Document of
The World Bank

FOR OFFICIAL USE ONLY

Report No: 30942

IMPLEMENTATION COMPLETION REPORT
(TF-28484)

ON A

GEF GRANT

IN THE AMOUNT OF SDRs 22.8 MILLION (US$32.8 MILLION EQUIVALENT)

TO THE

PEOPLE'S REPUBLIC OF CHINA

FOR AN

EFFICIENT INDUSTRIAL BOILERS PROJECT

December 10, 2004

This document has a restricted distribution and may be used by recipients only in the performance of their official duties. Its contents may not otherwise be disclosed without World Bank authorization.

CURRENCY EQUIVALENTS

(Exchange Rate Effective October 31, 2004)

Currency Unit	=	Yuan
Yuan 1.00	=	US$ 0.12
US$ 1.00	=	Yuan 8.28

FISCAL YEAR

July 1 June 30

ABBREVIATIONS AND ACRONYMS

CAS	Country Assistance Strategy
CFBC	Circulating Fluidized Bed Combustion
CO_2	Carbon Dioxide
ESCO	Energy Service Company
GEF	Global Environmental Facility
GHG	Green House Gas
GOC	Government of China
MMI	Ministry of Machinery Industry
NDRC	National Development and Reform Commission
NO_2	Nitrogen Oxides
PAD	Project Appraisal Document
PMO	Project Management Office
SETC	State Economic and Trade Commission
SMIA	State Machinery Industry Administration
SO_2	Sulfur Dioxide
TCE	Ton of Coal Equivalent
TPH	Ton-steam per Hour
TSP	Total Suspended Particulates

Vice President:	Jemal-ud-din Kassum
Country Director	David R. Dollar
Sector Manager	Junhui Wu
Task Team Leader/Task Manager:	Robert P. Taylor

CHINA
EFFICIENT INDUSTRIAL BOILERS PROJECT

CONTENTS

Project ID: P035693	*Project Name:* EFFICIENT INDUSTRIAL BOILERS PROJ
Team Leader: Robert P. Taylor	*TL Unit:* EASEG
ICR Type: Core ICR	*Report Date: December 22, 2004*

1. Project Data

Name: EFFICIENT INDUSTRIAL BOILERS PROJ
L/C/TF Number: TF-28484
Country/Department: CHINA
Region: East Asia and Pacific Region

Sector/subsector: District heating and energy efficiency services (96%); Central government administration (4%)
Theme: Climate change (P); Environmental policies and institutions (P); Pollution management and environmental health (P)

KEY DATES			*Original*	*Revised/Actual*
PCD:	09/15/1994	*Effective:*	02/14/1997	02/14/1997
Appraisal:	06/30/1996	*MTR:*		
Approval:	12/23/1996	*Closing:*	06/30/2001	06/30/2004

Borrower/Implementing Agency: GOC/MINISTRY OF MACHINERY
Other Partners:

STAFF	Current	At Appraisal
Vice President:	Jemal-ud-din Kassum	Nicholas C. Hope (Acting)
Country Director:	David R. Dollar	Nicholas C. Hope
Sector Manager:	Junhui Wu	Jane Loos
Team Leader at ICR:	Robert P. Taylor	Neil Hughes
ICR Primary Author:	Robert P. Taylor; Feng Liu	

2. Principal Performance Ratings

(HS=Highly Satisfactory, S=Satisfactory, U=Unsatisfactory, HL=Highly Likely, L=Likely, UN=Unlikely, HUN=Highly Unlikely, HU=Highly Unsatisfactory, H=High, SU=Substantial, M=Modest, N=Negligible)

Outcome: S
Sustainability: L
Institutional Development Impact: SU
Bank Performance: S
Borrower Performance: S

	QAG (if available)	ICR
Quality at Entry:		S
Project at Risk at Any Time:	No	

3. Assessment of Development Objective and Design, and of Quality at Entry

3.1 Original Objective:

The principal objective of the project was to reduce greenhouse gas (GHG) emissions, as well as emissions of total suspended particulates (TSP), sulfur dioxide (SO_2) and nitrogen oxides (NO_x), through: (a) the development of affordable, energy-efficient and cleaner industrial boiler designs; (b) the mass production and marketing of the improved boiler models that have successfully met performance criteria; and (c) the broad dissemination of more energy-efficient and cleaner industrial boiler technologies throughout China through institutional strengthening, improved information exchange, and energy efficiency and environmental policy reform.

The objective of the project was important for China and was responsive to the circumstances and development priorities of the Chinese industrial boiler sector. It was consistent with the operational policies of the Global Environmental Facility (GEF), and was closely identified with Operational Program 5 (Removing Barriers to Energy Efficiency and Energy Conservation) under the climate change focal area of GEF. It also clearly reflected the Bank's Country Assistance Strategy (CAS) for China in facilitating an environmentally sustainable development process, especially in the promotion of cleaner energy technologies, urban pollution abatement, and global environmental benefits. Coal-fired industrial boilers have been critical to China's economic growth. But they were highly inefficient and highly polluting due to a lack of technical innovation in the industry and low environmental standards. Emissions from coal-fired industrial boilers were the primary cause of severe ambient air pollution prevalent in Chinese cities and contributed to serious acid rain problems in much of south and central China, posing serious threats to public health, eroding labor productivity, and damaging agricultural production and forestry. Coal-fired industrial boilers also accounted for about 30 percent of carbon dioxide emissions in China, making them a major target in China's effort to mitigate GHG emissions. This project attempted to address some of the critical underlying causes of these problems with an assistance program designed to effect a broad impact on the Chinese industrial boiler sector.

3.2 Revised Objective:

The original objectives were not changed.

3.3 Original Components:

The project included the following components (estimated total project cost and GEF financing at appraisal):

(i) Upgrading of existing Chinese boiler models ($53.1 million, GEF contribution of $16.5 million) through the introduction from abroad of advanced combustion systems and auxiliary equipment, especially the application of simple automatic controls;
(ii) Adoption of new high efficiency boiler models ($44.1 million, GEF contribution of $13.7 million) through the introduction of modern manufacturing techniques and boiler designs suitable for burning Chinese coals;
(iii) Technical assistance and training for boiler producers and consumers ($2.1 million, GEF contribution of $1.3 million); and
(iv) Monitoring and evaluation, and project management ($2.1 million, GEF contribution of $1.3 million).

In a nutshell, the original components (i) and (ii) involved 9 international boiler technology transfer

packages benefiting 9 domestic boiler manufacturers and 9 domestic boiler auxiliary equipment makers, aiming to cover the main boiler types and sizes in the Chinese coal-fired boiler market, from small and medium chain grate boilers to sophisticated circulating fluidized bed combustion (CFBC) boilers. These technology transfer packages were designed to either improve existing boiler models and technologies or fill certain technology gaps in the Chinese industrial boiler sector. The selection of technologies and areas of assistance were made based on extensive market studies and were sensible, given the nature of the sector and market at the time of project appraisal. The original component (iii) included 9 technical assistance (TA) subprojects, each with specific purposes and ranging from improving training of boiler operators to upgrading of design standards. They were designed to remove specific market and institutional barriers which would either slow the market penetration of energy-efficient industrial boilers or impede the realization of their energy-saving potential. They were an integral part of the project design. The original component (iv) addressed the capacity of the implementing agency, including administrative and financial management capacity, and was important for achieving project objectives.

The investment components (i) and (ii) were designed for implementation in two phases. GEF-supported technology transfer was to be completed in Phase 1, during which the beneficiaries would acquire the technologies, develop and test prototypes, and make production, financial and sales plans. Commercial production and sales of the new boilers would be supported with Phase 2 investments co-financed by GEF. A beneficiary could proceed with Phase 2 investments only after the Bank's review and approval of the prototype test results and proposed production, financial and sales plans for the new models. This phased approach was designed to ensure that only those beneficiaries who had succeeded in adopting the new technology to meet the project's performance criteria, and who had good technical and financial standing, could receive additional GEF assistance for commercial production. This mid-course evaluation between phases proved to be a successful project design feature, as it resulted in intensive dialogue with each boiler manufacturer on technical results and how best to proceed with commercial production and marketing plans. It also provided for necessary corrective actions: one of the 9 boiler manufacturers was not granted Phase 2 GEF financing because its operation was found financially unsustainable. One auxiliary equipment maker was granted with additional GEF investment financing because its GEF-supported product was gaining market share rapidly.

This project was a unique, one-of-a-kind effort for both the Chinese Government and the Bank. The project also was the first large GEF investment operation to support energy efficiency efforts in China. The project design benefited directly from a large national study funded by GEF: China - Issues and Options in Greenhouse Gas Emissions Control (1994), as well as earlier Bank work in coal utilization in China: Efficiency and Environmental Impacts of Coal Use (1991). Substantial research and investigation work was done in the China GHG emission control study to evaluate GHG emission sources and mitigation options. Investment in improving coal-fired industrial boilers was identified as one the most cost-effective options with a large impact. The project components addressed some critical needs of the Chinese industrial boiler sector, from boiler design and manufacture to installation and operation, and were comprehensive in scope.

3.4 Revised Components:

The original components were not changed. Two additional TA subprojects were included during implementation. One was the Sub-licensing Promotion Program designed to assist the planning and organization of technology dissemination activities beyond the completion of the project. The second was the National Sales and Marketing Promotion for GEF-supported Industrial Boilers designed to raise the general market awareness of the specific benefits of acquiring GEF-supported boilers. These additional TA activities were consistent with the original project design and addressed additional needs which emerged during project implementation.

3.5 Quality at Entry:

Quality at entry is rated satisfactory. The project objectives addressed critical energy efficiency and environmental protection needs of China and the development priorities of the Chinese industrial boiler sector. They were consistent with the operational strategies of the GEF and the Bank's CAS. The project design was based on solid and extensive knowledge of the sector. The assumptions and choices made at the time of entry were realistic and to the best knowledge of the project team. With the benefit of hindsight, the Chinese boiler market did not evolve exactly as the project design had projected, and thus there were a few misses for the project in the selection of particular boiler types or sizes. For example, since the late 1990s the small-size end of the coal-fired boiler market has been under intensive environmental pressure and has been shrinking more rapidly than expected. This development was due largely to the outright ban of coal-fired boilers below 10 ton-steam per hour (tph) capacity in many medium and large cities. However, most of the beneficiary domestic boilermakers were able to adapt new designs and technologies to larger boilers. So the technology transfer was still relevant and effective.

4. Achievement of Objective and Outputs

4.1 Outcome/achievement of objective:

The outcome of the project is rated satisfactory. The impact of the project on the Chinese industrial boiler sector has been broad and is considered substantial. The technology transfer supported by the GEF was by far the largest national investment in combustion efficiency improvements in the Chinese industrial boiler sector over the project period. All nine beneficiary boiler manufacturers successfully completed the transfer of international technology planned at project appraisal, and built prototypes (verification models) which met the predetermined and ambitious energy efficiency and environmental performance criteria. Eight went on to commercial production of GEF-supported boiler models and have achieved initial sales success. The GEF-financed technology transfers resulted in practical improvements in coal-fired industrial boiler designs which typically yield increases in fuel efficiency of some 5 percentage points—a large improvement for this industry. The new boilers are generally well catered to Chinese market conditions. A trade mark of most of the GEF-supported boilers is the use of the diaphragm wall, which reduced about 50% of the weight of the furnace housing traditionally made of refractory bricks while increasing the air-tightness of the furnace. This was a major improvement in technology for the boiler industry in China. The Volund corner-tube technology employed by three of the boiler works is already gaining a wide and sound reputation in the Chinese market. Other important aspects of the GEF-financed technology transfer for chain-grate boilers included improved boiler grate design and manufacturing, and use of efficient secondary air-induction systems. In addition to fuel savings and cost savings in boiler house construction, the GEF boilers are more amenable to meeting local environmental protection requirements. Three of the new boilers are specifically geared to reduce sulfur dioxide emissions, including a new CFBC boiler design, a “differential-speed bed” boiler for burning high-sulfur coal developed for the first time in China, and a boiler model with an integrated low sulfur coal briquetting device.

In addition to the specific technology transfers, the technical assistance activities of the project broadened the impact through assistance in revision and formulation of national and sector standards for boiler and boiler house designs and environmental controls, and by strengthening professional requirements for boiler operators. This further resulted in indirect energy efficiency improvements, by enhancing quality requirements across the industry, and helping to lay a foundation for improved boiler operation. Under GEF support, one national and four sector standards were formulated and promulgated, and two national and two sector standards were revised. The project also supported a major sector effort to popularize and standardize calculation methods for industrial boiler design. The technical manual and companion computer software and database developed under this project made it possible for scientific and accurate

engineering calculations to be implemented at any boiler factory, reversing the situation where only a few major manufacturers had this capacity.

The main quantitative outcome/impact indicator in the PAD is the annual sales of GEF-supported boilers, targeted at annual sales of a total boiler capacity of 17,940 tph at project completion, and 3000 tph for each beneficiary project boiler works within two years after project completion (a total of 27,000 tph of annual sales). Based on sales contracts completed by the end of October 2004, sales of GEF-supported boilers from the 8 beneficiary boiler manufacturers which have completed Phase 2 will be about 9,230 tph in 2004. The boiler works expect substantially increased sales in the coming years, but attainment of the 27,000 tph target for 2006 remains uncertain. Although a useful monitoring indicator for assessing results at the project's beneficiary boiler works, the ICR team found the tph annual sales outcome too simplistic as the main measure of the overall outcome of the project. The sales targets set at appraisal also are arbitrary, and probably, with hindsight, overly ambitious. One problem is the establishment of the same 3000 tph indicator for each boiler manufacturer. These indicators appear to have been useful targets during project supervision, to provide a benchmark for individual boiler works to gauge their work. However, with the changes in the market over the years, and especially the increasing demand for larger sized boilers at the expense of the smaller boilers, it is not reasonable to expect all of the participating boiler works to achieve the same sales outcomes. A more major problem with using these sales figures as the main measure of project impact is that they refer only to the nine boiler works. However, the project also supported technology transfer and production of high-efficiency boiler auxiliary components, such as boiler grates and blowers, for use in the nine boiler models, but also more generally in the market. Energy efficiency gains from some of these components also are major. One particularly successful example is the GEF-supported development and production of improved grates for chain-grate boilers at the Yongning Foundry Factory in Wafangdian City. This factory sold 13,000 tph equivalent of GEF-supported boiler grates by the end of August 2004, and is projected to reach about 20,000 tph equivalent annual sales in 2004, meaning that GEF-supported boiler grates will equip around 25% of all new chain grate industrial boiler capacity sold in China in 2004. That is very significant because the improved grates normally contribute to about 3-4 percentage points increases in boiler thermal efficiency.

The overall market impact at project completion has met the target set in the PAD. If the impact of the GEF-supported boilers and the energy-efficient boiler grates are considered together, sales of new boilers with substantial GEF energy-efficient components would total about 21,800 tph in 2004, compared with the 19,000 tph target set in PAD. By this broader market impact measure, the ratio of new boiler to total boiler production in 2004 is about 18% (21,800/120,000), compared with PAD estimate of 19% (19,000/100,000) at project completion. Whether the 35% overall market penetration ratio two years after project completion can be achieved remains uncertain, however, primarily because of the high mark set for the direct beneficiary boiler manufacturers.

The other outcome/impact indicator in the PAD, reduced CO_2 emissions per boiler through improved coal utilization, to be monitored two years after project completion, is likely to be achieved based on currently reported energy efficiency improvements of the GEF-supported boilers.

As the PAD had anticipated, the price risk of the GEF-supported boiler models has been a key factor affecting their market penetration. Primarily due to an increase of steel consumption the GEF-supported boilers cost 10 to 20% more to manufacture, compared to comparable traditional models. But the higher cost of GEF-supported boiler equipment is compensated by significant operation cost savings from improved thermal efficiency, and with a pay back time shorter than three years in most cases. Due to savings in refractory materials and shorter installation time, the installed cost of some GEF-supported

boilers are lower than those of comparable traditional boilers. These advantages are being confirmed and gaining wider notice with more GEF-supported boilers being installed. With a bit more time than originally expected the energy-efficient industrial boilers are likely to capture the market share originally anticipated, and the project's emissions reduction impact can be achieved.

4.2 Outputs by components:

Upgrading of existing Chinese boiler models. This component is rated satisfactory. As one of the two investment components of the project, it was designed to improve the thermal and environmental performance of popular domestic industrial boiler models, in the 1 to 20 tph (small to medium) size range, which was the dominant market segment at the time of project appraisal. The component involved 6 boiler manufacturers and 4 auxiliary equipment makers. Five of the six boiler manufacturers have successfully adopted GEF-supported designs and manufacturing upgrades with good initial sales results. Shanghai Sifang Boiler Works and Jiangxi Boiler Works have been the most successful so far, with contracted sales of 3,150 and 2,073 tph in 2004, respectively. A particularly successful story of this component was the transfer of improved boiler grate technology from Sinto Co. of Japan to the Yongning Foundry Factory, which has become a major supplier of new, high-efficiency grates to chain-grate boiler manufacturers throughout China. This component also had its failure in Tianshan Boiler Works, which, after completing the model development and testing, could not capitalize on the new technology and filed for bankruptcy in early 2004, due to its inability to compete in a more geographically integrated market place. In addition, all of the main boiler models of this manufacturer were 1 to 10 tph boilers, which had fallen out of market favor.

In summary, this component has achieved its sector policy objectives in most respects, and has fully achieved the physical objectives in boiler thermal efficiency and emissions requirements. Despite the failure in Tianshan the overall design of the component is considered appropriate for achieving the project objectives, and all other involved boiler works have been able to adapt GEF-supported technologies to their larger boiler models to meet the changing demand of the market.

Adoption of new high efficiency boiler models. This component is rated satisfactory. Designed to meet the emerging demand for relatively large industrial boilers in district heating and manufacturing, this component tried to cover three important market segments of the large-sized industrial boilers, including a large-capacity hot water boiler design for district heating, a co-generation steam boiler design suitable for coal of variable quality as well as for biomass, and a CFBC boiler design that was new in China. All three technology transfers were successfully completed, met predetermined energy-efficiency and environmental performance criteria, and turned into marketable products. However, the sales records for the three beneficiary boiler manufacturers have not been very strong so far. This seems to contradict with the booming sales of large industrial boilers in recent years. A closer look at the market reveals that the large-size end of the industrial boiler (40–135 tph) market is now dominated by CFBC boilers, caused primarily by government policy in sulfur control. But most of these CFBC boilers use a design that has had a much longer track record in the domestic market than the GEF-supported design. The GEF-supported CFBC boiler is also more expensive to make in part due to its limited initial production scale and use of more expensive materials. The associated boiler manufacturer has also experienced some financial difficulties. These issues are being addressed seriously by the beneficiary, which is implementing a major enterprise reform with drastic reduction of inefficient labor force and other cost cutting measures. The market acceptance of the GEF-supported CFBC boiler technology is likely to improve as cost control measures take effect and the specific design becomes more widely known.

The design of this component was sensible at the time of project entry in terms of anticipating a rise in the demand for large size boilers. However, the popularity of CFBC boilers, and at the same time, the

lukewarm initial market reception of GEF-supported CFBC boilers affected the short-term outcome of this sub-component. It is interesting to point out that, Jinan Boiler Works, the beneficiary of the co-generation steam boiler technology in this component, also has become China's dominant CFBC boiler supplier in the last ten year. Some industry experts anticipate that the current surge of demand for CFBC boilers will dissipate, and that a more balanced demand mix should favor the multiplicity of GEF-supported boilers.

Technical assistance and training for boiler producers and consumers. This component is rated satisfactory. A total of 11 technical assistance/training projects were completed, covering mainly six areas: (a) establishment of a systematic training curriculum and certification procedure for boiler operators; (b) revision of technical and environmental standards and improvement of design for industrial boilers and boiler houses; (c) verification testing and technical evaluation of GEF-supported boiler models; (d) production planning and marketing assistance to project beneficiaries; (e) general sales and marketing assistance to GEF-supported boilers; and (f) replication and dissemination of GEF-supported boiler technologies. These activities helped ensure that the technology transfers actually delivered on their energy efficiency and emission reduction expectations, and provided critical support for production scale-up and marketing. The TA activities generally served their function to strengthen the key links in the development and deployment of energy-efficient and less-polluting industrial boilers. One small effort--the pilot cities program designed to showcasing GEF-supported boilers--proved ineffective as the original participating cities of Shanghai and Jinan initiated policies to restrict the use of coal-fired boilers and withdrew from participation.

Monitoring and evaluation, and project management. This component is rated satisfactory. Since this project included over a dozen beneficiaries across China, and each one of them had a unique set of issues, the support for project monitoring, evaluation and management was important and necessary for achieving the project's objectives and outcomes. This component also supported the testing and evaluation of the energy efficiency and environmental performance of the verification boiler models, which was critical to assure the design quality prior to commercial production.

4.3 Net Present Value/Economic rate of return:

The economic justification for this project was based the *Incremental Cost* analysis required by GEF. The methodology adopted in the PAD was sound and practical. The main assumptions about the Baseline and the GEF Alternative were realistic, with the exception of the future sales of GEF-supported boilers. The main conclusions of the original incremental cost analysis for the project were derived from the two scenarios (Baseline vs. GEF Alternative) for a cumulative total of 432,000 tph of boiler production and sales by the 9 beneficiary boiler manufacturers over a 20-year span (including a 3-year development period at the beginning). The main benefit of this project is the reduction of CO_2 emissions, in addition to the local and regional benefits of reduced TSP and SO_2 emissions. The original incremental cost analysis estimated a total reduction of 180 million tons of CO_2 emissions as a result of the cumulative replacement of 432,000 tph boiler capacity with GEF-supported, more fuel-efficient industrial boilers. That translates into an undiscounted unit cost \$0.18/ton-CO_2 against the US\$32.8 million GEF grant approved, compared with the recent observed international prices for traded carbon credits of about \$3-\$5/ton-CO_2-equivalent.

Since the project did not follow exactly the path described in the GEF Alternative due to implementation delays and changes in market characteristics, its impact on CO_2 emission reduction also changed. The ICR team reassessed the cost-effectiveness of the project based on current estimate of CO_2 emission reduction. The reassessment included the 8 remaining beneficiary boiler manufacturers and the Yongning Foundry Factory (boiler grates), and estimates the impact of the new boilers and grates with a more conservative

projection of new boiler sales (reaching a maximum of 24,000 tph per year by 8 boiler makers by 2009, compared with the original assumption of 27,000 tph per year by 2002). The reassessment indicates that the project will be able to achieve about 160 million tons of cumulative CO_2 emission reduction by 2019, compared with the original 180 million tons by 2016. The re-estimated CO_2 emission reduction potential translates into a unit cost \$0.21/ton-CO_2 against the US\$32.8 million GEF grant approved (the spent amount was about \$1 million less than the approved due to currency exchange losses). The reassessment very clearly reaffirms the cost-effectiveness of this carbon mitigation project.

4.4 Financial rate of return:

Not applicable.

4.5 Institutional development impact:

The institutional development impact of this project was most significant in its TA activities supporting the formulation, revision and upgrading of national and sector technical standards for industrial boiler and boiler house designs, and the strengthening of the training curriculum and certification procedures for boiler operators. The promulgation of key new or revised standards raised the bar for design and engineering for the entire industrial boiler sector in China.

5. Major Factors Affecting Implementation and Outcome

5.1 Factors outside the control of government or implementing agency:

Market developments and competition affected the performances of participating domestic boiler manufactures in both positive and negative ways. Many of the nine beneficiary boiler manufacturers selected at project appraisal have strengthened their market positions during the course of project implementation. Several have struggled. Tianshan Boiler Works fared worst and filed for bankruptcy in early 2004. Harbin Industrial Boiler Company, asked to survive on its own by its former parent company in 2003, is still undergoing restructuring. The loss of Tianshan Boiler Works will have little impact on the project's overall outcome in the long term because the gap can be filled by other boiler works in the same technology transfer component (small and medium boilers), such as Shanghai Sifan and Yingkou boiler works. The lapse at Harbin Industrial Boiler Company may be more significant because it is the only CFBC technology transfer supported under the project.

The most prominent problem during project implementation was repeated delays in technology procurement for development of the improved boiler designs in Phase 1. Strictly speaking, this problem was outside of the Government's or implementing agency's control, as it was necessary to strictly adhere to the Bank's Procurement Guidelines of the time, and the procurement arrangements agreed with the Bank for the project were, with hindsight, inefficient.

The implementing agency completed a comprehensive review of potential international suppliers prior to project appraisal, visiting many countries abroad, identifying many suppliers who expressed a general interest in participating in the project. The most prominent problem during project implementation was repeated delays in technology procurement for development of the improved boiler designs in Phase 1. With 17 potential technology suppliers pre-qualified at project appraisal, the project procurement plan opted for a fully competitive, two-stage bidding process for technology procurement, in line with the principles of the Bank’s Procurement Guidelines for Goods and Works. The first stage of the process involved solicitation of technical proposals, based on very specific technical requirements listed for each package. The second stage involved solicitation of financial/commercial bids, and contract award to the least-cost bid. This system proved highly problematic, as (1) it was far too cumbersome; (2) the technical requirements listed for each package were very specific and narrow, following the project’s design to provide improvements to

each of the market's main submarkets; (3) the number of truly interested technology suppliers specializing in small to medium-sized coal-fired boilers turned out to be quite small, as these technologies were being phased out in most industrialized countries and the perceived risks of doing business in China was relatively high at that time, and (4) with the large number of individual packages, the contract value for individual packages proved too small to elicit a strong enough interest from many bidders to overcome the other problems listed above.

Through the strong and continuous efforts of the implementing agency, sound technology transfer packages were awarded for each of the 9 subprojects, resulting in successful boiler design developments in every case. However, the adopted procurement procedure proved inefficient and caused major delays in project execution. Only one package resulted in more than one responsive commercial bid. Others resulted in only one responsible bid or none at all. Two subproject proposals received no responsive bids, even after two rounds of rebidding, and had to be awarded on a sole-source basis. In general, initial responses to the technical bids were reasonably satisfactory, but once it became clear that contract values were low, bidders lost interest in continuing with the cumbersome process. Once contracts were awarded, contract negotiations proved difficult in some cases, due to difficulties in meeting commercial terms and performance criteria using Chinese coals. Coupled with misunderstandings concerning Chinese and international contracting procedures, all of these factors contributed to delays in finalizing technology transfer contracts. The eventual number of boiler design technology suppliers was five. Three suppliers provided technology to two or more boiler works. The entire technology procurement took almost two years longer than expected, causing the need for first extension of the project's closing date. The ripple effect of the prolonged technology transfer process led to delays in prototype installation and testing of most subprojects, as well as a very compressed schedule for Phase 2 procurement. This led to the request for the second extension of the project closing date.

5.2 Factors generally subject to government control:

The Government's progressive policies in energy conservation and environmental protection were a healthy foundation for the achievement of the project's objectives. However, the government's oversight to this project was affected by four major organizational changes at the ministerial level. The Ministry of Machinery Industry (MMI), counterpart agency at project appraisal, was dissolved in 1998, and its responsibility for this project was handed to the State Machinery Industry Administration (SMIA), a retained regulatory body of the former MMI. SMIA was dissolved in 2001 and the State Economic and Trade Commission (SETC) took over the counterpart responsibility. SETC was then dissolved in 2002, and subsequently project oversight moved to the National Development and Reform Commission (NDRC). Although the Government maintained its commitment to the project and strong efforts were made to smooth transitions, these administrative changes were at times disruptive due to changes in personnel and diversion of leadership attention.

The executive director position of the Project Management Office (PMO) was changed three times, causing some disruption to the continuity and consistency of project management. This was somewhat mitigated by the fact that all the persons who assumed the directorship had been intimated involved in the project. The initial set up of the project management was to have a relatively lean project management office with just a few professional staff while most of the technical supervision work would be supported by an expert group. This arrangement worked relatively well at the beginning. But with the dismantling of MMI and subsequent government administrative changes, the cohesiveness of this arrangement deteriorated somewhat.

5.3 Factors generally subject to implementing agency control:

Strong efforts were made by the implementation agency to deal with the procurement difficulties

experienced in Phase 1 implementation. The flexibility and practical approaches adopted by the implementation agency helped bring an eventually successful completion of the technology transfer. During the extended project implementation period, the staff of the PMO changed significantly. The staff turnovers, while not completely under PMO control, were somewhat disruptive to project management as the passing of responsibilities were not always seamless.

5.4 Costs and financing:

The total project cost was estimated at US$95.79 million at appraisal, including $32.81 million of GEF financing and $62.98 million of local financing. The reported actual total project cost was $121.11 million at project closing, including $31.86 million of GEF financing and $89.25 million of local financing. The GEF grant was fully utilized, and the difference between the appraisal and actual grant support was caused by fluctuation of the SDR/US$ ratio. The actual reported local cost financed by enterprises (equities or bank loans), exceeded the appraisal estimate by about 30%. This was mainly due to difficulties in estimating costs consistently. Many investments made by the boiler manufacturers were for production equipment which is used for both GEF-supported boiler models, as well as other models. Most boiler works have reported total investment costs with any relation to GEF boiler production, without attempting to allocate costs carefully between GEF and other boiler manufacturing, resulting in an over-estimation of costs, compared to appraisal estimates.

The general schedule of project disbursement was delayed because of the delays in technology procurement.

6. Sustainability

6.1 Rationale for sustainability rating:

The project's sustainability is rated likely. The initial market reaction to the majority of the boiler models introduced through GEF support has been positive, and a few models have made substantial inroads in their respective market segments. Higher energy efficiency and less polluting industrial boilers are expected to gain further market share as environmental requirements continue to rise. The main factors that support the project's sustainability include: (a) most of the technologies introduced by the project have proved to be practical, easily adopted and cost-effective; (b) government commitment to energy efficiency is strong and air pollution control is a high priority in urban development; and (c) coal will remain a primary fuel for industrial boilers in China for a long time. In addition, a few on-going projects are likely to extend the impact of the Efficient Industrial Boilers Project, including the Bank/GEF China Energy Conservation II Project, which supports the broad-based development of energy service companies (ESCOs), and a United Nations Foundation project in developing specialized ESCOs for the operation and management of coal-fired boiler houses. Furthermore, coal prices have been rising sharply due to stricter government regulation of the coal mining sector for quality and safety as well as a general rise in energy demand. All this is likely to further strengthen the competitiveness of GEF-supported boilers, as well as wider replication and dissemination of GEF-supported technical innovations.

6.2 Transition arrangement to regular operations:

Since the technologies transferred through GEF support have already been digested and commercialized by the project beneficiaries, this project is already under regular operation. Reaching the sales targets established at appraisal may take a few more years, but could be quite soon depending on domestic boiler market conditions. Arrangements have been made to promote wider replication and dissemination of GEF-supported boiler designs and technical innovations, as well as to continue to support project beneficiaries in their marketing and product enhancement efforts after the implementation completion. As part of the technical assistance to the PMO, a business plan for a technical service/consulting company was prepared before project completion. The company, named BGEF, which includes the project's original beneficiaries among its shareholders, should help facilitate further dissemination of technologies and

expand the impact of the project .

The replication and dissemination process is likely to take place in the absence of formal licensing procedures as many of the new boiler design features are not complicated and can be studied in the open and replicated without resorting to special instruction and training. In addition, except for the CFBC technology, all of the original rights to GEF-supported technologies either have expired or will expire before the end of 2004. However, it is very important for the Government to continue to help raise awareness in the market concerning the advantages of GEF-supported boilers and design technologies through special promotion channels and events. BGEF also should provide specific technical assistance/support to prospective boiler manufacturers who want to adopt or incorporate GEF-supported technologies.

The Bank recommended that a follow-up assessment of the project impact (ICR mission) be conducted before the end of 2006. This follow-up assessment should evaluate the market uptake of GEF-supported boilers and technologies, measured by actual sales of GEF-supported boilers from beneficiary boiler works and other boiler works and their share of the industrial boiler market, as well as the market success of auxiliary equipment makers supported by the project. The overall impact should be assessed based on coal savings capacity resulting from the project.

7. Bank and Borrower Performance

Bank

7.1 Lending:

The Bank's overall performance in the identification, preparation assistance and appraisal of the project was satisfactory. The Bank's performance in project **identification** was satisfactory. The project was consistent with GOC's desire to improve the energy efficiency and environmental performance of coal-fired industrial boilers, with the GEF's operational program in removing barriers to energy efficiency and energy conservation, and with the Bank's assistance strategy in promoting environmentally sustainable development and global environmental benefits.

The Bank's performance in **preparation** was satisfactory. During preparation the Bank fielded three comprehensive missions which included expertise in industrial boiler technology, environmental engineering, financial analysis, economics, operations and procurement. Technically, the project was well prepared with carefully selected technology and assistance packages, as well as detailed implementation work plan. The financial and economic analysis were thorough. Project targets were clear.

The Bank's performance at **appraisal** was also satisfactory. The Bank's appraisal team included a comprehensive skill mix required for the project and the members were all involved during preparation. The Government's commitment was evaluated and documented. Procurement and financial management capacities were reviewed. All relevant safeguard policies were reviewed and thoroughly discussed and agreed with Government. Continuity from identification through to appraisal was strong.

7.2 Supervision:

Supervision was adequate. The Bank met its formal supervision requirements during project implementation, providing responses and action letters generally in a timely manner, and meeting internal reporting deadlines. Task management through project preparation, appraisal and supervision changed several times, causing some disruption but no major problems as all task managers were participants in the original Bank team. Project implementation progress was adequately reported and implementation problems, such as procurement difficulties and delays, were identified early and addressed proactively. The quality of advice given to the implementing agency, and follow-up on advice and agreed actions, were

adequate. The task management team showed flexibility in dealing with the problems and difficulties encountered in procuring international boiler technologies and worked diligently and effectively with the borrower and implementing agency to resolve various issues. A total of 10 formal supervision missions were dispatched over the 6 years of project's implementation. No mission was dispatched for a stretch of about a year during 2002 and 2003, primarily because of the SARS epidemic in Beijing. Judging from the supervision documentation, however, it appeared that many missions should have allocated more time to visit the beneficiary boiler manufacturers, and focused somewhat more on driving for the substantive impact of the project, and somewhat less on procedural issues.

7.3 Overall Bank performance:

The Bank's overall performance was satisfactory.

Borrower

7.4 Preparation:

The Borrower's performance was satisfactory. There was close cooperation during preparation between the Government and the Bank, and between the Bank team and the counterpart team. The strong commitment of the Government to promoting energy efficiency and pollution control was key to gaining GEF support for the project. The extensive and effective support provided by the counterpart was essential to the design of the project.

7.5 Government implementation performance:

The Government's implementation performance was satisfactory. Despite unforeseen changes in counterpart agencies due to government reorganization, the Government maintained strong policy support and continued leadership of the project. The project management arrangements at the beginning were effective and economically efficient. But as the MMI apparatus was drastically scaled down and eventually removed from the central government administration, the original project management scheme was weakened.

7.6 Implementing Agency:

The implementation agency's performance was satisfactory. The PMO was very competent in the technical aspects of the project and had a clear understanding of the Chinese boiler market. It also maintained good and communicative relationships with the participating boiler works and other project beneficiaries. It worked hard, especially in the early implementation stage, to seek practical solutions to the various problems causing procurement delays, and oversaw a successful completion of the technology transfer process, despite the many difficulties encountered. Because of the complexity of this project PMO could have benefited from a more systematic management procedure in terms of work planning, task assignment, filing and reporting. This was reflected in delays of progress reports and insufficient documentation of some operations.

7.7 Overall Borrower performance:

The borrower's overall performance was satisfactory.

8. Lessons Learned

This project resulted in a generally satisfactory conclusion, despite numerous difficulties due to its complicated structure involving many beneficiaries, an inefficient technology procurement process, and a number of changes in the Government supervising entity and Bank task management. A key reason for the success achieved was the steady dedication to the project's goals by the implementing agency, participating boiler manufacturers, and Bank team.

The project was designed and appraised at a time when the boiler manufacturing industry was still largely subject to central planning. At project appraisal, all nine of the boiler manufacturers were state-owned enterprises completed owned by their supervising government authorities, and the Ministry of Machinery Industry was charged with responsible for the direction and development of the industry. The project design reflected this situation, with a carefully designed set of centrally-guided interventions, aiming to achieve maximum efficiency gains in each of the main product lines. Technology purchase requirements were planned in great detail, and procurement was arranged accordingly, using the standard World Bank procurement methods prevailing at that time. However, over the eight-year period following appraisal, China made a major transition to a market economy, with central planning in the boiler industry basically disappearing, and all but two of the nine boiler manufacturers becoming joint-stock companies or privately owned companies. The market for coal-fired industrial boilers also changed markedly, with demand for small-sizes diminishing, due to environmental protection measures, and demand for larger sizes increasing.

By adopting practical approaches, the implementing agency, boiler manufacturers and Bank team were able to adapt to many of these changes. For example, many of the boiler manufacturers have utilized the GEF-supported technologies purchased for boiler models and sizes outside of the original planned, narrowly targeted scope. However, in discussions during the ICR mission, both the Bank and implementing agency teams agreed that if a similar project were to be designed today, facing today's radically different economic structure and market, different approaches might be suggested. These could include (a) design of fewer technology transfer/boiler manufacturing subprojects—totaling perhaps four or five, and consolidating effort on those packages; (b) use of an output-based approach for procurement, detailing the core requirements to be achieved in each subproject package (eg. energy savings levels), but not specific designs, leaving procurement arrangements to be completed by boiler manufacturers using broad commercial practices, and disbursing against previously agreed performance levels for both Phase 1, followed by Phase 2; and (c) emphasis on overall energy savings performance indicators, rather than sales figures for each boiler manufacturer. However, both the Bank and implementing agency teams also agreed that such approaches could not have been adopted at that time. A flexible, output-based approach, in particular, could not have been implemented by either the Ministry or the boiler manufacturers under their control, as this would have been at odds with the current production planning system.

9. Partner Comments

(a) Borrower/implementing agency:

The Borrower accepts the findings and assessments of the ICR, and wants to stress the following points:

- The GEF China Efficient Industrial Boilers Project has provided unprecedented support to the Chinese industrial boiler sector. Despite encounting major difficulties and delays in implementation, the project stuck to its original goals and reached a satisfactory conclusion. The coal-saving objective of the project is fully consistent with China's national characteristics and the coal-saving capacity built through this project will have a lasting impact on China's sustainable development;
- The project has markedly improved the design and maunfacturing capacity of all project beneficiaries through international technology transfer and investments in advanced production equipment. The project has advanced the technical and environmental standards of the entire industrial boiler sector in China with financial assistance in the development and commercialization of a wide range of upgraded and new coal-fired industrial boilers and auxiliary equipment, as well as technical assistance in the formulation and revision of relevant national and sector technical

standards;

- The project has helped propel the technical capacity of the Chinese boiler sector to the forefront of countries producing coal-fired industrial boilers. China already exports fuel-efficient coal-fired boilers to the international market, extending the project's benign impact beyound borders; and
- Throughout the extended implementation period of the project, the Bank task team has worked diligently with Chinese counterparts to overcome many problems and difficulties during the implementation of this innovative project. The Bank persistant support and valuable assistance are highly appreciated.

Further comments from the Government project supervisory agency are in Annex 8.

(b) Cofinanciers:

Not applicable.

(c) Other partners (NGOs/private sector):

Not applicable.

10. Additional Information

Not Applicable.

Annex 1. Key Performance Indicators/Log Frame Matrix

Outcome / Impact Indicators:

Indicator/Matrix	Projected in last PSR[1]	Actual/Latest Estimate
1. Improved coal utilization: reduce CO2 emissions due to improved coal utilization in industrial boilers (coal consumption reduction kg/hr) in Year 2004	#1 Not Approved for Phase 2 #2 95 #3 147 #4 292 #5 150 #6 98 #7 1151 #8 1281 #9 1453	Not Applicable #2 95 #3 147 #4 292 #5 150 #6 98 #7 1151 #8 1281 #9 1453
2. Increased new boiler production and sales volume of all subproject enterprises (in 2004)	9478 tph, from 8 boilerworks	9230 tph, from 8 boilerworks
3. Increased steaming capacity ratio of new boilers (2004)	10%	18% **

** Includes boilers equipped with GEF-supported grates.

Output Indicators:

Indicator/Matrix	Projected in last PSR[1]	Actual/Latest Estimate
Predetermined performance criteria for model boiler units at the completion of Phase 1: Minimum thermal efficiency at 100%/60% load	#1 78/76% #2 78/76% #3 78/76% #4 82/80% #5 78/78% #6 78/76% #7 80/78% #8 80/78% #9 85/84%	#1 78/76% #2 78/76% #3 78/76% #4 82/80% #5 78/78% #6 78/76% #7 80/78% #8 80/78% #9 85/84%
Reduced dust emissions	100 mg/Nm3 for all subprojects except #4 #4 = 200 mg/Nm3	100 mg/Nm3 for all subprojects except #4 #4 = 200 mg/Nm3
Reduced SO2 emissions of the improved boiler models	#4 80% reduction #9 90% reduction	#4 80% reduction #9 90% reduction

[1] End of project

Annex 2. Project Costs and Financing

Project Cost by Component (in US$ million equivalent)

Component	Appraisal Estimate US$ million	Actual/Latest Estimate US$ million	Percentage of Appraisal
Upgrading of existing boilers	43.07	70.04	163
Adoption of new boiler designs	36.00	46.64	130
Technical assistance	2.08	2.30	110
Project management and M&E	2.12	2.12	100
Total Baseline Cost	83.27	121.10	
Physical Contingencies	5.11		
Price Contingencies	7.41		
Total Project Costs	95.79	121.10	
Interest during construction	5.59		
Total Financing Required	101.38	121.10	

Project Costs and Financing by Component
(thousand US$)

Project Component	Appraisal Estimate			Actual/Latest Estimate			Percentage of Appraisal
	Local	GEF	Total	Local	GEF	Total	
Upgrading of existing boilers	28,747	14,319	43,066	54,894	15,150	70,044	61%
Adoption of new boiler designs	24,007	11,990	35,997	32,753	13,890	46,643	77%
Technical assistance	789	1,294	2,083	789	1,512	2,301	90%
Project management and M&E	813	1,306	2,119	813	1,306	2,119	100%
Total baseline cost	**54,356**	**28,909**	**83,265**				
Contingencies	8,623	3,903	1 2,526				
Total project cost	**62,979**	**32,812**	**95,791**				
Interest during construction	5,586						
Total financing required	**68,565**	**32,812**	**101,377**	**89,249**	**31,858**	**121,107**	**83%**

Local = beneficary enterprises and government

Project Costs (GEF grant only) by Procurement Arrangement (Appraisal Estimate)
(thousand US$)

Project Component	Procurement Method			
	LIB	DC	Other	Total
Upgrading of existing boilers	6,861	5,081		11,942
Adoption of new boiler designs	9,550	1,370		10,920
Production equipment		3,910	3,440	7,350
Technical assistance			1,294	1,294
Project management and M&E			1,306	1,306
Total	**16,411**	**10,361**	**6,040**	**32,812**

LIB = limited international bidding
DC = direct contract
Other = international and national shopping, and consultant services

Project Costs (GEF grant only) by Procurement Arrangement (Actual/Latest Estimate)
(thousand US$)

Project Component	Procurement Method			
	LIB	DC	Other	Total
Upgrading of existing boilers	6,408	4,233	299	10,940
Adoption of new boiler designs	5,981	3,922	168	10,070
Production equipment	3,089	1,037	3,904	8,030
Technical assistance			1,512	1,512
Project management and M&E			1,306	1,306
Total	**15,478**	**9,192**	**7,301**	**31,858**

Annex 3. Economic Costs and Benefits

The cost effectiveness of the project was re-evaluated based on re-estimated carbon dioxide emission reduction potential resulted directly from GEF investment and the approved total GEF grant of US$32.8 million, although the actual spending was about one million US dollar short of the approved amount due to currency exchange losses.

The following information and assumptions are used in the recalculation of carbon dioxide emission reduction potential:

1. Sales of GEF-supported boilers in 2003 and 2004 from the eight beneficiary boiler makers who completed Phase 2 investments;
2. Sales of GEF-supported boiler grates in 2003 and 2004 from Yongning Foundry Factory;
3. Projected sales of GEF-supported boilers and grates based on recent sales and investment in production capacity;
4. The maximum annual production and sales of GEF-supported boilers from the eight boiler makers are limited to 24,000 tph;
5. The maximum annual production and sales of GEF-supported boiler grates from Yongning are limited to 24,000 tph equivalent;
6. On average the GEF-supported boilers imporve thermal efficiency by 5 percentage points over their market alternatives, from 73% to 78%;
7. On average boilers which use GEF-supported grates improve thermal efficiency by 3 percantage points over boilers with alternative grates, from 73% to 76%;
8. Eighty percent of the Yongning grates supply the eight beneficiary boiler makers;
9. The average annual operation of industrial boilers (for steam generation and space heating) is equivalent of 2500 hours of full load operation; and
10. The average life of industrial boilers is 16 years.

The following table is a summary of the calculation results:

	Impact of Eight Beneficiary Boiler Makers				Impact of Yongning Foundry Factory				
	Boiler Sales (tph)	Boilers in Operation	1tph annual coal savings (tce)	Annual Coal Savings (million tce)	Total Grate Sales (tph)	Net Sales to Others	Grates in Operation	1tph annual coal savings (tce)	Annual Coal Savings (million tce)
2000									
2001									
2002									
2003	6,810		18.9		13,000	7,552		11.6	
2004	9,230	6,810	18.9	0.13	20,000	12,616	7,552	11.6	0.09
2005	12,000	16,040	18.9	0.30	24,000	14,400	20,168	11.6	0.23
2006	15,000	28,040	18.9	0.53	24,000	12,000	34,568	11.6	0.40
2007	18,000	43,040	18.9	0.81	24,000	9,600	46,568	11.6	0.54
2008	21,000	61,040	18.9	1.15	24,000	7,200	56,168	11.6	0.65
2009	24,000	82,040	18.9	1.55	24,000	4,800	63,368	11.6	0.74
2010	24,000	106,040	18.9	2.00	24,000	4,800	68,168	11.6	0.79
2011	24,000	130,040	18.9	2.46	24,000	4,800	72,968	11.6	0.85
2012	24,000	154,040	18.9	2.91	24,000	4,800	77,768	11.6	0.90
2013	24,000	178,040	18.9	3.36	24,000	4,800	82,568	11.6	0.96
2014	24,000	202,040	18.9	3.82	24,000	4,800	87,368	11.6	1.01
2015	24,000	226,040	18.9	4.27	24,000	4,800	92,168	11.6	1.07
2016	24,000	250,040	18.9	4.73	24,000	4,800	96,968	11.6	1.12
2017	24,000	274,040	18.9	5.18	24,000	4,800	101,768	11.6	1.18
2018	24,000	298,040	18.9	5.63	24,000	4,800	106,568	11.6	1.24
2019	24,000	322,040	18.9	6.09	24,000	4,800	111,368	11.6	1.29
Subtotal				**44.93**					**13.06**

tph = ton-steam per hour (equivalent of 0.7MW)
tce = ton of coal equivalent, or about 29.3 GJ

The total direct impact of the project on coal consumption is re-estimated at about 58 million tce cumulative savings achieved by 2019, resulting in about 160 million metric ton of CO_2 emission reduction, compared with the appraisal estimates of 67 million tce and 180 metric million ton of CO_2, respectively. The undiscounted unit cost of CO_2 emission reduction to GEF is re-estimated at about US$0.21/ton-$CO_2$, compared with the appraisal estimate of about US$0.18/ton-$CO_2$. Recent observed international prices for project-based greenhouse gas emission reduction usually fall in the range of US$3-$5/ton-CO_2-equivalent. This reassessment of project impact re-affirms the project's cost-effectiveness in reducing CO_2 emissions.

Annex 4. Bank Inputs

(a) Missions:

Stage of Project Cycle	No. of Persons and Specialty (e.g. 2 Economists, 1 FMS, etc.)		Performance Rating	
Month/Year	Count	Specialty	Implementation Progress	Development Objective
Identification/Preparation				
January 1994				
July 1994				
December 1995				
Appraisal/Negotiation				
June 1996				
November 1996				
Supervision				
08/28/1997	*3*	TASK MANAGER (1); ECONOMIST (1); BOILER CONSULTANT (1)	S	
04/06/1998	*3*	TASK MANAGER (1); CONSULTANT (1); PROCUREMENT SPEC. (1)	S	
08/29/1998	*3*	TASK MANAGER (1); CONSULTANT (1); PROCUREMENT OFFICER (1)	S	
06/23/1999	*3*	TASK MANAGER (1); CONSULTANT (1); OPERATIONS OFFICER (1)	S	
10/22/1999	*3*	TASK TEAM LEADER (1); OPERATIONS OFFICER (1); PROCUREMENT SPECIALIST (1)	S	
10/22/1999	*5*	TASK TEAM LEADER (1); INDUSTRIAL SPECIALIST (1); PROCUREMENT SPECIALIST (1); TECHNOLOGY TRANSFER SP (1); DISBURSEMENT SPCIALIST (1)	S	
03/22/2001	*5*	TASK TEAM LEADER (1); INDUSTRIAL SPECIALIST (1); DISBURSEMENT OFFICER (2); BOILER CONSULTANT (1)	S	
10/27/2001	*3*	TASK TEAM LEADER (1); INDUSTRIAL SPECIALIST (1); DISB. SPECIALIST (1)	S	
06/18/2002	*5*	TASK TEAM LEADER (1); INDUSTRIAL SPECIALIST (1); PROCUREMENT SPECIALIST (1); DISB. SPECIALIST (1); BOILER SPECIALIST (1)	S	
11/07/2003	*4*	LEAD ENERGY SPECIALIST	S	

			(1); SR.OPERATIONS OFFR (1); CONSULTANT (1); PROCUREMENT SPECIALIST (1)		
ICR	10/18/2004	*2*	LEAD ENERGY SPECIALIST (1); cONSULTANT (1)	S	S

(b) Staff:

Stage of Project Cycle	Actual/Latest Estimate	
	No. Staff weeks	US$ ('000)
Identification/Preparation		
Appraisal/Negotiation		
Supervision		
ICR		
Total		

Annex 5. Ratings for Achievement of Objectives/Outputs of Components

(H=High, SU=Substantial, M=Modest, N=Negligible, NA=Not Applicable)

	Rating				
☐ *Macro policies*	○ *H*	○ *SU*	● *M*	○ *N*	○ *NA*
☐ *Sector Policies*	○ *H*	● *SU*	○ *M*	○ *N*	○ *NA*
☐ *Physical*	○ *H*	● *SU*	○ *M*	○ *N*	○ *NA*
☐ *Financial*	○ *H*	○ *SU*	○ *M*	○ *N*	● *NA*
☐ *Institutional Development*	○ *H*	● *SU*	○ *M*	○ *N*	○ *NA*
☐ *Environmental*	○ *H*	● *SU*	○ *M*	○ *N*	○ *NA*
Social					
☐ *Poverty Reduction*	○ *H*	○ *SU*	○ *M*	○ *N*	● *NA*
☐ *Gender*	○ *H*	○ *SU*	○ *M*	○ *N*	● *NA*
☐ *Other (Please specify)*	○ *H*	○ *SU*	○ *M*	○ *N*	● *NA*
☐ *Private sector development*	○ *H*	○ *SU*	● *M*	○ *N*	○ *NA*
☐ *Public sector management*	○ *H*	○ *SU*	○ *M*	○ *N*	● *NA*
☐ *Other (Please specify)*	○ *H*	○ *SU*	○ *M*	○ *N*	● *NA*

Annex 6. Ratings of Bank and Borrower Performance

(HS=Highly Satisfactory, S=Satisfactory, U=Unsatisfactory, HU=Highly Unsatisfactory)

6.1 Bank performance	*Rating*			
☐ *Lending*	○ *HS*	● *S*	○ *U*	○ *HU*
☐ *Supervision*	○ *HS*	● *S*	○ *U*	○ *HU*
☐ *Overall*	○ *HS*	● *S*	○ *U*	○ *HU*

6.2 Borrower performance	*Rating*			
☐ *Preparation*	○ *HS*	● *S*	○ *U*	○ *HU*
☐ *Government implementation performance*	○ *HS*	● *S*	○ *U*	○ *HU*
☐ *Implementation agency performance*	○ *HS*	● *S*	○ *U*	○ *HU*
☐ *Overall*	○ *HS*	● *S*	○ *U*	○ *HU*

Annex 7. List of Supporting Documents

1. Aide Memories and Project Status Reports;
2. Borrower's Evalauation Report, draft received on September 26, 2004;
3. Sales reports from project beneficiaries;
4. Consultant Study Reports financed under the project; and
5. Project Document: China Efficient Industrial Boilers (Report No. 16132-CHA).

Additional Annex 8. Letter from Government of China on ICR

Dear Mr. Taylor:

The GEF China Efficient Industrial Boiler Project was completed on July 30, 2004. The project management team of the World Bank has summarized the implementation states of the project, and drawn out *ICR of GEF China Efficient Industrial Boiler Project (for discussion) (*hereinafter Report). Based on hearing the work report of Project Management Office, I have carefully read the total content of the Report. In my opinion, the Report has evaluated the implementation course and final achievements of China Efficient Industrial Boiler Project more roundly and objectively. It is the conclusion that the gains of China Efficient Industrial Boiler Project are successful in these different aspects such as project content, achievements, effect on the Chinese industrial boiler industry, the sustainability of project and so on. Both my colleagues and I in National Development and Reform Committee basically agree with the conclusions of the Report, and the suggestions we put forward are listed as follows:

I. GEF China Efficient Industrial Boiler Project is one of the projects which are earliest supported by GEF with the largest amount of grant, broadest scope concerned, most project content and strongest effect on all aspects up to now. From investigation and research, design, implementation and final accomplishment, GEF China Efficient Industrial Boiler Project has passed the whole course basically in terms of the scheduled target and path, although the implementation course, resulted by many factors, was extended twice. There were two factories (one boiler maker and one auxiliary equipment maker) which did not enter the second stage after the first stage ended. Because of bad performance, one announced bankruptcy and one was sold to a foreign company. All kinds of assessment indexes of the project have reached the requirements in the grant agreement and its appendixes.

II. All contents of GEF China Efficient Industrial Boiler Project are conducted around coal burning boiler, which is completely corresponding to the basic national condition of China. As one large country with plentiful coal resource, the resource policy with the coal as main body is the fundamental national policy of China. Population, resource and environment are the three significant problems that the whole world must face, especially to China, their importance is more prominent. Beginning with the resource and environment, the contents of the project have become one significant part of the sustainable development of Chinese national economy. As to the features of the project itself, its sustainability is more obvious. With the continuously quickening step of industrialization and urbanization, the actual quantity demanded for industrial boiler will continuously increase. According to statistical information, the market sales volume of industrial boiler in 2003 has approximately come to 120,000 t/h, among which the proportion of coal burning boiler is over 80% and increase by approximately 15% than that of 2002. All the measures taken, including this project, to increase the coal burning efficiency of industrial boiler and spare no effort to reduce pollution will contribute greatly to realize the comprehensive basic wealth targets of China.

III. GEF China Efficient Industrial Boiler Project has played a compelling and great pushing role in adjusting the product structure of Chinese industry boiler manufacturing, transiting the design idea, improving the technology level, enlarging the productivity and perfecting the marketing system. The resulting scale of technology reformation is unprecedented, such as fixed asset investment, introduction of design and manufacturing technology, training of all kinds of management personnel and engineering technicians and even the abroad reviewing and studying of

various management experiences, their effects are also obvious to all. The beneficiary boiler manufacturing factories, whether judged by enterprise scale, production capacity, or technology level, are among the strongest in the Chinese industrial boiler industry. From the aspect of enterprise quantity, their proportion in the total quantity of industrial boiler industry is 1.3%, however, their market sales volume has been near to 30% of the total sales volume of the whole industry. With the complete finish of technology reformation of project support, their production capacity will still be improved obviously. At the same time, with the continuous popularization of technology introduction of the project, the market share of new model boiler which conforms to the energy conservation and environmental protection requirements will be increased significantly. It is sure that the contribution of the project to Chinese industrial boiler industry is very satisfactory. In this point, the project deserves high emphasis and appropriate evaluation.

IV. GEF China Efficient Industrial Boiler Project has helped Chinese industrial boiler industry to exploit international market. The markets of coal burning boiler in the world are located fundamentally in west Asian, East Europe and Southern American. In current, the technology and quality level of Chinese industrial boiler has kept ahead in these regions, and have been accepted by the market. As the export scale keeps enlarging, the project will produce satisfactory achievements about the effect on popularization of the technology of high performance industrial boiler in the whole world, environmental protection, especially on reducing the emission of carbon dioxide.

V. As the governing organization of the implementation of GEF China Efficient Industrial Boiler Project, the World Bank has provided great help to the related departments and enterprises of China, which was important for this was the largest, most complex and broadest representative of the earliest bulk items of GEF, and there was no support from referenced successful experiences. Especially in the stage of technology introduction, all of the current purchase manual, payment procedure and standard contract model were not applicable to the project. The project manager of World Bank and project management office have worked together, accompanying exploiting and concluding at the same time, to solve every concrete problem encountered at any time. Proved by the nearly ten years of cooperative work experience, the work of project management team and project manager of World Bank, project manager and those of the project management office of China are successful. As a result, I think that GEF China Efficient Industrial Boiler Project can act as one successful case of co-operation between Chinese government, World Bank and GEF. Herein, I express great respect and unfeigned admiration to the work of all concerned departments of the World Bank and all the staff of the project management team of China Efficient Industrial Boiler Project. I also offer faithful thanks to their support and help for all counterparts in China, and I expect wider co-operation in more fields in the future.

Liu Xianfa
Deputy Director of Department of Environment and Resource Conservation
National Development and Reform Committee

November 8, 2004