CHAPTER 3

Laos' Power System

3.1 Current operation situation of PDNs in Lao PDR

Electricite Du Laos (EDL) has a function to contribute socio-economic development of the nation by mean of: Generation, Transmission and Distribution of the electrical energy to meet domestic demand including power trading with neighboring countries following the power purchase agreements (PPA). EDL is running its business by following the business law of Lao PDR and avoiding any activities that may adverse impact to the common benefit and socio-economic development of Lao PDR.

3.2 Generation

The growth of power generation development in Lao PDR has been electrified more increased for supplying the demand, which compared with 2005 total capacity generation 670.8 MW (not included renewable energy). In this regard, 308.7 MW is belonging to EDL and 362.1 MW is belonging to IPP. The generation development increased 172% compared with 2008 as shown in Figure 3.1 is achieved.

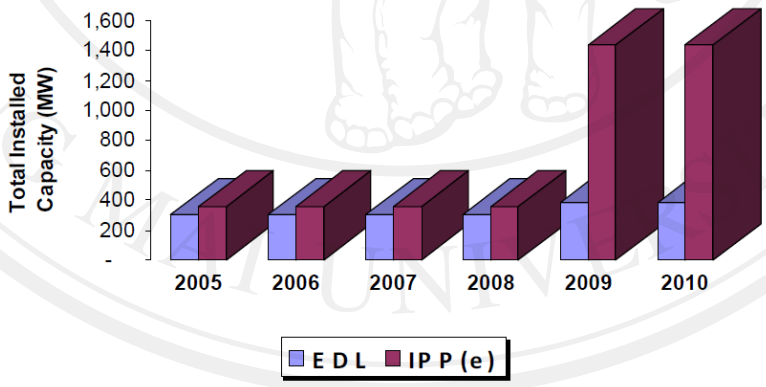

Figure 3.1 The growth of power generation in Lao PDR 2005-2010

Nowadays, the transmission system in Lao PDR has not connected each other. As a result, the generation capacity in 2009 total 1,826.8 MW, which all generation come from hydro power plants, increased 670.8 MW in 2009 about 1,156.0 MW from additional generation from Xeset 2 Hydro Power Plant and Namtheun 2 Hydro Power Plant. Moreover, EDL shared to generate accounts for 20.9%, IPP accounts for 78.9%.

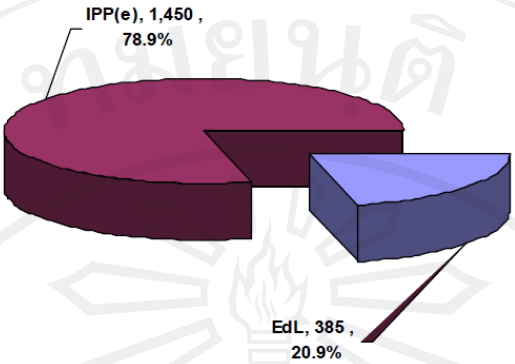

Figure 3.2 The Generation Capacity in 2010

Figure 3.3 The existing hydropower plants in Lao PDR.

3.3 Transmission

The existing 115 kV transmission systems in this area are connected with three (3) major hydropower plants namely: Nam Ngum 1 (155 MW), Nam Leuk (60 MW) and Nam Mang 3 (40 MW). These plants are supplying electric energy mainly to Central area and some parts of Northern area. The 115kV transmission system in this area is also interconnected to EGAT's system for the purposes of exchange power each other (import/export). There are two interconnection points namely: 1) from Phontong substation (Lao PDR) - Nongkai substation (EGAT, Thailand) by double (2) circuits of 115kV transmission lines and Single (1) circuit of 115kV transmission line from Thanaleng substation (Lao PDR) - Nongkai substation (EGAT, Thailand) and 2) from

Pakxan substation (Lao PDR) - Bungkan substation (EGAT, Thailand) by Double (2) circuits(Strung one circuit) of 115kV transmission line. In the horizon 2010-2020, the network in the Central area will be interconnected with neighboring countries system by 230kV transmission line with EGAT (Thailand) systems, from Nabong 1 substation, Vientiane Capital (Lao PDR) - Nongkhai 2 substation in year 2016. Moreover, this system will be connected with Southern area by 230kV transmission line from Thavieng - Thasala- Mahaxai substations in year 2016.

The high voltage transmission system development plan in Central area in horizon 2010-2020 owned by EDL, SPP/IPP(d) and IPP(e) are shown as follows:

♦ The total lengths of the planned transmission lines to be developed in horizon 2010- 2015 there are 753 km, 1,344 circuit-km owned by EDL, and 129 km, 246 circuit-km owned by IPP(d) respectively.

♦ The total lengths of the planned transmission lines to be developed in horizon 2016-2020 there are 40 km, 78 circuit-km owned by EDL, 121 km, 207 circuit-km owned by IPP(d) and 35 km, 35 circuit-km owned by IPP(e) respectively.

♦ The total lengths of the transmission lines to be developed in horizon 2010-2020 there are 793 km, 1,422 circuit-km owned by EDL, 250 km, 453 circuit-km owned by IPP(d) and 35 km, 35 circuit-km owned by IPP(e) respectively.

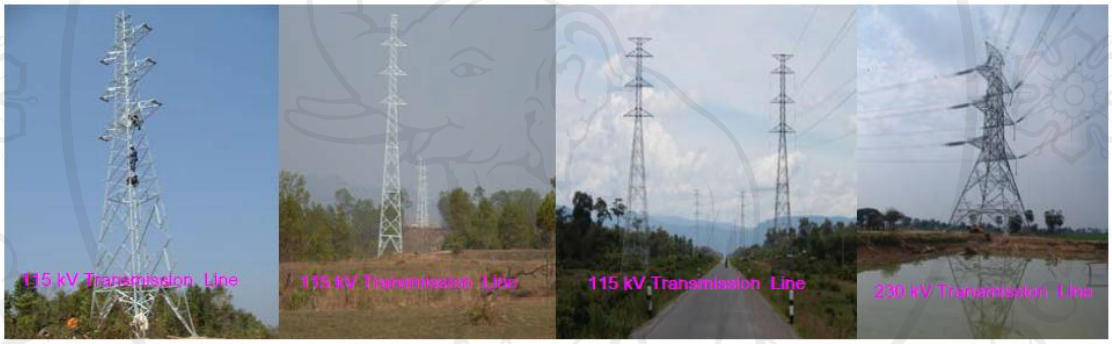

Figure 3.4 Existing high voltage transmission line in Lao PDR.

3.4 Distribution

EDL's distribution system included 12.7 kV, 22 kV, 25 kV, 34.5 kV and 35 kV in which these system have expanded to the urban and rural areas from distribution substation 115/34.5/22 kV. But the low voltage system is 400/220 V, 3 Phases. The statistic distribution networks for MV from 2003 to present has been expanded continuously range 6-15% per year; as shown in figure 3.5.

Figure 3.5 Distribution MV(12.7kV, 22kV, 25kV, 34.5kV and 35kV and LV 0.4 kV

Refer to the statistics of medium voltage network since 2003 up to 2009, the growth rate was in the range of 6-15%

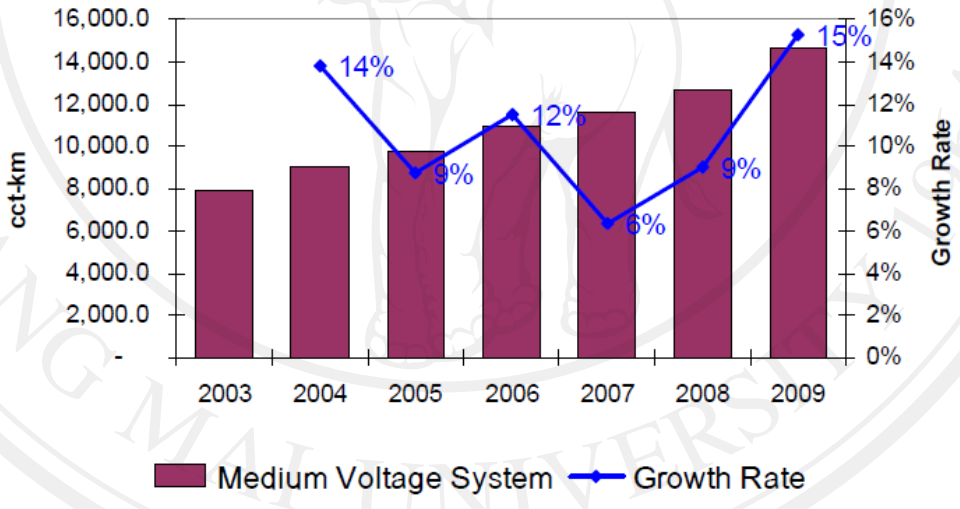

Figure 3.6 Historical trend of medium voltage system

The growth rate of installed capacity of distribution transformers in horizon 2003-2009 was in the range of 9-15%

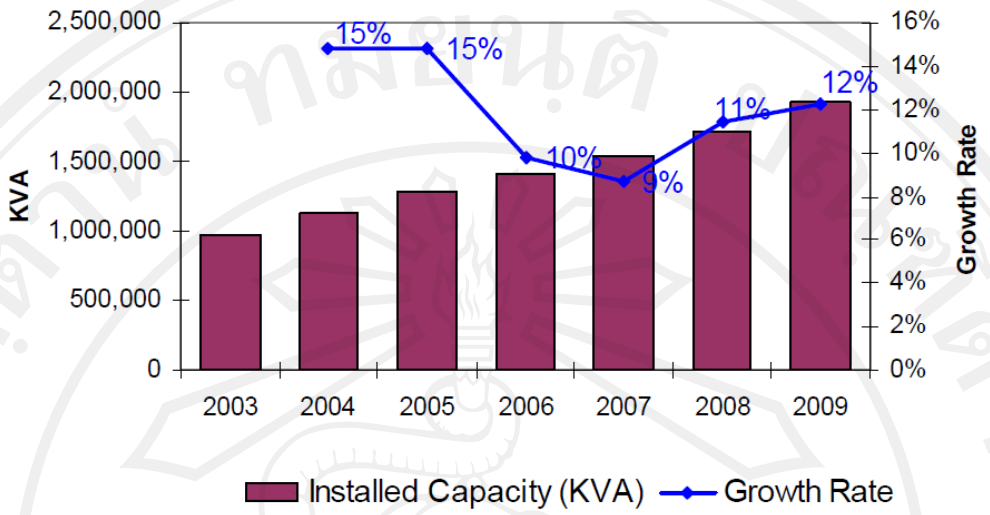

Figure 3.7 Historical trend of installed capacity of distribution transformers

3.4.1 Central area

Central Area consists of major network systems and largest number of consumers. There are three (3) major supply sources namely: Nam Ngum 1 (155 MW), Nam Leuk (60 MW) and Nam Mang 3 (40 MW). These power plants supply electric energy to Central area and some parts to Northern Area. The transmission system in this area is interconnected to EGAT's system via the 115kV system for the purposes of exchange power each other (import/export).

The average growth rate of energy demand (including system losses) and Peak Load in period 2010-2016 are 9.8% and 9.1% per annum respectively.

Table 3.1 Energy demand (Including system losses)

Unit= GWh

	Actual	Forecast						
	2009	2010	2011	2012	2013	2014	2015	2016
Vientiane Capital								
Residential Sector	983.4	1,046.6	1,116.3	1,193.3	1,279.0	1,374.4	1,480.7	1,598.9
Large Industries	-	66.2	221.8	401.6	401.1	400.5	408.3	468.2
Total	983.4	1,112.8	1,338.1	1,594.9	1,680.1	1,774.9	1,889.0	2,067.1

Table 3.2 Energy demand

Actual		Forecast					Unit= GWh	
	2009	2010	2011	2012	2013	2014	2015	2016
Vientiane Capital								
Residential Sector	828.8	885.2	947.6	1,016.7	1,093.6	1,179.3	1,275.1	1,381.8
Large Industries		56.0	188.3	342.2	342.9	343.7	351.6	404.7
Total	828.8	941.2	1,135.9	1,358.9	1,436.5	1,523.0	1,626.7	1,786.5
System losses	15.7%	15.4%	15.1%	14.8%	14.5%	14.2%	13.9%	13.6%

Table 3.3 Peak load

Actual		Forecast						
	2009	2010	2011	2012	2013	2014	2015	2016
Vientiane Capital								
Residential Sector	197.1	206.6	217.2	228.8	241.8	256.1	272.2	289.9
Large Industries	0	8	44.1	93.2	93.3	93.4	102.5	111.4
Total	197.1	214.6	261.3	322.0	335.1	349.5	374.7	401.3
Load factor of residential	57.0%	57.8%	58.7%	59.5%	60.4%	61.3%	62.1%	63.0%
Load factor of large industries		94.5%	57.4%	49.2%	49.1%	48.9%	45.5%	48.0%

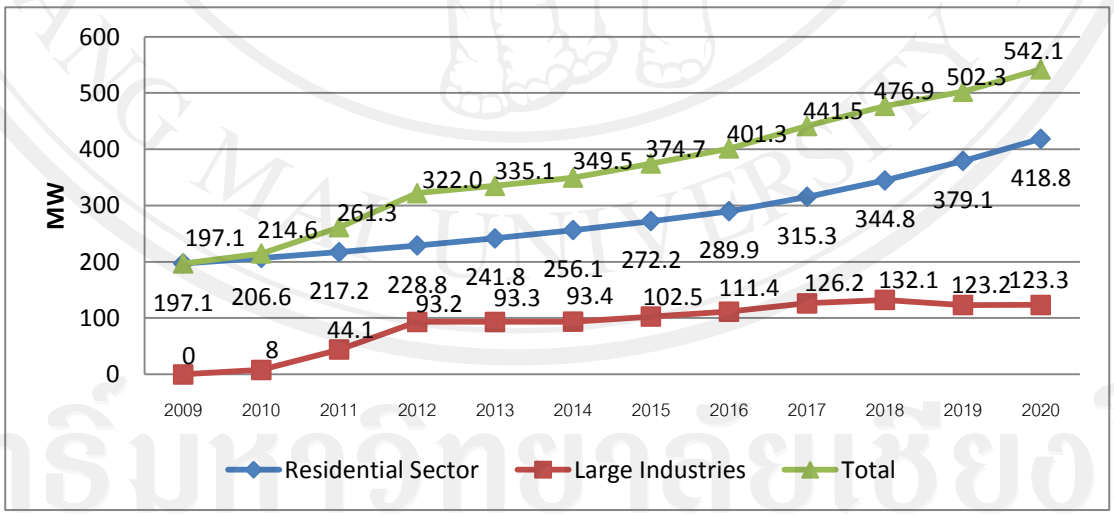

Figure 3.8 The summary of electricity demand forecast for Central Area.

Figure 3.8 is shown the summary of electricity demand forecast for Central area in horizon 2010-2016. The electricity demand forecast consists of the demand for Residential, Industries, Demand for projects during construction period and others. The results of forecasting indicated that the electricity demand forecast for residential

sector is normally increased while electricity demand for the industrial sector is abnormally increased in horizon 2012-2018 due to the demand for the projects during construction period.

The existing distribution system in Vientiane Capital consists of nine substations which as following: The substation includes two types: A type are five of 115kV/22kV substations such as: Phonethong Substation has 5 Feeders, Naxaythong Substation has 3 Feeders, Thanaleng Substation has 8 Feeders, Thangone Substation has 4 Feeders, Khoksa-at Substation has 3 Feeders and Second type is 22kV substations includes four substations such as: Sokpalaung Substation has 6 Feeders, Sesakhet Substation has 6 Feeders, Thatlaung Substation has 4 Feeders and Dongnasok Substation has 4 Feeders.

The power losses (including technical and non-technical losses) is calculated based on recorded power consumption in each distribution substation and sold power from the billing system. The power losses in the Vientiane Capital from 2006 to 2011 are shown in the table 4.3

Table 3.4: Results of power losses of the Vientiane Capital

Year	Power losses (%)
2006	19.17
2007	17.32
2008	14.99
2009	12.67
2010	11.88
2011	11.55

3.4.2. Load characteristics

Vientiane capital is an industrial, commercial, service and tourism centre of central region, there are a few industrial zones consume not much electricity, most of loads in the city are domestic and commercial load.

The character of electric load itself changes as a function of the number of consumers. Consumers may be conveniently classified into certain categories. Certain ranges of load densities (normally expressed in kVA or kW) depend on customer's demand. Some of categories are classified as follows:

1. Re: are usually loads in household such as lighting loads (neon lights, fluorescent lamps), heating loads (cooking, hot water heaters, irons, other appliances).
2. Commercial: This type of load mainly consists of lighting for shops and advertisement boarding, fans, air-conditioning, heating and other electrical appliances used in commercial establishments, such as shops, restaurants, market places, etc.

3. Industrial: are loads in manufacturing plants, military bases. Extremely wide variations, most of load are induction motors so the power factor is low.
4. Agricultural: This type of load is required for supplying water for irrigation by means of suitable pumps by electric motors.
5. Other loads: Apart from the loads mentioned above, there are other loads such as bulk supplies, street light, loads in hospitals, schools, and government loads.

Figure 5 it is shown load profile curves of sum feeders in nine substations. The data consider average daily loads on May 2011. Load profile for this month is higher than other months on 2011.

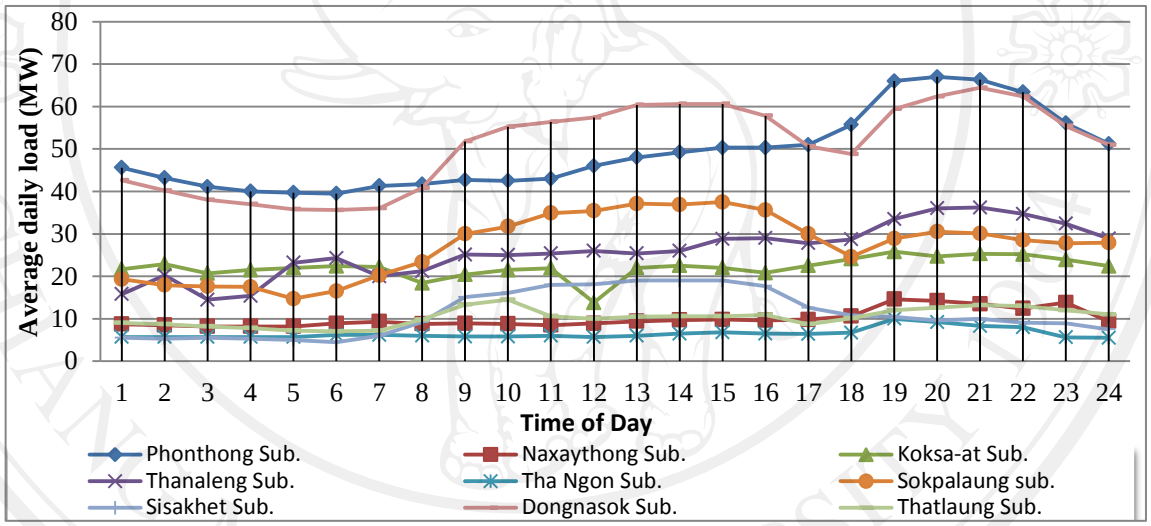

Figure 3.9 Summary the average daily loads of nine substations in Vientiane Capital

3.4.3 General characteristics of distribution system in Laos

The followings are lists of general characteristics of distribution system in Laos that are defined in the distribution design manual of EDL as shown in table 3.1 below.

Table 3.5 Standard distribution system configuration

Voltage level	Standard system	
	Phase	**Wire**
Medium	Three	Three
	Two	Two
Low	Three	four
	Two	Two

Table 3.6 Frequency and voltage limit

Items			Limits	
			Upper	**Lower**
System frequency	50 Hz		50.75 Hz	49.25Hz
Medium	Nominal	22,000 V		20,900 V(-5%)
	Desired	22,500 V		
Low voltage	Line- neutral	230 V	243.8 V (+6%)	207 V (-10%)

3.5 MV distribution

The standard EDL MV distribution voltage is 22kV. The system is three-phase, solidly grounded. The related design voltages and insulation levels are:

- Nominal voltage 22kV
- Highest (operating) system voltage approx. 23kV
- Highest system voltage for equipment (Um) 24kV
- Power frequency withstand 50kV
- Rated impulse withstand 125kV

The above values are consistent with Um = 24kV from IEC60071-1.

3.6 Standard medium voltage supply

- Frequency 50Hz ± 0.75Hz (ie. 49.25Hz to 50.75Hz) apart from momentary fluctuations.
- Three-phase 3-wire solidly grounded system.
- 22,000volts between phases for 2-wire single supply,
- 22,000volts between phases for three-phase supply.
- A tolerance of ± 5% on nominal voltage apart from momentary fluctuations.

3.7 Distribution system configurations

3.7.1 Three phase MV

The most widely used systems of MV distribution are three-phase. EDL has standardized on the 3-wire solidly earthed configuration. The characteristics of

this configuration are a three-conductor main distribution network supplied from a star connected transformer(s) at the major substation with a solidly earthed neutral. Three-phase MV/LV distribution transformers are connected to all three phases directly on the main line or on 3-wire spur lines. The system also allows the use of transformers with a 2-wire primary (commonly called single phase) that are connected across any two of the three main conductors directly on the main line or on 2-wire or 3-wire spurs [2].

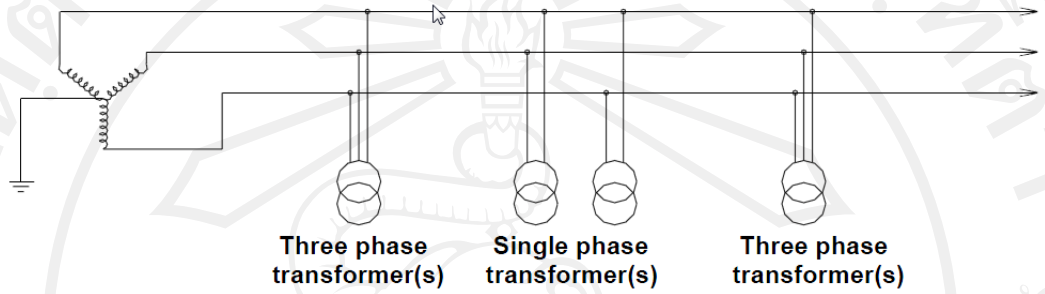

Figure 3.10 MV, Three-phase, three-wire system

A three-phase backbone feeder may commonly have a rating of up to about 8MVA usually limited by permissible volt drop. Three phase lines are invariably installed where there are motors of more than 5kW individual rating. Spur lines are of more limited capacity, say 500kVA, and if of 2- wire construction can only supply single-phase loads. Any electrical imbalance due to the presence of two wire spurs can be reduced by the connection of different spurs to different pairs of conductors on the three phase line to achieve equal current loading in each phase conductor along the main three phase feeder.

While some countries (eg. USA, Japan) use a three-phase 4-wire system with extensive use of phase-neutral single-phase transformers, the configuration could result in higher overall costs if used by EDL. The existing 3-wire solidly earthed configuration is entirely satisfactory for EDL, and should be retained. Any attempts to introduce alternative systems should be strongly opposed because of additional operational complexity and a wider range of required materials [2].