The Republic of the Union of Myanmar
Ministry of Electric Power

DATA COLLECTION SURVEY
ON
CAPACITY DEVELOPMENT OF POWER SECTOR DEVELOPMENT PLANNING
IN
THE REPUBLIC OF THE UNION OF MYANMAR

FINAL REPORT
SUMMARY

September 2015

Japan International Cooperation Agency

NEWJEC Inc.
The Kansai Electric Power Co., Inc.

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Data Collection Survey on Capacity Development of Power Sector Development Planning

FINAL REPORT
SUMMARY

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Abbreviation

Symbol	Abbreviation
ADB	Asian Development Bank
BOT	Build Operate and Transfer
BS	Balance Sheet
CF	Cash Flow
C/P	Counterpart
DEP	Department of Electric Power
DEPP	Department of Electric Power Planning
DHPI	Department of Hydropower Implementation
DHPP	Department of Hydropower Planning
DRD	Department of Rural Development
EIA	Environmental Impact Assessment
EPGE	Electric Power Generation Enterprise
ESE	Electricity Supply Enterprise
F/S	Feasibility Study
FESR	Framework of Economical and Social Reform
GCC	Generation Control Center
GDP	Gross Domestic Production
GT	Gas Turbine
GTCC	Gas Turbine Combined Cycle
HPGE	Hydropower Generation Enterprise
IFC	International Finance Corporation
IPP	Independent Power Producer
IRR	Internal Rate of Return
JICA	Japan International Cooperation Agency
JV	Joint Venture
LRMC	Long Run Marginal Cost
LRAIC	Long Run Average Incremental Cost
MEPE	Myanma Electric Power Enterprise
MESC	Mandalay Electricity Supply Corporation
MOAI	Ministry of Agriculture and Irrigation
MOE	Ministry of Energy
MOECAF	Ministry of Environmental Conservation and Forestry
MOEP	Ministry of Electric Power
MOF	Ministry of Finance
MOI	Ministry of Industry
MOLFRD	Ministry of Livestock, Fisheries and Rural Development
M/P	Master Plan
NEMC	National Energy Management Committee
NEMP	National Electricity Master Plan
NEP	National Electrification Plan
O&M	Operation and Maintenance

Symbol	Abbreviation
OJT	On the Job Training
PDP	Power Development Plan
PGDP	Power Generation Development Plan
PL	Profit and Loss statement
PPA	Power Purchase Agreement
PPP	Public Private Partnership
PSD	Power System Department
PTP	Power Transmission Team
PTSCD	Power Transmission and System Control Department
SCADA	Supervisory Control And Data Acquisition
SEA	Strategic Environmental Assessment
TPD	Thermal Power Department
WASP	Wien Automatic System Planning
WB	World Bank
YESB	Yangon City Electricity Supply Board
YESC	Yangon Electricity Supply Corporation

1. OUTLINE OF THE SURVEY

1.1 Background of the Survey

JICA (Japan International Cooperation Agency) has conducted the Project for Formulation on the NEMP (National Electricity Master Plan) to support the preparation of the said Mater Plan (M/P) since 2013. Hereafter MOEP (Ministry of Electric Power) and related organizations will have to implement and regularly update - the M/P by their own capacity. On the other hand, the M/P is yet new concept to Myanmar and the human resource and institutions in charge are still not capable of handling it by their own initiatives. Therefore, the capacity development of MOEP on the formulation and operation of the M/P is an urgent issue based on the long term viewpoint.

1.2 Outline of the Survey

Item	Substance	Remark
Purpose	1) Capacity development and analysis on the organization of MOEP related to the formulation and operation of the M/P 2) Recommendation on the future technical cooperation project for the capacity development of Power Sector Development Planning	1) Data collection and analysis 2) Clarification of technical issues 3) Capacity development and institutional establishment
Implementation Agency	MOEP	Confirmation of specific parties concerned
Scope of Works	(1) To review the existing report and assess the current situation of the M/P. (2) To confirm the policy status of the M/P and the process of decision making. (3) To study the organizational structure related to the M/P of electricity sector and clarify issues. (4) To assess the technical capacity on the M/P, such as power demand forecast, power development plan, power system planning, and economic / financial analysis including long-run marginal cost, by conducting the training program on analysis and simulation of the software application for officials of Myanmar side. (5) To hold the training and seminars on the capacity development (6) Based on the study, the result of assessment will be compiled and propose the possible technical cooperation for the capacity development on electricity sector master planning.	1) Confirmation of other donors cooperation 2) Holding the Seminar in Myanmar twice

1.3 Implementation Structure

Implementation structure of the consultants is shown in Fig. 1-1.

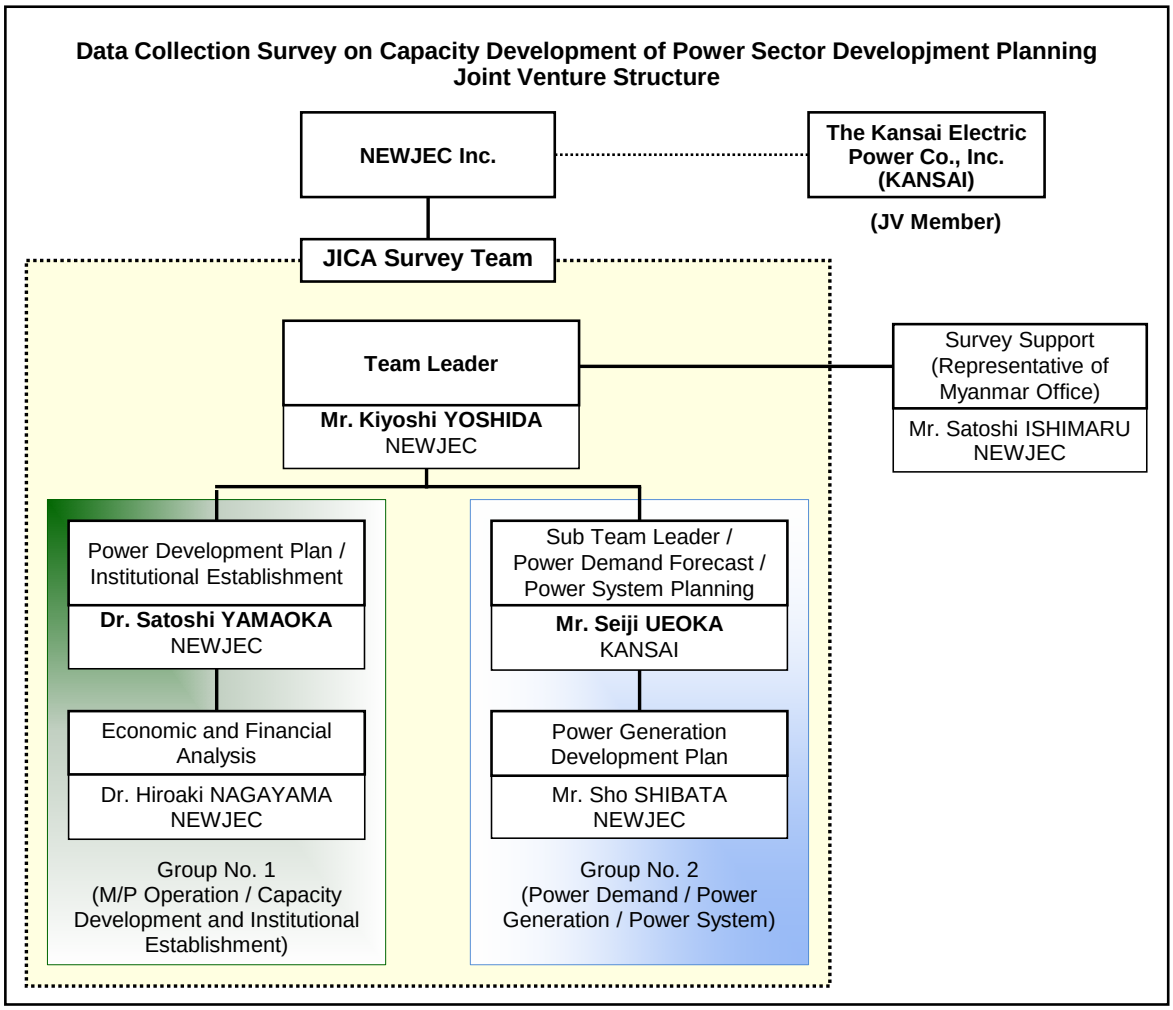


Fig. 1-1 Implementation Structure

1.4 Survey Schedule

Components of this Survey are classified into three phases: “Confirmation of the Current Status of the M/P”, “Capacity Development and Institutional Establishment for the M/P”, and “Future Operation Plan and Technical Assistance of the M/P”.

Main components and terms of this Survey are shown in Fig. 1-2 and overall flow chart of this Survey is shown in Fig. 1-3.

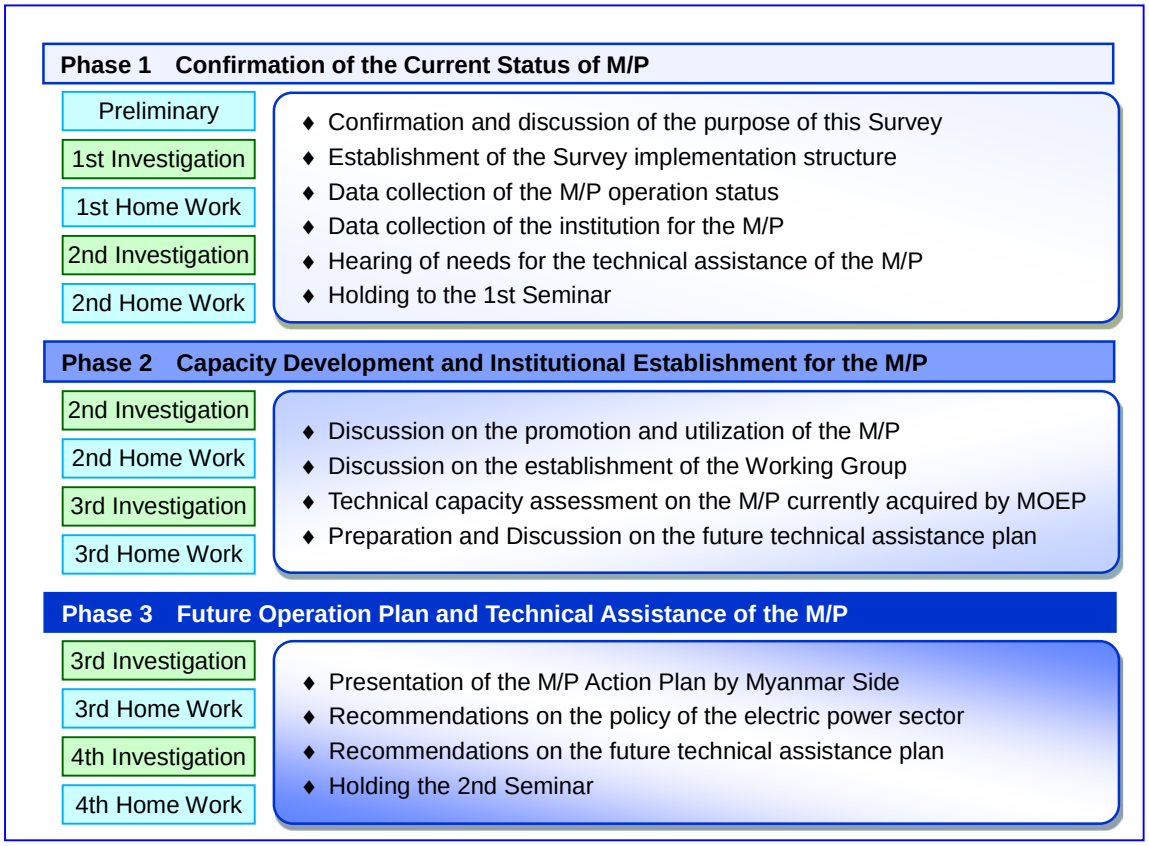


Fig. 1-2 Main Study Components and their Implementation Time

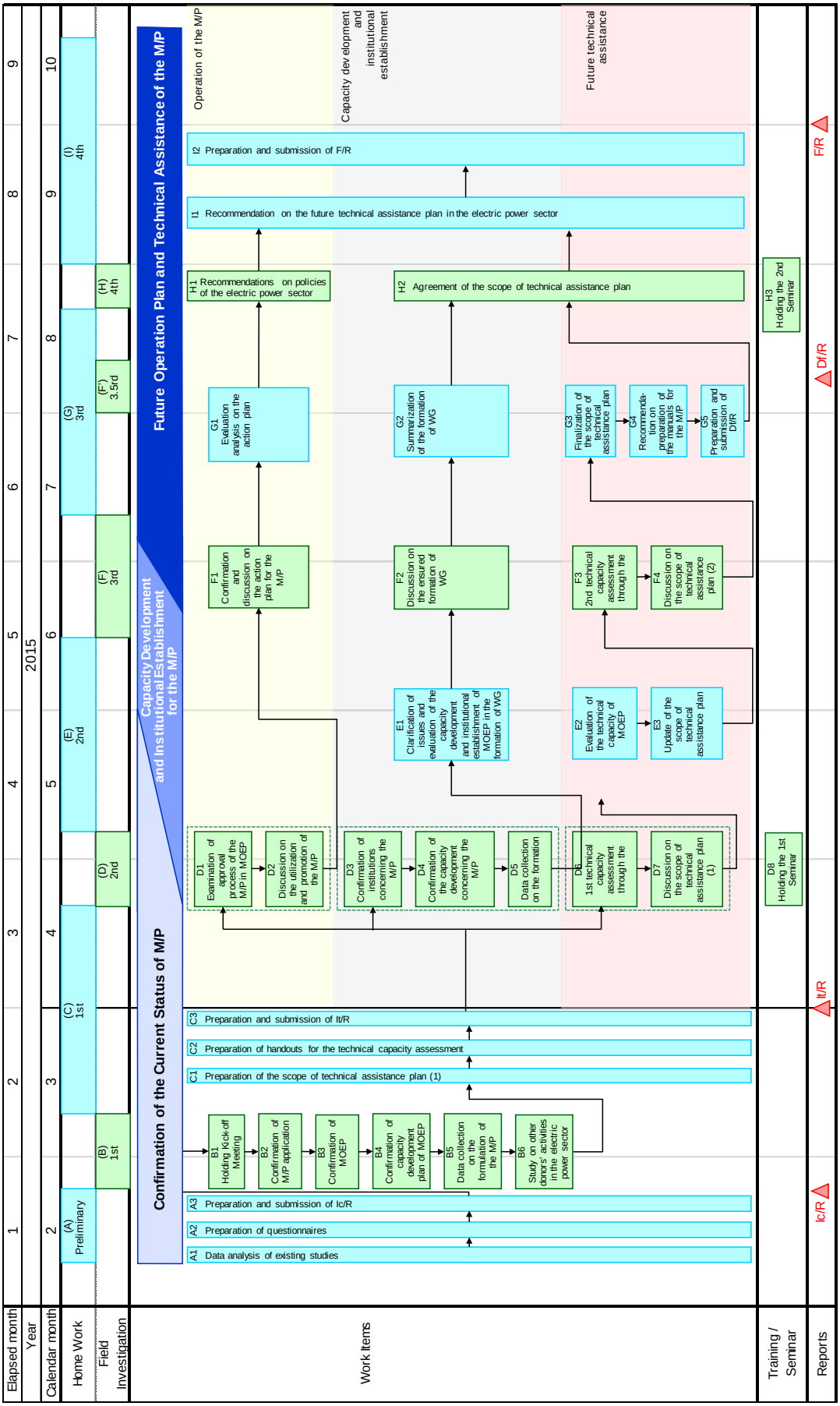


Fig. 1-3 Overall Survey Flow Chart

1.5 Seminar in Myanmar

In this Survey, the seminar of M/P had been held twice during 2nd and 4th investigation in Myanmar. The 2nd seminar was planned to disclose the Action Plan of the M/P by MOEP.

1st Seminar	
Venue	MOEP Hall
Date	2nd Investigation (5th of May, 2015)
Participants	50 persons
Purpose	To explain the outline of this Survey and request for the cooperation
Contents	· Basic approaches, substances, methodologies and schedule · Presentation for the technical assistance plan of the M/P Formulation and Operation [i) Power Demand Forecast, ii) Power Generation Development Plan, iii) Power System Development Plan, iv) Economic and Financial Analysis, v) Efficiency of JV/IPP Investment and Burden] · Request for the MOEP and proposal for formation of the working group
2nd Seminar	
Venue	MOEP Hall
Date	4th Investigation (28th of August, 2015)
Participants	100 persons
Purpose	To present the Action Plan of the M/P and contents of the future technical assistance plan
Contents	· Presentation for the Action Plan by Myanmar Side [i) Power System Planning, ii) Power Development Planning and iii) Economic and Financial Analysis] · Introduction of contents of the future technical assistance plan

Ministry of Electric Power
and
Japan International Cooperation Agency

1st Seminar on Data Collection Survey on Capacity Development of Power Sector Development Planning in the Republic of the Union of Myanmar

Time	*Topics*	*Resource Person/Speaker*
13:00-13:20	***Opening Address***	**Director General** Department of Electric Power Ministry of Electric Power **Mr. Kiyoshi YOSHIDA** Project Team Leader JICA / NEWJEC
13:20-13:40	***Plan and Lessons for Power Development in Myanmar***	**Dr. Satoshi YAMAOKA** JICA / Utsunomiya University
13:40-14:10	***Power Demand Forecast / Power System Development***	**Mr. Seiji UEOKA** JICA / The Kansai Electric Power Co., Inc
14:10-14:30	***Concept of the Power Generation Development Plan and Major Findings in the M/P2014***	**Mr. Sho SHIBATA** JICA / NEWJEC
14:50-15:10	***2nd Training-Workshop on Capacity Development of Power Sector Development Planning***	**Dr. Hiroaki NAGAYAMA** JICA / Kyoto University
15:10-15:30	***Discussion***	
15:30-15:40	***Closing Speech***	**Dr. Satoshi YAMAOKA** JICA / Utsunomiya University

Fig. 1-4 Agenda for the 1st Seminar

1st Seminar on May 5th, 2015


Opening Addres


Seminar Scenary


Power Development Planning


Economic and Financial Analysis


Q&A

Ministry of Electric Power
and
Japan International Cooperation Agency

2nd Seminar on Data Collection Survey on Capacity Development of Power Sector Development Planning in the Republic of the Union of Myanmar

Time	*Topics*	*Resource Person/Speaker*
14:00-14:20	***Opening Address***	**Deputy Minister** Ministry of Electric Power **Mr. Kiyoshi YOSHIDA** Project Team Leader JICA / NEWJEC
14:20-14:40	***Reporting the Result of Data Collection Survey on Capacity Development of Power Sector Development Planning***	Dr. Satoshi YAMAOKA Utsunomiya University
14:40-14:55	***Group 1 (Power System Planning)***	**to be appointed** Ministry of Electric Power
15:10-15:25	***Group 2 (Power Development Planning)***	**to be appointed** Ministry of Electric Power
15:25-15:40	***Group 3 (Economic and Financial Analysis)***	**to be appointed** Ministry of Electric Power
15:40-15:55	***Tea Break***	
15:55-16:10	***Action Plan for the Formulation of National Electricity Master Plan***	**to be appointed** Ministry of Electric Power
16:10-16:20	***Closing Speech***	**U Khin Maung Win** Director General Department of Electric Power Planning Ministry of Electric Power

Fig. 1-5 Agenda for the 2nd Seminar

2nd Seminar on August 28th, 2015

Opening Address

Seminar Scenary

Presentation of JICA Survey Team

Presentation of MOEP

Closing Speech

1.6 Outline of the M/P in the Previous Study

(1) Comparison of Three Scenarios

In this section, outline of the middle and long term NEMP until 2030 prepared in the Previous Study is described. Based on the MOEP's development plans which had been prepared by each department, three development Scenarios had been formulated and evaluated considering the economy, environmental impacts, feasibility of the power generation development, and energy security. Outline of these Scenarios is shown in Table 1-1 and annual transition of the power supply for Myanmar is shown in Fig. 1-6.

Table 1-1 Outline of the Development Scenarios

Development Scenario	Outline
Scenario 1 Domestic Energy Consumption Scenario (Large Scale Hydro Oriented)	The utilization of domestic power resources will be maximized based on the MOEP's original power development plan in Myanmar. For example, hydropower including large scale ones and gas-fired plants are fully developed, with the power supply deficit compensated by coal-fired thermal power plants.
Scenario 2 Least Cost Scenario	The overall generation cost will be minimized. Therefore, compared with the above scenario, power supply from coal-fired thermal power plants will increase and that from gas-fired plants will decrease in order to minimize cost.
Scenario 3 Power Resources Balance Scenario	The best combination of power resources is proposed considering feasibility of project implementation and the primary energy forecast. In this scenario, hydropower plants with higher priority will be selected, namely realistic hydropower project plans with a shorter lead time to completion and with a shorter distance to demand centers. Gas-fired plants will be fully developed as long as adequate gas supplies can be expected. However, the capacity of domestic energy resources such as hydropower, gas, and renewable energy is insufficient for future demand and comprises some risks in the power supply. Coal-fired thermal power plants will be developed to compensate for them. This is the most effective when balancing power resources in the viewpoint of energy security.

Close discussions on the comparison of three scenarios had been implemented between MOEP and JICA Team throughout the Previous Study. Finally, Scenario 3 "Power Resources Balance" is confirmed as the optimum one to be proceeded for further study at the workshop on 27th May 2014, considering utilization of domestic energy, supply conditions of each primary energy and overall energy security.

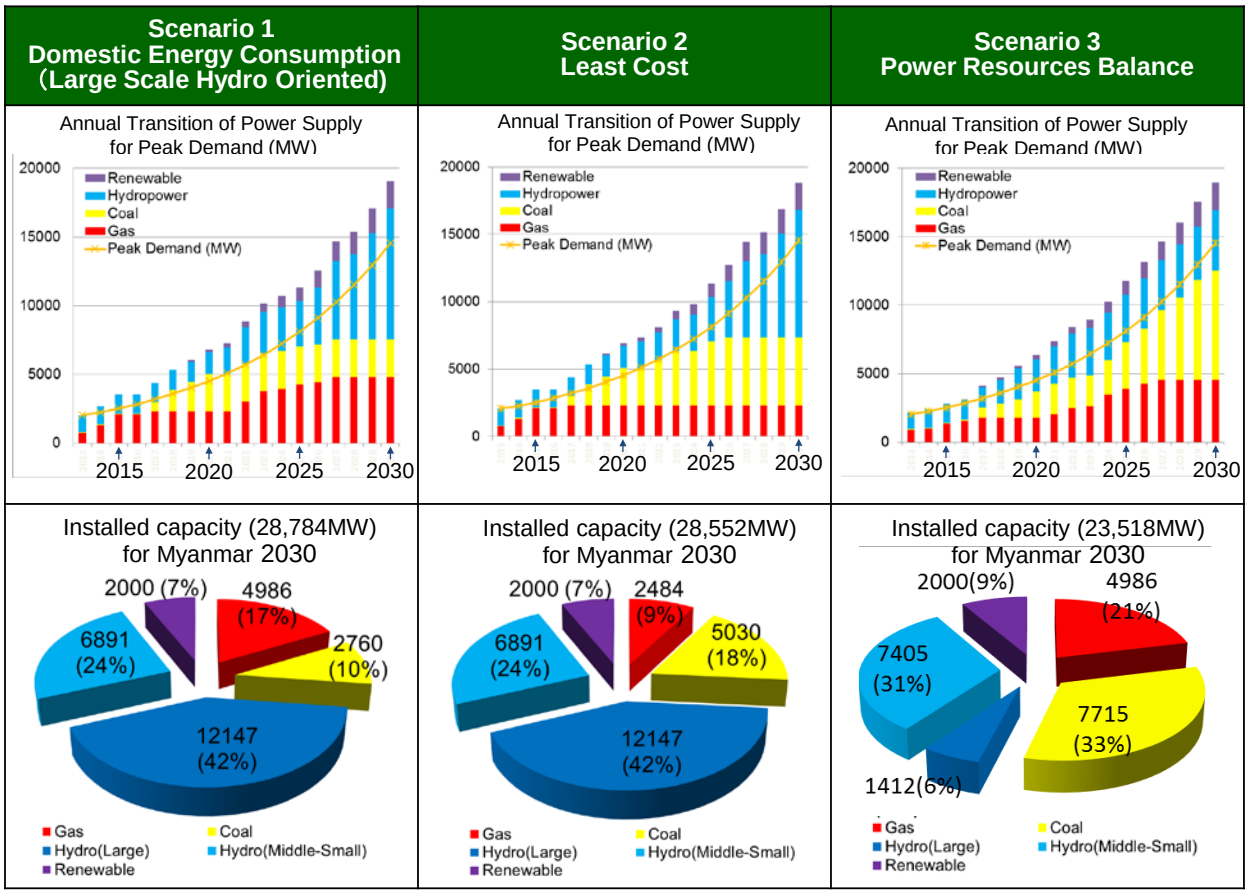


Fig. 1-6 Annual Transition of Power Supply and Installed Capacity in 2030 for Myanmar per each Scenario

(2) Scenario 3 :Power Resources Balance (Revised)

The quantity of power supply and the operational year of power plants of Scenario 3 had been reviewed through additional interviews and discussions with MOEP. As results, annual transition of the power supply and salient indicators in 2013, 2020, and 2030 and financial gap between the power tariff and LRMC (Long Run Marginal Cost) are finalized as shown in Fig. 1-7, Table 1-2 and Fig. 1-8 respectively.

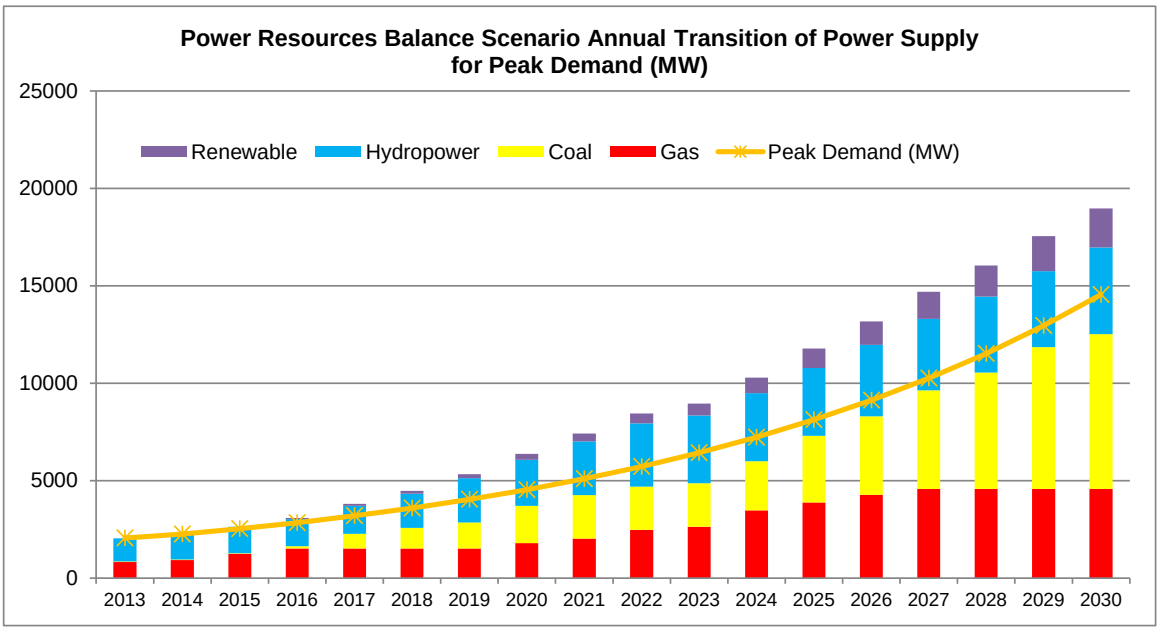


Fig. 1-7 Annual Transition of the Power Supply for the Revised Power Resources Balance Scenario

Table 1-2 Salient Indicators of the Revised Power Resources Balance Scenario

Indicators			2013	2020		2030	
				High	Low	High	Low
Power Demand Forecast	Power Consumption		8,613GWh	22,898GWh	19,514GWh	77,730GWh	48,639GWh
	Maximum Power Demand		1,969MW	4,531MW	3,862MW	14,542MW	9,100MW
Primary Energy	Hydropower		2,361 MW	4,721 MW		8,896 MW	
	Gas		247 bbtud	348 bbtud		679 bbtud	
	Coal		300,000 ton	5,795,000 ton		23,373,000 ton	
	Renewable Energy		0 MW	200 MW		2,000 MW	
Power Supply Composition for Myanmar	Hydropower		2,361 MW (65.0%)	4,721 MW (53.6%)		8,896 MW (37.7%)	
	Gas		1,152 MW (31.7%)	1,969 MW (22.3%)		4,758 MW (20.2%)	
	Coal		120 MW (3.3%)	1,925 MW (21.8%)		7,940 MW (33.6%)	
	Renewable Energy		0 MW (0.0%)	200 MW (2.3%)		2,000 MW (8.5%)	
	Total		3,633 MW (100%)	8,815 MW (100%)		23,594 MW (100%)	
Power System Facility	Transmission (km)	500kV	0 km	1,029 km		2,659 km	
		230kV	3,047 km	7,434 km		9,624 km	
		132kV	2,109 km	2,389 km		2,511 km	
	Substation (MVA)	500kV	0 MVA	50,000 MVA		17,500 MVA	
		230kV	3,760 MVA	11,500 MVA		16,030 MVA	
		132kV	1,323 MVA	2,153 MVA		2,873 MVA	
Overall Development Cost	Power Generation		–	13.8 Billion USD		55.2 Billion USD	
	Transmission		–	2.7 Billion USD		5.6 Billion USD	
	Total		–	16.5 Billion USD		60.8 Billion USD	

Source: Prepared by JICA Survey Team

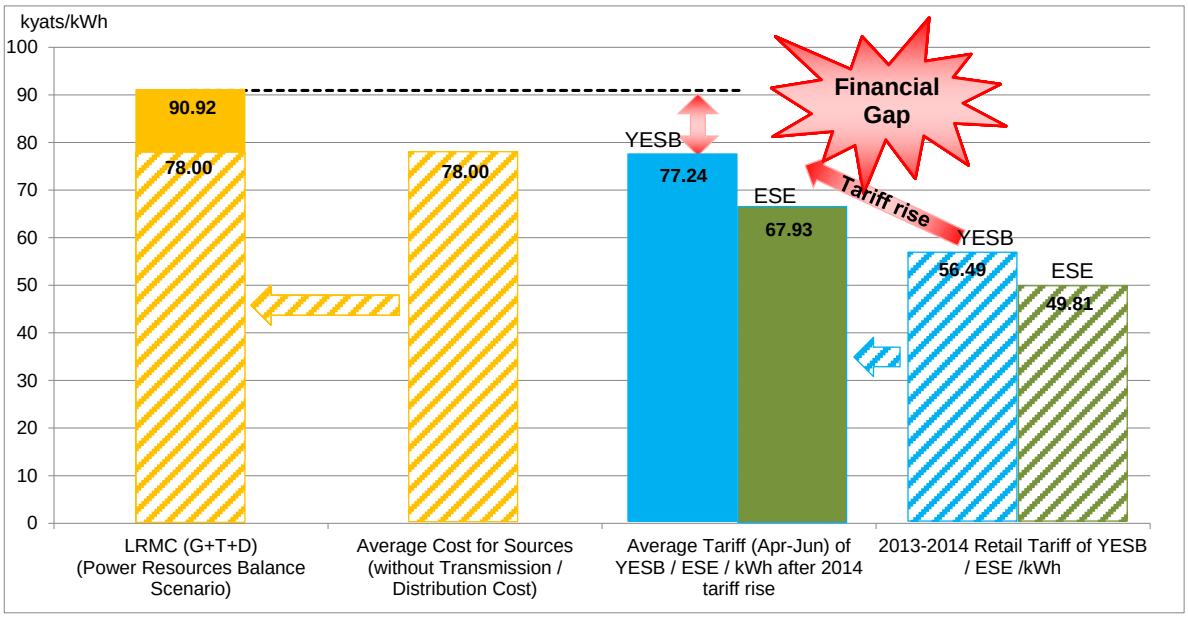


Fig. 1-8 Financial Gap between Power Tariff and LRMC

The M/P in the Previous Study was the initial trial and had been formulated based on the close discussion between the MOEP and JICA Team. Compared with the existing development plans, there are four (4) significant points in Myanmar.

(1) Revision of the power generation plan which is oriented in large scale hydropower projects and the balance of power resource composition
(2) Scenario evaluation involving the environmental assessment
(3) Indication of the financial gap between the current power tariff and appropriate levels
(4) Risks of high dependence on the JV (Joint Venture) / IPP (Independent Power Purchaser) scheme in the power generation development

Regarding (1), existing power generation development plans had been oriented in large scale hydropower projects and were revised to balance power resources appropriately. It was a turning point for policies of the electric power sector in Myanmar.

Regarding (2), it is also a remarkable aspect to involve environmental and social considerations as SEA (Strategic Environmental Assessment) in the comparison of study of Scenarios and to set the criteria of environmental impacts for the decision making of policies.

Regarding (3) and (4), although financial issues in the electric power sector were concerned by stakeholders, only qualitative opinions had been suggested due to the lack of systematic and quantitative analysis for the electric power tariff. Previous Study had indicated the appropriate tariff level which corresponds to the realistic power generation and transmission costs and the difference of burden for Myanmar by the development and fund procurement scheme. This analysis is expected to be the basis for the study of power tariff and development scheme in the future.

JICA Team acknowledge that it is important to follow the direction shown in the Previous Study and to implement the capacity development for the advanced formulation and operation of the M/P.

2. PRESENT STATE OF POWER SECTOR AND POINTS TO BE DISCUSSED

2.1 Present State of Energy Sector in Myanmar

GoM (Myanmar Government) established NEMC (National Energy Management Committee) in January 2013 for overall matters on energy sector of the State and implement the National Energy Plan for short and long term objectives in compliance with the National Energy Policy. GoM would have to implement such energy projects as oil, natural gas and coal after drafting the National Energy Plan.

Based on discussions in NEMC, the draft of the National Energy Policy (Myanmar version) had been compiled and submitted to the President Office in April 2014, and its English version was made with ADB (Asian Development Bank) support in May 2014 and finalized at the end of 2014.

2.2 Status of Power Sector

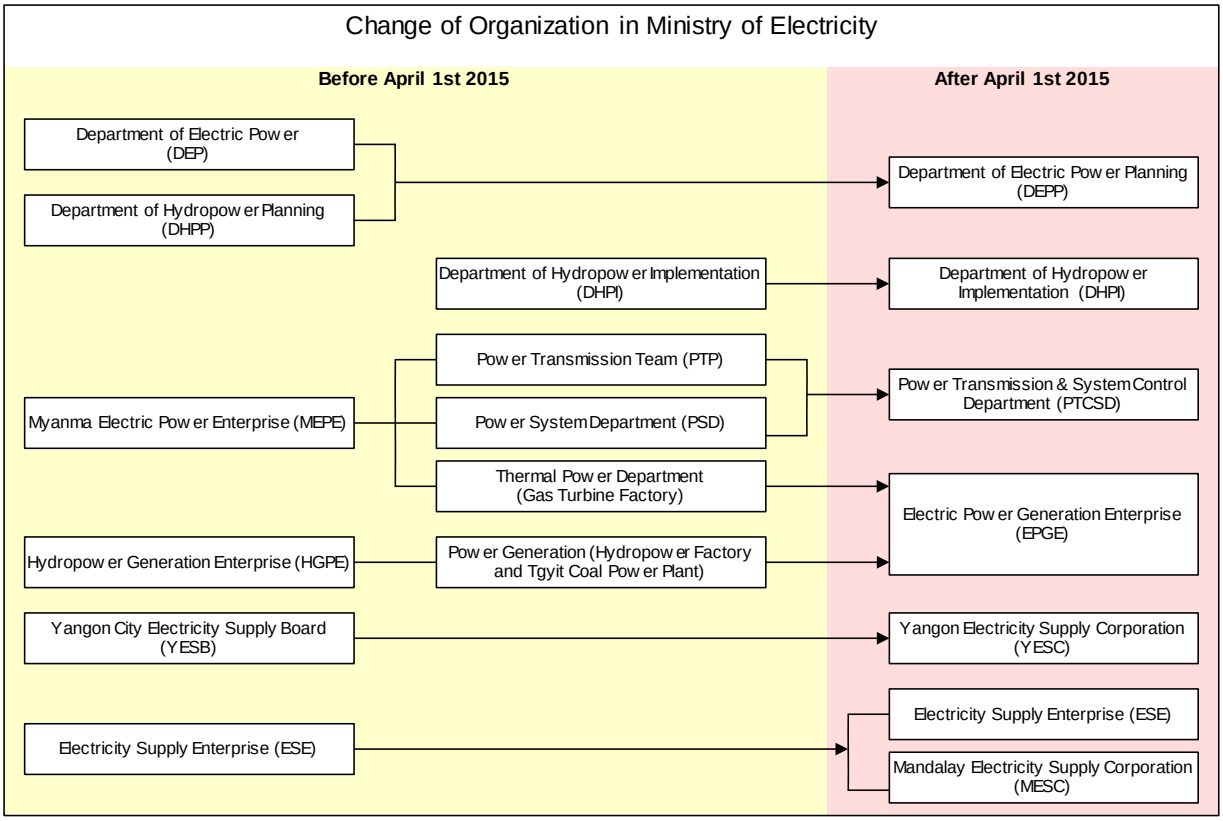


Fig. 2-1 Restructuring of Organization of MOEP (April 2015)

Source: MOEP

Restructuring of organization of MOEP was undertaken in April 2015 as shown in Fig. 2-1. MOEP had started preparation or operation of the following four institutional restructuring:

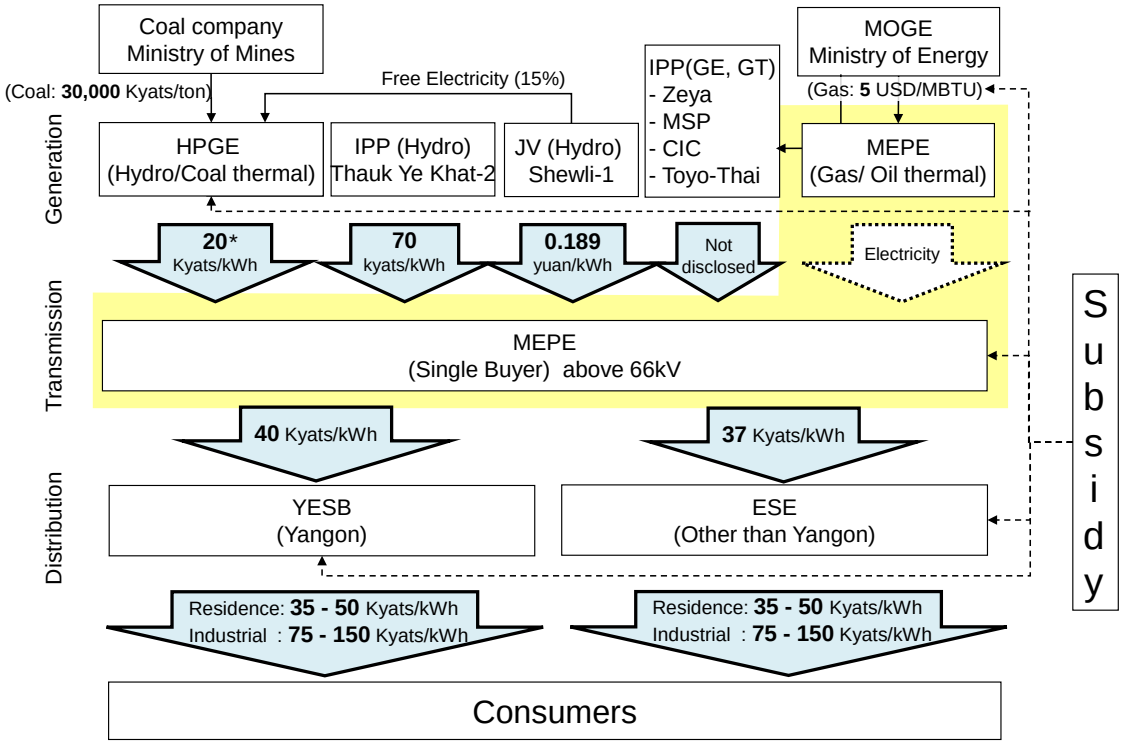
- Merger of planning sections: DEP (Department of Electric Power) and DHPP (Department of Hydropower Planning),

- Merger of generation sections: HPGE (Hydropower Generation Enterprise) and TPD (Thermal Power Department) in MEPE (Myanma Electric Power Enterprise),

- Corporatization of YESB (Yangon City Electricity Supply Board) and Mandalay regional office of ESE (Electricity Supply Enterprise) and,

- Establishment of Permanent Secretary

In 2006, Myanmar power sector was reformed from the vertical integration by MEPE to 4 enterprises, generation by HPGE, MEPE and IPPs, transmission by MEPE, distribution by YESB and ESE. MEPE plays a role of the single buyer similar to the power sector of Thailand and Indonesia as shown in Fig.2-2. The unit prices to buy and sell electricity (kWh) between enterprises are also indicated in Fig.2-2.



Source: prepared by JICA Study Team based on local newspaper and/or MOEP information

Fig.2-2 Electric Power Supply System (April 2014)

2.3 Reform of Power Sector

(1) Power Sector Structure

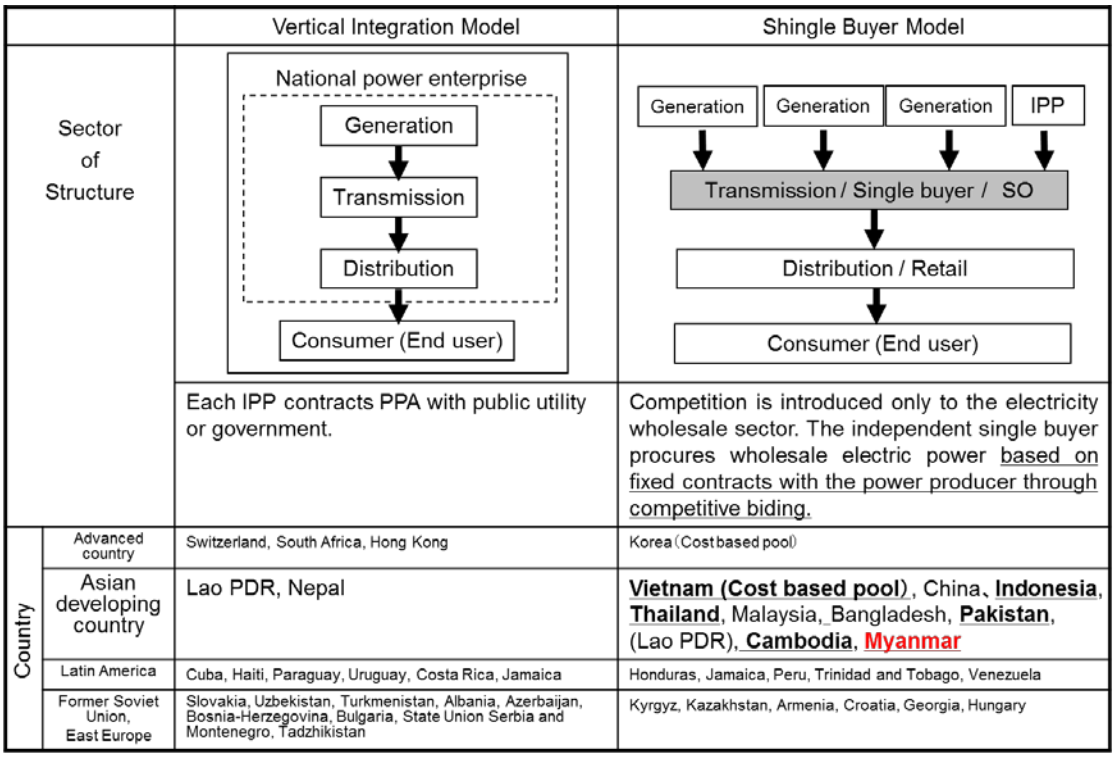
1) Institutional Restructuring of MOEP

MOEP has not been restructured after MOEP (1) and MOEP (2) were consolidated into one ministry in September 2012. Three governmental departments (DEP, DHPP, DHPI (Department of Hydropower Implementation)) and four state owned enterprises (MEPE, HPGE, ESE, YESB) exist under MOEP, and governance doesn't function effectively. After April 2015, institutional restructuring is being undertaken. But MOEP doesn't have a section to study a structure of electric power sector. Though DEP simply plans to increase employees in the present departments and enterprises of MOEP, they need a new organization and specialized persons for new tasks. Support of experts and capacity building to the power sector are essential.

The current movement of sector reform undertaken by MOEP advances in the right direction. But more reform is required to solve significant issues such as financial deficit of MOEP and power development to meet more demand increase. The approach of corporatization and privatization in power sector is expected to let the power sector work effectively and efficiently. Bid solicitation initiated by GoM is suggested to manage the IPP projects like on-going Myingyan Gas Power Plant.

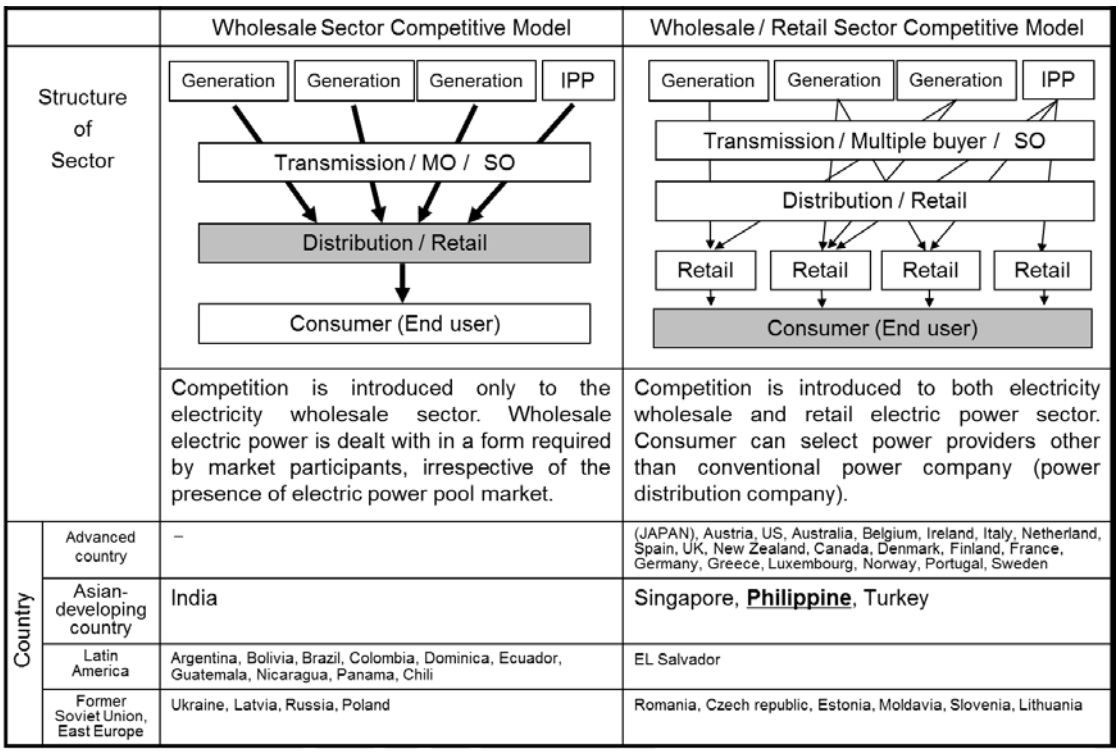
On the other hand the internal human resources are shortage in the present departments and enterprises in MOEP. They need a new organization and specialized personnel for extra tasks. Donors support of experts and capacity building to the power sector are essential.

MEPE plays a role of the single buyer similar to the power sector of Thailand and Indonesia as shown in Fig. 2-3 and Fig. 2-4. In Asia each country selects his own power sector model. Deliberate reform seems desirable for MOEP so that GoM should avoid the confusion against the fast movement to unbundle generation, transmission and distribution, or accelerate private competitiveness.



[Note] SO: System operator, MO: Market operator
Source: H.Nagayama, Political economy of separation of power generation from distribution and transmission, 2012

Fig. 2-3 Power Sector Model in Each Country (1/2)



[Note] SO: System operator, MO: Market operator
Source: H.Nagayama, Political economy of separation of power generation from distribution and transmission, 2012

Fig. 2-4 Power Sector Model in Each Country (2/2)

2) Establishment of an appropriate pricing policy

An appropriate pricing policy on power tariff for retail and wholesale is necessary to improve financial situation of state owned enterprises in the power sector.

In the case that GoM develops most of new power projects through IPP scheme due to shortage of project finance, financial burdens of Myanmar will increase as studied in the previous M/P. Thus, introduction of IPP projects, setting of power tariff, and injection of governmental subsidy should be implemented appropriately.

3) Bidding and PPA procedures based on international standards

In Myanmar, MOEP started to negotiate PPA (Power Purchase Agreement) mostly after completion of the construction in the past projects. This PPA negotiation takes time and IPP plants cannot start operation just after completion. According to MOEP, effective PPA period for hydropower IPPs is one year and renewal negotiation is necessary every year, but PPA period for gas-fired and coal-fired IPPs differs from project to project. MOF (Ministry of Finance) doesn't give Myanmar governmental guarantees for IPP projects. This could be hard situation in project finance for foreign investors to participate in IPP projects at present. It is required that international standard or procedure for bidding and IPP contract should be applied to project implementation.

(2) Power Development Plan

1) Updating Power Development Plan of hydropower based on the previous M/P

MOEP should update a long term Power Development Plan in Myanmar based on the previous M/P. It would be necessary to study a development plan against peak demand in dry season in consideration of plant utilization factors of hydropower stations in dry season and types of hydropower stations such as run-of-river, regulation-pond and reservoir types. Moreover, most hydropower projects are located in the north area and the present main transmission lines of 230kV running from north to south does not have enough capacity to transmit full electricity from north to south. Therefore, the long term Power Development Plan should correspond with an expansion plan of bulk transmission lines.

2) New thermal power plants developed by MOEP

Though MOEP makes every effort to forward new IPP projects such as gas engines and gas-fired thermal plants around the existing thermal power plants in Yangon Area as short term countermeasures for power supply, MOEP needs to make a middle-long term gas-fired development plan considering gas procurement for power generation.

MOEP also needs to study new coal-fired thermal power projects utilizing domestic coal and/or imported coal in view of diversity power sources, future stable power supply, future gas supply amount, etc.

3) Management of IPP installation

MOEP will have more than 50 plans to be constructed by BOT (Build Operate and Transfer) scheme and JV/BOT in addition to about 10 hydropower and a few thermal power projects to be newly developed by MOEP own investment. This development plan presents that the IPP projects will generate power of more than 80% of the total installed capacity in 2030-31. As described in the previous M/P, financial burdens of Myanmar will increase, provided that the installed capacity ratio of IPP to the total capacity is substantial. MOEP should study this situation focusing on appropriateness of planned annual supply and demand balance, agreement

of the transmission line expansion plan, and effects to power tariff.

Power supply in rainy season is usually 1.4 times as large as that in dry season. Power supply of gas-fired and coal-fired plants can be reduced by the increase of hydropower generation in rainy season to minimize power generation cost of the national grid. Though most of gas-fired and coal-fired thermal power plants are planned to be developed though BOT and JV/BOT schemes, MOEP should study various sources for procurement of electricity in dry season, including development of thermal power plants own by MOEP and import of electricity from surrounding countries, so that MOEP can ensure capacity of electricity supply corresponding to the demand and minimize the generation cost of the national grid.

4) Planning rehabilitation of existing power plants

In short term Power Development Plan, it is necessary to consider the capacity increased by rehabilitation of the existing power plants with completion time of the projects.

To secure the design installed capacity of the existing power plants, MOEP should reinforce organizations, arrange rules and manuals to implement proper operation & maintenance, and secure sufficient consumables to keep good condition of the existing facilities.

5) Establishment of procedures for power developments

By 2014, evaluation sequences of EIA (Environmental Impact Assessment) for the ongoing projects were unclear without applicable rule and enacting EIA for electricity power development. At present proponents should implement due EIA on the environmental guideline and receive approval from MOECAF (Ministry of Environmental Conservation and Forestry) before construction start.

At present, regulatory ministry on water right of rivers is unclear. MOAI (Ministry of Agriculture and Irrigation) controls water rights for irrigation and agriculture, and the City Development Committees in local governments control water rights for clean water. A regulatory ministry would be necessary to control water right of rivers for development of hydropower, irrigation and agriculture, water supply, etc.

Though attention to renewable energy such as solar and wind power is increasing for future power resources, there is no circumstance to introduce them by promoting measures against relatively high generation cost.

(3) Procurement of Power Fuel

MOEP is responsible for gas supply to ongoing gas-fired IPP projects. MOEP needs to study how to reflect cost of gas procurement into the electricity tariff. On the contrary, MOEP plans new IPPs of coal-fired thermal power projects, for which the developers should procure necessary coal for power generation by themselves. In this case, procurement cost of coal is to be included in the electricity tariff from IPP.

If a new gas-fired IPP project is planned from now, securing of required gas amount would be a critical issue. Gas ingredients are different among locations of gas production. MOEP needs to study not only required gas amount but also installation of gas pipes and plan of supply facilities according to gas ingredients.

MOE (Ministry of Energy) supplies domestic gas for the existing gas-fired power plants of MOEP. Demarcation between MOEP and MOE should be defined in gas procurement and supply for new gas-fired thermal generation.

(4) Rural Development (Rural Electrification)

According to the Census Report Volume 2, the 2014 Myanmar population and housing census, May 2015, a sizeable proportion of households in Myanmar use electricity (32.4%) as the main source of energy for lighting, followed by candle (20.7%). However, there is a huge difference between urban (77.5%) and rural areas (14.9%) in the use of electricity as the main source of lighting. The proportion of households using battery, generator and solar systems as the main source of lighting is considerable. It is also evident that, four out of five households in Myanmar use wood or charcoal as main sources of energy for cooking. In urban areas, over half of households use wood or charcoal, while in rural areas up to 80 percent use wood or charcoal for cooking. Overall, only 17 percent of households use energy such as electricity and liquefied petroleum gas for cooking. The proportion is higher in urban areas (46%) but very low in rural areas (6%).

An expansion plan of the national grid should be coordinated with the NEP (National Electrification Plan) on Rural Electrification presently supported by WB (World Bank). DRD (Department of Rural Development) of MOLFRD (Ministry of Livestock, Fisheries and Rural Development) and ESE are in charge of making the Master Plan on Rural Electrification, showing the future electrification plan until 2030. GoM including MOEP and other relevant organizations cooperate and implement rural electrification effectively with assistance of international donors.

3. BASIC APPROACHES OF THE SURVEY

In order to scrutinize the capacity development and institutional establishment for the capacity development of the M/P formulation and operation, it is necessary to assess the current baseline capacity of MOEP and to indicate the goal in the future. Fig. 3-1 shows the concept of the target capacity goal in the future.

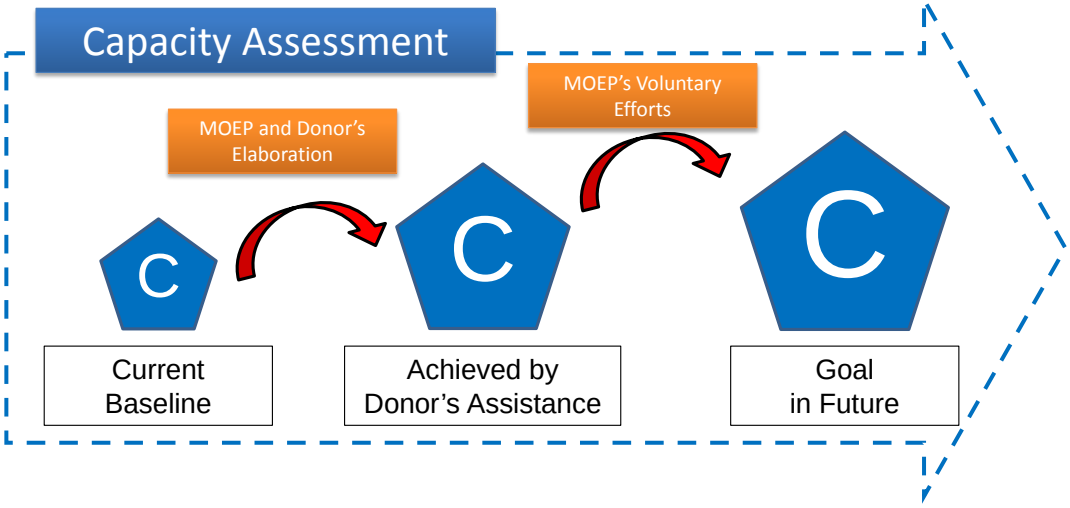


Fig. 3-1 Concept of the Goal of Capacity in the Future

Generally, improvement of the technical capacity of persons in charge tends to be focused on their capacity development program. However it is difficult to deal with unexpected personnel relocation and retirements by focusing on only personal resources. To establish the sustainable institutional structure on the formulation and operation of the M/P, it is important for the capacity assessment to recognize exact persons who are concerned (staffs), institution (MOEP), and external environment (policy, frameworks, etc.) as an interactive system.

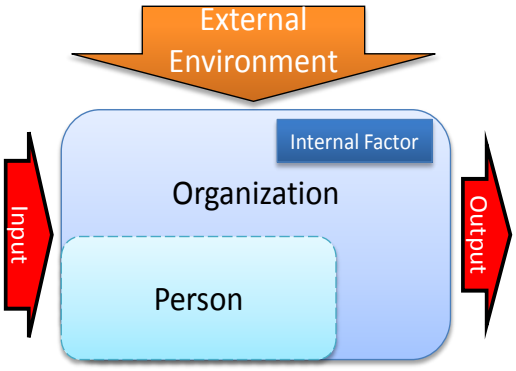


Fig. 3-2 Target of Capacity Assessment

3.1 Capacity Assessment on the Formulation and Operation of the M/P through the Training

In Previous Study, explanation and provision of the data and analysis related to the M/P had been implemented by JICA Team as the technical transfer for MOEP staffs concerned. The components of the analysis of the M/P are of power demand forecast, power generation development plan, power system plan, and economic and financial analysis. Study Flow of the M/P is shown in Fig. 3-3. In this Survey, the training program on the analysis and simulation of the M/P will be executed for MOEP staffs concerned to assess and develop their technical capacity. Contents of the training program are;

- Understanding and implementing a trial of methodologies on the power demand forecast

- Simulation of the power generation development software such as WASP (Wien Automatic System Planning)
- Simulation of the power system development analysis such as PSS/E
- Economic and financial analysis
- Investment efficiency of JV/IPP scheme development and burden of Myanmar

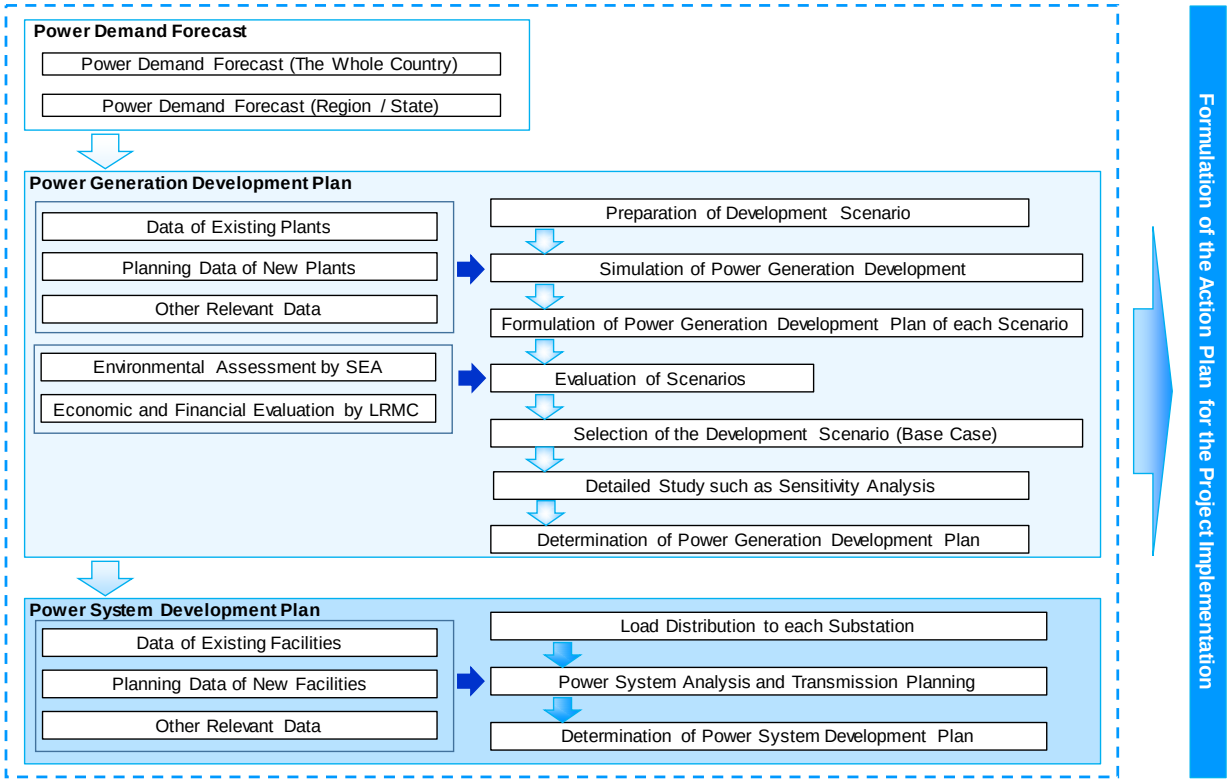


Fig. 3-3 Study Flow of the M/P

Work process of each analysis is generally classified into four (4) steps as follows:

- Data collection and preparation of their analysis
- Set-up of the basic analysis conditions
- Execution of the analysis
- Explanation and summarization of the analysis outputs

Focusing on each process, technical skills for using software are required in STEP1 and STEP3. Technical knowledge, experiences, and analytical perspectives are required in STEP2 and STEP4.

Regarding the evaluation of technical capacity, confirmation points are prepared at each step. Their understandings and skills were assessed by the questionnaire from staffs. JICA Survey Team will review the questionnaire at the beginning and the ending of the training.

3.2 Formation of Working Group for the M/P (in Short Term)

(1) Candidates of this Survey

JICA Survey Team requested MOEP to select candidates of the technical transfer trainees in this survey in the 1st investigation and MOEP assigned U Zaw Ye Myint as a leader of candidates and selected total 32 staffs from each department. Number of participants from each department is shown in Table 3-1.

In this survey, technical capacity of them will be assessed through the technical transfer training and details of Working Group for the M/P such as numbers and candidates will be studied.

Table 3-1 Number of Candidates from each Department

Department	Number
DEP	8
DHPP	3
DHPI	3
HPGE	3
MEPE	8
ESE	4
YESB	3
Total	32

(2) Grouping of Participants

As properties of the M/P formulation are wide scopes, participants are classified into following three (3) groups to emphasize the training efficiency considering the participants' expertize and training program.

- Power System Planning Group
- Power Development Planning Group
- Economic and Financial Analysis Group

Leaders and members of each group are shown in Table 3-2.

Explanation of this Survey

Discussion with Leaders

Table 3-2 Participants of Technical Transfer Training in this Survey

Sr.No	Name	Position	Department
1	U Zaw Ye Myint (Group Leader)	Deputy Chief Engineer	MEPE
(1) Power System Planning			
2	U Moe Theat (Leader)	Superintend Engineer	MEPE
3	U Thant Zin	Superintend Engineer	ESE
4	U Myo Win Zaw	Executive Engineer	MEPE
5	Daw Phyu Phyu Khin	Assistant Director	DEP
6	U Nyein Chan	Assistant Engineer	ESE
7	U Ye Naing Linn	Assistant Engineer	HPGE
8	U Myo Zaw Htwe	Assistant Engineer	MEPE
(2) Power Development Planning			
9	Daw Myint Kyi Swe (Leader)	Deputy Director	DEP
10	U Kyi San Linn	Superintend Engineer	MEPE
11	Daw Thida Aye	Deputy Director	DHPP
12	U Aung Lwin	Deputy Director	DHPI
13	U Ye Tun Zaw	Executive Engineer	MEPE
14	Daw Yi Mon	Executive Engineer	YESB
15	Daw Chawe Thander Soe	Assistant Engineer	DEP
(3) Economic and Financial Analysis			
16	Daw Aye Aye Mon (Leader)	Executive Engineer	DEP
17	U Tun Lin Soe	Staff Officer	DEP
18	Daw Hnin Ei Khaing	Staff Officer	DEP
19	Daw Mya Thae Lwin	Assistant Director	DEP
20	Daw Thawe Thawe	Deputy Director	DHPP
21	U Tun Ko Ko	Assistant Director	DHPP
22	U Kyaw Kyaw	Assistant Director	DHPI
23	Daw Nandar Htoo	Staff Officer	DHPI
24	Daw Win Mya Aye	Deputy Director	MEPE
25	Daw Zin War Phuu	Assistant Director	MEPE
26	Daw Kai Zin Kyaw	Staff Officer	ESE
27	Daw Aye Cho Zin Yu	Staff Officer	ESE
28	Daw Ei Ei Lwin	Staff Officer	HPGE
29	Daw Yu Yu Min	Staff Officer	HPGE
30	Daw Khim Maw Lwin	Assistant Director	YESB
31	Daw Soe Thet Thet Han	Staff Officer	YESB

3.3 Power Demand Forecast

3.3.1 Outline

It is requested for demand forecast training participants to collect latest information as follows (mainly record after year 2013) in order to refer updated database through technical transfer,

- Demand record for whole country
- Demand record in each sector
- Demand record in each region and state
- Demand record in each substation

3.3.2 Confirmation of the Technical Capacity for the Power Demand Forecast

In the previous M/P, mid-term and long term demand forecast for whole country was conducted by the macro forecast method due to the constraint of data availability for forecast. Estimated power demand was allocated to each region and state based on past record and electrification plan. Although the current condition seems not to be changed since then, technical transfer will be conducted showing several ways for forecasting such as micro forecast method through 2nd and 3rd site investigation in order to consider methodology that suit for Myanmar by themselves. Technical transfer is planned through lecture and simulation using laptop computer based on the previous M/P.

Moreover, as the Working Group demand forecast and power development are common, technical transfer schedule would be coordinated each other. Items to be confirmed to understand technical level of Group members through 2nd and 3rd technical transfer program are shown in Table 3-3.

Table 3-3 Confirmation Items of the Technical Capacity in the Power Demand Forecast

	Items			Check points
Power Demand Forecast	Step 1	Input data preparation	Collection of record	- Understanding of forecasting method (micro, macro) - Understanding of the data to be collected - How to collect data - How to develop data file
			Collection of economic indicators	
			Collection of national development plan and electrification plan	
	Step 2	Setting conditions	Setting of parameters	- Setting of parameters based on collected information
	Step 3	Implementation of analysis	Demand analysis	- Forecasting demand with several scenarios (high/low case) using software
			Sensitivity analysis	
	Step 4	Evaluation and formulation of demand forecast	Comparison and evaluation of the output of analysis	- Understanding the result of analysis - Evaluation of several scenarios
			Formulation of demand forecast for M/P	

Table 3-4 Contents of 1st Training (Power Demand Forecast)

Date	Lecture	Remarks
Day 1	Basic concept and methodology of power demand forecast in the previous M/P	➢ Considering the request by C/P, had a lecture of a basic concept of power demand forecast and a methodology which was used in the previous M/P, with experience in Japan. ➢ It seems to be a little difficult to understand the process to calculate maximum demand using annual power consumption and load factor for C/P.
Day 2	Calculation of future power demand with the methodology of M/P	➢ Training for calculation of future power demand with a methodology which was used in the previous M/P in order to check the understanding of the methodology. ➢ Since some of C/Ps seem not to be accustomed to using a spreadsheet software, a lot of time was needed to carry out the calculation.

Table 3-5 Contents of 2nd Training (Power Demand Forecast)

Date	Lecture	Remarks
Day 1	Review of calculation of future power demand with the methodology of M/P	➢ In order to confirm the understanding about the methodology of demand forecast of previous M/P, had a review of 1st training with different data set. ➢ Regarding an elasticity factor and the process to calculate maximum demand, these items were not understood well and had a lecture again.
Day 2	Collecting information and short term power demand forecast for power system operation	➢ Lecture of the factor, such as GDP, population, economic activity and lifestyle of people, which influenced on power consumption, and explained what kind of data is necessary for demand forecast. ➢ Lecture of the outline of demand forecast for daily system operation according to the request by C/Ps. ➢ It is necessary to understand that demand forecast by each area (substation) is required for system planning.
Day 3	Regression analysis for power demand forecast	➢ Lecture and exercise of regression analysis for demand forecast using record of demand and some factors. ➢ Although C/Ps had never used the function of regression analysis of Excel software, they could understand the idea well. ➢ To explain it is important to collect various kinds of data and to analyze which factor has more impact on the power demand in Myanmar.
Day 4	Total practice of power demand forecast	➢ Training for micro forecasting method which is based on accumulation of each sector of power consumption, using sample data, and check validity of the output of micro forecast utilizing the output of macro forecast.

Table 3-6 Evaluation of Technical Capacity for the Power Demand Forecast

Item			Evaluation	
			Before training	After training
STEP0	Basic knowledge	Understandings of basic concept of power demand forecast	×	○
STEP1	Data collection and preparation of data base	Understanding of a methodology (micro, macro forecast)	―	△
		Understanding of the data to be required	―	△
		Understanding of how to collect data	―	△
		Skills to make database using Excel software	―	○
STEP2	Setting conditions	Skills to set of parameters based on collected information such as economic factors and social economic development plan	―	△
STEP3	Implementation of analysis	Understanding of the analysis and its procedure	―	△
		Skills to have output of several forecasting scenarios (high case/ low case) using Excel software	―	△
STEP4	Evaluation and formulation of demand forecast	Understanding of the output of analysis	―	△
		Skills to compare and evaluate of several forecasting scenarios	―	△

○ Excellent : Trainees can execute works by themselves
∆ Good : Trainees understand work contents and can execute works under the expert's guidance
× Fair : Trainees don't understand work contents and can't execute works.
― : Not implemented

Table 3-7 Comments on Technical Capacity of the Power Demand Forecast

Item	Comment
Technical Skills	➢ It is capable of basic work, such as data input, drawing figure and graph. ➢ Some of C/Ps input data directly in each cells without referring existing data cells when modify database and prepare analysis data. This is not efficient
Professional Knowledge	➢ Some of C/Ps understand the contents of previous M/P. But most of C/Ps do not understand the basic concept of demand forecast well. ➢ Sometimes it is difficult for C/Ps to understand what kinds of data are suitable to collect because they don't have experience to analyze the factors which have impact on power consumption in Myanmar.

3.4 Power Generation Development Plan (PGDP)

3.4.1 Outline

For power generation development in Myanmar, planning, designing, construction, and O&M (Operation and Maintenance) have been implemented by DHPP, DHPI, HPGE, DEP and TPD of MEPE under the MOEP.

In this survey, the training for the formulation of the power generation development plan will be implemented for the "Power Development Planning Group" related departments and DEP.

The training through the simulation of power generation development will be conducted in the 2nd and 3rd site investigation. Results of previous M/P simulation are used as training materials. In this training, participants implement series of tasks such as analysis data preparation, execution of the analysis and summarization of results by using their PCs.

3.4.2 Confirmation of the Technical Capacity for the PGDP

Confirmation items of the technical capacity in the power generation development plan are shown in Table 3-8.

Table 3-8 Confirmation Items of the Technical Capacity in the Power Generation Development Plan

	Items			Contents
Power Generation Development Plan	STEP1	Data collection and Preparation of the Analysis Data	Data collection of existing analysis	to understand items to collect to grasp data sources to be collected to consolidate the collected data in electronic files such as Excel to prepare the input data for analysis
			Data collection of new plants	
			Preparation of analysis data	
	STEP2	Set-up of the basic analysis conditions	Set-up of the conditions of tools	to understand basic conditions such as demand forecast cases and reserve margin rate to set basic conditions based on existing records and performance of other projects
	STEP3	Execution on the analysis	Execution of analysis	to understand the content and procedures of analysis to acquire the operation method and implement analysis to execute sensitivity analysis by trial and error
			Execution of sensitivity analysis	
	STEP4	Explanation and summarization of the analysis outputs	Comparison and evaluation	to understand property and outputs of the analysis to compare various outputs to summarize outputs and formulate the Action Plan for the particular project planning
			Interpretation of the results	

JICA Survey Team had planned to implement the training for few staffs based on the OJT (On-the-Job Training) style. However, six – seven training participants had been selected from each department of MOEP. As there had been big difference in understandings of the M/P among participants and some staffs have not been familiar with the M/P, the training program for PGDP was modified in order to emphasis the learning of basic concept.

Contents of the 1st training and 2nd training are shown in Table 3-9 and Table 3-10 respectively.

Table 3-9 Contents of 1st Training (Power Generation Development Plan)

Date	Lecture	Remarks
Day 1	Explanation of basic concepts of the PGDP	➢ Although JICA Survey Team gave some questions of contents for PGDP to participants, none can answer. Concept of the PGDP is seemed to be not understood well. ➢ Therefore, the training program was modified in order to emphasis the learning of basic concept and examples for neighboring countries were introduced. ➢ In Q&As, participants answered that environmental assessment were serious issues to be solved in the PGDP.
Day 2	Data management and collection	➢ Data management and collection for the PGDP was explained. For the data collection, it is important to clarify that "which department" and "who" handle the related data. Establishment of the future data management and collection system was discussed. ➢ Data preparation for the analysis was demonstrated by using existing data collected in the previous M/P. ➢ Participants could prepare the required data which JICA Survey Team had requested.
Day 3	Explanation of WASP and the optimum PGDP	➢ Outline of WASP and optimization of the PGDP was explained. ➢ Calculation of power generation unit cost (kWh/USD) for each source and major analysis conditions were explained. Practice of unit cost calculation was implemented. ➢ WASP was installed to PCs of participants. Constraints of WASP analysis and unstable behaviors as a software were explained.
Day 4	Holding the 1st Seminar	➢ Outline of the PGDP in previous M/P and issues to be solved in Myanmar were explained.
Day 5	Operation of WASP and Action Plan	➢ Practice of WASP analysis was executed by using participants PCs. ➢ Discussion on the action plan for the future technical assistance project was implemented. ➢ Questionnaires for the training evaluation and understandings were collected from participants.

Table 3-10 Contents of 2nd Training (Power Generation Development Plan)

Date	Lecture	Remarks
Day 1	Explanation of basic concepts of the PGDP and WASP	➢ As new participants joined the training, concepts of PGDP were explained again. Participants could express their opinion in Q&A and understandings of the PGDP were seemed to be improved. ➢ Flow chart of WASP and roles of each modules are explained.
Day 2 Day 3	Data input and analysis execution	➢ Details of modules (LOADSYS, FIXSYS, VARSYS, CONGEN, MERSIM and DYNPRO) were explained and contents of input data were confirmed. ➢ Methodologies and analysis conditions of each module in the previous M/P were explained. ➢ Participants input sample data and execute analysis of each module by themselves. Finally, they complete series of analysis by their hands. ➢ Outputs of analysis and how to load the results in excel were explained.
Day 4	Confirmation of outputs	➢ Salient outputs such as GWh, cost, LOLP and capacity factor were explained. Participants prepare the table of annual power generation by each power source (kWh) and graph of annual transition.
Day 5	Sensitivity analysis	➢ Sensitivity analysis of gas fuel cost was executed and difference of power generation amount was confirmed. ➢ WASP analysis was executed in the low case of power demand forecast and it was confirmed that power plants were excessed based on the current list.

Evaluation of technical capacity of participants for Group 2 is shown in Table 3-11.

Table 3-11 Evaluation of Technical Capacity for the Power Generation Development

Item			Evaluation	
			Before	After
STEP0	Basic knowledge	Understandings of basic concepts for the PGDP	×	△
STEP1	Data collection and preparation of the analysis data	Understandings of data to be collected	△	△
		Understandings of responsible departments of required data	△	○
		Preparation and summarization of collected data to Excel.	―	○
		Preparation of datasets for Analysis	―	△
STEP2	Set-up of the basic analysis conditions	Understandings of analysis conditions for the PGDP such as demand forecast and reserve margin	―	△
		Preparation of the analysis conditions considering examples of other projects and performance of existing projects	―	△
STEP3	Execution on the analysis	Understandings of analysis contents and process	―	△
		Acquirement of WASP operation skills and analysis execution	―	△
		Skills to implement sensitivity analysis by varying analysis conditions through a trial and error process	―	△
STEP4	Explanation and summarization of the analysis outputs	Understandings of outputs	―	△
		Comparison and evaluation of each study case	―	×
		Summarization of study results and preparation of recommendations for specific projects	―	×

○ Excellent : Trainees can execute works by themselves
△ Good : Trainees understand work contents and can execute works under the expert's guidance
× Fair : Trainees don't understand work contents and can't execute works.
― : Not implemented

Table 3-12 Comments on Technical Capacity of the PGDP

Item	Comments
Software Skills	➢ Participants have basic capacity to prepare data input, graphs and table by using excel. ➢ Many members were working inefficiently by not using the cell reference, and instead were inputting all the data one by one when the given data had to be processed and completed as an analyzed data. ➢ Some members were working efficiently by applying inbuilt EXCEL formulas. ➢ No one has used programming software such as VBA.
Professional Knowledge	➢ Participants who have been in charge of the previous M/P understand the data contents of PGDP well. However, concept of the PGDP itself is seemed to be not acknowledged. ➢ Participants have general knowledge of hydropower and gas power. Staffs of DHPI and MEPE also understand details of analysis conditions. Meanwhile, there is only Tigyit coal power plant in Myanmar and most of staffs have less knowledge of coal power plants. ➢ Participants do not have capacity to utilize outputs of WASP and summarize in the report. Concept of PGDP is still new for them and their understanding level does not reach to handle it by themselves

3.5 System Development Planning

3.5.1 Outline

It is requested for participants of system development planning to collect latest information related to the system planning as follows in order to refer updated database through the technical transfer,

- List of existing transmission lines (66kV and higher voltage classes)
- List of existing substations and power transformers (132kV, 230kV)
- List of existing capacitors and shunt reactors
- Latest power system diagram
- Amount of distribution transformers in each region and state

As for software currently utilized,

- Name of software: NEPLAN
- Numbers of license: 5
- Responsible department for system analysis: PSD (Power System Department)
- Update of software: no maintenance plan

JICA Survey Team plan to exchange opinions regarding software for power system analysis with MOEP including Group members, and also plan to confirm the conditions of support from ADB regarding grid code and standard of system planning.

3.5.2 Confirmation of the Technical Capacity for System Development Planning

Items to be confirmed to understand technical level of Participants through 2nd and 3rd technical transfer program are shown in Table 3-13.

Table 3-13 Confirmation Items of the Technical Capacity in the System Development Planning

	Items			Check points
System Development Planning	Step 1	Input data preparation	Collection of existing system data	- Understanding of basic concept and procedure for planning - Understanding of the data to be collected - How to collect data - How to develop data file
			Collection of power demand forecast and power development plan	
			Organization data for analysis	
	Step 2	Setting conditions	Setting of planning standard	- Understanding of the criteria of transmission capacity, voltage, system stability based on the system condition
	Step 3	Implementation of analysis	Power system analysis	- Analyzing power flow, short circuit capacity, voltage, and system stability using example data
			Sensitivity analysis	
	Step 4	Evaluation and formulation of system development planning	Comparison and evaluation of the output of analysis	- Understanding of the result of Analysis - Calculating a rough cost for implementation - Evaluation of several scenarios
			Formulation of system development planning for M/P	

Table 3-14 Contents of 1st Training (System Development Planning)

Date	Lecture	Remarks
Day 1	- Outline of the previous M/P - Experience of power system development in Japan	➢ Lecture of outline of the previous M/P using presentation material was implemented since it is also necessary for system planning to understand demand forecast and power development plan. ➢ Lecture of the experience of Kansai Electric's system development which realized high reliability power supply through long term system development plan in order to tell the importance of M/P.
Day 2	- Lecture of demand forecast in the previous M/P - Discussion about organization and role allocation in MOEP for power system planning	➢ Lecture of demand forecast methodology in previous M/P using presentation material according to the request by C/Ps. ➢ It seemed that C/Ps understood the process to forecast the power consumption and the maximum power demand using macro approach. On the other hand, practical work process using the output of demand forecast to make system plan was yet to be obtained. ➢ Then had a discussion about the role of each department and enterprise in MOEP for power system planning. This is an important issue to make action plan for M/P. ➢ It is important to have key persons to understand the whole picture of M/P to manage it.
Day 3	Basic concept of system planning (1)	➢ Lecture of the procedure of system planning and basic knowledge of power flow and short circuit capacity ➢ Exercise of calculation of power flow with simple system diagram ➢ Some of C/Ps could handle the calculation without support and the rest could do with additional explanation and support. In the end, all of C/Ps could understand well.
Day 4	Basic concept of system planning (2)	➢ Lecture of the criteria such as thermal capacity, short circuit capacity, transient stability, voltage stability, to reinforce transmission lines and substations ➢ Exercise of how to supply power to new customers from existing grid. ➢ Exercise of calculation of utilizing factor of substation with several cases. ➢ C/Ps almost looked understood well.
Day 5	1st seminar	➢ Presentation of the outline of demand forecast and system development planning in previous M/P, issues and outline of training in this survey.

Table 3-15 Contents of 2nd Training (System Development Planning)

Date	Lecture	Remarks
Day 1	Power demand forecast	➢ Training to follow the demand forecast process of the previous M/P in order to understand the way by using the prepared spreadsheet data. ➢ Most of C/Ps seemed to be understood well.
Day 2	Evaluate outline of power flow on a whole Myanmar grid	➢ Training to calculate the power flow among five large blocks (areas) in Myanmar in order to grasp the outline of necessary transmission capacity. ➢ Calculate the amount of demand and generation in each block allocating all power station (hydro, gas, coal) to each block using power development list. ➢ Most of C/Ps seemed understand well through exercise.
Day 3	System analysis using sample diagram	➢ Training of power flow analysis with simple diagram. ➢ Since the same software as M/P was used in the training, C/Ps could not use it in their laptop computers. Therefore outputs of software (spreadsheet data) were distributed prior to the work by C/Ps. Then they could calculate the power flow and phase angle of each transmission line. ➢ It seemed that such kind of exercise was useful for them to enhance their understandings. ➢ Lecture of system stability using the same study case ➢ Lecture that it is effective to reduce grid impedance, applying higher voltage, and quick isolation of fault point to improve system stability according to the result of simulation.
Day 4	Power flow analysis using the system in Yangon area	➢ Lecture and training of system analysis in Yangon area using NEPLAN which is used in MOEP. ➢ Case study of power flow based on the demand forecast and power development plan in 2020. ➢ C/Ps input the prepared case study data in the NEPLAN software. ➢ Lecture of the effect of installing second 500kV substation and changes of generation development on transmission system in Yangon area based on the result of simulation. ➢ Only expert staff of NEPLAN could handle it and others had no experience to use it. It is assumed that it is necessary so long time for them to use it.
Day 5	Discussion about action plan	➢ Discussion of action plan among leaders of group 1 and group 2 which would presented in 2nd seminar by C/Ps. ➢ “Organization and institution”, “Data management”, “Capacity development” are the main topics for action plan.

Table 3-16 Evaluation of Technical Capacity for the System Development Planning

Item			Evaluation	
			Before training	After training
STEP0	Basic knowledge	Understanding of basic concept of power system plan	×	△
STEP1	Data collection and preparation of data base	Understanding of the data to be collected (existing grid, demand forecast, power development plan)	△	○
		Understanding of how to collect necessary data	△	○
		Skills to make database of collected data using Excel software	―	○
		Skills to prepare datasets for analysis	―	△
STEP2	Setting conditions	Understanding of system development standard and criteria	―	×
STEP3	Implementation of analysis	Understanding of the analysis and process	―	△
		Skills to use system analysis software (NEPLAN, etc.)	―	×
		Skills to implement sensitivity analysis by varying conditions	―	×
STEP4	Evaluation and formulation of system development plan	Understanding of the output of calculation	―	△
		Skills to evaluate the system development cost	―	―
		Skills to formulate system development plan and make action plan	―	―

○ Excellent : Trainees can execute works by themselves
△ Good : Trainees understand work contents and can execute works under the expert's guidance
× Fair : Trainees don't understand work contents and can't execute works.
― : Not implemented

Table 3-17 Summary of Technical Capacity for the System Development Planning

Item	Comments
Technical Skills	➢ Only the staffs of system analysis team can handle NEPLAN currently. As other C/Ps don't have experience to use this software at all, they could not improve their skill to handle this software in this short term training although they seemed to get the image what kind of output is obtained using this software. ➢ When using Excel software to simulate system, some of C/Ps worked efficiently using prepared functions.
Professional Knowledge	➢ It may be difficult for C/Ps to understand the whole process of system development plan due to the time constraints. ➢ C/Ps have basic knowledge of electricity well. ➢ C/Ps can understand what kind of information is necessary for system planning ➢ Standard and criteria to reinforce system is to be prepared

3.6 Economic and Financial Analysis

3.6.1 Outline

Following components were implemented as training and lectures on the economic and financial analysis.

- Lecture on the basic knowledge of economic and financial analysis
- Evaluation of the F/S of power generation projects
- Analysis of LRMC/LRAIC (Long Run Average Incremental Cost)
- Establishment of MEPE financial analysis

Confirmation items of the technical capacity in the economic and financial analysis are shown in Table 3-18.

Table 3-18 Confirmation Items of the Technical Capacity in the Economic and Financial Analysis

		Items			Contents
Economic and Financial Analysis	Operation of forecasted financial model	STEP1	Understanding of analytical model	Understand analytical model (forecasted integrated financial model)	to understand analytical model(forecasted integrated financial model)
		STEP2	Set-up of the basic analysis conditions	Set-up basic conditions and criteria	to understand the major assumptions
		STEP3	Execution on the analysis	Run simulation and implementation of sensitivity analysis	to understand the simulation analysis to correct the faults in the program if there is any bug
		STEP4	Comparison of the results by development schemes	Compare results	to compare the results to compute overall financial burdens that the Myanmar shall take by the conditions such as financial schemes (IPPs, own funds, etc.)
				Interpretation of the results	
	Computation of LRMC／LRAIC	STEP1	Understanding of computation of LRMC/ LRAIC	Understand the LRMC/LRAIC computation	to understand the LRMC/LRAIC computation
		STEP2	Set-up of the basic analysis conditions	Set-up basic conditions and criteria	to understand the major assumptions to set up the conditions based on the power development plan and power system plan
		STEP3	Execution on the analysis	Run simulation	to understand the content and procedures of analysis to acquire the operation method and implement analysis
		STEP4	Explanation and summarization of the analysis outputs	Comparison and examination of the results	to evaluate the figures of LRMC/LRAIC in comparison with the other countries cases.
	Evaluation of F/S	STEP1	Understand the analytical model	Understand analytical model	to understand the analytical model
		STEP2	Set-up of the basic analysis conditions	Set-up assumptions of F/S in the analytical model	to reflect the assumptions of F/S into the analytical model
		STEP3	Execution on the analysis	Run simulation	to understand the contents of simulation analysis to correct the faults in the program if there is any bug
		STEP4	Comparison of the results by development schemes	Compare results	to compare the results of competition
				Interpretation of the results	

3.6.2 Confirmation of the Technical Capacity for Economic and Financial Analysis

As the components of the economic analysis are rich and varied, MOEP requested to compensate the lecture on the basic knowledge of economic and financial analysis. Therefore, JICA Survey Team had started to implement the training for economic and financial analysis from the 1st site investigation.

May 9th and 10th

Lectures
（Economic and Financial Analysis）

Members of Group 3
（Economic and Financial Analysis）

Table 3-19 Contents of 1st Training (Economic and Financial Analysis)

Item	Property
Participants	Total 14 staffs (DEP 5, DHPP 2, DHPI 2, MEPE 2, ESE 2 and YESB 2)
DAY1	AM Provided lecture about basic and minimum knowledge for understanding project finance. In practice, calculation for Loan repayment cases for hydropower plants in the Philippines and for Capital Cost for power plant projects was conducted. PM Explained structure of Excel model and conducted sensitivity analysis by using an actual example of 100MW GTCC of Thaketa.
DAY2	AM Further study on sensitivity analysis conducted with different conditions from Day 1 by applying a real-world example of the 100MW GTCC Thaketa case. Calculated project value with cash flow analysis. Subsequently, explanation was given on Excel structure on finance model of MEPE and sensitivity analysis. For example, there was a debate about expected changes of MEPE finance if wholesale unit price of HPGE is raised, since several organizations whose profit was contrary to each other participated. PM Initially, Q&A session was planned but there were no particular questions. Therefore as per survey results a lecture was conducted based on a recent loan policy of the World Bank, outlining policies about renewable energy and problems in Germany.
Issues on the training management	- Students' computers were old and therefore break-even point analysis practice was not carried out. Need "Sol-Bar function". - In WINDOWS 8, it was impossible to project to the screen. Assistant's PC (WINDOWS 7) worked for projection. However, his (her) keyboard arrangement was different from that of Japanese computer, as a result, it was difficult to control Excel sheet while projecting the sheet. - There was a huge gap of financing and accounting knowledge among students as it was difficult to find the middle ground for the level of lecture. This time, it was set to the highest level. Students with the highest level were able to understand calculation formulas for WACC and Equity IRR easily. Students with the lowest level could not use Excel and basic finance knowledge such as future value was also new for them.
Remarks	- Lectures on PPP will be scheduled as a result of many requests.

Table 3-20 Contents of 2nd Training (Economic and Financial Analysis)

Item	Contents
Participants	Total 15 staffs (DEP 5, DHPP 2, DHPI 2, MEPE 3, ESE 2 and YESB 2)
DAY1	1) Review of the first workshop We first started with some calculation tests of FIRR and Capital Recovery Factor to each type of generation as a review for the first workshop. It appeared that half of the participants understood the content covered at the first workshop. 2) Lecture and practice of financial index After providing lectures on WACC, LCOE, DSCR, etc. that are necessary for the project evaluation, we used Thaketa's 100MW GTCC Excel model. 3) Lecture on the concept of PPP Upon request from MOEP, a lecture was provided to explain examples of the basic concepts of PPP for each country. PPP has no solid definition across the cases and its definition varies from one country to another. 4) Answered questions regarding the previous M/P There were some questions raised related to the previous M/P. The questions pertained not only to financial issues, but also to power sector reforms in Myanmar.
DAY2	1) Creating Cash Flow table Creating a Cash Flow table based on BS and PL was practiced. Since the relationship between financial statements (BS and PL) and Cash Flow has been incorporated in an Excel model, it is necessary for the participants to understand the mechanism. In order to check the students' understanding, a practice was done after the lecture. Half of the participants had understood the contents. 2) Sensitivity analysis by using MEPE's finance model Sensitivity analysis on changing gas prices per unit by using MEPE's finance model was conducted. However, MEPE and DHPI, who have to be in charge of the MEPE financial modeling, did not participate on the second day workshop. 3) Financial analysis and economic analysis After providing a lecture on financial analysis and economic analysis, a practice was done by utilizing Thaketa's 100MW GTCC Excel model. Heat rate of Simple Cycle GT and diesel gens were also provided as examples for computation, and the practice for obtaining EIRR was conducted by utilizing the same model. ADB transmission report was also referred to. 4) LRAIC and LRMC Practice for obtaining LRAIC value was done after providing a lecture on conceptual differences between LRMC and LRAIC. 5) Concept and terminology in the F/S analysis Calculation practice and a lecture on concept of Interest During Construction, Price Contingency, and Physical Contingency in F/S were provided.
Remarks	1. We asked which authorities will be in charge of addressing issues such as: 1) Achieving the optimal balance in finance for choosing electric power in Myanmar 2) We asked DEP and DHPP how to resolve Myanmar's financial burden, and their answer was that the new EPGE will be in charge of deciding investment (Currently, there are no legitimate authorities in charge of these issues as the organizational restructuring is in progress). For evaluating F/S, DEP is in charge of renewable energy such as solar, DHPP will be in charge of hydro and coal power, and MEPE will take charge of gas. Staff members of YESC are more interested in privatization problems. In a nutshell, this means that participants have their own interests. 2. About half of the participants understood the first lecture's contents. However, there were some participants who did not understand the lecture. Therefore, it will be better to have a review session in the third workshop. 3. In the third workshop we plan to cover : Hydro projects gained from DHPP and Mega Solar Project F/S from DEP.

This time, the analysis of F/S, which was provided by DHPP and DEP, was firstly conducted. An EXCEL file template was used which was developed by the instructor using data of the F/S handed in by developers.

Table 3-21 Contents of 3rd Training (Economic and Financial Analysis)

Item	Property
Participant	Total 16 staffs (DEP 4, DHPP 2, DHPI 2, MEPE 4, ESE 2 and YESB 2)
DAY1	Calculation practice was conducted for figuring out which case has more tax merit between the Depreciation case, which purchased machines, and the Lease case for reviewing the previous workshop. In the solar case, the structuring fee and interest during construction is considered as a loss year before the commercial operation has started. The explanation on loss carry over, which allows losses to offset the earnings before taxes in succeeding years, was made as well. Mechanism and impact of 250% of accelerated depreciation on cash flow was also explained. The Reserve Fund for payment for the principal and interest was prepared. An explanation of this mechanism and its impact on the cashflow was explained.
DAY2	For the June 22nd lecture review, we performed a computation practice of changing the depreciation method from a straight line to 250% accelerated depreciation and observed how cash flow will be affected. We also pointed out that the company pays interests after the commercial period by capitalizing to form the bank loan even after they've paid out interest during the construction period.
DAY3	As for the review for the lecture of DAY1, an analysis on the changing of IRR, given that the compound annual interest rate is replaced with a semi-annual compounding calculation, was conducted. In addition, practice was administered on calculating the change of IRR when principal amortization is replaced with equal monthly payments with interest. Practice for the sensitivity analysis was conducted by calculating the IRR with the change of tariffs and the percentage of Free Power (currently at 10%) with an Excel file of D Project made by the instructor.
Remarks	It seems that the comprehension level of participants has been improved compared to the March and May lectures. However, it is still difficult for the students to analyze the FS, understand its structure, and identify errors by themselves. In addition, replicating the information on FS in their own Excel file is still far from perfect, as it requires the students to have Excel skills, knowledge of accounting and finance, and commitment to the class. The instructors will also need to provide training with patience. Some of typical work can be done as mentioned above, yet it was hard to see a pattern of thinking, analyzing, and proposing issues voluntarily from the students. It seems that students had no idea about composing an action plan. They were not able to set a target, and it was difficult to imagine that they could make a full commitment.

The chart below indicates the level of evaluation results after the third field inspection.

The level of understanding varies from person to person, but the evaluation was made to the students' average performance.

Table 3-22 Evaluation of Technical Capacity (F/S Assessment)

Check list			Evaluation			
			Before	1st	2nd	3rd
STEP 0	Basic knowledge	Understanding of basic concepts of finance such as present value, future value, and compounded interest rate, and solving exemplary questions correctly.	△	△	○	○
		Having basic knowledge of accounting such as depreciation, equal monthly payment with interest, and principle equal repayment.	△	△	△	○
		Creating CF chart from BS and PL.	△	△	△	○
		Understanding of technical terms of electricity infrastructure projects such as interest during construction, contingency, free power, heat rate, etc.	△	△	○	○
STEP 1	F/S understanding	Understanding of F/S structure.	―	×	×	△
		Understanding of the meaning of F/S data and the relevance of individual data.	―	×	×	△
		Organizing F/S data and filling them out by using formulas in Excel spreadsheets.	―	×	×	×
STEP 2	Excel model establishment and analysis practice	Replicating the F/S data into one's unique model.	―	×	×	×
		Replicating the sensitivity analysis in F/S report in one's unique model.	―	×	×	×
STEP 3	Result, explanation and summary	Figuring out errors from F/S report.	―	×	×	×
		Understanding of economic analysis and its calculation.	―	×	―	―
		Giving feedback for the results of the analysis to the investors who made the F/S, confirming the contents and debating.	―	―	―	―

○ Excellent : Trainees can execute works by themselves
△ Good : Trainees understand work contents and can execute works under the expert's guidance
× Fair : Trainees don't understand work contents and can't execute works.
― : Not implemented
BS=Balance Sheet
PL=Profit & Loss Statement
F/S=Feasibility Study Report

Table 3-23 Evaluation of Technical Capacity (LRMC/LRAIC)

Check list			Evaluation			
			Before	1st	2nd	3rd
STEP 0	Basic knowledge	Understanding of the LRMC principle.	―	―		―
		Understanding of the LRAIC principle.	―	△	＼	＼
STEP 1	F/S understanding	Understanding of the list of data that has to be collected.				
		Understanding of the list of data that has to be collected.	―	△	＼	＼
		Summarizing the collected data into EXCEL spreadsheets.				
		Summarizing the collected data into files such as Excel.	―	△	＼	＼
STEP 2	Practicing analysis	Calculating LRMC				
		Calculating LRAIC	―	△	＼	＼
STEP 3	Result, explanation and summary	Explaining the analysis result with comparisons to those of different countries.				
		Explaining the analysis result with comparison with those of different countries.	―	△	＼	＼

○ Excellent : Trainees can execute works by themselves
△ Good : Trainees understand work contents and can execute works under the expert's guidance
× Fair : Trainees don't understand work contents and can't execute works.
― : Not implemented
＼ : N/A

An analysis on MEPE's financial model shows that the technical assistance of the World Bank mandates the construction of MEPE's financial model and provides training for its application. Therefore, the division of duty and responsibility was requested.

Table 3-24 Evaluation of Technical Capacity (MEPE Finance Model)

Check lists			Evaluation			
			Before	1st	2nd	3rd
STEP 0	Basic knowledge	Understanding of the financial relationship between MEPE and other organizations.	△	―	―	―
STEP 1	Data compilation and data creation.	Understanding of the model structure.	―	△	―	―
		Inputting the assumptions such as investment plan, IPP ratio and the fuel price from M/P to a finance model.	―	―	―	―
		Reflecting the schedules for depreciation and debt repayment in the finance model.	―	×	―	―
STEP 2	Practicing analysis	Figuring out bugs that appear in the Excel models when the premises are changed.	―	×	―	―
		Calculating the sensitivity analysis on breakeven, and on the wholesale price.	―	×	―	―
		Calculating the nationwide burden from the assumption change.	―	×	―	―
STEP 3	Result explanation and summary	Understanding the results and the details.	―	×	―	―
		Debating and negotiating based on the analysis results.	―	×	―	―

○ Excellent : Trainees can execute works by themselves
△ Good : Trainees understand work contents and can execute works under the expert's guidance
× Fair : Trainees don't understand work contents and can't execute works.
― : Not implemented

Table 3-25 Comments on the Technical Capacity of the Economic and Financial Analysis

Item	Contents
Software Skills	➢ Can carry out basic daily tasks such as inputting data and making tables and graphs ➢ Many members were working inefficiently by not using the cell reference, and instead were inputting all the data one by one when the given data had to be processed and completed as an analyzed data. ➢ Some members were working efficiently by applying inbuilt EXCEL formulas. ➢ Can use EXCEL functions such as NPV, IRR.
Professional Knowledge	➢ The understanding of basic concepts is progressing the training has been processed. However, there is much to be done before the members become able to understand F/S by themselves, replicating and comprehending the model, and negotiating with investors.

4. RECOMMENDATIONS ON THE FUTURE TECHNICAL ASSISTANCE PROJECT

In this Chapter, recommendations on the capacity development of power sector development planning are summarized. JICA Survey Team have pointed that improvement of following three items are important for the capacity development through data collection, training for the technical capacity assessment and discussion with MOEP staffs in this Survey.

1. Establishment of Organization / Institutional System for Power Sector Planning
2. Development of Institutional Capacity for Information/Data Collection and Management
3. NEMP Update through Joint Work, and Development of Technical Capacity for Power Sector Planning

4.1 Establishment of Organization / Institutional System for Power Sector Planning

As described in Chapter 2, shortage in human resources are chronic issues for MOEP. These circumstances are common for governments in other Southeastern Asian countries. Ideally they are supposed to recruit adequate resources and assign staffs to required areas appropriately under the proper sector reform. However, it is not feasible for MOEP to implement the way just mentioned above immediately. Therefore it is realistic strategy to prepare the countermeasures in short term and consider the direction to reach in the middle and the long term.

In this Survey, recommendations on forming the Working Group considering the future technical assistance in the short term are summarized. Data collection for forming the Working Group will be implemented focusing on the current capacity development system of MOEP and considering the sustainable institutional establishment.

4.1.1 Formation of the Working Group

(1) Implementation Structure for M/P under the Initiative of Working Group

Implementation structure as shown in Fig. 4-1 had been adapted for the previous M/P study and training program in this Survey. This structure is suitable and effective for the formulation of M/P which requires the integration of wide information and comprehensive consideration under the initiative of Consultants.

Meanwhile it is necessary for MOEP to formulate and operate the M/P by his own initiative in future technical assistance project. As Consultants only assist the Working Group to formulate and operate the M/P, the implementation structure should be established in order to execute required tasks under the Working Group's initiative as shown in Fig. 4-2.

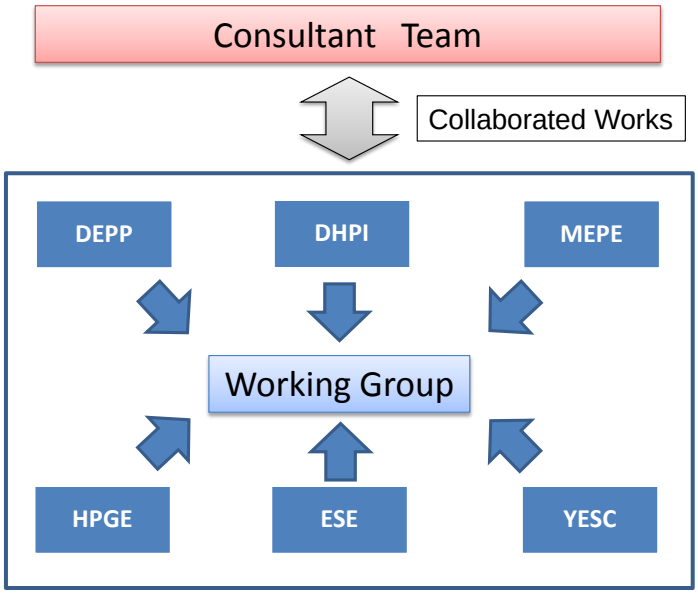


Fig. 4-1 Implementation Structure under the Consultants Initiative (Previous M/P and Training in this Survey)

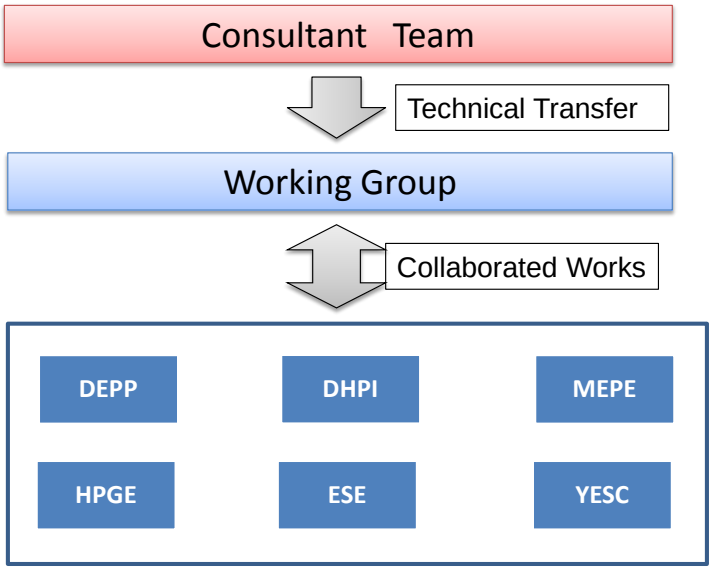


Fig. 4-2 Implementation Structure under the Working Group's Initiative (Future Technical Assistance Project)

(2) Arrangement of Responsible Institution for the M/P

It is strongly recommended to arrange the responsible institution for the M/P from aspects as shown in Table 4-1.

Table 4-1 Importance of Responsible Institution for the M/P

Establishment of Sustainable Implementation Structure	M/P should be continuously updated by MOEP. In order to obtain the institutional sustainability, it is necessary for MOEP to recognize the M/P as the permanent mandate and to appoint suitable institution.
Consistency of the M/P Formulation	As the M/P study is composed of various analysis such as power demand forecast, power generation development plan, power system plan, economic and financial analysis and environmental assessment, it is necessary to integrate these studies based on the comprehensive viewpoint. Therefore the M/P formulation is expected to be handled by one institution to obtain the consistency of studies.
Assignment of Full-time Staffs	According to interviews with MOEP staffs concerning the future technical assistance project, assignment of full-time staffs is strongly proposed. Currently, MOEP staffs have a lot of works and hardly concentrate on the M/P formulation and operation. It is possible to manage and assign required human resources intensively for the M/P by establishing the exclusive institution.

Although DEPP (Department of Electric Power Planning) and MEPE are proposed as candidates of responsible institutions according to the discussion with MOEP, DEPP who have been in charge of the previous M/P and related sector development planning is expected to be the one. U Khin Maung Win, Director General of DEPP also noted that DEPP will organize the Electric Power Development Planning Division which will be in charge of sector development planning. The Working Group is expected to be mainly composed of staffs from this division. Draft new organization chart of DEPP is shown in Fig. 4-3.

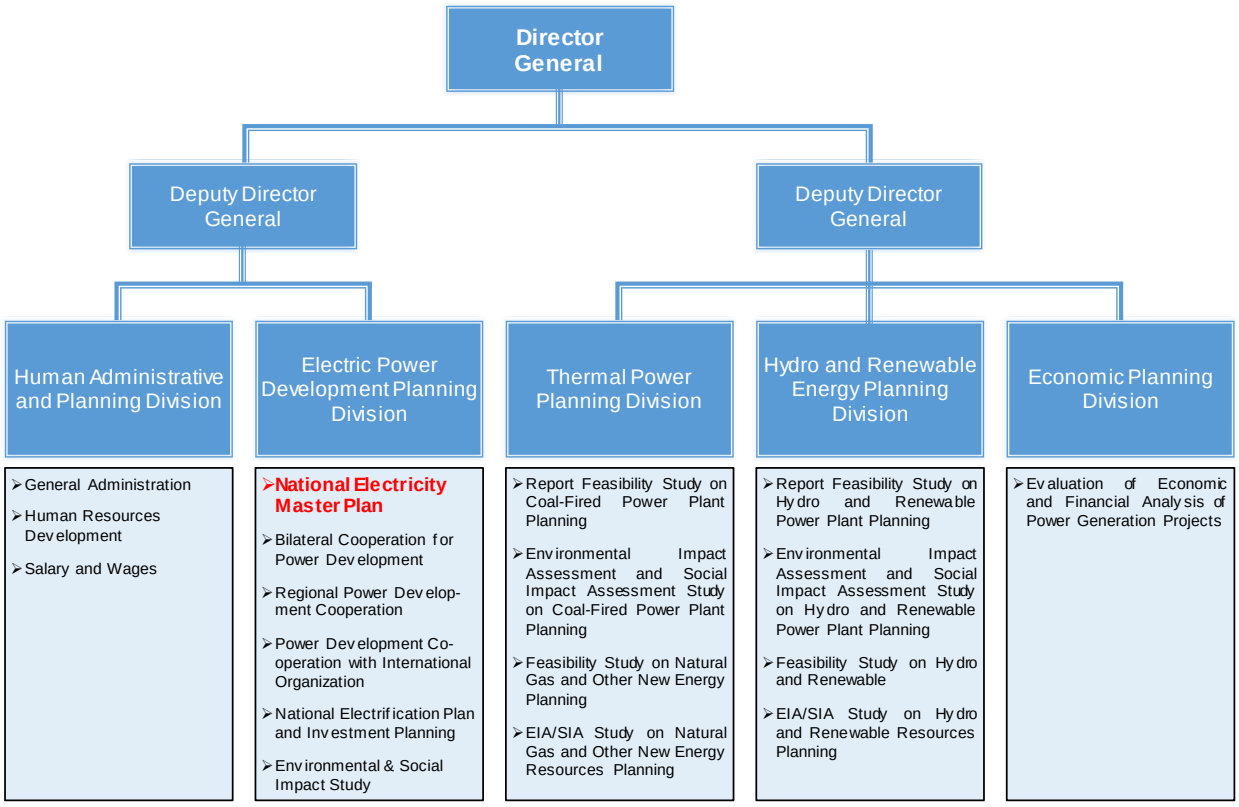


Fig. 4-3 New Organization Chart of DEPP (Draft in June, 2015)

(3) Selection of Core Staffs

As shown in Chapter 3, participants of the training in this Survey were widely assigned from each department and the training was implemented by classroom lecture style. Meanwhile, technical capacity and understandings of each participant were not uniform. JICA Survey Team concentrated the training on the learning of the basic concept for the M/P considering the difference of understanding among participants. However, staffs in charge of each analysis are assumed to be two or three persons. In the future technical assistance project, it is necessary to improve staff's capacity within short period and training program should be implemented intensively. Therefore two or three staffs should be assigned to each analysis as "Core Staffs" who are mainly in charge of the M/P study.

(4) Arrangement of Sub Group

Experts of each analysis will be dispatched to MOEP in the future technical assistance project and it is recommended to arrange sub groups for each expertize area in the Working Group as shown in Table 4-2.

Table 4-2 Sub Group and Staff Assignment

Sub Group		Number of Staffs
1	Power System Planning	3 ~ 4
2	Power Development Planning	3 ~ 4
3	Economic and Financial Analysis	2
4	Environmental and Social Consideration	2

4.2 Development of Institutional Capacity for Information/Data Collection and Management

Through interviews with MOEP staffs and the confirmation of data management situation in MOEP, data management and collection is an important issue to be solved for the formulation and operation of the M/P. Data management and collection is one of the difficult task in the previous M/P study because it is necessary to collect various data which managed by each department. Although JICA Survey Team had completed the data collection, improvement of data management and collection is very critical for the promotion of working efficiency.

Shelf of Specific Project Information

Shared Desktop Computer

Fig. 4-4 Current Situation of Data Management in MOEP

4.2.1 Data Management by “Person” to “Institution”

A big problem to be solved on the data management in MOEP is high dependence on the personal management by each staffs which causes following issues.

I. Data sharing is not functioned among stakeholders. Especially, latest information of on-going projects cannot be shared.

II. Data is not appropriately taken over in case of the personnel relocation and project information is not accumulated in the institution in charge.

III. Antivirus countermeasures are not in a consistent way in personal PCs and there are serious risks in the security.

To solve these matters, handling of data management should be shifted from “Person” to “Institution”. Countermeasures for the hard aspect such as introduction of required number of PCs and soft aspect such as improvement of information literacy are necessary for MOEP. Institutional data management should be established in the Working Group and database operation related to the M/P should be studied in the future technical assistance project.

4.2.2 Improvement of Efficiency in Data Collection Process

It is recommended to clarify the data collection process and to establish the database related to the M/P. In addition, data collection should be designed to process automatically and periodically as a routine works.

Good examples for data collection system are processes of annual reports preparation of MEPE, HPGE, ESE and YESC (Yangon Electricity Supply Corporation). Update of these reports become their routine works in each department. Establishing the similar data collection and update system for the M/P, efficiency in data collection and update can be improved.

Table 4-3 Main Data to be Collected in the M/P

Item	Data Collection	Institutions concerned
Power Demand Forecast	Power demand information such as regional distribution, consumers and seasonal load variation and power supply conditions	DEPP MEPE HPGE ESE
Power Generation Development Plan	Salient features, operation / maintenance situation and rehabilitation / expansion projects of existing power plants, development plan and progress of new power plants	DEPP MEPE HPGE ESE
Transmission and Power System Development Plan	Salient features, operation / maintenance situation of existing power system facilities, transmission network map, load dispatching operation system, accidents report of outages and power current diagrams	DEPP MEPE
Power System Operation	Power system operation structures, performance records of system operation such as outages, demand and supply control situation, power system control situation and the progress of SCADA (Supervisory Control And Data Acquisition) system introduction	DEPP and MEPE
Economic and Financial Analysis	Power tariff system and levels of each consumers financial statements of each enterprise	DEPP

Concept of data management and collection system is shown in Fig. 4-5.

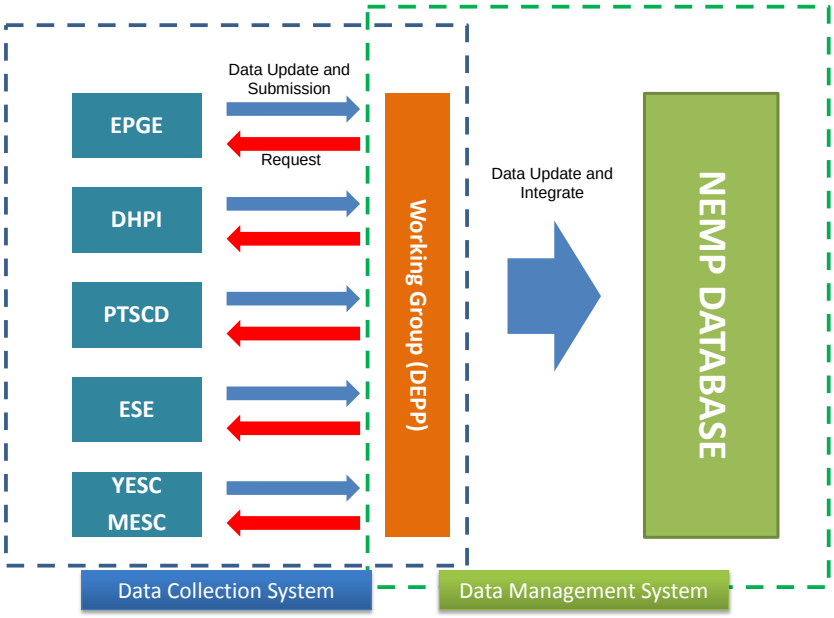


Fig. 4-5 Establishment of Data Management and Collection System

4.2.3 Utilization of Statistic Information Sheet

Utilization of statistic information sheet is recommended for the development of NEMP database. It is an typical format prepared by Excel spreadsheet which contains major statistic indicators.

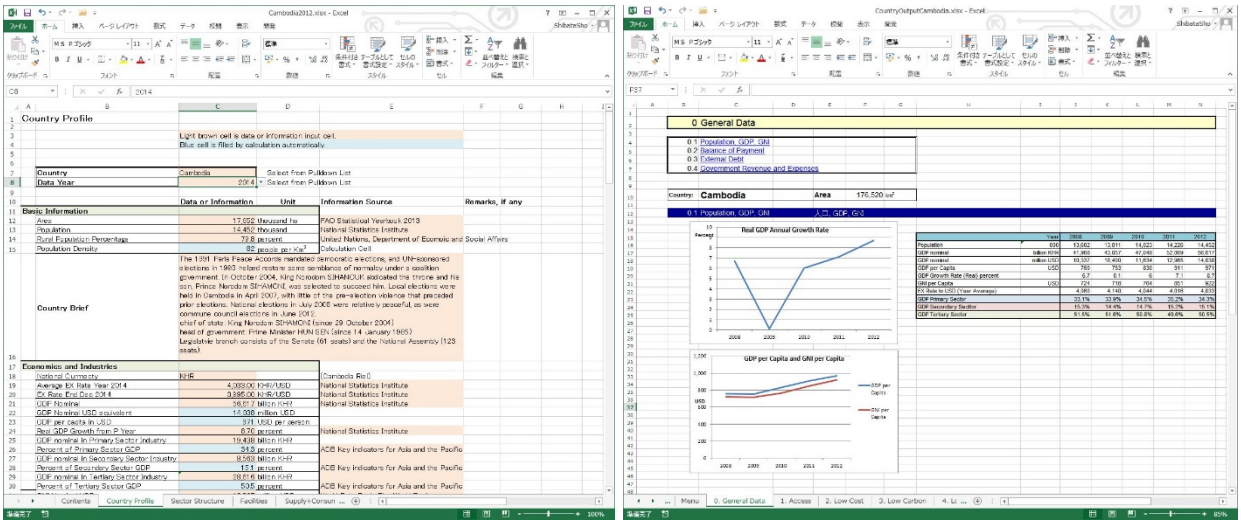


Fig. 4-6 Example of Statistic Information Sheet

Table 4-4 Main Components of Statistic Information Sheet

Item	Components
Country Profile	Basic Information, Economics and Industries, Poverty, Government Revenue and Expenses, Balance of Payments, Energy Balance
Sector Structure	Basic Information, Liberalization of Electricity Market, Energy Conservation and Demand Side Management, Renewable Energy Policy and Power Sector Enterprises
Facilities	Generation Facilities, Peak Load, Available Rated Capacity, Largest Grid, Transmission Lines, Grid and Cross Border Transmission Lines
Supply Consumption	Gross Generation, Grid Supply, Electricity sold, Power Supply Shortage Issues, Electricity Trade with Neighbor Countries, Transmission and Distribution Loss, Average Sales Value, Sample Calculation under Current Tariff, Subsidy paid by Government, Number of Supply Contracts, Supply Interruption, Fuel for Generation, Fossil Energy Supply and Consumption, Fuel Cost in thermal generation, Power Purchase Cost
Financial	Financial Information, Sales, Cost, Cashflow, Change in Equity, B/S, Note to Financial Statement

4.3 **Development of Technical Capacity for Power Sector Planning**

4.3.1 Clarification of the Role of M/P in MOEP

As described Chapter 2, responsibility of MOEP for the formulation and operation of M/P is stipulated in “Rules” of Electricity Law. M/P is recognized as the fundamental policy which indicates vision and target of electric power sector.

Formulation and operation of M/P sometimes requires political decisions such as energy security and tariff revision. These matters are beyond technical issues and hardly determined without the close commitment of high officials. Therefore it is essential for the future technical cooperation project to involve high officials and to share common views for the M/P. It is also important to clarify

the role of M/P and formulation process in MOEP and to stipulate them in the legal framework such as “Regulation” of Electricity Law.

4.3.2 Formulation and Operation of the M/P based on the SPDLI Cycle

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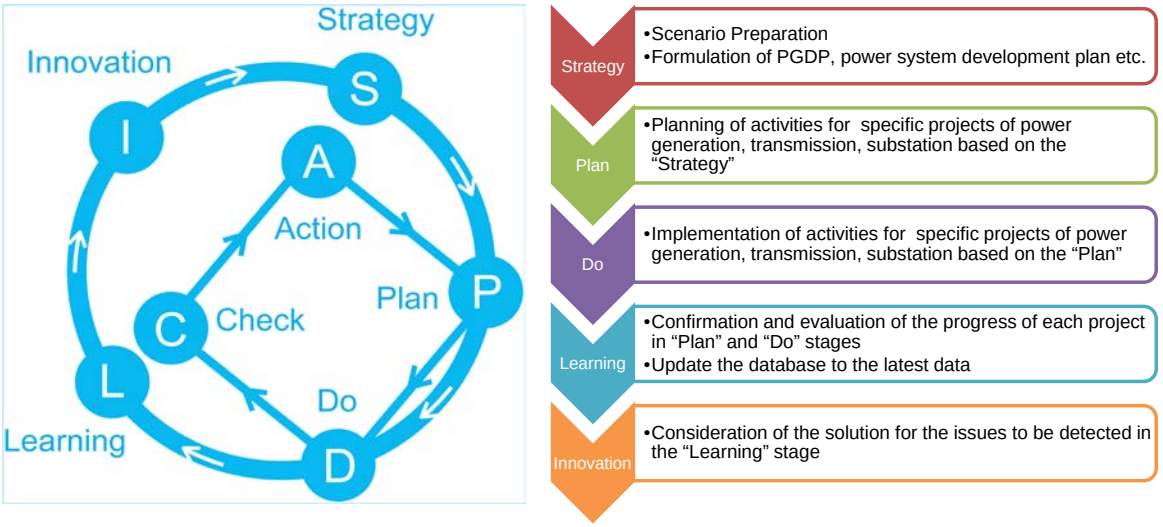

Fig. 4-7 Concept of SPDLI Cycle

Source: Capacity Assessment Handbook (JICA, 2008)

PDCA cycle is a famous methodology of project management composed of four (4) process “Plan”, “Do”, “Check” and “Action”. By repeating this cycle, project activities are continuously revised and updated. However, the M/P is medium/long term development plan of the power sector which requires a broader perspective than individual project implementation.

JICA Survey Team proposes to utilize SPDLI cycle for the M/P formulation and operation. It is composed of “Strategy”, “Plan”, “Do”, “Learning” and “Innovation” and expands the concept of PDCA to not only the individual project but also the strategy planning.

Generally, PDCA or SPLDI in the technical assistance project is not completed in one cycle It is important to repeat this cycle continuously and develop the capacity by spiral-up function. Duration of the future technical assistance project is planned to be two (2) years and this cycle will be repeated two times within the project period.

4.3.3 Technical Transfer Based on the OJT Style

In the future technical assistance project, it is recommended to implement the OJT style to core staffs of each group as shown in Fig. 4-8. It is also preferred to prepare the working space for Japanese experts in same room of the Working Group for the close

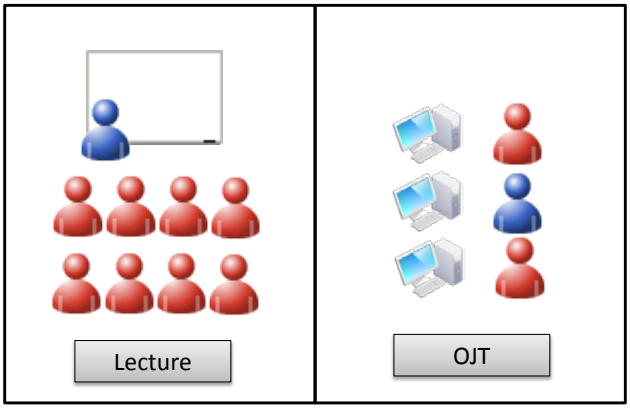

Fig. 4-8 Style of the Technical Transfer

communication.

Regarding the formation of the Working Group, it is recommended and suggested to place more than one staffs in charge, especially in the field with vast amounts of works such as the power generation development and power system development. For example, the combination of a junior engineer who has advantages in software skills and a senior engineer who is with much more of experience and knowledge is expected for an effective assignment.

JICA Survey Team also strongly recommends to arrange core staffs to concentrate on the technical assistance project and not to reallocate to other department during the project period.

4.3.4 Focused Points in the Technical Capacity Development

Based on the training in this Survey, it was clarified that following three (3) points are essential for the technical capacity development.

(1) Deep Understandings of the Basic Concept for the M/P
(2) Improvement of Skills of Basic Office Software
(3) Improvement of Skills of Simulation and Programing for each Analysis

4.3.5 Recommendation on the Preparation of Formulation and Operation Manual for the M/P

The M/P should be updated periodically. It is necessary for MOEP to establish an educational system to instruct both younger and new staffs to formulate and operate the system by MOEP itself. Therefore, study processes and contents of the M/P are expected to be clarified and standardized. Advantages of standardization of these processes are;

- Improvement of understandings of work contents for staffs by the clarification of study processes
- Improvement of the work efficiency by the preparation of format of the input data and basic analysis conditions
- Securing the sustainability by simplifying the takeover of related works among the staffs

According to the above understandings, JICA Survey Team considers that standardization of study processes, namely, preparation of the manual for “Power Demand Forecast,” “Power Generation Development,” and “Economic and Financial Analysis” is quite effective for the capacity development of MOEP. It is also supposed to enhance staffs’ capacity by involving the manual preparation by themselves.

Following two (2) items are focused on the manual preparation.

① Description of Practical Study Process
② Introduction of Case Study

Examples of manual contents for each analysis are shown below.

Table 4-5 Power Demand Forecast

Item		Contents
1.	Introduction	- Outline of power demand forecast
2.	Basic data for forecast	- Data collection of record of power demand from the viewpoint by sector, voltage, area - Data collection of economic indices - Data collection of national development plan, national electrification plan
3.	Setting basic parameters for demand forecast	- Study of appropriate parameters having a strong correlation with power demand - Study of appropriate parameters for macro forecasting method - Study of appropriate parameters for micro forecasting method (by voltage, by area)
4.	Power consumption forecast for mid – long term	- Set up fundamental parameters - Estimation of transmission/ distribution loss - Calculation of power consumption (Wh) using Excel software - Sensitive analysis
5.	Maximum demand forecast for mid – long term	- Evaluation of load curve and load factor in the year - Calculation of maximum power demand by voltage - Calculation of maximum power demand by substation

Table 4-6 Power Generation Development Planning

Item		Contents
1.	Introduction	Concept of Power Generation Development Planning
2.	Existing Power Plants and Power Generation Plan	Data collection of following items; - Existing power plants - New power generation development projects
3.	Set-up of Basic Conditions	- Planning of supply forecast of primary energy - Case study of the power demand forecast - Preparation of development scenarios - Set-up of basic conditions
4.	Implementation of the Simulation for the Optimum Power Generation Analysis by using WASP	- Methodologies of WASP computation - Implementation of sensitivity analysis
5.	Formulation of the Middle and Long Term Optimum Power Generation Development Planning	- Determination of power source composition in the middle/long term - Estimation of annual power generation (kWh) and fuel requirements - Estimation of investment cost

Table 4-7 Power System Planning

Item		Contents
1.	Introduction	- Outline of power system plan
2.	Basic data for power system plan	- Data collection of existing power system facility - Data collection of power demand forecast and power generation development plan - Data collection regarding national electrification plan
3.	Criteria for system reinforcement	- System capacity (thermal capacity, short circuit capacity, transient stability, voltage stability) - Views for system configuration
4.	System Analysis using software tool	- Preparation of input data - How to use system analysis tool - Study of output
5.	Mid – long term power system development plan	- Estimation of investment amount and a period of construction - Evaluation of alternative plans including power generation plan - Establish optimum system development plan

Table 4-8 Economic and Financial Analysis

Items		Contents
1.	Introduction	Outline of Economic and Financial Analysis
2.	Understanding of Basic Concepts for Economic & Financial Analysis	Financial (Present Value, Future Value, Compounded Interest Rate etc.) Accounting (Depreciation, Principal and Interest Equal Repayment, Principal Equal Repayment etc.) Electricity project (Contingency, Interest During Construction, Heat Rate, Capital Recovery Factor etc.) LRMC/LRAIC
3.	F/S Analysis	Basic Structure Financial Analysis Economic Analysis
4.	MEPE Financial Model	Model Structure How to take necessary data from the Master Plan Computation of Break-even wholesale price

Table 4-9 Environmental and Social Considerations

Item		Contents
1.	Introduction	Outline of SEA (Strategic Environmental Assessment)
2.	Scoping	Preparation of check list for the major environmental items Estimation of serious adverse impacts of projects Set-up of evaluation criteria
3.	Preparation of scenario alternatives	Preparation of zero-option Preparation of development scenarios
4.	Evaluation of Scenario Alternatives by Multi Criteria Analysis	Determination of Multi Criteria Analysis Evaluation of each power source and transmission projects Evaluation of environmental impacts of each scenario alternatives Sensitivity analysis Mitigation measures

4.4 Future Technical Assistance Project

Draft of the future technical assistance project was prepared and discussed. Comments from deputy ministers, director generals and participants of training had been collected and reflected to the draft.

4.4.1 Environmental and Social Considerations

Scoping of items which affects serious environmental impact was implemented in the previous M/P. As scoping is very essential for implementation and effective function of SEA, scoping results in the previous M/P were reviewed and environmental and social considerations in the future technical assistance project was discussed with MOEP. As a result, it is confirmed among the MOEP and JICA Survey Team that components of technical assistance for environmental and social considerations are assumed to be SEA as same as the previous M/P. Main components are shown below.

- Review baseline conditions of SEA for this Project.
- Review the sector policies of electricity, environment and others relevant to this Project in the SEA context, including objectives and targets, alternatives, and action plans.
- Conduct workshops to consult with MOECAF and other relevant parties including stakeholders on the ESC study based on SEA.
- Review the SEA
- Prepare and finalize the SEA report reflecting comments from MOECAF and other relevant parties.

Scoping will be implemented to several alternative development scenarios including the environmental and social consideration option. Update of the SEA will be focused on serious negative impact items such as resettlement, indigenous people, ecosystem / rare species, protected area, air pollution and climate change.

As describe in Section 4.1, Sub group for Environmental and Social Consideration will be arranged in the Working Group of future technical assistance project. One or two staffs from DEPP will be assigned to this sub group.

Although participations from MOECAF to the sub group were discussed, it is determined not to include staffs from MOECAF due to the difficulty of implementation of the OJT for staffs of other ministries. Therefore supports from MOECAF are expected to be provision of comments, consultation and evaluation of the SEA study.

4.4.2 Considerations of Gender

There are significant regional gap of electrification between urban and rural area in Myanmar and diesel generators, solar home systems and batteries are assumed to be used in the rural area. Over 50% of households use charcoal and wood as energy in the urban area and it reaches to 80% in the rural area. Only 17% households use electricity or liquid fuel for cooking.

It is assumed that burden of women such as household duties and working are large due to the non-electrification. Thus it is important to reflect the electrification by the grid expansion to the M/P in order to reduce their burden by using electrical products such as rice cookers. In addition, improvement of living environment for women is also expected by replacing the kerosene, charcoal and wood which sometimes cause respiratory diseases to electricity. However, it is not planned to

input experts and activities to the future technical assistance project.

4.4.3 Outline of the Future Technical Assistance Project

Based on the above consideration, outline of the future technical assistance project is summarized below.

Table 4-10 Outline of the Future Technical Assistance Project

Items	Components
Overall Goal	The power sector development is promoted based on the National Electricity Master Plan (NEMP).
Project Purpose	The capacity of MoEP for power sector development planning is enhanced through the process of reviewing, updating and utilizing National Electricity Master Plan (NEMP).
Outputs	1. The institutional capacity and mechanism of reviewing, updating and utilizing NEMP in MoEP and in GoM is strengthened. 2. The necessary information and data for power sector development planning is collected and managed by MoEP. 3. The technical capacity for power sector development planning is developed, and NEMP is updated regularly.
Activities	1. Establishment of Organization / Institutional System for Power Sector Planning (responsibility, authority, approval/development process, etc.) 1.1. To clarify the current status and responsibilities of each department/division for power sector development planning and utilizing the National Electricity Master Plan (NEMP), and identify the institutional constraints and challenges. 1.2. Based on the above 1.1, to assign the working group members who are in charge of each field of power sector development planning. 1.3. To clarify the roles, process and rules of each department/division based on the work flow of the power sector development planning. 1.4. To examine and prepare an institutional mechanism for planning, reviewing and regularly updating the NEMP and assist in establishing an approval process within GoM. 1.5. To provide technical and/or policy-related advices on institutional arrangements and regulatory framework in the power sector, based on information obtained through the Project Activities 1, 2 and 3.
Activity	2. Development of Institutional Capacity for Information/Data Collection and Management 2.1. To identify constraints and challenges for information/data collection and management on power sector development planning. 2.2. To strengthen the mechanism for collecting, managing and updating the required data and information for the following: (a) Power demand forecast (including rural electrification) (b) Power generation development plan (including IPP and renewable energy) (c) Power system development (d) Economic and financial analysis (in particular in the aspect of financial burden of electricity tariff and subsidy on users/taxpayers) (e) Environmental and social consideration in the power sector 2.3. To improve the information/data management system including statistics.
	3. NEMP Update through Joint Work, and Development of Technical Capacity for Power Sector Planning

Items	Components
	3.1. To acquire the analysis methods, program and simulation, and enhance the technical capacity for the following assessment necessary for power sector development planning: (a) Power demand forecast (both micro and macro methods) (b) Power development plan, including availability of primary energy, optimal energy mix and power generation development plan (including renewable energy) (c) Power system plan (including consistency with power distribution line expansion and rural electrification) (d) Economic and financial analysis (in particular in the aspect of financial burden of electricity tariff and subsidy on users/taxpayers) (e) Environmental and Social Consideration in the power sector 3.2. Based on the above 3.1, to analyze and prepare the short, medium and long-term priority investment plans. 3.3. To make recommendations based on the following activities and reflect them in power sector development planning: (a) To analyze and prepare the recommendations on power generation development plans for each major fuel source based on the above 3.1 and 3.2. (b) To widely collect information on institutional arrangements and regulatory framework in the power sector (including IPP, corporatization/privatization of public utilities and policy incentives for renewable energy), analyze the policy implications of such institutional and regulatory changes, and prepare technical and/or policy-related recommendations. 3.4. To jointly review and update the NEMP with MoEP staff and JICA Experts, including the results of 3.1 through 3.3 above. 3.5. To prepare a manual for planning process and methodologies for power sector development planning, and utilize it for the policy / planning process of the Government.


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