India

Anpara B Thermal Power Station Construction Project (1) – (5)

External Evaluation: Chiaki Nakamura

Field Survey: September 2004

1. Project Profile and Japan's ODA Loan

Region Map of Project Site

View of Anpara B Thermal Power Station

1.1 Background

Based on a government policy of economic deregulation, India has been promoting long-term structural reforms in the industrial, public, and trade sectors and been endeavoring to fortify the competitiveness of the country's industries on an international level. However, economic and industrial activities have been negatively affected by the fact that the electric power sector, one of the vital sectors that holds the key to all industrial infrastructure, is constantly plagued by the problem of electric power shortage on a national scale.

The state of Uttar Pradesh (UP) has a land area equivalent to approximately 60% of Japan and a population (approximately 148 million people) that is slightly larger than Japan's, but the capacity of its power generation facilities is only about as large as Shikoku Electric Power Company. The facility capacity for power generation in UP was 3,744 MW as of the end of March 1982, but the actual supply was not sufficient to meet demand for reasons that include the low rate of operation of thermal power plants, which account for approximately 70% of facility. As a result of insufficient supply of electric power, there were constant limitations on the supply of electric power which produced serious effects on the society and economy of UP. Because UP gave priority to the agricultural sector in supplying electric power, the electric power shortage was more pronounced in the industrial sector. In 1988, peak demand in UP was forecasted to grow by approximately 10% per year, and so the serious supply shortage was forecast to continue unabated.

This project, which was implemented in five phases, from December 1984 to December 2002, was planned for the purpose of alleviating such electric power shortages in this state.

1.2 Objectives

The objective of this project was to alleviate electric power shortages in UP by constructing a coal-fired thermal power plant with a facility capacity of 1,000 MW (500 MW ×2 facilities) in the Sonbhadra region in southeastern UP, and thereby to contribute to the economic development of the state.

Figure 1: Site Map of this Project

1.3 Borrower/Executing Agency

President of the Republic of India/Uttar Pradesh Rajya Vidyut Utapadan Nigam Limited (UPRVUNL)[1]

1.4 Outline of Loan Agreement

	Phase 1
Loan Amount/ Disbursed Amount	24,100 million yen/24,100 million yen
Exchange of Notes/Loan Agreement	August 1982/December 1984
Terms and Conditions -Interest Rate -Repayment Period (Grace Period) -Procurement	 2.7% 30 years (10 years) General Untied (Consultant agreement is partial untied)
Final Disbursement Date	December 1992

[1] In January 2000, operations were divided by sector due to unbundling of the State Electricity Board. The current executing agency (thermal power plant sector) is Uttar Pradesh Rajya Vidyut Utapadan Nigam Limited (UPRVUNL).

Main Agreement	Mitsui & Co., Ltd./Bharat Heavy Electricals (Japan/India)
Consultant Agreement	Tokyo Electric Power Services Co., Ltd./ Electric Power Development International Co.,Ltd (Japan/Japan)
Feasibility Study(F/S), etc.	1981, Government of India

	Phase 2
Loan Amount/Disbursed Amount	14,295 million yen/13,901 million yen
Exchange of Notes/Loan Agreement	September 1987/February 1988
Terms and Conditions -Interest Rate -Repayment Period (Grace Period) -Procurement	 2.75% 30 years (10 years) General Untied (Consultant agreement is partial untied)
Final Disbursement Date	February 1993
Main Agreement	Mitsui & Co., Ltd./Bharat Heavy Electricals (Japan/India)
Consultant Agreement	Tokyo Electric Power Services Co., Ltd./ Electric Power Development International Co.,Ltd (Japan/Japan)
Feasibility Study(F/S), etc.	1981, Government of India

	Phase 3
Loan Amount/Disbursed Amount	49,801 million yen/49,801million yen
Exchange of Notes/Loan Agreement	September 1990/January 1991
Terms and Conditions -Interest Rate -Repayment Period (Grace Period) -Procurement	 2.5% 30 years (10 years) General Untied (Consultant agreement is partial untied)
Final Disbursement Date	August 1993
Main Agreement	Mitsui & Co., Ltd./Bharat Heavy Electricals (Japan/India)
Consultant Agreement	Tokyo Electric Power Services Co., Ltd./ Electric Power Development International Co.,Ltd (Japan/Japan)
Feasibility Study(F/S), etc.	1981, Government of India

	Phase 4
Loan Amount/Disbursed Amount	13,224 million yen/13,200 million yen
Exchange of Notes/Loan Agreement	October 1992/December 1992
Terms and Conditions -Interest Rate -Repayment Period (Grace Period) -Procurement	 2.6% 30 years (10 years) General Untied (Consultant agreement is partial untied)
Final Disbursement Date	December 1995
Main Agreement	Mitsui & Co., Ltd./Bharat Heavy Electricals (Japan/India)
Consultant Agreement	Tokyo Electric Power Services Co., Ltd./ Electric Power Development International Co.,Ltd (Japan/Japan)
Feasibility Study(F/S), etc.	1981, Government of India

	Phase 5
Loan Amount/Disbursed Amount	17,638 million yen/17,426 million yen
Exchange of Notes/Loan Agreement	December 1993/January 1994
Terms and Conditions -Interest Rate -Repayment Period (Grace Period) -Procurement	 2.6% 30 years (10 years) General Untied (Consultant agreement is partial untied)
Final Disbursement Date	December 2002
Main Agreement	Mitsui & Co., Ltd./Bharat Heavy Electricals(Japan/India)
Consultant Agreement	Tokyo Electric Power Services Co., Ltd./ Electric Power Development International Co.,Ltd (Japan/Japan)
Feasibility Study(F/S), etc.	1981, Government of India

2. Results and Evaluation

2.1 Relevance

2.1.1 Relevance of Plan at the Time of Appraisal

In India's national development plans (5-year plans), promotion of economic growth was consistently mentioned as a major topic.

The electric power shortage in UP was serious even though preparation of infrastructure

including electric power is a prerequisite for poverty alleviation and economic growth. For that reason, in UP's 6th (1980-1984), 7th (1985-1989), and 8th (1992-1996) 5-year plans, alleviation of the electric power shortage was mentioned as an important issue.

This was a project to construct a coal-fired thermal power plant with an output of 1,000 MW in the Sonbhadra region in southeastern UP. As a measure in response to the above issues, the project had high priority.

2.1.2 Relevance of the Plan at the Time of Evaluation

In the current 10th (2002-2007) 5-year plan, poverty alleviation and economic growth are positioned as major topics.

Economic growth in UP is tending toward a slow down, and preparation of more substantial infrastructure including electric power remains an important issue. UP has been implementing reforms in the electric power sector since 1999 with the aim of alleviating the shortages in the electric power supply.

Thermal power generation occupies significant portion of the Power Plants' Power Generation Capacity in 2002 (Figure2) primarily attributable to the independece of Uttar Anchal from UP in 2000, where many hydroelectric power plants were located(Table1). UP does not possess sufficient water resources and cannot adequately meet the rapidly growing demand for electric power with hydroelectric power. Consequently, the importance of this project, which contributes to an expansion in thermal power generation facilities, continues to be high.

In India, it has been expected that private sector plays siginificant role to mitigate electric power shortages in recent days. Although it would be difficult to privatize the electric power sector soon, privatization will be realized in the long term. At the current stage, the role of the public sector is still essential, and priority of this project is high.

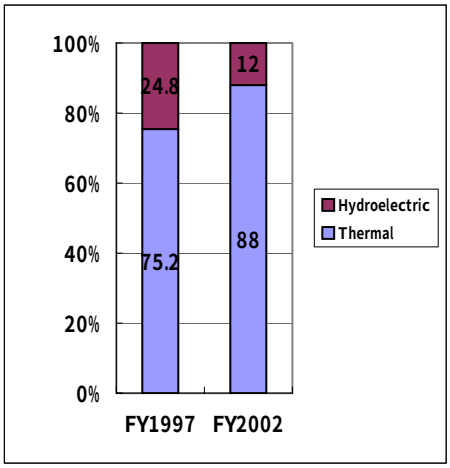
From the above standpoints, the project's importance is considered high at the current stage in time.

Table 1: Power Plants' Power Generation Capacity (end of March 2000)

Fuel	Plant Name	MW	%
Coal	Obra	1,442	26.6
	Anpara B	1,000	18.5
	Anpara A	630	11.6
	Harduaganji B.C.	374	6.9
	Panki	242	4.5
	Paricha	220	4.1
Hydro	Yamuna Satges I to IV	355	6.6
	Rihand	300	5.5
	Ramaganga	198	3.7
	Chilla	144	2.7
	Khordi	120	2.2
	Obra	99	1.8
	Maner Bhali	90	1.7
	Khara	72	1.3
	Khatima	41	0.8
	Mini/Micro Hydel	36	0.7
	Matatila	30	0.6
	Pathri	20	0.4
Total		5,413	100

Note: The shaded plants were transferred to Uttar Anchal.
Source: SEB Report 2001, 2002

Figure 2: Trends in UP's Thermal and Hydroelectric



Source: Planning Commission, 2002

2.2 Efficiency

2.2.1 Output

Figure 3: View of Anpara B Thermal Power Plant

The overall plan of Anpara B Thermal Power Plant is consisted of two power generation facilities with an output of 500 MW each. Of those, facility #1 was funded by ODA loan, and facility #2 was funded by the former Export-Import Bank of Japan. Equipments used jointly by both facilities are funded by ODA loan. The overall output is as follows.

(1) 2 power generation facilities with an output of 500 MW each (boilers, turbines, generators, and electrical facilities)

(2) Equipment used jointly by both facilities #1 and #2 such as water, coal, ash processing equipment, and materials and machinery for engineering works.

The output, including the component of the former Export-Import Bank of Japan, was implemented as planed. The plants have operated successfully and maintenances were made appropriately after the completion of facility #1 of the Anpara B Thermal Power Plant in March 1994 and facility #2 in October that year. Furthermore, spare parts were additionally procured to maintain the smooth operation of the power plant and to restock the supply. In September 1999, the Government of India made it obligatory for all coal-fired thermal power plants to recycle coal ash, and in May 2000, the Japan Bank for International Cooperation (JBIC) implemented a project supervision study. Based on the recommendations of the review,

additional construction of a collection system for coal ash (fly ash) [2] was made.

2.2.2 Project Period

The project period in the original plan was for 80 months from December 1984 to July 1991 (from the date of the loan agreement to completion of the fly ash processing facility), but the actual project period was 203 months, from December 1984 to October 2001. The main reasons for the delay were the land acquisitions and resident relocations involved in fly ash dump construction. The government implemented the monetary compensation for the resident relocation (752 households), offering of alternative land, and preparation of infrastructure including water pipes and roads. The power plants started operation in 1994 and delivered benefit of the project successfully besides a delay the project for 123 months (approximately 10 years). For the additional output mentioned above, the project was extended an additional 14 months, to December 2002.

2.2.3 Project Cost

The project cost, 140,183 million yen, was 96% of the original figure of 145,866 million yen despite the fact that additional output was added.

As stated above, although there was a delay in the project period, the output was implemented basically according to plan and the project cost was within the original plan. Thus, it can be said that overall there were no problems in the efficiency of the project's implementation.

2.3 Effectiveness

2.3.1 Actual Operation of the Power Plant

Table 2: Operating Condition of the Power Plant Facilities

	Planned (FY94)	Actual (FY03)
Maximum Output (MW)	1,000	1,000
Annual Electric Power Generation (GWh)	6,318	7,616
Plant Load Factor (%)	72	87
Availability Factor (%)	90	91

Note: Data for plan was based on the 5th appraisal.
Source: UPEVUNL

Ever since the start of operations of the Anpara B Thermal Power Plant in 1994, its operation has been satisfactory, with a plant load factor[3] of approximately 87% and an availability factor[4] of 91% (FY2003) of its maximum output of 1,000 MW. The annual electric power generation exceeds the level in the plan at the time of the 5th appraisal (Table 2).

In particular, this plant displays a high average plant load factor of 88.2% (FY2001),

[2] This project constructed a fly ash collection facility, including a limestone silo, which began operation in November 2001. The facility has the capacity to process just over 10% (900 tons/day) of the ash produced by Anpara A Thermal Power Plant and Anpara B Thermal Power Plant.

[3] The plant load factor = annual electric power generation/(maximum output × annual hours) × 100

[4] The availability factor = (annual hours of operation/annual hours) × 100

compared to the rate of 59.7% for UP overall and 69.9% for India overall. The central supervision system in the central control room is thought to contribute to the efficient operation of the plant by preventing mechanical malfunctions and human error, thus enabling the plant to operate properly.

2.3.2 Contribution to the Supply and Demand Balance of Electric Power in UP

Supply shortages of electric power in UP have been gradually ameliorated from FY1991 (10.3%, 17.8% at peak usage) to FY2001 (9.9%). However, as stated above, due to the fact that Uttar Anchal became independent of UP in 2000 and power distribution from power generation plants in Uttar Anchall to UP ceased, the supply and demand balance of electric power in UP remains as precarious as ever. In particular, the transmission/distribution loss rate is in an upward trend, and this high loss rate during transmission and distribution is a factor in the supply shortage (Table 3) [5].

The power generation capacity of the Anpara B Thermal Power Plant was 1,000 MW in 2000, and this is equivalent to 20% of the total power generation capacity of UP[6].

Table 3: Fluctuations in Transmission/Distribution Voltage Loss Rate in UP

	Electric Power Generated (GWh)	Transmission/Distribution Voltage Loss (GWh)	Transmission/Distribution Voltage Loss (%)	Amount of Electric Power Sold (GWh)
FY1996	35,853	8,812	24.6	27,041
FY1997	36,425	9,295	25.5	27,130
FY1998	38,985	10,359	26.6	28,626
FY1999	39,864	16,189	40.7	23,675
FY2000	40,661	15,528	38.2	25,132
FY2001	40,241	14,716	36.6	25,525

Source: UPPC

2.3.3 Recalculation of Financial Internal Rate of Return (FIRR)

The FIRR at the time of appraisal was calculated as 9.04%, taking as expenses the project cost as well as operation, maintenance, and management costs, taking as benefits the income from sale of electricity produced by this project, and assuming a project life of 25 years from the start of operation. This evaluation recalculated a FIRR of 7.58% using the same assumption. The lower figure at the time of evaluation is due to an increase in the unit cost of fuel, etc.

2.4 Impact

2.4.1 Contribution to Economic Development

Generally, it can be said that an improvement in the electric power infrastructure leads to the development of industries. As no data exists on the average annual growth rate of the GRDP of

[5]Due to the unbundling of different sectors in January 2000, Uttar Pradesh Power Corporation Limited (UPPCL) became the executing agency for the electricity transmission and distribution sector.

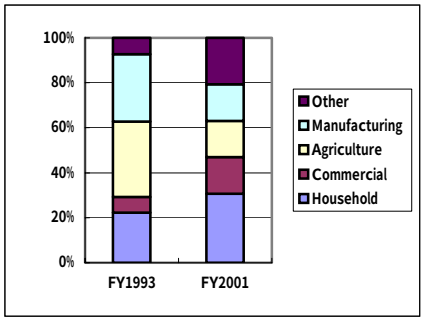
[6] Source: The SEB Report, 2002

Lucknow, the main electricity-consuming city in the area of the power plant, the economic development of UP overall will be examined for the sake of reference.

The average annual growth rate of UP's GRDP from FY1993 to FY2001 was 4.5%, which is less than the average annual growth rate of 5.7% for the nation. The foremost reason for UP's continued economic slump starting in the 1990s is thought to be slow agricultural growth[7].

There is no clear direct relationship with this project, but looking at the amount of electric power sold to each type of user in UP, the amount sold to manufacturers declined from approximately 30% in FY1993 to 18% in FY2001, admist a lack of significant visible growth in electric power generation. This decline is presumed to be due to the manufacturing sector's shift to self-generation of their own electric power in UP, to avoid purchasing power from the power company whose supply is unstable and whose prices are high. Shortages in the electric power supply in UP are considered to be one factor restraining economic development. (Table 4).

Fig.4 Change in the Amount of Electric Power Sold by Sector in UP (%)



Source：Planning Commission, 2002

As stated above (in 2.3.1), the power plant funded by this project supplies 7,616 GWh of electric power annually. Given the per capita electricity consumption in UP (194 kWh), the plant is providing electric power for approximately 39 million people (cf. equivalent to 30% of Japan's population of approximately 130 million)

2.4.2 Impact on the Environment, Surrounding Residents, and Relocated Residents (Impact Evaluation Study Results)

At the same time as this evaluation study, an "Impact Evaluation in the Project Ex-Post Evaluation" was carried out by the Graduate School of Environmental Management at Hosei University. This impact evaluation study investigated the impact of this project on the environment and relocated residents. For details, refer to the impact evaluation study.

2.5 Sustainability

2.5.1 Sustainability of Operations by the Executing Agency

2.5.2.1 Technical Capacity

All workers, including newly hired, periodically receive training using the latest simulators in preparation for emergencies, etc., at the power plant. The power plant facilities are being

[7] World Bank, India: Reducing Poverty, Accelerating Development, 2000.

operated properly in accordance with the operation and maintenance manual. Thus, there are no technical problems in basic operation, maintenance, and management.

2.5.2.2 Operation and Maintenance System

The Uttar Pradesh State Electricity Board (UPSEB) prior to the unbundling of sectors implemented the operation and maintenance of Anpara B Thermal Power Plant built by this project in January 2000. Since the unbundling, Uttar Pradesh Rajya Vidyut Utapadan Nigam Limited (UPRVUNL) has been in charge. In the power plant, a total staff of 2,200 persons is employed under the General Manager. Of those, 300 are engineers. With an average of 23 years of employment, the retention rate is high and the workforce is stable.

2.5.2.3 Financial Status

According to financial statements for the past 10 years, the power plant's revenue from electricity sales is growing steadily and covers operating expenses and fuel expenses fully (Table 4). The price of electricity in FY2003 was 1,598 rupees/kWh and is scheduled to be raised to 1,720 rupees/kWh in FY2004.

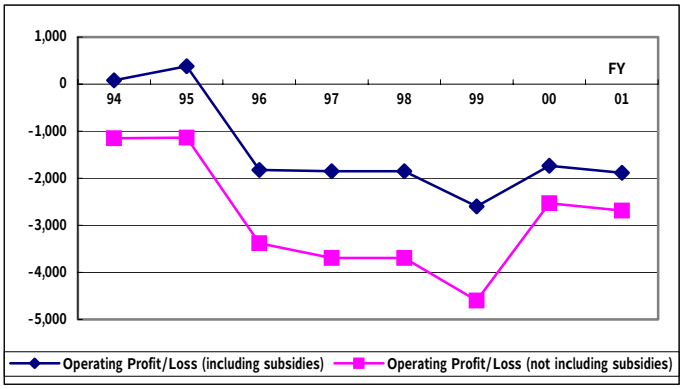
Table 4: Trends in Revenue and Expenses of Anpara B Thermal Power Plant (million rupees)

FY	Expenses				Electricity Sale Revenue (2)	Cash Flow (2)-(1)
	Initial Cost	Fuel Expense	Operation/ Maintenance Expense	Total (1)		
1994	4,204.50	1,669.89	68.87	5,943.17	7,106.65	1,163.48
1995	293.70	2,487.08	139.30	2,920.08	9,463.29	6,543.21
1996	110.00	2,681.46	182.46	2,973.92	9,413.87	6,439.95
1997	33.00	3,311.72	288.41	3,633.13	10,701.18	7,068.05
1998	-	3,173.00	406.41	3,579.41	10,206.00	6,626.59
1999	-	3,944.58	362.09	4,306.67	11,155.70	6,849.03
2000	-	3,633.89	472.18	4,106.07	10,948.75	6,842.68
2001	-	3,855.77	407.12	4,262.89	10,234.25	5,971.36
2002	-	3,580.02	399.87	3,869.89	10,364.39	6,366.50
2003		4,320.66	386.10	4,706.76	10,878.23	6,171.47

Source: UPEVUNL

Issues such as realization of reasonable electric fee and improvement of collection rates are not resolved in the electricity sector in UP, and Uttar Pradesh Power Electric Company (UPPCL)'s financial deficit is not covered. UPPCL is the position of negative operating profit (Table 5) even with subsidies from state. Consequently, reform of the electric power sector is urgently required for state's financial position.

Table 5: Trends in UPPCL's Operating Profit/Loss (ten million rupees)



Source: Planning Commission, 2002

3. Feedback

3.1 Lessons Learned

None

3.2 Recommendations

None

Comparison of Original and Actual Scope

Item	Planned	Actual Performance
1. Output	(1) 2 power generation facilities with 500 MW output each (boiler, turbine, generator, electric facilities, other) (2) Equipment used jointly by the 2 power generation facilities including water, coal, and ash processing equipment, machinery and materials for engineering works, etc.	(1) As planned (2) As planned (3) Addition of spare parts and fly ash silo system construction
2. Project Period Consultant Agreement Foundation Work Power Generation Facilities Substation Facilities Other Facilities	 December 1984 – July 1991 November 1986 - March 1989 November 1986 - October 1990 November 1986 – August 1990 November 1986 - December 1989	 December 1984 – October 2001 （including additional output）
3. Project Cost Foreign Currency Local Currency Total ODA Loan Portion Exchange Rate	 96,217 million yen 49,649 million yen (11,996 million rupees) 145,866 million yen 119,058 million yen 1 rupees＝4.1 yen	 98,403 million yen 41,780 million yen (11,289 million rupees) 140,183 million yen 118,428 million yen 1 rupees＝3.7 yen