Chapter 3 Measures to Strengthen Governance in Power Sector

Based on the discussion on the current situation of power sector governance in Chapter 2, the following three measures are proposed to strengthen the power sector governance in this chapter:

i) Formulation of the comprehensive national power development plan;

ii) EDL's role and improvement of financial position; and

iii) Comprehensive management for sustainable power development.

3.1 Formulation of NPDP

One of the major expected outputs of the study is to propose the improvement of the current PDP. From the review of the current PDP described in Chapter 2 (Section 2.2 and Section 2.5), the following two major improvement points are observed:

1) To secure the comprehensiveness in the PDP. In other words, not only the mere facility development plan but also the policies for power development should be included. For example, the policies regarding how to deal with large industrial demand, in how power generation should be demarcated (domestic or export) or in what way the future power system should be configurated. These issues cannot be concluded just by simulation, but the government has to take its time making decisions.

2) Technical improvement by providing the methodologies including the reliability of demand forecasting, the ranking in generation planning and the accuracy of system analysis.

The first point is substantially important, and the proposal for improvement is detailed in this section as the formulation of the National Power Development Plan (NPDP). Meanwhile, the second point, originally requested from the Laotian side as described in Chapter 1, is an urgent matter to be improved, and major technical issues on demand forecast, generation planning, and transmission planning, and the methodologies for improvement are detailed in Chapter 4.

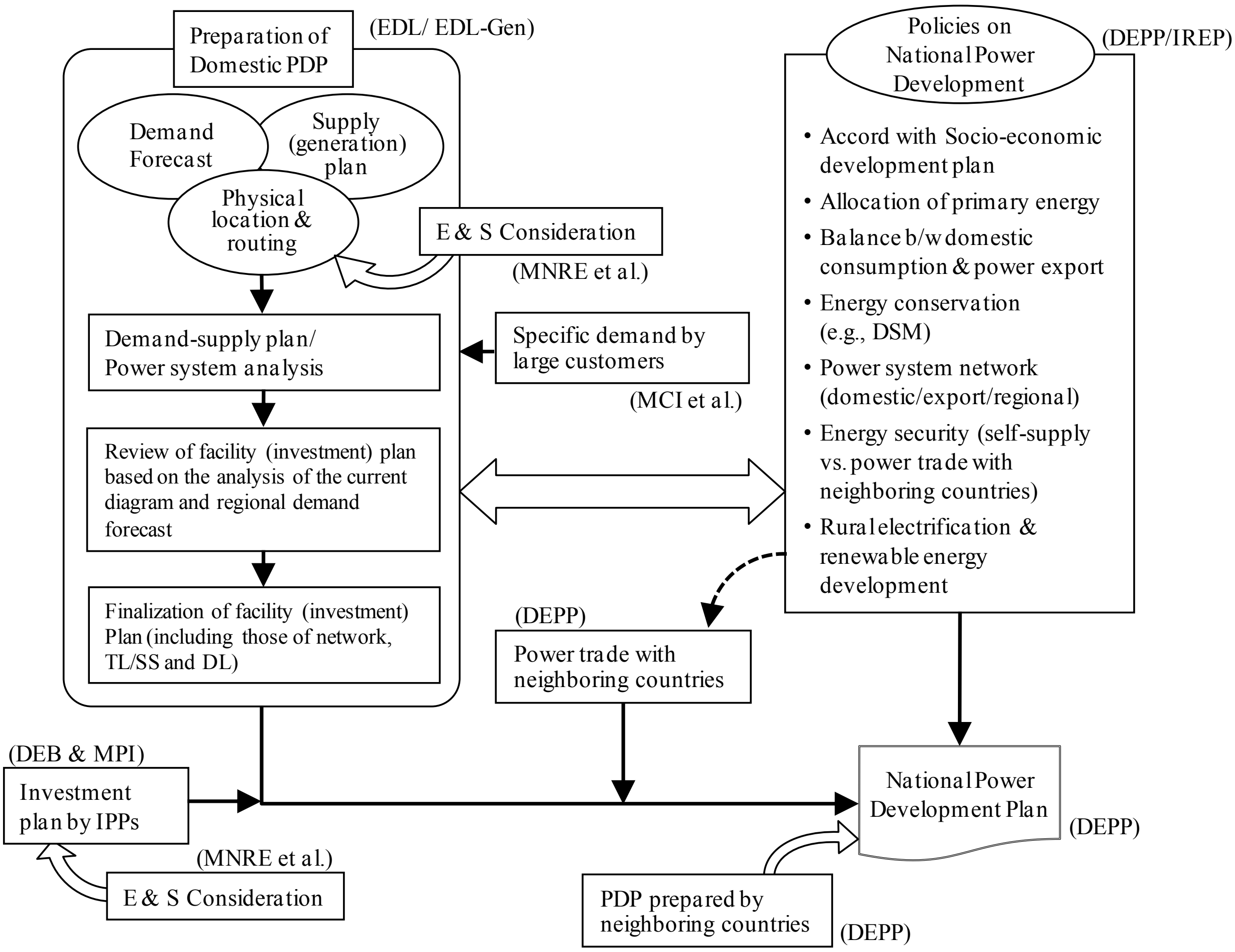
3.1.1 Structure of NPDP

The NPDP is expected to play the role of a policy paper for deciding the direction of the power sector which has not been clearly stated so far, and the following issues should be stated:

- Clarification of the power sector contribution to the national socio-economic development
- Long-term vision of energy (electricity) security and allocation including linkage with neighboring countries
- Direction of power development including:
- Power sector structure (organization, market etc.)
- Financial sustainability (tariff policy)
- Private sector participation not only IPPs but concession in transmission, distribution and service provider

- Endorsement of the Government on power development for stakeholders (utilities, private investors, donors, financial institutions etc.)

As indicated in Figure 3-1, the proposed structure of NPDP consists of three major parts. The foundation of the preparation process of the NPDP is ―Policies on National Power Development". This part should include such issues as socio-economic development plan, allocation of primary energy, balance between domestic consumption & power export, energy conservation (e.g., DSM), power system network (domestic/ export/ regional), issues on energy security (self-supply vs. dependency on neighboring countries), and trend on rural electrification & renewable energy development. The second major part is ―domestic power development", corresponding to the current EDL-PDP. This part should include such issues as demand forecasting, power supply (generation plan), physical location and routing of power facilities, demand-supply plan (power system analysis), and review of facilities (optimization of investment). It also discusses specific demand by large customers. The last part is external factors. The issues include such topics as status of IPP investment and power trade with neighboring countries.



(Source) Study Team.

Figure 3-1: Overall strucutre of NPDP

3.1.2 Clarification of policies for future power development

Up to now, comprehensive power development policy has not been set forth in Laos, although the policy papers such as the Strategy Plan for Developing the Energy and Mines have been released. However, these documents stated only the targets of rural electrification ratio and a sort of slogan — Laos shall be the battery of the ASEAN region. The outlook for future power demand and supply was also attached to the Strategy Plan, but its contents did not go beyond those of the existing PDP prepared by EDL.

In this circumstance, there are some key elements for the government (and the MEM especially) to discuss and concretize for its policy for power development, as follows.

3.1.2.1 Energy security, and balance of risk and cost

It is true that Laos is endowed with abundant hydro resources. However, this does not mean that it must secure the domestic power supply by developing its own resources. Optimized power development must be planned by taking into account the balance of risk and cost.

The current PDP holds various risks including an uncertain demand outlook and a deteriorating EDL financial position caused by the scheduled huge investment. The accelerated deterioration of cash position over the past three years is a particularly serious concern.

Meanwhile, Laos has become strongly involved with the GMS countries in ties of economic activity and mutual dependence; economic activities in the region are becoming increasingly intertwined. Optimization of future power development also must be discussed in relation to economic linkage in the region.

To make the future power supply cost-effective and risk-minimum, now is the time to contemplate possible scenarios for power development and clarify measures to maximize Laos‘ advantage in the region. Pursuing development of domestic hydro resources is not always the best answer. This is because hydropower in Laos has a strong cost advantage compared to other power sources in neighboring countries, but this advantage may change depending on demand size and load factor.

Power purchase from neighboring countries rather than power generation in Laos could be advantageous in some cases, if investment risk and risk cost are carefully evaluated. Laos continues to export a large amount of power on the macro level, but this is not the case on the micro level. For example, in the mid-2010s, the mining sector is forecasted to have a high power demand. To secure the power supply to meet the large demand increase in the future from not only the mining sector but also other economic activities, EDL started to make large-scale investments in power development in the late 2000s. The problem here is that, on one hand, the prospects for demand increase are still clouded with much uncertainty, while on the other hand, EDL has already taken the associated investment risk, which it may not be able to absorb financially in the long range.

One measure to solve the problem would be to have any demand increase beyond EDL capacity filled by power import from EGAT, whose capacity is sufficiently large to absorb it (this level of demand increase is marginal for EGAT). Although the power-purchase price from EGAT is higher than the hydropower generation cost in Laos, this differential must be regarded as cost necessary for investment-risk mitigation.

This is the thrust of how to strike the right balance between investment risk and associated cost. In addition, another question for discussion is the party which should pay the cost; the reasonable answer may be that the beneficiary should pay it.

3.1.2.2 Optimal make-up of power generation and trade

Laos has four options to supply electricity as follows, and synchronization of these options must be one of the key components (or aspects) in policy discussion:

- EDL‘s (or EDL-Gen‘s) own generation;
- Power purchase from IPPs for domestic supply (IPP(d));
- Power purchase from IPPs for export (IPP(e)); and
- Power import from EGAT.

The optimal combination of these options should be clarified in the NPDP as a target (or ―norkmal") for future power development. Generally, the EDL as the system operator should have a reservoir type generation with a regulation capability, and IPPs, in contrast, a run-of-river type generation with constant energy supply (in other words, for base-load supply).

Excessive introduction of IPP (d) also causes excessive energy generation in the rain season especially, and the EDL is averse to purchase of the output. This is because the EDL as an off-taker has only one option: reselling it to EGAT at a low price.

Viewed from the energy-security perspective, heavy dependence on IPPs will make the demand-and-supply balance vulnerable, because their motivations may easily change along with changes in the business environment, as exemplified by the Asian currency crisis in 1997 and the Lehman Brothers collapse in 2008. Therefore, heavy dependence on import may also jeopardize the reliability of energy supply.

From the investment viewpoint, the financial capacity of the EDL should also be carefully evaluated by taking into account matters indicative of its financial position such as the level of debts and schedule for reimbursement.

The advantages and disadvantages of these options are summarized in Table 3-1.

Table 3-1: Advantages and disadvantages of each option

Option	Advantage	Disadvantage
EDL's own generation	• The EDL can manage the progress of projects. • EDL can operate generation according to its convenience.	• The EDL needs to procure the funds while considering its financial capacity.
IPPs for domestic supply IPPs for export	• The EDL can avoid financial burden. • IPP facilities are transferred after concession period without compensation.	• Too many IPPs may bring reverse spread to the EDL. • EDL may have some difficulty in managing the progress of projects. • IPPs motivation will be volatile. • PPA is critical.
Import from EGAT	• No generation facilities are required (no financial burden, no environmental and social impact).	• Energy security is lower. • PPA is critical.

(Source) Study Team.

The proper combination of the various options should be determined upon deliberation of all of the above factors quantitatively.

3.1.2.3 Rational development of water resources

The Government of Lao PDR has identified the development of hydropower as vital to the nation's economic growth and poverty eradication. At the same time, fast and large volume of hydropower development is changing the way of water and putting pressure on the environment and people's livelihoods. Water resources are essentially the property of the people for alternative uses in agriculture, urban and industrial supply, recreation, wildlife, human consumption, and maintenance of environmental quality. With the aim to protect and sustain water resources, the Law on Water and Water Resources was issued in 1996, laying down the overall principles, regulations and measures for water resource management. However, no ministry or department was responsible for managing water resources at that time, and the law lacks detailed regulations. (According to the Article 23 of the law, the Government organizations responsible for water resources will issue regulations concerning water resource development, but they have not yet been developed.) Until recently, the approaches taken to water management were project by project planning methods, and appropriate and adequate to the project at hand. However, new approaches are needed that will integrate water resource use among different users and across different economic sectors.

In this context, the Ministry of Natural Resources and Environment (MNRE), responsible for water management and newly established in 2011, succeeding from the former Water Resource and Environment Administration (WREA), is currently under preparation of the revision of the law to manage in accordance with the current conditions with the assistance of IFC.

As far as hydropower development is concerned, watershed management should be considered. The only comprehensive development scheme was designed for Nam Ou river basin with the total capacity of 1,156 MW of seven cascade projects, three of which are currently under construction.

All of the initial three IPP projects in Laos adopted water diversion plans to obtain the head and optimize the project plan: Theun Hinboun (from Nam Theun to Nam Hinboun), Houay Ho (from Houay Ho to

Xekong), and Nam Theun 2 (from Nam Theun to Xebang Fai). As a matter of course, water diversion, by and large, may hamper the hydro potential of upstream rivers (Nam Theun and Houay Ho in the above example). In addition, recent small scale hydropower development up to 15 MW spurred by the amendment of the Electricity Law, may bring conflict with conventional larger hydro potentials. Optimal development of hydro potential of river basin should be discussed including EDL, SPP and IPP projects.

3.1.2.4 Configuration of power grid

The EDL system is, at present, isolated from transmission lines owned by IPPs, which export power to EGAT. Meanwhile, there are strong needs for the EDL to construct new transmission lines to connect new power stations (many of them are expected to be IPPs) and demand centers.

The MEM and the EDL must clarify the optimal configuration of the national grid in the future. There are several different opinions for the ideal configuration because of the difference of viewpoints (or aims): reinforcement of the regional interconnection between the EDL and EGAT networks or establishment of backbone lines across the country (from the northern to the southern regions).

The focal points of this discussion are supply reliability (or security of supply), supply flexibility, cost, and associated risks.

3.1.2.5 Investment and funding

The constraints on EDL financial capacity are a big concern for future power development.

While EDL turnover rapidly increased during the 2000s—quadrupled from 2001 to 2010, profit did not follow the increase in turnover. As shown in Figure 2-32, the ratio of profit to sales deteriorated year by year, in other words, the EDL profitability continued to decline.

To make EDL power development sustainable, cash generation is definitely needed because part of the fund necessary for the future investment must be generated from today‘s profit. In the first half of the 2000s, investment by the EDL did not greatly exceed the cash generation from operating activities, but in the second half of the 2000s the EDL started to accelerate investment. To cope with the rapid increase in power demand beyond 2010, in particular, the EDL has made major investments based on debt-finance since 2009. As a result, its free cash flow[29] has fallen into deficit (see Figure 2-33). This situation is apparently behind the current investment-debt downward spiral.

In the current projection of PDP 2010-20, the fund procurement required for the EDL is estimated at 43,452 billion kip (or 5,431.5 million US dollars) between 2010 and 2015, and 47,798 billion kip (or 5,974.7 million dollars) between 2016 and 2020.

Of this total fund requirement, 7.6% is planned to be financed by cash, and the balance, by loans. In other words, the EDL must invest a total of 3,316 billion kip, or 553 billion kip a year, during the 2010-15 period by equity finance. Furthermore, during the 2016-20 period, this equity portion will increase to a

[29] Free cash flow represents the cash that a company is able to generate after laying out the money required to maintain or expand its asset base.

total of 3,647 billion kip, or 729 billion kip a year.

One big question is whether or not the EDL can shoulder this financial burden. The answer is very negative.

The NPDP must consider the EDL capability for investment by careful assessment of its financial position. If this capability were too low, it would be advisable to curb direct investment, and elaborate some other scheme for domestic supply, such as private sector investment and power import.

3.1.2.6 Rural electrification

(1) Methodology and mechanism

In the current PDP, the plan for rural electrification in each province is synchronized with the government targets (i.e., a household electrification rate of 80% in 2015 and 90% in 2020) as shown in Table 3-2.

Table 3-2: Household electrification rate, 2010-20

Item	2010	2015	2020
Total HH	1,036,773	1,167,135	1,301,334
Electrified HH	756,604	947,890	1,168,618
- EDL	730,048	904,163	1,123,985
- Others	26,556	35,720	47,289
Electrification ratio	72.9%	81.2%	89.8%

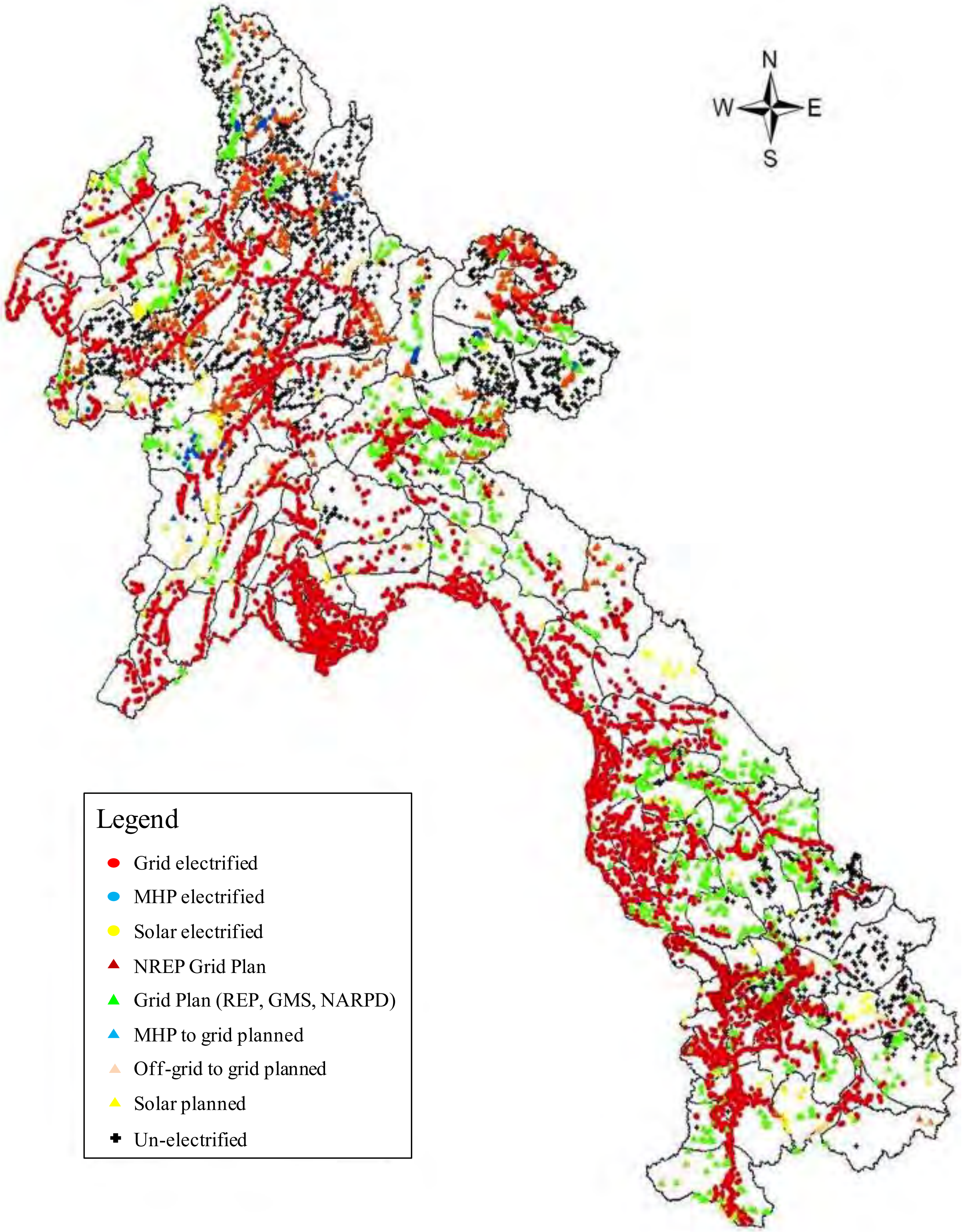
(Note) Miscalculations or arithmetic errors were found in the original data.
(Source) PDP 2010-2020 (Revision-1).

In general, rural electrification is implemented using one or more of the following methods[30]:

- Grid extension;
- Mini-grid systems; and
- Stand-alone systems.

Although the village electrification plan was designed in PDP 2010-20 (Revision-1) as shown in Figure 3-2, the criteria for selection of electrification options are not explained in the PDP. The roles and responsibilities of the EDL and the relevant organizations (the PDEM especially) are also not specified, and those issues should be discussed.

[30] The latter two are often called ―off-grid system".



(Source) PDP 2010-2020 (Revision-1)

Figure 3-2: Village Electrification Plan

(2) Consistency with energy policy

The Renewable Energy Development Strategy in the Lao PDR (RE Strategy) was formulated by the MEM with the assistance of the Government of Finland (GOF) and approved by the Prime Minister in October 2011. The Government of Laos (GOL) advocates an ambitious target to increase the renewable energy share of the total energy consumption to 30% by 2025. Since total energy consumption is forecasted 4.930 million TOE in 2025, the contribution of renewable energy is expected to be 1.479 million TOE, 0.417 million TOE (or 4,850 GWh of electricity[31]) of which the power sector is expected to use (see Table 3-3).

Table 3-3: Renewable energy development, 2010-20

	Types	2015				2020				2025			
		MW	GWh	CF (%)	MUSD	MW	GWh	CF (%)	MUSD	MW	GWh	CF (%)	MUSD
1	Small-hydro	80	593	84.6	288	134	989	84.2	629	400	2,977	85.0	1,010
2	Solar	22	163	84.5	41	36	267	84.8	90	33	244	84.5	144
3	Wind	6	47	88.5	24	12	93	88.5	52	73	547	85.5	72
4	Biomass	13	93	81.7	21	24	186	88.5	45	58	430	84.7	192
5	Biogas	10	70	79.7	48	19	140	83.9	105	51	384	85.9	168
6	Solid waste	9	70	88.5	55	17	128	85.9	120	36	267	84.8	168
	Total	**140**	**1,035**	**84.4**	**477**	**242**	**1,803**	**85.0**	**1,041**	**651**	**4,850**	**85.0**	**1,754**

(Source) Renewable Energy Development Strategy, MEM, 2011..

Small-scale hydropower is defined as hydropower whose capacity is not more than 15 MW. The size of total small-hydro resources is estimated at 2,000 MW, but less than 12 MW have been developed.

In the current PDP, it was planned to develop five EDL projects (with a combined capacity of 52.7 MW) and nine IPP projects (54.2 MW) by 2020. However, the total energy output from these projects would be 514 GWh, given that the capacity factor is expected to be 55%. The gap between the Renewable Strategy and the PDP is substantial.

The figures for other types of renewable energy, particularly solar and wind power are even more unrealistic; their capacity factor of 85% also cannot be unexpected. Development of these renewable energies is not mentioned in PDP 2010-20.

When compiling the NPDP, comments should be made on the consistency (or inconsistency) with other energy policies including renewable energy policy.

3.1.2.7 Energy efficiency

The management of energy efficiency is important for the optimal power supply as well as power development and transmission development. Effective measures for the energy efficiency management include, for instance, system loss reduction and demand side management (DSM).

In Laos, there is a lot of room for the improvement of energy efficiency, as the ratio of distribution loss amounts to 15% at the maximum, and the load factor in rural area is around 40%.

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31 The energy conversion factor defined by the IEA is used: 1 TOE = 41.87 GJ = 11,630 kWh.

The countermeasures for the reduction of distribution loss are as follows:

- Facility measures including the upgrade of deteriorated facilities, decrease of low-voltage lines, and upgrade of the voltage
- Decrease of the non-technical loss by the replacement of electricity meter

On the other hand, DSM is a scheme of controlling and optimizing the power demand with the cooperation of customers.

DSM makes it possible to reduce the costs of both electricity industry and customers, lowering investment cost of power plant and transmission system construction, and diminishing environmental impacts of the development. In the GMS region, energy management including DSM is implemented in Thailand.

The measures for DSM are as follows:

- To strengthen and promote energy conservation
- Load management by load pattern adjustment for optimal peak by hourly power tariff
- Load management by direct control of equipment from the power utility
- Introduction of high-efficiency electric appliances

In the future, when the demand growth saturates and the construction of new power plants is getting difficult, the necessity of DSM will more and more increase, by which the demand can be controlled. In preparation, the adoption of appropriate measures for energy efficiency management should be discussed in the NPDP.

3.1.2.8 Environmental and social consideration

(1) Summary of findings and key points for development of NPDP

To render recommendations for the development of the National Power Development Plan (NPDP) of the government of Laos the current Environmental Impact Assessment (EIA) related policies, laws and regulations, institutional arrangements, implementation procedures, and guidelines for development projects in Laos were examined. It is proposed that the NPDP is to be a comprehensive national electric power development policy document to guide power development, and generation, transmission, and distribution activities. The NPDP is to be consistent with the regional power arrangements.

Because the development of the NPDP is a process of power sector policy formulation, Strategic Environmental Assessment (SEA) needs to be adopted and applied in the process. The NPDP is proposed to be an overall power-sector development policy under which hydropower, thermal, and renewable energy projects, and transmission and distribution schemes are justified. Therefore, for the development of the NPDP it is necessary to employ a method of environmental impact assessment which is capable of handling sub-sector-wide and multi-project analysis to minimize economic, financial, and environmental costs, and to maximize benefits of government's interventions. To this end, SEA is proposed as an instrument for implementing such analysis. Currently, SEA is adopted as a policy and master plan formulation tool in many other countries, and the focus of development partners in environment sector in Laos has shifted to the establishment of SEA framework from the development of EIA capacity. Since MONRE is preparing a SEA decree to be proclaimed in 2013, the legal and institutional framework in Laos is ready for the application of SEA to the formulation of the NPDP.

The results of the examination also indicate that it is necessary for the government to establish the NPDP to guide and check financial-return-oriented power development by IPPs. The sustainable development of the power sector requires well-balanced considerations of private and social gains in the NPDP.

(2) Recommendation for NPDP development support

Since the NPDP is considered to be a national power sector development policy, SEA should be an appropriate tool for its development, and should be introduced for the formulation of the NPDP. SEA is a methodology which is able to handle sector-wide and multi-project analyses to minimize economic, financial, and environmental costs, and to maximize aggregate benefits of public and private interventions. It is important for the Government to balance environmental benefits and financial gains rendered by power projects. Particularly, IPP projects are financial-return-oriented private investment, and therefore, government's policy guidance to achieve well-balanced private and social gains should be provided based on the policy articulated in the NPDP.

SEA requires a set of information used for evaluation and ranking across proposed projects. Collection of such information from primary sources is very expensive and not practical for the development of the NPDP. Instead of using the primary data it is recommended utilizing the existing secondary geo-referenced data. Since all the proposed projects are location specific geo-referenced datasets are necessary for the evaluation of candidates' site specific characteristics. Table 3-4 shows a summary of identified GIS digital data available in Laos, and the applications of these datasets are also recommended for the development of the NPDP.

Table 3-4: GIS digital data availability in Laos

GIS digital data classification
First level classification
  Second level classification
    Third level classification
	Data type	Data covering area	Source*1	Year	Data availability

Electricity infrastructure					
EDL PDP system data					
Existing and planned hydropower project sites	point	national	MEM	2008	official use
Existing sub-stations	point	national	MEM	2011	official use
Transmission lines: Existing	line	national	MEM	2011	official use
Transmission lines: Under construction	line	national	MEM	2011	official use
Transmission lies: Planned	line	national	MEM	2011	official use
Thermal stations	point	national	MEM	2008	official use
Reservoir of hydropower projects	polygon	national	MEM	2008	official use
Rural electrification					
Status of electrification	point	national	MEM	2011	official use
Status of small hydropower development	point	national	MEM	2011	official use
Status of solar power system	point	national	MEM	2011	official use
Distribution system by province	line	province	MEM	2011	official use
Administrative boundaries and capitals	line	national	MEM	2011	official use
Natural features					
Hydrology					
Laos national data	polygon	national	NGD		public domain
Mekong sub-regional data	polygon	regional	NMRC		public domain
Geology					
Geological map	point	national	NGD		public domain
Mineral occurrence	point	national	NGD		public domain
Soil type	polygon	national	NGD		public domain
Social and economic features					
Social features	point	national	NGD		public domain
Infrastructure	line	national	NGD		public domain
Land use	polygon	national	NGD		public domain
Agriculture	polygon	national	MAF		public domain
Forestry	polygon	national	DFRM		public domain
Digitized 1/100000 or 1/50000 topographical maps					
Index map of topographical maps	polygon	national	NGD		public domain
Scanned topographical maps	scanned raster	national	NGD		public domain
Contour	line	national	NGD		public domain
Digital Elevation Model					
Satellite imagery	raster	national	NGD		public domain
Hill shade	raster	national	NGD		public domain
DEM	raster	national	NGD		public domain

Note 1: NGD: 1) DFRM: Department of Forest Resource Management, Ministry of Natural Resources and Environment (MONRE); 2) EDL: Electricité du Laos; 3) ERSDAC: Earth Remote Sensing Data Analysis Center; 4) MEM: Ministry of Energy and Mines; 5) NGD: National Geographic Department, Ministry of Home Affairs; and 6) NMRC: National Mekong River Committee, MONRE
(Source) Study Team.

3.1.2.9 Laos' position in GMS power network

Laos takes the position that it should be the battery of the GMS and export 7,000 MW of power to Thailand by 2015 and 5,000 MW to Vietnam by 2020.

The potential hydropower resource is estimated at 12.5 - 23 GW, and this figure is quite large for Laos. However, the existing power capacities in the region are as follows: 31 GW in Thailand, 21 GW in

Vietnam, and 3.4 GW in Myanmar.

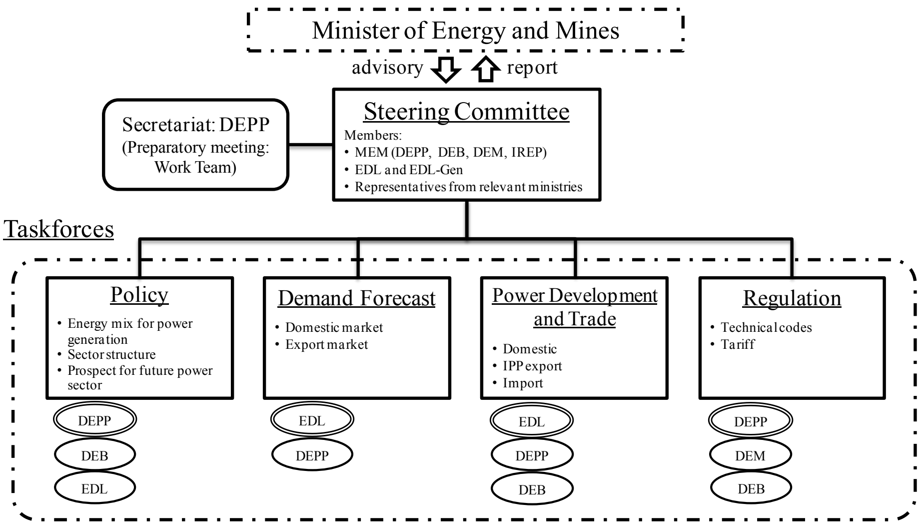
Under these circumstances, Laos will not be able to retain its strong presence as a power exporter forever. Although there is no clear answer for the future role of Laos in the region, it is possible to draft some scenarios, that is, evolution into an interconnection hub in power trade, discharge of a role of back-up power supplier, and growth into a provider of ancillary service in the regional network.

Whatever the future prospect is, it is necessary for the government to discuss and clarify Laos' position in the region in the future power policy paper.

3.1.3 Approaches for preparation of NPDP

3.1.3.1 Organizational arrangement for preparation of NPDP

The Study Team proposed the formulation of a new organizational structure to carry out the preparation of the NPDP as illustrated in Figure 3-3.



(Source) Study Team.

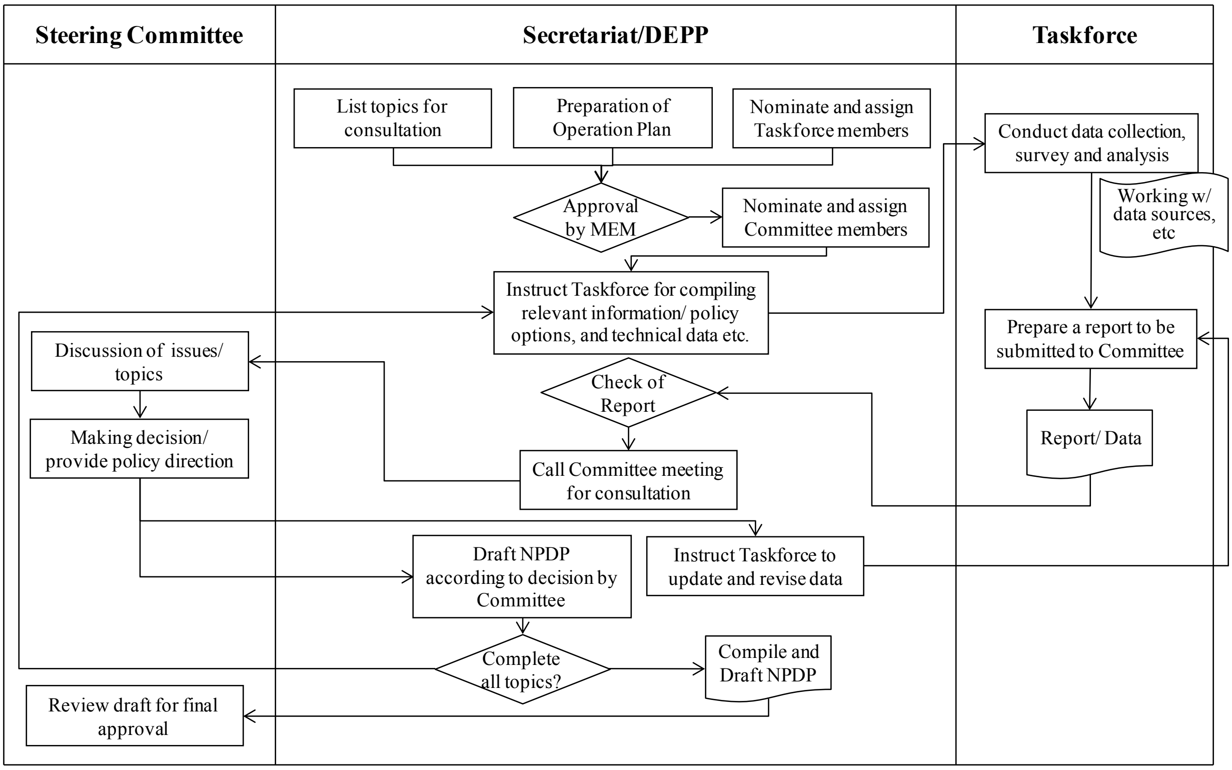
Figure 3-3: Organizational structure for formulation of NPDP

DEPP must make its effort to facilitate the preparation process with a significant input from stakeholders regularly[32]. DEPP is highly in need of utilizing all available technical expertise in the power sector in Laos. For example, basic data collection, analysis and accumulation of fundamental facts technically relevant to preparation of the NPDP shall be relied on EDL. Industrial data shall be provided by MIC. Economic forecast shall be discussed with MPI. DEPP, on the other hand, shall allocate its time and efforts to facilitate dialogue with these stakeholders to complete the process. Such endeavor requires setting up an inter-ministerial arrangement. A steering committee headed by Vice Minister of MEM as an advisory board of the Minister of MEM may be necessary. Thematic taskforces shall be established under the steering committee, comprising of representatives from the relevant ministries and agencies. DEPP shall function as the secretariat of the steering committee, and the Director General shall be the Secretary

[32] According to DEPP's request, the proposed NPDP will be published once every three years. It should be updated every year.

of the committee. Work team is an internal meeting within DEPP to discuss the policy issues and prepare the materials for steering committee meetings as the duty of the secretariat. DEPP's necessary set of competency to carry out the role of the secretariat of the steering committee for preparation of the NPDP is summarized in appendix III.

The overall workflow shown in the Figure 3-4 aims at preparation of the NPDP in a timeframe of three-year period with a minimal external technical assistance to the proposed organizational structure. The work team may start discussion of necessary topics and to prepare the first draft the NPDP as early as the first quarter of 2013 (January 2013 as a preliminary meeting of work team). The task may be expected to complete by the first quarter of 2014. The first NPDP may be reviewed by stakeholders including management of MEM for the power policy formulation. DEPP, secretariat of the work team, may want to seek appropriate technical assistance to donor community to facilitate the process. It is expected to improve and complete the NPDP by the final year of three year period. The final NPDP will be reliable and accurate one because trial and error for preparation of the NPDP may provide all stakeholders to furnish proper and reliable NPDP.



(Source) Study Team.

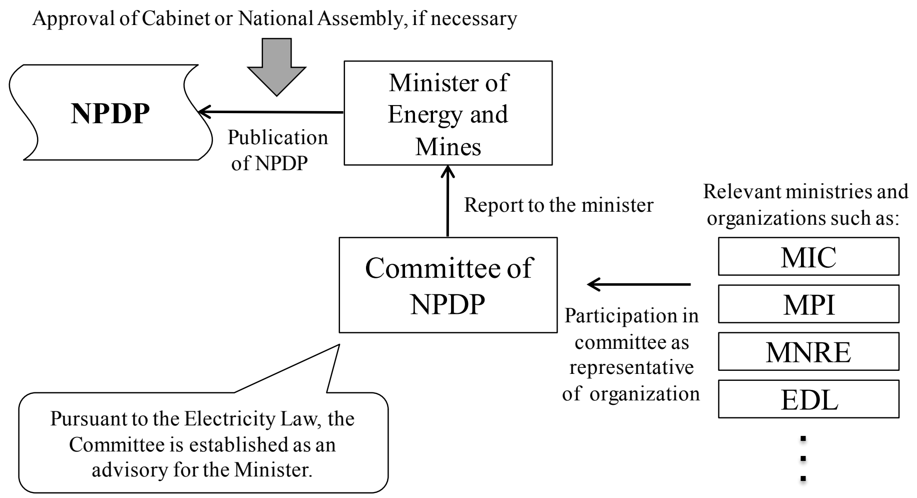
Figure 3-4: Work flow for preparation of NPDP

The details of the steering committee, taskforce and working team are described below.

(1) Steering committee

A steering committee backed by a legal ground shall be established to facilitate the preparation of the NPDP (Figure 3-5).

The committee shall be an inter-ministerial body consisting of representatives from the relevant organizations and stakeholders from both the power and economic sector. Members may include related departments of MEM, such as DEPP, DEB, DEM, IREP, and EDL. Other stakeholders such as EDL-Gen, MPI, MIC and MNRE may participate in the committee depending on the topics. Under the committee, a work team will be established to carry out drafting of the NPDP. The team, composed of senior staff members of DEPP, is an implementing body to prepare the draft of the NPDP with help from relevant ministries and agencies.



(Source) Study Team.

Figure 3-5: Prospective organizational arrangement for steering committee

The committee will oversee the preparation process mainly carried out by the secretariat. The steering committee may consult and direct the secretariat for preparation of data, facilitating discussion, submission of draft discussion papers, etc. The committee members will discuss and approve the drafts prepared by the secretariat. The draft terms of reference of the proposed steering committee is explained in Table 3-5.

Table 3-5: Terms of Reference of steering committee

Items	Description
General Purpose:	The steering committee for preparation of the National Power Development Plan (NPDP) is commissioned by and responsible to the Minister of the Ministry of Energy and Mines (MEM) to assume the primary responsibility for preparation of the NPDP to meet the national socio-economic development plan such as NSEDP.
Duties & Responsibilities:	• The committee is established as an advisory board for the Minister of Energy and Mines. It is expected to play an advisory role to ensure successful implementation of preparation of the NPDP of Laos; • Members of the committee will receive the implementation plan and methodology and their agreement will be sought. This process will also apply to the draft synthesis report; • The committee members should provide strategic advice in the execution of the preparation of NPDP and in meeting its objectives. In particular, they will advise the secretariat at every stage of preparation of the NPDP; • The committee initiates, produces, regularly reviews, updates and where necessary recommends changes to draft of the NPDP and its work plan; • The committee reviews the need for specialized taskforces on selected topics, and recommend the establishment or closure of such groups; • The committee is expected to meet once two months or whenever deemed necessary at key stages in the preparation process of the NPDP. The Committee reviews the progress of implementation and also, proposed future action plan for next two months, and offers suitable suggestions / recommendations; • The committee, however, should make to meet at key stages of implementation at convenience (i.e., the implementation planning meeting; during public consultation, if any; at finalization of the draft the NPDP; and through their participation in its key dissemination activity(s). On the draft report, the committee should provide their comments in writing; • The committee facilitates in ensuring smooth coordination between different institutions and individuals, concerned ministries, consultants and representatives and donors; • The committee offers suggestions and recommendations necessary for execution in a timely manner and instructs DEPP as secretariat in this regard; and • The committee will deliver their endorsement to the outputs of the activities, prior to wider dissemination. And ensure to carry forward the main findings of the research to policy makers and other important key stakeholders, which include the National Assembly, private sector and general public.
Composition:	The steering committee composes of: • Concerned departments of the Ministry of Energy and Mines (viz., DEPP, DEB, DEM, and IREP) • EDL • EDL-Gen • Ministry of Industry and Commerce (MIC) • Ministry of Planning and Investment (MPI) • Ministry of Natural Resources and Environment (MoNRE)
Roles required:	• The steering committee shall consist of a minimum of a chair, deputy chair, secretary and ordinary members; • The chair sets the agenda, convenes meetings and ensures that they are properly conducted; • The deputy chair takes the role of the chair when the chair is not present; and • The secretary plans, co-ordinates and monitors all steering committee-related activities including distributing the agenda, attending the meetings, preparing minutes and reporting recommendations to MEM.
Secretariat:	Secretariat of the steering committee is assumed by the following divisions of DEPP • Power System Planning Division • Energy Policy Division • Electricity Generation Planning Division, and • Environmental Engineering Division

(Source) Study Team.

(2) Taskforce

Four Taskforces for i) policy, ii) demand forecast, iii) power development and trade, and iv) regulation consisting of experts from the relevant organizations shall be initially established under the steering committee. Additional groups may be added when appropriate. Considering the size and number of experts available in the electric power sector in Laos, the initial set-up of the team, however, shall be simplified.

The taskforces may provide the steering committee the data and information as well as technical analyses prepared by the respective organizations. The taskforces shall report to the Vice Minister of Energy and Mines through the steering committee.

(3) Work team

In light of DEPP's mandates, preparation of the NPDP through work team (WT) meetings has many advantages, because of the following reasons:

- The WT arrangement provides benefits to DEPP in building consensus of organizations concerned for preparation of the NPDP though inclusive process;
- Collective knowledge of the organizations concerned provides diverse opinions, perspectives and stimulation,
- Effective use of available resources; use of advantages of participating departments,
- Improved meeting management (improvement of logistics, facilitation, consensus building, decision-making, etc.)

To practice the work of secretariat and to assure the feasibility of the organizational arrangement, the work team was launched on a trial basis in this Study. The work team has carried out four preparatory meetings.

3.1.3.2 Clarification of roles and responsibilities of each organization

For the preparation of the proposed the NPDP, the DEPP is expected to play the following roles:

- Draft (and appropriate) necessary legislative framework for the NPDP,
- As a secretariat, organize and provide administrative support for all meeting carried out by the Steering Committee and Taskforces,
- Draft policy recommendations and the NPDP,
- Oversee such activities carried out by EDL & consultants as data collection, analysis and compilation of draft of the NPDP,

On the other hand, EDL and EDL-Gen play the following roles:

- Assist preparation of the NPDP in such technical areas as:
  - Demand forecasting (modeling, data collection, analysis, etc.),
  - Investment planning (IPP (d) & IPP (e)),
  - Power trade (export & import), and

- − Power system planning and analysis
- Assist the work team to draft policy recommendations and the NPDP,
- Prepare EDL's own business plan based on the NPDP (optional)

The roles of the other organizations to participate in the preparation of the NPDP are summarized in Appendix IV.

3.1.3.3 Preliminary work team meeting

A series of the work team meetings were planned and carried out from January to March 2013 on a trial-basis during the Study period. The purpose of the WT meeting is to practice and experiment the roles and functions of secretariat held by DEPP for the proposed steering committee. It also makes DEPP to understand the legal and institutional framework of the NPDP. When such meeting is completed, the C/P is expected to demonstrate some basic functions and activities of the secretariat. In this connection, they practice and improve some basic skills in improving organizational management through the discussion of items to be included in the NPDP. The description of the WT meeting is shown in Appendix V

The issues derived from the trial work team meetings are that there are needs of clarifying the roles of entities participating meeting. For example, DEPP holds a responsibility of formulating power sector policies in Laos. Such demarcation of role differences shall be maintained by DEPP. The themes selected in the meetings so far are too general and in need of clarifying into more specific themes. Selection of topics shall be assisted by the expert if such process shall be carried out as activities of technical cooperation.

Such external assistance shall be carefully designed to ensure the balance of maintaining a certain level of ownership by Lao side and intervention by Japanese experts. This is challenging especially if the work team meeting is expected to produce tangible outcome each time, clear direction and initiatives from external assistance is needed. This is true especially if such assistance is completed in relatively short period of time.

3.1.3.4 Capacity development for organizational management for preparation of NPDP

(1) Analysis of problems and challenges for organizational management

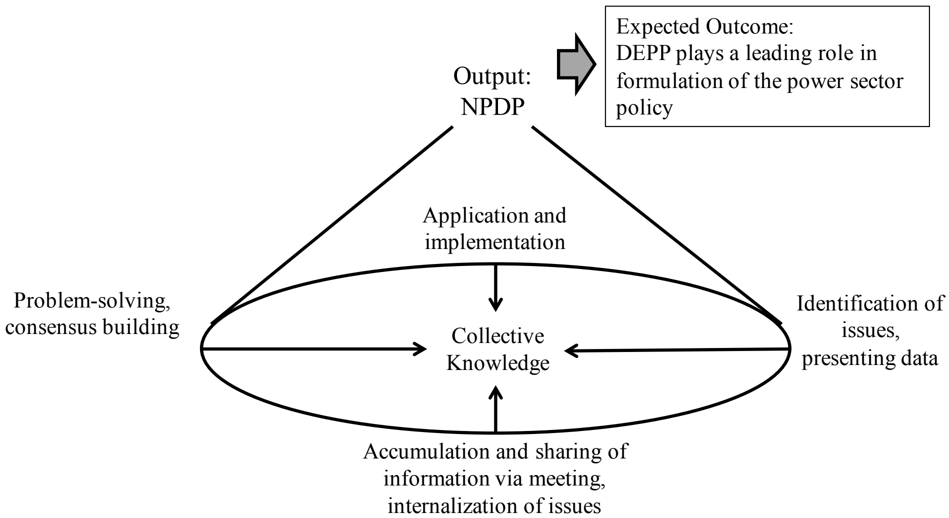
- Based on the analysis of managerial issues discussed in Section 2.3, the problems and challenges facing the power sector in Laos are summarized as following:MEM's restructuring divided small departments into even smaller ones despite the scarce resources and capacity,
- Sectionalism is widely observed throughout the power sector organizations. It affects negatively effectiveness of inter-organizational collaboration and information sharing in the sector,
- Absence of acknowledging the policy formulation as the top priority among the duties of the department, rooms for improvement in technical and administrative capacities, and tendency to tenacity to technical details rather than broad views,
- Divisions do not necessarily carry out all the duties listed in the mandates of the organizations. The mandates of the departments are not fully implemented, and

- Dependent on external consultants because of past donor supports. Room to improve ownership if DEPP prioritizes things between tasks to do by themselves and by outsourced.

(2) Basic strategy for improvement of organizational management

Considering the above challenges, a basic strategy for improvement of organizational management was determined as ―Enhancing DEPP‘s capacity for formulating NPDP through a series of policy dialogues with concerned parties". This strategy was developed by taking the following requirements and conditions into account:

- An intervention, such as technical assistance, may be able to influence positive effects if designed well, because of relatively small number of recipients. On the other hand, the receptivity is limited because of the size and overall capacity of the organizations concerned.
- In response to MEM‘s request on seeking a sustainable ―mechanism" to develop and maintain the NPDP, it is recommended to initiate an organizational arrangement to create collective intelligence. MEM is highly in need of collaborating with stakeholders with relevant expertise in the power sector of Laos,
- The ―mechanism" shall not be rigid structure. It may want to include a wide range of stakeholders for the dialogue. Depending on the topics, external human resources shall be invited,
- The organizational arrangement shall be functioned as a basis for information sharing to break the barrier among divisions and organizations. Such collaboration shall be based on functional and practical work mutually beneficial for all parties concerned. In this regard, preparation of the NPDP shall be a good opportunity for cooperation across the power sector,
- Build up small successes and repeat the process by facilitating a series of policy dialogues. The topics shall be carefully selected with some assistance provided by experts. The process shall be in slow and steady manner (incremental approach), and
- The external experts shall only facilitate the process, not to push own agenda persuasively. The proposed dialogues shall be mutual learning opportunities for the concerned parties.



(Source) Study Team.

Figure 3-6: Strategy for improvement of organizational management

The strategy is relevant because of its assumption that has profound implications: large groups of people are smarter than an elite few, no matter how brilliant—better at solving problems, fostering innovation, coming to wise decisions. To foster collective intelligent and favorable environment, the following condition is necessary. First, diversity of the participants is necessary. Each participant brings about their own information to contribute. Second, some level of independence assures opinions not influenced by others; third, a diverse perspective ensures different opinions, lastly, existence of a mechanism to converge a decision point. A mechanism to create knowledge is a key to successful implementation of this challenging task.

(3) Incremental approach for improvement of organizational management

As discussed in the previous section, capacity development for organizational management is designed in two tiers and carried out incrementally. The first tier shall be carried out approximately between 2013 and 2015, and will be implemented as a means to facilitate preparation of the proposed NPDP utilizing the work of secretariat (initially working team). Using this framework, the C/P mostly DEPP will learn how to effectively collaborate with others. As shown in the Figure 3-6, the benefit of collective knowledge through such organizational arrangement for creating knowledge is beneficial for resource-scarce DEPP.

Table 3-6: Incremental approaches for preparation of NPDP

	Short-term (2013-2015)	Long-term (2016-20)
Objectives	Strengthening process Facilitation capacity	Activities aligned with MEM's strategic plan (NPDP)
Methodology	Preparation of the NPDP	Strategic planning
Activities (examples)	Technical areas: Preparation of the NPDP (Policy formulation, demand forecast, investment plan, regulation, etc.)	Technical areas: Enhancement of analytical skills, and knowledge acquired through preparation of the NPDP (levels may vary)
	Non-technical areas: Project planning, negotiation, decision-making, consensus-building, etc.	Non-technical areas: Strategic planning (identify goal, mission, environment, objectives action plans, etc.)
Implementation	Services of consultants	Services of LT experts.

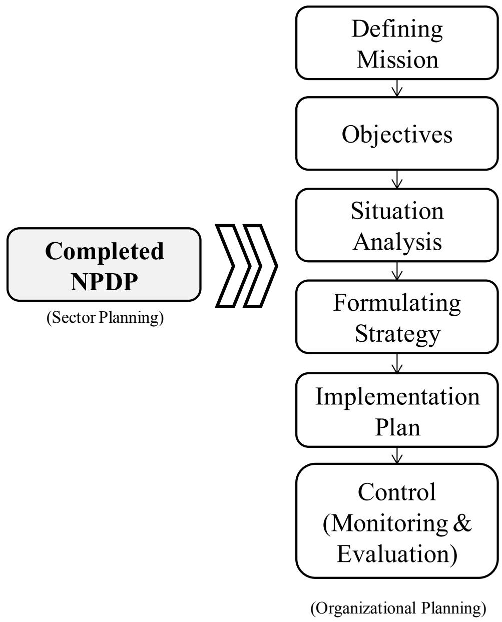
(Source) Study Team.

In the process, technical contents directly related to preparation of the NPDP, for instance demand forecast, system analysis, generation planning, etc. will be strengthened through technology transfer by external experts. The technical contents are the foundation of this technical cooperation because preparation of the NPDP requires so-called ―hard skills." Considering such technical capacity is weaving warp, non-technical skills, such as facilitation, meeting management, decision making, etc. are the woof of thread. The list of resources of such training is explained in Appendix VI.

Following the first tier of the capacity development as a foundation as discussed above, the second tier shall be built upon completion of the NPDP. A set of capacity development activities through strategic planning is recommended.

Strategic planning is a continuous and systematic process where an organization makes decisions about intended future outcomes, how outcomes are to be accomplished, and how success is measured and evaluated. It is a deliberate process to in which top executives and appropriate associates periodically would formulate the organization‗s strategy, and then communicate it down the organization for implementation.

Defining the organization‗s mission statement, based on clearly stated vision and values is the most important element of the public sector strategic plan. The mission statement is derived from the answers from the question, "What is our business and what should it be?" They need to bring out into the open alternative definitions and to think them through carefully[33].



(Source) Study Team.

Figure 3-7: Proposed strategic planning process

Though it is not always required, the vision statement is often a part of defining the mission, and it tells a long-term future state of what the organization will look like. The values are included sometimes to ensure that those running the organization depend on.

Development of a new strategic plan consists of addressing key issues that will end up being a blueprint for the organization's success. The next key issues include its goals and objectives. Next, look at what assets and resources the organization has. Then finally, it should consider the programs, services, and activities the organization will implement to meet its goals and objectives. These items will make up the

[33] Drucker. P. F. ―Management". Harper Business; Revised edition (April 22, 2008) . p. 141, Harper Collins Publishers Inc. New York, NY.

strategic plan, which is then packaged and shared internally, with donors, and with the public.

At DEPP, the process shall be closely linked to the completed NPDP which shows the policy direction of the power sector of Laos. When the proposed NPDP is completed, the power sector policy and strategy will be defined and optimum use of available resources will be identified. Based on the NPDP, DEPP is ready to develop its own business plan to implement and monitor the progress of the plan with specific indicators. The NPDP is a basis of formulating organizational strategy and is a highlight of the process, because strategic planning in the public sector is different from that of the private sector. The difference from the private sector is the use of profit as measurement of success in the private sector. The public sector does not measure its performance by its profit as the private sector counterparts do. In contrast, the executives of the public sector must measure success in terms of non-financial or programmatic performance goals. Accordingly, the strategic planning at DEPP may want to include such indicators as figures representing its service level against the necessary cost of the said services.

A strategy is an overall approach, based on an understanding of the broader context in which an organization function, its strengths and weaknesses, and the challenges to address. A strategy provides a framework within which to work, it clarifies what the organization attempts to achieve and the approach to employ. Strategy itself does not spell out the specific activities.

Depending on the progress of the proposed NPDP‘s completion and adoption, it may start approximately from 2017 until 2020 as an end of the proposed activity. Strategic planning consists of re-defining and formulating DEPP‘s (and departments of MEM as a whole, if accepted) mid-tem, annual and monthly business plans based on the strategy subscribed in DEPP. This is going to be a ―break-down” process to realize the proposed DEPP. Because the strategic planning process is only successful when it is carried out by ―top-down” initiatives, promoting of the idea and strong leadership from the top of management is recommended. Additional work by long-term experts and the JICA Laos Office to initiate such technical cooperation is essential.

3.1.4 Contents of NPDP

The Study Team listed a more detailed draft of the table of contents of the National Power Development Plan for further discussion with the Lao side as shown in Table 3-7 for the preparation of the compilation of NPDP. Also the Study Team explained the difference between the Governments related documents such as ―The Seventh National Socio-Economic Development Plan (2011-2015)” and ―The Strategy Plan for Developing the Energy and Mines from 2006 to 2020”.

Table 3-7: Table of Contents of NPDP (Draft)

1. Introduction
    - 1.1 Background and legal basis
    - 1.2 Organizational structure of the committee and taskforces
2. Current status of the power sector
    - 2.1 EDL power supply to the domestic market
    - 2.2 IPPs and power export
3. Policy-related issues
    - 3.1 Energy security, risk, and cost
    - 3.2 Optimal make-up of power generation and trade
    - 3.3 Rational development of water resources
    - 3.4 Configuration of the national grid
    - 3.5 Investment and funding
    - 3.6 Rural electrification
    - 3.7 Energy efficiency
    - 3.8 Environmental and social consideration
    - 3.9 Prospect for the future position of Laos‘ power sector in the GMS region
4. Power Development Plan (2013 – 2033)
    - 4.1 Domestic market
        - 4.1.1 Demand forecast
        - 4.1.2 Generation planning
        - 4.1.3 Transmission and substation planning
    - 4.2 Export market
        - 4.2.1 IPP development for export
        - 4.2.2 Transmission and substation planning for export
5. EDL finance and power tariffs
    - 5.1 Necessary investment and funding schedule
    - 5.2 Burden on EDL finance
    - 5.3 Tariff levels

(Source) Study Team.

3.2 Perception of EDL role and future power development

EDL as the government-owned-utility has taken full responsibility for power supply to the domestic market. In 2010, the section in charge of power generation was split off from EDL and became a separate company, viz., the EDL-Generation Public Company (EDL-Gen). Although 25% of the shares of EDL-Gen were sold in the capital market through initial public offering (IPO), EDL still owns the majority of shares (i.e., the remaining 75%). In this context, EDL-Gen, whose management is strongly controlled by EDL as the holder of majority interest, is financially a part of EDL.

Although the EDL position as the exclusive power supplier to the domestic market will not change under the current power development plan, the structure of power generation will be drastically diversified. To cope with the rapid demand increase in the 2010s, EDL plans to increase power purchase from IPPs rapidly. As a result, although the capacity of the EDL-owned power plants accounted for 67.5% of the total capacity in 2010, this share will continue to decline and fall to 20.2% by 2021 (see Figure 3-8). In particular, in the second half of the 2010s, EDL will heavily depend on the SPP/ IPP (d), whose service is dedicated to EDL.

Due to this structural change of the domestic power supply, EDL will be exposed to various risks, such as uncertainty about the progress of the planed IPP projects, commitment of power purchase from them even if demand is not as high as forecasted, and the financial burden brought by its own investment.

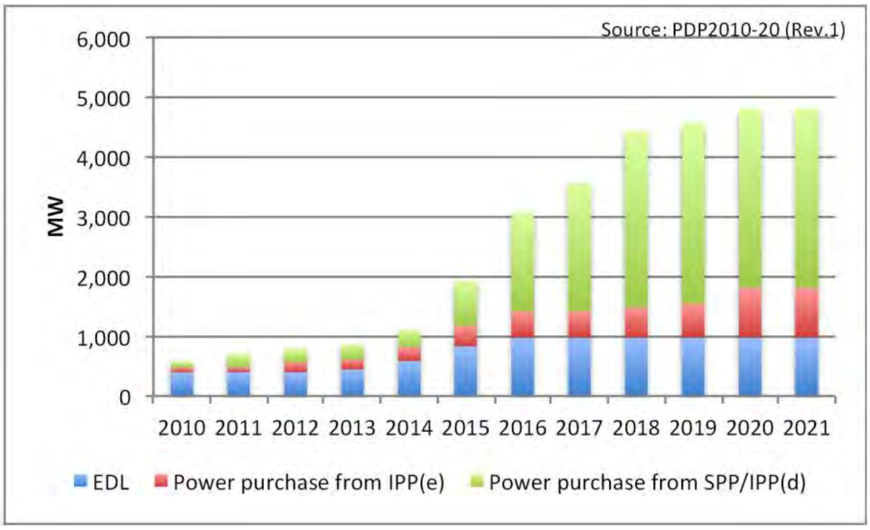


Figure 3-8: Make-up of power generation capacity, 2010 - 2021

3.2.1 Reduction of investment risk

As discussed in the previous chapter, it is not tolerable for EDL to shoulder the huge amount of financial burden scheduled in PDP 2010-2020 (Revision-1). In the worst case, there is a strong possibility that EDL will not be able to pay back loans, in other words, it will face the event of default.

3.2.1.1 Compression of EDL investment

To reduce the financial risks arising from the future investment, it is definitely necessary to compress EDL investment.

First, EDL must mitigate investment risk if there is big uncertainty associated with power demand (or market). This is the case for power supply to new mining projects planned in the mid-2010s. There are several measures to avoid investment. One is to have the mining industry take responsibility for the power supply by purchasing power directly from EGAT or establishing a power generation company dedicated to the industry. The latter option is commonly known as captive power in an industrial complex.

Second, EDL must prioritize the scheduled investment not only in the generation subsector but also in the transmission subsector. In PDP 2010-2020 (Revision-1), for example, planned investment in the transmission subsector is much higher than that in the generation subsector: 29% of the total investment is for transmission, 21% for the 500 kV national grid, and 29% for generation. Prioritization of the transmission investment from renewal of the existing facilities to construction of new ultrahigh voltage lines must be carefully evaluated from the viewpoints of necessity, cost to effect, and possibility of alternatives.

Finally, it is recommended to consider an optimized (in respect of cost-effectiveness) configuration of the transmission system including IPP facilities and minimize the necessary investment. EDL is, at present, responsible for managing the network connected to domestic consumers, but has nothing to do with the power export by IPPs.

In the future, however, EDL is expected to be strongly involved in the power trade in the GMS, alongside the IPPs engaged in power export. In this situation, while there will be various mixed transmission facilities owned by not only EDL but also IPPs, there is no clear rule for rational planning for the country's transmission system. (Furthermore, some of the transmission assets will be handed over to EDL after the termination of the concession agreement, and this will make the network system planning and management more complex.)

Network system planning lacking clear vision for the long-term future will result in redundant investment in and irrational use of the transmission assets.

3.2.1.2 Reinforcement of EDL equity

The current ratio of debt to equity is quite high compared to other major ASEAN utilities (around five times as high as theirs). If EDL continued to increase debt (i.e., loans from donors) and invest in power development, it would face difficulties in repayment of interest and amortization in the future, given the current cash position.

For this reason, EDL equity needs to be enhanced with injection of capital from the government, because the EDL status still has the status of a government-owned-utility.

3.2.1.3 Issuance of consolidated EDL financial report

As repeatedly mentioned, the financial position of EDL has continued to deteriorate, and EDL may possibly face difficulties in repayment of its debt in the future.

In 2011, it recorded operating loss of 404.4 billion kip and net loss of 15.8 billion kip. By contrast, its subsidiary — EDL-Gen — recorded operating profit of 629.1 billion kip and net profit of 563.6 billion kip (see Figure 3-9).

Several findings emerge from this financial result. First, the EDL operating loss in 2011 was caused by the high price of power purchase from EDL-Gen as compared to the original generation cost of EDL in the past. Second, EDL-Gen made a profit in exchange for EDL operating loss. Finally, the EDL net profit was compressed by dividends received from EDL-Gen.

This situation seems somewhat like a conflict of interest. Again, in 2011 EDL recorded operating loss of 404.4 billion kip and non-operating income of 518.3 billion kip, the majority of which must be the dividends from EDL-Gen. The operating loss was largely offset by the non-operating profit, and EDL net profit resulted in a small loss of 15.8 billion kip.

As suggested by the above, without combined analysis of the financial positions of EDL and its affiliate, the real status of EDL finances cannot be clarified. For this reason, its financial statement should be reported on two bases: single-company and consolidated.

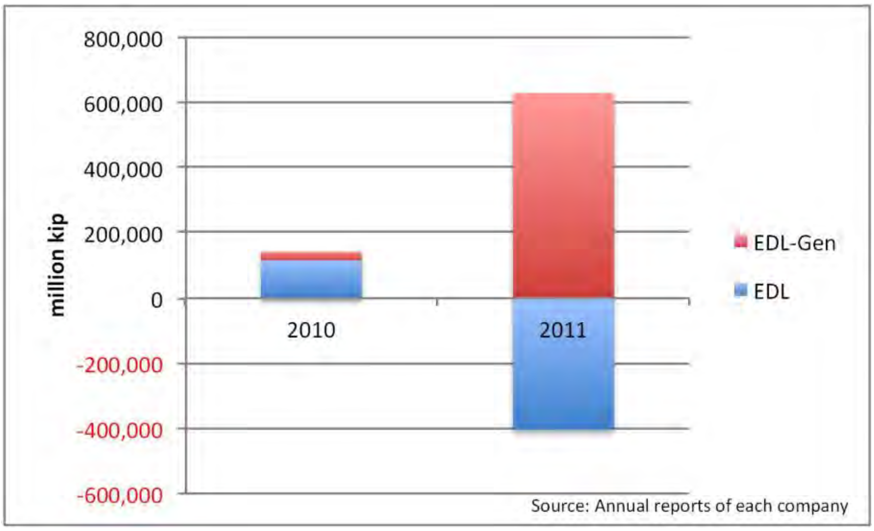


Figure 3-9: Operating profits of EDL and EDL-Gen

3.2.2 Necessity of reform of current tariff scheme

As discussed in Chapter 2, the current tariff levels may not be high enough for EDL to secure its future power investment. There is consequently a strong need to consider the appropriate cost structure of the tariff levels (this tariff study is expected to be carried out with the technical assistance of the World Bank), and reform of the tariff scheme.

In the current PDP, power supply continues to increase the magnitude of dependence on IPPs rather than EDL-owned-facilities. In this situation, all costs for power purchase from IPPs must be reflected faithfully in power tariffs, because external costs are beyond the control of EDL.

In addition, power import from the EGAT is also expected to increase to compensate for the seasonal imbalance of demand and supply (in the drought season especially), even though power trade as a country is in overwhelming surplus on an annual basis. The cost of imported power is, however, higher than that of domestically generated power. This marginal cost increase (i.e., short-run marginal cost) should also be reflected in tariffs.

3.3 Comprehensive management aimed at sustainable power development

3.3.1 Internal linkage in MEM to strengthen governance

As already explained, the mandates of each department and institution are stipulated as the ministerial decrees of the MEM, and EDL has its mission. EDL has the obligation to supply electricity throughout the country and develop the PDP (like facility plan) as the EDL-PDP. A national level comprehensive PDP (NPDP) including power importation and exportation will be developed by the Government (MEM) with the DEPP as the secretariat. Other organizations under the MEM have their own mandate, shown in

Table 3-8 under each development stage.

Table 3-8: Duties and mission of relevant organizations under the MEM

Org.	Duty (Departments) and Mission (EDL)	Major Responsibility
DEPP	Study, research and draft policy and the energy development plan or amend the policy and have the existing energy development plan such as…for middle and long term period in order to propose to the Government for consideration.	Formulation of policy and plan
DEB	Support the various energy business investment projects that are invested by state and private both domestic and foreign as set forth in the role of the Ministry of Energy and Mines	Monitor of project progress
DEM	Study, research and draft the energy law, improve or build the regulations, technical standard, safety regulations, efficiency standard and energy saving... Promote and supervise monitoring of supply, distribution, services and energy usages strictly corrected according to the technical standard, effectiveness, savings and safety.	Management (regulation) of projects
IREP	Promote and develop of small electricity productions in order to connect with transmission line network or for specific usage that has —the install capacity from 15 MW or below". Build and improve database on the renewable energy and the rural electrification.	Promotion of rural electrification and renewable energy
EDL	Ensure sufficient and consistently reliable power to consumers throughout Laos at the most economical cost. Promote and develop sources of power supply giving utmost consideration to preservation of environment and welfare of society. Support the party and government policies on industrialization and modernization by becoming a model for a well-managed state enterprise capable of complementing with other national economic sectors.	Reliable power supply

(Source) Study Team.

These related organizations under MEM should co-operate with each other and set up a better management framework for the promotion of power development including the development by IPPs. The next section describes the necessary mechanism to promote IPP projects in line with the comprehensive workflow with each development stage.

3.3.2 IPP management mechanism

3.3.2.1 Overview

It is clarified that there are five stages for IPP development. In the planning stage (mid-long term), the NPDP will be prepared as a reference document to consider the future IPP development by the DEPP, as the secretariat using information of DEB, IREP and EDL. Before the MOU to CA stage, the DEB is a gate for the developers to negotiate and monitor the projects implemented by IPP developers. The DEM conducts examination and inspection to check the conformity to the Lao Electric Power Technical Standards (LEPTS). Table 3-9 shows the major roles of each organization under the clarified stages.

Table 3-9: Major roles of agencies under the MEM

No.	Development Stage	DEPP	DEB	DEM	IREP	EDL	PDEM
1	Planning (long-mid term: NPDP)	✓✓✓	✓	N/A	✓✓	✓✓✓	*
2	Planning (before MOU)	✓✓✓	✓✓	N/A	✓	*	*
3	Implementation (MOU – PDA)	✓✓	✓	✓	N/A	*	*
4	Implementation (PDA – CA – COD)	N/A	✓✓✓	✓✓✓	N/A	*	*
5	Operation	N/A	✓	✓✓✓	N/A	*	*

* Practically, EDL and PDEM do not act as a part of the development stage above apart from the preparation of (domestic) PDP by EDL.
(Source) Study Team.

3.3.2.2 Necessity of formulation of regulations

Still it is a necessary to develop the prime minister or ministerial decrees under the Electricity Law for the appropriate power project implementation and it may take a one to three year period:

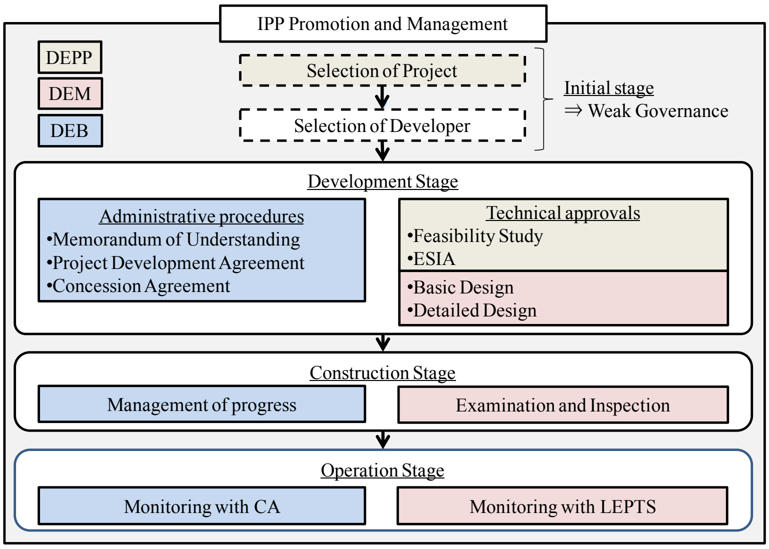
i) Determination of conditions and standards of the Head of engineers (chief engineers) — Article 25
ii) Registration of individuals, legal entities or organizations wishing to invest in electricity business — Article 26
iii) Detailed procedures, contents of each task components and authorization of the MOU, PDA and CA — Article 29

From the next section, the proposed mechanism will be explained with the consideration of ~~"tr~~ansparency, accountability and efficiency".

3.3.2.3 Proposed mechanism for each stage

(1) Planning stage (mid to long-term)

This Study concentrated specifically on the planning stage (before MOU) as one of the critical issues for governance because a well-planned project preparation can achieve transparent, accountable and efficient IPP management as shown in Figure 3-10.

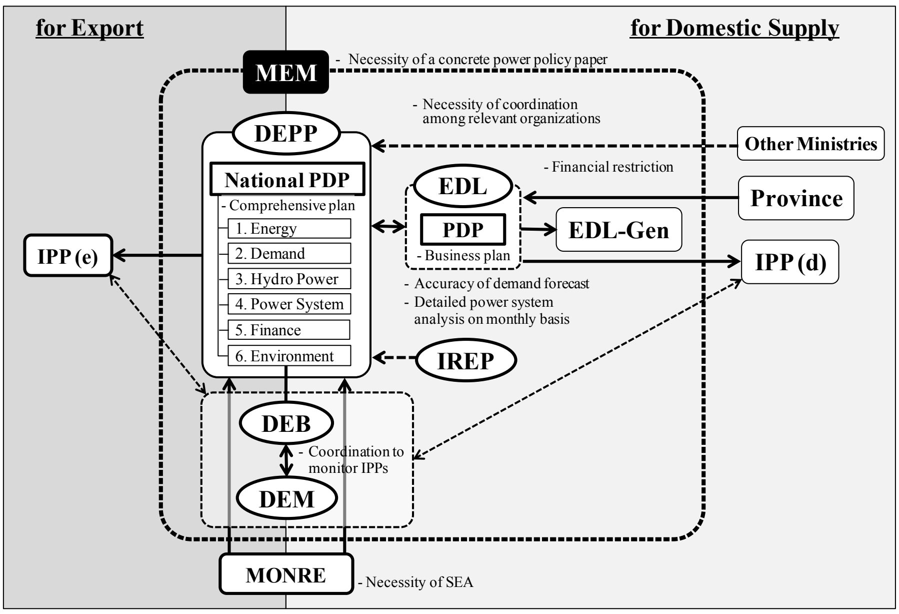


(Source) Study Team.

Figure 3-10: Workflow among relevant departments

< Hydropower database: accountability and efficiency >

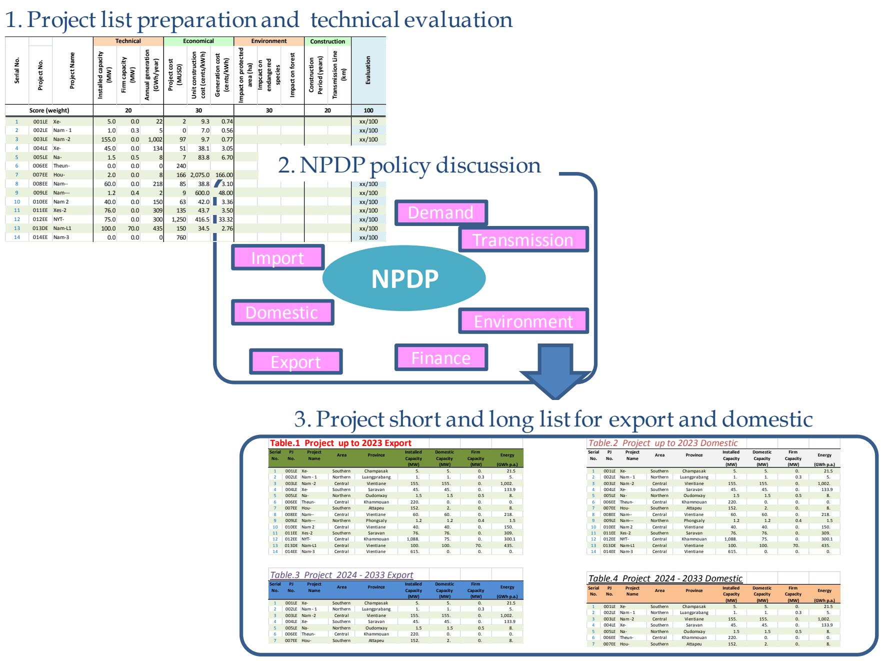
From the 1990's, Laos started hydropower projects as its own natural resources to be one of the major income measures from the neighboring countries. At that moment, an inventory study was conducted entitled ―Hydropower Development Plan for the Lao PDR, 1998" and the possible hydropower was clarified. However, more than 10 years have passed since the said comprehensive study. Some potential sites were already developed, and some information was updated and some projects are under development stages. Therefore, it is necessary to prepare a comprehensive and uniform hydropower database from relevant organizations such as DEPP, DEB, EDL and PDEM including the progress of on-going projects.



(Source) Study Team

Figure 3-11: Outline of NPDP development procedure

Then the potential data should be prioritized with consideration of the current natural and social environmental situation, progress of the project with the reason of the barriers, etc. It may be possible to conduct a new inventory study using a donor fund. Then, through the policy discussion under the framework of the NPDP as shown in Figure 3-11: the balance of export and import, reservoir or run of river, IPP (d) or, IPP (e) will be decided. Finally, a hydropower list will be prepared in the DEPP (MEM) as the preparatory database in the planning stage. The proposed outline of data preparation system is shown in Figure 3-12.

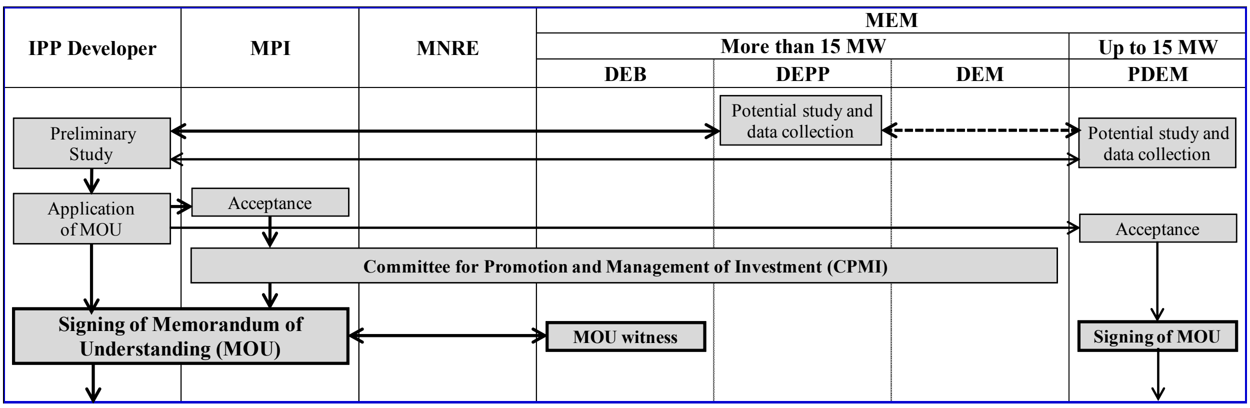


(Source) Study Team.

Figure 3-12: Outline of hydropower data list preparation

(2) Planning stage (before MOU)

The current workflow before the conclusion of MOU is shown in Figure 3-13.



(Source) Study Team.

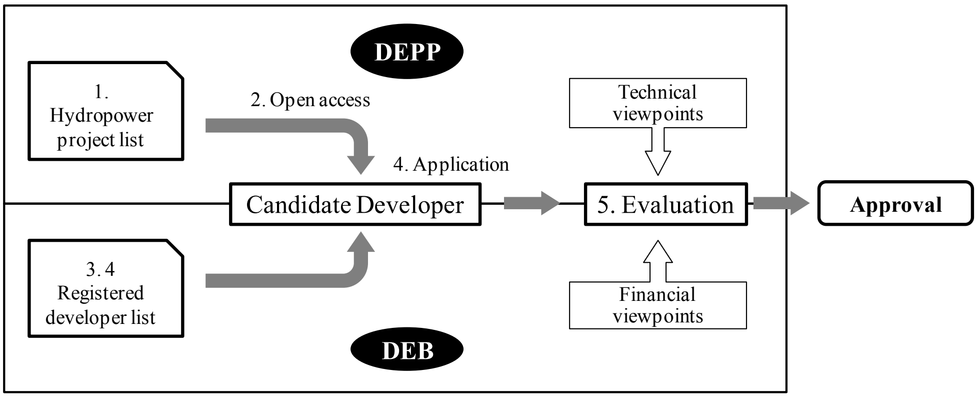
Figure 3-13: Current development flow before MOU

< Developer invitation system: transparency >

Currently, the developers have to find out the potential hydropower sites by themselves and the applications will be submitted to the MPI. The applications will be forwarded to the DEB for consideration with their criteria of financial performance. This system has to be taken because a clear hydropower database is not prepared as described before.

Therefore it is proposed to develop a better mechanism to invite potential investors for transparency and accountability, by both the technical and commercial points of view as follows (see Figure 3-14):

1. DEPP should prepare a uniform project list;
2. The project list should be open (published) by, e.g., the website of the DEB;
3. DEB should prepare a potential developer list;
4. Registered developers can access the project list and apply for MOU;
5. If more than one developer submits the application for a project, the MEM should carry out the evaluation from both financial and technical aspects. The DEB may be in charge of the evaluation with technical inputs from the DEPP.



(Source) Study Team

Figure 3-14: Proposed developer invitation mechanism

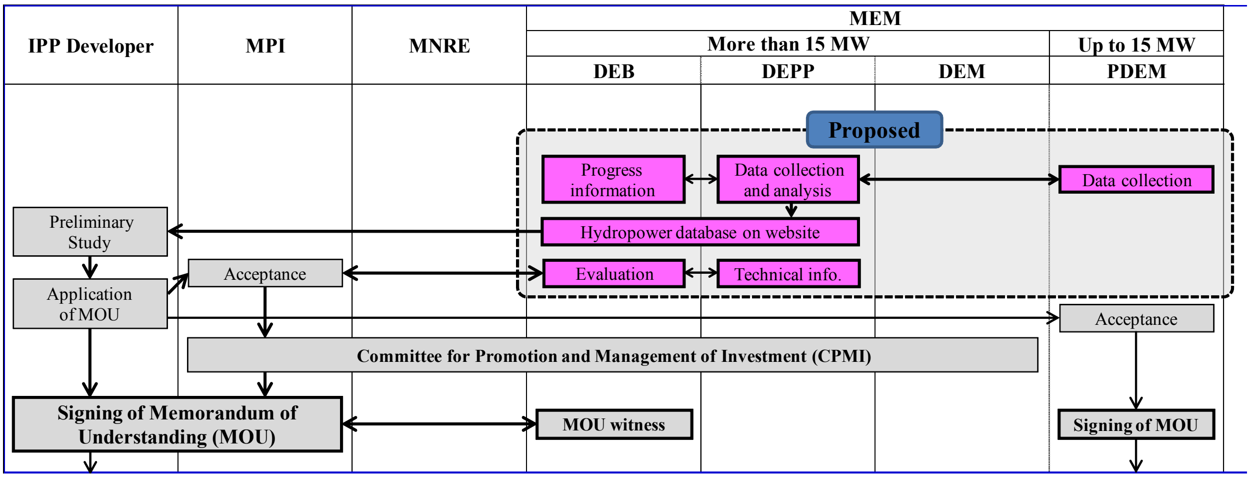
The development process can be more transparent and accountable even if one of the five measures could be achieved. Proposed necessary actions, organization in charge and assumed period are shown in Table 3-10.

Table 3-10: Proposed necessary activities, organizations and assumed period

No.	Activities	MPI	MEM			Period (year)
			DEPP	DEB	DEM	
1	Preparation of technical database		✓✓			1
2	(Inventory study)		✓✓			1-2
3	Call for tender/ bid	✓✓				3-5
4	Long-list preparation			✓✓		
5	Technical evaluation		✓✓			
6	Financial evaluation			✓✓		
7	Issuing the approval to developers	✓✓				

(Source) Study Team.

The new proposed work-flow with relevant organization is shown in Figure 3-15.

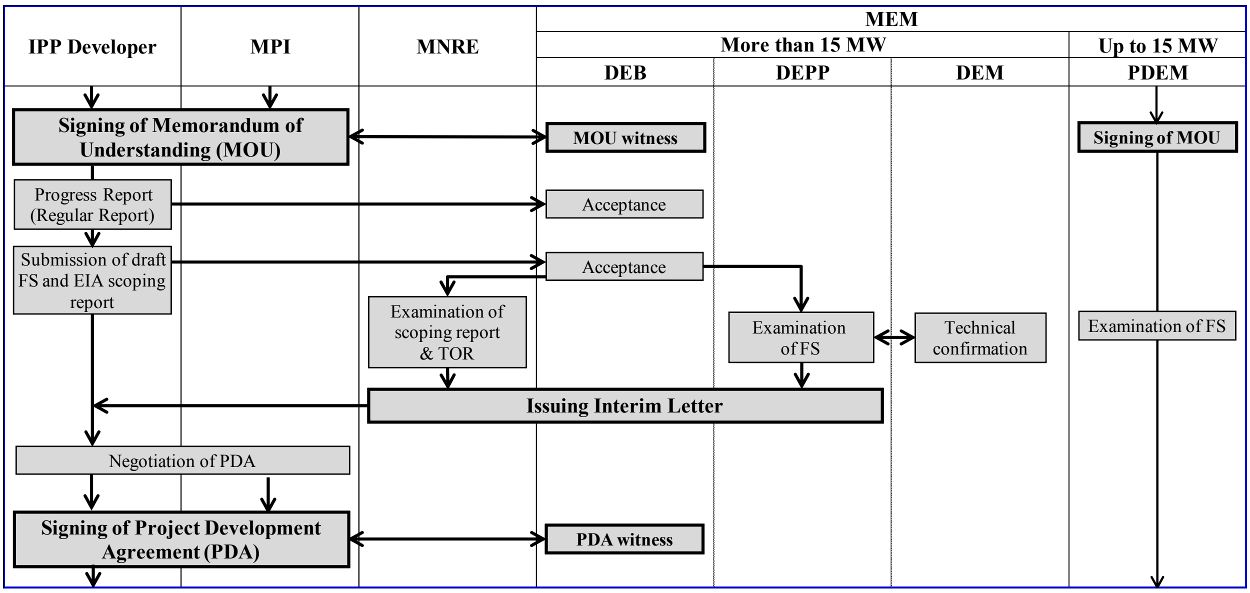


(Source) Study Team.

Figure 3-15: Proposed development flow before

(3) Implementation stage (MOU – PDA)

The current workflow between MOU and PDA is shown in Figure 3-16.

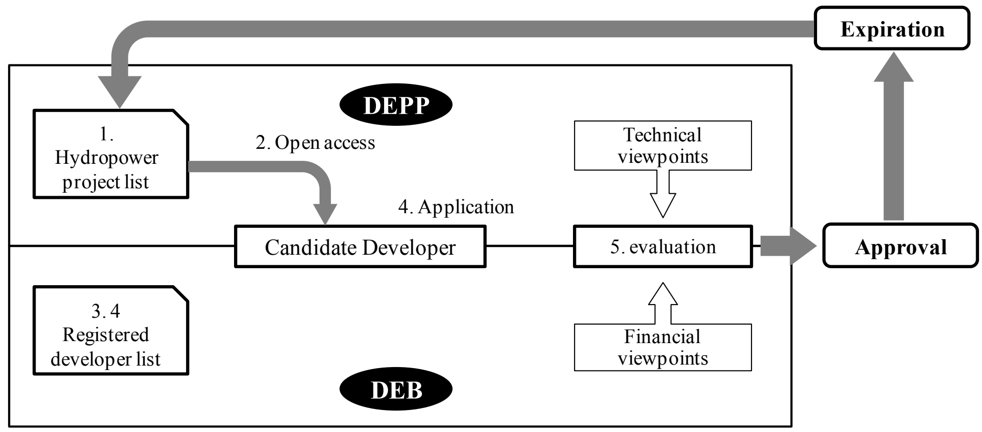


(Source) Study Team.

Figure 3-16: Current development flow between MOU and PDA

< Developer invitation system: transparency and efficiency for expired projects >

MOUs and PDAs for 16 projects were expired as of March 2013 after the enforcement of the new Electricity Law, of which Article 29 stipulates the concession procedures including the number and the period of extension of MOU and PDA, and new alternative developers are waiting in line to conclude MOUs or PDAs for those projects. Once the developer invitation system is set up, such MOU or PDA expired project will be open to select a new developer with transparency and efficiency as shown in Figure 3-17.



(Source) Study Team

Figure 3-17: Developer invitation mechanism for expired project (proposed)

< FS examination system: transparency and efficiency>

Currently, the DEB only receives and forwards F/S reports to the DEPP for their technical examination. The examination is conducted by the DEPP to check the table of contents of the F/S attached to the MOU. Sometimes the DEB, a negotiator with developers, makes some comments with technical and socio-economic consideration. Once both developers and MEM confirm that the projects will be feasible, the developers are allowed to step into the PDA stage. However, from the developer side, the criteria for proceeding to PDA are not clear.

Therefore, it is proposed to set up an evaluation system (criteria) for F/S examination in DEPP focusing on the efficient power development such as:

a) Hydrology and probable power output in comparison with the Government's plan;
b) Minimum technical requirements e.g., dam safety with minimum geological survey; and
c) Scoping and TOR for the EIA as stipulated in the EIA Guidelines.

Proposed necessary activities, organization in charge and assumed period are shown in Table 3-11.

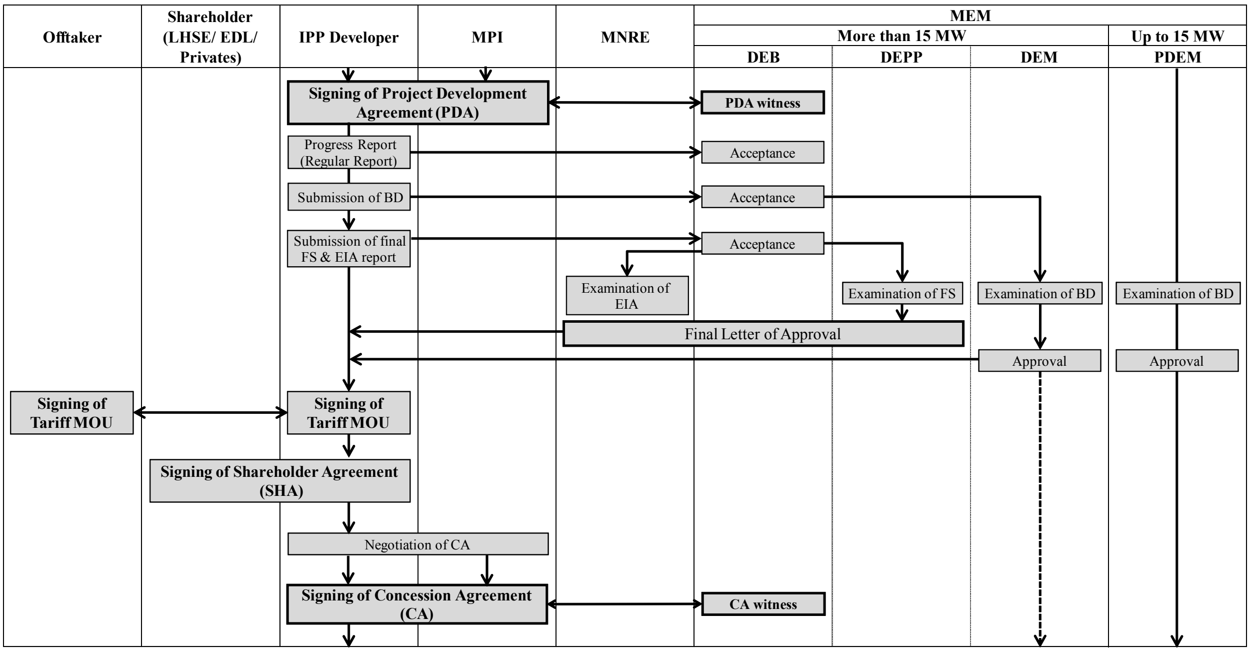
Table 3-11: Proposed necessary actions, organizations and assumed period

No.	Activities	MPI	DEPP	DEB	DEM	Period (year)
1	Criteria to evaluate F/S		✓✓	(✓)		1-2

(Source) Study Team.

(4) Implementation stage (PDA – CA)

The current workflow between PDA and CA is shown in Figure 3-18

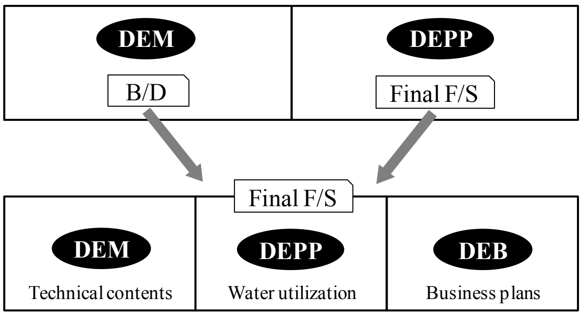


(Source) Study Team.

Figure 3-18: Development flow between PDA and CA

< Re-arrangement of activities before CA: transparency and efficiency >

Three activities (two examinations and a negotiation) are to be conducted in parallel during the PDA to the CA stage as shown in Figure 3-18. The DEM carries out the examination on the basic design (B/D) documents, the DEPP still conducts the examination of the final F/S and the DEB starts negotiation of the CA. The process looks confusing for developers. The final F/S may include more detailed technical calculation and drawings. It may also include more concrete business plans after completing the tariff MOU, shareholder agreement and formulation of the special purpose company (SPC). To make the F/S examination or evaluation process clearer, it is proposed that the final F/S and B/D will be combined as one document. Among the contents of the documents, the DEPP will check the utilization of water resources, DEM will check the technical matters and DEB will check the business plans as shown in Figure 3-19. Proposed necessary actions, organization in charge and assumed period are shown in Table 3-12.



(Source) Study Team

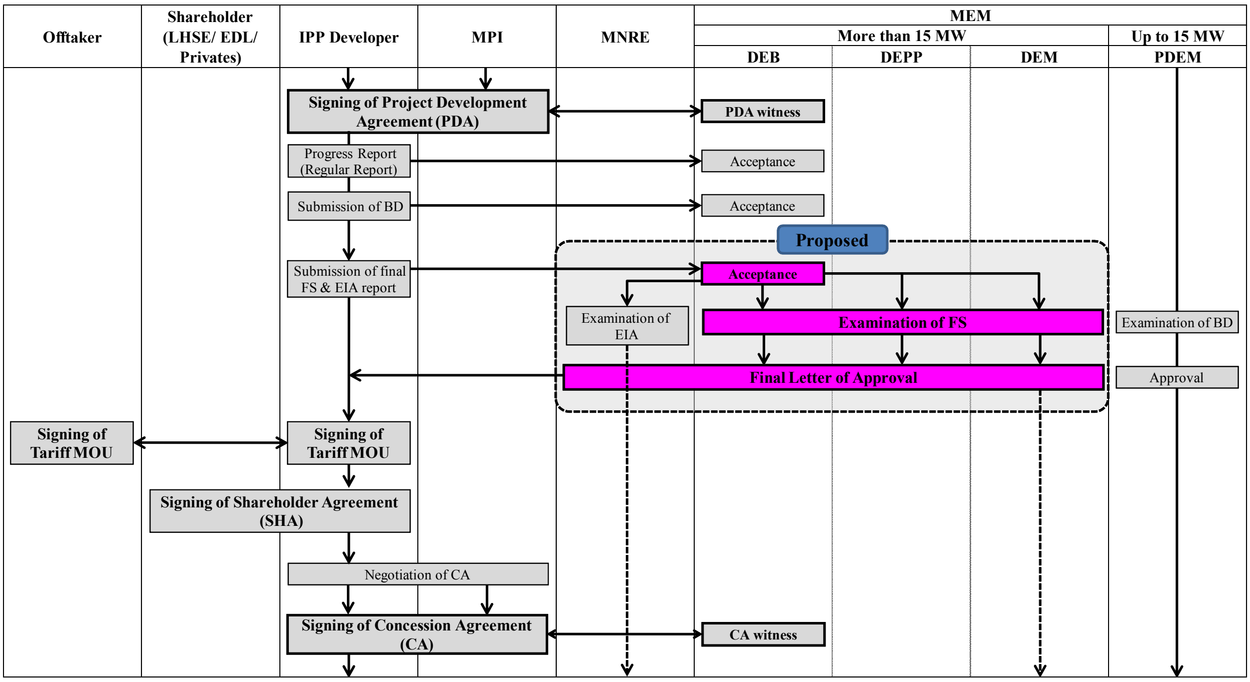
Figure 3-19: Proposed F/S examination

Table 3-12: Proposed necessary actions, organizations and assumed period

No.	Activities	MPI	DEPP	DEB	DEM	Period (year)
1	Re-consideration of the F/S definition		✓✓	(✓)		1-2

(Source) Study Team.

The new proposed work-flow with relevant organization is shown in Figure 3-20.

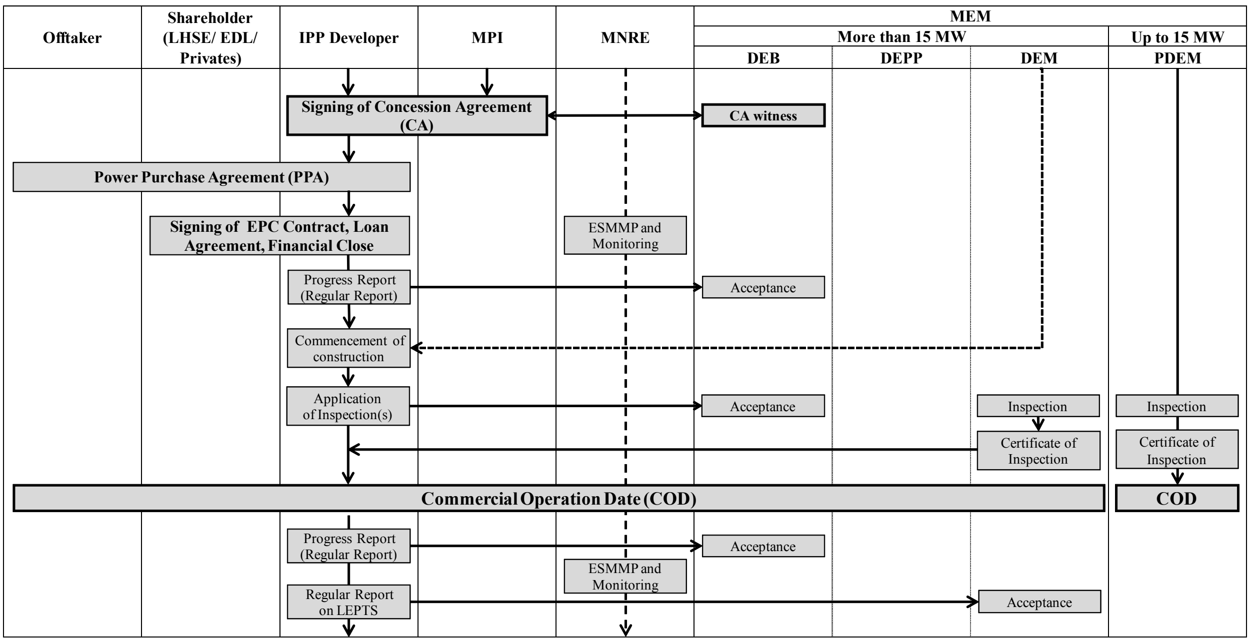


(Source) Study Team.

Figure 3-20: New development flow between PDA to CA (proposed)

(5) Implementation stage (CA – COD – commercial operation)

Current workflow from CA through to commercial operation is shown in Figure 3-21.



(Source) Study Team.

Figure 3-21: Development flow between CA to commercial operation

< Clarification of technical performance during operation and after concession period: accountability >

Many technical conditions are stipulated in CA documents during construction, operation and before transfer of the projects to the GOL after the concession period. For example, in the operation stage, developers shall submit regular reports (operation, dam monitoring records, etc.) to the MEM. The GOL may need, at least, the production performance with facility conditions as minimum requirement before undertaking the assets after the concession period. Such minimum requirements should be clarified and stipulated in the CA (DEM, DEB and EDL).

< Two engineers in CA for efficiency >

Currently, there are two types of Governmental engineers stipulated in CA:

- GOL engineer (for DEM):
  To carry out examinations and inspections for the conformity to LEPTS.
- Contract, site or monitoring engineer (for DEB):
  To monitor the project for all technical matters including progress, environmental measures and special cases (e.g., the technical regulation of the Mekong River Commission (MRC)).

The definition of the GOL engineer under the DEM, basically to carry out examination and inspection, is clearer than the contract (site or monitoring) engineer under the DEB. Clear roles, activities and capabilities of the engineer to be described in the CA is being studied by the WB-TA experts institutionally and technically together with utilization of the GOL engineer.

At least, it is recommended for the DEM and DEB to prepare:

a) One word (name) of the two engineers to enable the developers' clearer understanding and efficiency in the CA; and
b) The DEM staff may be involved in the monitoring activities more than current opportunities (e.g., once a month) to check the conformity to the LEPTS after the DEM increased the number of experienced staff.

Proposed activities, organization in charge and assumed period are shown in Table 3-13.

Table 3-13: Proposed necessary activities, organizations and assumed period

No.	Activities	MPI	DEPP	DEB	DEM	Period (year)
1	Development of detailed conditions after the concession period in CA			✓✓	✓✓	1-2
2	Coordination between GOL engineer and contract engineer			✓✓	✓✓	1-2

Note: Specifically, the technical cooperation to CA is being studied by the World Bank up to year 2014.
(Source) Study Team.

3.3.3 Possibility to collaborate with World Bank

The World Bank has started a component of technical assistance (TA) for DEB since January 2013 as a part of ―Technical Assistance for Capacity Building in the Hydropower and Mining Sectors". During the project up to February 2014 (practically December 2013), four experts (team-leader, institute, technical, and financial) are assigned for:

i) preparation of requirements and procedures for monitoring the construction and operation of hydropower projects;
ii) preparation of model contractual requirements including templates in CAs to ensure sound environmental and social safeguard management and monitoring;
iii) provision of resources and technical assistance to support site inspection and monitoring of on-going hydropower project construction in line with CAs; and
iv) training for the DEB staff at central and provincial levels for managing the implementation of CAs.

Among the issues for the better mechanism to promote IPP development, the activities under the CA can be treated in the WB-TA. Institutionally, the TA also focuses on the transparent and accountable work-flow and mechanism such as:

a) An evaluation system to select a candidate among the registered developers to be given the right to proceed into the MOU stage for the F/S;

b) A better framework between PDA and CA stages with the roles and TORs of the relevant departments to receive and examine the detailed F/S, B/D and CA negotiations; and

c) An information sharing system utilizing the information and communication technology (ICT) in the DEB as the control point for the on-time project progress management among the relevant departments.

3.3.4 Future monitoring and management on workflow

Currently, workflows are independently managed by concerned department such as the DEB and DEM. For future monitoring and management of the whole IPP development workflow, there are two possibilities considered.

a) DEB for efficient management in the near future
The DEB has been managing the progress of the IPP projects using the progress reports from them. It may also develop an information sharing system using intranet devices. The progress database will be set up in the DEB and the information will be distributed on time to the concerned departments: the DEM for the examination and inspection purposes; and the DEPP for the planning purposes. EDL may be able to access the database.

b) DEPP for the future policy and planning
As already mentioned, the DEPP is in charge of developing a hydropower potential database with prioritization for EDL, IPP (d) and IPP (e) after the policy decision. The DEPP can control the most appropriate usage of the water resources for the most efficient river system development with economical and environmental consideration. The DEPP can monitor and manage the process of IPP development after the concrete set-up of the policy and planning activities even if the information sharing system will be left in the DEPP.

Practically, the DEB may start the information sharing system to monitor and control the IPP progress. However, it is recommended that the DEPP in charge of policy and planning on the power development should monitor IPP development in future.

3.3.5 Power development mechanism manual (guidance)

The Study prepared guidance on the power development mechanism for IPP development with a work-flow and necessary activities of the concerned public organizations in each development stage. Table 3-14 shows the contents of the guidance.

Table 3-14: Proposed contents of power development mechanism guidance

Contents

Chapter 1	Preface
Chapter 2	Objective of the Guidance
Chapter 3	Legal and Institutional Background
3.1	Legal background (Electricity Law 2011)
3.2	Related organization for the IPP projects
3.3	Existing workflow
3.4	Proposed workflow
Chapter 4	Work Description in Each Development Stage
4.1	Roles of relevant organizations for IPP development
4.2	Overview of IPP development activities
4.3	Planning stage for mid-long term period
4.4	Planning stage before MOU
4.5	Study stage from MOU to PDA
4.6	Study and negotiation stage from MOU to PDA
4.7	Implementation stage from CA through COD to operation stage
Chapter 5	Newly Proposed Workflow
Chapter 6	Recommendations

(Source) Study Team.

Chapter 4 Improvement of EDL-PDP

One of the major expected outputs of the Study is to propose the improvement of the current PDP. From the review of the current power sector situation described in Chapter 2, the following two major improvement points are observed:

1) To secure the comprehensiveness in the PDP. In other words, not only the mere facility development plan but also the policies for power development have to be included. For example, the policies regarding how to deal with large industrial demand, in how power generation should be demarcated (domestic or export) or in what way the future power system should be configured. These issues cannot be concluded by just simulation, but the government has to take its time making decisions.

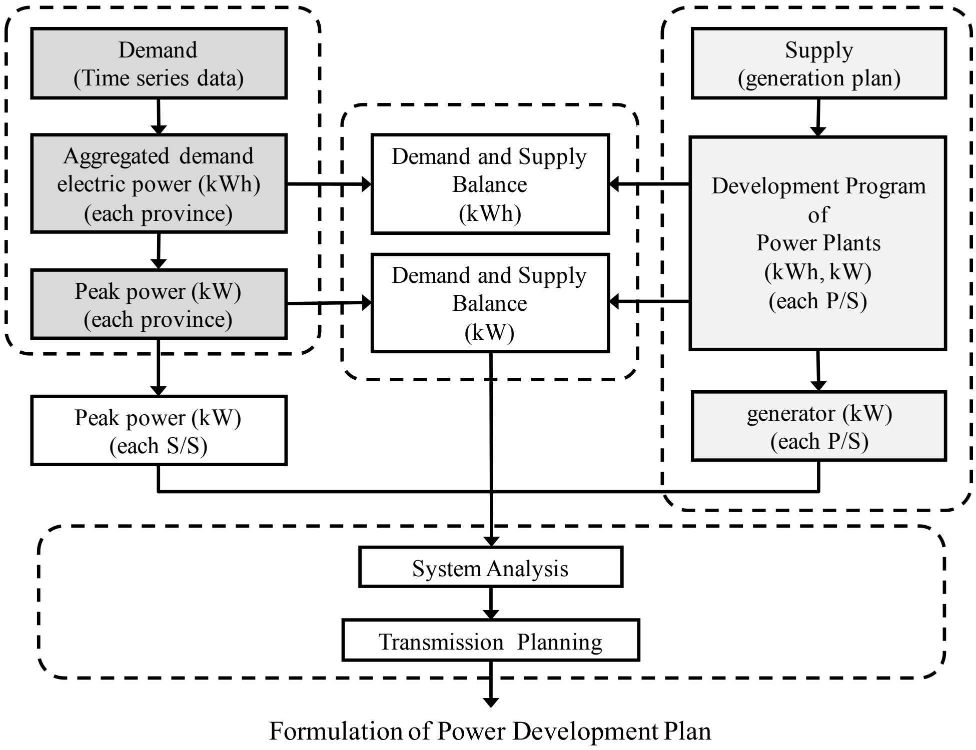
2) Technical improvement by providing the methodologies including the reliability of demand forecasting, the ranking in generation planning and the accuracy of system analysis.

The first item is substantially important, and the proposal for improvement is detailed in Chapter 3 as the formulation of the National Power Development Plan (NPDP). Meanwhile the second one is an urgent matter to be improved, and originally requested from the Laotian side as described in Chapter 1. In this context, technical improvement of the current PDP is suggested in this chapter. Major technical issues are demand forecast, generation planning, and transmission planning, of which the current problems and methodologies for improvement are described. In addition, the future images of power system are discussed.

4.1 Points of improvement

EDL is revising the PDP to complete in 2014, and technology transfer is conducted in this Study in order to increase the accuracy and the reliability of the EDL's PDP.

Formulation of the power development plan is based on the series of procedures called power system planning, as shown in Figure 4-1, and the power system planning consists of three factors: demand forecasting, generation planning and transmission planning.



(Source) Study Team.

Figure 4-1: Flow of power system planning

This study focused on two major improvement points for the revision of PDP as follows:

(1) Demand forecast by using econometric model

One of the largest problems in the current PDP is inaccuracy of demand forecasting, and the econometric model was introduced in this study in order to make the demand forecast more reliable.

(2) Power system planning on monthly basis

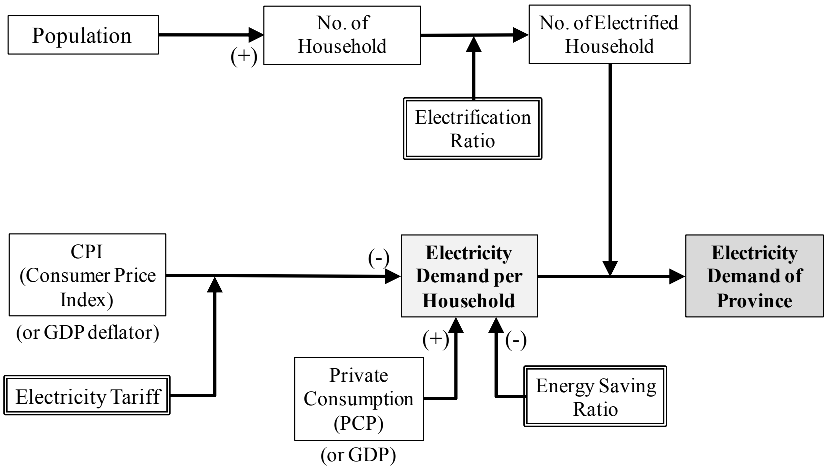
The EDL's power system planning has been so far conducted on the basis of annual balance. That is to say, annual total energy generation, and the balance of maximum power output and peak load have been the focal points of planning. However, the power flow situation in Laos changes a lot seasonally depending on the output of its dominant hydropower generation, so that monthly-based system planning is recommended in order to optimize power system development and operation.

4.2 Demand forecast

4.2.1 Outline of demand forecasting in econometric approach

(1) Basic concept

As mentioned in Chapter 2, the current PDP does not well explain the consistency between assumptions and results from a viewpoint of economics. In order to avoid such a problem, the Study Team recommends that the econometric approach should be introduced in the place of the current method that has already been finished, and in some sense the effectiveness is expired. As indicated in Figure 4-2, it is more reasonable and clearer to adopt the econometric approach based on economic theory in the place of the current method (Figure 2-20).



Note: Electricity Demand per household is estimated by using ―econometric method".
(Source) Study Team.

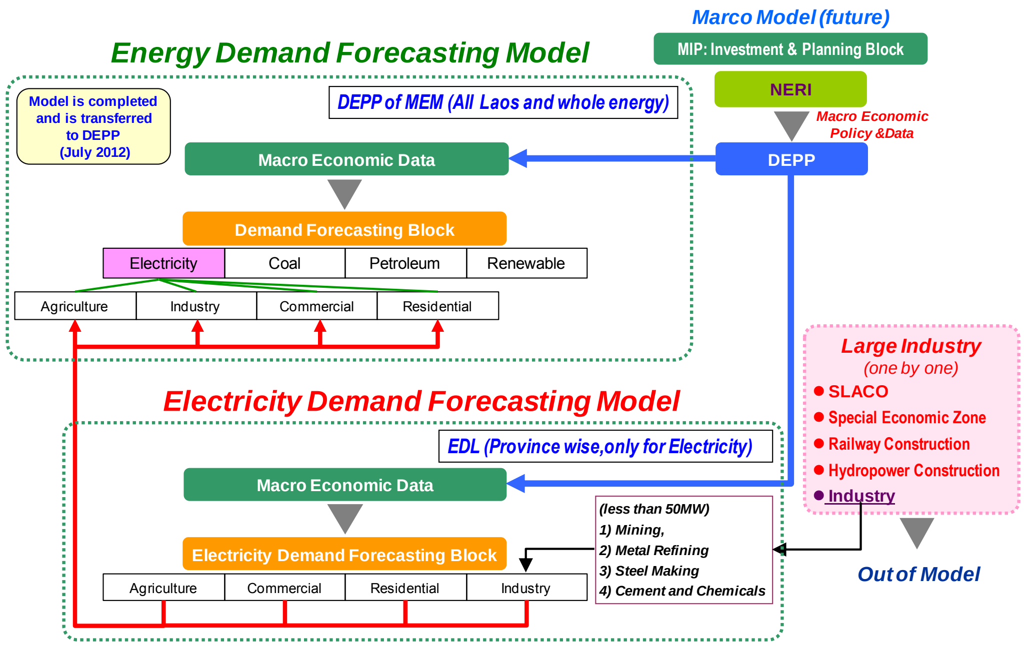
Figure 4-2: General calculation way based on economic theory

But if the econometric approach is introduced on all the aspects, it is still uncertain whether all the problems regarding the current methodology will be immediately resolved. That might not always give a correct estimation to us because the level of demand for the past 10 years is too low to exactly estimate a future demand by the econometric approach. Probably in three years or so, such situations will be completely changed. That is why it is the right way to regard the econometric model as a prototype for the time being and, to consider the coming three years to be the time for preparing a more comprehensive model along with improving the quality of data and extending the annual length of time series data in the pursuit of more exact, more available, and higher credible system.

(2) EDL model and DEPP model

As indicated in Figure 4-3, a new EDL model is connected with the DEPP model (already developed in another JICA project[34]) and they are all intended for using the same macro-economic data (precondition) given from NERI (MPI) in the future. The EDL model covers only electricity demand (kWh/year basis and by province), each province demand estimated being aggregated into all Lao electricity demand, which is transferred to the DEPP model covering all energy sectors. As explained in Chapter 2, the current PDP Category is changed to the IEEJ Category. The scope of demand forecasting is limited to Agriculture, Commerce, Residential and Industry (Industry 1 +Industry 2), regarding ―Large Industry" (excluding "Industry 2") as ―Reference" (outside model).

[34] Data Collection Study (Preliminary Assessment) on Energy Sector in Lao People's Democratic Republic.



(Source) Study Team.

Figure 4-3: The structure of EDL model and DEPP model

4.2.2 Work flow of model building and simulations (prediction)

(1) Work flow

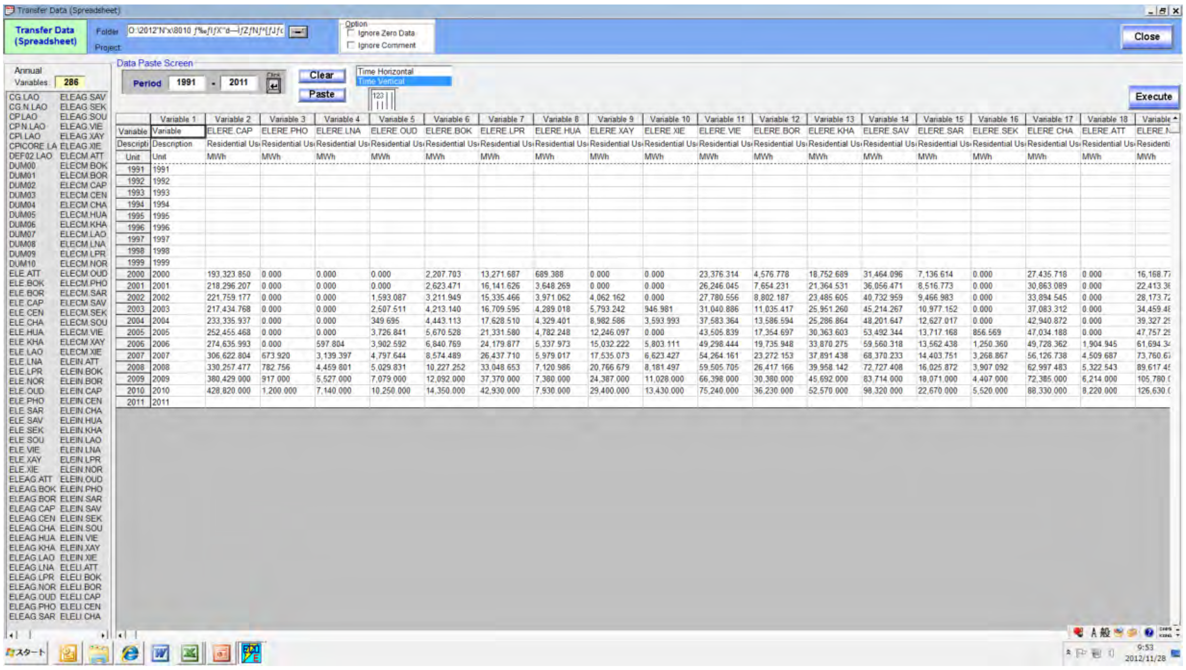
The tool (software) on which the econometric model can be operable is called ―Economate”, which is generally used for building and simulating various demand forecasting models in IEEJ. One of the reasons for adopting ―Economate” is that it is relatively easy to integrate various models.

Table 4-1 describes the work flow of model building and simulations. As indicated in Figure 4-4, the input data for demand forecasting can be easily transferred from ―data sheet” on ―Excel file” to the data file of ―Economate” by using the method of ―cut and paste”. Output data (simulation results) can be transferred to the ―data sheet” on an ―Excel sheet” almost in the same way.

Table 4-1: Work flow of model building and simulations on ―Economate”

Step 1:	Making Folder for Model Building
Step 2:	Import of Historical Data
Step 3:	Estimation of OLS (Ordinary Least Square)
Step 4:	Model Building
Step 5:	Test (Partial Test, Final Test) for Fitting the Model
Step 6:	Prediction (Simulation Results)
Step 7:	Making Summary Table for Simulation Results

(Source) Study Team.



(Source) Study Team.

Figure 4-4: Input data file in ―Econamate" system

(2) Model structure

A guidebook, ―Introduction to Electricity Demand Forecasting Model", explains how to formulate the demand function by OLS (Ordinary Least Square method) and depict the architecture of the model in more detail. In this section, Figure 4-5 shows as an example that the calculation way of Figure 4-2 is converted to the part of the model—a set of simultaneous equations.

--------- *HOUSEHOLD* ---------

'Vinetiane Cap.

HOUSE.CAP=-3064.61+.778508(HOUSE.CAP(1))+5.53944*(POP.LAO)*

'---------- HOUSEHOLD ELECTRIFIED ---------

*EHOUSE.CAP=HOUSE.CAP*ERATE.CAP/100*

'---------- RESIDENTIAL SECTOR ---------

'Vinetiane Cap.

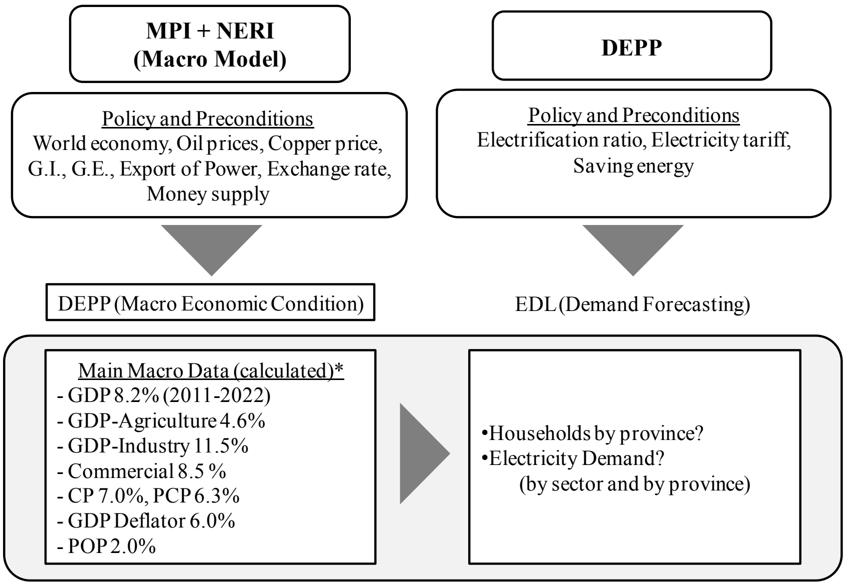
ELERE.CAP=(1-RE.SAVE)(EHOUSE.CAP*(1.28284+.404630*(ELERE.CAP(1)/EHOUSE.CAP(1))+.0000511*(CP .LAO)-.221681*(PELE.LAO/DEF02.LAO)+.091908*(DUM07)))*

(Source) Study Team.

Figure 4-5: Simultaneous equations for estimating residential demand

(3) Setting ―preconditions" and simulations

Various preconditions (exogenous data) are to be set in the model before simulating the model. As indicated in Figure 4-6, the model needs two types of exogenous data: macro-economic indicators and policy options (electrified rate, electricity tariff, and saving energy). The former need to be given by the MPI but in ―Default Case” such data is acquired by simulating the simple macro-economic model constructed by IEEJ. The latter is originally decided by DEPP but is set by IEEJ in ―Default Case”. Furthermore, Industry 2 (less than 50 MW) is selected from ―Large Industry Project” compiled by EDL.



(Source) Study Team.

Figure 4-6: Various exogenous data (preconditions) for prediction

4.2.3 Simulation results in ―Default Case”

The following table (Table 4-2) and the following figures (from Figure 4-7 to Figure 4-11) indicate simulation results in ―Default Case”. The accuracy of estimation is not better than expected before because the availability of the used time series data is much lower than required. The econometric method, so far, needs to be limited to ―Vientiane Capital” from a viewpoint of the accuracy and credibility; a few provinces can be applied to the econometric method in the case of measuring the elasticity of the tariff to demand. But, on the contrary, the strong willingness to improve the model leads to the enhancement of the quality and quantity of the required data, and understanding economy, data collection through full examination and a more properly estimated demand equation, are all required to improve demand forecasting.

Since demand forecasting has come to be based on the consistency between economic conditions and estimation results by introducing the econometric approach, estimation results have become clearer and more persuasive as the future targeted index is completely different from the current estimations.

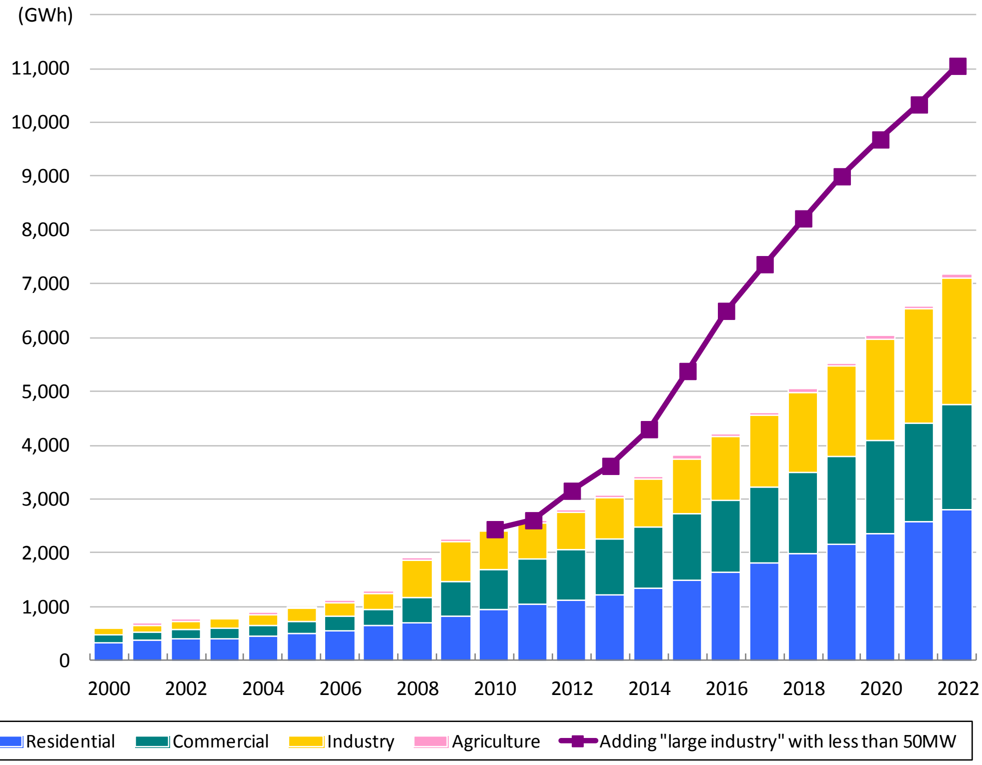
Table 4-2: Simulation result (estimated demand) in ―Default Case”

Demand (GWh)		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	
JICA Study	Residential	943	1,047	1,128	1,231	1,354	1,494	1,653	1,812	1,985	2,171	2,369	2,576	2,799	
	Commercial	749	845	927	1,021	1,120	1,227	1,327	1,423	1,523	1,625	1,730	1,835	1,956	
	Industry	707	668	702	783	896	1,037	1,175	1,322	1,487	1,673	1,884	2,124	2,358	
	Agriculture	43	47	49	52	56	59	61	63	64	66	68	70	72	
	Total	2,441	2,607	2,807	3,088	3,426	3,817	4,215	4,619	5,060	5,536	6,051	6,605	7,186	
PDP 2010[*1]	Others	1,968	2,134	2,325	2,526	2,747	2,991	3,260	3,561	3,957	4,410	4,929	5,525	6,203	2011 Miscalculation
PDP 2010 rev[*2]	Others	1,968	2,241	2,501	2,792	3,120	3,490	3,911	4,390	5,054	5,838	6,766	7,860	9,165	2011 Corrected
(Large Industry)															
Less than 50 MW				349	530	875	1,564	2,285	2,749	3,159	3,466	3,636	3,733	3,870	2012
Not less than 50 MW				1,085	1,403	2,217	2,693	3,572	5,241	5,716	5,999	9,809	9,154	9,215	
Total Large Industry				1,434	1,933	3,092	4,258	5,857	7,989	8,875	9,465	13,445	12,887	13,085	2012

Growth Rate		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2022/2010
JICA Study	Residential	11.1%	7.7%	9.2%	9.9%	10.4%	10.6%	9.6%	9.6%	9.4%	9.1%	8.7%	8.7%	9.5%
	Commercial	12.9%	9.7%	10.1%	9.8%	9.5%	8.1%	7.2%	7.0%	6.7%	6.4%	6.1%	6.6%	8.3%
	Industry	-5.5%	5.1%	11.6%	14.4%	15.7%	13.3%	12.5%	12.5%	12.5%	12.6%	12.7%	11.0%	10.6%
	Agriculture	9.6%	6.1%	5.6%	6.2%	6.2%	2.9%	3.3%	2.7%	2.7%	2.7%	2.7%	3.2%	4.5%
	Total	6.8%	7.6%	10.0%	10.9%	11.4%	10.4%	9.6%	9.5%	9.4%	9.3%	9.2%	8.8%	9.4%
PDP 2010[*1]	Others	8.4%	8.9%	8.7%	8.7%	8.9%	9.0%	9.2%	11.1%	11.4%	11.8%	12.1%	12.3%	10.0%
PDP 2010 rev[*2]	Others	13.9%	11.6%	11.6%	11.7%	11.9%	12.1%	12.2%	15.1%	15.5%	15.9%	16.2%	16.6%	13.7%

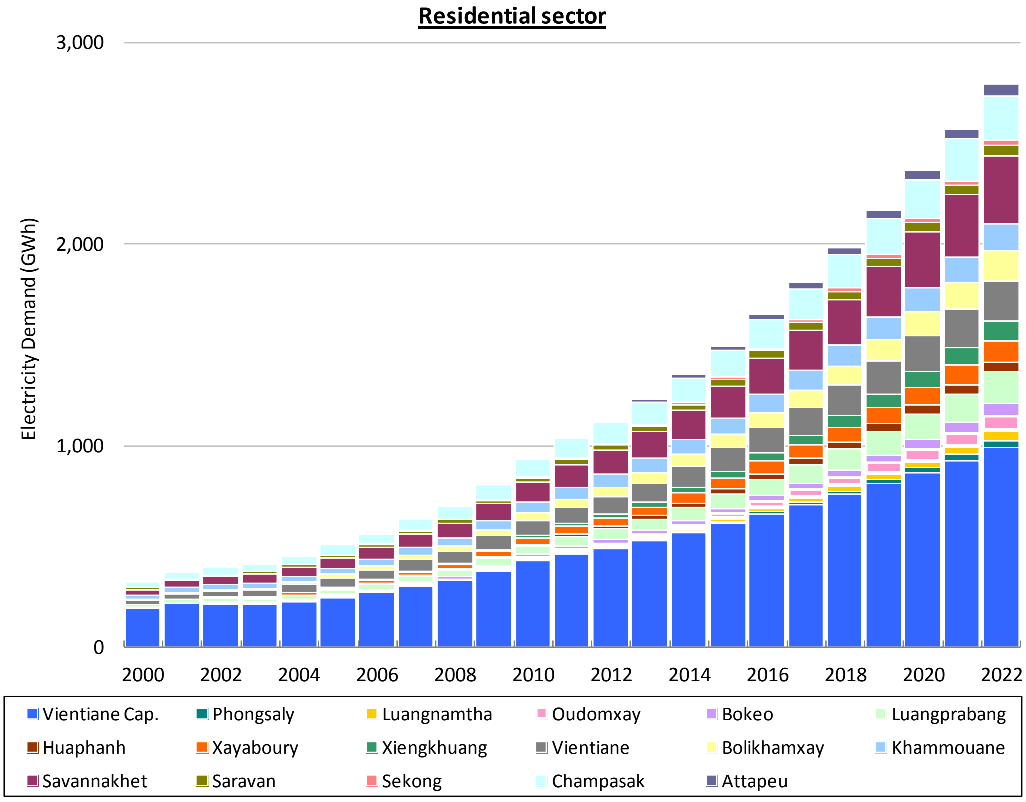
Note) *1: PDP 2010-2020, *2: PDP 2010-2020 (Revision-1)

(Source) Study Team.



(Source) Study Team.

Figure 4-7: Electricity demand by sector (2011-2022) in ―Default Case”

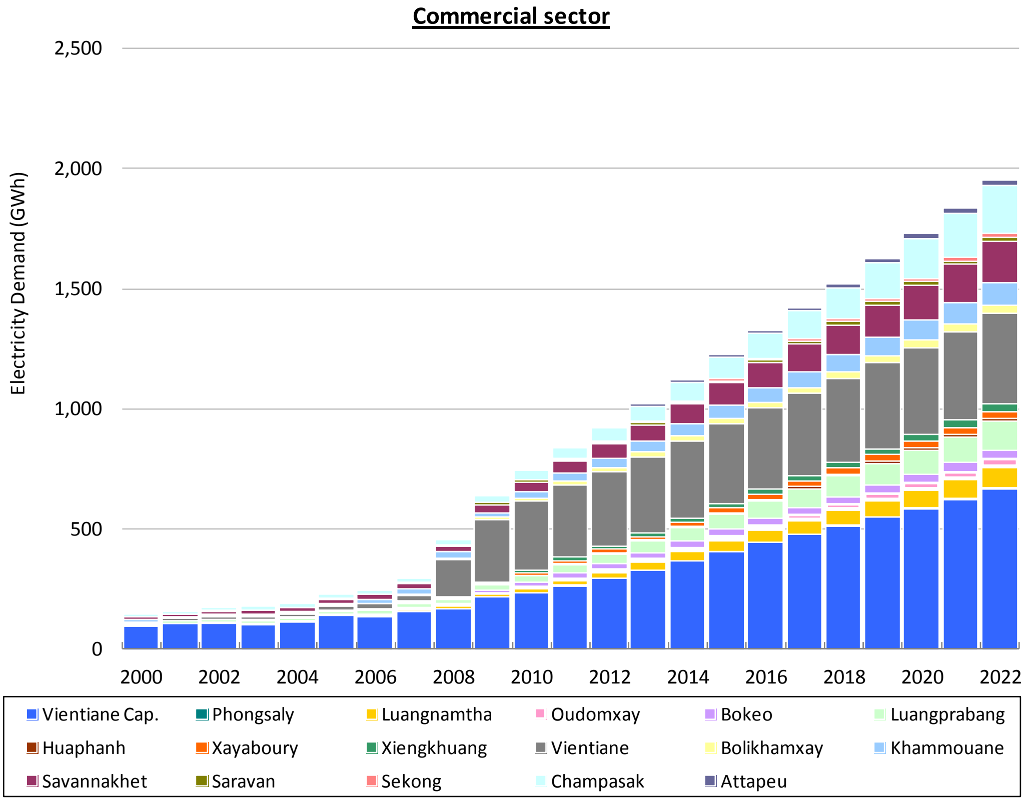


(Unit:GWh)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
CAP	193	218	222	217	233	252	275	307	330	380	429	465	492	527	569	616	664	709	759	811	865	927	993
PHO	0	0	0	0	0	0	0	1	1	1	1	2	3	4	6	8	10	14	17	22	27	31	35
LNA	0	0	0	0	0	0	1	3	4	6	7	7	9	11	13	16	20	23	28	32	38	44	51
OUD	0	0	2	3	0	4	4	5	5	7	10	12	15	18	22	27	32	38	44	51	59	67	75
BOK	2	3	3	4	4	6	7	9	10	12	14	15	17	19	22	24	28	31	35	39	43	49	55
LPR	13	16	15	17	18	21	24	26	33	37	43	46	51	57	64	72	82	92	103	115	128	142	158
HUA	1	4	4	4	4	5	5	6	7	7	8	12	14	17	19	23	26	30	33	37	42	46	51
XAY	0	0	4	6	9	12	15	18	21	24	29	39	41	45	50	56	63	68	75	81	89	95	101
XIE	0	0	0	1	4	0	6	7	8	11	13	14	18	22	27	33	41	49	58	68	79	89	99
VIE	23	26	28	31	38	44	49	54	60	66	75	79	87	95	104	115	126	138	150	162	176	189	204
BOR	5	8	9	11	14	17	20	23	26	30	36	42	47	53	59	67	76	86	97	108	121	133	148
KHA	19	21	23	26	25	30	34	38	40	46	53	63	66	70	76	82	89	96	103	111	119	128	137
SAV	31	36	41	45	48	53	60	68	73	84	98	111	120	131	144	160	181	203	227	252	280	307	336
SAR	7	9	9	11	13	14	14	14	16	18	23	26	27	29	31	32	35	37	39	42	44	47	50
SEK	0	0	0	0	0	1	1	3	4	4	6	5	5	6	7	9	11	13	15	18	21	24	27
CHA	27	31	34	37	43	47	50	56	63	72	88	98	105	113	122	133	144	156	168	180	194	207	222
ATT	0	0	0	0	0	0	2	5	5	6	8	11	12	15	18	21	25	29	34	39	45	51	58
Total	322	371	394	413	453	507	565	642	707	813	943	1,047	1,128	1,231	1,354	1,494	1,653	1,812	1,985	2,171	2,369	2,576	2,799

(Source) Study Team.

Figure 4-8: Electricity demand by province in Residential sector (―Default Case")

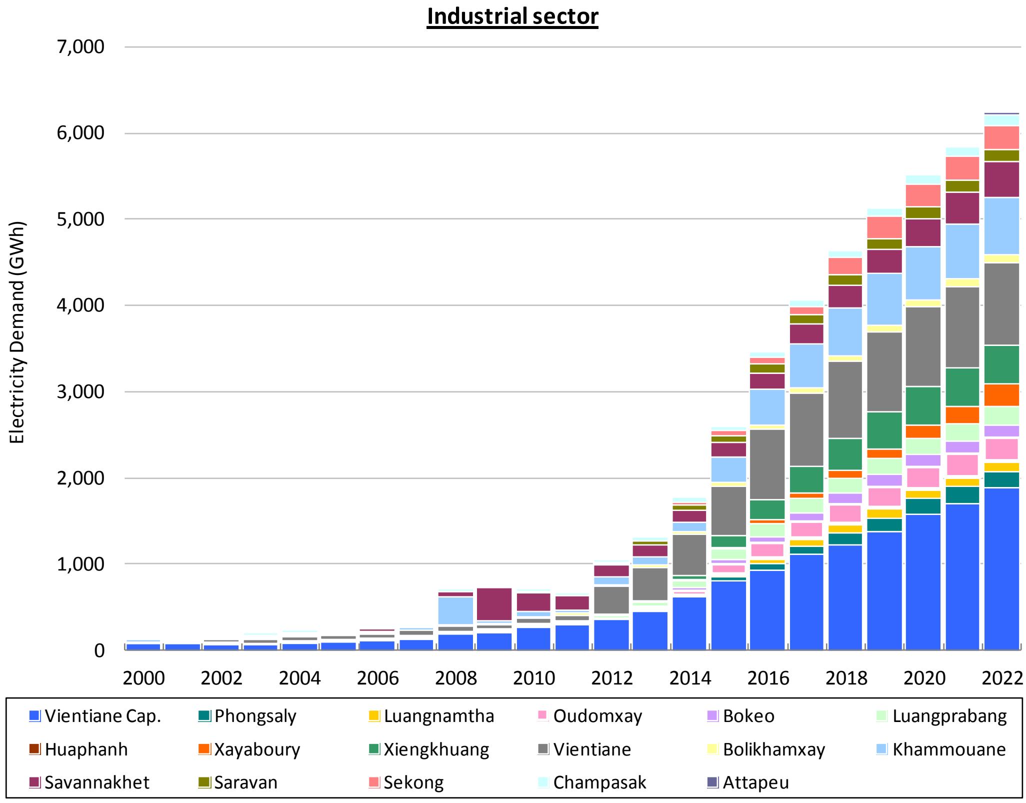


(Unit:GWh)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
CAP	97	108	113	108	118	144	142	158	170	219	236	265	295	330	368	407	444	478	514	550	586	623	667
PHO	0	0	0	0	0	0	0	0	1	1	1	1	1	1	2	2	2	2	3	3	3	3	4
LNA	0	0	0	0	0	0	1	10	12	13	19	25	29	35	41	48	54	60	65	72	78	84	91
OUD	0	0	1	1	1	2	2	3	3	4	6	8	10	12	14	16	18	20	23	25	27	30	32
BOK	1	1	1	1	1	2	3	3	4	8	15	20	22	24	26	28	29	30	31	33	34	35	37
LPR	7	8	9	10	10	12	14	16	20	23	28	35	41	48	55	63	70	77	85	93	100	108	117
HUA	1	1	1	1	1	1	2	2	2	3	3	4	4	5	6	7	7	8	9	10	10	11	12
XAY	0	0	1	1	2	2	3	4	5	6	8	11	12	14	16	18	20	22	24	26	28	30	32
XIE	0	0	0	0	1	2	2	3	4	6	13	15	16	17	19	21	22	23	25	26	27	29	31
VIE	8	10	11	15	13	14	19	24	156	260	287	301	309	316	323	330	337	343	349	355	362	369	377
BOR	2	2	2	3	3	4	4	5	6	7	14	16	18	20	21	23	24	25	27	28	29	31	33
KHA	7	8	7	8	7	10	17	26	23	21	26	34	38	44	50	57	62	67	73	79	84	90	97
SAV	11	7	13	14	14	15	18	20	22	33	41	50	59	69	80	91	103	114	125	136	148	159	172
SAR	2	2	2	3	3	3	3	3	7	6	7	7	7	8	8	9	10	11	12	13	14	15	16
SEK	0	0	0	0	0	0	1	1	2	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CHA	11	12	13	14	14	17	18	19	22	30	36	44	53	64	75	88	102	117	132	148	165	183	202
ATT	0	0	0	0	0	0	1	3	3	3	5	6	7	9	10	12	13	15	16	18	19	21	22
Total	147	160	173	178	189	229	250	300	461	645	749	845	927	1,021	1,120	1,227	1,327	1,423	1,523	1,625	1,730	1,835	1,956

(Source) Study Team.

Figure 4-9: Electricity demand by province in Commercial sector (―Default Case")

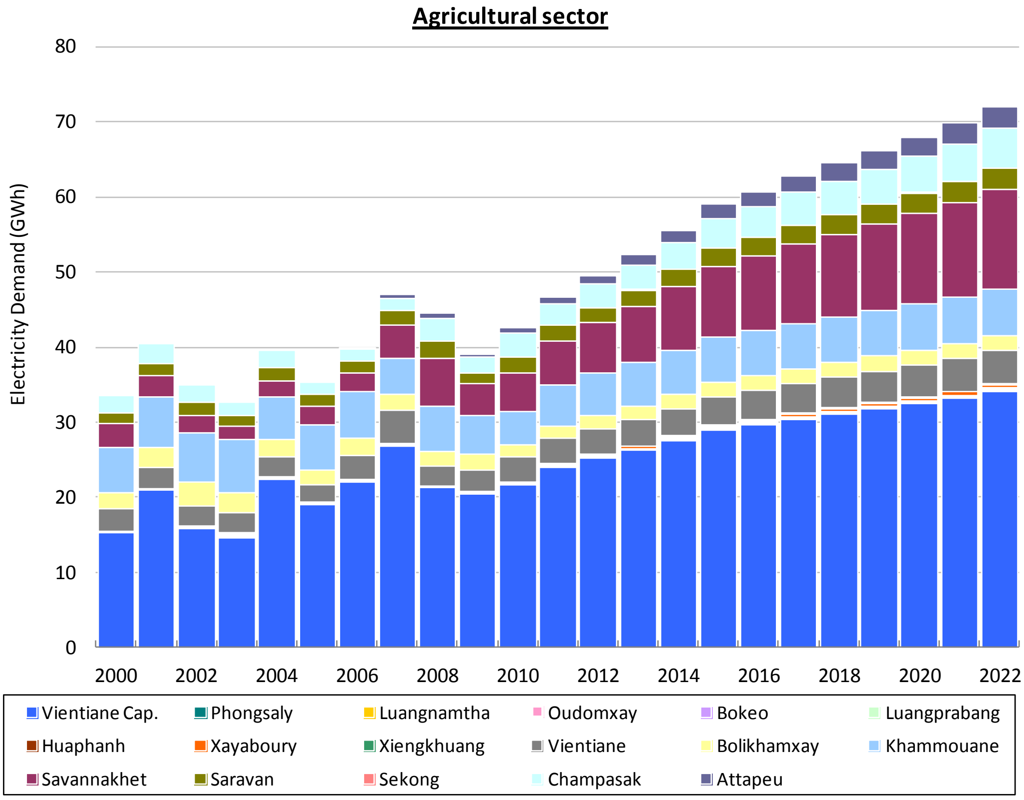


(Unit:GWh)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
CAP	71	69	76	73	93	105	117	135	189	209	275	304	366	462	614	804	923	1,105	1,212	1,369	1,566	1,700	1,875
PHO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	74	101	143	160	188	192	196
LNA	0	0	0	0	0	0	1	0	0	1	1	1	1	2	18	34	66	82	109	112	115	118	121
OUD	0	0	0	0	0	1	1	1	1	1	2	2	2	20	49	121	181	198	228	258	263	269	275
BOK	0	0	0	0	0	0	1	1	1	2	2	2	2	15	34	47	66	97	129	132	135	139	142
LPR	1	1	1	1	1	3	7	9	10	10	12	14	30	55	83	128	157	164	172	180	189	199	209
HUA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
XAY	0	0	1	1	2	4	6	7	7	9	11	12	13	15	18	21	40	74	94	113	144	202	259
XIE	0	0	0	0	2	3	3	3	2	2	2	2	2	3	38	138	235	309	369	441	446	452	457
VIE	15	17	34	46	50	50	47	63	53	56	58	60	314	384	482	572	815	849	898	928	936	946	954
BOR	1	2	2	5	9	10	13	13	15	14	22	23	26	30	36	42	47	53	60	68	76	86	95
KHA	23	20	17	22	21	17	15	19	331	31	50	42	85	92	100	293	413	517	555	599	619	641	661
SAV	13	9	16	17	19	23	25	26	59	389	229	157	133	134	148	171	195	221	251	285	324	368	411
SAR	2	2	3	4	4	4	6	11	6	6	7	7	29	48	62	76	99	122	125	129	132	137	140
SEK	0	0	0	0	0	0	0	1	1	2	2	3	3	4	33	56	74	92	206	259	265	272	278
CHA	9	10	14	18	17	16	16	18	24	27	31	35	39	44	50	58	66	74	84	94	106	119	133
ATT	0	0	0	0	0	0	1	2	2	2	3	4	4	5	6	7	9	10	11	13	15	17	19
Total	135	130	164	189	219	237	258	309	703	760	707	668	1,051	1,313	1,771	2,601	3,460	4,070	4,646	5,139	5,520	5,856	6,228

(Source) Study Team.

Figure 4-10: Electricity demand by province in Industry
(Industry 1+ Industry 2- less than 50 MW) (–Default Case")



(Unit:GWh)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
CAP	15	21	16	15	22	19	22	27	21	20	22	24	25	26	28	29	30	30	31	32	33	33	34
PHO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LNA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OUD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BOK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LPR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HUA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
XAY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
XIE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VIE	3	3	3	3	3	2	3	4	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4
BOR	2	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
KHA	6	7	7	7	6	6	6	5	6	5	5	5	6	6	6	6	6	6	6	6	6	6	6
SAV	3	3	2	2	2	2	2	4	6	4	5	6	7	7	8	9	10	11	11	12	12	13	13
SAR	1	2	2	1	2	2	2	2	2	1	2	2	2	2	2	2	2	3	3	3	3	3	3
SEK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHA	2	3	2	2	2	2	2	2	3	2	3	3	3	3	4	4	4	4	4	5	5	5	5
ATT	0	0	0	0	0	0	0	0	1	0	1	1	1	1	2	2	2	2	2	2	3	3	3
Total	33	40	35	33	39	35	40	47	44	39	43	47	49	52	56	59	61	63	64	66	68	70	72

(Source) Study Team.

Figure 4-11: Electricity demand by province in Agricultural sector (–Default Case")

4.3 Generation plan

4.3.1 Revision of Power Development Plan

4.3.1.1 Generation Plan for 2012-2025

After formulating PDP 2010-2020 Revision-1 in August 2011, EDL is getting to work on a new power development plan that is planned as a revision of PDP 2010-2020 Revision-1. The planning period of new power development plan is from 2012 to 2025. The name of the new EDL-PDP can be assuned as ―Power Development Plan 2012-2025" (PDP 2012) in this report.

The preliminary work on new EDL-PDP has just started in summer of 2012, and the draft of generation development plan for the new EDL-PDP has just been settled and authorized in EDL in October 2012. The generation plan is listed in accordance with the latest plan on the EDL projects, IPP (d) projects and IPP (e) projects. The specifications of the projects and the commercial operation date (COD) have been revised from PDP 2010 Rev.-1 based on the latest information from EDL, MEM, relevant organizations and IPP developers. The generation plan formulated by EDL is attached as Appendix VII. Table 4-3 to Table 4-5 show the generation projects in the PDP 2012 classified by the development schemes.

Table 4-3: PDP 2012 generation plan (EDL & EDL Gen)

Projects	Ownership	Ins. Capacity (MW)	COD	Status
Xelabam	EDL-Gen	5	1969	Existing
Nam Dong	EDL	1	1970	Existing
Nam Ngum 1	EDL-Gen	155	1991	Existing
Xeset 1	EDL-Gen	45	1991	Existing
Nam Ko	EDL	1.5	1996	Existing
Nam Leuk	EDL-Gen	60	2000	Existing
Nam Ngay	EDL	1.2	2001	Existing
Nam Mang 3	EDL-Gen	40	2005	Existing
Xeset 2	EDL-Gen	76	2009	Existing
Nam Song (Extension)	EDL	6	2012	Existing
Xelabam (Extension)	EDL	7.7	2013	
Nam Sana	EDL	14	2014	
Nam Khan 2	EDL	130	2015	Under Construction
Houaylamphanh Ngai	EDL	88	2015	
Nam Boun 2	EDL	15	2015	
Nam Phak	EDL	30	2015	
Nam Khan 3	EDL	60	2016	
Nam Chiene	EDL	104	2016	
Nam Hinboun	EDL	30	2016	
Xeset 3	EDL	23	2016	
Kengseuaten	EDL	54	2016	
Nam Ngum 1 (Extension)	EDL	40	2017	
Nam Ngao	EDL	20	2018	
Xedon 2,3	EDL	20	2018	
Nam Ngum-Nam Ken	EDL	70	2020	
Small hydropower plants		40		
Solars		15		

(Source) Study Team based on PDP 2012-2025.

Table 4-4: PDP 2012 generation plan (IPP (d))

Projects	Ins. Capacity (MW)	COD	Status
Nam Lik 1/2	100	2010	Existing
Nam Nhone	3	2011	Existing
Nam Tha 3	1.2	2011	Existing
Nam Phao	1.7	2011	Existing
Nam Ngum 5	120	2012	Existing
Nam Gnuang 8	60	2012	Existing
Nam Long	5	2013	Under Construction
Nam Sim	8	2013	
Nam Ngiep 3A	40	2013	
Tadsalen	3.2	2013	Under Construction
Xenamnoy 1	15	2013	
Nam Kong 2	66	2014	
Nam Ham 2	5	2014	
Nam Kong 3	45	2014	
Nam Pha Gnai	15	2014	
Houay Kaphea 2	5	2014	
Nam Ngiep 2	180	2015	
Nam Lik 1	60	2015	
Nam Beng	34	2015	
Nam Mang 1	64	2015	
Nam Tha 1	168	2015	
Nam Xam 1	94	2015	
Nam Xam 3	196	2015	
Nam Bak 1	163	2015	Transfer to EDL after construction
Nam Bak 2	40-45	2015	Transfer to EDL after construction
Nam Phouan	52.5	2015	
Sepon 3	54.4	2015	
Nam Samouay	5	2015	
Houay Pou	9	2015	
Houay Champi	5	2015	
Nam Phak	140	2016	
Nam Phai	86	2016	
Xe Bang Hieng 2A (Tad Sakhoy)	12.5	2016	
Houy Por 1	9.5	2016	
Nam Ou 2	120	2017	
Nam Ou 5	240	2017	
Nam Ou 6	180	2017	
Nam Pha	130	2017	
Nam Phoun	50	2017	
Nam Pot	14.5	2017	
Nam Seung 2	96	2018	
Xeneua	53	2018	
Nam Ngiep Meungmai	25	2018	
Nam Mo 1 (Nam Kanh)	55	2018	
Xe Lanong 1	60	2018	
Nam San 3A,3B	91	2018	
Nam Ou 1	160	2018	
Nam Ou 3	150	2018	
Nam Ou 4	116	2018	
Nam Ou 7	190	2018	
Xe Lanong 2	45	2018	
M Kalum (Lignite)	300	2018	

Projects	Ins. Capacity (MW)	COD	Status
Nam Kene	5	2018	
Don Sahong (Mekong)	240	2020	
Nam Kong 1	75	2020	
Lathseua (Mekong)	651	2020	
Xekaman 4	80	2020	
Sekong 3A (Upper)	105	2020	
Sekong 3B (Lower)	100	2020	
Thakho (Mekong)	50	2020	
Nam Neun	65	2020	
Sekong (Downstream)	76	2020	
Xexou	59	2020	
Nam Leng	50	2020	
Nam Nga	80	2020	
Xe Bang Hieng 1	50	2020	
Nam Ngum (Down)	60	2020	
Nam Feung 3	20	2021	
Nam Feung 2	25	2021	
Nam Feung 1	28	2022	
Nam Ang Tabeng	25	2022	
Xekatam	61.6	-	
Nam Seung 1	42	-	
Nam Pouy	60	-	

(Source) Study Team based on PDP 2012-2025.

Table 4-5: PDP 2012 generation plan (Off-take from IPP (e))

Projects	Installed Capacity (MW)	Domestic Supply (MW)	COD	Status
Houay Ho	152	2	1999	Existing
Nam Theun 2	1,088	75	2009	Existing
Xekaman 3	250	25	2012	Under Construction
Xekaman 1+Xanxai	290	64	2014	Under Construction
Hongsa (Lignite)	1,878	100	2015	Under Construction
Xepiane Houay Soy	115	11.6	2016	
Nam Ngiep 1	272	22	2018	
Xepian-Xenamnoy	390	40	2018	
Nam Mouan	124	30	2018	
Nam Theun 1	523	50	2019	
Xayabouly (Mekong)	1,285	60	2020	
Sekong 4	300	60	2020	
Sekong 5	330	190	2020	
Pak Beng (Mekong)	921	150	2020	
Sanakham (Mekong)	660	200	2020	
Paklai (Mekong)	1,320	132	2020	
Luang Prabang (Mekong)	1,200	114	2020	
Dak E Men	130	0	2020	
Bankoum (Mekong)	1,872	187.2	2020	
Nam Ngum 4	220	33	2020	
Nam Ma 1,2,3,4,5	149	22.4	2020	
Nam Et 1,2,3	420	60	2020	
Xebang Nouane 2	80	45	2021	
Nam Mo	120	15.5	—	

(Source) Study Team based on PDP 2012-2025.

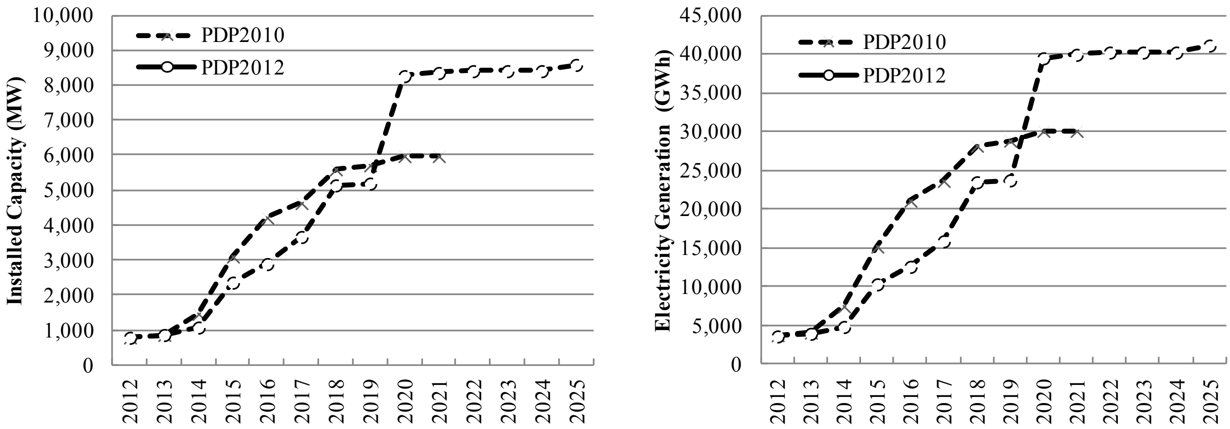
Table 4-6 shows the installed capacity and electricity generation listed in PDP 2010 Rev.-1 and PDP 2012. In PDP 2012, as a result of revising the project development, the total amount of the capacity and generation from 2012 to 2019 is less than the current EDL-PDP (PDP 2010 Rev.-1). From 2014 to 2017 especially, the supply capacity is at most 30% smaller than the current EDL-PDP and the electricity generation is 40% less in 2016. In PDP 2012, quite a large number of the projects are planned to be developed in 2020. As a result, the supply capacity and power generation for domestic supply in 2021 is 30% to 40% larger than the current EDL-PDP.

Table 4-6: Change of generation development plan in PDP 2012

Year	Installed Capacity (MW)			Generation (GWh)		
	PDP 2010 (a)	PDP 2012 (b)	(b)/(a)	PDP 2010 (c)	PDP 2012 (d)	(d)/(c)
2012	786	779	99%	3,703	3,563	96%
2013	859	858	100%	4,046	3,899	96%
2014	1,461	1,072	73%	7,436	4,786	64%
2015	3,102	2,356	76%	15,152	10,286	68%
2016	4,215	2,887	69%	21,081	12,547	60%
2017	4,631	3,662	79%	23,625	15,838	67%
2018	5,597	5,140	92%	28,168	23,460	83%
2019	5,712	5,190	91%	28,829	23,710	82%
2020	5,976	8,265	138%	30,088	39,465	131%
2021	5,976	8,355	140%	30,088	39,917	133%
2022		8,408			40,206	
2023		8,408			40,206	
2024		8,408			40,206	
2025		8,408			40,206	

(Source) Study Team based on PDP 2010 Rev.-1 and PDP 2012.

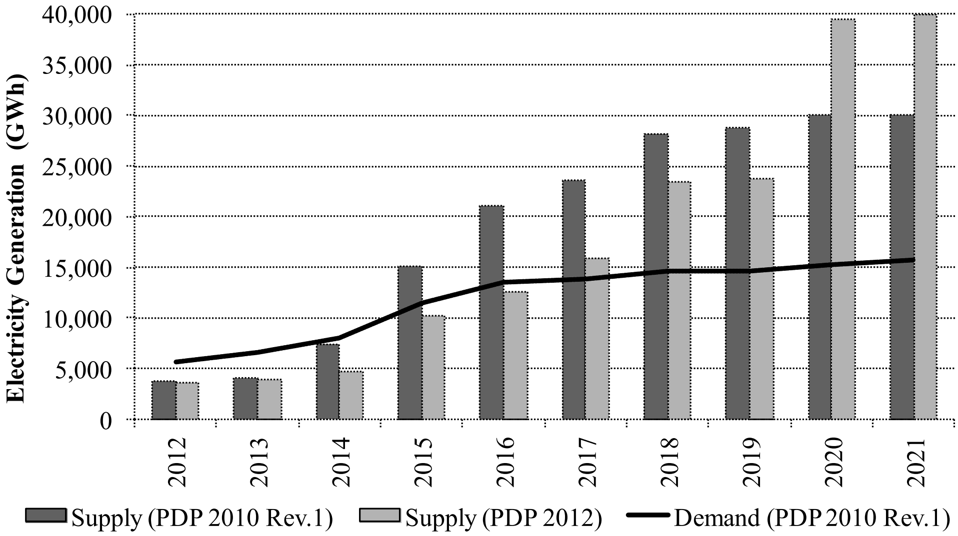
Figure 4-12 shows the comparison of power development plans. In PDP 2012, it is planned to develop more than 3,000 MW in the year of 2020, and total supply capacity in 2020 reaches to about 8,000 MW. However, only a few power developments after 2021 are considered in PDP 2012. From 2021 to 2025, only five projects with the total supply capacity of 143 MW are listed in PDP 2012.



(Source) Study Team based on PDP 2010 Rev.-1 and PDP 2012.

Figure 4-12: Comparison of power development of PDP 2010 Rev.-1 and PDP 2012

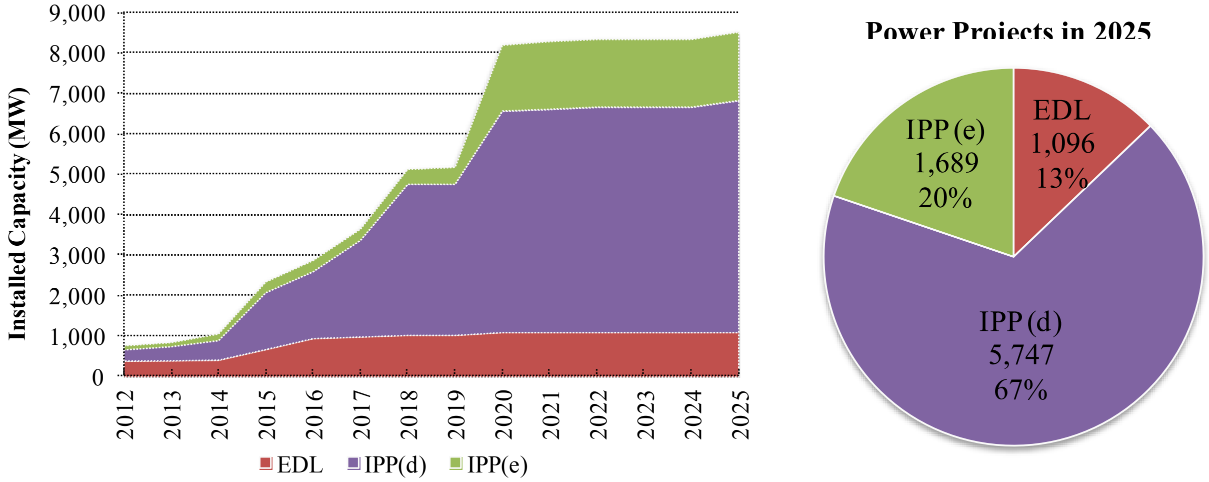
Figure 4-13 shows the power supply in PDP 2010 Rev.-1 and PDP 2012 comparing to the power demand by 2021. This figure shows the power supply to the domestic system from EDL, EDL-Gen, IPP (d) and EDL's off-take from IPP (e) power stations. The dotted-line is a domestic demand predicted in PDP 2010 Rev.-1. In PDP 2010 Rev.-1, the shortage of power supply to the domestic market will be resolved by 2015 as a result of the power development in 2014 and 2015. However, in the new EDL-PDP (PDP 2012), a supply shortage for the domestic system will continue after 2015 due to the reassessment of the power development schedule. Power supply will be surpassing the electricity demand in 2017, which means that the electricity import to domestic power system from neighboring countries will be exceeding the electricity export from the EDL system by 2016. If the power projects in PDP 2012 are developed as scheduled, the total power supply in 2020 will be nearly threefold to the domestic demand. The surplus electricity amounts to 25 GWh which can be exported to the neighboring countries.



(Source) Study Team based on PDP 2010 Rev.-1 and PDP 2012.

Figure 4-13: Electricity demand and power supply up to 2021

Figure 4-14 shows the power development in PDP 2012 by development schemes; EDL (EDL and EDL-Gen), IPP (d) and off-take from IPP (e). The composition of the development in new EDL-PDP is almost same as that of the current EDL-PDP. Most of the development is heavily dependent on the private investment by IPP schemes. In the new EDL-PDP, it is planned to develop about 7,800 MW of power projects in the planning horizon. The power development by EDL is about 700 MW which accounts for less than 10% of the total power development in the planning period. The share of EDL and EDL-Gen power supply will decrease to 13% of the total supply of the domestic system in 2025.



(Source) Study Team based on PDP 2012.

Figure 4-14: Power development by development schemes

Table 4-7 and Table 4-8 show the modification of the project development scheme and schedule from PDP 2010 Rev.-1 to PDP 2012. As shown in Table 4-7, 15 projects are converted their development scheme from IPP (e) to IPP (d), and change the electricity supply destination to domestic demand. The total capacity of the converted projects sums up to about 1,700 MW. According to information from DEPP, the Lao Government is putting effort to convert IPP (e) project to IPP (d) to secure the domestic power supply to the rapid growing industrial demand especially the demand of the mining sector. Four projects, Nam Bak 1, Nam Bak 2, Xedon 2 and Xedon 3 that were planned to be developed by IPP scheme will be developed as EDL projects. Xedon 2 and Xedon 3 will be constructed by IPP (d) scheme invested by a Chinese developer. However, after the completion of the construction, these power plants will be transferred to EDL. These are developed by a so-called Built-Transfer (BT) scheme, following Xeset 2, Nam Khan 2 and Nam Khan 3. According to DEPP, BT scheme was adopted to Xedon 2 and Xedon 3 under an exceptional circumstance, and will not be applied to other projects.

Table 4-7: Change of development scheme in PDP 2012

Project Name	Capacity (MW)	Ownership		COD	
		PDP 2010	PDP 2012	PDP 2010	PDP 2012
Nam Xam 1	94	IPP (e)	IPP (d)	2016	2015
Nam Bak 1	163	IPP (d)	EDL	2015	2015
Nam Bak 2	40-45	IPP (d)	EDL	2015	2015
Nam Xam 3	196	-- *1	IPP (d)	--	2015
Nam Phoun	50	-- *1	IPP (d)	--	2017
Xedon 2,3	20	IPP (d)	EDL*2	2018	2018
Nam Ngiep Meungmai	25	-- *1	IPP (d)	--	2018
Nam Mo 1 (Nam Kanh)	55	-- *1	IPP (d)	--	2018
Nam Kong 1	75	-- *1	IPP (d)	--	2020
Lathseua (Mekong)	651	-- *1	IPP (d)	--	2020
Xekaman 4	80	-- *1	IPP (d)	--	2020
Sekong 3A (Upper)	105	-- *1	IPP (d)	--	2020
Sekong 3B (Lower)	100	-- *1	IPP (d)	--	2020
Nam Neun	65	-- *1	IPP (d)	--	2020
Sekong (Downstream)	76	-- *1	IPP (d)	--	2020
Nam Feung 1	28	-- *1	IPP (d)	--	2022
Nam Ang Tabeng	25	-- *1	IPP (d)	--	2022
Nam Pouy	60	-- *1	IPP (d)	--	
IPP(e) → IPP(d)	1,685				
IPP(d) → EDL	183				

Notes: *1: Planned as an IPP(e) project, therefore not listed in PDP 2010.
*2: Constructed as IPP (d) and will be transferred to EDL after construction completed.
(Source) Study Team based on PDP 2010 Rev.-1 and PDP 2012.

Table 4-8 shows the projects of which scheduled start operation date are modified in the new EDL-PDP. COD of 26 projects are postponed for one to four years due to the delay of development. As a result of the delay of development, the supply capacity to domestic demand decreases by 30% to 40% in the middle of 2010 from the current development plan.

Table 4-8: Change of development schedule in PDP 2012

Project Name	Capacity (MW)	Ownership	COD		Remarks
			PDP 2010	PDP 2012	
Nam Sim	8	IPP (d)	2015	2013	
Nam Kong 2	66	IPP (d)	2015	2014	
Nam Ham 2	5	IPP (d)	2013	2014	Delay
Nam Kong 3	45	IPP (d)	2015	2014	
Houaylamphanh Ngai	88	EDL	2014	2015	Delay
Nam Boun 2	15	EDL	2014	2015	Delay
Nam Lik 1	60	IPP (d)	2014	2015	Delay
Nam Tha 1	168	IPP (d)	2016	2015	
Houay Champi	5	IPP (d)	2014	2015	Delay
Nam Chiene	104	EDL	2015	2016	Delay
Xeset 3	23	EDL	2013	2016	Delay
Nam Phai	86	IPP (d)	2015	2016	Delay
Nam Ngum 1 (Extension)	40	EDL	2014	2017	Delay
Nam Ou 2	120	IPP (d)	2016	2017	Delay
Nam Ou 5	240	IPP (d)	2016	2017	Delay
Nam Ou 6	180	IPP (d)	2016	2017	Delay
Nam Pha	130	IPP (d)	2015	2017	Delay
Nam Pot	15	IPP (d)	2015	2017	Delay
Nam Seung 2	96	IPP (d)	2017	2018	Delay
M Kalum (Lignite)	300	IPP (d)	2014	2018	Delay
Nam Kene	5	IPP (d)	2014	2018	Delay
Xepian-Xenamnoy	40	IPP (e)	2016	2018	Delay
Don Sahong (Mekong)	240	IPP (d)	2017	2020	Delay
Thakho (Mekong)	50	IPP (d)	2016	2020	Delay
Xe Bang Hieng 1	50	IPP (d)	2019	2020	Delay
Nam Ngum (Down)	60	IPP (d)	2018	2020	Delay
Xayabouly (Mekong)	60	IPP (e)	2019	2020	Delay
Sekong 4	60	IPP (e)	2016	2020	Delay
Xekatam	61.6	IPP (d)	2017	*TBD*	
Nam Seung 1	42	IPP (d)	2017	*TBD*	

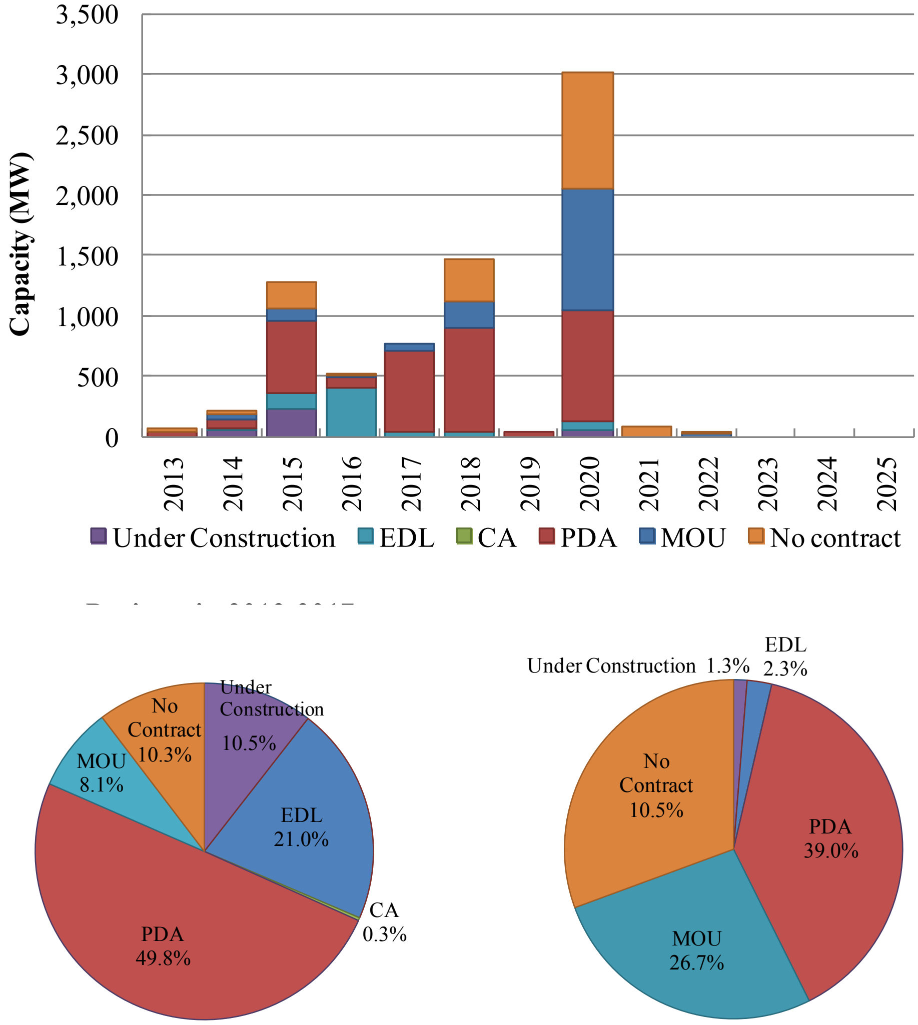
(Source) Study Team based on PDP 2012.

In PDP 2012, 39 projects are newly assigned as a power supply to the domestic demand. The total capacity of newly assigned projects is 1,340 MW by 2021.

4.3.1.2 Current status of generation development project

EDL is able to get the control of the development of projects owned by EDL itself and EDL-Gen. As for the IPP projects, GOL and EDL can exert an influence to some extent on the development of IPP projects through MOU/PDA/CA and PPA negotiation with the developers. For example, it is not so difficult for GOL and EDL to make the project delay by means of negotiation on MOU/PDA/CA or PPA. However, it needs to build a certain mechanism to keep and accelerate the schedule of IPP development.

As is shown in the previous section, the COD planned in PDP 2010 Rev.-1 is re-examined in PDP 2012 for quite a number of projects. Among the generation project in PDP 2012, quite a few projects still seem to be fraught with uncertainties about the development schedule. Figure 4-15 shows the progress of projects listed in PDP 2012. Some projects which are planned to be completed over the next five years are still on the planning or MOU stage. This is more conspicuous for the projects planned in the latter half of the planning period after 2018. Some projects show no progress in the process of agreement or FS approval in the past several years. The uncertainty of the project development is still important issue in the new EDL-PDP which should be fully considered.



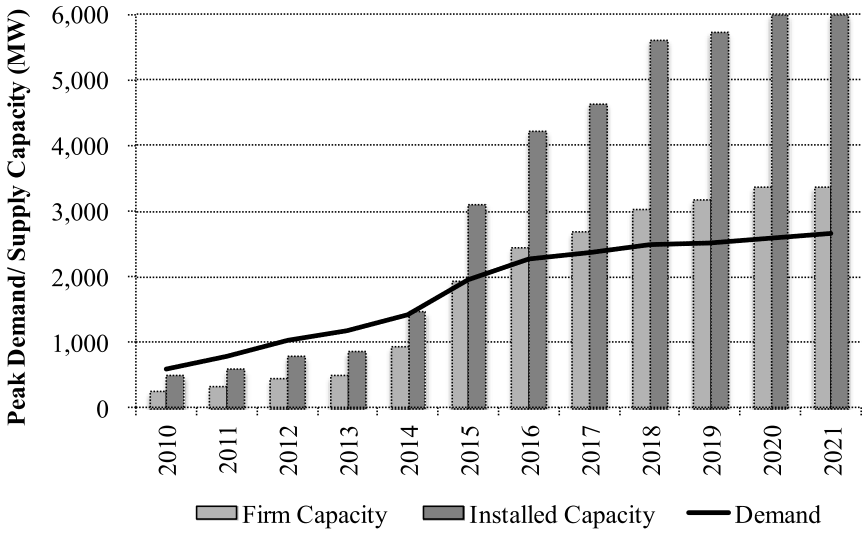
(Source) Study Team base on PDP 2012.

Figure 4-15: Progress of projects listed in PDP 2012

4.3.1.3 Generation plan for monthly demand/supply analysis

(1) Improvement of demand/supply analysis

In the current power development plan (PDP 2010 Rev.-1), the demand/supply balance is examined on a yearly basis; i.e., calculates the balance of annual electricity demand and annual electricity generation for the year from 2010 to 2021. Power balance of the system, i.e., the peak electricity demand and supply capacity is evaluated by the installed capacity of the power station. The power balance for the whole country is positive after 2015 in PDP 2010 Rev.-1 as a result of the power development mainly in the northern system.



(Source) Study Team base on PDP 2010 Rev.-1.

Figure 4-16: Progress of projects listed in PDP 2010 Rev.-1

All the power stations in Laos except proposed Hongsa Lignite thermal power and Kaluem Lignite thermal power are hydropower stations. Therefore, the supply capacity varies by the discharge of the river. In dry season, as the river flow decreased, the output of the hydropower station is much lower than its installed capacity. To ensure the supply from domestic power stations, the seasonal deviation of power output from the hydropower stations should be considered to ensure the supply capacity in dry season.

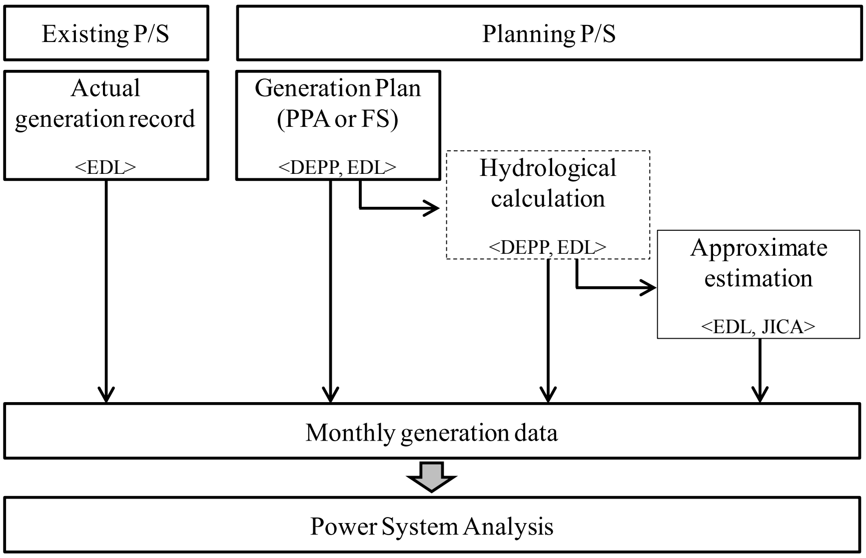
In the next EDL-PDP (PDP 2012), it is planned to consider the monthly demand and supply capacity in the demand/supply calculation. In this section, the Study Team prepares the monthly generation capacity and electricity generation to be utilized in the demand/supply calculation and system analysis.

(2) Monthly generation for demand/supply analysis

The monthly supply capacity and generation for each power station has not been organized in a methodical manner. Therefore, at the beginning of the monthly demand/supply analysis, monthly generation for existing and planning power stations should be estimated properly. Electricity supply from Hongsa and Kaleum thermal power stations can be estimated according to the planned plant factor for each power station. On the other hand, electricity supply from hydro power stations should be estimated taking the seasonal output deviation in consideration. In order to make the power development plan more precise and reliable, the monthly supply capacity and electricity generation should be calculated based on the discharge of the river and the operation of the reservoir. These data should be collected from EDL and developers of IPP projects in the new EDL-PDP.

In case monthly supply capacity and generation of proposed IPP projects cannot obtain from the developers, these data can be estimated from the hydrological and meteorological data measured by GOL. The output of hydropower station can be calculated from the inflow of the river and reservoir operation. These input data can be estimated by hydrological data such as rainfall and river discharge at the gauging and meteorological stations.

The EDL Power Research Development Office has got to work on the estimation of monthly generation on proposed hydropower projects listed in PDP 2012. The result of the estimation will be submitted to DEPP and shared among the relevant organizations. MEM also started the study on the estimation of the power generation of hydropower stations under the support from the World Bank. The consultant will begin to build the simulation program for calculating the electricity generation for all the power stations in Laos from this June.



(Source) Study Team.

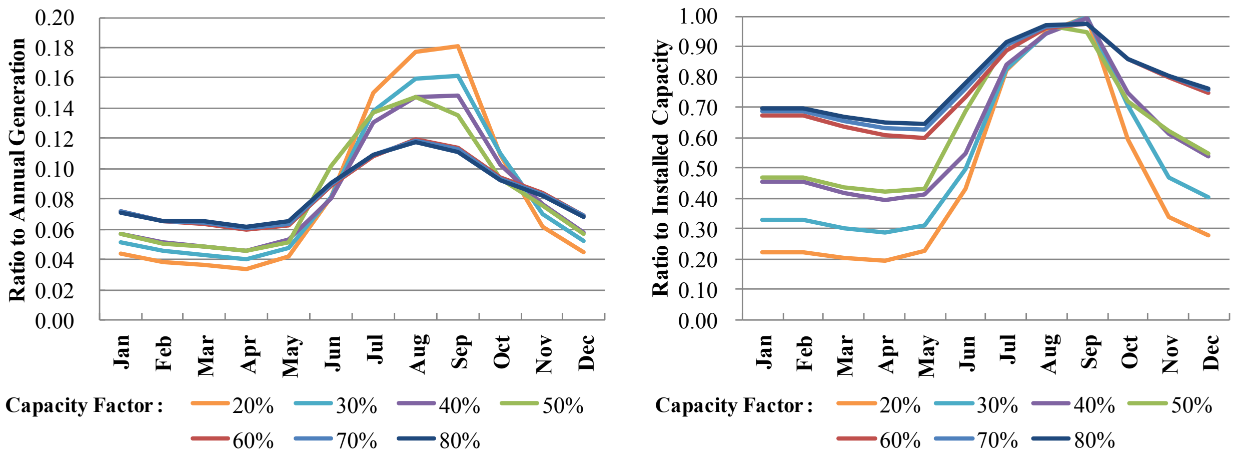
Figure 4-17: Preparation of monthly generation data

At present, data of monthly supply capacity and generation is not disclosed in the feasibility study report for most of the IPP projects, therefore in this study, monthly generation data for hydropower stations are estimated in the following method. This methodology was applied in the latest JICA study: ―Study on Power Supply and Demand in Central Region in Lao PDR" (Aug. 2012). The monthly supply capacity and generation are estimated by the following three methods according to the availability of generation data.

a) Existing power station
   Monthly supply capacity and generation is estimated from the operation record of each hydropower station.

b) Proposed power station (monthly supply plan is indicated in PPA or F/S report)
   Monthly supply capacity and generation indicated in PPA or F/S report are adopted.

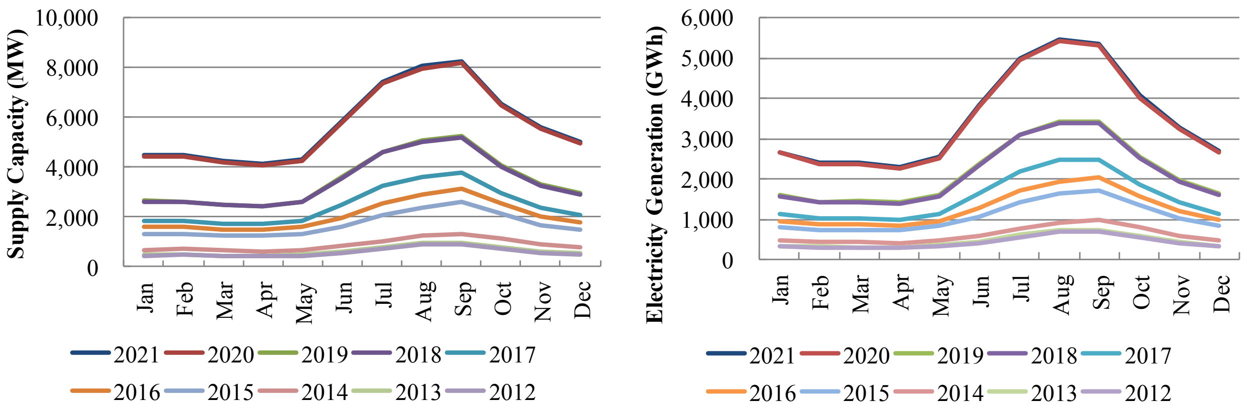
c) Proposed power station (monthly supply plan is not available)
   Monthly supply capacity and generation are calculated from the plant factor of each hydropower plant based on the methodology applied in the latest JICA study. The monthly supply capacity is estimated as a ratio to the installed capacity and the monthly generation as a ratio to the annual generation for each month as shown in Figure 4-18.



(Source) Study on Power Supply and Demand in Central Region in Lao PDR (Aug. 2012)

Figure 4-18: Ratio of monthly supply capacity and generation

The total supply for domestic demand for each year is shown in Figure 4-19. In 2021, the total installed capacity of the power stations for the domestic supply in Laos reaches about 8,000 MW, however the supply capacity in dry season from December to May is around 4,000 MW which is almost half of the installed capacity. The electricity generation in dry season shows the same trend of the supply capacity. The annual generation is planned to be 41 TWh in the year of 2021. Monthly generation in August is 5,400 GWh, however, that in April is less than 2,300 GWh.



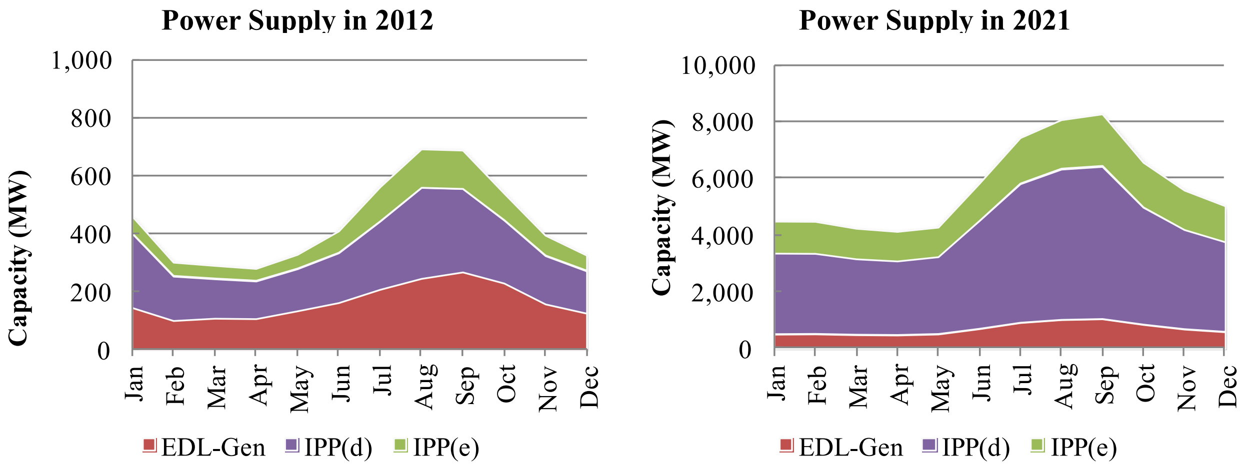
(Source) Study Team.

Figure 4-19: Monthly supply capacity and generation

In this study, electricity supply/demand calculation and power system analysis are conducted based on the generation data of existing and proposed power stations estimated by the methodologies above. The accuracy of these monthly generation data should be improved by collecting individual generation data of the proposed projects. EDL and EDL-Gen can estimate the monthly generation data of their future projects by themselves. The generation data for IPP (d) and IPP (e) should be submitted to EDL and MEM from the developers at the early stage of the feasibility study.

(3) Fluctuation of power supply

As described in the previous section, more than 80% of the power development in the EDL-PDP depends on the private investors by means of the IPP scheme. At present, most of the power stations in Laos are operated by EDL and EDL-Gen which are operators of the power system. The monthly and daily power fluctuations in the system are controlled by the system operator, i.e., EDL, by regulating and controlling the output of the power stations owned by EDL and EDL-Gen. However, in 2020, the constitution of the power supply drastically changes from the current situation. As shown in Figure 4-20, the proportion of the power generation supplied by EDL and EDL-Gen power stations decreased less than 20% of the total power supply. Power supply from IPP (d) and IPP (e) shares a considerable part of the power supply in 2020. Basically, the contract of the power off-take from IPP (e) power stations is ―take or pay" conditions, therefore the supply to the EDL system from IPP (e) power stations is constant and difficult to control to meet the power demand deviation in EDL‘s power system. In 2020, to manage the domestic power system effectively and efficiently, the availability to control the power output from IPP (d) power stations is crucial to stabilize the EDL‘s power system.



(Source) Study Team based on PDP 2010 Rev.-1.

Figure 4-20: Supply capacity by developers

In the following demand-supply estimation and power system analysis in the following section, the monthly power supply and generation calculated in this section will be adopted.

4.3.2 Enhance reliability of generation planning

4.3.2.1 Enhancement of generation planning

The power development in Laos is the most important fundamental policy to achieve the socio economic development. It is described in the seventh NSEDP that ―Development in the power sector is focused on using, developing, and expanding hydro sources, coal and renewable energy", ―to meet the twin objectives of supplying electricity domestically for the country‘s development, and export." It is crucial for Laos to achieve the economic growth by ensuring the electricity supply to the domestic industries such as the mining sector and industrial sector, and by generating income from the electricity export simultaneously.

As mentioned in the previous section, the development of power sources in the EDL-PDP is heavily dependent on IPP schemes both for domestic supply and power export. In order to achieve the target of the economic growth in NSEDP by ensuring the electricity supply to domestic industries and export, management of the power development, especially the development of IPP projects is one of the most significant roles of the Government of Laos. To accomplish the objectives of the ministry, MEM is required to perform its role on the policy challenges by the measures as follows;

- Control and enhance the IPP power development executed by private investor through policy measures.
- Collect and analyze the precise information on individual IPP project.
- Exchange and share the information with relevant ministries and agencies (including EDL and EDL-Gen).
- Establish the inter-organ structure to manage the power development.

The perspectives of the framework are detailed in the next section. With these issues in mind, the Study Team focuses on the second and third measures in this section with the aim of enhancement of the management of the EDL-PDP.

4.3.2.2 Compilation of project data

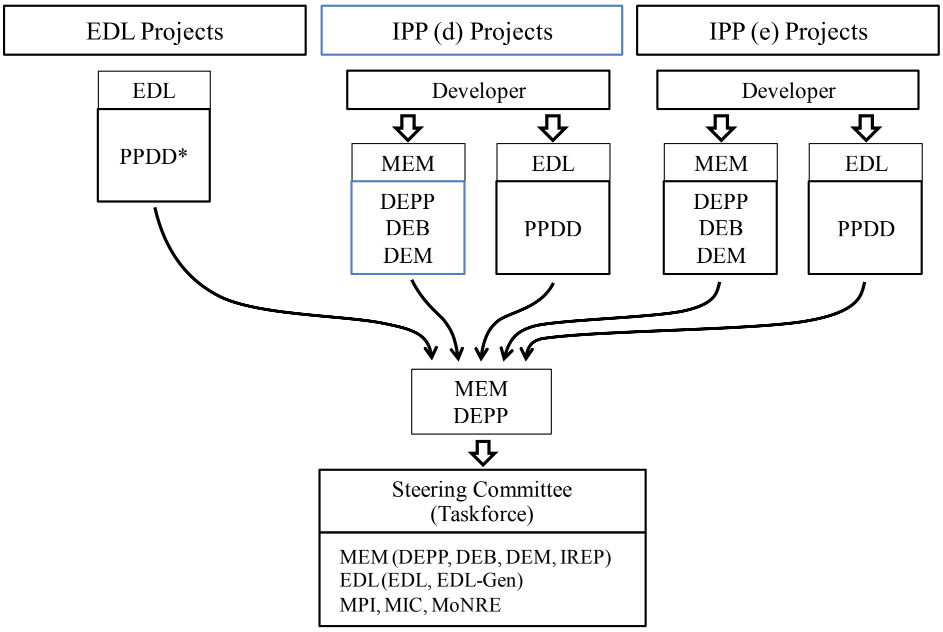
Power development plan and generation planning are formulated to achieve the specific objectives. In case of the EDL-PDP, the aim of the generation plan should be supplying electricity;

- to every person and industry in Laos.
- sufficiently to the domestic demand
- efficiently and effectively at the least cost

In order to accomplish these objectives, DEPP should collect and analyze data indispensable for the project management and policy decision making. Project data should be collected and compiled by the ministries and agencies concerned. For example, technical data of the project is collected by DEPP itself. Other project data is to be collected by;

- Generation data and reservoir operation data for EDL and EDL-Gen projects from DEPP.
- Construction cost, generation cost and tariff data from IPP developers through DEB and EDL.
- Natural and social environmental impact data from DEPP and NMRE.
- Progress of negotiation on MOU/PDA/CA from DEB.
- Progress of the construction from DEM.

These data compiled by DEPP as a database of the EDL-PDP project are utilized in the initial process of the formulation of the EDL-PDP to share the common perception of the generation planning among the related organizations. This database can be utilized for the discussion on National PDP.



* PPDD: Power Plant Development Department.
(Source) Study Team.

Figure 4-21: Compilation of project information

Table 4-9 shows the examples of the items compiled for the database. DEPP and JICA Team reached the common understanding on the necessity of the database, and started the data collection. The database of the projects will be utilized as a fundamental data for the Work Team meeting organized by DEPP.

Table 4-9: Template of project database (example)

Specification of the Project

PJ No.	Project Name	Area	Province	Owner	COD	Installed Capacity (MW)	Export Capacity (MW)	Domestic Capacity (MW)	Firm Capacity (MW)	Energy (GWh p.a.)	Plant Factor (%)
023LS	Xelabam (Extension)	Southern	Champasak	EDL	2013	7.7	0.0	7.7	3.1	37.1	55%
024DN	Nam Long	Northern	Luangnamtha	IPP(d)	2013	5.0	0.0	5.0	0.0	30.0	84%

Peak Generation Capacity

PJ No.	Project Name	Reservoir Capacity (MCM)	Annual Inflow (MCM)	Regulating Ratio	Maximum Discharge (m3/s)	Reguration Type	Peak supply Capacity
023LS	Xelabam (Extension)					Run off river	no
024DN	Nam Long					Weekly	yes

Status of Progress

PJ No.	Project Name	Status Contract	Status Technical	MOU	PDA	CA	FS Approval	Tariff MOU	PPA
045DN	Nam Xam 1	PDA	Interim	20/03/2008	19/09/2011		I(27/1/2010)		
054EN	Hongsa	UC	UC		19/12/2008	03/11/2010	12/10/2010		

Cost and Tariff

PJ No.	Project Name	Project Cost		Generation Cost			Tariff	
		Incl. IDC (MUSD)	Excl. IDC (MUSD)	Project Cost per kW (USD/kW)	Project Cost per kWh (cents/kWh)	Generation Cost (cents/kWh)	Initial Tariff(DEB) (cents/kWh)	Levelized Tariff(EDL) (cents/kWh)
021ES	Xekaman 3	273					3.99	4.31
022EC	Theun Hinboun (Ex)	498					4.63	5

(Source) Study Team.

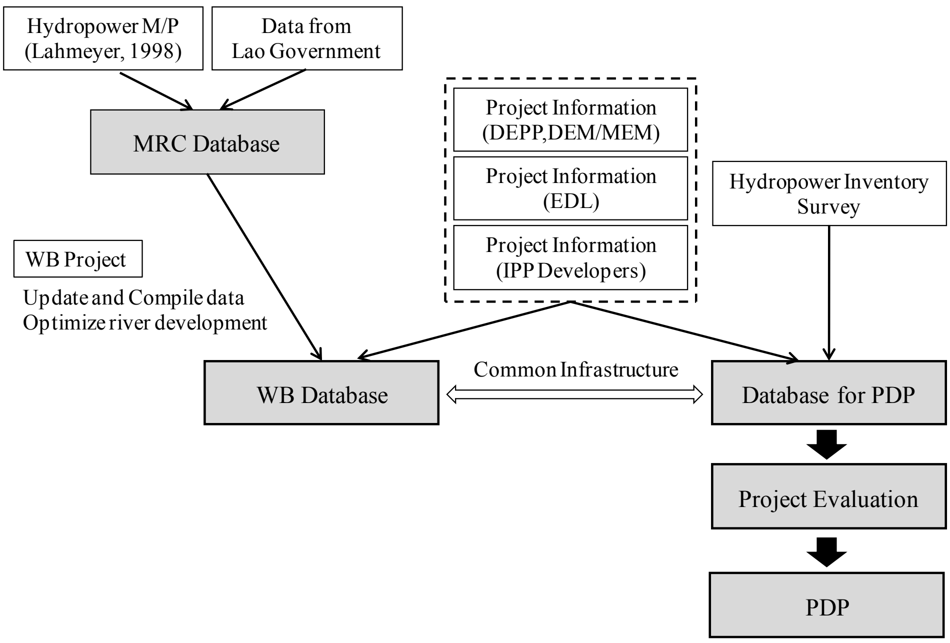
The database will be utilized to share the comprehensive information about the projects within the relevant organization, and to execute the evaluation of these projects. Taking the objectives of the database into account, the project database can be in the simple structure such as a MS Excel based database at the initial stage of the data collection. However, in the next step, it is better to formulate and manage the database in a more effective and efficient manner by applying some database structures. The tools and database to manage the hydropower resources are just planned to be developed by a World Bank project. The database developed in this project (WB/DB) can be best for the information infrastructure for project database for PDP. The general features of the planned WB/DB are shown in the following table.

Table 4-10: Project database structure

Item	Content
Database software	SQL and GIS
Listed projects	All the hydropower stations in Laos (Existing, UC/CA/PDA/MOU, Potential)
Contents of Database	Project data on − Geographical data − Hydrological data − Project Specification − Generation record − Environmental impact − Construction cost, Environmental cost , etc.
Tools	Estimate the generation Optimize the river basin development

(Source) Study Team.

WB/DB are planned to be managed by DEPP/MEM. Therefore, after completing the WB project on WB/DB, the project data collected for PDP can be integrated with the WB/DB, and updated and managed by DEPP/MEM, and shared with the relevant ministry and organizations.



(Source) Study Team.

Figure 4-22: Project database

4.3.2.3 Evaluation of project

(1) Methodologies of evaluation

Based on the project data collected and compiled, each project will be evaluated from the economic and environmental viewpoint so as to make the EDL-PDP more economical, effective and persuasive. The result of the evaluation should not be fully adopted to the project list in the EDL-PDP, however this evaluation can be the fundamental comprehension about the proposed project in order to start the EDL-PDP discussion among the stakeholders.

In this section, some basic concepts of the project evaluation methodologies are introduced. However, discussions on the methodologies should be taken place within MEM and with the relevant ministries and agencies.

(2) Evaluation criteria

The evaluation criteria should include economic and technical aspects such as development cost, environmental aspects such as impacts on protected area, and social aspects such as resettlement and compensation. The criteria applied to the estimation of the EDL-PDP project should be discussed and selected by relevant organizations and stakeholders at the Steering Committee of the National PDP. The evaluation criteria would be consistent with both development policy on electricity and strategic environmental assessment of Laos. Table 4-11 shows the example of the evaluation criteria of the EDL-PDP project. These items are only a draft for discussion and should be examined in depth within the relevant organization at the first stage of the evaluation.

Table 4-11: Evaluation items (draft)

Classification	Segment	Evaluation Items
Technical	Effectiveness	Installed Capacity (MW)
		Firm Capacity (MW)
		Annual Generation (GWh)
		Supply Capacity in Dry Season (MW)
		Supply Capacity for Daily Peak Demand (MW)
	Obstacles	Conflict with other projects (ex. Other Power Project, Mining, Infrastructure, etc.)
Economic	Cost	Project Cost (MUSD)
		Unit Construction Cost (USD/kW)
		Unit Construction Cost (cents/kWh)
		Generation Cost (cents/kWh)
	Tariff	Tariff (cents/kWh)
	Feasibility	Project IRR (%)
Environment	Natural Environment	Impact on Protected Area (ha)
		Impact on Endangered Species (Qualitative evaluation)
		Impact on Forest (ditto)
		Impact on Fish and Aquatic Organism (ditto)
		Improvement of Natural Environment (ditto)
		Other Significant Positive/Negative Impact on Natural Environment (Qualitative evaluation)
	Social Environment	Number of Resettlement (households)
		Reservoir Submerged Area (ha)
		Improvement of Social Environment (Qualitative evaluation)
		Other Significant Positive/Negative Impact on Social Environment (Qualitative evaluation)
Construction		Construction Period (years)
		Access Road (km)
		Transmission Line (km)

(Source) Study Team.

(3) Evaluation

Projects in the EDL-PDP are evaluated by relative valuation such as ―A to E" by each criterion. They are relative ranking which means rank A is better than the others, rank C is middle and rank E is worse than the others. Each item is evaluated based on the judgment standard listed below.

a) Technical aspects

- Installed capacity, firm capacity, annual generation
  Supply capacity and electricity generation are adopted to evaluate the contribution to demand. Rating for each project has been determined by capability of the projects.

- Supply capacity in dry season, supply capacity for daily peak demand
  Projects which have a peak supply capacity have a higher value for the power system. It can contribute to both enhance the stability of the power system and reduce the total cost of the power system. Rating for each project has been determined by capability of the projects.

- Conflict with other projects
  Conflict with the power projects and other development project should be evaluated. For example,

the construction of the reservoir may affect the existing or proposed mining project. River diversion projects may affect the existing and proposed hydropower project located downstream of the project. These impacts should be comprehensively evaluated in order to assess the impact of the project to the Lao economies.

b) Economic aspects

- Project cost (construction cost), unit construction cost
  Construction cost was adopted to evaluate economic efficiency.

- Generation cost
  Generation cost is one of the most important factors to make the EDL-PDP effective. Therefore much should be weighted on the evaluation of generation cost to the overall judgment.

c) Environmental aspects

- Impact on protected area, endangered species, forest and fish
  Impacts on natural environment are evaluated. The methodologies of strategic environmental assessment (SEA) can be applied correspondingly.

- Affected people
  Impact on affected people was evaluated by the number of households for resettlement and the number of households with affected land and assets.

- Impact on ethnic minority
  Impact on ethnic minorities was evaluated by the number of ethnic groups which are affected by the project.

- Other impact on environment
  Impacts on other natural and social environment such as historical and cultural properties were evaluated by their existence.

- Improvement of natural and social environment
  The construction of a power station affects the surrounding environment both positively and negatively. For example, the livelihood peripheral to Nam Theun 2 hydropower project had improved through the regional arrangement executed in the Nam Theun 2 project. These positive impacts on natural and social environment should be appropriately assessed in the course of evaluation.

d) Construction aspects

- Construction period
  Construction period was adopted to evaluate economic efficiency and time limit for growing peak demand.

- Length of access road and distance to existing grid
  Distance to load center or existing grid was adopted to evaluate transmission efficiency and losses.

Rating for each project has been determined as below.

(4) Ranking study

There are many methodologies to evaluate the project. Multi Criteria Decision Analysis is simple but persuasive way to prioritize the projects.

Table 4-12 is a template of Multi Criteria Decision Analysis. For example, all projects in the EDL-PDP will be evaluated from A to E by each criterion as mentioned earlier. The evaluations A to E were converted to 5 to 1 respectively, multiplied by the weights, and summed up by points. Total points represent the comprehensive evaluation of the project. Higher point means that the priority of the project is higher than the project with lower points. Projects in the EDL-PDP can be prioritized based on the evaluation of Multi Criteria Decision Analysis.

Table 4-12: Template of project evaluation

Project No.	Project Name	Technical						Economical					
		Installed capacity (MW)	Firm capacity (MW)	Annual generation (GWh/year)	Supply Capacity in Dry Season	Supply Capacity for Daily Peak Demand	Conflict with Other Projects	Project cost (MUSD)	Unit construction cost (USD/kW)	Unit construction cost (cents/kWh)	Generation cost (cents/kWh)	Tariff (cents/kWh)	Project IRR (%)
Score		20						30					
023LS	Xelabam (Extension)	6.0	2.6	25.0									
024DN	Nam Long	120.0	84.0	507.0									
025DN	Nam Sim	60.0	0.0	316.0									
026DN	Nam Ngiep 3A	25.0	15.0	96.0									

Project No.	Project Name	Environment									Construction			Evaluation
		Impact on protected area (ha)	Impcact on endangered species	Impact on forest	Impact on fish	Improvement of natural environment	Number of resettlement (households)	Inundated area (ha)	Improvement of Social Environment	Other impacts on environmental aspects	Construction Period (years)	Access Road (km)	Transmission Line (km)	
Score		30									20			100
023LS	Xelabam (Extension)													xx/100
024DN	Nam Long													xx/100
025DN	Nam Sim													xx/100
026DN	Nam Ngiep 3A													xx/100

(Source) Study Team.

4.3.2.4 Formulation of generation plan

It is confirmed through the discussion with DEPP/MEM and EDL that the DEPP is the primary organization who will be responsible for collecting project data and evaluating the generation projects through the collaboration work with relevant ministries and organizations.

Table 4-13 shows the work flow and role of the organizations to formulate the generation plan. DEPP will compose the database of the projects and priority list of these projects instructing the relevant body such as the EDL Power Research Development Office. The project data for database and necessary information for project evaluation will be submitted to MEM and EDL from the project developers and relevant organizations. DEPP organize the Work Team meetings among the organization concerned to discuss and examine the draft of the priority project list composed by MEM and EDL. Based on the priority list of the candidate generation projects examined in the Work Team, the draft of the generation plan for power development plan will be formulated for the demand/supply analysis.

Table 4-13: Formulation of generation plan

	Organizer	Executing body	Data sources
Project Database	DEPP	MEM/DEPP EDL/PDO	DEPP EDL IPP developer Hydrological data
Prioritization	DEPP	MEM/DEPP EDL/PDO	DEPP EDL IPP developer Related ministries
Discussion	Working Team (DEPP)	MEM/DEPP EDL/PDO	
PDP	Steering Committee MEM (NPDP) EDL (EDL-PDP)	MEM/DEPP EDL/PDO,SPO	

(Source) Study Team.

4.4 Transmission plan

In this section, based on a new methodology, power system analysis is conducted and the transmission plan is formulated. Then, prospects of the future transmission system are described.

4.4.1 Challenges in planning

The prerequisites in planning transmission facilities are as follows.

1) Proper demand forecast
2) Proper power facility development plan

If these are not appropriate, it can induce excessive capital investment or shortages in supply. Therefore, it is necessary for EDL to pay attention to any changes in demand forecast, commercial operation date of power plants, and these locations for formulationg the PDP.

In addition, the accuracy of the information mentioned above is also important. In particular, the timing when the large-scale demand is connected to the grid and its capacity need to be more clarified because the current PDP has a large gap between the actual demand and demand forecast as shown in Table 4-14, which causes large impact on power system planning.

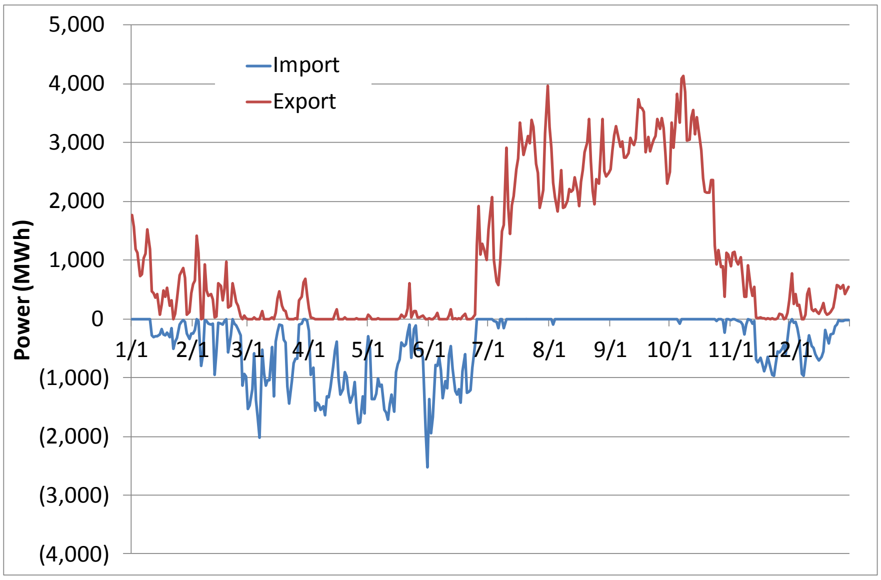
Table 4-14: Statistical errors of records

Year	Actual demand	Demand forecast	Difference[35]
2010	2,228 GWh	2,548.1 GWh[36]	114%
2011	2,399 GWh	3,645.5 GWh	152%

(Source) Electricity Statistics 2011; PDP 2010-2020 (Revision-1).

Table 4-14 indicates that the demand increase in one year estimated by EDL is about 40%, but the actual demand increase is only about 8% (there is more than 50% difference between the actual demand and demand forecast). If EDL simply applies the estimated demand, it is clear that EDL would have to invest excessively for future power system.

Next, the Study Team considers how to improve the accuracy of the demand and supply balance, which directly impacts on the EDL's income and expenditure since EDL performs power trades with EGAT in order to supplement the power balance. Figure 4-23 shows the total amount of power trade between Phontong S/S and Nong Khai S/S, Thanaleng S/S and Nong Khai S/S, and Pakxan S/S and Bung Kan S/S, which are the interconnecting points to EGAT.



(Source) Study Team base on the EDL information

Figure 4-23: Amount of power at interconnecting point between North and Central power system, and EGAT

Import and export are volatiling, frequently replacing each other even within the same month. (especially in February) The volatility can cause financial loss of EDL due to the price difference between export and import.

Laos has hydropower as its main power source and has rainy season and dry season, which induces fluctuations in power output depending on season. The unbalance in demand and supply needs to be adjusted by performing power trades among neighboring countries. However, the import price of EDL is

[35] The rate of difference is Demand Forecast divided by Actual Demand.
[36] In PDP 2010, the actual demand in 2010 is written as 2,548.1 GWh. However, in the Statistics 2011, the actual demand in 2010 was 2,228 GWh. So, that of PDP 2010 is put as a forecast (demand forecast).

higher than the export price. In order to maximize the income, it is necessary for EDL to do proper facilities operation such as storing water when lack of capacity is expected.

4.4.2 Demand and supply balance

4.4.2.1 Methodology of demand and supply balance calculation

The demand and supply balance has been checked in the current PDP on an annual basis. However, it is important to take into account the imbalance in demand and supply depending on the season in order to consider various situations of power supply such as occurance of bottlenecks due to excessive generation in the rainy season.

In this study, the method of monthly demand and supply calculation is proposed, which enhances the accuracy of the system planning and can be a basis for power system operation. In concrete terms, the result of monthly demand and supply calculation is used as follows:

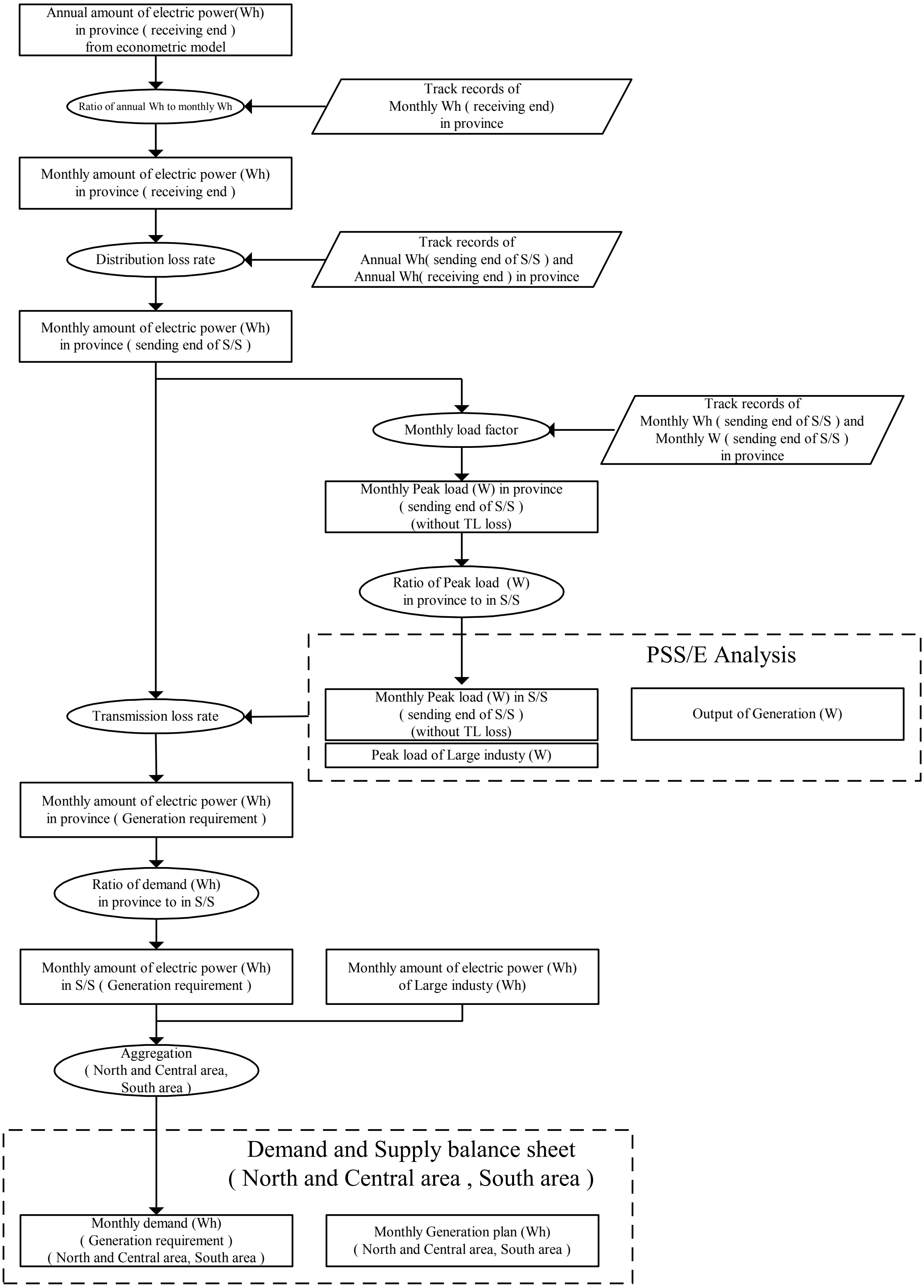
- Confirm the power supply cost and energy security on monthly basis.
- Prioritize and the commencement of operation of planned power plants. (reservoir and pondage type plants)
- Optimize annual operation schedule for hydropower plants. (reservoir and pondage type plants)
- Formulate the monthly system diagram and confirm the power flow in the rainy and dry seasons.
- Optimize the schedule of works of expansion and inspection which requires power outage.

The flowchart of the monthly demand and supply calculation is shown in Figure 4-24.

The monthly electric energy is calculated based on the annual electric energy at receiving end in each province which is computed by applying econometric model as described in Section 4.2. The annual energy is allocated to each month according to the ratio calculated from the track records. It is the data at the receiving end and does not include the distribution or transmission loss. The monthly energy, which is referred to as generation requirement, is calculated by adding these losses to the monthly energy at the receiving end.

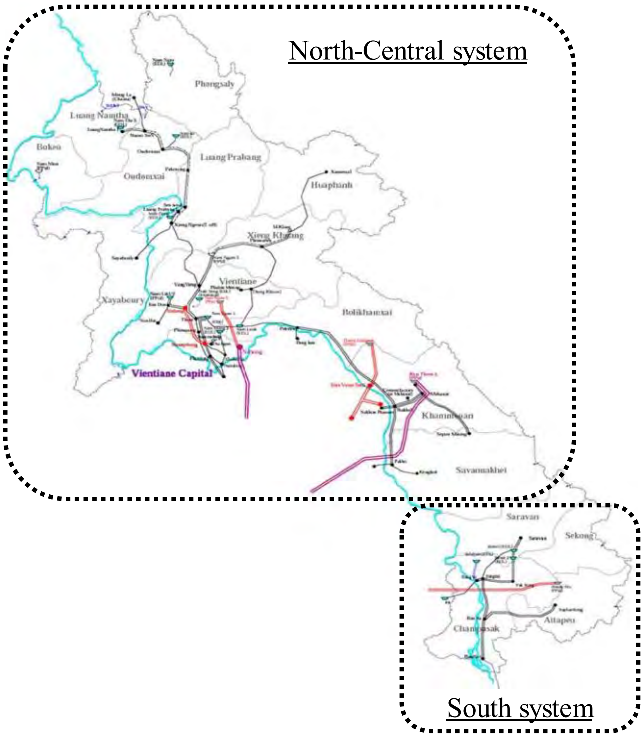
In order to check the balance between EGAT and EDL systems, demand and supply balance sheet is designed to form into two areas as the current system configuration, as shown in Figure 4-25.

The detail of monthly demand and supply calculation is shown in the manual.



(Source) Study Team.

Figure 4-24: Flow of monthly demand and supply calculation



(Source) Study Team base on the EDL information

Figure 4-25: Power system diagram

Preconditions of the monthly demand calculation are as follow,

1) Ratio of monthly demand to annual demand

The ratio of annual electric energy demand (Wh) to monthly electric energy demand (Wh) are calculated using the average of the track records in the past five years, as indicated in Table 4-15.

Table 4-15: Ratio of annual demand to monthly demand

No.	Province	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1	Phongsali	0.076	0.074	0.062	0.069	0.076	0.087	0.094	0.092	0.093	0.092	0.093	0.092
2	Bokeo	0.074	0.068	0.065	0.075	0.084	0.086	0.085	0.090	0.094	0.096	0.098	0.086
3	Luangnamtha	0.069	0.065	0.070	0.076	0.088	0.090	0.087	0.092	0.097	0.092	0.085	0.088
4	Oudomxai	0.069	0.087	0.068	0.088	0.074	0.087	0.093	0.084	0.092	0.089	0.084	0.085
5	Huaphanh	0.079	0.076	0.078	0.080	0.081	0.080	0.081	0.085	0.092	0.090	0.089	0.090
6	Xieng Khuang	0.081	0.070	0.082	0.085	0.085	0.086	0.077	0.082	0.084	0.085	0.087	0.096
7	Luang Prabang	0.073	0.070	0.075	0.082	0.089	0.092	0.092	0.092	0.089	0.087	0.081	0.078
8	Xayabuly	0.074	0.072	0.081	0.086	0.086	0.089	0.090	0.090	0.089	0.087	0.077	0.079
9	Vientiane Province	0.075	0.073	0.074	0.072	0.086	0.090	0.084	0.084	0.094	0.091	0.089	0.089
10	Vientiane Capital	0.071	0.070	0.078	0.084	0.091	0.089	0.088	0.088	0.088	0.087	0.084	0.081
11	Bolikhamxay	0.077	0.078	0.075	0.089	0.088	0.086	0.081	0.085	0.087	0.087	0.086	0.080
12	Khammouan	0.081	0.079	0.085	0.093	0.086	0.084	0.083	0.080	0.086	0.080	0.079	0.084
13	Savannakhet	0.068	0.078	0.082	0.091	0.092	0.087	0.082	0.086	0.083	0.083	0.083	0.083
14	Saravan	0.086	0.090	0.091	0.095	0.090	0.084	0.079	0.074	0.074	0.072	0.080	0.085
15	Sekong	0.073	0.070	0.081	0.089	0.085	0.089	0.081	0.085	0.085	0.086	0.087	0.089
16	Champasak	0.078	0.081	0.084	0.094	0.097	0.088	0.084	0.084	0.083	0.076	0.076	0.075
17	Attapeu	0.075	0.076	0.075	0.091	0.091	0.089	0.089	0.086	0.084	0.083	0.081	0.079

(Source) Study Team.

2) Distribution loss rate

Distribution loss means the technical loss of distribution facilities and non-technical loss from substation bus bar to customer. Distribution loss rate is calculated from the track records of energy (Wh) at the sending end and at the receiving ends. The target of distribution loss in 2030 is 6%, and starting from the track records of distribution loss in 2010, the figures between 2012 and 2020 are calculated by a linear interpolation. The precondition data calculated for this study is indicated in Table 4-16.

Table 4-16: Distribution loss rate (%)

No.	Province	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	Phongsali	8.6	8.5	8.3	8.2	8.1	7.9	7.8	7.7	7.6	7.4	7.3
2	Bokeo	11.2	10.9	10.6	10.4	10.1	9.9	9.6	9.4	9.1	8.8	8.6
3	Luangnamtha	5.6	5.6	5.6	5.7	5.7	5.7	5.7	5.7	5.8	5.8	5.8
4	Oudomxai	10.6	10.4	10.2	9.9	9.7	9.5	9.2	9.0	8.8	8.6	8.3
5	Huaphanh	14.3	13.9	13.5	13.1	12.7	12.3	11.8	11.4	11.0	10.6	10.2
6	Xieng Khuang	9.3	9.1	8.9	8.8	8.6	8.4	8.3	8.1	8.0	7.8	7.6
7	Luang Prabang	8.6	8.4	8.3	8.2	8.1	7.9	7.8	7.7	7.5	7.4	7.3
8	Xayabuly	12.3	12.0	11.7	11.3	11.0	10.7	10.4	10.1	9.8	9.5	9.1
9	Vientiane Province	5.7	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.9	5.9
10	Vientiane Capital	11.9	11.6	11.3	11.0	10.7	10.4	10.1	9.8	9.5	9.2	8.9
11	Bolikhamxay	13.0	12.6	12.3	11.9	11.6	11.2	10.9	10.5	10.2	9.8	9.5
12	Khammouan	12.6	12.3	12.0	11.6	11.3	11.0	10.6	10.3	10.0	9.7	9.3
13	Savannakhet	12.8	12.5	12.1	11.8	11.4	11.1	10.8	10.4	10.1	9.7	9.4
14	Saravan	15.7	15.2	14.7	14.2	13.7	13.2	12.8	12.3	11.8	11.3	10.8
15	Sekong	9.0	8.9	8.7	8.6	8.4	8.3	8.1	8.0	7.8	7.7	7.5
16	Champasak	10.0	9.8	9.6	9.4	9.2	9.0	8.8	8.6	8.4	8.2	8.0
17	Attapeu	7.4	7.3	7.2	7.2	7.1	7.0	7.0	6.9	6.8	6.8	6.7

(Source) Study Team.

3) Monthly load factor

Monthly load factor was calculated from the track records of energy (Wh) and power (W) at the sending ends. The Study Team assumed the load factor between 2012 and 2030 would increase linearly. In addition, the Study Team defined the target of monthly load factor in 2030 as 75%, which is the same as that in the PDP 2010-2020 of EDL (The highest ever monthly load factor in Laos is approximately 75%, recorded in Vientiane province). Furthermore, defining the averaged load factor of 2010 and 2011 as the starting point and that of 2030 (75%) as the other end, the coefficient (load factor increase per year) between 2012 and 2030 is determined by the linear interpolation. With the availability of more track records in the future, more precise calculation can be conducted by using spreadsheet which performs the linear interpolation. The precondition data in 2012 and 2020 calculated for this study is indicated in Table 4-17.

Table 4-17: Monthly load factor

(1) Year 2012

No.	Province	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1	Phongsali	0.40	0.41	0.45	0.49	0.53	0.51	0.43	0.40	0.41	0.48	0.46	0.45
2	Bokeo	0.40	0.41	0.45	0.49	0.53	0.51	0.43	0.40	0.41	0.48	0.46	0.45
3	Luangnamtha	0.40	0.41	0.45	0.49	0.53	0.51	0.43	0.40	0.41	0.48	0.46	0.45
4	Oudomxai	0.40	0.41	0.45	0.49	0.53	0.51	0.43	0.40	0.41	0.48	0.46	0.45
5	Huaphanh	0.45	0.47	0.35	0.46	0.44	0.44	0.44	0.46	0.45	0.46	0.44	0.45
6	Xieng Khuang	0.54	0.52	0.51	0.53	0.54	0.54	0.50	0.50	0.49	0.50	0.53	0.56
7	Luang Prabang	0.54	0.55	0.56	0.59	0.58	0.61	0.60	0.57	0.50	0.54	0.52	0.52
8	Xayabuly	0.54	0.56	0.58	0.58	0.61	0.60	0.59	0.58	0.58	0.56	0.55	0.54
9	Vientiane Province	0.61	0.57	0.57	0.61	0.60	0.59	0.53	0.61	0.58	0.64	0.65	0.57
10	Vientiane Capital	0.59	0.64	0.63	0.65	0.63	0.67	0.63	0.64	0.61	0.56	0.66	0.60
11	Bolikhamxay	0.61	0.60	0.64	0.63	0.64	0.65	0.62	0.62	0.60	0.61	0.57	0.56
12	Khammouan	0.68	0.66	0.67	0.64	0.63	0.66	0.64	0.65	0.64	0.55	0.64	0.63
13	Savannakhet	0.48	0.50	0.62	0.61	0.61	0.64	0.49	0.49	0.62	0.56	0.52	0.54
14	Saravan	0.46	0.58	0.60	0.59	0.56	0.57	0.56	0.54	0.56	0.54	0.46	0.45
15	Sekong	0.46	0.58	0.60	0.59	0.56	0.57	0.56	0.54	0.56	0.54	0.46	0.45
16	Champasak	0.46	0.58	0.60	0.59	0.56	0.57	0.56	0.54	0.56	0.54	0.46	0.45
17	Attapeu	0.58	0.63	0.58	0.64	0.56	0.51	0.66	0.54	0.52	0.60	0.59	0.63

(Source) Study Team.

(2) Year 2020

No.	Province	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1	Phongsali	0.56	0.56	0.58	0.61	0.63	0.62	0.57	0.55	0.56	0.60	0.59	0.58
2	Bokeo	0.56	0.56	0.58	0.61	0.63	0.62	0.57	0.55	0.56	0.60	0.59	0.58
3	Luangnamtha	0.56	0.56	0.58	0.61	0.63	0.62	0.57	0.55	0.56	0.60	0.59	0.58
4	Oudomxai	0.56	0.56	0.58	0.61	0.63	0.62	0.57	0.55	0.56	0.60	0.59	0.58
5	Huaphanh	0.58	0.59	0.53	0.59	0.58	0.58	0.58	0.59	0.58	0.59	0.58	0.59
6	Xieng Khuang	0.64	0.62	0.61	0.63	0.63	0.63	0.61	0.61	0.61	0.61	0.63	0.64
7	Luang Prabang	0.63	0.64	0.65	0.66	0.65	0.67	0.67	0.65	0.61	0.63	0.62	0.62
8	Xayabuly	0.63	0.65	0.65	0.65	0.67	0.67	0.66	0.65	0.66	0.65	0.64	0.63
9	Vientiane Province	0.67	0.65	0.65	0.67	0.67	0.66	0.63	0.67	0.65	0.69	0.70	0.65
10	Vientiane Capital	0.66	0.69	0.68	0.69	0.68	0.71	0.68	0.69	0.67	0.65	0.70	0.67
11	Bolikhamxay	0.67	0.67	0.69	0.69	0.69	0.70	0.68	0.68	0.67	0.67	0.65	0.64
12	Khammouan	0.71	0.70	0.71	0.69	0.69	0.70	0.69	0.69	0.69	0.64	0.69	0.69
13	Savannakhet	0.60	0.61	0.68	0.67	0.67	0.69	0.61	0.60	0.68	0.64	0.62	0.63
14	Saravan	0.59	0.66	0.66	0.66	0.65	0.65	0.64	0.63	0.64	0.64	0.59	0.58
15	Sekong	0.59	0.66	0.66	0.66	0.65	0.65	0.64	0.63	0.64	0.64	0.59	0.58
16	Champasak	0.59	0.66	0.66	0.66	0.65	0.65	0.64	0.63	0.64	0.64	0.59	0.58
17	Attapeu	0.66	0.68	0.65	0.69	0.64	0.62	0.70	0.63	0.62	0.67	0.66	0.69

(Source) Study Team.

4) Transmission loss rate

Transmission loss means the transmission and transformer loss in the grid which excludes the distribution facilities. Transmission loss rate is calculated using the software PSS/E. These are used for the calculation of the energy (Wh) and power (W) demands as generation requirements. The precondition data calculated for this Study is indicated in Table 4-18.

Table 4-18: Transmission loss rate (%)

No.	Province	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	Phongsali	1.2	0.9	2.9	1.3	1.1	1.0	1.0	1.0	1.3
2	Bokeo	1.2	0.9	2.9	1.3	1.1	1.0	1.0	1.0	1.3
3	Luangnamtha	1.2	0.9	2.9	1.3	1.1	1.0	1.0	1.0	1.3
4	Oudomxai	1.2	0.9	2.9	1.3	1.1	1.0	1.0	1.0	1.3
5	Huaphanh	1.2	0.9	2.9	1.3	1.1	1.0	1.0	1.0	1.3
6	Xieng Khuang	1.2	0.9	2.9	1.3	1.1	1.0	1.0	1.0	1.3
7	Luang Prabang	1.2	0.9	2.9	1.3	1.1	1.0	1.0	1.0	1.3
8	Xayabuly	1.2	0.9	2.9	1.3	1.1	1.0	1.0	1.0	1.3
9	Vientiane Province	1.2	0.9	2.9	1.3	1.1	1.0	1.0	1.0	1.3
10	Vientiane Capital	1.2	0.9	2.9	1.3	1.1	1.0	1.0	1.0	1.3
11	Bolikhamxay	1.2	0.9	2.9	1.3	1.1	1.0	1.0	1.0	1.3
12	Khammouan	1.2	0.9	2.9	1.3	1.1	1.0	1.0	1.0	1.3
13	Savannakhet	1.2	0.9	2.9	1.3	1.1	1.0	1.0	1.0	1.3
14	Saravan	4.3	3.9	2.9	1.3	1.1	1.0	1.0	1.0	1.3
15	Sekong	4.3	3.9	2.9	1.3	1.1	1.0	1.0	1.0	1.3
16	Champasak	4.3	3.9	2.9	1.3	1.1	1.0	1.0	1.0	1.3
17	Attapeu	4.3	3.9	2.9	1.3	1.1	1.0	1.0	1.0	1.3

(Source) Study Team.

4.4.2.2 Prospect of demand and supply balance

Electricity demand forecast is estimated on a monthly basis until 2020 as shown in Figure 4-26. Since the development of large industries such as gold/copper/zinc mining and non-ferrous metal refinery is mostly unclear at the moment, the Study focused on the base demand which already exists. Therefore, the result of the analysis is very unlikely to be influenced by the changes in the industry development plan.

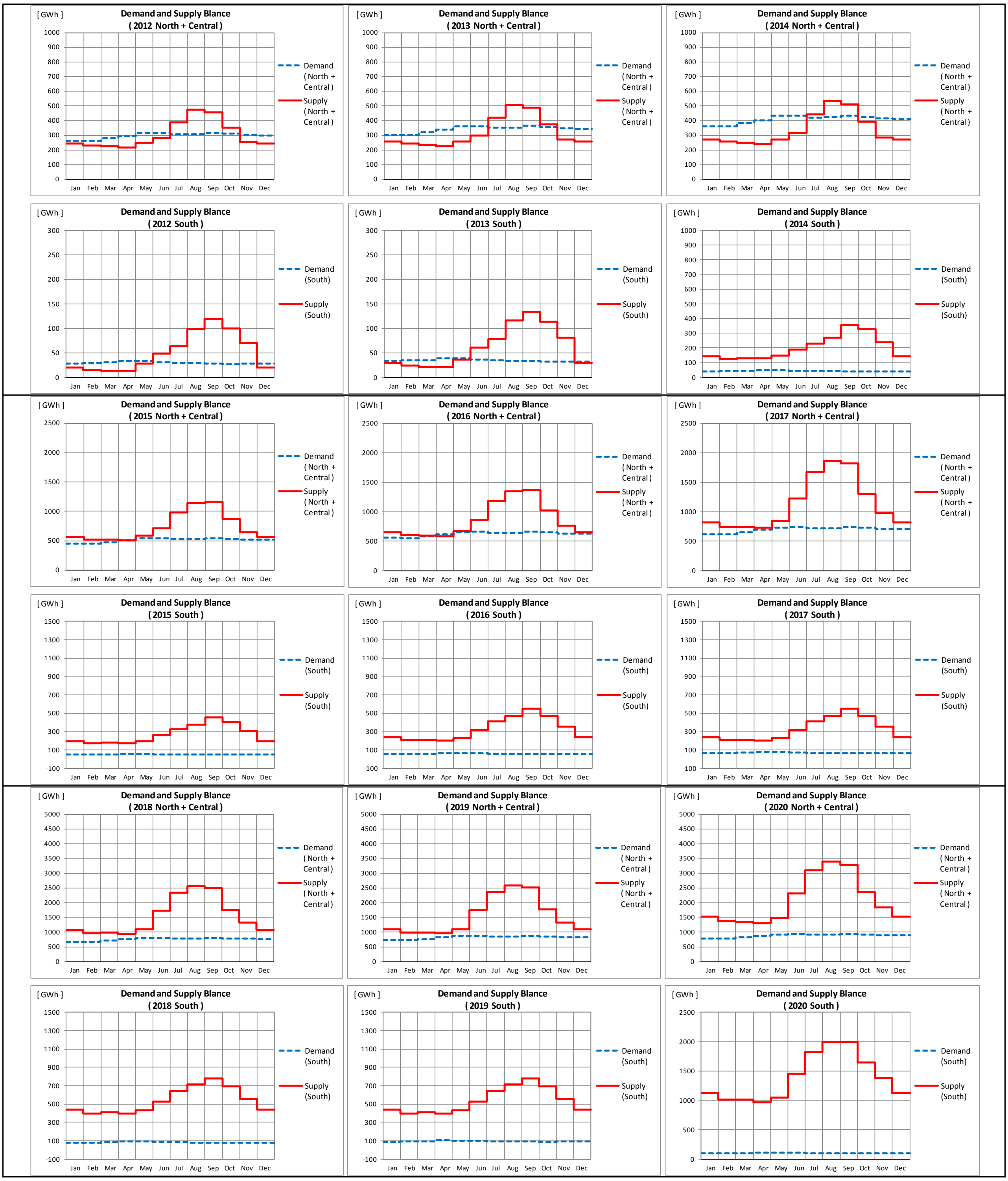
The monthly demand and supply balance from 2012 to 2020 in this study is shown in Table 4-19 and Figure 4-26. These figures show the amount of generation will increase to about 40,000 GWh in 2020, but that of demand will reach no more than 12,000 GWh in 2020. Thus, it must be considered whether the surplus supply could be exported to other countries or not as well as considering the power system development.

Table 4-19: Nationwide power demand and supply capability from 2012 to 2020

(Unit: GWh)

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020
Demand	3,871	4,438	5,388	6,600	7,998	8,944	9,877	10,732	11,510
Supply capability	4,215	4,579	6,467	11,981	14,243	17,477	24,782	25,032	40,637

(Source) Study Team.



(Source) Study Team.

Figure 4-26: Monthly demand and supply balance (Wh) from 2012-2020

4.4.3 System analysis

4.4.3.1 General condition

Based on the demand forecast in Section 4.2 and the generation plan in Section 4.3, the Study Team analyzed the power flow and voltage of future power system. The conditions of analysis are as follows:

1) Demand forecast: estimated demand in this study excluding the large-industry
2) Generation planning: PDP 2012-2025 (under preparation)
3) Power system development: current PDP data
4) Period of analysis: from 2012 to 2020

Based on the above conditions, the Study Team has considered the power system development plan.

4.4.3.2 System planning criteria

EDL‘s power system is to be planned in accordance with the criteria referred to as ‗Lao grid code‘. The review of transmission development plan is formulated taking into account of the information. Technical criteria, ‗Lao grid code‘, for power system planning are shown as below.

1) Load flow

During normal condition, the load on equipments shall be less than the thermal limit of the equipments. During emergency conditions, it shall be less than the emergency limit of the equipment.

2) Voltage

During normal condition, the bus voltage at any connection points shall be between 95% and 105% of the Nominal Voltage. Meanwhile, during emergency condition, it shall be between 90% and 110% of the Nominal Voltage.

3) Fault current

Equipment should be properly rated to be within Short Circuit Duties or Maximum Fault Currents in kilo amperes (kA) accordingly with the following voltage (kV) ratings or based on actual Fault Study as shown in Table 4-20.

Table 4-20: Maximum fault currents

Voltage level (kV)	Maximum fault current (kA)
500	50
230	50
115	40
35	12.5
22	12.5

(Source) Lao Grid Code.

4) Condition of transmission line

Conductors of transmission lines and line constants, which are input as the PSS/E data, are chosen from the list of the standardized conductors provided by EDL as shown in Table 4-21 and Table 4-22, respectively.

Table 4-21: Standardized conductors

Voltage (kV)	Current (A)	Conductor size	Capacity		Code Name
			(MW)	(MVA)	
22	290	70 mm^2 / 125 MCM	10	11	Mink
22	470	150 mm^2 / 311 MCM	16	18	Wolf
22	600	240 mm^2 / 477 MCM	21	23	Hawk
115	600	240 mm^2 / 477 MCM	100	120	Hawk
115	818	410 mm^2 / 795 MCM	140	165	Drake
115	1,636	2 x 410 mm^2 / 2 x 795 MCM	280	329	Drake
230	1,078	630 mm^2 / 1,272 MCM	365	430	Pheasant
230	2,156	2 x 630 mm^2 / 2 x 1,272 MCM	730	860	Pheasant
230	4,312	4 x 630 mm^2 / 4 x 1,272 MCM	1,460	1,700	Pheasant
500	3,272	4 x 410 mm^2 / 4 x 795 MCM	2,300	2,700	Drake
500	4,312	4 x 630 mm^2 / 4 x 1,272 MCM	3,200	3,760	Pheasant

(Source) Study Team based on EDL information.

Table 4-22: Line constants in PSS/E

Type	Positive-phase-sequence Impedance (pu/km)		
	Line R	Line X	Charging B
115 kV 240 mm^2 / 477 MCM	0.00091	0.00300	0.00038
230 kV 630 mm^2 / 1,272 MCM	0.00016	0.00079	0.00146

(Source) Study Team based on EDL information.

4.4.3.3 Peak load forecast

Peak load forecast was examined under the same condition as mentioned in 4.4.2.1. The peak load and supply capability from 2012 to 2020 are indicated in Table 4-23. The supply capability in 2020 is about 8,000 MW while the peak demand in 2020 is only about 2,500 MW.

Table 4-23: Nationwide peak demand and supply capability from 2012 to 2020

(Unit: MW)

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020
Peak demand	838	944	1,107	1,368	1,680	2,141	2,307	2,447	2,542
Supply capability	731	808	1,171	2,429	2,945	3,591	5,016	5,064	7,989

(Source) Study Team.

4.4.3.4 Power system plan formulated by Study Team

(1) Substation development

As a result of the system analysis by the study Team, transformer overload for the whole system is likely to happen. The substations which need the additional transformers are shown in Table 4-24. More than 40 substations will be required to reinforce the transformers in the next 10 years, which is much more than what is required in the current PDP. The result is different from the current PDP mainly because the assumption of ―Large Industry” demand is changed in a realistic manner according to the demand forecast in this study.[37]

In the current PDP, the demand type is categorized into two: —Large Industry” and —Others” (residential, commercial, etc). In the PDP, —Large Industry” is assumed to be supplied directly by the 115kV grid or higher, while —Others” are to be supplied from substations.

However, the demand scale and type of —Large Industry” ranges widely. A part of —Large industry” demand are relatively small (like small factories), which can be categorized into —Industry 2”[38]. It is rational that —Industry 2” demand is supplied not from the grid but from substations just the same as —Others”. In the system analysis this time, it is assumed that —Industry 2” demand is supplied through transformers at substations. In this reason, the necessary amount of transformer reinforcement has increased.

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[37] See Section 2.5.1 (3)

[38] See Section 2.5.1 (3)

Table 4-24: Substation development plan

(Unit : MVA)

Provinces		No.	Substation	Com. years	inst. cap	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	Phongsali	1	Boun Neua						40.0					20.0		
2	Bokeo	1	Houayxay							40.0			40.0			
3	Luangnamtha	1	Luangnamtha 1	2009	20							20.0				
		2	Luangnamtha 2							20.0		20.0				
4	Oudomxay	1	Oudomxay	2009	20						20.0					
		2	Namo	2012	40											
		3	M Houn							40.0						
		4	Pak Beng						40.0							
5	Huaphanh	1	Xam Neua 1	2012	40											
6	Xieng Khuang	1	Phonsavan	2003	16						60.0					
		2	Mkham	2012	10						40.0					
		3	Thavieng								20.0					
7	Luanprabang	1	Luangprabang 1	1994	25				40.0							
		2	Pakmong	2009	10											10.0
		3	Seinsouk	2012	60											
		4	Luangprabang 2							40.0						
8	Xayabuly	1	Xayabouly	2003	16								20.0			
		2	Paklay	2012	40											
		3	Hongsa							20.0						
9	Vientiane	1	Vangvieng	1994	32				40.0							
		2	Phonsoung	1990	22						20.0					
		3	Ban Don	2003	16											
		4	Non Hai	2003	16											
		5	Thalat	2006	30										30.0	
		6	Hinheup	2011	40											
		7	Thong Khon2								30.0					
10	Vientiane Capital	1	Phontong	1968	160						100.0					
		2	Thanaleng	1977	90											20.0
		3	Tha Ngon	1989	30											
		4	Khok sa at	2004	44							60.0				
		5	Naxaythong	2006	30											
		6	Pak Thang	2012	60											
		7	Nong Viengkham						40.0							
		8	Don Koi	2012	100											
		9	Na Bong 1							60.0						
11	Bolikhamxay	1	Pakxan	2000	32											20.0
		2	Naxai								20.0					
		3	Khonsong	2012	40											
		4	Thasala									40.0				
		5	Tha Bok							60.0						
12	Khammouan	1	Thakhek	2003	60						60.0					
		2	Mahaxai	2009	40											
		3	Nam Theun 2 (Substation)	2012	20											
13	Savannakhet	1	Pakbo	1996	40										20.0	
		2	Keng Kok	2004	20				20.0							
		3	Ban Lao Souliya	2012	90											
		4	Ban Na (SENO)							40.0						
		5	M Phin								40.0					
		6	M Nong								20.0					
14	Saravan	1	Saravan	2011	40											
		2	Taothan							40.0						
15	Xekong	1	Sekong	2011	40									40.0		
16	Champasak	1	Bang Yo	1991	60											20.0
		2	Ban Na	2005	40											
		3	Ban Hat	2005	40											
		4	Pakxong	2012	100											
		5	Ban Jiangxai	2012	30											
17	Attapeu	1	Saphaothong	2006	16										20.0	

[white box]: Planned in current PDP   [grey box]: Additionally required

(Source) Study Team.

(2) Reactive facilities development

The reactive facilities[39], which generate reactive power, are necessary in order to maintain proper voltage of the power system. The substations which need the installation of reactive facilities are shown in Table 4-25. Compared with the situation in the current PDP, more reactive power facilities (much more capacity for the voltage control) is necessary due to the increase of supply through substations. The proposed facilities are at minimum requirement level, and more reactive facilities would be needed to keep up with the demand increase in each substation.

Table 4-25: Reactive facilities development plan

Year	Substation	Voltage (kV)	Reactive facility	
			Type	Capacity (MVA)
2013	Namo Sw/S	22	SC	10
2013	Pakmong	22	SC	20
2014	Pakbeng	22 (tertiary voltage of Tr)	ShR	20
2014	Pakmong	22 (tertiary voltage of Tr)	ShR	20
2014	Thavieng	22 (tertiary voltage of Tr)	ShR	20
2015	Ban Na	22	SC	10
2015	Ban Hat	22	SC	10
2015	Saphaothong	22	SC	10
2016	Boun Neua	22	SC	20
2016	Vieng Phukha	22	SC	10
2016	Luang Prabang 2	22 (tertiary voltage of Tr)	ShR	20
2016	Houay Xay	22	SC	20
2016	Phonsavan	22	SC	20
	Ban Hat	22 (tertiary voltage of Tr)	ShR	20
2018	Luang Namtha 1	22	SC	10
2018	Ban Na	22	SC	10
2018	Boun Neua	22	SC	20

(Source) Study Team.

(3) Transmission line development

The system analysis adopted the generation development plan for PDP 2012-2015 (under preparation), which includes all of changes from the PDP 2010 (Revision-1). Because of this, a lot of changes are necessary in the transmission plan mainly due to the changes of installation timings and routes of transmission lines for power sources.

Figures VIII-1 to VIII-9 in Appendix VIII illustrate the results of power flow and bus voltage analysis under normal operating conditions from 2012 to 2020, and Tables VIII-1 to VIII-6 show the monthly demand forecast (GWh and MW) data in each substation in system analysis.

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[39] Typical reactive facilities are a static capacitor (SC) and a shunt reactor (ShR). An SC raises voltage of the power system by generating reactive power, and an ShR reduces voltage of the power system by absorbing reactive power.

1) North area

230 kV transmission lines which will connect from Nabong S/S to Liming S/S (in China) are planned to start operation in the year 2014 (230 kV Hinheup – Naxaythong transmission line is completed in 2012). In addition, 115 kV transmission lines which will configure the loop system across the Bokeo province, Luang Namtha province, Oudomxai province, and Luang Prabang province are planned, and those operations are planned to start in the year 2015. Under this condition, no overload conditions are found until 2020.

Nam Xam 1 P/S and Nam Xam 3 P/S are planned to start commissioning in the year 2015. If the power generated by Nam Xam 1 P/S and Nam Xam 3 P/S were to be delivered to the central area (Vientiane Capital etc), the 115 kV transmission line between Phonsavan S/S to Xamneua S/S would be overloaded. Thus, the following transmission lines must be reinforced as follows before Nam Xam 1 and Nam Xam 3 are operated.

a) Double the circuit line between Phonsavan S/S and M. Kham S/S.
b) Double the circuit line between M. Kham S/S and Xamneua 1 S/S.
c) Double the circuit line between Xamneua 1 S/S and Nam Xam 1 S/S.

2) Central area

Under the power system development in the current PDP, not any overload conditions are found until 2017. However, after Nam Ou #1, 3, 4 and 7 power stations start operating in the year 2018, the amount of electric power sent from North to Central will get larger and must be reinforced as follows.

a) Double the circuit line between Vangvieng S/S and Hinheup S/S.
b) Double the circuit line between Hinheup S/S and Talat S/S.
c) Triplicate the circuit line between Phontoung S/S and Naxaythong S/S.

3) South area

Under the condition of the power system development in the current PDP, not any overload conditions are found until 2017. After the year 2018, the capacity of surplus electric power will exceed 1,000 MW in South area in rainy season. However, the capacity of the transmission line between Bang Yo and Sirindhorn (EGAT), is 240 MW and that of transmission line connecting Ban Hat to Stung Treng S/S (Cambodia), is limited to 365 MW. If most of the surplus electricity in South area should be sent to domestic area (Savannakhet province or Central area), the 230 kV transmission line which connects Saravan to Ban Na (Seno) would be required. Yet, domestic interconnection, the one which connects South to North especially, should not be developed until the economical efficiency is improved. For this reason, electric power plants and transmission lines for export in South should be developed considering the possible amount of power export.

Based on the generation plan, the year in which the transmission line would be needed was revised as shown in Table 4-26.

Whereas the symbol ‗■‘indicates the year in which the transmission line is planned to start operation in the current PDP, the symbol ‗○‘ indicates the revised year which is recommended by the Study Team, and the symbol ‗□‘indicates the transmission line which is not in the current PDP but newly proposed by the Study Team.

Table 4-26: Transmission line development plan (long list)

(Legend) ■: Planned in current PDP, ○: Revised Year, □: Additional TL.

No.	Region	Project From	Project To	Voltage (kV)	Status	Sourse of fund	2012	2013	2014	2015	2016	2017	2018	2019	2020	No. of cct	Conductor size (No.x mm^2)	Length (km)	Length (km-c)	Owner
1	Northern	Li Ming (China)	Namo	230	Study	China			■							2	2 x 630	108	216	IPP (d)
2	Northern	Na Mo	Oudomxai	230	Study	China			■							2	2 x 630	50	100	IPP (d)
3	Northern	Pak Beng	Luangprabang 2	230	Study	China			■							2	2 x 630	145	290	IPP (d)
4	Northern	Pak mong	Luangprabang 2	230	Planned	China			■							2	2 x 630	120	240	IPP (d)
5	Northern	Thavieng	Tha Bok	230	Planned	--			■→	○						2	4 x 630	120	240	EDL
6	Northern	Nam Ngeip 2	Thavieng	230	Planned	--				■						2	1 x 630	18.5	37	IPP (d)
7	Northern	Nam Ou 6	Phongsaly	230	Planned	--					■→	○				2	1 x 630	18	36	IPP (d)
8	Northern	Phongsaly	Nam Ou 5	230	Planned	China					■→	○				2	2 x 630	48	96	IPP (d)
9	Northern	Pak mong	Nam Ou 2	230	Planned	China					■→	○				1	1 x 630	28	28	IPP (d)
10	Northern	Na Mo	Phongsaly	230	Planned	China					■→	○				2	2 x 630	115	230	IPP (d)
11	Northern	Phongsaly	Nam Ou 7	230	Planned	China							■			2	1 x 630	55	110	IPP (d)
12	Northern	Nam Ou 1	Luangprabang 2	230	Planned	China							■			1	1 x 400	34	34	IPP (d)
13	Central	Naxaythong	Nabong 1	230	Planned	--			■→	○						2	4 x 630	40	80	EDL
14	Central	Tha Bok	Nabong 1	230	Planned	--				■						2	4 x 630	52	104	EDL
15	Central	Nabong 1	Nong Khai 2	230	Planned	--				■→	→	→	→	→	○	2	4 x 630	37	74	EDL
16	Central	Nam Bak	Tha Bok	230	Planned	--				■						2	1 x 410	50	100	IPP (d)
17	Southern	Ban Hat	Stungtreng	230	Planned	--			■→	→	○					2	1 x 630	91	182	EDL
18	Southern	M. Kalum (Lignite)	Saravan	230	Planned	--				■→	→	→	○			2	1 x 630	46	92	IPP (d)
19	Southern	Ban na(Seno)	Saravan	230	Planned	--				■→	→	→	○			2	4 x 630	170	340	EDL
20	Southern	Pakxong	Ban Hat	230	Planned	--				■→	○					2	2 x 630	175	350	IPP (d)
21	Southern	Saravan	Pak Xong	230	Planned	--				■→	○					2	2 x 630	75	150	IPP (d)
22	Southern	Mekong Tha kho	Tha kho T-Off	230	Planned	--				■→	○					1	1 x 240	2	2	IPP (d)
23	Southern	Thavieng	Thasala	230	Planned	--					■→	→	○			2	2 x 630	172	344	EDL
24	Southern	Thasala	Mahaxai	230	Planned	--					■→	→	○			2	2 x 630	110	220	EDL
25	Southern	Mahaxai	Ban Na (Seno)	230	Planned	--					■→	→	○			2	2 x 630	100	200	EDL
26	Southern	Mekong Donsahong	Thakho T-Off	230	Planned	--						■→	→	→	○	2	1 x 630	4	8	IPP (d)
27	Northern	Na Mo	Boun Neua	115	Loan	ADB		■								1	1 x 240	102	102	EDL
28	Northern	Paklay	Tha Li	115	Loan	ADB		■→	○							2	1 x 240	86	172	EDL
29	Northern	Paklay	Sayaboury	115	Loan	ADB		■→	○							2	1 x 240	134	268	EDL
30	Northern	Paklay	Non Hai	115	Loan	ADB		■→	○							2	1 x 240	104	208	EDL
31	Northern	Nam Thoung	Houayxay	115	Planned	EDL			■→	○						2	1 x 450	55	110	EDL
32	Northern	Houayxay	Ton Pheung	115	Planned	--			■→	○						2	1 x 240	65	130	EDL
33	Northern	Ton phueng	Houayxay	115	Planned	PEA & EDL			■→	○						2	1 x 240	62	124	EDL
34	Northern	Nam Ngiew	Thavieng	115	MOU EDL Shareholder	--			■							1	1 x 150	14	14	IPP (d)
35	Northern	Nam tha 1	Nam Thoung	115	Planned	CSG			■→	○						2	1 x 300	42	84	EDL
36	Northern	Nam Beng	Pak Beng	115	Study	China			■→	○						1	1 x 240	12	12	IPP (d)
37	Northern	Nam Pot	Thavieng	115	Planned	Lao Company										1	1 x 150	10	10	IPP (d)

(Legend) ■: Planned in current PDP, ○: Revised Year, □: Additional TL.

No.	Region	Project		Voltage	Status	Sourse of fund	2012	2013	2014	2015	2016	2017	2018	2019	2020	No. of	Conductor size	Length		Owner
		From	To	(kV)												cct	(No.x mm^2)	(km)	(km-c)	
38	Northern	Na Mo	Boun Neua	115	Planned	--				■						1	1 x 240	98	98	EDL
39	Northern	Luangnamtha 1	Nam Thoung	115	Loan	Kuwait				■						2	1 x 240	91	182	EDL
40	Northern	Na Mo	Luangnamtha 1	115	Loan	Kuwait				■						1	1 x 240	42.7	42.7	EDL
41	Northern	Nam Chien	Thavieng	115	Planned	--				■→	○					2	1 x 240	35	70	EDL
42	Northern	Nam Phak	Na Mo	115	Planned	--				■→	○					1	1 x 240	29	29	EDL
43	Northern	Nam Pha	Luangnamtha 2	115	Planned	--				■						2	1 x 410	50	100	IPP (d)
44	Northern	Nam San 3	Tha Vieng	115	Planned	--				■→	→	→	○			1	1 x 240	21	21	IPP (d)
45	Northern	Nam Khan 3	Nam Khan 2	115	Planned	Exim China					■					2	1 x 150	45	90	EDL
46	Northern	Nam Xam1	Xam Nuea	115	Planned	--				○	←■					1	1 x 240	90	90	IPP (e)
47	Northern	M.Beng	Nam Tha1	115	Planned	--				○	←■					2	2 x 240	57	114	IPP (d)
48	Northern	Luangprabang 2	Sayabouly	115	Planned	--						■→	→	→	○	1	1 x 240	76	76	EDL
49	Northern	Nam San 3 (Down)	Nam San 3	115	Planned	--							■			1	1 x 97	9.5	9.5	IPP (d)
50	Northern	Mekong Sayaboury	Sayabouly	115	Planned	--								■		2	1 x 240	21	42	IPP (e)
51	Northern	Mekong Luangprabang	Sensouk	115	Planned	--								■		2	1 x 410	16	32	IPP (e)
52	Northern	Mekong Pakbeng	Pak Beng	115	Planned	--								■		2	1 x 400	23	46	IPP (e)
53	Central	Naxaythong	Pak thang	115	Study	Malaysia	■									2	1 x 240	12	24	EDL
54	Central	Ban Don	Non Hai	115	Planned	--			■							1	1 x 240	54	54	EDL
55	Central	Nam Mang 1	Tha Bok	115	Planned	Exim China			■→	○						1	1 x 240	12	12	IPP (d)
56	Central	Khoksa at	Nabong 1	115	Planned	--				○						2	1 x 450	22	44	EDL
57	Central	Nam Phai	Vangvieng	115	Planned	--				■→	○					2	1 x 240	57	114	IPP (d)
58	Central	Nam Gnuang 8	Kengseuaten	115	Planned	--				■→	○					1	1 x 240	20	20	EDL
59	Central	Nam Theun 1	Khonsong	115	Planned	--						■→	→	○		1	1 x 240	35	35	IPP (d)
60	Central	Pakxan	Bung kan	115	Planned	--							○			1	1 x 240	11	11	EDL
61	Central	Nam Ngum (Down)	Nabong 1	115	Planned	--							■→	→	○	2	1 x 240	18	36	IPP (d)
62	Central	Nam Ngiep 1	Pakxan	115	Planned	--							■			1	1 x 240	34.5	34.5	IPP (e)
63	Central	Nam Phouan	Thavieng	115	Planned	--				○	←	←	←	←■		2	1 x 240	38	76	EDL
64	Southern	Xeset 3	Pak Xong	115	Planned	China			■→	→	○					2	1 x 240	3.2	6.4	EDL
65	Southern	Xekaman-Xanxai	Saphaothong	115	Planned	ADB + Viet			■							2	1 x 240	51	102	EDL
66	Southern	Sirinthorn	Bang yo	115	Planned	--			■→	○						1	1 x 240	61	61	EDL
67	Southern	Taothan	Saravan	115	Planned	JBIC			■							2	1 x 240	65	130	EDL
68	Southern	Nongdeun	Taothan	115	Planned	JBIC			■							2	1 x 240	230	460	EDL
69	Southern	Pakbo	Nongdeun	115	Planned	--			■→	○						2	1 x 450	10	20	EDL
70	Southern	Saphaothong	Ban Na	115	Planned	--			■							1	1 x 240	123	123	IPP (d)
71	Southern	Nam Kong 2	Nam Kong 3	115	Planned	--			○	←■						1	1 x 240	10	10	IPP (d)
72	Southern	Nam Kong 3	Saphaothong	115	Planned	--			○	←■						1	1 x 240	26	26	IPP (d)
73	Southern	Pakbo	Mukdahan	115	Planned	--			■							1	1 x 240	14	14	EDL
74	Southern	Ban na(Seno)	M. Phin	115	Planned	--				■						2	1 x 240	140	280	EDL
75	Southern	M. Phin	Sepon Mining	115	Planned	--				■						2	1 x 240	136	272	EDL
76	Southern	Jiengxai	Bangyo	115	Planned	--			○	←■						1	1 x 240	10	10	IPP (d)
77	Southern	M. Phin	M. Nong	115	Planned	--				■						2	1 x 240	89	178	EDL

(Legend) ■: Planned in current PDP, ○: Revised Year, □: Additional TL.

No.	Region	Project		Voltage	Status	Sourse of fund	2012	2013	2014	2015	2016	2017	2018	2019	2020	No. of cct	Conductor size	Length		Owner
		From	To	(kV)													(No.x mm^2)	(km)	(km-c)	
78	Southern	Xeset 3	Xeset 4	115	Planned	--				■→	○					1	1 x 150	8	8	EDL
79	Southern	Nam Hinboun	Khonsong	115	Planned	--				■→	○					1	1 x 240	15	15	EDL
80	Southern	Sepon 3 (Up)	Sepon 3 (Down)	115	Planned	--				■						1	1 x 240	6	6	IPP (d)
81	Southern	Sepon 3 (Up)	M. Nong	115	Planned	--				■						2	1 x 240	49	98	IPP (d)
82	Southern	Sekong 4	Sekong	115	Planned	Russia					■→	→	→	→	○	2	1 x 240	25	50	IPP (e)
83	Southern	Xekatam	Pak Xong	115	Planned	--					■					2	1 x 240	35	70	IPP (d)
84	Southern	Nam Phak/Houaykatam	Pak Xong	115	Planned	--				○	←	←■				2	1 x 450	26	52	IPP (d)
85	Southern	Xelanong 2	Saravan	115	Planned	--							■			2	1 x 240	88	176	IPP (d)
86	Southern	Xelanong 1	M. Nong	115	Planned	Norway							■			2	1 x 240	16	32	IPP (d)
87	Southern	Xeneua	Sepon Mining	115	Planned	--							■			1	1 x 240	60	60	IPP (d)
88	Southern	Xedon 2	Saravan	115	Planned	--							■			1	1 x 240	41	41	IPP (d)
89	Southern	Xebanghieng 1	Ban na (Seno)	115	Planned	--								■→	○	2	1 x 240	65	130	IPP (d)
90	Northern	Nam Long	Viengphukha	22	Planned	Lao Company										1	1 x 95	44	44	IPP (d)
91	Northern	Nam Ham 2	Paklay	22	Planned	Cobri / PEA		■→	○							1	1 x 150	50	50	EDL
92	Northern	Nam Boun 2	Boun Neua	22	Planned	--			■→	○						1	1 x 150	45	45	EDL
93	Northern	Nam Ken	Nam Sana	22	Planned	--			■→	→	→	→	○			1	1 x 150	16	16	IPP (d)
94	Southern	HouayChampi	Selabam	22	Planned	Lao Company			■→	○						1	1 x 150	38	38	IPP (d)
95	Northern	Phonsavan	M.Kham	115	Planned	--				□						1	1 x 240	56	56	--
96	Northern	M.Kham	Xamneua 1	115	Planned	--				□						1	1 x 240	120	120	--
97	Northern	Xamneua1	Nam Xam 1	115	Planned	--				□						1	1 x 240	90	90	--
98	Northern	Vangvieng	Hinheup	115	Planned	--							□			1	1 x 240	41	41	--
99	Northern	Hingeup	Talat	115	Planned	--							□			1	1 x 240	47	47	--
100	Northern	Phontoung	Naxaythong	115	Planned	--							□			1	1 x 240	12	12	--

(Source) Study Team based on PDP 2010 Rev.-1.

4.4.4 Future transmission system

4.4.4.1 Issues for future transmission system

Under the current plan, IPP‘s large-scale power plants and transmission lines for export will be developed more and more, and the power plants for domestic supply will also be increasingly developed by IPPs. The power supply systems for domestic supply and for export are going to be developed separately as it is.

In this way, it seems that the future image of power development would be an extension of the current status, but the directions of the power supply are a bit unclear, and a rational power system plan with a long-term perspective would be necessary. Issues for the future power system would be as follows:

(1) Anxiety about EDL's financial constraints

While hydro-power development in Laos will be mainly left to IPP's private funds even for domestic supply, domestic transmission development is basically an important role of EDL. Under the financial constraints, as stated in Section 2.5.3, excessive transmission investment could worsen the financial condition of EDL.

(2) Domestic demand-supply balance

Due to introduction of much more hydro power for domestic supply, domestic demand will be satisfied even in dry season. However, in rainy season, a lot of excess power is expected which has to be exported.

(3) Power system stability

Large-scale introduction of domestic hydro power also gives rise to concern about power system stability of the domestic grid. Reinforcement of the grid would be necessary in order to realize a stable power supply from the newly installed power sources.

(4) Duplication of transmission lines

Increasing number of exporting IPP may result in the duplication of transmission facilities. This trend would be accelerated also by the increasing needs for exporting domestic excess power.

(5) Prospects for GMS grid

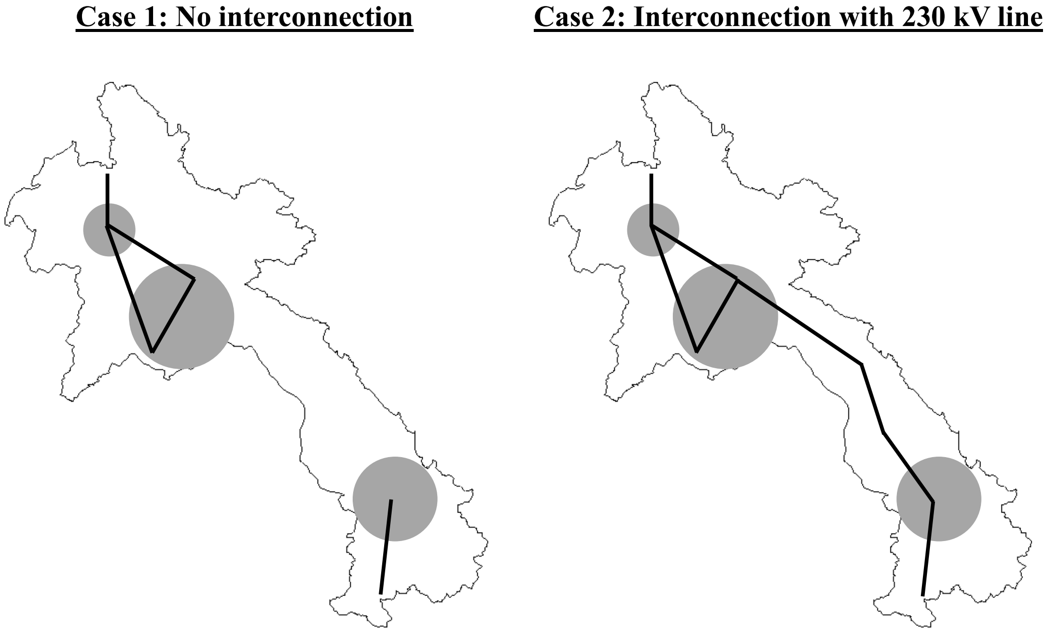
Regarding the GMS grid, even though a rough image exists, concrete aims and effects for each country are not clarified yet.

4.4.4.2 Prospects of future power system

(1) Immediate future power system

According to the EDL's plan, as the new power plants are developed in each region, a lot of 230 kV lines are planned, part of which are already completed including the route Luang Prabang (north) - Hinheup (central) - Naxaythong (Vientiane Capital) as of April 2013.

The current PDP also includes the 230 kV transmission line between the north and the south area, but whether to connect or not doesn't seem confirmed yet. As the construction of such long-distance transmission line requires much investment, under EDL's financial constraints as stated in Section 2.5.3.4, aims and profitability of the construction has to be examined carefully.



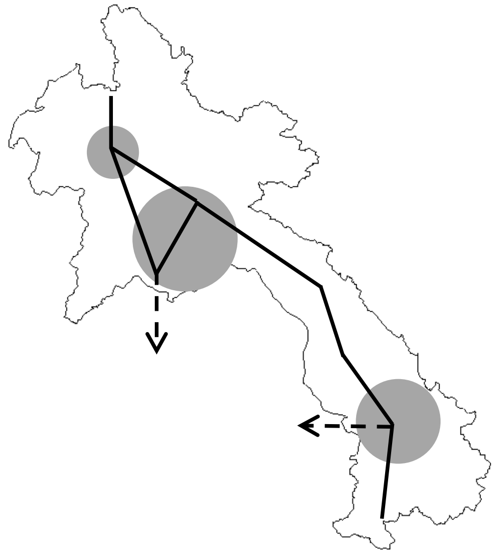
	Case 1	Case 2
Cost	--	200 MUSD for interconnection.
Operation	Similar to the current situation.	Operational benefit is uncertain (power surplus foreseen in both central and south regions)

(Source) Study Team.

Figure 4-27: Comparison of 230 kV North-South interconnection

According to the demand-supply calculation in Section 4.4.3, the demand will be satisfied even in the dry season in 2020, and a lot of excess energy will be generated in rainy season. This is more likely to happen in the south area especially, where more than 1,000 MW of excess power could be generated in rainy season in 2020. Under such condition, the necessity of the north-south connection is still unclear.

Even if the connection becomes necessary in the future, the voltage of 230 kV may not be enough due to stability issue due to the long distance with more than 500 km. Considering the compatibility with the GMS grid, 500 kV design may be better.



(Source) Study Team.

Figure 4-28: Export of excess power from domestic system

By the way, as mentioned above, a lot of excess power is expected from both the north-central grid and the south grid, it is necessary to export the amount accordingly. Methodology for the export is either to utilize existing routes or to construct new routes as shown in Figure 4-28. In either case, as existing 115 kV lines lack of sufficient capacity, lines with 230 kV or higher voltage will be necessary to evacuate the excess power. Additionally, when the new higher voltage connection is realized, it would be better to stop or decrease the existing lower voltage connection for more effective export and improvement of current situation where connections with neighbors with 115 kV or lower voltage lines are formed in a rather complex manner.

(2) Further future power system

The exporting IPPs and their transmission facilities will be transferred to Laos after the concession period expires. After the facilities are transferred, the following options will be possible as indicated in Figure 4-29.

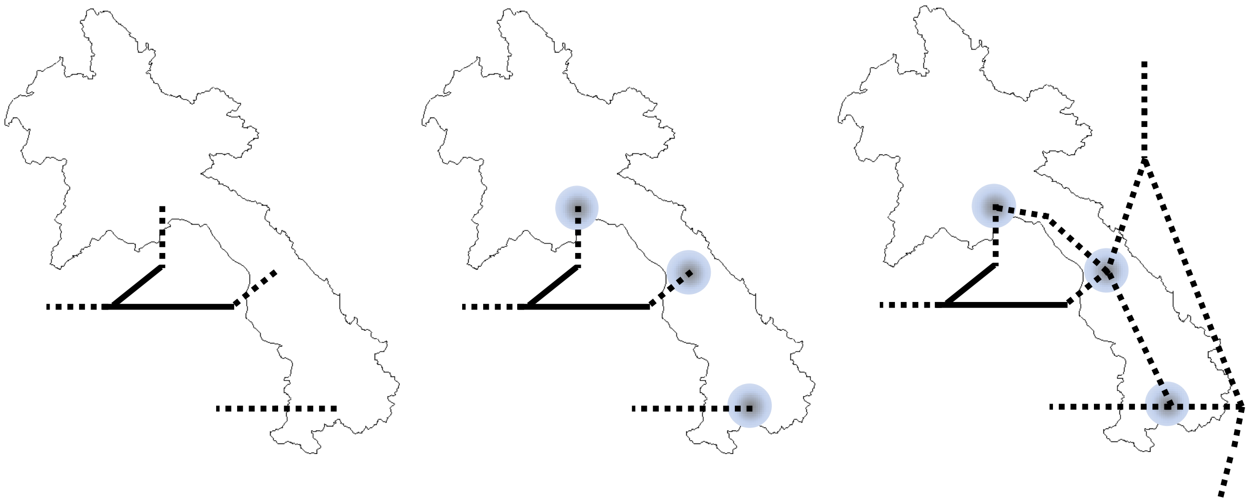
In the option 1, no operation or facility is changed. In the option 2, the existing domestic grid is connected to the transferred 500 kV grid, which is very advantageous for the Lao domestic grid. Firstly, the reliability of the domestic grid will be greatly enhanced due to the connection. Secondly, an effective exporting system can be realized, in which, after domestic consumption, the excess power can be exported collectively through the 500 kV line. In this scheme, the export under long-term contract with higher tariff can be expected.

After the option 2, the option 3 may come into reality based on the agreement with the GMS countries. In implementation of the option 3, it is important to discuss the aims, needs, methodology and technical feasibility with the stakeholders.

Option 1:
500 kV TL are operated as dedicated line to export ever after the transfer.

Option 2:
500 kV TL are connected with domestic grid.

Option 3:
500 kV TL are operated as a part of GMS grid.



	Option 1	Option 2	Option 3
Cost	No additional cost	Cost for connection to the nearest points	More investment are required.
System stability	Status quo	Improved.	More improved.
Operation	Status quo	Simple and rational export system to Thailand.	Flexible multilateral trades within ASEAN/GMS
System analysis	--	Laos and Thailand	GMS countries

(Source) Study Team.

Figure 4-29: Power grid options after transfer of 500 kV lines

4.4.4.3 Optimization of future power system

In the previous section, some supposed scenarios are described along the extension of the current situation.

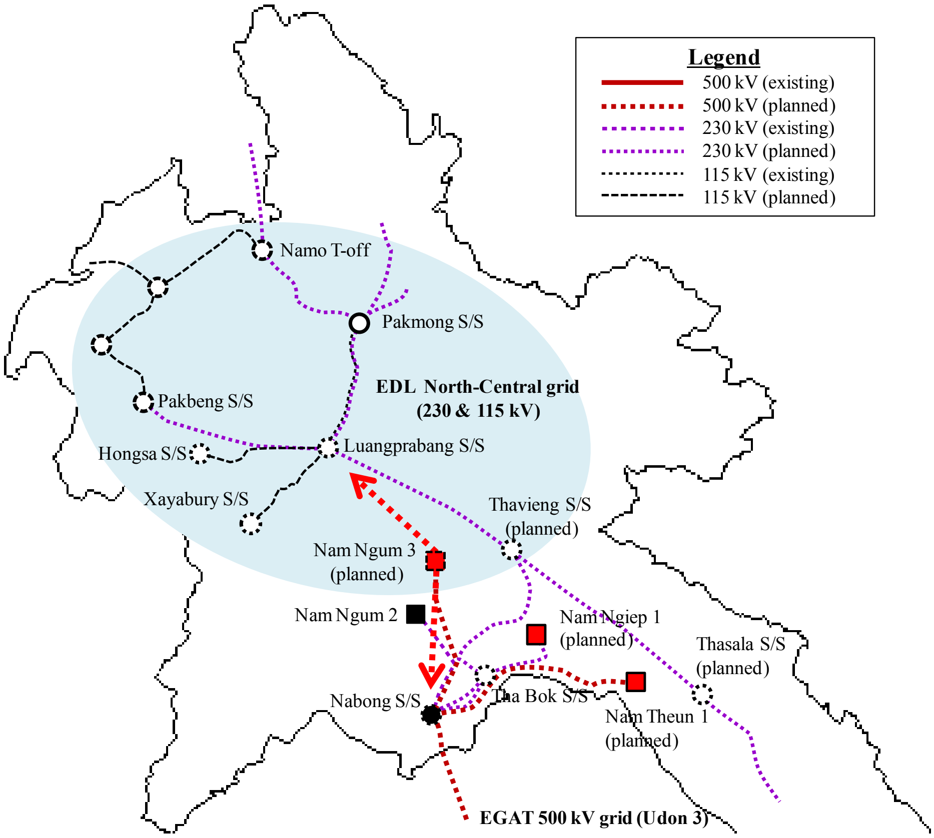
By the way according to the information as of April 2013, big changes regarding the plan of Lao's domestic grid are expected as follows:

- Nam Ngum 3 (460 MW) will be developed no longer by an exporting IPP but by EDL for domestic supply
- Nabong substation and the 500 kV transmission line, which now belongs to the exporting IPP Nam Ngum 2, will be owned by EDL so that the facility can be also shared by the other exporting IPPs.

The installation of Nam Ngum 3 would be a challenge for the EDL's grid because of the plant's large capacity compared with EDL's grid capacity (The capacity of Nam Ngum 3 is more than the maximum demand of the current north-central grid of EDL). For example, a drop-off of the plant would lead to system collapse of EDL grid, unless countermeasures (e.g. reinforcement) are taken for the grid.

Meanwhile, whether or not to connect the Lao domestic grid with Nabong substation is becoming an issue for discussion in the Lao government.

The connection could bring about a lot of advantages for Lao grid. The greatest benefit is this greatly enhances the stability of Lao domestic grid due to 500 kV connection. Thus, the connection would enable the introduction of large-capacity plant (like Nam Ngum 3) to the Lao grid.



(Source) Study Team.

Figure 4-30: Connection of EDL grid with Nabong

Another benefit is that the exporting system can be optimized. Not only the outputs from plural exporting IPPs' but also the excess power from EDL grid can be exported collectively through Nabong substation as the common facility. This is a rational form of the exporting facility without duplication. For the EDL grid especially, excess power (which is to be increased) can be collectively exported through Nabong. In this scheme, the domestic excess power can be exported systematically in bulk under long-term contract.

This is quite different from the existing form of power supply, in which the export system and the domestic supply system is completely separated. In this form of supply, domestic supply is firstly prioritized and then the rest of the power will be exported.

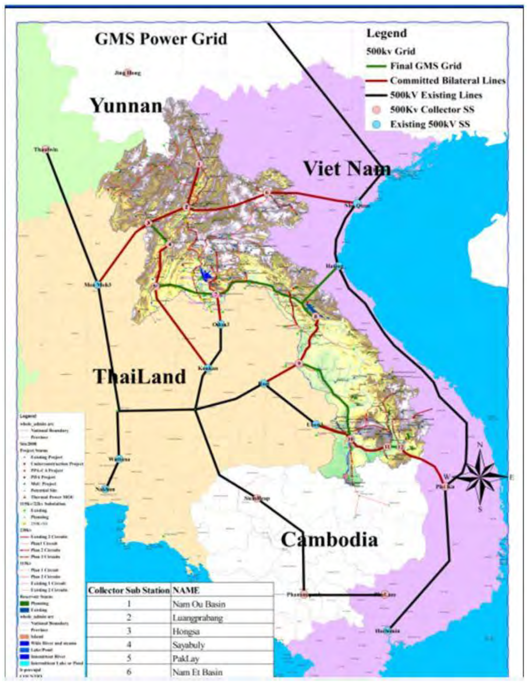
As such, this scheme could be a dominant option for Laos, which is optimized in terms of reliable and cost effective power supply. This option could be also getting ahead of the future form of power supply which is supposed to happen after around mid 2030s.

If this form of connection succeeds in Nabong, the same scheme may be applied to the south or the north area, which also could be a step towards the formation of the GMS grid.

4.4.4.4 Towards regional power trade in GMS

As described in the previous section, the connection of the domestic grid to the neighboring high-voltage grid would be currently a predominant option to be prioritized in order to optimize the domestic grid, and this could be the first step for the EDL grid towards the part of the GMS grid.

The institutional framework for GMS power trade has been so far prepared for its realization under the initiative of ADB. In 2008 in Vientiane, the MOU on ‗Roadmap for Implementing the Greater Mekong Sub-region Cross-Border Power Trading' was signed, which stipulates the actions and the timeline (regarding studies on trading rules, the GMS grid code and etc.) for implementation of Stage 1 and preparation of Stage 2[40]. Including these, a lot of studies have been conducted regarding the GMS power trade. According to an ADB study in 2009[41], 15% decrease of electricity costs (US$213billion) could be expected if the power markets in the GMS region are completely integrated.



(Source) Future Development of the Power Sector in Lao PDR (WB workshop on Sep. 2011).

Figure 4-31: Image of GMS grid

Nevertheless, it seems that a comprehensive system plan for rational formation of the GMS grid has not been prepared yet. Even though an image of the GMS grid exists as shown in Figure 4-31, the role of each transmission line in the GMS grid is not clear. On the other hand, cross-border high-voltage transmission lines for bilateral projects are continuously being prepared and constructed, which are expected to be backbones of the GMS grid.

However, a power system has to be optimally formed based on a long-term development plan. Otherwise the system could become economically irrational one with duplication. It is highly recommended to formulate a comprehensive and optimal GMS system plan at earlier stage.

The GMS system plan could be formulated, in the framework of GMS working groups, considering the factors including at least the needs for regional trade for each country and existing identified bilateral import-export projects.

40 Refer to Section 2.2.1

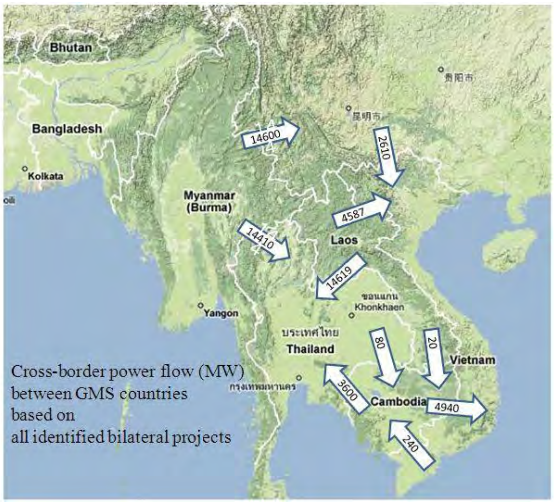
41 Building a Sustainable Energy Future: The Greater Mekong Subregion (2009, ADB)

Table 4-27: Needs for regional trade for each country

Country	Needs for regional trade
Thailand	- Need to diversify power generation other than natural gas - Difficulty in domestic development of hydro or coal due to environmental opposition - Need for importing low-cost hydro - MOU for 7,000 MW import by 2015 and 10,000 MW import by 2017 from Laos - MOU for the development of 5 hydro projects in Myanmar - MOU for 3,000 MW import by 2017 from China
Vietnam	- Need for importing low-cost hydro - Need for import for domestic supply constraints - MOU for 2,000 MW import from Laos
Laos	- Export hydro for earning revenues for economic development
Myanmar	- Export hydro for earning revenues for economic development

(Source) Study Team.

In formulating a power system plan, technical elaboration is essential. By collecting the latest grid data from each country, power system analysis has to be conducted including transient stability analysis. It should be noted that the GMS grid may include some loop configuration which can generate undesirable power flow in the grid, resulting in an obstacle to the operation. In order to avoid this, countermeasures including the introduction of direct current facilities may be necessary.



(Source) GMS Transmission & Trading Case Study (ECA, 2010)

Figure 4-32: Power flows based on all identified bilateral export projects

Once the power system plan is established, it is necessary that any cross-border high-voltage transmission projects in this region (including large-scale exporting projects) have to be proceeded in harmony with the plan. By doing that, the rational and optimal power system for the GMS power trade could be achieved.

4.4.5 Power system simulation software –DigSILENT”

4.4.5.1 Necessity of power system simulation software –DigSILENT”

The power system of EDL is connected to that of EGAT, moreover central and north is connected to south by way of power system of EGAT. For this reason, EDL could not ignore the power system of EGAT when performing power system analysis. EDL uses the software PSS/E for power system analysis, while EGAT uses the software DigSILENT. Thus, in order to get necessary power system data from EGAT, the data needs to be converted from the format of DigSILENT to that of PSS/E.

At present, EDL performs practically power flow analysis only. For this reason, the data such as impedance of transmission/distribution line, load condition, etc., are used, which are not so complicated. Therefore, it would not be a big problem to persist in PSS/E so long as the data are converted automatically. However, when performing transient stability analysis in the future (It will be performed according to the Grid Code), it may cause problems to exchange data with EGAT in terms of data compatibility, and the result of analyses may also be affected.

Moreover, considering the fact that EDL still uses version 31 of PSS/E since it does not have annual maintenance contract of PSS/E (version 33 is the latest as of September 2012), it would be quite reasonable for EDL to replace the analysis program with DigSILENT. In addition, EDL does not possess a skill to calculate the setting of protective relays. Therefore, DigSILENT, which possesses the function to calculate the protective relays setting, is virtually preferable to PSS/E, which does not have the function.

For the reasons mentioned above, JICA decided to provide DigSILENT to DEPP and EDL.

The software, which is compatible with neighboring countries, is going to be used in the future for the system analysis (system planning).

(Source) Study Team.

Figure 4-33: Usage of ―DigSILENT” system

4.4.5.2 Optional functions of DigSILENT

The ―Base Package” of DigSILENT possesses basic function, while optional functions can be added if necessary. The necessary functions for EDL are listed as below.

Table 4-28: List of functions necessary for EDL

Function	Purpose
Power flow analysis Fault current analysis	To estimate transmission/distribution line capacity and to design specification of substation equipments (to make power system planning)
N-1 contingency	To secure the system reliability when one line fault occurs (to make power system planning)
Transient analysis	To understand transient phenomena of the system when a fault occurs. (For the purpose of stable operation of generators and whole power system, and for the fault causes analysis)
Calculation of reliability evaluation indexes	To understand the system reliability quantitatively. To make economical investment plan for the system. (To make power system planning)
Protection relay settings calculation	To calculate protection relay settings
Distribution network optimization function	To plan and optimize 22 kV Vientiane distribution system.

(Source) Study Team.

For the reasons mentioned above, the optional functions necessary for EDL are highlighted in Table 4-29. The column ―Future" represents the status of five years later or more. And EDL does not intend to contract maintenance program. So the Study Team chose functions truly indispensable in the future unless strongly requested by EDL. In addition, EDL does not perform reliability analysis at the moment, however, the planning division strongly requested to have the function (currently, the economic index is considered to be applied and the function is necessary when doing this). Refer to the catalog attached for the details of each option. The details of each option are summarized in Table 4-29.

Table 4-29: Option of ―DigSILENT"

	Item PowerFactory V14.0 Functions	Present	Future
1	PowerFactory Base Package	**Required**	**Required**
2	Protection Functions (Overcurrent-time & Distance)	if any	if any
3	Overcurrent-Time Protection (Including item No.2 functions)	**if any**	**if any**
4	Distribution Network Optimisation	**if any**	**if any**
5	Harmonic Analysis	No need	if any
6	Optimal Power Flow I (reactive power optimization)	No need	if any
7	Optimal Power Flow II (OPF I + economic dispatch)	No need	No need
8	Reliability Analysis	**if any**	**if any**
9	State Estimation (SE)	No need	No need
10	Stability Analysis Functions	**if any**	**Required**
11	Electromagnetic Transients (EMT)	No need	No need
12	Transient Motor Starting	No need	No need
13	Small Signal Stability (Eigenvalue Analysis)	No need	No need
14	Dynamic Parameter Identification	No need	No need
15	DSL Crypting Option Included: DSL Crypt	No need	No need
16	PSS/E Export (*.raw, *.seq, *.dyn)	No need	if any
17	CIM Import and Export	No need	No need
18	OPC Interface (Ole for Process Control)	No need	No need

(Source) Study team based on the specification of DigSILENT.

After a series of discussions with the planning division, the Study Team confirmed that the number of license necessary for the planning division is seven in total. The form of the license is not server type but workstation type. This is because the workstation type does not require forming LAN or having server administration.

Meanwhile, the Study Team suggested that two licenses should be provided for DEPP of MEM. Basically, DEPP is supposed not to be performing any analysis but to determine standards or policies and administrate EDL. On the other hand, the organization which administrates IPPs is not EDL but DEPP. From this perspective, the software is necessary for DEPP, too. The form of the license is the same as that of EDL.

4.5 Technology transfer

The Study Team provided technology transfer mainly on demand forecast and power system planning through technical workshops and OJTs. The technical workshop on the methodologies to revise the current PDP for demand forecast, generation planning and system planning was held on October 10, 2012.

After the technical methodologies were confirmed in the first workshop, technical transfer was prepared on OJT basis in the field of demand forecast and system planning. Regarding the demand forecast, a technical workshop was held from April 2 to 4 2013, specifically, for the usage of new software ―Economate". The results of demand forecast and system analysis, and technical transfer were presented in the Final Workshop on April 9, 2013. The outline, schedule and participants of the technical workshops are briefed in Appendix IX.

Chapter 5 Recommendation

As a conclusion of the Study, future cooperation projects are proposed in this chapter.

Firstly, the project for the formulation of NPDP, which is one of the focal issues of the Study, is proposed with two options.

Secondly, potential yen-loan projects on expansion of transmission lines and substations are proposed, as per the expected output mentioned in Section 1.2.4. In addition to the loan project for installation of power facilities, technical cooperation for the training on maintenance of substations is proposed to properly operate and maintain the installed facilities.

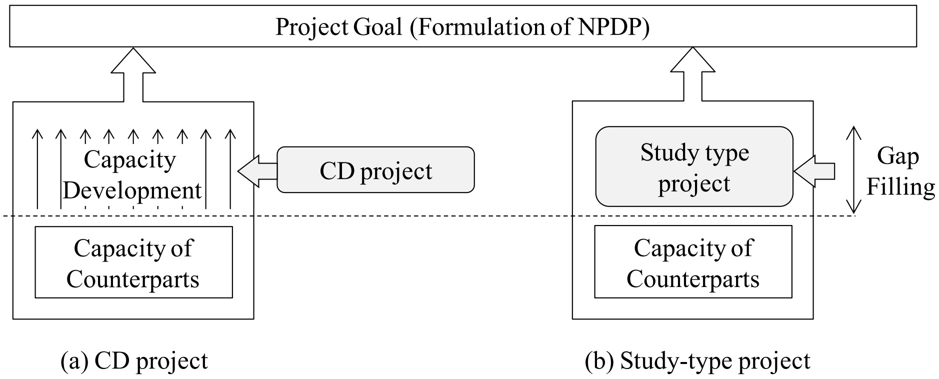
In the generation sub-sector, where private sector investments are mostly expected as mentioned in Section 4.3, possibility for the utilization of JICA‘s PSIF scheme, fully resumed last year, is discussed.

5.1 Technical cooperation for preparation of NPDP

As discussed in Chapter 3, the preparation of NPDP will be the most critical issue for not only DEPP but also whole the power sector in the context of power sector governance. In this study, preparatory work for the formulation of NPDP has been conducted, but the actual formulation will require further external support. JICA is basically positive to extend the technical support in this regard, and the Study Team proposed a technical cooperation (TC) project of JICA at first as detailed in 5.1.1. The main objective of the project is not only the formulation of NPDP itself, but also the capacity development for the formulation of NPDP, considering the sustainability of planning, revising and updating the NPDP. It will thereby take at least four years.

On the other hand, the top management of MEM and DEPP had different views on the formulation of NPDP. Under the limitation of human resources in DEPP, they desired a more shortcut approach and more tangible outputs directly from the consultant on the critical policy issues. The period of coming project should be at the longest one year, and the most critical policy issues for the time being are i) rational electricity tariff of EDL, including the discussions on cross-subsidies in the residential sector, and long-run marginal cost considering not only the generation cost of EDL-Gen but also payment of power import from foreign countries and domestic IPP, and transmission and distribution cost; and ii) realistic and sustainable investment planning of EDL along with the promotion of private sector investment.

Based on the above discussion, the Study Team finally proposes two options for the coming technical cooperation: "capacity development (CD) project" and "study-type project" named for convenience. The difference between the two options is illustrated in Figure 5-1. The gap between the project goal (formulation of NPDP) and the existing capacity of counterparts will be bridged mainly by capacity development in Option-1: CD project, and filled with the direct implementation of consultants in Option-2: study-type project.



(Source) Study Team.

Figure 5-1: Image of technical cooperation project

The general characteristics of the two options are summarized in Table 5-1, even though the coming project, whether either type is selected, should be implemented to realize both advantages as much as possible.

Table 5-1: General characteristics of CD project and study-type project

Option	Advantage	Disadvantage
CD project	• Easy to obtain project outputs • Efficient	• No capacity development of counterparts • Low sustainability
Study-type project	• Capacity development of counterparts • Sustainable	• Difficult to secure the quality of outputs • Slow and inefficient

(Source) Study Team.

5.1.1 Capacity development project

(1) Project title

The title of the proposed project is "Project for capacity development of electric power sector policy and planning".

(2) Project type

Technical Cooperation Project[42]

(3) Counterpart organization

Strictly pursuant to the Electricity Law and the ministerial decree for the mandate of DEPP, DEPP is the primary counterpart to formulate the national power development plan. In addition, DEB is the secondary counterpart to consider the situation and plan of IPP development, and EDL is also the secondary counterpart to formulate power system planning for domestic supply.

(Primary) Department of Energy Policy and Planning (DEPP), MEM
(Secondary) DEB, EDL

42 One of the project categories of JICA.

(4) Goal, purpose and indicators

The goal of the technical cooperation project is ―to strengthen the governance mechanism of the electric power sector of Laos, through human and institutional capacity development of the Department of Energy Policy and Planning (DEPP), and the Ministry of Energy and Mines (MEM)"

The indicators of the goal are 1) realization of more rational procedures for negotiating power exchange with the neighboring countries; 2) rational utilization of natural resources; 3) capacity development for DEPP to draft and recommend a variety of power sector policies through a series of dialogue with stakeholders; and 4) regular policy dialogue with concerned parties becomes general practice within DEPP.

The purpose of the project will be ―to prepare National Power Development Plan". Its indicator is ―National Power Development Plan is completed".

(5) Activities

The proposed project will provide resources for more informed policy making by establishing a new procedure to facilitate wider discussion of a variety of policy issues with stakeholders. The project will provide the government with a forum to elicit views and insights of stakeholders and international experts through seminars and workshops. The project also provides assistance on training to improve analytical capacity of knowledge base on such areas as reliability, stability of grid networks, demand forecasting, etc.

The scope of the project will cover 1) providing DEPP assistance for policy research and analysis, data collection, and information dissemination; and 2) creating a forum for policy dialogue and analysis through a partnership with the key stakeholders. The project will help improve the government's power sector policy agendas by evaluating existing policies and fill the necessity of drafting specific policy areas and providing feedback on implementation, assisting DEPP recommending new ideas and policy options to policy makers, assisting policy makers in analyzing and responding to regional and global economic challenges, and fostering constructive policy dialogue among stakeholders in countries and in the region.

(6) Expected outcomes

A set of sound power sector policies based on a solid base of data and evidence are the cornerstone of the Laotian energy sector. The JICA experts will collaborate with DEPP to strengthen the department's capacity for use of evidence-based decision-making in formulating new laws and policy documents. The project promotes open dialogue, helping form consensus in implementing new power sector strategies that optimize use of scarce natural resources.

To help ensure long-term sustainability in Laotian power policies, the project will work to build the capacity of staff members of DEPP to engage a variety of policy issues with stakeholders during the decision-making process.

(7) Output

The main output of the proposed activities will be organizational arrangement for carrying out dialogue on a variety of policy issues facing the power sector of Laos as well as the region. Numerous meeting of stakeholders will be convened to discuss these issues.

Background data as well as discussion papers on these issues and alternative policy options for discussion at the meeting will be prepared and provided.

Some experts on the issues, academics, representatives of development partners, and other stakeholders will be invited to participate in the discussions.

Field trips to neighboring countries to carry out policy dialogue on international issues will be carried out.

To follow up on the discussions, JICA expert will hold continuous dialogue with the policy makers and assist them with the sequencing and implementation of policies. JICA will also use the project to give extensive press and media coverage on the major themes discussed in the course of the technical cooperation project.

(8) Impact

The impact of the project will be better policy formulation on a range of issues on the electric power sector, confronting Laos, so that medium-term economic growth accelerates and poverty is reduced. The outcome of the project will be wider discussion and awareness of policy issues within the power sector. It will also encourage participation of stakeholders in policy formulation and hence facilitate broad support for the policies. The policy makers will be able to examine international best practice policy options and adopt those that suit Laos. The CD project will also provide opportunities for Laos to tap regional and international expertise through resource persons for seminars and discussions, to improve economic policy formulation and implementation in Laos.

(9) Implementation schedule

A draft of the tentative implementation schedule is shown in Table 5-2.

Table 5-2: Overall schedule for preparation of NPDP (Draft)

Stage	I. Preparation					II. Policy discussion								III. Formulation				IV. Approval			
Activities		First Year				Second Year				Third Year				Fourth Year				Fifth Year			
	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
Preparation																					
1. List of policy issues																					
2. Draft of implementation structure																					
3. Draft of overall schedule																					
4. Discussion among Secreratiat (Work Team)																					
Steering Committee																					
1. Approval of implementation procedures		◎																			
2. Reviewof interim report and report to Minister				◎		◎		◎		◎		◎		◎		◎					
3. Approval of final draft of NPDP																		◎			
4. Report and submission of NPDP to Minister																		◎			
Secretariat (DEPP)																					
1. Preparation of draft implementation procedures																					
2. Compilation of interim NPDP																					
3. Compilation of final NPDP																					
Taskforce I: Power Sector Policies																					
1. Fundamental data collection and analyses																					
(1) Primary energy potential																					
2. Policy issues in NPDP																					
(1) Energy security																					
(2) Optimization of generation and trade																					
(3) Rational development of water resources																					
(4) Configuration of national grid																					
(5) Investment and funding																					
(6) Rural electrification																					
(7) Environmental and social consideration																					
(8) Future prospect in region																					
3. Set-up development scenarios																					
Taskforce II: Demand Forecast																					
1. Fundamental data collection and analyses																					
(1) Socio-economic data (population, GDP etc.)																					
(2) Potential large demand (Mining, SEZ, etc.)																					
2. Demand forecast																					
(1) Calculation by econometrics model																					
(2) Daily load and load duration curves																					
(3) Load forecast at BSP (S/S)																					
Taskforce III: Power Development and Trade																					
1. Fundamental data collection and analyses																					
(1) Progress of IPPs																					
(2) Foreign power situations and plans																					
(3) Regional network																					
2. Generation development planning																					
(1) Long list of potential projects																					
(2) Prioritization of projects																					
(3) Optimization of generation development (Least cost)																					
3. Transmission development planning																					
(1) Modeling																					
(2) System analysis																					
(3) Transmission and S/S development planning																					
4. Distribution development planning																					
(1) Rough planning of distribution facilities																					
(2) Rural electrification planning																					
5. Export project development																					
Taskforce IV: Regulatory Issues																					
1. EDL Tariff and PPA study (WB-TA)																					
2. Strategic Environmental Assessment																					
(1) Comparison among scenarios																					
3. Capital requirement																					
(1) Capital requirement for domestic supply																					
(2) Capital requirement for export IPPs																					

(Source) Study Team.

5.1.2 Study-type project

While the above technical cooperation project aims the formulation of comprehensive power development plan along with the capacity development of DEPP as the secretariat, this study-type project focuses on the most critical policy issues and technical elaborates the current EDL-PDP utilizing the technologies transferred in this Study, i.e., the econometric model for demand forecasting and DigSILENT for power system planning.

(1) Project title

The title of the proposed project is ―Study on the formulation of National Power Development Plan".

(2) Project type

Technical Cooperation for Development Planning[43]

(3) Counterpart organization

For the sake of efficiency, the primary counterpart organization is assigned to EDL, which has primary data on generation, transmission, distribution and finance. Deputy Managing Director or Director of Departments class personnel of EDL should be appointed as counterparts in respective technical fields for smooth implementation of the project.

(Primary) EDL
(Secondary) DEPP, DEB

(4) Goal and purpose and indicators

The goal of the project is ―to formulate a rational and reliable power development plan, through introduction of advanced analytical technologies"

The indicators of the goal are 1) Critical policy issues are discussed in NPDP; 2) EDL-PDP is upgraded in terms of reliability and comprehensiveness; and 3) Advanced technologies for demand forecasting and system analysis are transferred to EDL.

The purpose of the project is ―to prepare National Power Development Plan". Its indicator is ―National Power Development Plan is completed".

(5) Activities

Corresponding to the above indicators, the following activities should be conducted:

1) Policy discussion is conducted:
   Urgent policy issues are tentatively i) cross subsidy, and ii) EDL investment plan as mentioned earlier, but the thematic issues should be determined reconfirming the opinion of the Lao side prior to the project. The consultant should make recommendations on the focal issues with data collection, analysis and evaluation, and the recommendations are discussed in the quarterly workshop where the high class officer under MEM (e.g., MD, Deputy MDs and Directors of EDL, DG and Deputy DGs in the department of MEM) participate.

2) EDL-PDP is upgraded in terms of reliability and comprehensiveness:
   i) Demand forecasting is conducted using the econometric model introduced in this Study;
   ii) Power system planning is conducted using DigSILENT;
   iii) Power supply and export are discussed and optimized from the viewpoint of EDL's financial

[43] One of the project categories of JICA.

condition (long-run marginal cost); and

iv) Formulation of transmission lines are discussed and optimized in accordance with the above generation development plan.

3) Advanced technologies for demand forecasting and power system analysis are transferred to EDL:

i) Demand forecasting and system analysis are conducted in collaboration with the counterpart personnel of EDL.

ii) Technology transfer workshops are held with the participation of EDL and DEPP staff.

(6) Implementation schedule

The project duration should be one year at longest as per the request from the counterpart of the Study. However, it should be adjusted according to the schedule of revision of EDL-PDP. In addition, limited policy issues will be discussed in this project, and the extension of the project in the future will be expected to cover all the policy issues to be discussed in the NPDP as listed in Chapter 3.

5.2 Transmission line and substation project for future ODA loan

In this section, based on the results of system analysis as mentioned in section 4.4.3, transmission line and substation projects are proposed which lead to the future ODA loan projects.

In addition, the result of the site survey is described in section 5.2.2, which shows the undesirable status of the maintenance for substation facilities such as switch gears and protection devices and the necessity of the capacity building for the maintenance skills. In this reason, the technical cooperation for training program for maintenance skills as well as a complement project is proposed, which could be the future grant aid project.

5.2.1 Transmission line and substation project for future ODA loan

5.2.1.1 Transmission line project

(1) Background of transmission line project

According to the current power development plan (PDP 2010 – 2020), the installed capacity in Laos will be increasingly developed from 800 MW in 2012 to 8,000 MW in 2020 and it requires the reinforcement or installation of more than 100 transmission lines in the next 10 years with necessity of financial resources.

In this study, system analysis was performed based on the power development plan data provided by EDL and the demand forecast modified by the Study Team as described in Chapter 4 with the conditions shown in Table 5-3. Then some projects are prioritized for the near future development considering the possibilities to utilize the Japanese yen loan:

Table 5-3: Data for system analysis

Category	Data
Generation plan	PDP 2012-2025 (under preparation)
Demand forecast	Implemented by the Study Team
Transmission plan	PDP 2010-2020 (Revision-1)

(Source) Study Team.

(2) Prerequisites on analysis

The prerequisites on the projects are as below,

1) Status of the transmission line projects

The system analysis for the transmission line was carried out based on the PDP 2010 – 2020 (Revision-1) because the PDP 2012 – 2025 data was not prepared. For this reason, the proposed projects need to be realigned with EDL before considering the implementation.

2) Consideration of large industries for the analysis

Since the development of large industries is still unclear, the analysis in this Study excludes the large industries.

3) Estimation of the project cost

Project cost is given simply based on a median of project cost of EDL-PDP 2010. Therefore it is necessary to carry out F/S to estimate each project cost in detail.

(3) Project list

As the result of system analysis, the list of transmission line development plan formulated in this Study is shown in **Table 4-26** in Chapter 4.

As mentioned in Chapter 4, the power supply is expected to increase rapidly in both the north-central grid and the south grid in the near future and a 230 kV transmission line network is needed in both areas for domestic and exportation purposes. In addition to 230 kV lines, some existing 115 kV transmission lines located in the end of the grid are expected to be connected with the planned power station, but most of them are constructed with a single line and will be in a lack of capacity.

From the above viewpoint, eight transmission line projects are picked up for ODA loan, including the estimation of project cost, as shown in Table 5-4. The locations of transmission line for each project are shown on the map in Figure 5-4.

The outline of each project is described as follows:

1) <u>230 kV transmission line (Naxaythong–Nabong-Thavieng)</u>

In Xieng Khuang Province (Central area), many IPPs such as Nam Ngiep 2 and Nam Ngum 4 are planned to start operation. In order to send the electric power generated by them to domestic area or for export, existing 115 kV transmission lines are not enough due to the capacity constraints of them and 230 kV transmission line network is required urgently. Thus, the series of 230 kV Naxaythong – Nabong –

Thavieng transmission lines should be constructed as proposed.

2) <u>230 kV transmission line (Saravan – Pak Xong – Ban Hat)</u>

In Saravan Province, a large scale coal fired thermal power plant is planned in addition to the hydropower IPPs such as Xe Kong 4 and Xe Kong 5. After 2018, the extra electric power in south area will be more than 1,000 MW during rainy season and the transmission line network to export such excess power is required. Thus, the 230 kV Saravan – Pak Xong – Ban Hat transmission line planned in the current PDP for the export to EGAT and EDC, should be constructed.

3) <u>115 kV transmission line (Phonsavan – Xamneua)</u>

Nam Xam 1 and Nam Xam 3 in Houaphan Province are planned to start operation in 2015 and the reinforcement of 115 kV Phonsavan – Xamneua is required in order to send the electric power to the domestic area.

4) <u>115 kV transmission line (Pakbo – Ban Na (Seno) – M. phin)</u>

In Khammouan and Savannakhet provinces, 115 kV Pakbo – Ban Na (Seno) – M. Phin transmission line and a substation to cope with increased demand in the near future need to be constructed in order to connect to a series of IPP (d) near the border of Vietnam.

5) <u>115 kV transmission line (Jiengxay – Bang Yo)</u>

In Champasak Province, the increased power in the south area will cause overload of the current 115 kV transmission line in the south area. 115 kV Ban Na - Jiengxay transmission line needs to be upgraded from two circuits (2 cct) to three circuits (3 cct) (According to the latest information from EDL, the MOU has already been signed for this transmission line project.).

6) <u>115 kV transmission line (Vangvieng – Hinheup)</u>

Increased power supply from IPPs in the north area such as Nam Ou #1 -7 will cause overload of the current 115 kV transmission line in the central area. 115 kV Vangvieng – Hinheup transmission line needs to be upgraded from one circuit (1 cct) to two circuits (2 cct).

7) <u>115 kV transmission line (Ban Don – Non Hai)</u>

In Vientiane Province, to connect the Sanakham Mining and EGAT, 115 kV Ban Don – Non Hai transmission line should be upgraded from one circuit (1 cct) to two circuits (2 cct).

8) <u>115 kV transmission line (Luangprabang 2 - Sayabouly)</u>

As mention above, IPPs supply in the north area such as Nam Ou #1 -7 cause overload of the 115 kV transmission line in the central area. 115 kV Luangprabang 2 - Sayabouly transmission line needs to be upgraded from one circuit (1 cct) to two circuits (2 cct).

Table 5-4: Transmission line development plan

No	Voltage (kV)	Region	Project From	Project To	Status	2010 Estimated Project Cost mil. USD	2011 Estimated Project Cost mil. USD	No. of Circuit	Conductor Size Number of Conductor per Phase x mm2	Length (1cct) (km)	Length (total)	Owner ship	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	230	Northern	Thavieng	Tha Bok	Planned	93.93	131.50	2	4x630	120	240	EDL			■						
	230	Central	Tha Bok	Nabong 1	Planned	40.70	56.98	2	4x630	52	104	EDL				■					
	230	Central	Naxaythong	Nabong 1	Planned	14.09	19.73	2	4x630	40	80	EDL			■						
2	230	Southern	Saravan	Pak Xong	Planned	37.80	52.92	2	2x630	75	150	IPP(d)				■					
	230	Southern	Pakxong	Ban Hat	Planned	88.20	123.48	2	2x630	175	350	IPP(d)				■					
3	115	Northern	Phonsavan	M.Kham	Planned	7.51	10.51	1	1x240	56	56	-									
	115	Northern	M.Kham	Xamneua 1	Planned	16.04	22.46	1	1x240	120	120	-									
4	115	Southern	Pakbo	Nongdeun	Planned	0.95	1.33	1	1x450	10	10	EDL			■						
	115	Southern	Nongdeun	Ban Na (Seno)	Planned	7.62	10.66	2	1x450	40	80	EDL			■						
	115	Southern	Ban na(Seno)	M. Phin	Planned	18.88	26.43	2	1x240	140	280	EDL				■					
5	115	Southern	Jiengxai	Bangyo	Planned	0.81	1.14	1	1x240	10	10	IPP(d)				■					
6	115	Northern	Vangvieng	Hinheup	Planned	1.47	2.06	1	1x240	41	41	-							■		
7	115	Central	Ban Don	Non Hai	Planned	4.40	6.16	1	1x240	54	54	EDL			■						
8	115	Northern	Luangprabang 2	Sayabouly	Planned	6.59	9.23	1	1x240	76	76	EDL						■			

*Magnification (1.4) is decided by GDP of 2009 and GDP of 2011

■: Planned in current PDP

(Source) Study Team base on the PDP 2010 Revision-1

(4) Preliminary SEA for proposed transmission line projects

When determining priority projects to the ODA loan among candidates through evaluation of environmental, social and economic impacts, it is expected to apply strategic environmental assessment (SEA) following the Guidelines for Environmental and Social Considerations of JICA. For the proposed 230 kV and 115 kV candidate transmission line projects in line with the Guideline, SEA exercise is demonstrated in this Study. The result shows that the 115 kV project between Pakbo – M. Phin and the 115 kV project between Vangvieng – Hinheup are likely to have the lowest impact among the candidate project if they were constructed. The detailed results are shown in Section 5.2.1.4.

(5) Status of projects

In this study, from the result of power system analysis, a long list of the transmission projects was formulated, and furthermore, a prioritized eight projects were selected as shown in Table 5-5.

The projects were all with no plans for financial resources (funds) when they were listed up in PDP 2010-2020 (Revision 1). The Study Team was not able to acquire updated information on the project status during the system analysis and the formulation of project lists.

After the completion of the lists, the Study Team talked with EDL management in April 2013 on the progress and the possibility of the projects development by the Japanese ODA loan. The project status as of April 2013 is shown in Table 5-5.

Table 5-5: Project status of the candidate transmission line projects

No.	Transmission line project	Project status
1	230 kV Naxaythong - Nabong - Thavieng	Under construction
2	230 kV Saravan - Pak Xong - Ban Hat	MOU singed
3	115 kV Phonsavan – Xamneua	Planned
4	115 kV Pakbo - BanNa (Seno) - M. Phin	Under construction
5	115 kV Jiengxay – BanYo	Under construction
6	115 kV Vangvieng – Hinheup	Planned
7	115 kV Ban Don - Non Hai	Planned
8	115 kV Luangprabang 2 – Sayabouly	Planned

(Source) EDL

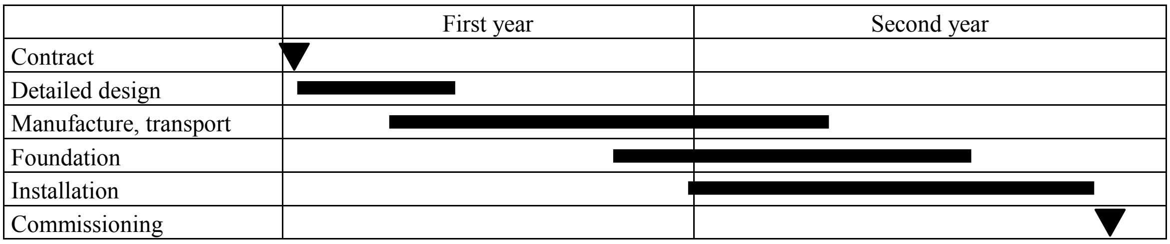
As shown above, some of the projects have already started. The rest of the projects still have the possibility to be adopted as the yen loan project.

(6) Next steps for Japanese ODA loan with project period

The step towards the adoption of the candidate projects as the yen loan projects will be as follows:

- Feasibility study;
- Loan requests;
- Appraisal mission by JICA;
- Exchange notes;
- Loan agreement; and
- Procurement of consultants and contractors.

After these steps with minimum two years period, the project will be implemented. The project period from the detailed design to commission is assumed to be approximately two years. Figure 5-2 shows the assumed project implementation period from the contract of consultant and contractor.



(Source) Study Team.

Figure 5-2: Implementation schedule

5.2.1.2 Substation project

(1) Background of substation project

As the result of the system analysis, more than 40 substations require reinforcement of the transformers in the next 10 years. On the other hand, the reinforcement of the reactive facilities is necessary in order to maintain proper voltage of the power system.

Thus, some projects are prioritized for the near future development considering the possibilities to utilize the Japanese yen loan. In addition, the technical cooperation project for training EDL engineers concerning planning of the transformer and reactive power facility is proposed. The purpose of this project is to improve the planning skills to identify the bottlenecks of the power system.

(2) Prerequisites

The following points need to be noted similarly as the transmission plan in section 5.2.1.1.

1) The estimated demand on the substations is larger than before due to the change in the method of demand forecast.

   The Large-scale industry demand is excluded in the demand forecast and the industry demand is partially allocated to the general demand. Due to this, the total capacity of transformers is slightly insufficient compared with the EDL-PDP.

   Therefore, when preceding the project, the actual demand ratio needs to be confirmed and the difference between actual demand ratio and planned demand ratio must be identified beforehand.

2) Confirmation of power factor and the target level of power factor adjustment

   In this analysis, the power factor is defined as 0.9 and the target level of the power factor is not defined specifically. It needs to be determined accordingly with the agreement with EGAT. Therefore, the target level of the power factor has to be revised when preceding reactive power planning and the project for arranging reactive power equipment. The amount suggested in this list is minimum requirement level and highly possible to increase.

(3) Project list

As the result of the system analysis conducted in Chapter 4 in this study, transformers which need to be newly installed compared with PDP 2010-2020 is shown in Table 5-6, and the minimum amount of the reactive facilities required to sustain voltage is shown in Table 5-7.

The substation expansion plan discussed in Chapter 4 is summarized here. Modifying the demand forecast based on PDP 2010-2020 in the same way as the power system analysis, the Study Team has identified the parts which will be likely to be overloaded.

At the same time, arrangement of reactive power equipments is important in order to keep the voltage in a proper level. For this reason, the Study Team has chosen those equipments so that the voltage can be within the recommended range which is specified in the Grid Code. The number of the equipments planned is minimum requirement level in the same way as the substation plan.

Table 5-6: Substation development plan (i.q. Table 4-24)

(Unit : MVA)

Provinces	No.	Substation	Com. years	inst. cap	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1 Phongsali	1	Boun Neua						40.0					20.0		
2 Bokeo	1	Houayxay							40.0			40.0			
3 Luangnamtha	1	Luangnamtha 1	2009	20							20.0				
	2	Luangnamtha 2							20.0		20.0				
4 Oudomxay	1	Oudomxay	2009	20						20.0					
	2	Namo	2012	40											
	3	M Houn							40.0						
	4	Pak Beng						40.0							
5 Huaphanh	1	Xam Neua 1	2012	40											
6 Xieng Khuang	1	Phonsavan	2003	16						60.0					
	2	Mkham	2012	10						40.0					
	3	Thavieng								20.0					
7 Luanprabang	1	Luangprabang 1	1994	25				40.0							
	2	Pakmong	2009	10											10.0
	3	Seinsouk	2012	60											
	4	Luangprabang 2							40.0						
8 Xayabuly	1	Xayabouly	2003	16								20.0			
	2	Paklay	2012	40											
	3	Hongsa							20.0						
9 Vientiane	1	Vangvieng	1994	32				40.0							
	2	Phonsoung	1990	22						20.0					
	3	Ban Don	2003	16											
	4	Non Hai	2003	16											
	5	Thalat	2006	30										30.0	
	6	Hinheup	2011	40											
	7	Thong Khon2								30.0					
10 Vientiane Capital	1	Phontong	1968	160						100.0					
	2	Thanaleng	1977	90											20.0
	3	Tha Ngon	1989	30											
	4	Khok sa at	2004	44							60.0				
	5	Naxaythong	2006	30											
	6	Pak Thang	2012	60											
	7	Nong Viengkham						40.0							
	8	Don Koi	2012	100											
	9	Na Bong 1							60.0						
11 Bolikhamxay	1	Pakxan	2000	32											20.0
	2	Naxai								20.0					
	3	Khonsong	2012	40											
	4	Thasala									40.0				
	5	Tha Bok							60.0						
12 Khammouan	1	Thakhek	2003	60						60.0					
	2	Mahaxai	2009	40											
	3	Nam Theun 2 (Substation)	2012	20											
13 Savannakhet	1	Pakbo	1996	40										20.0	
	2	Keng Kok	2004	20				20.0							
	3	Ban Lao Souliya	2012	90											
	4	Ban Na (SENO)							40.0						
	5	M Phin								40.0					
	6	M Nong								20.0					
14 Saravan	1	Saravan	2011	40											
	2	Taothan							40.0						
15 Xekong	1	Sekong	2011	40									40.0		
16 Champasak	1	Bang Yo	1991	60											20.0
	2	Ban Na	2005	40											
	3	Ban Hat	2005	40											
	4	Pakxong	2012	100											
	5	Ban Jiangxai	2012	30											
17 Attapeu	1	Saphaothong	2006	16										20.0	

[white box]: Planned in current PDP   [grey box]: Additionally required

(Source) Study Team.

Table 5-7: Reactive facilities development plan (i.q. Table 4-25**)**

Year	Substation	Voltage (kV)	Reactive facility	
			Type	Capacity (MVA)
2013	Namo Sw/S	22	SC	10
2013	Pakmong		SC	20
2014	Pakbeng	22 (tertiary voltage of Tr)	ShR	20
2014	Pakmong	22 (tertiary voltage of Tr)	ShR	20
2014	Thavieng	22 (tertiary voltage of Tr)	ShR	20
2015	Ban Na	22	SC	10
2015	Ban Hat	22	SC	10
2015	Saphaothong	22	SC	10
2016	Boun Neua	22	SC	20
2016	Vieng Phukha	22	SC	10
2016	Luang Prabang 2	22 (tertiary voltage of Tr)	ShR	20
2016	Houay Xay	22	SC	20
2016	Phonsavan	22	SC	20
	Ban Hat	22 (tertiary voltage of Tr)	ShR	20
2018	Luang Namtha 1	22	SC	10
2018	Ban Na	22	SC	10
2018	Boun Neua	22	SC	20

(Source) Study Team.

(4) Next steps for Japanese ODA loan with project period

As a result of the system analysis, the necessity of the substation project was confirmed and the long list was formulated. The substation projects to be prioritized and to be implemented by the yen loan will be determined through the technical cooperation project proposed in the next section. In this section, the approximate cost of the installation projects to be implemented as the yen loan project is estimated.

1) Transformer reinforcement project

Based on the project cost data owned by the Study Team, the cost of the transformer reinforcement project is approximately estimated.

The approximate project cost is estimated based on Table 5-6. The prioritized projects are selected as the ones which are listed by the year 2015 among the projects additionally required as a result of this study. Total costs of the prioritized projects are US$ 39.0 million as shown in Table 5-8.

Table 5-8: Approximate cost of prioritized transformer projects

Project category	Name of substation	Capacity of transformer (MVA)	Cost (Million USD)
New substation construction	M Houn	20	4.0
	Luangprabang 2	40	5.0
	Hongsa	20	4.0
	Nong Viengkham	40	5.0
	Naxai	20	4.0
Transformer expansion	Oudomxay	20	1.0
	Phonsvan	60	2.5
	Mkham	40	2.0
	Luangprabang 1	40	2.0
	Vangvieng	40	2.0
	Phonsoung	20	1.0
	Phontong	100	3.0
	Thakhek	60	2.5
	Keng Kok	20	1.0
Total cost			**39.0**

(Source) Study Team.

It should be noted that, in implementing the installation projects, it is necessary to conduct system analysis again based on the latest data, to exam the necessity of transformer installation and update the prioritized projects.

2) Reactive power equipment project

The effective area of voltage control by reactive power equipment is quite limited in the power system. Therefore, reactive power equipment has to be installed almost evenly in the power system, which enables the voltage control in every area. The necessary number of substations with reactive power equipment (voltage control substations) could be approximately estimated as: one substation per a district in average.

20 MVA of static capacitor and 20 MVA of shunt reactor are normally necessary in each substation and the installation cost of these is around US$ 0.5 million.

Considering the above, total cost of reactive power equipment installation can be estimated as approximately US$ 9 million.

When implementing the project, the exact amount of the equipment and the places for installation has to be calculated by the voltage analysis through the latest data.

3) Project period

The typical schedule of installation work of substation work will be as follows: assuming that all the projects are implemented in parallel, the project period will be approximately two years.

Items	first year	second year
Contract	▼	
Detailed design		
Manufacturing and transport of equipment		
Civil work		
Installation & testing		
Commissioning		▼

(Source) Study Team.

Figure 5-3: Schedule of installation work of substation

5.2.1.3 Complemental project (Technical cooperation for system planning)

(1) Necessity of technical cooperation for power system planning

The current status of EDL's system planning is as follows;

- Basic data is not collected & updated appropriately
- Transmission line development is not formulated based on the Grid Code
- Reactive power facilities are not planned based on the actually measured data such as reactive power balance

Considering the situation, as the system planning is the basis of construction projects, the technical cooperation is recommended to be included in the transmission line and substation ptoject proposed in previous section.

(2) Contents of technical cooperation for transmission planning

In order to improve the issue which is pointed out in this study regarding system planning, the following technical cooperation through the construction project is proposed.

a) Trainees: EDL Planning Division
b) Number of attendees: two (2) persons[44]
c) Contents:

- Technical cooperation for the methodology of the transmission planning based on the Lao grid code
  Instruct the methodology of designing equipment in accordance with the Lao grid code. This project provides the technical cooperation especially to make up for the deficiencies of the grid code which lacks[45] concreteness.

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44 In order to promote the establishment of the technology, it is recommended that two or more persons are targeted.
45 According to Lao grid code, system analysis should be done by system operator. However, only power flow analysis has been done by EDL. In particular, the lightning surge analysis and transient analysis are mentioned there, but the implementation of the

- Technical cooperation for system analysis: how to identify and solve issues from the results of the analysis

  Transformers and reactive power facilities development plan must be considered based on the actually measured data such as reactive power balance. However, verification between actually measured data and analysis results has not been done. Therefore, in order to improve the reliability of analysis and system planning, the Study Team recommends the technical guidance concerning the methods of solving the system issue by using the system analysis.

d) Period of project

- System planning: one (1) year

(3) Contents of technical cooperation for substation planning

Currently the result of the system analysis is not verified based on the actual power flow. The practice is not enough to find out bottlenecks in the power system. In particular, since reactive power planning is not conducted, the amount of reactive power equipment may not be enough to maintain proper level of voltage in the power system. Therefore, training program about reactive power equipment is proposed as below.

a) Trainees: EDL Planning division and Substation division
b) Number of attendees: four (4)
c) Contents of work:

- System analysis for identifying bottlenecks (overload and voltage)

  Make a transmission line development plan in order to solve the operational problem of power system as well as planning and designing reactive power equipments. Currently, the power system planning is performed based on the power flow analysis. In addition to this, in this training scheme, the training to properly arrange reactive power equipments is provided.

- System planning for transformer reinforcement

  In this scheme, the training on enhancing transformers is provided. In particular, the method to manage regional demand and planning schedule for construction is instructed.

- System planning for reactive power and voltage

  Currently, the standards to design reactive power equipments are unclear. The standard specification document is not prepared. Yet, reactive power equipments are important in terms of managing proper voltage level. For this reason, the skills necessary in designing reactive power facility, together with the skills to establish necessary EDL standards, are taught.

- Data collection management

  The scheme provides the training of how to collect and manage data, verify the result of the analysis based on the actual measured data, and tune the analysis model.

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analysis is difficult because the relevant provisions and technology does not exist.

– Management of short circuit capacity

Due to lack of Grid Code, the short-circuit capacity is not managed. The short-circuit capacity in lower class system can be problematic in the future along with the expansion of 500 kV or 200 kV transmission lines. This scheme instructs about how to manage this issue.

– Designing and installation work

Technical guidance for designing and installation work for the capacity building of EDL substation engineers.

d) Period of project

– System planning: one (1) year

– Technical instruction on installation works:two (2) years

1st year: Technical instruction on system planning

2nd year: Technical instruction on the designing for power facilities (as mentioned in Section 5.2.1.2)

3rd year: Technical instruction on the management and supervision for the installation of power facilities as mentioned in Section 5.2.1.2

5.2.1.4 Preliminary SEA for proposed transmission line projects

(1) Principle of SEA implementation

The establishment of legal and institutional framework for the strategic environmental assessment (SEA) is still underway in Lao PDR, and thus, it is assumed that the Guidelines for Environmental and Social Considerations of JICA (the Guidelines) are followed. The Guidelines define SEA an environmental and social impact assessment that is implemented at the policy, planning, and program levels, but not a project-level EIA. Because NPDP is assumed to be a national power sector development policy, SEA should be applied when it will be formulated to determine priority projects among candidates through evaluation of environmental, social, and economic impacts.

The Guideline defines the following seven principles to be considered during SEA implementation:

1) Coverage of a wide range of environmental and social impacts and issues
2) Implementation of measures for environmental and social considerations from an early stage to a monitoring stage. Therefore, SEA should be applied when conducting policy and/or master plan formulation.
3) Accountable and transparent implementation of SEA
4) Stakeholder participation during SEA implementation. Stakeholder opinions must be considered during decision-making processes to form a consensus of all parties involved.
5) Disclosure of information on environmental and social considerations to ensure accountability and to promote the participation of stakeholders
6) Enhancement of organizational capacity for the implementation of SEA and proposed measures

7) Prompt implementation of SEA

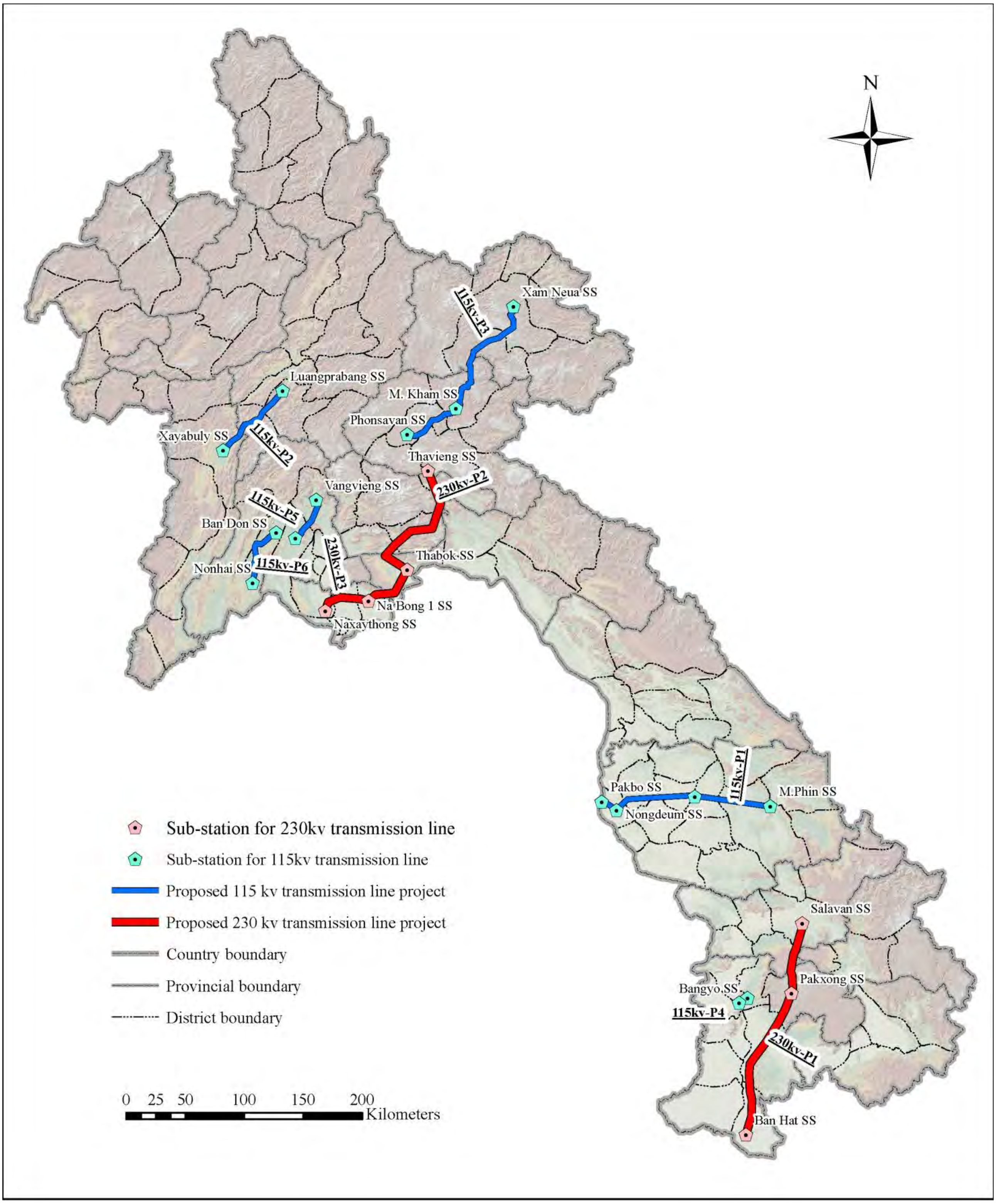
(2) Proposed transmission line projects

In this section a part of such SEA exercise is demonstrated for the proposed 230 kV and 115 kV transmission line projects by employing the data available in DEPP with the assumption that all the above seven (7) principals are followed. Table 5-9 and Figure 5-4 present names, characteristics, and locations of the proposed three (3) 230 kV transmission line projects and six (6) 115 kV transmission line projects. For this demonstration of SEA the projects "230 kV-P1," "230 kV-P2," and "230 kV-P2" are considered alternatives of 230 kV transmission line projects, and "115 kV-P1," "115 kV-P2," "115 kV-P3," "115 kV-P4," "115 kV-P5," and "115 kV-P6" are considered alternatives of 115 kV transmission line projects. However, because these projects are already selected for implementation, at the time of the development of NPDP SEA must be applied for selection of projects for implementation from alternatives identified by DEPP before conducting project-level EIA.

Table 5-9: Proposed transmission line projects

Project Name	230 kV-P1	230 kV-P2	230 kV-P3	115 kV-P1	115 kV-P2	115 kV-P3	115 kV-P4	115 kV-P5	115 kV-P6
Initial priority rank	1	2		3	4	5			
Voltage (kV)	230	230	230	115	115	115	115	115	115
Region	Southern	Northern and Central	Central	Southern	Northern	Northern	Southern	Northern	Central
Sub-Station (From/To)	Saravan Pak Xong Ban Hat	Thavieng Tha Bok Nabong 1	Naxaythong Nabong 1	Pakbo Nongdeun Ban Na (Seno) M. Phin	Luang-prabang 2 Sayabouly	Phonsavan M. Kham Xamneua 1	Jiengxai Bangyo	Vangvieng Hinheup	Ban Don Non Hai
Status in PDP of 2012	Planned	Planned	Planned	Planned	Planned	Planned	Planned	Planned	Planned
Circuit No	2	2	2	1 and 2	1	1	1	1	1
Conductor size	2x630	4x630	4x630	1x450 and 1x240	1x240	1x240	1x240	1x240	1x240
One circuit length (km)	250	172		190		176	10	41	54
Total circuit length (km)	500	344		370		176	10	41	54
Owner	IPP(d)	EDL	EDL	EDL	EDL		IPP(d)		EDL
Planned year	2015	2014 and 2015	2014	2014 and 2015	2017		2015	2018	2014
GIS measured length[*1] (km)	191.8	169.5	42.6	149.2	74.6	172.1	8.6	40.2	55.2

Note: 1) GIS measured length is length of a project determined by line data obtained from DEPP. This measurement is used to calculate per km values of natural and socioeconomic factors for strategic environmental assessment (SEA).
(Source) Study Team.



(Source) Study Team.

Figure 5-4: Locations of proposed transmission line projects

(3) Establishment of buffer zones

To compare and rank the three alternative 230 kV transmission line projects, and six alternative 115 kV transmission line projects based on the assessment of environmental and socioeconomic impacts, 2,000 m buffer zones (i.e., 1,000 m right and 1,000 m left hand sides of transmission line) are established following the standards proposed by the draft Environment Impact Assessment Guidelines. Details of these proposed transmission lines are presented in Table 5-9. It is assumed that direct and indirect environmental and socioeconomic impacts from construction and maintenance of these transmission lines. For 230 kV transmission line 40m right of the way, and for 115 kV transmission line 25 m right of the ways are also assumed.

(4) Assessment criteria and scoring scheme

Due to the limited secondary information and lack of primary data a small set of assessment criteria and their weights shown in Table 5-10 are established for this preliminary SEA. These criteria are classified into 1) Social factors, 2) Environmental factors, and 3) Technical factors. Each factor has sub-categories of criteria, and an evaluation weight is assigned to each criterion. The scoring scheme is shown in Table 5-11. Measured values of each criterion are examined and a score is given to the criterion based of the assessment of their expected impacts. In this case the largest value 5 is assigned to a criterion with no expected impact, and the smallest value 1 is assigned to a criterion with the expectation of very large negative impact. Although this example is rather qualitative due to the limited information, development of quantitative evaluation schemes is recommended.

Weights are set in such a way that they sum up to 100% and distributed according to the perceived importance of all stakeholders involved. The larger the weight the heavier the importance perceived by the stakeholders becomes. To achieve more comprehensive assessment a category of economic factors and more criteria items may be added as information becomes available. If a criterion is important to assess but there is insufficient secondary information for its assessment, primary data collection should be considered.

Table 5-10: Assessment criteria items and weights

Criteria	Weights
0. Overall assessment	**100%**
1. Social factors	**50%**
1.1 Settlement and built up areas	30%
1.2 Social facilities and structures	15%
1.3 Land use type	5%
2. Environmental factors	**30%**
2.1 Forest management categories	30%
3. Technical factors	**20%**
3.1 Current and planned reservoir for hydropower generation	20%

(Source) Study Team.

Table 5-11: Scoring scheme

Scoring category	Score
No impact	5
Minimal negative impact	4
Negative impact	3
Significant negative impact	2
Very significant negative impact	1

(Source) Study Team.

(5) Results of assessment

1) <u>Assessment of 230 kV transmission line projects</u>

Results of the assessment and ranking of 230 kV transmission line projects are shown in Table 5-12, Table 5-13, and Table 5-14. Each criteria item is assessed by the measurements of social, environmental, and technical factors. For example, the number of villages, number of households, number of population, and built up areas existing within the range of right of the way and buffer zone per one kilometer of transmission line under the criterion of "1.1 Settlement and built up areas" are compared. There are in average 0.01 villages, 0.19 households, and a population of 1.15 in existence within right of the way of one kilometer transmission line of project "230 kV-P2." This means that resettlement will be necessary if "230 kV-P2" project is implemented. On the other hand there is no village and household in the right of the way of project "203kV-P1" indicating no resettlement required. Although the total number of households (7.96) and population (48.45) in the buffer zone of "230 kV-P1" is larger than those (3.58 and 23.08) of "230 kV-P2," the resettlement in the right of the way of "230 kV-P2" should result in large negative impact. Thus, the low score of 2 (significant negative impact) is given to project "230 kV-P2" and the relatively high score of 4 (minimal negative impact) is given to "230 kV-p1." In the same way measurements of other criteria were examined and scores were given as shown in Table 5-12. In the case of "1.2 Social facilities and structures" the difference between "230 kV-P1" and "230 kV-P2" is small and the same scores of 4 are assigned. Regarding "1.3 Land use type" the areas of "Rice paddy," "Agricultural land," and "Urban or built up area" are compared to assess the magnitude of social impact. In this case it is assumed that the existence of these social features in the right of the way should result in large negative impacts, and thus score 2 is assigned to "230 kV-1" and "230 kV-P3" projects. As for "2. Environmental factors," "230 kV-P3" was given score 5 of no impact because neither National Biodiversity Conservation Area nor National Protection Forests are affected by the construction of the transmission line.

Table 5-12: Measured values per 1km 230 kV transmission line and scores assigned

Project Name	230 kV-P1			230 kV-P2			230 kV-P3		
GIS measured length[*1] (km)	192			169			43		
	Right of the way (40m)	Buffer zone (2,000m)	Score	Right of the way (40m)	Buffer zone (2,000m)	Score	Right of the way (40m)	Buffer zone (2,000m)	Score
Criteria									
1. Social factors									
1.1 Settlement and built up areas			**4**			**2**			**3**
Number of villages		0.13		0.01	0.10			0.30	
Number of households		7.96		0.19	3.58			49.85	
Number of population		48.45		1.15	23.08			297.43	
Built up area (ha)				0.02	1.24		0.03	6.50	
1.2 Social facilities and structures			**4**			**4**			**3**
Number of schools		0.03			0.03			0.12	
Number of bridges		0.01						0.02	
Number of dams (in operation and not used)									
Number of Buddhist monasteries		0.04			0.01				
Number of airports and air fields									
1.3 Land use type			**2**			**4**			
Forest (various types) (ha)	1.87	97.58		1.90	100.08		1.04		
Bamboo (ha)		0.20		0.29	13.60				
Un-stocked forest and other land (ha)	1.06	52.58		1.44	70.83		1.14	69.36	
Ray (shifting cultivation) (ha)		0.12		0.10	2.97		0.03	1.20	
Scrub and grass land (ha)	0.11	5.96		0.04	2.93		0.03	1.33	
Rice paddy (ha)	0.44	18.63		0.20	9.46		1.47	67.86	
Agricultural land (ha)	0.47	23.61							
Swamp (ha)	0.03	1.84			0.00		0.14	3.40	
Urban or built up area (ha)		0.66					0.02	1.28	
Water body (ha)	0.01	0.40		0.03	1.61		0.11	5.43	
Total	4.00	201.58		4.00	201.49		4.00	207.37	
2. Environmental factors									
2.1 Forest Categories			**2**			**2**			**5**
National Biodiversity Conservation Area (ha)	1.60	79.91		0.52	26.21				
National Protection Forest (ha)	0.23	11.38		1.22	60.79				
Production Forest (ha)	0.26	12.76		0.55	27.43				
Other areas (ha)	1.92	97.53		1.71	87.06		4.00	207.37	
Total area (ha)	4.00	201.58		4.00	201.49		4.00	207.37	
3. Technical factors									
3.1 Current and planned reservoir for hydropower generation			**5**			**3**			**3**
Length of transmission line over reservoir (m)		2.66			83.69			125.38	

Note: 1) GIS measured length is length of a project determined by line data obtained from DEPP. This measurement is used to calculate per km values of natural and socioeconomic factors for strategic environmental assessment (SEA).
(Source) Study Team.

Table 5-13: Summary of scores given to 230 kV transmission line projects

Criteria	Score		
	230 kV-P1	230 kV-P2	230 kV-P3
1. Social factors			
1.1 Settlement and built up areas	4	2	3
1.2 Social facilities and structures	4	4	3
1.3 Land use type	2	4	2
2. Environmental factors			
2.1 Forest Categories	2	2	5
3. Technical factors			
3.1 Current and planned reservoir for hydropower generation	5	3	3

(Source) Study Team.

Table 5-14: Ranking of 230 kV transmission line projects by the sum of weighed scores

Criteria	Weights	Ranking by the sum of weighted scores		
		230 kV-P1	230 kV-P2	230 kV-P3
Ranking		2	3	1
Total of weighted score for ranking	**100%**	3.5	2.6	3.6
1. Social factors	**50%**	1.9	1.4	1.5
1.1 Settlement and built up areas	30%	1.2	0.6	0.9
1.2 Social facilities and structures	15%	0.6	0.6	0.5
1.3 Land use type	5%	0.1	0.2	0.1
2. Environmental factors	**30%**	0.6	0.6	1.5
2.1 Forest Categories	30%	0.6	0.6	1.5
3. Technical factors	**20%**	1.0	0.6	0.6
3.1 Current and planned reservoir for hydropower generation	20%	1.0	0.6	0.6

(Source) Study Team.

Table 5-13 and Table 5-14 summarize the assigned scores, and weighted scores and their sums, respectively. Project "230 kV-P3" yielded the highest sum of weighted score (score 3.6) followed by "230 kV-P1" (score 3.5) and "23kV-P2 (score 2.6). Therefore, "230 kV-3," "230 kV-P1," and "230 kV-P2" are ranked one, two, and three, respectively indicating that implementation of project "230 kV-P3" likely has the lowest overall impact among the three projects if they were constructed.

2) <u>Assessment of 115 kV transmission line projects</u>

Results of the assessment and ranking of 115 kV transmission line projects are shown in Table 5-15, Table 5-16 and Table 5-17.

The same assessment method is adopted for the assessment of 115 kV transmission line projects. The obtained ranking shown in Table 5-18 indicates that projects "115 kV-P1" and "115 kV-P4" are ranked first due to low impacts on social and environmental factors. On the other hand project "115 kV-P2" is ranked last due to its relatively high negative impacts on social and environmental factors. However, the differences in the sum of weighted scores are small and results should be susceptible with change in choice of criterion items, and weighting and scoring schemes. Therefore, it is recommended that selection of the criteria and schemes should be done carefully in consultation with stakeholders concerned.

As demonstrated in this section, SEA is a tool to prioritize a set of candidate projects in consultation with stakeholders. Low ranked projects with large negative impacts can be eliminated as a result of SEA at the early stage of project development, and thus non-implementation option can be discussed systematically.

Table 5-15: Measured values per 1km 115 kV transmission line and scores assigned

Project Name	**115 kV-P1**			**115 kV-P2**			**115 kV-P3**		
GIS measured length*1 (km)	149			75			172		
	Right of the way (25m)	Buffer zone (2,000m)	Score	Right of the way (25m)	Buffer zone (2,000m)	Score	Right of the way (25m)	Buffer zone (2,000m)	Score
Criteria									
1. Social factors									
1.1 Settlement and built up areas			**4**			**3**			**4**
Number of villages		0.14			0.43			0.19	
Number of households		14.11			45.39			17.95	
Number of population		83.40			240.89			105.61	
Built up area (ha)	0.01	1.16		0.09	8.13			2.71	
1.2 Social facilities and structures			**5**			**4**			**5**
Number of schools		0.05			0.16			0.02	
Number of bridges		0.03			0.13			0.02	
Number of dams (in operation and not used)		0.01						0.01	
Number of Buddhist monasteries		0.06			0.07			0.01	
Number of airports and air fields								0.01	
1.3 Land use type			**2**			**3**			**4**
Forest (various types) (ha)	1.17	95.68		0.33	26.77		0.59	48.13	
Bamboo (ha)				0.06	6.62		0.01	1.22	
Un-stocked forest and other land (ha)	0.64	54.19		1.52	123.35		1.36	106.48	
Ray (shifting cultivation) (ha)	0.02	0.44		0.27	18.38		0.09	6.04	
Scrub and grass land (ha)					0.04		0.37	31.56	
Rice paddy (ha)	0.65	48.40		0.26	21.90		0.08	6.97	
Agricultural land (ha)		0.62		0.05	4.97				
Swamp (ha)									
Urban or built up area (ha)					0.26				
Water body (ha)	0.02	2.58		0.02	1.90		0.00	0.16	
Total	2.50	201.93		2.50	204.17		2.50	200.55	
2. Environmental factors									
2.1 Forest Categories			**4**			**3**			**2**
National Biodiversity Conservation Area (ha)							0.55	43.74	
National Protection Forest (ha)				0.83	66.42		0.81	64.55	
Production Forest (ha)	0.25	19.66					0.06	4.57	
Other areas (ha)	2.25	182.27		1.67	137.75		1.09	87.69	
Total area (ha)	2.50	201.93		2.50	204.17		2.50	200.55	
3. Technical factors									
3.1 Current and planned reservoir for hydropower generation			**5**			**5**			**5**
Length of transmission line over reservoir (m)		2.21			3.31			0.57	

Note: 1) GIS measured length is length of a project determined by line data obtained from DEPP. This measurement is used to calculate per km values of natural and socioeconomic factors for strategic environmental assessment (SEA).
(Source) Study Team.

Table 5-16: Measured values per 1km 115 kV transmission line and scores assigned (cont.)

Project Name	115 kV-P4			115 kV-P5			115 kV-P6		
GIS measured length*1 (km)	9			40			55		
	Right of the way (25m)	Buffer zone (2,000m)	Score	Right of the way (25m)	Buffer zone (2,000m)	Score	Right of the way (25m)	Buffer zone (2,000m)	Score
Criteria									
1. Social factors									
1.1 Settlement and built up areas			**3**			**4**			**2**
Number of villages		0.93			0.30			0.38	
Number of households		82.05			30.91			30.83	
Number of population		454.68			182.75			184.34	
Built up area (ha)		29.83		0.04	7.77		0.23	15.03	
1.2 Social facilities and structures			**4**			**4**			**5**
Number of schools		0.81			0.22			0.20	
Number of bridges		0.12			0.35				
Number of dams (in operation and not used)					0.02				
Number of Buddhist monasteries		0.93			0.25			0.11	
Number of airports and air fields					0.02			0.02	
1.3 Land use type			**1**			**3**			**2**
Forest (various types) (ha)	0.52	69.51		0.26	22.35		0.20	27.81	
Bamboo (ha)				0.04	6.05		0.04	6.41	
Un-stocked forest and other land (ha)	1.05	93.06		1.75	140.60		1.24	105.72	
Ray (shifting cultivation) (ha)				0.06	6.96		0.13	18.93	
Scrub and grass land (ha)								2.09	
Rice paddy (ha)	0.51	48.74		0.38	28.66		0.89	44.50	
Agricultural land (ha)									
Swamp (ha)									
Urban or built up area (ha)	0.42	23.76							
Water body (ha)		0.65		0.02	3.15		0.00	0.00	
Total	2.50	235.72		2.50	207.77		2.50	205.47	
2. Environmental factors									
2.1 Forest Categories			**5**			**5**			**4**
National Biodiversity Conservation Area (ha)									
National Protection Forest (ha)									
Production Forest (ha)							0.23	18.31	
Other areas (ha)	2.50	235.72		2.50	207.77		2.27	187.16	
Total area (ha)	2.50	235.72		2.50	207.77		2.50	205.47	
3. Technical factors									
3.1 Current and planned reservoir for hydropower generation			**5**			**4**			**5**
Length of transmission line over reservoir (m)					9.68				

(Source) Study Team.

Table 5-17: Summary of scores given to 115 kV transmission line projects

Criteria	Score					
	115 kV-P1	115 kV-P2	115 kV-P3	115 kV-P4	115 kV-P5	115 kV-P6
1. Social factors						
1.1 Settlement and built up areas	4	3	4	3	4	2
1.2 Social facilities and structures	5	4	5	4	4	5
1.3 Land use type	2	3	4	1	3	2
2. Environmental factors						
2.1 Forest Categories	4	3	2	5	5	4
3. Technical factors						
3.1 Current and planned reservoir for hydropower generation	5	5	5	5	4	5

(Source) Study Team.

Table 5-18: Ranking of 115 kV transmission line projects by the sum of weighed scores

Criteria	Weights	Ranking by the sum of weighted scores					
		115 kV-P1	115 kV-P2	115 kV-P3	115 kV-P4	115 kV-P5	115 kV-P6
Ranking		1	6	4	3	1	5
Total of weighted score for ranking	**100%**	4.3	3.6	3.8	4.1	4.3	3.7
1. Social factors	**50%**	2.1	1.7	2.2	1.6	2.0	1.5
1.1 Settlement and built up areas	30%	1.2	0.9	1.2	0.9	1.2	0.6
1.2 Social facilities and structures	15%	0.8	0.6	0.8	0.6	0.6	0.8
1.3 Land use type	5%	0.1	0.2	0.2	0.1	0.2	0.1
2. Environmental factors	**30%**	1.2	0.9	0.6	1.5	1.5	1.2
2.1 Forest Categories	30%	1.2	0.9	0.6	1.5	1.5	1.2
3. Technical factors	**20%**	1.0	1.0	1.0	1.0	0.8	1.0
3.1 Current and planned reservoir for hydropower generation	20%	1.0	1.0	1.0	1.0	0.8	1.0

(Source) Study Team.

5.2.2 Technical cooperation for training program for maintenance skills

(1) Background of project

Improper operation and management tends to shorten the lifetime of equipment, which would result in financial burdens to EDL. To improve the maintenance skills for the personnel at substations for better reliability, the technical cooperation project for training EDL engineers is proposed. By adopting new maintenance methodologies, the improvement of equipment reliability and effectiveness of investment are expected, in addition to the effective use of the current equipment. In this project, maintenance skills will be enhanced as well as deteriorated facilities will be replaced.

(2) Results of site surveys

To discern the actual situation of operation and maintenance of existing substations, the Study Team conducted on-site visits to the substations/switch stations of EDL in Vientiane area: Thanaleng S/S, Khoksaad S/S, Dongnasok Sw/S, Naxaythong S/S, Tha Ngon S/S, Phone Tong S/S, Thalat S/S and Phonsoung S/S, and had a series of interviews with the field staff of EDL served in the substations.

1) <u>Problems on substation</u>

As a result of the site visit, the following issues were found significantly problematic.

i) The designing of the substation is outsourced to a subcontractor when constructing it. EDL approves the designing, however, the calculations, verifications such as the protective relay settings are totally left to the subcontractor. In addition, technical standards for the transmission and substation facilities are not defined yet. Without having a uniformity of each facility, it could cause troubles for its improper coordination.

Ordering in full turn-key manner seems to be common for EDL and it is one of the standard ways. However, EDL (System Planning Office, Technical Standard Office etc.) should possess the knowledge on designing facilities and relay system to form the proper power system and operators of substations should also possess the knowledge to maintain the facilities properly.

ii) EDL does not have the knowledge regarding protective relay setting and relies on the subcontractor VASE[46] for this part. The protective relays coordination seems to be improper and the protection system may not be able to detect failures properly. For example, in a substation, the Study Team found a case that the primary of a transformer tripped due to a feeder fault. In this case, only the feeder which had a fault should have tripped and transformer should not have been affected in any way.

Protective relay setting should be updated on each time that the power system configuration is changed. Therefore, EDL should possess the knowledge of updating and making good or bad judgment of protective relay setting.

iii) The operators of substations are trying to keep all the equipment in proper conditions. However, they do not have enough skill to do this, thus not all the equipment are well maintained. Some facilities are left broken for a long time and some of them are important equipments necessary in case of emergency. For example a protection relay at a substation has been broken since several years ago, which may cause fatal damage to some of the equipment due to surge voltage or current.

Even in maintenance and repair of the major equipment, EDL does not have enough skill and relies on the subcontractor VASE. However, from the above situation, the operators of substations should possess the stripped-down knowledge necessary for initial response to accidents and temporary repair, in addition, to instruct the subcontractor to implement the work appropriately.

2) <u>Characteristics of failures</u>

During the on-site visits at substations, the Study Team obtained failure data about some substations. According to it, causes of the failures and the durations are broken down as in Table 5-19 below.

[46] Vientiane Automation and Solution Engineering Co., Ltd (VASE lao) is a private subcontractor taking full responsibility for maintenance of electric power equipment in EDL.

Table 5-19: Causes of failures and duration

Cause \ Duration	1 min. or less	2~5 min.	6~10 min.	11~60 min.	61~120 min.	121 min. or more	Total	Ratio
Effect from others	21	45	26	10	1	4	**107**	15.8%
Mechanical failure	4	6	--	6	--	4	**20**	3.0%
Weather	4	13	--	2	--	--	**19**	2.8%
Transmission failure	5	3	--	2	3	4	**17**	2.5%
Improper work	4	2	--	2	--	1	**9**	1.3%
Load fluctuation	6	1	--	--	--	--	**7**	1.0%
Contact with animal	4	2	--	1	--	--	**7**	1.0%
Object flown	2	--	--	1	--	1	**4**	0.6%
Car accidents	2	--	--	1	--	--	**3**	0.4%
Fire	1	--	--	--	--	1	**2**	0.3%
Overload	1	--	--	1	--	--	**2**	0.3%
Improper installation	--	--	--	--	--	2	**2**	0.3%
Electric shock	1	--	--	--	--	--	**1**	0.1%
Contact with trees	1	--	--	--	--	--	**1**	0.1%
Improper operation	1	--	--	--	--	--	**1**	0.1%
Unknown	335	83	6	29	8	14	**475**	70.2%
Total	**392**	**155**	**32**	**55**	**12**	**31**	**677**	100.0%
Ratio	57.9%	22.9%	4.7%	8.1%	1.8%	4.6%	100.0%	

*Data on the substations at Phone Tong, Thanaleng, Tha Ngon, Khoksaad, and Naxaythong in the year 2011.
(Source) Study Team based on EDL information

The distinctive characteristics are summarized as below:

- The power failures within a minute account for 57.9% of the total, 87% of which are left unknown.
- 16% of the total failures are caused by the effect from other failures (failures in other circuit or in other customer).
- 70% of the total failures are left unknown.

Based on the issues described above in addition to considering the technical skill level of EDL and the circumstances of distribution facilities, the Study Team would like to note as follows:

- Most of the failures are caused by the effect from other failures. Therefore, protection relay coordination or facility formation problem must be the issue.
- Most of the failures lasted for a short period of time, and most of their causes are left unknown, which makes it difficult for EDL to establish proper measure against them. Since detailed failure information is indispensable in order to take proper measures, EDL should acquire and record as much information as possible. The current table of failure data doesn't have enough description of failures. Therefore, EDL needs to come up with a proper failure data sheet which would enable staff to write down detailed descriptions.
- There were many cases when some foreign objects flown from somewhere were causing damage to the facilities. Therefore, distribution facilities formation needs to be well considered to keep proper distance between power cables and it is also important to use insulated cables.

(3) Contents of technical cooperation

Based on the site survey, technical cooperation projects are prepared as follows.

1) Improvement of maintenance skills for protection relay system and the replacement

(Technical guidance for replacement & maintenance method for protection system)

a) Trainees: Maintenance engineers at the substations
b) Number of attendees: three (3) (to five (5)) persons per province
c) Contents of work:

- Inspection items which are necessary
  Instruct the points of equipment maintenance to perform proper maintenance practices
- Maintenance method and the criteria about how to evaluate the measured data
  Instruct how to develop maintenance standards and criteria, how to operate and manage maintenance works to fulfill the requirements
- Design concept and how to supervise the replacement works
  Instruct the basic design techniques and how to manage the works which are required to upgrade the equipment

2) Improvement of maintenance skills for switch gears and the replacement

(Technical guidance for replacement & maintenance method for switch gear)

a) Trainees: Maintenance workers at the substations
b) Number of attendees: three (3) (to five (5)) persons / province
c) Contents of work:

- Inspection items which are necessary
  Instruct the points of equipment maintenance to perform proper maintenance practices
- Maintenance method and the criteria about how to evaluate the measured data
  Instruct how to develop maintenance standards and criteria, how to operate and manage maintenance works to fulfill the requirements
- Design concept and how to supervise the replacement works
  Instruct the basic design techniques and how to manage the works which are required to upgrade the equipment

3) Improvement of setting methods for protection relay system

(Technical guidance for the method of relay setting)

a) Trainees: Maintenance worker at the S/S, Transmission & substation division
b) Number of attendees: three (3) (to five (5)) persons/province, three person/division
c) Contents of the work:

- Purpose of protection

Learn the necessity of protective devices from the beginning.

- The theory of protection system
  Learn how each type of protective relay works from the beginning

- Design and operation method
  Learn how to design, manage, and operate protective relays.

- Protection coordination (time and sensitivity)
  Learn the concept of protective relay coordination.

4) Technical guidance for proactive maintenance

(Technical guidance for the method of maintenance management)

a) Trainees: Maintenance worker at the S/S
b) Number of attendees: three (3) (to five (5)) persons / province
c) Contents of the work:
   - Failure data management
     Introduce techniques to analyze failure data, which are necessary to perform proactive maintenance

   - Workflow analysis and required changes (organizational)
     Introduce workflow and organizations to perform proactive maintenance

   - Inspections management
     Introduce maintenance management procedures which are necessary to perform proactive maintenance

(4) Complemental project

As a result of site survey, some facilities (such as switch gears, protection relay, etc.) are left broken for a long time. The replacement of the facilities will be required by grant aid through the technical cooperation project proposed in the previous section.

The installation cost of one switch gear for a 22 kV facility is around US$ 0.03 million.

The installation cost of one protection relay for a 22 kV facility is around US$ 0.02 million.

There are about 40 substations and assuming that each substation has those problems mentioned above, the total cost of replacement works would be approximately US$ 2 million.

(5) Period of project

Technical guidance: three (3) year

- 1st year: Acquisition of the basic technology
- 2nd year: Field work (introduction of relevant equipment)
- 3rd year: Development of maintenance system

5.3 Private Sector Investment Finance for generation development

5.3.1 JICA's Private Sector Investment Finance

In many developing countries and regions, economic and social infrastructure encompassing electricity services is underdeveloped, and ODA Loan assistance has provided relatively large amounts of development funds under concessional terms to developing countries and regions to support their efforts for growth and development. An ODA Loan, which requires repayment, promotes efficient use of the borrowed funds and appropriate supervision of the projects, thereby bolstering developing countries' ownership which is crucial for economic growth and poverty reduction, in the development process. On the other hand, quite a few developing countries have been promoting private sector investment in the development of infrastructure such as electricity, gas, transportation and communication to compensate for the budgetary restriction of the public sector.

Against the backdrop, the Government of Japan made a decision on October 16, 2012 to fully resume JICA's Private Sector Investment Finance (PSIF). Hereafter, JICA will finance development projects in developing countries through Private Sector Investment Finance, and also will contribute to the deployment of the Japanese integrated infrastructure system.

According to the informal meeting on the JICA's PSIF under MOFA, major necessary conditions for PSIF are summarized as Table 5-20. Although each project needs to be evaluated individually, IPP projects for domestic supply generally seem in conformity with the requirements shown in the table.

Table 5-20: Draft key points for PSIF (excerpts)

Item	Contents
Country	ODA recipient countries
Project content	To be in accordance with the development policy of the recipient country's government, and a high development impact will be expected.
Field	Three fields: i) MDG/poverty reduction, ii) infrastructure and growth acceleration, and iii) the climate change measures
Necessity of JICA's PSIF	• The project will be feasible in terms of profitability, and the project will not be established with investment/lending by the existing financial institutions. • The added value by investment/lending of JICA, such as mitigation of country risk, pump-priming effect of private finance etc., is indispensable to the project
Appropriateness of business plan	• Construction plan, raw materials procurement plan, production and sales plans, business operation plan, funds and profit and loss plans, etc. are to be appropriate. • Environmental and social considerations have been made enough.
Prospects for achieving	The achievement of the business is to be expected from the viewpoint of validity of the business plan, investment environment, market potential, ability of partners, receiving attitude of the country etc.

(Source) Ministry of Foreign Affairs of Japan (translated by the Study Team)
(http://www.mofa.go.jp/mofaj/gaiko/oda/seisaku/kanmin/jica_ikenkoukan12.html)

5.3.2 Promotion of IPP project by Japanese investors

Once MEM establishes the priority of the development of power projects, the most critical issue in the next step is how to ensure the power projects development according to the assigned commencement schedule. The power projects in Laos will be developed both by public sector and private sector. EDL and EDL-Gen are developing power projects as public utilities. EDL-Gen was going to public in 2010.

However, 75% of the stocks are still owned by GOL, therefore it can be said that EDL-Gen is still under control of GOL. EDL and EDL-Gen are assigned to develop some part of power generation as public sectors of Laos in the current PDP. To ensure the power development by EDL and EDL-Gen, GOL is expected to manage these business entities by legislative measures and financial support.

On the other hand, as shown in the previous section, more than 80% of the newly developed generation capacity by 2025 heavily relies on the investment by private sector through IPP development schemes. The credibility of the development of these IPP projects is dependent on the capability of the investors and their decisions on investment. The measures to enhance the investment by private sector are examined in Section 3.3. Nevertheless, it can be said that some investors who have already concluded the MOU or PDA, obviously have insufficient technical or financial ability to complete the hydropower projects. These investors are expected to be excluded in terms of the expiration of MOU or PDA following the procedures defined in the new Electricity Law. In order to ensure the power development plan for domestic supply from IPP (d) projects, the investment environment of IPP (d) projects should be more attractive for foreign investors by improving transparency and fairness.

In addition to the improvement by the Lao side, the expansion of supportive measures to the investors will contribute to the enhancement of the development of IPP (d) projects. Japanese companies are expected to be reliable investors on the IPP (d) projects in Laos. The support from the Government of Japan (GOJ) is expected to encourage the Japanese investors to enter the IPP (d) power market by improving the financial condition and the investment environment. The GOJ support such as financial assistance through PPP (Public-Private Partnership) scheme and the special finance measures by JICA‘s PSIF is expected to enhance the Japanese investors entering the IPP (d) market.

Furthermore, these assistances by the GOJ are expected to reduce the investment risks in IPP market in Laos. Three Japanese companies so far concluded the MOU or PDA on the IPP projects. Two of four projects by Japanese investors were planned to be an IPP (e) project exporting electricity to Thailand. However, to meet the growth of domestic electricity demand, the Lao government has an intension to convert the IPP (e) projects to IPP (d) project. In case some of these two projects by Japanese investors oblige to convert their scheme to IPP (d) projects, the investors should deal with the change of investment conditions. Applying the PPP schemes and the Private Sector Investment Finance by JICA will contribute to reduce the investor‘s risks on the transformation to IPP (d) schemes.

Table 5-21: Japanese investors in IPP projects

Investor	Project	Market	Progress	Remarks
Kobe Green Power	Nam Phak	EDL	PDA	
Kansai EPCo	Nam Ngiep 1	EGAT/EDL	PDA	
	Xekatam	EDL	PDA	PDA has been expired since February 2012 despite the application of extension from the developer.
Chubu EPCo	Nam Mouan	EGAT/EDL	MOU	

(Source) Study Team based on DEB website and others.