

# CHAPTER 1

## Introduction

### 1.1 Background of the Study

At present, electrical power is the most important for developing countries. Electricite du Laos (EDL) is the state enterprise company under Ministry of Energy and Mine, and it is the one of leading state enterprises of socio-economic development promoting in Lao People's Democratic Republic (Lao PDR) on power supply to consumers in nationwide, to make sure proper tariff of electricity and transform Laos to be the one of the major sources of power generation in the ASEAN power Grid. EDL ensures sufficient power supply in nationwide as well as the left over to sell out to the neighboring countries by a proper tariff for Lao socio-economic development according to Lao government policies, to leave the underdeveloped countries into a developed country and modern industrialization country in the future time.

The total of the power generations in Laos includes Independent Power Producers for exporting (IPP<sub>e</sub>) with the installed capacity of 2,295.10 MW which is 75.14% of the generations in the country, Independent Power Producers for domestic (IPP<sub>d</sub>) with the installed capacity of 368.586 MW which is 12.07%, The EDL-Generation Public Company (EDL-Gen) with the installed capacity of 386.04 MW which is 12.64% and Small Power Plant (SPP) with the installed capacity of 4.775 MW which is 0.16% as shown in figure 1.1 [1].

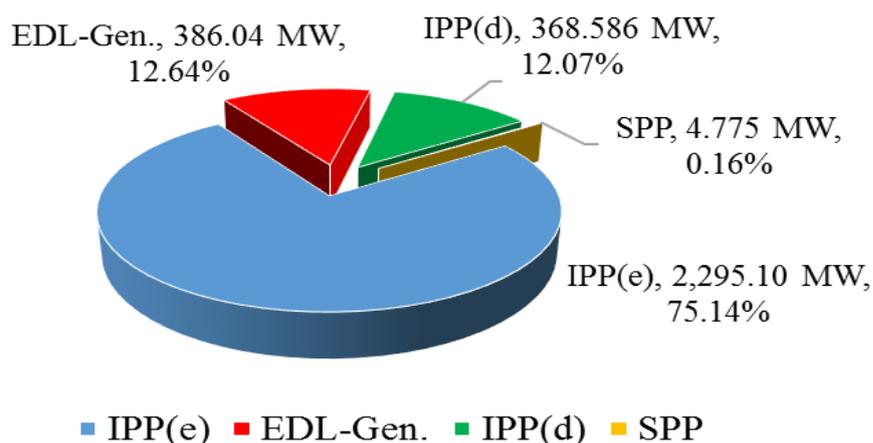


Figure 1.1 The existing generation of Laos country

The central-1 network includes of seven provinces such as Vientiane capital, Vientiane, Louangprabang, Xayaboury, Xaysomboun, Xiengkhouang, and Houaphan province. The generations which are supplied to these grid by EDL-Generation Public Company (EDL-Gen) as shown in table 1.1 and figure 1.2 which is namely: Nam Ngum 1 with capacity installed (155 MW), Nam Leuk (60 MW), Nam Mang 3 (40 MW) and Independent Power Producer for domestic supply (IPPd) Nam lik 1-2 with capacity installed (100 MW) and Nam Ngum 5 (120 MW). The central-1 network had been connected to the Electricity Generating Authority of Thailand (EGAT) system with 115 kV transmission lines [1-2].

Table 1.1 Existing Summary of generations in central-1 network of EDL

No.	Name of Hydro Power Plant	Location	Capacity Installation (MW)	COD	Ownership
1	Nam Ngum1	Vientiane	155	1971	EDL
2	Nam Leuk	Vientiane	60	2000	EDL
3	Nam Mang 3	Vientiane	40	2004	EDL
4	Nam Lik 1/2	Vientiane	100	2010	IPP <sub>d</sub>
5	Nam Ngum5	Xiengkhouang	120	2012	IPP <sub>d</sub>
<b>Total</b>			<b>475</b>		

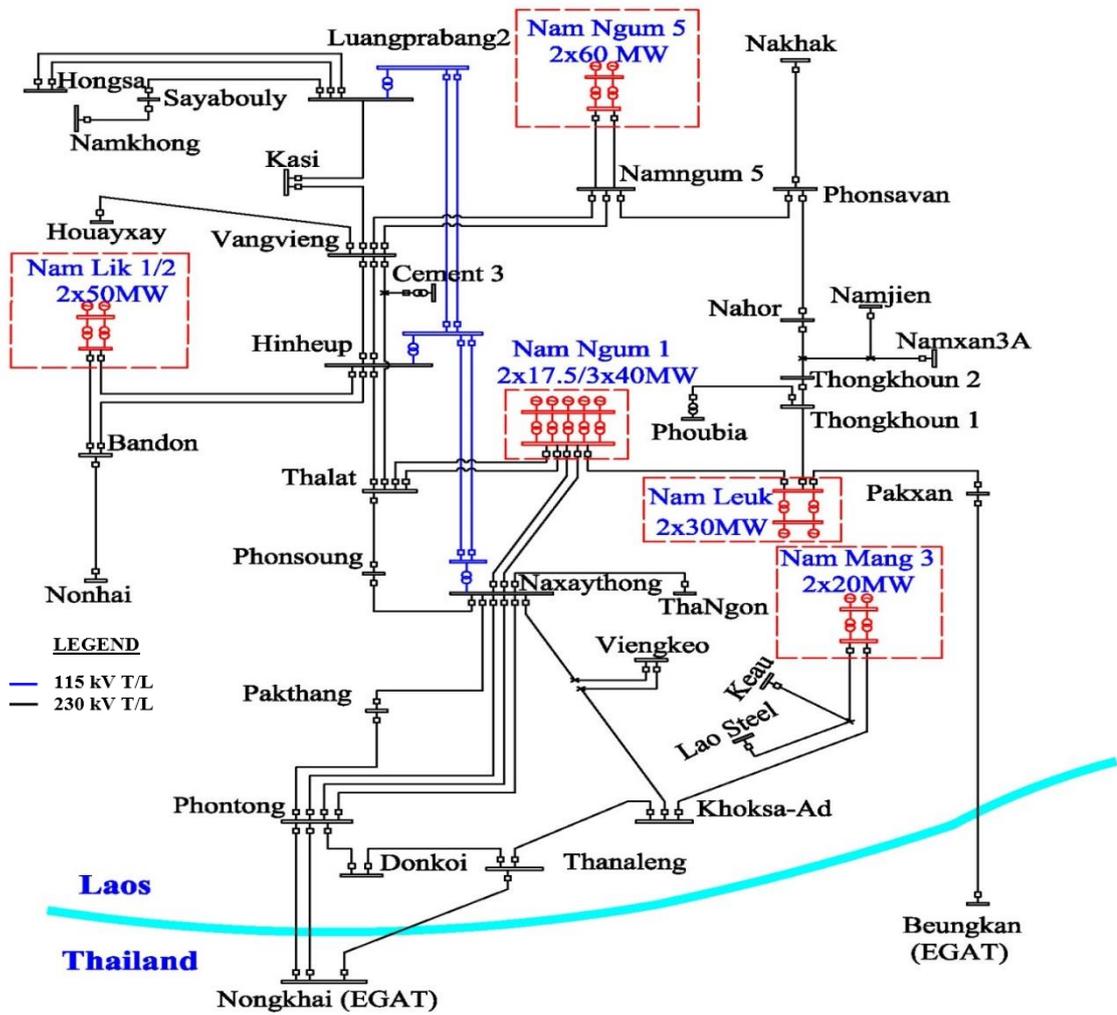


Figure 1.2 Existing single line diagram of the transmission system in central-1 network.

The EDL has power purchase agreement with each hydro power that supplied to the EDL's grid. The tariff each hydropower plants are different price as following in the table 1.2.

Table 1.2 The tariff of electricity from generation 2014

No.	Hydro Power Plant	Tariff (\$/kWh)
1	Nam Ngum 1	0.0533
2	Nam Luek	0.0533
3	Nam Mang 3	0.0533
4	Nam Lik 1-2	0.04822
5	Nam Ngum 5	0.04729

The power generation profile curves of the five hydro powers in central-1 network include EDL-Gen and IPP<sub>d</sub>. The data consider the average monthly generating 2014. The generation profile is different from other year which depends on water in the reservoir. The generation in central-1 network 2014 in EDL's grid is a hydro power plant as shown in figure 1.3.

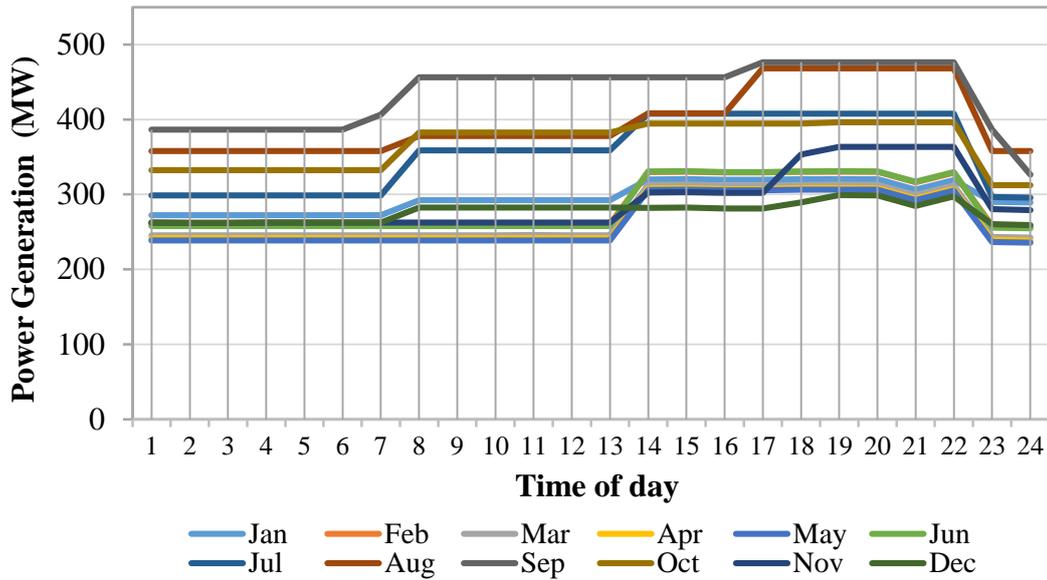


Figure 1.3 The power generation in central-1 network 2014.

The figure 1.4 shows the load demand curve a period of 24 hours in the central-1 network of EDL in year 2014 including Vientiane capital, Vientiane province, Xayaboury, Xiengkhouang, Xamneau and a part of Pakxan province. The demand load of EDL has two periods which are on-peak and off-peak. On-peak time starts at 09:00 a.m. to 10:00 p.m. This time period is usually higher usage of electricity because consumers are use electricity for working, industry, office, domestic and etc. Off-peak time starts at 10:00 p.m. to 09:00 a.m. This time power demand is usually low and the electricity supplied is cheaper rates than on-peak. Load profile curve is sum of load in central-1 network. The data average daily loads are different from other months.

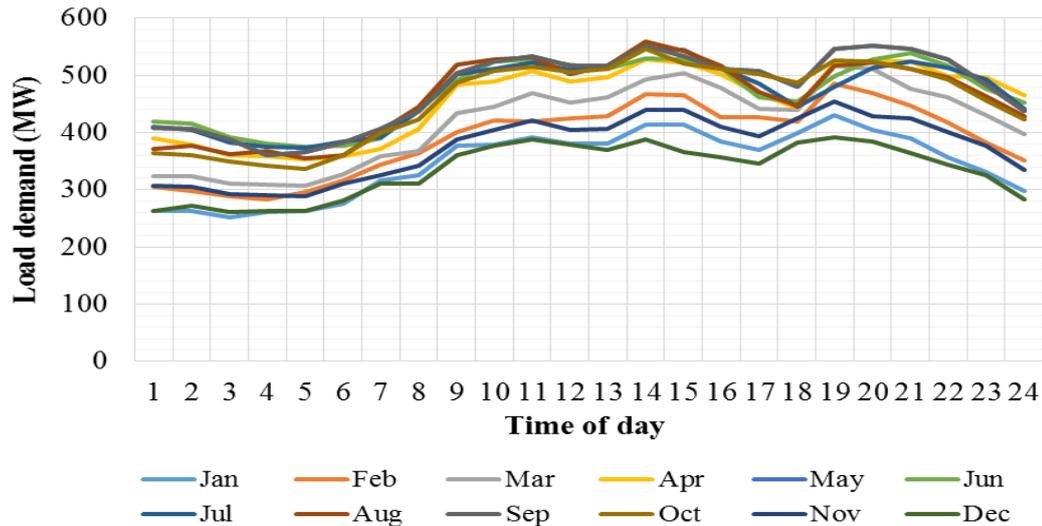


Figure 1.4 The power demand for the central-1 network 2014.

## 1.2 Rationale of the Study

In the past generations supplied to EDL's grid there is no many of hydro power plant. So, the EDL does not interest this point. At the present time, the generations supply to central-1 network of EDL was increasing. It is the most necessary to find the optimal economic dispatch for buying energy from other generation at minimum electricity cost. The consumptions grow up every year to ensure sufficient power supply in nationwide.

The purpose of this research studies on the optimal economic dispatch of generations in the central-1 network of Electricity du Laos, which have 5 generations in the system for finding the optimum cost.

The National Control Center (NCC) is the main control for control the EDL network such as transmission system and generation system shown in figure 1.5. The NCC is a very important issue for EDL of developing on the appropriate time. The main objectives of the NCC are control the system in order to keep reliable, stable in term of technical and economic aspects to efficiently manage power trading between EDL and EDL-Gen and Power Producers, to make the generation planning, to find the demand at each condition (Normal or Emergency).

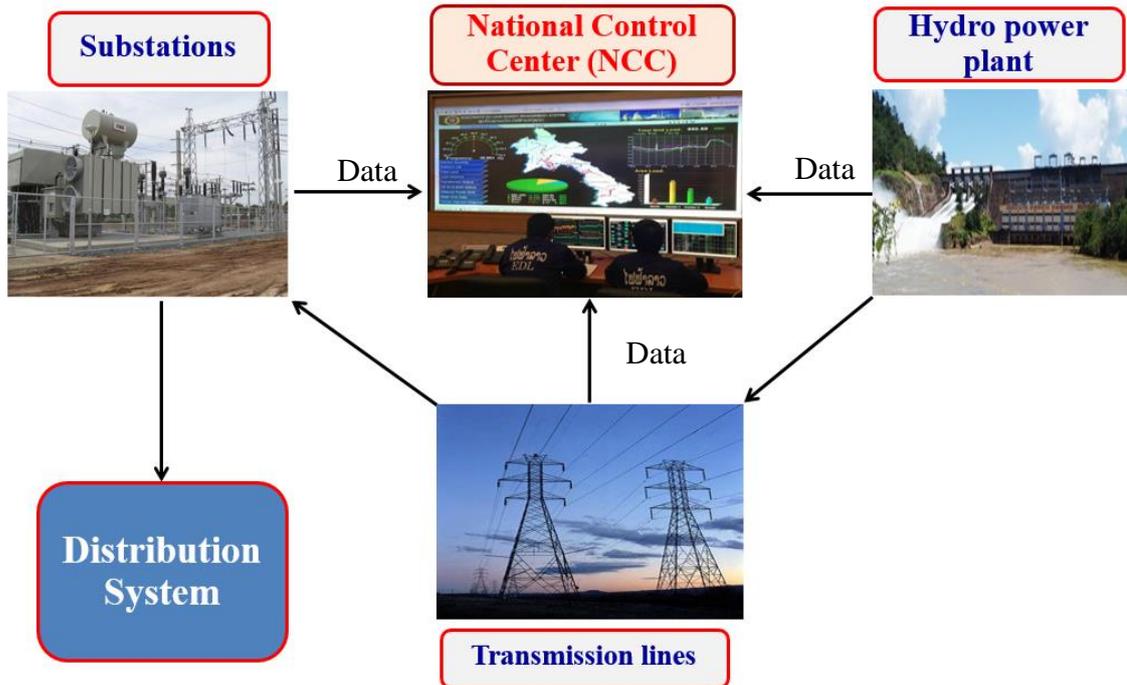


Figure 1.5 National control center of EDL.

### 1.3 Objectives of the Study

The main objectives of this research are as follows:

- To study the optimal economic dispatch of power generation from hydro power plants in the central-1 network of Electricity du Laos.
- To select the power generations at minimum electricity cost in the central-1 network of Electricite du Laos.

### 1.4 Scopes of the Study

The scope of study is the generation of transmission system in central-1 network of the Electricite du Laos as follow:

- Using actual data from generating, dispatching and parameters of the transmission system in the central-1 network for simulation power loss. The research has five hydro power plants namely:
  - Nam Ngum 1 hydro power plant.

- Nam Luek hydro power plant.
  - Nam Mang 3 hydro power plant.
  - Nam Lik1/2 hydro power plant.
  - Nam Ngum 5 hydro power plant.
- Consider cost function of power generation from base tariff and add transmission system loss.

### 1.5 Benefit of Study

- This research provides selection of power source and dispatch at minimum cost for generating electricity in central-1 network of Electricite du Laos.
- The results can be used for recommendation to saving cost for buying energy from power plants in central-1 network.
- To help operators of the national control center of Electricite du Laos decision for controlling electric power system to control power to higher efficiency.

### 1.6 Literature Reviews

Many researchers have suggested the principles which related to this research. I can summarize their researches as follows:

**M. Djukanovic, *et al.* [6]** studied the application of artificial neural networks to real-time optimal dispatch of generation of thermal units. The results showed the approach can take into account on the operational requirements and network losses. And the objective of optimal generation dispatch by using an artificial neural network for generation or penalty factors, which are depending on the input power of generator and identified system load change. After that, some additional iteration performed within an iterative calculation procedure for the solving of coordination equations by using reference-bus penalty-factors derived from the Newton-Raphson load flow.

**D. Rahul, *et al.* [7]** presented about economic load dispatch (ELD) is one of an important optimization tasks and operational decision which provides and economic condition for power system. It overviews of economic load dispatch problems and solution methodologies. MATLAB programming of different methods used for solving

economic load dispatch problem was done, and results are given in tabular form. Lambda iteration method is implemented for three cases of-without generation limits and losses, with generation limits and without losses and generation limits and losses.

**S. Panta, et al. [8]** studied about optimized the economic dispatch of electrical power plants by using an ANN. The method of economic dispatch for generating units at different loads must have total fuel cost at the minimum point. An obstacle in optimal economic dispatch of conventional methods is the changed load, and the back-propagation neural networks method to carry out instead the experimental results of electrical power system of 10 and 20 generating units respectively and the method used a feed-forward back-propagation type of neural networks to learn different condition in operation of each unit. By changing total load condition in one day, the minimum cost operation of each unit should be selected.

**D. O. Dike, et al. [9]** studied about economic dispatch of generated power using modified Lambda iteration method. The results showed the practical situations and under normal operating conditions, the generating capacity of power plants is more than the total losses and load demand. The power plants have different fuel costs, which are not the same distance from the load centers. So, we must develop methods from mostly remote load centers in the downtown. The software component propose try to estimate the optimal value of real power to be generated with the least possible fuel cost.

**N. Visali, et al. [10]** studied on economic load dispatch of thermal power plants using evolution technique including transmission losses. The results showed the economic dispatch is to minimize the operating fuel cost while satisfying the load demand and operational constraints. The proposed method is tested with two sample systems by considering various load demands. And the numerical have shown the performance and applicability of the proposed method. Also, the results obtained by the proposed method are compared with the existing methods.

**Z. Jizhongs, et al. [11]** studied a practical approach to implement the economic dispatch of the hydrothermal power system in Southern China. The results showed the propose economic dispatch method first computes the initial generation plans for all generator units including hydro units, which are determined according to the equal incremental principal of hydrothermal system. After that, the mathematical model of the

optimal dispatch which considered the network loss and security constraint, and it is set up based on the initial operation point. And the solution algorithm was modified interior point method. On the other hand, it showed the feasibility of the proposed dispatch method.



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