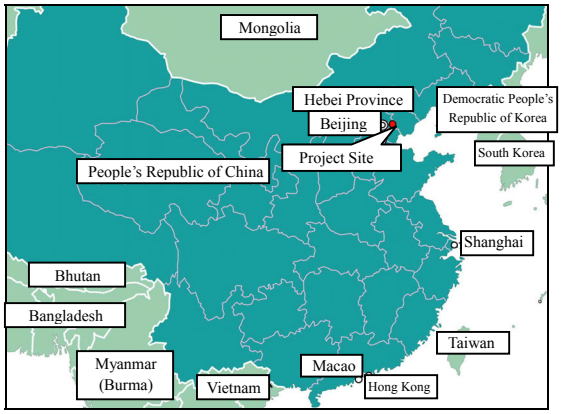
China

Sanhe Thermal Power Plant Project (I) (II)

Report Date: January 2003

Field Survey: October 2002

1. Project Profile and Japan's ODA Loan



People's Republic of China
Beijing East Yanjiao Economic Technical Development Zone
(an area 37.5km east of central Beijing)

Sanhe Power Plant

1.1 Background:

Power generation in China grew by an average 8% per year throughout the 1980s and by an annual average 9.5% during the first three years of the 1990s. 1992 review resulted in forecasts for planned growth being revised upwards to an average 8-9% per year for 1992-95 and an average 8% for the 1996-2000 period. Meanwhile, total industrial and agricultural production grew by an average 11% annually during the 1980s, surging to 20% per year during 1990-93, and power generation continued to lag behind industrial and agricultural production.

As part of the North China grid, the Beijing-Tianjin-Tangshan (BTT) area, the location of this project, is categorized as an extremely important network since it encompasses both Beijing and Tianjin special municipalities, and is responsible for powering Beijing City; the grid is designated as one of the most important targets for national investment in power. Estimated growth in power demand in the BTT area is essentially consistent with the average GNP growth forecast for the area of 10.6%, and between 1991-95 average annual growth in power demand was 9.2%, posting 9.8% per year between 1996-2000. There were plans to promote power investment in the BTT area on the basis of economic growth forecasts, however, supply was unable to keep pace with growth in power demand or the necessary installed capacity, and it was predicted that the shortages would continue in the short term.

1.2 Objectives

To construct a coal-fired thermal power plant with two 300MW generation units to be fueled using domestically produced coal in Sanhe City, located 37.5km east of Beijing in Hebei Province in order to alleviate power shortfalls in the BTT area.

1.3 Project Scope:

(i) Construction of a coal-fired thermal power station (2×300MW generation units)

(ii) Consulting services relating to (i)

The yen loan covered all foreign currency funds necessary for the above work.

1.4 Borrower/Executing Agency

Ministry of Foreign Trade and Economic Cooperation[1]/Power Industry Department, North China Power (Group) Corporation

1.5 Outline of Loan Agreement

	Construction Project (1)	Construction Project (2)
Loan Amount	10,948 million yen	13,652 million yen
Loan Disbursed Amount	10,137 million yen	12,862 million yen
Exchange of Notes	January 1995	October 1995
Loan Agreement	January 1995	November 1995
Terms and Conditions		
-Interest Rate	2.6%	2.3%
-Repayment Period	30 years	30 years
(Grace Period)	(10 years)	(10 years)
-Procurement	General untied	General untied
Final Disbursement Date	February 2002	December 2002

2. Results and Evaluation

2.1 Relevance

Average annual growth in power demand for the BTT area was estimated at 9.8% for 1996-2000, and ensuring stable supply resources had become a priority task. Actual growth in power demand and supply for the period was 7% on average, falling slightly short of forecasts as the impact of slow economic growth due to the Asian currency crisis in the latter half of the 1990s took effect, however, the trend toward growth in power demand was continuous.

[1] The current Ministry of Foreign Trade and Economic Cooperation. As of 1999, the borrower was changed to the government of the People's Republic of China (Ministry of Finance).

Moreover, demand for power has continued to expand since completion of this project and BTT area demand, according to the Sanhe Power Plant, was predicted to grow by approximately 10% in 2002. Transmissions from outside the area have been utilized to meet this growth in demand, and whilst there have been no critical shortages in supply post 1997, the year preceding completion, the BTT area incorporates the coastal region and the nation's capital, regions of remarkable economic growth in modern China, and thus more efficient, highly stable supplies of electricity continue to be necessary.

In addition, this project was identified as being an important infrastructure construction project both during appraisal and in subsequent plans[2] for Beijing/Hebei Province and was thus consistent with government policies for the region.

2.2 Efficiency

2.2.1 Project Scope

Despite modifications to detailed specifications of the project outline, the changes had no major impact on either the implementation schedule or project costs.

2.2.2 Implementation Schedule

The implementation schedule was delayed by about a year all told. This was the result of holdups between preparation of the equipment tender and securing the contract (roughly 9 months). Additionally, problems with equipment and customs inspections caused further delays, with the result that the start of commercial operation was pushed back by 18 months for generator 1 and by a year for generator 2.

2.2.3 Project Cost

Actual foreign currency costs were essentially in line with planned costs, however, the local currency portion overran Phase 2 plans by approximately 23%. The increase in local currency costs was partially the result of the modifications to detailed specifications, but was mainly caused by price increases.

2.3 Effectiveness

2.3.1 Generating Performance

Generator 1 became operational in December 1999 and officially commenced on-grid generation in June 2000, whilst generator 2 started operating in April 2000 and officially came on stream in October of the same year. The gaps between operational startup and the start of on-grid power

[2] The Sanhe Power Plant was mentioned in both the "Beijing National Socioeconomic Development [9-5] Plan and 2010 Target Forecasts" and the "Hebei National Socioeconomic Development [9-5] Plan and 2010 Target Forecasts" as being an important infrastructure construction project.

generation came about because defects were detected in part of the generators' equipment after they were put into operation (pressure in the reheating element not meeting design specifications, etc.) necessitating replacement and recalibration. In terms of generating performance, despite the initial delay in startup due to equipment problems and numerous stoppages for adjustment, the problems were dealt with fairly rapidly, as the result of which generation results for 2000 surpassed appraisal targets (Table 1). Results for 2001 and 2002 (up to October) were slightly lower than planned, but achieved upwards of 80% of target levels. The availability factor for both generation units was 80%+ in 2001 (Table 2), and there were decreases in both downtime due to malfunctions and failures over the previous year (Tables 2 & 3). The fact that generation has not reached planned levels is considered primarily attributable to the slightly low capacity factor figures, but is also the result of power demand on the network as a whole, and since the equipment is operating smoothly, this is not considered to be an issue. The first two years correspond the post startup equipment adjustment period, however, stable operation was realized in 2002, the third year, and as of November the generators have recorded continuously stable operation for upwards of 500 hours.

Table 1: Actual Annual Power Generation (GWh)

Item	Planned (JBIC appraisal figure)	Planned (Sanhe Power Plant figure)	Actual
1st year of operation (1999)[1]	175	N.A.	46
2nd year of operation (2000)	2,500	N.A.	2,792
3rd year of operation (2001)	4,200	3,773	3,630
4th year of operation (2002)[2]	4,200	2,874	3,140

Note 1: The result figure is estimated from power sales results.

Note 2: The result is for the period until October.

Table 2: Capacity factors, availability factors, failure rates

Item		2000	2001
Capacity factor (%)	Generator1	65.4	64.7
	Generator 2	65.2	69.2
Availability factor (%)	Generator 1	88.1	86.1
	Generator 2	67.5	83.7
Failure rate (%)	Generator 1	1.9	1.6
	Generator 2	8.5	4.4

Notes:
Capacity factor = volume of power generated during a certain period (kWh) / potential power generation during the same period (kWh)
Availability factor = number of hours operated within a certain period (hr) / total number of hours for the calendar days in the same period
Failure rate = downtime due to failures / (operating time + downtime due to failures)

Table 3: Operational downtime (hours)

Item	2000	2001	2002 (up to Oct.)
Downtime for routine inspections	1,263.60	721.66	795.00
Downtime due to breakdowns	779.53	467.35	19.07

Source: Tables 1-3 compiled from Sanhe Power Plant data

2.3.2 Alleviation of Power Shortages

As stated in 2.1 “Relevance”, a look at supply/demand conditions in the BTT area reveals that supply/demand has stabilized since 1997, and according to the North China Power Corporation, it has not been necessary to impose service interruptions due to supply shortages in recent years.

Next, although installed capacity at the Sanhe Power Plant represents only around 4% of total installed capacity for all power plants in the BTT area (figures for 2000), electricity supplies have been on the up since around 2000, the year the project was completed (Figure 1, Table 4), and the plant is considered to have made a substantial contribution to meeting recent growth in power demand. In view of the fact that power was previously imported from Inner Mongolia or Shanxi Province to meet shortages in the BTT area, the significance of this project lies in the fact that it is responding to recent increases in power demand, and that it is providing power to substitute for supplies that would have had to have been imported from other areas where the project not to have been implemented. Specifically, the construction of a power station in the Beijing metropolitan area where demand for power is at its highest has served to enhance trust in transmission efficiency and power supplies.

Figure 1: Power demand and supply volumes

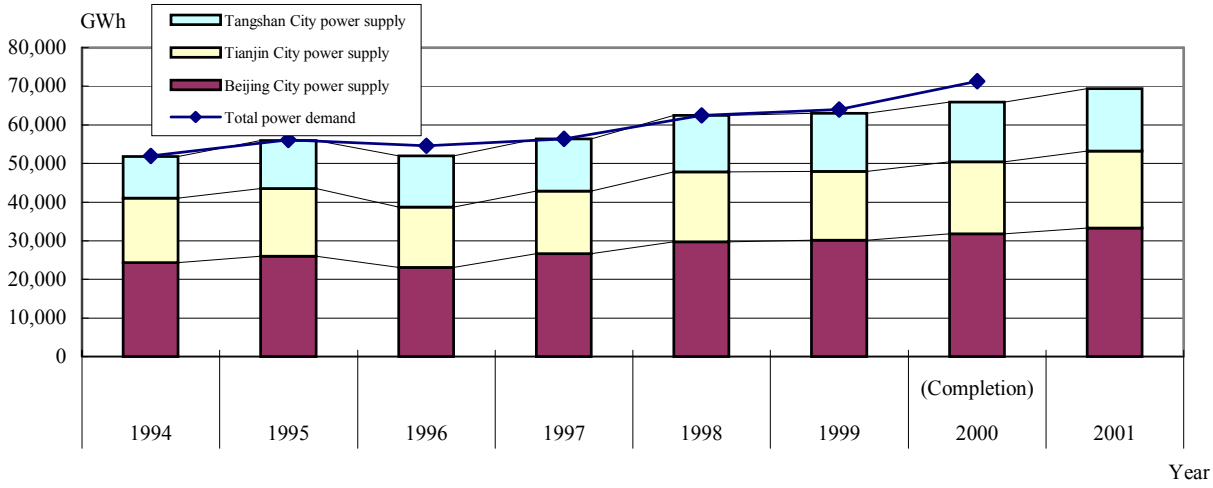


Table 4: Power Indicators for the BTT Area

Item		1993	1994	1995	1996	1997	1998	1999	2000	2001
Installed capacity (MW)	Planned	11,154	11,979	13,619	15,144	15,929	17,729	20,929	22,629	N.A.
	Actual	10,011	10,240	10,618	11,351	15,423	16,053	18,065	18,179	19,203
Maximum load (GW)	Planned	11,148	12,180	13,320	14,616	16,056	17,628	19,344	21,240	N.A.
	Actual	8,567	9,199	10,391	9,975	10,243	11,529	11,757	14,000	15,210
Power generated (GWh)	Planned	55,588	58,900	65,000	73,300	79,200	85,800	98,500	111,000	N.A.
	Actual	49,485	51,057	52,531	58,629	69,291	70,178	76,034	84,507	77,568
Power exported (GWh)	Planned	—	—	—	—	—	—	—	—	N.A.
	Actual	—	—	—	—	—	—	—	—	1,000
Power received from outside the area (GWh)	Planned	2,723	3,000	3,000	3,000	3,500	3,500	3,500	3,500	N.A.
	Actual	4,079	5,456	6,746	8,719	8,688	8,796	9,065	9,425	10,939
Transmission losses (%)	Actual	N.A.	8.09	8.37	7.56	7.12	7.56	8.06	8.21	7.95

Source: Figure 1 and Table 4 were compiled from North China Power Corporation data

2.3.3 Recalculation of Financial Internal Rate of Return (FIRR)

When the FIRR for the project was calculated using the factors listed below, as estimated at appraisal, the figure was 14.10%. However, recalculated on the basis of evaluation results and forecasts for the future, the figure becomes 8.19%. The main reason for the drop is that annual increases in selling prices have tended to be slightly lower than anticipated, whilst fuel costs increases have exceeded forecasts pushing costs over planned levels.

Project life: 25 years from start of commercial operation
Benefits: Revenue from power sales
Costs: Project investment costs, fuel costs, operation and maintenance costs, taxes

2.4 Impact

2.4.1 Regional Socioeconomic Development

The economies of all three cities in the BTT area have been on a growth trajectory since around the time of project completion (Table 5), from which it may be inferred that the power supplied via the project (approx. 4-5% of total supply in the BTT area according to results for 2000/2001) has responded to the upsurge in demand that has accompanied economic development in the region. When growth in power consumption for commercial, industrial and domestic purposes in the BTT area for this period is indexed to supply for 1994 as the benchmark (=100) (Table 6), it becomes clear that whilst the supply volume grew by 59% overall between 1994-2001, commercial use supply grew by approximately 379% and domestic use supply by approximately 162%, indicating that supplies to these two sectors have increased substantially. As stated in the "Effectiveness" section, the benefits to Beijing are thought to have been particularly marked because the project site is located near this city, and according to North China Power Corporation there has been an upsurge in the use of household electrical appliances, especially air conditioners, and the growth in demand for domestic uses has been remarkable in recent years.

Table 5: GDP for cities in the BTT Area
(Unit: 100 million yuan, standard prices for 1996[1])

Item	1996	1997	1998	1999	2000	2001
Beijing	1,615.7	1,760.8	1,968.3	2,156.1	2,438.3	2,779.7
Tianjin	1,099.5	1,201.6	1,307.8	1,437.8	1,612.6	1,797.4
Tangshan	607.3	691.5	764.5	825.4	900.0	983.1

Source: Statistical yearbooks for each municipality, China Statistical Yearbook 2002

Note: 1) GDP is based on 1996 prices. The figures are calculated using the CPI for all cities, as listed in the National Statistical Yearbook.

Table 6: BTT Area Sector-based Power Supply Indicators (where 1994=100)

	Item	1995	1996	1997	1998	1999	2000	2001
Power supply (GWh)	Commercial	114.62	126.34	193.01	278.38	327.70	380.56	479.02
	Industrial	107.30	113.13	117.28	122.41	122.41	130.09	141.23
	Domestic	116.64	129.38	152.51	176.95	192.92	224.08	262.13
	Total	108.25	114.79	121.98	130.60	133.08	143.77	159.19

Source: Calculated using North China Power Corporation data.

2.4.2 Social and Environmental Impacts

In terms of the social impact of the project, although no household relocation was undertaken it was necessary to acquire some land (agricultural). According to a report from the executing agency, no problems arose in connection with the land acquisition.

With regard to the project's environmental impact, during the course of the on-site inspection and field survey it was confirmed that the matters outlined below, which were raised by JBIC and the executing agency during the appraisal study, were being observed. Specifically:

・Coal sulfur content: 0.63% (actually 0.49%)

・Routine inspections implemented on the basis of the "Thermal Power Plant Environment Measurement Ordinance"

・Electrical ash collectors (99.89% collection rate confirmed, availability factor: 100%)

・Stack height: 240m

・Securing of a site for future desulfurization facilities

Moreover, all coal ash generated by the plant as waste is being sold for use in construction materials, such as cement. Furthermore, the plant passed the inspection of the National Environmental Protection Agency (NEPA) conducted in June 2001 after project completion.

A verification of the measurement results on the quality of air from vent and water emissions revealed that all values were in conformity with national standards (Table 7). Monitoring of air quality in the vicinity of the plant is undertaken biannually in summer and winter over a period of several days. Checks were performed on a sample of the results for key items measured on 7 consecutive days during the winter 2000 and winter 2001 monitoring studies revealing no specific problems that could be attributed to this project[3]. Further, the only residential area in the vicinity is for plant employees and no adverse effects on residents have been identified. In addition, the Sanhe Power Plant acquired domestic/international ISO14001 certification of its Environmental Management System in September 2002 and is prioritizing environmental management across all its operations.

Table 7: Measurement Results for Air Emissions

Item	Item measured	Appraisal specification	NEPA Limit threshold [1]	2000 (year completed)	2001	2002 (through Nov.)
Air	SO_2	—	2,100 mg/Nm^3 (installed processing capacity ＝＜1,500 mg/Nm^3)	904 mg/Nm^3	1,116mg/Nm^3	808.9 mg/Nm^3
	NOx	＜400ppm (=approx. 810 mg/Nm^3) [2]	650mg /Nm^3 (installed processing capacity ＝＜500 mg/Nm^3)	423 mg/Nm^3	346.5 mg/Nm^3	412.2 mg/Nm^3
	TSP	100mg/ Nm^3	200mg/Nm^3 (installed processing capacity ＝＜100 mg/Nm^3)	95.3 mg/Nm^3	47.5 mg/Nm^3	48.5 mg/Nm^3
Waste Water From Vent	pH	—	6-9	9	8.71-8.83	8.56
	BOD	—	60mg/l	17.4 mg/l	9.9 mg/l	21.0 mg/l
	COD	—	150mg/l	13.1 mg/l	30.5 mg/l	4 mg/l
	SS	—	200 mg/l	9.3 mg/l	83.5 mg/l	16 mg/l
	Oil	—	10 mg/l	3.5 mg/l	0.8 mg/l	0.5 mg/l

Notes: 1) Atmospheric SO_2 and dust levels conform to Level 2 of GB13223-1996, NOx levels conform to Level 3 of GB13223-1996. Wastewater conforms to the GB8978-1996 standard value.
2) Calculated from the value for NO_2.
Source: Sanhe Power Plant data

[3] Figures for some items (PM10, CO, etc.) exceeded reference values, but besides the fact the data is for the winter season when air pollution values are normally high, non-plant factors must also be incorporated, and hence it is difficult to make a strict judgment on the basis of available data alone.

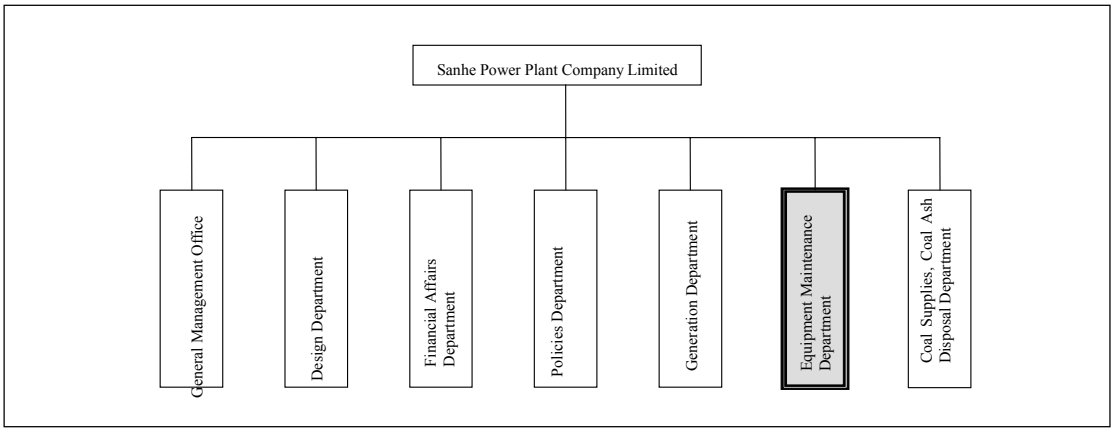
2.5 Sustainability

2.5.1 Maintenance System

The Sanhe Power Plant is currently being operated and maintained as a limited stock corporation (Sanhe Power Plant Co., Ltd.). “Beijing Guohua Electric Power Co., Ltd.”, which was established in March 1999 after being partially separated from North China Power (Group) Corporation, owns 55% of the stock.

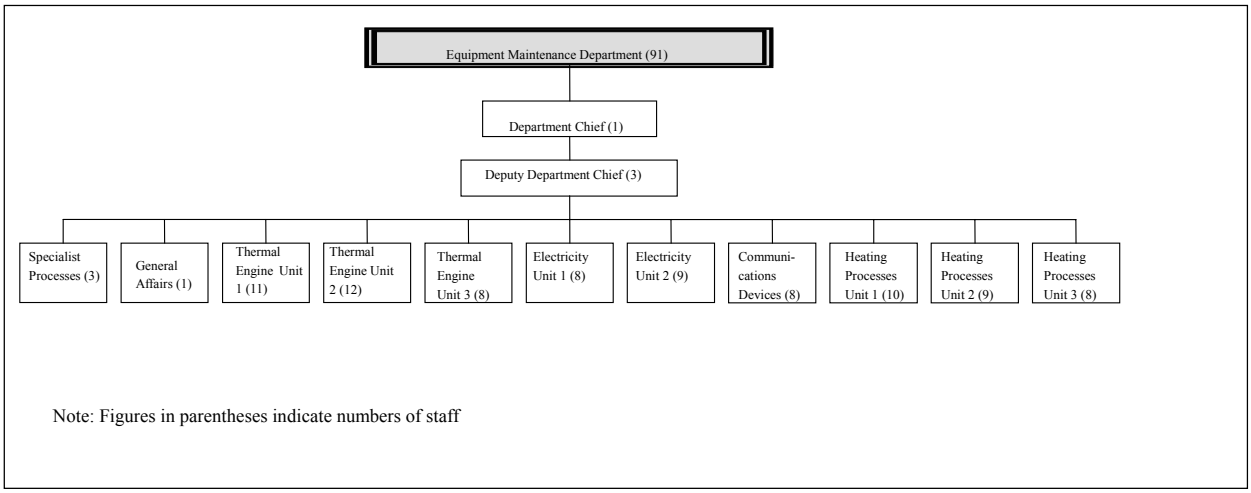
As the organization chart in Figure 2 shows, Sanhe Thermal Power Plant comprises seven departments and employs a total of 444 staff. As shown in Figure 3, the operation and maintenance of the project facilities is the responsibility of the Equipment Maintenance Department, which has a staff of 91.

Figure 2: Sanhe Power Plant Organizational Chart



Source: Sanhe Power Plant data

Figure 3: Facilities Maintenance Department – Organizational Chart



Source: Sanhe Power Plant data

2.5.2 Technological Capability vis-à-vis Operation and Maintenance

At the time of the field survey, equipment maintenance and generation conditions were favorable and no specific technological problems were identified. Routine inspections and maintenance work are being conducted in conformity with standards for inspection and maintenance established by Sanhe Power Plant Co., Ltd., and the plant has also adopted the NOSA management system[4]. In addition, all employees are subject to an internal evaluation of specialist technical ability and receive training, and those who successfully pass the tests obtain qualifications. Moreover, domestic training was implemented prior to the start of on-grid production, with workers being dispatched to other power plants within China, and 123 workers have also received training overseas. Training is planned and implemented on an annual basis, and the management has concluded a contract with a technical service provider and utilizes the services of outside technicians (North China Power Scientific Research Institute) when technical skills are found to be lacking. Where necessary, the plant receives assistance from 北京国華力源工程公司（also a subsidiary of Beijing Guohua Electric Power Co., Ltd.）.

2.5.3 Financial Status

Net profits for 2000, the year of completion, were negative because facilities operation had yet to stabilize, however, net profits have increased since 2001 as the result of operational stability, an increase in sales revenue in line with hikes in the selling price of power and the realization of cost reductions (Table 8). All financial indicators for 2001 improved over the previous year. Earnings are sufficient to cover current maintenance costs. The target for the future is to expand capacity to 1,200MW, the scale decided upon in the initial comprehensive plan, and plans are in progress to add two 300 MW generation units.

Table 8: Financial Data *Unit: Thousand RMB

Item	2000*	2001*	Item	2000	2001
Current assets	395,441	288,734	Liquidity ratio	52.8%	67.5%
Current liabilities	748,587	427,420	Equity ratio	20.8%	27.4%
Capital	856,395	1,034,130	Ratio of profit to	△0.0%	23.1%
Total assets (Total	4,101,374	3,765,602	Profit ratio of total	△0.0%	4.7%
Sales	564,467	768,399	Returns on equity	△0.0%	17.1%
Net profit	△74	177,735	—	—	—

Source: Sanhe Power Plant Company Limited audit and financial reports

[4] A system developed by the National Occupational Safety Organization (NOSA) in South Africa in 1951 for rating safety management systems according to five grades (stars). It has gained popularity in Latin America (Brazil, Chili, Peru), Hong Kong, and Australia. The Sanhe Power Plant is currently rated as Level 3 (3-star), but is moving towards a Level 4 (4-star) rating.

Comparison of Original and Actual Scope

Item	Original Plan (Phase 1)	Revised Plan (Phase 2)	Actual
1. Project Scope			
(1) Construction of a coal-fired thermal power plant (300MW×2)	・Boiler, steam turbine generator (2 each)	・As left	・As planned
	・Transformers, electrical equipment, measuring instruments and control devices	・As left	・As planned
	・Coal transport equipment, ash disposal equipment	・As left	・As planned
	・Main and auxiliary buildings	・As left	・As planned
	・Concrete stack with concentric internal cylinders	・As left	・As planned
	・Railway branch line	・As left	・As planned
	・De-mineralizing equipment, waste water processing equipment, fuel tank	・As left	・As planned
	・Construction equipment, various testing equipment and plant workers, special industrial tools, spare parts, etc.	・As left	・As planned
(2) Consulting services	Foreign consultants 55M/M	・As left	・As planned
2. Implementation Schedule			
・Consultant selection	Aug. 1994 – Jan. 1995		Sep. 1994
・Tender preparation – tender – tender evaluation – contract approval	Feb. 1995 – Jan. 1996		Feb. 1995 – Oct. 1996
・Preliminary design – approval – D/D	Mar. 1996 – Aug. 1998	As left	Mar. 1997 – early 1999
・Installation of generating equipment	Aug. 1996 – Dec. 1998 (generator 1) Jun. 1997 – Oct. 1999 (generator 2)		Nov. 1996 – Dec. 1999 Jun. 1997 – Apr. 2000
・Start of commercial operation	Dec. 1998 – (generator 1) Nov. 1999 – (generator 2)		Jun. 2000 – (generator 1) Oct. 2000 – (generator 2)
3. Project Cost			
Foreign currency	25,243 million yen	24,600 million yen	22,999 million yen
Local currency	14,144 million yen (1,189 million yuan)	20,756 million yen (1,774 million yuan)	31,522 million yen (2,186 million yuan)
Total	39,387 million yen	45,356 million yen	54,521 million yen
ODA loan portion	25,243 million yen	24,600 million yen	22,999 million yen
Exchange rate	RMB1 = JP¥11.9 (1994 rate)	RMB1 = JP¥11.7 (1994 rate)	RMB1 = JP¥14.4 (average rate for 1996-2002)

Third Party Evaluator's Opinion on
Sanhe Thermal Power Plant Project (I) (II)

Mr. Li Jiabin
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1. Relevance

The Project is located in the Beijing-Tanjin-Tangshan zone (BTT zone), the metropolitan area registering a strong economic growth in China. In terms of power grid system, this zone belongs to the Northern China Power Grid. Demand for power in this zone was predicted to grow by an annual average of 9.8% over 1996-2000, and securing stable power supply source was urgently needed. Whereas the Asian currency crisis has somewhat dented economic growth and actual power demand/supply grew by less-than-projected 7% on yearly average, power demand continued robust growth. The Project is also designated one of the key infrastructure construction projects in the 9th Five-Year Plans prepared by the Beijing municipal government and Hebei Province. Judging from these considerations, the Project's has very high relevance.

2. Efficiency

The work schedule was delayed by one year. The primary reason for it was a delay in the procedures from bidding preparation through contract signing.

The Project cost remained almost at the initially planned level for the foreign currency portion. There was a 23% increase for the local currency portion, however. This is attributable partly to changes in detailed specifications, but mainly due to a hike in the general price level.

3. Effectiveness and Impact

Starting from years around 2000 when the Project was completed, power supply for the BTT zone has grown consistently. One may safely conclude that the Project has made significant contribution to meeting the recently expanding demand for power in this zone. Given the fact that power was procured from Nei Mongol and Shanxi Province to make up for occasional power shortages in the BTT zone, the Project has actually helped meet rapidly increasing demand for power and provided alternative power to replace the one that had to be supplied from outside sources if there had not been the Project. It should be specially noted that by constructing a power plant in the metropolitan area where Beijing with the highest demand for power is located, there was an increased confidence in efficient transmission and power supply. Also, since Beijing households are using a growing number of electric appliances such as air conditioners in recent years, there has been a tremendous increase in their power use. In this context, it may be said that the Project has contributed to improve living standards of the consumers in Beijing.

With regard to environmental considerations, low sulfur coal was used, regular inspections were conducted consistently, electric dust extractors were installed, a 240-meter high smoke stuck was built, and a site was secured to install a desulfurizer in the future. As a result, both emissions and effluents have met China's national environmental standards. In addition, coal ash, a by-product of the operation, is sold as a material for cement production. Also, the Sanhe Thermal Power Plant places emphasis on environmental management in its operation, as attested by the acquisition of the ISO 14000 accreditation for environmental management systems in September 2002.

4. Sustainability

Sanhe Power Plant Co., Ltd. is responsible for management and operation/maintenance of the Sanhe Thermal Power Plant. Analysis of its organization, technology/human resources and finances reveals no particular problems in project sustainability. Setting its sight on 1,200MW capacity decided under the initial master plan, the Sanhe Power Plant Co., Ltd. is planning to build two additional 300MW units.

5. Recommendations

None.