3. Present Situation of Electric Power Industry

3. Present Situation of Electric Power Industry

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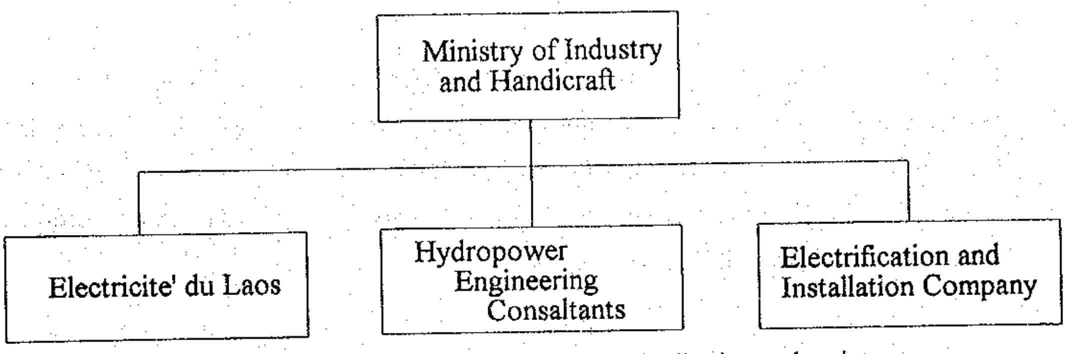
3. Present Situation of Electric Power Industry

3.1 Form of Electric Power Industry

3.1.1 Form of Enterprise

Most of electric enterprises in Laos are operated under state or public management. The greater part of them is run by EDL (Electricite' du Laos) established under the French administration and for the rest, only small hydropower and diesel power generation, etc. are operated by local governments in an isolated system. Fig. 3.1-1 shows the electric power industry organization in Laos.

Fig. 3.1-1 Electric Power Industry Organization in Laos



EDL
- Power generation, transmission and distribution and maintenance
- Construction
- Import and export of electric power

HEC
- Investigation
- Planning (F/S)
- Design

EIC
- Promotion of electrification
- Popularization of electric appliances

EDL is now under the control of MIH (Ministry of Industry and Handicraft) which is its supervisory office and conducts integrated management including power generation, transmission and distribution, and electricity export to Thailand. However, the Laos electric power system is still imperfect and the trunk transmission power system linking internally has not been well arranged yet. As main power systems, Nam Ngum power plant and Vientiane system, Xe Set power plant and the southern system and Thakhek district and Savannakeht system where electric power is supplied from Thailand are operated respectively in an isolated system.

EDL now conducts power management according to the condition of each system, centering on the above four main districts under the supervision of respective local governments. EDL Vientiane works together with these organizations in large scale investment, power selling and technical cooperation. In future, the organization of EDL will be reformed along with expansion of power systems. The organization reform project was already started in 1990 by UNDP finance.

As electric power related enterprises under the supervision of MIH besides EDL, HEC (Hydropower Engineering Consultants) conducts investigation and design of hydropower development and EIC (Electrification and Installation Company) work for facility investment and popularization of electric appliances to promote electrification.

Build Operate Transfer (BOT) projects and Joint Venture (JV) projects like Nam Thun Hinboun hydropower project recently started are directly managed by the Foreign Investment Management Committee (FIMC) under the Planning and Corporation Committee (PCC). PCC is an upper agency of the MIH. These BOT and JV projects are organized independently project by project.

3.1.2 Demand and Supply

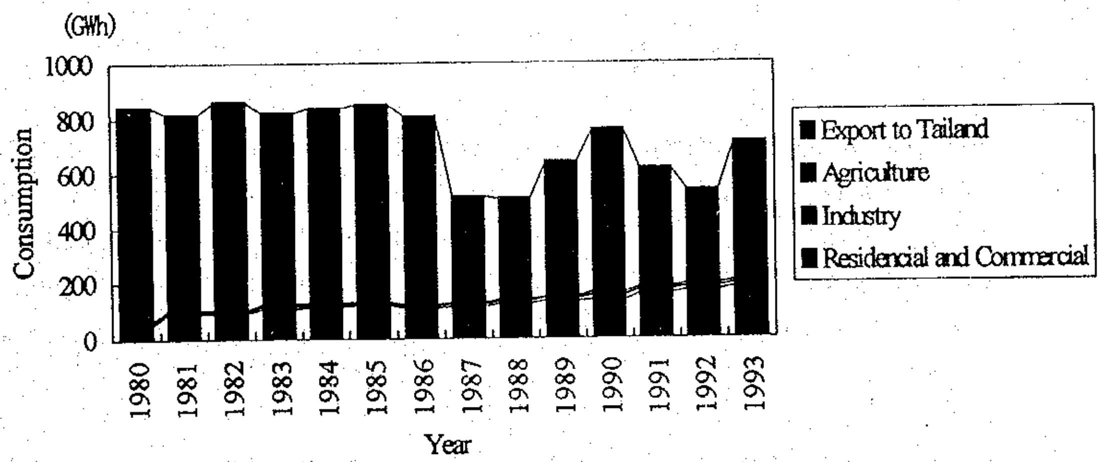
All electricity power in Laos makes use of water power except small scale internal combustion power generation and its greater part is generated by Nam Ngum hydropower plant of the Vientiane system and Xe Set hydropower plant of the southern system. Electricity power is mainly consumed in Vientiane, capital and its outskirts and it accounts for about 80 percent of power consumption (15 percent for the central system and 5 percent for the southern system). **Table 3.1-1** shows the electricity balance in 1980 through 1993. Demand centers on residential and commercial use, exclusive of export and only about 5 percent and 6 percent are consumed respectively for agricultural and industrial use, as shown in **Fig. 3.1-2**.

Table 3.1-1 Electricity Balance Record in Vientiane Area, 1980-1993

Year	Generated	Sending	Imported	Exported	Total supply	Consumption
1980	886.19	853.68	1.99	766.40	89.27	64.58
1981	845.88	799.36	8.39	708.70	99.05	74.97
1982	910.45	876.71	10.66	749.76	137.61	107.20
1983	863.38	834.00	13.37	694.41	152.96	123.26
1984	890.97	864.44	16.63	709.71	171.36	127.68
1985	906.62	867.91	17.56	716.28	169.19	130.28
1986	867.30	834.06	17.20	683.56	167.70	122.50
1987	566.60	549.59	17.99	387.25	180.33	125.53
1988	522.64	539.10	19.80	363.60	195.30	139.08
1989	698.02	677.74	23.09	490.54	210.29	149.20
1990	820.56	796.65	25.94	595.19	227.40	163.58
1991	684.22	664.38	34.90	436.00	263.28	180.52
1992	604.36	585.06	40.44	340.39	285.11	194.00
1993	798.50	770.45	53.69	504.37	319.22	207.27

Source : EDL

Fig. 3.1-2 Electricity Consumption Record by Type 1980-1993

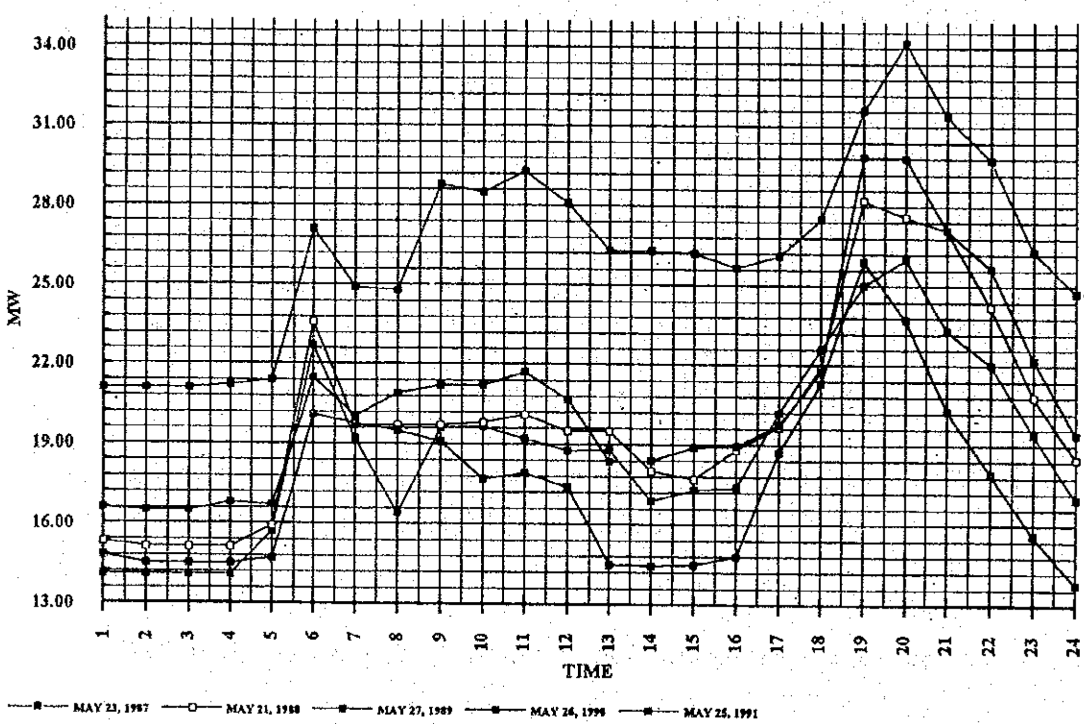


Source : EDL

Because electric for home and commercial use is the center of its demand, the consumption peak comes in May which is in the dry season and reaches the maximum temperature throughout the year and peak time in a day is from 18:00 to 22:00.

Fig. 3.1-3 shows the daily load pattern in Vientiane system of heavy load season in 1987 through 1991.

Fig. 3.1-3 Daily Load Curve in Vientiane System 1987-1991
(The third Wednesday in May)

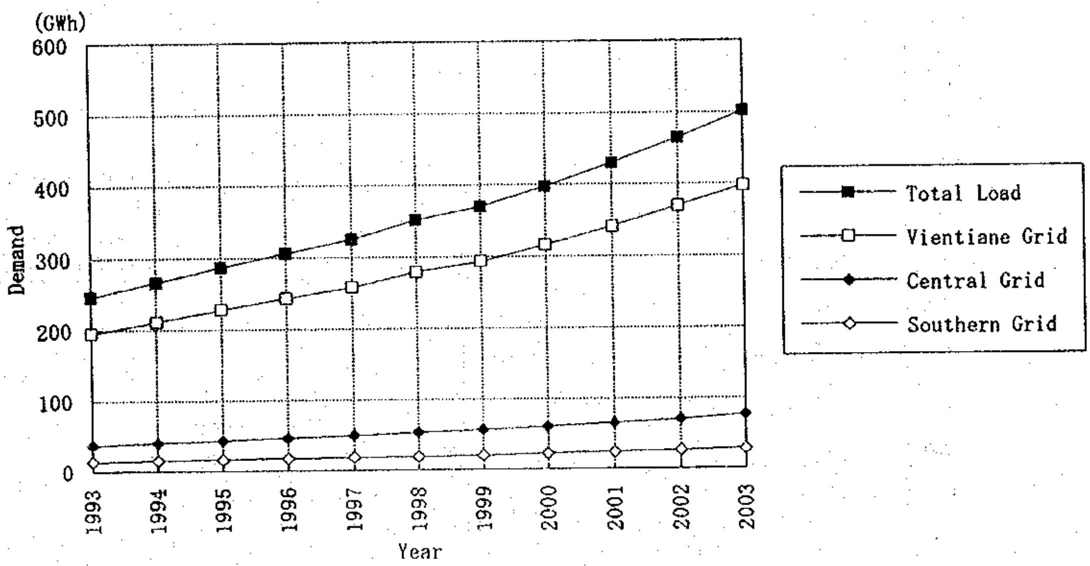


Source: EDL

Power consumption per capita in Lao is as low as 88 kWh in 1990 which is on the 1/12 level as compared with that of Thailand, neighboring country. If considered per one consumer, it makes no great difference from that of Thailand. This shows difference in the rate of electric power popularization and electrification between two countries. Electrification per capita in Thailand is about 70 percent but that in Laos is as low as about 6 percent.

It is considered that growth of power demand in Laos is linked with not only growth of economy and industry but also the electrification program and facility expansion program. Batteries are used as electric source for television, radio and lighting in the non-electrified district about 100 km away from the electrified district. Their cost is very high as compared with electricity charge and electrification is desired also for convenience. In the present power supply and demand structure centering on home and commercial consumption, these latent demand exists although not large in quantity. It is considered that demand will increases according to extension of transmission and distribution lines. **Fig. 3.1-4** shows the electricity demand forecast by EDL for 1994 through 2003.

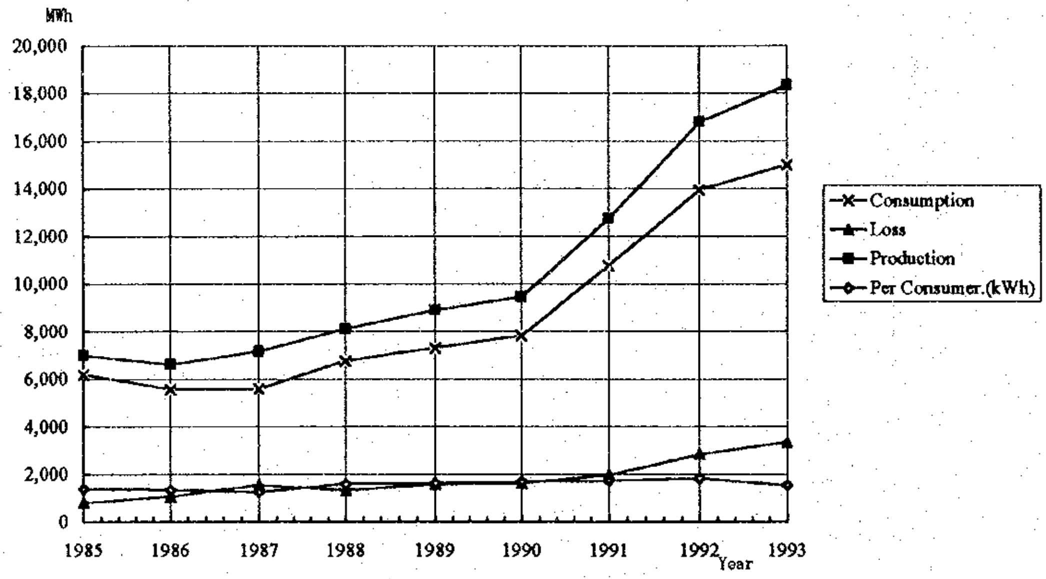
Fig. 3.1-4 Electricity Demand Forecast by System 1994-2003



Source: EDL

Area of this master plan are located in Champasack province, Seravan province, Attapu province, Sekong province and the southern system supplying power to Pakse city. However, Attapu and Sekong have an isolated system by diesel power generation at present. **Fig. 3.1-5** shows the electricity demand record up to 1993. This power supply and demand record in the southern area shows basically the same trend as other areas. The greater part of the electric power generated by Xe Set hydroelectric power plant and Selabam hydroelectric power plant is exported to Thailand. According to the 1992 record, 91,955 MWh of electric power was exported to Thailand and 2,117 MWh was imported from Thailand in the dry season. 14,997 MWh of power was consumed domestically and 1,617 KWh was consumed per one consumer. According to the long-term demand forecast by EDL, the demand will come to 22,000 MWh in 2000 and 28,000 MWh even in 2003.

Fig. 3.1-5 Electricity Demand Record in Southern Area 1985-1993



Source: EDL

3.1.3 Electricity Tariffs

Electricity tariffs of EDL in the country are politically curbed to the low level below generation cost and a subsidy of about 20 Kip/kWh on the average is included. Electricity tariffs and average unit price trial calculation example are shown in **Table 3.1-2**.

Table 3.1-2 Electricity Tariffs in Laos (Effective 1 June 1992)

Consumer	Charge (kip/kWh)	Minimum charge (kip/month)	Average (kip/kWh)
Residential			
From 0 to 100kWh	8	150	7.0
From 101 to 200kWh	15		
From 201kWh	25		
Embassies	60	1,500	N.A.
Commercial	47	700	5.0
Government offices	30	700	5.0
Agriculture	7	1,000	5.0
Industry	30	1,000	5.0

Source : EDL

3.1.4 Import and Export of Electric Power

Electric power is the most important export item to acquire foreign currencies. According to the 1993 record, 504.4 GWh or about 65 percent of 770.0 GWh generated was exported to Thailand and 53.7 GWh or about 26 percent of power consumption was imported in the dry season in the Vientiane system centering around Num Ngum hydropower plant. In the southern system centering around Xe Set hydropower plant, 92.0 GWh was exported to Thailand and 2.1 GWh was imported in the dry season. All power was imported from Thailand in Thakhek system and Savannakhet system of the central area.

Actual power transactions are conducted between EDL and EGAT of Thailand on the contract terms called TOD and **Table 3.1-3** shows electricity tariffs for trading. This electric power import/export contract is renewed every three years.

Concretely, electric power is measured by watt-hour meters installed for trading in Phone Tong sub-station of Laos in the Vientiane system and Udone Thai sub-station of Thailand and transactions are totalized every month. In the southern area, transactions are conducted between Bangyo sub-station of Laos and Sirindhorn power station of Thailand. The loss between two stations is equally shared by them.

As for the mutual power interchange pattern, the import and export plan is set monthly depending on the water level of the dam, rate of inflow and demand. The daily operation pattern is given by telephone from the actual operator (EGAT load-dispatcher) to the EDL operator on the preceding day. If any change becomes necessary during operation, the power generating rate can be changed by telephone in increments of 30 minutes.

Table 3.1-3 Electricity Tariffs in Trading (Effective November 1994)

Num Ngum (Vientiane system)	Charge (US$/kWh)	Xe Set (Southern system)	Charge (US$/kWh)
Export		**Export**	
Peak (18:30-21:30)	0.0580	Peak (18:00-21:00)	0.0580
Partial Peak (8:00-18:30)	0.0332	Partial Peak (7:30-18:00)	0.0332
Off peak (21:30-8:00)	0.0265	Off peak (21:00-7:30)	0.0265
Thakhek and Savanaknet		-	-
Import			
Peak (18:30-21:30)	0.0630		
Partial Peak (8:00-18:30)	0.0382	-	-
Off peak (21:30-8:00)	0.0315		

Source : EDL

3.2 Electric Power Equipment

3.2.1 Generating Equipment

The total generating capacity in Laos is 210 MW as of 1991 and about 94 percent of them are hydroelectric generating equipment while the remaining 6 percent are diesel or other small scale internal combustion power generating equipment.

Main power plants include the Nam Ngum hydroelectric power plant (150 MW) of the Vientiane system, Selabam hydroelectric power plant (2 MW) of the southern system and Xe Set hydroelectric power plant (45 MW) which started operation in 1991. **Table 3.2-1** shows the outline of the existing generating equipment and **Table 3.2-2** shows the operation record.

(1) Nam Ngum Hydroelectric Power Plant

The Nam Ngum hydroelectric power plant is a reservoir type power station and is located about 90 km north of Vientiane city. The first two sets of Phase 1 started operation in 1971 and then, Phase 2 and Phase 3 were reinforced. The existing five sets of the turbine and generator started operation in 1985. The specifications of the power plant are shown below.

	Phase 1	Phase 2 and 3
Reservoir		
Active storage volume	1,600 (M m^3)	4,700 (M m^3)
Installed capacity	30 (MW)	120 (MW)
Effective head	45.5 (m)	45.5 (m)
Number of unit	2	3
Turbine type	Francis	Francis
speed	176 (rpm)	136.4 (rpm)
Generator capacity	17.5 (MVA)	50 (MVA)
voltage	11.0 (kV)	11.0 (kV)
Frequency	50 (Hz)	50 (Hz)
Main transformer		
type	3-phase	1-phase
number	2	10
voltage	11/110 (kV)	11/110 (kV)
capacity	17.5 (MVA)	16.6 (MVA)

Generated electricity is step-upto three circuits of 115 kV transmission line and supply to the Vientiane system or is export to Thailand from Phon Tong sub-station through the international linkage line. Operation is done by notice from EGAT and the speed governor is in the limit operation mode and is not used for control of frequency of the system. The frequency of the Vientiane system is dependent on the EGAT system through the international linkage line. The power line carrier system is used as communication means with EGAT and transmission line protection and communication concerning operation of the power plant is done by using this telephone line.

Because this is the most important generating facility in Laos, thoughtful consideration is given to its maintenance and hourly operation record and annual regular inspection which is conducted for two weeks by removing water from the turbine are done. In addition, overhaul of the main equipment is conducted at intervals of 8 to 10 years for each unit.

(2) Xe Set Hydroelectric Power Plant

Xe Set hydroelectric power plant is the most important power plant in the southern system and is a run-off-river plant. It is located on the northern side of Bolaven Plateau and between Pakse city and Salavan city northeast of Pakse city. It started operation in 1991 and is the latest power plant in Laos. Its specifications are shown below.

Unit 1 and 2		**Unit 3, 4, and 5**	
Installed capacity	6 (MW)	Installed capacity	39 (MW)
Effective head	157 (m)	Effective head	157 (m)
Number of unit	2	Number of unit	3
Turbine type	Horizontal Francis	Turbine type	Vertical Francis
Generator capacity	3.5 (MVA)	Generator capacity	15 (MVA)
voltage	6.6 (kV)	voltage	6.6 (kV)
Frequency	50 (Hz)	frequency	50 (Hz)
Main transformer		Main transformer	
type	3-phase	type	3-phase
number	2	number	3
voltage	6.6/110 (kV)	voltage	6.6/110 (kV)
capacity	3.5 (MVA)	capacity	15 (MVA)

The power plant is of the run-off-river type and the reservoir has little adjusting capacity. Therefore, large and small turbines and generators are used to conduct operation according to flow duration.

Still, quantity of flow runs short in the dry season. Operation may drop to 3 MW or less and come below domestic demand of the southern system. Generated electricity is step-up to one 115 kV transmission line and 22 kV power distribution line. It is supplied to the southern system or exported to Thailand from the Bangyo sub-station through the international linkage line. The speed governor is in the limit operation mode and is not used for control of frequency of the system. The frequency is dependent on the EGAT system through the international linkage line in the same way as the Vientiane system. The power line carrier system is also used here as communication means with EGAT and power-transmission line protection. Notice concerning operation of the power plant is also done by using this telephone line. The greater part of electric power is transmitted through the Sirindhorn power plant and power transmission is done over a long distance of about 300 km to the load center in Thailand. Two banks of reactors are installed in the Xe Set power plant to control voltage of the transmission line.

(3) Selabam Hydroelectric Power Plant

The Selabam hydroelectric power plant is in the southern system along with the Xe Set power plant and is a run-off-river power plant located north of the Pakse city along the river Xe Dong. Three Kaplan turbines and generators with output of 680 KW are installed and electric power generated is connected to the 22 KV distribution network and is transmitted to the Pakse city.

This power plant started operation away back in 1969 and becomes obsolete. One turbine was in operation at the time of the field investigation and the discharge ring in the lower part of the casing was damaged (flowed out). A large-scale repair may be necessary to recover the designed performance of the power plant including replacement of turbines, generators, main transformers and other principal equipment.

Extension work of one Kaplan turbine and generator with output of 3 MW was finished and started commercial operation in 1994.

(4) Existing Generating Equipment in the Se Kong Basin Area

It is considered that the area to be covered by this master plan is basically included in the southern system in future. (According to the EDL plan, the Attapu district is to be kept in an isolated system even in future.) Under the present conditions, however, the terminal of the 115 KV power transmission line is the above-mentioned Xe Set power plant and the distribution network is constructed only to the Salavane city or Paksong city. As for the

Attapu district and Sekong district covered by the plan, the 22 KV distribution network of an isolated system and diesel generator with output of about 200 kW are installed by the local government in part of the central area only and it is operated only for four hours a day from 18:00 to 22:00.

3.2.2 Power Transmission and Transformation Equipment

Fig. 3.2-1 shows locations of the transmission and sub-station equipment controlled by EDL at present. As these transmission and sub-station equipment, there are the transmission line (115 kV) with route distance of 218 km, distribution line (22 kV) with route distance of 1,682 km and five sub-stations. In addition, it owns four international linkage lines with Thailand (two of them are 22 kV distribution lines.). As mentioned above, the supply area by EDL is divided into the Vientiane system supplying power to Vientiane city and it's surrounding area, the southern system supplying to the Pakse city and Saravan city and the Thakhek city and Savannakeht city receiving power from the Thailand distribution network and is limited to the principal cities. The transmission network linking the whole country has not built yet.

It is considered that the electricity of the area covered by this master plan will be exported to Thailand through the southern system in future. At present, 115 kV linkage line crossing the river Mekong is operated next to the Bangyo sub-station west of the Pakse city. A large scale equipment is installed to cross the river Mekong with a span of 999 m and steel towers of 84.7 m in height. The same or higher level of the equipment is necessary to export electric power generated in the area covered by this master plan to Thailand.

Table 3.2-1 Summary of Generating Facilities in Laos

Name of Power Station		Installed Capacity (MW)	Operation Commencement (Year)	Remarks
Nam Ngum	1	15	1971	Hydro
	2	15	1971	
	3	40	1978	
	4	40	1978	
	5	40	1984	
Sokpaluang	1	2	1971	Diesel
	2	2	1971	
	3	2	1971	
	4	2	1971	
Nam Ndong	1	0.336	1970	Hydro
	2	0.336	1970	
	3	0.336	1970	
Luang Prabang	1	0.1	1971-83	Diesel
	2	0.1	1971-83	
	3	0.235	1979	
	4	0.25	1960	
Selabam 1		0.68	1969	Hydro
2		0.68	1969	
3		0.68	1969	
Pakse		0.24	1970	Diesel
Champassak		0.1	1982	Diesel
Paksong		0.04	1981	Hydro
Xe Set	1	3	1991	Hydro
	2	3	1991	
	3	13	1991	
	4	13	1991	
	5	13	1991	
Savannakhet	1	0.2	1985	Diesel
	2	0.2	1985	
Other		3.0		Small Hydro Diesel
Total		210.5		

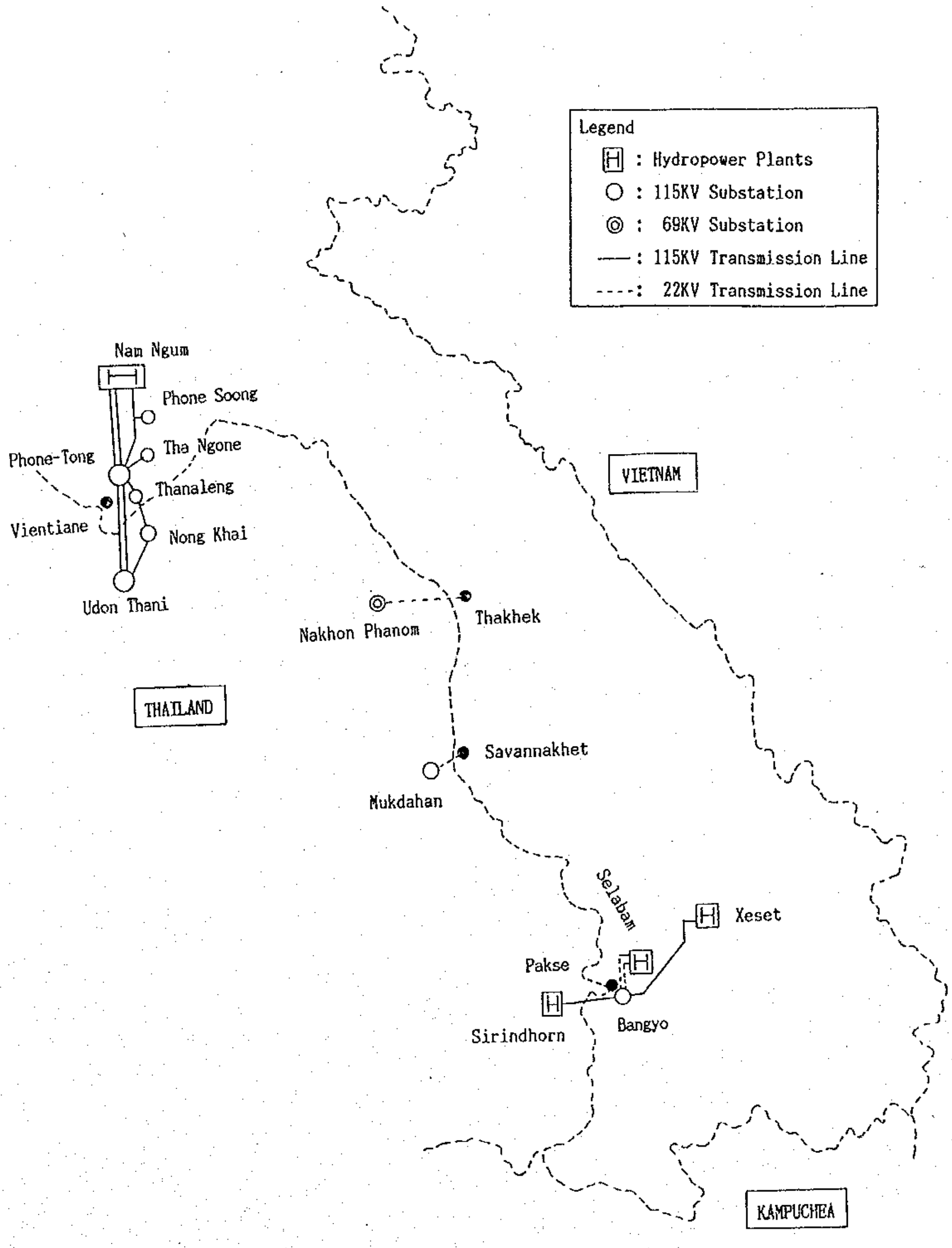
Note: These figures are the figures as of 1992

Table 3.2-2 Energy Production in 1992

(MWh)

Main	Nam Ngum		Xe Set		Selabam		Nam Ndong	
	Plan	Actual Production	Plan	Actual Production	Plan	Actual Production	Plan	Actual Production
1	56,196	38,659	3,740	4,109	250	131	389	360
2	52,576	52,692	2,096	2,328	250	0	273	290
3	45,803	44,534	2,188	1,944	250	0	263	222
4	44,321	53,222	2,727	1,738	250	174	164	264
5	45,773	54,394	6,545	3,385	250	174	144	219
6	53,252	59,033	11,817	10,214	250	174	144	300
7	77,133	68,210	23,607	25,613	250	863	190	300
8	107,659	68,922	33,551	30,552	250	926	400	433
9	107,121	46,002	32,619	27,602	250	975	402	444
10	80,625	47,809	26,209	17,046	250	847	402	402
11	54,543	35,987	12,790	8,270	250	1,096	516	371
12	59,996	35,017	9,111	4,707	250	250	523	346
Total	785,000	604,481 (77%)	167,000	137,057 (82%)	3,000	5,775 (193%)	4,251	3,951 (93%)

Fig. 3.2-1 Location Map of Main Power Station, Sub-Stations and Transmission Lines (Existing)



4. Electric Power Development Plan and Power Export Plan

4. Electric Power Development Plan and Power Export Plan

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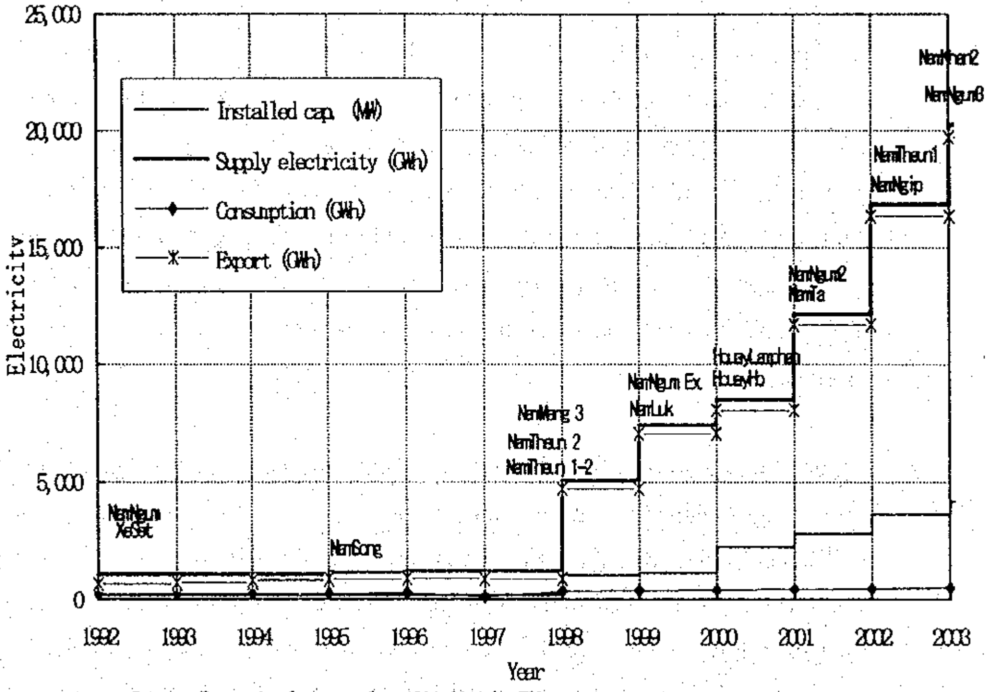
4. Electric Power Development Plan and Power Export Plan

4.1 Electric Power Development Plan in Laos

As shown in **Fig. 3.1-4**, the demand for electricity in Laos as estimated by EDL and based on today's data is 195 GWh in 1993, 398 GWh in the year 2000, and 502 GWh in the year 2003. When focusing solely on domestic demand, it is possible to satisfy that demand by a combination with the existing facilities and export to Thailand. However, as the Nam Ngum Hydro Power Plant is the only full capacity reservoir type power plant, the construction of a new hydro energy source will be vital to respond to the domestic demand throughout the year and to ensure electricity export as an important source of foreign revenue.

In addition, the power demand increase in Thailand, the major purchaser of electricity is 8% - 9%, a figure which is expected to continue to increase by approximately 6% in the future. In Thailand today, it is difficult to construct new power sources and transmission facilities due to environmental problems and increasing land costs. Consequently, Thailand expects Laos to supply it with more electricity to the extent where the two nations have now agreed that Laos will formulate plans to supply Thailand 1,500 MW by the year 2000. It is possible in the future that the study and development of hydro power sources will also be accelerated by the private sectors. The current electric power development plan by EDL is shown in **Fig. 4.1-1**.

Fig. 4.1-1 Current Electric Power Development Plan by EDL



Source: Power development plan 1991-2010 by EDL

Assuming that construction is promoted according to the plan, the total facility capacity in the year 2000 will be 2,255 MW (8,451 GWh annual power generation), 4,190 MW in the year 2003 (20,211 GWh annual power generation), and 6,279MW in the year 2010 (30,797 GWh annual power generation).

Regarding the sites in this Master Plan, some are partially included in the above development plan by EDL such as Se Kong 4 and Xe Namnoy 1. However, the majority will be appropriated for development after the year 2003.

Power development in Laos is basically not directly linked to the domestic demand and most electricity is exported. The development period will, therefore, be affected by the market price of electricity and construction fund procurement. Motivated by the export/import agreement between Thailand and Laos, currently, BOT style developments, being joint ventures with foreign capital are being studied for many projects.

Table 4.1-1 BOT Project List of Electric Power Development Plan in Laos

Project Name	Installed Capacity (MW)	Project Name	Installed Capacity (MW)
Nam Theun Hinboun (1/2)	210	Nam Ngum 3	400
Nam Then 2	600 (210)	Nam Ngiep	420
Houay Ho	130	Nam Theun 1	400
Hongsa Lignite (Coal Thermal)	150 (600)	Xe Namnoy	192
Nam Mang 3	30	Xe Kaman No. 1	255
Nam Ngum 2	320		

Source: MIH and others

Table 4.1-1 shows the power development projects now under study in some form for BOT style and carried out mainly by the private sectors. These development projects will be executed as soon as their funding is ensured and their development consortiums established.

Since the previously described power development plan of EDL is also not linked to domestic demand in Laos, it is, therefore, considered to be one of the development projects on the list. The development plans, including those not listed in **Fig. 4.1-1** and **Table 4.1-1**, will be affected by movements in the electricity market in Indochina. They are affected by development fund procurement, the demand increase in Thailand, the completion of the interconnection system with Vietnam, and the operation start of the Malaysian DC interconnection system.

The first development project promoted by the private sectors in Laos is the Nam Theun Hinboun Hydro Power Development Project. This project has been brought into a definite form by the Laotian Government (60% shares, loaned by the Asia Development Bank), a European development group NORDIC HYDRO (20% shares) and a Thai development group, MDX (20% shares). The electricity fee has been also agreed to by the Electric Power Agency (EGAT) of Thailand which is the purchaser. The construction works are going on.

As described in Chapter 3, in Laos, there is no power system running from north to south. For a future power system it is, therefore, necessary to plan not only a domestic interconnection system, but also to determine how to supply the power to the market efficiently along with these export power development plans. Since excessive facility construction as a future investment is not a preferred factor in the development promoted by the private sectors, it is possible that each private sector will construct minimum transmission/distribution facilities individually. This could possibly affect stability in the power system, transmission/distribution routes and the environmental landscape. It is necessary, therefore, to categorize the development plans locally or in each area to a certain level and to organize the transmission/distribution facility expansion plans and construction fund distribution accordingly. The Laotian Government has already initiated studies with a European consultant regarding the transmission/distribution facility expansion plan based on the electricity export plan. Its outline is described in **Fig. 12.2-1** in the Chapter 12.2. The comparison between the existing transmission/distribution lines and transmission/ distribution lines in the year 2000 is described in **Table 4.1-2**.

Table 4.1-2 Transmission Line Expansion Plan until Year of 2000

	Provinces	Number of		Existing Transmission Line						Plan to 2000							
										High Voltage			MV	LV	Trams-	Number of	
				HV	MV	LV	Transformer	Number	Villages	500kV	230kV	115kV	22-35kV	0.4kV	former	Houses	Villages
		Village	Household	km	km	km	set			km	km	km	km	km		installed	
		11,883	675,750	218	1,936	2,119	1,495	106,746	943	0	576	293	4,123	4,747	1,780	87,416	1,335
1	Vientione	476	80,400	105	700	1,081	848	55,728	303				282	517	157	5,173	73
2	Vientione Province	608	45,900		151	217	121	7,788	79				623	1,035	313	10,347	146
3	Phongsaly	667	25,200		8	16	8	250	5				30	50	10	2,000	10
4	Luangnamtha	521	18,500		12	10	7	500	5				20	30	10	2,000	10
5	Oudomxay	806	28,900		4	9	5	300	3				40	30	10	2,000	10
6	Luangprabang	401	16,700		5	14	8	800	6				40	30	10	2,000	10
7	Bo Kes	1,237	54,500		26	39	44	4,205	44			112	50	100	50	5,000	50
8	Huaphanh	890	31,500										179	31	59	6,358	50
9	Xayaboury	368	33,100		10	10	6	312	5			96	75	100	50	3,000	20
10	Xiengkhuang	536	27,600		10	25	8	1,200	5			85	20	100	50	3,000	20
11	Borikhamxay	549	25,900		5	20	6	1,500	8				175	178	54	2,629	54
12	Khammuane	880	44,500		271	150	109	7,172	148		176		706	696	292	10,354	212
13	Savannakhet	1,607	95,100		430	255	197	15,163	170				524	638	264	9,950	244
14	Saravane	720	38,400	113	120	75	37	2,337	33				319	254	67	5,793	62
15	Sekong	339	8,800								400		187	118	51	2,400	51
16	Champasack	869	75,500		181	185	87	9,276	125				823	770	308	13,912	288
17	Attapu	173	14,000		4	12	4	215	4				20	30	10	1,000	10
18	Special area	236	11,250										10	40	15	500	15

4.2 Electric Power Development Plan in the Se Kong Basin

The Project of this Master Plan is located in the Southern System which supply power to Champasack Privince, Selavane Province, Attapu Province, Sekong Province and Pakse City, as descrived below. The output of this Project will be connected to this Southern System. In the Southern System, the electricity demand was about 17 GWh in 1993, and it will be only 22 GWh in 2000, and 28 GWh in 2003. Therefore, the facility has sufficient capacity so far as annual energy generation is concerned, although power must be imported from Thailand in a dry seasen via the exsting power facilities.

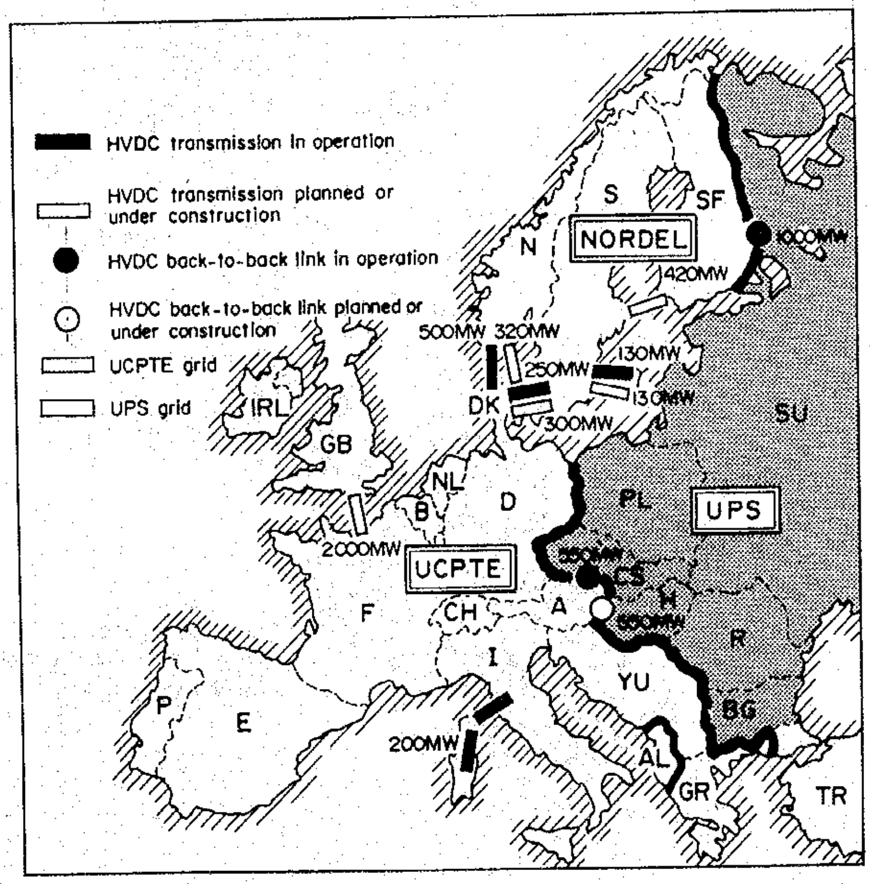
The current development plan of the EDL does not include a plan of power generating facilities for domestic power supply. In future, it is excepted that the development of power generating facilities designed for export such as this Master Plan study will encourage the expansion of roads and distribution lines, and the substation facilities for such distribution systems will be installed in these power plants for export. Specifically, Sekong Town will be fully electrified by the Se Kong No.4 power plant, and Attapu Town by Xe Kaman No.1 power plant, thereby providing the basis for rural electrification. Concerning Xe Namnoy power plant, the reliability and supply capacity of the existing facilities will be improved by interconnecting the distribution network of Pakson Town to the power plant. The construction cost of these regional supply facilities have been included in the estimation of the Pre-feasibility Study stage to be discussed later.

4.3 Electric Power Export Plan

4.3.1 Examples of Interconnection in System

The most important factor in planning electricity import/export is to determine which nation is the present and future market and where the location is. The development and construction of electric power facilities including power plants, substations and transmission lines require large capital investment. It is also difficult to change the systems, should the demand decline or client change. The key factor in an import/export plan is to accurately predict the demand in the market for the long term. In both Europe and North America, across-the-border electric power trade was planned and instituted at the multi-nation level wherein an electricity trade market was formed by mutual supplementation. The following examples are major trade cases in Europe.

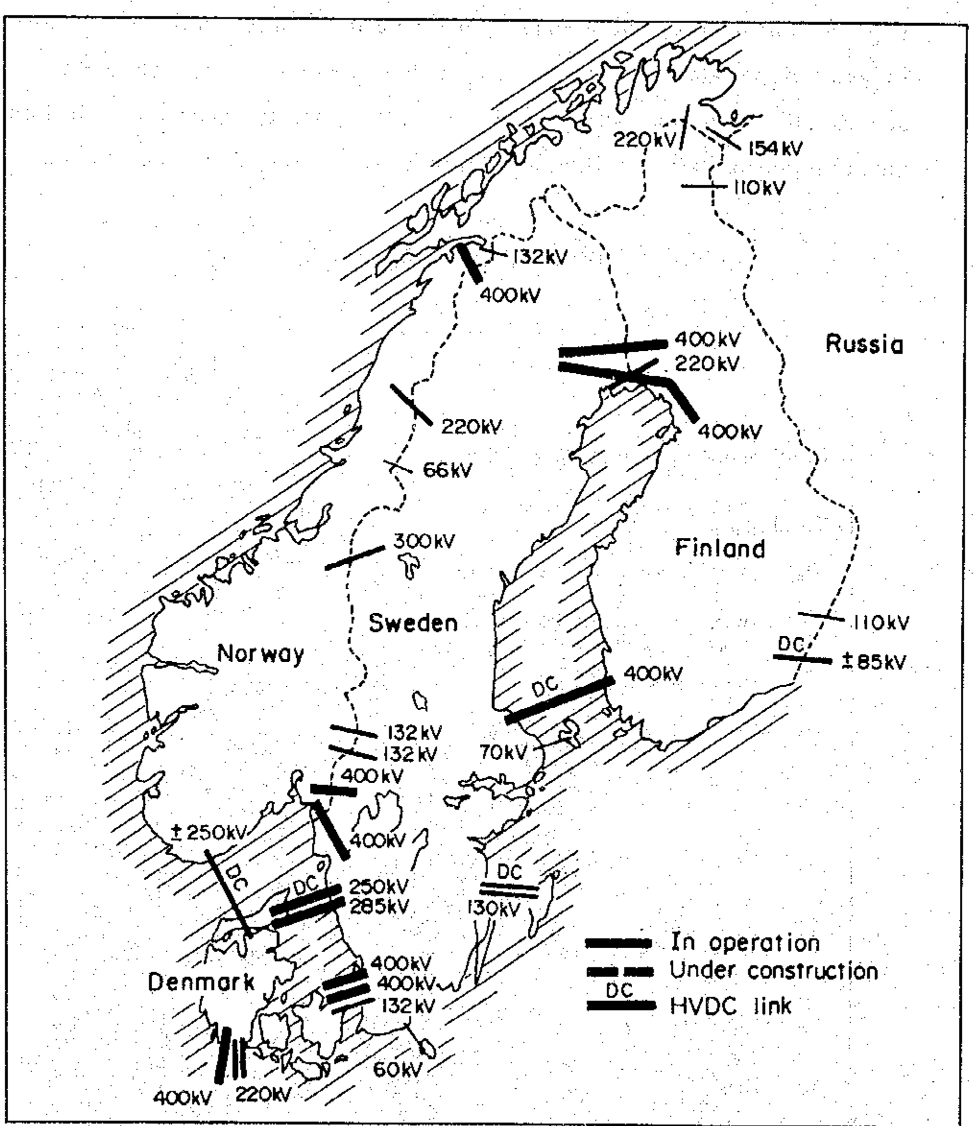
Fig. 4.3-1 Interconnection system in Europe



(1) NORDEL Interconnection System

NORDEL is an international cooperative organization in northern Europe (excluding Iceland), formed by Norway, Sweden, Finland, and Denmark wherein member nations are linked to their neighboring countries. The system incorporates a total of 22 circuits. The following figure provides an outline of the interconnection system.

Fig. 4.3-2 NORDEL Interconnection System



Among the NORDEL member nations, Norway is totally dependent on hydro power generation while Denmark totally depends on coal fired power generation. Finland's and Sweden's power generation facilities consist of a mix of hydro power, coal fired, oil fired, and nuclear power plants. In terms of capacities, the facility capacity of both Denmark and Finland exceeds their own maximum demand, thereby allowing a margin for the peak load. When evaluating their annual power generation volume, those of Norway and Sweden exceed their own demands, thereby enabling the export of power. NORDEL, regrouping of nations with different power sources, enables those nations to supplement their power and efficiently manage their energy sources.

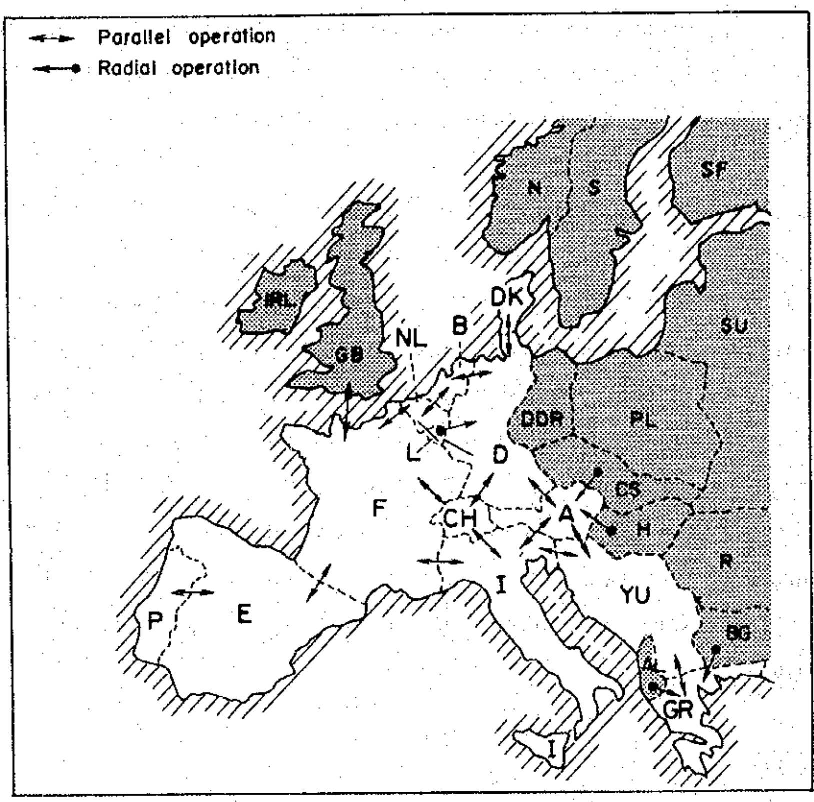
Depending solely upon hydro power, Norway's power generation capacity is greatly influenced by seasonal rainfall. Also, as that country's dam control capacity is restricted, Norway exports power to the neighboring nations during the wet season and imports the power produced by nuclear and coal fired power plants during the dry season. As Finland's power is based on nuclear and coal fired power generation with little or no dependency on hydro power, Finland imports economical peak power produced by hydro power plants in Norway to control its load. Finland also exports the base power during the dry season. Having no hydro power as a peak power source, Denmark increases its own coal fired power generation during the peak load period due to its high power generation unit price. In return, They import economical power from Norway.

(2) UCPTE

Established over 40 years ago, UCPTE is an international power cooperative organization in western Europe. Currently, it regroups of 12 nations mainly connected by 330 kV and 220 kV interconnection systems. The Laufenburg Power Dispatching Center (Laufenburg Power Corporation) in Switzerland, located in central western Europe, conducts power flow control, frequency control, and takes care of the power supply based on the UCPTE power exchange plan.

The basic operation of UCPTE is carried out with the base power export by nuclear generated power in France, seasonal and peak power supply by hydro generated power in Switzerland, Italy, and Austria. The power supply is conducted not only for long term contracts but also for emergencies according to instant load variations. It is handled equivalent to a new power plant plan when they plan power source development. UCPTE also owns interconnection systems such as BTB Substations and DC transmission facilities in the NORDEL member nations, UK, former eastern Europe, and Russia which are not UCPTE members. This enables a broad area of electricity import/export.

Fig. 4.3-3 UCPTE Interconnection System



There are other international power exchange organizations such as the UPS(former COMECON) system in eastern Europe and the former USSR, the interconnection system in north America where hydro power is exported from Canada to the U.S.A., and electricity exported from Turkey to certain eastern European nations.

In Asia, international electricity trading has been conducted between Laos and Thailand, Malaysia and Thailand, Malaysia and Singapore, and Hong Kong and mainland China. This trading, however, is done only between two nations and has not been developed to a level where the primary energy is supplemented throughout the area for its maximum efficient use.

4.3.2 Interconnection Plan in Indochina

The primary factors for consideration in planning international power exchange in Indochina are the hydro power resources of Laos and Myanmar and the power demand predictions of Thailand. With this, the manpower and fossil fuel resources of Vietnam and the recovery of Cambodia must also be considered, although they are not currently interconnected.

At this time, in 1992, Thailand's electricity generation (max. 88,730 MW) and its consumption (56,006 GWh/year) were the largest in Indochina in 1992, making Thailand the major consumer for the time being. According to the EGAT demand prediction, Thailand's max. power generation will reach 17,765 MW against 112,598 GWh annual power consumption in the year 2000. In the year 2005, its max. power generation and annual power consumption will reach 24,150 MW and 157,311 GWh. Demand will grow by an average of 6% to 10% annually in the future. Although power facility expansion has been planned in response to these predicted demands, the construction plans have been canceled or delayed due to environmental problems. The Thai and Laos governments have agreed to develop a 1,500MW facility in Laos by the year 2000 to supply power to Thailand. Assuming that the significant demand increase continues after the year 2000, Thailand will need to increase its power import and will become Laos's largest client.

In the case of Cambodia, that country still has no electric power system that completely encompasses the entire nation. Indeed, Cambodia is now making efforts to recover from the effects of the civil war. Considering Cambodia present status, there is little or no chance that it becomes a consumer or supplier of electricity in this, the 20th. century. Only when Cambodia clears the mines and stabilizes its political and social climates would it be possible to increase investment and aid from overseas, thereby resulting in increased power demands and power export/import.

In Vietnam, although it has a very large population (68 millions), certain geographic restrictions exist for interconnection system development as it is isolated by the Annam Mountains. Taking advantage of Vietnamies human resources and the primary energy resources including petroleum and natural gas, Vietnam has the potential to attract and develop industries significantly. Following the lifting of the trade ban by the U.S.A., investments from foreign nations increased sharply and demand for electricity has been increasing. Therefore, next to Thailand, Vietnam has a latent potential of becoming the second largest market in Indochina. According to a prediction by the Ministry of Energy of Vietnam, its max. electricity generation and its annual consumption will reach 5,390 MW and 27,200 GWh in the year 2000, and 6,950 MW and 34,570 GWh in the year 2005, assuming the highest figures. Assuming the low figures, its max. electricity generation and annual consumption will reach 4,595 MW and 23,180 GWh in the year 2000, and 5,680 MW and 28,410 GWh in the year 2005.

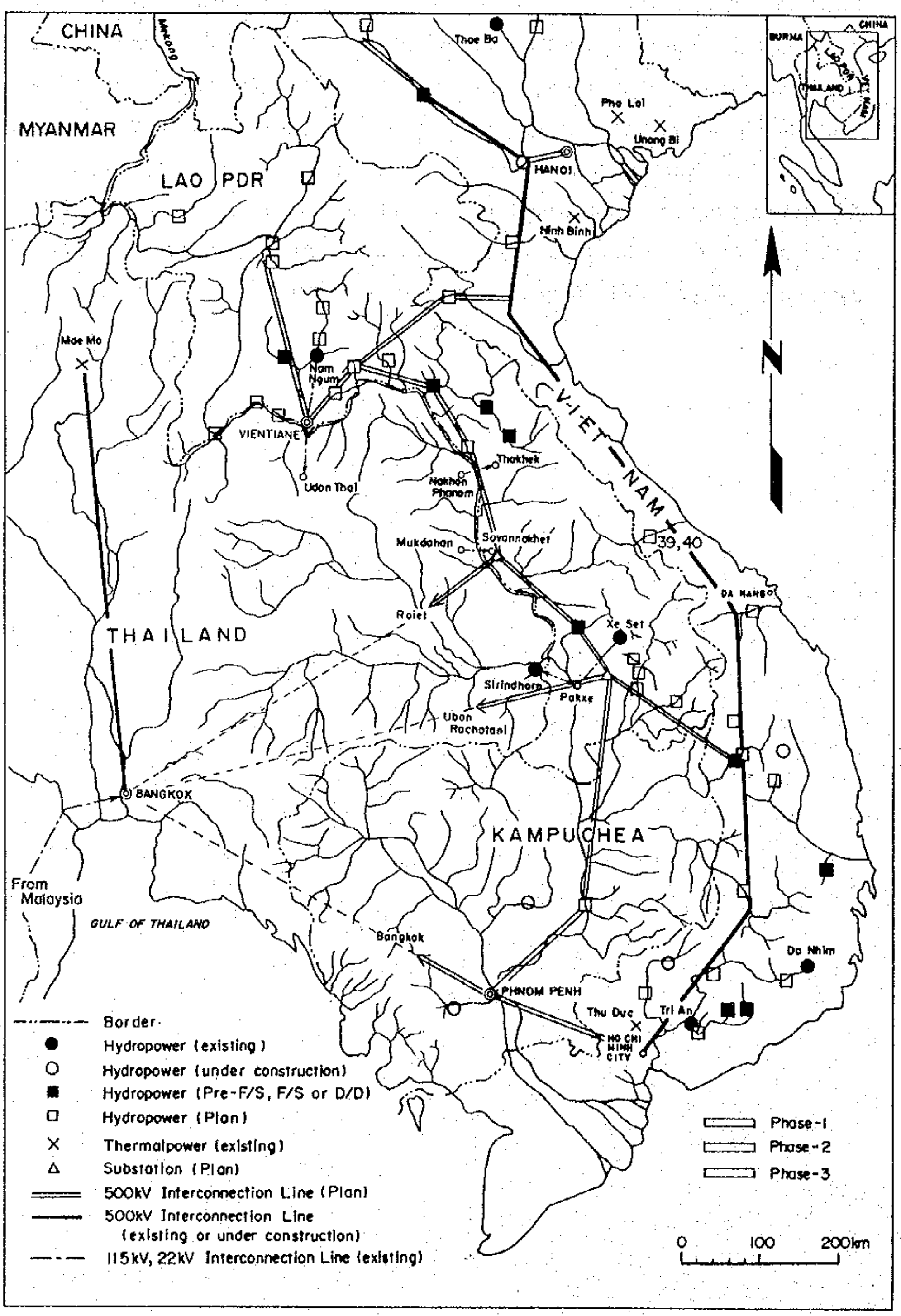
These figures strongly indicate that Vietnam will indeed become a large market. Additionally, Vietnam has already constructed a single 500 kV transmission line connecting the southern and northern systems. In contrast to this line, it is also possible to develop a 500 kV system along the international road which is planned to be built near Da Nang from southern Laos. It will not only improve electricity export from southern Laos, but will also serve to enhance the system stability of the south-north linkage and therefore, is a most valuable factor. In the dry season, contrarily, this would allow Vietnam to export the electricity generated at her coal fired power plants.

There is also a plan to develop a DC interconnection system between Thailand and Malaysia. When that is completed, it would be possible to supply electricity from Malaysia to Singapore through Thailand. Also, assuming development of DC transmission lines between Malaysia and Indonesia over the Straits, the electricity generated by the hydro power plants of Laos and Vietnam could be effectively used during the wet season. This would also enable distribution throughout Indochina of the electricity generated by nuclear power and the natural gas power in Indonesia, by the coal fired power and natural gas power in Vietnam.

Prior to any development of an interconnection system, however, it will be necessary to establish an international power cooperative organization similar to those of the previously described UCPTE and NORDEL systems. This would enable efficient construction and management of such an interconnection system throughout Indochina, including any required related fund procurement. Laos would play an important role as a power supplier and wheeling country and it is possible that it would coordinate the international power exchange, as does Switzerland in the UCPTE system. Laos would then be able to use the income realized from its electricity exports and the resultant wheeling fees to expand her own domestic infrastructures and to invite industries.

Once the interconnection system is completed, Thailand would not be her only market, thus providing an advantage when negotiating supply agreements. In the face of the present political and economic situations in Indochina, the development of an interconnection system is difficult. Heavy funding is especially required for the construction. However, development would be possible if the nations concerned progress carefully, step-by-step and considering the construction plan of power generation facilities based on the necessity for the demand. It is, therefore, quite meaningful to establish an international cooperative organization which would control the priority projects, manage fund procurement, and benefit concerning power source development and the interconnection systems, and to start talks accordingly. **Fig. 4.3-4** shows the concept of these interconnection network systems.

Fig. 4.3-4 Basic Concept of the Interconnection System in Indochina area



4.3.3 Power Export Plan in Laos

According to the present electricity export/import agreement with Thailand, the highest price (peak time) is US$0.058, as shown in **Table 3.1-3**. The demand/supply has been agreed in average for the newly agreed Nam Theun Hinboun Hydro Power Project with EGAT. There is almost no difference compared to the demand/supply agreement for the existing Nam Ngum Power Plant because the main client in the power export/import market in Indochina is currently Thailand. Since the wholesale price of EGAT in Thailand is approx. US$0.06, the price is expected to move at this level in the future. Therefore, projects able to achieve a low unit sale price and clear this price level will be developed.

How much electricity is to be accepted by Thailand will be determined by her demand estimate, power development plans and her energy security policy. Currently, 1,500MW in the year 2000 is the indicator set by the two governments. 1,500 MW in the year 2000 represents approx. 15% of the power supply facilities in Thailand in the year 2000 and is equivalent to the auxiliary stock in the supply system aimed by EGAT (PEAK + 15% (auxiliary)). An equivalent export/import market is expected in the future.

Vietnam is the second client with potential to expand this market significantly and interconnection with Vietnam is considered to have a large impact. As described in 4.3.2, therefore, it is ideal to connect all of Indochina with a 500 kV international interconnection system and use the Laotian hydro sources effectively. Considering all the major factors, including the agreement negotiations, it is necessary that in addition to Thailand, Laos acquires more clients. Cambodia is another potential client. The development site in this Master Plan is situated in the most southern part of Laos. Of all the power sources, it is the nearest to southern Vietnam, which is expected to be the future demand area and Cambodia. Therefore, its value as the resource is very large.

PART 2 HYDROPOWER POTENTIAL STUDY IN THE SE KONG BASIN

5. Existing Data

5. Existing Data

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5. Existing Data

5.1 Previous Studies

The Mekong Committee has carried out preliminary hydropower potential studies on the Se Kong Basin. The latest report of a series of the studies was issued in 1984 with 14 projects as shown in **Table 5.1-1**. On the other hand, for the basin of Xe Namnoy river, alternative development projects have been proposed by JICA in the Feasibility Study on Xe Katam Small-Scale Hydroelectric Power Development Project as shown in **Table 5.1-2**. The location of these projects is shown in **Fig. 5.1-1**. However, any field surveys such as topographic survey, geological investigation, environmental impact survey have not been surveyed in the basin, except some data at the meteorological and hydrological observation stations.

The review of these development plans proposed in previous studies are development plans proposed in previous studies are described in Chapter 7.

Table 5.1-1 Study conducted by Mekong Committee

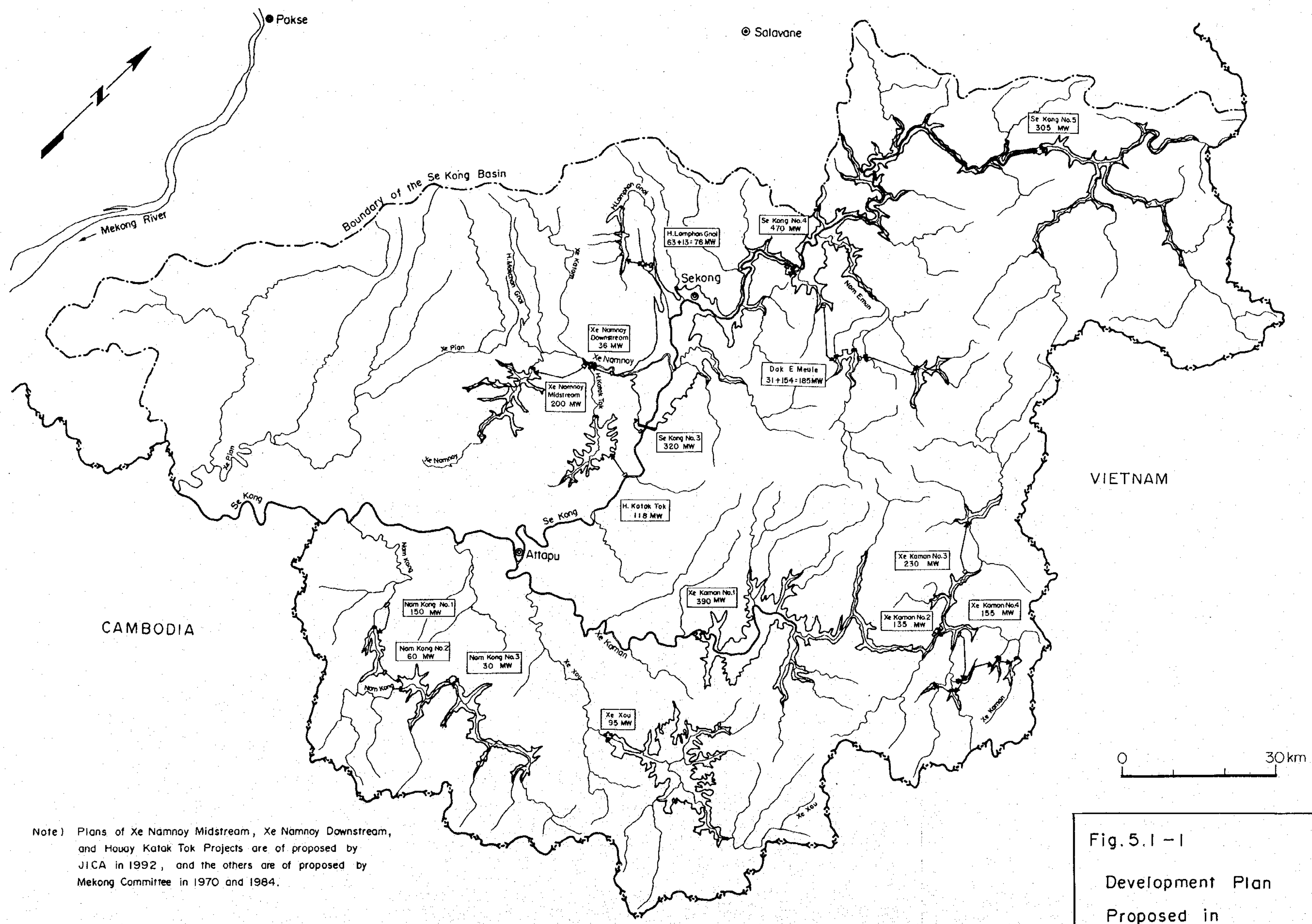
Site	Installed Capacity (MW)	Annual Energy Production (GWh)	Construction Cost (10^6 US$)
Se Kong No. 5	305	1,533	381.9
Se Kong No. 4	470	2,327	600.2
Se Kong No. 3	320	1,581	371.1
Dak E Meule	185	932	303.4
H. Lam Phan Niai	76	382	84.4
Xe Namnoy	530	2,653	622.4
Xe Kaman No. 4	155	769	172.5
Xe Kaman No. 3	230	1,143	230.1
Xe Kaman No. 2	135	668	208.2
Xe Kaman No. 1	390	1,940	439.1
Xe Xou	95	474	147.5
Nam Kong No. 3	30	146	41.4
Nam Kong No. 2	60	302	74.6
Nam Kong No. 1	150	763	149.2
Total	3,130	15,613	

Source: Lower Mekong Water Resources Inventory, 1984, Mekong Committee

Table 5.1-2 Study conducted by JICA

Site	Installed Capacity (MW)	Annual Energy Production (GWh)	Construction Cost (10^6 US$)
Xe Namnoy	200	529.1	158.4
Houay Katak-Tok	118	331.4	104.0
Xe Namnoy	36	181.9	61.2
Total	354	1,042.4	

Source: Feasibility Study on Xe Katam Small-Scale Hydroelectric Power Development Project, March, 1992, JICA



Note) Plans of Xe Namnoy Midstream, Xe Namnoy Downstream, and Houay Katak Tok Projects are of proposed by JICA in 1992, and the others are of proposed by Mekong Committee in 1970 and 1984.

Fig.5.1-1

Development Plan Proposed in Previous Studies

5.2 Meteorology and Hydrology

5.2.1 Meteorological Data in the Se Kong Basin and Surrounding Area

Meteorological stations in the southern Laos are mainly distributed along the Mekong River and on the Bolaven Plateau. The stations, most of which are controlled by DHM, have comparatively long term records and such data have been periodically furnished to the Mekong Committee.

In the Se Kong basin, there are few meteorological stations which were established before and after 1990. Especially in the east part of the Se Kong basin whose area shares more than 70% of the river basin, only three stations are existing in this area.

Only one station in Attapu in the said three, which is belonging to DHM, observes meteorological items such as rainfall,temperature, humidity, and wind etc. However, the data of other two stations in Sekong town and Dakchung are limited to rainfall.

The location map of these stations is attached as **Fig. 5.2-1** and the collected data are listed in **Table 5.2-1**.

Present situation of each station is as follows which are based on the observation during the site reconnaissance conducted between July 23 and August 23, 1993.

(1) Attapu Meteorological Station

Attapu located at the junction of the Se Kong River and the Xe Kaman River is the capital of Attapu Province. Although the building itself and the devices seem to have been completed quite before, the data are available from 1988.

(2) Se Kong Rainfall Station

The rainfall gauge is installed in the station in Se Kong town. The station is located about 35 km downstream of the Se Kong No.4 project site. Measurement is being continued on a daily basis by an observer in the village and the data are periodically sent to DHM in Attapu. The data are available from 1989.

(3) Dakchung Rainfall Station

This station was installed in 1987 by UNDP for their irrigation project purpose, and is situated in the mountain area of the Se Kong basin. The report on this project (**reference No. 6.3-1**) presents availability of daily records from April,1987 to April,1989.

(4) Five Rainfall Stations in the Xe Namnoy Basin

Five (5) tilting-bucket type rainfall gauges with automatic recorder, which are the same types as the gauges to be distributed in the Se Kong basin in this study, were installed in the Xe Namnoy basin in 1990 by JICA Study Team for Xe Katam Small Scale Hydropower Project.

The stations seem to be well maintained, though time delay was found in two recorders during our reconnaissance. It is deemed that time delay would have been caused by wrong sequence of the rolled paper equipped in the recorder.

The stations belonging to MIH are maintained by villagers and the data are conveyed to Vientiane through MIH in Pakse. The data from February, 1991 are available.

JICA Study Team for Master Plan Study on Hydroelectric Power Development in the Se Kong Basin has the intention to install three (3) automatic rainfall recorders and evaporation pans so as to contribute to the existing observation network.

The new observation stations were supposed to be distributed uniformly in the river basin. However, location was limited in terms of accessibility to the site and availability of observers.
After discussion between JICA Study Team and MIH, the equipment were installed in the four stations as tabulated below.

	Automatic Rain Gauge	Evaporation Pan Class A
Sekong Town	○	○
B. Pak Kayon	○	-
Attapu Town	○	○
B. Latsasin	-	○

○: to be installed

5.2.2 Hydrological Data in the Se Kong Basin

The available discharge data for the Hydropower Potential Stage were just the water level records and flow discharge measurement data in Attapu, as well as the monthly basis discharge data at B. Khmuon located at the river mouth of the Se Kong River obtained by the Mekong Committee. The former was available from July 1988 to June 1993 and the latter was from 1961 to 1969.

One (1) staff gauge station at the Se Kong River and three (3) staff gauge stations along the tributaries of the Se Kong River were found during the reconnaissance. However, the data of these stations did not contribute to our study at this Hydropower Potential Stage because of the following reasons.

(1) Sekong Town Water Level Gauging Station

A staff gauge is located at the right bank of the Se Kong River and water level has been read everyday by an observer in the village. Water level records from January 1989 are only available in MIH in Vientiane, because no discharge measurement was carried out and the rating curve has not been established yet.

Periodical discharge measurement and survey of river cross section were planned and carried out from October, 1993 by MIH using current meters supplied by JICA in order to obtain the data in the next pre-feasibility study stage.

(2) B. Latsasin Water Level Station

An automatic water level recorder and a staff gauge were installed at the left bank of the Xe Namnoy River in 1991 by JICA for the study on Xe Katam Small Scale Hydropower Development Project. The water level has been recorded and maintained by villagers since February 1991 and the data have been kept at MIH. Discharge records are also available. However, measurement was made only in small flow period. The data are not sufficient due to lack of the rating curve. Because the Xe Katam Small Scale Project had been planed as a run off river type, it was not necessary to measure the discharge in flood period at that stage.

Since each project in Xe Namnoy River is planed as a large scale project with a reservoir, discharge measurement should be carried out not only in dry season but also in wet season. So that, MIH planed and set up the facilities to measure river discharge by current meter even in wet season. Steel wire across the river and cables with pulleys to control the current meter from the bank were installed in October 1993.

(3) **B. Nonghin Water Level Station**

The same type water level recorder and a staff gauge were installed at the bank of Xe Katam River in 1991 by JICA for the same purpose as that of Xe Namnoy River.

River discharge measurement had been made only in the dry season, as same as mentioned in the case of Xe Namnoy River.

(4) **B. Fangdeng Water Level Station**

Although no data were found, one station was found during the reconnaissance. It could not be confirmed that what department or organization is responsible for that station.

B. Fangdeng is the village at the right bank of the Xe Kaman River and located 10 km west from Attapu. The discharge data at this station are important because the Xe Kaman No.1 project is one of the most promising projects.

The same type cableway as that in Sekong Town and B. Latsasin to measure the discharge was installed in October 1993.

Table 5.2-1 List of Collected Data (1/3)

as of Sep.12,1994

A : complete

B : not complete

1) Water Level Record

Station Name	Data	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	Remarks	File Name
Attapu	Daily									B	A	A	A	A	B	B	Se Kong	
Se Kong town	Daily										B	A	A	B	A	B	Se Kong	
B.Latsasin	Daily												B	A	A	B	Xe Namnoy	
B.Nonghin	Daily												B	B	B	B	Xe Katam	
Nikhom 34	Daily													A	A		Xe Katam	
B.Fangden	Daily												B	B	B	B	Xe Kaman	
B.Hatsaykhao	Daily														B	B	Xe Kaman	
B.Nanay	Daily								A	A	A	A					Xe Done	
Sowvama Khili	Daily							B	A	A	A	A		A	A		Xe Done	
Saravanne	Daily								B	B	A	A					Xe Done	
Khong Sedone	Daily										A	A					Xe Done	

2) Discharge Measurement

Station Name	Data	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	Remarks	File Name
Attapu										B	B	A	A	A	B		Se Kong	
B.Latsasin													B	B	B	B	Xe Namnoy	
B.Nonghin													B	A	B		Xe Katam	
Sekong T.															B	B	Se Kong	
B.Hatsaykhao															B	B	Xe Kaman	
Souvanna Khili														A	A		Xe Done	
Khong Sedone														B	B		Xe Done	

3) Discharge Record

Station Name	Data	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	Remarks	File Name
Attapu	Daily										A	A						
Xe Set P/S	Monthly										A	A	A	A	B			
	Daily						A	A			B	B		A				
Pleikrong dam	Monthly	A	A	A	A	A	A	A	A	A	A	A	A				Viet Nam,'51-79	
Yali dam	Monthly	A	A	A	A	A	A	A	A	A							Viet Nam,'51-'79	
Kontum	Monthly	A	A	A	A	A	A	A	A	A	A						Viet Nam,'51-74	
Khmuon	Monthly																'61-70	
	Daily																'61-70	
Siempang	Monthly																'65-68	
	Daily																'65-68	
Khong Sedone	Daily										A	A						
Saravanne	Daily										A	A						
Souvanna Khili	Daily							B	A	A	A	A					'61-'69	

4) Temperature Record

Station Name	Data	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	Remarks	File Name
Pakse	Monthly	A	A	A	A	A	A	A	A	A	A	B	A	A	A	B	'51-74	
	Daily												A	A	A			
Savannakhet	Monthly	A	A	A		A	A	A	A	A	A	A	A	A	B		'51-74,79	
Nikhom 34	Monthly												A	A	A	B		
	Daily												A	A	A			
Paksong	Monthly												A	A	A	B		
	Daily												A	A	A			
KM 42	Monthly												A	A	A	B		
	Daily												A	A	A			
Attapu	Monthly								A	A	A	A	A	A	B			
	Daily										B	A	A		B	B		
B. Latsasin	Daily													B	B	B		
B. Nonghin	Daily													B	A	B		
Vientiane	Monthly		A	A			A	A	A									

Table 5.2-1 List of Collected Data (2/3) as of Sep.12,1994

A : complete
B : not complete

5) Humidity Record

Station Name	Data	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	Remarks	File Name
Pakse	Monthly	A	A	A	A	A	A	A	A	A	A	A	A	A	A	B	'49-68	
	Daily												A	A	A			
Savannakhet	Monthly	A	A	A	A	A	A	A	A	A	A	A	A	A	B		'51-74	
Nikhom 34	Monthly												A	A	A	B		
	Daily												A	A	A			
Paksong	Monthly												A	A	A	B		
	Daily												A	A	A			
KM 42	Monthly												A	A	A	B		
	Daily												A	A	A			
Attapu	Monthly										A	A	A	A	B			
	Daily										B	A	A		B	B		
B. Latsasin	Daily													B	B	B		
B. Nonghin	Daily													B	A	B		
Vientiane	Monthly		A	A			A	A	A									

6) Evaporation Record

Station Name	Data	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	Remarks	File Name
Pakse	Monthly	A	A	A	A	A	A	A	A	A	A	A	A	A	A	B	'58-73,77-79	
	Daily		A			A	A	A	A	A	A		A	A	B		'61-64,67-74,76-79	
Savannakhet	Monthly	A	A	A		A	A	A	A	A	A	A	A	A	B		'58-69,71-74	
	Daily		A				A	A		A	A							
Nikhom 34	Monthly												A	A	A	B		
	Daily												A	A	B			
KM 42	Monthly												A	A	A	B		
	Daily												A	A	B			
Vientiane	Monthly		A	A			A	A	A									
Attapu	Daily										B	A	A		B	B		
Se Kong	Daily														B	B		
B.Latsasin	Daily														B	B		

7) Wind Record

Station Name	Data	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	Remarks	File Name
Pakse	Monthly	A	A	A		A	A	A	A	A	A	A	A	A	A	B		
	Daily												A	A	B		'61-64,67-74,76-79	
Savannakhet	Monthly	A	A	A		A	A	A	A	A	A	A	A	A	B			
Nikhom 34	Monthly												A	A	A	B		
	Daily												A	A	B			
Paksong	Monthly												A	A	A	B		
	Daily												A	A	B			
KM 42	Monthly												A	A	A	B		
	Daily												A	A	B			
Attapu	Daily										B	A	A					
Vientiane	Monthly		A	A			A	A	A									

8) Dew Point Record

Station Name	Data	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	Remarks	File Name
Pakse	Monthly	A	A	A		A	A	A	A	A	A	A	A	A	A	B		
Savannakhet	Monthly	A	A	A		A	A	A	A	A	A	A	A	A				
Vientiane	Monthly		A	A			A	A	A									
Nikhom 34	Monthly												A	A	A	B		
KM 42	Monthly												A	A	A	B		
Paksong	Monthly												A	A	A	B		

Table 5.2-1 List of Collected Data (3/3) as of Sep.12,1994

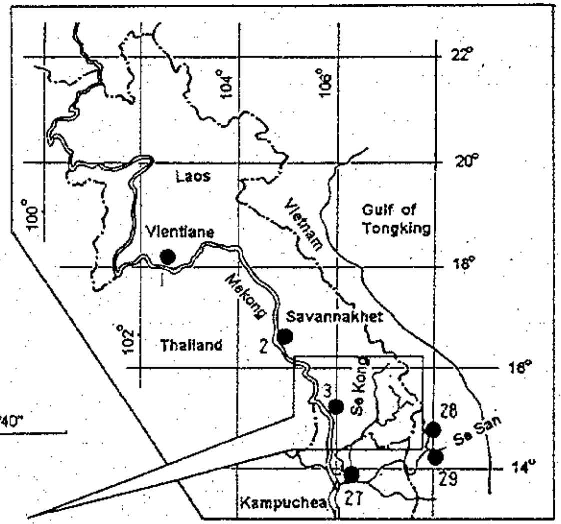
9) Rainfall Record

A : complete
B : not complete

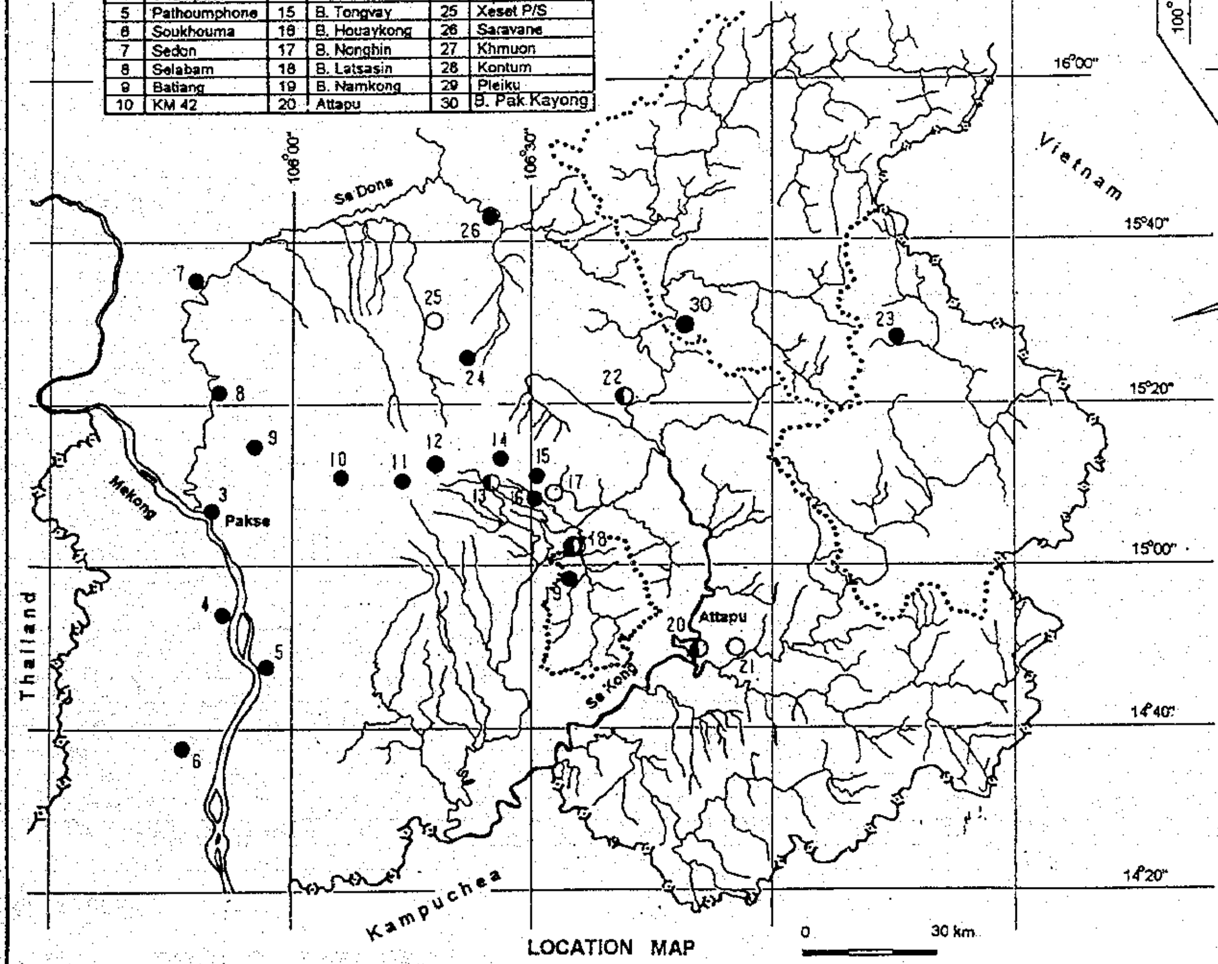
Station Name	Data	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	Remarks	File Name
Vientiane	Monthly		A	A														A	A	A	A	A	A	A								St.No. 215	
Attapu	Monthly																								A	A	B	A	A			St.No. 266	
	Daily																								A	A	A	A	A	B	B		
Se Kong town	Monthly																								B	A	B						
	Daily																								B	A	A	A	A	B	B		
B. Houaykong	Daily																											B	A	A			
B. Latsasin	Daily																											A	B	A	B		
B. Namkong	Daily																											A	B	A	B		
B.Pakkayong	Daily																													B	B		
B. Xekatam	Daily																											A	A	B			
B. Tongvay	Daily																											A	A	A			
Pakse	Monthly	A	A	A	A	A	A		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	B	St.No. 225, '60-64	
	Daily	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	B	'50-64	
Savannakhet	Monthly	A	A	A	A	A	A	A							A		A	A	A	B	A	A	A	A	A	A	A	A	A	B		St.No. 223, '51-64	
	Daily	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A		A	A	A	A	A	A	A	A							
Nikhom 34	Monthly																											A	A	A	B		
	Daily																									A	A	A	A	A	B		
Paksong	Monthly		A	B	A											B		A	A	B	A	A	A	A	A			A	A	A	B	St.No. 226	
	Daily	A	A	B	A	A	A	B							A	A	B	A	A	B	A	A	A	A	A	A		A	A	A	B	'64	
KM 42	Monthly															A	A	A										A	A	A	B		
	Daily															A	A	A		A	A	A	A	A	A	A	A	A	A	A	B		
Selabam	Monthly								A	A	B	A	A	A	B	B	A	B	A	A	A	A	A	A	A							St.No. 242	
	Daily								A	A	A	A	A		A		A	B	A	A	B	A	A	A	A	A		A	A	A	B		
Champasack	Monthly															B	A	B	A	A	A	A	A	A	B							St.No. 259	
	Daily															A	A		A	A	A	A	A	A	A	A		A	A	A	B		
Pathoumphone	Monthly	A	A	A	A	A	A	A								A	A	A	A	A	A	A	A	A	B					B		St.No. 255	
(Phiafay)	Daily	A	A	A	A	A	A	A								A	A		A	A	A		B					A	A	B	B	'64	
Soukhouma	Monthly															B	A	A	A	A	A	A	A	A	A							St.No. 256	
	Daily															B	B		A	A	B	B	B	A	A	A				A	B		
Nonghin	Monthly																A	A	A	A	A	A	A	A	A		A	A				St.No. 260	
	Daily																A	A	A	A	A	A	A	A	A	A	B	A	A	A	B		
Salavan	Monthly		A	B																				A	A	A	B					St.No. 227	
(Saravane)	Daily	A	B	B		B	B																	A	A	A						'64	
Khong Sedone	Monthly			B																B					A							St.No. 224	
	Daily	A	A	B	A	A	A		A							A				A					A			A	A	A	B	'63-64	
Batiang	Daily																											A	A	A	B		
Dakchung	Daily																							B	A	B							
Bolaven	Monthly																				B	A			A							St.No. 258	
	Daily															A					B	A			A	A							
Pleiku	Monthly	A	A	A	A	A	A	A	A	A	A			A	A	A	A	A	A	A	A	A	A	A	A	A						St.No. 815, '27,30-39	
	Daily																		A	A	A	A	A	A									
Kontum	Monthly	A	A	A	A			A	A	A	A			A	A	A	A	A	A	A	A	A	A	A	A	A						St.No. 809, '23,25,27	
	Daily																		A	A	A	A	A	A									

Hydrological and Meteorological Stations

No.	Station	No.	Station	No.	Station
1	Vientiane	11	Paksong	21	B. Fangdeng
2	Savannakhet	12	Nonghin	22	Sekong Town
3	Pakse	13	Nikhom 34	23	B. Dakchung
4	Champasak	14	B. Xekatam	24	B. Thateng
5	Pathoumphone	15	B. Tongvay	25	Xeset P/S
6	Soukhouma	16	B. Houaykong	26	Saravane
7	Sedon	17	B. Nonghin	27	Khmuon
8	Selabam	18	B. Latsasin	28	Kontum
9	Batiang	19	B. Namkong	29	Pleiku
10	KM 42	20	Attapu	30	B. Pak Kayong



KEY MAP



LOCATION MAP

● : Rainfall Station
○ : Water Level Gauging Station
◐ : Rainfall and Water Level Gauging Station
~<·>~ : International Boundary
····· : Catchment Boundary

Fig. 5.2-1 Location Map of Hydrological and Meteorological Stations

5.3 Topographic Maps

Topographic maps available for the study have been prepared and issued by NGD (National Geographic Department) as following scales.

1/50,000
1/100,000
1/200,000
1/500,000
1/1,000,000

These maps have been collected by the study team.

1/50,000 and 1/100,000 scale maps are covered all of the Se Kong basin, and the maps were very useful for the site selection of the hydropower potential study.

5.4 Geology

Existing data related to geology were collected in Laos and in Japan as follows.

Tien,P.C.(1988).	Geology of Kampuchea, Laos and Vietnam.
JICA (1992).	Feasibility Study on Xe Katam Small Scale Hydroelectric Power Development, FinaReport.
U.N.(1992).	Atlas of Mineral Resources of the ESCAP Region, Vol.7, Lao PDR.
Mullins,J.(1987).	Southern Area Development Master Plan, Sectoral Report, Geology and Mineral Resources.
ADB.(1990).	Geological and Mineral Occurence Map.