No.

Ex-Post Evaluation Report of Japanese ODA Loan Projects 2009
(Indonesia VI, India, Nepal, Philippines IV)

December 2010

JAPAN INTERNATIONAL COOPERATION AGENCY

OPMAC Corporation

EVD
JR
10-36

Preface

Ex-post evaluation of ODA projects has been in place since 1975 and since then the coverage of evaluation has expanded. Japan's ODA charter revised in 2003 shows Japan's commitment to ODA evaluation, clearly stating under the section "Enhancement of Evaluation" that in order to measure, analyze and objectively evaluate the outcome of ODA, third-party evaluations conducted by experts will be enhanced.

This volume shows the results of the ex-post evaluation of ODA Loan projects that were mainly completed in fiscal year 2007. The ex-post evaluation was entrusted to external evaluators to ensure objective analysis of the projects' effects and to draw lessons and recommendations to be utilized in similar projects.

The lessons and recommendations drawn from these evaluations will be shared with JICA's stakeholders in order to improve the quality of ODA projects.

Lastly, deep appreciation is given to those who have cooperated and supported the creation of this volume of evaluations.

December 2010
Atsuro KURODA
Vice President
Japan International Cooperation Agency (JICA)

Disclaimer

Table of Contents

Indonesia “Sipansihaporas Hydroelectric Power Project (E/S)”
“Sipansihaporas Hydroelectric Power Plant Project”
“Sipansihaporas Hydroelectric Power Plant Project II”

1. Project Description........1-1
 1.1 Background........1-1
 1.2 Project Outline........1-1

2. Outline of the Evaluation Study........1-2
 2.1 External Evaluator........1-2
 2.2 Duration of Evaluation Study........1-2
 2.3 Constraints during the Evaluation Study........1-2

3. Results of Evaluation (Overall Rating: A)........1-3
 3.1 Relevance (Rating: a)........1-3
  3.1.1 Relevance with the Development Policies of Indonesia........1-3
  3.1.2 Relevance with the Development Needs of Indonesia........1-4
  3.1.3 Relevance with Japan's ODA Policy........1-4
 3.2 Efficiency (Rating: b)........1-5
  3.2.1 Project Outputs........1-5
  3.2.2 Project Inputs........1-6
   3.2.2.1 Project Period........1-6
   3.2.2.2 Project Cost........1-7
 3.3 Effectiveness (Rating: a)........1-7
  3.3.1 Quantitative Effects........1-7
   3.3.1.1 Results from Operation and Effect Indicators........1-7
   3.3.1.2 Results of Calculations of Internal Rates of Return (IRR)........1-8
  3.3.2 Qualitative Effects........1-8
 3.4 Impact........1-11
  3.4.1 Impacts generated: Benefits to the area and people included in the project........1-11
  3.4.2 Other Impacts........1-12
 3.5 Sustainability (Rating: a)........1-15
  3.5.1 Structural Aspects of Operation and Maintenance........1-15
  3.5.2 Technical Aspects of Operation and Maintenance........1-16
  3.5.3 Financial Aspects of Operation and Maintenance........1-17
  3.5.4 Current Status of Operation and Maintenance........1-19

4. Conclusion, Lessons Learned and Recommendations........1-19
 4.1 Conclusion........1-19
 4.2 Recommendations........1-19
  4.2.1 Recommendation to Executing Agencies........1-19
 4.3 Lessons Learned........1-19

Comparison of the Original and Actual Scope of the Project........1-20

Third Party Opinion on Sipansihaporas Hydroelectric Power Project........1-21

India "Simhadri Thermal Power Station Project (I) (II) (III) (IV)"

1. Project Description 2-1
1.1 Back Ground 2-1
1.2 Project Outline 2-1

2. Outline of the Evaluation Study 2-2
2.1 External Evaluator 2-2
2.2 Duration of Evaluation Study 2-2
2.3 Constraints during the Evaluation Study 2-2

3. Result of Evaluation (Overall Rating: A) 2-2
3.1 Relevance (Rating: a) 2-2
3.1.1 Relevance with the Development Plan of India 2-2
3.1.2 Relevance with the Development Needs of India 2-3
3.1.3 Relevance with Japan's ODA Policy 2-3
3.2 Efficiency (Rating: a) 2-4
3.2.1 Project Outputs 2-4
3.2.2 Project Inputs 2-4
3.2.2.1 Project Period 2-4
3.2.2.2 Project Cost 2-6
3.3 Effectiveness (Rating: a) 2-7
3.3.1 Quantitative Effects 2-7
3.3.1.1 Results from Operation and Effect Indicators 2-7
3.3.1.2 Results of Calculations of Internal Rates of Return (IRR) 2-8
3.3.2 Qualitative Effects 2-9
3.3.2.1 Results of the Beneficiary Survey 2-9
3.4 Impacts 2-10
3.4.1 Impact on Mitigation of the Electricity Demand and Supply Gap in AP State 2-10
3.4.2 Impact on Industrial Development and Expansion of Employment Opportunities 2-12
3.4.3 Impact on Rural Electrification and the Improvement of People's Living Standards 2-12
3.4.4 Impacts on the Natural Environment 2-12
3.4.5 Social Impacts relating to Land Acquisition and Resettlement 2-15
3.5 Sustainability (Rating: a) 2-19
3.5.1 Structural Aspects of Operation and Maintenance 2-19
3.5.2 Technical Aspects of Operation and Maintenance 2-19
3.5.3 Financial Aspects of Operation and Maintenance 2-19
3.5.4 Current Status of Operation and Maintenance 2-21

4. Conclusion, Lessons Learned and Recommendations 2-21
4.1 Conclusion 2-21
4.2 Conclusion 2-21
4.2.1 Recommendation to the Executing Agency 2-21
4.2.2 Recommendations to JICA 2-22
4.3 Lessons Learned 2-22

Comparison of the Original and Actual Scope of the Project 2-23

Third Party Opinion on Simhadri Thermal Power Station Project (I) (II) (III) (IV) 2-24

Nepal "Kali Gandaki "A" Hydroelectric Project"

1. Project Description 3-1
  1.1 Background 3-1
  1.2 Project Outline 3-1

2. Outline of the Evaluation Study 3-2
  2.1 External Evaluator 3-2
  2.2 Duration of Evaluation Study 3-2
  2.3 Constraints during the Evaluation Study 3-2

3. Result of the Evaluation (Overall Rating: A) 3-2
  3.1 Relevance (Rating: a) 3-2
    3.1.1 Relevance with the Development Plan of Nepal 3-2
    3.1.2 Relevance with the Development Needs of Nepal 3-4
    3.1.3 Relevance with Japan's ODA Policy 3-5
  3.2 Efficiency (Rating: b) 3-5
    3.2.1 Project Outputs 3-5
    3.2.2 Project Inputs 3-7
      3.2.2.1 Project Period 3-7
      3.2.2.2 Project Cost 3-8
  3.3 Effectiveness (Rating: a) 3-9
    3.3.1 Quantitative Effects 3-9
      3.3.1.1 Results from Operation and Effect Indicators 3-9
      3.3.1.2 Results of Calculation of Internal Rates of Return (IRR) 3-11
    3.3.2 Qualitative Effects 3-12
  3.4 Impact 3-13
    3.4.1 Intended Impacts 3-13
    3.4.2 Other Positive and Negative Impacts 3-14
      3.4.2.1 Benefits to subject area and neighboring residents 3-14
      3.4.2.2 Impact on Natural Environment 3-15
      3.4.2.3 Implementation Status of Resettlement and Land Acquisition 3-16
  3.5 Sustainability (Rating: a) 3-17
    3.5.1 Structural Aspect of Operation and Maintenance 3-17
    3.5.2 Technical Aspects of Operation and Maintenance 3-18
    3.5.3 Financial Aspects of Operation and Maintenance 3-18
    3.5.4 Current Status of Operation and Maintenance 3-21

4. Conclusion, Lessons Learned and Recommendations 3-21
  4.1 Conclusion 3-21
  4.2 Recommendations 3-21
    4.2.1 Recommendations for Executing Agency 3-21
  4.3 Lessons Learned 3-22

Comparison of the Original and Actual Scope of the Project 3-24

Third Party Opinion on Kali Gandaki "A" Hydroelectric Project 3-25

The Philippines "Northern Negros Geothermal Project"

1. Project Description....4-1
1.1 Background....4-1
1.2 Project Outline....4-1
2. Outline of the Evaluation Study....4-2
2.1 External Evaluator....4-2
2.2 Duration of Evaluation Study....4-2
2.3 Constraints during the Evaluation Study....4-2
3. Results of the Evaluation (Overall Rating: D)....4-3
3.1 Relevance (Rating: a)....4-3
3.1.1 Relevance with the Development Plan of the Philippines....4-3
3.1.2 Relevance with the Development Needs of the Philippines....4-3
3.1.3 Relevance with Japan's ODA Policy....4-4
3.2 Efficiency (Rating: b)....4-5
3.2.1 Project Outputs....4-5
3.2.2 Project Inputs....4-6
3.2.2.1 Project Period....4-6
3.2.2.2 Project Cost....4-6
3.3 Effectiveness (Rating: c)....4-7
3.3.1 Quantitative Effects....4-7
3.3.1.1 Results from Operation and Effect Indicators....4-7
3.3.1.2 Results of Calculations of Internal Rates of Return (IRR)....4-8
3.3.2 Qualitative Effects....4-9
3.4 Impact....4-9
3.4.1 Intended Impacts....4-9
3.4.2 Other Impacts....4-9
3.5 Sustainability (Rating: b)....4-12
3.5.1 Structural Aspects of Operation and Maintenance....4-12
3.5.2 Technical Aspects of Operation and Maintenance....4-12
3.5.3 Financial Aspects of Operation and Maintenance....4-13
3.5.4 Current Status of Operation and Maintenance....4-13
4. Conclusion, Lessons Learned and Recommendations....4-13
4.1 Conclusion....4-13
4.2 Recommendations....4-14
4.2.1 Recommendations for the Executing Agency....4-14
4.2.2 Recommendations for JICA....4-14
4.3 Lessons Learned....4-14
Comparison of the Original and Actual Scope of the Project....4-15
Third Party Opinion on Northern Negros Geothermal Project....4-16

Indonesia

“Sipansihaporas Hydroelectric Power Project (E/S)”

“Sipansihaporas Hydroelectric Power Plant Project”

“Sipansihaporas Hydroelectric Power Plant Project II”

Indonesia

Ex-post Evaluation of Japanese ODA Loan Project
"Sipansihaporas Hydroelectric Power Project (E/S)"
"Sipansihaporas Hydroelectric Power Plant Project"
"Sipansihaporas Hydroelectric Power Plant Project II"

Masumi Shimamura, Mitsubishi UFJ Research and Consulting Co., Ltd.

1. Project Description

Project Site


Sipansihaporas Hydroelectric Power Plant

1.1 Background

Sipansihaporas Hydroelectric Power Plant is located along the Sipansihaporas River, which runs approximately 10 km in the east of the city of Sibolga, North Sumatra Province, on the Sumatra Island. The project provided two conduit-type hydropower stations, with a combined output of 50MW from Power Station No. 1 (33MW) and Power Station No. 2 (17MW), and related transmission lines.

North Sumatra Province, at the time of the project reparation, was faced by an urgent need to meet the rapid increase of power demand (peak load) in and out of its capital city Medan, and was in need of aggressive power development. The city of Sibolga, the project site, was also expected to see an increase in peak load when the ongoing regional development projects, such as construction of new factories and hotels, would be completed. In the meantime, efficient peak-load power stations were lacking in the region.

The Sixth Five-Year National Development Plan, under which the project was formulated, stipulated a steady power development in order to accommodate the growing power demand. Specifically, it focused on a goal of decreasing the country's oil dependence through increasing the shares of alternative energies and developing renewable energies. The construction of Sipansihaporas Hydroelectric Power Plant was expected as an important and vital renewable, clean energy source, from the standpoint of well-balanced power development.

1.2 Project Outline

The objective of the project is to meet the increasing power demand in North Sumatra Province by constructing hydropower plants with pondage, with an installed capacity of 50MW that respond to peak load on a daily basis on the middle reaches of the Sipansihaporas River running near Sibolga, North Sumatra Province, and thereby contributing to the economic development and the enhancement of living standard in the said area.

	E/S	Phase I	Phase II
Approved Amount / Disbursed Amount	820 million yen/ 580 million yen	2,978 million yen/ 2,699 million yen	8,408 million yen/ 6,760 million yen
Exchange of Notes Date / Loan Agreement Signing Date	November, 1992/ November, 1992	December, 1995/ December, 1995	December, 1996/ December, 1996
Terms and Conditions	Interest Rate: 2.6% Repayment Period/Grace period: 30years/10years Partially Untied	Interest Rate: 2.5% Repayment Period/Grace period: 30years/10years General Untied Consultant: Interest Rate: 2.3% Repayment Period/Grace period: 30years/10years General Untied	Interest Rate: 2.7% Repayment Period/Grace period: 30years/10years General Untied
Borrower / Executing Agency	The Government of Indonesia / PT. PLN (Persero)		
Final Disbursement Date	E/S: December, 1996 Phase I and II: October, 2005		
Main Contractor (Over 1 billion yen)	Kumagai Gumi Co., Ltd (Japan)・PT. Wijaya Karya (Indonesia) (JV)		
Main Consultant (Over 100 million yen)	PT.Trimitra Nusa Engineering(Indonesia)・PT. Gurmilang Pancang Kvetama(Indonesia)・Tokyo Electric Power Services Co., Ltd. (Japan) (JV) / PT. Jaya CM Manggala (Indonesia)・PT. Tata Guna Patria(Indonesia)・PT. Trimitra Nusa(Indonesia)・Tokyo Electric Power Services Co., Ltd. (Japan) (JV)		
Feasibility Studies etc.	July, 1990 JICA F/S		

2. Outline of the Evaluation Study

2.1 External Evaluator

Masumi Shimamura (Mitsubishi UFJ Research and Consulting Co., Ltd.)

2.2 Duration of Evaluation Study

Duration of the Study: April, 2010-December, 2010
Duration of the Field Study: 6-19, June, 2010, 22-28 August, 2010

2.3 Constraints during the Evaluation Study

None.

3. Results of Evaluation (Overall Rating: A)

3.1 Relevance (Rating: a)

3.1.1 Relevance with the Development Policies of Indonesia

At the time of appraisal, the Government of Indonesia identified, in its Sixth Five-Year National Development Plan (REPELITA VI: 1994-1999), one of its primary development goals as an enhancement of power supply reliability together with power development in line with the petroleum policy, which considers oil as a foreign currency source (i.e., “oil-free power source policy”). It aimed at developing power sources and constructing transmission lines commensurate with the resource reserves in individual regions. Furthermore, there was an apparent projection for a high growth in power demand and recognition of a necessity for aggressive power development in the country at that time. The project under review was consistent with the Government of Indonesia’s strategies, described in the Sixth Five-Year National Development Plan, to increase the reliability of power supply and develop hydropower resources, which would provide a clean and regional energy based on a renewable resource.

At the time of ex-post evaluation, the Government of Indonesia remains to be committed to the oil-free power source policy and an improvement of energy mix through power development, in its Medium-Term National Development Plans (RPJMN 2004-2009 and 2010-2014). RPJMN 2010-2014, aiming to enhance use of renewable energies, such as hydro and geothermal powers, targets at an output of 2,000MW in 2012 and 5,000MW in 2014. Also, the Government’s RUKN (National Electricity Global Planning 2008-2027) for the power sector clearly calls for further utilization of renewable energies. Moreover, PLN’s RUPTL (PLN Electricity Supply Plan 2010-2019) sets a goal of increasing the household (rural) electrification rate across the country to 91% by 2019, and aims to improve standard of living of the nation and to alleviate disparities among regions.

The following tables show inter-annual changes in the power source composition and the amount of power sold in Indonesia.

Table 1: Energy Consumption Ratio by Energy Source in Indonesia (%) (Energy Mix)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Oil	18.8	18.4	21.0	14.6	23.5	24.9	29.9	30.6	27.7	25.5	27.7
Natural Gas	34.6	34.8	30.4	25.0	20.8	18.6	14.3	12.7	13.0	13.5	14.2
Coal	30.2	31.7	34.5	28.9	27.1	28.2	25.9	26.1	28.8	29.3	27.6
Geothermal	3.5	3.4	3.2	2.9	2.9	2.6	2.6	2.4	2.4	2.2	2.3
Hydro	13.0	11.7	10.9	10.5	8.2	7.5	7.4	7.7	6.6	7.5	7.2
Purchase				13.1	17.6	18.2	19.9	20.5	21.5	22.0	20.9

Source: PLN Annual Report (2002-2008) (Total figures do not become 100% due to rounding error)

Table 2: Power Sales in Indonesia

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Power Sales (GWh)	65,261	71,332	79,165	84,520	87,089	90,441	100,097	107,032	112,609	121,246	129,019
Power Sales Growth Rate (%)	1.5	9.3	11.0	6.7	3.9	3.8	10.7	6.9	5.2	7.7	6.4
GDP Growth Rate (%)	-13.1	0.7	4.9	3.8	4.3	4.7	5.0	5.6	5.5	6.3	6.1

Source: Power Sales and Power Sales Growth Rate: PLN Annual Report (2002-2008)

Note: GDP Growth Rate (Real growth rate (based on the prices in 2000)): Ministry of Energy and Mineral Resources (ESDM) Handbook (2006, 2007, 2008)

3.1.2 Relevance with the Development Needs of Indonesia

At the time of appraisal, the power demand growth in North Sumatra Province was 14% in 1993 and was projected as approximately 15% per annum for the ensuing decade. It was therefore essential to secure a certain level of supply margin in order to maintain the reliability of power supply. The Government of Indonesia considered hydropower resources as a clean, regional energy based on a renewable resource and attached high priority to the development of hydroelectric generation. In addition, a construction of efficient peak-load power stations was expected as such facilities were lacking in the area included in the project. The project under review involved the development of power sources, contributing to the development of an oil-saving, clean and regional energy source and an efficient supply of electricity while managing the increasing power demand in the region. Thus, the necessity for and priority of the project were deemed high.

At the time of ex-post evaluation, the power demand in North Sumatra Province continues to show high growth. The growth in peak load increased 2.2-fold from 541.96MW to 1,170.70 MW during the 14 years between 1995 and 2009 (Table 3). North Sumatra Province remains to be categorized as a “Critical Area” in terms of power supply, and is designated as a priority area for developing power installations in PLN’s RUPTL (PLN Electricity Supply Plan 2010-2019). The peak-load hydropower stations provided by the project supply additional power to the North Sumatra region, but are not yet sufficient to satisfy the high power demand. A further development of power generation facilities is a pressing need.

Table 3: Power Demand in the Province of North Sumatra (GWh)

	1995	2000	2005	2006	2007	2008	2009
Energy Sales: Residential	880.80	1,527.29	1,989.34	2,119.94	2,196.17	2,458.13	2,657.31
Industrial	1,111.00	1,507.76	1,635.37	1,737.18	1,823.13	1,902.34	2,069.15
Commercial	203.70	388.36	609.11	675.39	694.83	895.22	960.75
Public	157.40	222.95	379.55	408.36	449.31	502.17	550.02
Total Growth rate (%)	2,352.90 15.88	3,646.35 7.00	4613.37 3.91	4,940.87 7.10	5,163.44 4.50	5,757.85 11.51	6,237.23 8.33
Total Production	3,005.46	4,142.87	5,476.01	5,616.17	5,908.60	6,469.15	6,881.32
PLN Use	110.28	0	0	0.35	0	0	0
Energy Requirement	2,895.18	3,881.31	5,476.01	5,615.82	5,908.60	6,469.15	6,881.32
Transmission & Distribution Losses (%)	18.73	11.98	15.09	11.32	11.88	10.18	9.36
Peak Load (MW)	541.96	865.00	970.00	1,021.00	1,052.00	1,113.00	1,170.70

Source: Results from questionnaire surveys to PLN

3.1.3 Relevance with Japan's ODA Policy

The objective of the project was consistent with the Government of Japan’s assistance policies at the time of appraisal. The Ministry of Foreign Affair of Japan’s 1999 ODA White Paper identified five priority areas of Japan’s assistance for Indonesia. For the “development of industrial infrastructure (economic infrastructure)” area, one of the five priority areas, (i) power, (ii) water resource development, (iii) transport and (iv) communications were specifically recognized as essential. Since the onset of the project, there has been no change in the assistance policies of the Government of Japan or JICA, which might affect the direction of the project. Thus, the consistency of the project with the Japanese assistance policies is still maintained.

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

3.2 Efficiency (Rating: b)

3.2.1 Project Outputs

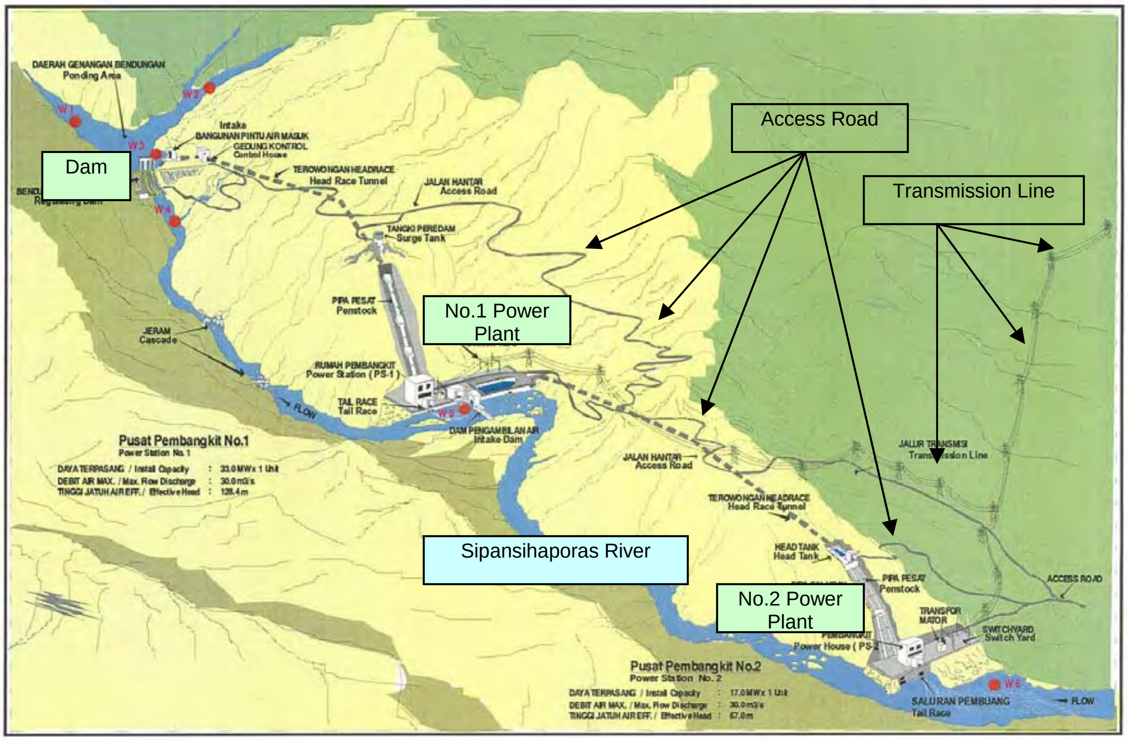
The review hereof considers the engineering service (E/S), first phase (Phase I) and second phase (Phase II) collectively as one project. The details of each subproject are as given in Table 4 below.

Table 4: Phasing and Each Content of Project

	Project Name	Major Contents
E/S	Sipansihaporas Hydroelectric Power Project (E/S)	Consulting Services (F/S, D/D, support for bidding process etc.)
Phase 1	Sipansihaporas Hydroelectric Power Plant Project	1. Construction of lower access road and base camp 2. Consulting Services (supervision for civil works, metal works, generator works and access road construction)
Phase 2	Sipansihaporas Hydroelectric Power Plant Project II	1. Civil works and discharge warning system 2. Metal Works 3. Turbine 4. Generator 5. Transmission Line

Source: PLN

All subprojects yielded the outputs planned at the time of appraisal with no change.



Source: PLN

Figure 1: Layout of the Project Site

As shown in Table 5 below, the inputs for the consulting services during E/S and Phase I were modified. As far as E/S is concerned, the input of foreign consultants was reduced whereas that of local consultants was increased, resulting in an increase of 23M/M overall. The reasons for the change included (i) bad weather which delayed the schedule, hence requiring additional engineers to facilitate the process and (ii) additional topographical surveys.

As for the consulting services in Phase I, the inputs of foreign and local consultants significantly increased by 844M/M in total. The reason for the increment was basically prolonged construction supervision, necessitated in association with the delay in the implementation schedules for metal works and civil works in Phase II (to be discussed later).

Table 5: Comparison of Planned and Actual Consulting Service (M/M)

	E/S		Phase I	
	Planned	Actual	Planned	Actual
Foreign	169	151	515	766
Local	91	132	630	1,223
Total	260	283	1,145	1,989

Source: Information from JICA, results from questionnaire surveys to PLN and interview survey results during field survey

Substation

Penstock

3.2.2 Project Inputs

3.2.2.1 Project Period

The overall project period, covering E/S, Phase I and Phase II, was planned as 165 months as opposed to 207 months including the extended loan period in reality, representing an expansion to 125.5% of the initial plan (See Table 6 for breakdowns). Due to the delay in the schedule, the project involved extension of the loan disbursement period for both Phase I and Phase II, in December 2003. The loan disbursement deadlines were extended to October 2005 for the two phases.

Table 6: Comparison of Planned and Actual Project Period

	Planned	Actual	Comparison
E/S	Sept. 1992* － Apr. 1995 (32 months)	Nov. 1992* － Oct. 1995 (36 months)	Delayed by 4 months
Phase I	Oct. 1995* － Oct. 2001 (73 months)	Dec. 1995* － Jan. 2005**	Delayed by 38 months
Phase II	Nov. 1996* － Oct. 2001 (60 months)	Dec. 1996* － Jan. 2005**	

Note 1: * At the time of Loan conclusion
Note 2: ** Project completion is considered at the time when project effect has generated in January, 2005.

The delay in the implementation schedule was caused mainly by the following factors:

① The local subcontractor undertaking the metal works in Phase II went into serious financial difficulties and failed to perform the obligation. It took some time for the prime contractor, contractually liable for the default, to make up for the local part.

② The soil at the site was unexpectedly too soft (volcanic ash clay layer) for civil works, such as the construction of the head race tunnel for Power Station No. 1 in Phase II, which slowed the progress of the works.

③ The site surveys, such as topographical survey, geological survey and geophysical exploration, were delayed in consequence of bad weather for E/S.

3.2.2.2 Project Cost

The total project cost, covering E/S, Phase I and Phase II, was initially estimated at 15,782 million yen, of which Japanese ODA loan would cover 12,206 million yen, consisting of 820 million yen for E/S, 2,978 million yen for Phase I and 8,408 million yen for Phase II. In actuality, Japanese ODA loan provided a total of 10,039 million yen—580 million yen for E/S, 2,699 million yen for Phase I and 6,760 million yen for Phase II—resulting in a lower amount than the initial estimate (82.2% of the planned amount).

There is no reliable evidence to confirm the actual project cost spent; because the amounts invested from the government and PLN budgets were not properly recorded in project accounting under imperfect project accounting system of PLN.

Despite the delay in the schedule and the increase in the outputs, the amount of Japanese ODA loan decreased mainly because (i) the international and local competitive biddings generated price competition, which held down the total project cost, and (ii) the Asian currency crisis, which occurred during the project implementation period, caused the local currency, Indonesian Rupiah, to depreciate against the Japanese yen.

Although the yen loan portion of the project cost was held within the initial plan, the project period was longer than planned, therefore the efficiency of the project is fair.

3.3 Effectiveness (Rating: a)

3.3.1 Quantitative Effects

3.3.1.1 Results from Operation and Effect Indicators

No operation and effectiveness indices were set at the time of appraisal. Table 7 below summarizes the results of unplanned outage hours, capacity factor, planned outage hours for inspection and repair, net electric energy production (power output) and maximum output, after the start of operation, based on data available at the time of ex-post evaluation. Incidentally, PLN does not measure the sedimentation condition in the ponding area in numerical values.

Table 7: Operation and Effect Indicators

Indicators (Unit)	Target at appraisal	Actual Performance				
	2005	2005	2006	2007	2008	2009
Operation Indicators						
Unplanned outage hours (hr/year)	NA	0.09	-	0.21	50.26	-
Capacity factor (%)	NA	38.31	41.68	47.01	20.90	26.88
Planned outage hours (hr/year)	NA	0.99	1.11	0.09	0.08	2.21
Annual total volume of inflow to the reservoir (m^3/Year)*	NA	NA	NA	NA	NA	290,236,923
Effect Indicators						
Net electric energy production (GWh/Year)	NA	167.78	182.54	205.92	91.54	117.74
Maximum output (MW)	NA	50	50	50	50	50

Source: Results from questionnaire surveys to PLN
Note: * Total inflow from Natolbak and Paramaan river to the reservoir of PLTA Sipansihaporas Dam site.

The operation from the start to 2007 was successful and the annual power output steadily increased. The unplanned outage jumped to 50.26 hours in 2008 because of a failure to the generator at Power Station No. 1 (End of March 2008 to June 2009). Consequently, years 2008 and 2009 saw a decline in both the capacity factor and the net electric energy production (power output), but the operation returned to normal when all the repair works was completed in June 2009.

PLN pointed out that the failure to the generator was caused by improper installation of the generator during the construction[1]. They also noted the reasons for taking such a long time to resume the operation as that (i) (as the incidence was covered by the defect warranty) the contractor needed to obtain approval of the insurance company and (ii) the coils had to be reassembled at the time of the repair work.

Both Power Stations No. 1 and 2 were working and generating power in good shape at the time of ex-post evaluation. The performance in 2010 is expected to surpass the pre-failure level in 2007.

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

Based on the cost[2] and benefit data obtained from PLN, the financial internal rate of return (FIRR) was recalculated using the same method employed at the time of appraisal. On the other hand, the economic internal rate of return (EIRR) was not analyzed in the ex-post evaluation, considering that the assumption of EIRR calculation at the time of appraisal was unknown.

Table 8: Assumption and Results of FIRR Recalculation

	At time of Appraisal	At time of Evaluation
FIRR	10.89% (Figure at the time of Phase I appraisal) 12.35% (Figure at the time of Phase II appraisal)	12.80%
Benefit	Revenue for power sales related with the project	Revenue for power sales related with the project (Assumed the power rate growth as 1.56%** in real terms after 2010)
Cost	Construction cost, Consulting service cost, Land acquisition cost, Tax, General administration cost, Contingency and O&M cost (excluding price escalation)	Construction cost, Consulting service cost, Land acquisition cost, O&M cost (excluding price escalation)
Project Life	50 years after project completion	

Note: ** Utilized the same assumption with those at the time of appraisal

The FIRR assessed at the time of ex-post evaluation was slightly higher than that at the time of appraisal. This was primarily because:

① the figures used as the cost did not include administrative cost, tax and interest, considering that the total project cost was uncertain; and

② the annual amount of electricity generated at the power stations turned out to be above the level planned at the time of appraisal (183GWh), with the highest output since the start of operation being 205.92GWh (2007). The performance in and beyond 2010 will expectedly continue to exceed this level.

3.3.2 Qualitative Effects

(1) Increased power supply to North Sumatra Province

As shown in Table 9, the quantitative contribution of Sipansihaporas Hydroelectric Power Plant to incremental power supply to the coverage area of the plant has been very limited with a

[1] Two places where coils were not properly installed were found when the generator was disassembled for the repair.

[2] Since the accurate figures for the total project cost and annual expenditure were unavailable, the data obtained from PLN, except administration cost, tax and interest, were referred to.

share in North Sumatra Province being 3.11% and that in the entire Sumatra Island being 0.55%, in terms of installed capacity.

On the other hand, from the viewpoint of increasing the electrification rate in the coverage area, the project electrified some villages, demonstrating particular benefits brought about by power supply. (See below.)

Table 9: Share of Sipansihaporas Hydroelectric Power Plant

	Installed Capacity (MW)	Share of Sipansihaporas Power Plant
North Sumatra total	1,608	3.11%
Sumatra total[3]	9,145	0.55%
Hydroelectric power station total in Sumatra	893	5.60%

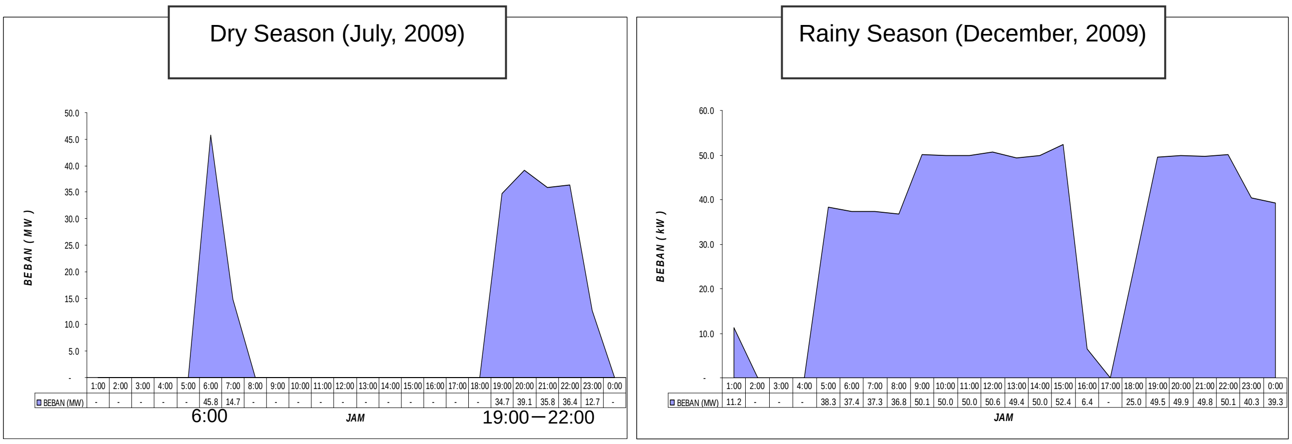
Source: Results from questionnaire surveys to PLN

(2) Increased electrification rate in the coverage area

The interviews with local residents[4] around the project site during the field visits found that Sihaporas Village, with a population of approximately 50 households, was electrified anew after the completion of the project. The villagers became able to use rice cookers, washing machines, TV units and the like and enjoy a enhanced standard of living.

(3) Creation of significance as an efficient peak-load hydropower plant

Sipansihaporas Hydroelectric Power Plant becomes operational during peak load hours (from 19 to 22 o'clock and 6 o'clock) in both the dry season (April to September) and the rainy season (October to March). It serves as a plant to accommodate peak load. During the rainy season when a sufficient flow rate can be obtained, the plant also operates during off-peak hours, thereby contributing to supplying incremental electricity (Figure 2).



Source: Results from questionnaire surveys to PLN

Figure 2: Sipansihaporas Power Plant's common operation hours and power outputs

[3] All grids in Sumatra had been connected at the time of ex-post evaluation. Rantau Prapat − Bagan Batu were connected on August 14, 2007; this in turn connected the North Sumatra grid and the Central-South Sumatra grid, which had existed independently, establishing the whole Sumatra grid.

[4] A total of five (5) interviewees from Sibuluan Village and Sihaporas Village.

(4) Increased transport capacity and enhanced standard of living for the local residents due to the construction of access roads

An interview survey regarding the access roads[5] (one accessing the power plant for maintenance work and one connecting with the water intake point) was conducted targeting users of the roads, namely local residents, manager and staff of the hotel, managers of the nursing school and shopkeepers along the roads. Their response is summarized below.

Table 10: Interview Results with the Local Residents and Workers along the Access Roads

Interviewees	Responses
Local residents in Sibuluan Village and Shihaporas Village	・ It has become easier to transport farm products and food stuff by using the access road ・ It has become easier to go to Sibolga City because of the newly established public bus system along the access road ・ Quality of life has improved because school, mosque, church etc. were newly constructed along the access road ・ Socialization between Sibulan Villagers and Shihaporas Villagers has been facilitated after the construction of the access road (travel time between the two villages has reduced from 3-4 hours on foot to 10 minutes by bicycle)
Hotel manager and staff along the access roads	・ Hotel was newly opened after the access roads were constructed − with the expectation of economic benefits because the area had potential for leisure places (hiking, fishing, bathing etc.) ・ Income level has increased after opening the hotel and shops
Managers at the nursing school	・ Nursing school has moved in from Sibolga City after the access roads were constructed ・ Employment opportunities for students are expected to increase in the local areas after students graduate from the school
shopkeepers along the access roads	・ Shop was newly opened two years ago (after the access roads were constructed) − with the expectation of economic benefits ・ Local employment opportunities have increased and income level has risen – enjoying better living ・ Many shops have newly operated around the area and economic activities have increased

As evident above, the interviewed local residents and people engaged in economic activities along the roads all benefit from the project, and they are specifically satisfied with the economic benefits and appreciative of the project.

[5] The access roads are two-way two-lane, paved roads with a total length of approximately 5 km, connecting Sibuluan Village, Sihaporas Village and the project site.

Access road constructed under the project

Hotel along the access road

(5) Job creation associated with the construction works under the project

All local residents interviewed pointed out the effect of job creation during the construction. Most of the villagers, men and women, in Sibuluan and Sihaporas, were employed in the preparation and assistance work for constructing the access roads for six years. The construction under the project provided them with a new revenue source.

In this way, Sipansihaporas Hydroelectric Power Plant has created significance as an efficient peak-load hydropower plant (not assumed for base load power source), while the FIRR figure is at sufficient level when compared against the net electric energy production (power output) assessed at the time of appraisal. Furthermore, local residents and people engaged in economic activities in the area unanimously acknowledge the benefits brought about by the project.

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

3.4 Impact

3.4.1 Impacts generated: Benefits to the area and people included in the project

As previously mentioned, the share of Sipansihaporas Hydroelectric Power Plant in the power supply to its coverage area is so minimal that it is difficult to measure its direct impact based on the changes in regional indicator values.

As a matter of fact, the changes in industrial power demand in North Sumatra Province (Table 11) do not indicate a clear correlation between the growth of industrial GRDP and the operation of the power plant.

Table 11: Industrial GRDP Growth and Power Demand in North Sumatra Province

	1995	2000	2005	2006	2007	2008	2009
Industrial GRDP Growth Rate (%)	9.21	3.54	4.76	5.47	5.09	2.92*	2.76*
Growth Rate for Power Demand (%)	-	-2.22	0.93	6.23	4.95	4.34	8.77
Growth Rate for PLN Power Supply (%)	-	6.74	3.63	2.56	5.21	9.49	6.37

Source: Industrial GRDP: BPS-Statistics of Sumatra Utara Province (* estimated figures)
Note: Growth Rate for Power Demand and Growth Rate for PLN Power Supply: Results from questionnaire surveys to PLN

The electrification rate in North Sumatra has steadily been increasing (Table 12); therefore, though the share of the plant in incremental power supply is limited, it is thought that the project has contributed to an increased electrification rate[6].

Table 12: Power Demand in North Sumatra Province

	1995	2000	2005	2006	2007	2008	2009
Total Population(1,000)	11,062.7	11,642.0	12,326.7	12,643.5	12,833.2	13,042.3	13,248.4
Population Growth Rate (%)	1.52	0.47	1.68	2.57	1.50	1.63	1.58
Electrification Rate (%)	51.01	65.05	74.04	73.48	74.29	75.53	77.60
GRDP Growth Rate (%)	9.09	4.98	5.48	6.20	6.00	6.00	6.00

Source: Results from questionnaire surveys to PLN

There is no clear correlation between the trend in foreign direct investment (FDI) as well as domestic investment in North Sumatra Province and the operation of the power plant (Table 13). While there might be a very slight contribution, it is difficult to measure the impact of the power plant based on the changes in regional indicator values.

Table 13: FDI and Domestic Investment to North Sumatra Region

	1995	2000	2005	2006	2007	2008	2009
Amount of New FDI (U$1,000,000)	670.67	69.66	107.94	606.02	246.87	74.05	0.50
New FDI Project	15	20	12	12	17	3	2
Amount of New Domestic Investment (IDR1,000,000,000)	249.02	65.59	599.40	797.26	1,855.44	117.41	688.90
New Domestic Investment Project	11	6	6	3	7	6	1

Source: BPS-Statistics of Sumatra Utara Province

3.4.2 Other Impacts

(1) Impacts on the natural environment

No negative impact of the project on the natural environment has been observed during and also after the implementation of the project. During the hearing survey with two local NGOs, knowledgeable of the area included in the project, and five local residents, they did not mention any negative impact on the natural environment resulting from the implementation of the project. Incidentally, according to PLN, Sipansihaporas Hydroelectric Power Plant is certified by the National Standard of Safety and Health Condition and ISO 14000.

The Environmental Impact Assessment (AMDAL) was reapproved by the Central Committee of the Ministry of Energy and Mineral Resources on July 3, 1996. During the implementation of the project, an environmental monitoring was conducted every three months. Monitoring activities after the plant was put into service include water quality analysis (four times a year), monitoring of impact on flora and fauna (twice a year), and monitoring of impact on local residents (once a year). The results of individual monitoring items are summarized in Table 14 below. The contents of the environmental monitoring activities by PLN during the implementation of the project as well as after the plant was put into service are deemed as satisfactory in terms of frequency and management. In addition, there was no particular impact of the unexpectedly soft ground on the land features in the vicinity of the project site.

---

[6] A record taken at the time of appraisal states “electrification of 50,000 households” but the rationale for this figure cannot be obtained from Table 12. Theoretically, 74,074 households were electrified as a result of the implementation of the project.

- ➔ A half of the newly electrified households use 450w of electricity and the other half 900w: =Average per household: 675w
- ➔ Each household uses electricity for 12 hours/day.
- ➔ Maximum output (50MW)

Table 14: Environmental and social monitoring activities by PLN in association with the project

Monitoring results during the implementation of the project	
Air pollution	Monitoring on the access roads found the dust and exhaust gas levels below the standard.[7]
Noise	Monitoring around the plant found the noise level slightly above the standard.[8]
Water quality	Water samples taken at an upstream side and downstream side of the dam, intake point and cascade points were found as good.[9]
Impact on flora and fauna in the protected forests and basins	Monitoring based on the Red Data Book (1990)[10] issued by the International Union for Conservation of Nature and Natural Resources (IUCN) found the distribution and diversification as good.[11]
Impact on flora and fauna underwater	Monitoring based on the Shannon-Wiener Diversity Index at the above-mentioned monitoring points for water quality found no particular contamination.[12]
Impact on soil functions	Monitoring on the vegetation distribution around the project site found no particular impact.
Monitoring results after the plant was put in service	
Water quality	Monitoring based on the same water quality monitoring criteria as those used during the implementation of the project found 23 items, including the total suspended substance (TSS), biochemical oxygen demand (BOD), and dissolved oxygen (DO) as below the standards.
Impact on flora and fauna	Monitoring based on the abovementioned criteria found the distribution and diversification as good.
Impact on local residents	Interview and other surveys targeting local residents found no particular adverse impact. Positive impacts[13], such as enhancement of economic and social activities, were identified.

PLN autonomously strives to fulfill its corporate social responsibility (CSR) by supporting forestation activities and NGOs' environmental activities. To this end, PLN also makes a continuous effort to improve the sustainability of the project. As part of its education and advocacy activities, they organized a seminar by an environmental expert for the villagers of Sipan and Sihaporas in 2009; the lecturer explained the importance of forest preservation and its relationship with the Sipansihaporas Hydroelectric Power Plant. Another such activity is a forestation program called "One Man One Tree". PLN's activities to preserve forests and environment like these help protect water resources, indispensable for hydroelectric power generation, and also build and maintain a good relationship with local residents and NGOs. These initiatives and considerations contribute to improving the sustainability of the project and draw attention as a good practice.

(2) Impact of land acquisition and relocation of residents

As initially planned, the project did not involve relocating local residents. The land acquisition process was properly carried out based on the governing Indonesian regulation (Presidential Degree No.55-1993). The public hearings and consultation with the residents duly

[7] (1) Standard and (2) Actual data as follows (Unit: $\mu g/m^3$). Dust: (1) 260, (2) 49.25～76.30, NOx: (1) 92.5, (2) 29.20～38.15, Sox: (1) 260, (2) 46.65～89.90, CO: (1) 22,600, (2) 547～1149, H2S: (1) 42, (2) 1.02～3.98

[8] (1) Standard and (2) Actual data as follows (Unit: dBA). (1)70, (2)50～82

[9] (1) Standard and (2) Actual data as follows. TDS(mg/L): (1)1,000, (2) 16.80～20.60, pH: (1)5～9, (2) 6.54～7.45, Cl(mg/L): (1) 600, (2) 2.98～4.21, SO4(mg/L): (1)400, (2) 1.00～5.08, Fe(mg/L), (1) 5.0, (2) 0.11～2.01, DDT(mg/L): (1) 0.042, (2)N.A., Coliform(MPN/100mi): (1) 10,000, (2) 30～185 etc.

[10] Data book that describes endangered wildlife.

[11] Birds (9, 8 and 6 species), mammals (7, 3 and 5 species), amphibian (2, 2 and 2 species), reptiles (3, 4 and 3 species) were observed at the respective monitoring points.

[12] Two benthic organisms, planktons (11, 11 and 23 species) and five fish species were observed at the respective monitoring points.

[13] Promoting exchange among villagers, improving livelihood and quality of life, etc. in Sibuluan and Sihaporas.

held did not see any opposition or resistance from the residents against the plan, including the amount of compensation[14]. The table below compares the initial plan and the actual land acquisition.

Table 15: Comparison of Areas of Land Acquisition

Status of land acquired	Plan	Actual
Public land	71.1ha	21.23ha
Private land	45.4ha	67.14ha
Total	116.6ha	88.37ha

Source: Results from questionnaire surveys to PLN

According to PLN, the area of public land decreased from the plan while that of private land increased because some residents, knowing that the land prices were high up due to the implementation of the project, started to claim and demand ownership of the land.

Although there was no special measure put in play by PLN to recover and improve the residents' livelihood, they constructed a mosque, church, storage, public water supply point, and others along the access roads, as part of their CSR activities. These have led to enhancement of the social activities of the residents, which further raised the level of acceptance of the project among the local residents[15].

(3) Other impacts: Impact on the river use of residents living downstream

According to the results from the hearing survey with local residents, the status of their use of the Sipansihaporas River has not changed because of the implementation of the project. They continue to use the river for fishing, bathing, laundry, washing dishes and so forth without feeling any negative impact of the power plant.

Also, they mentioned that the discharge warning system was properly functioning: an alarm 20 minutes before discharge. The residents were well informed of different alarm patterns telling different messages, and hence there has been no particular accident.

Thus, the project is deemed as to have yielded a significant number of positive impacts while curbing negative impact on the natural environment and so on.

Local residents using the Sipansihaporas River

Structure with discharge warning system

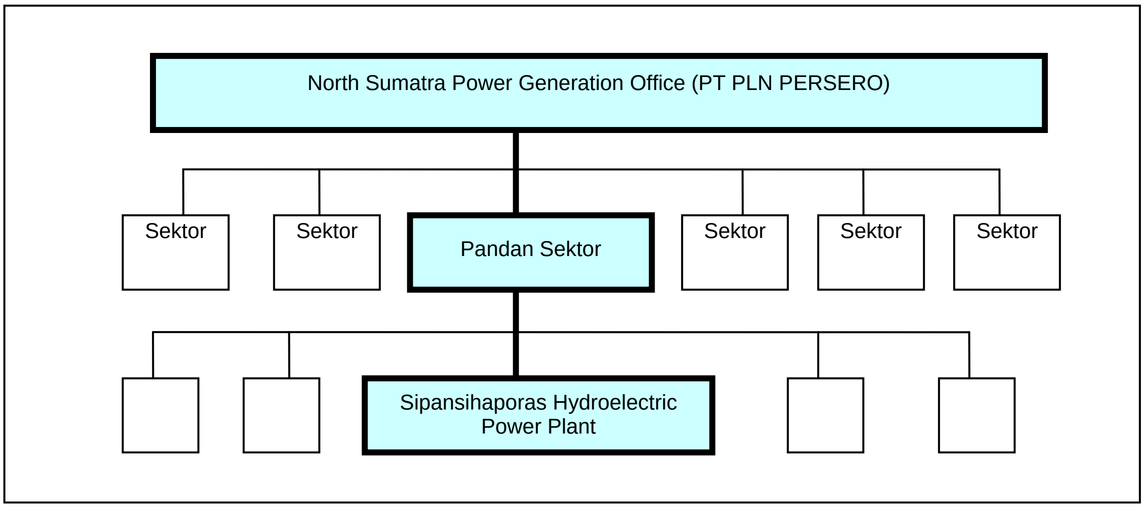
[14] For the residents who were affected by the land acquisition, the project provided monetary compensation but no other particular measures for recovering their livelihood.

[15] PLN continues to support activities at the mosque and the church even after the completion of the project.

3.5 Sustainability (Rating: a)

3.5.1 Structural Aspects of Operation and Maintenance

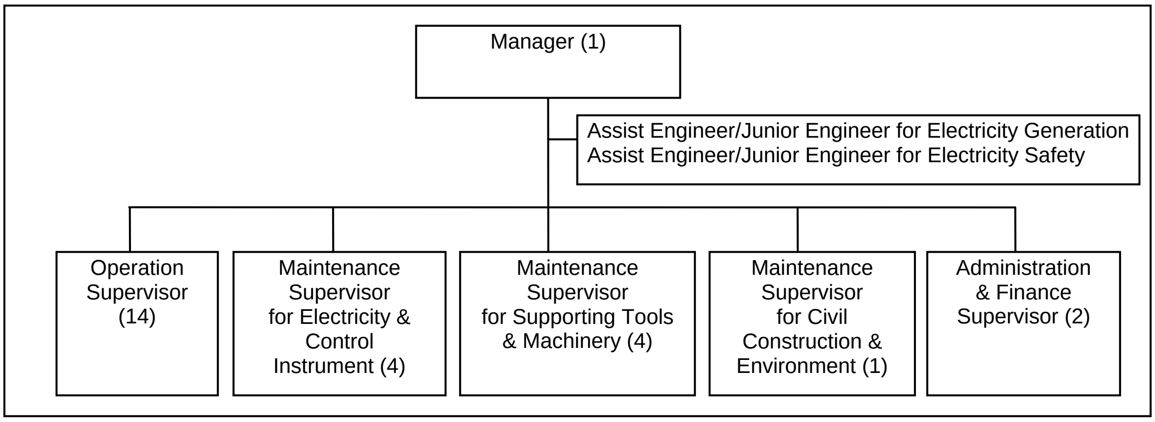
The operation and maintenance of the project is undertaken by PLN's North Sumatra Power Generation Office (PT PLN (PERSERO) Pembangkitan Sumatra Bagian Utara) in Medan, North Sumatra Province. As of June 2010, approximately 1,400 people are working at power offices (Sektors) and other units under the supervision of the Office. There are six Sektors, as of June 2010, under the North Sumatra Power Generation Office. Of these, Pandan Sektor (about 200 employees) is responsible for the operation and maintenance of Sipansihaporas Hydroelectric Power Plant (Figure 3).



Source: Results from questionnaire surveys to PLN and interview surveys during field survey

Figure 3: Institutional Structure of Operation & Maintenance (O&M)

The organizational structure of Sipansihaporas Hydroelectric Power Plant is illustrated in Figure 4 below. It was restructured in this way after April 2008, until when (i) electricity and control instrument, (ii) supporting tools and machinery, and (iii) civil construction and environment had been sub-units of one department (former Maintenance Supervisor). PLN pointed out that the division of the former Maintenance Department into three units led to faster decision-making, more profound expertise and higher organizational efficiency of Pandan Sektor.



Source: Results from questionnaire surveys to PLN and interview surveys during field survey

Note: * Number of PLN staffs in parentheses (There are additional staffs (non-regular member of staffs) engaged in each position.)

Figure 4: Simplified Organizational Structure of Sipansihaporas Hydroelectric Power Plant

The numbers of staff members (regular and non-regular) in charge of Sipansihaporas Hydroelectric Power Plant at Pandan Sektor are provided in Table 16 below.

Table 16: Number of Staffs Engaged in Sipansihaporas Hydroelectric Power Plant and its O&M Staffs

Year	Number of Staffs	Of these, Number of Staffs in Charge of O&M	Percentage of O&M Staffs
2005	73	21	28.8%
2006	88	18	20.5%
2007	92	21	22.8%
2008	91	19	20.9%
2009*	74	17	23.0%

Source: Results from questionnaire surveys to PLN and interview surveys during field survey
Note: * Figures in 2009 is the data at the beginning of the year

The total number of employees at PLN as of June 2010 is roughly 45,000. PLN reshuffled its organization in December 2009 and kicked off with the new organization at the beginning of February 2010. The organization used to be siloed into (i) construction and (ii) sales and administration according to the responsibility to be borne by the board members. The verticals were then reorganized into three regions: (i) Java-Bali, (ii) Western Indonesia (Sumatra, Kalimantan, Batam, Bangka), and (iii) Eastern Indonesia (Sulawesi, eastern islands, Irian), each with four positions, a. power generation, b. power transmission, c. power distribution/sale, and d. construction management and IPP.

PLN pointed out that the regional division is expected to contribute to an assurance of consistency from planning to procurement, construction, generation, transmission, distribution and sales, thereby achieving more efficient operation. At the time of ex-post evaluation, however, the organization was still in the transition phase to the new system and no tangible change or effect could be ascertained. It was also pointed out that there was no particular impact of the restructuring of PLN on the operation and maintenance structure of Sipansihaporas Hydroelectric Power Plant.

3.5.2 Technical Aspects of Operation and Maintenance

Training sessions and seminars necessary for the operation and maintenance of the power plant were provided during the implementation of the project, after the completion and before the start of operation, and after the start of service.

During the implementation of the project, the consultant and the makers of generators and transformers provided training on maintenance and administration to a total of 50 PLN staff members (two sessions in Indonesia and two sessions in Japan, including a visit to a hydropower plant in Japan).

23 PLN personnel undertook training on maintenance and management of the generators, electricity and machinery between the completion of the project and the start of operation. The breakdown of trainees is given in Table 17 below.

Table 17: Number of Staffs Receiving Training in the Transition Period
(After project completion and before the operation)

Areas for Training	Number of PLN staffs
Generator	5 staffs
Mechanic	2 staffs
Electricity	16 staffs

Source: Results from questionnaire surveys to PLN and interview surveys during field survey

Since the start of service at the power plant, the following personnel from Pandan Sektor have participated in PLN's cross-sectional training sessions (Table 18). (PLN's training sessions typically take place at PLN Training Center in Jakarta, but trainings related to hydropower are conducted intensively at the training unit in Padang, West Sumatra Province.)

Table 18: Number of Staffs Receiving Training at PLN Training Center during Operation Stage (Number of Staffs participated from Pandan Sektor)

2006	1 staff
2007	5 staffs
2008	9 staffs
2009	16 staffs
2010	4 staffs
Total	35 staffs

Source: Results from questionnaire surveys to PLN and interview surveys during field survey

For information purpose, Tables 19 and 20 below outline the academic background and the number of years of experience of the personnel in charge of the operation and maintenance of Sipansihaporas Hydroelectric Power Plant at Pandan Sektor.

Table 19: Academic Background for O&M Staffs

Year	University graduates or higher	High school graduates	Secondary school graduates
2005	10%	90%	0%
2006	0%	100%	0%
2007	10%	90%	0%
2008	16%	84%	0%
2009	18%	82%	0%

Source: Results from questionnaire surveys to PLN and interview surveys during field survey

Table 20: Number of Years of Experiences for O&M Staffs

0-5 years	6-10 years	11 years or more
7 staffs	5 staffs	7 staffs

Source: Results from questionnaire surveys to PLN and interview surveys during field survey
Note: * Figures as of June, 2009

In view of this operational structure and the current favorable operation and maintenance conditions, there is no particular problem observed in the technical aspect.

3.5.3 Financial Aspects of Operation and Maintenance

The operation and maintenance costs associated with Sipansihaporas Hydroelectric Power Plant are first estimated by Pandan Sektor. The estimation will be reviewed by the North Sumatra Power Generation Office in Medan and then the PLN headquarters in Jakarta. Once approved, the budget is drawn out from the headquarters' ordinary budget and allocated to the Sektor through the Power Generation Office. Generally, 70 to 80% of the requested budget is allocated to the operation and maintenance costs. According to PLN, with regard to predictive maintenance and regular maintenance, the full amount is secured without a problem (provided that, for maintenance work other than that of generators, such as repainting of the power houses, the requested amount may not necessarily be secured in full.) In case of an emergency action, which requires additional cost, the Power Generation Office provides an additional budget allocation. Table 21 shows the annual operation and maintenance budgets associated with Sipansihaporas Hydroelectric Power Plant. On the whole, the amount of budget has been slightly increasing.

Table 21: Annual O&M Budget for Sipansihaporas Hydroelectric Power Plant

2005	IDR 4,550,042,351
2006	IDR 4,273,080,227
2007	IDR 7,667,106,018
2008	IDR 5,284,503,474
2009	IDR 7,683,897,066

Source: Results from questionnaire surveys to PLN and interview surveys during field survey

The overall financial situation of PLN (Table 22) indicates that the organization is supported by a massive amount of government subsidy[16] and suggests that it is virtually a service provided by the state. The factors behind the high-cost structure are identified as the high financial burden for fuels and lubricants necessary for power generation, inefficient operation, low electricity rate[17], and so on[18]. Incidentally, the financial situation of PLN as a whole and the operation and maintenance of the power plant should be discussed at different levels; PLN's overall financial conditions have no direct impact on the project.

Table 22: Trend of Financial Performance of PLN on Consolidated Basis

Unit: billion IDR

	2005	**2006**	**2007**	**2008**	**2009**
Power Sales	63,246	70,735	76,286	84,250	90,172
Government Subsidy	12,511	32,909	36,605	78,577	53,720
Other Income	786	1,082	1,152	1,382	1,330
Total Operation Income	76,543	104,726	114,043	164,209	145,222
Fuel & Lubricant Cost	37,355	63,401	65,560	107,783	76,235
Maintenance Cost	6,511	6,629	7,269	7,620	7,965
Personnel Cost	5,508	6,720	7,064	8,344	9,758
Other Cost＊	26,650	28,478	31,612	36,851	41,318
Total Operation Cost	76,024	105,228	111,505	160,598	135,276
Operation Profit	519	-502	2,537	3,611	9,946
Non-operating Profit and Loss**	-2,694	1,547	-5,635	-15,802	2,257
Tax	2,746	2,973	2,547	112	1,848
Total Profit	-4,921	-1,928	-5,645	-12,304	10,356

Source: PLN Annual Report
Note 1: Partial inconsistency of figures exists due to rounding error
Note 2: * Power Purchase, Depreciation of Fixed Assets etc.
Note 3: ** Tax Revenue and Cost, Foreign Exchange Profit and Loss etc.

16 The government subsidy for PLN is stipulated as a Public Service Obligation (PSO) by Article 66 of the Law on State Enterprises of 2001 (financial compensation for state-owned enterprises).

17 The Government of Indonesia raised the electricity rate on July 1, 2010, for the first time in the seven years since 2003. (A revision of the electricity rate requires approval of the national parliament.)

18 PLN aims to reduce government subsidies, raise the electricity rate, increase the self-financing ratio, and introduce private fund aggressively, in order to improve its financial and management conditions. To achieve its objectives, however, there are various hurdles to overcome, particularly in the aspect of electricity pricing, as it involves politically sensitive elements.

3.5.4 Current Status of Operation and Maintenance

The generation equipment was kept in good shape, in general, at the time of ex-post evaluation, posing no particular concern. (As formerly stated, the generator of Power Station No. 1 went down at the end of March 2008 and was out of service until it was repaired in June 2009; since then it has been in nominal operation.)

The access roads were partially damaged (for a few meters) in consequence of flooding and were under repair work at the time of the site visit.

There was no particular problem observed in terms of regular maintenance: daily, weekly and monthly maintenance activities were duly performed. When the accumulative number of operation hours exceeds 20,000 and 40,000, in the future, extraordinary maintenance work will be performed.

PLN monitors the state of sedimentation in the ponding area using the depth sounder, instead of taking numerical measurements. In 2008, they removed sand and gravel sediments using an excavator near the generator of Power Station No. 1. Furthermore, they open the spillway gate (every six months) to discharge sediments together with water into the main stream. There was no particular problem identified at the time of ex-post evaluation, but a comparison against photos taken in 2008 reveals a steady increase of deposited silt. It is essential to continue monitoring so that appropriate measures will be taken before the sedimentation adversely effects the operation of the plant.

No major problem has been observed in the operation and maintenance structure, technology and finance, therefore sustainability of the project is high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

Although the implementation schedule was extended, the project was highly consistent with policies and yielded many positive effects and impacts both quantitatively and qualitatively. Thus, the project is evaluated to be highly satisfactory as (A).

4.2 Recommendations

4.2.1 Recommendation to Executing Agencies

[Managing deposited silt in the ponding area]

While there was no particular problem in managing deposited silt in the ponding area at the time of ex-post evaluation, certain measures will likely be needed in the future. Currently PLN does not measure numerical data on sedimentation status but monitors the situation using the depth sounder. Because it is possible to measure numerically the sedimentation situation when using the depth sounder, PLN should record its data and manage them appropriately in order to make careful planning and necessary action to remove/flush or dredge deposited silt.

4.3 Lessons Learned

The forest preservation and environmental conservation activities that PLN carries out autonomously as part of their CSR efforts are noteworthy as they set a good practice case. PLN has established and maintains good relations with local residents and NGOs. Their continued efforts with consideration given to environmental protection have also contributed to the improvement of sustainability of the project. Thus, it is worth consideration to include such activities as part of project components, as a means to support the executing agency or other related organizations.

End

Comparison of the Original and Actual Scope of the Project

Item	Plan	Actual
1. Project Outputs	Dam Intake Dam Spillway Hydroelectric Power Plant (No.1 and No.2 P/S: Total installed capacity of 50MW) Access road Discharge Warning System Transmission Line Consulting Service (F/S, D/D, Support for bidding process) 260M/M Consulting Service (Supervision for civil works, metal works, generator works and access road construction) 1,145M/M	Same as planned Same as planned Same as planned Same as planned Same as planned Same as planned Same as planned Consulting Service (F/S, D/D, Support for bidding process) 283M/M Consulting Service (Supervision for civil works, metal works, generator works and access road construction) 1,989M/M
2. Project Period	E/S: September, 1992－April, 1995 (32 months) Phase I: October, 1995－October, 2001 (73 months) Phase II: November, 1996－October, 2001 (60 months) Total: 165 months	E/S: November, 1992－October, 1995 (36 months) Phase I: December, 1995－January, 2005 Phase II: December, 1996－January, 2005 Total: 207 months
3. Project Cost Foreign currency Local currency Total Japanese ODA loan portion Exchange Rate	 9,372 million yen 6,410 million yen 15,782 million yen 12,206 million yen E/S: 1IDR＝0.064 yen (April 1992) Phase I: 1IDR＝0.045 yen (April 1995) Phase II: 1IDR＝0.046 yen (April 1996)	 Amount of total project cost was not available at Ex-post Evaluation. 10,039 million yen 1IDR＝0.0102 yen (Average for 1998)

Third Party Opinion on Sipansihaporas Hydroelectric Power Project

Prof. Dr. Usman Chatib Warsa, Ph.D, University of Indonesia

The rapidity of ongoing regional development in North Sumatra Province has lead to soaring demand for electricity supply. The Sipansihaporas Hydroelectric Power Project was expected to be a vital renewable resource in response to the above urgent need in addition to contribute to the economic development and the living standard improvement of the coverage area.

In terms of Relevance, the conclusion that the reviewed project was highly relevant seems reasonable. At the appraisal, the project was predetermined by the Indonesian's REPELITA VI: 1994-1999 to increase the use of hydropower plant as a renewable and reliable resource. The policy, in which, the Government of Indonesia remains to be committed. It was also catalyzed by the increasing power demand in North Sumatra Province. Even during ex-post evaluation, the province need of power supply stays critical with the Government's priority for power installation development. The project area is one of the five priority areas of Japan's assistance for Indonesia; therefore the project remains consistent with Japan's ODA policy.

When it comes to Effectiveness, it is fair to say as highly effective. Quantitatively, while the data shows a significant output drop in 2008-2009 due to generator failure, it also shows that in 2007 the plant generated power above the planned level; a level in which expected to exceed in the future. The FIRR value is considered acceptable, however the accurate total project cost and annual expenditure were unavailable; hence the figures were referred to. In the future, it is recommended that such data to be obtainable. Qualitatively, although currently the plant contribution is very limited, it serves efficiently in accommodating peak-load in both dry and rainy seasons. It also has improved the electrification rate in the reporting area. Additionally, local residents also benefited from the access road and enjoyed job creations associated with the project.

Finally, there are several positive impacts to highlight in addition to electricity supply and economic activities brought about by the project. It is mentioned that a nursing school has moved in to the area; this surely has affected the healthcare awareness for the locals. And with electrification, people were exposed to technology; this would inspire future generations to have a higher education.

(End)

India

“Simhadri Thermal Power Station Project (I) (II) (III) (IV)”

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

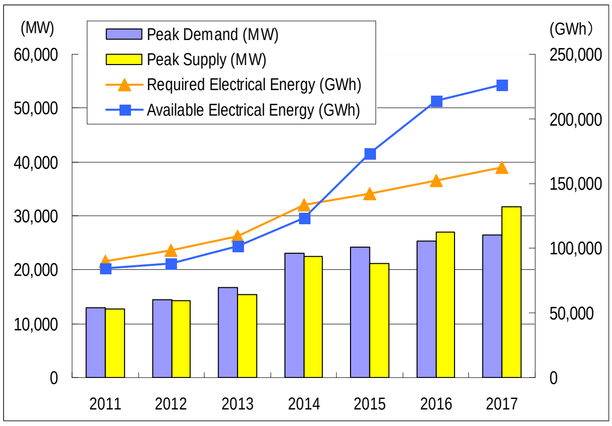
3. Result of Evaluation (Overall Rating: A)

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

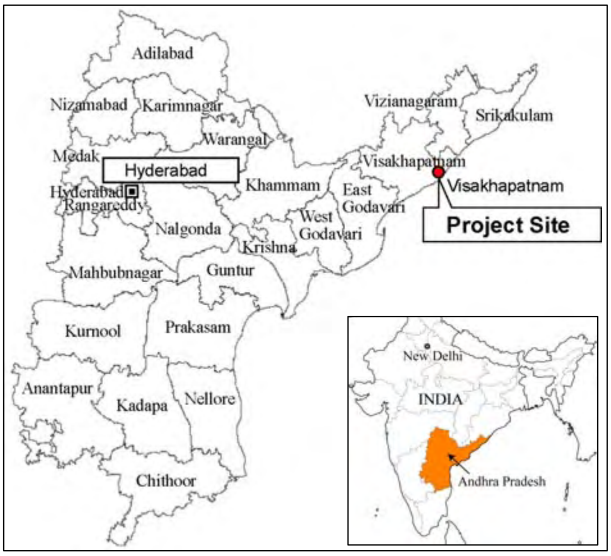


Figure 2: Project Site Map

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.

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).

---

[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>

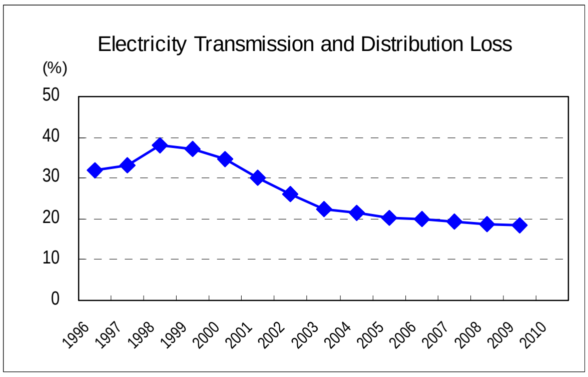
- Cost: Project cost, fuel cost and operation and maintenance cost
- Benefit: Induction effect and switching effect
- Project life: 25 years after commencement of commercial operation
- Plant load factor: 65% (Annual electrical energy generated: 6,000GWh)

[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

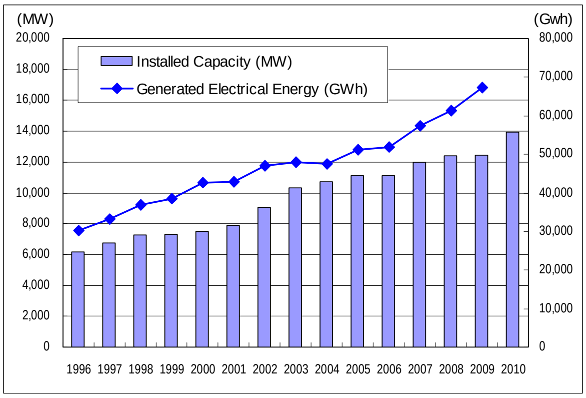
Packaging and Paper Manufacturer

Steel Wire Manufacturer

3.4 Impacts

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

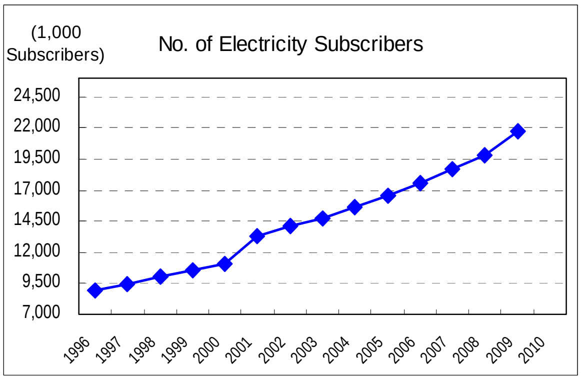
AP State has promoted the development of electric power resources for the mitigation of constant power shortages. The total installed power generation capacity of AP State doubled from 6,163MW (1996) to 12,427MW (2009) and the annual generated electrical energy increased 2.2 times from 30,119GWh/year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

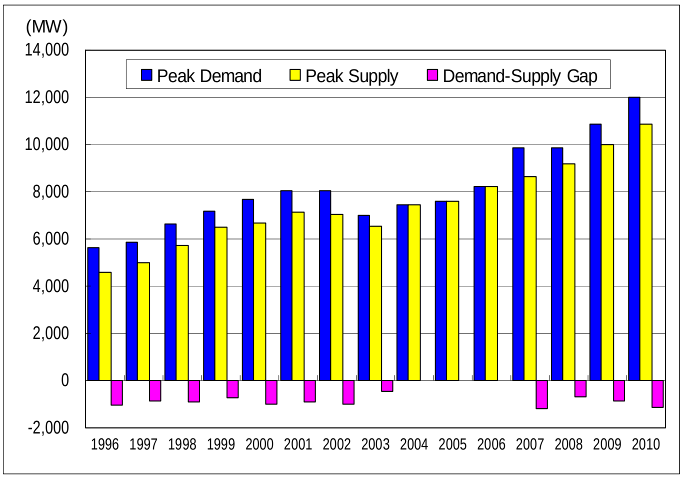
Figure 5: No. of Electricity Subscribers in AP State

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.

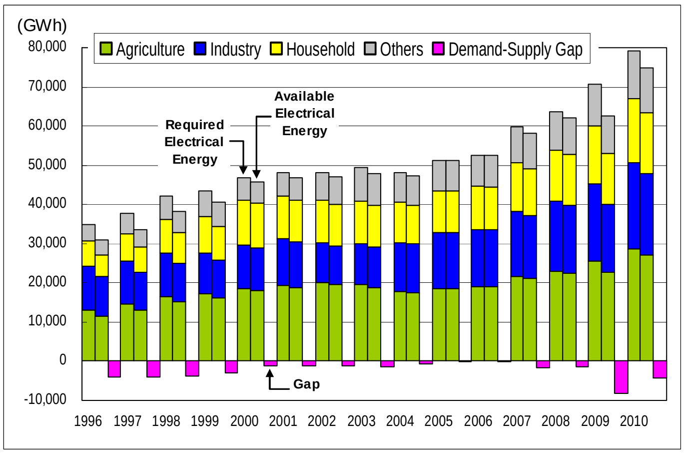
Even now, the existing power generation capacity can not satisfy demand.

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

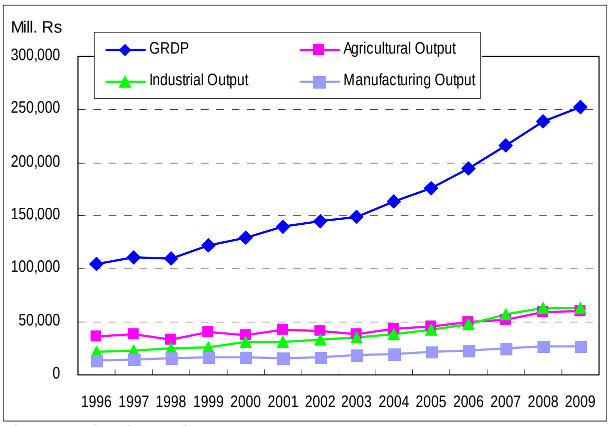
Figure 7: Required Electrical Energy and Available Electrical Energy in AP State

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)	μg/m^3	88.3	74.4	80.0	81.9	88.0	81.9	74.5	73.6	200
Respirable Particulate Matter (RPM)	μg/m^3	-	37.0	44.4	47.8	48.9	47.0	42.2	35.7	100
Sulfur Dioxide (SO_2)	μg/m^3	18.0	15.8	15.2	14.2	15.4	12.3	8.9	17.0	80
Nitrogen Oxide (NOx)	μg/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)

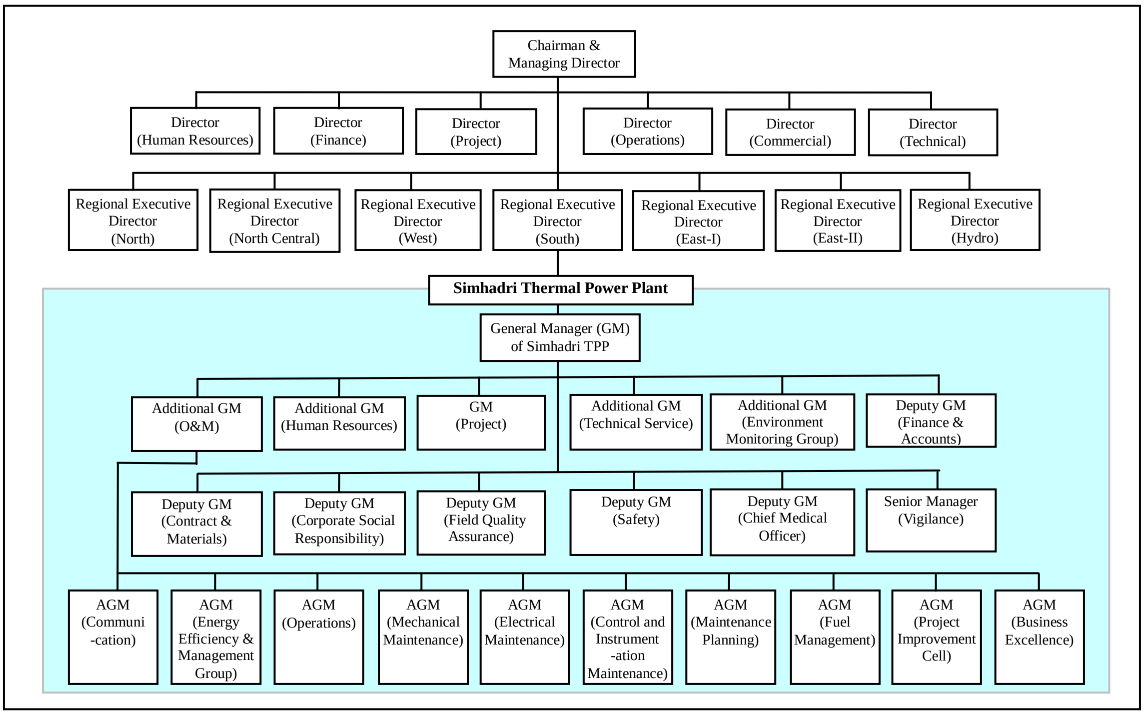
[30] This impact study primarily covered PAPs from 20 villages, 547 sample PAPs from 2,790 land displaced and homestead oustees.

[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)

Dr. Subrata K Mandal, Senior Economist
National Institute of Public Finance and Policy, New Delhi

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)

Nepal

“Kali Gandaki “A” Hydroelectric Project”

Nepal

Ex-post Evaluation of Japanese ODA Loan Project
"Kali Gandaki "A" Hydroelectric Project"

Hajime Onishi, Mitsubishi UFJ Research & Consulting Co., Ltd.

1. Project Description

Location Map


Photo: Water Intake Dam

1.1 Background

More than 80% of the land of Nepal is covered by precipitous mountains, with the Himalayas where the 8,848 m high Mt. Everest (Mt. Chomolungma) is located. In addition to its advantageous terrain for hydropower development, Nepal is known for having enormous potential for hydropower because of its vast areas of snow and ice, as well as high rainfall caused by the monsoon.

On the other hand, the precipitous terrain and geology of Nepal causes technical difficulties and requires high cost for construction of large-scale hydropower plants, therefore the progress of hydropower development of Nepal was always behind the power demand. While the power demand showed a rapid growth in 1996, annual 11.3% increase in electrical energy and 8.9% in peak demand, the power shortage at the peak time was 19% of the total supply volume; as a result, load shedding was executed in the capital of Kathmandu. The power supply shortage is recognized as the largest bottleneck of Nepal's economic development; there was a high demand for the solution to this problem, especially among industrial circles.

Promotion of power source development was the priority issue of the government at the time due to such background, therefore rehabilitation of existing power plants, development of transmission and distribution network, and prompt construction of new large-scale hydropower plants were desired.

1.2 Project Outline

The objective of this project is to provide a stable power supply system for Nepal through solving the peak-time electricity shortage by the construction of hydroelectric "run-of-the-river" type power plant on Kali Gandaki River with the capacity of 144MW, being located at 180 kilometers (aerial distance) west from Kathmandu, thereby contributing to the economic growth of the country.

Loan Amount / Disbursed Amount	16,916 million yen (JICA portion only) / 13,542 million yen (JICA portion only)
Exchange of Notes / Loan Agreement Signing Date	October 1996 / October 1996
Terms and Conditions	Interest Rate: 1.0% Repayment Period: 30 years (Grace Period: 10 years) Conditions for Procurement: General Untied
Borrower / Executing Agencies	Guarantor: His Majesty's Government of Nepal (at the time of appraisal) / Nepal Electricity Authority, NEA
Final Disbursement Date	July, 2007
Main Contractors (over 1 billion yen)	IMPREGILO S.P.A. (Italy), NOELL STAHL - UND MASCHINENBAU GMBH (Germany), Toshiba (Japan)・Mitsui Corporation (Japan) (JV), CEGELEC (France)・Toshiba (Japan)・Mitsui Corporation (Japan) (JV), TATA INTERNATIONAL Limited (India)・Marubeni Corporation (Japan) (JV) (Note: Toshiba and Mitsui Corporation were awarded two contracts as a member company of Joint Venture.)
Main Consultant (over 100 million yen)	MORRISON KNUDSEN INTERNATIONAL, INC (USA)・NORCONSULT INTERNATIONAL A.S. (Norway)・IVO INTERNATIONAL LTD (Finland) (JV)
Feasibility Studies, etc.	1992: Feasibility Study (by UNDP) 1993: Detailed Design (by ADB, UNDP and Government of Nepal)

2. Outline of the Evaluation Study

2.1 External Evaluator

Hajime Onishi (Mitsubishi UFJ Research & Consulting)

2.2 Duration of Evaluation Study

Duration of the Study: April, 2010-November, 2010

Duration of the Field Study: May 30, 2010 – June 13, 2010 / August 15, 2010 – August 20, 2010

2.3 Constraints during the Evaluation Study

None.

3. Result of the Evaluation (Overall Rating: A)

3.1 Relevance (Rating: a)

3.1.1 Relevance with the Development Plan of Nepal

Relevance with the national policies

In 1996, at the time of the project appraisal, a total of 170.3 billion rupee (approx. 4 billion US$) of government expenditure was planned in the Eighth Five-Year Plan (1992-1997) for the following objectives;

1) Sustainable economic growth (target: 5.1%/year)
2) Creating new employment (target: 1.4 million persons)
3) Poverty alleviation
4) Correction of regional disparities

Of the above, expenditure of the power sector accounted for around 21% of the total expenditure, and was one of the priority fields for investment following the agriculture sector. The plan also claims to "utilize low-cost energy generated through hydropower for manufacturing processes and realize comparative advantage in the agriculture, industry, and tourism sectors, etc.", thus utilization of hydropower was deemed a means of achieving national priority policy goals.

On the other hand, peace-building, poverty alleviation, promotion of employment, etc. are set up as the policy goals of the present "Three-year national development interim plan (2007/08-2010/11)[1]" which is the top priority national plan. In order to achieve these goals, "promotion of investment for infrastructure development" is set up as the core strategy, which includes enhancement of investment into hydroelectric plant construction as one of the priority fields. The following long-term visions regarding hydropower generation are advocated: a) ensure power generation capacity to satisfy the national demand, b) extend areas for electrification, and c) promote hydropower generation as a source of obtaining foreign currency, and additionally, total 2,115MW of energy development has been set up as a concrete objective.

Hence, promotion of investment to the power sector has been among the high national priority policies since the planning of the project until now, therefore the project, which aims to formulate a stable power supply structure, is highly relevant with the national priority policy.

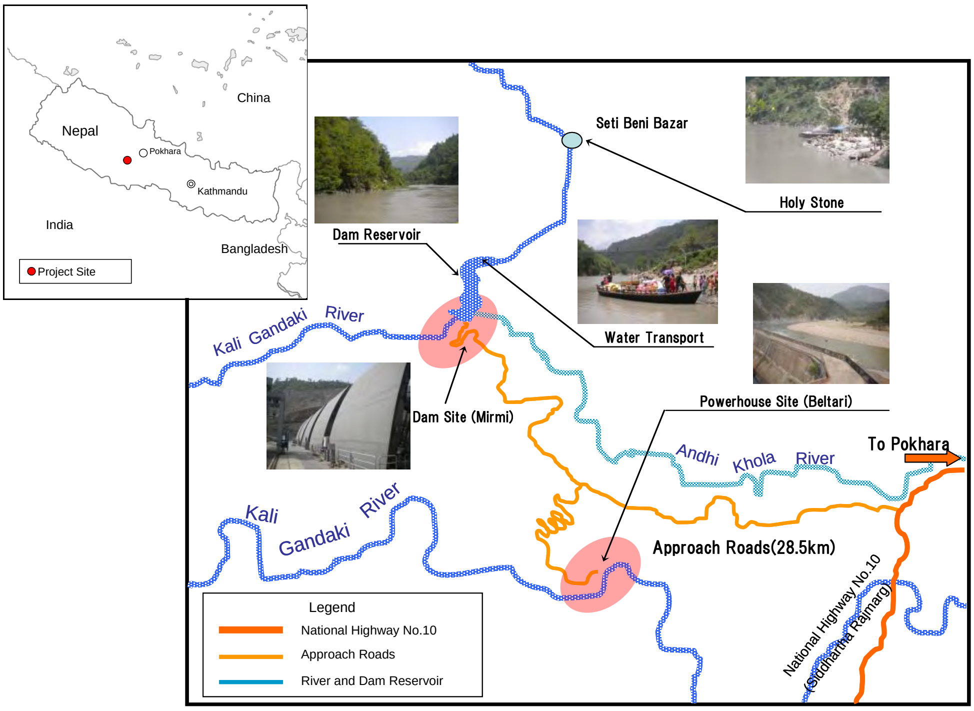


Figure 1: Location of the Project Site

[1] After the completion of Tenth Five-Year Plan (2002-2007), the three-year national interim plan was established having the peace-building, poverty alleviation, and promotion of employment as the pillars. This plan is positioned as the "interim extension" of the Tenth Five-Year Plan.

Relevance with the sector policies

Although there were no specific policy guidelines regarding the power sector at the time of appraisal in 1996, 2 types of policies specifically for the power sector have been established later on. In the Hydropower Development Policy 2001, which was firstly established in 2001, 1) development of low-cost hydraulic energy utilizing the rich potential hydropower capacity, and 2) stable supply of reliable and high-quality power services[2], were set up as priority objectives. In the Energy Crisis Management Action Plan which was approved by the cabinet of the former administration in December 2008, various concrete long-term and short-term plans were prepared for solving chronic power shortage and were listed, for example, DSM (Demand Side Management), utilization of renewable energy, enhancing power purchase from India, etc., as well as prompt implementation of hydropower plant projects currently being planned, from the perspective of strengthening the power supply system.

Above two policies are still in effect under the present administration that was established in May 2009, and since both aim to stabilize the power supply system through hydropower generation, the objective and direction of the project is completely relevant to those sectoral policies[3].

3.1.2 Relevance with the Development Needs of Nepal

In 1996, the power demand in Nepal showed rapid growth while the power supply capacity was insufficient; therefore load shedding was executed in Kathmandu and other places of the country. Even now, the power demand is still continuing to increase, urging the needs for power source development. The development of power generation facilities is behind the rapidly increasing needs[4], and since 2007 until now, the gap of supply and demand is widening. If this project which contributed to increase the reserve margin was not implemented in 2002[5], the gap of supply and demand as of present may have been larger[6].

Table 1: Power Supply and Demand in Nepal

Unit: MW

Fiscal Year of Nepal[3)]	**Installed Capacity**	**Peak Demand (Parentheses show % increase from the previous year)**	**Demand- Supply Gaps**
1999/00	*440*[1)]	351.9 (N/A)	88.1
2000/01	440	391.0 (11.1)	49.0
2001/02	584	426.0 (9.0)	158.0
2002/03[2)]	604	470.3 (10.4)	133.7
2003/04	613	515.2 (9.5)	97.8
2004/05	613	557.5 (8.2)	55.5
2005/06	615	603.3 (8.2)	11.7

[2] Other objectives include; 1) organic link between electrification projects and economic activities, 2) promotion of rural development through enhancement of rural electrification, and 3) promotion of hydropower generation for export, etc.

[3] There are no resources such as fuel, coal, or natural gas, etc. in Nepal, and hydropower is the only substantial power source. Negative views are given to introduction of thermal power generation due to; 1) physical difficulty in developing fuel supply routes, 2) issues of maintenance and operation cost associated with increasing fuel cost, and 3) issues regarding preparation of foreign currency for purchasing fuel, etc.

[4] No large scale power generation plants except for Middle Marsyangdi Power Plant (70 MW), have been newly constructed after the completion of Kali Gandaki Power Plant in 2002, and only upgrading capacities of existing power plants were implemented.

[5] Index for indicating allowance of supply capacity (total capacity of all power plants) to the peak demand. For example, the reserve margin of 2002 was 37.1% (= (584/426-1)×100). (see Section 3.3 Effectiveness for details)

[6] Regarding total power generation capacity of all facilities of FY 1999/2000 and after, it increased approx. 33% from 440 MW to 584 MW, as a result of starting the operation of Kali Gandaki “A” Plant from May 2002 of this project. On the other hand, the peak power demand is increasing at approx. 10% yearly, and the reserve margin turned to a negative value in FY 2006/2007, indicating the demand exceeding the supply.

Fiscal Year of Nepal[3)]	Installed Capacity	Peak Demand (Parentheses show % increase from the previous year)	Demand- Supply Gaps
2006/07	617	648.4 (7.5)	-31.4
2007/08	689	721.7 (11.3)	-32.7
2008/09	689	812.5 (12.6)	-123.5

Source: Answers to the questionnaire to NEA and NEA Annual Report 2008/09
Note 1): Installed capacity in 2000 is not known, and then assumed as 440MW.
Note 2): The commencement of the operation of Kali Gandaki "A" Hydroelectric Plant was May 2002.
Note 3): Fiscal year of Nepal starts from July 16 of the year and ends at July 15 of the next year.

In Kathmandu, 16 hours of load shedding was executed daily at maximum in the dry season of the year 2009[7]. The remote cause for the supply and demand gap to increase largely was; 1) lack of the national budget of Nepal (large-scale hydropower plant construction projects cannot be implemented by the budget of Nepal independently), 2) reluctance of donor countries to give assistance to large-scale power plant projects due to Nepal's political risk, 3) low motivation of private investors to invest in large-scale power infrastructure projects, also due to the political risk (excluding investors of India), etc.[8]

3.1.3 Relevance with Japan's ODA Policy

According to the Japan's 1999 ODA White Paper of the Ministry of Foreign Affairs, 1) development of human resources, 2) social sector, and, 3) economic infrastructure were focused from 1991 to 1998 by Japan as priority issues for Nepal. In particular for above 3), basic economic infrastructures such as power, roads, bridges, water supply, and communication were emphasized. Therefore, the consistency of the project with the aid policy of Japan was extremely high.

However, many of the power plants in Nepal, including Kali Gandaki "A" Hydroelectric Plant are run-of-river type, and storage cannot be adjusted seasonally (or annually). In order to eliminate the power supply and demand gap at present, construction of reservoir type hydro power plants (with annual storage that can utilize the water flow of rainy season) is essential. Based on this theory, JICA is planning to implement a "Study on the Hydroelectric Power Station and Water Reservoir Master Plan Project". Although Kali Gandaki "A" was planned as "run-of-river type power plant that cannot adjust storage" as described above, the prior expectations to the project in 1996 was prompt supply of "base-load power" across Nepal where power supply was insufficient, therefore construction of run-of-river type power station was appropriate, and this project was implemented on a timely manner in response to the situation of the recipient[9].

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

3.2 Efficiency (Rating: b)

3.2.1 Project Outputs

This project was implemented by the co-financing of JICA and ADB. Comparison of the plan and actual performance is shown in the below tables. Regarding JICA's portion, the 3

[7] Load shedding is still executed 8-12 hours average daily until present (as of June 2010).
[8] The Managing Director of NEA points out the reason for not constructing new large-scale power plants after the completion of Kali Gandaki Power Plant in 2002 as "political turbulence continuing since 2002, as well as the lowered motivation of investors and international donors triggered by it" (Source: interview with the Managing Director of NEA)
[9] Additionally, a large-scale power plant project "Arun III Hydropower Plant Project" (power plant capacity: 402 MW) which was planned for the same period was cancelled due to failure of coordination between donors, therefore the needs increased for prompt launch and completion of the Kali Gandaki project for the purpose of securement of base-load power.

components, namely, civil engineering work (Contract lot C2), steelwork structures, and power generators, have no major changes. For the turbines, carrying-in and installation of the runner was carried out as planned based on the initial contract of Contract lot 6, however, a part of the runner was found with major wear at an overhaul, the first periodic checkup after the commencement of operation, conducted in September-October 2003. In response, total of 3 additional components; 1) additional procurement of 3 runners with wear resistant coating and replacing with the above runners, 2) additional procurement of spare main parts with wear resistant coating, and 3) implementation of training programs on operation and maintenance (proposed by JICA[10]) for Nepal Electricity Authority (hereafter referred to as NEA) personnel were carried out.

Additionally for the transmission lines, the route of the lines and locations of steel towers were changed due to the below reasons; as a result, the total length of the transmission lines have changed[11].

- ✓ Avoidance of land acquisition in Butwal and other densely populated areas
- ✓ Change of substation connecting to the transmission line in Pokhara
- ✓ Change of transmission line route in the surrounding areas of Pokhara Airport, according to the instruction from the Civil Aviation Authority of Nepal

Regarding output of ADB's portion, there are no major changes in civil engineering work (Contract lot C1 and C3). Environmental measures were conducted as planned (details described later in Section 3.4 Impact). NEA is not aware of the M/M performance, therefore output of consulting services is not known.

Table 2: Changes in Output

Project Components	Original	Actual	Differences
【JICA Portion】 1.Civil Works (Lot-C2)	Construction of headrace tunnel: 5,925m in length	5,905m in length	Mostly as planned
2.Hydraulic Steel Work (Lot-4)	Installation of gates: 3 effluent gates, 6 water intake gates, etc.	Almost the same	Mostly as planned
3.Electrical Equipment (Lot-5)	Installation of generators: 3 generators (48MW x 3), etc.	The same	As planned
4.Mechanical Equipment (Lot-6)	Installation of water turbines: 3 vertical Francis-type turbines, etc.	Installation: As planned Additional component: Training programs for NEA staff, Repaire works, etc.	Additional components
5.Transmission Line (Lot-7)	Construction of two transmission lines: 132 kV, 58 km to Pokhara, 48 km to Butwal	66 km to Pokhara, 40 km to Butwal	Extension of lines due to route realignment

[10] Although the training fee for the NEA staff was included in the original agreement between NEA and the contractor, JICA had judged that it was not "utilized effectively", thus the importance of training for operation and maintenance was pointed out, from a mid-to-long-term perspective. In response, NEA established a proposal for the staff training program, which led to the start of the training program from August 2003, by a separately hired consultant from Japan, through their close investigation and prioritization. The contents of the program included 1) Operation and Maintenance (O&M) training through overhaul of generator and turbine, 2) establishment of O&M manual (including establishment of spare parts control system) by the consultant. Moreover, the periodic overhaul in September to October 2003 was carried out as a part of the above O&M training. (Source: JICA material)

[11] Source: JICA material

Project Components	Original	Actual	Differences
【ADB Portion】 1.Civil Works (Lot-C1 & C3)	Construction of water intake dam (Height: 43m, Length of crest: 98m, Gross reservoir capacity: 7.7 million. m^3), desanding basin, powerhouse, etc.	Almost the same	Mostly as planned
2.Consulting Services	567.2M/M (Foreign: 523.5M/M, Local: 43.7M/M)	Foreign: 735M/M, Local: not known	N/A
3.Environmental Mitigation	Environmental monitoring activities, Acquafarming of migratory fish	The same	As planned

Source: JICA internal documents and results of interviews

Additionally, rehabilitation of Kali Gandaki Hydroelectric Plant[12] is included in one of the additional components of the "Power Development Project" approved in 2009 by the World Bank. It is noted in this project that the direct cause for the rehabilitation is the "problems in design and operation of the desanding basin", however, NEA claims that "remotely caused by the progressing development in the upstream of the dam, floating objects and silt inflowed into the desanding basin more than predicted at the time of designing, and partially entered the turbine through the headrace tunnel, resulting in damage to the turbine". In addition to the above, JICA specialists that were dispatched to NEA explained that "tractive force (force to convey sand, etc. downstream) of the Kali Gandaki River was stronger than assumed, and inflow of sediments into the desanding basin was more than predicted at the time of designing[13]".

3.2.2 Project Inputs

3.2.2.1 Project Period

The project period was longer than planned.

The project was scheduled from October 1996 to December 2000, a period of 51 months, but it extended to 71 months, from October 1996 to August 2002[14], which was equivalent to 139% of the original plan. As described in Section 3.2.1, major change of design was made for construction of the transmission lines, and land acquisition for the construction of steel towers in Pokhara (Chine Danda Area, etc.) have consumed several months.

Table 3: Comparative Table of Project Periods (JICA Portion)

Task	Original Schedule (months)	Actual (months)	Differences (months)
Tender / Contract[1)]	Sep.1996 – Jan.1998 (17.0)	Sep.1996 – Jun.1998 (22.0)	- 5.0
Civil Works (Headrace Tunnel)	Jan. 1997 – May 2000 (41.0)	Jan.1997 – Nov.2001 (59.0)	- 18.0
Hydraulic Steel Work	Feb.1999 – Jul.2000 (18.0)	Dec.1997 – Jan.2002 (50.0)	- 32.0
Generators	Jun.1999 – Oct.2000 (17.0)	Jul.2000 – Feb.2002 (20.0)	- 3.0
Water Turbines	Feb.1998 – Sep.2000 (32.0)	May 1998 – Jan.2002 (45.0)[3)]	- 13.0

[12] A two-week field survey was implemented in June 2010 by an Italian consultant team. Details of the survey will be described in the report submitted by the consultant team, however, the following reports are expected as of August 2010; 1) repair of turbine runners, 2) procurement of spare parts for turbine and related parts, 3) repair and procurement of new main inlet valve, and, 4) research regarding hydraulic characteristics of Kali Gandaki "A" Hydroelectric Plant. (Source: Results of interviews with NEA)

[13] Current situation of the main inlet valve and turbine planned for replacement in above World Bank project shall be described later in relation to Section 3.5 Sustainability.

[14] The loan disbursement for the project is planned to be completed in July 2007, however as shown in Table 3, construction works have been completed by August 2002, and all turbines of the power plant have started the operation in May 2002. As described in Section 3.3 Effectiveness, the power plant shares a quarter of the national power supply volume as the largest hydropower plant in Nepal. Since the effect of the project is starting to appear after May 2002, it is fair to consider that the completion of the project was in the month when the above operation started.

Task	Original Schedule (months)	Actual (months)	Differences (months)
Transmission Lines[2)]	Mar.1999 – Mar.2000 (25.0)	May 1998 – Aug.2002 (51.0)	- 26.0
Commissioning	Mar.2000 – Dec.2000 (10.0)	Jan.2002 – May 2002 (5.0)	5.0
Total[4)]	Oct.1996 – Dec.2000 (51.0)	Oct.1996 – Aug.2002 (71.0)	- 20.0

Source: JICA internal documents, answers to the questionnaire to NEA and results of interviews
Note 1: Detailed Design (D/D) of the Project was completed before L/A conclusion and the consultant team of D/D was continuously in charge of construction supervision.
Note 2: The construction of a transmission line between the powerhouse and Butwal was completed in May 2002 whereas that of a line between the powerhouse and Pokhara was done in August 2002. When the power plant started its operation in May 2002, power transmission toward Butwal was firstly started.
Note 3: The additional component was completed in June 2007.
Note 4: For the definition of the date of project completion, refer to the Footnote-14.

Table 4: Comparative Table of Project Periods (ADB Portion)

Task	Original Schedule (months)	Actual (months)	Differences (months)
Tender / Contract	Apr.1996 – Dec.1996 (9.0)	Apr.1996 – Jan.1997 (10.0)	- 1.0
Construction of Dam and Desanding Basin	Jan.1997 – May 2000 (41.0)	Jan.1997 – Jan.2002 (61.0)	- 20.0
Construction of Powerhouse	Jan.1997 – May 2000 (41.0)	Jan.1997 – May 2002 (65.0)	- 24.0
Consulting Services	Not known (Appointed before L/A)	Jan.1996 – Aug.2002 (69.0)	N/A
Environmental Measures, etc.	Not known	Completed by 2002	N/A
Total[1)]	Oct.1996 – Dec.2000 (51.0)	Oct.1996 – Aug.2002 (71.0)	- 20.0

Source: ADB (2004) Project Completion Report (PCR) of Kali Gandaki "A" Hydroelectric Project
Note 1: For the definition of the date of project completion, refer to the Footnote-14.

There were two main causes of delay; 1) lagging construction of transmission lines due to change of design and sluggish land acquisition, and 2) delay due to difficult natural/ground conditions for civil engineering work (headrace channel, dam, desanding basin, and powerhouse)[15].

However, although all generators of the power plant started the commercial operation by May 2002 as mentioned above, it was discovered at the overhaul in September-October 2003 that the turbine had severe wear, as described in Section 3.2.1. For this reason, the turbine runners of all three generators were planned for replacement, thus the additional component was carried out by June 2007[16]. It is said that "failure of design and operation of desanding basin which was ADB's portion may possibly have caused the wear" on the turbine runners, as mentioned earlier, while NEA explains that it was due to the unexpected inflow amount of sediment caused by progressing development at upstream of the diversion dam or tractive force of the Kali Gandaki River being stronger than predicted, therefore the wear on the turbine runners was an event of force majeure.

Consequently, inadequacy of design or operation of the desanding basin cannot be confirmed at present. However, investigation and preventive measures for the wear on turbine runners shall be fundamentally taken in the Power Development Project of the World Bank.

3.2.2.2 Project Cost

Total project cost was lower than planned (lower than 99% of the original plan).

The total cost of the project was originally 42,893 million yen (equivalent to 405.72 million US dollars, the Japanese ODA loan share was 16,916 million yen and the ADB loan share was 160 million US dollars) but the actual project cost was 354.8 million US dollars (the

[15] Source: response of questionnaire from NEA and results of hearing
[16] In response to the decision of additional component for the turbines, the final loan disbursement date was extended in October 2004.

Japanese ODA loan share was 13,542 million yen and the ADB loan share was 157.1 million US dollars), which was equivalent to 87% of the original plan.

As a result of efficient order placement through the international competitive bidding, the total project cost decreased. In particular, the project cost for all components of JICA's portion including civil engineering work (headrace tunnel), steelwork structures, generators, turbines, and transmission lines, were below the estimation due to above reasons.

Although the project cost was much lower than planned (82% of the original plan), the project period was longer than planned (139% of the original plan), therefore efficiency of the project is fair.

3.3 Effectiveness (Rating: a)

3.3.1 Quantitative Effects

3.3.1.1 Results from Operation and Effect Indicators

No operation and effect indicators were set at the time of appraisal. Net electric energy production data were mainly analyzed here, within the limited data obtained. Additionally, the reserve margin was focused for reviewing the level of contribution to solution for power shortage at peak hours.

(1) Net electric energy production and presence of power supply volume

As shown in the below table, the annual net electric energy production of Kali Gandaki "A" Hydroelectric Plant is steadily increasing since the start of operation in May 2002. The annual net electric energy production of FY2008/2009 increased 2.5 times from the start of operation in FY2002/2003 (=805.63 GWh / 319.48 GWh). As mentioned below in Section 3.5 Sustainability, electricity production is increasing in proportion to proficiency in operation while the difficult issue, "rotational replacement of the turbine runners during continuous operation", is also successfully dealt with.

Like the annual net production, the achievement rate of the target energy production is also increasing since the start of operation, and has reached almost 100% in FY 2008/2009.

Table 5: Net Power Generation, Achievement Rate and Other Data of Kali Gandaki "A" Hydroelectric Plant

Fiscal Year of Nepal[4]	Target Electric Energy Production[3] (GWh) a	Net Electric Energy Production (GWh) b	Achievement Rate (%) b/a	Net Electric Energy Production in Nepal (GWh) c	Presence of Power Supply by Kali Gandaki "A" Plant (%) b/c
2002/03[1]	812.10	319.48	39.3	2,066.45	15.5
2003/04	812.10	577.21	71.1	2,261.13	25.5
2004/05	812.10	505.02	62.2	2,380.89	21.2
2005/06	812.10	614.18	75.6	2,642.75	23.2
2006/07	812.10	656.70	80.9	2,780.92	23.6
2007/08	812.10	768.02	94.6	3,051.82	25.2
2008/09	812.10	805.63	99.2	3,185.95	25.3
2009/10	764.72	*657.68*[2]	*86.0*	*3,310.77*	*19.9*

Source: Prepared from internal documents provided by Kali Gandaki-A Hydropower Department (KGA), NEA Annual Report 2008/09, etc.

Note 1: The power plant started its operation in May 2002.

Note 2: Annual net electric energy production of 2009/10 was the accumulated data up to May 2010.

Note 3: In the case of setting the target electric energy production, maximum possible energy production is firstly calculated from the monthly average flow of Kali Gandaki River and other data. Then, the energy consumption of Kali Gandaki-A Plant itself was deducted. Since the fiscal year of 2009/10, the target value was slightly down considering the actual net production up to the previous year.

Note 4: Fiscal year of Nepal starts from July 16 of the year and ends at July 15 of the next year.

Regarding the presence of Kali Gandaki "A" Hydroelectric Plant from the power supply volume perspective, the annual net electric energy production supplied by the power plant is at around 25% of the total energy production in Nepal, consistently from the start of operation. It is literally the "base-load" power source, and is contributing to the stable power supply across the country.

(2) Trend of reserve margin and presence of installed capacity – contribution to solution to power shortage during peak hours and stable power supply

As shown in the below table, the reserve margin was extremely strengthened accompanying the start of operation of Kali Gandaki "A" Hydroelectric Plant[17]. The reserve margin that had been lowered to 12.5% right before the start of operation increased to 37.1% in FY2001/2002 right after the operation, and maintained around 20% until FY2003/2004. It can be observed that in the above years, the project made a remarkable contribution to solving the power shortage at peak hours.

As for the presence of the power plant from the perspective of installed capacity, the plant, with the capacity of 144 MW, shared around 25% of the total installed capacity across Nepal after starting the operation in FY2001/2002, and the total capacity of the nation drastically increased from 440 MW to 584 MW (increase rate: approx. 33%). Moreover, although the share of the installed capacity lowered to around 20% in FY2008/2009, the presence of the plant is still valued.

Table 6: Power Supply and Demand, Reserve Margin and Presence of the Project

Fiscal Year of Nepal	**Installed Capacity (MW)** **a**	**Peak Demand (MW)** **b**	**Demand – Supply Gap (MW)** **c = a-b**	**Reserve Margin (%)** **c/b*100**	**Presence of Kali Gandaki-A Plant (%)** **144MW / a*100**
1999/00[1)]	*440*	351.9	88.1	25.0	N/A
2000/01	440	391.0	49.0	12.5	N/A
2001/02	584	426.0	158.0	37.1	24.7
2002/03	604	470.3	133.7	28.4	23.8
2003/04	613	515.2	97.8	19.0	23.5
2004/05	613	557.5	55.5	10.0	23.5
2005/06	615	603.3	11.7	1.9	23.4
2006/07	617	648.4	-31.4	-4.8	23.3
2007/08	689	721.7	-32.7	-4.5	20.9
2008/09	689	812.5	-123.5	-15.2	20.9

Source: Prepared from the answers to the questionnaire to NEA, NEA Annual Report 2008/09, etc.
Note 1: Installed capacity in 1999/2000 is not known, and then assumed as 440MW.
Note 2: The commencement of the operation of Kali Gandaki "A" Hydroelectric Plant was May 2002, highlighted in green color in the above table.
Note 3: Reserve margin is the index for indicating allowance of supply capacity (total installed capacity of all power plants) to the peak demand. For example, the reserve margin of 2008/09 was calculated as minus 15.2% (= (689-812.5) / 812.5*100).

(3) Various effects of replacing the turbine runners

As described in above Section 3.2, the project started its commercial operation in May 2002. However, due to the severe wear of turbine runners found in the overhaul in October 2003, it was decided that three turbine runners must be replaced[18]. A total of 6 water turbine runners,

---

[17] This point is consistent with the result of the company interview described in Section 3.3.2.

[18] Background, cause, and concrete measures for replacing the turbine runners are as follows.

- ✓ Wear caused by sediment is predicted from the time of initial design, therefore a part of the runner is treated with wear resistant coating. On the other hand, inflow of sediments to the desanding basin were more than predicted due to the strong tractive force of the Kali Gandaki River, allowing the sediments to enter the including 3 runners procured through additional components, as well as the existing 3 procured in the project (surface coated later on), are replaced in the permanent overhauling conducted yearly, where 1 or 2 turbine(s) are replaced in rotational turns.

Above replacing work is conducted intensively in the dry season[19] since the output is lower, therefore impact to the output capacity due to replacement work is minor. In case one of the turbines stops operation, the maximum output is lowered due to the decreased flow, consequently the impact to the output capacity is limited[20].

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

(1) Financial Internal Rate of Return (FIRR)

FIRR figures were recalculated with several conditions described in the table below as the base scenario. With the electricity revenue as the parameter, two cases were assumed: a slightly more pessimistic case than the base scenario (Scenario 1) and a optimistic case (Scenario 2) to conduct sensitivity analysis of the recalculated FIRR. Table-7 below shows the recalculation results.

Table 7: Recalculation of FIRR

Timing	Preconditions and Assumptions for Recalculation (Project Life: 50 years after the completion of the Project for each case)	FIRR
At the time of appraisal (in 1996)	Costs: Not known (may include costs of construction, operation & maintenance, etc.) Revenue: Not known (may include electricity revenue, etc.)	12.7%
At the time of ex-post evaluation (in 2010)	**Base Scenario** Costs: Construction cost, consulting service cost, operation & maintenance cost (based on the actual expenditure up to 2009) Revenue: Electricity revenue (assuming 25% increase in electricity tariff in 2011, being US$0.114 per kWh in 2003 as a base year for recalculation) System losses: Assuming reduction of system losses (incl. transmission ones) down to 22.5% in 2015 and to 20.0% in 2020 respectively, being 25% in 2003 as a base year for recalculation	10.1%
	Scenario-1 (Pessimistic than base scenario) Costs: The same with base scenario Revenue: Electricity revenue (assuming no increase in electricity tariff in the future) System losses: Assuming no improvements in system losses (being remained as 25%, the level of losses in 2003)	8.9%
	Scenario-2 (Optimistic than base scenario) Costs: The same with base scenario Revenue: Electricity revenue (assuming 25% increase in electricity tariff in 2011, then 25% increase every five years after 2011) System losses: The same with base scenario	11.9%

turbine through the headrace tunnel and penstock, causing wear to the entire runner.

- ✓ Regarding the overhaul carried out in September to October 2003, (as described in footnote of Section 3.2 on efficiency), JICA pointed out the significance of operation, maintenance and management training from the mid-to-long-term perspective, and therefore the training program started in August 2003. The periodic overhaul carried out in September to October 2003 was part of the training program. If the training was not proposed by JICA, finding the wear on the turbine may have been delayed.
- ✓ Level of deterioration of maximum output of each turbine until the overhaul in 2003 is unknown. All turbine runners that were replaced had wear resistant coating on the entire runners.

[19] During dry season of Nepal which lasts from October until the next May, the flow volume of the river becomes extremely low.

[20] As described in Section 3.5, the condition of the sediment in the reservoir does not have major problems, since the sediment flows out during the flood in the rainy season due to the strong tractive force of the Kali Gandaki River. The power plant is a run-of-river type, where sediments do not cause direct impacts on power generation capacity itself.

The recalculation resulted in lower figures than 12.7% at the time of project appraisal. Since materials at the time of appraisal are not available, details of the process of calculation at that time are unknown, however, the following 3 reasons can be assumed; 1) the electricity tariff is remaining at a very low level (deferred for 9 years due to political reasons), 2) reduction of system loss hardly progressed (still 25% as of 2010, the same level as the time of project appraisal), and, 3) construction of new power plants did not start, and the electric power selling to India associating with exporting electric power was not enhanced. Above 1) which was particularly critical for the recalculation for FIRR is deemed as an external factor, hence the result of FIRR value recalculation shall be excluded from the effectiveness evaluation.

Results of the sensitivity analysis were 8.9% in the case of Scenario 1, and 11.9% in case of Scenario 2. Scenario 2 is based on an extremely optimistic outlook with regard to increase in the tariff, but still marks slightly lower value for IRR compared to the time of appraisal. In order to strengthen profitability of the project, the electricity tariff must be increased.

(2) Economic Internal Rate of Return (EIRR)

The economic internal rate of return (EIRR) was not calculated due to limited resources for this study because it would have been necessary to clarify input data from the beneficiary side, such as (1) cost savings from substitution of traditional firewood, kerosene, diesel, etc. and (2) the target area residents' WTP (Willingness to Pay) for electricity usage through individual interviews or through the estimation by using prices of substitution goods and electricity tariff level.

3.3.2 Qualitative Effects

Improvement of business environment for private firms through an increase in electricity supply

During the site survey, we conducted in-depth interviews with five heavy electricity users of which headquarters are located in Kathmandu (4 manufacturers and 1 tourism company[21]) in order to find out how the project improved their business environment. Respondents expressed their opinions that were introduced in the table below as direct impacts of an increase in electricity supply by the project.

Table 8: Results of Interviews with Private Firms in Kathmandu (Multiple Answers)

Responses	**Respondents (Number of respondents is shown in parentheses.)**
Frequency of power cuts were reduced after the commencement of power plant operation.	Manufacturers (3)
Production amount was increased due to the appropriate production planning based on the anticipation that stable power supply was expected to continue.	Manufacturers (1)
Operation efficiency of the plant was increased because of stable power supply and of improvement in its quality.	Manufacturers (1)
Management decision about additional investment was made because of stable power supply and of improvement in its quality.	Manufacturers (1)
Sales volume was increased by participating in the project as a steel supplier	Manufacturers (1)
Power supply condition became better only for a few years after the commencement of power plant operation and it has gotten worse again.	Manufacturers (4)
The completion of the power plant construction did not affect our investment planning.	Manufacturers (1)
The project has had limited impacts on our business.	Tourism (1)

[21] The types of business in details are; 1 cement manufacturer and 3 steel makers for manufacturing, and 1 hotel for tourism.

The above interview result indicates that the business environment of some companies has improved for a certain period, after starting the operation of Kali Gandaki “A” Hydroelectric Plant in 2002. On the other hand, although the companies are fully aware of the presence of the project as the base source of power supply, they have considerably negative images for the worsened situation of supply and demand, thus are likely to underrate the contribution of the project.

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

3.4 Impact

3.4.1 Intended Impacts

Kali Gandaki “A” Hydroelectric Plant is connected to the national grid through transmission lines to the Pokhara area constructed in the project, therefore benefits of the project is spread across the country. Impacts shall be evaluated based on the above statement.

(1) Trend of GDP

GDP in Nepal has been growing at annual rates of 3-6% for the last decade, except for the period of chaos associated with the political change in 2002. After starting the operation of Kali Gandaki “A” Hydroelectric Plant in 2002, the growth rate is slowing to 3-5%, which previously was 4-6%.

Table 9: Macroeconomic Indicators of Nepal

Item	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GDP (billion US dollars)[1]	5.03	5.49	5.60	6.05	6.33	7.27	8.13	9.07	10.28	12.61
GDP Growth Rate (%)[2]	4.4	6.2	4.8	0.1	3.9	4.7	3.1	3.7	3.3	5.3
GDP per Capita (US dollars)	211	225	224	236	242	272	299	327	363	438
GDP Deflator (%)	8.9	4.5	3.4	11.6	3.1	4.2	6.5	7.0	7.7	6.7

Source: World Development Indicators
Note 1: Nominal price
Note 2: Inflation-adjusted rate, based on year 2000 prices

As far as the above chart shows, clear connection between GDP growth and completion of the project cannot be found. However, the project’s contribution to industrial activities as a base-load power source is evident, and also through contribution to the inflow of FDI (mentioned below) or promotion of employment, the project also supported the development and enhancement of the economy of Nepal.

(2) Trend of FDI and creation of employment

Number of cases and investment amount of Foreign Direct Investment (hereafter referred to as “FDI”) to Nepal is rapidly increasing since around FY2004/2005. Particularly the amount, which marked an average of 1.5 billion rupee in the four previous years of FY2004/2005, increased to an average of 4.2 billion rupee in the four years after FY2004/2005. With regards to types of industries, investment to the service industry is increasing, in addition to the manufacturing and the tourism that traditionally have enjoyed high numbers of cases and amount of FDI.

Table 10: FDI to Nepal and Employment Generation by FDI

Fiscal Year[2)] / Item	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09
New FDI	71	96	77	74	78	63	116	188	212	150
	1,418	3,102	1,210	1,794	2,765	1,636	2,606	3,227	9,811	5,356
Employment Generated by FDI	4,703	6,880	3,731	3,572	2,144	5,559	7,358	7,389	10,677	8,305

Source: "Industrial Statistics 2008/09", Department of Industry, Ministry of Industry of Nepal
Note 1: The upper figures show the number of investment registered and lower figures show FDI (unit: 1 million Nepal Rupees)
Note 2: Fiscal year of Nepal starts from July 16 of the year and ends at July 15 of the next year.

Additionally, for creation of employment accompanying FDI, a certain level of employment is being created every year, by the support of FDI. Employment was generated for more than 10,000 persons by FDI in FY2007/2008, for the first time in 15 years since FY1992/1993.

The increase of FDI does not necessarily indicate the impact of the project, since various causes are involved other than strengthening of power supply. However, it can be considered that a certain scale of power supply improved the business/investment environment of Nepal, and partly contributed to the attraction of companies and enhanced investments.

3.4.2 Other Positive and Negative Impacts

3.4.2.1 Benefits to subject area and neighboring residents

The project contributed to electrification of at least 3,000 households in 2 areas near the construction site of the power plant (Beltari Area where the power plant is located, and Mirmi Area where the diversion dam is located). In addition, below 4 items were confirmed as secondary impacts to the local community of the power plant location[22].

- ✓ Significant reduction of transportation cost and time for residents of above Beltari Area and Mirmi Area, due to construction of approach roads (28.5 km in total, completed in 1995)[23]
- ✓ Start of regular service of skiff (operated by the Bote ethnic group that was subject to relocation) on the dam reservoir connecting Mirmi Area and Seti Beni Bazar on the upstream side by water transportation, which triggered contribution to development of retailing in Seti Beni Bazar[24].
- ✓ Contributed to development of new businesses[25] and creation of employment in Beltari Area and Mirmi Area[26].
- ✓ Contributed to local community development through social development projects such as construction of schools, renovation of temples, microcredit program, etc. (that were implemented as a part of social impact mitigation measures, as described later).

The reduction of transportation time and cost due to construction of the approach road and water transportation on the reservoir achieved great effect, especially in both Beltari and Mirmi

[22] Source: Interview with local residents at the time of field survey
[23] Transportation time from Beltari and Mirmi areas to the Galyang Area having the nearest market (20km away from Beltari and Mirmi) reduced drastically from 3.5 hours to 1 hour after the project. (Source: interview with residents of both areas)
[24] One of the responses of retailers of Seti Beni Bazar to the interview was that "transportation cost reduced 75% due to start of operation of the skiff".
[25] Operation of skiff described above, management of rest house by the reservoir, and freshwater fish farming, etc.
[26] Employed by Kali Gandaki "A" Plant, small boat operation business, etc.

areas that are located in precipitous mountains, where convenience of the residents have improved dramatically.

In Nepal, construction of long approach roads is required for construction projects of hydropower plants, because of the nation's precipitous terrain. Due to such background, construction of these roads remarkably improve the accessibility of mountainous regions that are out of existing transportation networks, therefore hydropower plant construction projects have a "road construction project" aspect[27].

3.4.2.2 Impact on Natural Environment

(1) Implementation status of Environmental Impact Assessments (EIA) and Environmental Monitoring[28]

The Environmental Impact Assessment (EIA) was completed in December 1995, through the loan from ADB.

Regarding the environment monitoring, a Mitigation Management and Monitoring Plan (hereafter referred to as "MMMP") was developed by the consultant at the time of detailed design and bidding documents preparation (before signing the L/A of the project). As the executing body of the MMMP, "Kali Gandaki Environmental Management Unit" (hereafter referred to as "KGEMU") was established in January 1997. KGEMU is responsible for supervising environmental mitigation and monitoring plans set by each contractor based on the above MMMP as a guideline. The actual activities are performed by contractors[29].

Additionally, for the environmental monitoring after the project, the Environmental and Social Studies Department (ESSD) of NEA made monitoring reports concerning environmental and social impacts, for each year from 2003 to 2006. Items for measurement of impact include; 1) physical environment (hydrology, water quality, soil property, etc.), 2) biological environment (forest, animals, fishes, etc.), and 3) social environment (land acquisition, work environment, situation of the agricultural and livestock industries, and situation of the local economy, etc.).

(2) Observed impacts

The below impacts to nature were reported through the environmental monitoring activities after the above project.

- ✓ Reduction of flow in the dry season is observed, at a low percentage compared to before implementation of project, at the diversion dam and downstream of the power plant[30].
- ✓ Regarding the impacts on the population of fish and diversity of species, trapping and hauling of fish at the downstream of the dam and the construction of hatcheries were adopted as alternative measures for environmental mitigation, because positive impacts by the construction of fishway were not observed in any other dams in Nepal at the time of project appraisal. On the other hand, the environmental impact assessment survey which was conducted after the completion of dam construction reported that the population of fish have been shrinking and diversity of species have also declined as a result of shutoff of the route for fish migration from the down-stream to the up-stream[31].

---

[27] For example, improvement of neighboring residents' convenience due to construction of access roads is pointed out for the Kulekhani Hydropower Project. (Source: "Kulekhani Disaster Prevention Project (2)", ex-post evaluation and others, by JICA, 2004)

[28] Mitigation and monitoring of environment were implemented under the loan from ADB.

[29] Environmental mitigations and monitoring plans established by the contractors include; 1) waste management such as construction waste soil, 2) management of natural environment for fish and animals, 3) forestation, and 4) social impact mitigation measures. Furthermore, contents of the social impact mitigation measures are; 1) construction of freshwater fish farms and ponds for seedling, 2) construction and renovation of schools (3 schools in total), 3) renovation of temples, 4) implementation of a microcredit program, and 5) construction of a simple water supply system, etc.

[30] Source: NEA-ESSD (2003) Post Construction Environmental Impact Audit Study

[31] According to reports from ESSD of NEA, 31 fish species were confirmed at the baseline survey implemented prior

Moreover, since it had been pointed out before the project that the Holy Stone of Seti Beni Bazar might submerge underwater due to the sediment in the reservoir, construction for reinforcement around the stone was executed as a part of the environmental mitigation measures of the project. Although the residents of Seti Beni Bazar replied that "the Holy Stone has submerged just once in the past, by a large-scale flood which occurred in September 2009" at the hearing, no special problems are observed in normal conditions[32].

3.4.2.3 Implementation Status of Resettlement and Land Acquisition[33]

The project involved resettlement of local residents and land acquisition. Table-11 below shows the scale and process of the resettlement.

Table 11: Status of Resettlement and Land Acquisition of the Project

Item	Original Plan (in 1996)	Actual (in 2003)
Project Affected Families (PAFs)	1,081 households	1,468 households
Scale of Resettlement	54 households	217 households in total
Resettlement Action Plan (RAP) and its process, etc.	RAP and rehabilitation program were prepared before 1996 through ADB loan. Before the commencement of the Project, land acquisition of 540 households and resettlement of 8 household were completed in line with the construction of access roads.	Due to the time delay in building new houses for resettled residents, some of the households moved to temporary houses (at their own expense), then moved again to new houses after the completion of the building.
Scale of Land Acquisition	200ha	207ha
Completion of Resettlement	Dec.1999	2001

Source: JICA Internal documents and NEA (2003) Post Construction Environmental Impact Audit Study

Note: The types of compensation were the following two: i) to receive a new house with free land, or ii) to receive compensation without a new house. The target household selected one of the above two options.

As a base plan concerning relocation of residents and land acquisition, the Acquisition, Compensation and Resettlement Plans (ACRP) were prepared by the consultant at the time of creating detailed design and bidding documents (before signing L/A of the project).

The "Post Construction Environmental Impact Audit Study" prepared in 2003 by NEA reported that the average income of the PAFs (Project Affected Families) have increased six times from 22,000 rupee (before the project), to 128,000 rupee (as of 2003). In addition, i) improved convenience of the residents' lives due to a reduction in transport time and ii) improvements in social service delivery by the construction and rehabilitation of schools and temples were pointed out, according to the interviews with PAFs conducted in the field survey of this study. This can be considered a success of the social impact mitigation measures implemented in the project.

The project completion report written by ADB in 2004 mentioned that "17 households of the Bote ethnic group were significantly impacted by the project (some of the households were forced to relocate twice)". However, in the interview with the leader and several concerned persons of the 17 households of the Bote ethnic group, all replied that they are "very pleased with the life at present"[34]. It is deemed that there were no particular problems in the relocation

to the project, but have reduced to 22 species in 2006. However, it is also noted in the report that "monitoring must be continued to determine the impact in details". (Source: NEA-ESSD (2006) Environmental and Social Monitoring Report of Kali Gandaki "A" Hydroelectric Project)

[32] However, minor submerging of the Holy Stone does occur frequently in the rainy season, only soaking the bottom part of the stone. (Source: Results of interviews with Seti Beni Bazar residents)

[33] Relocation of residents and land acquisition were implemented under the loan from ADB.

[34] The employment state of the Bote ethnic group at present are; employed at the hydroelectric plant (4 persons), managing rest house business by the reservoir (1 household), newly involved in freshwater fish farming (7 persons), and engaging in the operation of skiff at the dam reservoir (6 persons). Secured employment, increase in the incomes

process and compensation[35].

3.5 Sustainability (Rating: a)

3.5.1 Structural Aspect of Operation and Maintenance

NEA[36] is responsible for operation and maintenance (O&M) of the power plant facilities that were built in the project. There seems to be no problem with the operation and maintenance structure.

NEA consists of two groups: Business Group and Corporate Offices. Under these two groups, there are nine departments in total: Distribution & Consumer Services, Electrification, Generation, Transmission and System Operation, and Engineering Services were under Business Group[37] whereas Planning, Monitoring & IT, Administration, Finance and Internal Audit were under Corporate Offices. In addition to these internal departments, NEA has three subsidiary companies (Upper Tamakoshi Hydropower Limited, Chilime Hydropower Company Limited and Power Transmission Company Nepal Limited).

The operation and maintenance of Kali Gandaki "A" Hydroelectric Plant is in charge of "Kali Gandaki-A Hydropower Department" which is under the (3) Generation department described above. Implementation structure of work is as shown in Table 12.

Table 12: Operation and Maintenance System of Kali Gandaki "A" Hydropower Plant

Stage/Category of Maintenance Activities	Planning	Preparation of Tender Documents	Implementation	Supervision
Daily Maintenance	KGA	KGA	KGA	KGA
Periodical Maintenance	KGA	KGA	KGA	KGA
Large Scale Maintenance	Consultant	Consultant	Contractors	NEA HQ and Consultant

Source: Answers to the questionnaire to NEA
Note: KGA refers to the site office of Kali Gandaki-A Hydropower Department

As shown in the above table, the operation and maintenance (excluding large-scale repairs) of the power plant are implemented by direct management. O&M manuals have been prepared by the consultant in the additional component of the project, and transfer of maintenance and management skills, including replacing work of turbine runners has been completed through OJT. Additionally, no particular problems regarding implementation structure of KGA are found for bidding and managing the contractors upon large-scale repairs.

As shown in the below table, the number of employees have been reducing since FY2001/2002. It is considered that numbers of excess employees were downsized in response to the recommendation for "Rationalization and commercialization of public agencies, given by the World Bank and IMF", which was already in progress before the project implementation. The number of employees at Kali Gandaki "A" Hydroelectric Plant reduced significantly after the completion of the construction, staying at the same level since then, and is maintaining appropriate manpower (also for the number of O&M staff).

---

and improvement in convenience in the daily lives were answered by the Bote people as reasons for high satisfaction. (Source: Results of interviews with Bote ethnic group)

[35] Regarding the scale of relocation, the main reason for the fourfold increase of relocated households to 217 from the initial plan of 54 households (as shown in Table 11), is repeated relocations of the same households due to the delay in construction of temporary houses.

[36] NEA was founded in 1985. It is responsible for all electrical projects including selling of electric power, as well as planning, design, construction, operation, maintenance and management of power generation, power transmission, power transformation, and power distribution.

[37] "Internal unbundling system" was introduced in 2003 for these 5 Business Groups, and these groups are all financially independent. (The General Manager of each Business Group is primarily responsible for the operation.)

Table 13: Number of Staff of NEA and Kali Gandaki-A Hydropower Department (KGA)

Fiscal Year of Nepal	Number of Staff NEA	Number of Staff KGA
2001/02	9,790	259 (172)
2002/03	9,860	171 (107)
2003/04	9,673	177 (110)
2004/05	9,779	178 (111)
2005/06	9,540	211 (144)
2006/07	9,272	172 (130)
2007/08	9,298	175 (143)
2008/09	9,280	181 (145)

Source: NEA Annual Report 2008/09
Note 1: The staff who are involved in O&M activities are shown in parenthesis.
Note 2: Part-time workers are included in the number of staff.
Note 3: Authorized number of staff of NEA is 10,314 as of 2009.

3.5.2 Technical Aspects of Operation and Maintenance

Technical skills of engineers and workers

The total number of employees at Kali Gandaki "A" Hydroelectric Plant assigned to technical jobs for operation, maintenance, and management are 145 persons as of July 2009, consisting of 20% of university graduates, 40% of high school graduates, and 40% of under high school graduates. Personnel at the management level have more than ten years of experience in operation and management of the hydropower plant.

As shown in the above table, around 80% of the staff of Kali Gandaki "A" Hydroelectric Plant are assigned to technical jobs for operation, maintenance, and management. NEA owns many of the run-of-river type hydropower plants, and through operation of these power plants, sufficient skills of O&M have been accumulated. There seems to be no problem with both the quantity and quality of engineers and technical staff.

Training programs provided by contractors of the Project

Various trainings for technical staff for maintenance have been conducted by the consultant and contractors through implementation of the additional component. Three types of training are provided; 1) lecture (on turbine, generator, switchgear, various software, and control system), 2) OJT, and 3) overseas training[38]. Furthermore, contents of the trainings are; 1) numerical calculation training required for O&M planning, and 2) training for operation of equipment using simulators. Training is conducted by the contractor constantly, and the contents of the training are valued by the trainees[39].

On the other hand, 1) aging of experienced staff, and 2) loss of opportunities for OJT (and technical skills not transferred to the next generation) due to new power plant projects remaining stagnant after 2002, are pointed out.

3.5.3 Financial Aspects of Operation and Maintenance

(1) Earnings condition

The earnings condition is extremely bad, due to the following three reasons; 1) the expense for power purchase from independent power producers (hereafter referred to as "IPP"), which shares 30% of the total power supply, is 40% of the total expense, and is 80% of cost of sales, 2) unpaid electdricity bills, and 3) the electricity tariff remaining at the same level for 9 years since 2001[40].

[38] Overseas training conducted for approx. 1 month in Japan, Germany, and France.
[39] Source: Interview with trainees
[40] A surplus was achieved only in FY2006/2007 after FY2001/2002, and all the rest of the years were in deficit. The amount of deficit of FY2008/2009 was 4.7 billion rupee (approx. 6 billion yen), which further increased from 1 billion rupee in the previous year.

The payment for IPP is especially a major burden. While load shedding accompanying the increase of gap in power supply and demand is recurring, securing a stable power supply source is being urged; therefore the power purchase from IPP is one of the few options (as well as importing power from India).

In addition, accounts receivable are increasing together with the unpaid electricity bills. It is said that "collecting the bill unpaid by the local government that share around 30% of the accounts receivable is extremely difficult"[41]. The receivables turnover ratio is approximately 3.0 as shown in the below table, and the days sales outstanding is around 120 days, which indicates that an average of 4 months are required for collecting the bills. On the other hand, payment conditions of the private sector have no problem in general.

Table 14: Profit and Loss (P/L) Statement of NEA

Unit: Million NPRs.

Item	2004/05	2005/06	2006/07	2007/08	2008/09[2)]
Sales	12,605	13,332	14,450	15,041	15,220
Cost of Sales	7,462	8,333	9,035	9,531	10,675
of which, power generation-related	*642*	*811*	*856*	*980*	*1,122*
of which, power purchase-related[1)]	*5,760*	*6,392*	*6,968*	*7,437*	*8,423*
Gross Profit on Sales	5,143	4,999	5,415	5,511	4,545
Operating Profit	3,654	3,516	4,118	3,651	2,370
Interest Expense	3,080	3,051	2,385	2,274	2,809
Depreciation	1,734	1,817	1,856	1,895	2,231
Current Profit	▲1,093	▲1,565	267	▲1,171	▲4,631
Gain from the prior-term adjustments	▲220	297	47	152	▲50
Net Operating Profit after Tax	▲1,313	▲1,268	314	▲1,019	▲4,681

Source: Prepared from NEA Annual Report 2008/09
Note 1: Power purchase expenses from IPP and others
Note 2: Provisional numbers

However, as of August 2010, it is assumed that ETFC (Electricity Tariff Fixation Commission) which is the agency in charge of electricity tariff regulation will advise the government for average 25% of price increase in electricity tariffs, and introduction of price adjustment mechanism (public comment regarding the price increase was made)[42]. A 25% increase can drastically improve NEA's financial standing; the trends for raising electricity tariffs deserve continued attention.

(2) Financial status

The balance sheet and financial indices of NEA are shown below.

[41] NEA Finance claims the following three reasons for the difficulty in collecting the payment; 1) physical accessibility issues due to undeveloped roads to local governments, 2) public safety and security issues due to political background, and 3) issues due to enforcement of law.

[42] The recommendation for price increase of electricity tariffs was also anticipated in the past, but was not implemented because of the political consideration for the poor. However, some of the top management of NEA acknowledged that "unlike in the past, price increase of this time is highly feasible". (Source: Results of interviews with the top management of NEA)

Table 15: Balance Sheet (B/S) of NEA

Unit: Mil.NPRs.

Item	2004/2005	2005/2006	2006/2007	2007/2008	2008/2009[1)]
Assets					
Current Assets	8,868	9,355	10,199	11,409	9,805
Quick Assets	3,698	4,088	5,151	5,721	4,766
Fixed Assets	69,004	74,555	81,809	89,350	99,053
Total Assets	**77,872**	**83,910**	**92,008**	**100,759**	**108,858**
Liabilities and Equity					
Equity Capital	15,868	17,568	21,580	23,177	22,159
Current Liabilities	17,466	19,854	22,812	26,213	28,481
Fixed Liabilities	44,538	46,488	47,616	51,369	58,218
Total Liabilities and Equity	**77,872**	**83,910**	**92,008**	**100,759**	**108,858**

Source: Prepared from NEA Annual Report 2008/09

Note 1: Provisional numbers

Table 16: Financial Indices

Item	2005/2006	2006/2007	2007/2008	2008/2009
Receivable Turnover Rate	3.3	2.8	2.6	3.2
Days Sales Outstanding	112	130	139	114
Gross Debt (mil.NPRs)	66,342	70,428	77,582	86,699
Current Ratio (%)	47.1	44.7	43.5	34.4
Quick Asset Ratio (%)	26.9	28.9	26.9	19.2
Capital Ratio (%)	20.9	23.5	23.0	20.4

Source: Prepared from P/L and B/S

The rate of equity as of FY2008/2009 was 20.4%, and is showing downtrend in the recent years. The interest-bearing debt is increasing consistently, and the burden for interest payment is pressuring the business. Additionally, the current ratio and quick ratio are far below 100%, therefore financial stability and short-term solvency are still viewed with doubt. Furthermore, the government subsidy is not provided for NEA.

Regarding the financial report of NEA, the Auditor's General Office (AGO) is in charge of the financial audit of government-linked companies, however, the auditing capability has been questioned by donor organizations such as ADB. In order to ensure transparency of the financial report, audit by an external private financial consultant is required (Actually, AGO is planning to entrust an external private financial consultant for financial audit of this year).

(3) Operation and maintenance expenditure relating to the Project

The expenditure for maintenance relevant to the project in FY2008/2009 was 114 million rupee (approx. 150 million yen), which accounts for 8% of the total budget for O&M of NEA (1.46 billion rupee) in FY2008/2009.

After starting the operation in 2002, the annual expenditure for operation and maintenance varies. The maintenance expenditure includes cost for manpower, fuel, repair (including those outsourced), and vehicles, etc., and of these, "repair cost" which includes all costs involved in permanent overhauling accounts for 40-60% of the total every year. Additionally, manpower cost required for maintenance work (travel allowance and the like) are increasing in the recent years.

Table 17: Budget of NEA and Status of O&M Expenditure

Unit: Million NPRs.

Financial Year	2004/05	2005/06	2006/07	2007/08	2008/09
NEA Budget / NEA O&M Budget					
NEA Budget	12,713	14,023	14,778	16,131	13,675
NEA O&M Budget	647	741	1,059	1,487	1,464
O&M Budget and Expenditure of Kali Gandaki-A Hydropower Department (KGA)					
O&M Budget	134	139	126	132	115
O&M Expenditure	85	154	189	189	114
Personnel Expenses	*23*	*28*	*27*	*30*	*40*
Fuel Expenses	*15*	*40*	*32*	*27*	*19*
Maintenance Expenses	*37*	*75*	*121*	*121*	*43*
Vehicle Expenses	*5*	*7*	*6*	*7*	*8*
Administration Expenses, etc.	*5*	*4*	*3*	*4*	*4*

Source: Answers to the questionnaire to NEA

Note: Personnel expenses includes those related to O&M activities such as allowances, etc.. Fuel expense covers purchase cost of diesel fuel for KGA generators (to be used in case of power cut). Maintenance expenditure includes purchase cost of spare parts, subcontracting costs for O&M activities, etc..

However, there are cases where the approved yearly budget is below the actual expense; therefore accuracy of budget estimation must be improved.

3.5.4 Current Status of Operation and Maintenance

In general, there are no problems with the utilization, operation and management of the facilities/equipment that were constructed and carried in (dam, reservoir, generator, turbine, and other structures).

The turbine runners that were replaced in the additional component of the project are still replaced at the permanent overhauling, 1 or 2 mill(s) at a time, yearly. As described in Section 3.3, statement for effectiveness, replacing work is carried out intensively during dry season when the generation output is lowered, therefore the impact to output capacity of the power plant is extremely limited[43]. On the other, replacement of the turbine runners every year may cause a difficult situation for securing the stable energy production.

Deposited sediments in the reservoir are discharged in the rainy season utilizing the high tractive force of the Kali Gandaki River; therefore serious problems have not occurred. (However, data such as ratio of sediment, etc. are unknown)

There has been no major problem until now for operation and maintenance. However, since Kali Gandaki "A" Hydroelectric Plant is the largest power source of Nepal as described earlier, the situation does not allow the operation to be suspended even during permanent overhauling. Taking advantage of the "opportunity" when output is lowered in the dry season, parts and equipment have been effectively replaced until today. The turbine runners shall continue to be replaced in rotational turns (carry out maintenance and management work during operation of power plant), until the completion of the large-scale Upper Tamakoshi Hydroelectric Plant (456 MW) planned for operation in FY 2012/2013.

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

The project and policy are highly consistent with each other, and problems are not found for the operation and maintenance. Although the finance remains an issue in terms of sustainability, an increase of electricity tariffs is planned, through which a major improvement of financial strength of NEA can be expected. Moreover, many positive impacts have been realized, efficiency was above expectation during the project period, and project cost was within the planned budget.

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

4.2 Recommendations

4.2.1 Recommendations for Executing Agency

Recommendation-1

In response to the steady increase of power demand, the gap between power supply and demand is rapidly widening. Since Kali Gandaki "A" Hydroelectric Plant is the base power plant that covers one quarter of the national power generation, further efficient operation is

[43] Regarding the water turbines and main inlet valves of the turbines which are subject to the research in the previously mentioned "Power Development Project" of the World Bank, total of 6 runners (including 3 provided for spare parts) for the turbines are constantly replaced yearly for a few quantities. The main inlet valves will be reviewed for necessity of re-design through surveys in the WB project to plan appropriate measures to deal with the problem.

required. Fundamental measures are planned to be proposed within this fiscal year by the consultant team through the Power Development Project of WB from a technical point of view[44], and NEA must proceed with measures to take prompt actions in response to the proposals from the consultant team from now (for example, special measures which enable immediate and efficient organization of manpower or budget, in response to the details of recommendations or the scale of measures).

Recommendation-2

However, the effect of efficient operation of Kali Gandaki "A" Hydroelectric Plant only is limited, which cannot be a fundamental solution for eliminating the gap between supply and demand. In order to drastically eliminate the gap is to build new large-scale power plants, therefore NEA must make all efforts necessary for completion of Upper Tamakoshi Hydroelectric Plant, as well as prompt implementation of other projects under preparation (for example from a short-term view, accelerate communication with potential donors, or building frameworks within NEA in preparation for new projects).

Recommendation-3

There is still uncertainty as to whether the increase of electricity tariffs is realized. To facilitate the price increase, there is no doubt that NEA must make efforts at the same time for cost reduction. NEA must continue with its management efforts for reduction of employees and costs (prompt execution of concrete measures is demanded for reducing transmission loss that is remaining at high level, or reducing nontechnical loss).

4.3 Lessons Learned

The overhaul of generators performed in September to October 2003 was not included in the initial TOR of the project; however, this was a part of an additional training program that was proposed to NEA by JICA separately from the project, from a mid-to-long term perspective. In hindsight, if the above overhaul work was not proposed, the wear on the turbine may have been found much later, causing critical damage to security of effectiveness and sustainability of the project. There is a growing recognition that the tractive force of rivers has been unexceptionally increasing across Nepal remotely due to global warming or progressing development in the upstream area. When planning a hydroelectric project in Nepal in future, due consideration shall be made during detailed design (such as reviewing coating method of runners of mills); it is also advisable to oblige the executing body to conduct frequent permanent overhauling after completion of the project (for example, 1 year after completion). (In some cases, permanent overhauling may be included in the project components, and be implemented within the domestic currency budget of the executing body.)

Additionally, the approach roads (28.5 km in total) developed by the budget of Nepal before the start of the project, made a great impact to the economic activities of the local community. Construction of long approach roads is necessary in construction projects of hydropower plants in Nepal due to the precipitous terrain, and these roads make huge contribution to improving the accessibility of mountainous regions that are out of the existing road network. However, the degree of benefits of the impacts are subject to the population and economy of the beneficiary area, therefore hydropower plant projects in low-population areas may result in relatively low impact. Therefore, when implementing hydropower plant projects in Nepal, aspect of "road construction project" must be taken into account, and the access road construction must be integrated with the power plant construction. Consequently, the road construction aspect shall be evaluated in a positive manner. (For example, 1) evaluate the road

[44] These measures are expected to include the research on hydraulic characteristics of Kali Gandaki "A" Plant (incl. capacity assessment of desanding basin), repairing of turbine runners, replacement of main inlet valves, etc.. For the details, refer to Footnote-12.

construction component solely, calculate EIRR if possible, and 2) if EIRR calculation is difficult, include the qualitative impact of the road construction component in the ex-ante evaluation of the project.)

End

Comparison of Original and Actual Scope of the Project

Item	Plan	Actual
A) Output 【JICA Portion】 1.Civil Works Construction of headrace tunnel (Lot-C2)	Length: 5,925m, Diameter: 7.40m, Slope: 0.35%	Length: 5,905m, Diameter: 7.40m, Slope: 0.35%
2. Hydraulic Steel Work (Lot-4) ・ Installation of gates ・ Others	3 effluent gates and 6 water intake gates Steel linning of penstock and pressure shaft Installation of stop log gates, etc.	As planned As planned Mostly as planned
3. Electrical Equipment (Lot-5) ・ Installation of generators ・ Others	3 generators (48MW x 3) Installation of electrical equipment such as swich gears, etc.	As planned As planned
4. Mechanical Equipment (Lot-6) ・ Installation of water turbines ・ Others	Vertical Francis-type turbines: 3 sets Installation of governer and other mechanical equipment	As planned As planned (Additional component: O&M training programs for NEA staff, Repaire works, etc.)
5. Transmission Line (Lot-7) ・ Construction of two transmission lines (132kV)	58 km from powerhoues to Pokhara, 48 km from powerhouse to Butwal	66 km to Pokhara, 40 km to Butwal
【ADB Portion】 1.Civil Works ・ Construction of water intake dam (Lot-C1)	Concrete gravity dam (Height: 43m, Length of crest: 98m, Gross reservoir capacity: 7.7 million. m^3)	Height: 43m, Length of crest: 105m, Gross reservoir capacity: 7.7 million. m^3
・ Construction of desanding basin (Lot-C1)	Open-air type	As planned
・ Construction of powerhouse (Lot-C3)	Dimension: 24m x 40m x 100m	21m x 43m x 91m
2.Consulting Service	567.2M/M (Foreign: 523.5M/M, Local: 43.7M/M)	Foreign: 735M/M, Local: not known
3. Environmental Mitigation Measures	Environmental monitoring activities Acquafarming of migratory fish	As planned As planned Implementation of social impact mitigation measures
B) Project Period	October1996 – December 2000 (51 months)	October 1996 – August 2002 (71 months)
C) Project Cost (incl. ADB Portion)		
Foreign currency	33,832 million yen	241 million US dollars
Local currency	9,061 million yen (4,795 million Nepal Rupee)	114 million US dollars
Total	42,893 million yen	355 million US dollars
Japanese ODA loan portion	16,916 million yen	13,542 million yen
Exchange rate	1 Nepal Rupee ＝ 1.89 yen (as of March 1996)	N/A

Third Party Opinion on Kali Gandaki "A" Hydroelectric Project

Prof. Dr. Narendra Man Shakya
Institute of Engineering, Tribhuvan University, Nepal

The Kaligandaki Hydro Power Project was conceptualized to meet growing power demand in Nepal in a least cost, environmentally sustainable and socially acceptable manner. The project is thus designed to minimize load shedding to meet daily peak load requirements and compliment the non-peaking small plants. The project had met its objective in conformity with National policies of sustainable economic growth, poverty alleviation, regional development and the employment generation. Project in the region, once considered as remote area, has resulted in multiple beneficial impacts to the local community through the improvement of public infrastructure such as access roads, rural electrification, telecommunications and health services, enhanced educational facilities. The project is very relevant with respect to the hydropower sectoral policy of the country. The project is very much the part of the least cost generation expansion plan under various alternatives because of its low environmental and social impacts along with its daily peaking nature. The FIRR and EIRR of the project are 9.8% and 15% respectively. The EIRR is higher than opportunity economic cost of capital (10%) in the country. After the completion of Kaligandaki Hydropower project there has not been any major power schemes implemented in the country except Middle Marshyangdi hydropower project (70 MW). Because of the rapidly increasing power demand in the country the grim deficit of current power supply would have been inconceivably worse without Kaligandaki HP. Therefore the relevance of the project in terms of sectoral policies and development needs are very high.

Most of the proposed requirements set forth in the various project's documents for mitigating adverse environmental impacts due to project construction have been implemented. Release of 4 cu.m/s minimum of water during dry season and 6 cu.m/s on religious days has been observed. A siren warning system is in operation at the powerhouse and dam site. The project has had a positive effect on forests, as the use of alternative sources of energy has increased. The post-construction environmental Impact Audit study indicates that construction disturbances have settled down. A considerable amount of cash flow to the local community during project construction ensures at least the previous living standard of project affected families. Most of the project affected families have managed to achieve a better standard of living. Local people, including the affected families, are now more amenable to more commercial activities for income generation.

The operation of the project has contributed significantly to Nepal's power system, reducing the need for load shedding, catering to the need of energy for future electrification and boosting economic development of the country. The benefits to government and the local populations include improved infrastructures and employment opportunities. The project has contributed in producing trained and experienced manpower in various skilled job related to large hydropower projects. The project is the most sensitive and important power station within National integrated power system. The efficient and effective operation of the plant should be given utmost priority by the government. In addition the construction of new power plants is urgent needs of the country. The frequent need of the overhauling of hydro-mechanical equipments and ever-decreasing dependable flows suggests the need of detail and critical studies of hydrology and sedimentology of the project sites including long term prediction due to future climate change impacts during design phase of hydropower projects in Nepal. This may greatly help in optimal sizing and minimal maintenance of the system.

(End)

The Philippines

“Northern Negros Geothermal Project”

The Philippines

Ex-Post Evaluation of Japanese ODA Loan Project
"Northern Negros Geothermal Project"

Nobuyuki Kobayashi, OPMAC Corporation

1. Project Description

Project Site


Northern Negros Geothermal Power Plant

1.1 Background

The Philippines has a very limited source of fossil fuel and has depended on imported energy for its energy. In the early 1990s when this project was formed, imported oil accounted for approximately 70% of total energy consumption. Less dependency on imported energy has been a priority in energy sector strategy since the 1970s. Geothermal, as a promising source of domestic energy, has been developed in the Philippines, where volcanoes are abundant. In 1995, geothermal power plants accounted for approximately 10% of the installed generation capacity of the Philippines. The executing agency of this project, the Philippine National Oil Company – Energy Development Corporation (PNOC-EDC)[1] had been engaged in the development of geothermal energy for a long period.

Negros Island, where the project is located, is a part of the Visayas grid where electricity demand showed a massive growth from the mid-80s. In 1996, the time when appraisal for this project was conducted, demand in the Visayas grid was expected to expand in the future and, therefore, the development of electrical power was urgently required to meet this growing demand. The project site is in the northern region of Negros Island in which the Visayas grid supplies energy and is adjacent to the national park in Mt. Kanlaon. The development of geothermal energy began in the 1970s. The drilling of exploration wells in 1994 revealed a certain level of energy source.

1.2 Project Outline

The objective of this project is to utilize domestic energy source and ensure the stable electricity supply to the Visayas grid by the construction of geothermal power plant in the province of Negros Occidental, thereby contributing to the promotion of regional economy nearby the Visayas Grid.

[1] The name of the executing agency at the time of the appraisal

Approved Amount/ Disbursed Amount	14,460 million yen / 10,510million yen
Exchange of Notes Date / Loan Agreement Signing Date	March 1997 / March 1997
Terms and Conditions	Interest Rate: 2.7% (Consulting services: 2.3%) Repayment Period: 30 years (Grace Period: 10 years) Conditions for Procurement: General untied
Borrower / Executing Agency(ies)[2]	Energy Development Corporation /Same as above Guarantor: Government of the Republic of the Philippines
Final Disbursement Date	July 2006
Main Contractor (Over 1 billion yen)	Miescor Builders, Inc. (Philippines), Kanematsu Corporation (Japan)・Fuji Electric Systems Co., Ltd.(Japan) (JV)
Main Consultant (Over 100 million yen)	Institute of Geological & Nuclear Sciences Limited (NZ)・PB Power (NZ) Ltd・Sigma Energy Technology, Inc.(Philippines)・Kyushu Electric Power Co. Inc. (Japan)・West Japan Engineering Consultants Inc. (Japan) (JV)
Feasibility Studies, etc.	The Government of the Philippines, Feasibility Study (1993) JICA "Special Assistance for Project Formation for Northern Negros Geothermal Project" (1995)
Related Projects	None

2. Outline of the Evaluation Study

2.1 External Evaluator

Nobuyuki Kobayashi, OPMAC Corporation

2.2 Duration of Evaluation Study

Duration of the Study: February 2010 – November 2010

Duration of the Field Study: May 25, 2010 – June 7, 2010, August 22, 2010 – August 28, 2010

2.3 Constraints during the Evaluation Study

The executing agency of this project was privatized and listed on the Philippine Stock Exchange. For this reason, the duty of confidentiality was taken into account when this evaluation report referred to evaluation information. Assessing the estimate of geothermal resources and the adequacy of the feasibility study required technical knowledge. Although the evaluation is based mainly on the information obtained from the executing agency, there are some points which do not allow clear judgment.

[2] The name of the executing agency at the time of the ex-post evaluation

3. Results of the Evaluation (Overall Rating: D)

3.1 Relevance (Rating: a)

3.1.1 Relevance with the Development Plan of the Philippines

The national development strategy at the time of the appraisal was the Medium-Term Philippine Development Plan 1993-1998. The strategy aimed at not only the promotion of domestic energy but also the diversification of electric sources for a stable supply of electricity at a reasonable cost. The development of geothermal power was on the focus for the diversification of electric sources.

Less dependence on imported energy and the further utilization of domestic energy sources has been a policy in the energy strategy since the 1970s. The Philippine Energy Plan 1992-2000, the energy sector strategy at the time of the appraisal, regarded geothermal power generation as a promising source of domestic energy. In order to ensure a stable and sufficient supply of electricity at a reasonable cost, the expansion of the generation capacity for the effective use of domestic energy sources was stressed.

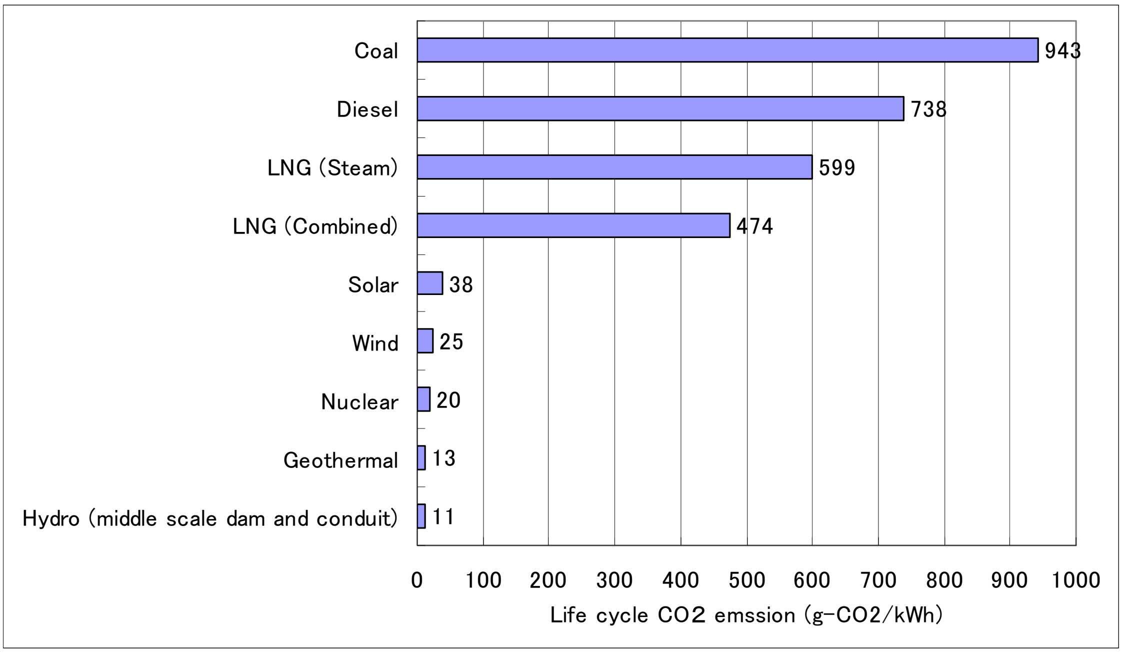
The national development strategy at the time of the ex-post evaluation was the Medium-Term Philippine Development Plan 2004-2010. Energy independence is the pillar of the energy strategy and emphasizes the development of domestic energy. In addition, the plan advocates a wider development of renewable energy such as geothermal, wind, solar, hydro and biomass as well as exploration for oil and natural gas in the Philippines with the objective of fully utilizing domestic energy. In order to fully take advantage of renewable energy, the Renewable Energy Act of 2008 sets out incentives such as reductions in income tax and the import duty on equipment.

As for the Philippine Energy Plan 2007-2014 sector policy, the share of domestic energy over total energy consumption remains at a similar level. While the total energy supply in 2006 was 38.7 million tones of oil equivalent (MTOE), this is expected to rise to 54.5 MTOE (a 41% growth from 2006). The plan forecasts that domestic energy (the total of domestic oil, domestic natural gas, biogas, hydro, geothermal, etc.) will account for 57% of the total supply of energy while geothermal will account for 20% in 2014.

The implementation of this project corresponded to national and sector policies at both the time of the appraisal and that of the ex-post evaluation. The use of domestic energy had been pursued from the time of the appraisal to the ex-post evaluation. The ongoing national development strategy focuses more on the development of renewable energy. As the wider use of renewable energy is advocated, geothermal energy continues to be developed. A law to promote the utilization of domestic energy has been enacted. The sector strategy at the time of the ex-post evaluation spelled out the policy of maintaining the share of domestic energy under a massive growth of energy consumption. Geothermal energy has the biggest share among domestic energy sources and its development is expected to continue.

3.1.2 Relevance with the Development Needs of the Philippines

The Visayas grid, which this project is connected to, recorded the highest demand growth in the country for the decade until 1995. The development of electrical power was an urgent task as demand for electricity was expected to grow at 12% p.a in the decade from 1995 to 2005 at the time of the appraisal. At the time of the ex-post evaluation, the Transmission Development Plan 2009, the strategy set by NGCP, forecasted a maximum demand growth of approximately 40 % (5% p.a.) from 2009 to 2018. This is expected to reach dependable capacity in 2010. Tight supply and demand is likely to continue for next several years. Given the tightness of supply and demand, it can be seen that the development of electrical power in the Visayas grid is appropriate and is consistent with the development needs of the Philippines.



Source: Central Research Institute of electric power industry "Evaluation of Life Cycle CO2 Emissions of Power Generation Technologies" (July 2010)

Figure 1: Life cycle CO_2 emission by power source

After adopting the Kyoto protocol in 1997, the international community has accelerated efforts to reduce greenhouse gases including carbon dioxide (CO_2.). The Philippines ratified the Kyoto protocol in 2003. In terms of CO_2 emission, geothermal power is a desirable source of electricity. According to the past data in Japan, the CO_2 emission from geothermal power is smaller than that from fire power, and moreover, is smaller than that from other renewable energy sources. The life cycle CO_2 emission[3] per kWh from geothermal power is second only to hydro power (see Figure 1). The development of geothermal power is highly necessary to achieve both the satisfaction of the growing electricity demand in the Philippines and the control of greenhouse gas emissions simultaneously.

3.1.3 Relevance with Japan's ODA Policy

Japan's Official Development Assistance (ODA) Charter, the preceding charter approved in 1992, referred to the close relationship between Japan and East Asia, including ASEAN, and placed a special emphasis on assistance to the Asian region. The charter prioritized assistance in infrastructure development. Moreover, in the ODA Annual Report for FY 1997, the country assistance strategy for the Philippines regarded the establishment of economic infrastructure as a priority and set out a policy to support the development of the economic infrastructure mainly in the energy sector.

At the time of the appraisal, Japan's ODA Charter placed importance on both assistance to Asian countries and on infrastructure development. Furthermore, the country assistance strategy emphasized assistance specifically in the energy sector. The project has been consistent with Japan's ODA Policy as this project assists infrastructure development in the power sector in the Asian region.

[3] The life cycle CO_2 emission includes not only the CO_2 emission from the operation of a power plant but also the CO_2 emission from other relevant activities such as the construction and disposal of a power plant and the exploration and transport of fuel.

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

3.2 Efficiency (Rating: b)

3.2.1 Project Outputs

This project financed (1) the drilling of geothermal wells, (2) fluid collection and disposal systems (FCDS), (3) the construction of a geothermal power plant, and (4) consulting services. In the implementation of the project, construction works and procurements were adjusted (see Table 1). At the time of the appraisal, the National Power Corporation (NPC) was expected to construct transmission lines. However, an electricity purchase agreement was not made and, thus, construction period and specific sections of transmission lines were not determined. As a result of the government decision in 2001 on the partition and privatization of NPC, the executing agency changed the buyer from NPC to the wholesale electricity market and electric cooperatives and also constructed transmission lines.

Table 1: Major changes in outputs and the reasons

Changes	Reasons
A decrease in the drilling of geothermal wells (planned: 21 wells, actual: 18 wells)	In order to cope with drilling problems and the decline in well output, the executing agency increased the number of production wells (planned: 14 wells, actual: 15 wells). In addition, the number of reinjection wells was reduced as the drilling of production wells enabled an accurate estimation of brine reinjection (planned: 7 wells, actual: 3 wells). While the total number of geothermal wells was planned at 21 wells, the actual number was 18 wells.
An increase in the installed capacity of the power plant (planned: 40MW, actual: 49.37MW)	The installed capacity was assumed to be 40MW at the time of the appraisal. Although a bidder proposed a larger capacity (54MW), the capacity was adjusted to the appropriate level (49.37MW) in consideration of the forecasted amount of brine and steam. The change in the installed capacity required negotiations on project cost. However, as neither party could agree, a retender was carried out.
Construction works for the geothermal power plant (planned: with a gas abatement system, actual: without a gas abatement system)	The ambient air model showed that hydrogen sulfide was within the environmental standard set by the Philippine government both outside the power station and the buffer zone[4], assuming a installed capacity of 49.37MW.[5] As it was concluded the power plant was harmless to residents nearby, a gas abatement system was not installed.
Scope change in consulting services	The evaluation of environmental management and environmental monitoring was added to the consulting services. This scope change was made in order to assess the appropriateness of environmental safeguards from an expert viewpoint.

Source: Project Completion Report on Northern Negros Geothermal Project

[4] The buffer zone was established in the area surrounding the geothermal power plant in light of effects on the natural environment from the power plant.

[5] In Japan, the Offensive Odor Control Law set concentration limit at 0.02-02ppm, the similar level of the Philippine environmental standard (0.07ppm).

3.2.2 Project Inputs

3.2.2.1 Project Period

The project period was significantly longer than planned (353% of the original plan) (see Table 2). At the time of the appraisal, both the development of geothermal wells and the construction of a power plant with sizable capacity were planned to be carried out almost simultaneously in order to shorten the project period and close a supply demand gap of electricity of this region in a short period. The delay was caused mainly by (1) unclear prospects in the electricity purchase agreement due to the Asian financial crisis, (2) retendering of the construction of a power plant (see "3.2.1 Outputs"). Since the Asian financial crisis caused the Philippines government to reduce the fiscal deficit, NPC became cautious about a new electricity purchase agreement. For this reason, EDC temporarily suspended the implementation of new projects, including this one, and this resulted in the delay in consultant selection.

Table 2: Details of the project implementation

	Plan	**Actual**
Signing of the loan agreement	March 1997	March 1997
Selection of consultants	December 1996 – June 1997	February 2000 – December 2000
Bidding and award of main contracts	June 1997 – January 1998	November 2001 – April 2006
Steam field development	April 1997 – July 1999	November 2000 – September 2006
Construction and commissioning of power plant	January 1998 – December 1999	March 2005 – February 2007
Construction of transmission lines	July 1997 – September 1998	March 2003 – June 2006
Consulting services	June 1997 – December 1999	January 2001 – April 2007
Project completion[6]	December 1999 (34 months)	February 2007 (120 months)

Source: EDC

3.2.2.2 Project Cost

The project cost was lower than planned. The planned project cost (after adjustment) was JPY 18,298 million, reflecting the reduction in the number of geothermal wells and the cancellation of the gas abatement system. The actual project cost was JPY 16,578 million (91% of the original). The depreciation of the Philippine Peso against the Japanese Yen, caused by the Asian financial crisis, resulted in the project cost being in Japanese Yen.

Although the project period was significantly longer than planned, the project cost was lower than planned, therefore efficiency of the project is fair.

[6] For both "Plan" and "Actual", project completion is defined as the end of construction including commissioning.

3.3 Effectiveness (Rating: c)

3.3.1 Quantitative Effects

3.3.1.1 Results from Operation and Effect Indicators

(1) Steam amount, Maximum output, and Net electricity energy production

Immediately after the commencement of plant operation, the amount of steam was approximately two thirds of the amount forecasted by the executing agency. Due to the adhesion of calcite and the waning of steam from production wells, the amount of steam started declining in the last half of 2007. Operation was halted temporarily from May 2008 to May 2009 because of rehabilitation works. The amount of steam recovered after the rehabilitation works but in April 2010 it had not reached the forecasted amount.

In tandem with the decrease in the amount of steam, the maximum output of the power plant and net electric energy production also declined. The maximum output was half of the installed capacity immediately after the commencement of plant operation. After the rehabilitation works, the maximum output slightly recovered and had stayed at a fifth of the projected figure (85% of the installed capacity) in April 2010. Net electric energy production followed a similar pattern and, at the time of the ex-post evaluation, had stayed at a fifth of the amount forecasted at the appraisal.

Photo 1:Production well under development

Out of eight production wells, there were three active wells, two reserve wells, and three inactive wells at the time of the ex-post evaluation. The development risk of the heat source is a fundamental issue in a geothermal power plant. It can be assumed that this project made efforts to reduce the risk with the feasibility study and the Special Assistance for Project Formation study. In geothermal development for a geothermal power plant, assessment before plant operation is not very precise in general[7]. Even with a sufficient source of heat, the inappropriate location of a production well occasionally results in insufficient steam. Thus, geothermal development involves the risk that the amount of steam is smaller than its estimate. As for the geothermal development for this project, the development area was adjacent to a protected area in the national park. This constricted the location of drilling points. In addition, silica adhesion in the pipes did not allow a simultaneous discharging test at multiple wells. This prevented the accurate assessment of the geothermal resource.

In order to conduct drilling in a location closer to the heat source, the executing agency is developing additional production wells in the buffer zone adjacent to the power plant by using its own budget. One production well was completed in March 2010 and the discharging test of the well was held until the end of June 2010. External experts hired by EDC having reviewed the estimate of the geothermal resource using the results of the discharging test, the executing agency will decide on the further development in the buffer zone by the end of 2010.

(2) Operational hours and unplanned outages

The operation of the power plant was halted from May 2008 to May 2009 because of the rehabilitation works for the geothermal wells. The availability factor[8] decreased in 2008 and

---

[7] The status of underground resources cannot be assessed directly. As information on geothermal resource starts to increase after plant operation, the accuracy of resource assessment improves.

[8] Total operational hours / Total hours

2009 (see Table 3). Since June 2009, monthly operational hours of the FCDS and the power plant were above 90% of the planned total hours. Unplanned outages were frequently caused by machine troubles (see Table 4). These were mainly due to trouble in the main stop valve of the steam pipe (see "3.5.4 Current Status of Operation and Maintenance").

Table 3: Operational hours and Availability factor

	2007	2008	2009
Total hours	8,760	8,784	8,520
Total operational hours	7,422	3,709	5,343
Availability factor (%)	84.7%	42.2%	62.7%

Source: EDC

Table 4: Unplanned outages (frequency and hours)

	2007	2008	2009
Unplanned outages (frequency)	3	0	3
Machine troubles (frequency)	3	0	2
Human errors (frequency)	0	0	1
Unplanned outages (hours)	70.59	0.00	89.48
Machine troubles (hours)	70.59	0.00	77.00
Human errors (hours)	0.00	0.00	12.48

Source: EDC

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

The Financial Internal Rate of Return (FIRR) for this project is below the forecast at the time of the appraisal (7.0%). The assumptions of the FIRR are as follows:

Table 5: Assumptions for the FIRR

Item	At Appraisal	At Ex-post Evaluation
Costs	Investment costs, operation and maintenance costs, income tax (based on the assumption at the appraisal: 26% until 15 years after project completion and 35% after 16 years and from thereon), steam costs	Investment costs (including the additional costs for new development), operation and maintenance costs (based on the amount provided by EDC), income tax (10%), contribution to the community fund (0.01 peso/kWh)
Benefits	Electricity sales, Steam sales (it was itemized to estimate government share. This revenue was offset by steam costs)	Electricity sales (actual sales for 2007 – 2009, the estimated amount based on 2010 actual data for 2010 – 2012, and the estimated amount by EDC for 2013 and after; data provided by EDC for the electricity tariff)
Project life	25 years after the project completion (1999 – 2023)	25 years after the project completion (2007 – 2031)

Source: appraisal documents, EDC

The FIRR is lower than the estimate at the appraisal. This is mainly due to (1) electricity sales being smaller than forecast at the appraisal and (2) additional investment costs for new production wells.

3.3.2 Qualitative Effects

(1) Interview with beneficiaries

In this ex-post evaluation, managers and employees of private companies in Bacolod City and those of the National Grid Corporation of the Philippines (NGCP) were interviewed on the frequency of blackouts and the stability of voltage.

The interviews with the staff of the private companies revealed that rotating blackouts had continued for almost one year and especially during the summer months when demand increased. Before the development of the buffer zone, the executing agency agreed to give priority to the province of Negros Occidental in the sale of electricity from the project. At the time of the ex-post evaluation, the power plant did not generate sufficient energy and had little room for additional supply. The electric cooperative whose supply area covers Bacolod City was expected to purchase energy from other firms after 2011 and, thus, could not enter into an electricity purchase agreement with the executing agency.

Large users in Bacolod City had backup generators. However, they strongly demanded a stable supply of electricity as the electricity costs of the backup generators were twice those of the usual electricity tariff. According to the user, in addition, switching to backup generators required the rearrangement of production lines, a process that is time-consuming. Meanwhile, NGCP staff suggested that the power plant contributed to the stability of voltage at the time of peak demand.

The lack of sufficient power generation from the Northern Negros Geothermal Power Station was not a sole reason for the unstable power supply in Bacolod City. It should be noted that the demand increased and, further to that, the electric cooperative was reluctant to enter into a new electricity purchase agreement because of an existing agreement with another firm. While the power plant played a limited role as a base load power station, it contributed to the stability of voltage to a certain degree.

This project has achieved its objectives at a limited level, therefore its effectiveness is low.

3.4 Impact

3.4.1 Intended Impacts

(1) Proportion in the Visayas grid

In 2008, the Northern Negros Geothermal Power Station accounted for negligible portions of both gross power generation and electricity consumption in the Visayas grid. Therefore, it is presumed that the power station has played a limited role in the stable supply of electricity and that it has had a very marginal impact on the macro economy.

3.4.2 Other Impacts

(1) Impacts on the natural environment

The monitoring data provided by the executing agency showed that the hydrogen sulfide in ambient air is within the environmental standard (0.07ppm). Although a gas abatement system was not installed at the Northern Negros Geothermal Power Station, hydrogen sulfide levels satisfied the environmental standard set by the Department of Environment and Natural Resources (DENR). According to the executing agency, monitoring of surface water was conducted at Pattan River and Bago River. DENR set the environmental standards for heavy metal and chemical substances (hexavalent chromium, lead, cadmium, arsenic, etc.) in light of the use of river water. Pattan River corresponds to Class B (level which allows swimming) and

Bago River to Class D (level which allows irrigation)[9]. Noise was below 50dB under normal operation and there was no difficulty in daily living[10].

In addition, the executing agency regularly reported monitoring results to the third party Multi Sectoral Monitoring Team (MSMT)[11].

(2) The development of the buffer zone

At the time of the ex-post evaluation, the executing agency developed a new steam field in the buffer zone adjacent to the power plant as an additional source of heat. At the time of the appraisal, it had not been discussed whether the buffer zone would be developed. The Mt. Kanla-on Natural Park Act of 2001 (RA9154) was approved in 2001 and this act showed that the development of the buffer zone was permitted.

Before the development of the buffer zone, the executing agency made an agreement with the provincial government of Negros Occidental. The major items on which the both parties agreed were (1) the priority of the electricity supply to the province of Negros Occidental, (2) reforestation, and (3) the monitoring of the development area. Reforestation was begun and aimed at 535 ha, an area larger than that agreed with the provincial government (400 ha). A local farmer's association participated in reforestation. On the monitoring of the development area, the committee of the provincial congress has conducted inspections without prior notice several times since 2008. Furthermore, the committee reviewed the design drawings of the development site and access roads and recommended design changes in order to reduce the environmental burden.

(3) Land acquisition and resettlement

In 2000, the executing agency reached an agreement with residents on the conditions of land acquisition. Land acquisition for this project required the resettlement of 42 households. While 25 households moved to a relocation site, 13 households selected cash compensation. For 4 households, only farmland was acquired. Replacement land was allocated to these households. Following the agreement on resettlement, the executing agency allocated 200 m^2 of land and 25m^2 of a house to each relocated household. According to the executing agency, land ownership and cultivation rights were unclear as land registration was incomplete at the project site. For this reason, households whose farmland was acquired were allocated 1 ha if they had a Certificate of Land Ownership Award (CLOA) and 0.5ha if they did not have a CLOA. The executing agency issued certificates of land ownership to relocated households. The procedures for land transfer require the satisfaction of residency for 5 years and, following this, the completion of land registration. At the time of the ex-post evaluation, the transfer of allocated land was incomplete due to a delay in legal procedures at the land registration office, though the executing agency took the necessary actions.[12] The executing agency took on all costs related to land registration.

Photo 2: Relocation site

[9] According to power station staff, DENR officially classified Pattan River and Bago River. The Regional Office of DENR monitored Pattan River as Class B and Bago River as Class D.

[10] 50dB corresponds to "quiet office." (Architectural Institute of Japan "Sound Insulation Standards of Building and Design Guidance")

[11] MSMT members include the staff of environmental departments of municipalities, DENR staff, and NGO staff.

[12] The executing agency expected that land registration would be completed by the end of 2010.

Interviews with resettled residents (three households) revealed that there were several households whose cultivation areas were reduced after relocation and that the improvement of transportation had led them to switch to more profitable commercial crops as well as leading to an increase in employment opportunities. The executing agency provides income enhancement programs to the farmers' associations in the area neighboring the power plant (32 associations) including to the relocated households. Via the income enhancement programs, there is a small contracting program (contracting of cleaning, etc,) and support for vegetable farming and native chicken feeding. The executing agency monitored the livelihood of the relocated households from the pre-resettlement period to the time of the ex-post evaluation. The results show that the average income of the relocated households improved after resettlement (see Table 6). The reasons for an increase in income included switching to more profitable crops, an increase in employment opportunities, additional income from the small contracting programs, and business activities started with crop damage compensation at the time of resettlement. At the time of resettlement, the executing agency set a target for the average value of household assets at 429, 112 pesos. In 2009, the average value of household assets for the relocated households reached 495,920 pesos and surpassed the target.

Table 6: Household Income

Unit: peso

	2000	2006	% change
Resettled households (Average)	43,501.53	145,915.52	+235.4%
Western Visayas (Average)	109,600	129,905	＋18.5%

Source: EDC, NSCB "2009 Philippine Statistical Year Book"

The executing agency developed and maintained the road to the power station and the road was used as a community road by residents. In addition, the executing agency repaired and refurbished a health center in the neighboring community and provided medicine for the center.

Philippine law allows land acquisition by a project to contribute to public welfare with the deposit of compensation in accordance with legal procedures if a land owner does not agree with the sale of land. This project acquired land in several places for the construction of transmission lines by following the above procedure. At the time of the ex-post evaluation, there were approximately 20 cases where compensation to land owners had not been settled. As the land owners did not agree with the sales price, the executing agency was waiting for court decisions but was ready to pay compensation in accordance with Philippine law.

(4) Brine spill accident

In February 2009, a malfunction in the pump of the production well in the PT-B field[13] caused a brine spill accident for 4 hours. The incident was reported to the DENR and an independent investigation was requested by EDC. MSMT conducted an environmental assessment and reported the assessment results to DENR and other offices in April 2009. The assessment revealed that the executing agency did not violate the relevant environmental regulations and confirmed that there was no residual negative effect on farm soils. The case was cleared by the DENR on April 17, 2009. Despite the closure of the case, EDC assisted the farmers to regain the original harvest of the farmers. According to MSMT, some residents claimed skin allergies but there was the lack of clear proof of causality between the symptoms and the accident based on the hospital records in the affected area. According to the executing agency, the accident was connected with the rehabilitation works of the production wells where the fluid collection and recycling system and wells were on shutdown, thus, it would not happen again under normal operation. A warning device and perimeter canals to trap brine were

[13] This project developed geothermal resource at three locations, PT-A, PT-B, and PT-C.

installed for the reduction of any future damage.

The contribution to the stable supply of electricity and the regional economy is considered to have been limited. On the other hand, no severe negative impacts have been found as the executing agency has made efforts to reduce the burden on the natural and social environments. The monitoring activities for ambient air, water, the development of the buffer zone, and for the livelihood of the relocated households are carried out appropriately and routinely.

3.5 Sustainability (Rating: b)

3.5.1 Structural Aspects of Operation and Maintenance

At the time of the appraisal, the state-owned company, the Philippine National Oil Company (PNOC) owned the executing agency. At the time of the ex-post evaluation, PNOC sold all equities and the executing agency became a subsidiary of the private corporation Red Vulcan Holdings. The executing agency is listed on the Philippine Stock Exchange.

The operation and maintenance (O&M) of the facilities constructed by this project is separated into two sections. One is for the O&M units of the geothermal wells and the administration department and the other for the O&M of the power plant. The executing agency separately manages the two sections for clarity of responsibility as the operation of the geothermal wells and that of the power plant have different natures. The responsibility for O&M of the facilities constructed by this project is clearly defined.

3.5.2 Technical Aspects of Operation and Maintenance

The contractor and the consultant (Fuji Electric Systems and West Japan Engineering Consultants) provided training for the power plant to the executing agency. The executing agency had sufficient experience in the operation and maintenance (O&M) of geothermal wells as it had operated geothermal wells since the 1970s. At the time of the ex-post evaluation, the staff engaged in the O&M of the geothermal wells and the power plant were required to have 40 hours training per year. The training is intended to brush up basic knowledge of O&M. According to the executing agency, employees had skills adequate for daily operation but there was no expert to supervise the overhaul of the power plant. The executing agency requested the contractors to send an engineer when necessary.

The number of employees who work at the project site is approximately 170 persons. Out of these, the number of staff directly engaged in the O&M of the geothermal wells and the power plant is shown below. In light of its past experience, continuing training and the adequate number of staff, it is concluded that the executing agency has the appropriate technological capabilities for daily O&M.

Table 7: The number of staff engaged in O&M

Responsibilities	Number of staff	Engineers
FCRS operations	26	12
FCRS maintenance	14	4
Steam field technical services	17	3
Power plant	40	30

Source: EDC

3.5.3 Financial Aspects of Operation and Maintenance

Since the executing agency is a listed company, it discloses financial statements based on accounting standards in the Philippines. ROA[14] was 4% in 2009, which can be considered an appropriate profitability for an electric utility (see Table 8). Profitability, both ROA and ROE[15], declined in 2008 due to foreign exchange loss. Both the current ratio[16] and the total debt equity ratio[17] worsened from 2007 to 2009 but the levels of these ratios do not suggest that the financial stability of EDC is in peril.

Table 8: Financial Indicators for EDC*

	2007	2008	2009
ROA	12.2%	1.9%	4.0%
ROE	25.4%	4.7%	11.1%
Current Ratio	1.33	0.87	0.88
Total Debt Equity Ratio	1.08	1.41	1.79

Note: * based on the annual reports of EDC for 2008 and 2009

At the time of the ex-post evaluation, electricity sales from the Northern Negros Geothermal Power Plant did not adequately cover the O&M costs of the plant because of insufficient power generation. Therefore, the visibility of financial sustainability is not clear. The executing agency anticipates that the ongoing development of geothermal wells will result in an increase in the electric sales sufficient for the O&M.

3.5.4 Current Status of Operation and Maintenance

The power plant is expected to have minor maintenance (inspection, lubrication, etc.) biennially and major maintenance (inspection and, if necessary, the replacement of critical parts such as a turbine) every four years. The latest biennial maintenance was held during the rehabilitation works. There were malfunctions in the main stop valve of the steam pipe after project completion. As this problem occurred within the warranty period, the contractor sent a specialist to the power plant and replaced the parts which had caused the malfunctions.

No serious injury which had affected the operation of the geothermal wells and the power plant was found during the site survey. The corrosion caused by hydrogen sulfide was marginal. There was no serious damage disrupting the project effects.

Some problems have been observed in terms of finance; therefore sustainability of the project is fair.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

The project was consistent with the development policy of the Philippines, with its development needs and with Japan's ODA Policy as it supported the Philippine government in the development of domestic energy source. Thus, the project is considered to have relevancy. Meanwhile, the project period was prolonged due to the Asian financial crisis and retender for the power plant. The overall evaluation result of this project is attributable to effectiveness,

[14] Net profit / Total Assets
[15] Net Profit / Total Equity
[16] Current Assets / Current Liability
[17] Total Liabilities / Total Equity

evaluated to be low. At the time of the ex-post evaluation, power generation was below plan because of the insufficient amount of steam. However, the executing agency has taken the necessary steps to augment steam including additional investment and, at the time of ex-post evaluation, has also engaged third party to assess the project. This result needs to be reviewed with the recovery of steam amount in the future. Safeguards on the natural and social environments were carried out appropriately in accordance with the law. The executing agency managed its social and environmental safeguards effectively and properly, through which it was able to minimize conflicts with the stakeholders. The power plant alone does not generate enough revenue but the executing agency is financially stable. There was no issue disrupting the sustainability of project effects in either the structural or the technical aspects or in the current status of the facility. The project is considered helpful by the transmission company as it helps stabilize the voltage of the grid.

In light of the above, this project is evaluated to be (D)unsatisfactory.

4.2 Recommendations

4.2.1 Recommendations for the Executing Agency

It is desirable that EDC continuously pursues efforts to recover power generation in consideration of the results of the discharging test.

4.2.2 Recommendations for JICA

It is desirable that JICA continuously monitors EDC's efforts to recover power generation.

4.3 Lessons Learned

In the Philippines, where geothermal resources abundantly exist, geothermal power is a promising renewable energy source. In addition, geothermal power is more desirable than other power sources in terms of CO_2 emission. The effectiveness of the project was low. However, this result needs to be reviewed with the recovery of steam amount in future and does not mean that the relevancy of geothermal power generation in the Philippines is undermined. The development risk, as a unique risk of geothermal power generation, severely affects project effectiveness. This risk became an issue for this project also. For this Project, the executing agency conducted a feasibility study. The development risk was tried to be reduced by conducting the Special Assistance for Project Formation study but it could not be completely avoided. The tightness in the electricity demand and supply and additional cost needs to be taken into consideration. Nevertheless, it is desirable that measures to reduce development risk are examined at appraisal.

End

Comparison of the Original and Actual Scope of the Project

Item	Original	Actual
1. Project Outputs	(1) Drilling of wells (14 production wells and 7 reinjection wells) (2) Procurement and construction of FCDS (3) Construction of geothermal power plant (20 MW×2 units) including transmission lines (4) Consulting servivces (geothermal fesibility study, D/D, procument support, construction supervision)	(1) Drilling of wells (15 production wells and 3 reinjection wells) (2) As planned (3) Construction of geothermal power plant (49.37 MW×1 unit) including transmission lines (4) Consulting servivces (geothermal fesibility study, D/D, procument support, construction supervision, evaluation of environmental monitoring)
2 Project Period	March 1997 – December 1999 (34 months)	March 1997 – February 2007 (120 months)
3.Project Cost		
Amount paid in Foreign currency	12,196 million yen	10,427 million yen
Amount paid in Local currency	7,084 million yen	6,151 million yen
	(1,771 million Ph. Peso)	(2,412 million Ph. Peso)
Total	19,280 million yen	16,578 million yen
Japanese ODA loan portion	14,460 million yen	10, 510 million yen
Exchange rate	1 Ph. Peso = 4.00 yen (As of May 1996)	1 Ph. Peso = 2.55 yen (As of 2005)

Third Party Opinion on Northern Negros Geothermal Project

Prof. Fernando Y. Roxas, Asian Institute of Management

Relevance

The Northern Negros Geothermal Project (NNGP) ranks very high on the relevance benchmark because it directly addresses many issues relevant during the time of project inception and are still relevant today. The Cebu-Negros-Panay sub-grid has always had the highest electricity demand growth rate in the country. Because of scale, majority of the additional capacities are envisioned to be coal-fired plants. Geothermal plants are a valuable, environmentally benign resource which helps the economy grow its generation portfolio but mitigate the increase in green house gasses from fossil fuels. But unlike other Renewable Energy technology like wind or solar, geothermal plants contribute non-intermittent power which does not require more ancillary services for grid stability. Moreover, the NNGP provides valuable voltage support that improves the quality of service even in Panay Island.

Efficiency

The development of the NNGP did not result into cost over-runs for PNOC EDC. However, there was a long delay in completion time as the off-taker, NPC deferred taking on additional liabilities in the wake of the suppressed demand after the Asian Financial Crisis. However, these delays were caused by externalities that no one could have foreseen.

Effectiveness/Impact

On these measures, the NNGP does not achieve commendable results primarily because the project did not even come close to the capacity or the energy that was designed for. The main reason for the shortfall is the discrepancy between the amount of steam forecasted and actually delivered at well head. Thus, the output today in terms of both MWs and energy is only a fifth of installed capacity and expected generation. Moreover, the plant was closed from May 2008 to May 2009 due to problems at the production wells.

Sustainability

Because of low production levels, NNGP could not even cover its own running costs.

Since the continued operation of the plant will required the drilling of new production wells, which cannot be funded by NNGP’s earnings, the project cannot be deemed sustainable as a stand-alone enterprise.

Lessons learned

From an economic and technological standpoint, it would seem more prudent in the future to quickly install small capacities early and learn more about the nature of the brine and the dynamics of the reservoir before committing to larger plants. Early revenues minimize the capex for succeeding units. Likewise, the larger units will be designed with better data and information.

(End)