CHAPTER 1

Introduction and Literature Review

1.1 Background of the Study

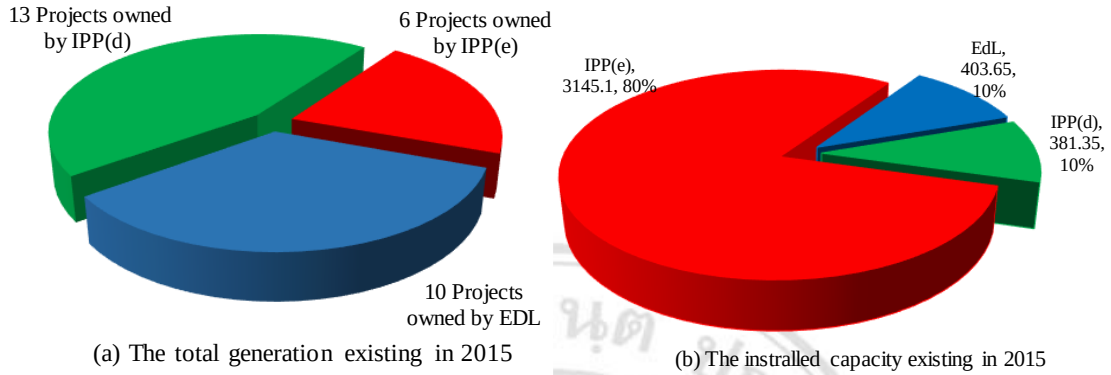
Lao PDR is a small country in Southeast Asian at the central of Indochina peninsular, and it lies between latitude 19.85° north and longitude 102.50° east. The Lao PDR has divided up the electric system four an area (North, Central 1, Central 2 and South).

Electricite Du Laos (EDL) is one of leading state enterprises in promoting and encouraging the socioeconomic development in Lao PDR by providing and supplying enough power to the nationwide with the reliable, cost-effective, and to become a power source in ASEAN countries, to secure both power supply to domestic demand and export to neighboring countries with reasonable price. The environmental and socioeconomic developments are the key issues to be taken into account for the generation development plan. To fulfill the policy of the party and government of Laos PDR and moving forward to become the modern industrialized country step by step, EDL is a thriving entity to take part in achieving the government targets. EDL is a state-owned corporation under the Ministry for Energy and Mines, which owns and operates the country's main generation, transmission and distribution assets in Lao PDR, and manages electricity imports into its grids and exports from its stations [1], [2].

1.1.1 The existing generation and load demand forecasts

The generation development in Laos PDR has been continuously developed. The power development plan (PDP) in 2015 have 29 projects and total installed capacity is 3,933 MW, the 10 projects are owned by EDL 403.7 MW, 10.27%, the 13 projects are owned by Domestic Independent Power Producer (IPP (d)) 381.4 MW, 9.7% and the 6 projects are owned by Exporting Independent Power Producer (IPP(e)) 3,145 MW,

78.9%. The existing generation and installed capacity in 2015 as shown in the Figure 1 [1], [2].



(a) The total generation existing in 2015 (b) The instralled capacity existing in 2015

Figure 1. 1 The existing generation and installed capacity in 2015.

The load demand forecasting is very important for EDL, to response the energy demand for the power development plan in the future. The demand forecast in north and central 1 area consists of the demand for residential, industries, demand for projects during the construction period and other service. The load demand forecast in north and central 1 area as shown in the figure 2. [2].

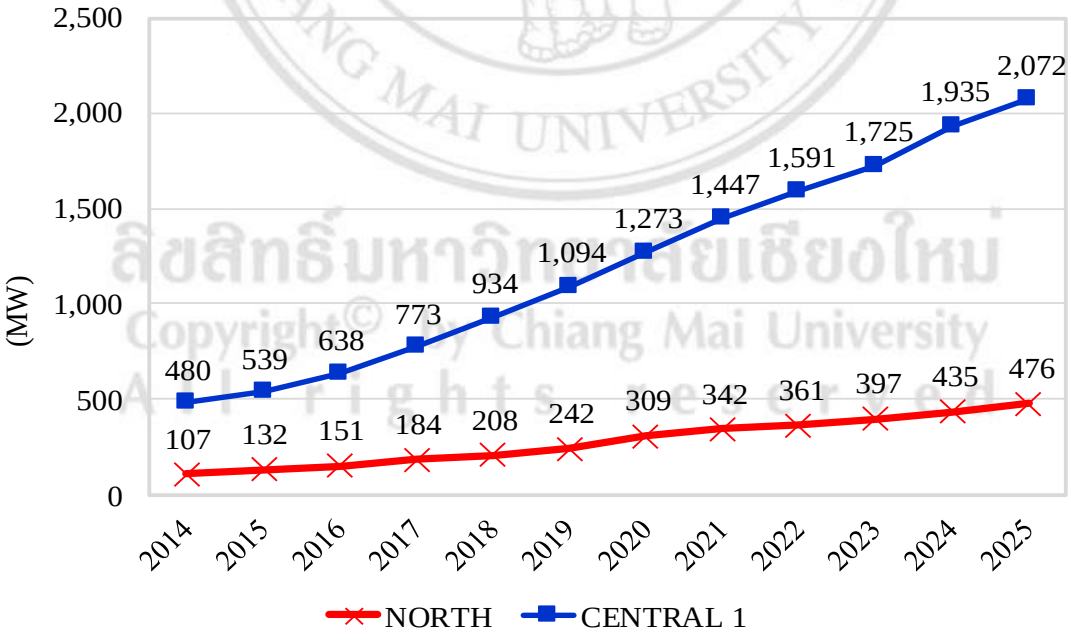


Figure 1. 2 The load demand forecast in north and central 1 area of EDL.

1.2 Rationale of the Study

Currently, the economic growing has increased rapidly in Laos PDR, causes domestic and foreign investors are interested to invest in industrial and mining exploration. Which causes the load demand increase and necessary in the generation development for response the electric demand increase.

Mostly in Laos PDR, the generation is hydropower which the lack energy in the dry season and the more energy produced in the rainy season. The generation development plan depends on whom development, that not regardless the location, transmission system, and techniques of EDL. Which this problem importance for the transmission system, voltage, load, fault, loss, and electricity import/export from neighboring countries such as China, Vietnam, and Thailand. Therefore the generation expansion planning is important of EDL, to the response load demand and the system planning appropriately.

From the power development plan of EDL (2015-2025), this will study in north and central 1 area. In that the north have more the generation development planning, and the central 1 have more energy demand such as: in Vientiane capital, to response supply in the special economic zone and industrial. This will study and analysis the power flow and the reliability system in north and central 1 area of the Laos PDR.

1.3 Objectives of the Study

1) To find the generation planning for reliability improving of the power system in north and central 1 area of Laos PDR.

1.4 Scopes of the Study

1) The study power development plan for generation planning and system reliability appropriate in the northern and central 1 of the Laos PDR (2015-2025).

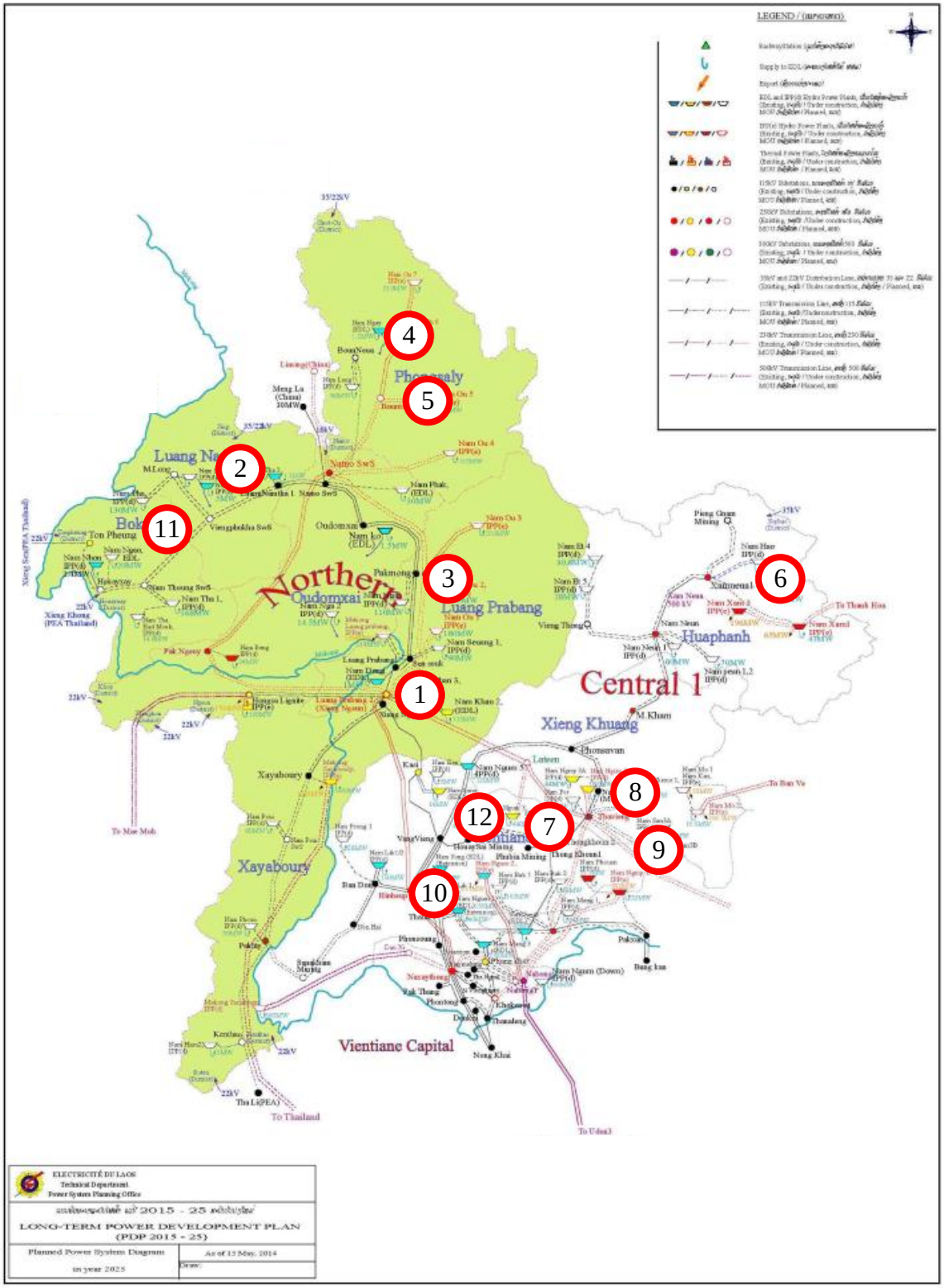
2) The planning considering for power development of EDL (2015-2025), in north and central 1 area of the Laos PDR. Especially, 12 projects to connected grid system, as shown in the table 1.

Table 1. 1 The 12 projects will connect to grid system.

No.	Name of project	Location	Installed Capacity (MW)	Owner-ships
1	Nam Khan3	Luangprabang	60	EDL
2	Nam Long 2	Luangnamtha	13	IPP.D
3	Nam Ou 2	Luangprabang	120	IPP.D
4	Nam Ou 6	Phongsaly	180	IPP.D
5	Nam Ou 5	Phongsaly	240	IPP.D
6	Nam Sim	Houaphanh	9	IPP.D
7	Nam Phagnai	Saysomboun	15	IPP.D
8	Nam Chien	Saysomboun	104	EDL
9	Nam San 3B	Saysomboun	45	IPP.D
10	Nam Lik 1	Vientiane Pro	64	IPP.D
11	Nam Tha 1	Borkeo	168	IPP.D
12	Nam Pai	Saysomboun	88	IPP.D

Remark: Electricité du Laos (EDL), and Domestic Independent Power Producer (IPP.D).

Figure 1.4 show the each project connected to the network system in the north and central 1 area of EDL.



Source: EDL, System Planning Office, [2]

Figure 1. 3 The location of projects study in north and central 1 area of the Lao PDR.

2). The calculation and analysis of the power flow and system reliability assessments, which used the software DigSILENT.

1.5 Benefit of Study

1) Appropriate the generation planning for improving reliability of power system in north and central 1 area of Laos PDR.

2) Attain grid line in the generation planning for improving reliability of power system for the EDL.

1.6 Literature Review

Research that was extensively studied in terms of determining the generation planning study for reliability system are as follows:

H. Kim, et al [3] have presented an optimization model for the planning problem of energy source expansion. The Bender's decomposition was used in this model to exploit effectively network system. The demonstration results are a practical and flexible tool to solve the real long-range for generation planning problems.

W. Gandulfo, et al [4] have presented a stochastic mixed-integer programming formulation (SMIP) for analyzing the generation planning to supply the energy demand to industrial and mining load large. In this research considers power loss in power system within the development in future. The results can be saved the cost of 1.1 % of generation investment.

H. Ying-Yi, et al [5] have presented the LOLE criteria for planning the power system. The simulation used is Monte Carlo to test the investment analysis of power system expansion. The method has efficient for solving impact of the electric system. This method is developed the small power generation for improving the reliability system within 15 years in the future.

A. Yaghoo, et al [6] have proposed the expansion planning of generation and transmission system. The method used is equivalent load duration curve to compute load probability of the criteria loss, expected energy not supply. These results help to plan for the power system expansion in next five years from 1991 and 1996 of each region of Iran.

P. Tiabrat and B. Eua-arporn [7] P. Tiabrat and B. Eua-arporn have presented a method for generation system expansion planning, which is considered from load forecast uncertainty and energy limited units. The method is based on predefined risk criteria which is evaluated by the probabilistic methodology to ensure the adequate and appropriate power supply for long-term demand.

B. Alizadeh and S. Jadid [8] B. Alizadeh and S. Jadid [8] have presented approach the expansion planning problem of the power system. This research used a mixed integer programming to cover difference constraints. This method presents a static plan which analyzes and evaluates the minimum cost deviation from the initial point (Pre-expansion conditions) in a manner which matches the peak load requirements of the planning period (post-expansion conditions). The project has capable of suggesting an economical level of reliability for a given system by reflecting cost and worth of reinforcements. To numerically evaluate the efficiency of the proposed method, simulation results on the modified Garver6-bus and IEEE 30-bus systems are provided. In spite of huge computation burden at hierarchical level II (HLII) reliability assessment, the results indicated the high efficiency of this proposed method.

P. Kongmany, et al [9] have presented the transmission development plan of Electricite du Laos (EDL), that consider in the central-1 and northern regions of the Lao PDR for the years 2010-2020. The power flows analysis steady-state of peak load is conditions base on the contingency (N-1). The improvement in the power development plan of EDL is the reliability adjustment of the network. The economic reasoning will indicate the internal rate of return and the benefit cost ratio of each transmission system expansion project. This research is used DIgSILENT software for the power flow analysis and transmission system reliability assessments.