Laos

Ex-Post Evaluation of Japanese Grant Aid Project
"The Project for Nam Ngum I Hydropower Station Rehabilitation in the Lao People's Democratic Republic"

External Evaluators: Hisami Nakamura, OPMAC Corporation

1. Project Description

Project Location

Water Turbine Generator (Unit No. 1)

1.1 Background

The Nam Ngum I Hydropower Station (hereinafter refereed to as "Nam Ngum I HPP") is located approximately 90km north of Vientiane, the capital of Laos, and 140km upstream from the watershed of the Nam Ngum River and the Mekong. Its construction was undertaken in three stages, beginning with the first stage in 1966 supported by financial assistance from various donors, including Japan. It was formerly the largest hydropower station operated by Electricite du Laos (EDL) and has a total installed capacity of 150MW. The Nam Nguam I HPP supplies electricity to the Central-1 Region, including Vientiane Municipality. In addition, it plays an important role in the national economy of Laos through the export of surplus electricity to Thailand which generated foreign earnings.

The facilities of Units No.1 and 2 including power generators, major transformers, switchgear and control boards, were built in 1971. However, since its start of operation, the facilities and equipment have exceeded their normal service life and no major rehabilitation work has been carried out on them. The potential for serious accidents or stoppages has been a continuous cause of concern for the operator. In December 1999, a 115kV circuit breaker experienced problems due to aging, leading to a complete shutdown of the power station.

Under the Nam Ngum I Hydropower Station Rehabilitation financed by Japanese grant aid (654 million JPY) in 1980, Units No. 1 and 2 were rehabilitated, involving the dismantling and re-assembling of the turbines. Eighteen years have passed since then, and it was recognized that there was an urgent need for further rehabilitation.

Furthermore, the construction of spillway gates for the Nam Ngum Hydropower Project (II), which involved the installation of two additional generators (Units No.3 and No.4), raised the water level of the reservoir. As a result, the turbine discharge and turbine output of Units No.1 and 2 decreased. It was therefore necessary to recover the turbine discharge to the original design level.

Finally, at the time that this project (hereinafter referred to as "the Project") was being planned, it was projected that domestic demand for electricity would continue to steadily increase, while there were no clear plans for alternative energy generation in the region. It was therefore deemed necessary to rehabilitate the Nam Ngum I HPP in order to ensure a stable supply of electricity.

1.2 Project Outline

The objective of the Project is to restore performance and reliability of electricity supply as well as to improve skills of technicians in charge, by rehabilitating the significantly deteriorating Unit No. 1 and Unit No. 2 of the Nam Ngum I Hydropower Station and their associated common equipment which were essential to their operation.

Grant Limit / Actual Grant Amount	1,204 million yen / 1,124 million yen
Exchange of Notes Date	May 2002
Implementing Agency	Electricite du Laos (EDL)
Project Completion Date	June, 2004
Main Contractor(s)	Hitachim Ltd (Lot1), Tsukuba Denki Co., Lod (Lot2)
Main Consultant(s)	Nippon Koei Co., Ltd
Basic Design	Basic Design Study on the Project for Nam Ngum I Hydropower Station Rehabilitation
Detailed Design	December, 2002
Related Projects (if any)	[ODA Loan Projects] "The Nam Ngum Hydropower Project" (1974) "The Nam Ngum Hydropower Project II" (1976) [Grant Aid Projects] "The Project for Repair of Nam Ngum Dam Power Station" (1980) "The Project for Repair of Nam Ngum Dam Power Station Unit No.3 and No.4" (FY 1989/90) [Cooperation after the implementation of the project] "Preparatory Survey on Nam Ngum I Hydropower Station Expansion" (FY 2009) "Assistance to Reservoir Operation for the Nam Ngum 1 Hydro Power Station" (FY 2010)

2. Outline of the Evaluation Study

2.1 External Evaluator

Hisami Nakamura, OPMAC Corporation

2.2 Duration of Evaluation Study

The study was carried out over the following periods:

Duration of Study: October, 2009 – August, 2010

Duration of Field Study: March 14– 20, 2010

2.3 Constraints during the Evaluation Study
None

3. Results of the Evaluation (Overall Rating: A)
3.1 Relevance (Rating: a)
3.1.1 Relevance with the Development Plan of Laos

(1) Consistency with National Development Plan

The 6th Congress of the Lao People's Revolutionary Party in 1996 set as its national goal that the country should graduate from Least Developed Country (LDC) status by 2020. The *Socio-Economic Development Strategy for 2020* was formulated to achieve this goal. The *Ten Year Socio-Economic Development Strategy 2001-2010* and the five-year *National Socioeconomic Development Plan (NSEDP)* were also formulated as milestones within the overall strategy.

At the time that the Basic Design Study for the Project was being conducted in 2001, one of the six key strategies in the medium term strategy was the expansion of infrastructure including hydropower stations. In the 5th NSEDP (2001-2005), a 3.7 percent annual growth rate of total installed capacity and energy production was proposed as a sectoral goal. For the 6th NSEDP (2006-2010), it was expected that 2,000MW would be added to the existing total installed capacity, resulting in a capacity of 2,700MW with energy production at 14-15 billion kWh by 2010.

In the National Growth and Poverty Eradication Strategy (NGPES), it is stated that the national electrification rate should increase to 70% by 2010 though the development of hydropower.

Given this context, the Project was highly relevant for the country's development plans and was consistent with the country's goals related to hydropower generation, as set out in the medium and long-term development strategies.

(2) Consistency with Hydropower Development Plan

In August 2004 (after the completion of the Project), the Power System Development Plan (PSDP) was formulated which indicated pipeline hydropower projects to develop new energy sources for both export and domestic consumption. The implementation of the PSDP was underway at the time of this ex-post evaluation and the potential expansion of the Nam Ngum I HPP through the construction of Unit No. 6 was also mentioned. The Nam Ngum I HPP continues to be vital for electricity development in Laos.

[Priority given to the Project]

For domestic electricity supply in Laos, service areas are divided into four regions: Northern Region, Central-1 Region, Contral-2 Region and Southern Region. There has been no change in the classification of these service areas since the Basic Design Study was conducted. The Nam Ngum I HPP provides service to Central-1 Region and Northern Region.

Central-1 Region includes the capital city and five municipalities which account for 70 percent of domestic electricity consumption. It is the area with the highest demand in the country (at the time of this ex-post evaluation). At the time when the Project was planned, the energy production level of the Nam Ngum I Power Station was 1,117GWh. This figure exceeded the electricity consumption in the area (456.61GWh) and the surplus was exported to the Electricity Generating Authority of Thailand (EGAT), contributing to foreign exchange earnings. As of 2009, the Nam Ngum I HPP supplied 70% of the total electricity production in this area,

confirming its status as one of the most important power stations[1] in Laos.

As the Basic Design Study highlighted, the shutdown of power supply in 1999 was induced by the deteriorating performance of Units No. 1 and 2. Since mitigation of such an unstable and vulnerable situation was critical, the implementation of the Project was highly prioritized

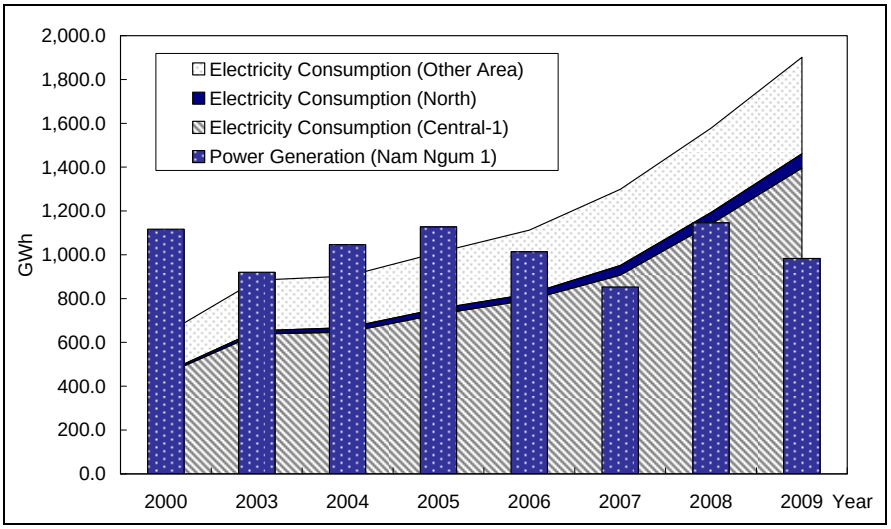
In addition, the Project was expected to increase the capacity of Units No.1 and 2 by an additional 5,000kWh (5MW) in total. Based on a cost-benefit analysis, it was found that the Project would be financially advantageous compared to the construction of an alternative power plant to generate 5,000kWh.

3.1.2 Relevance with the Development Needs of Laos

It was found that the Project is highly relevant to the development needs of Laos, as suggested in the Basic Design Study.

Electricity consumption of Central-1 Region (GWh) increased by 1.6 times from 456.61GWh in 2000 (when the Project was planned) to 729.01GWh in 2005 (when the Project was completed). Consumption in 2009 reached 1,396.05GWh, three times the level in 2000 and 1.9 times the level in 2005. Meanwhile, EDL made efforts to expand electricity networks to achieve rural electrification. As a result, electricity demand grew further, particularly in the Northern Region. It increased ninefold from 7.04GWh in 2000 to 64.67GWh in 2009 (Figure 1).

Maximum electricity demand during the peak hour (MW) reached 217.01MW in the Central-1 Region in 2006. In parallel, total installed capacity in the region expanded from 216MW in 2003 to 256MW in 2006. Of this 256MW, the Nam Ngum I HPP covered 155MW, accounting for 60% of the total installed capacity in the region. Therefore, it can be concluded that the expansion achieved by the Project met the increasing electricity demand in the region, as determined by peak load and electricity consumption.



(Source) A document provided by EDL Department of Planning (2010)

Figure 1: Electricity consumption and Amount of Power Production of the Nam Ngum I

[1] Currently, primary power stations in Laos are Nam Theun 2 Hydropower Station and the Nam Ngum I Hydropower Station.

Table 1: Electricity Demand and the total installed capacity in Central-1 and Northern Region

	2000 (Plan)	2003	2004	2005 (Completion)	2006	2007	2008	2009
Electricity Demand (Peak Time) (MW)								
Central-1	116.4	164.49	175.66	213	217.01	140.90*	155.30*	117.80*
North	-	7.01	7.06	8.27	12.78	6.7**	6.7**	6.32**
Laos	159.74	208.82	238.75	313.09	364.54	374.69	344.84	405.35
Total Installed Capacity (MW)								
Central-1	211	216	216	216	256	256	256	256
North	0	1.5	1.5	1.5	2.7	2.7	2.7	2.7
Nam Ngum 1	150	150	150	155	155	155	155	155
Laos	270.12	271.62	271.62	307.54	307.54	308.74	308.74	384.74
Maximum Output (MW)								
Nam Ngum 1	150	175.7	190.5	182.9	170.0	169.2	191.5	172.5

(Source) Documents provided by EDL Department of Planning (2010)
(Note) The data on electricity demand (peak load) in 2007-2009 is available only at province level. For the Central-1 Region, the maximum value of Vientiane Municipality (the area with the highest demand) is indicated. For the Northern Region, the value at municipality level is used.

Electricity exports (GWh) from Central-1 and Northern Regions fell from 744.51GWh in 2000 to 363.78GWh in 2008 because of the continuous rise in electricity consumption in these regions. The sales price for electricity exports has also been decreasing which has resulted in a reduction of income for the Nam Ngum I HPP. The income which had been 205.6 billion kip (approximately 1.3 billion JPY) in 2005 fell to 113.6 billion kip (approximately 2.1 billion JPY)[2] in 2008. Nevertheless, electricity is still one of the most important exports and accounts for 7% of total exports from Laos. The Nam Ngum I HPP produced electricity equivalent to 11% of the total export income in 2008, which contributed to the economy of Laos.

Table 2: Electricity Export and Domestic Sales

(Unit: GWh)

	2000	2003	2004	2005	2006	2007	2008
Electricity Consumption							
Central-1	456.61	638.09	646.91	729.01	794.76	907.56	1,140.65
North	7.04	14.91	20.55	24.87	26.01	43.49	52.32
Laos	639.85	883.73	902.76	1,011.06	1,112.40	1,298.41	1,577.86
Electricity generation							
Laos	1,578.54	1,316.84	1,416.45	1,715.05	1,639.29	1,398.37	1,777.57
Nam Ngum HPP1	1,117.00	919.85	1,046.39	1,127.28	1,013.77	852.94	1,145.77
Electricity Export	862.94	434.66	507.05	727.75	547.05	267.97	391.78
Central-1	744.51	348.30	452.79	653.79	455.22	206.75	363.78
Electricity Import	159.92	229.34	277.59	325.63	334.55	475.94	509.95

(Source) Documents provided by EDL the Nam Ngum I Hydropower Station
(Note1) The consumption level includes system losses
(Note 2) Electricity exported from Central-1 Region is a total of the Nam Ghum I, Nam Mang 3, and Nam Luek

[2] The sales price of electricity generated by the Nam Ngum I for export to Thailand is 1.6 baht/kWh at peak hour and 1.2 baht/kWh at off peak hour as of 2008. The cross exchange rate with kip is 96.67 JPY in 2005 and 84.50 JPY in 2008.

3.1.3 Relevance with Japan's ODA Policy

When the Project was being planned in 1998, Japan's ODA policy for Laos stated that careful attention should be given to the development of hydropower within the framework of infrastructure improvement, by considering various factors including potential to acquire foreign currency, increase in electricity demand in neighboring countries and potential environmental impact.

Japan provided continuous assistance to the Nam Ngum I HPP from the outset when Units No. 1 and 2 were constructed, and therefore support for the rehabilitation of obsolete facilities was a means to respond to the rapid increase in electricity demand without causing a negative environmental impact. Thus it can be concluded that the Project was consistent with Japan's ODA policy for Laos at the time of the Basic Design Study.

The Project has been highly relevant to the country's development plan and development needs, and as well as Japan's ODA policy, therefore its relevance is high.

3.2 Efficiency (Rating: a)

3.2.1 Project Outputs

The planned inputs by both the Japanese and Laotian side were completed as scheduled. The major outputs are indicated in Table 3. As a result of the Project, the measured outputs of Units No. 1 and 2 expanded by 5MW in total as planned.

Table 3: Outputs produced by the Project

Japanese Side	
Plan (Basic Design Study)	**Actual**
The Units No.1 and 2 • Turbines, Generators (standard outputs 17.5MW) • Transformers, 115kW Switchyard Equipment and Busbars • Control Boards • DC Power Supply Equipment • Rehabilitation and Renewal of Intake Gate Facilities, etc	As panned * However, according to the Project Completion Report, there were some changes in a pipe arrangement and a configuration between disconnectors and the existing transmission lines.
Lao Side	
Plan (Basic Design Study)	**Actual**
The rehabilitation and update of common equipments for the Unit No. 1 and 2, air compressors of emergency diesel generators, and fuel and labor for test operation	As planned

Photo 1: Motor Control Center

Photo 2: Main Transformers (the Unit No. 1)

3.2.2 Project Inputs

3.2.2.1. Project Period

The Project implementation period between the Exchange of Notes (E/N) through to completion was 26 months (104% of the plan), which was slightly longer than planned. Nevertheless, the period required for equipment procurement and rehabilitation work was 18 months (85% of the plan) which was shorter than planned. It can be concluded that overall, the Project was efficiently implemented.

Table 4: Project Period

Item	Plan (Basic Design Study)	Actual
Exchange of Note (E/N)-Completion of the rehabilitation works	**25 months**	**26 months (Completed in June 2004)**
Exchange of Note (E/N)- Completion of the rehabilitation of the Unit No. 1	20 months	23 months (completed in March 2004)
Procurement of equipments for the Units No. 1 and 2 – Completion of rehabilitation works	21months	18 months

3.2.2.2. Project Cost

As indicated in Table 5, the total Project cost was 1.129 billion JPY which accounts for 93.7% of the planned budged (1.205 billion JPY). While the planned cost financed by Japan was 1.204 billion JPY, which is the limit for E/N, the actual cost was 1.124 billion JPY which was about 7 percent lower than planned. Exchange rate devaluation and increase in labor cost doubled the actual cost financed by Laos. However, the part covered by Laos accounts for only 0.5 percent of the total cost and its overall influence was limited.

Table 5: Project Cost

Item	Plan	Actual
Total Project Cost	**1.205 billion JPY**	**1.129 billion JPY**
Japan Side (Grant Aid)	1.204 billion JPY (E/N/ Limit)	1.124 billion JPY
Procurement of Equipments	1.118 billion JPY	1.044 billion JPY
Equipment Design and Supervision	85 million JPY	80 million JPY
Lao Side	2.02 million JPY	5.45 million JPY

(Note) Exchange Rate for the cost financed by Lao Side 1 USD = 112.4231 JPY 1USD＝10,826 Kip (July 2004)

In light of the above, both the Project period and Project cost were mostly as planned. Therefore efficiency of the Project is high.

3.3 Effectiveness (Rating: a)

3.3.1 Quantitative Effects

3.3.1.1. Results from Operational Indicators

Upon completion of the rehabilitation work in 2005, utilization of Units No.1 and 2 was above the target (82.38%). However, with the exception of 2008, utilization remains below the target. This is due to the low water level in the reservoir. In particular, the amount of rainfall in 2007 was below average which caused drought and a low utilization rate (below 60%).

The duration of unexpected shutdowns due to system failures was only 1-4 hours per year. This indicates that reliable operations were achieved.

Based on observations of the conditions of Units No.1 and 2, the expected service life remains

as planned. While the number of accidents per year was initially foreseen to be about 11 for 10 years after the rehabilitation, the number of reported accidents was 0 since rehabilitation (to the date of this ex-post evaluation). Therefore, it is considered that the expected results of improving the electrical and mechanical functions as well as the recovery of the reliability and security of Units No.1 and 2. has been achieved by the Project.

Table 6: Utilization of Units No.1 and 2 (Performance Indicators)

	Target (2005)	2005	2006	2007	2008	2009
Facility Utilization (%)						
Unit No.1	82.38	84.14	77.84	55.39	84.84	73.98
Unit No.2		84.98	77.33	59.93	84.85	74.04
Hours of Operation (h)						
Unit No.1	-	7,903.17	7,549.01	5,489.26	7,260.57	6,872.40
Unit No.2		8,008.38	7,601.25	5,902.25	7,273.21	6,885.44
Planned outage for Inspections and Rehabilitation (h)						
Unit No.1	-	192	288	522	0	144
Unit No.2	-	144	408	504	0	144
Unplanned outage (h)						
Units No. 1 and 2	-	1:00	2:48	1:56	4:02	4:26

(Source) Developed based on a document provided by the Nam Ngum I Hydropower Station

Table 7: Functions and Conditions of Units No.1 and 2

Performance Indicator	Baseline(2001)	Target (2005)	Actual (2005～2010)
Expected service life*	15～35 (0～3.7) Year	15～35 Year	15～35Year
Number of Accidents **	25	11.6	0

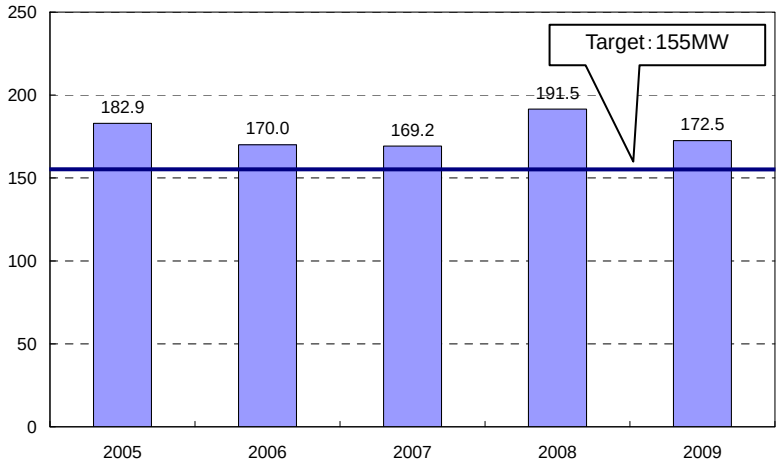
(Source) Developed based on a document provided by the Nam Ngum I Hydropower Station

(Note1) *Standard of expected service life is average years of durability and ( ) indicates the expected residual life at the time of rehabilitation (year 2003)

(Note2) ** The total number of accidents of Unit No.1 and 2 between 1990 and 2000. The target is the number of accidents foreseen in the first 10 years after the rehabilitation.

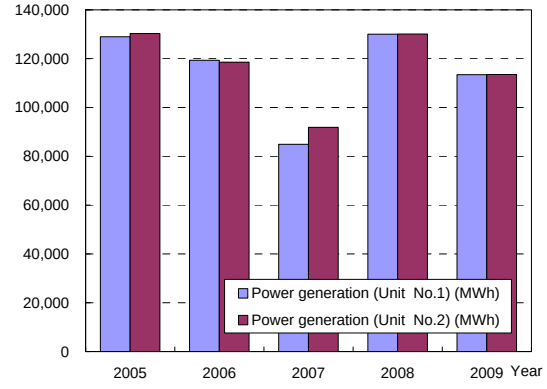
Another expected result of the Project was an increase in maximum output of the Nam Ngum I HPP from 150MW to 155MW. The Project led to the functional recovery of Units No.1 and 2, resulting in a maximum output of 170-190MW (in 2005-2009), which is more than planned.

After 2005, the total maximum output of Units No.1 and 2 constantly covered 21-23% of overall power generated by the Nam Ngum I HPP. Immediately after the completion of the Project in 2005, the total power generated by the two units was 259.3GWh. In the year 2008, which had the highest utilization rate, 260.1GWh were generated.



(Source) Developed based on a document provided by the Nam Ngum I Hydropower Station

Figure 2: Maximum Output of Nam Ngum I Hydropower Station



(Source) A document provided by the Nam Ngum I Hydropower Station

Figure 3: Power Generation (Units No. 1 and 2)

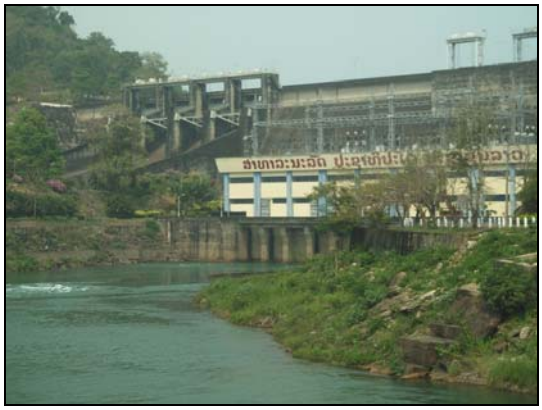


Photo 3: Full View of Nam Ngum I Hydropower Station

3.3.2 Qualitative Effects

In the Project, training was held in Japan to transfer technology for dismantling and reassembling turbines and generators. Trainees from the Nam Ngum I HPP are currently engaged as trainees at the EDL Training Center. This contributed to improving the maintenance skills of engineers of hydropower stations.

The Project has largely achieved its objectives, therefore its effectiveness is high.

3.4 Impact

3.4.1 Intended Impacts

(1) Benefits for the target areas and population

[Beneficiary: EDL]

As of 2009, there were 78 engineers in EDL involved in the maintenance of hydropower stations. Among them, 21 engineers have technical skills to conduct maintenance for generators and other associated equipment.

The training, which aimed to support technology transfer, resulted in the reinforcement of the maintenance system and technical capacity of EDL.

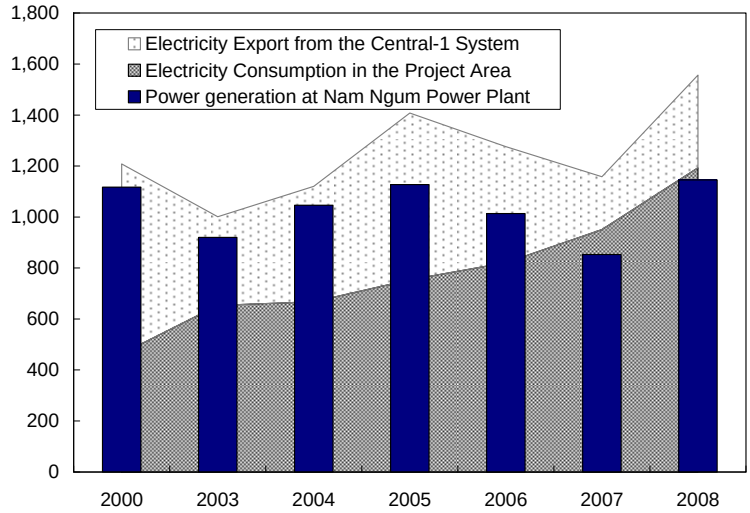
As noted earlier, the engineers who received training in Japan are now engaged in human resource development for hydropower stations. The Nam Ngum I HPP also provides on-the-job training to develop skilled engineers. Therefore, the Project contributed to reinforcement of maintenance system and the capacity development of engineers for hydropower generation in EDL.

Table 8: Training on hydropower technology (2009)

Training Name	Number of Trainees	Number of Days
Maintenance of Hydropower Generation (Group1)	38	27
Maintenance of Hydropower Generation (Grouop2)	34	27
Maintenance of Hydropower Generation (Group3)	39	27

(Source) EDL, "Statistical Year book 2009"

[Beneficiaries: Residents in Central-1 Region and Northern Region]
After the implementation of the Project, the electrification rate improved in Central-1 and Northern Regions (the service areas covered by the Nam Ngum I Hydropower Station) due to newly constructed transmission and distribution networks. In 2009, the electrification rate at the provincial level was 47-98% in Central-1 Region and 12-62% in Northern Region respectively. Accordingly, electricity consumption and electricity sales in these regions have been increasing.



(Source) Developed based on a document provided by the Nam Ngum I Hydropower Station
(Note) Electricity export is the total exports from three power stations including the Nam Ngum I Hydropower Station in Central-1 Region

Figure 4: Level of electricity consumption in the targeted regions, the amount of electricity export, and amount of power generated by the Nam Ngum I Hydropower Station

As of 2000, the total electricity consumption in Central-1 Region and Northern Region was 463.65GWh which accounts for 40% of the Nam Ngum I HPP's output. The surplus was exported to Thailand. In 2003 during the implementation of the Project, electricity consumption was boosted in the targeted regions while electricity exports decreased to 348GWh. Consequently, 70% of electricity generated by the Nam Ngum I HPP was consumed in those

regions. After 2003, electricity consumption in those regions continued to grow and reached 1,192GWh, more than the annual amount of power production by the Nam Ngum I HPP. The Project was a response to this continuous growth of electricity consumption through the rehabilitation of the power generation facilities in the Nam Ngum I HPP, the primary power station in the region. The Project contributed to promoting electrification and expanding power supply in the targeted regions.

3.4.2 Other Impacts

(1) Impacts on the natural environment

The Basic Design Study pointed out that the grease lubricant used for the turbine operating mechanism and out-dated shaft sealing box was causing water pollution. As the rehabilitation transformed the mechanism itself and grease is no longer being used, the water quality has improved. There were no other environmental impacts caused by the Project[3].

(2) Economic Impact

In the Basic Design Study, a positive economic impact was expected through the reduction of maintenance costs after the rehabilitation, as well as an increase in annual income from the increase in power generation.

The actual maintenance cost after the rehabilitation is less than before the Project, as no large-scale maintenance works have been required for Units No. 1 and 2 and their common equipment. Therefore, the Project has contributed to the reduction of the maintenance costs of the entire power station.

The income from power generation has been constantly above that for the base year. However, the actual volume of power generation remains lower than that of the base year (1,138.5GWh) except in the year 2008. The increase in income was a result of the sales price change since the average electricity price rose to 2.25 times as much as the base year. Thus, the increase in the income of the Nam Ngum I HPP was not a result of the Project.

Table 9: Maintenance costs and income from power generation of the Nam Ngum I

	Baseline (2001)	**After the Project (2009)**
Maintenance Cost	11.30 billion kip	9.68 billion kip
Income from power generation	38.59 billion kip	44.84 billion kip

(Source) A document provided by the Nam Ngum I Hydropower Station

3.5 Sustainability (Rating: a)

3.5.1 Structural Aspects of Operations and Maintenance

The Nam Ngum I Hydropower Station is managed by EDL, a state-owned enterprise which is in charge of power generation, transmission and distribution for domestic and international electricity services. The structure of EDL at the time of the ex-post evaluation is shown in Figure 5. Under the supervision of the Board of Holdings, four Managing Directors are responsible for managing EDL.

[3] Among the items removed by the project, the existing excitation transformers, 11kV voltage transformers and 11kV capacitors used the insulating oils containing toxic chemicals, including Polychlorinated Biphenyl (PCB). It was planned that those toxic wastes should be securely stored under lock and key at a specially designated place in the powerhouse which was protected by an oil fence. At the time of this ex-post evaluation, by reviewing the storage condition, it is found that EDL sold the steel scraps disposed by the Project, including the toxic wastes, to a private steel maker in Vietnam subject to the condition that the steel maker should store the insulating oil with PCB at a proper space with concrete fence for safekeeping.

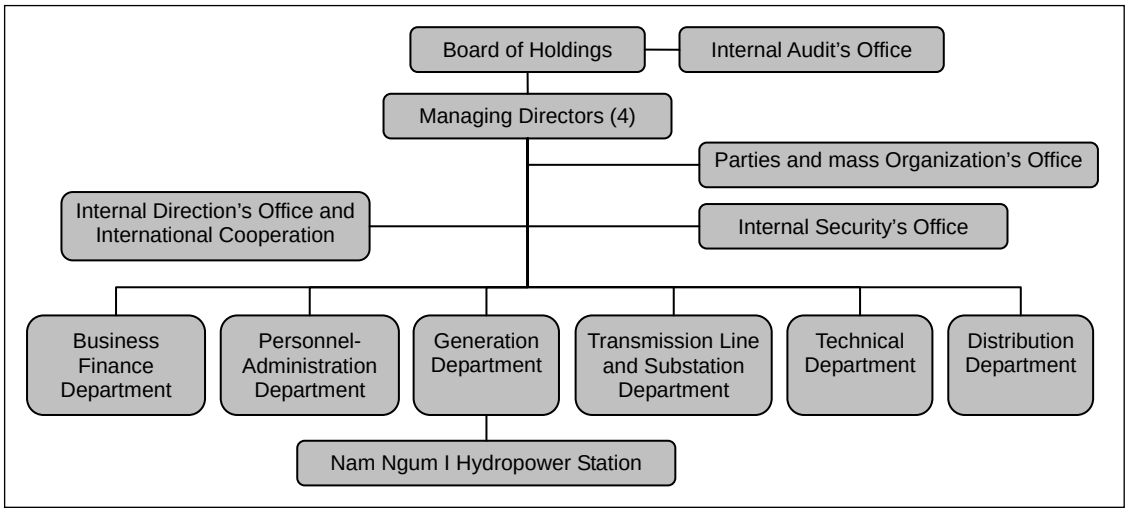


Figure 5: Organizational Structure of EDL

With regard to the maintenance plan for power stations, the EDL Headquarters approves the budget after conducting a technical appraisal of proposals made by each power station.

Maintenance of the Nam Ngum I HPP is conducted by 73 staff including 15 engineers working for four departments: Operations and Control Department, Electrical Department, Mechanical Department and Civil Department (Figure 6).

The Operations and Control Department is in charge of machines and equipment for power generation, as well as for water management. The Electrical Department looks after electrical networks and the Mechanical Department is in charge of all other machines and equipment. The Civil Department conducts inspections, monitoring and maintenance of the dam.

Through the Project, awareness of proper operations and maintenance has been raised and the system and structure for maintenance has been reinforced.

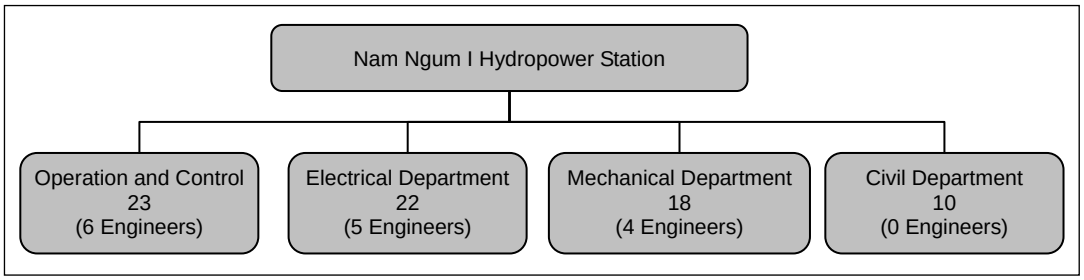


Figure 6: Maintenance Structure of the Nam Ngum I Hydropower Station

3.5.2 Technical Aspects of Operations and Maintenance

Ordinary inspections have been properly undertaken. No detailed inspections including the dismantling and reassembling of turbines or occasional inspections have been undertaken since the completion of the rehabilitation work, as there is usually no need for frequent detailed inspections or special inspections. Currently EDL is in the process of setting up a maintenance structure to conduct detailed inspections, building on the experience gained through this rehabilitation project. Nevertheless, the short term training provided by the Project is not sufficient to build all the capacities required for detailed inspections involving dismantling and reassembling, and make a proper judgment for future maintenance. At this moment, it is still

necessary to rely on external support to formulate overhaul plans and commission overhaul work.

Meantime, EDL has made efforts in building internal technical capacity to properly maintain hydropower stations. Engineers working for the Nam Ngum I HPP have also taken technical training at EDL training centers.

Table 10: Training taken by engineers from the Nam Ngum Hydropower Station

Training Course	Number of participants	Frequency	Duration
Hydropower	4	4 times per year	2 weeks each time
Mechanical works	4	4 times per year	2 weeks each time
Electrical works	9	4 times per year	2 weeks each time
Civil works	39	4 times per year	2 weeks each time

(Source) A document provided by the Nam Ngum Hydropower Station

Despite a lack of sufficient skills required for dismantling and reassembling, ordinary inspection has been properly undertaken. As for detailed inspections, EDL is currently formulating a 5 year plan, setting up a team of experts, and commissioning tasks to external consultants when necessary. In light of these activities, no major problem in the maintenance structure is expected.

3.5.3 Financial Aspects of Operations and Maintenance

After the completion of the Project, the operations and maintenance (O&M) cost for the Nam Ngum I HPP in 2006 was 138 billion kip. Although it declined to 10 billion kip in 2008 and 10.3 billion kip in 2009, the budget for O&M again rose in 2010 to over 21 billion kip. Out of the entire O&M cost, maintenance costs take up 94-97% and the remaining 3-6% is used for personnel. Maintenance costs went down by 20% from 134 billion kip in 2006 to 95.6 billion kip in 2008. It then rose to 204.5 billion kip, which is more than double compared to the previous year.

No major repair work has been required for Units No. 1 and 2 since 2005, and there have therefore not been any specific costs for those units.

Table 11: Operations and maintenance cost for the Nam Ngum I Hydropower Station

(Unit: 1 billion kip)

	2005	2006	2007	2008	2009	2010
Operation and maintenance cost	**128.53**	**138.01**	**124.56**	**100.85**	**103.07**	**210.75**
Personnel cost	3.49	3.94	4.29	5.24	6.26	6.19
Equipment Maintenance cost	125.04	134.07	120.27	95.61	96.81	204.55

(Source) Documents provided by EDL and the Nam Ngum Hydropower Station

EDL prepares technical reports analyzing the urgency and necessity of repairs and the need for any significant updating of machines and equipment. Based on these analyses, EDL then gives budgetary approval. In 2008 and 2009, the repair works requested by the office of Nam Ngum I HPP was not approved and was carried over to 2010. This resulted in a significant gap between the planned budget and the actual expenditure in 2008 and 2009.

3.5.4 Current Status of Operations and Maintenance

During this ex-post evaluation, a site visit was undertaken to review the status of the maintenance of machines and equipment installed by the Project. The site visit confirmed that

operations and maintenance were being conducted properly, as well as ordinary and periodical inspections.

The spare parts procured by the Project are still in stock and EDL has not yet procured any parts.

Currently, the Nam Ngum I HPP plans and conducts ordinary inspections and maintenance during the dry season to avoid discharges. The Generators are usually stopped for 1 to 3 weeks and necessary repair work such as the removal of mud on the turbine runner are carried out. In 2008, it was not possible to conduct the scheduled maintenance and inspection during the planned period because the rainy season began early that year. The Nam Ngum I HPP was forced to run the generators in order to avoid discharges.

The stabilization of water flow to the reservoir as an effect of commissioning Nam Ngum II Hydropower Station could potentially increase the plant factor of Units No. 1 and No.2, and therefore shorten the period when maintenance can be carried out. However, there is a plan to install another unit, Unit No.6, at the Nam Ngum I HPP. If it is installed, the operational hours of Units No.1 and 2 could be reduced, which would allow the proper maintenance of those units. This would shorten the frequency of the exchange of consumable parts and reduce operation and maintenance costs.

No major problems have been observed in the operation and maintenance system. The sustainability of the Project is therefore deemed to be high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

The Project aimed to stabilize the electric supply in the country by rehabilitating equipment and facilitating the functional recovery of the Nam Ngum I Hydropower Station. Since the Station has been one of the primary power stations in the country, the demand for the Project was high. Considering its history, and the continuity of assistance from Japan to this power station, relevance for Japan's aid was high. The expected results of this assistance have been steadily achieved and the Project has had a positive impact, such as capacity building for maintenance skills of hydropower stations in the country. Given that the maintenance structure and system is currently being strengthened, the Project can be considered highly sustainable.

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

4.2 Recommendations

4.2.1 Recommendation to Executing Agency

None

4.2.2 Recommendation to JICA

None

4.3 Lessons Learned

The Nam Ngum I Hydropower Station was constructed and expanded with international assistance from various countries including Japan. It has been one of the primary power stations in the country. Through Japan's continuous assistance and Lao's high reliance on Japanese technology for hydropower generation, the Nam Ngum I HPP has led to the improvement of

hydropower generation technologies and capacity development in the country.

In the Project, not only rehabilitation work but also maintenance skills for hydropower generation plants were developed, which led to skill development of engineers of the Nam Ngum Hydropower Station and EDL as a whole. It also promoted the reinforcement of the operations and maintenance system and structure. Such assistance contributing to human resource and skills development has had positive spill-over effects such as development of human resource, technical capacity, and the organizational structure of the overall electricity sector. At the same time, a lack of knowledge and skill required for the overhaul of generators, inspection, and the identification of problems caused by accidents has been recognized as an issue. This was not well integrated as a component of the rehabilitation project. The short-term training by contractors was not sufficient for technology transfer.

It is necessary to give high priority to technology transfer in the above-mentioned areas during future project identification processes, in order to improve operations and maintenance capacity and eventually enhance the sustainability of hydropower generation in Laos. In this regard, it is recommended that the training components of grant aid projects be reinforced or supported through other aid schemes.

(End)