CHAPTER 7
CONCLUSION AND RECOMMENDATION

Luang Prabang (LPB) province is one of eight Northern provinces, located in the center Northern part of Laos. It is consisted of eleven districts which has been electrified by Nam Dong small-hydro plant (1MW) since 1971. The Electricite' Du Laos grid has been connected to the center of LPB power substation in LPB district since 1994. The electricity is transferred from the Nam Ngum1 hydropower plant. Beside this, there are two other micro-hydropower plants, i.e., Nam Mong MHP (70 kW) which is built in 2000 and Nam Pa MHP (18 kW) which is built in 1998 are both as isolated grid plants system.

The objectives of this study are to demonstrate the effective cost and prove economic feasibility study of an improvement and rehabilitation three of existing micro-hydropower plants in LPB province Lao PDR. Improving their efficiency of operating performance by raising the rate of their energy production is a concept for sustainable development for the micro-hydropower plant, and it also leads to be more reliable supply of electricity energy in region of LPB province. From The results of feasibility study of these projects can be concluded as follows :

7.1 Case Study 1 (Feasibility Study for the Improvement Nam Mong MHP)

The improvement case of Nam Mong MHP is a technical and economical feasibility study for setting up the synchronous system with a Semi-Auto control system to Nam Mong MHP for connecting to EDL grid. The results of feasibility study can be concluded as follows:

1) Connection of Nam Mong 22 kV grid to the EDL's grid is technically and economically feasible,

2) The installed capacity is 70 kW and the average of the real energy generation is 185,809 kWh/year. The electricity consumption is only 121,620 kWh/year or 65% of real energy generation while the energy surplus is 64,086

kWh/year. This information directly related to the assessment of the economic of the project,

3) The total project cost is 9,900 US$,

4) The results of economic analysis based on an average import rate form PEA Thailand electricity tariff of 0.0563 US$/kWh and discount rate 10%. It was indicated that the project is economically attractive and summarized as follows :

Internal Rate of Return (IRR)	33%
Benefit-Cost ratio (B/C)	2.40
Net Present Value (NPV)	17,901 US$
Payback period	3.69 years
Unit Energy Cost	0.0235 US$/kWh

The synchronous system with the Semi-Auto control system is a necessity for Nam Mong micro-hydropower plant with the installed capacity 70 kW to connect to the EDL's grid region.

7.1.1 Recommendation

1) This study is an economic feasibility study, where the economic key indicators assist to the economic feasibility of the project. Furthermore, the project viability should be considered to the feasibility study in term of the financial analysis.

2) For sustainable operation, of Nam Mong MHP should have an appropriate plant management, i.e., organization, operation and maintenance (O&M), and regulations

a) Power Station Staff and Organization System.

To manage the Nam Mong MHP the EDL and The Provincial of Energy and Mining, management of energy generating for raise generation plant efficiency after the synchronous system has been set up and the number of operators should be reduce and become the EDL staff. In order to achieve the effective operation of Nam Mong MHP, to meet initial objective, and to achieve a long operation life by maintain the working function of facilities and equipment, The organization chart should be improve for O&M, and is suggested in the figure 7.1.

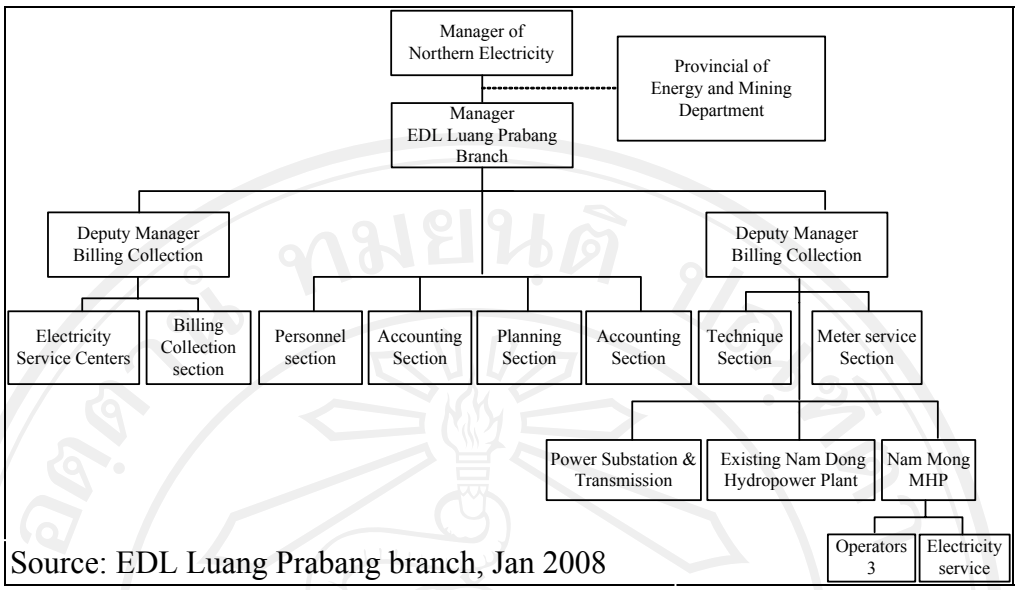

Figure 7.1 The Organization Chart of Electricity' after improvement by Connecting the Grid of Nam Mong to the grid of EDL.

The benefit of improvement of organization (See figure 7.1) will be as follows :

- Unaffected to the previous organization for the project is an under the provincial authority.
- The supplying of electricity for the seven villages and vicinity village in Nam Bak district will be more reliable
- The cost of O&M will be reduced and the project will be more sustainable

To achieve the effective operation of Nam Mong MHP, the maintaining the working function of facilities, equipment and O&M manual should basically prepared as follows:

a) Necessity of Good Operation and Maintenance

The operators have to operate and maintain Nam Mong MHP with strict compliance to its O&M manual. The operator should understand following :

- Operators must be efficiently conduct O&M of Nam Mong with the work plan, rule and regulation,
- Operators must be familiar themselves with all the Nam Mong MHP equipments and their performance or function in order to conduct corrective and preventive maintenance.

▪ Operators must always monitor plant's condition including facilities and equipment. When they find some trouble or accidents, they sould inform of it to a person in charge to recovery it, and

▪ Operators must avoid any accident. For the purpose, repairing or improving facilities are preventively conducted as necessary.

b) Management of Operation and Maintenance Aspects

The operation records of Nam Mong MHP and its equipment with contents of all maintenance works performance are important data in order to manage power station.

- Management of Operation Aspects

▪ Operation rule for water diversion, operation rule for intake gates, manual Star and Stop of main unit, operation rule for switching equipment should be easy for understanding.

▪ Operation Chart in a graphical presentation of operation chart should be easy to review and understand.

▪ Chart for the emergency communication and emergency communication route, method of communication, should be in the poster-like table for easy reference.

▪ Table chart of transmission line as a single line connection diagram and power transmission line network diagram are to be presented in one single poster to illustrate the relationship between switching equipment and corresponding charge (Energized) section.

▪ Daily operation logs, monthly operation logs, accident report for the maintenance on the station operation.

- Management of maintenance aspects

▪ Maintenance rule (Maintenance Manual) prescribes the intervals and method of daily and period inspection and indicates precise repairing for equipment.

▪ Record in custody is reports on daily and periodical maintenance work, accidents report, maintenance record, etc.

▪ Drawing for station Management, civil structures, electro-mechanical generating diagram and other drawing are necessary for maintenance work.

c) Capacity Building of Maintenance and Management Engineers

The engineers engage in the management of a power station should be grouped, by their expertise, into three fields of civil, electrical and mechanical engineers.

During the power station operation, daily work would be in the electrical and mechanical field and the O&M staff will require electrical and mechanical engineers skills.

7.2 Case Study 2 (Feasibility Study for the Development New Nam Dong MHP)

The objective of this study is to demonstrate the technical viability and economic feasibility for developing a New Nam Dong MHP by using the water outflow rate of the existing Nam Dong small hydropower plant in LPB province of Lao PDR.

The results of the feasibility study can be conclude as follows :

1) Incorporation of the plant structure connects at the tailrace existing Nam Dong hydropower plant. The project is technically and economically feasible.

2) The steel pipe with the inside pipe diameter 0.574 m and the total pipe length 345 m and completed with the standard support concrete is designed for the New Nam Dong MHP Project.

3) The powerhouse is planned to be constructed near the Nam Dong river bank. It is an indoor type and designed as concrete structure for 1 propeller turbine and generating facilities,

4) The suitable installed capacity is 100 kW and annual energy generation potential is approximately 575,769 kWh/year,

5) The 22kV distribution line from the powerhouse of New Nam Dong MHP to the EDL existing distribution line is 0.5 km long.

6) The total project cost is 227,150 US$/100 kW,

7) The results of economic analysis based on an average import rate form PEA Thailand electricity tariff of 0.0563 US$/kWh and discount rate 10%. It was

indicated that the project is economically acceptable. The results are summarized as follows :

Internal Rate of Return (IRR)	12%
Benefit-Cost ratio (B/C)	1.12
Net Present Value (NPV)	27,700 US$
Payback period	14.79 years
Unit Energy Cost	0.0502 US$/kWh

7.2.1 Recommendation

The decision making of an implementation New nam Dong MHP project should be considered or studied in term of the renewable energy resource for the Laos country. The positive effects of the project to the society as a whole including the benefit of electricity generated and minimal environmental impact to the local area should also consider as follows :

1) Environmental Assessment (EA)

An Environmental Assessment (EA) should accompany a feasibility study of New Nam Dong. It will determine the expected environmental impact due to construction, operation, and closing the project

a) Initial Environmental Examination

An initial environment examination (IEE) that is requirement in further of the EA should be prepared for the development New Nam Dong MHP. It should be a brief study to identify and describe the environmental and social impact of the project. It should consider the data that is available from the government of Laos, published data from similar project in similar locations, general fill observations, or others available data the results of IEE results.

The examination of potential impacts is the most important in the IEE. The potential impacts should be examined by using impact matrix as shown in table 7.1, (The Regulation Defined Environmental Assessment Process, See appendix B, Figure B.6)

Table 7.1 The Matrix for Scoping

	No.	Likely Impacts	Construction Phase			Operation Phase		
			Dam, Water way and Power facilities	Transmission	Access road	Water Intake	Water discharge	Operation of Power Station
Social Environment Regarding the Impacts on 'Gender" might be related to all criteria of Social Environment	1	Local economy such as employment, livelihood, etc						
	2	Land utilization of local resources						
	3	Social institution such as Infrastructures and local utilization institution						
	4	Existing Social infrastructure and Service						
	5	The poor, native and ethnic people						
	6	Misdistribution of benefit and damage						
	7	Culture heritage						
	8	Local conflict of interest						
	9	Water Usage or water rights						
	10	Sanitation						
	11	Hazard (Risk) Infectious diseases						
Natural Environment	12	Ground water						
	13	Soil Erosion						
	14	Hydrological Situation						
	15	Coastal Zone						
	16	Flora, Fauna and Biodiversity						
	17	Landscape						
	18	Air Pollution						
	19	Water Pollution						
Pollution	20	Soil Contamination						
	21	waste						
	22	Noise and Vibration						
	23	Ground Subsidence						
	24	Offensive Subsidence						
	25	Bottom Sediment						
	26	Accidents						

Rating: A: Serious impact is expected.

B: Some impact is expected

C: Extend impact is unknown

No Mark: No impact is expected IEA is not necessary.

2) Planning for Development New Micro-Hydropower Plant

The planning for development the New Nam Dong MHP or the other similar projects should be under taken with many major work items, i.e., identification of load center and power demand, the potential location based on the topographical maps (map study), water discharge, system layout planning for the scheme economic evaluation in order of economic viability. The procedural steps are shown in the figure 7.2.

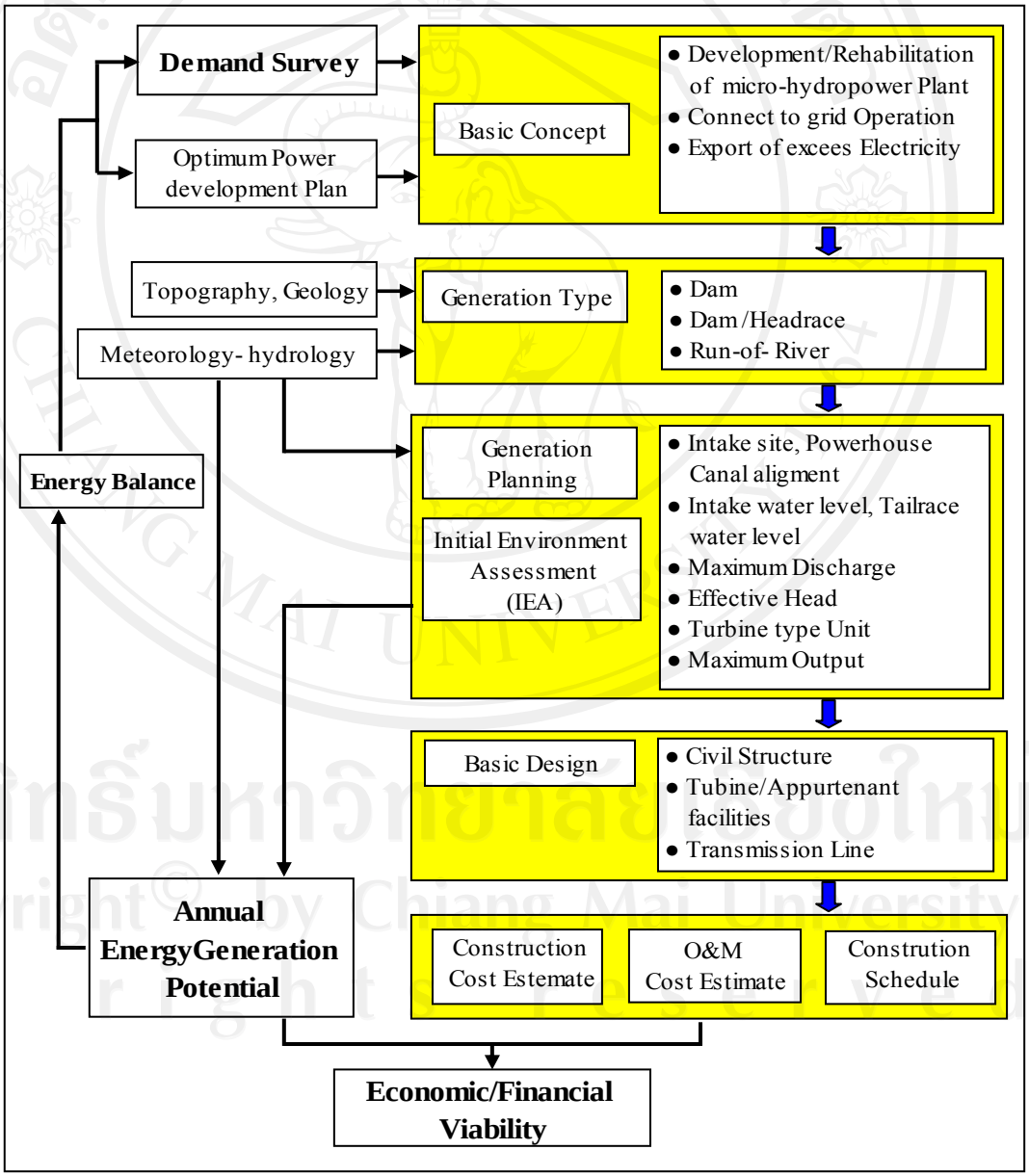

Figure 7.2 The flow chart for development New micro-hydropower Plant.

3) The Organization

To manage New Nam Dong MHP, the EDL planned to focus on managing the energy generating for raise plant efficiency of the existing Nam Dong small-hydropower plant. In order to achieve the effective operation of New Nam Dong MHP, to meet initial objective, and to achieve a long operation life by maintain the working function of facilities and equipment, The organization chart O&M should be required, and is shown in the figure 7.2.

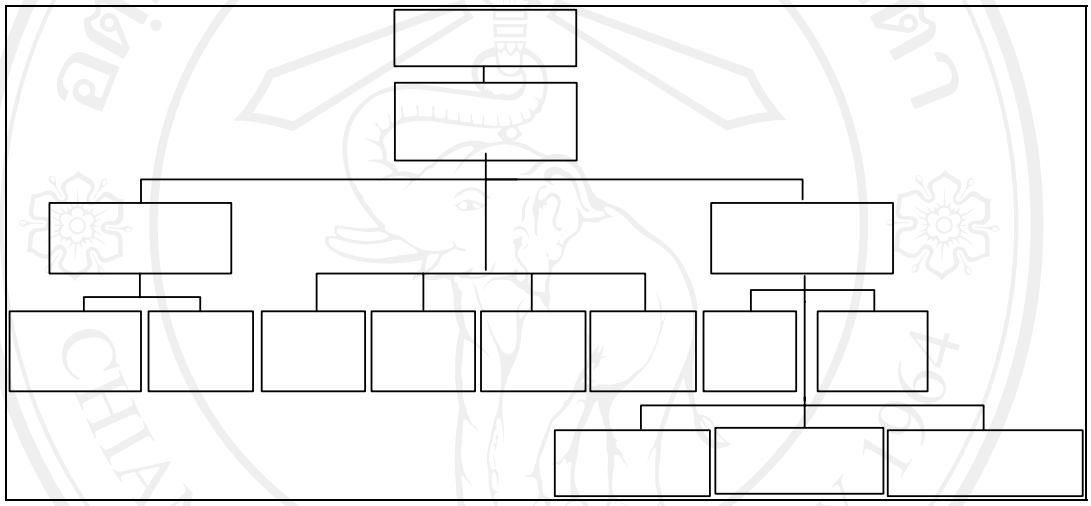

Figure 7.3 The Organization chart of the development New Nam Dong MHP

4) Operation and Maintenance (O&M) Management

For sustainable operation of New Nam Dong MHP, an appropriate O&M should be set up. To be able operation for long period if New Nam Ding MHP are properly operated and maintained. The Simple O&M Management should be considered by the following stage shown in figure 7.4.

Manage
Northern El

Manag
EDL Luang
Branc

Deputy Manager
Billing Collection

Electricity Service Centers | Billing Collection section | Personnel section | Accounting Section

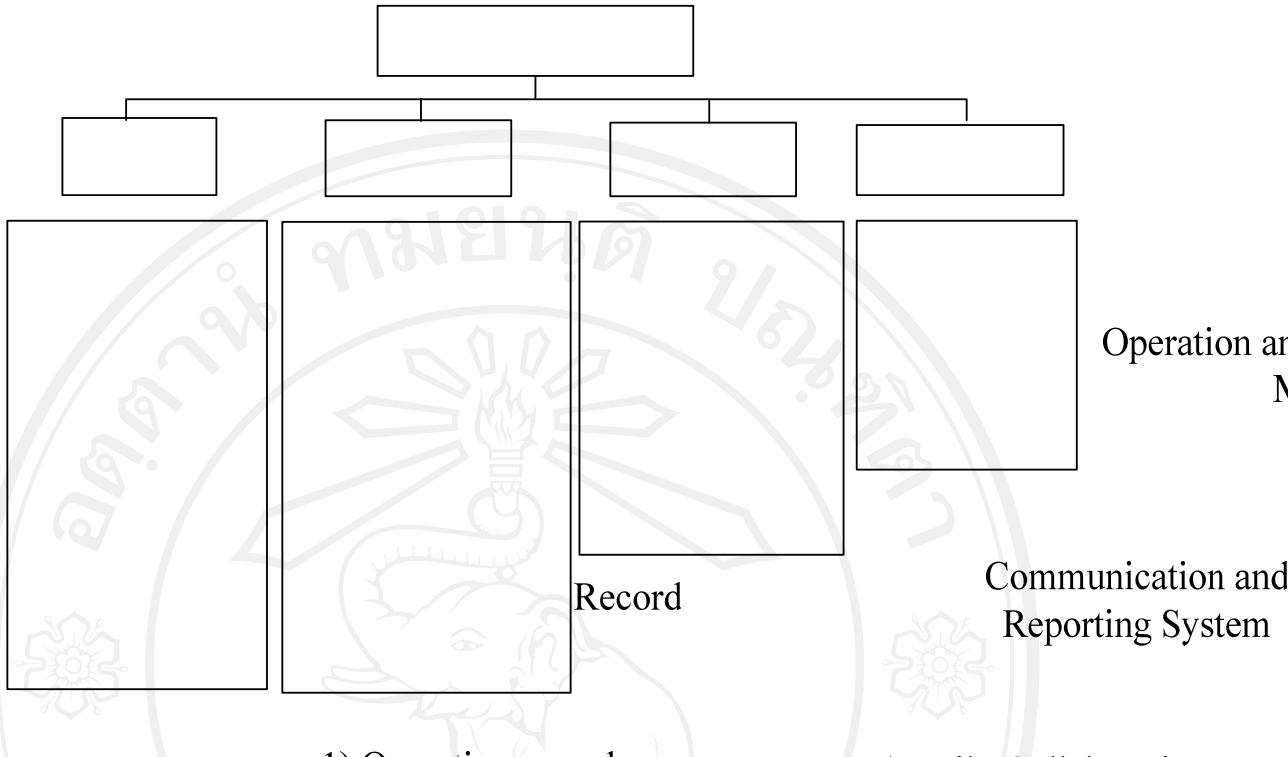

Figure 7.4 The Operation and Maintenance management chart.

7.3 Case Study 3 (Feasibility Study for the Rehabilitation Existing Nam Pha MHP)

The objective of this study is to demonstrate the technical viability and economic feasibility on the rehabilitation of the existing non-productive energy Nam Pha MHP incase of water supply is for multipurpose and generated electricity supply, the main purpose is for an irrigation. The economic indicators, i.e., Net Present Value (NPV), Benefit-Cost ratio (B/C) and Internal Rate of Return (IRR) are used to evaluate the viability of the project.

The result of the feasibility study can be concluded as follows :

1) The rehabilitation of project is done by modifying the plant structures. It is not technically and economically feasible to recover low elevation between the intake and the powerhouse that the effective head is only 4.56 m. It is therefore a very low energy production potential.

2) The installed capacity potential is 18 kW. The annual energy generation potential from the project is approximately 78,840 kWh/year,

3) The new 22kV distribution line will be 1.0 km long,

4) The total project costs 161,781 US$/18 kW,

5) The results of economic analysis based on an average import rate form PEA Thailand electricity tariff of 0.0563 US$/kWh and discount rate 10%. It was indicated that, the project is economically unacceptable. The results are summarized as follows :

The Benefit-Cost ratio (B/C)	0.19
Net Present Value (NPV)	(154,552) US$
Unit Energy cost	0.2866 US$/kWh.

7.3.1 Recommendation

Even though the results of study showed the rehabilitation of existing Nam Pha micro-hydropower plant is technically infeasible and is not economically acceptable. The further study should consider the benefit of multi purpose uses such as electricity, water, irrigation, etc.

The use of electricity is a main purpose, the feasible method is an extension the EDL's grid to Kok Vanh village where it was electrified electricity by Nam Pha MHP where and can electrify to other the vicinity villages. The 22 kV distribution line with 8.0 km long and its cost is approximately 120,000 US$1[1] included the costs equipment and installation should be considered, to meet the government targeting for poverty alleviation and the economic growth to eight Northern province for raise the electrification rate for the whole country to 90% by 2020 [10].

7.4 Benefit of Study

7.4.1 The results of this study can be used as a guide for rehabilitation and improvement for such micro-hydropower plants, the methodology can be widely used in a similar purpose of any other projects.

7.4.2 The study justify for the decision making to the efficiency and stability of electricity generation of the project.

[1] System Planning office, " Power Development Plan (2007-16)", EDL, March 2008