Lao People's Democratic Republic
Department of Electricity, Ministry of Energy and Mines
Electricité du Laos

Lao People's Democratic Republic Data Collection Survey on Power System Development in Southern Region in Lao PDR

Final Report
(Summary)

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Japan International Cooperation Agency

Tokyo Electric Power Company Inc.
Tokyo Electric Power Services Co., Ltd.
Nippon Koei Co. Ltd.

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Abbreviations

A	Ampere
ACSR	Aluminum Conductor Steel Reinforced
ADB	Asian Development Bank
CA	Concession Agreement
cct	Circuit
CIF	Cost, Insurance and Freight
COD	Commercial Operation Date
CSG	China Southern Power Grid Co.
DC	Direct Current
DOE	Department of Electricity in MEM
EDL	Electricité du Laos
EGAT	Electricity Generating Authority of Thailand
EIRR	Economic Internal Rate of Return
EPZ	Economic Private Zone
FS	Feasibility Study
FC	Foreign Currency
FIRR	Financial Internal Rate of Return
FY	Fiscal Year
GDP	Gross Domestic Product
GMS	Greater Mekong Sub-Region
GW	Giga Watt
GW h	Giga Watt hour
HVDC	High Voltage Direct Current
Hz	Hertz
IEC	International Electrotechnical Commission
IPP	Independent Power Producer
IRR	Internal Rate of Return
JICA	Japan International Cooperation Agency
JPY	Japanese Yen
kA	Kilo- Ampere
kV	Kilo-Volt
Lao PDR	Lao People's Democratic Republic
LC	Local Currency
LDC	Load Dispatching Center

LDC	Least Developed Country
LEPTS	Lao Electric Power Technical Standards
MEM	Ministry of Energy and Mines (Lao PDR)
MOM	Minutes of Meeting
MOU	Minutes of Understanding
MV	Medium Voltage
MW	Mega Watt
MWh	Mega Watt hour
NPV	Net Present Value
O&M	Operation & Maintenance
ODAF	Oil Directed Air Forced
ONAF	Oil Natural Air Forced
OPGW	Optical fiber Ground-wire
PDA	Project Development Agreement
PDEM	Provincial Department of Energy and Mines
PDP	Power Development Plan
pF	Pico Farad
PLC	Power Line Carrier
PPA	Power Purchase Agreement
PSS	Power System Stabilizer
PSS/E	Power System Simulation/Engineering
ROW	Right Of Way
S/W	Scope of Work
SLACO	Sino Lao Aluminum Company
SEZ	Special Economic Zone
S/S	Substation
TL	Transmission Line
TR	Transformer
UHV	Ultra High Voltage
UNOSAP	United Nations Operational Satellite Applications Programme
USD	United States Dollar
UXO	Unexploded Ordnance
WB	World Bank

Chapter 1 Outline of the Study

1.1 Objectives and Targets of the Study

The construction of 115kV Pakbo-Saravan Transmission line was recommended to be urgently needed to contribute the reduction of imported power by utilizing the surplus power in the south (currently in the South 2) via the interconnection between the south and the central (currently South 1) in line with Power Sector Policy Statement of Lao PDR. (Stable and continuous domestic power supply at a reasonable price will be maintained and expanded to promote economic and social development.)

The objectives of the study is to prepare a report for the formation of a future yen loan-financed project by reviewing the latest PDP2010-2020(draft) of Lao PDR, developing some power development scenarios through discussions with the Laos side and analyzing the electric power system in Lao PDR. Specifically, the Study Team will conduct the following activities.

- ❖ To conduct a power system analysis of the interconnection link between the central and southern systems and the local system of the southern area for the period of PDP2010-2020
- ❖ To develop a basic design for the transmission lines / substations projects in the interconnection link between the central and southern systems and the local system of the southern area

The counterpart divided the system into three regions, North, Central and South, however, we divided the South system into two regions, South 1 and South 2 to distinguish the location at the sending point and at the receiving point of the interconnection targeted in this study.

Table 1-1 Regions of Power Network System of Laos

Area	Provinces
North (N)	Phongsaly, Bokeo, Luang Namtha, Oudomxai, Huaphanh Xiengkhuang, Luang Prabang, Sayaboury
Central (C)	Vientiane Province, Vientiane Capital, Bolikhamxai
South 1 (S1)	Khammouan, Savannakhet
South 2 (S2)	Champasak, Saravan, Xekong, Attapeu

1.2 Differences between the latest PDP and previous JICA MP Study

The main differences between the latest PDP and previous JICA MP Study (Jan.2010) in around South 1 -2 Area for plan in 2015 are as follows.

- 230kV Seno -Saravan T/L (2015) was proposed to be commissioned after 2020 in MP Study. According to the F/S DFR made in April 2011 by Sino-Hydro, it was proposed to be commissioned in 2015 and would cost 162 million USD.
- According to the latest plan, Nongdeun substation was constructed in 2012. Its load was 111 MW in 2015 and 121 MW up to 2020.
- 115kV Pakbo-Saravan T/L was expected to be commissioned in 2014 the same year as in MP Study.
- M.Kalum thermal power plant was proposed after 2020, however, according to the latest PDP, it has been planned in 2014 and its capacity is 300-600 MW.

1.3 Target Area

Figure 1-1 shows the surrounding area of South 1. We call this area the "Target Area"

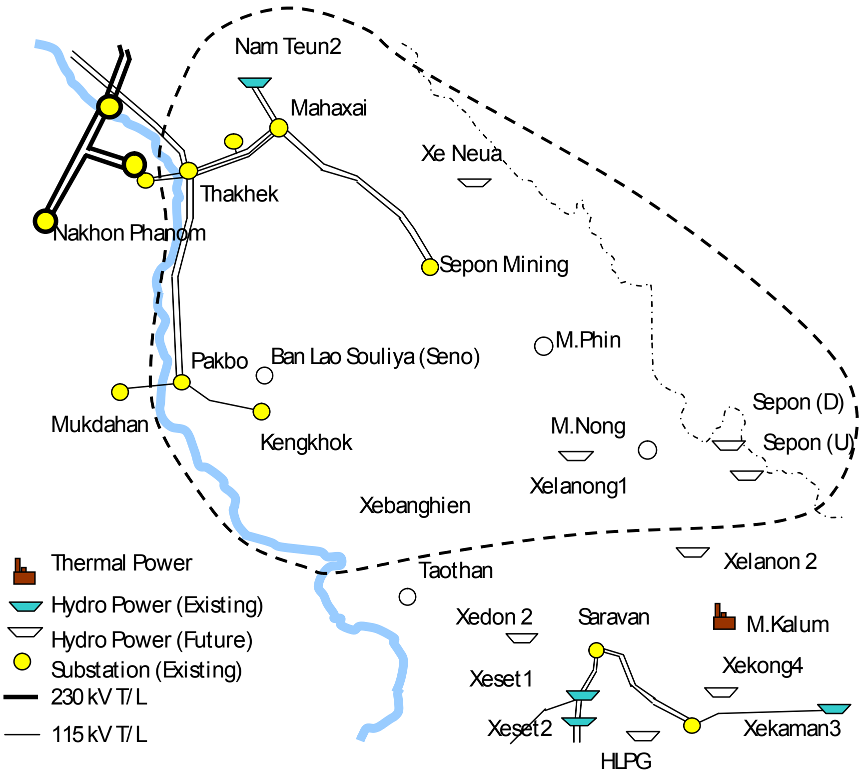

Figure 1-1 Power System in Target Area

Table 1-2 shows the balance between the power supply ability and peak power demand in the Target Area. Full Generation indicates a case of full power outputs of hydropower generators in the wet seasons and the Firm Generation indicates the case of secured power outputs of hydro power generators even during dry seasons. The Target Area has an energy deficit in all cases. Thus, it is needed to supply power from other areas to the Target Area.

Table 1-2 Balance between Power Supply Ability and Peak Power Demand in Target Area

(Unit: MW)

Item	Area	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Peak Demand	Khammouan	49.0	51.0	53.2	55.5	78.0	113.8	192.9	192.7	213.9	219.6	219.7
	Savannakhet	87.8	92.6	106.7	160.4	245.0	250.0	285.8	292.3	319.7	337.6	338.5
	Sub Total	**136.8**	**143.6**	**159.9**	**215.9**	**323.0**	**363.8**	**478.7**	**485.0**	**533.6**	**557.2**	**558.2**
Full Generation	Nam Theun 2	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0
	Xeneua	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	53.0	53.0	53.0
	Xe Lanong 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	60.0	60.0	60.0
	Sepon 3 (Down)	0.0	0.0	0.0	0.0	0.0	0.0	30.0	30.0	30.0	30.0	30.0
	Sub Total	**75.0**	**75.0**	**75.0**	**75.0**	**75.0**	**75.0**	**105.0**	**105.0**	**218.0**	**218.0**	**218.0**
	Surplus	**-61.8**	**-68.6**	**-84.9**	**-140.9**	**-248.0**	**-288.8**	**-373.7**	**-380.0**	**-315.6**	**-339.2**	**-340.2**
Firm Generation	Nam Theun 2	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5
	Xeneua	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.3	20.3	20.3
	Xe Lanong 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.0	27.0	27.0
	Sepon 3 (Down)	0.0	0.0	0.0	0.0	0.0	0.0	21.0	21.0	21.0	21.0	21.0
	Sub Total	**52.5**	**52.5**	**52.5**	**52.5**	**52.5**	**52.5**	**73.5**	**73.5**	**120.8**	**120.8**	**120.8**
	Surplus	**-84.3**	**-91.1**	**-107.4**	**-163.4**	**-270.5**	**-311.3**	**-405.2**	**-411.5**	**-412.8**	**-436.4**	**-437.4**

In the Target Area, in spite of a few power stations planned, there is a lot of power consumption of substations and large mining/ industrial loads. As mentioned above in this section, the Target Area will have a power deficit throughout the years regardless of the seasons at present and for the future. The power deficit in the Target Area in 2015 will be around 300 MW during the dry season and exceed the ability of power-transmission to the Target Area via the existing transmission line. Thus, a new transmission line is needed to supply power to the Target Area in around 2015.

Chapter 2 Study Scenarios

The four scenarios of power development were set out through the discussion of DOE and EDL regarding the existence of the M Kaleum thermal power plant, hydropower plants located at Mekong Main River, Xekong 4&5, Nam Khon 1 hydropower stations and SLACO. According to the DOE's opinion, although there are two hydropower stations planned at the Mekong Main River, Thakho and Don Sahong, both of them will be developed and if its development is realized, Don Sahong hydropower station will be developed. Thus, all the cases do not take into consideration the development of Thakho. The power development scenarios are shown in Table 2-1.

Table 2-1 Classification of Each Case

Case	M Kaleum	Xekong 4 & 5 Nam Khon 1	DonSahong Thakho (Mekong)	SLACO
Case G1	✔		✔	
Case G2		✔	✔	✔
Case G3	✔	✔	✔	✔
Case G4				✔

(Source: Data for preparing PDP 2010-2020 provided by EDL, June 2011)

The supply-demand balance of the southern 1 is bad in all the cases, and it turns out that in the cases G2 and G4 without M Kaleum, there is no margin in the supply power also in the southern 2.

Via discussions with the DOE and EDL, in the case of insufficient power sources in the South region, SLACO in the Attepeu province was assumed to be supplied directly from China via 500 kV transmission lines or DC lines. When surplus power becomes too large to export via the existing interconnection to EGAT, the power exports to China or Cambodia was assumed to be possible. Figure 2-1 shows the Target Area and the locations of the power stations and the large power consumers in the South region described in the PDP.

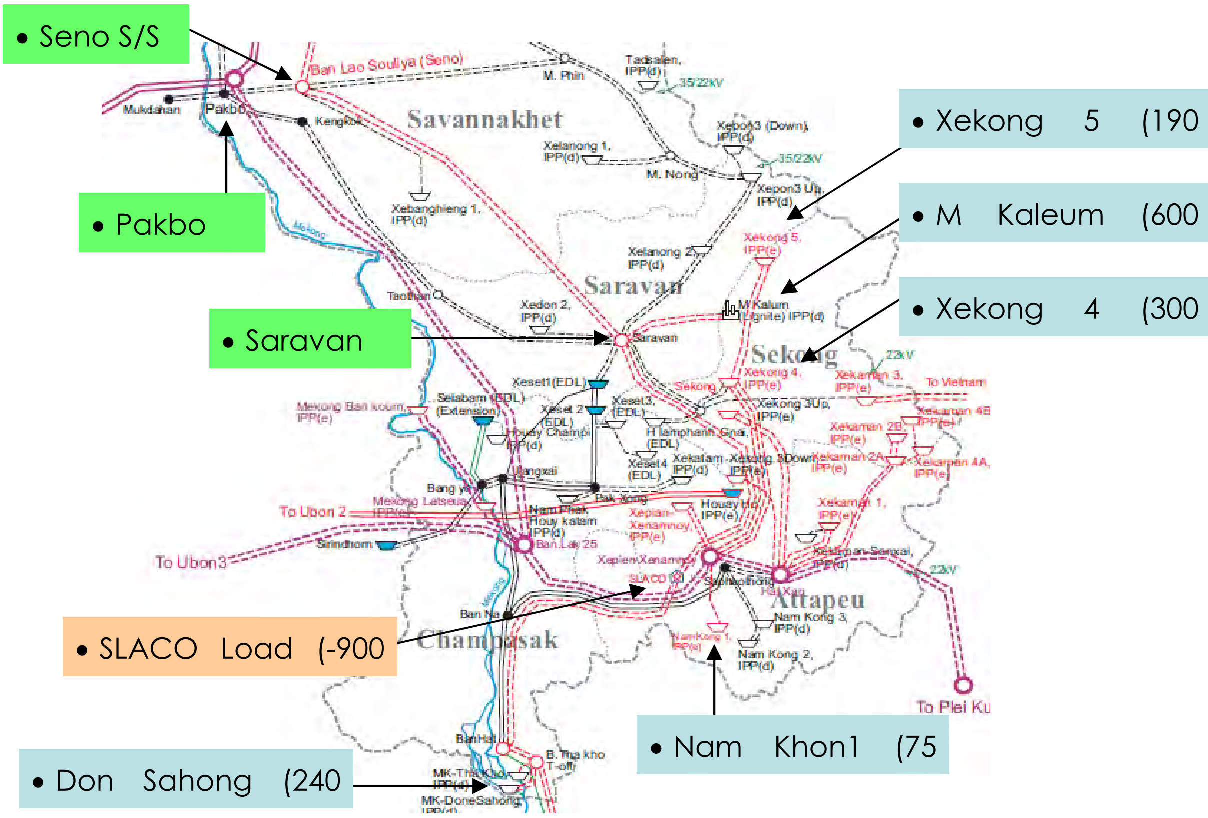

Figure 2-1 Location of Power Stations and Large Power Consumers

Two cases of power network system plans corresponding with the power development scenarios were set out to examine the justification of the 115 kV Pakbo-Saravan transmission line as follows.

- TA: Construction of 115 kV Pakbo-Saravan in 2015
- TB: Construction of 230 kV Seno-Saravan in 2015 instead of 115 kV Pakbo-Saravan

Cases TA and TB have the same interconnection capacity. Although EDL Bang Yo SS in the S2 system and EGAT Sirindorn SS are connected by the interconnection line, the power cannot be supplied from EGAT to EDL around the area due to tight supply and demand balance and EGAT system constraints. The study assumes power supply from EDL to EGAT only via this interconnection.

There is no interconnection between S2 to CSG in Cases G1 and G3. There are interconnections between S2 to CSG to supply SLACO demand in Cases G2 and G4.

Chapter 3 Supply and Demand Balancing by Cases

The supply and demand balancing simulation of Cases G1 to G4 will be conducted in 2015, 2018 and 2020.

3.1 Supply and Demand Balancing by Case G1

2015

The supply power of the north & central system during a dry season can be secured by importing power from neighboring countries.

The supply and demand balancing in the southern 1 system cannot be secured without interconnection lines. Surplus power supply is in the southern 2 system. The interconnection transmission line is necessary to supply the surplus power to other systems.

2020

The supply and demand balance is secured in the north & central system and the southern 2 system minus imported power. The interconnecting transmission lines are required to utilize the surplus power among interconnected systems efficiently. Supply and demand balance can be secured with the interconnection transmission line in the southern 1 system.

3.2 Supply and Demand Balancing by Case G2

2015

This case is the zero development of a large thermal power plant of M Kaleum. The supply to SLACO is assumed to be imported power directly from China through the HVDC or the 500kV transmission line. The supply and demand balancing of the north & central system in the dry season is secured by imported power from neighboring countries. The supply and demand balance in the southern 1 system cannot be secured without interconnection lines.

The surplus of supply power is in the southern 2 system. However, there is a power shortage at peak demand during May and the dry season in the southern system 2. It is necessary to secure power supply in the southern 2 system, by developing 100MW of power plants in the southern 2 system or by importing power supply.

2020

The supply and demand balance can be secured minus imported power in the north & central system and the southern 2 system. Surplus supply power is in the systems. The interconnection transmission line is necessary to supply surplus power to other systems. The supply and demand balance in the southern 1 system can be secured with interconnection lines.

3.3 Supply and Demand Balancing by Case G3

This case is the same as the draft PDP2010-2011 by EDL. Imported power from China is assumed in the north & central system.

2015

The supply and demand balance of the north & central system and the southern 1 system can be secured by power exchange with other systems and power imports from neighboring countries. There is surplus power in the southern 2 system because SLACO will not yet be fully operational in 2015.

2020

The supply and demand balance of the north & central system can be secured, without power imports and power exchanges. The supply and demand balance in the southern 1 system can be secured by power imports and power exchanges from interconnected systems. The power should be imported to secure the balance between supply and demand in the southern 2 system through the transmission line for the SLACO direct supply from China.

3.4 Supply and Demand Balancing by Case G4

This case is without the large thermal power plant of M Kaleum (600MW) and Don Sahong hydropower plant (240MW) which is Mekong main stream development and Xekong4,5 & Nam Khon1 (75MW) that are expected to supply to SLACO.

2015

There are deficit power supplies in every system of Laos due to a lack of power development. Supply and demand can be balanced with import power from neighboring countries.

2020

The supply and demand balance in the north & central system can be secured itself. The supply and demand balance in the southern 1 system can be secured with power imports and power exchanges from other systems. The supply and demand balance of the southern 2 system in the dry season can be secured with power imports and power transfers from other systems.

Chapter 4 Study Cases for Transmission Lines

4.1 Case TA Case G1

2015

The deficit in power in the Target Area will be eliminated by power transmission via the 115 kV Pakbo-Saravan transmission line from the South 2 area..

2018

The 230 kV designed Seno–Saravan transmission line will be constructed in parallel with the 115 kV Pakbo–Saravan transmission line to correspond with an increase in the power supply from the South 2 area to the Target Area where the deficit in power will be increased.

4.2 Case TB Case G1

2015

The deficit in power in the Target Area will be eliminated via power transmission from the South 2 area by the 230 kV designed Seno-Saravan transmission line operated at 115 kV.

2018

The 230/115 kV transformers will be installed at the Seno and Saravan to upgrade the Seno – Saravan transmission line to 230 kV and increase the capacity of the transmission line to correspond with an increase in the power supply from the South 2 area to the Target Area where the deficit in power will be increased.

4.3 Case TA (1) Case G2

All the areas will have a deficit in power during the dry season in 2015. In this case, the transmission line for SLACO will be constructed from other areas, the deficit of power is assumed to be eliminated by supplying via the transmission line that also supplies the portion of the deficit in power in the South 1 area and the interconnection between South 1 and South 2 will transmit the power from South 2 to South 1.

2015

The deficit in power in the Target Area will be eliminated via power transmission from the 115 kV Pakbo-Saravan transmission line from the South 2 area.

2018

The 230 kV designed Seno–Saravan transmission line will be constructed in parallel with the 115 kV Pakbo–Saravan transmission line to correspond with an increase in the power supply from the South 2 area to the Target Area where a deficit in power will be increased.

4.4 Case TA (2) Case G2

SLACO is supplied from other areas via the exclusive 500 kV or DC transmission lines in the same manner as in the previous case (1). This case assumed that the deficit in power in S1 and S2 in 2015 would be eliminated by supplying through the interconnection from EGAT. The newly expanded interconnections were assumed between EGAT and S1.

The interconnection between South 1 and South 2 will transmit the power from South 1 to South 2 in 2015. In 2018, the deficit in power in Target Area will be eliminated by power transmission by the 115 kV Pakbo-Saravan transmission line from South 2 area.

4.5 Case TB (1) Case G2

2015

South 2 is supplied from other areas via the exclusive 500 kV or DC transmission lines to SLACO, and the deficit in power in the Target Area will be eliminated via power transmission from the South 2 area by the 230 kV designed Seno-Saravan transmission line operated at 115 kV.

2018

The 230/115 kV transformers will be installed at Seno and Saravan to upgrade the Seno – Saravan transmission line to 230 kV and increase the capacity of the transmission line to correspond with an increase in the power supply from the South 2 area to the Target Area where the deficit in power will be increased.

4.6 Case TB (2) Case G2

This case assumed that the deficit in power in S1 and S2 in 2015 would be eliminated by supplying through the interconnection from EGAT. The newly expanded interconnections were assumed between EGAT and S1.

The interconnection between South 1 and South 2 will transmit the power from South 1 to South 2 in 2015. In 2018, the deficit in power in Target Area will be eliminated by power transmission by the 115 kV Pakbo-Saravan transmission line from South 2 area.

4.7 Case G3 and Case G4

The way of correspondence with Case G3 would be similar to Case G1 and Case G2 would be similar to Case G4. Especially in 2015, the deficit in power of S2 in Case G2 and G4 are the same because the commissioning year of Xekong 4&5, Nam Khon1 and Mekong is 2016. The methodologies of the interconnections between South 1 and South 2 up to 2020 become the following in correspondence with Case G1 to Case G4.

Chapter 5 Power System Analysis

This study carries out a power system analysis by using PSS/E which is used in EDL according to the transmission system development scenario.

The transmission system development plan of EDL must satisfy the N-1 criteria which does not allow any power outages under the single failure of power equipment such as the transmission line and the transformer. This study adheres to the same criteria and creates a development plan taking into account the loss of high voltage transmission lines in the target area.

The transmission system development plan must satisfy the criteria under the fault conditions.

5.1 Power Flow Control

The import/export power flows are controlled by the phase shifter in this study in order to achieve the power flow conditions illustrated in the previous chapter. EDL also discussed the power flow control via the phase shifter in their PDP 2010-2020.

5.2 Power Flow and Voltage Analysis in the Year 2015

The study targets the dry season as the severer assumption. This study has developed some scenarios shown in the previous chapter. The following two cases are examined in this study:

- Case TA: 115kV Pakbo-Nongdeun-Taothan-Saravan 2 circuits
- Case TB: 230kV designed Seno-Saravan 2 circuits operated in 115kV

Both Cases satisfy N-1 criteria and voltage criteria.

5.3 Fault Current Calculation

The fault current level of each bus is much less than the maximum fault current limit in both cases in each year.

The system stability for the cases was analyzed. The power flow limitations restricted by the transient stability are summarized in Table 5-1.

Table 5-1 Power Flow Limitations Restricted by Transient Stability

Cases	Power Flow Limitation Restricted by Stability (Total amount of power flow from Saravan to Seno and Pakbo)
(1) 115 kV transmission line 2 circuits (2) 230 kV transmission line 2 circuits	400 MW
(1) 115 kV transmission line 2 circuits (2) 230 kV transmission line 2 circuits operated at 115 kV	250 MW
(1) 230 kV transmission line 2 circuits	250 MW

Chapter 6 Candidates of Measures in South 1 Area and Prioritized Project

6.1 Comparison between Case TA and Case TB

Case TA (Construction of the 115 kV Pakbo-Saravan transmission line in 2015) and Case TB (Construction of the 230kV Seno-Saravan transmission line instead of the construction of the 115 kV Pakbo-Saravan transmission line in 2015) were compared. The difference between Case TA and Case TB is the schedule of its investment and their system losses although both cases will be expected to supply to the same power demand and respond to the same domestic power generation and the final system configurations (after 2020) would become the same.

A cost comparison was made between Case TA and TB by estimating the cost of facilities and system losses. The amount of the difference of the system losses was estimated from the results of the power flow analysis and the cost of system losses was evaluated via the power import tariffs from EGAT. The year of becoming the same system configuration both of Case TA and Case TB was assumed in 2025 according to the growth of power demand in the South 1 area.

Case TB has a larger initial investment than Case TA because it develops the 230 kV system as the first step. The total costs at present value indicate that Case TA is more economical than Case TB.

Thus, the following schedule is recommended in Case TA.

- 2015: 115 kV Pakbo-Saravan Transmission Line
- 2018: 230 kV designed Seno-Saravan transmission line operated at 115 kV
- After 2020: 230/115 kV transformers installed in Seno and Saravan to upgrade the Seno-Saravan Transmission line to 230 kV

From the aforementioned results, in the same manner as in the case of the JICA Study on the Power Network System Plan (MP Study), the 115 kV Pakbo–Saravan transmission line is recommended as the highest prioritized project.

TACSR 240 mm^2 was found to be more economical from the results of the JICA Study on the Power Network System Plan, therefore, TACSR 240 mm^2 is recommended for the conductor used in this project. The 115 KV Taothan substation will be installed on the route of the 115 kV Pakbo-Saravan transmission line following the results of the JICA Study (MP Study).

6.2 Recommended Case

Figure 6-1 to Figure 6-3 illustrates the system configuration of the recommended case from 2015 to 2020.

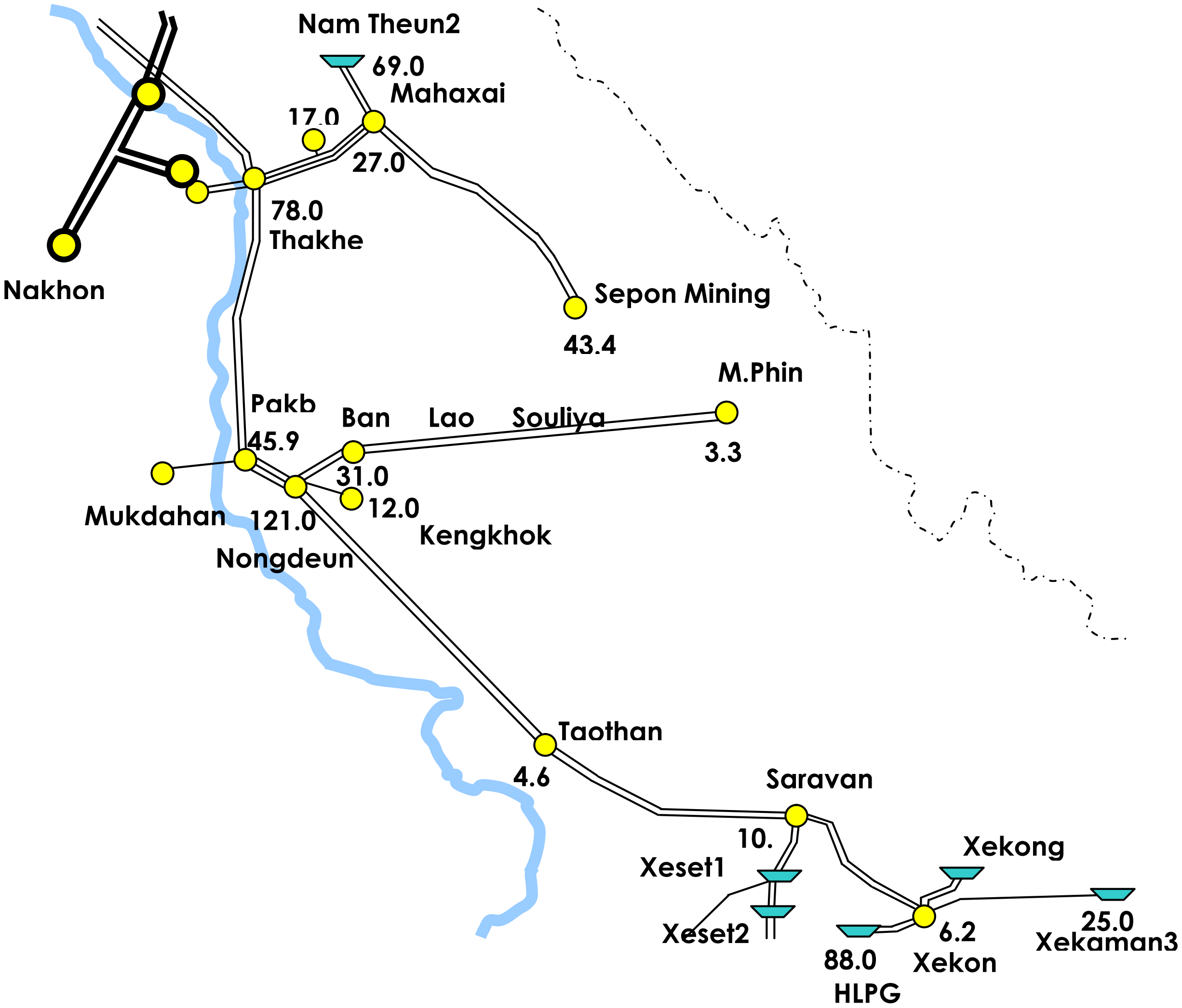

Figure 6-1 System Configuration of Recommended Case (2015)

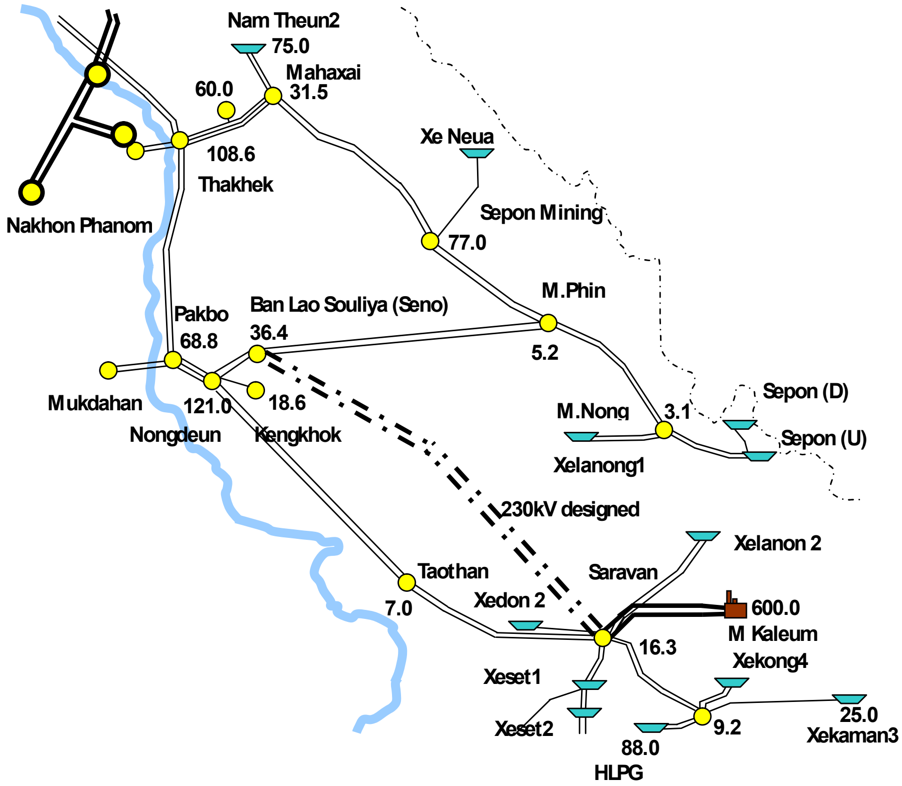

Figure 6-2 System Configuration of Recommended Case (2020)

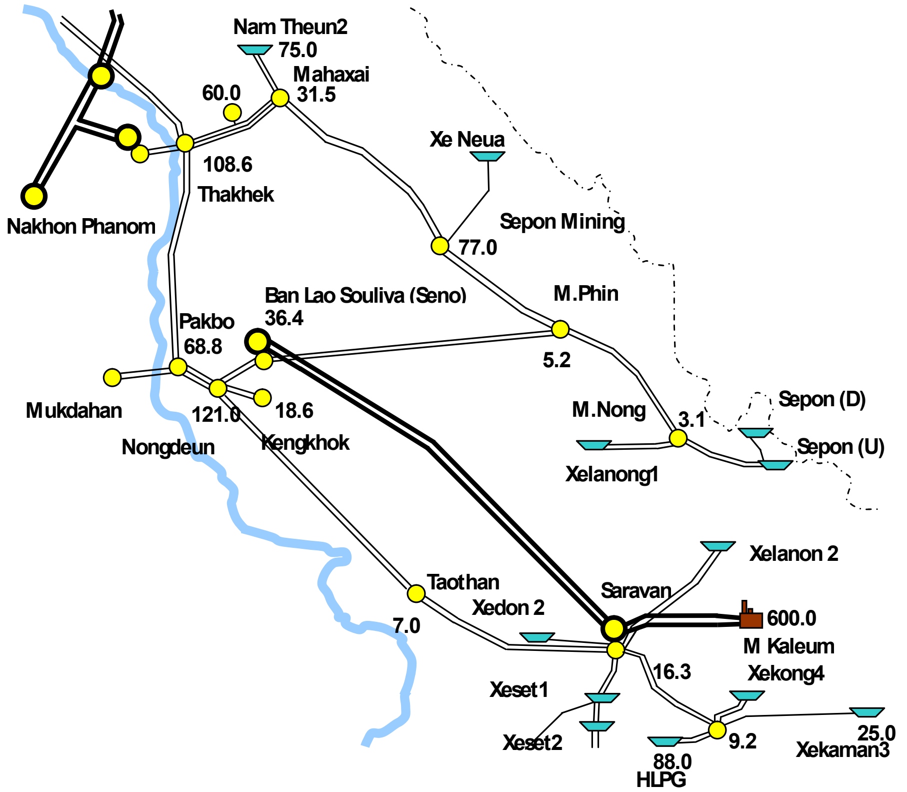

Figure 6-3 System Configuration of Recommended Case (after 2020)

Chapter 7 Design Confirmation of the Facilities of the Highest Prioritized Project in Central-South Area

7.1 Present Situation of Transmission Line Route of the Highest Prioritized Project

As stated by EDL, there is a plan to construct a new Nongdeun substation along the MP transmission line route, 4 km apart from the Pakbo substation in the SEZ to supply SEZ. The preliminary design and site acquisition for Nongdeun substation has already been finished, and the EPC contract between EDL and a consultant company in Thailand was made in July of 2011. Then the construction will be completed within 2012. As a result of a discussion with EDL, the study team and EDL agreed that the MP transmission line should connect Pakbo substation and Saravan substation via Nongdeun substation and Taothan substation. Furthermore, the existing 115kV transmission line will also lead to Nongdeun substation.

At the same time, the 115kV transmission line which connects Nongdeun substation and M.Phin substation through the Ban Lao Souliya (Seno) substation is planned to be completed in 2014, and the Nongdeun substation was designed as such a configuration.

As a result of the study, the study team proposed the MP transmission line rerouting shown in the following figure and agreed on it with EDL. This new route runs in parallel with the existing 115kV transmission line from Pakbo substation and leads into Nongdeun substation. Then the route goes out line from Nongdeun substation and return to the originally proposed route.

The study team confirmed that no residential area nor nature reserve area exists on the new route through the site survey, so that no impact to the resettlement nor to the environment by rerouting exists. In regard to the incoming Nongdeun substation of the MP transmission line, it matches the bay configuration designed by EDL as well as EDL's facility planning. Via this rerouting, the MP transmission line will not be affected by the design and/or the progress of the 115kV transmission line between Nongdeun and M.Phin via Ban Lao Souliya (Seno) planned to be constructed by China around the same time.

The study team also confirmed that EDL has already finished the site acquision for Nongdeun substation in the SEZ and there is no existing resettlement or environmental impact.

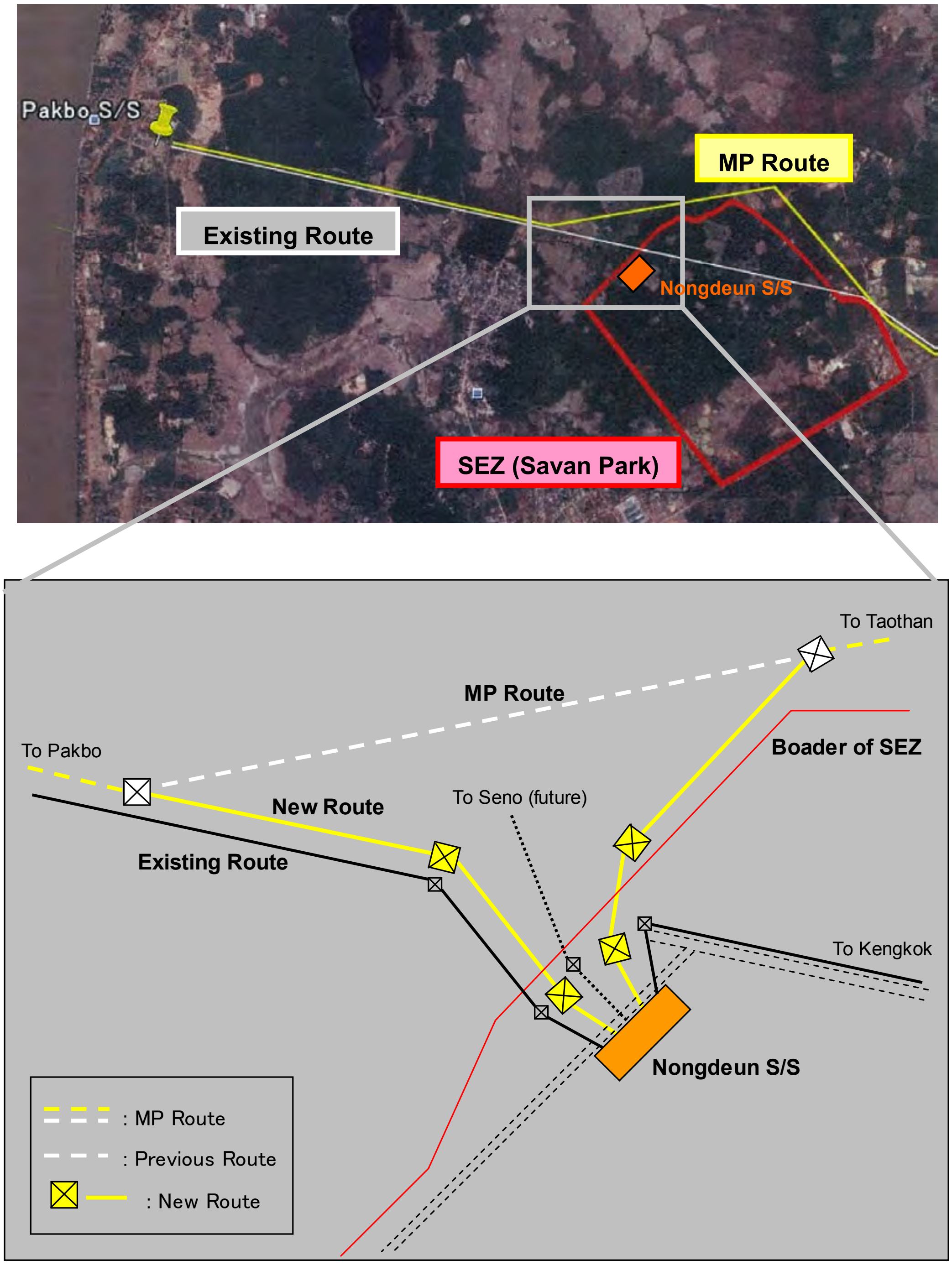

Image of new transmission line route around Nongdeun S/S

Figure 7-1 Transmission Line Rerouting near Nongdeun Substation

7.2 Implementation Schedule of the Highest Prioritized Project

The period from the appointment of the project consultants to the conclusion of the turn-key contracts for both the transmission line and substations was assumed to be 12 months and the period from the conclusion of the contracts to the taking-over of the facilities was assumed to be 24 months, therefore the total implementation period was assumed to be 36 months after the appointment of the project consultants in the MP study. Even if the incoming addition of Nongdeun substation is considered, the total implementation period is assumed to be 36 months, the same as the conclusion of the MP study.

7.3 Total Project Costs

Table 7-1 shows the total costs for the project estimated under the aforementioned conditions. The estimation of the MP study is also written in the table for reference.

Table 7-1 Total Project Costs (1,000USD)

Items	Estimation in MP study			Estimation in this study		
	FC	LC	Total	FC	LC	Total
Transmission Lines	18,235.3	6,011.7	24,247.0	20,506.5	6,376.0	26,882.5
Substation Facilities	5,580.5	2,433.8	8,014.3	6,845.6	2,800.4	9,646.0
Sub-total	23,815.8	8,445.5	32,261.3	27,352.1	9,176.4	36,528.5
Compensation	-	166.8	166.8	-	166.8	166.8
Environment Monitoring	-	43.1	43.1	-	43.1	43.1
UXO Survey & Clear	-	271.2	271.2	-	271.2	271.2
Consultant Fee	2,258.3	192.0	2,450.3	1,914.6	642.3	2,556.9
Physical Contingency	1,190.8	422.3	1,613.1	2,811.8	994.7	3,806.5
Price Contingency	714.5	253.4	967.9	765.9	770.8	1,536.7
Administration Cost	-	-	-	-	1,998.2	1,998.2
Tax & Duty	-	-	-	-	4,230.5	4,230.5
Interest During Construction	-	-	-	526.8	-	526.8
Total	**27,979.4**	**9,794.3**	**37,773.7**	**33,371.2**	**18,294.0**	**51,665.2**

Chapter 8 Economic Evaluation of the First Priority Project

The project of 115 kV Pakbo-Saravan transmission line in the central southern areas was evaluated from the viewpoint of the below benefits as:

(1) Avoidance of power outage in the two southern areas
(2) Reduction of exported and imported energy
(3) Avoidance of investment of long distance 22 kV distribution line between Saravan-Taothan
(4) Increased power supply capacity to Nongdeun Substation

The financial benefits of this project is calculated based on the revenue obtained from increased demand due to the energy consumption of final customers, which is expected to be supplied by this transmission project.

The project is evaluated to be economically appropriate since 15 % of EIRR is greater than 12 % of the Opportunity Cost of Capital (OCC).

The project is evaluated to be financially appropriate since 6 % of FIRR is greater than 2.7 % of the Weighted Average Cost of Capital (WACC).

Chapter 9 Recommendations

9.1 The transmission line from other areas to Target Area in South area

The transmission line connected to the Target Area is needed in 2015 from the South 2 area where surplus power is expected. An efficient construction schedule was found by first constructing the 115 kV Pakbo-Saravan transmission line in 2015 and second the 230 kV Seno-Saravan transmission line. Thus, the 115 kV Pakbo-Saravan transmission line should be implemented as the first prioritized project as follows.

- Pakbo-Nongdeun-Thaotan-Saravan 115 kV with 2 circuits
- Bay for 2 circuits at Pakbo substation
- Bay for 4 circuits at Nongdeun substation
- Bay for 2 circuits at Saravan substation
- Installation of Taothan substation

This project will contribute to eliminating power supply interruptions in the South 1 area, reducing power imports to the South 1 area and power supply to Taothan substation in Saravan province and Nongdeun substation in Savannakhet province.

9.2 Interconnections between Target Area and the Neighboring Country

The study and the planning of the re-conductoring of the 115 kV transmission lines between EGAT and Thakhek, adding a circuit to the 115 kV transmission line between EGAT and Pakbo and installing the phase shifters to control the power flow of EGAT-Thakhek/Pakbo should proceed in cooperation with EGAT, because the increase in power imports from EGAT by modifying the interconnections such as those measures may be considered more economical than the construction of large power transmission lines such as 230 kV from far places.

9.3 Interconnections between Laos and Neighboring Countries and Plan of Thermal Power Station

The power generation of Laos mainly consists of hydropower stations. Thus, the power output capacity of the generators largely varies between the wet and dry seasons. On the other hand, power demand in Laos is not so much different between the wet and dry seasons. Thus, the difference in the ability of the power outputs of the generators should be adjusted based on the amount of imported or exported power from the neighboring countries via the interconnections or the thermal power plants installed in Laos.

Thus, it is considered that the following list of facilities is required in the future to adjust such a huge amount of surplus power and the study of them is needed.

- Large power interconnections to neighboring countries
- Replacement of planned hydropower stations to thermal power plants