key value-added of the GEF grant was that the project raised their awareness of the energy-saving potential of rehabilitation technologies. The satisfactory results spurred their interests in continuing the plant retrofit using their own funds. Some of the thermal plants clearly expressed an intention to continue collaboration with the GEF/World Bank to further improve their plant's thermal efficiency.

Part I: Closing Workshop

3. High level government officials attended the project closing workshop. Their comments on the GEF project are briefly summarized as follows:

- The project has made significant contributions to help the GOC achieve its national target of energy intensity reduction via energy efficiency improvements in the power sector.
- The project successfully targeted three strategic areas of improvements that are in line with government priorities in energy conservation during China's 11^{th} and 12^{th} FYP.
- In particular, the energy-saving technologies demonstrated in the project have had wide demonstration impacts on promoting energy efficiency technologies in China's power sector.
- The ESD simulation system is essential to sustained operational improvements of the pilot ESD.

Part II: Follow-up ICR mission

4. In October 2014 an ICR mission held meetings with project beneficiaries in three provinces to assess the benefits of the GEF project to sub-grant recipients.

5. During the meetings, the following questions were raised to beneficiaries and PMUs:

- What was the value-added that the GEF project brought to your company?
- In which areas could the Bank team improve for better performance?
- From your perspective, what are lessons learned during the project implementation?

6. The feedback to these questions is summarized below by province.

Shanxi Province:

7. **Wuxiang Hexin Power Generation Co., Ltd**

- The Implementing Agency (IA) expressed its appreciation towards Shanxi PMU and the Bank team for their timely provisions of assistance and guidance throughout project implementation.
- The IA has significantly improved its procurement and bidding practices because of the experience with this Bank project.
- The IA stressed the importance to have third-party post-completion evaluation, as conducted under the Project. This evaluation was required by the Bank team and conducted by the PMU. The evaluation was supported by a consultant hired by the PMU.

8. **Shanxi Yangguang Power Generation Co., Ltd**

- The IA benefitted from undertaking the GEF project. It has strengthened its working flow management and improved its procurement procedures.

9. **Shanxi Project Management Unit (PMU)**

- The Shanxi PMU commended that the GEF grant effectively promoted adoption of efficiency-improving technologies in thermal plants by reducing the upfront capital costs and sharing technical risks.
- The PMU stressed that the demonstration effect of plant rehabilitation is significant in Shanxi province**.**
- The PMU benefited greatly from the management of the GEF project. The project experience has sharpened the PMU's project management skills and contributed to an accumulation of experience with procurement, contract management, and financial management.
- The PMU attributed the project delay to the lack of guidance during the early period of project implementation prior to the first Bank supervision mission.

- The PMU also expressed its appreciation for the intensified supervision efforts led by the existing Bank team since the first mission, following the change of TTL on the Bank's supervision team.

10. **Shanxi Environmental Protection Bureau (EPB)**

- EPB pointed out that the GEF project played a critical role in helping Shanxi EPB advance the pollutants emission control agenda in Shanxi province.
- EPB expressed its appreciation for the Bank team in providing strategic guidance on how to shape up the trading system and which direction to follow in the future.
- Shanxi EPB benefited from the Bank's sound project management system. The EPF significantly improved its project management skills and gained valuable experience.

Guangdong Province

11. **Guangdong Power Grid Corporation** provided a few lessons learned and a suggestion for the project.

12. **Lessons Learned:**

- Prolonged project preparation undermined the added-value of the ESD simulation system to the pilot ESD in Guangdong. The corporation had expected to have the ESD simulation ready before the pilot ESD, so findings from the ESD simulation system could be integrated into the real ESD. However, the ESD simulation system was ready only after the pilot ESD had started.
- Strong management-level commitment and good coordination among the various departments are pre-conditions to project success.
- Quality staff in the project management units is important for successful project delivery.
- Effective project management and supervision helps support smooth project implementation.
- The World Bank's flexibility in project management is a key to success.

13. **Suggestion:** Sufficient measures need to be in place to hedge foreign exchange risks to mitigate the potential adverse financial impacts on project implementation.

Shandong Province

14. **Shandong PMU (Coordinating the closure of nine small coal-fired plants in Shandong)**

- The PMU attributed the implementation delay in closing down small inefficient plants in Shandong to the delayed preparation of the Operational Manual.
- The PMU acknowledged the Bank's intensified efforts in project supervision following the first mission. In their view, these efforts are key to the successful closure of the nine thermal plants, given the rapidly evolving external environments.

15. **Jinan Beijiao Power Generation Co., Ltd.**

- The IA is encouraged by the benefits associated with the rehabilitation.
- The positive results led the company to collaborate with the Energy Institute of Tsinghua University to undertake additional efficiency enhancement measures.

16. **Huangtai Power Generation Co., Ltd.**

- The IA thanked the GEF for its financial support during the period it was struggling financially due to the rapidly rising price of coal.
- The company explicitly expressed its intention to continue the cooperation with the GEF/World Bank in the fields of waste heat recovery and district heat supply.

Annex 6. Stakeholder Workshop Report and Results
(if any)

Annex 7. Summary of Borrower's ICR and/or Comments on Draft ICR

Summary of Borrower's ICR

1. The Borrower prepared a detailed Recipient Completion Report (Borrower ICR). The Recipient Completion Report described project outcomes by theme, dissemination activities, impacts, indicators, success factors, and lessons learned. The outputs and outcomes of the Project were summarized in table below.

Table A7.1. Key outputs and outcomes of the project components

Project Component		Project Output	Project Outcome
(1) — Mechanisms to Support the Closure of Inefficient Coal-fired Small Units	Mechanism for the Closure of Small Units (MCSU)	Operational Manual for the Closure of Small Units ("the Manual"), including a financial incentive mechanism, to guide the closure of small coal-fired units. Closure of 225 MW of inefficient small coal-fired units in Shandong. Evaluation reports on the closure of small coal-fired units in Shanxi and Shandong.	The closure of inefficient coal-fired units in Shandong contributed to enhancement of thermal efficiency and reduction of GHG and air pollutants emissions of thermal generation units in the province. The Manual provided inputs to a national regulation "Central Government Fiscal Incentives to Phase out Inefficient Capacity" in 2011.
	Establishment of CHP On-line Monitoring System (Shandong province)	Development and operation of a CHP online monitoring system in Shandong. Knowledge sharing and training activities.	The system helped Shandong provincial government authorities to monitor real-time heat output of provincial CHP units to ensure the enforcement of local government policy.
	SO_2 Emission Allowance Trading (National Level)	Feasibility study and evaluation report on China SO_2 emission allowance trading. Evaluation report on SO_2 emission allowance trading in Shanxi and Shandong. Dissemination activities of the Shanxi and Shandong SO_2 emission allowance trading	The dissemination activities contributed to a more comprehensive scientific understanding of SO_2 emission allowance trading across China. It led to the issuance of the "Guidance Note on Further Promotion of Pollutants Emission Allowance Paid Utilization and Pilot Trading"

Project Component		Project Output	Project Outcome
		pilots.	by the State Council in August 2014.
	SO_2 Emission Allowance Trading (Shanxi province)	Enhanced pilot emission allowance trading system, with pollutants coverage extended from one type to six. Feasibility study on CO_2 emission allowance trading. Dissemination and capacity building activities.	The operational experience and lessons learned from the provincial pilots in Shandong and Shanxi will contribute to the design and operation of a national wide pollutants emission allowance trading system. The operation of the national emission trading system will contain the total pollutants emissions in China, thus mitigating adverse impacts associated with air pollution.
	SO_2 Emission Allowance Trading (Shandong province)	Establishment and pilot operation of pollutants emission allowance trading in the city of Weifang. Recommendations drawn from the pilot operation for province-wide emission allowance trading. Dissemination seminars, workshops, and capacity building activities.	
(2) — Demonstration of Power Plant Efficiency Improvement	Jinan Beijiao Thermal Power Plant (Shandong)	Completion of retrofit work to recover wasted heat for district heating.	Successful completion of retrofit work at the six thermal plants resulted in improved thermal efficiency and reduced coal consumption and GHG emissions per kWh in Shandong and Shanxi provinces. The project also created strong demonstration impacts, promoting the rapid replication of project-supported retrofit technologies across provinces.
	Huangtai Thermal Power Plant (Shandong)	Successful conversion of 2X330 MW units from power generation only into CHP operation.	
	Weihai Thermal Power Plant (Shandong)	Completion of integrated rehabilitation including installation of variable speed drives for various types of fans.	

Project Component		Project Output	Project Outcome
	Yangguang Thermal Power Plant (Shanxi)	Successful demonstration of undertaking retrofit work based on recommendations from a standard energy audit.	
	Wuxiang Hexin Thermal Power Plant (Shanxi)	Completion of the addition of peak cooling capacity to 2X600 MW units that successfully reduce capacity loss in summer.	
	China Power Taiyi Power Plant (Shanxi)	Completion of integrated rehabilitation including installation of phase-transition heat exchangers to recover waste heat to pre-heat combustion air.	
	Studies on plant retrofit	The "Standard Procedure of Energy Audit for Thermal Plants." The "O&M Best Practice for Thermal Plants." Evaluation report on thermal plants rehabilitation.	The evaluation report on the thermal plants' rehabilitation provided technical inputs to "Administrative Measures on Fiscal Incentives on Energy-saving Technologies," issued jointly by MOF and NDRC in 2011. The "Standard Procedure of Energy Audit for Thermal Plant" provided key inputs to the "Notice on Undertaking a Comprehensive Upgrading of Coal-fired Power Plants," issued jointly by MOF and NDRC in 2012.
(3) — Transition to ESD	Policy studies and dissemination	The following policy studies on ESD have been completed: 1. Financial compensation mechanism 2. Information disclosure rules of ESD 3. Methodology & procedure for	Following the revisions by relevant authorities, policy study #2 was adopted as the implementation rules for the Guangdong province energy saving and power generation dispatch. Policy study #3 provided

Project Component		Project Output	Project Outcome
		verification of units' efficiency 4. Assessment of pilot operation of ESD in five provinces 5. Electricity pricing under the ESD 6. Integration of ESD with power market 7. Third party evaluation of Guangdong ESD simulation system Dissemination activities for ESD pilots	technical inputs to the sound formulation of the merit order table of coal-fired units, which is essential to the operation of the ESD system. The ESD simulation system enhances the energy saving potential of the pilot ESD by identifying potential areas of improvement. Operation of the CHP online monitoring system facilitates the energy-saving dispatch in Guangdong province.
	ESD and CHP system operations	Establishment and operation of a CHP online monitoring system Development and operation of an ESD simulation system. Dissemination seminars and workshops.	

2. The Recipient Completion Report is summarized as follows:

3. **Outcome:** The GEF project contributed to the improvement of thermal efficiency in the power sector via three strands of targeted support. The outcomes of the individual components are briefly summarized as follows:

Component (1): Mechanisms to Support the Closure of Small Inefficient Generation Units

4. *Mechanism to close small thermal plants:* A transparent and efficient fiscal incentive mechanism was established. This mechanism successfully supported the closure of nine small thermal plants in Shandong and contributed to the issuance of a national policy in 2011, titled "Central Government Fiscal Incentives to Phase out Inefficient Capacity."

5. *CHP online monitoring system:* The developed CHP online monitoring system provided technical inputs to the verification of thermal efficiency of CHP units. It helped formulate a merit order table of thermal units for the grid company dispatch center to follow. It also facilitates the enforcement of government regulation on heat supply for CHP units.

6. *SO_2 emission allowance trading system:* An SO_2 emission allowance trading system was established in Shanxi and Shandong, contributed by the GEF project to its development and improvements of the trading mechanism. The output of the project provided technical inputs to the formulation of a national SO_2 emission allowance trading system.

Component (2): Demonstration of Power Plant Efficiency Improvements

7. The thermal efficiency rehabilitation projects at six thermal plants in Shanxi and Shandong achieved or exceeded the intended energy-saving objectives. Under the leadership of the NPMO, a variety of dissemination activities were carried out at the provincial level. These activities have brought about considerable demonstration effect to thermal plants, including plants from other provinces. This has led to the rehabilitation of thermal efficiency on a much broader scale, involving plants at many geographic locations.

8. The GEF project also supported studies to introduce international experience and summarize experience and lessons learned from the supported rehabilitation. The "Evaluation report on thermal plants rehabilitation" provided technical inputs to the issuance of "Administrative Measures on Fiscal Incentives on Energy-saving Technologies," which was issued jointly by MOF and NDRC in 2011.

9. The "Standard Procedure of Energy Audit for Thermal Plants" also provided input to the "Notice on Undertaking a Comprehensive Upgrading of Coal-fired Power Plants," issued jointly by MOF and NDRC in 2012

Component (3): Transition to Efficient Generation Dispatch

10. The GEF project promoted the ESD pilot in Guangdong through developing the ESD simulation system and the CHP online monitoring system, and by completing a number of policy studies on financial compensation and information disclosure. Several knowledge-sharing conferences were held to disseminate the experience from the Guangdong ESP pilot to other provinces (Henan, Jiangsu, Sichuan, and Guizhou). This facilitated the transition from current generation dispatch practice to an efficient generation dispatch model in other provinces, resulting in reduced coal consumption and reduced GHG emissions associated with power generation.

11. **Impacts:** The GEF project has brought about significant impacts from economic, technical, and social perspectives.

12. From an economic point of view, the GEF project achieved improvements in energy efficiency, reduced coal consumption, and GHG emissions, thus avoiding costs associated with national and global environmental pollution.

- Component 1 established an incentive mechanism for closing down small thermal power plants. The mechanism helped solve the obstacles encountered in the

implementation process. It also contributed to the achievement of coal-savings targets in thermal plants.

- Component 2 enhanced the technical capacity of the six thermal plants to implement EE measures and thus achieved remarkable economic benefits and energy savings. The pilot efficiency improving technologies created significant demonstration effect via dissemination activities.
- Component 3 promoted the development of domestic scheduling techniques of ESD, improved the efficiency of ESD operation, and promoted the rational distribution of energy.

13. From a technical perspective, Component 1 drew upon the Bank's prior experience with closing small thermal plants to design an operational manual and adapt it to China's context. The Operational Manual provided for financial compensations to the closed thermal plants based on the capacity to be closed. This played an important role in achieving the target of plant closures during the 11th FYP.

14. Component 2 supported studies on international experience with standard procedures of energy auditing and best practices on plant O&M. Those studies strengthened technical capacity of thermal plants in designing and implementing EE measures.

15. Under Component 3, Guangdong Power Grid Corporation drew upon international experience and best practices to develop the ESD simulation system. This system assesses the potential of improvement in existing ESD operation and provides useful guidance. In addition, an international expert on ESD was hired to provide key inputs and recommendations for the development of the ESD simulation system.

16. From a social perspective, the GEF project brought about positive social impact on project areas and beyond. The project contributed to coal savings and GHG emission reductions. The project also alleviated air pollution by increasing coverage of district heating. It also created positive social impacts and raised the living standards of people in the project areas by avoiding the environmental damage caused by coal.

17. **Indicators:** The GEF project reached or surpassed the PDO level indicator targets established at appraisal. However, 7 out of a total of 18 intermediate indicators were not met; these related to (i) the efficiency of Weihai Botong power plant, as one of the three rehabilitation activities was not completed by the end of 2013 (one indicator); (ii) annual coal savings and GHG emission reductions in Weihai Botong plant (two indicators); and (iii) annual coal savings and GHG emission reductions in Huangtai and Beijiao power plants (four indicators). Reductions in the Huangtai and Beijiao plants were not achieved as both plants were operated for fewer hours in the non-heating seasons, although their targeted efficiencies were met.

Success Factors

The following observations apply:

18. **Government commitment and collaboration between departments are the basis for project success.** The GEF project, from preparation to conclusion, received considerable attention from officials in Shandong and Shanxi provinces, at Guangdong Power Grid Corporation, and at MOF and NEA. This played a critical role in the materialization of counterpart funds. Cooperation among relevant departments is key to ensure the successful implementation of the project.

19. **Strong management capacity at the project management units is critical for successful project implementation.** Since project inception, the project management units in the three provinces had focused on establishing competent project executing agencies. During the project, their capacity improved as they grew more experienced with the daily project management and also received training from the World Bank. This strong management capacity played an important role in project implementation.

20. **Effective management and supervision ensure smooth project implementation.** The project established independent project management units and the appointment of project management personnel was competitively based. The PMU stipulated a series of implementation procedures, regulations, as well as monitoring tools, to avoid conflicts of interest between management personnel and beneficiaries, reflecting the independence and impartiality of project management. The measures also established effective supervision of project management and PMU staff.

21. **Bank's flexible management is the key to project success.** Some planned project activities became obsolete because of swift government interventions, in particular related to the closure of small thermal plants. The NPMO in consultation with the World Bank cancelled some activities and redesigned news ones. This flexibility is desirable.

Lessons Learned:

22. **Exchange rate fluctuations affected some project activities adversely.** The GEF grant is denominated in U.S. dollars. Over the course of project implementation, The renminbi (RMB) appreciated against the dollar, from a USD to RMB exchange rate of 1:8 in early 2006 to a 1:6 rate in 2014. This resulted in 25 percent reduction of total available funds, which put pressure on the IAs to seek other financing sources. As such, this volatility of foreign exchange had an adverse effect on project implementation. Because of this, it is recommended that future projects set aside adequate contingencies to deal with risks associated with foreign exchange rates.

23. **Dissemination efforts at the national level should be included as a major design element to promote the application of knowledge and project outputs.** The project was designed to largely focus on the provincial level activities, although a national PMO was also established to coordinate the national activities. The GEF project has produced valuable studies and demonstrated leading energy-saving technologies that contributed to the closure of small thermal units, improvement of ESD operation, and enhancement of plant thermal efficiency. The experience and lessons from the GEF

project are significant for the implementation of the national EE program. However, dissemination of some of the project outputs was limited to the provincial level and thus has not yet been broadcast to a broader range of stakeholder at the national level. The potential impacts of knowledge outputs could have been even more significant if the project was designed to have a greater link to line ministries at the national level.

Annex 8. Comments of Cofinanciers and Other Partners/Stakeholders

Annex 9. List of Supporting Documents

1. **Project Documents**
   a. The World Bank / GEF, Thermal Power Efficiency Project: Project Appraisal Document, Report No. 47907-CN, April 1, 2009
   b. The World Bank / GEF, Thermal Power Efficiency Project: Grant Agreement, GEF *TF094204-CN*, 2009
   c. Amendment to the GEF Grant Agreement for TF094204, 2013

2. **Project Implementation Plans**
   a. Project Implementation Plans for GEF Thermal Power Efficiency Project, 2010
   b. Project Implementation Plans for GEF Thermal Power Efficiency Project, 2011
   c. Project Implementation Plans for GEF Thermal Power Efficiency Project, 2013

3. **Restructuring Paper**
   a. Restructuring Paper on a 1st Proposed Project Restructuring of Thermal Power Efficiency Project
   b. Restructuring Paper on a 2nd Proposed Project Restructuring of Thermal Power Efficiency Project
   c. Restructuring Paper on a 3rd Proposed Project Restructuring of Thermal Power Efficiency Project

4. **Supervision Reports (Aide Memoires)**
   a. Aide Memoire CHINA GEF Thermal Power Efficiency Project supervision mission May 10 – June 3, 2010
   b. Aide Memoire CHINA GEF Thermal Power Efficiency Project supervision mission October 18, 2010 – September 28, 2011
   c. Aide Memoire CHINA GEF Thermal Power Efficiency Project supervision mission February 7-17, March 26, April 17 and May 2, 2012
   d. Aide Memoire CHINA GEF Thermal Power Efficiency Project supervision mission April 8-15 2013
   e. Aide Memoire CHINA GEF Thermal Power Efficiency Project supervision mission April – May 2014
   f. Implementation Status Results Report, China-Thermal Power Efficiency: Sequence 05, 2014
   g. Implementation Status Results Report, China-Thermal Power Efficiency: Sequence 04, 2013
   h. Implementation Status Results Report, China-Thermal Power Efficiency: Sequence 03, 2012
   i. Implementation Status Results Report, China-Thermal Power Efficiency: Sequence 02, 2011

j. Implementation Status Results Report, China-Thermal Power Efficiency: Sequence 01, 2010

5. Project Reports

a. Mechanism to Close Small Units (MCSU) Operational Manual, 2010

b. Report on the Standard Procedure of Energy Audit for Thermal Power Plants, 2011

c. Study on Financial Compensation Mechanisms for ESD, 2011

d. Report on Rules of Information Disclosure under ESD, 2011

e. Guidance Note on O&M Best Practice for Thermal Power Plants, 2012

f. Evaluation Report on Rehabilitation of Thermal Power Plants, 2012

g. Evaluation Report on Closure of Small Thermal Units in China, 2012

h. Third Party Evaluation of Guangdong ESD Simulation System, 2014

i. Assessment Report on Pollutants Emissions Allowance Trading in Shanxi and Shandong, 2014

j. Assessment Report on Pilot ESD in Five Provinces, 2014

k. Implementation Completion Report of the Thermal Power Efficiency Project, 2014