

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.

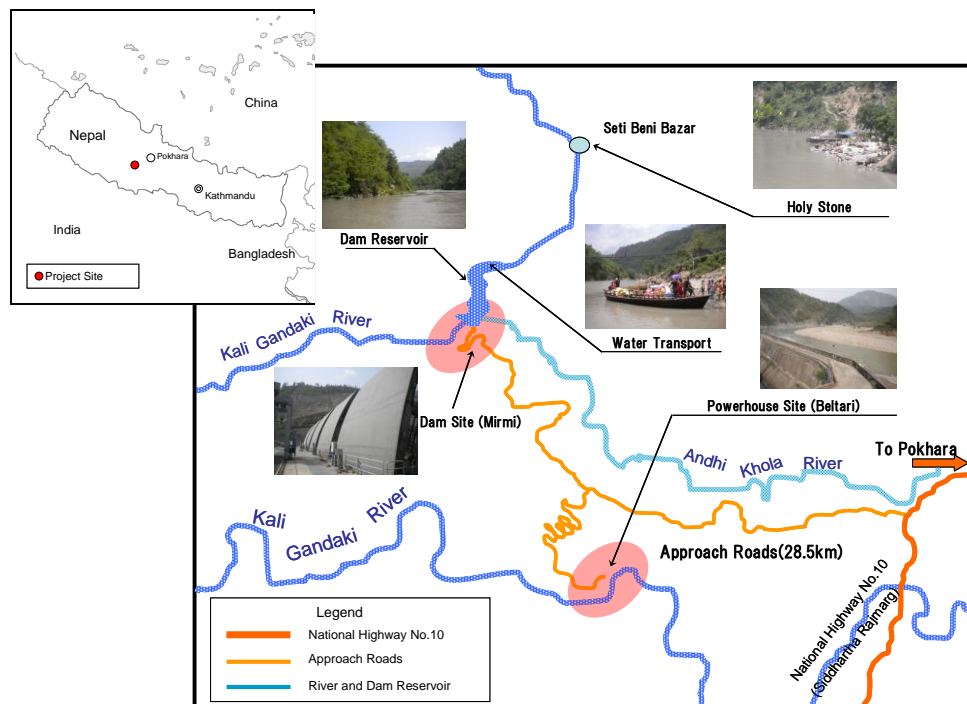


Figure 1: Location of the Project Site

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 services², 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 policies³.

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 needs⁴, 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 2002⁵, the gap of supply and demand as of present may have been larger⁶.

Table 1: Power Supply and Demand in Nepal

Fiscal Year of Nepal ³⁾	Installed Capacity	Peak Demand		Demand- Supply Gaps
		(Parentheses show % increase from the previous year)		
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

Unit: MW

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 2009⁷. 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 recipient⁹.

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 JICA¹⁰) 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 changed¹¹.

- ✓ 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 Plant¹² 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 inflow 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 designing¹³”.

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 2002¹⁴, 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 2007¹⁶. 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 Plant¹⁷. 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 replaced¹⁸. 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 season¹⁹ 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 limited²⁰.

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 company²¹) 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 1,418	96 3,102	77 1,210	74 1,794	78 2,765	63 1,636	116 2,606	188 3,227	212 9,811	150 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 location²².

- ✓ 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 Bazar²⁴.
- ✓ Contributed to development of new businesses²⁵ and creation of employment in Beltari Area and Mirmi Area²⁶.
- ✓ 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" aspect²⁷.

3.4.2.2 Impact on Natural Environment

(1) Implementation status of Environmental Impact Assessments (EIA) and Environmental Monitoring²⁸

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 contractors²⁹.

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 plant³⁰.
- ✓ 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-stream³¹.

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 conditions³².

3.4.2.3 Implementation Status of Resettlement and Land Acquisition³³

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 compensation³⁵.

3.5 Sustainability (Rating: a)

3.5.1 Structural Aspect of Operation and Maintenance

NEA³⁶ 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 Group³⁷ 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 training³⁸. 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 trainees³⁹.

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 electricity bills, and 3) the electricity tariff remaining at the same level for 9 years since 2001⁴⁰.

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
<i>of which, power generation-related</i>	642	811	856	980	1,122
<i>of which, power purchase-related¹⁾</i>	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
<i>Personnel Expenses</i>	23	28	27	30	40
<i>Fuel Expenses</i>	15	40	32	27	19
<i>Maintenance Expenses</i>	37	75	121	121	43
<i>Vehicle Expenses</i>	5	7	6	7	8
<i>Administration Expenses, etc.</i>	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 limited⁴³. 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 view⁴⁴, 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
<p>A) Output 【JICA Portion】 1. Civil Works Construction of headrace tunnel (Lot-C2)</p> <p>2. Hydraulic Steel Work (Lot-4) • Installation of gates • Others</p> <p>3. Electrical Equipment (Lot-5) • Installation of generators • Others</p> <p>4. Mechanical Equipment (Lot-6) • Installation of water turbines • Others</p> <p>5. Transmission Line (Lot-7) • Construction of two transmission lines (132kV)</p> <p>【ADB Portion】 1. Civil Works • Construction of water intake dam (Lot-C1) • Construction of desanding basin (Lot-C1) • Construction of powerhouse (Lot-C3)</p> <p>2. Consulting Service</p> <p>3. Environmental Mitigation Measures</p>	<p>Length: 5,925m, Diameter: 7.40m, Slope: 0.35%</p> <p>3 effluent gates and 6 water intake gates Steel lining of penstock and pressure shaft Installation of stop log gates, etc.</p> <p>3 generators (48MW x 3) Installation of electrical equipment such as switch gears, etc.</p> <p>Vertical Francis-type turbines: 3 sets Installation of governor and other mechanical equipment</p> <p>58 km from powerhouses to Pokhara, 48 km from powerhouse to Butwal</p> <p>Concrete gravity dam (Height: 43m, Length of crest: 98m, Gross reservoir capacity: 7.7 million. m³) Open-air type</p> <p>Dimension: 24m x 40m x 100m</p> <p>567.2M/M (Foreign: 523.5M/M, Local: 43.7M/M)</p> <p>Environmental monitoring activities Aquaculture of migratory fish</p>	<p>Length: 5,905m, Diameter: 7.40m, Slope: 0.35%</p> <p>As planned As planned Mostly as planned</p> <p>As planned As planned</p> <p>As planned As planned (Additional component: O&M training programs for NEA staff, Repaired works, etc.)</p> <p>66 km to Pokhara, 40 km to Butwal</p> <p>Height: 43m, Length of crest: 105m, Gross reservoir capacity: 7.7 million. m³ As planned</p> <p>21m x 43m x 91m</p> <p>Foreign: 735M/M, Local: not known</p> <p>As planned As planned Implementation of social impact mitigation measures</p>
B) Project Period	October 1996 – 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

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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)