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PROJECT PERFORMANCE ASSESSMENT REPORT



CHINA

Thermal Power Efficiency Project

Report No. 127121

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1818 H Street NW
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**THERMAL POWER EFFICIENCY PROJECT
(TF-94204)**

June 13, 2018

*Financial, Private Sector, and Sustainable Development
Independent Evaluation Group*

Abbreviations and Acronyms

CAPEX	Capital Expenditure kWh Kilowatt hour
CHP	Combined Heat and Power M&E Monitoring & Evaluation
CO2	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 Nm3 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
GW	Gigawatt SERC State Electricity Regulatory Commission
IAs	Implementing Agencies SO2 Sulfur Dioxide
ICR	Implementation Completion and Results Report
tce	Tons of Coal Equivalent
IGCC	Integrated Gasification Combined Cycle
TWh	Terawatt Hour

Director-General, Independent Evaluation	: Ms. Caroline Heider
Director, IEG Financial, Private Sector & Sustainable Development	: Mr. Jose Candido Carbajo Martinez
Manager, IEG Sustainable Development	: Ms. Midori Makino
Task Manager	: Mr. Christopher Nelson

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This report was prepared by Christopher Nelson who assessed the project in March 2016. The report was peer reviewed by Varadan Atur and panel reviewed by Stephen Hutton. Richard Kraus provided administrative support.

Preface

This is a Project Performance Assessment Report (PPAR) by the Independent Evaluation Group (IEG) of the World Bank Group on the China Thermal Power Efficiency Project (P098654). The project was selected for a PPAR to better understand the contribution it has made to Greenhouse Gas abatement measures through plant efficiency improvements and energy management reforms.

The project was approved on May 5, 2009 and the closing date was extended twice from the original December 31, 2012 to June 30, 2014, through two Level II project restructurings. Total expenditure for the project was US\$19.7 million covered totally by the GEF grant. The China Thermal Power Efficiency project PDO was “to reduce coal consumption and greenhouse gas emissions per unit of electricity production in Shanxi province, Shandong province and Guangdong province”.

This PPAR presents its findings and conclusions based on a review of the World Bank’s project documentation, combined with a field mission to China carried out between November 21st and December 2nd, 2016. IEG conducted interviews with a range of different stakeholders linked to the program including project coordination unit staff, project beneficiaries, both provincial and central government counterparts and partners, World Bank staff and power supply company representatives.

Following standard IEG procedure, the draft PPAR was shared with relevant Government officials for their review and comment, and no comments were received.

Summary

This is a Project Performance Assessment Report (PPAR) of China Thermal Power Efficiency Project (P098654). The project was approved by the World Bank's Executive Board on May 5th, 2009.

The project responded to China's need to improve the performance of its existing infrastructure in the thermal power sector. China's rising energy demand had relied heavily on domestic coal production and the rapid expansion of local thermal power generation plants that utilized this coal. Increasingly, these plants were having adverse environmental impacts, particularly in regions experiencing significant increases in energy demand from the manufacturing sector.

The Government of China recognized the need to make changes and to this end, they introduced a range of new initiatives to improve efficiency and reduce coal consumption. In the government's 11th Five Year Plan (2006–10), there was a commitment to a 20 percent reduction in energy consumption per unit of gross domestic product by 2010. Specific measures to improve the coal-fired thermal power generation efficiency included: closure of inefficient small coal-fired plants; the introduction of Energy Saving Dispatch (ESD) systems to ensure greater efficiency; the rehabilitation of existing generation units; and the scale up of renewable power generation

The project's development objective (PDO) was to reduce coal consumption and greenhouse gas (GHG) emissions 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. The theory of change for the project was premised on the need to show how small technological improvements could have considerable environmental and economic benefits for the thermal power sector in China. The three designated provinces were chosen based on their existing reliance on coal fired power as well as their economic and demographic importance. The project design sought to provide sufficient demonstration effects to ensure other provinces would follow the lead of the early adopters in instigating changes to their thermal plants and thus reducing GHG emissions in line with the government's commitment.

What Worked?

This field assessment found that the project was well-timed, was built on sound analysis and was a thoughtfully targeted response to a very specific development problem. In addition, the World Bank was well placed to add technical knowledge and seed funding from the Global Environment Facility to ensure thermal power plants in the three targeted provinces committed to the necessary changes to reduce GHGs. Most significantly, the project's timing and approach was aligned such that provincial governments finally committed to plant closures that had been proposed, but had not been instigated for many years.

The project showed that external help and international expertise working at the provincial level helped to support and reinforce successful central government policy. Stakeholders were positive

about the World Bank's ability to facilitate the international exchange of ideas and bring outside expertise to technical challenges in the sector. In addition, the project was successful in piloting and instituting technical improvements in designated power plants because of its ability to bring international knowledge to local decision-makers. The intention of piloting new approaches in the project was to get beyond existing models of energy and plant management to ensure improvements could be made to existing infrastructure investments. Where the capital investments were applied, there were considerable efficiency gains and importantly, the project showed that these improvements could also be profitable. Subsequent spill-over effects and plant investments in other provinces shows that the pilot was effective in shifting the energy model, a substantial achievement in China's large and complex energy market.

There were three essential elements in the project delivering on its results. First, the plant level efficiency investments were well managed, carefully integrated and had an immediate impact on lowering GHGs and improving efficiency. Second, the project team's commitment to work in the thermal coal energy sector amplified the immediacy of the project's impact and showed that the World Bank's technical expertise is well placed to provide support to traditional energy sectors with adverse environmental impacts. Third, the project illustrated the positive impact of World Bank efforts to advocate for change. The World Bank's reputation and the project's partnership with provincial governments helped in the commitment to inefficient plant closures that had been proposed, but not initiated for many years. Having the necessary support structures in place ensured that the difficult decisions came to fruition.

What didn't work?

While the project substantially achieved its objectives, there were shortcomings. First, the team underestimated the government's commitment to compensatory actions and social protection measures for affected workers. This resulted in a redundant component being incorporated into the design. While the funds were successfully reassigned to supporting innovative technologies, the oversight did lead to initial project delays. In addition, there were operational shortcomings. These included ill targeted analytical work that did not have the desired impact and limited visibility of World Bank staff, limiting the potential partnership impacts. Conversations with project stakeholders revealed that research teams were tasked with analytical work that was not at the forefront of policy, thus limiting its applicability to government energy sector reforms. Similarly, a range of partners voiced their disappointment at the limited engagement with World Bank partners limiting the potential learning opportunities and exposure to international expertise. While these issues did not prevent progress against the project's objective, they are useful lessons for future projects in the sector.

Results

With regards to the project's performance ratings, there was consistent progress against the designated outcomes, as outlined in the table below. The project was **substantially relevant** to the World Bank's country assistance strategy for China and aligned to the government's development strategy. The project's objective was **substantially** achieved and the efficiency with which the project was implemented was assessed as **substantial**.

World Bank performance is rated **moderately satisfactory**. There was a clear linking of the project’s activities to the theory of change underpinning the expected transformation of the sector, but there were minor shortcomings with quality of supervision. The government had a strong and ongoing commitment to making the project work. In addition, the high capacity of the project management units at the provincial level was a key aspect of the project’s success leading to an overall **satisfactory** rating for borrower performance.

The monitoring and evaluation system was accessible, regularly maintained and provided good data to those who needed it, resulting in a **substantial** rating. The risk to development outcome for RDP is **moderate**. The retrofitted technologies sufficiently demonstrated their commercial viability and have been adopted by power stations in other provinces, as intended.

Project Ratings Summary

	ICR*	ICR Review*	PPAR
Outcome	Satisfactory	Satisfactory	Satisfactory
Risk to Development Outcome	Moderate	Moderate	Moderate
Bank Performance	Moderately Satisfactory	Moderately Satisfactory	Moderately Satisfactory
Borrower Performance	Moderately Satisfactory	Satisfactory	Satisfactory
Monitoring and Evaluation	N/A	Satisfactory	Satisfactory

Lessons

Piloting and demonstrating potential technological improvements to lower costs and improve environmental performance works well in environments where operators are risk averse and constrained by government policy. The impact of this project illustrated the benefits of interventions that “show and don’t tell”. Seeing how easily the changes could be made to their plants and experiencing the benefits first hand led to considerable uptake amongst other operators. Experience in the China energy market is significantly determined by government oversight and regulation. Experiencing the immediacy of project benefits led to spillover effects with other plants instituting similar changes both for cost reasons and to respond to government emission reduction requirements.

The World Bank’s international experience and expertise has the capacity to make an important contribution to pollution reduction in the thermal power sector. This project showed that even in ‘undesirable’ sectors, such as coal fired thermal power production, where there is a reticence to commit project resources, the World Bank can have considerable impact on pollution reductions. With a relatively small financial outlay, this project showed that: (a) the World Bank’s presence in the sector can have catalytic impacts on policy level dialogue and decisions leading to smooth closure of inefficient generation assets; and (b) dramatic efficiency improvements can be retro-fitted to existing coal-fired energy plants with considerable pollution

reduction benefits through low cost rapid response measures. This project provides a strong case for the World Bank to strengthen its focus on efficiency enhancement opportunities in thermal power sector.

External help and international expertise provided by World Bank projects at the provincial level in middle income countries helps support and reinforce successful central government policy. In this instance, the project showed that taking global knowledge and international expertise to a given development problem, instituting a set of pilots and then demonstrating the benefits of applying the model was a necessary conduit for shifting opinion amongst small energy plant operators in China. The project's efforts at bringing international experience to the regions and taking plant operators to demonstration sites provided the necessary assurance that plant improvements would be cost effective and low impact. Working at the provincial level gave authority to the regional governments, ensured the pilots were 'hands-on' and it amplified 'spill-over' opportunities as the communication of benefits took place amongst and between provincial leaders. This decentralized approach empowered provincial governments to make necessary changes by seeing the immediate benefits, while knowing that these reforms had central government support.

Analytical work needs to respond to the immediate needs of the sector rather than being determined by supply-side factors. The analytical work completed by various organizations with project funds was of a high standard and rigorously prepared. However, the organizations procured to undertake the research acknowledged that there were other more pressing issues that required investigation and would have been more useful for the provincial energy sector. Decisions on the scope of work and the associated topics was determined early in the project cycle. As circumstances changed, the analytical work did not evolve leading to the preparation of technical papers that had marginal value. The various institutions charged with completing the research tried to communicate these issues, but having committed to the topics the World Bank and the government did not provide the space and time to make potentially useful changes. This limitation was amplified by the lack of a dissemination strategy for the completed research.

A "hands-off" approach by the World Bank in high-capacity environments can lead to missed opportunities in maximizing a project's potential. In this project, the strong performance of relevant project management units amongst the provincial governments resulted in efficient disbursements and good implementation project ratings. While this reflects well on the capacity and abilities of the local project team, it also led to more limited World Bank oversight which diminished the potential value of global dissemination of ideas and research. The limited interaction between the World Bank and its partners also amplified frustration amongst project recipients and prevented greater learning amongst counterparts. Providing sufficient supervision time and energy to well performing projects has the potential to amplify the project's gains.

Barriers to the closure of small inefficient power units are often political. Fostering the key relationships with partners is essential in knowing what and how reforms can be implemented in challenging environments. The closure of the small plants during the project's implementation was only indirectly linked to the project. Consultations with the Department of Energy in Beijing revealed that closing small inefficient plants had been mandated since 2001, but the pressure on supply and government inertia had made the policy ineffective. The World Bank's conversations in the project preparation period incentivized provincial governments to prioritize

the implementation of shut down protocols and compensation arrangements that partly contributed to the closure of nine small coal-fired plants. The value added through the project was the policy dialogue, the relationships at the provincial level and the profile of the World Bank as a contributor to the broader energy strategy.

José Carbajo Martínez
Director, Financial, Private Sector, and
Sustainable Development
Independent Evaluation Group

1. Project Background and Context

1.1 The China Thermal Power Efficiency project sought to reduce coal consumption and greenhouse gas emissions per unit of electricity in three provinces in China – Shanxi, Shandong and Guangdong. The project was conceived as a response to the predominance of coal in China’s energy mix and the need to find ways of improving existing infrastructure over and above weaning the country away from this reliance as an energy source. China’s rising energy demand had relied heavily on domestic coal production and the rapid expansion of local thermal power generation plants that utilized this coal. Increasingly, these plants were having adverse environmental impacts, particularly in regions experiencing significant increases in energy demand from manufacturing sector.

1.2 Unfortunately, the rapid growth in power demand was met by construction of low efficiency coal-fired power plants, which consumed considerably more coal than their Japanese and European counterparts for equivalent power generation (366 gce/kWh in China compared to the 300 gce/kWh benchmark elsewhere). This was, in part, due to the large number of small inefficient units, inefficient dispatch of generated power, small combined Heat and Power units operating for electricity power production only, and old mid-sized coal-fired units that were outdated.

1.3 The Government of China recognized the need to make changes and to this end, they introduced a range of new initiatives to improve efficiency and reduce coal consumption. In its 11th Five Year Plan (2006–10), there was a commitment to a 20 percent reduction in energy consumption per unit of gross domestic product by 2010. Specific measures to improve the coal-fired thermal power generation efficiency included: closure of inefficient small coal-fired plants; the addition of new large high-efficiency thermal plants, including clean coal technologies; the introduction of Energy Saving Dispatch (ESD) to ensure greater efficiency; the rehabilitation of existing generation units; and the scale up of renewable power generation. There were two reasons coal-fired plants in China had been slow to embrace international technologies. First, the ad hoc and rapid growth meant there was considerable variability in the provision and procurement of plant and equipment. While much of the technology was imported in the early growth phase, the domestic market responded quickly to local expansion but only with rudimentary requirements. Second, power companies were still adjusting to the market based model, limiting their understanding of international approaches. Therefore, both the distribution and generation of power did not meet international best practice.

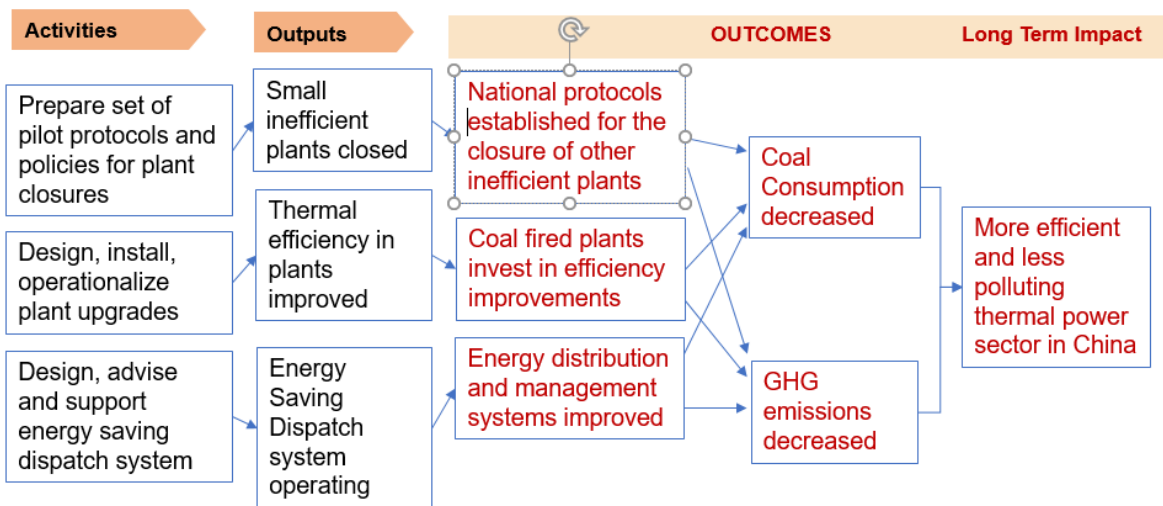
1.4 To achieve their goal of a 20 percent reduction, the government required technical assistance and global knowledge that the World Bank was well positioned to provide. The World Bank’s partnership with the government was aligned with the promotion of clean energy and improved energy efficiency through an approach of technology transfer, demonstration, replication and scale-up” The government proposed a GEF project to provide a pilot model that could be rolled out to provinces across the country once there was proof of concept.

1.5 The project development objective (PDO) was to reduce coal consumption and greenhouse gas (GHG) emissions 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. To deliver against this objective, the project was divided into five components. The first component was to support the closure of small plants through the preparation of, and technical assistance to, policy and guidance documents outlining required incentive mechanisms, resettlement plans and compensation approaches. Component two provided funding for power plant efficiency improvements in the three provinces, including heat and power unit conversions, waste heat recovery works, and power generation efficiency recommendations. Component three was committed to supporting the transition to efficient generation dispatch through the preparation of detailed regulatory requirements and the piloting of energy management systems. The fourth component was the provision of technical assistance to improve operational management. This included the hiring of international and local consultants for technical advisory, procurement and financial management at the implementing agencies to improve on energy management in the three target provinces. The fifth and final component was the provision of project management support.

1.6 The theory of change (see below) for the project was premised on showing how small technological improvements could have considerable environmental and economic benefits for the thermal power sector in China. The three designated provinces were chosen based on their existing reliance on coal fired power as well as their economic and demographic importance. The project design sought to provide sufficient demonstration effects to ensure other provinces would follow the lead of early adopters in instigating changes to their thermal plants and thus reducing GHG emissions in line with the government's commitment.

PDO: To reduce coal consumption and greenhouse gas emissions per unit of electricity production in Shanxi province, Shandong province and Guangdong province



Project Design

Description of components: To reduce coal consumption and GHG emissions in the targeted provinces, the project was designed around five components that responded to the theory of change outlined in the previous diagram. They were as follows:

1. The first component was to establish a set of mechanisms (designated protocols in the theory of change) to support the closure of inefficient small coal fired power generation units.
2. The second and most resource intensive component sought to demonstrate power efficiency through plant improvements in the targeted provinces.
3. The third component was to support the transition to more efficient energy dispatch systems.
4. The fourth component was technical assistance to support the various changes.
5. The fifth component was project management.

Description of (actual) project financing:

Components	Appraisal Estimate	Actual Costs	Percentage of Appraisal
Mechanisms to support the closure of inefficient small units	36.420	37.269	102.3%
Demonstration of power plant efficiency improvements	56.361	51.256	90.9%
Transition to efficient energy dispatch	7.297	4.637	63.6%
Technical Assistance to Project Implementation	1.852	1.500	81.0%
Project Management	1.916	1.700	88.7%
Contingencies	5.110		
Total	108.96	96.36	88.4%

2. What Worked

Design and Preparation

2.1 The China Thermal Power Efficiency project was a well-designed initiative that built on sound analysis to address a clear development problem, the inefficient operation of small coal fired power plants.

2.2 There was a logical relationship between these components, connecting the closure of inefficient plants to improvements in others. The design acknowledged the technical and financial constraints experienced by operators and sought to utilize World Bank expertise to provide guidance for plants undertaking rehabilitation. The government intended to use the World Bank as both a champion for change and to access international expertise in shifting the existing culture amongst small-plant managers in the thermal power sector. Importantly, the design targeted low cost, high return approaches that could be easily replicated elsewhere in the country, emphasizing the catalytic nature of GEF projects. It was also designed as a pilot project set in a diverse group of provinces with different energy problems. The design of a pilot was appropriate in this instance as a proof-of-concept, particularly in the efficient use of grant funds to illustrate the benefit of capital improvements to relevant plants. This would ensure its applicability elsewhere in the medium to longer term.

2.3 In addition to its design features, the project was highly relevant to the development challenges in China. Both the government and the World Bank strategies prioritized “more efficient energy supply” in their development plans. The government had identified the closure of small coal-fired generation units as a priority in its 11th Five Year plan (2011–15), and the World Bank aligned its commitment to efficient energy supply in its Country Partnership Strategy (2006–10). Both strategies covered energy priorities in depth and the project’s focus on piloting new mechanisms to improve thermal power efficiency is highly relevant to this end. The focus on energy efficiency carried into the subsequent World Bank strategy (2013-16) with its focus on “more efficient energy supply”.

Implementation and Supervision

2.4 The project showed that external help and international expertise working at the provincial level helped support and reinforce successful central government policy. The right policies are obviously important, but increasingly decentralized governments and the emerging importance of private sector activity makes provincial engagement essential as this is where most action takes place. The project highlights the importance of getting the right technology in place where it is needed and international expertise advising on what is global best practice. The evaluation team found that stakeholders were positive about the World Bank’s ability to facilitate the international exchange of ideas and to bring outside expertise to technical problems. The project benefitted from taking global knowledge to a given development problem, instituting a set of pilots and then demonstrating the benefits of applying the model elsewhere.

The project’s support and provision of international expertise from European energy providers had two impacts. First, the evaluation team found that the successful ‘proof of

concept' relating to plant efficiency improvements made it easier to convince senior management of the power plants to access commercial funds for capital investment. Second, World Bank oversight of the investments also encouraged plant technology innovation where provincial authorities were tentative in instituting change. The various plant managers explained that while central government mandates on emission reductions frightened them, the action instituted by "provincial regulatory authorities to impose or threaten operational restrictions" was a more important driver of change. The decentralization of energy arrangements meant that increasingly provincial mandates drove reform and action. The project's emphasis on provincial reforms ensured it could respond to these pressures.

2.5 The project was successful in achieving technical improvements in power plants because of its ability to bring international knowledge to local decision-makers. Exposure to power providers from other countries worked well in motivating the plants to think differently about their technology choices and approaches to design. Chinese private sector power companies preferred to purchase Chinese plants over international technology, because they favored lower upfront investment costs even if that meant higher operating costs in the future. This project showed that the historic investment decisions in low cost, low technology plant investments were often to the detriment of longer term efficiency. Plant manager perceptions on investment decision making were changed by their interaction and discussions with international power companies facilitated by the project. Additionally, the efficiency gains of these relatively minor investments in plant improvements showed the importance of taking on the risks of institutional change. As one plant manager said, "we will not borrow money to invest in something we have not seen working in our province as there is too much pressure from the government on our costs and on reliable supply".

2.6 The evaluation team found that the World Bank can play an important role in bringing international thermal power plant technology to local companies, even in a high capacity country like China. This project was an example of a larger government approach of trying to use the World Bank and GEF financing to support innovative pilots for improving energy efficiency and driving greater investment in energy plant updates and remodeling. In this instance, the grant funding provided the necessary stimulus for experimenting with new technologies and approaches which ultimately led to wholesale changes in the sector. In a focus group session with the government's IFI division, the evaluation team found that the MOF wanted World Bank support and GEF funding to be linked to international knowledge that complemented the government's Green Growth approach. The intention of piloting in this project was to bring participants to the table and get beyond existing models of energy management and plant management to ensure improvements could be made to existing infrastructure investments. This project was only one of an energy portfolio for the government valued at \$2.5 billion. Therefore, it was expected to influence government working concepts drawn from international experience. In addition, the World Bank was to be an active partner in brokering knowledge networks, particularly those with European energy providers and with international energy research organizations. Bringing in the necessary technical assistance to advise and design the intended plant improvements and to sustain the reform mandate was an important outcome of the project and ensured that GEF projects in the energy sector were having the 'catalytic' impact they intended – to reduce GHG emissions from thermal power plants.

Results

2.7 The project had three elements that proved essential to delivering on its results:

2.8 **First, the project was successful in supporting plant level efficiency improvements through piloting and demonstrating power station improvements that were low cost and made considerable gains in reducing emissions.** The improvements included implementation of peak cooling technologies, integrated plant efficiency rehabilitation, waste heat recovery, and CHP conversion to targeted plants (see section 14.2). Three different project stakeholders made the same observation regarding operators instituting change in the energy sector, “the Chinese must see it to believe it”. There was suspicion amongst plant managers on the need for change. Thus, the hard data generated by the pilot interventions was necessary for convincing decision makers in other plants to adopt innovations. Since the plant improvement investments in the three provinces, there have been subsequent investments in similar equipment in other plants (7 specific cases were provided by the project team) funded either by provincial budgets or by the private companies operating the plants. There were three factors responsible for this additional impact: the considerable cost savings in coal consumption for the renovated plants; the improved customer heating benefit that was part of the plant improvement process; and the exposure of plant management and engineers to international experience in the sector.

2.9 The evaluation team found that the power plant efficiency gains were made through the initiation of four process reforms: plant energy assessments and calibration; flexible energy dispatch; dual electricity and heating function; and boiler management and utilization. At the first plant visit in Shanxi, the General Manager explained how the World Bank project sought to respond to these reforms. Activities included the identification of renovation requirements, procurement support, training and quality assurance. Importantly, the project team also sought to benchmark changes, share the experience with other plants and bundle future options for capital investment. These were incorporated into the plant’s management plan. Further, the General Manager explained that “changing our thinking about the energy future was needed for small plants unsure about their short-term viability”. As part of the reforms, plant calibration was improved to identify opportune tweaks to capital equipment. Minor changes were made to the plants that resulted in considerable efficiency gains. Excess heat pipes were installed and used for secondary functions and cooling mechanisms were improved through water quality changes and ambient temperature utilization. The evaluation team viewed the quality of the capital improvements at both the Shanxi and Shandong power plants, where plant managers acknowledged the benefits including the cost effectiveness of the changes, the technical demonstration aspect of the works and the sustainability of cost savings.

2.10 The demonstration effect carried through to efficiency benefits and adherence with government policy priorities. Changes made at the different plants were small in scale, but led to immediate efficiency benefits that contributed to the government’s efforts to lower emissions. In Shanxi, this included capital improvements to frequency convertors, rotor calibrations, boiler insulation adjustments, and updates to pumps, fans and condensers. Other operational improvements were also made: project management training was provided; budgeting was streamlined; and technical assistance was provided to 40 other plant operators

through a ‘train-the-trainer’ program. The government’s role was also significant. Energy audits were regularly undertaken with support from the Global Environment Facility (GEF), targets were set and enforced for annual emission reductions, and the demonstration plants were widely promoted with teams visiting from Jiangsu, Heilongjiang and Guangdong Provinces. Local government authorities were also supportive providing counterpart funding for community heating investments.

2.11 Second, the project’s achievements provide justification for the World Bank to work in an “undesirable” sector where there is potential for pollution reduction. There has been pressure on the World Bank to avoid coal. In these regions in China, engaging with coal made financial and environmental sense. The existing energy demands in China are such that moving immediately away from coal fired production to alternate forms of energy is neither technically feasible nor politically palatable. Given its international experience, the World Bank is well placed to provide support to improving the way the thermal power sector in China works. The impact of this investment showed the potential benefits of continued engagement, particularly with regards to extracting efficiency gains through new complementary technologies.

2.12 Reinforcing the premise of investing in the coal-fired energy sector, partners and stakeholders interviewed by the evaluation team argued strongly for further World Bank engagement in the coal sector.” At the Environment Protection Bureau in Shanxi, officers explained the importance of establishing a trading platform for the buying and selling of carbon credits to be used by companies operating in the coal sector. The EPB noted that thermal power companies were beginning to cooperate with central authorities as training and support was provided. Likewise, the support from the project opened a dialogue previously absent about the viability of various plants in the region. The EPB monitoring and enforcement team used project funding to increase their skills, formulate better automated systems and establish sufficient evidence to close certain plants. The project’s engagement with thermal energy companies also improved their openness to international best practice. EPB staff argued that changes in thermal plants would have been impossible without engaging with their management.

2.13 In Shandong, the provincial EPB was equally forthright on the need to improve the thermal power sector’s short-term performance. The Deputy Director of the EPB explained how both carbon trading preparations and operational changes to the management of the grid were improved through the project’s technical assistance. An enhanced system assessment was undertaken in addition to changes to operations management protocols. “The project instituted plant monitoring systems that better illustrated inefficiencies in the grid and therefore helped designate plants for closure. This was a dramatic change in an environment where slow decision making was the norm. It energized many in the regulatory branches”. Most importantly, the project brought international expertise and experience to local level policy discussions and led to an additional 18 Shandong energy plants undertaking energy efficiency reforms. The project also had flow-on effects with nationally funded energy efficiency reforms being instituted in Hunan, Beijing, Tianjin, and Inner Mongolia.

2.14 Third, the project was successful in advocating for the initial steps required for the closure of small, inefficient coal plants, with associated environmental and economic

benefits. The perceived authority/reputation of the World Bank helped drive the provincial governments to commit to the national government's reduction targets and make the necessary closures part of the policy dialog. The bundling of the investments with efficiency improvements at the various plants helped to make the national and provincial government decisions possible. While the national and provincial governments were ultimately responsible for the closures, the project helped to minimize the social costs of plant closures by providing guidance and technical assistance on compensatory measures, redundancy rules, shut down protocols, and social protection standards for workers. Social costs were also modest because of the geographically distributed nature of the industry. This meant that redundant workers had similar opportunities nearby. The response from plant managers, employer groups, and feedback from regional development officers was that growing energy demand ensured that employees were redeployed elsewhere. The geographic spread of power plants means work opportunities in the sector are dispersed. This ensured that most workers did not need to relocate as there were similar opportunities nearby.

2.15 The closure of plants was indirectly linked to the project. Consultations with the Department of Energy in Beijing revealed that closing small inefficient plants had been mandated since 2001, but the pressure on supply and government inertia had made the policy ineffective. The World Bank project amplified the conversation and linked closures to beneficial investment elsewhere. This incentive, coupled with guidance on redundancy rules, shut down protocols, and compensation arrangements resulted in the closure of nine small coal-fired plants. In linking the project to the plant closures, it should be noted that the cancellation of the component in Shanxi, and the substantial reduction of targets in Shandong shows that closures were happening before the project and continued even without direct support from the project. This doesn't necessarily illustrate a shortcoming of the project, rather it reflects the aggressive approach China was taking to its strategy (including closures) as its targets were large (50 GW reduction by 2010). The value added through the project was the policy dialogue, the relationships at the provincial level and the profile of the closure as part of the broad strategy.

3. What Didn't Work

Design and Preparation

3.1 **In formulating the design, the team underestimated the government's commitment to compensatory actions and social protection measures for affected workers.** Initial resistance to the proposed changes did not eventuate and the GEF resource set aside to facilitate the plant closures was not required. This shortcoming was partly offset by allocating the funds to support more innovative rehabilitation technologies under Component 2, but it did distract the implementation team's early efforts at engaging the provincial partners who were more committed to the changes than was initially thought. In addition, the preparation of the operational manual to guide plant closure of small thermal units was delayed, thus diminishing the project's contribution to the closures. However, this was offset by the Ministry of Finance utilizing the report for national policy on power sector reform. Otherwise, the project had few design shortcomings.

Implementation and Supervision

3.2 **From an operational perspective, there were two shortcomings regarding implementation and supervision. First, the analytical work on power sector issues financed by the project had limited impact¹, because some of the work did not respond to the immediate needs of the sector, and for other work there was a lack of suitable dissemination approaches.** The World Bank team utilized capable research organizations to undertake supply-driven research on tariff pricing mechanisms, power sector fiscal efficiency measures and on fiscal incentives for energy saving. However, in discussions with the relevant research organizations, the evaluation team found that the overly prescriptive nature of the work meant it was not necessarily required, was not appropriately disseminated, nor was it immediately applied. Two of the institutes pointed out that they were procured to do work that did not make a useful contribution to improving energy efficiency in the targeted provinces and was not responding to the immediate needs of the sector.

3.3 In the first of the evaluation team's discussions with research bodies, the disconnect between 'task' and 'need' was apparent. The work done on decommissioning triggers was useful in prioritizing plant shut-downs, but the work on capital shortfalls was only partly reflective of what was already happening in the sector. The research team found that resistance to change was a cultural issue more than a capital constraint. So, while the research refined some of the knowledge on sector investment priorities, it did not adequately investigate why provincial governments were slow in allocating subsidies to efficiency improvements. Discussions with the second contracted research institute validated these claims. Their report on operation and maintenance best practice for thermal power plants (2012) was useful in providing new information on responding to seasonal power variation, but the report missed the opportunity to formulate rules on the trading mechanism being rolled out. Linking the research to policy work in countries with existing trading platforms would have made the dissemination of lessons more useful for provincial application. Research participants saw this as a limitation of the project that could have been picked up in supervision missions and sufficiently revised.

3.4 Second, the World Bank missed opportunities during supervision to maximize potential added value because high capacity amongst counterparts (and smooth disbursements) led to a 'hands-off' approach by the World Bank to many of the project activities. Conversations with the research teams revealed that there had been no direct interaction between the research institutions responsible for the technical reports and the World Bank. In addition, provincial officers explained that consultations with the World Bank was rare, with implementing agencies playing the primary role in project activities and reporting. While this reflects well on the capacity and abilities of the local project team, it also diminished the potential value of global dissemination of ideas and research which was a core aspect of the intended design. The limited interaction between the World Bank and its partners also amplified frustrations amongst recipients and prevented the World Bank from potentially learning from its counterparts. This was particularly evident on the research side where high capacity teams did not have an audience to communicate their findings other than through publication. Three of the research teams visited by the evaluation team had never met anyone from the World Bank.

3.5 The limited exposure and interaction between World Bank staff and project stakeholders was even more pronounced given the persistent requests from the government for more exposure to international experts. In discussions with the NEA Thermal power division, the technical expertise from Japan and France was acknowledged as the best feature of the project. NEA's Director explained that "international 'best practice' is the best means of pushing us to change ... without international experts, we don't know the steps towards improving clean energy options". The enthusiasm and appetite for technical assistance made the limited exposure to World Bank staff a missed opportunity for the project. This issue was highlighted in discussions with World Bank staff who acknowledged the difficulty of supporting small grant funded projects with limited supervision budgets. "Chinese counterparts will draw on outside expertise when it aligns to their needs ... the difficult task is knowing what is possible and in sufficiently understanding the stakeholder arrangements that will lead to reform. This takes time and is not always possible with small projects." Getting the right mix of expertise and matching this to the needs of project teams proved challenging in a resource constrained environment. Ensuring GEF grant projects are sufficiently aligned to broader work in the sector portfolio may amplify the opportunities for access to international expertise. In reflecting on the outcomes of the project, the World Bank team explained that "the value of the GEF grant was that it worked as an initial stimulant, providing the necessary funds to capital starved small energy providers". While this illustrates a strategic alignment between the GEF grant and scaled up investments in the energy sector, there was a disconnect between government priorities and those of the World Bank with regards to future investments.

Finally, it is worth noting that the project design underestimated the government's commitment to change in the thermal power sector. While the achievement hinged on early agreement between central authorities and the project team, once underway, compensation standards were raised and social protection measures were instituted for workers. Therefore, project costs for the component on plant closures were small and were reallocated during restructuring to rehabilitation technologies. As the technical Manager of the National Power Grid Company explained, "the initiation of the project ensured that closures were on the table. Without the World Bank's authority, it was difficult to make closures part of the energy conversation but the government was clearly wanting to make changes". Providing the initial energy and authority for change was the achievement of the project, but underestimating the appetite for change was a shortcoming of the design.

Results

3.6 While there were features that ensured good results against the project's objective, there were shortcomings and areas for improvement.

3.7 The project's pilot SO₂ emission trading system had variable uptake amongst pilot provinces. Emissions trading and management in China is still in its infancy. The national government is taking small steps with pilot provinces and sought to use the project to test a provincial trading model. However, recent national government caps on pollution emissions is the 'scarier' issue for plant managers given the control and enforcement by central authorities, and thus there is reticence towards the utilization of trading models. Few officials understood how a provincial trading model might complement and/or replace designated

reduction targets. The trading platform was intended to ultimately replace government quotas, but this was not how it was perceived by provincial officers. Amongst project stakeholders, there was a sense that the provincial governments wanted to see others do it first. A pilot emissions trading system established under the project had limited success, and was unlikely to see replication in other province. In Shanxi, the pilot cap and trade carbon market model had been instituted, but trading was not binding and oversight for local power operators was limited due to insufficient support and outreach. In conversations with the trading team and with government officials, the evaluation team found that considerable additional technical support was required to operate and maintain a viable carbon market. Until the model is more widely used in Shanxi, it is difficult to see it being replicated in other provinces.

3.8 Part of the reason for the limited success of the trading model was the disparate nature of energy markets. Renewable energy options had proliferated but were not connected to the central grid. Coordination was difficult and capacity amongst those working to establish carbon markets was weak. This was reinforced in conversations with Shandong provincial officials who were not aware of progress on the Shanxi pilot. In the evaluation team's visit to the Shanxi trading center, interviews with the trading staff revealed that uptake of the trading model had been slow. The team explained that setting up the platform took time and many of the energy plants were not aware of their obligations. "We have successfully provided a workable system, but there are still difficulties in getting all of the energy companies to understand the benefits. We also have patchy compliance amongst the smaller companies and the trading platform is restricted. It will take some time before we see a viable system for the province" (Interview with Shanxi Trading Office staff).

3.9 The project efforts to improve energy generation dispatch had mixed results. While technical assistance provided the necessary analytics for ESD assessment, including identifying the barriers to unreasonable benefit distribution, the experience in the experimental provinces and the transition to widespread adoption has had variable results. In both project analytical documents (CPECC Study on Tariff Pricing Mechanisms for Energy Dispatch) and discussions with provincial finance and energy administrators, the evaluation team found that project support resulted in improved knowledge of potential coordination deficiencies where bottle necks could reduce the effectiveness of the grid. But generating a universal model to be rolled out proved difficult given the existing variation in core energy requirements and the designated benchmark tariff mechanism. Even after project support and guidance, an ESD model proved elusive due to differences between provinces on core energy supply and differential benchmark tariffs (pg.25 CPECC). Grid management in hydropower reliant provinces in particular followed different protocols, thus highlighting the central issue – conflict of interest amongst parties who participate in power generating transactions and grid enterprises. Understanding how a uniform ESD system should be managed in a reduced emissions environment remains uncertain, and what benefits could be achieved through partnering more effectively with the private sector has not yet been solved.

3.10 The project provided sufficient analytical support and technical guidance from international experts on ways to improve management of the grid, but staff at the Shandong project management office acknowledged a range of challenges in getting changes to stick. First, the quickly changing nature of the sector meant different investment partners were

coming and going, making provincial government oversight difficult. Second, the renewables sector was highly speculative with capital works not always complementing provincial plans. Third, the scale of growth made centralized control problematic. Provincial governments had instituted regulatory models, but sufficiently funding these regulators during periods of considerable grid and generation expansion wasn't possible. Thus, there was variability in the monitoring and compliance of energy suppliers across provinces.

3.11 The project's **Component 3: Transition to Efficient Generation Dispatch** (GEF Grant US\$4.07 million and counterpart funds US\$3.23 million) sought to reduce system-wide coal consumption and GHG emission for power generation by supporting the transition from the current system dispatch practices to an efficient generation dispatch optimized for coal savings. The pilot implementation of ESD in the Guangdong Provincial Power Grid, including the development and improvement of the detailed regulations required to commence the piloting was undertaken and applied to five pilot provinces. This work covered the 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.

3.12 What the project found was that cost and income monitoring systems and tariff adjustment mechanisms required in different provinces will take time to adopt a tariff linkage or adjusting benefit distribution structure (pg.28 CPECC) necessary to guarantee an ESD approach. The project's pilot experience showed that additional analysis and variable systems will be required for different energy supply systems in the short term and only then will it be possible to transition to an ESD model (pg.30 CPECC).

4. Other Important Findings

4.1 **Institutional Strengthening** – there was widespread dissemination of the achievements of the project, particularly amongst similarly sized plants in other provinces. Visits organized by the project management units for interested officials from other provinces were well organized, regular and extremely effective in harnessing interest in energy efficiency retrofit measures elsewhere. Three additional companies have already committed their own funds to make changes in other provinces and awareness of the approach is widespread, as evidenced during discussions with provincial planners from other regions. In addition, staff at the Shandong Power Grid Company, the Guangdong Power Grid Corporation and the Provincial Environmental Protection Bureaus (Shanxi and Shandong) increased their knowledge of energy efficiency retrofit approaches that are now being rolled out to other plants in the provinces. The oversight function has begun to move outside of the project units and be applied to operational field staff responsible for regulatory oversight. This shift from a control based model to a support function was an important change articulated by many plant managers.

4.2 **National Pollutants Emission Trading Scheme** – while difficult to establish and slow to be integrated into energy market operations, the design and trial operation of an SO₂ trading system served as a key test towards a national pollutants emission trading model. The

trial led to the issuance by the State Council of a *Guidance Note on Further Promotion of Paid Use of Pollutants Emission Allowance and Pilot Trade* (2014). This publication drew heavily on the experience of the EPB in Shanxi and sought to stimulate provincial councils building trading platforms into their energy plans.

4.3 Monitoring and Evaluation utilization – the design of the monitoring system was both pragmatic and sufficiently resourced, if overly weighted towards the measuring and recording of outputs. This resulted in a regular reporting protocol that was managed effectively by the project management units at the provincial level, but that provided limited insight on the broader transformative impact that was expected. So while the M&E led to recorded data illustrating the benefits of the demonstration technologies, it did not necessarily capture what characteristics determined the flow on effects for changing the behavior of plant managers and provincial leaders. The analytics helped the project team to share their experiences, promote the benefits of the technologies and illustrate the different impacts for each of the investments at the pilot plants, but they did not help in communicating what qualitatively and behavioral changes were required to make the reforms stick. Reassuringly, the monitoring datasets were shared with interested parties that were considering their own efficiency improvements.

4.4 Fiduciary and safeguard issues – there were no significant findings with regards to the World Bank policies on environment and social safeguards, nor with the project management units dealing with protocols on procurement and fiduciary reporting. Specific details on these issues can be found in Annex F of this report.

5. Lessons

5.1 Piloting and demonstrating potential technological improvements to lower costs and improve environmental performance works well in environments where operators are risk averse and constrained by government policy. The impact of this project illustrated the benefits of interventions that “show and don’t tell”. Seeing how easily the changes could be made to their plants and experiencing the benefits first hand led to considerable uptake amongst other operators. Experience in the China energy market is significantly determined by government oversight and regulation. Experiencing the immediacy of project benefits led to spillover effects with other plants instituting similar changes both for cost reasons and to respond to government emission reduction requirements.

5.2 The World Bank’s international experience and expertise has the capacity to make an important contribution to pollution reduction in the thermal power sector. This project showed that even in ‘undesirable’ sectors, such as coal fired thermal power production, where there is a reticence to commit project resources, the World Bank can have considerable impact on pollution reductions. With a relatively small financial outlay, this project showed that: (a) the World Bank’s presence in the sector can have catalytic impacts on policy level dialogue and decisions leading to smooth closure of inefficient generation assets; and (b) dramatic efficiency improvements can be retro-fitted to existing coal-fired energy plants with considerable pollution reduction benefits through low cost rapid response

measures. This project provides a strong case for the World Bank to strengthen its focus on efficiency enhancement opportunities in thermal power sector.

5.3 External help and international expertise provided by World Bank projects at the provincial level in middle income countries helps support and reinforce successful central government policy. In this instance, the project showed that taking global knowledge and international expertise to a given development problem, instituting a set of pilots and then demonstrating the benefits of applying the model was a necessary conduit for shifting opinion amongst small energy plant operators in China. The project's efforts at bringing international experience to the regions and taking plant operators to demonstration sites provided the necessary assurance that plant improvements would be cost effective and low impact. Working at the provincial level gave authority to the regional governments, ensured the pilots were 'hands-on' and it amplified 'spill-over' opportunities as the communication of benefits took place amongst and between provincial leaders. This decentralized approach empowered provincial governments to make necessary changes by seeing the immediate benefits, while knowing that these reforms had central government support.

5.4 Analytical work needs to respond to the immediate needs of the sector rather than being determined by supply-side factors. The analytical work completed by various organizations with project funds was of a high standard and rigorously prepared. However, the organizations procured to undertake the research acknowledged that there were other more pressing issues that required investigation and would have been more useful for the provincial energy sector. Decisions on the scope of work and the associated topics was determined early in the project cycle. As circumstances changed, the analytical work did not evolve leading to the preparation of technical papers that had marginal value. The various institutions charged with completing the research tried to communicate these issues, but having committed to the topics the World Bank and the government did not provide the space and time to make potentially useful changes. This limitation was amplified by the lack of a dissemination strategy for the completed research.

5.5 A 'hands-off' approach by the World Bank in high capacity environments can lead to missed opportunities in maximizing a project's potential. In this project, the strong performance of relevant project management units amongst the provincial governments resulted in efficient disbursements and good implementation project ratings. While this reflects well on the capacity and abilities of the local project team, it also led to more limited World Bank oversight which diminished the potential value of global dissemination of ideas and research. The limited interaction between the World Bank and its partners also amplified frustration amongst project recipients and prevented greater learning amongst counterparts. Providing sufficient supervision time and energy to well performing projects has the potential to amplify the project's gains.

5.6 Barriers to the closure of small inefficient power units are often political. Fostering the key relationships with partners is essential in knowing what and how reforms can be implemented in challenging environments. The closure of the small plants during the project's implementation was only indirectly linked to the project. Consultations with the Department of Energy in Beijing revealed that closing small inefficient plants had

been mandated since 2001, but the pressure on supply and government inertia had made the policy ineffective. The World Bank's conversations in the project preparation period incentivized provincial governments to prioritize the implementation of shut down protocols and compensation arrangements that partly contributed to the closure of nine small coal-fired plants. The value added through the project was the policy dialogue, the relationships at the provincial level and the profile of the World Bank as a contributor to the broader energy strategy.

¹ Including the Report on Rules of Information Disclosure under ESD; the Evaluation Report on Closure of Small Thermal Power Plants; and Assessment report on Pollutants Emissions Allowance Trading in Shanxi and Shandong.

Appendix A: Principal Ratings

	ICR*	ICR Review*	PPAR
Outcome	Satisfactory	Satisfactory	Satisfactory
Risk to Development Outcome	Moderate	Moderate	Moderate
Bank Performance	Moderately Satisfactory	Moderately Satisfactory	Moderately Satisfactory
Borrower Performance	Moderately Satisfactory	Satisfactory	Satisfactory

* The Implementation Completion Report (ICR) is a self-evaluation by the responsible World Bank global practice. The ICR Review is an intermediate IEG product that seeks to independently validate the findings of the ICR.

Based on the overview provided in Section 2.1-2.3 above, relevance of objectives and relevance of design are both rated **Substantial**. While the relevance of objectives is qualified by alignment with the government’s development plan and the World Bank’s commitment to “more efficient energy supply” (CPF FY2011–15), the project falls short in identifying the strategic element in choosing how this investment in the coal-fired thermal power sector differs from opportunities in other energy sectors, particularly renewables. A minor shortcoming in the design was the lack of sufficient guidance on how the energy saving dispatch (ESD) mechanism and the policy studies were to inform and contribute to reforms and improvements in the thermal power sector as opposed to the energy sector as a whole.

The project’s outcome indicators were good measures of the project objectives. The indicators showed that:

Average coal consumption per unit of coal-fired electricity output – In all three provinces, both the original and revised reduction targets were exceeded. In Shanxi, the average consumption was reduced from 373 to 347 gce/kWh against a target of 354 gce/kWh. In Shandong it was reduced from 382 to 332 gce/kWh against a target of 366, while in Guangdong it was reduced from 342 to 299 gce/kWh against a target of 330 gce/kWh. The reductions were more substantial in Shandong and Guangdong than they were in Shanxi. Rather than a shortcoming of the project’s performance in Shanxi, this was due primarily to underestimating the government commitment to plant closures and implementation in the other two provinces. The reduction targets were exceeded by between 37 percent and 258 percent illustrating the impressive performance against outcome indicators.

Reduction of GHG emissions per unit of coal-fired electricity output in selected provinces – original and revised targets for GHG emissions were also exceeded in the three provinces by between 38 percent and 242 percent, though the intermediate outcomes for GHG reductions in four of the six plants did not meet their targets mainly due to less operational hours for these plants. In Shanxi, the reduction was from 1020 to 951 kgCO₂/MWh against a target of 970 kgCO₂/MWh. In Shandong the reduction was from 1045 to 909 kgCO₂/MWh against a target of 1002 kgCO₂/MWh, and in Guangdong the reduction was from 935 to 815 kgCO₂/MWh against a target of 900 kgCO₂/MWh. This reflects the improved energy management in the provinces and the secondary nature of these less efficient plants.

In addition to meeting the reduction targets, significant progress was made against the three priority areas of project activities. First, in mitigating the financial barriers of closing inefficient small-sized coal-fired units, provincial governments were provided with technical details outlining the necessary fiscal incentives to necessitate the closures. This technical support led to the issuance of the national policy, *Central Government Fiscal Incentives to Phase out Inefficient Capacity* and has led to further plant closures of over 150 GW since 2013. Second, the project was successful in demonstrating the viability of investments in efficiency improvements to existing mid-sized thermal units. The preliminary technical assistance contributed to administrative policies for energy saving technologies (MOF 2011) and mandates on comprehensive upgrading of coal fired power plants (MOF 2012). These policies have resulted in the technologies becoming standard industry practice in thermal plant rehabilitation. Third, the project developed effective regulations to implement the pilot ESD programs as well as conducting studies to support transition to efficient generation dispatch. This included successful support to the actual ESD dispatch rule in Guangdong that improved the current ESD model in the province. It also undertook technical reports including, an *assessment report on Pilot ESD in Five Provinces, 2014* and the *assessment report on Pollutants Allowance Trading in Shanxi and Shandong, 2014* both of which contributed to the transition to efficient generation dispatch in the three provinces.

Thus, the project's goal to reduce coal and GHG emissions in the three provinces is rated **Substantial**.

The economic internal rates of return (EIRR) were estimated using cost benefit analysis and the financial rates of return (FIRR) used cash flow analysis. The EIRR was conducted at appraisal and at completion for the investment sub-components for the first three power plants (Jinan Beijiao, Huangtai and Yangguang). In addition, EIRR was calculated for the three additional plants rehabilitated following restructuring, both at the time of the restructure and at completion. This resulted in EIRRs of between 11.3 percent at the low end and 176.2 percent at the upper end. Factors affecting these rates included lower than estimated capital expenditures and a decrease in the coal price which reduced the coal saving benefit. The overall EIRR for the various investments showed strong economic returns and excellent environmental and global benefits as a consequence of the investments.

Table 1. EIRRs and FIRRs at ICR and Appraisal

<i>Project</i>	<i>EIRR ICR</i>	<i>EIRR App</i>	<i>FIRR ICR</i>	<i>FIRR APP</i>	<i>Brief Explanation</i>
Beijiao Thermal Power	76.8%	26.7 %	91.79 %	16.96 %	significantly lower CAPEX
Huangtai Thermal Power Plant	176.2%	20.4 %	186.77 %	23.73 %	significantly lower CAPEX
Yangguang Power Plant	85.7 %	78.7 %	90.91 %	88.69 %	Lower CAPEX
Wuxiang Hexin Power Plant	20.8 %	25.1 %	11.9 %	13 %	Higher CAPEX Lower coal price

Taiyi Thermal Power Plant	11.3 %	16.4 %	5.3 %	7.7 %	Lower coal price
Weihai Thermal Power Plant	31.2 %	32.8%	20.1 %	25.4%	Lower coal price

Data taken from ICR pg 17.

The financial analysis of the six subcomponent objectives used the same ex-ante and ex-post cash-flow methodology. It had considerably higher returns ex-post due primarily to the lower capital expenditure outlays with rates varying between 7.7 percent at the low end up to 186.77 percent at the top end. The results largely confirmed the EIRR calculations showing extremely good returns for the projects investments on a purely financial basis. Adding environmental benefits to these financial returns shows clearly this was a **Substantially** rated project with regards to efficiency.

With a **Substantial** rating for relevance of objectives and design, a **Substantial** rating for efficacy in the three provinces, and **Substantial** achievement on efficiency, the overall outcome rating is **Satisfactory**.

Risk to development outcome is rated **moderate**. The retrofitted technologies sufficiently demonstrated their commercial viability and have been adopted by power stations in other provinces, as intended. The successful demonstration effect of the plant improvements showed that investing in efficiency gains made both financial and environmental sense. Plant managers acknowledged that there was strong commitment to further investments that improved performance against the government energy emission targets. In addition, the government under the 12th FYP (2011–15) planned further reforms and improvements in the sector, particularly regarding small thermal units. In summary, the project's risks against the different components is as follows:

The government's commitment to close down 50GW of inefficient small thermal plants was surpassed by 25 percent and further commitments of a 20GW reduction were in the 12th FYP (2011–15);

During the 12th FYP, thermal plant rehabilitation continues to be a government priority and three provinces¹ have already committed to further investments in changes piloted during this project.

The ESD operations in Guangdong are committed in the 12th FYP and are likely to be extended to other provinces in the 13th FYP following new ESD dispatch rules being instituted.

Bank Performance for the project is rated **Moderately Satisfactory**. In terms of the project's quality at entry, there was a clear linking of the project's activities to the theory of change underpinning the expected transformation of the sector. This was informed by previous World Bank experience in thermal power plant rehabilitation and lessons drawn from operations in the mining sector in China, Russia and Poland. The preparation time for the project (2.5 years) was longer than the government would have liked, but conversations with

the provincial authorities revealed that this made the impact of project activities immediate as much of the negotiation for the plant closures was wrapped into the project preparation period. This was one of the reasons for the swift government action on the plant closures. In addition, the M&E design was pragmatic and manageable for the provincial authorities, though it lacked sufficient detail on the broad range of issues that hindered the set up and operations of the trading platform.

With regards to the quality of supervision, there were minor shortcomings. As outlined in section 3.8, while the project team undertook the mandatory steps to ensure the various activities were delivered as expected and the team prepared comprehensive summaries of project contributions, there was a feeling amongst stakeholders that greater visibility and proactivity on the World Bank side might have amplified the achievements. Stakeholders argued that the World Bank was a distant partner and this remained a minor shortcoming in what was a very successful project.

The central government through its commitment to policy reform and its engagement with project counterparts showed a strong and ongoing commitment to making this project work. In addition, the high capacity of the project management units at the provincial level was a key aspect of the project's success and while some of the implementing agencies performed better than others, there was consensus that much of the impact was due to the approach they took to instigating the various activities. Therefore, the overall rating for borrower performance is **Satisfactory**.

As outlined in section 4.2, there was innovation and thoughtful application in the design, implementation and utilization of the project's monitoring and evaluation. The system was accessible, regularly maintained and provided good data to those who needed it to make necessary changes to the project at different times. The MIS informed the restructure and was the source for much of the regular reporting. Importantly, the information was also usefully applied to data platforms that illustrated the efficiency and performance benefits of a set of pilot projects. This proved extremely useful for other plants looking to undertake similar investments. For these reason, Monitoring and Evaluation is rated Substantial.

¹ Discussion with PIU staff in Shandong

Appendix B: Basic Project Information

Project cost: Actual project cost US\$96.4 million, 88.4 percent of the appraised estimate of US\$108.96 million.

World Bank Project Financing:

Country – China

Project Name – Thermal Power Efficiency

Project ID – P098654

ICR Date 02-20-2015

Original Commitment – USD 19.70M

Revised Amount – USD 19.54M

Environmental Category – B

GEF Grant of US\$19.70 million was disbursed.

Borrower contribution: At appraisal, the counterpart funding was estimated at US\$89.26 million, of which US\$15.50 million was central government (Recipient) and US\$73.76 million was from the provincial governments, power plants and commercial loans from local banks (sub-borrowers). At project closure, the actual contribution of the Recipient increased to US\$25.52 million, and the contribution from sub-borrowers reduced to US\$51.3 million. Total US\$76.82 million.

Dates: The project closing date was extended twice by a total of 18 months from the original closing date of December 31, 2012 to June 30, 2014, through two project restructurings. The first extension in 2012 was for one year to December 31, 2013, due to delays. During project restructuring in January 2013, the scope of activities and intermediate activities were modified and the outcome targets were revised upward. The second project closing date extension in 2013 was for six months to complete the studies and dissemination activities.

Appendix C: Methods and Evidence

This report was prepared following document review and field work carried out in two of the three targeted regions. Shandong and Shanxi provinces were chosen as the field investigation sites for two reasons. First, geographic proximity to Beijing and to each other made it possible for the evaluation team to cover more sites in the limited time available. Secondly, Shandong is the most populated region of the country, an important manufacturing hub and therefore a high energy user. This was a key factor in its inclusion in the original project design. Shanxi is a smaller province heavily reliant on coal mining and power generation for its state revenues and therefore in need of technical assistance to improve its energy performance. It provided a useful contrast to the Shandong experience. Guangzhou was more closely aligned to Shandong in terms of its provincial profile and therefore its achievements were covered through conversations with relevant parties in Beijing.

The project site visits covered four of the six pilot power stations. These were again determined by geographic location, but included both examples of those in the original cohort of pilots and those added in the post restructure period.

Interviews with relevant power station managers were complemented by additional discussions with second tier operational staff who provided technical insights. Tours of the pilot power stations included inspections of the installed and updated equipment and presentations on the impacts of the relevant investments.

Conversations with provincial counterparts and the project management units were undertaken in a workshop format with questions being given to participants, answers prepared in pairs and then broad discussion of the issues. This allowed a facilitated means of extracting inputs from all participants and not just those in more powerful positions.

Two sets of questions were prepared based on the two cohorts of interviews conducted against the different components. Those directed at plant operators and teams were focused more on the efficiency benefits and technical merits of the project, while those who prepared the analytical materials were asked questions about the projects relationships and the dissemination process in addition to technical feedback.

Appendix D: List of Those Consulted

- Mr. Lei Zhang, Director Ministry of Finance: International Department – Economy and Construction
- Mr. Min Tian, Section Chief, Ministry of Finance: International Department – Economy and Construction
- Ms. Lidia Giang, Section Chief, Ministry of Finance: International Department – Economy and Construction
- Mr. Shan Baoguo, State Grid Energy Research Institute
- Mr. Ma Yiqun, Senior Engineer, State Grid Energy Research Institute
- Mr. Liu Qing, Deputy Director, China Power Engineering Consulting Group Corp
- Mr. Ren Yuzhi, Director of General Division – National Energy Administration- Electric Power Department
- Mr. Kang Gouzhen, Director NEA Thermal Power Division
- Mr. Wan Hei, Director NEA Energy Transmission
- Mr. Ji Ri, General Administrator NEA power division
- Mr. Jiang Jing Jun, NEA Power Sector Division
- Ximeng Peng, Senior Energy Specialist, World Bank
- Jie Tang, Senior Energy Specialist, World Bank
- Mr Li, General Manager, Mr. Cao Zhao, Safety Manager – Yangguang Thermal Power Co. Ltd.
- Mr. Zhang Li Min, Director for Production, Mr. Zhang Shou Bin, Manager for Energy Saving, Wuxiang Hexin Power Generation Co. Ltd.
- Mr. Han, Director, Shanxi Environmental Protection Agency
- Mr. Louan Jun, Huangtai thermal power Co. Ltd.
- Mr. Li Yi, Production Manager, Jinan Beijiao Thermal Power Co. Ltd.
- Mr. Wang Aoxin, Manager, Shandong Power Grid Company
- Mr. Fan Feilang, Deputy Director, Shandong Environmental Protection Bureau
- Mr. Meng Li, Provincial Ministry of Finance, Shandong PMU former staff
- Mr. Tai Bing, Director Shandong Project Management Office

Appendix E: PPAR Overview

About this Report

The Independent Evaluation Group assesses the programs and activities of the World Bank for two purposes: first, to ensure the integrity of the Bank's self-evaluation process and to verify that the Bank's work is producing the expected results, and second, to help develop improved directions, policies, and procedures through the dissemination of lessons drawn from experience. As part of this work, IEG annually assesses 20-25 percent of the Bank's lending operations through fieldwork. In selecting operations for assessment, preference is given to those that are innovative, large, or complex; those that are relevant to upcoming studies or country evaluations; those for which Executive Directors or Bank management have requested assessments; and those that are likely to generate important lessons.

To prepare a Project Performance Assessment Report (PPAR), IEG staff examine project files and other documents; visit the borrowing country to discuss the operation with the government, and other in-country stakeholders, and interview Bank staff and other donor agency staff both at headquarters and in local offices as appropriate, as well as using other evaluative methods when needed.

Each PPAR is subject to internal IEG peer review, panel review, and management approval. Once cleared internally, the PPAR is commented on by the responsible Bank country director. The PPAR is also sent to the borrower for review. IEG incorporates both Bank and borrower comments as appropriate, and the borrowers' comments are attached to the document that is sent to the Bank's Board of Executive Directors. After an assessment report has been sent to the Board, it is disclosed to the public.

About the IEG Rating System for World Bank Evaluations

IEG's use of multiple evaluation methods offers both rigor and a necessary level of flexibility to adapt to lending instrument, project design, or sectoral approach. IEG evaluators all apply the same basic method to arrive at their project ratings. Following is the definition and rating scale used for each evaluation criterion (additional information is available on the IEG website: <http://ieg.worldbankgroup.org>).

Outcome: The extent to which the operation's major relevant objectives were achieved, or are expected to be achieved, efficiently. The rating has three dimensions: relevance, efficacy, and efficiency. *Relevance* includes relevance of objectives and relevance of design. Relevance of objectives is the extent to which the project's objectives are consistent with the country's current development priorities and with current Bank country and sectoral assistance strategies and corporate goals (expressed in Poverty Reduction Strategy Papers, Country Assistance Strategies, Sector Strategy Papers, Operational Policies). Relevance of design is the extent to which the project's design is consistent with the stated objectives. *Efficacy* is the extent to which the project's objectives were achieved, or are expected to be achieved, taking into account their relative importance. *Efficiency* is the extent to which the project achieved, or is expected to achieve, a return higher than the opportunity cost of capital and benefits at least cost compared to alternatives. The efficiency dimension generally is not applied to adjustment operations. *Possible ratings for Outcome:* Highly Satisfactory, Satisfactory, Moderately Satisfactory, Moderately Unsatisfactory, Unsatisfactory, Highly Unsatisfactory.

Risk to Development Outcome: The risk, at the time of evaluation, that development outcomes (or expected outcomes) will not be maintained (or realized). *Possible ratings for Risk to Development Outcome:* High, Significant, Moderate, Negligible to Low, Not Evaluable.

Bank Performance: The extent to which services provided by the Bank ensured quality at entry of the operation and supported effective implementation through appropriate supervision (including ensuring adequate transition arrangements for regular operation of supported activities after loan/credit closing, toward the achievement of development outcomes. The rating has two dimensions: quality at entry and quality of supervision. *Possible ratings for Bank Performance:* Highly Satisfactory, Satisfactory, Moderately Satisfactory, Moderately Unsatisfactory, Unsatisfactory, Highly Unsatisfactory.

Borrower Performance: The extent to which the borrower (including the government and implementing agency or agencies) ensured quality of preparation and implementation, and complied with covenants and agreements, toward the achievement of development outcomes. The rating has two dimensions: government performance and implementing agency(ies) performance. *Possible ratings for Borrower Performance:* Highly Satisfactory, Satisfactory, Moderately Satisfactory, Moderately Unsatisfactory, Unsatisfactory, Highly Unsatisfactory.

Appendix F: Other Issues

Implementation, environment and social safeguards, financial management, procurement

Procurement was managed in accordance with World Bank policies and procedures. In the evaluation team's discussions with the provincial authorities, respondents explained that the training and support in setting up systems consistent with World Bank procedures was thorough, comprehensive and well prepared. In addition, provincial PMUs utilized guidance and training provided by the World Bank to institute systems for other potential project funds. There were minor procurement issues confirmed by the TTL relating to record keeping in the Shandong PMU, but these were addressed through regular supervision missions and did not cause any undue impact on the roll-out of activities.

Financial management was also satisfactory, with regular financial reporting submitted on time. Project supervision identified several minor issues with regards to the structure and oversight of the PMUs, but these were also resolved through regular supervision missions. A bonus of the changes was an improvement in disbursement rates, highlighting the impact of careful World Bank supervision. Both the provincial authorities and the task team lead acknowledged that the strong relationship established between the World Bank and the PMUs ensured sound financial management. PMU staff understood the strict protocols for World Bank fiduciary oversight and responded positively to the support provided to this end.

Environmental and social safeguards

The project at appraisal was assessed as a category "B" project with the following two safeguard policies triggered: Environmental Assessment (OP/BP 4.01), and Involuntary Resettlement (OP/BP 4.12). A third safeguard, the Safety of Dams (OP 4.37), was triggered during the project restructuring in 2012-13 due to the Wuxiang Power Plant and the Taiyuan No.1 Plant plans to utilize water from reservoirs formed by two existing dams – the Guanhe and the Jinyanghu. The three policies were applicable to the activities associated with plant closures and rehabilitation.

Environmental Management Plans (EMP) were successfully prepared for the nine small plants closures and the six plants that underwent rehabilitation in accordance with the Environmental Management Framework (EMF). The plans included detailed assessments of the impact of noise, dust, waste water, and solid waste and appropriate remediation arrangements for these. The monitoring data and reporting included in the World Bank's operational portal showed that the plants fully complied with relevant environmental standards outlined in the EMP.

With regards to the involuntary resettlement safeguard triggered by the planned plant closures, an approved Resettlement Plan Framework (RPF) was prepared and followed through to completion in June 2013. Compensation and social protection measures were included in the original plans and instituted for affected workers. In conversations with plant employees, the evaluation team found that a large number of those laid off from closed plants were redeployed elsewhere by power companies due to the increased demand for skilled workers in the sector, particularly from larger thermal plants coming online. World Bank documentation indicated that social policies were followed and applied as outlined in the RPF.