Lao PDR

Nam Leuk Hydropower Project

Report Date: January 2003

Field Survey: December 2002

1. Project Profile and Japan's ODA Loan

Site map: Vientiane Province

Nam Leuk Hydroelectric Power Plant

1.1 Background

The Mekong River flows through Laos from north to south, and with an estimated hydropower potential of 18,000 megawatts or more, the country is endowed with some of the most abundant water resources in Indochina. In 1996, Laos' main hydroelectric power plants were the Nam Ngum Power Plant (150 megawatts) to the northeast of the capital, Vientiane, and the Xeset Power Plant (45 megawatts) in the southern province of Saravan, and its gross hydroelectric generating capacity, including small-scale facilities, was pegged at 201 megawatts. With approximately 70% of the total generation capacity of 216 megawatts, including diesel generation, being exported to Thailand, power was regarded as an important export commodity and a valuable source of foreign exchange earning. Under a 1993 power purchase agreement, Laos pledged to supply 1,500 megawatts of power to Thailand by 2000, a 1996 Memorandum of Understanding (MoU) promised 3,000 megawatts by 2006, and in 1994, it signed a MoU with Vietnam agreeing to supply 2,000 megawatts by 2010. Domestic demand for power, on the other hand, had remained at low levels, but with the development of the industrial sector and so forth, in 1993 it had risen to occupy 30% of total production output. Growth was forecast to continue accelerating and it was predicted that by 2000, consumption would have virtually doubled over its 1993 level, to 477 GW hours.

Under these circumstances, there was a pressing need to expand the existing transmission and distribution networks, and simultaneously, to promote the development of hydropower as a means of strengthening the power supply system. Under its hydropower development policy, the government of Laos (GOL) was focused on the development of power resources in the area around Nam Ngum to the north, and had selected the Nam Leuk Hydroelectric Power Plant project as being important both in terms of its priority and maturity.

1.2 Objectives

Construction of a 60 megawatt hydroelectric power plant on the Nam Leuk river where it flows near the southeastern side of the existing Nam Ngum reservoir, with the objective of strengthening the domestic power supply system, and at the same time, of contributing to increased foreign exchange earnings from power sales to Thailand and other countries in the region.

1.3 Project Scope

This project involved damming the waters of the Nam Leuk river, diverting them to the Nam Ngum reservoir via a headrace tunnel to obtain a drop of approximately 180 meters, and the construction of a power plant with an annual generation capacity of approximately 215 GWh. The followings were co-financed by the Asian Development Bank (ADB) and the Japan Bank of International Cooperation (JBIC). Japan's ODA loan covered all foreign currency costs necessary for the implementation of items (4), (5) and (6).

(1) Dam (rock-filled; revetment 46.5m × 800m; effective storage capacity: 154 million m^3)
(2) Storage reservoir (area: 12.8km^2)
(3) Headrace tunnel (length: 2,814m; internal diameter: 3.5-4.9m)
(4) Penstock (length: 471m; internal diameter: 2.4-3.4m)
(5) Power station (on land; capacity: 60MW)
(6) Transmission lines (power station-Paksane; AC 115kV; length: 85km)
(7) Access roads (new road: 43.8km; road betterment: 39.4km)
(8) Consulting services

1.4 Borrower/Executing Agency

People's Democratic Republic of Laos/Electricite du Laos (EdL)

1.5 Outline of Loan Agreement

Loan Amount Loan Disbursed Amount	3,903 million yen 3,902 million yen
Exchange of Notes Loan Agreement	October 1996 October 1996
Terms and Conditions -Interest Rate -Repayment Period (Grace Period) -Procurement	 1.0% 30 years (10 years) General untied
Final Disbursement Date	December 2001

2. Results and Evaluation

2.1 Relevance

The GOL assigned priority to power sector development under its Fourth Five-Year Economic and Social Development Plan (1996-2000) and put forward the strengthening of the domestic power supply system[1] via the development of hydro power plants and the transmission and distribution system as a key policy initiative. This project was implemented with the objectives of constructing a power plant to develop the abundant water resources in the Nam Ngum basin, strengthening the supply system in the "Central 1" region[2], and earning foreign exchange via exports of surplus power. These objectives were consistent with the GOL's plan to promote domestic rural electrification and its plan to promote power sales to neighboring countries and were also compatible with the priority areas of the economic cooperation being provided to Laos by Japan, and the project was highly relevant at appraisal.

Hydropower development not only continues to be a key energy policy initiative, revenue from power exports occupies a key position within the framework of national finances. In this context, independent

[1] The country is divided into four power regions: the Northern Region, Central 1, Central 2 and the Southern Region.
[2] Bolikhamxai Province, Vientiane Province, Louangphrabang Province, Xiangkhoang Province, Xaignabouri Province, Vientiane Special City.

power producers (IPP) are moving ahead with a number of large-scale hydroelectric power plant construction plans involving, among other things, the conclusion of bilateral power purchase agreements and Project development agreements, and the Nam Theun 2 power plant. Meanwhile, the GOL is adhering to its basic policy of self-sufficiency in power and is working on its plan to develop a national transmission grid targeting the interconnection of the domestic networks. Total domestic consumption increased from 337.5 GWh in 1995 to 648.6 GWh in 2000, and demand was growing at the exponential annual rate of 15.1% on average. Thus, even at evaluation, this project is considered to have remained consistent with Laos government policy and with domestic needs.

2.2 Efficiency

2.2.1 Project Scope

The following changes were made in project scope vis-à-vis the plans formulated at appraisal.

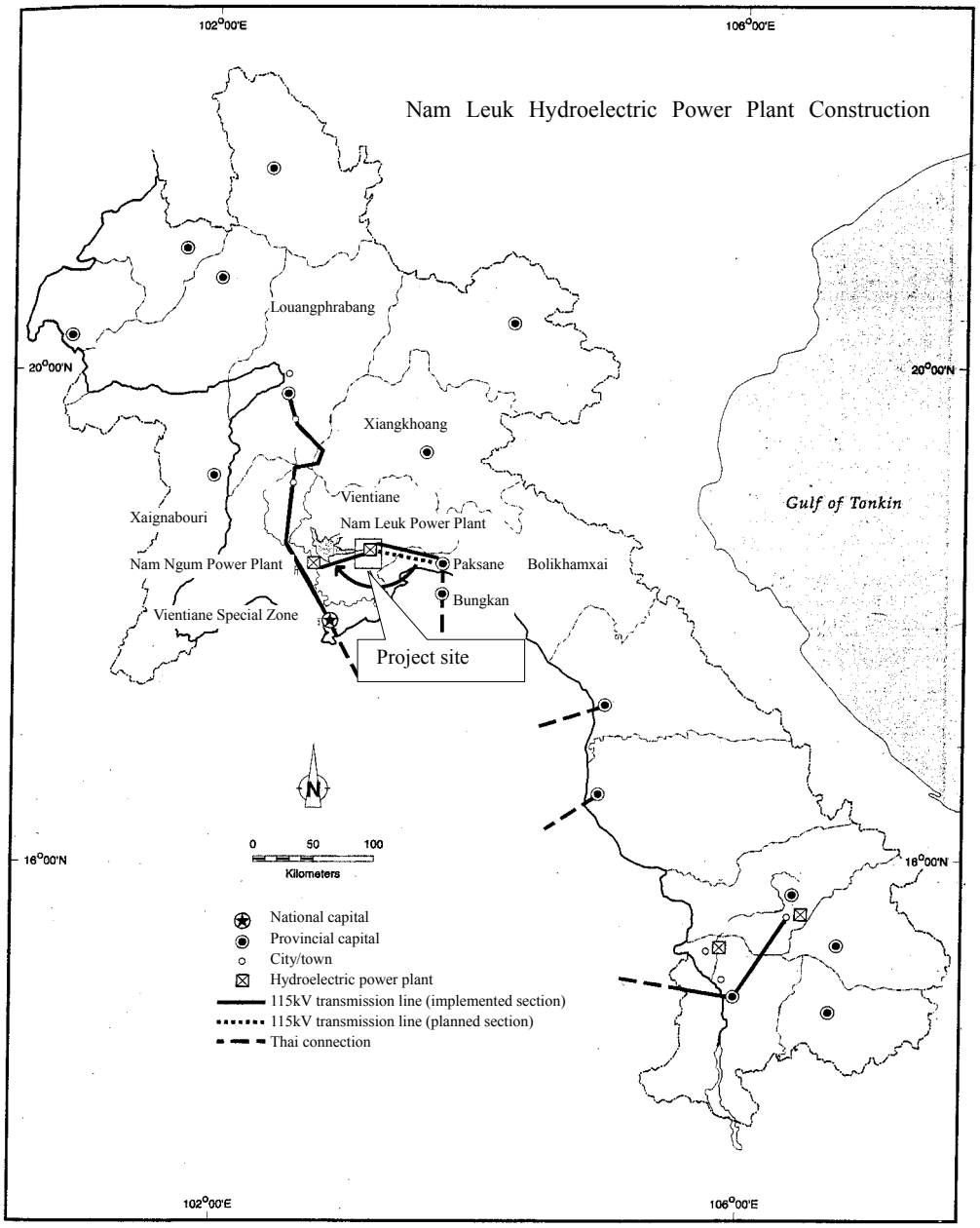
1) Components covered by Japan's ODA loan

(1) Transmission line (number of circuits, sections) changes and substation addition

Initially, a 115kV transmission line (double-circuit) was to be laid between the power plant and Paksane (85km), however, the plans were revised to include the construction of transmission lines (single-circuit) on two sections, i.e. the power station-Paksane section (85km) and the power station-Nam Ngum section (55km) (see Figure 1). This was because the voltage step up (22kV→115kV) necessary for power exports on the section between the delivery point and Bungkan on the Thai side was postponed due to circumstances in Thailand, which made it impossible to export power via the Paksane route. In order to secure the alternative Vientiane route, the additional construction of the power plant-Nam Ngum section and a substation with gas insulated switchgear (GIS)[3] at the Nam Ngum power plant was necessary. In view of the projected increases in costs accompanying these changes, the transmission lines were changed to single-circuit lines that would meet domestic demand for power. These revisions were judged to be relevant in terms of economy and efficiency.

[3] Due to the difficulties encountered in acquiring land for the substation at the Nam Ngum power plant, GIS was adopted as the switchgear can be installed in a small space, ensures a high degree of safety/performance and offers superior maintenance labor-savings.

Figure 1 Transmission Lines – Comparison of Planned and Actual Scope



2) Components covered by ADB funds

(1) Changes to the headrace tunnel lining

Initially, the headrace tunnel was planned to have a partial lining, however, this was changed to a concrete lining. This was because clay seams, discovered during excavation test, would not be able to withstand a partial lining, resulting in the decision to make the change in terms of durability, safety and efficiency. This revision reduced the necessary flow velocity from $39m^3/s$ to $38m^3/s$ increasing efficiency by 2.5% and is expected to link to maintenance cost savings in the long term.

(2) Access Roads

Slight modifications were made to the length of the access roads. This was in line with the transfer of the construction site for the operation center from the right bank to the left bank of the Nam Xan river but had no particular negative impact on operations and was appropriate in terms of environmental impact and emergency response capability.

(3) Increase in Consulting Services

The original 200 man months (M/M) was increased to 315.5 M/M. The objective of this increase was to support/supervise the civil engineering contractor due to insufficient performance capability, and to recover the delays[4] encountered in access road and operation center construction, etc. EdL, ADB and the consultants examined various alternatives, including the replacement of the contractor, however, in view of the fact that the work would be further delayed by selection procedures and in consideration of various uncertainties, including the inability to guarantee the quality of the incoming contractor, the decision was made to continue with the existing contract and for assignment of additional consultant.. These measures to accelerate construction progress made it possible to avoid the projected delays[5].

2.2.2 Implementation Schedule

A 49-month implementation schedule from January 1996 through January 2000 was planned at appraisal (to cover the entire process from consultant selection through the start up generation operations), however, the actual schedule spanned 51 months from January 1996 through March 2000. The two-month delay was caused by the need to undertake additional surveys and designs in line with the addition of a second transmission line section. The construction of the transmission line section between the power station and Nam Ngum was completed in February 2000, with the power station-Paksane section being completed in March. The generation facilities, however, were completed on schedule, and these hold ups did not affect peak supplies during the dry season. The fact that the delays were confined to two months in spite of the various changes and problems with external factors is attributed to the appropriate measures that were taken to recover delay, including the provision of additional consulting services.

2.2.3 Project Cost

Appraisal plans envisaged total project costs of 11,081 million yen, with 3,903 million yen or approximately 35% (the foreign currency portion of equipment procurement) to be funded by Japan's yen loan, approximately 49% (the foreign currency portion of civil engineering works and consulting services and the service charge) to be financed by ADB, and the remaining 16% (environmental mitigating measures cost and the local currency portion) to be covered by the budgets of the GOL and the executing agency. The final total was 12,474 million yen, of which 3,902 million was provided as yen loan funds. On a yen basis the overrun in total project costs equates to approximately 12%, however, on a dollar basis costs stopped at 107.7 million as against 118.7 million at appraisal, so that in spite of the scope expansions, the increases in environmental mitigation measures cost and compensation costs, and the measures to accelerate civil engineering works, it was possible to keep total costs below the contract price and thus to within the initially planned figure.

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[4] One year after the start of construction, the work was already nine months behind schedule, and it was feared that this would have a major effect on project plans as a whole.

[5] According to the executing agency, the dam was completed in August 1999, the storage reservoir in October (the last month of the rainy season), headrace construction was completed in December, generation commenced in January 2000 (as planned), trial operations were conducted through February/March, on-grid generation via the Nam Ngum route commenced in March, and via the Paksane route in April, and it was possible to sufficiently meet peak demand during the dry season (April).

In summary of the various analyses given above, although additional costs were generated due to scope modifications and construction progress, since these linked to demonstrable results, there are not considered to have been any major problems in terms of efficiency. In this respect, it is possible to pinpoint the fact that the co-financing of the project with ADB served to strengthen execution management, which in turn led to increased efficiency in implementation.

2.3 Effectiveness

2.3.1 Strengthening of Power Supply System

In order to construct an efficient and safe power network it is necessary to develop facilities that are capable of controlling the output of power plants in response to varying demand and to guarantee the reliability of supplies in the transmission system. As is evidenced below, these conditions have been satisfied via the implementation of this project.

As illustrated in Table 1, after project completion annual production reached 263GWh in 2000 and 237GWh in 2001, surpassing the planned figures in both years. The volume for 2002 was slightly under par, but this was the result of low precipitation in the Nam Leuk reservoir area and is believed to have been a temporary depression.

Table 1: Nam Leuk Power Plant Annual Output & Distribution Volumes (GWh)

	Output			Distribution
	Plan	Actual	Gap	Actual
2000	203.64	263.07	59.43	244.15
2001	228.70	237.18	8.48	236.00
2002	214.20	211.16	-3.04	210.14

Source: EDL

Note 1: Planned figures for 2000 are for January-December, actual figures are for March-December.

Note 2: Planned and actual figures for 2002 are for January-October.

Peak demand and gross national consumption (forecasts) for 2000 through 2005 are as shown in Table 2. Estimated “in the absence of the project”, it becomes clear that peak demand will outstrip maximum output in 2001. Viewed in terms of necessary installed capacity including reserve supplies it becomes obvious that peak shortfalls in supply will occur frequently between 2000 and 2005 and that the stability of supplies will have been impaired.

Table 2: Peak Demand & Maximum Output

		1999	2000	2001	2002	2003	2004	2005
1	Peak demand (MW) Plan	112.59	122.72	133.76	145.8	158.92	173.23	188.82
	Actual	171.60	205.90	223.38	251.46	280.57	305.13	331.17
	Average annual increase (%)	-	20.0	10.9	10.1	11.6	8.8	8.5
2	Maximum output (MW) Actual	211.10	271.10	271.10	271.10	271.10	311.10	387.10
	Result in absence of project	211.10	211.10	211.10	211.10	211.10	251.10	327.10

Source: JICA Master Plan Study of Transmission and Transformer Facilities in Laos PDR (2002)

The project aimed to strengthen the power supply system in the Central 1 region byconnecting Xaisomboun Special Zone (currently Vientiane Province), and to provide a substitute for power imports in

Bolikhamxai Province. The project resulted in 540 households in 11 villages in the Long Sang district of the Xaisomboun Special Zone becoming able to receive grid services and a reduction in power imports in Bolikhamxai Province from 9.16GWh in 1999 to 3.17GWh in 2000.

As is demonstrated above, this project is considered to have contributed to strengthening the power supply capability in the Central 1 region.

2.3.2 Exports of Surplus Power

As mentioned above, the scope was modified so that power from the Nam Leuk power station could be exported via two routes, i.e. the Vientiane route and the Paksane route. Power has been exported via the Vientiane route since 2000 in conjunction with the Nam Ngum power plant and via the Paksane route since March 2002. Combined power exports from the Nam Leuk and Nam Ngum power plants were 472.40GWh in 1999, but figures of 744.52GWh and 696.31GWh were recorded in 2000 and 2001, respectively. The executing agency regards 32% of this to be generated by the Nam Leuk power station. The share of gross national exports, including those from other power stations, was 28% in 1999, however, given that no new power stations have been constructed since 2000, the current share is believed to be even higher.

2.3.3 Recalculation of Financial Internal Rate of Return (FIRR)

The recalculation of project FIRR yielded a figure of 7.34%, which is lower than the appraisal figure of 9.3%. In calculating cost, project cost, maintenance cost and environmental mitigation measures cost submitted by the executing agency during this survey were used. The benefit calculation employed data on generation, transmission losses, export output, the power selling price, distribution losses, domestic output, domestic electricity prices, and distribution costs. FIRR was calculated as the difference between revenues in the case of the project being implemented and in the absence of the project. The lower rate is attributed to differences in the (1) power selling price, (2) domestic price, and (3) loss ratio assumptions. At appraisal, the power selling price (1) was set as "the current annual average price of US$0.031/kWh, assuming an increase of 20% every five years with a maximum of US$0.109/kWh". In contrast, at recalculation the price stipulated under the beneficial power purchase agreement valid until 2003 was taken as the current selling price, and since EDL was planning to undertake a review of prices with a view towards increasing the tariff from 2004 onwards, the calculation was premised on "the current selling price of US$0.0278/kWh, with annual increases of 4.8% from 2004 onwards, and a maximum price of US$0.0424/kWh. The domestic price (2) was assumed to be US$0.070/kWh[6] at appraisal, however, the collapse of the domestic currency (LAK) in the wake of the Asian currency crisis had reduced dollar-denominated domestic tariffs, which were between US$0.238-0.062/kWh at recalculation. It should be noted that the GOL's plan to increase prices by 2.3% every month for three years from 2002 is reflected in this price. The loss ratio (3) was taken as 10% at appraisal, but set at between 12%-18.69%, the figure in the data presented by the executing agency, at recalculation.

2.3.4 Calculation of Economic Internal Rate of Return (EIRR)

The EIRR was not calculated at appraisal, however, an attempt was made during the ex-post evaluation using 2000 as the standard year and assuming the project life to be 40 years. The resultant EIRR was 13.37%. the economic value of project investment costs, maintenance costs and environmental mitigation measures cost as the project's cost, and export savings, import earnings, and newly created demand as the project's benefits.

[6] Source: ADB Post Completion Report.

From the above, it is considered that this project has strengthened the stability of the domestic supply network and contributed to increasing power exports, and since its internal rates of return are also appropriate, it is generally considered that the initial objectives have been achieved.

2.4. Impact

2.4.1 Power Exports Resulting in Increased Acquisition & Decreased Outlay of Foreign Currency

As stated in "2.3 Effectiveness", the Nam Leuk power plant is promoting power exports and providing energy import substitutes in Bolikhamxai Province. However, thus far, no incontrovertible improvements have been observed in the total value of energy exports and imports in Laos, which was established as a leading project objective.

Figures 1 and 2 illustrate energy supply volumes and energy import and export volumes together with their monetary values for the period from 1996 through 2001. The supply volume posted considerable growth in 2000 and maintained this level in 2001, thereby evidencing the substantial increase in domestic supply capacity effectuated by this project. The volume of exports increased in 2000, the year of project completion, but declined slightly in 2001. This is attributed to a surge in domestic demand during 2000-2001, which reduced the volume of surplus power available for export. On the other hand, although energy imports, which were trending upwards until 1999, dropped slightly in 2000, they were back up again in 2001. This is believed to be due to rapid increases in demand in the Central 2 and Northern Regions where generation facilities and transmission lines remain underdeveloped.

Further, falling export prices and the depreciation of the Kip against the dollar in recent years have meant that the value of power exports has not grown in proportion to increases in export volumes. Given that import/export volumes are contingent upon domestic and external demand for power and that import/export prices are controlled by the price and conversion rate fixed in power purchase agreements, they are not in a form that is proportional to supply volume growth. In order to acquire foreign exchange it is first necessary to increase the volume of exports. Since the means of securing this has already been achieved via the conclusion of power purchasing agreements with Thailand and Vietnam, increase of the supply volume after the completion of new power plants will lead to growth in foreign currency earnings.

Figure1: Power Supply and Import/Export Volumes

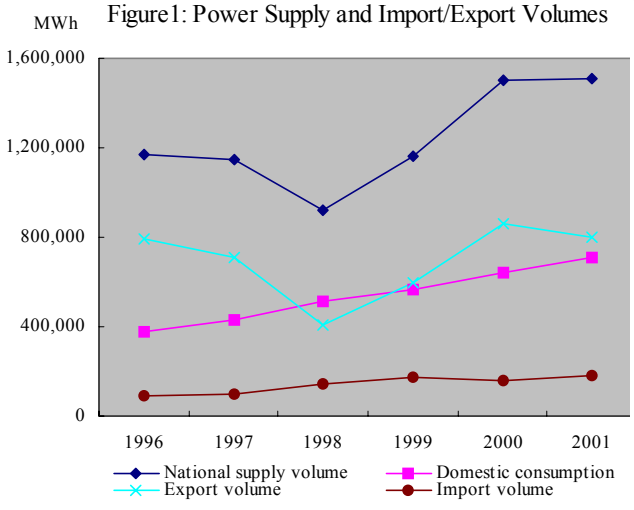
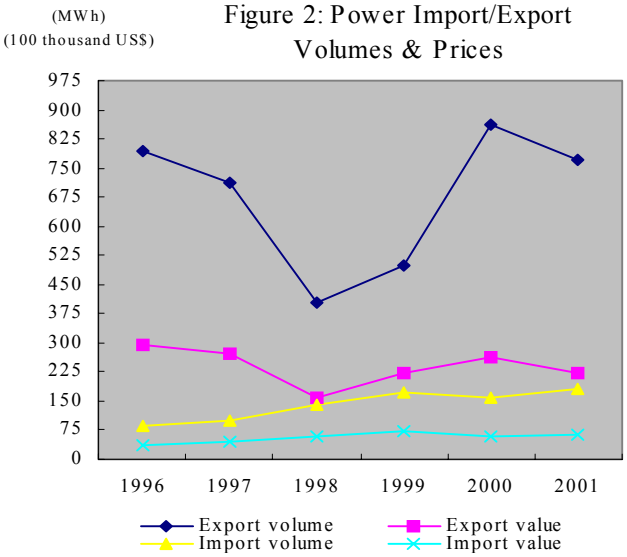


Figure 2: Power Import/Export Volumes & Prices



Source: EdL

2.4.2 Social Impacts

1) Regional Development & Improved Living Standards

Although not specifically anticipated at appraisal, the project is believed to have had an impact in the form of regional development and improved living standards.

(1) Improved household electrification rate

In Laos there is no interconnected transmission system covering the entire country, the power systems are closed within each region ofCentral 1, Central 2 and the Southern region. This project was situated in the Central 1 region where the Nam Leuk, Nam Ngum and Nam Dong power plants supply the provinces of Bolikhamxai, Vientiane and Louangphrabang, as well as the Vientiane Special Zone by the transmission network. Table 3 shows the fluctuations in the household electrification rate in the Central 1 region during 1997 to 2001. The electrification rate increased between 1999 (pre-project) and 2000 (post-completion), and growth in the two provinces of Bolikhamxai and Louangphrabang, at 20.3% and 88.8%, respectively, has been much higher than the national average of 8.46%.

Table 3: Household Electrification Rate (%)

	1997	1998	1999	2000	2001
National average	18.0	30.0	33.1	35.9	35.1
% increase		66.67	10.33	8.46	-2.23
Bolikhamxai Province	5.9	26.0	27.1	32.6	35.8
% increase		340.68	4.23	20.30	9.82
Vientiane Province	25.0	48.0	48.3	49.2	52.0
% increase		92.00	0.62	1.86	5.69
Louangphrabang Province	19.0	12.0	12.5	23.6	25.6
% increase		-36.84	4.17	88.80	8.47
Xiangkhoang Province	14.0	7.2	13.5	12.3	13.0
% increase		-48.6	87.50	-8.89	5.69
Xaignabouri Province	13.0	14.0	11.4	23.1	16.5
% increase		7.69	-18.57	102.63	-28.57
Vientiane Special Zone	59.0	87.0	95.0	94.9	96.0
% increase		47.46	9.20	-0.11	1.16

Source: Statistics of Electricity Consumption; Department of Electricity, Ministry of Industry and Handicrafts

(2) Improved standards of living

After construction of the plant up to the time of this survey, 540 households in 11 villages in the Long Sang district has been electrified. Among those households, a survey was undertaken targeting twelve households in the villages of Ban Thamdin and Ban Konevat, where were electrified first and have been benefited for the longest period, and Ban Kengsan, the center of the district. in order to ascertain the changes in the living standards of residents who received direct effects arised from the project The survey targeted farming villages with road access; the average age of respondents was 35.83 years; in terms of educational level, approximately half of the surveyed population had received middle schooling or less; the average number of people per household was 7.91. The survey was undertaken via interviews based on a questionnaire sheet containing 24 items. Questions covered the main source of power, average daily hours of electricity usage, owned electrical products, lifestyle, and income, etc. The main results of the survey are summarized hereunder.

Prior to project implementation, diesel power was used by eleven households and kerosene by one, however, all respondents now enjoy the benefits of on-grid services. In terms of the average number of hours of electricity use per day, as compared to pre-project, when eleven households used electricity for less than five hours a day, post-completion, six households responded that they are now using electricity for 12 hours a day. All respondents have purchased new electrical items since becoming able to receive grid services, including refrigerators, electric fans, and rice cookers, enabling them to enjoy a more comfortable living environment. In terms of lifestyle changes, six households claimed to have seen reductions in the time spent on and the burden of housework, nine households stated that their evening entertainment and economic activities had expanded, and twelve households answered that nocturnal safety had improved, providing clear evidence of improvements in living environments. Again, seven households have experienced a job change and are now engaged in occupations that use electricity, such as sales of drinking water and the provision of copy services. As a result, all respondents stated that the project has linked to increases in income, demonstrating that the use of electricity provided by the grid has contributed to improved living standards.

(3) Involuntary resettlement / compensation

A total 1,400 hectares of land was required, however, according to the 1996 Environmental Impact Assessment (EIA) report since there were no resident on the project site the need for involuntary resettlement would not arise, and that compensation was only to be awarded in respect of paddy land acquired temporarily (36.5 hectares) or permanently (12.5 hectares) for project implementation. Notwithstanding, a supplementary study undertaken in respect of the environmental mitigating measures that was incorporated into the project plans with the aim of avoiding any impact of project implementation, revealed a potential threat to the livelihoods of residents in neighboring settlements from flooding, which could result in damage to a third of annual agricultural produce and a 50% reduction in per household fish catches. In response to these findings, a plan was devised under which residents would be resettled to villages where it was possible to secure higher economic and living standards. Ultimately, 16 families living on a terrace near the power station or the reservoir chose to be relocated and were resettled in villages on the right-hand bank of the Nam Xan river (Ban Thamdin: 1 family; Ban Kengsan: 2 families), Ban Long Sang (3 families), and the southern village of Ban Kok Hai (10 families). These residents were paid compensation for resettlement and provided with rice during the move and during the period of establishing self-sufficiency. Compensation was undertaken for the residents who elected not to move in the form of payment in kind or the provision of alternative land.

During interviews with the executing agency and some of the residents who had been relocated (total: 22 people), it was confirmed that the wishes of the residents had been incorporated into the resettlement process. By way of example, one of the residents that was relocated to BanThamdin received a cash sum of approximately 370 thousand yen, 246kg of rice (equivalent to a 2-year supply for a family of 6), and arable land (approx. 6,400m^2) in compensation, enabling him to secure a higher standard of living than he had enjoyed to date. This resident has built a new home and is living without constraint; he claims to be highly satisfied with the compensation he received.

Major improvements have been effectuated to living standards in the areas near the project site where villagers were relocated, with the construction of roads enhancing accessibility, and compensation provided in the form of electrification, and the construction of various facilities including water stations, schools, bridges and fish ponds. It is thus believed that the project had almost no negative impacts on local residents.

2.4.3 Environmental Impacts

This project was the first development project to be undertaken within the National Biodiversity Conservation Area (NBCA) at Phou Khao Khouay (PKK), an area primarily designed for forest conservation, and from the outset, there were fears that it would have an adverse impact on the environment. The EIA that was undertaken between 1994-95 examined the impact on water quality in the Nam Leuk reservoir and the Nam Leuk and Nam Xan rivers, on the flow rate in the lower reaches of the Nam Poun, on theBangken terrace, the forest, soil erosion, and on wildlife. The GOL had budgeted approximately LAK1,166 million for measures to minimize the impact on these items, which with funds from ADB made for a total of around US$1.71 million (approx. 184 million yen) to be spent on various measures such as fish protection, control of illegal logging, afforestation, hunting prevention, treatment of construction waste and so forth. The executing agency reports that an advisory committee and information center were established as a means of fortifying these measures, which created a system for responding to problems while exchanging information with specialists, the executing agency, the NBCA, the Science, Technology and Environment Agency, district government officers and local citizens.

Although there were some negative impacts on the environment during construction, including on fish and domestic foul due to deteriorated water quality and water pollution, and on flow rates in the Nam Poun

and at the Tat Leuk waterfall, because such thoroughgoing measures had been implemented all the effects were temporary, and one year after completion had recovered to virtually normal levels, according to the executing agency, the management of the NBCA and citizens, etc.

Since August 2001, EdL has been allocating 1% of its profits from power exports to cover environmental mitigating measure for the NBCA. Conservation activities are primarily undertaken by the management of the NBCA, however, it is hoped that a system can be established that will enable EdL, as a plant operator, to be keenly attentive and responsiveso as to take a timely and necessary measure in case any adverse impact is arisen from the plant.

As evidenced above, the fact that negative environmental impacts were minimized as the result of the planning, monitoring and feedback undertaken with the cooperation of all involved parties and incorporated into environmental conservation measures at every stage of project implementation is highly evaluated. It is worth noting that this project is currently being used as a model for development projects in Laos.

2.5 Sustainability

During this survey it was confirmed that project workers have a strong sense of ownership and that this is forming the basis for essentially appropriate maintenance of generation equipment and facilities. The sustainability of adequate operation and maintenance of the project requires that a 24 hour system capable of responding to emergency situations and development of a maintenance system , sufficient number of parts for repairs/replacement, possession of present technical level or higher, and enough budget to ensure high quality management of the project facilities. The current status of the organization, its technical capability and financial status are given below.

2.5.1 Organizational Capability

EdL was inaugurated in 1962 as the national power utility; it became an independent public corporation in 1997, under the jurisdiction of the Ministry of Industry and Handicraft (MIH). It is primarily involved in the construction of generation facilities, and manages the entire supply process for the nation from generation, through transmission, power transformation, and distribution. It is also responsible for power exports to Thailand. As of June 2002, EdL employed 2,502 full-time employees and 331 temporary staff in six divisions. Aside from Nam Leuk, there are four other power plants, namely, Selaham, Nam Ngum, Xeset and Nam Dong, which are controlled and operated by EdL's generation division. EdL has twelve branch offices dotted across the country, which are responsible for the operation of regional distribution facilities and for generation assets.

The Nam Leuk hydroelectric power plant consists of three departments, operations, maintenance and management, which were being operated by 34 full-time employees and 11 temporary staff as of December 2002. The operations department is run on a three-shift system (2 staff per shift), to provide operational supervision at the plant 24-hours a day. The 12 members of the maintenance division work in three separate groups: the electrical unit, the machinery unit and the dam unit. Operation and maintenance is undertaken in conformity with the maintenance manuals provided by the consultant and the construction contractor when the facilities were transferred, with all items listed for daily, weekly, monthly and yearly inspections being carried out accordingly.

Considering sufficient stock of spare parts and no specific organizational problems on operation and maintenance activity it is believed that project effects can continue for the time being..

1) Technical Capability

There are nine engineers employed at the Nam Leuk hydroelectric power plant. The maintenance of hydro power plants is understood to require a wealth of experience, but since three of the engineers have more than twenty-years experience, one has more than ten years and five have more than two years, their technical capabilities are not at issue.

Regular in-house technical training is provided on a weekly basis by the responsible division, with the content adapted to suit operations being undertaken at the plant. Monitoring and feedback operations are also thoroughgoing and training results are well established. The engineers who provide the training are highly experienced having received on-the-job training during project construction and carried out maintenance work with the consultant two years after completion, and they are more than capable of dealing with routine problems. With respect to the plans to provide more substantial technical training, whilst budget constraints currently make it difficult to implement this plan, various approaches are under consideration, including human resource training in cooperation with the Electricity Generating Authority of Thailand (EGAT). The sustainability of the project will not merely hinge on providing training to maintain technical standards, finding ways for core personnel to acquire sophisticated knowledge and technical skills so as to become advisors is an issue that will need to be addressed in the future.

2) Financial Status

According to the financial statements presented by EdL, EdL is recording favorable income and profit figures, with annual operating income at LAK 268,508 million in 1999, LAK 340,744 million in 2000 and LAK 399,197 million in 2001, and net profits of LAK 46,908 million in 1999, LAK 39,902 million in 2000 and LAK 118,739 million in 2001. The ratio of operating income to net sales was 42.48% in 1999, 41.80% in 2000, and 45.56% in 2001 and is on the up. The equity ratio is also improving, and increased from 7.5% in 1999, to 9.5% in 2000 and 28.9% in 2001, and EdL is now achieving the target equity ratio of 20% that it established for 1993 onwards. Profitability of electricity supply service has been improved.

Interest on the debt and exchange rate fluctuation, as much as to equivalent to the operating income, has been accumulated. Aside from this project, EdL has borrowings totaling US$384 million, with four loans from the World Bank worth US$109.48 million, 13 loans from the ADB totaling US$204.81 million, two loans worth US$13 million from the Nordic Development Fund (NDF), and three loans from Laos banks worth US$54.3 million[7]. Those are sub loaned from the Ministry of Finance, the primary borrower, at the annual interest rate of 2.3% - 11.6%, with the burden of foreign exchange rate risks falling on EdL of the loans, In 1997, the LAK stood at 1,220 against the dollar, however, it depreciated dramatically in the wake of the economic crisis, and in November 2002, it had fallen to LAK 10,830 to the dollar. The collapse of the LAK has resulted in huge foreign exchange losses and this is affecting EdL's balance of payments.

To address these problems, in 2000 the Ministry of Finance put forward a draft plan to restructure EdL, and it is currently carrying out various fiscal reforms, including capitalization of loans, easing of sub loan conditions (interest rate reductions, extension of expiry dates, etc.), reevaluation of its fixed assets portfolio, debt write-offs, and so forth. The tariff collection rate stood at approximately 70% in 1996, however, no data has been obtained evidencing any improvement on this situation.Consequently, EdL is now achieving the target capital/equity ratio of 20% that it established for 1993 onwards.

Current ratio, a figure representing a stability in short term, sharply declined in 1998 and then stayed in the downward trend, however, recovered to 178% due to the government's financial support. The ratio of capital to fixed assets dropped to 137% in 2000, then improved to 93% in 2001. Those figures show the

[7] Source: EDL

EdL's financial stability has no urgent problem. On the other hand, the asset ratios, a figure representing stability in a long term, also showed similar increase to 1,226% in 1998 and then have been staying at high range even after recovering to 382% in 2001, that showed that EdL's financial improvement is crucial in a long term. Aside from the governmental supports mentioned above, a number of other measures to improve its financial status, including a electricity tariffs phased increase to cover supply costs, an execution of a system losses reduction plan, and a review of its tariff collection operations[8], are required to be continued.

Table 4: EdL Fiscal Indicators

	1997	1998	1999	2000	2001
Sales(Million LAK)	58,443	95,165	268,508	340,744	399,197
Operating Income (Million LAK)	4,820	-7,393	46,908	39,902	118,739
Foreign Exchange Fluctuation (Million LAK)	-2,058	14,335	38,875	120,643	78,122
Intrest(Million LAK)	13,116	36,493	99,437	90,683	43,073
Net Income (Million LAK)	4,820	-7,393	46,908	39,902	118,739
Total Assests(Million LAK)	537,422	1,138,029	2,362,929	2,669,694	2,618,065
Foreign Exchange Fluctuation comprised in Assets (Million LAK)	234,847	673,994	1,447,454	1,474,852	1,202,542
Net Income allocating Foreign Exchange Fluctuation from Assets (Million LAK)	-230,027	-446,540	-726,552	12,504	391,043
Long Term Loans(Million LAK)	391,085	898,673	1,845,022	1,505,671	1,823,097
Operating Income/Net Sales	31.70%	24.10%	42.48%	41.80%	45.56%
Capital/Assets Ratio	18.78%	10.98%	7.46%	9.51%	22.46%
Currenct Ratio	97.45%	60.49%	58.97%	27.60%	178.46%
Fixed Ratio	489%	856%	1226%	953%	382%
Ratio of Capital to Fixed Assets	100%	104%	107%	137%	93%

3. Feedback

3.1 Lessons Learned

Ownership and strong management capabilities on the part of the executing agency are key to the success of a project.

The project's success is attributed, in part, to a strong sense of project ownership among executing agency personnel and to operational management and technical support from a competent consultant. The support of a foreign consultant, extending over many years, has enabled local personnel to acquire project management capabilities of an international standard as well as the skills and technologies needed to guide

8 In 1996, the tariff collection rate stood at approximately 70%. There is no improvement in ratio afterward.

the project to success, and it is believed that these conscientious and thoroughgoing measures linked to major results. The strong sense of ownership among executing agency personnel has also had a favorable impact on the operation and maintenance of generation facilities and has helped to establish a relationship of cooperation with local residents.

To minimize adverse impacts, meticulous environmental conservation and compensation measures must be undertaken with the involvement of all parties from the planning stage.

Thanks to the fact that meticulous attention was given to environmental conservation measures and compensation during the execution of this project, it was possible to minimize any adverse environmental impacts. The measures were carried out via a series of careful surveys and processes undertaken from the planning stage, and the fact that the impact on the livelihoods of local residents was carefully vetted through a number of studies, that information was shared among all the parties involved, and that adequate feedback was undertaken, is believed to have been key to the success of the resettlement operation.

Improved performance as the result of co-financing

It is observed that co-financing this project with the ADB contributed to improvement of project performance through ADB's environmental/social considerations and its support for consultant's proactive action to accelerate work schedule, aside from diversification effect of financial risk associated with a mega-project, which is usually expected for co-financing project.

3.2 Recommendations

(To EdL) Many of its structural problems, its cash flow and tariff collection system, etc. may be attributed to the grave state of EdL's finances. To achieve sound management, EdL needs to endeavor to reduce both its uncollected bill ratio and transmission losses.

(To the Ministry of Finance) EdL's sound management is not only contingent upon efforts within EdL to reduce both its uncollected bill ratio and transmission losses, attempts by the Ministry of Finance to effectuate structural improvements will be necessary to enable EdL to break free from a structure under which profits from export sales are used to cover losses.

Comparison of Original and Actual Scope

Item	Plan	Actual
1. Project Scope		
1) Dam		
(1) Type	Rock-filled	Rock-filled
(2) Revetment height	46.5m	46.5m
(3) Revetment length	800m	800m
2) Storage reservoir		
(1) Area	12.8km^2	12.8km^2
(2) Capacity	154 million m^3	154 million m^3
3) Headrace tunnel		
(1) Length	2,814m	2,830m
(2) Internal diameter	3.5m－4.9m	3.5m－4.9m
4) Hydraulic pipeline		
(1) Length	471m	451m
(2) Internal diameter	2.4m－3.4m	3.4m
5) Power plant		
(1) Type	On land	On land
(2) Capacity	60MW (30MW × 2)	60MW (30MW × 2)
6) Transmission lines		
(1) Sections	Power plant-Paksane	(1) Power plant-Paksane (2) Power plant-Nam Ngum
(2) Voltage	AC 115kV	(1) (2) AC 115kV
(3) Circuit	Double	(1) (2) Single
(4) Length	85km	(1) 85km, (2) 55km
7) Access road		
(1) New	43.8km	38.575m
(2) Improved	39.4km	38m
8) Environmental impact countermeasures		
9) Consulting services	200M/M	315.5M/M
2. Implementation Schedule	Jan. 1996 – Jan. 2000 (49 months)	Jan. 1996 – Mar. 2000 (51 months)
Environmental impact survey	May 1994 – Dec. 1995	1 May 1994 – Dec. 1995
Detailed design	May 1994 – Dec. 1995	1996 – 2000
Tender evaluation	Jan. 1996 – Jul. 1997	Jan. 1996 – Oct. 1997
Civil engineering works	Oct. 1996 – Aug. 1999	Dec. 1996 – Dec. 1999
Steel structures	Jul. 1997 – Aug. 1999	Apr. 1997 – Nov. 1999
Electric equipment	Jul. 1997 – Jan. 2000	Apr. 1997 – Nov. 1999
Transmission facilities	Jul. 1997 – Jul. 1999	Oct. 1997 – Mar. 2000
3. Project Cost		
Foreign currency	10,314 million yen	9,550 million yen
Local currency	767 million yen (Local currency: Kip)	2,924 million yen (Local currency: Kip)
Total	11,081 million yen	12,474 million yen
ODA loan portion	3,903 million yen	3,902 million yen
Exchange rate	1 kip = 0.11 yen	1 kip = 0.188452 yen

Third Party Evaluator's Opinion on
Nam Leuk Hydroelectric Power Plant Construction Project

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Relevance

The Namleuk Hydropower Project is highly relevant to the Lao government's development plan and the needs of the local people to improve the living condition and environment. At the launch of the project, the government development plan focused on poverty reduction and the development of infrastructure. The latest policy focuses on industrialization and modernization.

The government of Laos has placed an importance on the production of hydro electricity not only as one of the primary tasks in the development plan, but also one of the major export and income sources for the government. Socio-economic Development Plan for fiscal year 1998-1999 of the State Planning Committee, approved by the second congress of the 4th National Council, dated September 28, 1998, mentioned that the hydropower dam construction is one of the outstanding income sources. The conference put a priority on the completion of Nam Leuk Dam construction in the fiscal development plan.

In the recent congress of the National Council, the government's development plan targets the country development on industrialization and modernization. Thus, power supply to industrial zone is one of the key contributions to support the functioning of industrial development.

The population in the project area as well as in Xiengkhuang Province does not have an access to stable electricity supply before the project. After the completion, although the power cost is high for the local people, they have an access to stable electricity.

The design of the plant is highly beneficial to not only the dam itself, but to the other dam. In the past, the water level at Nam Ngeum Dam decreased enormously in dry season, thus affecting the output of power production. After the completion of the Nam Leuk Dam, however, the water is released to the Nam Ngeum Dam Reservoire, increasing the efficiency of the dam.

Impact

The overall goal of the project is highly accomplished, in spite of minor delay in some tasks. The output of the project is higher than planned (with the difference of 59.43GWh, and 8.48GWh in 2000 and 2001 respectively). There are mostly positive impacts, both direct and indirect, as stated in the Nam Leuk Hydroelectric Power Plant Construction Project report. In addition, hydro electricity production is the only way for the country who does not produce hydrocarbon that causes the air pollution. Now the CO_2 emission right is a commodity traded in the international market.

The supply of power to the rural and remote area is one of the physical evidence of social-economic development and safety. When electricity access is available, the people affected feel confident and put more effort in improving the living environment. An example of the improvement is family entertainment, output of production and services, the feeling of safe living, and lifestyle.

One of the disregarded positive impacts is that the construction of the dam increases fishery and fish supply to the local area. Since Laos does not have an access to the sea for fishery resources, the dam reservoir is one of the main fish breeding sites, as evidenced by Nam Ngeum Dam. Currently, fishery at Nam Ngeum Dam reservoir is the major fish production source supporting the market in Vientiane and Luang Prabang.

The number of people who are affected by the dam construction differs on definitions and time of the data. But final figure of relocated families released by EdL is 16 and the affected people are well compensated.

In conclusion, the project is very efficient and the operation has achieved its objective in a timely manner without serious negative impacts. The accomplishment of the project has improved the income generation for the country, the society, the environment and the ways of lives of the local people.