India

Ex-Post Evaluation of Japanese ODA Loan Project
"Simhadri Thermal Power Station Project (I) (II) (III) (IV)"

Keishi Miyazaki, OPMAC Corporation

1. Project Description

Project Site

Simhadri Thermal Power Plant

1.1 Back Ground

In Andhra Pradesh State (AP State), which is an agricultural state in southern India, the agricultural sector has been the largest electricity consumer. The sector share was approximately 40% of the electricity sales amount in AP State, which was more than the nationwide average of approximately 30%. Because of this, there has been a shortage of electricity supply for the industrial sector, and this has become a bottleneck in the economic development of AP State. In 1996, the Andhra Pradesh State Electricity Board (APSEB) estimated that there would still be an approximately 8% electricity supply shortage during peak hours in 2004 (the expected completion year of this project) even if all of the proposed power station construction projects were realized as planned. This was expected as the electricity demand of AP State had grown by an average of 9.6% in the last five years. The government of India had a policy to strengthen the electricity supply capacity of AP State through the joint efforts of the public and private sectors and by promoting new electric power generation projects of the central and state governments as well as of the Independent Power Producers (IPP). However, since the progress of proposed electric power generation projects by IPP was delayed, it was foreseen that the exiting electricity demand and supply gap would be further widened.

1.2 Project Outline

The objective of this project was to cope with the growing electricity demand and to assure a stable electricity supply in Andhra Pradesh State by the construction of a 1,000MW coal-fired thermal power station in Vishakhapatnam which would use coal produced in Orrisa State, thereby contributing to industrial development, employment creation and the improvement of people's living standards through the electrification of rural areas and households in AP State.

	(I) ID-P120	(II) ID-P138	(III) ID-P140	(IV) ID-P144
Approved Amount/ Disbursed Amount	19,817 million Yen/ 19,371 million Yen	12,194 million Yen/ 12,191 million Yen	27,473 million Yen/ 27,294 million Yen	5,684 million Yen/ 1,251 million Yen
Exchange of Notes Date/ Loan Agreement Signing Date	January 1997/ February 1997	March 2001/ March 2001	February 2002/ February 2002	March 2003/ March 2003
Terms and Conditions - Interest Rate - Repayment Period - Grace Period - Condition of Procurement	 2.3% p.a. 30 years 10 years Untied	 1.8% p.a. 30 years 10 years Untied	 1.8% p.a. 30 years 10 years Untied	 1.8% p.a. 30 years 10 years Untied
Borrower / Executing Agency	National Thermal Power Corporation Ltd. (NTPC) / NTPC (Guarantor: Government of India)			
Final Disbursement Date	April 2007	April 2007	April 2007	April 2007
Main Contractor (Over 1 billion yen)	Baharat Heavy Electricals Ltd. (India), Hindustan Steel Works Construction Ltd. (India), Larsen & Toubro Ltd. (India)			
Main Consultant (Over 100 million yen)	None			
Feasibility Studies, etc.	Feasibility study: July 1995, NTPC. SAPI: Special Assistance for Project Implementation (SAPI) for Simhadri Thermal Power Station Project (I) (II), 2010, JICA.			
Related Projects	Simhadri-Vizag Transmission System Project Phase (I) (ID-P127, 1997) and Phase (II) (ID-P142, 2002).			

2. Outline of the Evaluation Study

2.1 External Evaluator

Keishi Miyazaki, OPMAC Corporation

2.2 Duration of Evaluation Study

Duration of the Study: February 2010 – November 2010
Duration of the Field Study: May 2 - May 15, 2010 and August 9 – August 15, 2010

2.3 Constraints during the Evaluation Study

None

3. Result of Evaluation (Overall Rating: A)

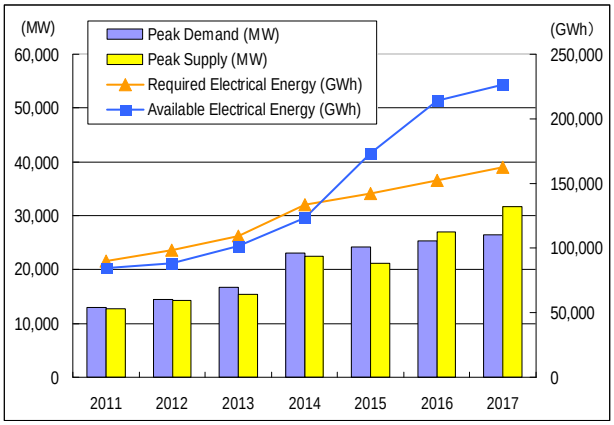
3.1 Relevance (Rating: a)

3.1.1 Relevance with the Development Plan of India

At the time of appraisal, total investment in the power sector in the 8th Five Year Plan (1992-1997) was the share of 18.3% (795.9 billion Rs.) of total public investment (4,341 billion Rs.), the largest share of public investment overall. The 8th Plan emphasized (i) the improvement of the plant load factor of existing plants, (ii) the reduction of transmission and distribution losses, (iii) the improvement of the financial capacity of power suppliers, (iv) the

promotion of development of power resources, and (v) the promotion of commercial sources of energy. Since this project aimed to strengthen the power generation capacity of AP State, it was consistent the priority item of promoting the development of power resources.

At the time of the ex-post evaluation, the 11th Five Year Plan (2007-2012) estimated a 6,665.2 billion Rs. for power sector investment, which counted for 32.42% of total investment in India including both the public and private sectors (20,561 billion Rs.). It corresponds to the largest share in the total investment in India. The 11th Plan set out power sector development strategies including (i) the capacity development of the Central Electricity Regulatory Commission (CERC) and the State Electricity Regulatory Commission (SERC), (ii) the reduction of transmission and distribution losses, (iii) the promotion of rural electrification, and (iv) the promotion of open access for private investors. Since this project aimed at contributing to industrial development, employment creation and the improvement of people's living standards through electrification in rural areas and the households in AP State by strengthening the power generation capacity of State, it is consistent with the power sector development strategy for the promotion of rural electrification.



Source: APTRANSCO

Figure 1: Electricity Supply and Demand Estimate in AP Sate

3.1.2 Relevance with the Development Needs of India

At the time of appraisal, there was a shortage in the electricity supply for the industrial sector due to the growing electricity demand in the agricultural sector of AP State, the agricultural sector being the largest sector in the State. In particular, the rapid growth of the IT related industrial sector had boosted electricity demand in AP State, and thus electricity shortage had become a bottleneck in the economic development. It was estimated that there would be 6% power shortages during peak hours in 2004 when this project was scheduled to be completed. Therefore, the necessity for developing new power generation was high.

At the time of the ex-post evaluation, the power demand-supply gap had not been resolved and further increase in the power demand of the industrial, agricultural and household sectors are expected in AP State even after the completion of this project. According to an estimation of the Andhra Pradesh Transmission Corporation Lt. (APTRANSCO), which is in charge of the electricity transmission sector in AP State, the power demand will continue to exceed the power supply capacity until 2014 even when the planned and on-going power generation development projects are realized (See Figure 1).

3.1.3 Relevance with Japan's ODA Policy

At the time of appraisal, the Japanese Country Assistance Program for India had not yet been established by the Ministry of Foreign Affairs in Japan. However, based upon preceding study and research into the Japan's ODA strategy to India, as well as on policy dialogue between the Japanese and Indian governments, the current Japan's Country Assistance Program for India formulated in May 2006 can be seen to have set up priority areas including economic infrastructure development, particularly for power and transport infrastructure as prioritized in the 11th Five Year Plan of India.

This project has been highly relevant the Indian development plan, development needs, as well as Japan's ODA policy, therefore its relevance is high.

3.2 Efficiency (Rating: a)

3.2.1 Project Outputs

This project was to construct a 1,000MW coal-fired thermal power station 25km south-east of Vishakhapatnam City. The major planned outputs were a main plant including two units of boilers, two units of steam turbines with a 500MW output each, two units of steam generators with a 588MW output each (power factor: 0.85); an ash handling plant including an ash disposal system and an ash dyke (area: 249 ha, storage capacity: 48,160,000m^3) which is designed for a disposal life of 25 years; a reservoir (area: 112ha); an electrostatic precipitator; a fuel oil handling and storage system; a cooling water system (natural air ventilation system, capacity: 60,000ton/hour)[1], a transformer, a switching facility and so on. The above main outputs were realized as planned.

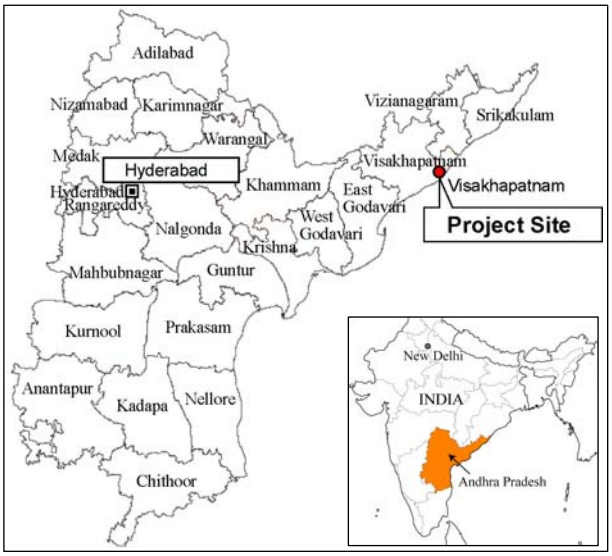


Figure 2: Project Site Map

Consulting services were excluded from the project scope covered by the Japanese ODA loan, and the National Thermal Power Corporation Limited (NTPC) was directly involved in project management including the construction supervision of this project. All of the planned outputs were completed within the planned schedule and the commercial operation of the plant commenced ahead of schedule[2]. In addition, the transmission facility of the project was to be provided by the Japanese ODA loan project "Simhadri -Vizag Transmission System Project (I) (II)[3]" implemented by APTRANSCO, but was already completed in December 2005.

3.2.2 Project Inputs

3.2.2.1 Project Period

The actual implementation period was 84 months from February 1997 (project start[4]) to January 2004 (project completion[5]) against 91 months of the planned project period[6] from February 1997 to August 2004. This was shorter than planned. The actual project period meant a 7 month early completion or a 92% shorter period than planned. The synchronization of unit 1 and unit 2 was started 1 month and 4 months earlier than planned respectively. Also the commercial operation of unit 1 and unit 2 started 2 months and 3 months earlier than planned (See Table 1).

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[1] Sea water was used for the cooling water system in this project.

[2] Due to this, this project was awarded the Best Project Management Award in 2005 by the International Project Management Association (IPMA).

[3] Simhadri-Vizag Transmission System Project (I) (II) was to construct 400kV and 220kV transmission lines and switching facilities in the target areas of AP State between Vishakhapatnam and Hyderabad (approximately 600 km). This was completed in December 2005.

[4] The project start was defined as the signing of loan agreement of ID-P120 (phase I).

[5] The project completion was defined as the completion of the major works of the project outputs leading to the sustained commercial operation of the plant.

[6] The planned implementation period estimated at the appraisal of ID-P138 (phase II) in 2001 was deemed as the planned period for plan-actual comparison in this ex-post evaluation. The reasons for this were that economic sanctions against India was exercised by the Japanese government in May 1998 and as a result of this the signing of loan agreement ID-P138 was postponed until March 2001 together with the reexamination and revision of the project period and cost.

Table 1: Comparison of Planned and Actual Project Period

Activities	Plan (Note 1)	Actual
1. Signing of loan agreement of ID-P120 (Phase I)	February 1997	February 1997
2. Main plant turnkey package		
a) Preparation of tender documents and contract award	October 1997 – August 1998	October 1997 – November1998
b) Unit 1 Synchronization	March 2002	February 2002
Commercial operation	July 2002	September 2002
Acceptance	September 2002	July 2002
c) Unit 2 Synchronization	December 2002	August 2002
Commercial operation	June 2003	March 2003
Acceptance	June 2003	January 2003
3. Coal handling system package (from tender to system acceptance)	February 1998 – June 2003	February 1998 – March 2003
4. Cooling water system package (from tender to system acceptance)	April 1998 - June 2003	March 1998 – March 2003
5. Make up water system package (from tender to balance commissioning)	November 1997 – January 2003	November 1997 – November 2002
6. Cooling tower package (from tender to balance commissioning)	April 1998 – November 2002	April 1998 – July 2002
7. Chimney package (from tender to balance commissioning)	April 1998 – February 2002	April 1998 – September 2001
8. Water demineralization plant package (from tender to balance commissioning)	May 1998 – September 2002	March 1998 – December 2001
9. Effluent treatment plant and water pre-treatment package (from tender to balance commissioning)	May 1998 – September 2002	March 1998 – June 2001
10. Railway siding package (from tender to commissioning)	October 1997 – December 2001	October 1997 – December 2001
11. Ash handling plant package (from tender to end of construction)	May 1998 – August 2002	May 1998 – August 2002
12. Project completion (Note 2)	August 2004	January 2004

Source: JICA appraisal documents and NTPC.
Note 1: The planned implementation period revised at the appraisal of ID-P138 (Phase II) in 2001 was adopted.
Note 2: The project completion was defined as the completion of major works of the project outputs leading to the sustained commercial operation of the plant.

Based upon an interview survey the NTPC, the major factors in realizing the early completion of the project are analyzed as follows:

(i) Since this project was designated as a showcase project for NTPC, priority resource mobilization was given to this project. This included the mobilization of high-caliber staff to the taskforce of the project and the allocation of a sufficient budget amount;

(ii) The contractor's project implementation capacity as well as its credibility were high;

(iii) Due to NTPC past experience and performance, the project management capacity of NTPC was high;

(iv) The AP State government and the Vishakhapatnam municipality government strongly supported this project. This was because the Chief Minister of AP State at that time was actively promoting power sector reform[7] and the development of the State and he

[7] The AP State is one of the front runner states of India in the power sector reform. After the establishment of the Andhra Pradesh Electricity Reform Act in 1998, AP State has undertaken a comprehensive power sector reform of the State such as the unbundling of the AP State Electricity Board (APSEB) to generation, transmission and distribution

wielded strong leadership. The high priority and importance of this project in AP State was due to the fact that electricity generated in the Sihmadri Power Plant was to be exclusively utilized in the State. Therefore, the project enjoyed the advantages, for example, of a shorter time than for ordinary projects in obtaining environmental clearance as well as local governments' support for land acquisition and resettlement;

(v) This project adopted land acquisition and resettlement based upon a negotiated compensation scheme together with a community development program, which facilitated a smooth land acquisition and resettlement process (for more information please see below, "3.4.4 Social Impacts relating Land Acquisition and Resettlement").

3.2.2.2 Project Cost

The actual project cost was 90,946 million yen against the 97,369 million yen planned cost[8], which was 93% of the planned cost. Looking at the actual costs for individual items, the actual cost for the ash dyke increased from 2,014 million yen to 4,812 million yen on account of adoption of downstream method of dyke raising due to increase in ash quantity. The actual cost for the railway siding increased from 2,177 million yen to 3,460 million yen due to change in location of take off point and electrification of entire siding. However, he actual costs for other items were either almost the same as the planned cost or less. As a result, the actual total project cost was within the planned total project cost (See Table 2).

Table 2: Planned and Actual Project Cost

Items		Plan*			Actual		
		FC (Mill. Yen)	LC (Mill. Rs)	Total (Mill. Yen)	FC (Mill. Yen)	LC (Mill. Rs)	Total (Mill. Yen)
1	Main plant turnkey	14,919	14,297	49,804	15,366	15,546	54,428
2	Coal handling plant	153	871	2,278	151	910	2,438
3	Cooling water system & make-up water system	333	1,550	4,116	352	1,892	5,106
4	Water system	-	235	573	-	216	543
5	Cooling tower	-	831	2,027	-	835	2,098
6	Ash Dyke	-	826	2,014	-	1,915	4,812
7	Chimney	-	232	565	-	194	487
8	Railway siding	-	892	2,177	-	1,377	3,460
9	Site packages	-	1,509	3,682	-	1,536	3,860
10	Land acquisition	-	864	2,107	-	894	2,246
11	Misc. tools & plants	-	281	686	-	178	447
12	Engineering, administ-ration, consultancy, commissioning & corporate asset allocation	-	2,098	5,120	-	1,993	5,008
13	Taxes & duties	-	600	1,464	included in respective packages		
14	Price escalation	359	5,043	12,664	included in respective packages		
15	Contingency	788	1,506	4,464	-	42	106
16	IDC	3,628	-	3,628	-	1,356	3,407
17	ERV on direct loan					995	2,500

companies, the establishment of AP State Electricity Regulatory Commission (APERC), and electricity tariff reform.

[8] The planned project cost estimated at the appraisal of ID-P138 (phase II) in 2001 was deemed as the planned cost for plan-actual comparison in this ex-post evaluation. The reasons for this were that economic sanctions against India were exercised by the Japanese government in May 1998 and as a result the signing of the loan agreement of ID-P138 was postponed until March 2001 together with the reexamination and revision of the project period and cost. In the appraisal of ID-P138, the estimated project cost was scaled down from the 140,159 million yen estimated at the appraisal of ID-P120 (Phase I) in 1999 to 97,369 million, which was about 70% of the estimated project cost in ID-P120.

Items	Plan*			Actual		
	FC (Mill. Yen)	LC (Mill. Rs)	Total (Mill. Yen)	FC (Mill. Yen)	LC (Mill. Rs)	Total (Mill. Yen)
Total Cost excl. WCM	**20,180**	**31,635**	**97,369**	**15,869**	**29,879**	**90,946**

Source: JICA appraisal documents and NTPC.
Note 1: The planned project cost revised at the appraisal of ID-P138 (Phase II) in 2001 was adopted.
Note 2: Exchange rate used: 1 Rupee=2.44 yen in December 1999 for planned cost, 1 Rupee=2.5127 yen as an annual average between 1999 and 2004 for the actual cost.
Note 3: FC: Foreign Currency, LC: Local Currency, IDC: Interest during construction, ERV: Exchange Rate Variation, WCM: Working Capital Margin

Both project period and project costs were within the plan, therefore efficiency of the project is high.

3.3 Effectiveness (Rating: a)

3.3.1 Quantitative Effects

3.3.1.1 Results from Operation and Effect Indicators

Table 3 indicates the key operation and effect indicators of Simhadri Power Plant from 2003/04 to 2009/10. All of the key indicators such as maximum output, plant load factor (PLF), availability factor, Auxiliary Power Ratio, Gross Thermal Efficiency and Net Electricity Energy Production fully met the targets. In particular, PLF of Simhadri Power Plant in 2008/09 and 2009/10 exceeded 97%, which was the top-level performance of all power generation plants in India[9]. The average PLF of national power generation plants under the central government's administration was 84.3% in 2008/09; the average PLF of the state's power generation plants under the state government administration was 71.2% in 2008/09; the average PLF of IPPs was 91%: and the average PLF of all power generation plants in India was 77.2%[10].

Table 3: Key Operation and Effect Indicators

		2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10
Maximum Output (MW)	Plan	1,000	1,000	1,000	1,000	1,000	1,000	1,000
	Actual	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Plant Load Factor (%)	Plan	56.08	66.31	85.00	85.00	85.00	85.00	85.00
	Actual	87.90	92.72	88.38	92.10	88.57	97.41	97.27
Availability Factor (%)	Plan	80.00	85.00	89.00	89.00	89.00	89.00	89.00
	Actual	90.30	93.23	93.72	92.44	87.68	94.54	94.38
Auxiliary Power Ratio (%)	Plan	8.00	7.50	7.50	7.50	7.50	7.50	6.00
	Actual	<8.00	<7.50	<7.50	<7.50	<7.50	<7.50	<6.00
Gross Thermal Efficiency (%)	Plan	33.60	35.00	35.00	35.00	35.00	35.00	35.00
	Actual	>33.60	>35.00	>35.00	>35.00	>35.00	>35.00	>35.00
Net Electricity Energy Production (GWh)	Plan	4,495	5,344	6,962	6,962	6,962	6,962	6,962
	Actual	7,244	7,663	7,304	7,622	7,324	8,080	8,051

Source: NTPC
Note: a) Plant Load Factor (%) = Gross Generated Energy / (Rated Output x Annual Hours) x 100
b) Availability Factor (%) = (Annual Operating Hours / Annual Hours) x 100
c) Auxiliary Power Ratio (%) = (Annual Auxiliary Power Consumption / Annual Power Generation) x 100
d) Gross Thermal Efficiency (%) = Annual Power Generation x 860) / (Annual Fuel Consumption x Fuel Calorific Value) x 100
e) Net Electricity Energy Production (GWh) = Annual Power Generation - Annual Auxiliary Power Consumption

[9] According to NTPC's 33rd Annual Report 2008-2009, the average plant load factor of all power generation plants under NTPC was 91% in 2008/09.
[10] Ministry of Power, Annual Report 2009-10.

The outage hour and time for every cause also met the targets except in 2007/08 (See Table 4). The reason for the planning outage hour in 2007/08 not achieving its target (the actual planning outage hour in 2007/08 was 1,878 (Unit 2) hours against 1,402 hours in the plan) was that additional maintenance of Unit 2 was required to rectify vibration in the turbine bearing of the Unit. This problem had been discovered during the overall and post resynchronization of Unit 2.

Table 4: Outage Hour and Time for Each Cause

Cause		2003/04		2004/05		2005/06		2006/07		2007/08		2008/09		2009/10	
		Hour	Time	Hour	Time	Hour	Time	Hour	Time	Hour	Time	Hour	Time	Hour	Time
Human Error	Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unit 1	Actual	0	0	0	0	4.39	2	0	0	0	0	0	0	1.68	1
Unit 2	Actual	3.57	2	0	0	0	0	0	0	1.8	1	0	0	0	0
Machine Trouble	Plan	876.00	72	876.00	72	526.00	48	526.00	48	526.00	48	526.00	48	526	48
Unit 1	Actual	551.14	19	138.39	7	234.74	10	101.31	6	204.24	7	69.25	1	121.52	2
Unit 2	Actual	512.11	16	124.55	7	67.82	5	130.09	6	80.44	6	96.74	2	183.5	6
Planning Outage	Plan	2,102.40	4	2,102.40	4	1,402.00	4	1,402.00	4	1,402.00	4	1,402.00	4	1,402	4
Unit 1	Actual	642.47	1	410.43	1	429.77	1	699.90	1	0	0	789.90	1	0	0
Unit 2	Actual	0	0	512.12	1	363.31	1	393.47	1	1,878.61	2	0	0	677.31	2

Source: NTPC

3.3.1.2 Results of Calculations of Internal Rates of Return (IRR)

(1) Financial Internal Rate of Return (FIRR)

The result of the recalculation of FIRR of this project at the time of the ex-post evaluation was 12.6%, which was almost the same as the original FIRR of 12.03% at the time of appraisal[11]. The FIRR calculation at appraisal was based upon the preconditions below:

<Precondition of FIRR calculation at appraisal>

- Cost: Project cost, excluding interest during construction, fuel cost, and operation and maintenance cost.
- Benefit: Revenue of electricity sales (11,690 million Rs./year)
- Project life: 25 years after commencement of commercial operation
- Plant load factor: 65% (Annual electrical energy generated: 6,000GWh)
- Generation cost: 2.12 Rs./kWh

(2) Economic Internal Rate of Return (EIRR)

The EIRR at the time of appraisal was 36.63%. Due to difficulty in collecting the necessary information and data for the recalculation of EIRR, the ex-post evaluation did not exercise the recalculation of EIRR. The EIRR calculation at appraisal was based upon the preconditions below:

<Preconditions of EIRR calculation at appraisal>

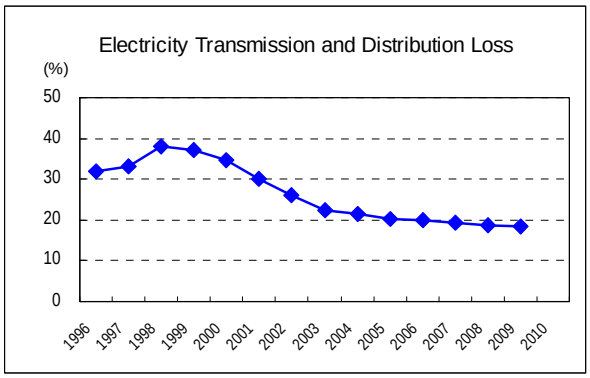
- Cost: Project cost, fuel cost and operation and maintenance cost
- Benefit: Induction effect and switching effect
- Project life: 25 years after commencement of commercial operation
- Plant load factor: 65% (Annual electrical energy generated: 6,000GWh)

[11] This ex-post evaluation deemed the IRR calculated at appraisal of ID-P140 (phase III) in 2002 as the planned IRR. The reasons were: (i) since there was a major modification of project cost at appraisal of ID-P138 (phase II) in 1999-200, it was considered that the planned IRR should have been that calculated after ID-P138; and (ii) detailed and traceable information for how to calculate the IRR was only available in the appraisal documents of ID-P140.

3.3.2 Qualitative Effects

3.3.2.1 Results of the Beneficiary Survey

The electricity generated by Simhadri Power Plant is exclusively sold to APTRANSCO. The electricity is then distributed to individual electricity consumers in AP State through the distribution companies. APTRANSCO says that it has received a stable electricity supply from Simhadri Power Plant since its project completion in 2004. This has contributed to an increase in the reliability of the APTRANSCO electricity transmission service. Also, APTRANSCO recognize that the stable electricity supply and relatively cheap electricity sales price, which are thanks to the high generation efficiency of Simhadri Power Plant, have indirectly served to improve the financial capacity of APTRANSCO.



Source: APTRANSCO

Figure 3: Electricity Transmission and Distribution Loss in AP State

The Andhra Pradesh Central Power Distribution Company Ltd. (APCPDCL) [12] reported that after the completion of Simhadri Power Plant, the electricity supply became stable without fluctuation and that the load shedding time decreased. APCPDCL assessed Simhadri Power Plant to be the most efficient and productive power plant in AP State. The NPL of Simhadri Power Plant was the highest among all the power generation plants in AP State including the Andhra Pradesh Power Generation Company Ltd. (APGENCO) and IPPs, the NPL of which were 85% and 85-90% respectively. The results of the interview survey with five local businesses[13] as electricity bulk users also suggested that there was an improvement in the quantity and quality of the electricity supply after the completion of Simhadri Power Plant.

Therefore, it can be said that Simhadri Power Plant has played an important role in providing a stable electricity supply in AP State as a base-load power generation plant. AP State has actively promoted power sector reform including capacity enhancement of the power distribution sector. This has led to some positive effects, for example, transmission and distribution loss has improved from more than 30% in 2001 to 18.5% in 2010. It should be noted that the improvement in the quantity and quality of the electricity supply after the completion of Simhadri Power Plant, which was perceived by electricity consumers as a positive effect of this project, is supported by the effect of the improvement in transmission and distribution loss (See Figure 3).

This project has largely achieved its objectives, therefore its effectiveness is high.

[12] In AP State there are four power distribution companies: Andhra Pradesh Central Power Distribution Company Ltd. (APCPDCL) covering the state's capital of Hyderabad, Andhra Pradesh Southern Power Distribution Company Ltd. (APSPDCL), Andhra Pradesh Eastern Power Distribution Company Ltd. (APEPDCL) and Andhra Pradesh Northern Power Distribution Company Ltd. (APNPDCL).

[13] The five local businesses included in the interview survey were selected from local manufacturing companies in Jeedimetra Industrial Estate in Hyderabad. This industrial estate receives its electricity supply from APCPDCL.

Photographs: Interview Survey with Electricity Bulk Users in Hyderabad

Chemical and Drug Manufacturer

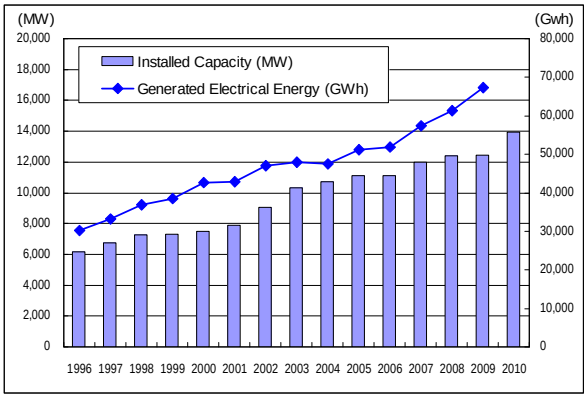
Packaging and Paper Manufacturer

Steel Wire Manufacturer

3.4 Impacts

3.4.1 Impact on Mitigation of the Electricity Demand and Supply Gap in AP State

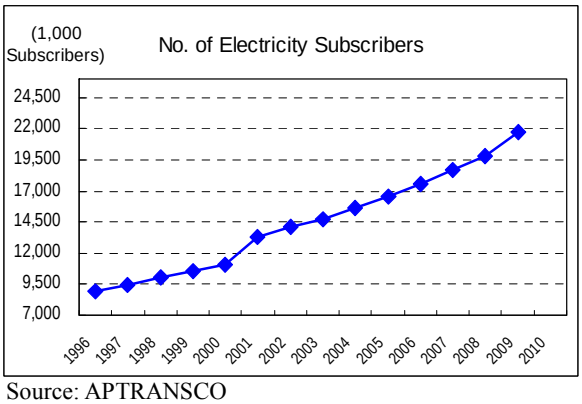
AP State has promoted the development of electric power resources for the mitigation of constant power shortages. The total installed power generation capacity of AP State doubled from 6,163MW (1996) to 12,427MW (2009) and the annual generated electrical energy increased 2.2 times from 30,119GWh/year (1996) to 67,387GWh/year (2009) during the 13 year period between 1996 and 2009 (See Figure 4).



Source: APTRANSCO

Figure 4: Total Installed Capacity and Generated Electrical Energy in AP State

As of 2009, Simhadri Power Plant shared 8% of the total installed power generation capacity and 11.9% of the generated electrical energy in AP State, and thus it can be seen that Simhadri Power Plant has played an important role in the power generation sector in the State. Therefore, it is evident that this project contributed to mitigating the electricity demand and supply gap in AP State through the provision of 8,000GWh of a stable electrical energy supply per year as a base-load power generation plant.



Source: APTRANSCO

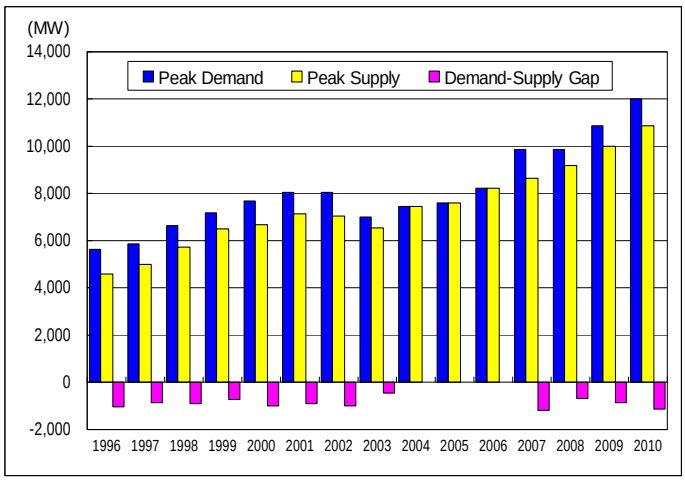
Figure 5: No. of Electricity Subscribers in AP State

However, the electricity demand of the agricultural sector, the largest electricity consumer in AP State, as well as that of the industrial sector and the household sector, has been constantly expanding with the dramatic increase in electricity subscribers in the State. For example, the number of subscribers increased from 11,100,000 in 2000 to 21,710,000 in 2009 (See Figure 5)[14].

[14] Because of this, AP State suffers regularly from scheduled shedding and major electricity consumers such as factories and businesses are obliged to depend upon the electricity supply of their captive generators in order to cope with this problem.

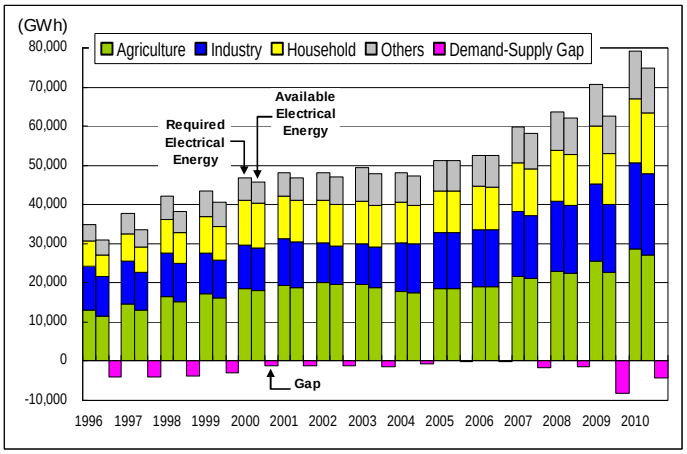
Even now, the existing power generation capacity can not satisfy demand.

As shown in Figures 6 and 7, the electricity demand and supply gap was balanced only in the three year period between 2004 and 2006 during the last 15 years from 1996 and 2010. At present, the Second Stage of this project is under construction by NTPC, and is expected to be completed in FY 2011-12. If the Second Stage project is completed, the installed power generation capacity of Simhadri Power Plant will be strengthened from 1,000MW to 2,000MW, and this is expected to further contribute to easing the power shortage in AP State[15].



Source: APTRANSCO

Figure 6: Peak Electricity Demand and Supply in AP State



Source: APTRANSCO

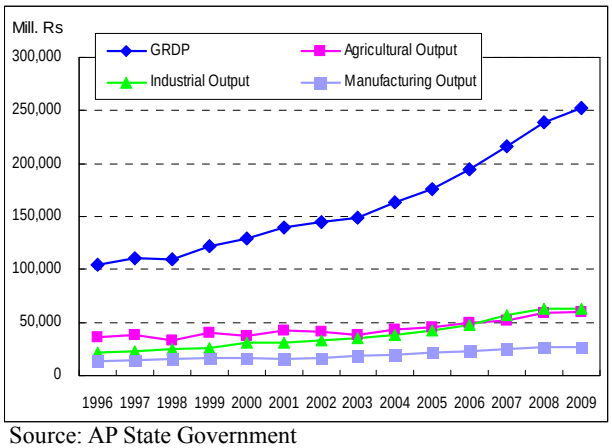
Figure 7: Required Electrical Energy and Available Electrical Energy in AP State

[15] The electrical energy generated by the additional 1,000MW generation capacity in the Second Stage of the project is planned to be allocated not only to AP State but also to neighboring states including Karnataka State, Kerala State and Tamil Nadu State.

3.4.2 Impact on Industrial Development and Expansion of Employment Opportunities

The Gross Regional Domestic Product (GRDP), agricultural output, industrial output and manufacturing output have steadily increased every year (See Figure 8).

It can be assumed that Simhadri Power Plant has played a role in supporting the industrial development of AP State through the provision of a stable electricity supply as a base-load power generation plant. Regarding the impact on the expansion of employment opportunities, it has been difficult to analyze this impact considering the logical relationship between the scope of this project and the impact.



Source: AP State Government

Figure 8: GRDP, Agricultural, Industrial and Manufacturing Outputs in AP State

3.4.3 Impact on Rural Electrification and the Improvement of People's Living Standards

The electrification ratio[16] in AP State was already at 100% in 2002, before the completion of this project. Therefore, it was difficult to analyze the impact of this project on rural electrification. Similarly, the impact of the project on the improvement of people's living standards has not been analyzed due to difficulties in measurement.

3.4.4 Impacts on the Natural Environment

(1) Impact on Ambient Air and Water

The Environment Impact Assessment (EIA) of this project was conducted in 1994 by NTPC and Techno-Economic Clearance was obtained in 1996 from AP State. Also, JICA conducted "Special Assistance for Project Implementation (SAPI) for Simhadri Thermal Power Station Project (I) (II)" in 2001. The SAPI team studied and reviewed the environmental regulations and environmental protection measures in India as well international environmental standards and environmental protection measures in Japan and USA. They recommended[17] the

[16] According to the definition revised in February 2004, village electrification is defined as: (i) basic infrastructure such as distribution transformers and distribution lines provided in the inhabited locality as well as in the Dalit Basti/ hamlet where they already exist, (ii) electricity is provided to public places such as schools, the Panchayat office, health centers, dispensaries, community centers etc. and (iii) the number of households electrified should be at least 10% of the total number of households in the village.

[17] The SAPI team proposed nine recommendations on the environmental management measures of this project and six recommendations on ash utilization. The status of implementation of these recommendations by NTPC is as follows: (1) heavy metal and trace analysis of coal: under implementation; (2) heavy metal and trace analysis of coal ash: under implementation; (3) installation of the monitoring stations of ambient air quality at least four locations: six stations were installed; (4) installation of a meteorological monitoring station with a meteorological mast of 10 meter height at an open terrain: implemented; (5) inclusive of drinking water standards parameters in the groundwater monitoring program: implemented; (6) installation of six down gradient monitoring wells in addition to the existing six up gradient monitoring wells: nine wells were installed at up and down gradient; (7) monitoring of community development plan: under implementation by the CSR section of Simhadri Power Plant; (8) ISO 14001 Certification: obtained in 2004; (9) preparation of response plan in case environmental monitoring date exceeds the standards: under implementation; (10) establishment of the specific strategies for exploiting the potential market of coal utilization: implemented; (11) utilization of coal ash for fly ash based products, road construction and agriculture: under implementation; (12) utilization of coal ash for surface mining application and wasteland reclamation: utilization for wasteland reclamation in the plant was implemented and utilization for wasteland reclamation near the plan is under implementation; (13) incentives for promotion of coal ash utilization: under implementation such as free provision of coal ash to brick/block manufacturers and sharing of coal ash transport cost; (14) study on environmental impact of coal ash and its mitigation measures: under implementation; and (15) market survey for other similar projects: under implementation.

more effective EIA and environmental protection measures and revised fly ash utilization measures[18] for NTPC. These recommendations by SAPI were reflected in this project. NTPC has monitored ambient air quality, effluent water quality and flue gas every month according the guidelines set by the Andhra Pradesh Pollution Control Board (APPCB) and the Ministry of Environment and Forests, and results are reported to the respective environmental authorities regularly[19].

In Simhadri Power Plant, the ambient air concentration discharged from the chimney is monitored at six environmental monitoring stations installed around the plant. The ground concentration (24 hours) of major parameters such as Suspended Particulate Matter (PSM), Sulfur Dioxide (SO_2) Nitrogen Oxide (NOx) fully met Indian environmental standards thanks to the installation of a high stack, electrostatic precipitators as well as due to the utilization of low-sulfur coal (See Table 5). Three of the environmental monitoring stations for ambient air quality out of the six mentioned above were additionally installed by NTPC based upon the recommendation of SAPI. Similarly, all of the parameters (annual average) for effluent water satisfy Indian environmental standards (See Table 6). The monitoring data for ambient air and discharged water is checked by the central control room of the Simhadri Power Plant online and the same monitoring data can be accessed at the NTPC headquarters and the Ministry of Environment and Forests for 24 hours.

Table 5: Ambient Air Monitoring Data around the Plant

Parameter	Unit	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	Indian standards
Suspended Particulate Matter (SPM)	$\mu g/m^3$	88.3	74.4	80.0	81.9	88.0	81.9	74.5	73.6	200
Respirable Particulate Matter (RPM)	$\mu g/m^3$	-	37.0	44.4	47.8	48.9	47.0	42.2	35.7	100
Sulfur Dioxide (SO_2)	$\mu g/m^3$	18.0	15.8	15.2	14.2	15.4	12.3	8.9	17.0	80
Nitrogen Oxide (NOx)	$\mu g/m^3$	25.7	24.5	20.8	18.8	18.5	15.3	10.3	11.5	80

Source: NTPC

Note: Above ground concentration is 24 hours data. The ground concentration is measured twice a week at six monitoring stations. The concentration at stack is monitored in 24 hours consecutively.

Table 6: Effluent Water Monitoring Data

Parameter	Unit	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	Indian standards
pH	pH	8.10	8.47	8.25	8.10	7.61	8.00	8.17	7.96	5.50~8.50
Difference in temperature between intake and discharge	℃	3.40	2.30	2.10	0.90	1.40	2.33	1.80	2.5	5
Total Suspended Solids (TSS)	ppm	51.8	21.45	14.58	10.00	19.92	12.83	12.59	19.8	100
Free Available Chlorine	ppm	N/A	N/A	N/A	N/A	N/A	N/A	N/A	<0.1	0.5
Phosphate as $P0_4$	ppm	ND	3.84	3.84	0.136	0.42	0.26	N/A	0.6	20

[18] In order to meet the new government regulations regarding the utilization of fly ash "Dumping and Disposal of Fly Ash Notification" being effective from September 14, 1999, the SAPI team re-assessed the fly ash utilization measures of this project.

[19] This project is required to report the monitoring results of ambient air, effluent water, and flue gas to APPCB for every month and to the Central Pollution Control Board (CPCB) for every three months.

Parameter	Unit	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	Indian standards
Oil & Grease	ppm	ND	3.7	N/A	1.03	2.42	1.38	<0.2	3.5	20
Total Chromium	ppm	BDL	0.146	0.16	0.071	<0.01	0.13	N/A	<0.01	0.2
Iron	ppm	0.37	N/A	0.13	0.05	0.08	0.048	N/A	0.07	1.0
Zinc	ppm	0.025	0.476	0.240	0.063	N/A	0.330	0.138	0.060	1.0
Copper	ppm	0.078	0.052	0.050	0.033	0.009	0.080	0.061	0.040	1.0

Source: NTPC

Note 1: Above monitoring date is an annual average. The discharged water of this plant is measured in 24 hours at the outlet of the waste water treatment facility.

Note 2: ND: Not Detectable, BDL: Below Detectable Level, N/A: Not Available.

Note 3: The cooling water of this plant is tanked from the sea and discharged back into the sea after use having been cooled down.

The ex-post evaluation team of this project conducted an interview survey with the special secretary of AP State in change of environment and the District Collector of Vishakhapatnam municipality government as well as with several local residents near the Simhadri Power Plant including the village chiefs. No particular health hazards for local residents or environmental damage for the neighboring communities created by this project were observed[20].

(2) Recycling of Coal Ash

At the time of appraisal, this project set the target of achieving 30% of utilization of fly ash within 3 years and 100% utilization within 9 years after the commencement of operation, based upon the requirements of the guidelines of the Ministry of Environment and Forest. Table 7 shows the ash utilization plan with actual performance and estimates. Ash utilization reached 70% in 2007/08 and 2008/09. Ash was mostly utilized in low lying areas, filling in plants and raising ash dykes, also as a raw material for ash based products such as cement, concrete, bricks and tiles. However, the utilization of ash declined to 45% in 2009/10 due to a fall in the consumption of ash at cement plants, for the filling of low lying areas and road construction as construction activities fell influenced by the economic recession of 2009/10. Recently NTPC has prepared a five year rolling plan from 2010/11 to 2014/15 and has reset its target in order to achieve 100% of ash utilization by 2013/14. To realize this target, various efforts have been made by NTPC including marketing activities for customer development, joint ventures with cement factories, business promotion to the National Highway Authority of India (NHAI), show case projects for fly ash utilization in the agricultural sector, and the organization of PR seminars and workshops.

Table 7: Ash Utilization Plan

(Unit: 1,000 tons)

Year	Ash production	Ash utilization target	Ash Utilization							
			Low lying area filling	Cement & concrete	Ash dyke raising	Ash based production	Road	Others	Total	Utilization ratio
2003/04	1,950	165	179	30	62	2	-	-	273	14.0%
2004/05	2,065	410	443	13	29	28	-	4	517	25.0%
2005/06	1,765	600	628	115	28	37	32	10	850	48.2%
2006/07	2,043	735	799	227	222	70	4	6	1,328	65.0%
2007/08	2,304	890	1,107	258	2.5	107	139	10	1,624	70.5%
2008/09	2,364	1,050	888	222	319	182	14	35	1,660	70.2%

[20] Some of the local residents interviewed claimed that there had been damage to salt farms and to the health of local residents in the summer due to suspended substance travelling by air from the fly ash treatment plant. Regarding this, the Environmental Department of AP State stated that the cause and effect between the claimed health and environmental damage and this project could not be scientifically proven since there was a cement factory near the Simhadri Power Plant.

Year	Ash production	Ash utilization target	Ash Utilization							
			Low lying area filling	Cement & concrete	Ash dyke raising	Ash based production	Road	Others	Total	Utilization ratio
2009/10	2,217	1,300	174	190	304	216	2	114	1,000	45.0%
2010/11	2,012	1,267	60	235	525	235	66	146	1,267	63.0%
2011/12	2,020	1,414	200	175	600	200	100	139	1,414	76.0%
2012/13	2,024	1,821	300	250	600	250	100	321	1,821	90.0%
2013/14	2,050	2,050	400	275	600	300	100	375	2,050	100.0%
2014/15	2,050	2,050	400	275	600	300	100	375	2,050	100.0%

Source: NTPC
Note: The date from 2003/04 to 2009/10 is actual data and the data after 2010/11 is an estimation.

Photographs: Ambient Air Monitoring Station, Ash Handling Plant, and an Example of Fly Ash Utilization


Meteorological Observation Equipment and Ambient Air Monitoring Equipment

Ash Handling Plant (Ash Dyke)

Manufacturing of Sun-Dried Bricks made by Fly Ash

In recent years, housing development projects have taken place near the plant and these areas may be developed as residential areas in the future, also leading to an increase of population. Should this be the case, it is feared that new residents in the area might find environmental problems relating to the plant. Regarding this issue, the Environmental Department of AP State has recommended that NTPC acquire additional land in the vicinity of the plant and reserve this land as a green belt with tree plantation in order to separate the plant from the residential area. According to NTPC, extensive plantation near the plant is already underway near the township and ash disposal area of the plant and additional plantation is also being undertaken around the coal handling area, especially during the Second Stage of this project. However, there is no plan for additional land acquisition due to difficulties in arranging additional budget as well as difficulties in the coordination of existing road locations.

No particular negative impact on environment was observed at the time of ex-post evaluation.

3.4.5 Social Impacts relating to Land Acquisition and Resettlement

A total of 1,369 ha of land was acquired and 80 households were resettled by this project. The reason why the number of resettled households increased from 71 in the plan to an actual 80 was the re-lining of the drainage channel near the plant. These 80 households were compensated for their land and houses and those who wished were given 163m^2 of land in free of charge for each household in the resettlement area of the project. In the resettlement area community roads, electricity and water wells were provided (See Table 8).

Table 8: Land Acquisition Area and No. of Resettled Household

Item	Plan	Actual
1. Total Acquired Land	1,369 ha	Same as planned
2. Resettlement Area	2 ha	Same as planned
3. No. of Project Affected People	N.A.	2,272
4. No. of Resettled Households	71 households	80 households

Source: NTPC and SAPI Report (2001)

The above land acquisition and resettlement process was implemented within the framework of the "Resettlement and Rehabilitation Policy (May 1993)" and the "Resettlement and Rehabilitation Guideline and Community Development Plan (1999)" which were established through consultation between NTPC and the Village Development Advisory Committee (VDAC)[21]. Regarding the unit land price for compensation, Rs. 225,000 per acre[22] was adopted, a price which was 3-4 times higher than the available market price. This was the best land price for land owners and was favorable in comparison with ordinary cases. In addition, those losing land were provided with additional benefits as incentive[23], according to their houses type of crops and agricultural products produced on their land The main reason why this favorable land compensation price was possible was that since NTPC made fast-track land acquisition a priority, the land acquisition and resettlement process was proceeded in a participatory manner involving all stakeholders including NTPC, land owners and VDAC, and the land compensation price was determined based upon the negotiation. Also an adequate land acquisition and resettlement budget was prepared in the project costing.

Furthermore, based upon the community development plan (total project cost: 50 million Rs.) NTPC provided various types of support to those losing land and to local residents near the plant, including resettled residents, for the purpose of improving their living standards and promoting employment opportunities. As support for infrastructure development, resettled residents were allowed preferential shop allotment in townships together with the construction of roads, drinking water facilities, health facilities, educational facilities, and other community facilities. Also, vocational training at the local technical training institute[24], computer training, tailoring training for women[25], family planning operations incentives, and cataract operations were provided. Moreover, support was directly linked to employment creation and (i) 51 resettled residents were directly employed by NPTC as employees of Simhadri Power Plant, (ii) there was preferential allotment of small contracts for horticulture, housekeeping, cleaning etc. to cooperative societies[26] formed by the local community, (iii) trained local people were introduced to the local maintenance companies subcontracted for the maintenance work of the plant by NTPC, and (iv) there was short-term direct employment of local people as casual labor during the construction of this project[27] (See Table 9 and Table 10).

[21] VDAC was comprised of 25 members including district collector: 1, NTPC officials: 2, government officials: 4, elected village heads: 8, representatives of those losing land: 10 (SAPI Report).

[22] According to NTPC, the market rate for the land price in the project target area was Rs.50,000- 60,000 per acre.

[23] Out of the 2,376 Project Affected Persons (PAPs), 1,448 persons were recognized as the Eligible Land Oustees as per the Resettlement and Rehabilitation eligibility criteria (compensation less than Rs. 3,000,000). LINFO (Land Oustees Information) cards were being prepared and ready for the distribution to all the 1,448 eligible land oustees (PAPs). LINFO cardholders were nominated to receive benefits like counseling for income generation schemes, awards of petty contracts, shop allotments, training etc (SAPI Report).

[24] Industrial Training Institute (ITI).

[25] This tailoring training (a three months' course) was organized in association with the District Rural Development Agency. This training aimed to provide skilled manpower to meet the technical requirements of foreign apparel companies located in the nearby Vishakha Export Promotion Zone (VEPZ).

[26] At present, there are 12 cooperative societies with 200 members.

[27] The on-going Second Stage Project also employed local people as a short tem casual labor by priority.

The above support for community development has been continued by NTPC as a Corporate Social Responsibility (CSR) activity of Simhadri Power Plant. Even after the completion of this project, NTPC has supported the construction of roads, schools and health facilities in the local communities as well as vocational training for local residents, together with the preferential allotment of small contracts to cooperative societies and afforestation[28]. According to NTPC, 75 women out of 85 who received tailoring training successfully got employment at an apparel company.

Table 9: Major Works implemented by the Community Development Plan

(Until April 2003)

	Item	Amount
1	Major roads (R&B)	5
2	Pnachayat roads (village roads)	17
3	Community halls	11
4	Bus shelters	7
5	Additional blocks in schools	6
6	Toilet block for girls' high school	1
7	Shed in burial grounds	7
8	Market yard	1
9	Drinking water tube well with hand pumps	46
10	Supply of pile lies for water distribution	4.5km
11	Training at Industrial Training Institute (ITI) (No. of students)	150
12	Computer training (No. of students)	40
13	Tailoring training for Women	40
14	Individual toilets (matching grant)	117
15	Family planning operations-incentives	450
16	Cataract operations	300
17	Shops allotment	10
18	Furniture for primary schools	16
19	Furniture for ZP high schools	8
21	Furniture for junior college, Parawada	1
21	Laboratory equipment for school, college	4
22	Furniture for primary health centers	2

Table 10: Expenditure Statement for the Community Development Plan

(Unit: 1,000 Rs.)

	Item	Amount
1	Socio-Economic Survey (SES)	510
2	Supplementary SES studies	385
3	Counseling of PAPs Part I/II/III	1,826
4	Preparation of LINFO cards	47
5	Training of land oustees/nominees	828
6	Community Development Works	
	a. Roads	36,697
	b. Education	3,167
	c. Health	125
	d. Drinking water	1,365
	e. Other works	4,475
7	Community welfare programs	804
8	Deployment of sociologist	124
9	Miscellaneous expenditure	195
10	Public Information Center building	-
	Total	50,548

Source: NTPC (for Table 9 and 10)
Note: Expenditure statement for community development plan covers the cumulative expenditure until April 2003.

In sum, the land acquisition and resettlement process of this project was implemented in a participatory manner with the involvement of all stakeholders including NTPC, land owners and VDAC and the process was based upon clear standards and guidelines. Also, the compensated land price was higher than in ordinary cases as the land price was determined based upon negotiation and this process was implemented together with the community development program. This facilitated the promotion of local people's understanding and support for this project, and consequently the land acquisition and resettlement process proceeded smoothly and without any particular problems.

In 2007 Andhra University conducted a social impact study on this project[29], and they

[28] NTPC has supported afforestation in the areas near the plant and in Vishakhapatnam municipality since 1998/99, and a total of 600,797 trees were planted during the 8 years between 1998/99 and 2006/07.
[29] "Social Impact Study of Simhadri Project", Andhra University, 2007.

evaluated that the project had had a substantial positive impact on the local communities after implementation of the community development program. These impacts include, for example, an increase in per capita income for the local residents near Simhadri Power Plant, an increase in school enrollment and particularly an improvement in school enrollment for girls, an improvement in access to public services including education and health services, drinking water and transport[30]. This ex-post evaluation also conducted an interview survey with selected resettled people. An improvement in local people's living standards and an improvement in access to education, health and transport services after the implementation of this project were observed in line with the study results of Andhra University.

The interview survey with selected resettled people did however reveal that they had an employment issue. Most of the resettled people used to be small farmers with their own small plot of land or were peasant cultivators. After resettlement, they were obliged to change their profession from farmers to other new professions, but this change was not necessarily successfully achieved by everyone. Some people started a new business using money received as compensation and others got new jobs after receiving vocational training. There were people who could not get a new job even after receiving training and who could not do work except for farming due to lack of capacity. These were mostly aged people. As mentioned above, NTPC has made an effort to promote job opportunities for local people, but solving this employment issue is a tough challenge as it is closely linked to other factors such as the status of local economy and the capacity of the people. In respect, a comprehensive approach may be necessary through utilizing public support programs such as job guarantee schemes under the National Rural Employment Guarantee Act 2005 (NREGA) [31] in association with the State Government and by promoting income generation activities through micro-finance programs in collaboration with the local governments and NGOs.

Overall, it can be concluded that no negative social impact was observed at the time of the ex-post evaluation.

Photographs: Interview Survey with Resettled People

Resettlement Area

Interviewed Resettled People (1)

Interviewed Resettled People (2)

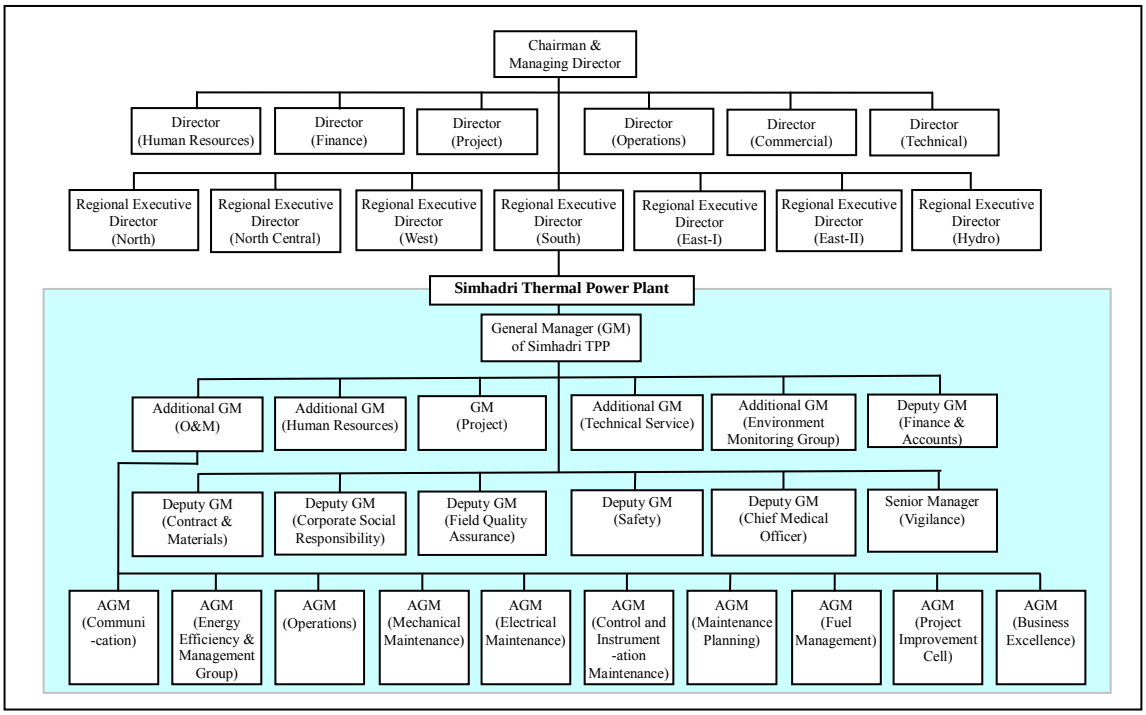
[30] This impact study primarily covered PAPs from 20 villages, 547 sample PAPs from 2,790 land displaced and homestead oustees.

[31] National Rural Employment Guarantee Act 2005 (NREG), established in August 2005 and enacted in February 2006, aims to enhance livelihood security in rural areas by providing at least 100 days of guaranteed wage employment in a financial year to every household under the poverty line whose adult members volunteer to do unskilled manual work.

3.5 Sustainability (Rating: a)

3.5.1 Structural Aspects of Operation and Maintenance

The operation and maintenance (O&M) agency of this project is the National Thermal Power Corporation Ltd. (NTPC). NTPC is the largest power generation company in India with a 29% share of the total generated electrical energy in the country. As of June 2010, the total number of employees at NTPC was 24,955 and among these 615 employees were working at Simhadri Power Plant directly engaged in O&M of the project facilities (out of 615 employees, 73 staff were working for the Second Stage of this project). Simhadri Power Plant acquired the certificates for ISO9001 (Qualify management system), ISO14001 (Environment management system), and OHSAS18001 (Occupational safety and health management system). No particular problem has been observed in the structural aspects of the O&M agency. The organizational chart of NTPC is shown in Figure 9.



Source: NTPC

Figure 9: Organizational Chart of NTPC

3.5.2 Technical Aspects of Operation and Maintenance

NTPC as well as Simhadri Power Plant has received many awards[32] in the past, and their technical capacity is recognized as top-class in India by the Indian government. NTPC has established a training program for their employees, and all employees must attend the 7-days training course every year. Since Simhadri Power Plant is checked through a technical audit by the NPTC headquarters every year, there is no particular problem for the technical aspects of the O&M agency.

3.5.3 Financial Aspects of Operation and Maintenance

Table 11 indicates the O&M budget of Simhadri Power Plant. The cost of O&M has increased

[32] Simhadri Power Plant received many awards for its outstanding performance in operation. For example, the National Award (Gold) for Meritorious Performance in the Power Sector, the National Award (Silver) for Meritorious Performance in the Power Sector, and the Gold Shield for Outstanding Performance among Thermal Power Stations.

every year. The reason that the actual O&M cost exceeded the planned cost in 2007/08 was because an additional O&M cost was required for maintenance of the turbine bearing of Unit 2. Also employment costs increased in 2008/09 and 2009/10 on account of revisions of pay, emolument and retirement benefits for employees. Simhadri Power Plant itself evaluates that the O&M budget for the plant has been adequately allocated by NTPC headquarters. There has been no delay in payment for electricity purchases from APTRANSCO to NTPC. Regarding the financial status of NTPC in the 4 years between 2005/06 and 2008/09, the major financial indicators were good with 7-8% of Return on Total Assets, 18-21% of Return on Sales, and 0.37-0.41 of Total Asset Turnover, indicating that the profitability (Return on Investment) of NTPC is high. Also, with the Current Ratio at 252-305% and Equity to Assets Ratio at 52-61%, the solvency of NTPC is also high. The financial status of NTPC is sound and there is no particular problem with the financial aspects of the O&M agency.

Table 11: Operation and Maintenance Budget of Simhadri Power Plant

(Unit: Million Rs.)

	2003/04		2004/05		2005/06		2006/07		2007/08		2008/09		2009/10	
	Plan	Actual	Plan	Actual	Plan	Actual	Plan	Actual	Plan	Actual	Plan	Actual	Plan	Actual
Employment cost	412	257	375	257	300	238	385	275	377	398	507	636	639	664
O&M cost	404	175	159	216	197	228	242	246	273	362	274	365	415	426
Overhead	202	181	249	176	203	196	198	198	216	226	218	261	249	310
Total	1,018	613	783	649	700	662	825	719	865	986	999	1,262	1,303	1,400

Source: NTPC

Table 12: Financial Analysis of NTPC based upon Consolidated Statement of NTPC Group

Major Operation Indicator (Unit: Million Rs.)

Item	2005/06	2006/07	2007/08	2008/09
(1) Sales	275,478	338,392	386,350	442,453
(2) Operating Expenses	232,768	276,897	310,038	382,005
(3) Depreciation	20,710	20,998	22,060	24,949
(4) Operating Income	42,710	61,495	76,312	60,448
(5) Profit/Loss before Tax	66,407	89,614	103,510	93,073

Note: Sales excludes other income including interests.

Major Financial Indicator (Unit: Million Rs.)

Item	2005/06	2006/07	2007/08	2008/09
A. Total Assets	742,069	841,294	935,527	1,100,541
B. Current Assets	160,305	228,224	263,157	324,633
C. Current Liabilities	63,574	76,935	86,225	120,334
D. Total Equity	450,006	487,125	528,629	574,076
E. Net Sales	275,478	338,392	386,350	442,453
F. Net Income after Income Tax	58,408	68,983	74,699	80,925
Financial Indicators				
Return on Total Assets (F/A)	8%	8%	8%	7%
Return on Sales (F/E)	21%	20%	19%	18%
Total Assets Turnover (E/A)	0.37	0.40	0.41	0.40
Current Ratio (B/C)	252%	297%	305%	270%
Equity to Assets Ratio (D/A)	61%	58%	57%	52%

Source: NTPC Annual Report 2006-2007, 2007-2008, 2008-2009.

3.5.4 Current Status of Operation and Maintenance

Simhadri Power Plant has exercised routine maintenance, preventive maintenance, and major maintenance including an overhaul of the project facilities based on the annual maintenance plan. It has also introduced a computerized maintenance management system. Whilst major maintenance, such as overhauls, is conducted by the manufacturers of the facilities, the maintenance of boilers is outsourced to private maintenance companies. Therefore, the role of NTPC in O&M of the project facilities is mainly management and supervision. O&M manuals are established and are utilized.

A stable supply of coal fuel for the plant comes from the state-owned coal mining company in the Orrisa State based upon a 20 years contract. Also, coal is transported from the coal mining company to the plant by Indian Railways. According an interview survey with APTRANSCO, they see no problem with the O&M of the project facilities as the supply of electricity by Simhadri Power Plant is stable, and they never experienced any trouble with the electricity supply from the plant.

During the field survey of the ex-post evaluation, the evaluation team visited the major project facilities including boilers, generators, the cooling tower, the ash handling plant, the railway sidings, the control center, ambient air monitoring stations etc. and examined the operational status and the O&M procedures of each facility through interviewing the person in charge. No particular problem was found. Therefore, no particular problem with the current status of the O&M of the project facilities has been observed.

No major problems have been observed in the operation and maintenance system, therefore sustainability of the project is high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

This project has been highly relevant with the Indian development plan and development needs, as well as with Japan's ODA policy, therefore its relevance is high. The project outputs were realized as planned, and both the project period and the project cost were within the plan, therefore the efficiency of the project is high. Since the key operation and effect indicators such as maximum output, plant load factor, available factor, gross thermal efficiency and net electricity energy production fully met the targets, this project has largely achieved its objectives, and thus its effectiveness is high. Also the sustainability of this project is high.

In light of above, this project is evaluated to be highly satisfactory.

4.2 Conclusion

4.2.1 Recommendation to the Executing Agency

(1) Expansion of the Green Belt Area between the Plant and Neighboring Areas

Currently the Second Stage of this project is on-going and the total installed capacity of Simhadri Power Plant will be expanded from the existing 1,000 MW to 2,000 MW after completion of the Second Stage project. Although no major negative environmental issue has been observed in the neighboring communities and with residents so far, there will be a risk of claims about environmental issues on the part of local residents in the future with the development of housing projects and with population growth in the communities neighboring the plant. In order to cope with potential future risks, it is recommended that the feasibility of an extended green belt area surrounding the Plant through additional land acquisition and afforestation is examined.

(2) Promotion of Employment Opportunities for Resettled People

In order to mitigate employment problems of resettled people, continuous efforts must be made by NTPC using counter measures through CSR activities such as support for vocational training and education. In addition, it is recommended that an examination is made of the feasibility of a comprehensive approach by utilizing public support programs such as the job guarantee schemes under the National Rural Employment Guarantee Act 2005 (NREGA) in association with the State Government and by promoting income generation activities through micro-finance programs in collaboration with local governments and NGOs.

4.2.2 Recommendations to JICA

None

4.3 Lessons Learned

Generally speaking, the land acquisition and resettlement process is a bottleneck in the smooth project implementation of many ODA projects. In the case of this project, the process was implemented in a participatory manner with the involvement of all stakeholders including NTPC, land owners and VDAC and the process was based upon clear standards and guidelines. Also the compensation land price was higher than the ordinary price as the land price was determined based on negotiations which referred to the available market land price. This process was implemented together with a community development program aiming at the improvement of local people's living standards as well as the promotion of employment opportunities. This facilitated local people's understanding and support for the project, and consequently the land acquisition and resettlement process ran smoothly. Such an approach will be a good lesson for other similar projects.

End

Comparison of the Original and Actual Scope of the Project

Item	Original	Actual
1. Project Outputs	a) Boiler x 2 units b) Steam turbine with 500MW output x 2 units c) Steam generator with 588MW outputs (power factor: 0.85) x 2 units d) Ash handling plant (area: 249 ha, capacity:48.16 million m^3) e) Reservoir (area: 112ha) f) Electrostatic precipitator g) Fuel oil handling and storage system h) Cooling water system (natural ventilation system, capacity: 60,000 ton/hour) i) Transformer j) Switching facility	Same as planed.
2. Project Period	February 1997-August 2004 (91 months)	February 1997-January 2004 (84 months)
Start of Synchronization	Unit 1: March 2002 Unit 2: December 2002	Unit 1: February 2002 Unit 2: August 2002
Start of Commercial Operation	Unit 1: July 2002 Unit 2: June 2003	Unit 1: September 2002 Unit 2: March 2003
3. Project Cost		
Amount paid in Foreign Currency	21,180 million Yen	15,869 million Yen
Amount paid in Local Currency	77,189 million Yen (31,635 million Rupees)	75,077 million Yen (29,879 million Rupees)
Total	97,369 million Yen	90,946 million Yen
Japanese ODA loan portion	65,168 million Yen	60,109 million Yen
Exchange rate	1 Rupee = 2.44 Yen (As of December 1999)	1 Rupee = 2.5127 Yen (Average between 1999 and 2004)

Third Party Opinion on Simhadri Thermal Power Station Project (I) (II) (III) (IV)

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Relevance

Simhadri Thermal Power Station Project (I) (II) (III) (IV) was undertaken to cope with growing electricity demand and to assure stable electricity supply in the Andhra Pradesh State, thereby contributing to the industrial and agricultural development, employment creation and improvement of people's living standards thorough the electrification in the rural area and households in the State. It is consistent with the power sector development strategy for the promotion of economic development of Andhra Pradesh.

Impact

As of 2009, Simhadri Power Plant shared 8% of the total installed power generation capacity and 11.9% of the generated electrical energy in AP State, and thus the project has played an important role in the power generation sector in the State. The project contributed to mitigating the electricity demand and supply gap in AP State through the provision of 8,000GWh of a stable electrical energy supply per year as a base-load power generation plant.

All the parameters for effluent water and the ground concentration of major air polluting parameters of the power plant fully met Indian environmental standards. NTPC has prepared a five year rolling plan in order to achieve 100% of fly ash utilization by 2013/14.

The land acquisition and resettlement process of this project was implemented in a participatory manner with the involvement of all stakeholders and the process was based upon clear standards and guidelines. Consequently, the land acquisition and resettlement process progressed smoothly.

Effectiveness

The project outputs were realized as planned, the project period and the cost were within the plan, and therefore the efficiency of the project is high. Since the key operation and effect indicators such as maximum output, plant load factor, available factor, gross thermal efficiency and net electricity energy production fully met the targets, this project has largely achieved its objectives, and thus its effectiveness is high.

(End)