

VI-2 TELECOMMUNICATIONS DEVELOPMENT PLAN

VI-2.1 Overview

1) Institutional Setting

The telecommunications sector in Lao PDR has a centralized structure to provide the service. As a government body, the Ministry of Communications, Transport, Post and Construction, Transport (MCTPC) initially provided telecommunications service directly. Then, the Entreprise de Telecommunications Lao (ETL) was established as a public corporation (100% government owned) to provide telecommunications service. In 1996, the Lao Government and Sinawatra International established “Lao Telecommunications Company Limited (LTC) ” as a joint venture to take over most of the operations of ETL. The duration of this contract is 25 years from 1996 to 2021.

The separation between the government body and telecommunications service provider is still in progress. As a government owned enterprise, ETL receives grant aid from foreign donors but LTC actually utilizes them. Currently, responsibilities of ETL are in the following four areas:

- Development and operation of CSC (China-Southeast Asia Terrestrial Cable) project,
- Operating/maintaining the facilities granted by foreign donors,
- Telecommunications research and quality control, and
- Providing domestic and international telecommunication services (from December 2001).

In addition, the “Telecommunications Act,” which is now being discussed in the Parliament, is considering the establishment of a telecommunications sector regulatory body within the government.

2) Previous Development Plans

(1) The First Telecommunications Network Development Plan (1986-90)

The Plan was prepared under the Second National Development Plan. The sector plan improved the existing equipment and trained telecommunications staff with financial support from IDA. In 1990, the International Telecommunications Union (ITU) and UNDP engaged a consultancy firm DETECON to prepare a Long-term Development Plan (1991-2000).

(2) Telecom I and Telecom II (1992-95)

The two plans developed a digital communication system by replacing the short wave transmission backbone. The following facilities were installed:

- Digital switching system:
 - Vientiane (3 main stations and 7 remote stations)
 - Other 5 cities (4 main stations and 1 remote station)
 - Added 17,200 lines
- International telecommunications system:
 - Installed direct links to Japan, Hong Kong and Singapore in addition to Australia.
- Microwave transmission system:
 - Installed microwave transmission system between Luang Prabang and Pakse (1178 km). The system works as a backbone of the current system. It has 34 Mbps capacity in PDH (Plesiochronous Digital Hierarchy).
- Rural telecommunications system:
 - Installed 11 rural telecommunications systems for 208 subscribers.

(3) Telecom III (1994-97)

In 1993, ITU and DETECON prepared a plan to increase the capacity to 20,000 by 1995. ITU revised the plan and prepared Telecom 2000.

(4) Telecom 2000 (1996-2000)

The plan set the target of capacity as 51,018 in 2000 and 101,950 in 2005. The plan has been implemented by LTC after the cooperatization scheme. It includes the following components:

- Expansion of network
- Separation between the international and long distance exchanges
- Development of CSC optic fiber project
- Introduction of a service system for subscribers
- Improvement of the training center

3) National Network

The national telecommunications network in Lao PDR is still at its infancy. Based on the Telecommunications Master Plan, supported by ITU in 1988, the national backbone was constructed by the microwave transmission system in 1994 as a part of Telecom II program as shown in Figure VI.2-1.

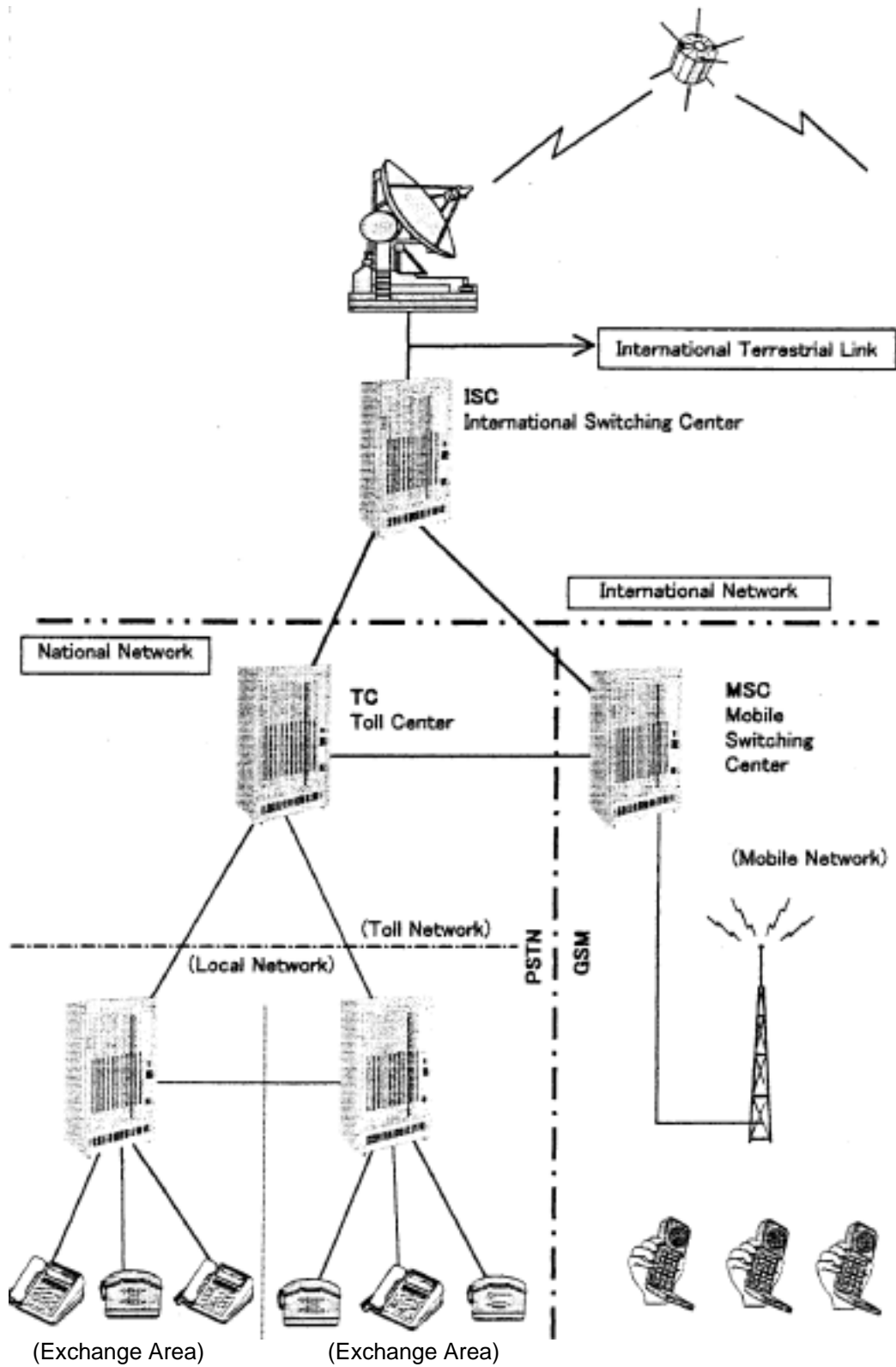
Xaysomboune province is connected to the national backbone by a satellite link.

Infrastructure Development Plan



Source: LTC.

Figure VI2-1 National Telecommunication Network



Source: LTC.

Figure VI2-2 Basic Network Configuration in Lao PDR

4) Public Switching Telephone Networks (PSTN)

PSTN structure is simple and equipped with digital exchanges. The telephone exchange network has three levels; i.e., a secondary switching center (SSC), primary switching center (PSC) and a terminal exchange (TE). The 25 telephone branches belong to one of the SSCs.

TableVI2-1 Switching Units and Hierarchy

Secondary	Primary		Terminal	Area code	Exchange code	Number of Switching unit		Remarks	
						MSU	RSU		
			MSU	RSU					
Pakxe									
	Pakxe	Pakxe		31	2X	1		TLS	
			Khong	31	51		1		
	Salavan		Salavan	34	21		1		
Khanthabouli									
	Khanthabouli	Khanthabouli		41	2X	1			
			Outhomphon	41	43		1	TLS	
Thakhek									
	Thakhek	Thakhek		51	21	1		TLS	
Pek									
	Pek		Pek	61	31		2		
	Xamu-Nua	Xamu-Nua		64	31	1			
Luangphabang									
	Luangphabang	Luangphabang		71	2X	3		TLS	
	Xaignabouli		Xaignabouli	61	31		1		
Xai									
	Xai		Xai	81	31		2		
	Louang Namtha		Louang Namtha	86	31		1		
Vientiane									
	Vientiane	Nampou		21	22	2			
			Naxaythong		21	63		1	
			Airport		21	5X		1	
			Thongpong		21	61		1	
			Sisattank		21	35	2		
			Thadeua		21	83		1	
			Nahai		21	81		1	
			Xaysettha		21	4X	2		
			Donnounge		21	73		1	
			Thangone		21	75		1	
	Pakxan		Pakxan	54	21		1	RSU of Nampou	
	Phonhong		Phonhong	23	21		1	RSU of Nampou	
			Vangvian		23	51		1	RSU of Nampou
				8	17		13	19	

Source: LTC

5) Mobile Phone System

LTC provides the mobile phone service of GSM (Global System for Mobile communications) 900MHz in six cities. Because each service area is limited to the city only, the area coverage for service is quite limited. Although the total mobile system has only a 11,000 mobile unit capacity, the current number of mobile units is 11,671 (July 2000). Consequently, the mobile phone system has a long waiting list. Practically, a new mobile unit is hardly obtainable due to the capacity limit.

In SKR, only Thakhek and Savannakhet cities have a mobile phone service. The Vientiane area has the capacity of 9,000 mobile units and five other cities have a joint capacity of 2,000.

Table VI2-2 Telephone Tariff for PSTN and Mobile System

	Savannakhet	Khammouan	Vientiane
Savannakhet	150	200	300
Khammouan	250	150	250
Vientiane Mun.	350	350	250

Remarks: Kip/min.

Legend:

	PSTN Tariff
	Mobile Tariff

Source: LTC

The difference between PSTN and mobile phones for the current long distance tariff is small. Consequently, the mobile tariff will be lower than the PSTN tariff if the price of mobile units continues to drop.

6) International Telephone Service

International calls to and from Lao PDR have three routes (Table VI.2-3):

The table shows that the international gateways are limited to the routes via satellites. In addition, the completion of CSC cable is expected to expand the international telephone capacity along the route. The International Direct Dialing (IDD) is available at most tourist hotels.

Table VI2-3 International Gateways and Capacity

Mode	Country	bps	Number of circuits
Satellite			
INTELSAT			
	Australia	2048	60 *
	China	512	8
	Japan (KDD)	2048	60 *
	Singapore	1024	30 *
	Viet Nam	512	16
	S. Korea	512	16
	Germany	512	8
	Taiwan	512	8
	Malaysia	512	16
	Hong Kong	512	16 *
ASIASAT			
	Hong Kong	512	16
Microwave			
	Thailand (TOT)	34,000 (34M)	
CSC Cable (under construction)			
	China	Up to	
	Viet Nam	2,500,000 total	
	Thailand (CAT)	(2.5G)	
	Malaysia		
	Singapore		

Note: *Transit to other countries.

7) Internet Service

The availability of the Internet service is still limited in Lao PDR because the data communication system is not well developed. LTC officially provides Internet services only in Vientiane with the following three options:

- Dial-up service for individual users (10 hr/month US\$12+)
- Dial-up service for corporate "Lines-to-Net" (60 hr/month, 4users, US\$ 105+)
- Dial-up service for corporate "LAN-to-Net" (300 hr/month, 15 accounts, US\$ 450+)

There are several Internet cafes in Vientiane and other major cities. The Internet cafes in other cities than Vientiane are operating by direct connection via their own satellites.

VI-2.2 Telecommunications in SKR

The telecommunications in Savannakhet and Khammouan Region (SKR) are similar to Vientiane Municipality. As the value added services (e.g., Internet and international calls) are becoming available from Vientiane, the timing and the amount of services are insufficient to meet the existing demand.

For PSTN, the distinction between the secondary and primary switching center are not discernable in SKR. Figure VI.2-3 shows the switching hierarchy in the SKR. Outside Vientiane Municipality, the current hierarchy of four levels does not have clear meaning. Although switching capacity is increasing, the actual subscribers are not expanding. The potential reasons are as follows:

- LTC does not provide appropriate subscriber lines to users.
- Telephone user charge is too expensive for people.
- The service area is limited.

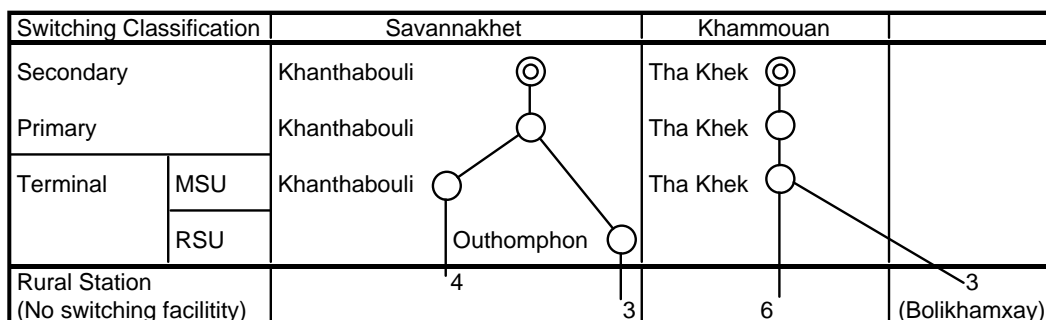


Figure VI2-3 Switching Hierarchy in SKR

The table below shows the basic indicators of telecommunications in SKR.

Table VI2-4 PSTN Lines in SKR

Province	Fixed Line (Line)	Population	Pop./Line	GPP/capita (US\$/capita)
Savannakhet	3,482	761,924	218.8	202
Khammouan	2,100	309,041	147.2	255
Vientiane Mun.	23,629	569,000	24.1	493
Others	5,625	3,506,202	626.5	
Total	34,836	5,146,167	147.7	232

For mobile phone service, the number of users is unclear but the service is available only within the city areas of Thakhek and Savannakhet.

VI-2.3 Proposed Telecommunications Program

1) Network Structure Improvement

The current network structure at the national level is basically a star network connected by a microwave transmission. The microwave system has only 34Mbps capacity.

Because some microwave repeaters are powered by solar batteries, the shortage of sunlight in the rainy season occasionally causes batteries to discharge. Consequently, the telephone lines between SKR and Vientiane are often interrupted. The discharge of power decreases the reliability of the whole network.

2) Service Provision System and Privatization

The telecommunications sector in Lao PDR is moving towards privatization. Following this trend, the telecommunications sector is expected to upgrade the level of service. Even under the current privatization scheme, LTC works as if it is a public corporation due to the absence of competitors.

3) Internet Service

The provision of Internet service is an appropriate segment for privatization. Current Internet service by LTC cannot catch up with the increasing demand of Internet users. LTC should provide only the backbone of data communication infrastructure.

4) Expansion of PSTN

PSTN is the most basic function of current telecommunications service. However, the future of PSTN is not promising because the mobile system is growing more rapidly.

The most urgent issue of PSTN is to utilize the existing unused capacity of switching units. There are several areas where the telecommunications service is not available only due to the subscriber's lines.

5) Rural Telecommunications

The expansion of service area coverage is also an issue of telecommunications. To improve telecommunications service in the rural area, there are several options besides PSTN system. The Multiple Access System and mobile system can be used as the most promising service option for the current non-serviced area.

6) Mobile System

In the future, the mobile system will be the mainstream telephone service in both voice and data communication. The reason is its flexible and quick service provision. In addition, the price of mobile units and exchanges are decreasing rapidly. To satisfy the diversified telecommunications needs of users, the telecommunications development strategy should shift from PSTN to the mobile system.

VI-2.4 Direction of Telecommunications Development in SKR

1) Development Plan by LTC

The table below shows the PSTN development plan by LTC.

Table VI2-5 PSTN Development Plan by LTC

Province	Area Code	Existing Capacity	Capacity Extension Plan					Total	
			2000	2001	2002	2003	2004		2005
Savannakhet	41	3,880	1,536	512		1,792	1,024	1,536	10,280
Khammouan	51	2,160		1,024	1,536		512		5,232
Vientiane	21	27,123	4,872	8,680	6,432	1,412	5,496	2,236	56,251
Others		12,202	6,656	4,608	6,656	9,984	5,120	6,144	51,370
Total		45,365	13,064	14,824	14,624	13,188	12,152	9,916	123,133

Source: LTC

The above capacity extension plan is based on the new installment of switching facilities. Although such installment is a necessary condition, it is not a sufficient condition. As described in VI.2.3, the shortage of subscriber lines is also a critical issue for the current telecommunications sector.

2) Development Target

Based on the economic framework for SKR, the following table indicates the development target up to 2020. The target assumes the number of people per unit will be almost 15 around the year 2020.

Table VI2-6 Development Target up to 2020

Savannakhet	2000	2005	2010	2015	2020
Fixed Line	3,482	5,571	8,914	14,262	22,820
Mobile	400 ^{*1}	2,186	10,082	19,499	53,051
Total	3,882	7,757	18,996	33,761	75,871

Khammouan	2000	2005	2010	2015	2020
Fixed Line	2,100	2,940	4,116	5,762	8,067
Mobile	300 ^{*1}	703	3,589	7,931	22,706
Total	2,400	3,643	7,705	13,694	30,774

Note: *1: Estimate by Study Team.

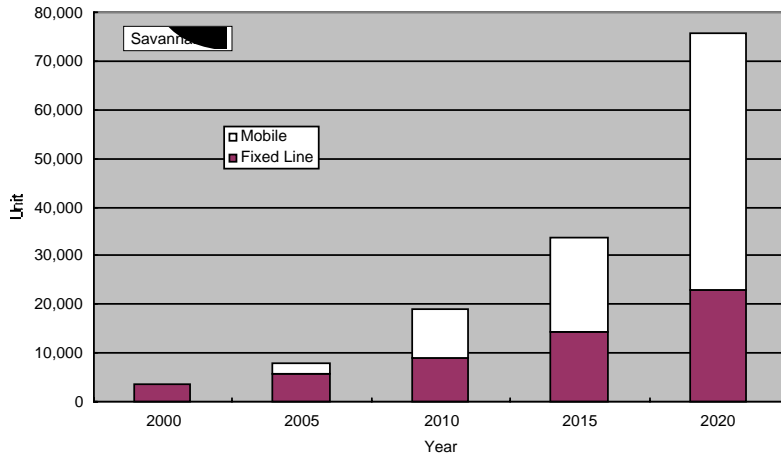


Figure VI2-4 Development Target for Savannakhet

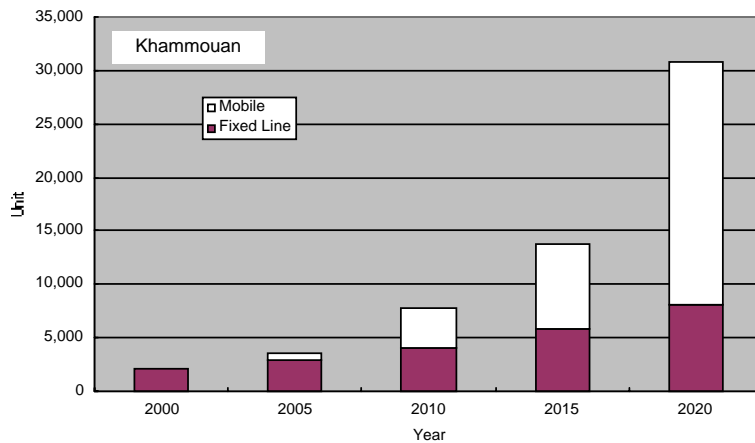


Figure VI2-5 Development Target for Khammouan

VI-2.5 Proposed Telecommunications Projects

1) International Telecom Gateway

The New Mekong Bridge and the proposed Savannakhet SEZ will increase the demand for international calls to and from Savannakhet. The current international gateway in Lao PDR is limited to Vientiane and the weak domestic national transmission line may decrease the attractiveness of the SKR. This project intends to establish a second gateway for international calls for Lao PDR.

Currently, there is no telecommunications link between Savannakhet and Mukdahan. The following alternatives are envisioned for this project:

(1) Optic fiber connection over the New Mekong Bridge

This will be the most feasible option. Connection to the optic fiber loop in Northeastern Thailand at Mukdahan will provide an efficient and sufficient international telephone service including the Internet.

(2) Microwave connection over the Mekong

A microwave connection will be the cheapest option. Considering the various demands of telecommunications users, especially for data communications, the capacity of a microwave connection may not be sufficient.

(3) Satellite connection

A satellite connection may not be feasible due to its cost effectiveness.

2) Rural Telecommunications Improvement

This project intends to improve accessibility to telecommunications in the two provinces. Because the switching units are located only in Thakhek and Savannakhet, the rural area has no access to telecommunications. Not only the conventional telephone system, but also new systems (e.g., Digital Remote Multi-access System) should be considered for telecommunication improvement in the remote areas.

3) Main Backbone Improvement

The current main transmission system by microwave is not so reliable and communications between Vientiane and the south are often interrupted, especially in the rainy season. It is necessary to establish a more reliable transmission system.

Three major alternatives are envisioned as follows:

- (1) Optic fibers to replace the current microwave transmission system.

This system has already been proposed in the GMS telecommunications program by ADB. However, the optic fiber line and exchange system may be too expensive. So, this project will be implemented in the medium and long-term.

- (2) Electricity power line for the current microwave transmission system.

As the microwave repeaters in the off-grid area use solar battery system, they are not reliable. To supply stable electric power to the repeaters, additional investments in power distribution are necessary. In addition, this alternative does not increase the capacity of the main backbone.

- (3) Thai telecommunications network to connect Lao domestic calls in case of interruption.

This option is possible after the international telecom gateway is opened at Savannakhet as proposed above. There is a slight problem in cost sharing and technical aspects.

VI- 3 ELECTRIC POWER DEVELOPMENT PLAN

VI-3.1 Overview

1) Background

Lao PDR is a mountainous country with 5.1 million in population, over 80% of which live in the rural areas. The Lao economy is one of the least developed in Asia with a per capita GDP of about US\$ 300 in 2000.

Continued economic growth is needed to alleviate poverty and to achieve social and economic development goals. The proper and stable supply of electric power is one of the most important components for economic development. Lao PDR has large, mostly untapped, energy reserves, principally hydroelectric power, and electric power demand is expanding especially in the central regions. The Lao power sector is still in an infant stage with the grid serving about 35% of its population.

The power sector is expected to develop with dual goals. Domestically, it should be extended to provide low cost and reliable electric power for the benefit of Lao people. Internationally, it should earn foreign exchange from export sales. These objectives are attainable through encouraging optimal use of the country's natural resources, promoting efficiency in the power sector institutions, and creating a favorable environment for various investments.

Savannakhet is the second largest province in terms of land area and population, as well as power consumption. Khammouan ranks third in power consumption. These two provinces occupy significant positions in power development planning.

2) Development Policy

With regard to power sector development, the Government of Lao PDR (GOL) has the following basic policies:

- Maintain and expand an affordable, reliable and sustainable electric power supply in Lao PDR.
- Promote power generation for export to meet GOL revenue objectives.

National electrification is still low, and GOL has a policy of spreading electric power supply among all segments of population including those in remote and isolated areas, while ensuring the reliability and affordability of services. Electric power supply in the rural areas is to be achieved by expanding and improving the Main Grids as far as possible, and Off Grid supply to remote communities.

Generation for the Main Grids is to be executed from the following three sources:

- Small to medium hydroelectric power generation projects, generally up to about 60 MW, developed by EdL primarily to supply the national market.
- Domestic off-take entitlements from IPP projects in the country.
- Imports from neighboring countries (Thailand and Vietnam).

Generation for export is to be provided from the following two sources:

- Surplus energy from EdL's hydroelectric projects (Nam Ngum, Nam Leuk and Xeset at present) after meeting the domestic demand.
- IPP development of large hydroelectric projects (Theun Hinboun and Houay Ho at present).

Hydroelectric power is one of the most important sources of foreign exchange earning to meet GOL's budget demands. In 1998 the power export amounted to US\$ 60.7 million, accounting for 18% of the total export revenue. GOL intends to promote international power trade through strategic Government-to-Government power export agreements and inter-governmental cooperation on mutually beneficial power exchanges with neighboring countries for least cost supply.

VI-3.2 Power Sector Review

1) Institutional Settings

Overall responsibility for power sector development is vested with the Department of Electricity (DOE) under the Ministry of Industry and Handicraft (MOIH). Under the Electricity Law, DOE has prime responsibility for policy formulation and strategic planning. Under DOE, there are two power-related organizations. The Hydro Power Office (HPO) is responsible for strategic power planning, identification of hydroelectric projects and evaluation of IPP proposals.

Electricite du Laos (EdL) is responsible for designing, constructing, and operating and maintaining generation, transmission and distribution facilities including power export and import. EdL is a state-owned corporation. EdL's reform is underway to attain commercially motivated and autonomous management. There is an idea to introduce an independent regulatory agency with authority for overall management of the power sector and for electricity pricing. EdL is the implementing agency for necessary development including hydroelectric power projects for domestic power supply and is a shareholder where GOL participates

in the ownership of IPP projects. The overall organization of EdL is summarized below.

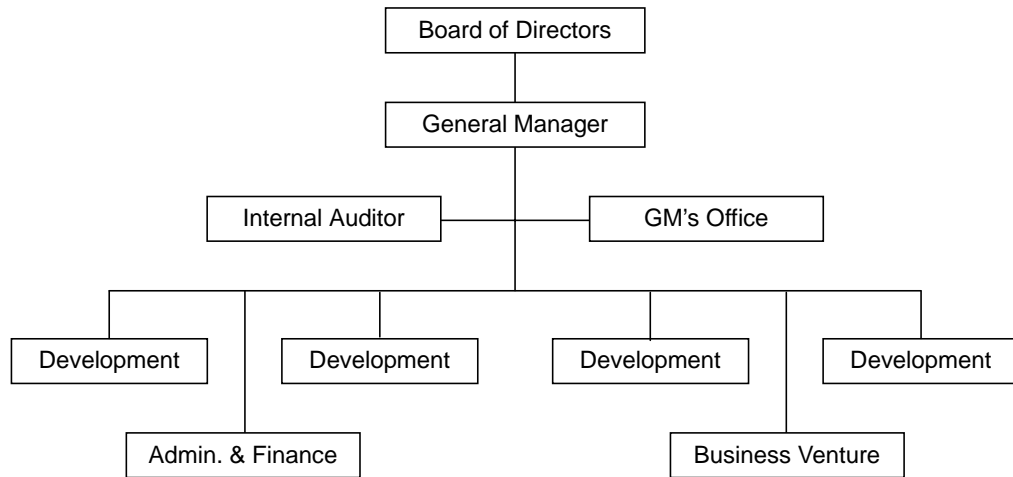


Figure VI3-1 Summarized Organization of EdL

Power distribution activities in the provinces, which include local power generation by small hydro or diesel, are managed and operated by nine Provincial Branch Offices under the Deputy General Manager, Distribution. The branch offices are located at Vientiane, Savannakhet, Khammouan, Champasak, Luangprabang, Saravane, Bokeo, Bolikhamxay and Houphan. Power supply in the other seven small provinces is under the control of branch offices of adjacent large provinces. Operation and maintenance (O&M) of the distribution facilities is under the control of each branch office.

Isolated off grids of less than 2 MW in capacity fall within the jurisdiction of the provincial authorities and MOIH. Small off grid systems of less than 100 kW, including solar photovoltaic, micro-hydro and pico-hydro, are within the jurisdiction of the district authorities and MOIH.

Power statistics, load forecast, and power system data of EdL are prepared with the under-mentioned 4 regional divisions. However, this is not an administrative division and there are no area organizations.

- 1) Central 1 area: Vientiane municipality, and Luangprabang, Xayabury, Xienkuang, Vientiane and Bolikhamxay provinces, and Xaysomboun special region
- 2) Central 2 area: Khammouan and Savannakhet provinces
- 3) Northern area: Phongsaly, Luangnamtha, Oudomsay, Bokeo and Huaphanh provinces

- 4) Southern area: Saravan, Sekong, Champasak and Attapeu provinces

2) Private Sector Participation

GOL has a policy to promote development of hydroelectric power projects to increase export of electric energy to neighboring countries through private investment (IPPs) in the form of BOT or BOOT with a transfer period of 20 to 30 years after commissioning. A Memorandum of Understanding (MOU) is issued when GOL accepts a proposal from investors. The investor, thereafter, is allowed to evaluate, design, construct and operate the project.

Usually, funds necessary for development of IPPs are arranged by investors. Under the Lao Law, GOL must participate in shareholding of every IPP, in principle, with a share of at least 20 to 30% in equity. EdL represents GOL as a shareholder. The share of EdL is 60% for the Theun Hinboun project, 25% for the proposed Nam Theun 2 project, and 20% for the Houay Ho project. The Theun Hinboun Company, which was funded by EdL (60%), a Thai group (20%) and a Norway-Sweden group (20%), has a concession period of 30 years. They export the power to EGAT of Thailand and receive payments half in Thai baht (equivalent to US dollar) and the other half in US Dollar through bank transfer. On the other hand, the Houay Ho project was constructed by a joint venture of a Korean firm (60%), a Thai company (20%) and EdL (20%). The overall average tariff per kWh agreed with EGAT is US cent 4.8 for the Theun Hinboun project and US cent 4.6 for the Houay Ho project.

3) Power Balance

The power balance of the EdL system, exclusive of export by IPP, for the period from 1990 to 1999 is shown on the following page. It is noted that hydroelectric generation decreased significantly in 1998 due to severe drought.

Table VI3-1 Balance of Generated and Consumed Energy in EdL System

Year	Installed Capacity (MW)	Energy Generation (GWh)	Energy Consumption (GWh)			
			Consump. In Country	Export	Import	Net Export
1990	163.56	821	165	595	28	567
1991	209.21	835	221	563	35	528
1992	209.90	752	253	460	41	419
1993	211.75	920	265	596	48	548
1994	217.39	1,198	279	829	57	772
1995	218.25	1,085	338	676	77	599
1996	218.60	1,248	380	792	88	704
1997	221.80	1,219	434	710	102	608
1998	415.00	948	513	405	142	263
1999	625.40	1,169	566	598	173	425

Source: EdL

Power consumption in Lao PDR has been growing rapidly, and was less influenced by the Asian economic crisis including Thailand. Energy consumption for the period from 1986 to 1999 is graphically illustrated below.

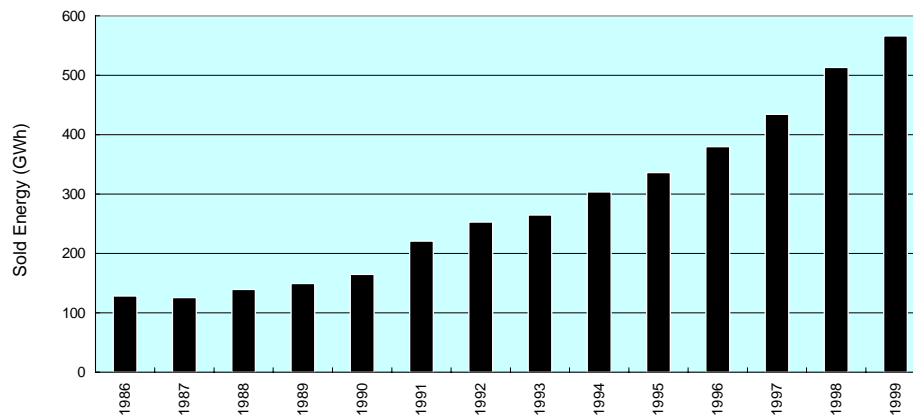


Figure VI3-2 Energy Sales

A relatively high growth rate of over 10% was recorded since 1994. The load growth of Lao PDR has not been influenced much by the drop in industrial demand due to the economic recession as the residential demand occupies the largest portion.

4) Generation System

Based on a government policy, only hydroelectric power generation has been developed since completion of the Nam Ngum project (first stage) in 1971. The total generating capacity of the country as of mid-2000 was 637 MW, consisting of

33 hydroelectric plants of 625 MW (98%) and 11 diesel plants of 12 MW (2%). The current electricity supply in Lao PDR is almost totally (99.95%) hydroelectric power, and diesel plants are operated only for small off grid rural supply. The list of existing hydroelectric power plants is tabulated below:

Table VI3-2 Existing Hydroelectric Power Stations

Name of Power Station	Province	Max. Output (MW)	Annual Energy (GWh)	Owner	Year of Commission
Theun Hinboun	Khammouan	210	1,620	IPP	1998
Nam Ngum 1	Vientiane	150	960	EdL	1971
Houay Ho	Attapeu	150	617	IPP	1999
Nam Leuk	Vientiane	60	245	EdL	2000
Xeset 1	Saravane	45	181	EdL	1991
Selabam	Champasak	5	34	EdL	1969
Nam Phao	Bolikhamsay	1.6	7	Province	1995
Nam Ko	Oudomxay	1.5	8	Province	1996
Nam Dong	Luangprabang	1	5	EdL	1970
24 Micro Power Stations		1.3	----	Province/ District	---
Total		625.4	3,677		

Source: EdL

Of the total output of 625 MW, the Theun Hinboun (210 MW) and Houay Ho (150 MW) are export-oriented IPP projects, and their guaranteed capacity at the border points is 187 MW for the Theun Hinboun and 126 MW for the Houay Ho. These power stations have domestic off-take arrangements; 5% of the output for the Theun Hinboun and a separate 2 MW generator for the Houay Ho. These two power stations commenced power export in 1998 and 1999, respectively.

The Nam Ngum/ Nam Leuk power system (210 MW in total) is supplying the Central 1 and a part of Northern areas, and the Xeset and Selavan power system (50 MW in total) is operated for the Southern area. Surplus energy of these two systems is exported to Thailand through 115 kV lines.

Two small hydroelectric power stations are operated to supply off grid systems of provincial authorities, while one station located near the EdL grid has already been integrated into the EdL grid. Micro hydro plants (and off grid diesel plants) are usually operated by the provincial or district authorities.

5) Transmission and Distribution System

The main transmission system voltage for domestic supply of Lao PDR is 115 kV. At present EdL has three separate 115 kV systems in the country. The Central 1

and Southern 115 kV systems have power stations and are operated with a power surplus, while the Central two system has no power source and is operated by imports from the Thai system. The particulars of each system are explained below.

- a) The Central one system with two power stations of Nam Ngum (150 MW) and Nam Leuk (60 MW)
This system has been supplying power to the areas between Vientiane and Luangprabang through 115 kV transmission lines, and it was recently extended to Paksan of Bolikhamxay with the completion of the Nam Leuk power station. Surplus energy from this system is exported to Thailand through 115 kV lines from a substation in Vientiane. Lao side arrangement for 115 kV export from the new Paksan substation has been completed but the Thai side arrangement for power receiving is not ready yet.
- b) The Central two system for power receiving from Thailand
The Savannakhet system with a 115/22 kV substation receives power from EGAT of Thailand through a 115 kV Mekong river crossing line for power supply to Savannakhet province.
- c) The Southern system with two power stations of Xeset (45 MW) and Selaban (5 MW)
This system is supplying power to Champasak and Saravane provinces with its center in Pakse. There is only one 115 kV line between the Xeset power station and Pakse. Surplus energy of this system is exported to Thailand from the Bangyo substation near Pakse.

Two 220 kV double circuit lines are operated to export the generated power of the two IPP power stations (Theun Hinboun and Houay Ho) to Thailand. The transmission line from the power station to the international border point was constructed and operated by IPP of each respective power project. These two lines are used exclusively for power export to Thailand, and are not connected with the EdL power grids.

Most of the 115 kV transmission lines are of single circuit construction and the single contingency (N-1) criteria for system reliability is not satisfied. Lists of the existing transmission lines and substations in Lao PDR are presentation in the following. The system diagram of the existing transmission system is shown in Figure VI3-3.

Table VI3-3 List of Existing Transmission Lines

No.	From	To	No. of Circuits	Length (km)	Cct-km (km)	Conductors
(230 kV Lines)						
1	Theun Hinboun	(Nakhon Phanom)	2	86*	172	ACSR 1272 MCM
2	Houay Ho	(Ubon Ratchathani)	2	70*	140	ACSR 1272 MCM
(115 kV Lines)						
1	Nam Ngum 1	Thalat	4	5	20	ACSR 240 mm ²
2	Thalat	Phone Tong	1	71	71	ACSR 240 mm ²
3	Nam Ngum 1	Phone Tong	2	73	142	ACSR 240 mm ²
4	Phone Tong	(Nong Kai)	1	29	29	ACSR 95 mm ²
5	Phone Tong	(Udon Thani)	2	75	150	ACSR 240 mm ²
6	Thalat	Luang Prabang	1	210	212	ACSR 120 mm ²
7	Naxaythong	Tha Gon	1	12	12	ACSR 150 mm ²
8	Nam Leuk	Nam Ngum 1	1	55	55	ACSR 240 mm ²
9	Nam Leuk	Paksan	1	85	85	ACSR 240 mm ²
10	Paksan	(Bung Kan)	1	3	3	ACSR 240 mm ²
11	Pakbo	(Mukdahan)	1	2	2	ACSR 240 mm ²
12	Xeset 1	Bangyo	1	115	115	ACSR 240 mm ²
13	Bangyo	(Sirindhorn)	1	67	67	ACSR 240 mm ²

Note: 1. (): Substation in Thailand. 2. * Distance up to border point.

Source: EdL

Table VI3-4 List of Existing Substations

No.	Name of SUBSTATION	Voltage Ratio	Q'ty of Transform.	Unit Cap. (MVA)	Total Cap. (MVA)
1	Nam Ngum	115/22	1	7.5	7.5
2	Phone Tong	115/22	3	30	90
3	Thanaleng	115/22	1	10	32
4	Phone Soung	115/22	1	10	10
5	Thagone	115/22	1	22	22
6	Vang Vieng	115/22	1	5	5
7	Luang	115/22	1	12.5	12.5
8	Pakxan	115/22	1	5	5
9	Pakbo	115/22	2	10	20
10	Xeset	115/22	1	5	5
11	Bangyo	115/22	2	8	32

Source: EdL

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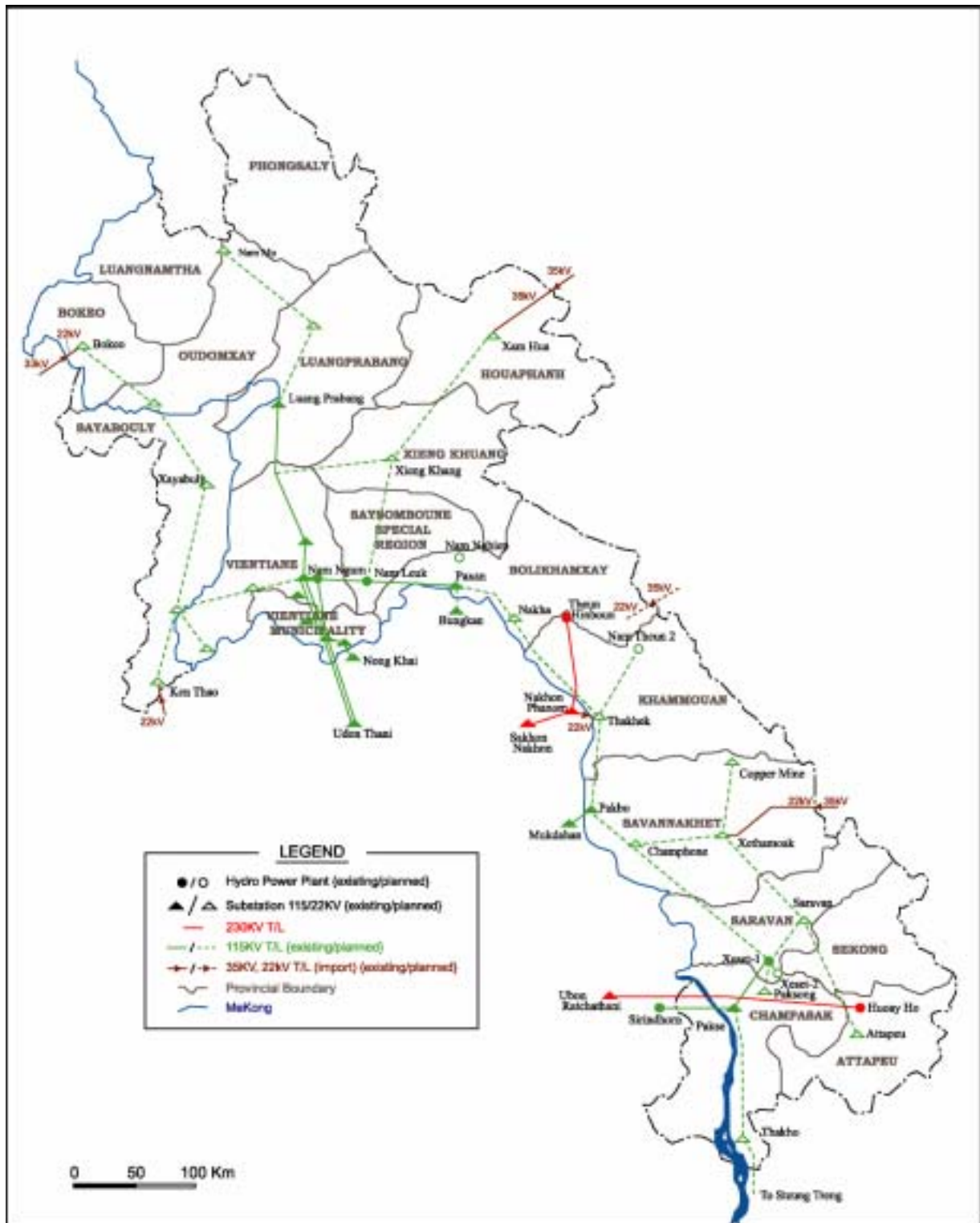


Figure VI3-3 Transmission System Diagram

EdL has computer software, PSS/E of PTI of the USA, for transmission system analysis, and is reviewing its system on the present conditions and future development.

EdL's MV distribution system voltage is 22kV. 22kV lines are extended to urban and rural areas from 22 kV busses of 115/22 kV substations. The LV distribution system to supply general consumers is of 380/230 V, 3-phase and 4-wire. The MV distribution system is well covered in and around Vientiane municipality, the largest load center. Usually in other areas, the number of 115/22 kV substations is limited in the sparsely populated areas, and the length of distribution lines far exceeds a normal distribution distance. Therefore, large voltage drops and variation of receiving voltage are inevitable, and the reliability of supply is low.

Outside the areas covered with a grid distribution system, small private diesel generators (mostly 5 to 10 kW) are operated and car batteries are also used for small household use, mostly for lighting and watching television. For the latter, people must regularly go to battery charging stations.

6) Power Exchange with Neighboring Countries

Power Export

Export of electric power to Thailand is being executed by the following two methods:

- Export from the Theun Hinboun and Houay Ho power stations of IPPs through 230 kV transmission lines, which are independent systems without a connection with the EdL system.
- Export of surplus energy after meeting demand in the country, from Vientiane (Nam Ngum/ Nam Leuk system) and from Pakse (Xeset system) through 115 kV transmission lines.

Power Import

In Lao PDR, certain areas are receiving electric power from Thailand and Vietnam. At present the following 3 categories of electric power import are in operation:

a) Import from EGAT of Thailand

In 1999 the imported energy amounted to about 8% of production in the country. Relatively large power with peak demand exceeding 10 MW is imported at Savannakhet and Thakhek. The imported power from EGAT is the major source for power supply in these two provinces. For the Nam Ngum and Xeset systems, supply from the Thai system is required in dry

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season and in emergency cases. The Xeset power station is a run-of-river plant, and a considerable import is required in dry season.

- b) Import from Provincial Electricity Authority (PEA) of Thailand
A little power is imported from PEA of Thailand through a 22 kV line at Kenthao of Xayabuly province, and through a 33 kV line at Houxay of Bokeo province to meet local power demand in the areas. At Bokeo a 33/22 kV transformer is provided near the border. The imported energy was 3 GWh in 1998.
- c) Import from Power Companies (PC)/ EVN of Viet Nam
All the existing major power sources of the country are located in the western side of the country. Therefore, the eastern mountainous part of the country needs supply from the Vietnamese power grids. Power is imported through Vietnamese 35 kV distribution lines to Samnua in Houaphan province and Xepone of Savannakhet province. A 35 kV distribution line is extended into the Lao territory for the former and a 35/22 kV transformer is provided at the border for the latter. The power import to 4 districts around Laksao in the southeastern part of Bolikamsay province is under negotiation with financial assistance of ADB.

Power Exchange with EGAT

The 1999 traded energy with EGAT of Thailand is summarized below:

Table VI3-5 1999 Traded Energy with EGAT

(Unit: GWh)

Location	Export to EGAT	Import from EGAT
Nam Ngum	327.8	31.1
Xeset	111.2	14.0
Theun Hinboun	1,400.3	1.9
Houay Ho *	55.6	0.3
Paksan	---	9.0
Thakhek	---	52.9
Savanakhet	---	59.8
Total	1,894.9	169.0

* Part of period operation

Source: EdL

Power Tariff

Tariff for energy export and import have been determined through regularly held negotiations with the related authorities of Thailand and Vietnam. The same rates are applied to the power trade with EGAT for the Nam Ngum/ Nam Leuk, Savannakhet and Thakhek systems. While for the Xeset system, the old tariffs are

temporarily applied due to minor disagreements. The current trading tariff with EGAT is given below.

**Table VI3-6 Power Tariff of Nam Ngum/ Nam Leuk,
Savannakhet and Thakhek Systems**
(Effective from 1 October 1999 to 30 September 2003)

(Unit: Baht/kWh)

Category	Import	Export	
		Normal Case	Emergency case
Monday-Saturday (Peak)	1.22	1.41	1.22
Monday-Saturday (Off Peak) & Sunday (All Day)	1.14	1.33	1.14

Peak time: 6:00 pm - 9:30 pm, Off Peak time: 9:30 pm - 6:00 pm
Source: EGAT

Table VI3-7 Power Tariff of Xeset System
(Effective from 1 May 1997 to 30 April 2001)

(Unit: US cent/kWh)

Category	Import	Export	
		Normal Case	Emergency case
Peak (6.00pm - 9.00pm)	5.80	6.30	5.80
Partial Peak (7.30am - 6.00pm)	3.75	4.25	3.75
Off Peak (9.00pm - 7.30am)	3.00	3.50	3.00

Source: EGAT

The power trade with PEA of Thailand and with PCs of Vietnam is for power import only.

- a) With PEA of Thailand, import: 1.90 Bht(5 US cents)/kWh
- b) With Vietnam, import: 6.00 US cents/kWh

For trade with Thailand the power tariffs are expressed in Thai Baht, but actual payment is being made in converted US Dollar, half at a rate of 1.0 US dollar equivalent to 38.0 Baht and the remaining half at the actual rate at the time. Power rates for IPP projects are determined project by project through negotiation between EGAT and each power supply consortium in the form of Power Purchase Agreement (PPA).

7) Power Tariff System

Lao power tariff system for customers is simple. The energy consumption is charged according to kWh rates, and there is no capacity charge based on the contract power. A uniform tariff is applied throughout the whole EdL supply area. Time-of-day or seasonal differential tariff is not adopted. The tariff system has

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seven categories of Residence (subdivided into 4 based on monthly consumption), Diplomacy and International Organizations, Trade and Business, Entertainment, Government Agencies, Irrigation and Industry. Tariff for small residential consumers and irrigation is relatively low, while tariff for entertainment and foreigner's use is relatively high.

In principle, power tariff is determined from a commercial viewpoint to cover all the operating costs for power supply activities including costs for depreciation of necessary facilities. Based on this target, in 2000 and 2001, tariff in Kip is being raised at the rate of 3.0 to 3.5% every month, as summarized below. The 1999 overall average tariff of Kip 113.4 /kWh (US cents 1.65 /kWh) will nearly double in terms of Kip.

Table VI3-8 Transition of Electricity Tariff in 2000 and 2001

(Unit: Tariff per kWh)

Category		Inc. Rate	May 2000	Dec. 2000	Dec. 2001
1.	Residence				
	0-50 kWh/mo	3%/mon	32 kip	39 kip	56 kip
	51-100 kWh/mo	3.5%/mon	69 kip	88 kip	133 kip
	101-200 kWh/mo	3.5%/mon	104 kip	132 kip	200 kip
	Over 200 kWh/mo	3.5%/mon	225 kip	287 kip	433 kip
2.	Diplomacy & International Organizations	2%/year	0.0969 \$	0.0969 \$	0.0988 \$
3.	Trade & Business	3%/mon	257 kip	316 kip	450 kip
4.	Entertainment	3%/mon	321 kip	395 kip	563 kip
5.	Government Agencies	3.5%/mon	208 kip	265 kip	400 kip
6.	Irrigation	3.5%/mon	87 kip	110 kip	167 kip
7.	Industry	3.5%/mon	208 kip	265 kip	400 kip

Note: Conversion rate as of May 2000 is US\$1 equivalent to 7560 kip.

VI-3.3 Regional Electric Power

1) Power Demand

Major parameters of the 1999 power demand of the country, Savannakhet and Khammouan are summarized below.

Table V13-9 Major Parameters of Power Demand in 1999

No.	Item	Country	Savannakhet	Khammouan
1	Population, (000)	5,091	745	302
2	GDP per capita (US\$)	268	285	320
3	Installed capacity, (MW)	625.4	0.5	0.2
4	Peak generation, (MW) *	150.3	13.4	12.1
5	Annual generation, (GWh) *	1,168.8	62.4	53.7
6	Annual consumption, (GWh)	565.5	52.2	50.0
7	7 year average growth rate, (%)	12.4	12.9	24.5
8	Consumption per capita, (kWh/yr)	111	70	166
9	Annual load factor, (%)	43.0	44.5	47.0
10	Loss factor, (%)	13.3	16.3	6.8

Note: * Received power is shown for Savannakhet and Khammouan.

Source: EdL

A large per capita power consumption of Khammouan compared with that of Savannakhet would be derived from the wood processing activities, plywood factories, sawmills, etc. in the province. Large power supply in the areas, not far from the Thakhek substation, would have resulted in a low loss factor.

The growth rate of consumption of Savannakhet and Khammouan (Study Area or Central 2 Area under EdL division) was higher than the average of the country. The 1999 power demand and average growth rates for 7 years from 1992 to 1999 are summarized below:

Table VI3-10 Summary of Power Demand and Growth Rates

No	Item	Country	Savannakhet	Khammouan
1	1999 Peak (MW)	150.3	13.4	12.1
2	1992 Consumption (GWh)	252.7	22.3	10.8
3	1999 Consumption (GWh)	574.1	52.2	50.0
4	Growth Rate (%)	12.4	12.9	24.5

Source: EdL

In terms of provincial power sales, Savannakhet ranks second (9.1% of the country) and Khammouan third (8.7%). The growth rates were high in small provinces reflecting the recent progress in rural electrification. The high growth of Khammouan was derived from wood processing and irrigation pumping. The power consumption record of Savannakhet and Khammouan is tabulated below.

Table VI3-11 Historical Power Consumption Record

	Required Energy (GWh)			Maximum Demand (MW)		
	Country	Savannakhet	Khammouan	Country	Savannakhet	Khammouan
1992	252.74	22.27	10.81	63.48	5.66	3.00
1993	256.74	24.21	13.98	65.99	6.40	4.00
1994	279.44	28.13	16.87	73.45	7.40	4.30
1995	342.72	31.27	21.95	87.08	8.40	5.40
1996	385.52	33.49	28.19	97.61	8.90	8.00
1997	440.11	37.47	34.66	111.39	9.78	10.90
1998	520.86	42.29	44.78	130.03	10.73	10.50
1999	574.09	52.19	49.99	150.27	13.40	12.14

Source: EdL

Among the 1999 energy sales, residential sales accounted for 50%, and the industrial sales represented 20% in the EdL grid. The share of the industrial sales is increasing. The trend is similar in Savannakhet. However in Khammouan, industry was the largest sector with a share of 41% while the residence consumption shared 32%. The category-wise power sales of the country, Savannakhet and Khammouan are shown below.

Table VI3-12 Category-Wise Energy Sales of EdL in 1999

Category	Country		Savannakhet		Khammouan	
	(MWh)	(%)	(MWh)	(%)	(MWh)	(%)
Residence	285,053	50.4	27,590	52.9	15,968	31.9
Diplomacy & International Organizations	7,712	1.4	76	0.1	0	0
Trade & Business	58,553	10.4	4,807	9.2	4,344	8.7
Entertainment	11,069	2.0	645	1.2	379	0.8
Government Agencies	54,465	9.6	3,968	7.6	1,879	3.8
Irrigation	33,906	6.0	3,186	6.1	6,701	13.4
Industry	114,789	20.3	11,890	22.8	20,721	41.4
Total	565,547	100.0	52,192	100.0	49,991	100.0

Source: EdL

The overall household electrification ratio at the end of 1999 was estimated to be 35%, or an increase from 15% in 1995. According to a policy paper, GOL aims to provide electricity to 90% of the population by 2020. The electrification ratios of districts, villages and households of the country, Savannakhet and Khammouan are summarized on the next page.

Table VI3-13 Summary of Electrification Ratios in 1999

(Unit: %)

Item	Country	Savannakhet	Khammouan
District	77.3	80.0	88.9
Village	22.3	21.6	42.0
Household	34.8	36.0	43.3

Source: EdL

The daily load factor is low, or around 45% as shown in Savannakhet and the daily load pattern is of typical evening peak. The daily load pattern of Khammouan is of daytime peak as this system contains a lot of industrial loads. Typical daily load curves of Savannakhet and Khammouan are shown below.

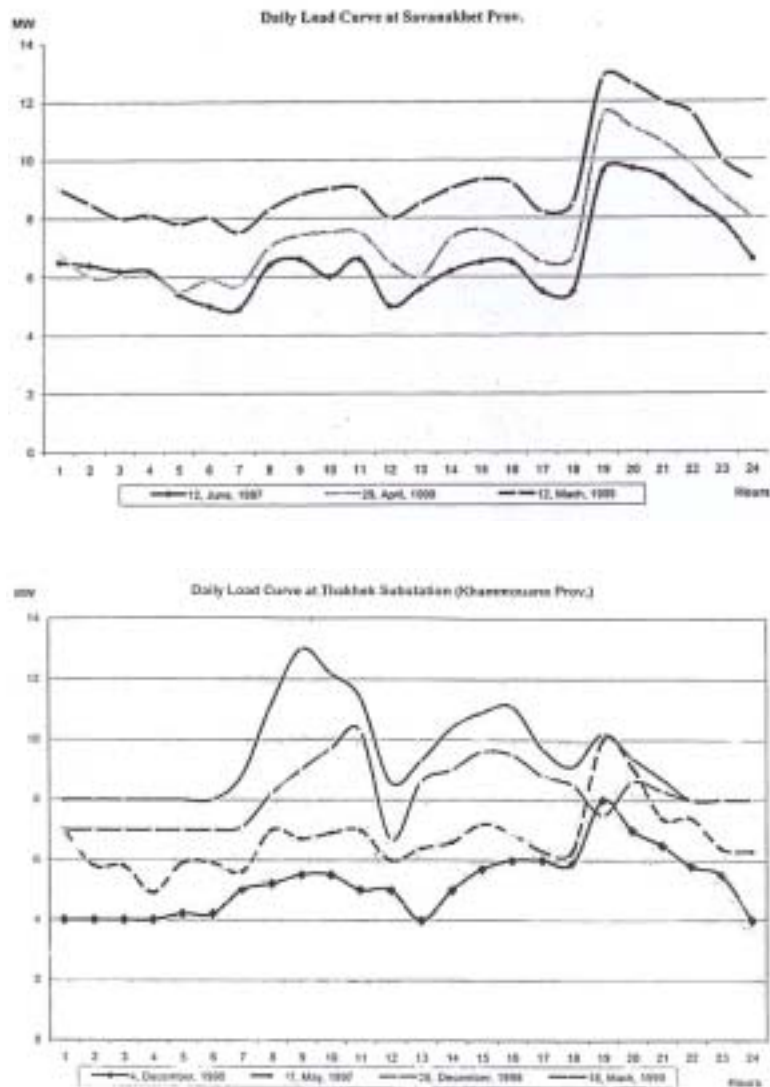


Figure VI3-4 Daily Load Curves

2) Power Demand Forecast

Long-Term Forecast of EdL up to 2010

Long-term power demand forecast for the country, areas and branch offices is regularly prepared by EdL. The recent forecast covers the period up to 2010. In this forecast, the historical trends were reviewed and extended to the future taking into consideration changes in the situation. The current high growth rate of the country exceeds 10% and it is assumed to continue up to 2003, and to settle down thereafter at around 8% by 2010. This assumption seems reasonable, referring to examples of other developing countries. The estimated growth rate of Savannakhet is high up to 2003 when a copper mine is scheduled to commence its operation, then settles down to an order of 5% thereafter. The EdL forecast for peak demand and energy requirement of the country, Savannakhet and Khammouan provinces is shown below.

Extension of Long-Term Forecast up to 2020

In the EdL forecast, the overall growth rate of power demand is estimated to be around 8% towards 2010. This rate is expected to gradually slow down to a rate of 7% by 2020, referring to various examples in other developing countries. For forecasting future power demand, the Savannakhet load was divided into 2 portions; the mining load (25 MW) was assumed to remain unchanged up to 2020 and normal growth rate was assumed for the rest of demand.

Table VI3-14 Summary of Area-wise Forecast Peak Demand and Energy

Item	Country	Savannakhet	Khammouan.
Peak Demand (MW)			
1999	150.3	13.4	12.1
2005	324.9	54.5	26.7
2010	458.8	67.0	38.0
2015	640.4	85.7	53.3
2020	886.1	110.8	74.8
Energy (GWh)			
1999	574.1	52.2	50.0
2005	1,375.1	316.8	110.1
2010	2,018.7	394.7	158.7
2015	2,916.9	481.4	222.6
2020	4,121.8	597.6	312.3

Source: EdL

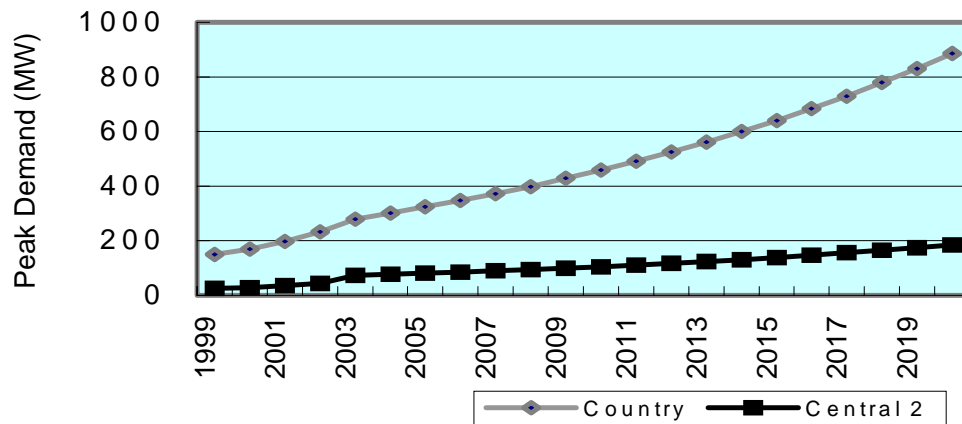


Figure VI3-5 Long-Term Forecast of Peak Demand

The forecast peak demand of the country and Savannakhet and Khammouan region (Central 2 Area) area is graphically shown above.

3) Power Sources

The existing power sources for Savannakhet and Khammouan are summarized below.

a) Savannakhet province

- 115 kV receiving from Thailand: At the Pakbo substation in the suburb of Savannakhet; 115/22 kV transformer capacity is 2 x 10 MVA.
- 35 kV receiving from Vietnam: At the eastern end of the province; 35/22 kV transformer capacity is 5 MVA.
- Mini-hydro power plant of 500 kW, with assistance from Japan, at Nongvilay of Nong district for off grid power supply (operated by the province).

The supply from Vietnam is smaller than the rated capacity as the border point is about 80 km from the Dong Ha substation of PC 3. The mini-hydro plant at Nongvilay cannot be operated in the dry season due to lack of water flow.

b) Khammouan province

- 22 kV receiving from Thailand at Thakek with capacity of 15 MW, Thai side transformer capacity for exclusive use is 25 MVA.
- 5% output of the Theun Hinboun power station allocated for local supply.
- Diesel power plant of 250 kW in Boualapha district for off grid power supply (operated by the province).

The available power of the Theun Hinboun power station (about 10 MW) is not fully utilized. The present supply is small within 1 MW for small villages in the vicinity.

The peak demand in 2000 reached 15.5 MW in Savannakhet (2 MW increase over 1999) and 12.5 MW in Khammouan (1 MW increase). Both are approaching allowable capacity and peak load shedding has commenced.

4) Transmission and Distribution System

The power importing line voltage is 115 kV at Savannakhet and 22 kV at Thakhek. Both Mekong crossing transmission lines are of double-circuit construction with a 115 kV design. Of the available two circuits, the Thakhek receiving uses two circuits and one circuit is in use for the Savannakhet receiving. Power is distributed with 22 kV lines from the substations at Savannakhet and Thakhek to load centers in the provinces. Major population centers, as well as load centers are located in the western parts of the provinces. 22 kV lines are extended over a long distance in the sparsely populated areas. Also, from the eastern end of Savannakhet, a line is extended to distribute the power from Vietnam. All existing distribution facilities are relatively new and in good operating conditions.

A summary of transmission and distribution facilities in Savannakhet and Khammouan is shown in the table below:

Table VI3-15 Summary of Transmission and Distribution Facilities

Line	Country	Savannakhet	Khammouan
230kV Lines (cct-km)	312	---	2 x 86
115kV Lines (cct-km)	758.5	1.7	---
22kV lines (cct-km)	4,437	855	809
0.4kV lines (cct-km)	4,214	547	453
SS Capa. (MVA)	241.0	20.0	---
Dist. Trans. (MVA)	657.4	66.2	76.8

Source: EdL

In spite of EdL's efforts for rural electrification, there are districts that have not been electrified; three districts in Savannakhet and one district in Khammouan. These districts are mostly mountainous and located in the central to eastern parts of the provinces.

A drawing showing the location of major centers and coverage of the distribution systems of two provinces is illustrated on the following page.



Figure VI3-6 Existing and Planned Distribution System in Study Area

VI-3.4 Electric Power Development Plan

1) National Power Development

Generation Development

Based on government policy, future generation development in Lao PDR will depend mostly on the available hydroelectric potential. The available hydroelectric potential in the country is estimated to be 18,000 MW, which is widely scattered on the main rivers and tributaries of the Mekong river. The past developed output of 625 MW corresponds only to 3.5% of the potential and, therefore, Lao PDR has a lot of hydroelectric potential for future development.

The development of generation projects in Lao PDR is being planned under three categories:

- Small to medium hydroelectric power generation projects, generally up to about 60 MW, developed by EdL primarily to supply to the national market.
- IPP development of large hydroelectric projects for power export.
- Mini development for Off Grid power supply

The development of the first category will be carried out with fund arrangement of GOL, utilizing international cooperation of agencies such as the World Bank, ADB, and bilateral sources.

MOUs have been issued to a number of IPP development projects. However, due to the Asian economic recession, the growth of power demand in Thailand slowed down, and together with the shortage of development funds, execution of projects has been delayed. At present there is no generation project now under construction by either IPP and EdL. However, 13 hydroelectric power projects are scheduled as tabulated on the following page.

Of the 13 projects in the table, the Nam Theun 2 project is in the most advanced stage; this is the largest IPP scheme conceived at present. PPA with EGAT are in the final stages of negotiation and will be concluded shortly, and the construction works could be commenced in 2002 and completed by 2006. The Nam Theun 2 Electricity Consortium (NTEC) will hold 75% equity, Transfield of Australia (5%), EdF (35%), Italian-Thai Development of Thailand (15%) and EGCO of Thailand (20%). While EdL will have a 25% share during the 25-year concession period. This project will be developed to transfer 920 MW of power for 16 hours a day on weekdays (6 days per week) at the Lao-Thai border. The power station will be provided with 4 x 247 MW units for power export and in addition 2 x 43 MW units for station use and supply to EdL. 75 MW in total power will be supplied to EdL at

the Thakhek 115/22 kV substation (sent through a 115 kV, 2-circuit transmission line) and at the power station site (22 kV). All 115 kV lines, Thakhek substation facilities and 22 kV facilities at the power station will be provided by NTEC. PPA for supply to EdL is to be concluded between EdL and NTEC. Payment terms are similar to the Theun Hinboun Project, half in US dollar and the remaining half in Thai baht (equivalent to US dollar). The agreed overall average tariff will be 4.66 US cents per kWh.

Table VI3-16 List of Hydro Power Projects Scheduled to be Completed by 2010

Project	Max. Output (MW)	Ann. Energy (GWh)	Year of Completion	Area	Developer
Xeset 2	76	301	2005	Southern	EdL
Nam Theun 2	995	5,400	2006	Central-2	BOT
Nam Ngum 2	615	2,233	2007	Central-1	BOT
Nam Ngum 3	460	2,035	2007	Central-1	BOT
That Kho	30	190	2007	Southern	EdL
Sekong 4	443	1,925	2007	Southern	BOT
Nam Maung 3	50	141	2005	Central-1	EdL
Nam Mo	100	657	2006	Central-1	BOT
Xeset 3	20	83	2008	Southern	EdL
Xekaman 1	468	1,924	2008	Southern	BOT
Xepian Xenamnoy	439	1,864	2008	Southern	BOT
Sekong 5	253	1,550	2009	Southern	BOT
Nam Ngum 4	54	267	2008	Central-1	EdL
Total	4,003	18,570			

Source: EdL

In addition, the Nam Ngiep hydroelectric project (about 300 MW) on the Nam Ngiep river, located in Bolikamxay, has been studied with JICA assistance to confirm its feasibility. This project may be taken up as a combined project for power export by IPP and domestic supply depending on further investigations and financial arrangements.

Transmission System Extension

GOL has a policy to formulate the national Main Grids well covering the country by interconnecting the regional grids and extending to unelectrified areas to promote electrification activities and to substitute present power import with domestic supply.

At present one Power Transmission and Distribution System Project financed by ADB is ongoing to extend the 115 kV Nam Ngum/ Nam Leuk transmission system to Xienkuang and Xayabuly provinces and to reinforce the distribution system in the Vientiane area. The project comprises 115 kV lines of 325 km in length, four

115/22 kV substations, and about 350 km of MV and 400 km of LV lines. Further 115 kV system extension for electrification in the three northern provinces, Oudomxay, Luang Namtha and Phongsaly, is under study with assistance of ADB.

The extension of the Nam Ngum/ Nam Leuk 115 kV transmission system toward the southeast is contemplated. This system comprises 115 kV line extension from the Paksan to Thakhek and Savannakhet (185 + 90 km), and further to Xeset via Champhone. The section between Thakhek and Savannakhet will be essential to transfer the Nam Theun 2 power to Savannakhet. The Pakbo - Champhone transmission line (50 km) and Champhone substation will be constructed under the SPRE project. The distance between Champhone and Xeset is 180 km. The conceived 115 kV transmission system extension plan up to 2010 is presented in the attached Figure VI 3-3 together with the existing system.

There is a 500 kV system interconnection plan related to the IPP power development. Most of the IPP power stations, except for the Nam Theun 2 Project, are of 200 to 500 MW output, and the 230 kV transmission is adequate for sending out the generated power. However, the 500 kV transmission will be needed to send power to Thailand from a group of power stations. Under such circumstance, it is considered appropriate to send out power from each power station at 230 kV and provide three 500/230 kV substations, in the Vientiane area, central area and southern area, as shown on the following page. As of 2010, power to Thailand will be sent out from the Nabong substation (north) to Udon Thani and Savannakhet to Roi Et, and power to Vietnam will be sent out from the central substation to Ha Tinh and the southern substation to Pleiku. The prime purpose of this plan is the economic attainment of security of power export, and its execution plan will be finalized according to the progress of IPP developments.

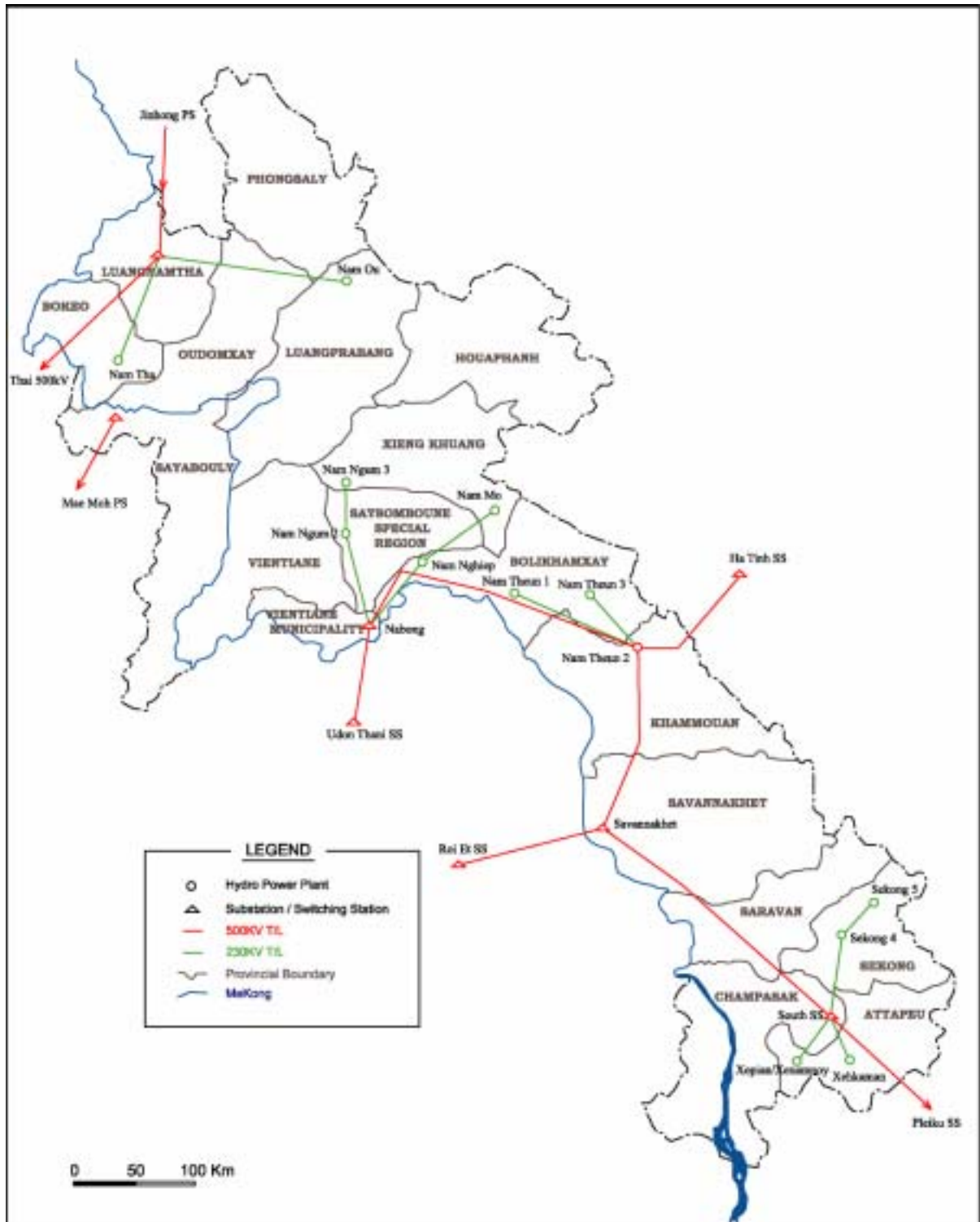


Figure VI3-7 500kV System Plan for IPP Projects

This plan will be realized by establishing a Lao National Grid Company (LNGC) under IPP scheme to manage and to operate this 500 kV system, by purchasing the generated energy from IPP consortiums and exporting it to foreign countries in a coordinated manner.

On the double-circuit 500 kV transmission line from the Nam Theun 2 and Thailand, a switching station will be constructed near Savannakhet for the necessary switching and metering of exporting power. Provisions will be arranged for possible connection of another line from the south. The line transmission capacity must have some allowance taking into account future increase in transmitting power.

2) Power System Development in SKR

Coming Large Demand

Savannakhet Province: The population of district centers in four districts just east of Savannakhet city (i.e., Xeno, Kengkok Kang, Donghen Nua and Parksong) is increasing and they will become sizable load centers in the near future. Industrial activities represented by garment factories are emerging in the Savannakhet area. A Special Economic Zone (SEZ) is planned along Route 9 between the New Mekong Bridge and Xeno. Installation of additional pumping sets to increase rice production will also increase demand. Near Ban Buong of Vilabuly district, a copper mining project by an Australian joint venture is planned to commence operation in 2002/2003. The power demand of this mine is estimated to be about 25 MW.

Khammouan Province: A cement factory with load capacity of 5 MW is planned in the area between Thakek and Mahaxay. There is a plan to install a plywood plant of 4 MVA in the Mahaxay area. In the southern parts of Nongbok and Sebangfai districts many pumping irrigation projects (3 MW in total) are planned. A pulp mill is also planned.

Power Sources

The existing power receiving facilities to import power from Thailand to the two provinces is almost fully loaded. As for the Pakbo substation of Savannakhet, the substation capacity will be increased from 20 MVA to 40 MVA, under the ongoing SPRE project. As for Khammouan province, immediate actions need to be taken to overcome power deficiency before the commissioning of the Nam Theun 2 project in 2006. Conceivable measures are:

- Increased power imports from Thailand. The existing Mekong crossing line has considerable allowance to increase power transfer, but the access lines between the line terminal point and the substation need to be reinforced by additional line installation or by replacing line conductors. At the Nakong Phanom substation of Thailand, EGAT installed one 25 MVA transformer for exclusive use for export to Lao PDR and there will be no capacity constraint on the Thai side.
- Increase of 22 kV power taking from the Theun Hinboun power station by connecting with a 22 kV main feeder from the Thakhek substation (probably along the Mekong river).
- Construction of a new 115 kV power importing system by replacing the current 22kV facilities. The existing river crossing transmission line is of 115 kV design.
- Installation of 230 kV power tapping facilities at the THPC's Thakhek substation at Ban Veun.

An urgent decision and execution is required. It is required to select one measure taking into account various factors and look for a financing source for the works.

The necessary power for these two provinces is at present received from Thailand and partly from Vietnam. However in the future the main supply source will be converted to the supply in the country. 75 MW power from the Nam Theun 2 power station and 115 kV interconnection will be the major supply source for the two provinces after 2006.

The terrain of the two provinces is generally flat and there are not many hydroelectric power sites except for the Nam Theun basin. In the southeast corner of Savannakhet province close to the border with Vietnam, there is the Xepon project on the Xepon river. This project is a reservoir type scheme, and a head of 250m can be obtained with a 35m weir and a 8.7km tunnel. The output will be 75 MW with a firm capacity of 70 MW. This project is considered promising, but only a preliminary study has been conducted. Some support from the Vientiane system and from the southern system can be expected after the 115 kV interconnection from the north to the south is completed.

3) Transmission System Extension in SKR

Under the Southern Provinces Rural Electrification (SPRE) project, the following transmission facilities will be provided to reinforce the transmission system in Savannakhet province:

- Supply of 115/22 kV, 2 x 20 MVA transformers. The supplied transformers will be installed in the existing Pakbo substation, and the existing transformers (2 x 10 MVA) at Pakbo will be shifted to the new Champhone substation.
- Construction of a 115 kV line connecting Pakbo and Champhone. This line will be a single circuit line with ACSR 240 sq-mm conductors of 50 km in length.
- Construction of a new 115/22 kV substation at Champhone.

The construction of a 115 kV branch line from Champhone to the mining project site needs to be planned to send power necessary for the mining operation (about 25 MW). This line is also essential to reinforce the power supply system in the central to eastern part of Savannakhet. Two 115/22 kV substations are planned, one at Xethamouak for supply to the central to eastern part of the province and the other at Ban Boung for supply to the mine, northern to eastern part of Savannakhet and as well as the southern to eastern part of Khammouan.

4) Distribution System Extension in SKR

At present, the SPRE project for reinforcement of distribution systems in the southern area of the country is under execution with the World Bank fund. The project components in the two provinces are summarized below:

Table VI3-17 Summary of Distribution System Components in the Two Provinces of the SPRE Project

Item	Savannakhet	Khammouan
22 kV lines (3-phase) km	310	135
12.7 kV lines (1-phase) km	---	62
400 V lines km	227	128
Consumer connections	13,080	7,340

Source: EdL

A series of distribution system extension projects have been executed and are planned for future execution mainly by utilizing aid from international agencies, such as the World Bank and ADB. Such distribution system extension and reinforcement are required at around a 3 year interval. There are also projects undertaken with GOL fund.

The 22 kV distribution system facilities of 15 MW capacity will be arranged by NTEC at the Nam Theun 2 power station. This arrangement will contribute to reinforce the 22 kV system in the north to northeastern areas of Khammouan province.

Requests for distribution system extension are usually raised by local authorities, irrigation departments, etc. Distribution system reinforcement plans of each province are prepared by the EdL's provincial branch office and proposals are submitted to EdL for review by EdL and consideration by GOL. GOL finally selects projects to be executed, referring to available funds and urgency of the projects.

In Lao PDR, a fund for extension of 22 kV systems for rural electrification is disbursed by GOL. Meanwhile, 30% of funds for distribution transformers and LV lines is to be arranged by each village. In principle, the electrification of rural communities shall be planned as far as possible by extension of the 115/22 kV Main grids. Construction of Off Grid systems including utilization of renewable resources such as hydro, solar energy, biomass, etc. shall be planned only in case that such extension of the main grids is not applicable.

5) Proposed Development Programs

The development plans and programs required for power supply in the Savannakhet and Khammouan Region are chronologically summarized as shown below.

a) Ongoing and Immediately Required Projects

Ongoing Projects

SPRE Project: To be completed by 2002

- 115 kV transmission line of single circuit, 50km, Pakbo - Champhone
- Capacity increase of 115/22 kV Pakbo substation, 20 to 40 MVA
- Construction of 115/22 kV Champhone substation, 20 MVA
- Distribution system in 2 provinces

Projects Necessary to be Taken up Immediately

- Increase in power receiving capacity of the Thakhek system for the period before commissioning of the Nam Theun 2 power station in 2006 by any of the following measures:
 - i) Increase of 22 kV import from EGAT.
 - ii) Connection of the Theun Hinboun 22 kV system with the Thakhek 22 kV main system.
 - iii) Construction of Thakek 115 kV substation.
 - iv) Installation of 230 kV tapping facilities at the THPC's 230 kV substation at Ban Veun.
- Study on 115 kV system extension from Champhone to the mining project site, as well as 22 kV system reinforcement in the central to eastern part of Savannakhet province.

b) Medium-Term Projects to 2005

Already Established Plans

- 75 MW take-out from Nam Theun 2 power station, at the Thakhek substation (115/22 kV) and at the power station site (22 kV).

Proposed Plans

- 115 kV system extension to the mining project site in Savannakhet province before 2003.
- 115 kV transmission line construction between Thakhek and Pakbo substations before the commissioning of the Nam Theun 2 power station.
- Distribution system extension as the next phase to the current SPRE project.
- Feasibility study on the Xepon hydroelectric project.

c) Long-Term Projects to 2010

- Construction of the Nam Ngiep project in the Bolikhamxay province studied by JICA.
- Construction of 115 kV lines between Paksan and Thakhek and between Champhone and Xeset for national power exchange and for security of supply.
- 115 kV connection between Xethamouak in Savannakhet province and Xeset
- Construction of some additional 115/22 kV substations as required, on the existing 115 kV lines or together with 115 kV lines.
- Construction of small hydroelectric projects by EdL in two provinces.
- A series of distribution system reinforcement.

d) Long-Term Requirements to 2020

- Introduction of 230 kV interconnection will surely be required to increase power interchanging capability
- Off-take from two IPP projects of Nam Theun 1 and 3
- Construction of Xepon hydroelectric project depending on its feasibility
- Construction of medium scale hydroelectric projects in the area, additional off-takes from IPP projects and reinforcement of power receiving capability from the north and from the south
- Reinforcement of 115 kV transmission system; lines and substations
- Further reinforcement of distribution system

6) Social and Environmental Impact

It is a recent tendency to seriously consider the social and environmental concerns related to development activities. Especially for execution of hydro

development projects, utmost care is needed to mitigate social and environmental concerns. In Lao PDR, the Science, Technology and Environment Agency (STEA) is the main coordinating agency for environmental planning and management for all sectors.

a) Impacts Related to Hydroelectric Power Development

The environmental impacts related to the hydroelectric power development include the following:

- Degradation of water impounded in reservoir, of permanent nature or during transition period, and landslides due to water impounding.
- Changes in water flow regime; significant in case of trans-basin diversion scheme, which causes various impacts such as changes in fish population due to increase and decrease in river flow, fishing in reservoir, irrigation water problems, land erosion, changes in water quality, difficulty in obtaining clean water, etc.
- Destruction of forest reserve; utmost care shall be taken with logging operations in the reservoir areas, which is to be carried out according to government rules.
- Impacts on endangered species; extinction of any species shall be avoided to preserve biodiversities.
- Resettlement that will ensure original living conditions of inhabitants.
- Proper compensation in case the original living conditions cannot be attained.

b) Impacts Related to Lignite-Fired Power Development

The emission of sulfur-dioxide gas is a great concern for a lignite-fired thermal power plant, and the cost of desulfurizing facility is high. Thus the formerly conceived 600 MW Hong Xa lignite plant for export to Thailand was suspended due to the resultant high generation cost.

c) Impacts Related to Transmission Line Construction

For construction of transmission and distribution lines over open fields, a considerable amount of destruction in forest reserves is inevitable. Transmission line routes shall be selected as far as possible avoiding forest reserves and swampy lands which require special foundations. Distribution lines shall be aligned as far as possible within the road reserves. Removal of houses and resettlement problems due to line construction must be reduced to the minimum.