

No. 9

**The Follow-up Study for the Study
on the Institutional Capacity Building
for the DOE under a Restructured Philippine
Electric Power Industry
in the Republic of the Philippines**

Manual for PDP Preparation

Revised Edition

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**Japan International Cooperation Agency
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Abbreviations

DDP	Distribution Development Plan
DU	Distribution Utility
DOE	Department of Energy
EC	Electric Cooperative
EPIRA	Electric Power Industry Restructuring Act
ERC	Energy Regulatory Commission
GDP	Gross Domestic Product
GRDP	Gross Regional Domestic Product
IAEA	International Atomic Energy Agency
IEA	International Energy Agency
IOU	Investor-Owned distribution Utilities
IRR	Implementing Rules and Regulations
JICA	Japan International Cooperation Agency
LOLP	Loss of Load Probability
MEDP	Missionary Electrification Development Plan
MEP	Missionary Electrification Plan
NEA	National Electrification Administration
NECDDP	National Electric Cooperatives Distribution Development Plan
NEDA	National Economic Development Authority
NPC	National Power Corporation
PDP	Power Development Program
PEP	Philippine Energy Plan
PPA	Power Purchase Agreement or Adjustment
QTP	Qualified Third Party
SPUG	Small Power Utilities Group
TRANSCO	National Transmission Company
TDP	Transmission Development Program
UC	Universal Charge
WASP	Wein Automatic System Planning Package
WESM	Wholesale Electricity Spot Market
WB	World Bank

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under a Restructured Philippine Electric Power Industry in the Republic of the Philippines**

Manual for PDP Preparation Revised Edition

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**Manual
for
the Power Development Plan
Preparation
(Overview)**

Section 1 Overview

1. Outline of the Manual

1.1 Objective of the PDP Manual

This manual clarifies the work schedule and its flow for the smooth preparation of the Power Development Program (hereinafter referred to as PDP) through collaboration between DOE and related organizations under EPIRA. Related subordinate plans such as TDP (Transmission Development Plan) and the MEDP (Missionary Electrification Development Plan) are referred to in the 各 PDP manuals for integration with PDP pursuant to EPIRA. Therefore, the work flow diagram of these programs is clarified considering the PDP preparation schedule.

1.2 Contents

The PDP manual consists of the following six sections:

- (1) Common Issues
- (2) Demand Forecasting
- (3) Power Supply Plan
- (4) Transmission Development Plan
- (5) Missionary Electrification Plan
- (6) Distribution Development Plan

The work flow diagram in the preparation of the PDP is clarified in the manuals. The necessary items and their timeframes are also given. The roles and responsibilities of the related organizations for the preparation evaluation and approval of the subordinate program are also explained. Engineering documents to understand technical and policy issues are attached at the end of the manual, if necessary.

1.3 Keeping the PDP manual

Manuals and their electronic files are kept in the power bureau of DOE. Revision should be made every October as soon as the plan is submitted to Congress.

2. Common Issues

2.1 The objective of PDP

Contestable policy enters the power sector through EPIRA. The role of DOE is to lead the power industry, which is divided into three sectors, i.e., the generation, the transmission and the distribution sector, through their policy to realize stable, high quality, low price electricity. To achieve this, PDP is the most important tool in indicating the ideal picture of the future power sector. In addition, the encouragement of private investors is the most important policy in supporting the realization of PDP.

2.2 Integration with subordinate programs

2.2.1 Integration Policy in PDP (2004-2013)

Pursuant to EPIRA, PDP should integrate subordinate programs. Here, subordinate programs mean the following:

- a. Transmission Development Plan (TDP)
- b. Distribution Development Plan (DDP)
- c. Missionary Electrification Plan (MEDP)

Considering the contents and schedule of PDP, the following policy is applied to the subordinate programs:

- TDP: Integration and coordination of all projects

All power development projects and transmission projects newly planned should be integrated.

- DDP: Data integration

DDP may be used as a data-gathering tool. The necessary data for preparing PDP, such as demand in each franchise data and facility data item is collected as a part of DDP and reflected in PDP.

- MEDP: Integration of document

PDP, which is the national grid plan, differs from MEDP, which is the energized plan, for the un-energized plan too greatly to integrate both data and contents.

Therefore, the integration may be conducted only on documentation. In future, an effective grid extension methodology may be integrated.

2.2.2 Integration of TDP

As described, the integration of TDP with PDP should be conducted in all power development projects and transmission development projects. Table 2.2.1 shows the necessary items to be arranged in related organizations.

Table 2.2.1 Items to be arranged for TDP integration

Items	Contents	Dataflow
<u>a. Demand</u> - Actual Peak Demand - Demand Forecasting	- Data Submission - Demand forecast Results	- TRANSCO to DOE - DOE to TRANSCO
<u>b. Power Development Projects</u> - Ongoing Projects - Committed Projects - Retirement Projects - Indicative Projects	- Project List - Project List - Project List - Necessary Capacity Addition by Fuel Type and Area	- DOE to TRANSCO
<u>c. Transmission Development Projects</u> - First Draft Plan - Evaluation Results	- First Draft Plan - Evaluation Results (Project List to be considered)	- TRANSCO to DOE - DOE to TRANSCO

2.2.3 Integration of DDP

Pursuant to EPIRA, all distribution utilities must submit DDP to DOE by March 15th every year. The contents of DDP are (1) the Distribution System Development Plan and (2) the Power Demand and Supply Plan. However, the former is not directly related to PDP. Meanwhile, the latter includes the demand forecast and supply plan that can be utilized for PDP. Therefore, the necessary data for their franchise area can be collected by using DDP as data-gathering tool.

Table 2.2.2 shows the data that can be collected as a part of DDP. In future, island grids or independent grids may be connected to the national grid. In this case, integration of DDP will be an important portion of PDP.

Table 2.2.2 Data that can be collected by DDP

Items	Integration with the PDP
<p><u>a. Demand for Franchise Area</u> - Actual Peak Demand - Demand Forecasting</p> <p><u>b. Power Supply Plan</u> - By supply contract with NPC - By own Facilities - By supply contract with IPP - Data of Embedded Generator</p>	<p>- Reference Data for Demand Forecast</p> <p>- Basic Data for the Power Development Plan</p>

2.2.4 Integration of MEDP

PDP is the national grid plan, while MEDP is the energized plan for the un-energized plan.

Therefore, integration does not have to be conducted even for the data as DDP.

Since MEDP covers the most important and sensitive issues, MEDP itself should be a part of PEP / PDP. Therefore, MEDP may as well be integrated with PDP as an independent part.

In future, the grid extension may become more important not only for supplying power to all of the Philippines, but also to save OPEX. Therefore, the present status is to observe the electrification situation and to arrange databases for future PDP that integrates the unenergized areas with the national grid-by-grid extension.

2.3 Responsible organizations and their responsibility

Table 2.2.3 shows organizations and their responsibilities in preparing PDP. PDP and MEDP are prepared by DOE from this year.

Table 2.2.3 Organizations and their responsibilities

Organization	PDP	TDP	MEDP	DDP
DOE	Preparation	Evaluation /Approval	Preparation	Integration / Preparation
NEA	Arrangement of EC data		Arrangement of EC data / Submission of draft energized plan	Integration of EC's plan
ERC	Approval of projects	Approval of projects	Approval of Universal Charge	Approval of Charge
TRANSCO	Coordination of the projects	Preparation		
Generation Companies	Data submission			
PIOUs	Data submission		Submission of the list of barangays	Preparation for franchise area
ECs	Data submission		Submission of the list of barangays	Preparation for franchise area
NPC-SPUG	-		Submission of draft energized Plan	

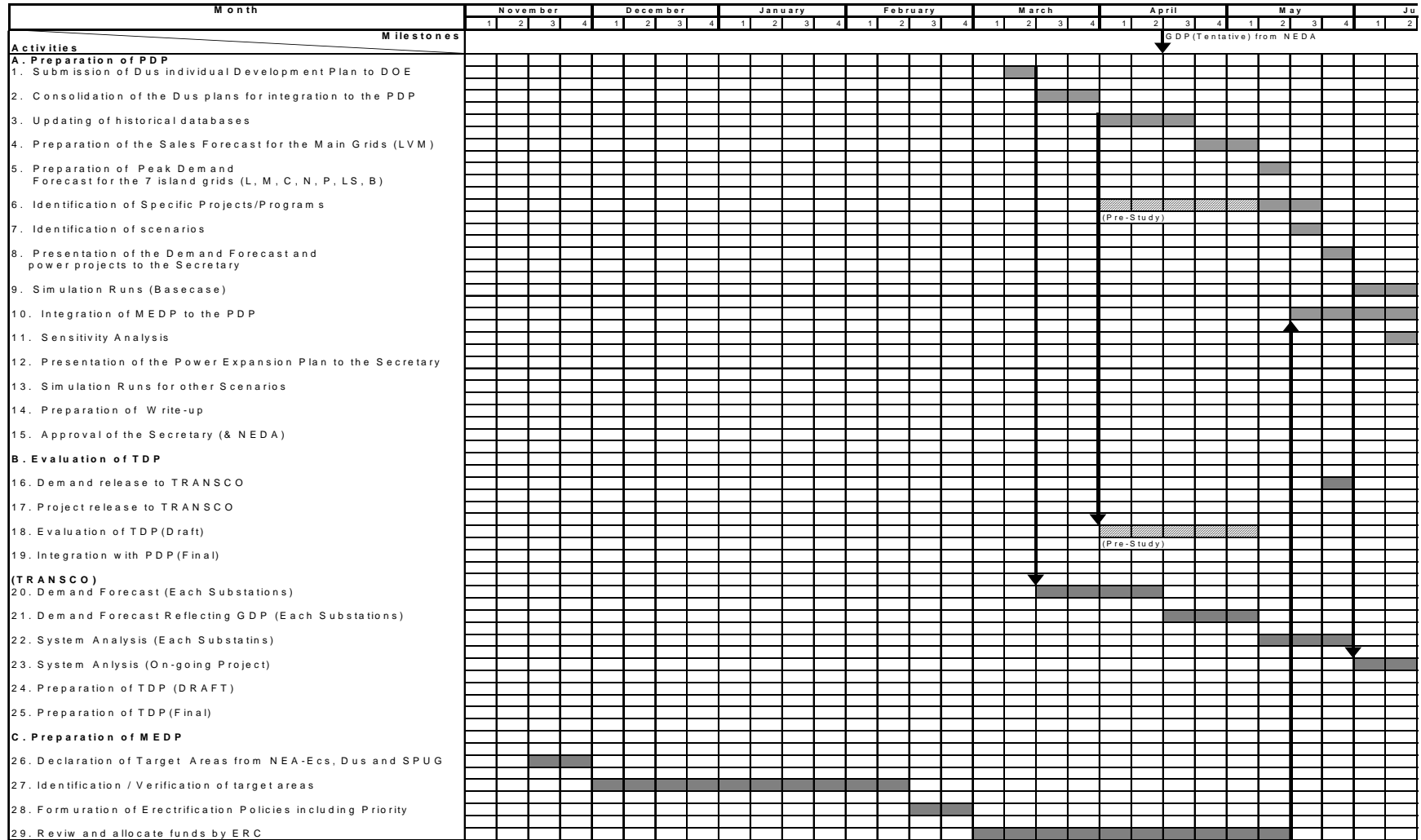
3. Workflow / Overall Schedule

3.1 Workflow / Overall Schedule

Table 3.1 shows the overall schedule for preparing PDP. As described, PDP has to be prepared by integrating the other subordinate plans. Therefore, the overall schedule should include the schedule of these plans as well as PDP itself.

Each workflow of PDP, TDP and MEDP is described in the technical volumes.

Table 3.1 Overall Workflow of PDP



4 Checklists

Workflow, checklists are attached at the end of each section. Therefore, the work should be conducted using these lists.



Manual
for
the Power Development Plan
Preparation
(Demand Forecasting)

Section2 Demand Forecasting

The manual for demand forecasting consists of the following. Detailed explanations are provided in each chapter.

- 1: Outline of the demand forecasting part of this manual
- 2: Method of data collection and preparation process
- 3: Methodology and process of demand forecasting
- 4: File system of demand forecasting
- 5: Verification of forecasting results
- 6: Remarks
- 7: References

1. Outline of Manual

The following outlines are the process of demand forecasting.

<Data collection and checking>

STEP 1: Collecting an estimation of future population and estimation of future regional population.

STEP 2: Collecting GDP and GRDP actual and forecasted GDP data from NEDA. Breaking down the forecasted data into regional GDP data.

STEP 3: Collecting sales data from utilities including PIOUs and ECs.

STEP 4: Collecting actual data of TRANSCO peak demand in the previous year and load factor from TRANSCO.

<Demand forecasting>

STEP 1: Demand forecasting by cross-referencing sectors and regions.

STEP 2: Rearrangement of the results as island peak demand. Separation of forecasted demand between the main grid (On-Grid) and the isolated grid (Off-Grid).

STEP 3: Modifying the TRANSCO peak to the SYSTEM peak by adding demand supplied by embedded generators.

STEP 4: Creating variations in forecasting results.

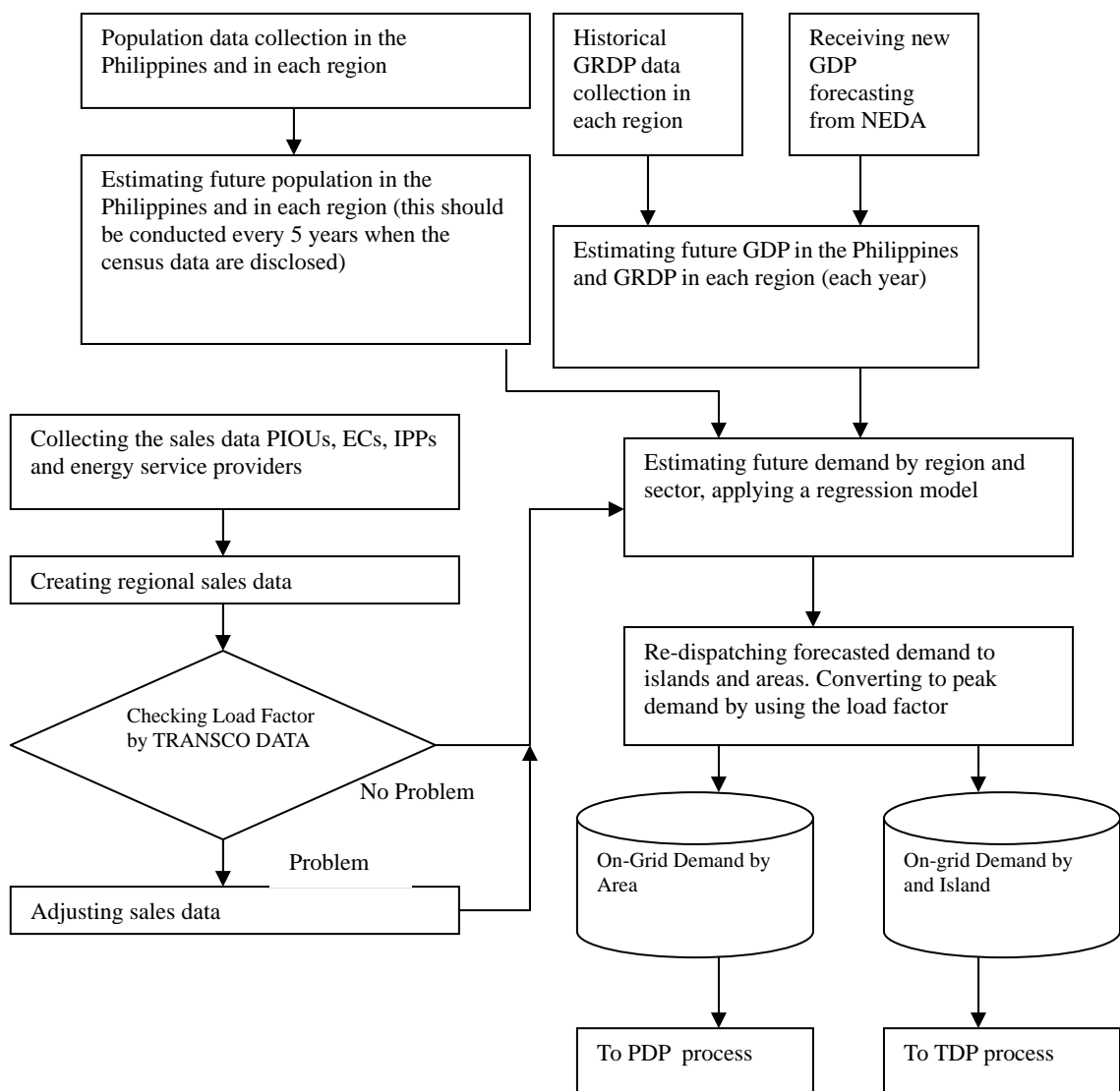
STEP 5: Verifying the results by checking the growth rate and elasticity

A workflow diagram is shown in the following figure as well as the recommended timetable

for demand forecasting tasks. The most critical point in this workflow is the collection of GDP-related data from NEDA that usually takes place in the middle of April. This point cannot be changed. Therefore, to construct a safety schedule for the remaining part of the planning, it is important that the remaining data collection and treatment be completed before the GDP data is disclosed.

Details of the tasks are given in following diagram.

Fig. 1-1 Flow diagram of demand forecasting



Month	February				March				April				May			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Milestones					Sales data from NEA and PIOUS Peak and Load Factor Data from TRANSCO								GDP(Tentative) from NEDA			
Activities													transfer the result to PDP,TDP,MED			
A. Demand forecasting Schedule	Any time Census data are disclosed															
1. Forecasting Future Population	█				█				█				█			
2. Data collection from Distribution utilities					█											
3. Check Sales Data comparison with TRANSCO Data									█							
4. Updating of historical databases of sales data									█							
5. Creating GDP and GRDP Scenarios									█							
6. Forecasting Sales Data by Regions													█			
7. Preparation of Peak Demand													█			
Forecast for the 7 island grids (L, M, C, N, P, LS, B)																

Fig. 1-2 Recommended timetable of demand forecasting tasks

2. Data collection

This chapter discusses contents in the manual on data collection. Figure 2.3 shows the data flow for data collection of DOE and several organizations. **Collected data items**¹ are the following.

- Population
- GDP, GRDP
- Sales Data
- Actual Peak Demand

¹ See “7.1 Data Source” for data sources referenced in the demand forecasting for PDP 2004.

2.1 Population data

(1) Data collection

Outline:

Population data depends on the data disclosed by NSO. Necessary data are the following:

Total population in the Philippines disclosed every five years

Regional population data in the Philippines disclosed every five years

Official future population forecasting results in the Philippines

Practical Process adopted in PDP2004-2013:

Actual available population data collected as national census data by area are shown in following table.

Table 2-1 Population according to the national census data

Date	Luzon	Visayas	Mindanao
05/01/1975	22,790,274	10,133,392	9,146,994
05/01/1980	26,080,694	11,112,523	10,905,243
05/01/1990	33,357,887	13,041,947	14,298,160
09/01/1995	38,249,776	14,158,443	16,205,487
05/01/2000	42,810,872	15,520,152	18,133,864

The following table shows population projections, which is available on the website of “The State of the Philippine Population Report 2000.” These projections were adopted in the demand forecasting in PDP2004-2013.

Table 2-2 Population projections on “The State of the Philippine Population Report 2000”

POPULATION PROJECTIONS	2005*	2010*	2015*	2020*	2025*	2030*	2035*	2040*	
Total (in millions)	84.2	91.9	99	105.6	111.5	117.1	122	126.2	
By sex	Male	42.4	46.2	49.8	53	55.9	58.6	61	62.9
	Female	41.8	45.6	49.2	52.5	55.6	58.4	61	62.9
By Age group (% of total)	0 - 14 yrs	33.80%	31.10%	28.60%	26.20%	24.10%	22.40%	21.10%	19.90%
	15 - 64 yrs	61.80%	63.90%	65.60%	67.00%	68.00%	68.30%	68.10%	67.70%
	65 and over	4.40%	5.00%	5.80%	6.80%	8.00%	9.30%	10.80%	12.40%
Average annual growth rate	1.87	1.66	1.45	1.23	1.07	0.95	0.81	0.66	
Population Density (persons per square kilometer)	281	306	330	352	372	390	407	421	
Crude birth rate	25.1	22.3	20	18	16.6	15.6	14.5	13.3	
Crude death rate	5.9	5.6	5.5	5.5	5.7	6	6.3	6.8	

It is possible to refer to the estimated future population of the cities to check estimated regional population. These data can be referenced from the National Statistic Book, and are easily collected. However, for regional population, which is not shown in this book, DOE should evaluate and estimate this itself.

(2) Data preparation

Outline:

By selecting the period from 1990 – 2015, and then connecting actual data of 1990, 1995 and 2000 and projected data of 2005, 2010 and 2015, it is found that these data series are almost linear. Using this characteristic, we can determine population by region and by year through following steps.

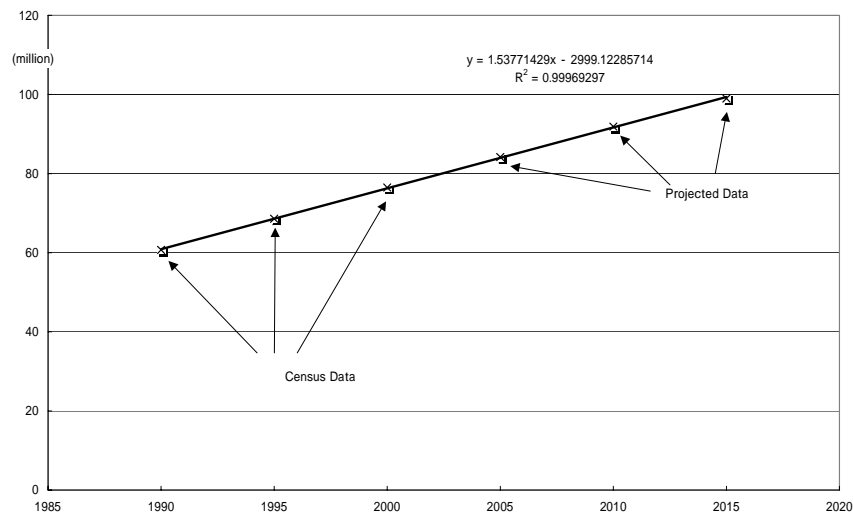


Fig. 2-1 Linearity of actual and projected population in the entire Philippines

- STEP 1: Estimating the functions of the future population explained by year
- STEP 2: Estimating the functions of the population share by region and adjusting total percentage as 100%
- STEP 3: Multiplying the estimated population by area to population share by region

Practical Process adopted in PDP 2004-2013:

The following explanations provide more detail of the above process.

i) Estimation of population by area (STEP 1)

Looking at actual population by area from 1990 to 2000, population growth in each area is almost linear. In addition, projected population in the entire Philippines is also almost linear until 2015. Therefore, it is reasonable to estimate future population growth by area as linear. The following figure shows this linear growth of population estimated using past growth trends and projection.

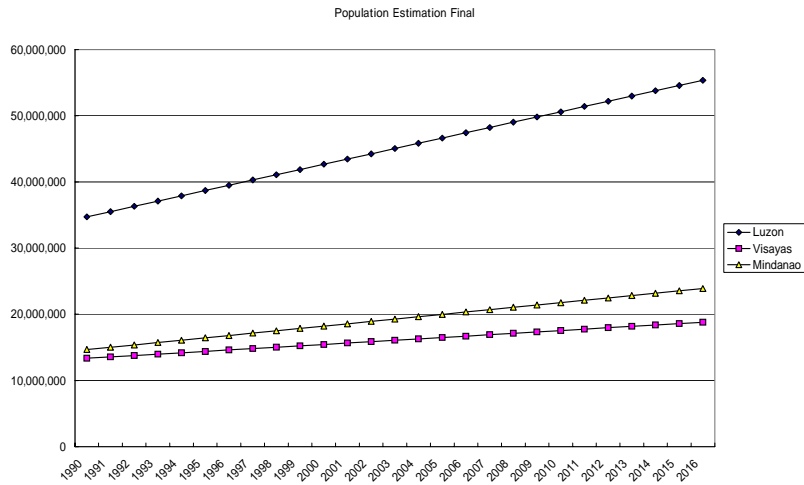


Fig. 2-2 Population growth estimation by area

ii) Estimation of population share by region (STEP2)

To estimate population share by region against area, a **single regression process**² using “STATISTICA” is required. These regressions are done between the percentages of the share of the regional population against the area population. The results can be obtained as the functions shown in the table below, where X means the year number (such as 2002) and Y means the percentage share.

² See “7.2 Single regression by STATISTICA” for explanation of how to run single regression using STATISTICA

Table 2-3 Results of a single regression between year and % share of population

Region Name	Formulation
NCR	National Capital Region $Y = -0.0006266X + 1.4892217$
CAR	CAR $Y = -0.000247X + 0.525955$
Region1	Ilocos Region $Y = -0.0008324X + 1.7619274$
Region2	Cagayan Valley $Y = -0.0004453X + 0.9558348$
Region3	Central Luzon $Y = 0.0001758X - 0.1657567$
Region4	Southern Tagalog $Y = 0.002777X - 5.279507$
Region5	Bicol Region $Y = -0.0008016X + 1.7123248$
Region6	Western Visayas $Y = -0.001349X + 3.099273$
Region7	Central Visayas $Y = 0.001508X - 2.649635$
Region8	Eastern Visayas $Y = -0.000158X + 0.550361$
Region9	Western Mindanao $Y = -0.000156X + 0.483345$
Region10	Northern Mindanao $Y = -0.000218X + 0.587344$
Region11	Southern Mindanao $Y = 0.000594X - 0.901758$
Region12	Central Mindanao $Y = 0.000110X - 0.075010$
ARMM	ARMM $Y = 0.000455X - 0.778276$
Caraga	Caraga ^{1/} $Y = -0.000784X + 1.684354$

Finally, the future percentage share is calculated by inserting the year number (such as 2002, 2003, etc). The results, which can be obtained through the forecasting process in 2003, are shown in the following figure. In this process, adjustment for setting the total of percentage share of regions in the same area to be 100% is required.

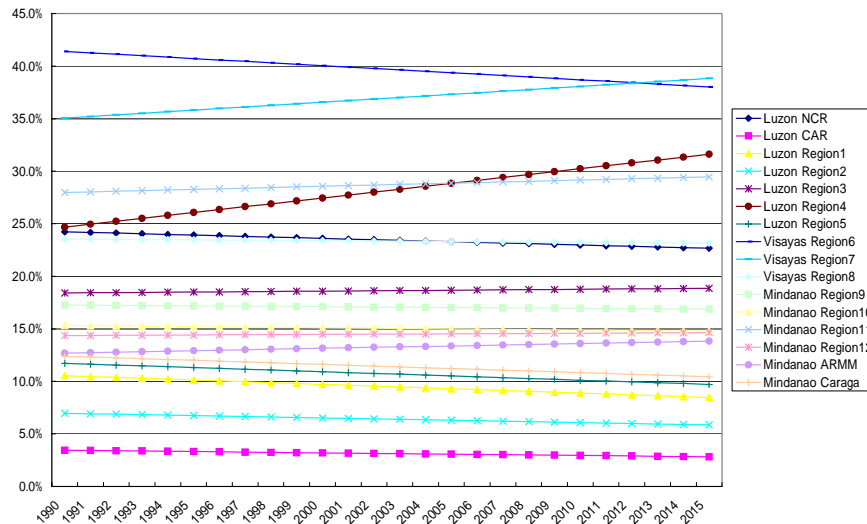


Fig. 2-3 % share of regional population obtained using a practical forecasting process

iii) Calculation of regional population (STEP3)

Finally, the regional population projection is obtained by multiplying the percentage share of the regional population and the area population. The results are shown in the following figure.

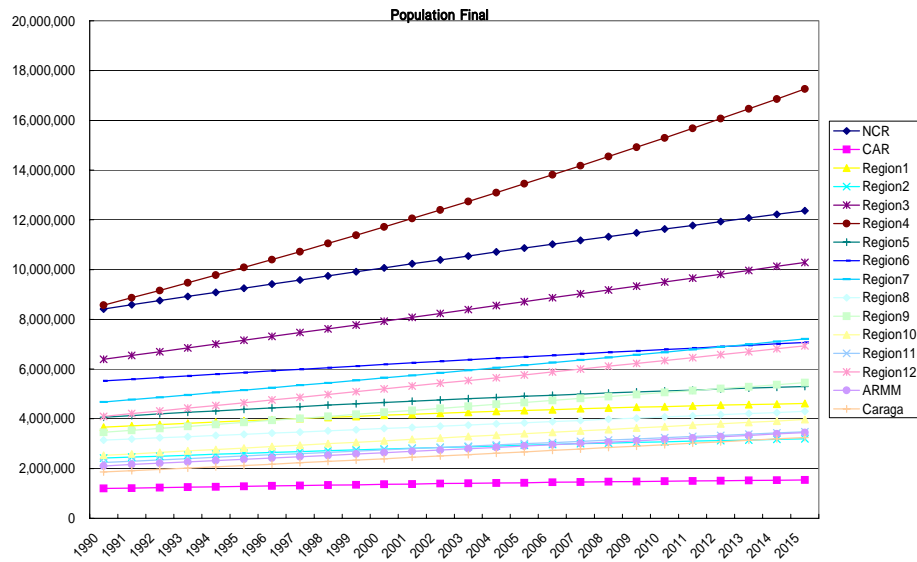


Fig. 2-4 Results of regional population

2.2 GDP, GRDP

(1) Data Collection

Outline:

Actual data on GDP and GRDP (regional GDP) should be collected from NEDA. The data to be collected are as follows:

Actual GDP in the previous year disclosed by NEDA

Actual GRDP in the previous year disclosed by NEDA

Forecasted rate of GDP increase for more than the next 10 years

The NEA tentatively discloses the actual GDP from the previous fiscal year, and GDP is forecast in the middle of April or early May. Because this schedule will not change, it is not necessary to change the data collection for GDP-related data from the previous planning. Officially, the GDP forecast is disclosed for the next five years based on economical activity study results for the next few years, using the economical forecasting model in NEDA. In addition, in this process, NEDA refers to several forecasts on the Philippines' economic situation compiled by external organizations. However, looking at the results of estimation longer than five years, the estimation model has less reality, so on some points, the results are often an overestimation. Therefore, when DOE applies these results to demand forecasting, adjustment of the GDP estimation results is required.

Practical process adopted in PDP 2004-2013:

In the forecasting process of PDP2004-2013, the modification shown below was adopted.

STEP 1: Obtaining two GDP scenarios established by NEDA in PDP2004-2013 (High GDP growth case and Low GDP growth case). A case in which the growth rate after 2008 is the same as the average low cases in NEDA data between 2003 and 2007 is assumed.

STEP 2: Finding future regional GDP share by region

STEP 3: Calculating future regional GDP by region

Therefore, we adopted three GDP growth scenarios as shown below.

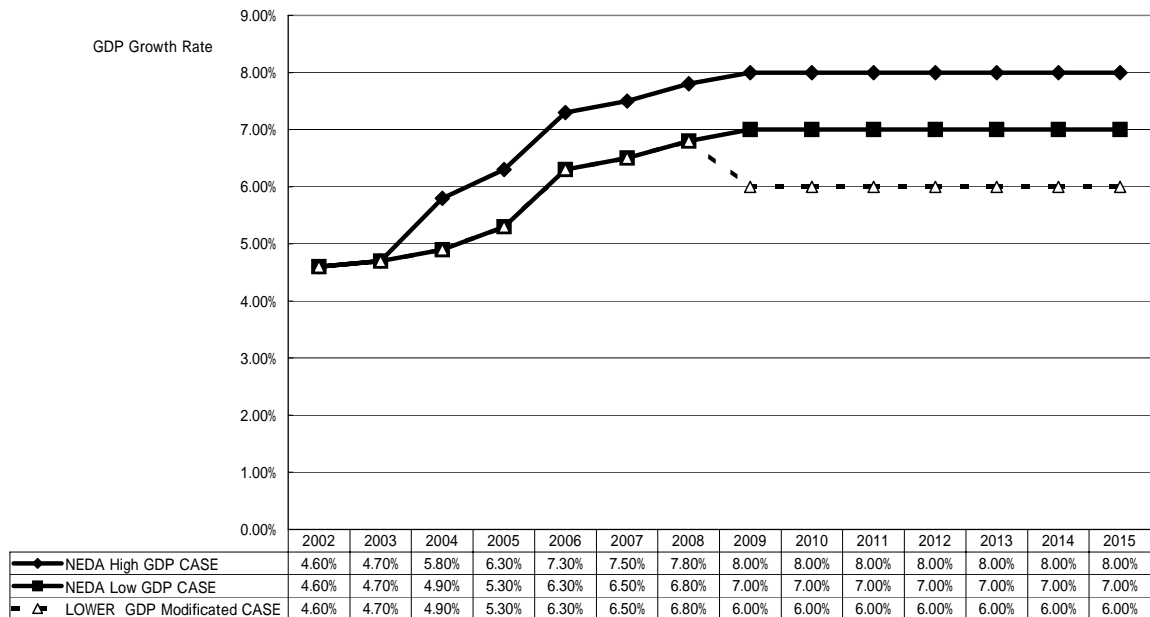


Fig. 2-5 GDP scenarios adopted in the forecasting process in PDP2005-2014

NEDA’s forecasting GDP data are actually national targets, and they are usually very optimistic. Thus, DOE should assume a more pessimistic scenario than NEDA’s targets to evaluate investors’ risk regarding delaying the demand growth of a worse economical condition.

Remarks:

In addition, looking at published data in the National Statistic Book, GRDP data on the electricity, gas and water sector data are lacking for the previous fiscal year. Disclosure of these data seems to be later than for other sectors. For example, in the 2002 Year Book, GRDP data on the electricity, gas and water sector in 2001 are not available. Therefore, DOE may have to collect this missing data directly from NSO.

(2) Preparation

Outline:

DOE must estimate future GRDP itself because NEDA does not estimate it. In addition, detailed GRDP data from the last year seem to be disclosed after the disclosure of the final actual GDP data in July. Therefore, the actual GRDP data in past years excluding those of the previous year are only available for an estimation of the future GRDP share in the forecasting process. As shown in the later part of the manual, the non-residential part of demand is calculated as one sector. Therefore, the breakdown of GDP to sectors is not necessary.

Practical process adopted in PDP:

i) Obtaining a GDP forecast and calculating a new assumption GDP Value (STEP 1)

Because future GDP target by NEDA is given as the growth rate, calculation of future GDP value is first required. This process is necessary for the three GDP scenarios mentioned above.

ii) Finding future regional GDP share by region (STEP 2)

Using actual regional GDP (GRDP), it is possible to find the future share of each region's GDP against the total GDP in the Philippines. This percentage share can be obtained by **single regression**³ between the actual GRDP share and the year. Regression results shown as coefficients of the formulation are shown in the following table, and the percentage share results are shown in the following figure.

Table 2-4 Coefficients of the formulation

	NCR	CAR	Region I	Region II	Region III	Region IV	Region V	Luzon
a	-0.647178	-0.97413	-0.188464	-0.200507	0.658146	-0.557404	0.407849	-1.50168
b	0.000477	0.00050	0.000110	0.000111	-0.000283	0.000357	-0.000190	0.00108

	Region VI	Region VII	Region VIII	Visayas
a	0.371481	-0.826736	0.379600	-0.075654
b	-0.000150	0.000448	-0.000178	0.000120

	Region IX	Region X	Region XI +CARAGA	Region XII +ARMM	Mindanao
a	0.409576	2.596237	-0.492801	0.061420	2.577338
b	-0.000191	-0.001278	0.000283	-0.000013	-0.001201

³ See “7.2 Single regression by STATISTICA” for information on how to run STATISTICA.

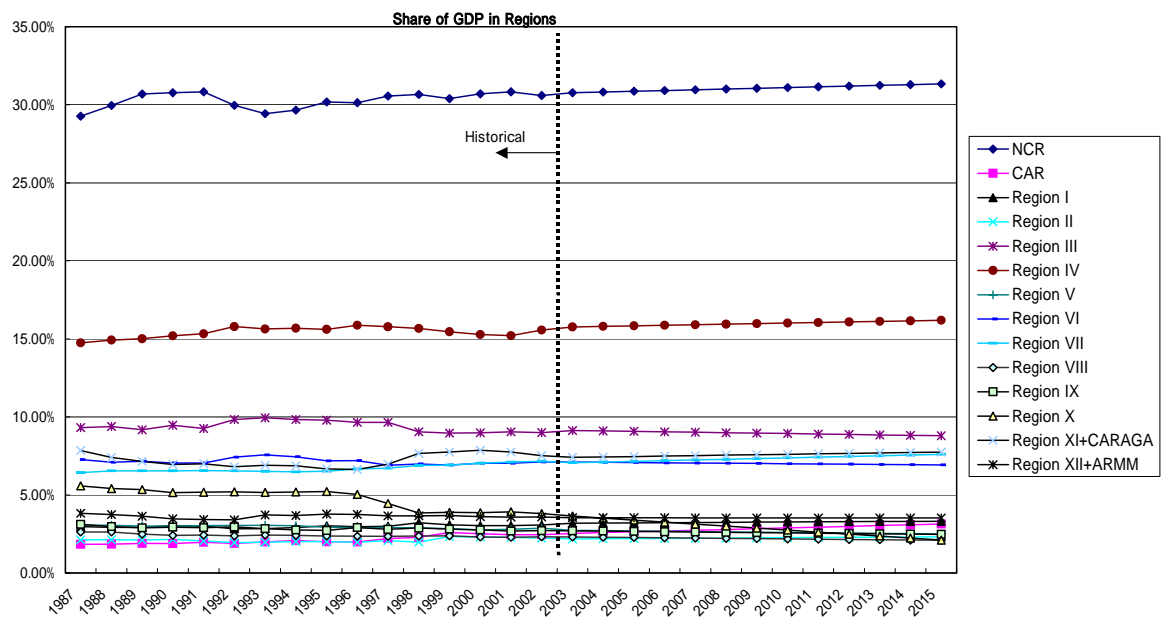


Fig. 2-6 % share of GRDP against total GDP in the Philippines

iii) Calculating future regional GRDP (STEP 3)

Multiplying the percentage share of GRDP and the GDP scenario of the entire Philippines, the future GRDP values are obtained. This process is necessary for each of the three GDP scenarios mentioned above.



Fig. 2-7 GDP scenario broken down to regional GDP scenarios

Remarks:

These processes for breaking down to regional GDP scenarios should be updated when new scenario for GDP targets and actual GDP data from the previous year are disclosed. In this case, a GDP spreadsheet related should be extended throughout the year.

2.3 Sales data**(1) Data Collection****Outline:**

Due to restructuring NPC, it will soon be difficult to collect sectional sales data from NPC. Therefore, a demand forecasting based on sales data by distribution utilities has been adopted for the new demand forecasting .

Practical process adopted in PDP:

Sales data from PIOUs and municipal utilities are collected by ERC directly for rate regulation. Copies of these data are also sent to DOE. Sales data before Year 2001 can be collected from this information. However, some data were lacking in the historical data stock, and these data were recorded in paper format. The creation of a digital database and interpolation of lacking data were necessary.

NEA and NPC-SPUG collected data from ECs independently, and these data were collected on digital media. The data collection route through NEA should be the main route, and " The Chronicle," which is published by NEA every three years is the best reference for collection of past data. In addition, NEA may disclose the data of the previous year before starting the demand forecasting process. By referring to these data, a sales database for ECs can be prepared and updated.

However, ideally, DOE should collect copies of these sales data directly from ECs and PIOUs using the data collection for DDP. This will contribute to efficient and accurate data collection.

The data that have been collected are as follows:

- Annual sales data by sector (residential, commercial and industrial) in utilities
- Amount of contract (connection) data by sector (residential, commercial and industrial) in utilities
- Annual purchased energy in utilities

- Annual energy loss in utilities
- Annual consumption in utilities

		LUZON							
		1. Angeles Electric Corporation	2. Bauan Electric Lights System	3. Cabanatuan Electric Corp.	4. Dagupan Elec. Corp.	5. Ibaan Elec. & Eng'g. Corp.	6. La Union Electric Company, Inc.	7. Manaoag Utility Inc.	8. Manila Company
Bulk Power	1990								
	1991								
	1992								
	1993								
	1994								
	1995								
	1996								
	1997								
	1998								
	1999								
	2000								
	2001								
Comm/ Gen. Ser.	1990	61,075,585	933,192	11,393,855	18,645,264	732,328		211,347	3,776.4
	1991	48,782,105		12,822,561	18,926,538	698,509		263,951	3,750.8
	1992	44,727,633		12,331,686	19,625,902	789,790		206,555	3,815.8
	1993	47,341,346		12,545,533	22,670,121	852,636		263,013	3,784.4
	1994	59,436,282		17,538,927	25,714,339	1,130,448	17,787,284	299,327	4,747.0
	1995	72,909,463	2,112,505	18,883,190	28,758,558	1,337,667	23,383,749	346,022	5,140.3
	1996	103,075,333	2,292,637	33,510,579	30,534,208	808,809	33,983,813	297,509	5,805.0
	1997	134,621,550	2,168,124	36,559,883	32,549,463	1,752,386	25,602,520	248,996	6,313.5
	1998	140,664,488	2,335,587	45,287,412	34,317,132	1,938,085	28,997,134	354,428	6,870.4
	1999	146,748,171		48,703,909	35,142,420	2,035,591	30,688,272		7,038.1
	2000	167,664,443		51,611,050	39,188,330	1,911,348	32,379,409		7,507.2
	2001	165,890,417		51,914,495	41,792,645	2,375,011	34,070,547		7,905.7
Ind'l/ Gen. Pow.	1990	4,715,992		8,006,939	14,859,640	1,918,456		410,273	3,980.2
	1991	3,843,828		9,070,265	15,242,933	2,368,430		324,910	4,335.0
	1992	4,102,481		8,746,803	16,665,402	1,927,930		388,721	4,430.4
	1993	4,574,133		8,716,876	20,344,261	1,697,273		367,719	4,333.0
	1994	4,817,387		10,953,051	24,023,120	2,653,609	2,845,334	467,559	5,048.2
	1995	4,612,800	0	10,734,797	27,701,979	2,027,510	2,096,660	469,125	5,327.1
	1996	5,294,361	0	8,636,607	31,520,431	1,222,608	3,533,555	519,689	5,909.1
	1997	5,346,277		6,465,525	35,487,736	2,881,436	3,173,138	570,253	6,213.4
	1998	5,486,154		7,175,166	40,466,033	2,493,280	4,165,777	814,834	5,952.6
	1999	4,876,949		5,487,417	44,497,618	2,557,186	5,004,614		5,974.4
	2000	8,171,269		5,305,238	47,228,609	2,267,076	5,843,451		6,359.8
	2001	12,399,915		5,136,094	55,423,661	1,554,967	6,682,288		6,503.2
Others	1990	3,751,075	427,389	5,589,106	1,395,708	150,144		71,456	89.9
	2001	3,028,614		5,770,274	4,330,000	60,700		65,755	64.0

Fig. 2-8 Database of sales data

Remarks:

In this year's process, sales data are collected from these sources.

1) Sales Data of PIOUs and Municipals

Summary data on the sales of private owned utilities and municipal utilities by sector and on the energy balance (such as purchase, self consumption or generated) were collected as approved summary sheets recorded on the ERB or the ERC form. These data are available at the monitoring division in DOE. In addition, we used back numbers of annual reports stocked in ERC.

2) Sales Data of ECs

Principally, the historical sales data of each EC were collected by referencing the chronicles.

3) Sales Data in Transmission

To check trends in direct sales in transmission level, we collected historical direct sales data of NPC from TRANSCO. These data, after WESM started, can be collected as settled traded energy generated for costumers connected to transmission system.

2.4 The data from TRANSCO

(1) Data collection

Out line:

Historically, peak energy in PDP means the system peak, which equals the TRANSCO peak plus demand capacity supplied by an embedded capacity. To determine this system peak, the following data are necessary.

The annual TRANSCO system peak demand and the TRANSCO peak in Luzon, the Visayas and Mindanao grids.

Annual load factor in the Luzon, Visayas and Mindanao grids.

Annual loss factor in the Luzon, Visayas and Mindanao grids.

These data in sub-grids in the Visayas

Practical process adopted in PDP2004-2013:

In the process of PDP2004-2013, historical peak data were collected from TRANSCO. These data are supplied via Ms. Dina Dezon. Both the TRANSCO peak and the system peak include embedded supplied capacity supplied by TRANSCO. However, there is no guaranty that this system peak can be collected from TRANSCO in future. Therefore, DOE must collect TRANSCO peak from EMS in TRANSCO and embedded demand from DDP data collection directly.

3. The method of demand forecasting

3.1 Forecasting method of sales data

The following flowcharts are an outline of the demand forecasting process. There are two parts in these charts. The first (Process I) is for demand forecasting of the main grid in Luzon, the Visayas and Mindanao. The second process is for demand forecasting of the sub-grid in the Visayas.

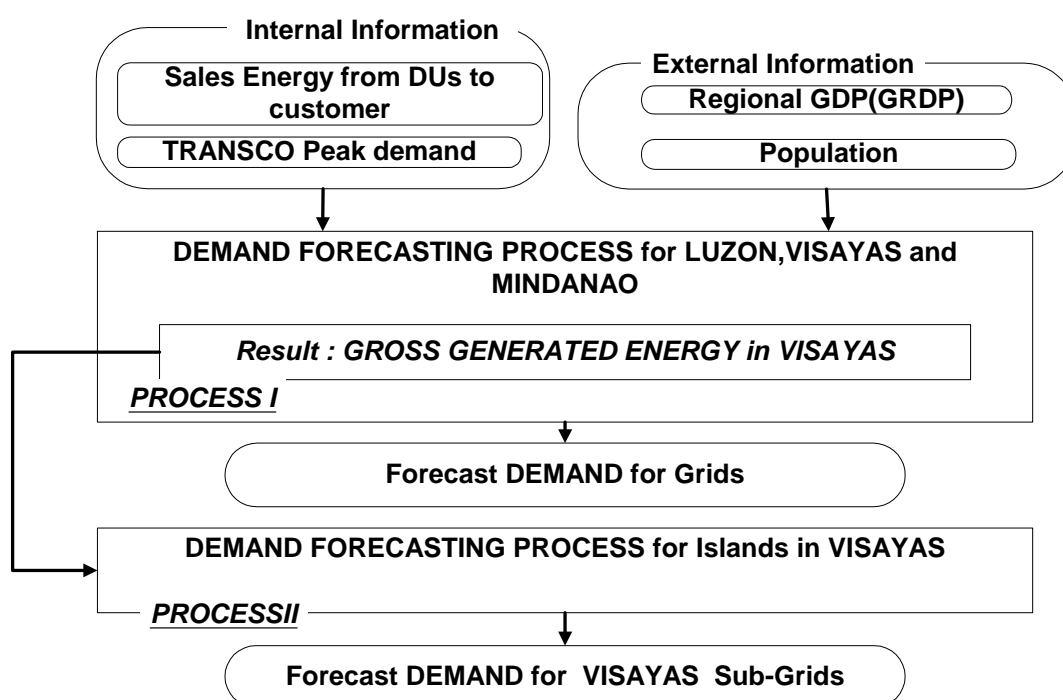


Fig. 3-1 Outline of the process of demand forecasting

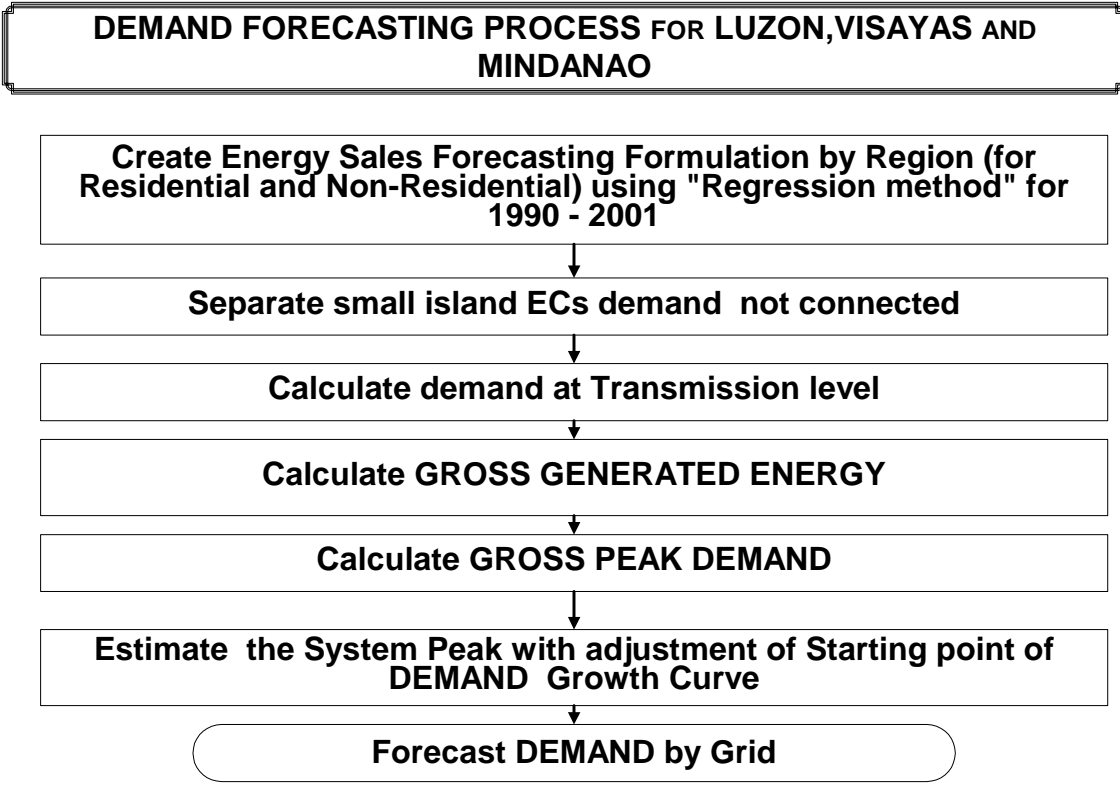


Fig. 3-2 Outline of Process I

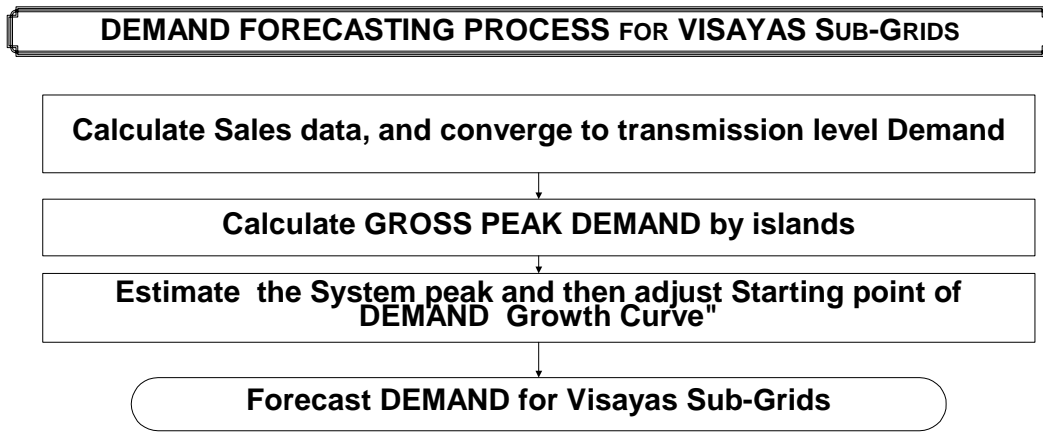


Fig. 3-3 Outline of Process II

STEP1: Regression model for forecasting sales in distribution

As the first step in demand forecasting, sales data in each region are forecasted using the regression model. In this case, “STATISTICA” can be applied to find **multi and single regression** results⁴.

Forecasted demand in distribution is categorized into two sectors, residential and non-residential. Looking at historical data, it seems that separating the non-residential sector into individual sectors such as industrial, commercial and others is very difficult because sales are sometimes categorized as industry and at other times categorized as bulk. In addition, this energy cannot be separated. Therefore, we decided to merge non-residential demand into one category.

Therefore, the formulations for forecasting are as follows.

$$\text{Residential Sales (GWh)} = a + b \cdot \text{Regional Population} + c \cdot \text{Regional GDP/Capita}$$

$$\text{Non-Residential (GWh)} = a + b \cdot \text{Regional GDP}$$

Here, GDP/Capita and Population are thought do not strongly correlate (no multi-colinearity) based on the analysis shown in the following figure.

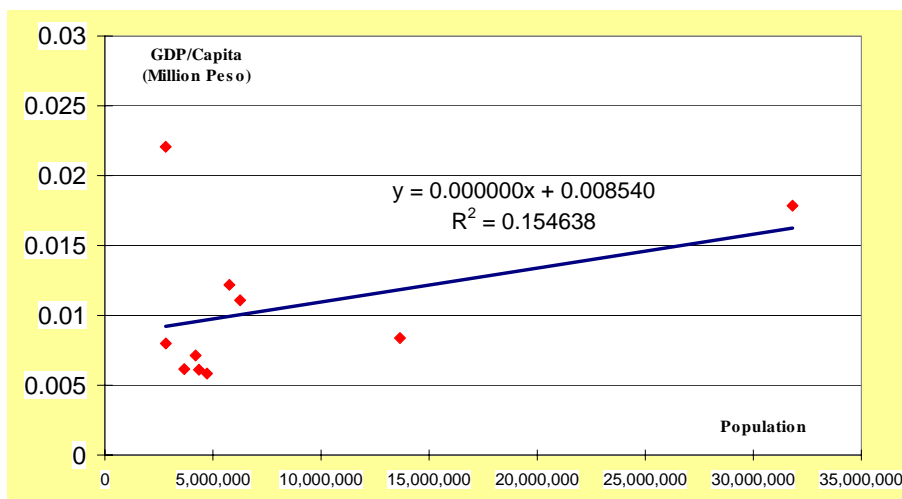


Fig. 3-4 Relationship between GDP/Capita and Population

The functions used for forecasting, derived from the regression process, are shown below.

⁴ See “7.3 Multiple regression by STATISTICA” for information on how to run multiple regression using STATISTICA.

In these regressions, NCR, CAR, Reg3 and Reg4 are treated as one region because the MERALCO franchise is included. In addition, Reg10, Reg12, ARMM and Carga are merged into one region because these historical data were merged previously. Coefficients of regression formula in PDP2005-2014 are shown below.

Table 3.1 Coefficient of regression formula for residential demand

Coefficient	NCR-CAR-Reg3-Reg4	Reg1	Reg2	Reg5	Reg6
a	-19,205,070,000	-1,905,928,000	-729,324,600	-1,308,398,000	-2,453,592,000
b	662.812	485.727	293.615	246.275	520.481
c	425,647,300,000	53,182,860,000	15,478,460,000	76,947,610,000	-18,858,360,000

Coefficient	Reg7	Reg8	Reg9	Reg10+Reg12+ARM M Carga	Reg11
a	-1,732,168,000	-937,043,800	-606,090,500	-1,833,963,000	-995,484,800
b	356.691	218.394	147.039	123.349	398.934
c	31,093,500,000	55,874,700,000	28,078,390,000	95,056,680,000	12,377,960,000

Table 3.2 Coefficient of non-regression formula for residential demand

Coefficient	NCR-CAR-Reg3-Reg4	Reg1	Reg2	Reg5	Reg6
a	-9,355,974,000	-357,886,400	-77,423,740	-233,122,600	-459,364,700
b	44,394	22,431	9,927	16,782	14,547

Coefficient	Reg7	Reg8	Reg9	Reg10+Reg12+ARM M Carga	Reg11
a	-554,749,200	-184,380,500	-335,914,100	-82,634,040	-429,311,000
b	24,482	14,274	23,547	5,693	16,993

3.2 Conversion method to peak demand

STEP 1: Estimation of Area Gross Generated Energy

Gross generated energy was calculated using the following formula in each grid by using the “Adjustment Factor (% Value difference of gross generation and sales in distribution against sales in distribution companies).” These AF values are calculated by using the actual sales data and the actual gross generated energy from generation between 1999 and 2001.

Gross Generation (GWh) by Grid

$$= \text{Energy Sales in Distribution} * (1 + \text{AF})$$

In PDP2005-2014, values in Table 3-3 were used as AF.

STEP 2: Conversion to Peak Demand

Peak demand (MW) is calculated as the following formula.

$$\text{Peak Demand (MW)} = \text{Gross Generated Energy (MWh)} / 8760 \text{Hours} / \text{Load Factor}$$

In PDP2005-2014, values in Table 3-3 were used as AF..

Table 3-1 Adjustment Factors AF and Load factors LF in each grid

	AF (Adjustment Factor)		LF (Load factor)	
Luzon	23%	NPC Direct Sales 7% Transmission Loss 8% Self consumption in Station 8%	62%	5 years average 61.6%
Visayas	33%	NPC Direct Sales 15% Transmission Loss 10% Self consumption in Station 8%	50%	5 years average 49.6%
Mindanao	40%	NPC Direct Sales 20% Transmission Loss 10% Self consumption in Station 10%	58%	5 years average 57.4%

3.3 Rearrangement of Energy Sales

STEP 1: Creating variation

Original forecasted demands are characterized by declining elasticity between growth rate and GDP growth rate. In the last forecast, we created variation as a constant elasticity case, in which the elasticity is kept the same as the Year 2003 value even after 2003. Treatment of creating variation is very easy as shown in the following steps.

- Set the 2003 demand the same as the original.
- Calculate the growth rate maintaining the same elasticity from the GDP growth rate in the area
- Calculate new peak demand using the calculated demand growth rate

STEP 2: Adjustment Peak

Peak demand calculated using the process in 3.4 does not pass through actual peak demand in 2002 because this MW growth is calculated based on data from 1990 to 2001. Thus, the growth curve is adjusted to pass through the actual peak value in 2002. In this process, the growth rates are kept the same as the original as shown in the following figure.

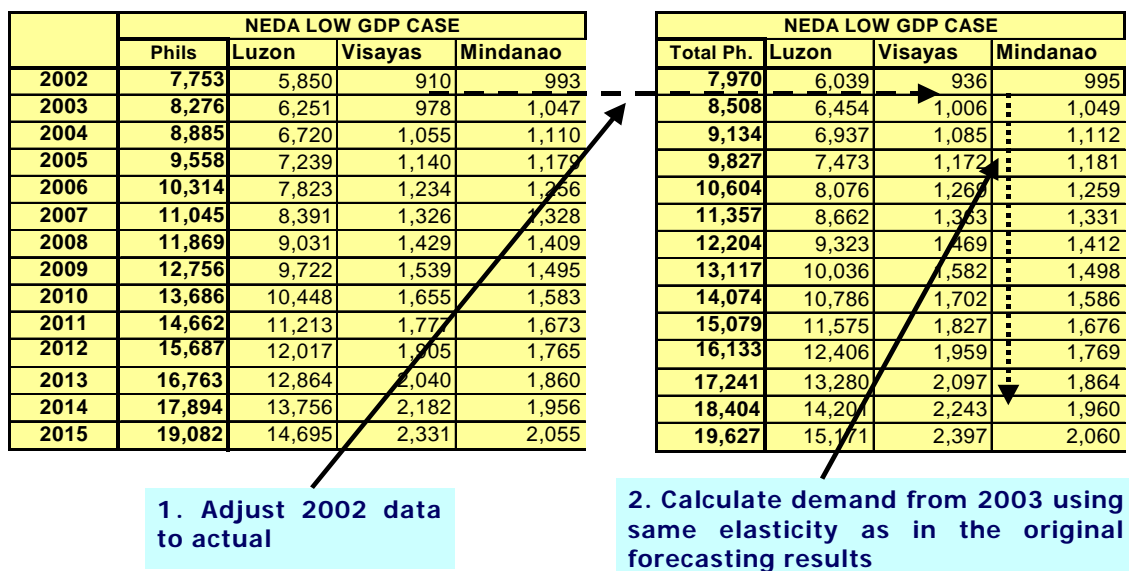


Fig. 3-5 Adjustment methods for peak demand to pass through the Year 2003

STEP 3: Peak in an island's sub-grid

Peak demand in each island in the Visayas is found using the following steps. First, the sales data of each DISCO in Regions 6-8 were re-allocated among the islands when these DISCOs are located on large islands of the Visayas. Next, the future share of sales is estimated using the trend in the percentage share of sales in the Visayas.

Table 3-2 % share of demand in the Visayas

	CEBU	PANAI	NEGROS	BOHOL	LEYTE-SAMAR
1990	46.0%	16.2%	19.6%	2.3%	16.0%
1991	45.9%	17.0%	19.7%	2.3%	15.1%
1992	47.5%	16.6%	19.0%	2.2%	14.6%
1993	48.7%	16.3%	18.5%	2.2%	14.3%
1994	49.3%	15.8%	18.2%	2.3%	14.4%
1995	49.9%	15.6%	17.8%	2.5%	14.2%
1996	48.8%	15.6%	17.4%	2.5%	15.6%
1997	47.7%	15.5%	17.4%	2.6%	16.8%
1998	46.2%	16.0%	17.4%	2.5%	17.8%
1999	46.2%	16.4%	16.8%	3.2%	17.5%
2000	46.3%	16.4%	16.6%	3.0%	17.8%
2001	45.8%	16.2%	17.0%	3.1%	17.9%
2002	46.4%	15.9%	16.2%	3.3%	18.3%
2003	46.3%	15.8%	15.9%	3.3%	18.6%
2004	46.2%	15.8%	15.6%	3.4%	19.0%
2005	46.1%	15.8%	15.4%	3.5%	19.3%
2006	46.0%	15.7%	15.1%	3.6%	19.6%
2007	45.9%	15.7%	14.8%	3.7%	19.9%
2008	45.8%	15.7%	14.5%	3.8%	20.3%
2009	45.7%	15.6%	14.2%	3.9%	20.6%
2010	45.6%	15.6%	13.9%	4.0%	20.9%
2011	45.5%	15.6%	13.7%	4.1%	21.2%
2012	45.4%	15.5%	13.4%	4.2%	21.6%
2013	45.3%	15.5%	13.1%	4.2%	21.9%
2014	45.2%	15.5%	12.8%	4.3%	22.2%
2015	45.1%	15.4%	12.5%	4.4%	22.5%

STEP 4: Gross generated energy in an island's sub-grid

Using these future share data, we found the future sales energy of an island, and then they are converged generated energy and peak using percentage value, which means the adjustment factor (AF) between generation and sales and load factor.

Gross Generated Energy(MWh) = Sale energy in DISCOs * (1+AF (%value))

Table 3-3 AF in each sub-grid

Panay	Negros	Cebu	Bohol	Leyte-Samar
3.9%	41.0%	34.4%	5.5%	136.9%

4. The file system of Demand Forecasting

For demand forecasting, file systems of Excel that are linked to each other are created to easily handle forecasting. The structure of this file system is shown in the following figure.

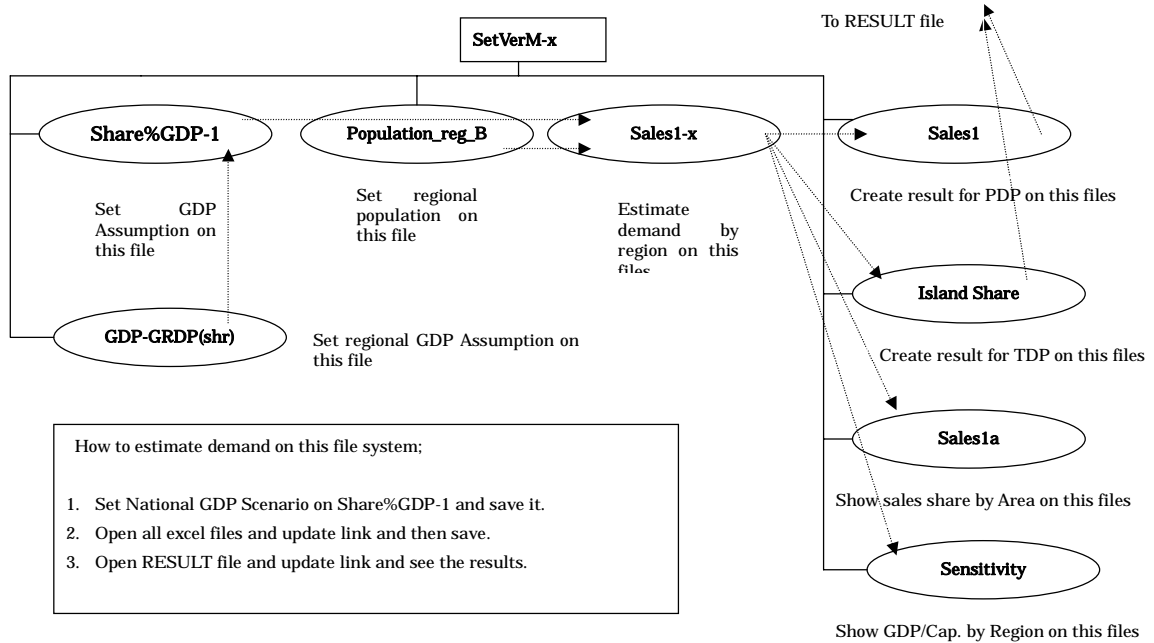


Fig. 4-1 File system for forecasting

(1) shareGDP%-1 file

In this file, the GDP assumption is input. These data are input on the sheet named “Total Phil. Assump.”

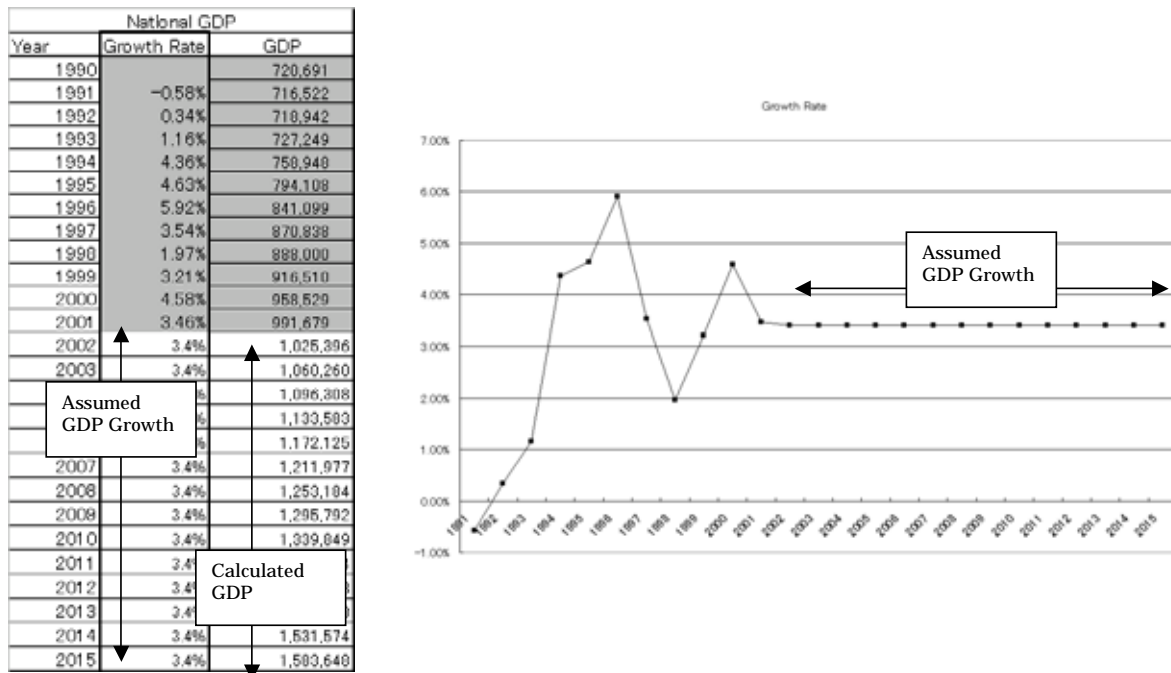


Fig. 4-2 Input sheet and figures in the file share GDP%-1

(2) Sales1-x files

On the Sales1-x (X=1,10) files, future sales in the distribution system are calculated using the above regression results. This process is conducted when these files are open. In these files, the historical sales data of each region are calculated as residential and non-residential, then the future sales volume is forecast in the table shown in Fig.4-3.

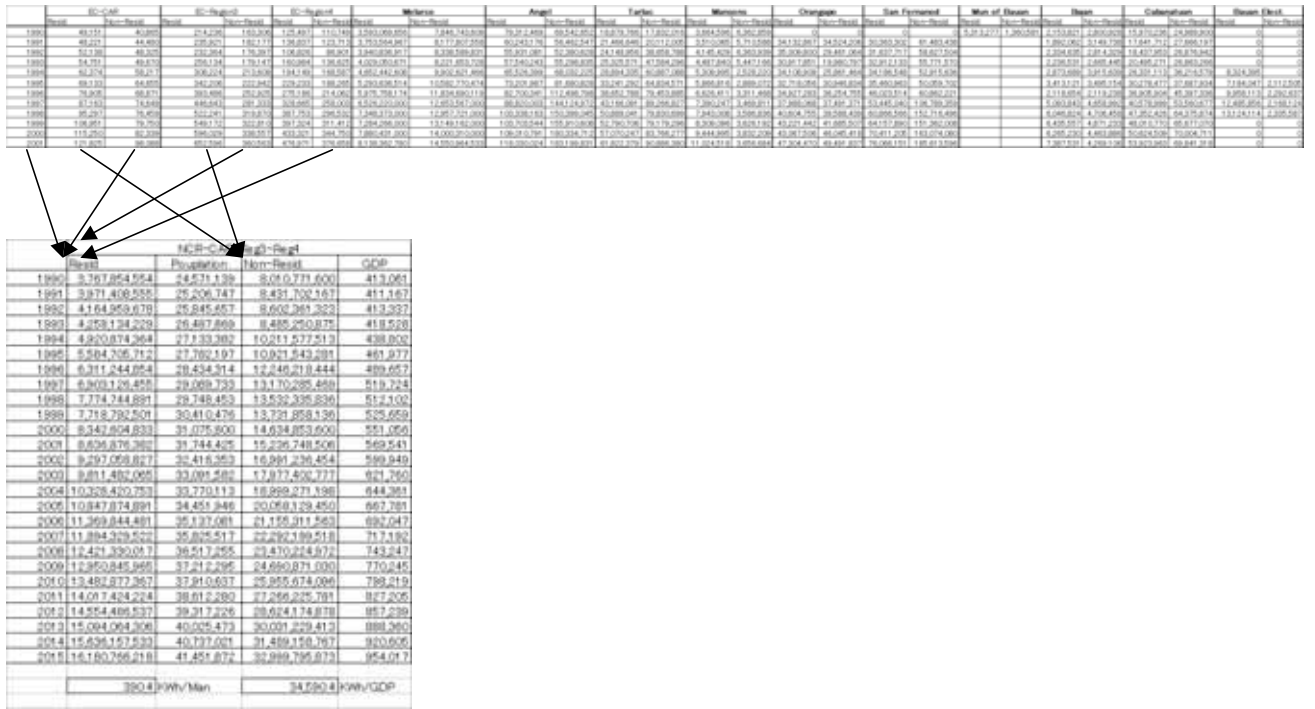


Fig. 4-3 Creating actual and estimated demand by sector

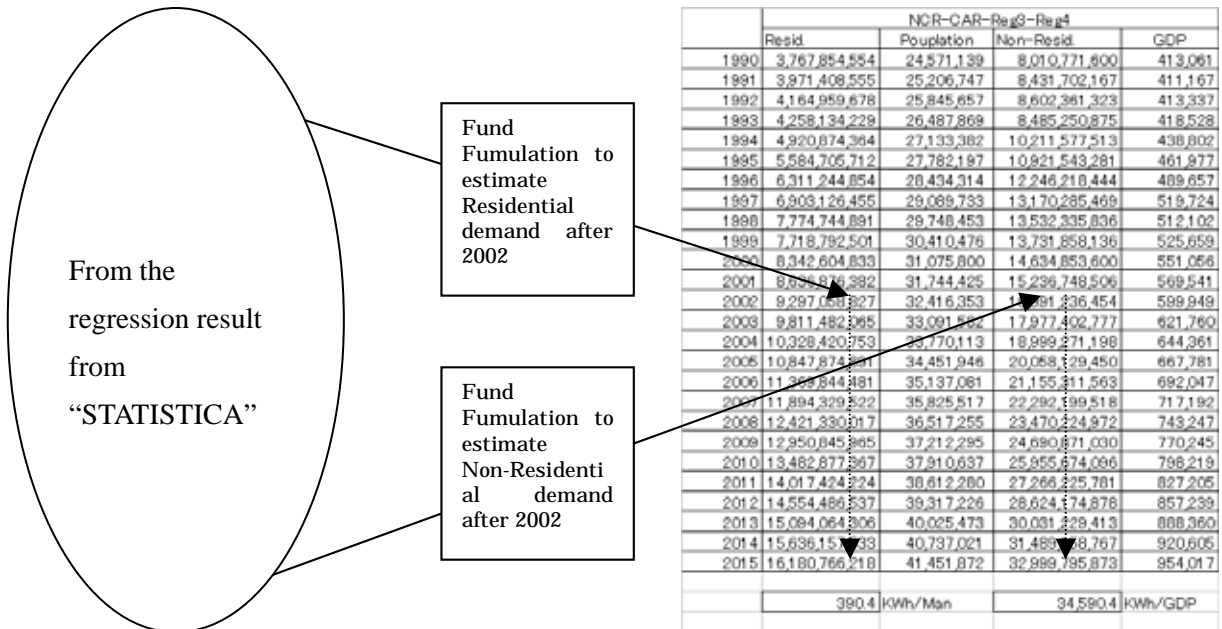


Fig. 4-4 Applying regression results to forecasting sales energy in distribution

(4) RESULT and RESULT_ADJUSTED file

Calculated peak demands are summarized in this file. In addition, the growth rate and elasticity are evaluated in this file. Using these results, variation such as constant elasticity is also created in this file, too. Between RESULT and RESULT_ADJUSTMENT file, fitting starting point on actual demand in the last year is processed.

MW	NEDA High GDP CASE				NEDA LOW GDP CASE				LOWER GDP Modified CASE				PEP2003-2012 LOW GDP Case Result				PEP2002
	Total Ph.	Luzon	Visayas	Mindanao	Total Ph.	Luzon	Visayas	Mindanao	Total Ph.	Luzon	Visayas	Mindanao	Total Ph.	Luzon	Visayas	Mindanao	
2002	7,970	6,039	936	995	7,970	6,039	936	995	7,970	6,039	936	995	8,249	6,308	941	1,000	8,390
2003	8,605	6,530	1,013	1,061	8,508	6,454	1,006	1,049	8,505	6,454	1,003	1,049	8,833	6,752	1,007	1,074	9,131
2004	9,326	7,090	1,100	1,136	9,134	6,937	1,085	1,112	9,129	6,937	1,079	1,112	9,518	7,275	1,084	1,159	9,983
2005	10,135	7,718	1,197	1,220	9,827	7,473	1,172	1,181	9,818	7,473	1,163	1,181	10,257	7,835	1,168	1,254	10,951
2006	11,030	8,416	1,302	1,312	10,604	8,076	1,269	1,259	10,591	8,076	1,256	1,259	11,139	8,503	1,276	1,360	12,036
2007	11,925	9,115	1,409	1,401	11,357	8,662	1,363	1,331	11,340	8,662	1,346	1,331	11,997	9,161	1,377	1,459	13,228
2008	12,930	9,903	1,527	1,500	12,204	9,323	1,469	1,412	12,094	9,255	1,438	1,402	12,870	9,830	1,477	1,563	14,540
2009	14,019	10,759	1,655	1,605	13,117	10,036	1,582	1,488	12,879	9,872	1,532	1,474	13,813	10,548	1,592	1,673	16,009
2010	15,172	11,667	1,790	1,715	14,074	10,786	1,702	1,586	13,694	10,517	1,631	1,547	14,815	11,319	1,707	1,789	17,606
2011	16,393	12,632	1,933	1,828	15,079	11,575	1,827	1,676	14,543	11,189	1,733	1,621	15,890	12,149	1,829	1,912	19,325
2012	17,686	13,657	2,085	1,945	16,133	12,406	1,959	1,769	15,426	11,890	1,840	1,696	17,033	13,034	1,958	2,041	0
2013	19,058	14,746	2,245	2,066	17,241	13,280	2,097	1,864	16,345	12,622	1,950	1,773	0	0	0	0	0
2014	20,512	15,905	2,415	2,192	18,404	14,201	2,243	1,960	17,303	13,387	2,066	1,850	0	0	0	0	0
2015	22,055	17,137	2,596	2,321	19,627	15,171	2,397	2,060	18,300	14,186	2,186	1,929	0	0	0	0	0

Constant Elasticity Case

MW	NEDA High GDP CASE				NEDA LOW GDP CASE				LOWER GDP Modified CASE				PEP2003-2012 LOW GDP Case Result				PEP2002
	Total Ph.	Luzon	Visayas	Mindanao	Total Ph.	Luzon	Visayas	Mindanao	Total Ph.	Luzon	Visayas	Mindanao	Total Ph.	Luzon	Visayas	Mindanao	
2002	7,970	6,039	936	995	7,970	6,039	936	995	7,970	6,039	936	995	8,249	6,308	941	1,000	8,390
2003	8,605	6,530	1,013	1,061	8,508	6,454	1,006	1,049	8,505	6,454	1,003	1,049	8,833	6,752	1,007	1,074	9,131
2004	9,368	7,120	1,107	1,142	9,177	6,967	1,093	1,117	9,170	6,967	1,086	1,117	9,518	7,275	1,084	1,159	9,983
2005	10,270	7,817	1,218	1,236	9,957	7,564	1,196	1,197	9,946	7,564	1,184	1,197	10,257	7,835	1,168	1,254	10,951
2006	11,322	8,628	1,347	1,347	10,883	8,272	1,319	1,292	10,865	8,272	1,301	1,292	11,139	8,503	1,276	1,360	12,036
2007	12,413	9,472	1,482	1,458	11,808	8,982	1,442	1,384	11,784	8,982	1,418	1,384	11,997	9,161	1,377	1,459	13,228
2008	13,702	10,470	1,642	1,590	12,906	9,822	1,591	1,494	12,743	9,724	1,541	1,478	12,870	9,830	1,477	1,563	14,540
2009	15,168	11,605	1,824	1,739	14,148	10,771	1,759	1,617	13,780	10,527	1,674	1,578	13,813	10,548	1,592	1,673	16,009
2010	16,790	12,862	2,026	1,901	15,508	11,812	1,946	1,750	14,901	11,397	1,819	1,685	14,815	11,319	1,707	1,789	17,606
2011	18,585	14,256	2,251	2,078	17,000	12,954	2,153	1,893	16,114	12,339	1,976	1,799	15,890	12,149	1,829	1,912	19,325
2012	20,573	15,800	2,501	2,271	18,636	14,206	2,381	2,048	17,426	13,358	2,148	1,920	17,033	13,034	1,958	2,041	0
2013	22,773	17,512	2,779	2,482	20,429	15,579	2,634	2,216	18,844	14,462	2,334	2,049	0	0	0	0	0
2014	25,208	19,409	3,087	2,712	22,394	17,084	2,914	2,396	20,379	15,656	2,536	2,186	0	0	0	0	0
2015	27,905	21,511	3,430	2,963	24,549	18,735	3,223	2,591	22,038	16,949	2,755	2,333	0	0	0	0	0

Fig. 4-6 Creating variation on the file “RESULT_ADJUSTED “

5. Verification of forecasting results

To check the propriety of the results and to understand the meaning of the results, verification should be carried out by several types of analysis. This chapter presents these methods of analysis.

STEP 1: Create growth curve and comparison with the last PEP results

The first check should be comparison of the results with the previous forecasting results. For example, in the forecasting work in PDP 2004-2013, the following type of figure is prepared to show the difference among the results of the growth curve includes the previous forecasting results.

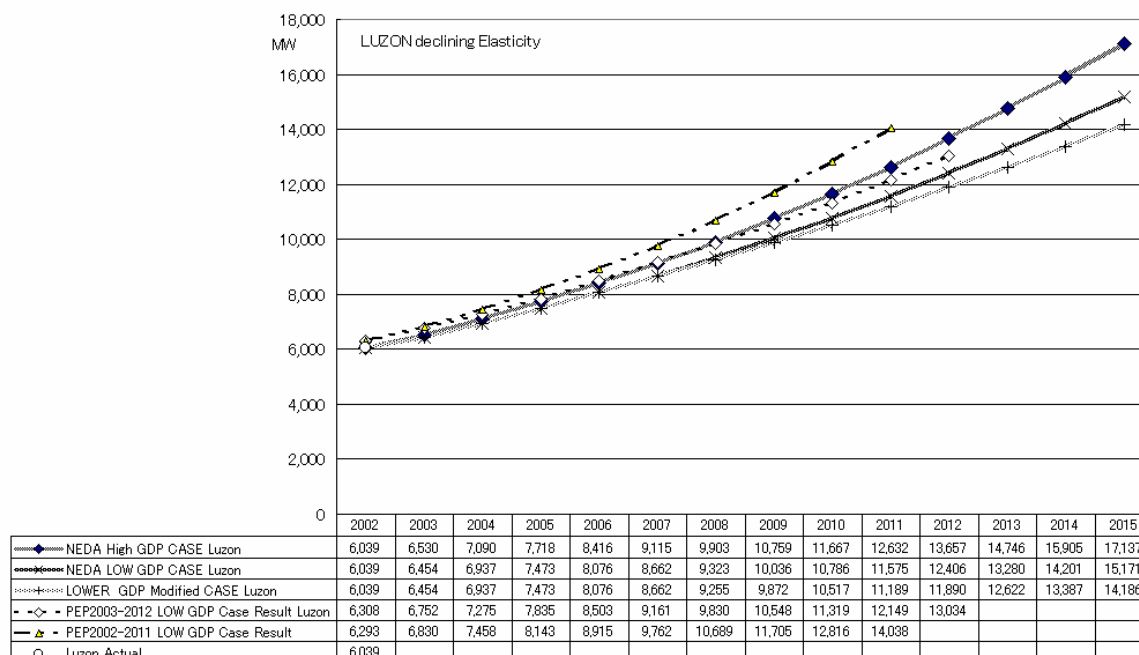


Fig. 5-1 Comparison among growth curves

STEP 2: Comparison with historical demand

Comparison with historical data in the graphics is useful for checking the continuity of the curve based on each scenario. For example, the following graph shows the historical growth curve and the forecasted curve by scenario. Looking at this graph, we can understand that positive growth requires better economic conditions because the most pessimistic growth curve is on the

trend of the past growth curve visually.

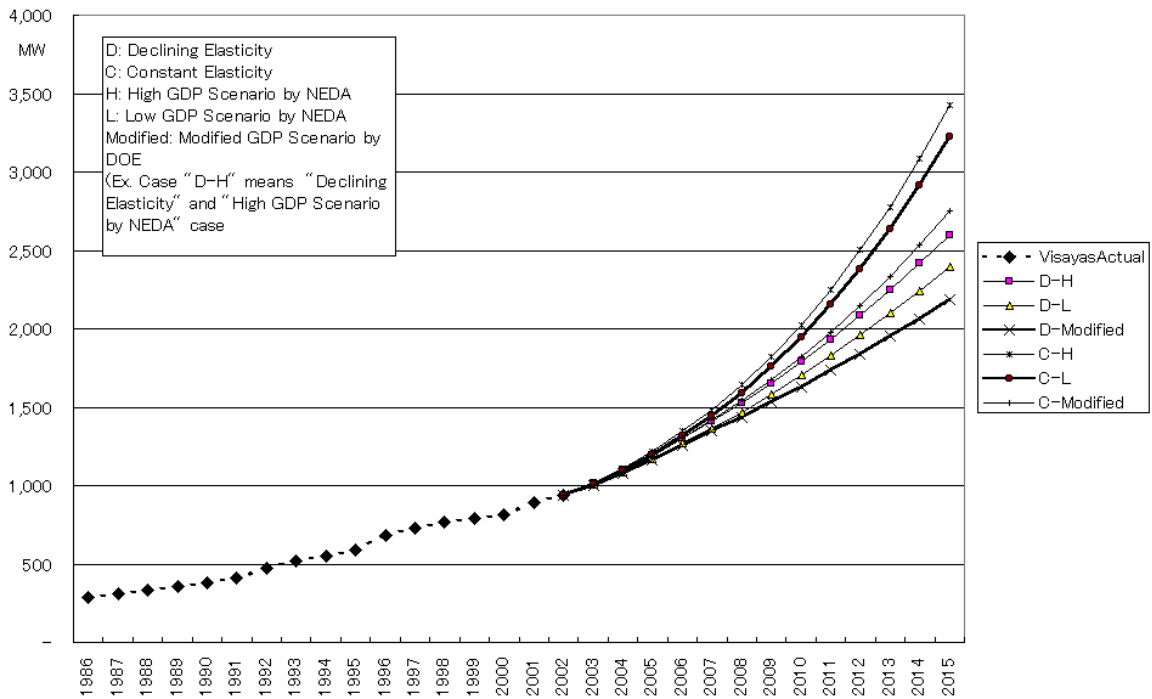


Fig. 5-2 Comparison with the historical growth curve

STEP 3: Checking by growth rate

Checking the growth rate with historical data is important in assessing the propriety of the results. These checks are usually examined in the demand forecasting process. The following figure is an example of this type of check in the forecasting works of PDP2004-2013.

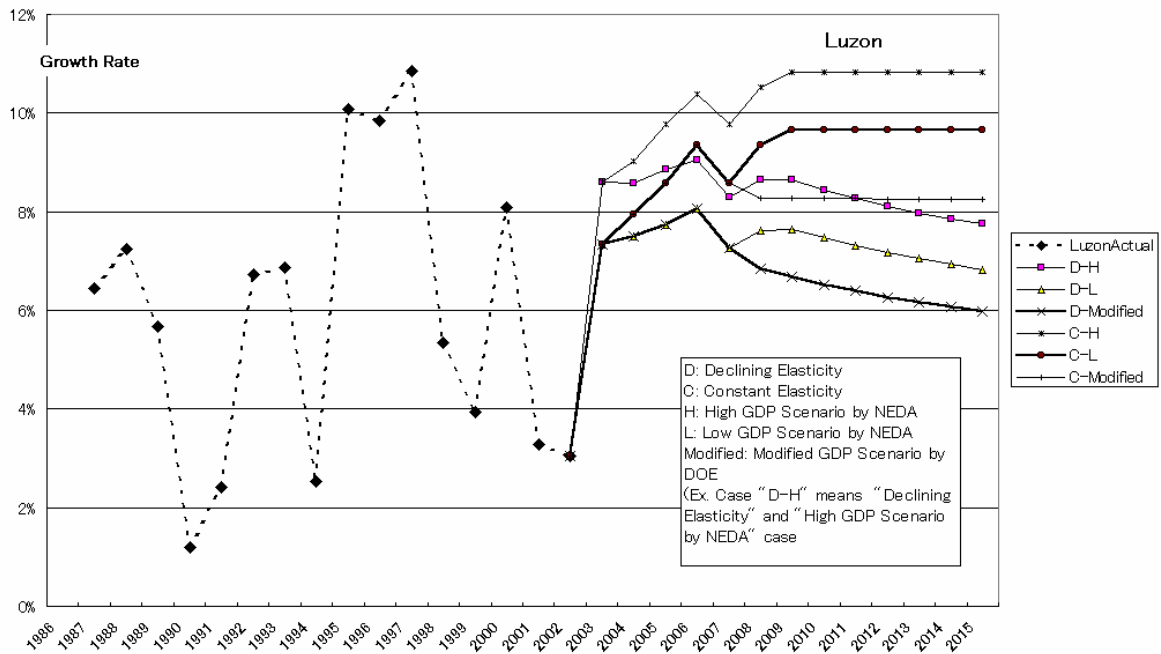


Fig. 5-3 Example of a graph showing growth rate trends

STEP 4: Checking by elasticity

In addition, with elasticity defined by the following formula, it is important to check the propriety of the results. Elasticity in the Philippines is declining. Forecasting results more strongly depends on how we estimate this trend in the future rather than GDP projection.

In addition, this graph visually shows the meaning of the difference in scenario from the viewpoint of elasticity.

$$\text{Elasticity} = \frac{\text{the growth rate of Demand}}{\text{the growth rate of GDP or GRDP}}$$

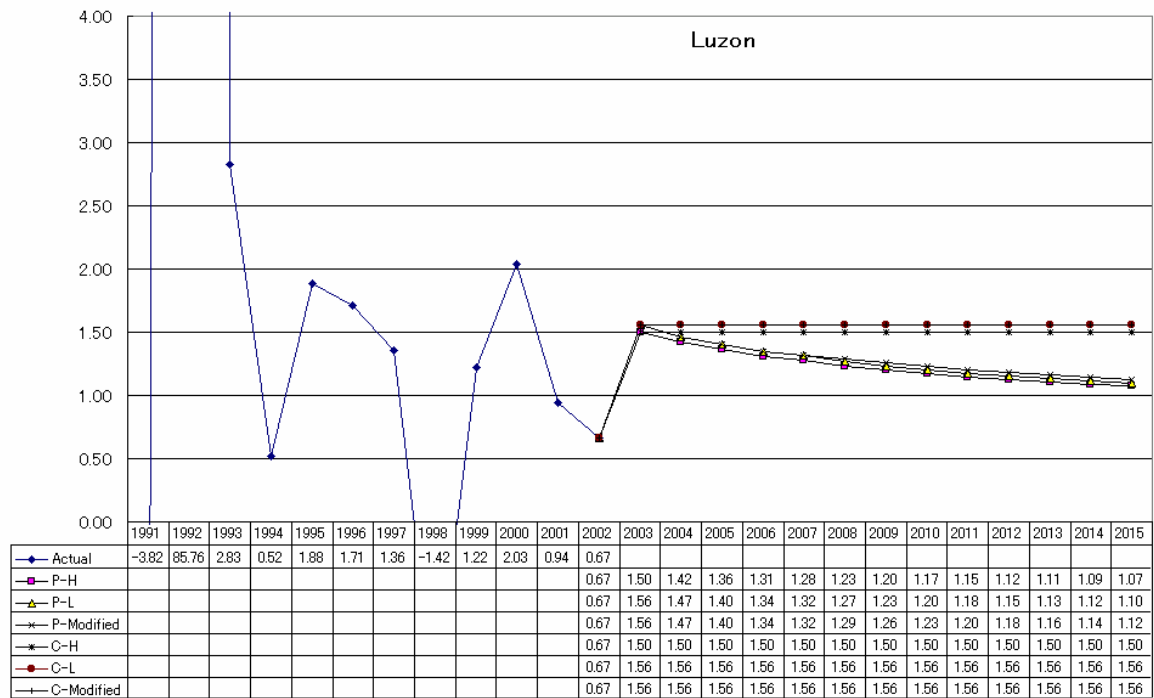


Fig. 5-4 Example of a graph showing elasticity trends

STEP5 Comparison with DDP Aggregation results

From PDP2005-2014, DOE aggregates demand forecasting results by distribution utilities beside of macro approach. Because the approach of DDP aggregation is different from macro approach, comparison between DDP aggregation and macro approach is needed for understanding difference of both future trends.

In PDP2005-2014, growth rate in DDP aggregation are averagely 2% lower, therefore forecasted demand in year 2014 are 20% difference between them.

To analyze such difference of the results and those reason, growth curve of each case and comparison of growth rate become very important.

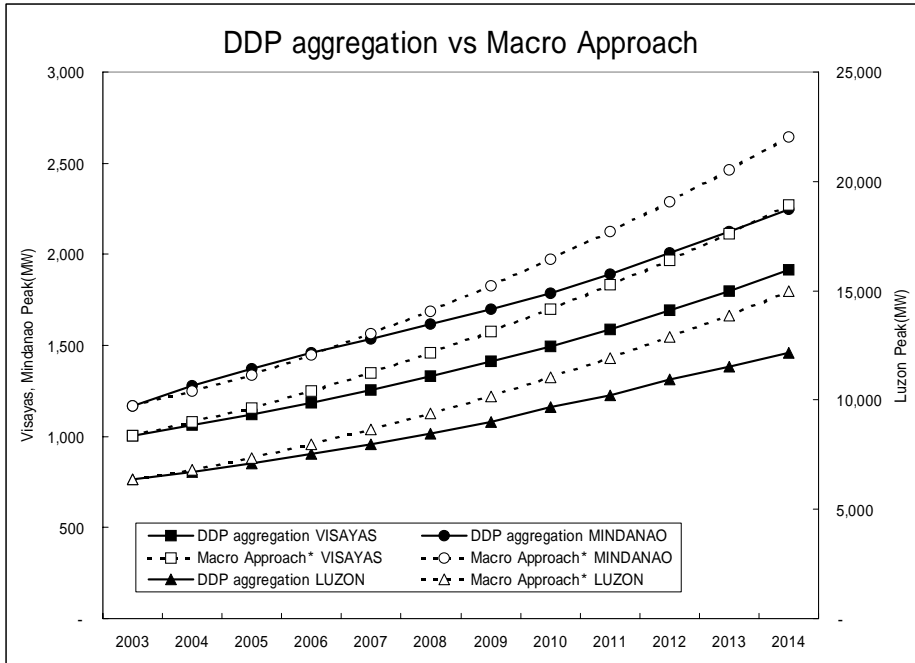


Fig. 5-5 Comparison of demand growth curve between DDP aggregation case and Macro Approach

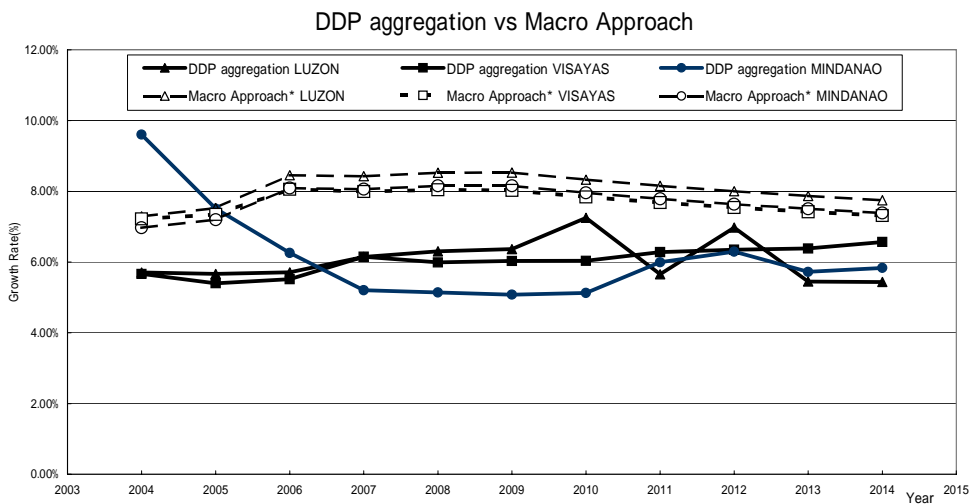


Fig. 5-6 Comparison of demand growth rate

6. Remarks

The process of demand forecasting in Year 2003 was carried out in the transient situation of the liberalization process. Historical data can be collected and measured in the traditional way. However, the data collection should be changed considering the status of liberalization in demand forecasting works after Year 2003.

The facilities in the power system have not changed since restructuring as shown in the following figure. This means that the terms of collected data after restructuring are the same as before restructuring.

However, real power flow among entities will be changed after restructuring of power sector market. Through comparison with the relations among entities based on real-time power transfer before and after restructuring, NPC, which is the entity most responsible for national planning in the power sector, is unbundled. Therefore, DOE must collect data by itself. Thus, DOE must approach these data on distribution by establishing a DDP data collection. This data collection structure was established through work for PDP2005-2014

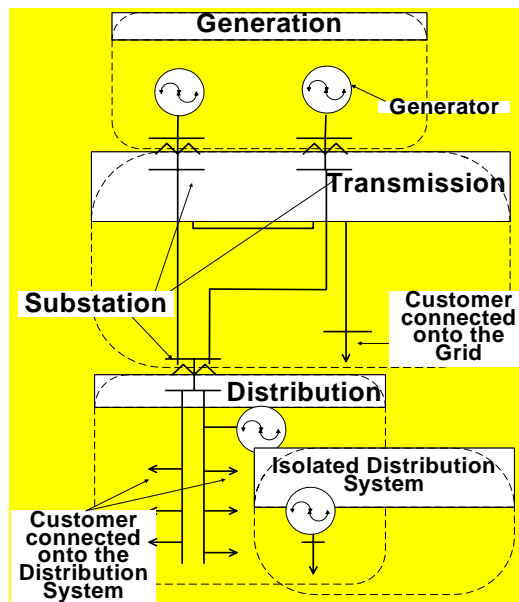


Fig. 6-1 Structure of facilities in the power system

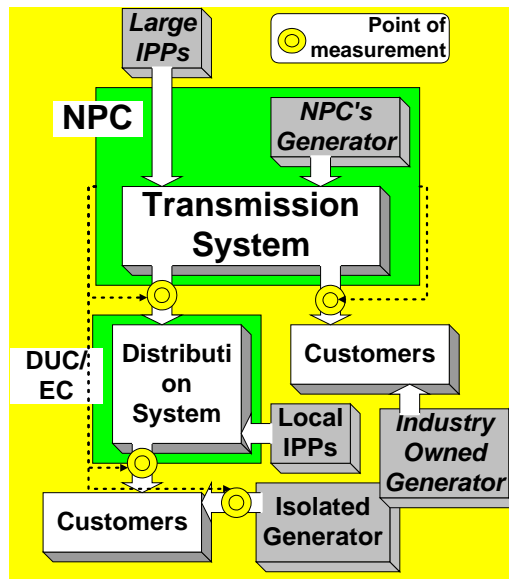


Fig. 6-2 Real power flow among entities before restructuring

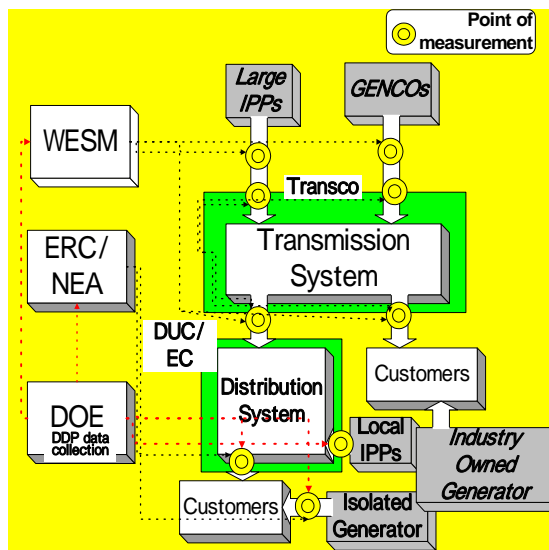


Fig. 6-3 Real power flow among entities after restructuring

It is difficult to collect data on the transmission level. From this year, historical direct sales data on the transmission system can be obtained from TRANSCO. After WESM starts, WESM will record settlement data, including actual bilateral transfers. Therefore, DOE should establish a data collection from WESM.

If WESM starts, some data should be collected through WESM. However, in Mindanao, because open market will not open soon, same kinds of data should be collected from system operator in Mindanao instead of WESM.

The data, which should be collect from WESM or system operator, are following.

- Total energy (MWh) transmitted on the transmission system
- Annual peak demand on transmission system
- Total loss on the transmission system
- Total sold energy (MWh) to customer which are not utilities

Using those data, Adjustment Factor (AF) and Load Factor (LF) in Macro approach should be updated.

In addition, TRANSCO will be only responsible to TRANSCO Peak demand. There is no guaranty to prepare System Peak data. Therefore, DOE also estimate system peak by adding embedded capacity supplying demand collected by DDP data collection.

In this year, DOE aggregated demand-forecasting results from utilities (DUs) based on peak demand (kW) forecasting. However, another approach can be considered. That is aggregation of sales energy (MWh). The process is following.

- Evaluating purchased and generated energy of each DUs including embedded generation
- Aggregating forecasting results of purchased and generated energy of DUs in target area
- Converting aggregated purchased and generated energy to system peak using AF and LF used in Macro approach
- Adjusting start point of demand growth using same method as Macro
-

Using this process, loss in distribution system and transmission system are considered automatically based on previous some years historical data.

Those data collection structure among organizations are shown block diagram on the next figure.

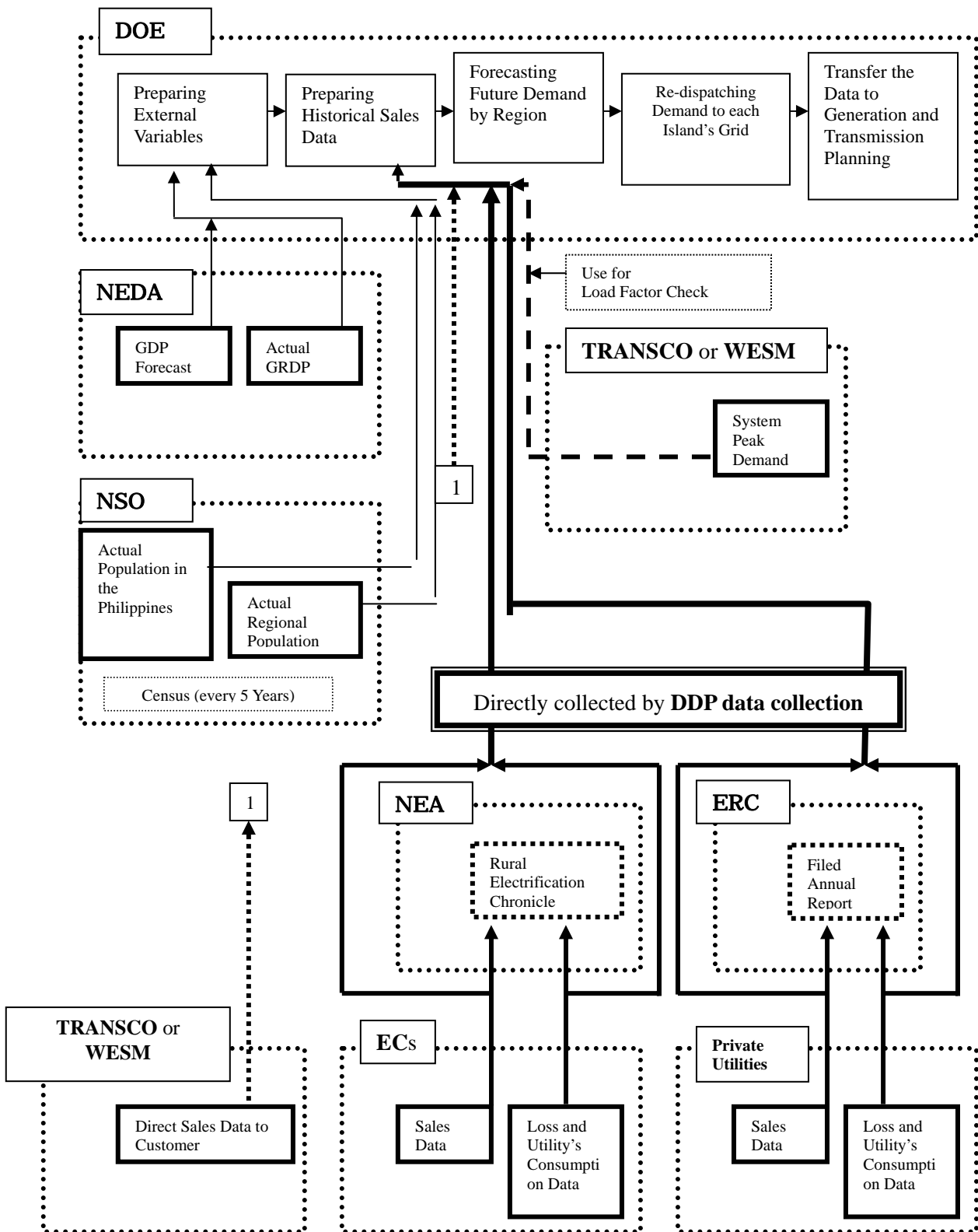


Fig. 6-4 Data flows among entities

7. Reference

7.1 Data Source

In the work for PDP 2004-2013, the following data sources were referenced.

Philippines Energy Plan 2002-2011 (DOE)
Philippines Energy Plan 2003-2012 (DOE)
National Year Book 2002 (NSO)
Statistics on GDP in 2002 (NSO)
Chronicle 2000 (NEA)
Chronicle 2003 (NEA)
Approved Summaries of sales data of PIOUs (DOE/ERC)
Annual Reports of PIOUs (DOE/ERC)
System and TRANSSCO Peak data (TRANSCO)
NPC's historical direct sales data (TRANSCO)
GDP projection (NEDA)

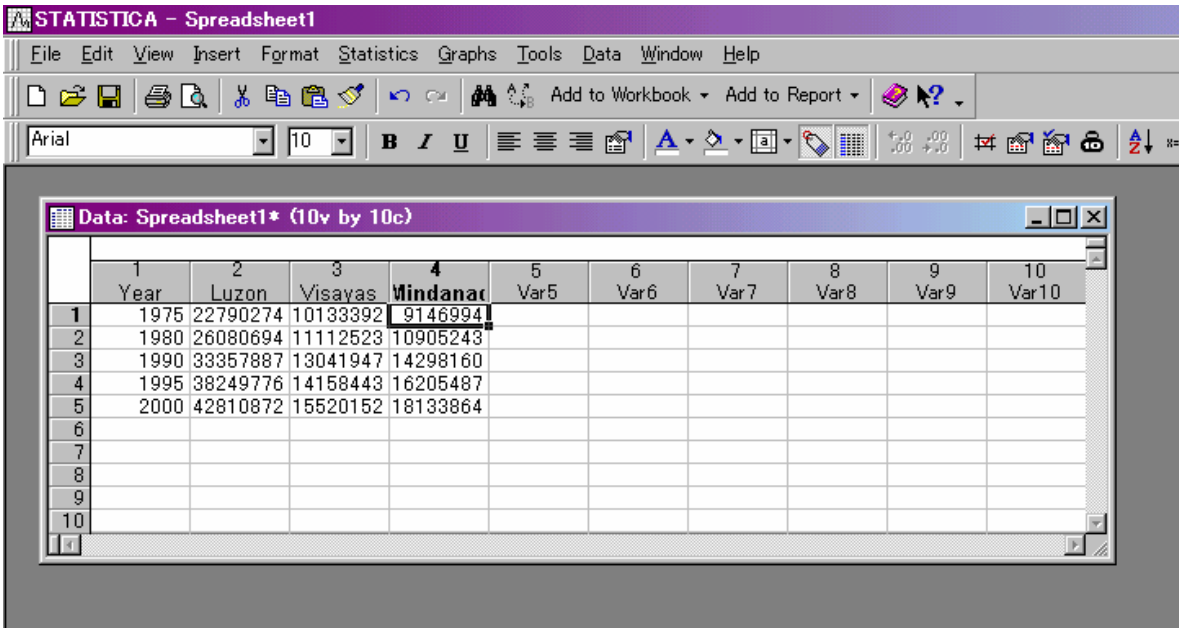
8. STATISTICA

8.1 Single regression

STEP 1: Open and prepare the spreadsheet

- 1) First, click the STATISTICA Icon and open a new spreadsheet.
- 2) Copy and paste each stream of data in the longitudinal direction on the spreadsheet.
- 3) Change the name from “Var#” to the discretional name of the data.

In the figure below, “Var1” was changed to “Year.” In addition, other columns have the names of areas. In those columns, actual population data associated with the year in the first column are input.



The screenshot shows the STATISTICA software interface with a spreadsheet titled "Data: Spreadsheet1* (10v by 10c)". The spreadsheet has 10 columns and 10 rows. The first column is labeled "Year" and contains the years 1975, 1980, 1990, 1995, and 2000. The next three columns are labeled "Luzon", "Visayas", and "Mindanac", representing population data for these regions. The remaining columns are labeled "Var5" through "Var10" and are currently empty. The cell containing the value 9146994 in the "Mindanac" column for the year 1975 is highlighted.

	1 Year	2 Luzon	3 Visayas	4 Mindanac	5 Var5	6 Var6	7 Var7	8 Var8	9 Var9	10 Var10
1	1975	22790274	10133392	9146994						
2	1980	26080694	11112523	10905243						
3	1990	33357887	13041947	14298160						
4	1995	38249776	14158443	16205487						
5	2000	42810872	15520152	18133864						
6										
7										
8										
9										
10										

Fig. 8-1 Data input on the spreadsheet

STEP2: Start of regression process

- 1) Pull down the “Statistics” menu
- 2) Click the “Multiple Regression” menu to open the “Multiple Linear Regression Spreadsheet2” menu.

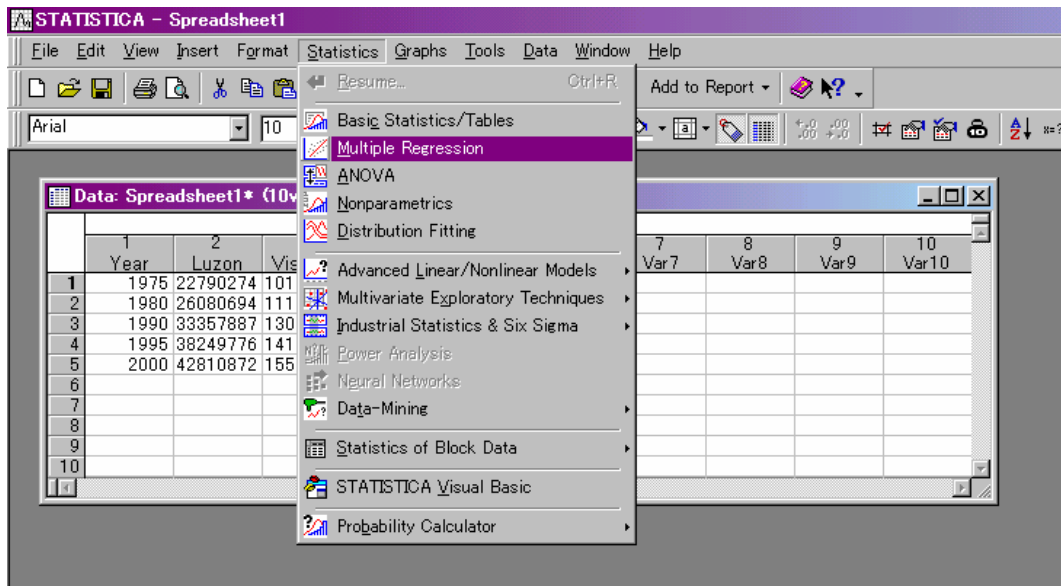


Fig. 8-2 Pull down menu of “Statistics” and the position of the “Multiple regression” menu

STEP3 :Identify target variable and explaining variable

1) Push the “Variables” button to open the menu to select variables on the “Multiple Linear Regression Spreadsheet2” menu.

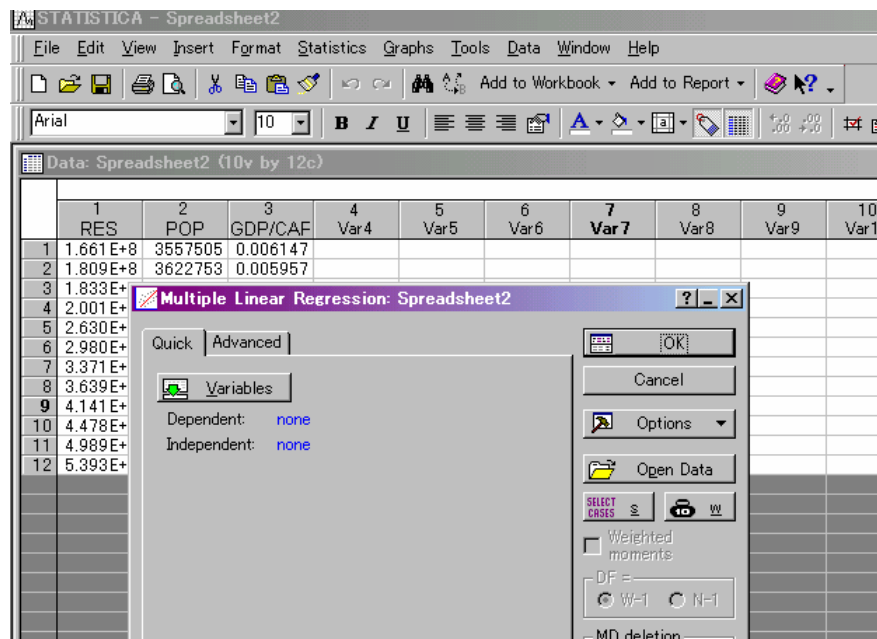


Fig. 8-3 “Multiple Linear Regression Spreadsheet2” Menu

STEP 4: Selection of variables

- 1) Select one of the variable-dependent variables as the target variable.
- 2) Select one of the variables as the independent variable, which is the explaining variable.
- 3) Then push “OK” button and return to the “Multiple regression spreadsheet2” menu.
* In the case of the figure below, the year is selected as an independent variable, and Luzon is selected as a dependent variable.

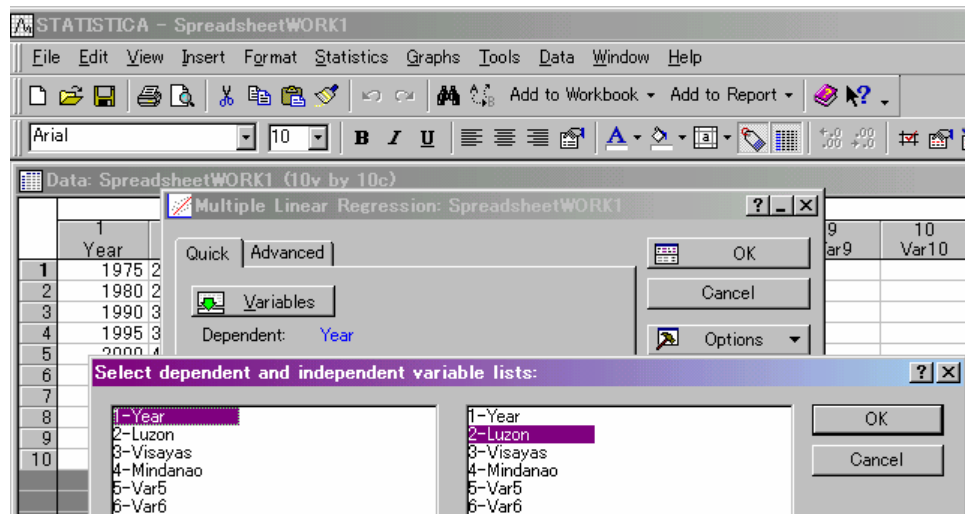


Fig. 8-4 Selection of variables

STEP5: Run regression

- 1) Click the “Run” button on the “Multiple regression Spreadsheet2” menu.
- 2) STATISTICA then opens the “Multiple regression results: Spreadsheet1” shown below.

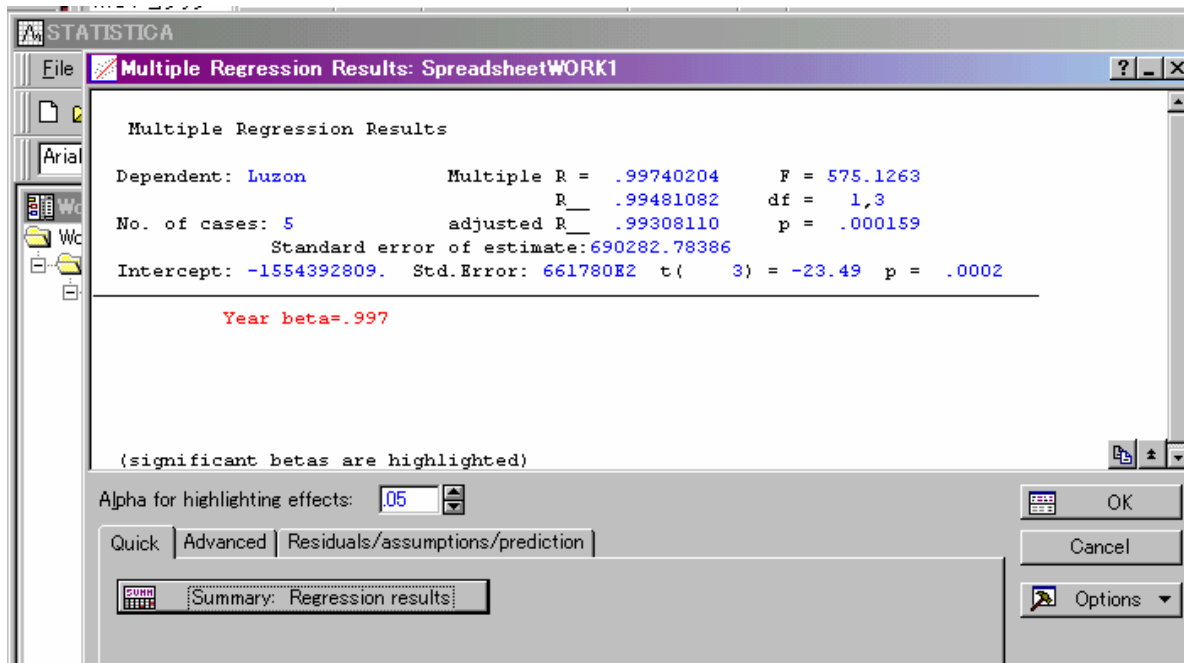


Fig. 8-5 “Multiple Regression Results: Spreadsheet1”

STEP6 :Open “Summary” and select the coefficient of the regressed formula

- 1) Push the “Summary: Regression results” button on the “Multiple regression results: Spreadsheet1” to open the “Regression Summary”
- 2) Select the coefficient from the spreadsheet shown below.

$$\text{Luzon Population} = a * \text{Year} + b$$

$$a: \text{Column “B” and row “Luzon”} = 7.9831\text{E}+5$$

$$b: \text{Column “B” and “Intercept”} = -55439.3 \text{ E}+9$$

In this case, $R=0.997402$ and $R^2=.99481082$. This means this regression model will experience the dependent variable, “Luzon population,” by the independent variables “Year.”

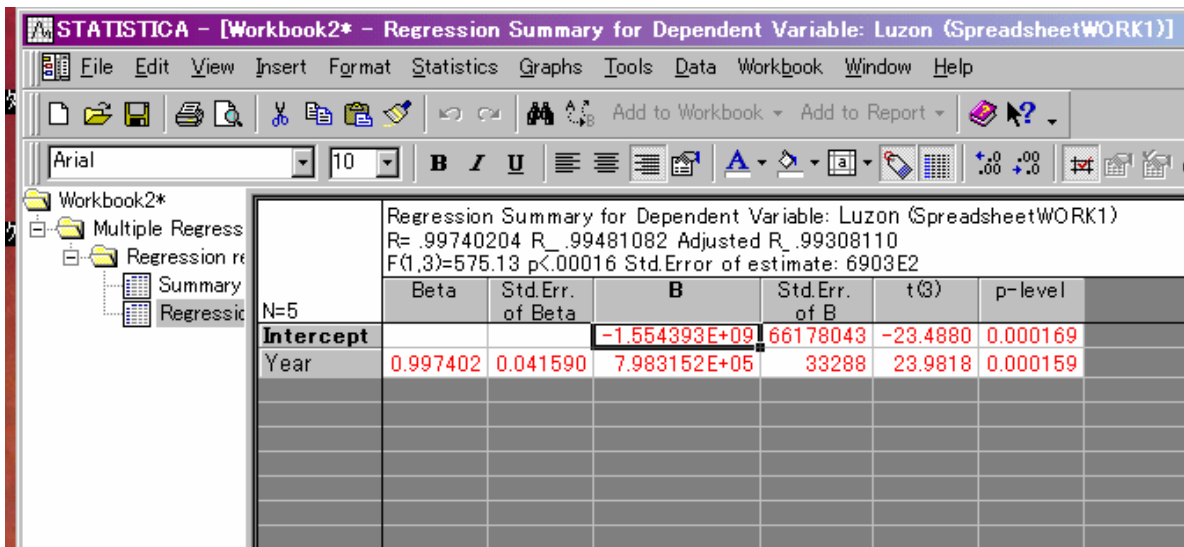


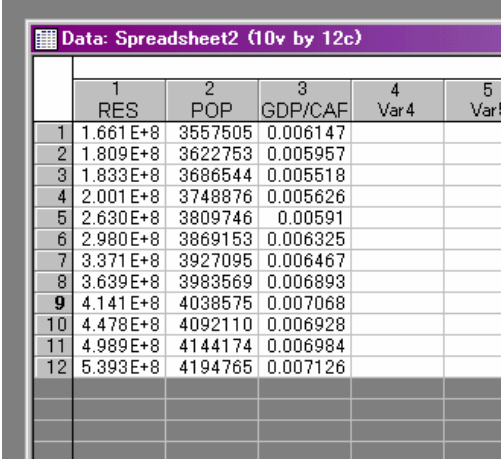
Fig. 8-6 “Regression Summary for Dependent Variables” spreadsheet

8.2 Multiple regression by STATISTICA

STEP 1: Open and prepare the spreadsheet

- 1) First, click the STATISTICA icon and open a new spreadsheet.
- 2) Copy and paste each stream of data in the longitudinal direction on the spreadsheet.
- 3) Change the name from “Var#” to the discretionary name of the data,

These processes are the same as in the case of single regression. In the case of the figure below, “Var1” was changed to “RES,” which means “Residential consumption.” The second “POP” means population, and the third means GDP/Capita. In those columns, each data item in the same row are data of the same year.



	1 RES	2 POP	3 GDP/CAF	4 Var4	5 Var5
1	1.661E+8	3557505	0.006147		
2	1.809E+8	3622753	0.005957		
3	1.833E+8	3686544	0.005518		
4	2.001E+8	3748876	0.005626		
5	2.630E+8	3809746	0.00591		
6	2.980E+8	3869153	0.006325		
7	3.371E+8	3927095	0.006467		
8	3.639E+8	3983569	0.006893		
9	4.141E+8	4038575	0.007068		
10	4.478E+8	4092110	0.006928		
11	4.989E+8	4144174	0.006984		
12	5.393E+8	4194765	0.007126		

Fig. 8-7 Data input on the spreadsheet

STEP 2: Starting the regression process

- 1) Pull down the “Statistics” menu.
- 2) Click the “Multiple Regression” menu to open the “Multiple Linear Regression Spreadsheet2” menu.

These processes are same as in the case of single regression.

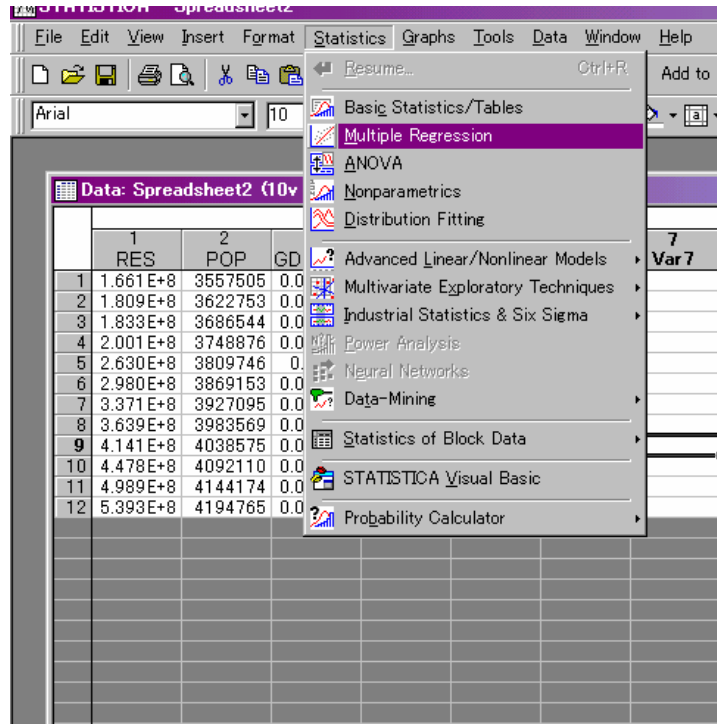


Fig. 8-8 Pull down the “Statistics” menu and position the “Multiple regression” menu

STEP 3: Identify the target variable and the explaining variable

- 1) Push the “Variables” button to open menu for selecting variables in the “Multiple Linear Regression Spreadsheet2” menu.

This process is the same as in the case of single regression .

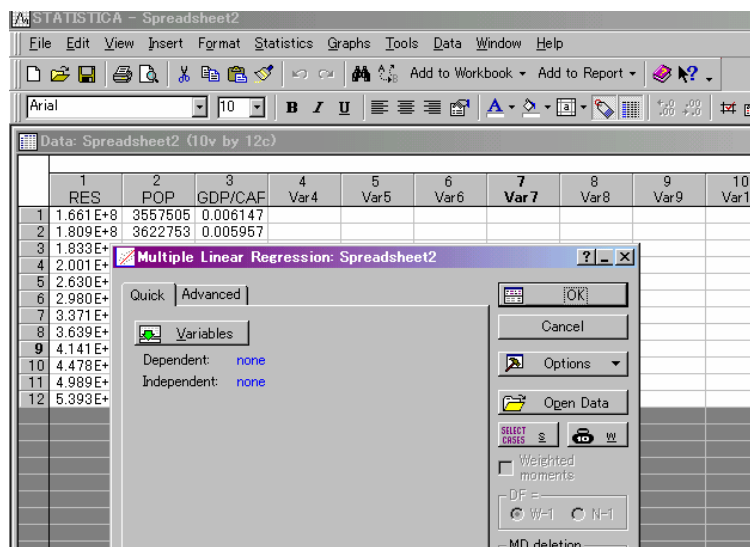


Fig. 8-9 “Multiple Linear Regression Spreadsheet2” Menu

STEP 4: Selection of variables

- 1) Select one of the variables as the dependent variable, which is the target variable
- 2) Select two of the variables as independent variables, which are explaining variables
- 3) Then push the “OK” button and return to the “Multiple regression spreadsheet2” menu.
* In the case of the figure below, RES is selected as a dependent variable, and POP and GDP/Cap are selected as independent variables.

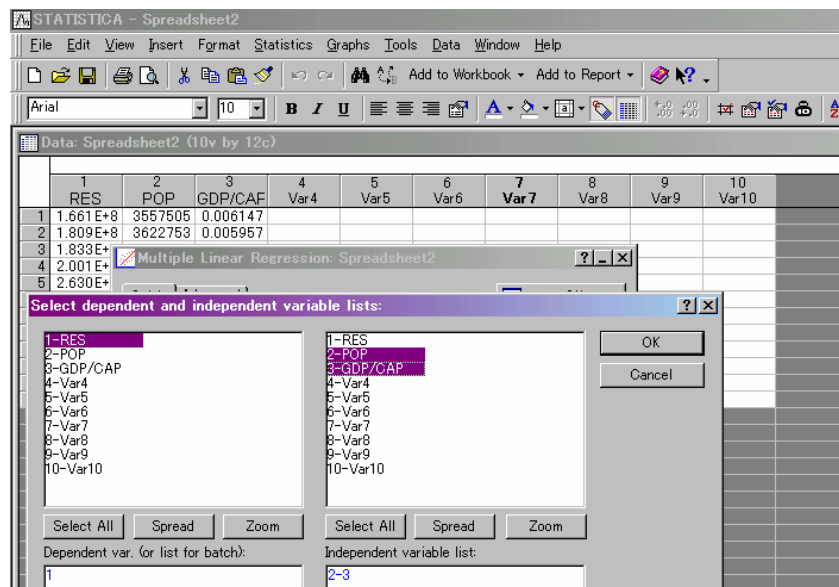


Fig. 8-10 Selection of variables

STEP5 :Run regression

- 1) Click the “Run” button on the “Multiple regression Spread sheet2” menu.
- 2) Then STATISTICA opens the “Multiple regression results: Spreadsheet1” shown below.

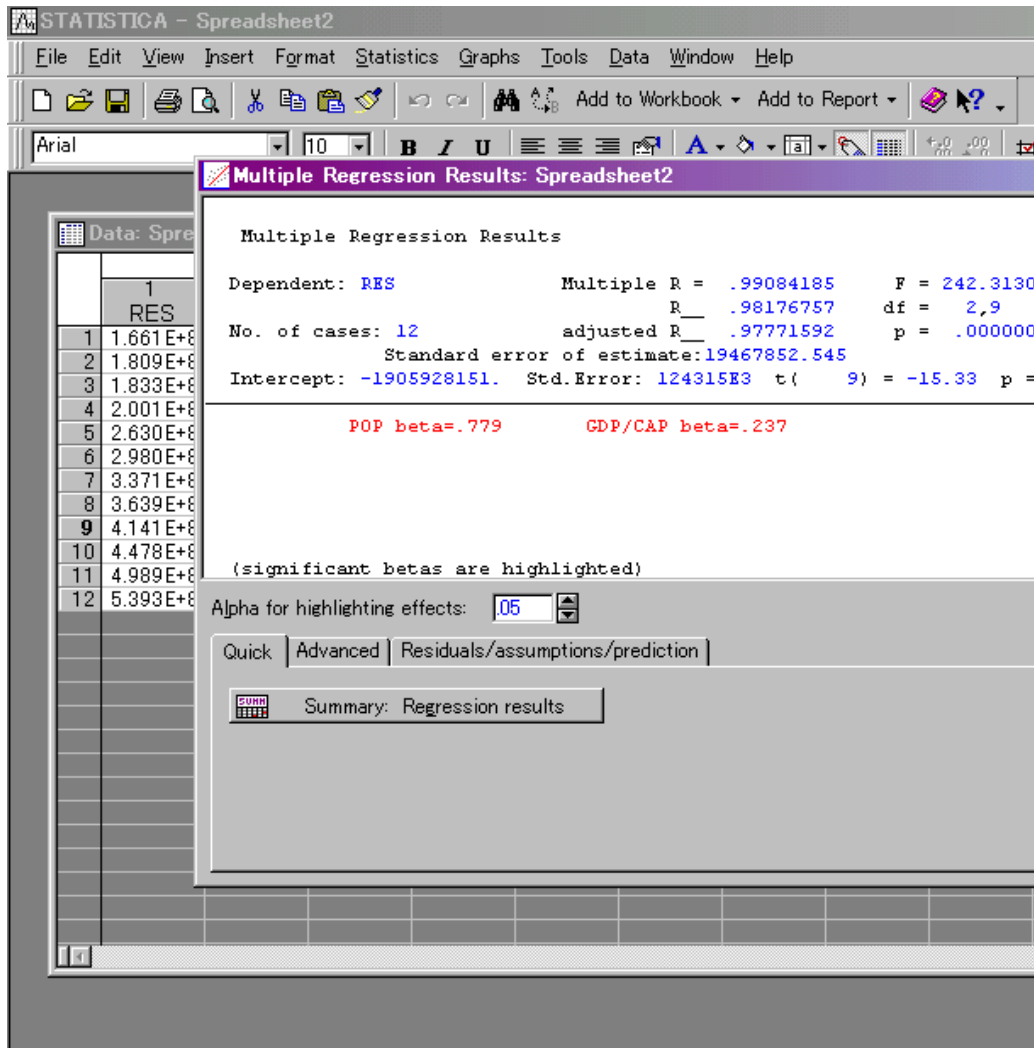


Fig. 8-11 “Multiple Regression Results: Spreadsheet1”

STEP 6: Open “Summary” and select the coefficient of the regressed formula

- 1) Push the “Summary: Regression results” button on the “Multiple regression results: Spreadsheet1” to open the “Regression Summary.”
- 2) Select the coefficient from the spreadsheet below.

$$\text{RES (residential consumption)} = a * \text{POP (Population)} + b * \text{GDP/Cap (GDP/Capita)} + c$$

$$a: \text{Column “B” and row “POP”} = 4.857272 \text{ E}+2$$

$$b: \text{Column “B” and “GDP/Cap”} = 5.3182866 \text{ E}+10$$

c: Column “B” and “Intercept” = -1.905928 E+8

In this case, $R=0.997402$ and $R^2=.98176757$. This means that this regression model will experience the dependent variable “Luzon population” by the independent variables “Year.”

STATISTICA - Workbook2* - [Regression Summary for Dependent Variable: RES (Spreadsheet2)]

File Edit View Insert Format Statistics Graphs Tools Data Workbook Window Help

Regression Summary for Dependent Variable: RES (Spreadsheet2)
 $R = .99084185$ $R^2 = .98176757$ Adjusted $R^2 = .97771592$
 $F(2,9) = 242.31$ $p < .00000$ Std. Error of estimate: $1947E4$

	Beta	Std. Err. of Beta	B	Std. Err. of B	t(9)	p-level
N=12						
Intercept			-1.905928E+09	1.243150E+08	-15.3314	0.00000
POP	0.778595	0.089568	4.857272E+02	5.587705E+01	8.6928	0.00000
GDP/CAP	0.237174	0.089568	5.318286E+10	2.008434E+10	2.6480	0.02650

Fig. 8-12 “Regression Summary for Dependent Variables” spreadsheet



Manual
for
the Power Development Plan
Preparation
(Power Supply Plan)

Section 3 Power Supply Plan

1. Outline of this Section

1.1 Scope

This manual describes how to prepare the power supply plan as a part of the power development program. Here, the power development program (hereinafter referred to as the PDP) includes demand forecasting, the power supply plan and the transmission development plan.

1.2 Contents

This manual consists of the following:

- Methodology of Data Collection
- Preparation of the Power Supply Plan
- Coordination with the Transmission Development Plan
- Checklist
- List of Technical Documents

1.3 Simulation Software

The following simulation software is used for the preparation of the power supply plan.

- WASP-IV (Ver . 4.01)
 - : To prepare the least cost power development plan
- The GTMax (Ver. 4.0)
 - : To solve the optimal siting of power sources and interconnection issues

DOE has official licenses of this software. Since the license belongs to the (power supply bureau), the license registration form is kept there.

The latest version of WASP-IV can be obtained from IAEA. IAEA may send the latest version of the WASP-IV if it is upgraded.

Regarding the GTMax, the DOE has a perpetual license only for the version 4.0. However the DOE also can have the latest version in the special discount. Please contact to the Adica Consulting.

Since these software have complete manuals, the handlings of the software is not described in this manual. Please refer the manuals to understand the software methodology.

1.4 Overall Workflow

Figure 1.1 shows the workflow diagram of PDP. Receipt of the forecasted demand is considered a critical point in the schedule. Therefore, the data update of the simulation software should be conducted in advance, and the adjustment work with TDP should be conducted efficiently.

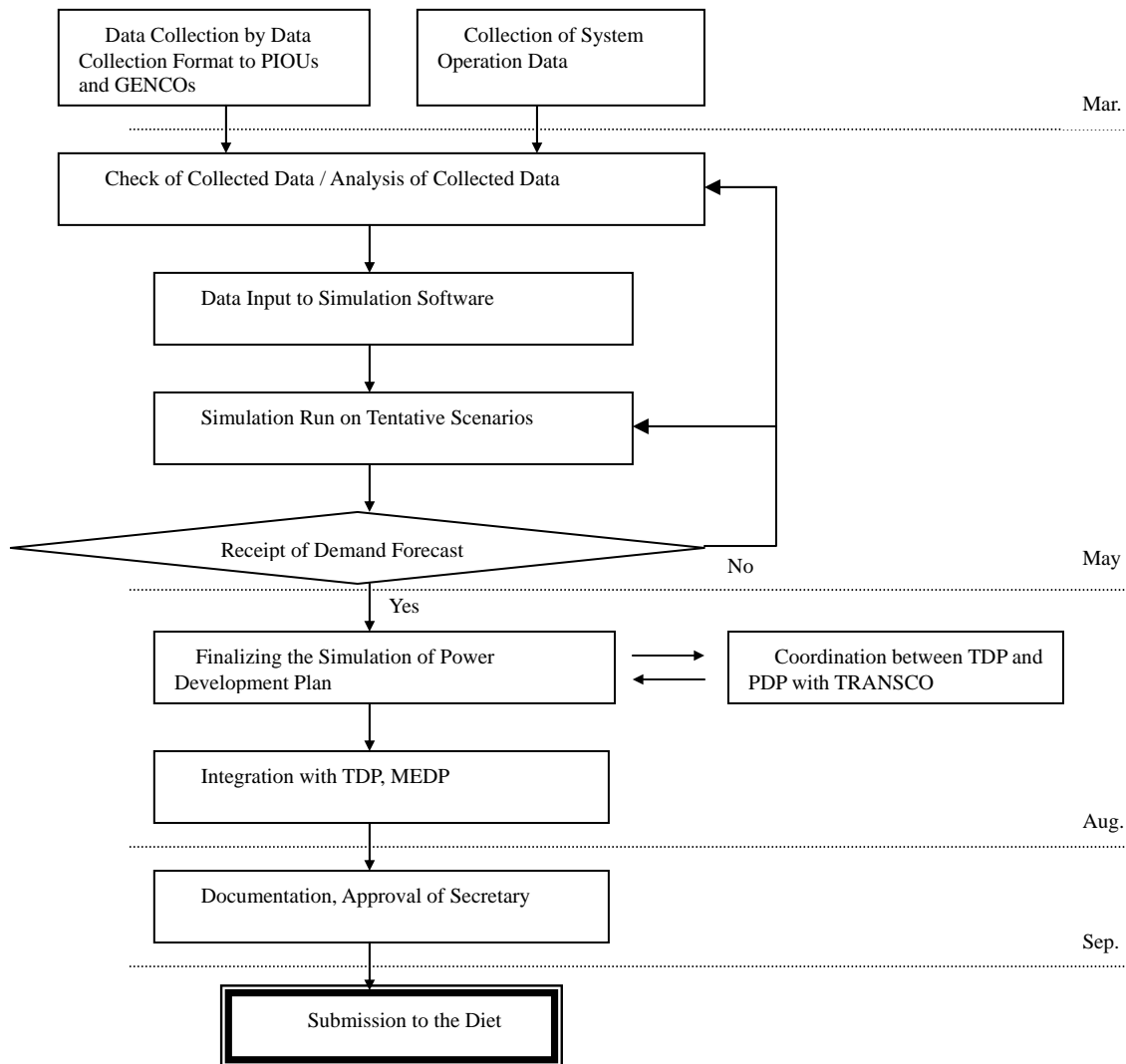
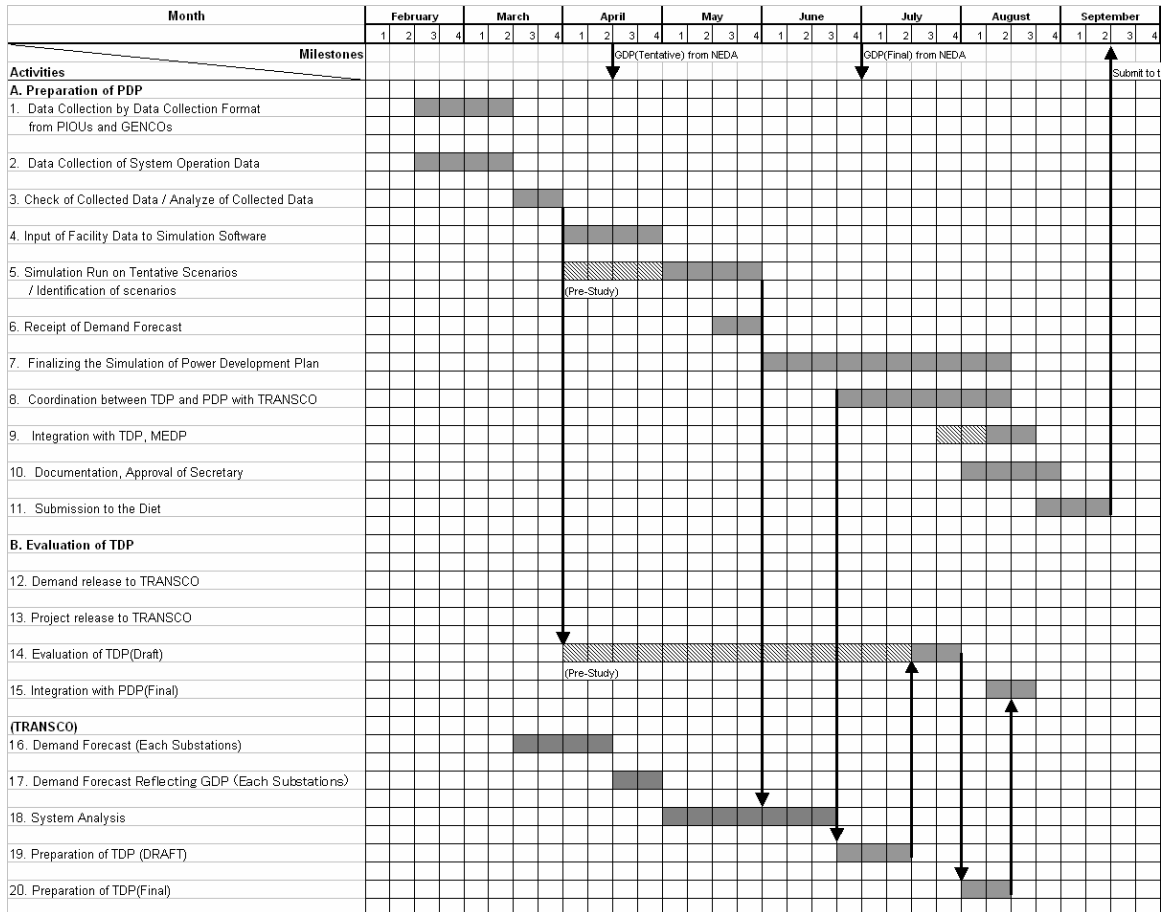


Fig. 1.1 Workflow of PDP

Table 1.1 shows the timetable of PDP

Table 1.1 Overall Schedule for PDP



The following is a brief explanation of the items to be conducted. Refer to the latter section for tips.

(1) Data Collection by Data Collection Format to PIOUs and GENCOs

Data collection from GENCOs, etc. should be conducted by using the special format. Please refer to Chapter 2, Data Gathering.

(2) Collection of System Operation Data

Please refer to Chapter 2, Data Gathering.

(3) Checking Collected Data / Analyzing Collected Data

Before inputting the collected data, it is better to compare the collected data with the previous data. In addition, certain data should be arranged. Please refer Chapter 3, WASP-IV Tips.

(4) Data Input to Simulation Software

Data should be input to WASP-VI and the GTMax. Please see the tips on data input and operation in Chapter 3, WASP-IV Tips.

(5) Simulation Run on Tentative Scenarios

If the GDP growth forecast is delayed, the demand forecast may also be delayed. Therefore, a tentative simulation should be conducted to confirm the input data. In addition, a sensitive study should be conducted to determine policy.

(6) Receipt of Demand Forecast

Demand forecasting is not part of the power supply plan. However, the demand forecast is the most important milestone. Therefore, it is necessary to pay attention to the prospective schedule of the demand forecasting.

(7) Finalizing the power supply plan

The power supply plan is finalized based on the demand forecast. The scenarios are determined tentatively before being studied at length.

(8) Coordination between TDP and PDP with TRANSCO

Coordination work will be conducted by providing the information of indicative plants to TRANSCO. The interconnection issues will be studied at length.

(9) Integration of TDP and MEDP with PDP

Integration will be conducted with TDP and MEDP. The contents to be described in PDP should be confirmed for TDP. The equipment not connected with the national grid is described for MEDP. Simulation software is not used here.

(10) Documentation, Approval of the Secretary

Documentation of PDP will be conducted effectively at the same time as the simulation is running. Approval of the secretary is received, if necessary. The necessary information will be submitted for adjustment with PEP.

(11) Submission to the Diet

Pursuant to EPIRA, PDP will be prepared and submitted to the diet by September 15th.

2 Data gathering

2.1 Necessary Data

Table 2.1 shows the necessary data for the WASP-IV and the GTMax. Most of the data can be used as common data.

Table 2.1 necessary data for the PDP simulation

Data Name	Contact	Remarks
Load Shape	System Operator - Luzon - Visayas - Mindanao	Data should be collected from the system operator directly by area.
System Operation Report	System Operator	Used to confirm the results of simulation
System Maintenance Plan	System Operator	Used to confirm the results of simulation
GDP forecast	NEDA	
Discount Rate	NEDA	
Generation Data for Existing Plants	NPC PIOUs GENCOs	By using the attached questionnaire
Generation Data for Indicative Plants	Historical Data General Documents	Historical Construction Cost Technical sheet such as Gas turbine world
Fuel Cost	NPC PIOUs GENCOs	- Results of open bidding can be available for coal or oil - DOE has to preserve the confidentiality of proprietary or commercially sensitive information
Schedule of Committed Projects	Related Organizations	
Transmission Development Plan	TRANSCO	As an initial plan

2.2 EPIRA Regulations

The following is a description for data gathering in EPIRA. DOE can order the submission of necessary data to companies, paying attention to confidentiality, etc.

< EPIRA Regulations >

A Generation Company shall submit to DOE any information as may be required by the DOE for the preparation of the PDP, subject to appropriate measures to preserve the confidentiality of proprietary or commercially sensitive information.

2.3 Data Gathering

2.3.1 Generation facility data

The data gathering must be conducted as shown in Fig. 2.3.1.

The questionnaire attached at the end of this manual should be used for data gathering of existing facilities. Data for ongoing projects can be also collected by using the same questionnaire.

Regarding the regional demand – supply plan, DDP should be used as a data-gathering tool.

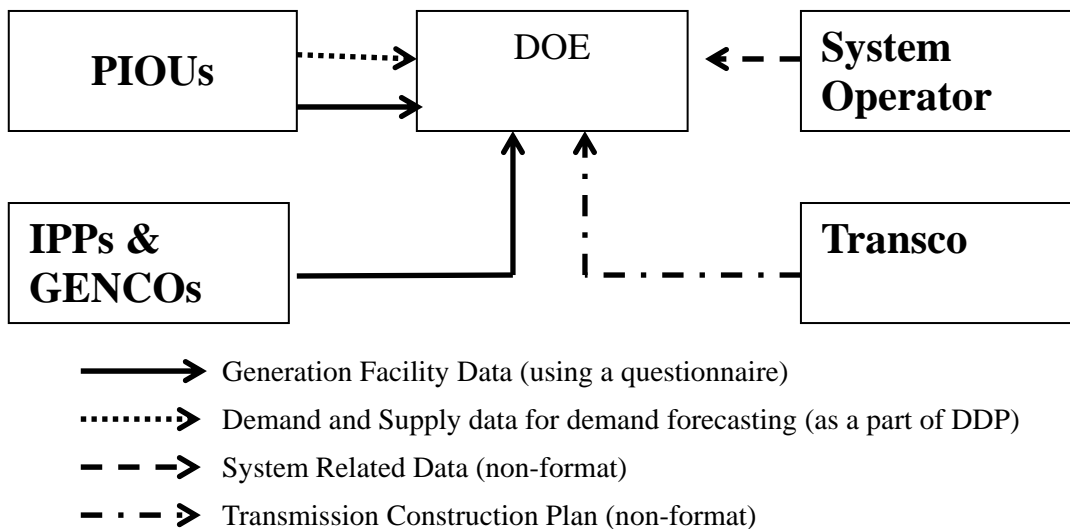


Fig. 2.3.1 Data Gathering system

2.3.2 System-Related Data

System operation data is very useful for evaluating simulation results. This is released by the system operator in March. Forced outage rates and other data are given in the report. The system maintenance plan is also released in March. By using the above documents, the actual condition of the existing facility can be obtained.

Although the short-term power supply plan is different from the long-term power supply plan, the data is useful. Therefore, the short-term supply plan prepared by the system operator should also be collected.

The load shape does not need to be replaced every year. If DOE wants to replace it, it can be received from regional system operator.

2.3.3 Data for Indicative Plants

a. Construction Cost

“Gas Turbine World” is available to determine the construction cost for gas turbine and combined cycle power plants. Since the figures given in “Gas Turbine World” is not included civil work, transmission connection cost or fuel facilities, adjustment is required. The adjustment should be conducted by using historical data or using the following equation.

Total investment = Facility Cost (based on the gas turbine world) x 130%
*30% is for the “complementally investment” based on the
experience of the JICA study team.

Historical data should be applied to determine coal-fired power plants. Historical data can be obtained from the website or from IPPs. The data may not be confidential because capital and assets are given in the annual report. Inflation should be considered. The actual inflation data can be obtained from the governmental website of the National Statistics Office in the Philippines.

b. Fuel Price

NPC can submit coal price and oil price. The information is not confidential because they procure their fuel by open bidding.

DOE has to collect gas price from NPC and MELALCO. Since the data is confidential, measures to preserve confidentiality should be taken.

c. Unit Performance Data

The questionnaire described before is used to collect performance data. Since sensitive data as well as fuel cost is collected, necessary measures to preserve confidentiality should be taken.

2.3.4 Common Data

The discount rate should be replaced if NEDA changes the standard. GDP is also released by NEDA in June.

3. Preparation of the Power Supply Plan

3.1. Preparation Flow

Figure 3.1 shows the preparation workflow for simulation.

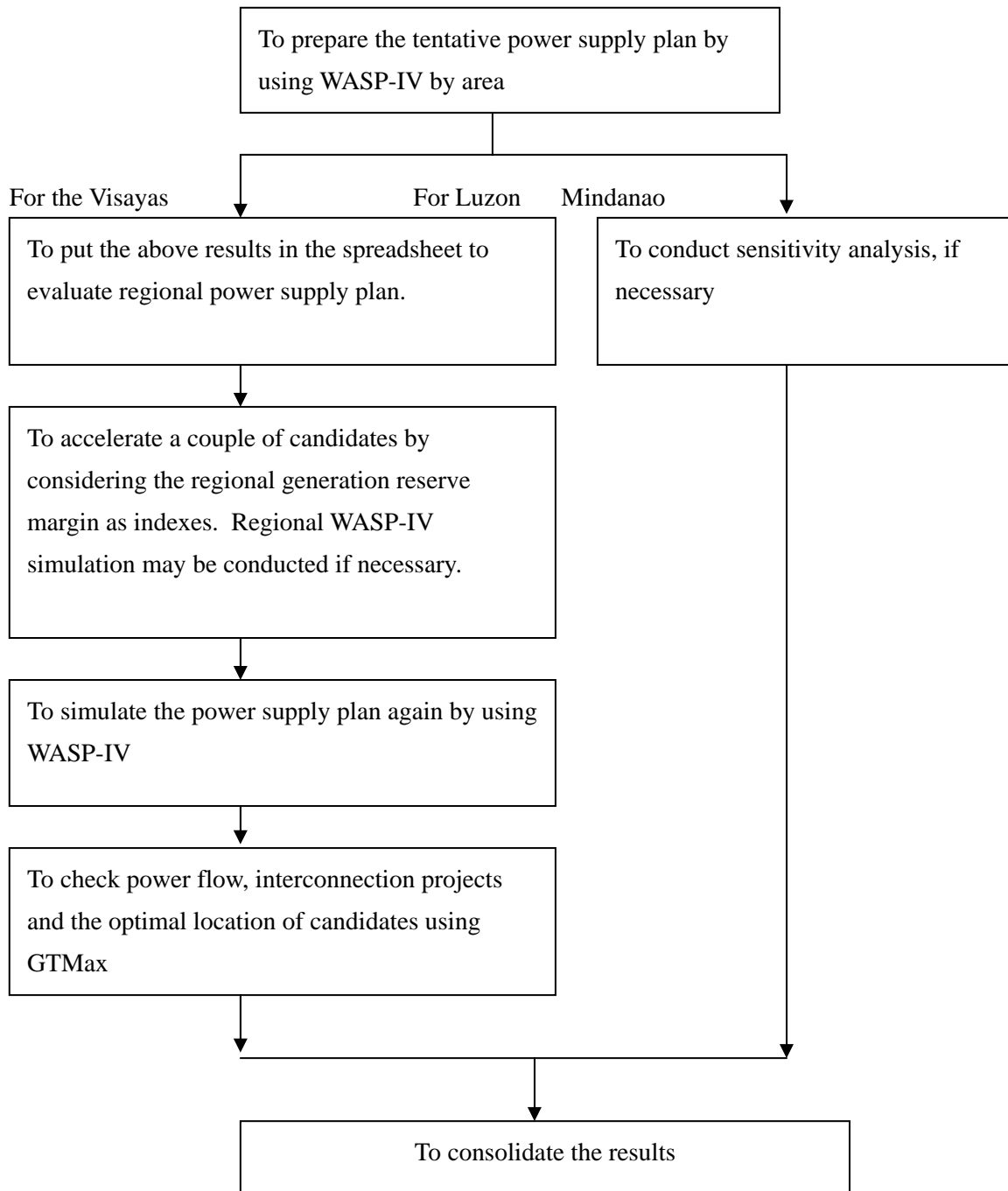


Fig. 3.1 Workflow for Simulation

3.2 WASP-IV calculation

3.2.1 Folder Structure of the WASP-IV

Consider Study ID and Case ID. These data are given as the following folders.

```
Study ID = 1 ----->  WASP-IV\Study_01
Case ID  = 1 ----->  WASP-IV\Study_01\Case_01
Case ID  = 2 ----->  WASP-IV\Study_01\Case_02
```

The information of the folders is given in the file of

```
----->  WASP-IV\system\BasicInfo.DAT
```

3.2.2 Data folder of WASP-IV

The WASP-IV data are so small that they can be sent by e-mail .

The following are the necessary files to be sent:

```
CCD.DAT          --- for common data
loadsy.dat       --- for loadsy module data
fixsys.dat       --- for fixsys module data
VARSYS.dat       --- for varsys module data
congen.dat       --- for congen module data
mersim.DAT       --- for mersim module data
mergeibin.dat    --- for mersim module data
DYNPRO.dat       --- for dynamic module data
remersim.SAV     --- for remersis module data
reprobat.dat     --- for reprobat module data
```

Unfortunately, the following files cannot be copied automatically when anew case is created by copying the old case. Therefore, they have to be copied manually.

```
*remersim.SAV    --- for remersis module data
*reprobat.dat     --- for reprobat module data
```

3.2.3 TIPS for operation

Data update of the WASP-VI should be conducted first. Most of the collected data can be used directly to the WASP-IV. Please check the manual of WASP-IV first. The following are remarks for the data input by module.

a. COMMON

The first problem you meet maybe caused by a change of calculation year. If you change the first year of study, all the data of first year will be deleted. As a result, there may be problems with FIXSYS, VARSYS and REPROBAT. Specifically, if you change the first year from 2003 to 2004, change the following:

Problem 1: Schedule of committed projects and retirement

The schedule of committed projects and retirement in FIXSYS may include some important information in the first year. For example, the constraints of transmission lines are described by deducting the number of power plants as retirement plants. This information is all deleted. In this case, check if the number of retirement units does not exceed the current number.

Problem 2: Mismatch of the calculation period

The calculation period or calculation year must be described separately from the common module in DYNPRO and REPROBAT.

This needs to be checked if there are problems with this module after changing the calculation period.

b. LOADSY

Forecasted demand should be input in LOADSY. Since calculation is conducted for 15 years, some data should be arranged. (The calculation period may need to be extended.)

A coincident peak should be prepared for VISAYAS demand. Of course, it is possible to use the non-coincident peak when the regional, island power development plan is calculated. In this case, pay attention to the energy. When you use the non-coincident peak for the simulation, calculated energy becomes greater than the necessary energy.

After running the LOADSY, it is necessary to at least check the load factor.

c. FIXSYS

Almost all collected data can be input to the WASP-IV directly except for incremental heat rate. This is calculated by the following equation.

Incremental Heat Rate

$$\begin{aligned} &= \quad [(\text{Maximum Output}) \times (\text{Heat Rate at Maximum Output}) \\ &\quad - (\text{Minimum Output}) \times (\text{Heat Rate at Minimum Output})] \\ &\quad / (\text{Maximum Output} - \text{Minimum Output}) \end{aligned}$$

If the minimum output data are not available, you can assume it to be 40% of the maximum output. Since WASP-IV calculates the optimal operation in the duration method, data at minimum output does not greatly affect the results. However, it is necessary to pay attention to the data at maximum output. Shutdown and startup loss should be included in the heat rate. The simplest way to consider the above is to use the actual heat rate as the heat rate at maximum output.

It is necessary to pay attention to periods when you input the data. Since the WASP-IV has a Fortran-based future, almost all data should be input with a “period.” In some cases, WASP-IV makes an error in the data read if you forget the “period.” as follows.

Example: “300” means “0.300”; it is necessary to input it as “300.” with a period

However, forced “outage rate” and “maintenance day” should be input in integers.

d. VARSYS

The same as with FIXSYS, almost all collected data can be input to WASP-IV directly. If the design data is not available, the data of the latest unit should be applied.

Before inputting the data, drawing to the screening curve is strongly recommended. Please see the WASP-IV manual.

e. CONGEN

It is necessary to determine the initial configuration. The easiest way to determine the initial configuration is to solve the fix expansion plan first. After solving this, you can move to the optimal expansion plan. Once you move to the optimal expansion plan, you cannot go back to the fix expansion plan. You may be in trouble that all tunnel width data is deleted and it is necessary to initialize the configuration again.

It is also necessary to consider the maximum number of configurations. Many configuration courses take a lot of calculation time. The maximum number of configurations is 500 for a year and 5000 in total.

Special Remarks / Tips

There may sometimes be problems with index errors. The following are considered to be the reasons:

Reason 1.

A mismatch of data among LOADSY, FIXSYS, VARSYS and temporary files stored.

(Solution)

Clear the old simulation file by using the common module. Then simulate LOADS, FIXSYS and VARSYS again.

Reason 2.

A data mismatch of temporary files between CONGEN and DYMPRO. Some data, such as the previous best solution, is sent from DYMPRO to CONGEN as the index. Therefore, DYMPRO should be completed before opening the CONGEN except for initial run. If the MERSIM is complete and DYMPRO results in fault, you cannot open the CONGEN again.

(Solution)

Most of these cases are caused by configuration in CONGEN. It may occur in the configuration that the generation reserve is OK but LOLP is not satisfied. Therefore, change (delete) the LOLP index in DYNPRO and run DYNPRO again. After this, you can open CONGEN.

f. MERSYM

You can simulate using MERSYM easily. The point of MERSYM is to evaluate the simulation results. Initially, it is necessary to check the loading order of the power sources. You can check the operation situation of every year in the output files. Some temporary files are arranged and integrated at the running of REPROBAT. Therefore, in order to check the capacity factor of each power source, REPROBAT should be completed.

The WASP-IV uses old simulation files to save calculation time for the MERSYM. Therefore, if you change some data in LOADY, FIXSYS or VARSYS, it is necessary to clear the old simulation files. Otherwise, you will obtain have wrong solution.

Clearing the old simulation files and a confirmation run is strongly recommended at the end of optimization as well.

g. DYNPRO

It is necessary to complete DYNPRO. If an error occurs in DYMPRO, the CONGEN file cannot be opened. Most of these cases are caused in the LOLP criteria. You may complete DYNPRO by deleting the LOLP criteria.

In addition, after the completion of REPROBAT, you cannot go back to DYNPRO directly. It is necessary to go back to CONGEN again for further simulation.

h. REMERSIM

This is a module only to calculate the amount of fuel. This module is not affected to the results of optimization.

The data file is independent of FIXSYS and VARSYS. Therefore, it is necessary to check the data of REMERSIM again when you replace the data in one of these modules.

The data file of REMERSYM is not copied automatically. Therefore, it is necessary to copy the “REMERSIM .sav” manually to the expected data folder.

i. REPROBAT

You can use this module easily. However, running REPROBAT affects the temporally files of DYMPRO and MERSIM. Specifically:

- Before checking the capacity factor in the report of MERSYM, complete REPROBAT.
- After running REPROBAT, go back to CONGEN, even when you need to replace the LOLP criteria.

The data file of REPROBAT is not copied automatically. Therefore, it is necessary to copy the “REPROBAT.dat” manually to the expected data folder.

Special Remarks / Tips

As WASP-IV uses the WordPad as the viewer, you can easily transfer data from REPROBAT to EXCEL

The steps are:

- (1) To cut out the necessary data
- (2) To rename and save the data as “#####.txt”
- (3) To start the Excel, open the “#####.txt” with Fixed Width
- (4) To adjust the width and open it

3.2.4 Tips for Sensitivity Analysis

- (1) Take or Pay Contract

WASP-IV can treat the loading order of the power plant directory. However, inputting the loading order is too messy. It is necessary to indicate the loading order twice for a power plant because the loading order of minimum capacity operation and intermediate – maximum loading order are treated separately in the WASP-IV. Moreover, it is necessary to allocate the loading order for all plants. This means that the economic loading order should be scrutinized before using the loading order module.

To lessen the above work, to “fake” input is effective.

Example:

- If you allocate the take or pay contract to a natural gas power plant, you can input 10% of the fuel cost instead of 100% of the fuel cost. The loading order of gas-fired power plants is changed automatically. The optimal power development can be calculated in this manner.
- If you calculate the total investment of the system, it is necessary to adjust the operation cost of gas-fired power plants. Multiply 10 times the operation cost of these power plants. You can confirm it in the MERSIM module.
- Of course, you can confirm the cost by putting in the loading order.

- (2) How to consider transmission constraints in the WASP-IV

WASP-IV cannot treat multiple areas and interconnection issues. However, if you know the constraints of the transmission line, you can treat the constraints by using “fake” input in the same way as the take or pay contract.

Example:

- If you know the impact of the transmission lines like “only 500 MW of 1000 MW can be dispatched at some power plants,” you can reflect the current situation by changing the capacity itself to 500 MW.
- You can change the installed capacity; however, it is necessary to prepare two power plants to describe this, and it is too messy. Therefore, the simplest way to describe this is to reduce the unit number by using the retirement schedule. You can change the total capacity of plants very easily.

(3) Group limit

You can use the group limit module. However, if you use this module, the calculation time will be too long. (Of course, it depends on the input data)

If you want to calculate constraint development such as energy constraints or environmental emission constraints, it is necessary to use this module. However, if you want to calculate the amount of emission, it is better to calculate by hand.

(4) Fuel Cost Impact

You can calculate fuel cost impact by using the fuel cost escalation module in DYNPRO. However, the loading order still remains at the current price. Therefore, it is better to change the cost directly in FIXSYS or in VARSYS if the change is dramatic.

(5) Data input for the PDP (2004-2013)

For the PDP (2004 - 2013), the following input is applied for the study:

- Take or Pay contract by using the fuel cost reduction tips for Santa Rita, Ran Lorenzo and Ilijan. Gas price is set at 10%.
- Constraints of the transmission line between Batangas to Manila by deducting the number of units in Batangas.

3.3 Preparation of the Regional Supply Plan

3.3.1 Basic Approach for Preparation of the Regional Supply Plan

Since WASP-IV cannot treat multiple areas, a regional supply plan has to be prepared step by step. In this report, the development plan for the VISAYAS is prepared as an example. The basic approach is as follows:

(1) Preparation of the Total Development Plan for Areas by using WASP-IV.

You can prepare the power development plan for an area considering the regions as a system. In this case, the power development plan for the total VISAYAS is prepared. The results are shown in Table 3.3.1.

Table 3.3.1 Initial run of the WASP-IV for VISAYAS

Total VISAYAS									
	Demand	Ex.Cpa	Install				I.C.	Total	G.R.M
			DS	GT05	CL05	acc			
2003	1,006	1,470				0	0	1,470	46.1%
2004	1,085	1,567				0	0	1,567	44.4%
2005	1,172	1,602				0	0	1,602	36.7%
2006	1,269	1,602				0	0	1,602	26.3%
2007	1,363	1,576	50	100		150	0	1,726	26.6%
2008	1,469	1,576				150	0	1,726	17.5%
2009	1,582	1,576		100		250	0	1,826	15.4%
2010	1,702	1,576		150		400	0	1,976	16.1%
2011	1,827	1,485	50	150		600	0	2,085	14.1%
2012	1,959	1,485	150			750	0	2,235	14.1%
2013	2,097	1,485	50	50	50	900	0	2,385	13.7%

(2) Distribution of Candidates

Based on Table 3.3.1, distribute the indicative plants to islands by using the special table as shown in Table 3.3.2. The interconnection constraints between islands are considered in this table.

By using this spreadsheet, you can see that the regional power supply is not sufficient in Panay and Negros.

Table 3.3.2 Initial Distribution of Candidates to Islands

2003/10/17 15

	Leyte-Samar Grid								Bohol								Cebu Grid												
	Demand	Ex.Cpa	Install	Acc	I.C. Out	Total	G.R.M	TL	Demand	Ex.Cpa	Install				I.C.	Total	G.R.M	TL	Demand	Ex.Cpa	Install				I.C. in	out	Total	G.R.M	TL
											DS	GT05	CL05	acc							DS	GT05	CL05	acc					
2003	182	695		0	-163	532	192.4%	440	41	49				0	2	52	25.0%	35	406	427.5				0	160	-80	508	25.0%	200
2004	200	695		0	-207	487	143.9%	440	46	49				0	8	57	25.0%	35	438	427.5				0	199	-80	547	25.0%	200
2005	220	695		0	-284	410	87.0%	440	51	6				0	57	64	25.0%	100	472	427.5				0	227	-64	590	25.0%	400
2006	242	695		0	-277	418	72.8%	440	56	6				0	64	71	25.0%	100	510	427.5				0	213	-3	637	25.0%	400
2007	264	695		0	-343	352	33.1%	440	62	6				0	72	78	25.0%	100	547	427.5				0	271	-15	684	25.0%	400
2008	289	695		0	-355	340	17.4%	440	69	6				0	75	81	17.5%	100	588	427.5				0	280	-17	691	17.5%	400
2009	317	695		0	-329	365	15.3%	440	76	6				0	81	87	15.4%	100	633	427.5		100		100	248	-46	730	15.4%	400
2010	346	695		0	-293	402	16.0%	440	83	6		50		50	41	97	16.1%	100	679	427.5		50		150	252	-41	789	16.1%	400
2011	378	695		0	-264	431	14.1%	440	92	6				50	48	105	14.1%	100	728	336.7	0	150		300	215	-21	831	14.1%	400
2012	411	695		0	-225	469	14.1%	440	100	6				50	58	115	14.1%	100	779	336.7	50			350	167	35	889	14.1%	400
2013	447	695		0	-186	508	13.7%	440	110	6				50	69	125	13.7%	100	833	336.7		50		400	117	93	947	13.7%	400

	Negros											Panay											Total VISAYAS										
	Demand	Ex.Cap	Install Cap.				I.C.		Total	G.R.M	TL	Demand	Ex.Cap	Install Cap.				I.C.	Total	G.R.M	TL	Demand	Ex.Cpa	Install				I.C. in	out	Total	G.R.M		
			DS	GT05	CL05	Acc	in	out						DS	GT05	CL05	Acc							DS	GT05	CL05	acc						
2003	194	166				0	80	-80	166	-14.6%	80	182	132.6				0	80	213	16.5%	80	1,006	1,470				0	0	1,470	46.1%			
2004	205	166				0	80	-15	230	12.2%	80	196	230.5				0	15	246	25.0%	80	1,085	1,567				0	0	1,567	44.4%			
2005	218	243				0	64	-34	273	25.0%	80	212	230.5				0	34	265	25.0%	80	1,172	1,602				0	0	1,602	36.7%			
2006	232	243		50		50	3	-6	290	25.0%	160	229	230.5		50		50	6	286	25.0%	160	1,269	1,602		100		100	0	1,702	34.2%			
2007	244	243				50	15	-2	306	25.0%	160	246	204.8		50		100	2	307	25.0%	160	1,363	1,576		50		150	0	1,726	26.6%			
2008	258	243				50	17	-6	304	17.5%	160	264	204.8				100	6	311	17.5%	160	1,469	1,576				150	0	1,726	17.5%			
2009	273	243				50	46	-23	315	15.4%	160	284	204.8				100	23	328	15.4%	160	1,582	1,576		100		250	0	1,826	15.4%			
2010	288	243				50	41	0	334	16.1%	160	305	204.8		50		150	0	354	16.1%	160	1,702	1,576		150		400	0	1,976	16.1%			
2011	303	243				50	21	32	346	14.1%	160	327	204.8		50		200	-32	373	14.1%	160	1,827	1,485		50	150	600	0	2,085	14.1%			
2012	318	243		50		100	-35	55	363	14.1%	160	350	204.8		50		250	-55	399	14.1%	160	1,959	1,485		150		750	0	2,235	14.1%			
2013	333	243		50		150	-93	79	379	13.7%	160	374	204.8			50	300	-79	426	13.7%	160	2,097	1,485		50	50	900	0	2,385	13.7%			

Here DS: Diesel (50MW)
 GT05: Gas Turbine (50MW/Oil)
 CL05: Coal (50MW)

Here, the generation reserve margin is calculated by the following equation.

$$\begin{aligned}
 \text{- Supply Capacity (MW)} &= (\text{Existing Capacity} + \text{Additional Capacity}) \\
 &\quad + (\text{Interchange IN} - \text{Interchange Out}) \\
 \text{- Generation Reserve Margin} &= \frac{\text{Supply Capacity} - \text{Peak Demand}}{\text{Peak Demand}} \\
 \text{(\%)} &
 \end{aligned}$$

It is necessary to distribute all power plants to the areas by considering the generation reserve margin as an index. It is not necessary to be too sensitive since the optimal location of plants is finally determined by GTMax.

(3) Acceleration of candidates

To meet regional supply and balance, a couple of power plants should be accelerated. In this case, 100 MW of gas turbine is accelerated until 2003, and 50 MW of diesel is accelerated until 2006. To calculate the necessary capacity addition (acceleration) that satisfies LOLP = 1 day /year, use WASP-IV. To determine the island's capacity addition, adapting the non-coincident peak is recommended.

In this case, the necessary capacity addition that satisfies LOLP = 1 day /year in Panay and Negros is as follows:

	Panay	Negros
2006	50 MW	50 MW
2008	50 MW	

Table 3.3.3 shows the revised power development plan reflecting the islands' capacity addition. You can determine the necessary capacity addition for all of the Visayas except for the optimal location / siting.

(4) Confirmation Run of WASP-IV

You can calculate the optimal power development plan in the above condition by treating accelerated capacity as fixed development. For this purpose, you should only put the necessary configuration in CONGEN, then calculate again.

]Table 3.3.3 Power Development Plan (Second Draft)

	Leyte-Samar Grid								Bohol								Cebu Grid												
	Demand	Ex.Cpa	Install	Acc	I.C. Out	Total	G.R.M	TL	Demand	Ex.Cpa	Install				I.C.	Total	G.R.M	TL	Demand	Ex.Cpa	Install				I.C. in	out	Total	G.R.M	TL
											DS	GT05	CL05	acc							DS	GT05	CL05	acc					
2003	182	695		0	-155	540	196.7%	440	41	49				0	2	52	25.0%	35	406	427.5				0	153	-72	508	25.0%	200
2004	200	695		0	-134	561	180.8%	440	46	49				0	8	57	25.0%	35	438	427.5				0	126	-6	547	25.0%	200
2005	220	695		0	-184	510	132.5%	440	51	6				0	57	64	25.0%	100	472	427.5				0	127	36	590	25.0%	400
2006	242	695		0	-227	468	93.5%	440	56	6				0	64	71	25.0%	100	510	427.5				0	163	47	637	25.0%	400
2007	264	695		0	-343	352	33.1%	440	62	6				0	72	78	25.0%	100	547	427.5				0	271	-15	684	25.0%	400
2008	289	695		0	-355	340	17.4%	440	69	6				0	75	81	17.5%	100	588	427.5				0	280	-17	691	17.5%	400
2009	317	695		0	-329	365	15.3%	440	76	6				0	81	87	15.4%	100	633	427.5		100		100	248	-46	730	15.4%	400
2010	346	695		0	-293	402	16.0%	440	83	6		50		50	41	97	16.1%	100	679	427.5		50		150	252	-41	789	16.1%	400
2011	378	695		0	-264	431	14.1%	440	92	6				50	48	105	14.1%	100	728	336.7	0	150		300	215	-21	831	14.1%	400
2012	411	695		0	-225	469	14.1%	440	100	6				50	58	115	14.1%	100	779	336.7	50			350	167	35	889	14.1%	400
2013	447	695		0	-186	508	13.7%	440	110	6				50	69	125	13.7%	100	833	336.7		50		400	117	93	947	13.7%	400

	Negros											Panay						Total VISAYAS												
	Demand	Ex.Cap	Install Cap.				I.C.		Total	G.R.M	TL	Demand	Ex.Cap	Install Cap.				I.C.	Total	G.R.M	TL	Demand	Ex.Cpa	Install				I.C.	Total	G.R.M
			DS	GT05	CL05	Acc	in	out						DS	GT05	CL05	Acc							DS	GT05	CL05	acc			
2003	194	166		50		50	72	-45	242	25.0%	80	182	132.6		50		50	45	228	25.0%	80	1,006	1,470		100		100	0	1,570	56.1%
2004	205	166				50	6	35	257	25.0%	80	196	230.5				50	-35	246	25.0%	80	1,085	1,567				100	0	1,667	53.6%
2005	218	243				50	-36	16	273	25.0%	80	212	230.5				50	-16	265	25.0%	80	1,172	1,602				100	0	1,702	45.2%
2006	232	243				50	-47	44	290	25.0%	160	229	230.5	50			100	-44	286	25.0%	160	1,269	1,602	50			150	0	1,752	38.1%
2007	244	243				50	15	-2	306	25.0%	160	246	204.8				100	2	307	25.0%	160	1,363	1,576				150	0	1,726	26.6%
2008	258	243				50	17	-6	304	17.5%	160	264	204.8				100	6	311	17.5%	160	1,469	1,576				150	0	1,726	17.5%
2009	273	243				50	46	-23	315	15.4%	160	284	204.8				100	23	328	15.4%	160	1,582	1,576		100		250	0	1,826	15.4%
2010	288	243				50	41	0	334	16.1%	160	305	204.8		50		150	0	354	16.1%	160	1,702	1,576		150		400	0	1,976	16.1%
2011	303	243				50	21	32	346	14.1%	160	327	204.8	50			200	-32	373	14.1%	160	1,827	1,485	50	150		600	0	2,085	14.1%
2012	318	243	50			100	-35	55	363	14.1%	160	350	204.8	50			250	-55	399	14.1%	160	1,959	1,485	150			750	0	2,235	14.1%
2013	333	243	50			150	-93	79	379	13.7%	160	374	204.8			50	300	-79	426	13.7%	160	2,097	1,485	50	50	50	900	0	2,385	13.7%

Here DS : Diesel (50MW)
 GT05 : Gas Turbine (50MW/Oil)
 CL05 : Coal (50MW)

3.4 Optimal Location / Interconnection Issues

3.4.1 outline of GTMax

GTMax is used to determine the optimal location and for interconnection analysis. The least cost dispatch for regional demand is determined by linear programming. The interconnection power flow is calculated automatically in this process. As the total system operating cost can be calculated, the optimal location of indicative power plants can be determined by switching the connected point to the system (in particular, by comparing the operation cost of both “real line connection” and “break line connection” in Fig. 3.4.1)

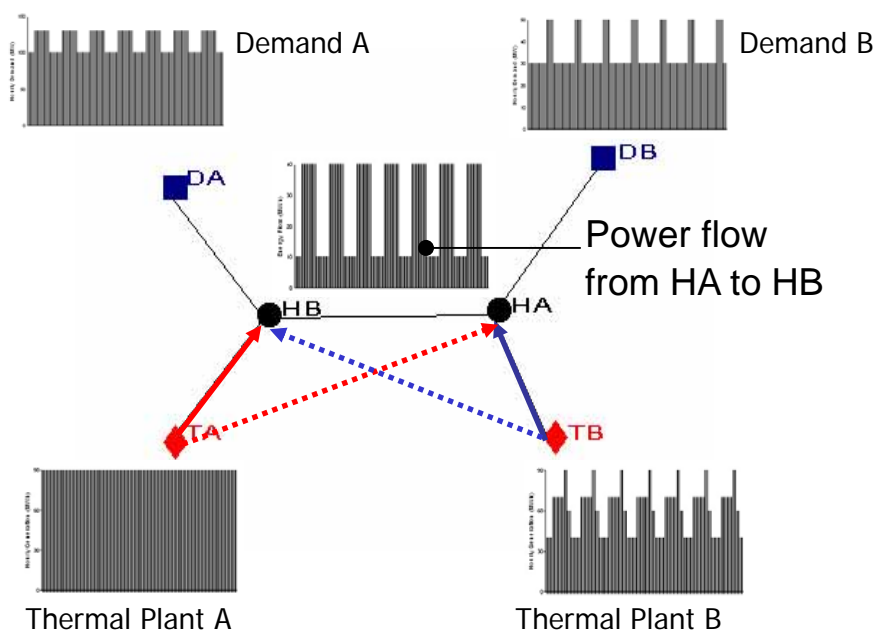


Fig. 3.4.1 Outline of the GTMax

3.4.2 Determining the Optimal Location

As mentioned in Section 3.3, the optimal location can be determined by the GTMax by comparing the object functions. Location in Table 3.3.3 is only the initial location. You can determine the optimal location to be the case that achieves the minimum object function.

To optimize the location smoothly, it is necessary to understand the condition that realizes the minimum object function. It is necessary to pay attention to the interconnection power flow because the interconnection power flow may not be constrained in the optimized location. Therefore, place the location of the candidate in another area to alleviate the congestion of the interconnection power flow. It is better to determine the location of the base power plant first.

The location of peak power plants will not be affected by the objective function. In this case, location should be determined only using the regional generation reserve margin.

3.4.3 GTMax data preparation

Almost all data for the GTMax can be diverted from the data of WASP-IV. However, the following data should be collected additionally only for the GTMax, which calculates the supply plan of a typical week:

- 1) Chronological load curve for each area
- 2) Capacity of interconnection between areas
- 3) Actual operation data for hydro power plants

It is desirable to collect the actual data accurately. However, the GTMax can simulate the system operation with some assumptions even if you cannot collect all data. (The validity of simulation result should be verified deliberately in this case.)

1) Chronological load curve

The GTMax requires hourly demand data (8760 hours / year) for each year by area. However, the future demand is forecasted only on the peak demand (kW) and on the production (GWh). Therefore, the future load shape should be prepared by using the historical load shape in the following manner:

$$PL(t) = PL0(t) * (Pmax(y) / Pmax0) * k(t)$$

t: time (1-8760)

y: year

PL(t): hourly demand in future

PL0(t): actual hourly data (data of 1996 is used in this study)

Pmax(y): future peak demand of the year (from demand forecast)

Pmax0: actual peak demand (data of 1996 is used in this study)

k(t): compensation value of energy (adjust total energy for the year)

Compensation Value k is calculated as follows:

$$k(t) = 1 - u(t) * \alpha$$

Where, $u(t)$ is the rank of the demand(t) in a year, for example, $u(t) = 1$ for the maximum peak demand in a year and $u(t) = 8760$ for the minimum demand in a year: Alpha is used for adjusting the total of hourly demand to the forecasted production in a year. Alpha can be calculated by using the attached excel worksheet.

2) Hydro

Hydro plants operation data are prepared by each hydro plant.

-

As the GTMax simulates the weekly operation, data of dependable capacity and available production in a week should be input. Monthly data can be applied by breaking down into weekly energy. To remove the affects of rainfall by year, it is desirable to apply an average data in a couple of years.

If dependable capacities data are not available, it is necessary to assume them from the monthly energy and the capacity factor. 80% in load factor is usually picked up as a typical condition. If the actual capacity factor is greater than 80% in capacity factor, the install capacity can be use as the dependable capacity. If the actual capacity factor is smaller than 80%, the dependable capacity is set at the capacity calculated from the actual generation by assuming the capacity factor at 80% as follows:

Calculated dependable capacity

$$= \text{Monthly energy} / (\text{Hours of the month} * 80\%)$$

(80% is an assumption value)

Note: 80% is good assumption for the run-of-river-type hydros. However, it cannot be applied to the reservoir type hydro because of peaking operation. Therefore the data should be collected with all efforts in order to determine the realistic data.

3) Thermal

a) Forced Outage Rate

Average maintenance days cannot be treated in the GTMax although it can be treated in the WASP-IV. . For the long-term simulation by the GTMax, maintenance day should be converted to the maintenance outage rate. The total of maintenance and forced outage rate should be deducted as “outage rate”. Specifically, the dependable capacity is set lower than the capacity used in WASP-IV considering the outage.

Example: F.O.R. = 5%, Maintenance outage = 36 days / year

- Total Outage Rate = 5% + 36days/365days = 15%

- Dependable capacity input in the GTMax

= 85% of the dependable capacity(of WASP-IV.)

Therefore, the total of generation capacity is different from the installed capacity.

b) Thermal Cluster

In GTMax, the number of nodes (thermal, hydro, firm purchase, etc.) affects the memory and calculation time requirements. Therefore it is better to reduce the number of thermal nodes by using the thermal cluster. . However, there are certain limitations when using a thermal cluster as follows:

-Although the number of thermal units is *not* limited, the price function is limited at most nine.

- Therefore, it is necessary to create the thermal cluster by at most nine units in order to express the operation of each unit accurately.

- In addition, the GTMax cannot clarify the operation of unit consisting the thermal cluster.

Therefore, the units require the sensitivity study should not be treated as a part of thermal cluster.

c) Minimum generation

Since the GTMax cannot treat stop operation, or not in service, the minimum generation capacities input in the GTMax are not the same as the actual.

Although the minimum generation capacities of base – or middle type units are set at the same value to actual, however, that of peaking units should be set at zero. (To set the minimum generation capacity means to guarantee the must-run of tease unit.) Therefore, the simulated capacity factors should be examined deliberately. If the result differs from the actual greatly even in the middle load unit, the capacity should be change at the reasonable capacities.

d) Variable cost function

In this study, variable cost function is calculated from WASP-IV's minimum and incremental heat rate and fuel cost as follows:

Base type units: at minimum capacity block

$$\text{Costmin} = \text{HRmin} * \text{FuelCost}$$

$$\text{CostMax} = \text{HRmax} * \text{FuelCost}$$

$$\text{Where, HRmax} = \text{HRmin} + \text{HRinc}(\text{Pmax} - \text{Pmin})$$

4) Which week should be chosen for the simulation?

The GTMax can simulate every week of the year (52week/year) although it takes a very long time. Therefore, a typical week of the year should be chosen for the simulation.

The necessary conditions for a typical week are:

- a) It should include the largest demand in critical areas or islands.
- b) Other islands' or areas' peak demands are also should be relatively great. (Between the 3rd and the 5th greatest is desirable.)

The 45th week is chosen as the typical week in this study, because the Panay's, Negros' and Cebu's peak demands are close to the peak of the year.

5) Firm purchase

The GTMax cannot treat the must-run unit directly. Therefore, IPPs that have Take-or Pay contracts should be represented as firm purchases. Necessary maximum – and minimum-transaction is set as the contract. Geothermal plants are treated as firm purchases because each of these plants have a target capacity factor. Forced and maintenance outage should be represented by deducting the average outage capacity from the maximum capacity. The minimum capacity is set at zero or its own minimum capacity.

6) General issues

Hourly, daily and weekly generation or purchase should have a consistency. For example, the maximum weekly generation should be greater than the minimum daily generation * 7(days/week), or the minimum hourly generation * 168 (hours/week). Since the GTMax checks the mismatch or consistency of data, the calculation does not complete with the mismatched data.

7) Which transmission line should be modeled in the GTMax?

Although the GTMax can model all transmission lines, it takes a very long time to simulate it. In

addition, all data should be input accurately if the loop connection is included. It is too messy to prepare the long-term planning. Therefore, the simple transmission model that satisfies enough accuracy should be prepared as follows:

a) Interconnection between areas. The definition of 'area' is that it has its own load curve and load forecast, and its own power development plan.

b) Transmission lines that affect with the results of GTMax in an area: for example, transmission lines between huge power plants and substations. Pay attention to the limitation of power flow. If the transmission line capacity is too small against the both sides demand, the area should be divided into two areas.

8) Checkpoints of the results

After completing the data input on demand, thermal, hydro, firm purchase, etc, simulate the system operation. Be careful on the run note's message and status. If you find any error message, go back to the data edit to correct any errors. In order to simulate the realistic operation, the result should be verified deliberately from the following viewpoints:

a) Check the market value of substations. There should be *no* substation of which market value exceeds \$9999. Since it represents a power deficit (black out) at the substation, check the transmission line's capacity, the hourly thermal output, or the hourly output of thermal cluster. If the error cannot be remove by replacing the above values, check the system demand and supply capacity. If these figures are appropriate, the result is correct, that is power deficit will occur. Therefore the result of WASP-IV and / or transmission development plan should be reviewed.

b) Check the hourly generation of thermal, hydro, firm purchase. If hourly output change is too great or is fluctuating, the hourly rump rate should be checked. The hourly or daily minimum output of the thermal cluster should be checked also. It may be due to fluctuation in the load curve.

c) Check the hourly power flow of the transmission line with its capacity limit. If the power flow is not the same as anticipated, the hourly load, hourly generation of thermal, thermal cluster and hydro should be checked again.

3.4.5 Interconnection Issues

Figure 3.4.2 shows the methodology of the study. The GTMax is used as the simulation

software.

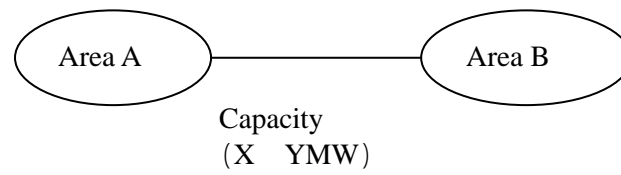


Fig. 3.4.2 Methodology of the study

The following is the study flow:

- 1) To calculate the supply cost for Area A and Area B considering interconnection constraints (Cost 1 for Transmission Capacity X)
- 2) To calculate the supply cost for the same area considering transmission reinforcement (Cost 2 for Transmission Capacity Y)
- 3) Cost 1 minus Cost 2 equals the merit of transmission line reinforcement.
- 4) To calculate the Net Present Value by considering investment cost

4. Checklist

Table 4.1 shows the checkpoint at milestones for preparing PDP. The items to be completed with the preparation of PDP, and the contact addresses of related organizations are given. It can be used as the checklist based on the workflow.

Table 4.1 Checklist for preparing PDP

No.	Items to do	Deadline	Contact
1.	Were DDPs submitted as scheduled?	Mar. 15	PIOUs NEA
2.	Were data format already distributed?	Mar. 15	PIOUs IPPs NPC
3.	Was system operation report collected?	Mar. 15 -31.	System Operator
4.	Were all data formats submitted?	Mar. 31	
5.	Check of the current operation status by collected data	Mar.31 Apr. 30	DOE
6.	Confirmation of new projects	Mar.31 Apr. 30	PIOUs IPPs NPC TRANSCO
7.	Data input in simulation software - Confirmation of simulation run	Apr. 30	DOE
8.	Confirmation of energy policy -Sensitivities analysis - Trend of recent demand	May. 31	DOE
9.	Schedule check of the demand forecast - NEDA's scenario	May.1,15	DOE
10.	Confirmation of the demand forecast	May. 31	DOE
11.	Provision of the demand forecast to the TRANSCO?	May. 31	TRANSCO
12.	Provision of the information of indicative plants to the TRANSCO - Necessary capacity addition by draft development plan - Candidates of indicative plants	May. 31	TRANSCO
13.	Confirmation run of simulation software	May. 31 - Aug.15	DOE
14.	Provision of power development plan to the TRANSCO?	3 rd week of Jun.	TRANSCO
15.	Coordination with TDP	Jun.- Jul.15	TRANSCO
16.	Evaluation of TDP	Jul.31	TRANSCO
17.	Documentation -Coordination with sub ordinate plans	Aug. 15	
18.	Public Consultation	Aug. 31	
19.	Approval of PDP by Secretary	Aug. 31	
20.	Submission to the congress	Sep.15	

5 Technical Documents

5.1 Manuals

Manuals written in Bold letter is strongly recommended to read before using the software.

(a) WASP-IV

- **Wien Automatic System Planning (WASP-IV) Package user's manual**
 - The theory of optimization is described in Chapter 1.
 - The limitation of WASP-IV is described in Chapter 2.
 - How to use the WASP-IV is described in Chapter 3 to Chapter 11.
 - The new future of WASP-IV is described in Chapter 12.
- Wien Automatic System Planning (WASP-III plus) user's manual (Vol. 1)
- Wien Automatic System Planning (WASP-III plus) user's manual (Vol. 2)
 - The calculation flow of each module is described. Although some of contents are different from Version 4, the most of contents is the same. To know the calculation flow is very helpful to understand the WASP.
- **Materials distributed in Technical Seminar (Feb. 8 to 28, 2003)**
 - The calculation theory is described briefly. Especially, explanation on MERSYM is very useful to understand the system operation analysis.

(b) GTMax

- **GTMax Users Manual (Version 4.0)**
 - The basic information on GTMax is described briefly. To read with the seminar materials is recommended.
- **Materials distributed in Technical Seminar (Feb. 8 to 28, 2003)**
 - How to use the GTMax is described step-by-step.

5.2 Technical Report submitted by JICA

JICA submitted many technical reports. These are kept in the power bureau. Some of them are useful for understanding how to prepare the PDP. Especially the following reports are recommended to read.

- Technical Report (June 23,2003)
 - This is the first report by JICA. Basis of data used in the simulation are described. Also the initial analysis on interconnection issue are explained.
- **Technical Report (June 23,2003)**

- This is the first report by JICA. Basis of data used in the simulation are described. Also the initial analysis on interconnection issues is explained.
- Technical Report (July 9,2003)
 - Screening curve is explained.
- Technical Report on Necessity of Interconnection between Leyte -Mindanao
 - How to solve the necessity of interconnection roughly by using WASP-IV is described.
- **Technical Report on Necessity of Interconnection**
 - How to solve the necessity of interconnection by using GTMax is described.

5.3 General Publication

The following publication is recommended to read for understanding the least cost planning.

- A Guidebook of Expansion Planning for Electrical Generation Systems

IAEA (Technical Report Series No.241)

- How to prepare the power development plan is explained from the demand forecasting to power development plan.



Manual
for
the Power Development Plan
Preparation
(TDP)

Section 4 Transmission Development Plan

This manual for TDP evaluation and approval consists of the following:

- 1 Purpose of Evaluation**
- 2 Scope of Evaluation**
- 3 Work Flow**
- 4 Schedule**
- 5 Methodology of Evaluation**
- 6 Checklist**

1. Purpose of Evaluation

1.1 Purpose of Evaluation

Under Section 2 of the act (EPIRA), the policy of the state is to ensure the quality, reliability, security and affordability of the electric power supply. TDP evaluation by DOE ensures that the transmission plan in the Philippines is coordinated with demand increase and the power development plan, and that the quality, reliability, security and affordability of the system are at an appropriate level. If necessary, DOE will order TRANSCO to improve TDP.

Meanwhile, separate from the TDP evaluation by DOE, ERC and NEDA evaluate each project considering transmission charges and funding, respectively.

1.2 Responsibilities of DOE and TRANSCO

DOE has to prepare and update the Power Development Program (PDP) annually and integrate it into the Philippine Energy plan (PEP) under Section 37 of the act.

TRANSCO shall be responsible for the preparation of TDP, and shall submit TDP for approval by DOE for integration into PDP and PEP under Section 9 of the act and Section 10 of Rule 6.

2. Scope of Evaluation

2.1 Evaluation Period

As DOE prepares PDP and PEP for ten years, TRANSCO also has to prepare TDP for ten years and likewise, DOE has to evaluate it for ten years, although the evaluation period is not stated under the act or the rules.

Meanwhile, Grid Code 6.2.6 states that TRANSCO shall collate and process the planning data submitted by the users into a cohesive forecast and use this in preparing the data for the five-year statement of TDP. However, this does not mean that TRANSCO does not have to prepare TDP for the latter five years. From this, TRANSCO can assume the data to prepare TDP for the latter five years.

2.2 Facilities for Evaluation

2.2.1 Scope of TDP and DDP

The scope of TDP prepared by TRANSCO and DDPs prepared by DUs is clarified as follows:

Table 2.1: Scope of TDP and DDP

Assets	Planning Entity	Program
Transmission (Subtransmission*1)	TRANSCO	TDP
Subtransmission Distribution	DUs	DDP

*1 Before the transfer of subtransmission assets to DUs

2.2.2 Distinction between Transmission Assets and Subtransmission Assets

Under Section 7 of the act, ERC shall set the standards of voltage transmission that shall distinguish the transmission from the subtransmission assets. Pending the issuance of these new standards, the distinction between transmission and subtransmission assets shall be as follows:

Table 2.2: Distinction between Transmission and Subtransmission Assets

	Transmission Assets	Subtransmission Assets
Luzon Grid	500 kV, 230 kV	115 kV, 69 kV
Visayas Grid	230 kV, 138 kV, 69 kV	69 kV*
Mindanao Grid	138 kV	69 kV

* In case of not forming part of the main transmission grid and being directly connected to the substation of the distribution utility

Under Section 4 of Rule 6, the function as well as the voltage has to be considered to distinguish between transmission and subtransmission assets. Currently, TRANSCO owns some subtransmission assets, and TRANSCO shall transfer them to the DUs under Section 8 of the act.

Although the current TDP includes subtransmission lines, they will be included in the DDPs prepared by DUs after the transfer.

3. Work Flow

3.1 TDP Preparation and Evaluation

3.1.1 Work Flow

Figure 3.1 shows the workflow for TRANSCO and DOE to prepare and evaluate TDP, respectively.

In advance of TRANSCO's preparation of TDP, DOE makes a demand forecast, prepares the power development plan and hands over the information to TRANSCO.

Table 3.1 and Table 3.2 show the information that should be provided by DOE to TRANSCO.

Table 3.1: Information Provision by DOE to TRANSCO

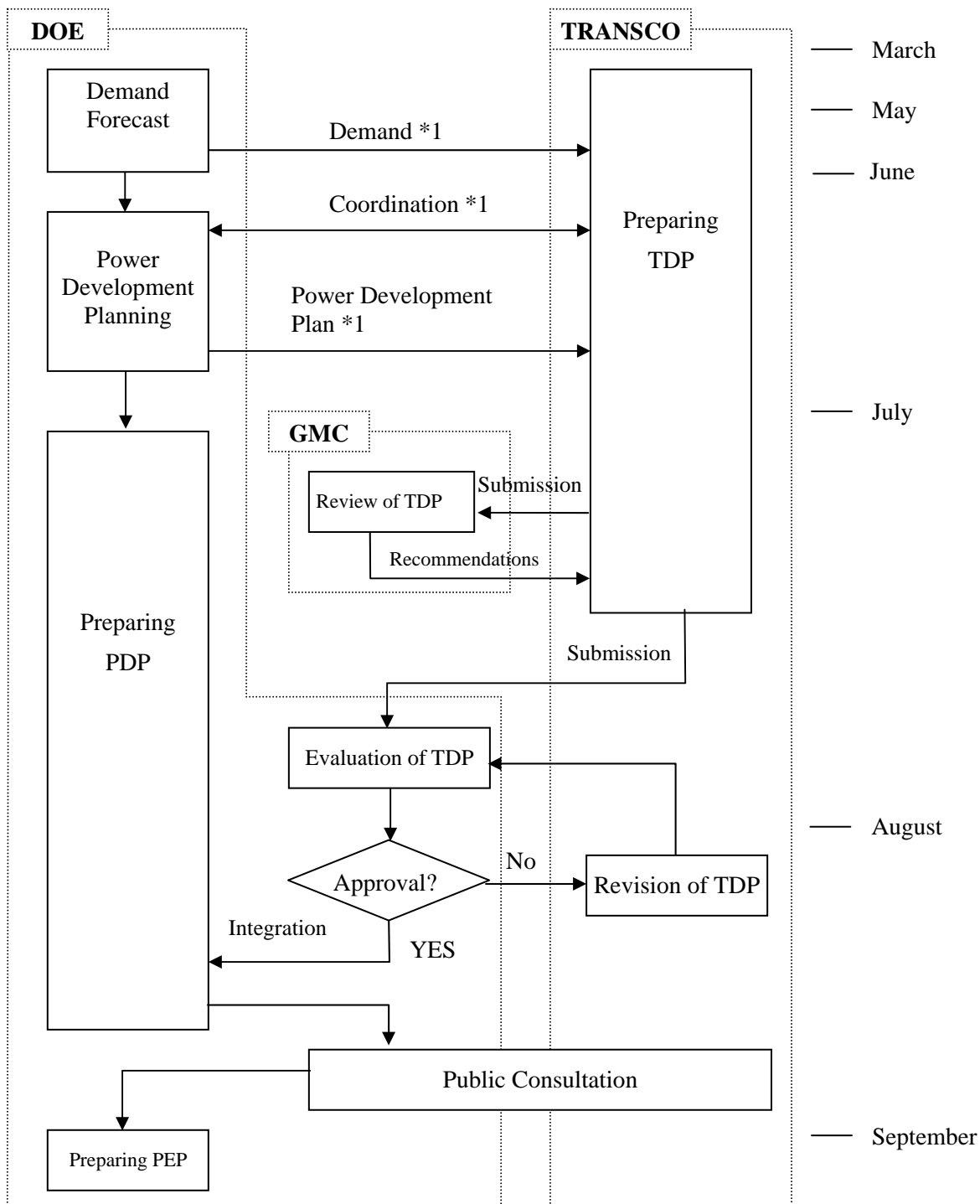
Items	Contents
Demand Forecast	<ul style="list-style-type: none"> - For 10 years - For Luzon, the Visayas (Leyte-Samar, Cebu, Negros, Panay, Bohol) and Mindanao
Power Development Plan	<ul style="list-style-type: none"> - Results of WASP simulation - List of committed projects - List of indicative projects that should be included in the TDP from political point of view - List of decommissioned plants

Table 3.2: Information regarding Power Development Plan

Items	Contents
Project Data	<ul style="list-style-type: none"> - Location of the site - Fuel Type - Capacity - Year of commissioning
Decommissioning Data	<ul style="list-style-type: none"> - Plant Name - Generator Number - Capacity - Year of decommissioning

After preparing TDP, TRANSCO submits TDP to the Grid Management Committee (GMC). GMC reviews TDP and makes recommendations based on it. TRANSCO then submits TDP to DOE. DOE evaluates and approves it, and integrates it into PDP and PEP.

Fig 3.1: Work Flow



*1: To exchange information, meetings with TRANSCO are necessary.

As transmission development planning is closely related to power development planning, it is impossible to make transmission development plan independently. To accommodate demand increase in an area, there are two options: one is power development in the area, and the other is transmission expansion. Therefore, DOE and TRANSCO need to cooperate and decide which option should be taken.

To coordinate the power development plan and the transmission development plan, exchanging of a lot of data and feedback of the results of the study are necessary between DOE and TRANSCO. Therefore, holding periodic meetings is necessary during TDP preparation. Generating companies, such as NPC and IPPs, and distribution utilities, such as MERALCO, should attend the meetings, if necessary.

3.1.2 Contents of TDP

The contents that should be included in the TDP are the following:

- (1) Planning Assumptions
(Demand Forecasts, List of Power Development Projects)
- (2) Planning Criteria
- (3) Summary of the existing facilities
(Transmission Lines, Substations)
- (4) List of Transmission Development Projects
(Voltage, Capacity, Year of commissioning, Cost, etc.)
- (5) Maps of the Grids (Luzon, the Visayas, Mindanao)
- (6) Profile of Total Investment
- (7) Historical Values of Performance Indicators

3.1.3 Materials for Submission

In addition to TDP, DOE requires the following documents and data for TDP evaluation. TRANSCO has to submit them to DOE annually.

- (1) Data of PSS/E
- (2) Single-line Diagram (Luzon, the Visayas, Mindanao)
- (3) Grid Map (the Philippines)
- (4) List of Individual Existing Facilities

Table 3.3 shows the list of individual existing facilities that should be submitted by TRANSCO.

Table 3.3: Contents of the List of Individual Existing Facilities

Items		Contents
Transmission Line		<ul style="list-style-type: none"> - Rated Voltage - Names of the Terminals - Number of circuits - Size of conductors and number of conductors per phase - Thermal Capacity - Line Constant
Substation	Transformer	<ul style="list-style-type: none"> - Rated Voltage - Rated Capacity - Number - Reactance
	Shunt Capacitor Shunt Reactor	<ul style="list-style-type: none"> - Rated Capacity - Number
	Series Capacitor Series Reactor	<ul style="list-style-type: none"> - Rated Capacity - Number
	Circuit Breaker	<ul style="list-style-type: none"> - Rated Voltage - Rated Capacity - Rated Breaking Capacity

3.2 Planning of Interconnection

3.2.1 Work Flow

Interconnection connects independent island systems to supply power for the economical operation of the generators and to improve reliability.

Table 3.4 lists the entities responsible for the planning and construction of interconnection. In the case of major interconnections, such as those between Luzon, the Visayas and Mindanao and those between the main islands of the Visayas (Leyte, Samar, Cebu, Negros, Panay and Bohol), DOE and TRANSCO are responsible for planning.

In the case of small-island interconnections, TRANSCO and DUs are responsible for planning.

Table 3.4: Classification of Interconnection

	Assets	Responsible Entities	
- Major Interconnection (Luzon-Visayas-Mindanao) - Visayas-Main-Island Interconnection (between Leyte, Samar, Cebu, Negros, Panay, Bohol)	Transmission	Planning	DOE & TRANSCO
		Construction	TRANSCO
- Small-Island Interconnection	Transmission	Planning	TRANSCO & DUs
		Construction	TRANSCO
	Sub- transmission Distribution	Planning	DUs
		Construction	DUs

To plan interconnection between islands, comparison between power development of the island or interconnection is required to clarify which method is appropriate.

Table 3.5 shows the responsibilities of DOE and TRANSCO regarding planning main interconnections.

Coordination between DOE and TRANSCO is necessary for planning interconnection, and meetings are therefore necessary. If necessary, generating companies and distribution utilities should join these meetings.

Figure 3.2 shows the workflow for planning interconnections.

Table 3.5: Responsibilities of DOE and TRANSCO

	Responsibility
DOE	<ul style="list-style-type: none">- Demand Forecast (each island)- Power Development Planning (including the decommissioning program)- Economic Analysis (using GTMax)- Policy Making- Planning in the case of the delay or cancellation of power development
TRANSCO	<ul style="list-style-type: none">- Power Flow Analysis (PSS/E)- Feasibility Study- Cost Estimation- Schedule Estimation- Reliability Check (N-1 rule)

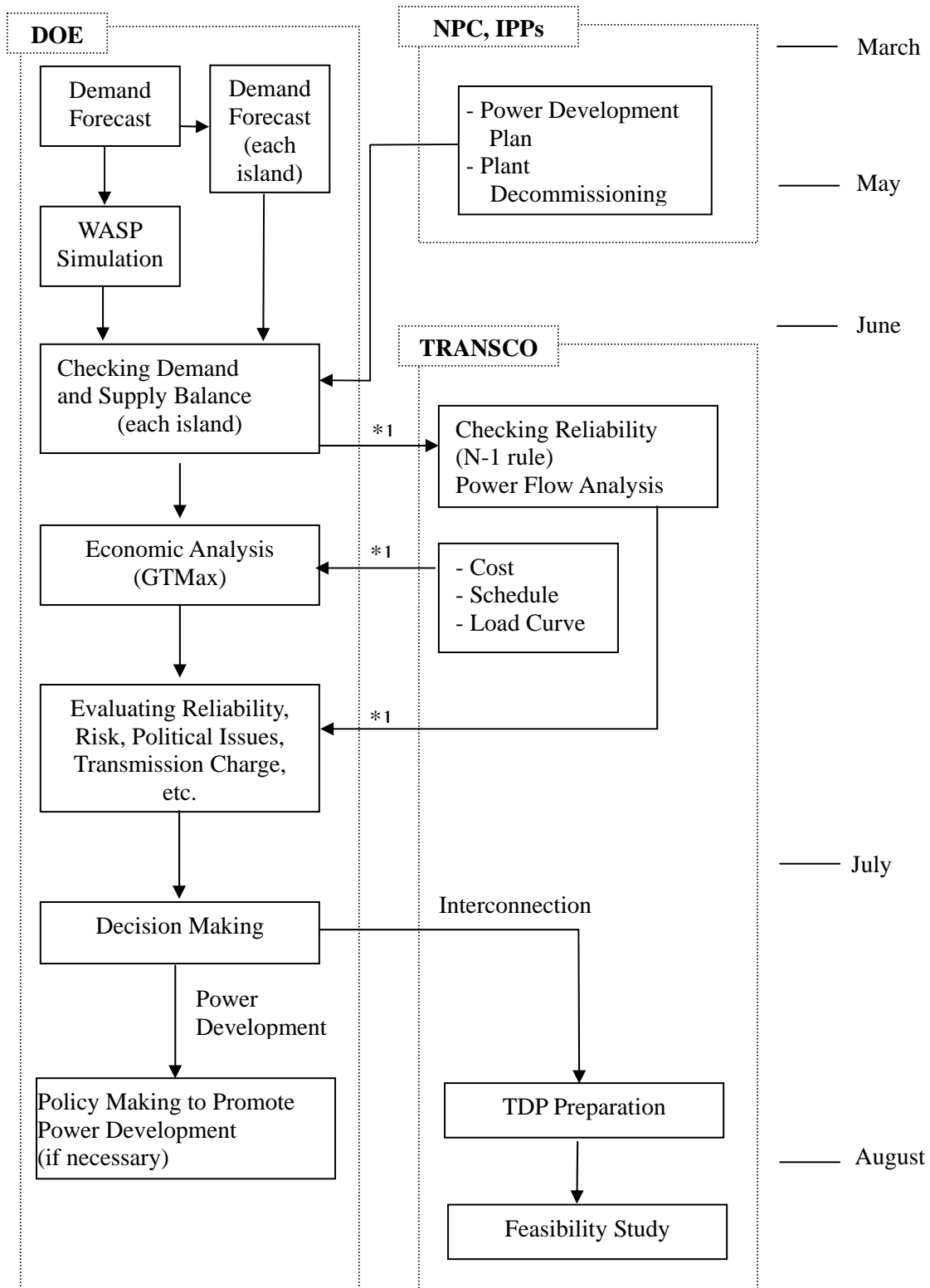


Fig 3.2: Work Flow (Interconnection)

*1: To exchange the information, meetings with TRANSCO are necessary.

3.2.2 Methodology for Planning Interconnection

Table 3.6 shows the items to be considered for planning interconnections. When making a decision on interconnection, all of these items should be considered.

Table 3.6: Items to be considered for planning interconnections

Items	Contents
Economic Analysis	- Fuel reduction - Capital cost for interconnection - Capital cost reduction by reducing power development
Demand and Supply Balance	- Probability of power shortage - Risk of unpredicted demand increase - Risk of delay or cancellation of power development
Reliability	- Satisfaction of the N-1 rule
Other	- Impact on the transmission charge - Advantage of a united system for the spot market - Political issues

(1) Economic Analysis

When economic analysis is conducted, the following items needs to be considered:

Table 3.7: Economical Effects of Interconnection

New Interconnection	Upgrade of Existing Interconnection
- Saving of fuel cost - Reduction in peak demand - Reduction in reserve margin	- Saving of fuel cost

In the case of adopting an interconnection, fuel cost will be reduced due to the optimal operation of the generators. Fuel cost reduction by optimal operation can be calculated with GTMax (refer to Chapter 3).

Reduction in peak demand is expected due to interconnection because the load curves of each system are different, and there is a time lag between the peak demands of the each system. The amount of expected reduction is calculated based on the actual load curves of each system.

Reduction in reserve margin is also expected with interconnection. However, for reduction in the reserve margin, consultation with TRANSCO is necessary.

According to TRANSCO, the necessary reserve margin for the Luzon System, the Visayas System and the Mindanao System is currently 13.2%.

With reduction in the peak demand and the reserve margin, power development can also be reduced. As a result, capital cost (depreciation and interest) can be reduced in relation to power development.

The steps for economical analysis are as follows:

- 1) Calculate fuel cost reduction with interconnection annually
(using GTmax)
- 2) Calculate investment reduction regarding power development
 - Considering peak-demand reduction and reserve-margin reduction
 - Adopting a gas turbine unit price
- 3) Add the net present values of the following items:
 - Fuel cost reduction
 - Investment and salvage value of the interconnection
 - Investment reduction in power development
 - Annual maintenance cost of the interconnection

Table 3.8 is an example of economic analysis. The negative numbers indicate outgoings and the positive numbers indicate income. In this case, as the total NPV is negative, the interconnection is not economical.

Table 3.8: Example of Economic Analysis for Interconnection (M\$)

	Interconnection		Operation Cost Saving		Power Development Reduction	Project NPV
	Construction Cost	Salvage Value	Actual Value	Present Value		
2003(NPV)	-185.57	33.79		55.64	10.80	-85.34
2004						
2005						
2006						
2007	-292.00				17.00	
2008			5.11	2.90		
2009			5.65	2.86		
2010			30.31	13.71		
2011			27.09	10.94		
2012			18.46	6.66		
2013			12.53	4.03		
2014			12.53	3.60		
2015			12.53	3.21		
2016			12.53	2.87		
2017			12.53	2.56		
2018		184.93	12.53	2.29		

Discount Rate = 12%

Life of Interconnection = 30years

Ignoring Maintenance Cost of Interconnection

(2) Demand and Supply Balance

The demand and supply balance of each island needs to be checked. Power shortages may

occur due to the delay or cancellation of power development. Therefore, it is necessary to check the probability of each power development project.

It should also be considered that interconnection avoids power shortages caused by unpredicted demand increase.

(3) Reliability

Reliability also needs to be checked for interconnection planning. If the system does not satisfy the N-1 rule, an interconnection is necessary.

Reliability can be also improved by power development in the island.

(4) Other

The impact on the transmission charge, the advantage of a united system for the spot market and political issues should also be evaluated in planning interconnection.

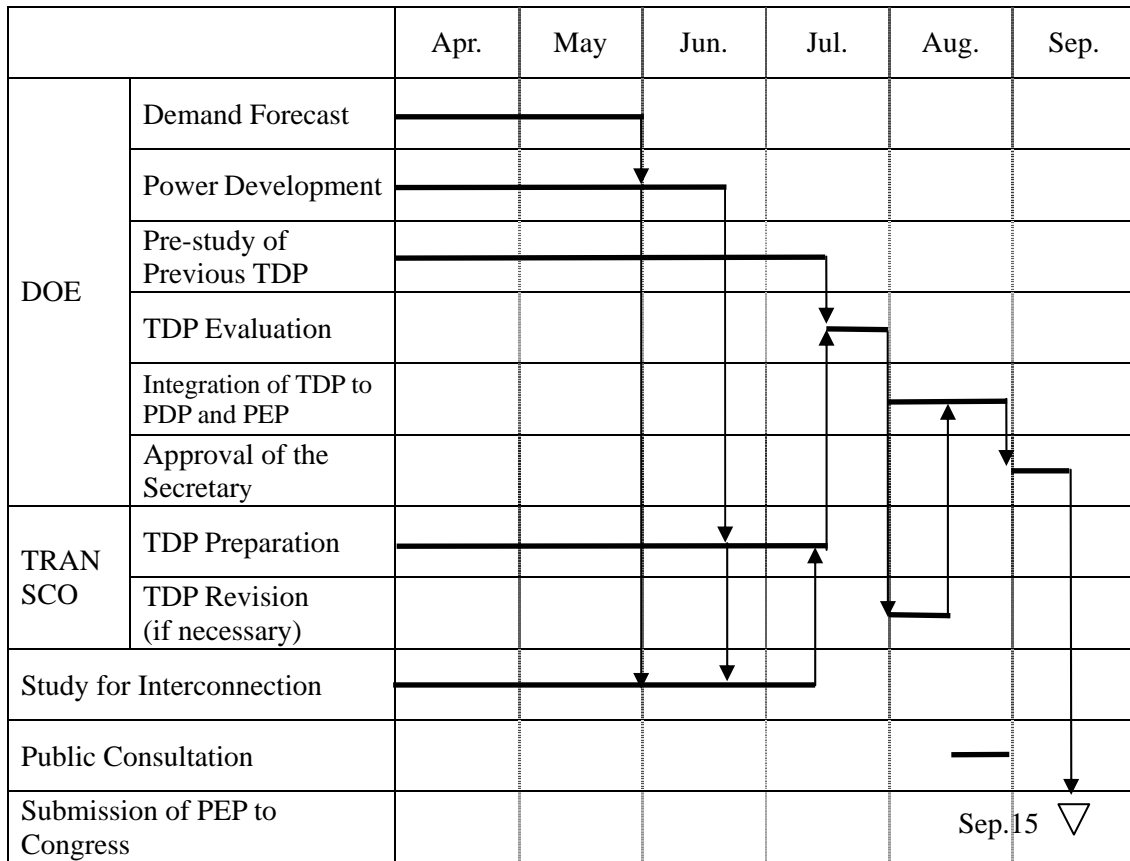
4. Schedule

Figure 4.1 shows the schedule for TDP preparation and TDP evaluation.

TRANSCO prepares TDP in coordination with the demand forecast and the power development plan prepared by DOE. After submission of TDP by TRANSCO, DOE evaluates and approves it, and integrates it into PDP and PEP. Therefore, the schedule is very tight.

To cope with this tight schedule, a pre-study for TDP evaluation is implemented from April based on the previous TDP and the latest information. After the demand forecast and power development plan are finalized, and the latest TDP is prepared, the points that have changed from the previous TDP are checked.

Fig 4.1: Schedule for TDP preparation and evaluation



5. Methodology for Evaluation

5.1 Reliability

5.1.1 Reliability Criteria

For power development, probabilistic methodology has been established, such as the Loss of Load Probability (LOLP) Method. However, regarding transmission planning, where such methodology has not been developed, the N-1 rule is internationally adopted.

This means that not only is there no interruption without a contingency, but also that all demand can be supplied with an N-1 outage contingency (such as the outage of one generator, one circuit of transmission line or one transformer). In addition to this, the criterion that does not allow large area and long period blackouts is often adopted.

Under Section 2 of the act, the policy of the state is to ensure the quality, reliability, security and affordability of the electric power supply. TRANSCO shall comply with the provision of the Grid Code in the process of improving and expanding its transmission facilities under Section 9 of the act and Section 9 of Rule 6.

Although the criteria for system expansion are not concretely stated in the Grid Code, Chapter 7 (Grid Operations) states that the N-1 rule should be adopted for grid operation criteria.

To accommodate continuing to operate in the normal state following the loss of one generating unit, transmission line, or transformer, the N-1 rule needs to be applied for planning.

However, as the transmission system in the Philippines is evolving, strict application of the criteria may not be suitable or practical for specific stages in transmission planning. Therefore, it is desirable to develop the system step by step to accommodate the N-1 rule, considering the effect of blackouts and investment.

[Grid Code]

Chapter 7 Grid Operations

7.2 Grid Operating States, Operating Criteria, and Protection

7.2.1 Grid Operating States

7.2.1.1 The Grid shall be considered to be in the Normal State, when:

- (a) The Operating Margin is sufficient;
- (b) The Grid Frequency is within the limits of 59.7 and 60.3 Hz, as specified in Section 3.2.2;
- (c) The voltages at all Connection Points are within the limits of 0.95 and 1.05 of the nominal value, as specified in Section 3.2.3;
- (d) The loading levels of all transmission lines and substation Equipment are below 90% of their continuous ratings; and
- (e) The Grid configuration is such that any potential fault current can be interrupted and the faulted Equipment can be isolated from the Grid.

7.2.2 Grid Operating Criteria

7.2.2.1 The Grid shall be operated so that it remains in the Normal State.

7.2.2.2 The Grid shall be operated and maintained to meet the Power Quality standards specified in Article 3.2.

7.2.2.3 The Security and Reliability of the Grid shall be based on the Single Outage Contingency criterion. This criterion specifies that the Grid shall continue to operate in the Normal State following the loss of one Generating Unit, transmission line, or transformer.

5.1.2 Performance Indicators

The reliability level of TRANSCO is evaluated by checking the historical trend of the following indicators, which are specified in Section 7 (C) of Rule 6:

(1) Number of Interruption Events

Number of interruption incidents per year (caused by failure of the TRANSCO system)

(2) Sustained Average Interruption Frequency Index (SAIFI)

$$\text{SAIFI} = \frac{\text{Summation of connected MVA impacted by outages } > 10 \text{ min.}}{\text{Total connected MVA}}$$

(3) Momentary Average Interruption Frequency Index (MAIFI)

$$\text{MAIFI} = \frac{\text{Summation of connected MVA impacted by outage } \leq 10 \text{ min.}}{\text{Total connected MVA}}$$

(4) Sustained Average Interruption Duration Index (SAIDI)

$$\text{SAIDI} = \frac{\text{Summation of (Outage MVA x minutes } > 10 \text{ min.)}}{\text{Total connected MVA}}$$

(5) System Interruption Severity Index (SISI)

$$\text{SISI} = \frac{\text{Total Delivery Point Unserved Energy (MWh)}}{\text{System Peak Load (MW)}}$$

(6) Frequency of tripping per 100 c-km (FOT)

$$\text{FOT} = \frac{\text{Summation of Tripping Incidents}}{\text{Total Ckt length/100 ckt.km.}}$$

(7) Average Forced Outage Duration (AOD)

$$\text{AOD} = \frac{\text{Summation of Outage Duration}}{\text{Sum of Frequency}}$$

(8) Accumulated Time Error (ATE)

The yearly summation of the number days, of which accumulated time error is +/- 7.5 seconds or more

(9) Frequency Limit Violation (FLV)

The yearly summation of the number of days in case the number of violations of the permissible frequency deviation (plus minus 0.3 Hz, based on the Grid Code) exceeds 25 (rainy season) or 30 (dry season)

(10) Voltage Limit Violations (VLV)

The yearly of the number of days, in case the voltages violate the permissible deviation (+/- 5%, based on the Grid Code)

It should be noted that SAIFI and SAIDI in the Philippines are different from those applied internationally. Internationally, SAIFI stands for the System Average Interruption Frequency Index, which means the number of interruptions per customer. SAIDI stands for the System Average Interruption Duration Index, which means the duration of interruptions per customer.

5.1.3 Power Quality

Under Grid Code 3.2, TRANSCO has to ensure the quality of electric power in the grid.

A power quality problem exists when at least one of the following conditions is present and significantly affects the normal operation of the system:

- (1) The system Frequency has deviated from the nominal value of 60Hz;
 - (2) Voltage magnitudes are outside their allowable range of variation;
 - (3) Harmonic Frequencies are present in the system;
 - (4) There is imbalance in the magnitude of the phase voltages;
 - (5) The phase displacement between the voltages is not equal to 120 degrees;
 - (6) Voltage Fluctuations cause Flicker that is outside the allowable Flicker Severity limits;
- or
- (7) High-frequency Overvoltages are present in the Grid.

However, these matters are the responsibility of ERC regulation. Therefore, DOE does not need to check all of these problems unless they threaten the reliability of the power system and safety.

5.2 Technical Check Points

5.2.1 Grid Code

Under Section 9 of Rule 6, TRANSCO needs to comply with the Grid Code in improving and expanding its transmission facilities to ensure and maintain the reliability, adequacy, security, stability and integrity of the grid.

Chapter 6 of the Grid Code states the responsibilities of TRANSCO regarding grid planning. Based on this, TRANSCO needs to conduct impact studies regarding the connection of new facilities, such as generating plants and load.

The following items are stated in the Grid Code:

- Load Flow Studies
- Short Circuit Studies
- Transient Stability Studies
- Steady-State Stability Analysis
- Voltage Stability Analysis
- Electromagnetic Transient Analysis
- Reliability Analysis

Transient stability analysis is sometimes substituted for the steady-state stability analysis. Electromagnetic transient analysis is usually conducted for detailed study. Reliability analysis is basically studied by DOE under the new act.

Therefore, these three items can be omitted from the TDP evaluation.

(1) Load Flow (Power Flow)

Based on Grid Code 6.3.2, TRANSCO shall perform load flow studies to evaluate the behavior of the Grid for the existing and planned Grid facilities under forecasted maximum and minimum Load conditions and to study the impact on the Grid of the connection of new Generating Plants, Loads, or transmission lines.

DOE needs to check the following points:

- (a) No transmission facilities are overloaded in the normal condition.
- (b) No transmission facilities are overloaded in case of an N-1 contingency (adoption of emergency rating).
- (c) The voltage of each bus is between 0.95 and 1.05 on in the normal condition.

(2) Short Circuit

Based on Grid Code 6.3.3, TRANSCO shall perform short circuit studies to evaluate the effect

on Grid Equipment of the condition of new Generating Plants, transmission lines, and other facilities that will result in increased fault duties for Grid Equipment. These studies shall identify the Equipment that could be permanently damaged when the current exceeds the design limit of the Equipment such as switchyard devices and substation buses. The studies shall also identify the circuit breakers, which may fail when interrupting possible short circuit currents.

DOE needs to check following points:

- (a) The short-circuit currents are within the design limits of the equipment (three-phase short circuit current and single-phase short circuit current are applied).

(3) Transient Stability

Based on Grid Code 6.3.4, TRANSCO shall perform transient stability studies to verify the impact of the connection of new Generating Plants, transmission lines, and substations and changes in Grid circuit configurations on the ability of the Grid to seek a stable operating point following a transient disturbance.

DOE needs to check following points:

- (a) The grid remains stable after any single outage contingency for all forecasted load conditions.
- (b) The grid remains controllable after a multiple outage contingency. In the case of grid separation, no total blackout should occur in any Island Grid.

(4) Voltage Stability

Based on Grid Code 6.3.6, TRANSCO shall perform voltage studies to determine if the Grid is vulnerable to voltage collapse under heavy loading conditions. A voltage collapse can proceed very rapidly if the ability of System's Reactive Power supply to support system voltages is exhausted. The studies shall identify solutions such as the installation of dynamic and static Reactive Power compensation devices to avoid vulnerability to collapse.

DOE needs to check the following point:

- (a) Voltage collapse does not occur under heavy loading conditions.

5.2.2 Planning Criteria of TRANSCO

TRANSCO applies the N-1 rule for TDP preparation to comply with the Grid Code. Meanwhile, in the case of multiple failures, voltage collapse and cascaded outages are not allowed, although load shedding and generation shedding are accepted. Table 5.1 shows the planning criteria of TRANSCO.

[Conditions of the N - 1 Rule]

- The generators must remain stable.
- The under-frequency load shedding must not be activated.
- The power flows must remain lower than the rating of the network equipment and must not overload the remaining element.
- The bus voltages must remain within the limits.

Table 5.1: Planning Criteria of TRANSCO

Acceptable Limits	Allowable Remedial Actions
1. Normal Condition	
- Transmission line loading: <100%	Line reinforcements
- Transformer loading: <100%	Transformers additions
- Steady-state voltage range: +/-5%	Reactive power dispatch or compensation
2. Single-Line Outage (N-1) Contingencies	
- Transmission line loading: <100%	Line reinforcement
- Transformer loading: <100%	Line reinforcement
- Steady-state voltage range: +/-10%	Reactive power dispatch or compensation
- Transiently stable for 3-phase fault with normal clearing	Generator control fine tuning, reactive power dispatch, compensation or additional reinforcement
3. Severe contingencies	
- Transmission line loading: <120%	Automatic load dropping (ALD), generator tripping (GT), transfer tripping scheme (TTS)
- Transformer loading: <120%	
- No voltage collapse	
- No cascaded outages	
4. Load Rejection	
- Dynamic overload: 30%	Excitation system specification, reactive power compensation
- Peak Volts/Hertz ratio: 1.5p.u./p.u.	
- No self-excitation	
5. Line Restoration	
- Maximum voltage difference: 15%	Reactive power compensation
- Maximum open-end voltage: 120%	

Source: T D P 2002-2012 (September 2002)

5.3 Consistency with other Programs

5.3.1 PDP

Consistency with the power development plan prepared by DOE is required for TDP.

Therefore, a check is conducted to determine whether the transmission plan for each power development plan is precisely included in TDP and whether the timing and capacity are consistent with the development plan.

With respect to indicative projects planned by DOE, because definite sites have not been decided, TRANSCO assumes provisional sites for transmission planning. Therefore, the validity of the provisional sites assumed by TRANSCO has to be checked.

5.3.2 DDP

Consistency with distribution development plans prepared by the distribution utilities is required for TDP.

Therefore, a check is conducted to determine whether the distribution plans, such as substation and subtransmission line plans, are consistent with TDP.

Under Distribution Code 6.2.2.2, all Users shall submit the demand forecast to the Distributor for the five succeeding years by calendar week 23 (June) annually. The Distributors prepare DDPs and submit them by March 15 based on the data. Therefore, the demand forecasts for DDPs are based on the previous year in comparison with the demand forecast by DOE.

5.3.3 Transmission Plan of Generation Companies

Under Section 9 of the act, a generation company may develop and own or operate dedicated point-to point limited transmission facilities. Therefore, checking their consistency with TDP is necessary.

Under the act, provided that such assets are required for competitive purposes, their ownership shall be transferred to TRANSCO at a fair market price.

5.4 Other Check Points

5.4.1 Economics

The plan needs to be economical from a long-term perspective. For comparison with an alternative plan, the total present values of investments should be compared. It should be noted that reliability should be at the same level for economical comparison. Table 5.2 shows an example of economic comparison.

Table 5.2: Example of Economic Comparison (MP)

	Alternative 1		Alternative 2	
	Actual Investment	Present Value	Actual Investment	Present Value
2006(Present)	1,666	1,666	11,660	11,660
2007		0		0
2008	7,816	6,231	857	683
2009		0		0
2010	2,025	1,287	1,366	868
2011		0		0
2012	3,067	1,554	683	346
Total	14,574	10,738	14,566	13,557

Note: Discount Rate = 12%

If the initial investment is too large, an alternative plan should be considered, otherwise the initial investment could become stranded cost with the changing situation in the future.

5.4.2 Long-term Planning

After the privatization of TRANSCO, the concessionaire might reduce investment, and appropriate reinforcement might not be implemented for demand increase and power development from a short-term perspective.

In the case of expansion from a short-term viewpoint, reinforcement could be repeated during the short term and this may not be economical. In some cases, as many transmission lines could be constructed in the same area, the landowner would oppose the plan and it would be difficult to implement it.

Therefore, it is desirable that the scales of the facilities accommodate twice or three times the demand.

The adopted voltage should also be checked. In some cases, the transmission lines should be designed for higher voltage for upgrading in the future.

5.4.3 Unit Capacity of Generators

A check is conducted to determine whether the unit capacity of the generator is too large considering frequency drop and load dropping caused by the generator tripping.

Currently, the largest capacities of the generators of each system are as follows:

Table 5.3: Largest Current Unit Capacities

System	Unit Capacity	Plant
Luzon System	654.8 MW	Sual Coal Unit1-2
Visayas System	77.5 MW	Malitbog Geothermal Unit 1-3
Mindanao System	85.0 MW	Pulangui IV Unit 1-3

5.4.4 Interconnection between Islands

(1) Major Interconnection

Interconnections between the main islands are planned by DOE and TRANSCO. Therefore, evaluating them is basically unnecessary.

(2) Small-Island Interconnections

For evaluation of small-island interconnection, the results of economic analysis should be checked between power development with diesel generation on the island and the construction of interconnection. The assumptions for the study also have to be checked.

In addition, the demand and supply balance on the island and reliability should be checked. (Refer to 3.2.2 Methodology for planning interconnection.)

5.4.5 Transmission Charge

The impact on the transmission charge also needs to be checked, if necessary. For a rough estimation, the following calculation can be used:

Incremental Transmission charge for each year =

$$\frac{\text{Additional capital cost for each year (depreciation plus interest)}}{\text{Energy sales of the year}}$$

If the maintenance cost regarding the transmission plan can be estimated, it should be added to the additional cost for each year.

Table 5.4 shows the example of calculation of the incremental transmission charge.

Table 5.4: Example of Incremental Transmission Charge

		2005	2006	2007	2008	2009	2010
Peak Demand(MW)	Luzon	7,473	8,076	8,662	9,323	10,036	10,786
	Visayas	1,172	1,269	1,363	1,469	1,582	1,702
	Mindanao	1,181	1,259	1,331	1,412	1,498	1,586
	Total	9,827	10,604	11,357	12,204	13,117	14,074
Increase Rate			7.9%	7.1%	7.5%	7.5%	7.3%
Load Factor			70.0%	70.0%	70.0%	70.0%	70.0%
Station Use			4.0%	4.0%	4.0%	4.0%	4.0%
Transmission Loss			4.0%	4.0%	4.0%	4.0%	4.0%
Sales Energy (GWh)	(a)		59,822	64,070	68,848	73,997	79,398
[Interconnection]							
Investment (Mp)		4,500.0					
Remaining Value (Mp)		4,500.0	4,350.0	4,200.0	4,050.0	3,900.0	3,750.0
Depreciation (Mp/y)	(b)		150.0	150.0	150.0	150.0	150.0
Interest Rate			12.0%	12.0%	12.0%	12.0%	12.0%
Interest (Mp/y)	(c)		540.0	522.0	504.0	486.0	468.0
Capital Cost (Mp/y)	(d)=(b)+(c)		690.0	672.0	654.0	636.0	618.0
Incremental Transmission Charge (p/kWh)	(e)=(d)/(a)		0.011534	0.010489	0.009499	0.008595	0.007784
5-Year Average			0.00958	0.00958	0.00958	0.00958	0.00958

Ignoring Maintenance Cost

6. Checklist

6.1 Reliability

Items	Check Points
Reliability Criteria	(1) Do the reliability criteria comply with the Grid Code? - Application of the N-1 rule
Reliability Standard	(1) Are the following performance indicators becoming worse? (a) Number of Interruption Events (b) Sustained Average Interruption Frequency Index (c) Momentary Average Interruption Frequency Index (d) Sustained Average Interruption Duration Index (e) System Interruption Severity Index (f) Frequency of Tripping per 100c-km (g) Average Forced Outage Duration (h) Accumulated Time Error (i) Frequency Limit Violation (j) Voltage Limit Violations

6.2 Technical Check Points

Items	Check Points
Power Flow	(1) No transmission facilities are overloaded in the normal condition. (2) No transmission facilities are overloaded in case of an N-1 contingency. [cf. TRANSCO adopts an emergency capacity rating (110% of the normal capacity rating) in case of an N-1 contingency.] (3) The voltage of each bus is between 0.95 and 1.05 in the normal condition. [cf. TRANSCO adopts a voltage range between 0.9 and 1.1 in case of an N-1 contingency.]
Short circuit	(1) The short-circuit currents are within the design limits of the equipment (a three-phase short circuit current and single-phase short circuit current are applied.)
Transient Stability	(1) The grid remains stable after any single outage contingency for all forecasted load conditions. (2) The grid remains controllable after a multiple outage contingency. In the case of grid separation, no total blackout should occur on any island.
Voltage Stability	(1) Voltage collapse does not occur under heavy loading conditions. [cf. TRANSCO adopts no voltage collapse with a severe contingency.]

6.3 Consistency with other Programs

Items	Check Points
Consistency with PDP	(1) Is TDP consistent with the power development plans prepared by DOE?
Consistency with DDP	(1) Is TDP consistent with the development plans of substations and sub-transmission lines prepared by the distribution utilities?
Consistency with other planning	(1) Is TDP consistent with the transmission planning of generation companies?

6.4 Other

Items	Check Points
Economics	(1) Is the plan economical? (2) Is the initial investment not too large?
Long-term planning	(1) Are expansions not repeated over a short period? (It is desirable that the scales of the facilities should accommodate the twice or three times the demand) (2) Do the facilities have adequate margins to accommodate additional power development and demand increase? (3) Is the adopted voltage adequate? (4) Should the facilities be designed for higher voltage for upgrading in the future?
Unit capacity of generator	(1) Is the unit capacity of the generator too large considering frequency drop with a generator tripping? (With a generator fault, does a lot of load need to be rejected?)
Interconnection between small Islands	(1) Is power shortage expected on the island? (2) Is the interconnection plan economical compared with power development? (3) Is the interconnection needed for reliability? (4) Are the timing and the capacity of the interconnection appropriate considering the demand forecast? (5) Do the advantages of the interconnection outweigh the disadvantages?
Transmission Charge	(1) Is the impact of the plan on the transmission charge at an allowable level?

Appendix

This appendix consists of the following contents:

- 1 Compilation in Dynamic Simulation
- 2 Path Addition for PSS/E

1 Compilation in Dynamic Simulation

1.1 Necessary cases

- When dynamic simulation is conducted for power systems including DC interconnections (e.g. the Philippine system)
- When user-written routine orders are added
- When user-written models are added

1.2 Reason why this procedure is needed

PSS/E searches "dsusr.dll" when it starts. The original "dsusr.dll" deals with neither DC interconnections, user-written routine orders nor user-written models. So if the currently analyzed power system includes them, it is necessary to create a new "dsusr.dll" before dynamic simulation.

1.3 Conditions that re-compilation is necessary

Once a new "dsusr.dll" is created, you do not need to re-create it unless you change the currently analyzed power system parameters. However, dynamic simulation is usually conducted in different conditions. The following table shows the cases where re-compilation is necessary and not necessary:

Cases	Re-compilation
Cases where components of AC devices such as transmission lines, machines and so on are changed. For example <ul style="list-style-type: none"> ➤ Case where the value of "Pgen" is changed ➤ Case where the value of "Line R" is changed ➤ Case where new lines are added to the data 	Not necessary
The following cases where components of DC devices (e.g. two-terminal DC lines) are changed: <ul style="list-style-type: none"> ➤ Case where control mode is changed from "power" to "current" ➤ Case where the value of "Setval" is just changed without adding code in any of the connection subroutines or without creating user models 	Not necessary

Cases	Re-compilation
The following cases where components of DC devices (e.g. two-terminal DC lines) are changed: <ul style="list-style-type: none"> ➤ Case where the value of "Setval" is changed by adding code in any of the connection subroutines or by creating user models 	Necessary
Cases where DC interconnections, user-written routine orders or user-written models are newly added	Necessary

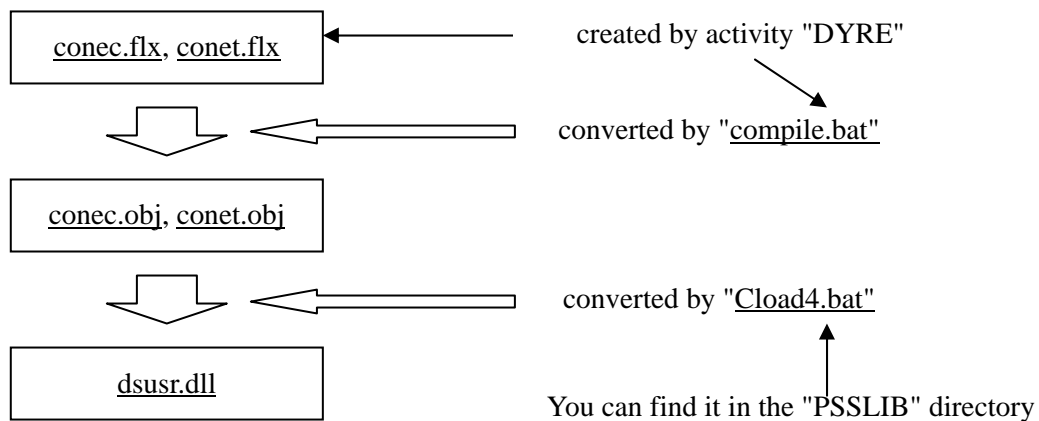
1.4 Flow of compilation procedure

(1) First step

Subroutine files ("conec.flx" and "conet.flx") are converted to object files ("conec.obj" and "conet.obj") using "COMPILE.bat".

(2) Second step

The object files ("conec.obj" and "conet.obj") are converted to an order file ("dsusr.dll") using "Cload4.bat".



1.5 Detailed procedures

Procedures	Remarks
<p>A) Setting up PSS/E dynamic simulation</p> <ol style="list-style-type: none"> 1. Create a folder in your favorite place 2. Name it anything you like E.g.: C:\ABC project analysis 3. Create a new shortcut for "Pssds4" on the Windows desktop (..\PTI\psse29\PSSEXEX\Pssds4.exe) 4. Change the "start in" directory in the Pssds4 shortcut properties into "C:\ABC project analysis" 	<p>PSS/E is usually started by clicking the shortcut icon. If you already have the shortcut for Pssds4, you do not need to create a new one. Identify your working directory ("Start in" directory) in your shortcut properties</p>
<p>B) Prepare the data you want to analyze</p> <ol style="list-style-type: none"> 1. Copy the following data you want to analyze and paste them in the working directory: ***.sav, ***.dyr. 	
<p>C) Prepare required files to conduct compilation</p> <ol style="list-style-type: none"> 1. Copy the original "cload4.bat" in the "..\PTI\PSSE29\PSSLIB" and paste it in the working directory as the same name. 	<p>The original "cload4.bat" exists in the "..\PTI\PSSE29\PSSLIB".</p>
<p>D) Launch the "Pssds4.exe"</p>	
<p>E) Go to the load flow environment</p> <ol style="list-style-type: none"> 1. Load flow > LOFL 	
<p>F) Read load flow data</p> <ol style="list-style-type: none"> 1. File > Open > Read Saved Case File (*.sav) 	<p>If you have converted data, you can read it instead of unconverted data and skip procedure G)</p>
<p>G) Prepare a converted load flow file</p> <ol style="list-style-type: none"> 1. Convert the file <ol style="list-style-type: none"> a. Edit > Convert > CONL/RCNL (Load Conversion) b. Edit > Convert > CONG (Generator Conversion) 2. Ordering network Power flow > Solution > ORDR 3. Factorize admittance matrix Power flow > Solution > FACT 4. Refine the load flow solution Power flow > Solution > TYSL 5. Save the converted file as a different name File > Save As " *_cnv.sav 	<ol style="list-style-type: none"> 1. Generators and loads are converted in preparation for dynamic simulation. <ol style="list-style-type: none"> a. Typical numbers are as follows: P; Constant I = 100%, Constant G=0% Q; Constant I = 0%, Constant G=100% b. "Use- Zsorce" is usually selected "Zpos" is used for unbalanced fault analysis "Assume all branches are in-service" is usually selected. In case of memory shortage, "Ignore out-of-service" is selected to save memory. "Use voltage vector as start point" is usually used "TYSL" is executed to remove mismatch after conversion.

Procedures	Remarks
H) Go to the dynamic simulation environment 1. Dynamics > RTRN	
I) Read dynamic modeling data 1. File > Input > read dynamic modeling data (DYRE) a. Read dynamic modeling data (***.dyr) b. Create "conec.flx", "conet.flx" and "compile.bat". i) Push "select" button for the "conec file" ii) Type "conec" in the blank and select "open". iii) Push "select" button for "conet file" iv) Type "conet" in the blank and select "open". v) Push "Select" button for "compile file" vi) Type "compile" in the blank and select "open". vii) Select "OK" 2. Stop PSS/E	Appearance of the new "conec.flx", "conet.flx" and "compile.bat" in the working directory The following compilation procedures cannot be continued without finishing PSS/E once.
J) Implementation of compilation 1. Double click on "Compile.bat" in the working directory	Appearance of the new "conec.obj" and "conet.obj" in the working directory.
K) Implementation of Cload4 1. Double click on "cload4.bat" in the working directory 2. Move the newly created "dsusr.dll" to the PSSEXEXE directory	Appearance of the new "dsusr.dll" in the working directory. The "dsusr.dll" is an indispensable file to conduct dynamic analysis. See the section 4.1.5 If you have an old "dsusr.dll" in the PSSEXEXE directory, you need to rename it or delete it in advance.
Relaunch Pssds4 Continue dynamic analysis based on the normal procedure.	You do not need to input "conec.flx", "conet.flx", and "compile.bat" this time. You can ignore the message, "COMPILE AND CLOAD4 BEFORE RUNNING SIMULATIONS", because you have already conducted this procedure.

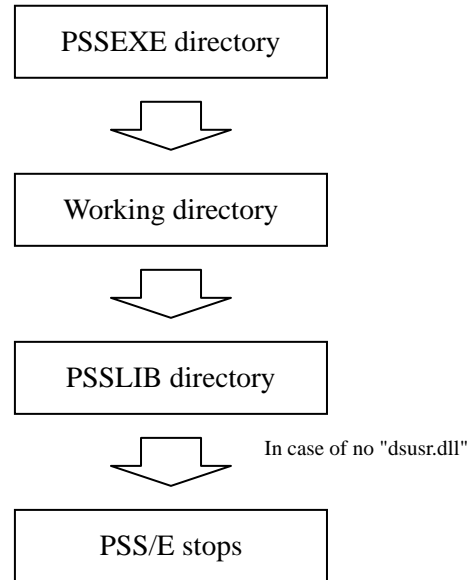
1.6 Preferable location of "dsusr.dll"

At first, PSS/E searches "dsusr.dll" in the "PSSEXEXE" directory where PSS/E executable files are stored, then in the "working directory" ("Start in" directory) and finally in "PSSLIB" directory. If there is no "dsusr.dll" file in these three directories, PSS/E will stop. The original "dsusr.dll" file is stored in the PSSLIB directory.

The "PSSEXEXE" directory has first priority for PSS/E to search "dsusr.dll". Therefore, it is preferable to move the newly created "dsusr.dll" file to the "PSSEXEXE" directory.

You need to pay attention to which "dsusr.dll" file is used for dynamic simulation because PSS/E may have several "dsusr.dll" files in different directories.

Searching order for "dsusr.dll"



1.7 Necessary software

COMPAC Visual Fortran compiler (Standard Edition) Version 6.6B or higher version.
(<http://www.compaq.co.jp/products/dvf/visual/index.html>)

1.8 Reference

POM vol 5-1-2, Installing PSS/E 2.2.2 and Installing PSS/E

2 Path Addition for PSS/E

2.1 Necessary cases

This procedure is necessary if you cannot create the objective files ("conec.obj" and "conet.obj") using "COMPILE.bat", or if the object files ("conec.obj" and "conet.obj") cannot be converted to an order file ("dsusr.dll") using "Clod4.bat".

2.2 The cause of this Problem

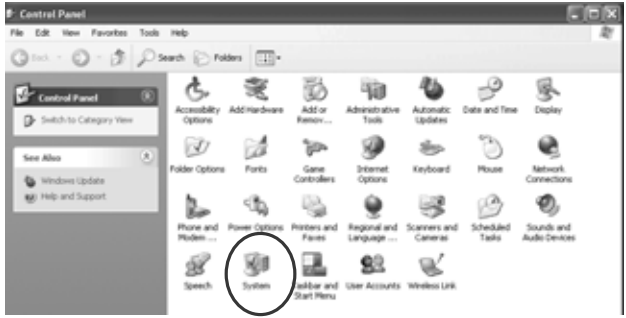
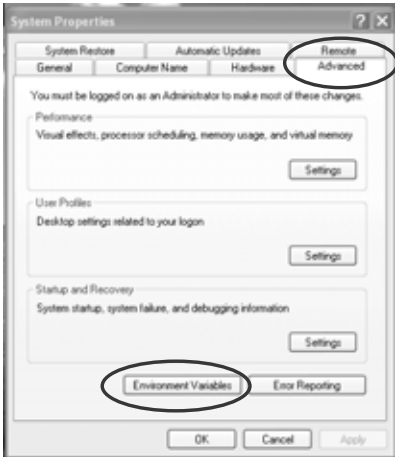
In the above-mentioned cases, the path for PSS/E could not be created while PSS/E was installed. Therefore, batch files including the path for PSS/E do not work. You can check whether the path for PSS/E is successfully created or not, using the "command prompt".

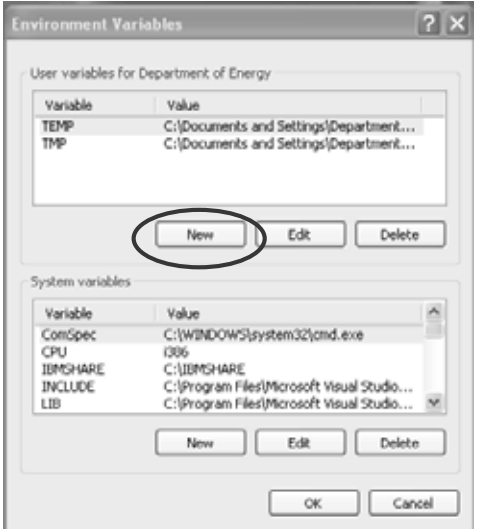

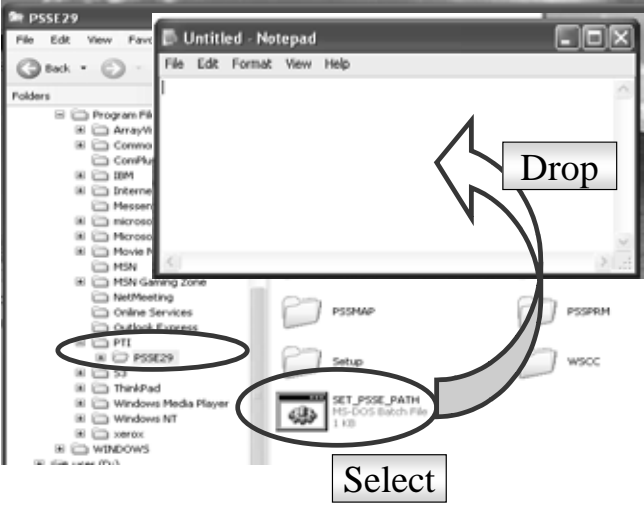
- i) Start menu > Program > Accessory > Command prompt
- ii) Input "set"


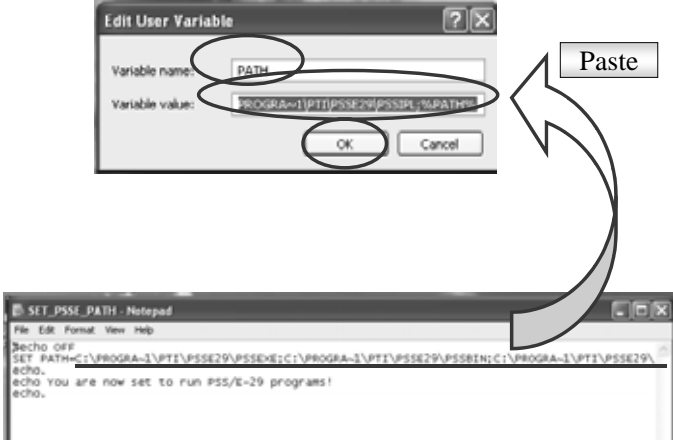
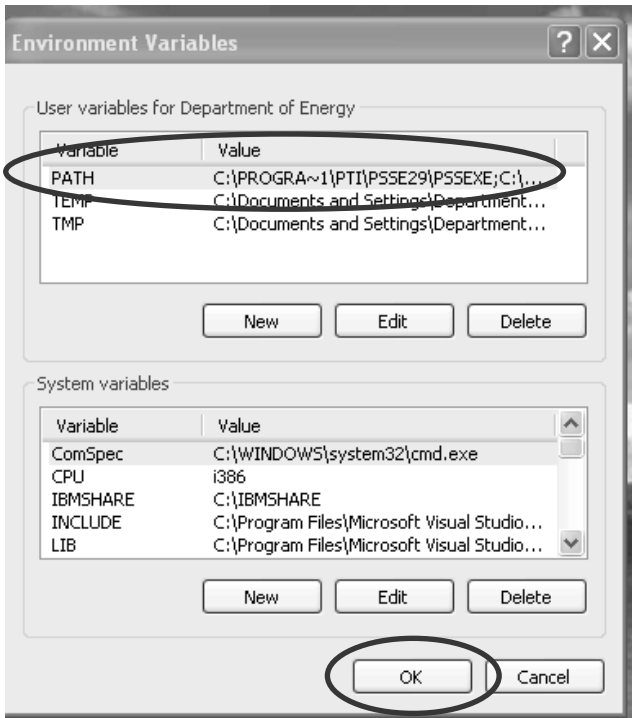
2.3 Countermeasure against this Problem

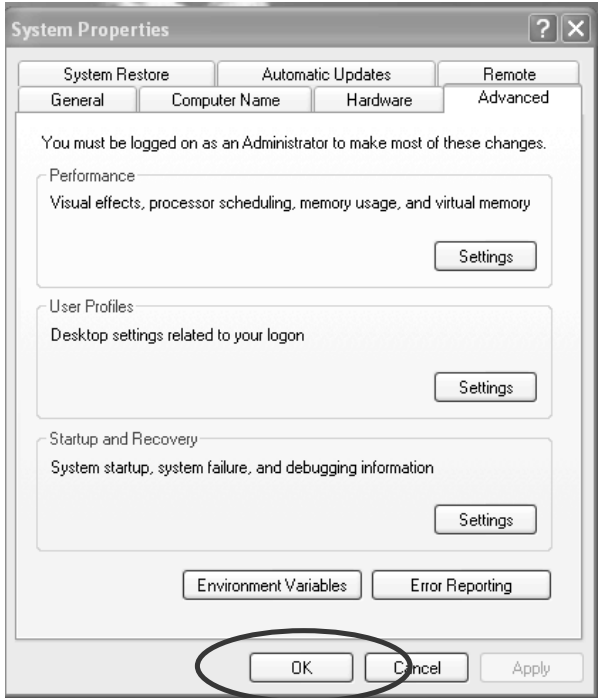
The necessary path for PSS/E is installed, by editing the "environment variables".

2.4 Procedures of this countermeasure

	Instructions	Screen
1	<p>Control Panel</p> <p>i) Open "System" in the control panel.</p>	
2	<p>System Properties</p> <p>i) Select the "Advanced" tab. ii) Select "Environment Variable" to edit and add new environment variables.</p>	

	Instructions	Screen
3	<p>Environment Variables</p> <p>i) Select “New” to add the new environment variable, “PATH”, to user variables</p>	
4	<p>New User Variable</p> <p>i) This screen, for adding a new environment variable, appears.</p> <p>ii) Leave this screen and go to the next step</p>	
5	<p>Open "SET_PSSE_PATH.bat" by Notepad</p> <p>i) Launch Notepad</p> <p>ii) Select “SET_PSSE_PATH.bat” in the PSSE29 directory and drop it on the Notepad screen to see the path.</p>	

	Instructions	Screen
6	<p>Select Effective Path in the "SET_PSSE_PATH.bat"</p> <p>i) Select "C:\PROGRA~1\PTI\"Select all characters in the second line except "SET PATH=".</p> <p>ii) Copy it using "Copy " in Edit menu.</p>	
7	<p>New User Variable</p> <p>i) Paste what you copied in the blank for variable value</p> <p>ii) Type "PATH" in the blank for variable name.</p> <p>iii) Click "OK" to close window.</p>	
8	<p>Environment Variables (PATH added)</p> <p>i) Confirm the new "PATH".</p> <p>ii) Click "OK" to close window.</p>	

	Instructions	Screen
9	<p><i>Environment Variables (PATH added) cont'd</i> i) Click "OK" to close window.</p>	 <p>The screenshot shows the 'System Properties' dialog box with the 'Advanced' tab selected. The 'Performance' section is expanded, showing 'Visual effects, processor scheduling, memory usage, and virtual memory' with a 'Settings' button. The 'User Profiles' section is expanded, showing 'Desktop settings related to your logon' with a 'Settings' button. The 'Startup and Recovery' section is expanded, showing 'System startup, system failure, and debugging information' with a 'Settings' button. At the bottom, there are buttons for 'Environment Variables' and 'Error Reporting'. The 'OK', 'Cancel', and 'Apply' buttons are at the very bottom, with the 'OK' button circled in red.</p>



**Manual
for
the Power Development Plan
Preparation
(MEDP)**

Section 5 Rural Electrification

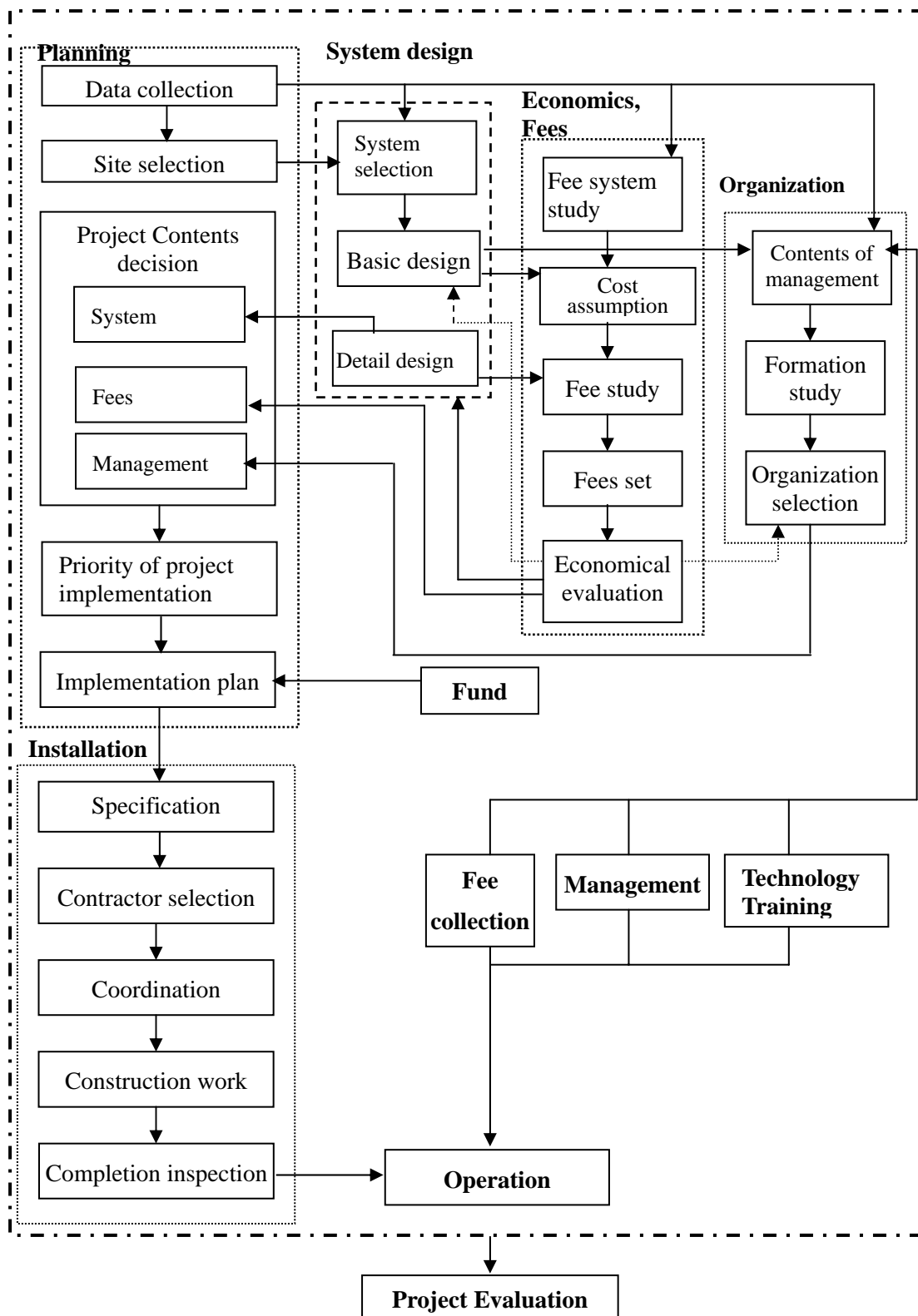
Rural electrification projects have been implemented in many areas over the world. However, sustainable system management was not considered sufficient after their introduction. Therefore, many systems could not be managed appropriately for a long time because of lack of maintenance. Currently, based on these experiences, it is important to carry out a sustainable project where a system can be carefully maintained for a long time.

To prepare the rural electrification plan, it is necessary to consider the whole process flow of the project that includes planning, system design, installation, fee setting and building management organizations, etc. From this point of view, therefore, this manual is consists of the following.

- 1 General process flow of the rural electrification project and planning steps**
- 2 Concept of the manual**
- 3 Workflow and organizations concerned**
- 4 Schedule**
- 5 Key points**
- 6 Data collection and database**
- 7 Selection procedure for electrification**
- 8 Training**
- 9 Establishment of the operation and management system**

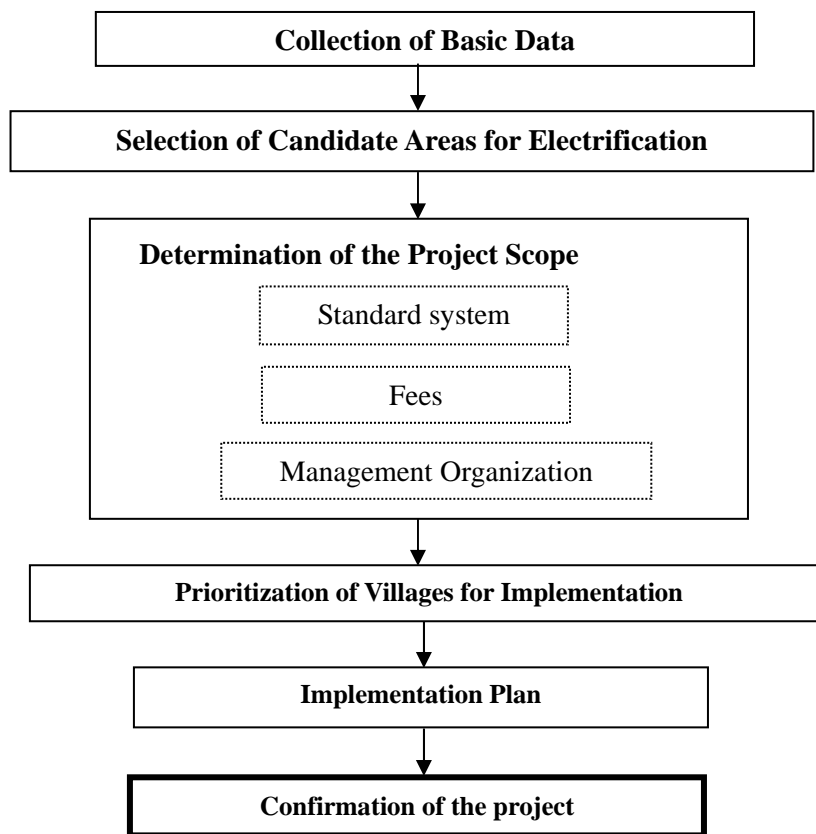
1. General process flow of the rural electrification project

General process flow of the rural electrification project is described as follows. The project promotion steps are indicated to show how they relate.



To implement the rural electrification project, it is necessary to make a specific project plan considering scope, site and cost. This work is planning. The flow of planning is shown in the diagram below. First, basic data needed to determine the scope of a project and sites are collected. Based on these data, an area to implement rural electrification project is selected. Then the appropriate scope of the project, such as the standard system, fees and management organization, etc., is studied. Next, the appropriateness of the planned project is verified through economic analysis, etc., and the scope of the project is determined. Finally, to decide on the project, a priority order of areas selected for the project is determined, necessary costs are calculated, and a financial plan is made.

< Flow of planning >



[Points for Planning]

(1) Sustainable project

A sustainable project is a system that is carefully maintained for a long time. Project cost, such as system cost and maintenance cost, is collected as an electricity charge or a service charge. When the government starts a rural electrification project, the most important issues are funds and technical foundation. There are many fund options such as grant support and various loans. It is

desirable that the necessary cost is collected from residents and through government assistance in promoting a project. It is also important to decide on the electricity charge by considering capability of resident payment. For technical foundation, it is desirable that installed systems are easy to handle and maintain, as residents are not familiar with the system or with electricity. Furthermore, it is important to establish an organization that trains, educates and provides technical support for the site engineer, to maintain the systems for a long time.

(2) Clarification of the project objective

It is important to clarify the role, policy and objective of rural electrification projects for planning and implementing. The project scope, such as system design, fee setting and management organization should be studied according to the policy and the objective. If the policy and the objective are not clear, the project will become unfocused project.

(3) Collection of appropriate data

As planning is carried out based on the collected data, appropriate data is needed. These data can be collected from the related authorities using various ways such as interview and questionnaire survey. For data collection, it is important to select items and effectively pick necessary data for compilation and arrangement. It is also important to verify the reliability of the data.

(4) Project evaluation

It is important to evaluate a planned project considering the appropriateness of content and problems. This work should be carried out before implementation of a project. If funds are procured from international organizations, etc., the results of project evaluation will be reflected for financing examination by these organizations.

2. Concept of the manual

Rural electrification, which is described in this manual, is included not only in the Missionary Electrification Development Plan (MEDP) decided by EPIRA, but also in the expansion of the electrification area where the existing grid line is extended by the Distribution Utilities. This manual concentrates on the following points:

- Work flow and schedule
- Responsibilities of the organizations concerned in rural electrification

This manual has been created to prepare rural electrification plans. However, the prepared plan based on this manual is not for evaluating individual plans. This plan provides a comprehensive view of rural electrification in the Philippines. The rural electrification plan is a subordinate plan of PDP and is prepared so that the necessary data of this plan are considered as being consolidated into PDP and PEP. PDP and PEP has to show a prospect of power development to private sectors. Therefore, the manual is prepared from the perspective of both the customer and the investor. It is not prepared from the perspective of the supplier. The procedure for preparing the manual is described in the following paper.

3. Workflow and organization concerned

3.1 Workflow of preparation of the rural electrification plan

The workflow for the preparation of rural electrification is described in Fig. 3.1.

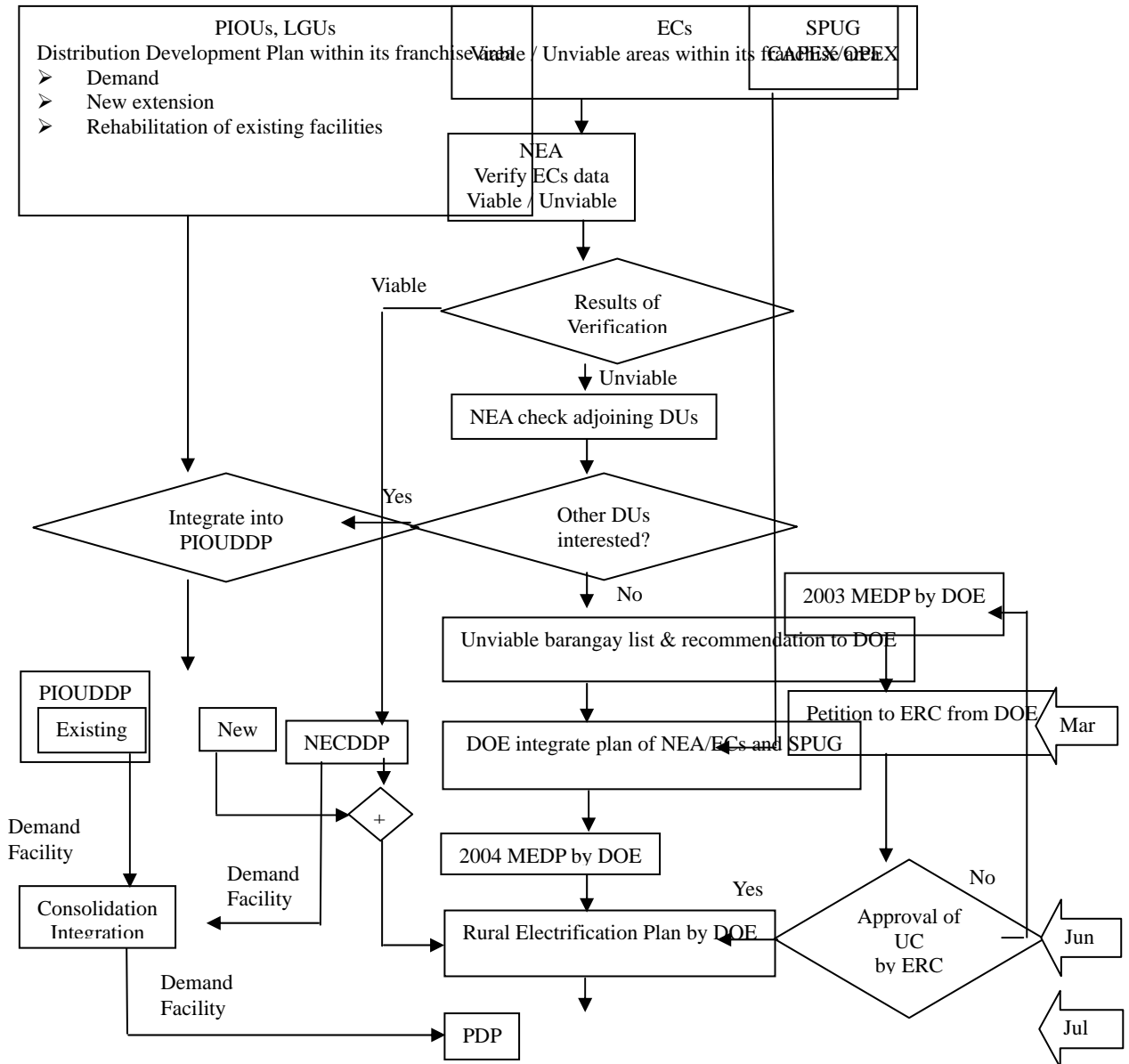


Fig. 3.1 Workflow of preparation of the rural electrification plan

Based on this workflow, the key points are as follows.

- (1) Classification of viable / unviable barangay in the franchise area of the distribution utilities

and NEA/ECs.

The distribution utilities and NEA/ECs classify all unenergized barangays as viable / unviable in their the franchise area. The criteria of classification are given below.

- 1) Grid extension
 - It is comparatively easy to access the existing grid network.
 - Grid extension is the most economical.
 - The number of customers is comparatively high.
- 2) Introduction of new and renewable energy systems
 - Location of the barangay is far from the existing grid network

General criteria are as follows:

 - Land/coastal area : 10 km or more from the existing grid
 - Mountainous area : 3 km or more from the existing grid
 - Island area : 1 km or more from the existing grid
 - Number of customers exceeds 20
 - Customers who can pay fees

3.2 Confirmation of contents of the submitted document from the subordinate organization by NEA/DOE

NEA evaluates and integrates the unenergized barangay list, which is classified and prepared by ECs and submitted to DOE. On the other hand, DOE evaluates and integrates the electrification plan, which is submitted directly from the distribution utilities and the local government utilities.

3.3 Investigation of electrification method of unenergized area by NEA

Based on the unenergized barangay list by the ECs, according to the promotion management map on NEA, NEA asks the adjoining ECs about the availability of grid extension. If the adjoining ECs decide to extend the grid line, these nominated barangays are added to the grid extension list (viable list). If the distribution utilities are not interested, the names of these barangays are kept on the unviable barangay list.

3.4 Consolidation of each electrification plan by DOE

DOE consolidates the viable/unviable barangay list from NEA, the electrification plan of the distribution utilities and the SPUG plan (OPEX and CAPEX is included), and prepares the rural electrification plan.

3.5 Appraisal and approval of the universal charge by ERC

Based on MEDP, DOE petitions ERC for a universal charge to implement rural electrification. DOE confirms the results of the appraisal of the universal charge by ERC. Based on these results, DOE reviews the plan if necessary.

3.6 Responsibilities of the organizations concerned

Various governmental organizations and power companies etc., promote rural electrification. Therefore, to achieve the target of barangay electrification, it is important that there is mutual communication among these organizations and that the responsibilities of each organization are clarified at each step of the workflow. The relation of the organizations concerned is described below.

Table 3.1 Related organizations

Organization	Prepared Plan	Responsibilities	Fund Source
DOE	MEDP DDP	Preparation of PEP (Philippine Energy Plan) and PDP (including subordinate plans) Promotion of utilization of indigenous and renewable energy Promotion of rural electrification	ER1-94 National Budget
NEA-EC	NEA EC	NECDDP Management of ECs Improvement of ECs operation Promotion of electrification by grid extension Preparation of electrification plan in its franchise area Promotion of electrification by grid extension	NEA Budget ECs investment
NPC-SPUG	MEP	Promotion of electrification in the missionary area (management of UC use) Management of existing facilities	UC
ERC		Appraisal and approval of universal charge	
PNOC-EDC		Promotion of electrification by introduction of renewable energy	PNOC-EDC own ER1-94 National Budget
PIOUs	PIOUDDP	Promotion of electrification by grid extension Collection of universal charge from beneficiaries	PIOUs own ER1-94

4. Preparation schedule of rural electrification plan

Benchmarks in the preparation of the rural electrification plan are as follows.

15th Mar: Submission of electrification plans to DOE from the organization concerned

End of June: Approval of the universal charge / finalization of MEDP / consolidation with PDP

15th Sep: Opening of list of unviable barangays

The schedule of rural electrification preparation is described in the following chart.

5. Key points in preparing the rural electrification plan

5.1 Data collection

- Basically, by 15th of Mar, NEA/ECs and PIOU (Private Investor Owned Utilities) submit their own plan to DOE. To do this, NEA collects the necessary data from EC and makes a decision on viability. Finally, viable barangays are listed in NECDDP (grid extension plan) and unviable barangays are listed in the missionary electrification plan.
- PIOU prepare their own plan; however, this plan includes the new electrification of unenergized areas and rehabilitation of existing facilities. DOE only considers integrating new electrification plans into the rural electrification plan. However, PIOU make a decision on viability in preparing the viable/unviable list.
- Format for collecting data will be attached.

Regarding the distribution plan, which is submitted by the distribution utilities, demand forecast and the facility plan are evaluated, and necessary data are transferred to the fixed format, which is distributed by DOE.

5.2 Evaluation of subordinate programs

- DOE consolidates the list of unviable barangays, which is submitted by NEA/EC and PIOU, and prepares MEDP adding CAPEX (Capital Expenditure)/OPEX (Operation Expenditure) and new SPUG installation.
- Rural electrification, which consolidates MEDP, NECDDP by NEA/EC and DDP by PIOU, is finalized in July and consolidated into PDP.
- SPUG prepares the management and operation plan of the existing facilities and calculates OPEX and CAPEX. SPUG also prepares the new installation plan and submits it to DOE.
- DOE evaluates the validity of the new installation plan and contents of OPEX/CAPEX. After evaluation, DOE submits the rural electrification plan to ERC.

5.3 Consolidation with PDP

- For an unviable barangay electrification plan, MEDP is prepared based on the introduction of an individual power source. MEDP is combined with the grid extension plan, which is part of NECDDP by NEA and DDP by PIOU, to make the rural electrification plan.
- The facility plan and demand forecast of DDP, which are prepared by the distribution utilities and rural electrification plan, will be integrated into PDP. Demand forecast will

be used for checking the demand forecast using macro demand analysis.

5.4 Petition for the universal charge

- Criteria of prioritization of MEDP projects will be clarified and described.
- The portion of OPEX, which is required during existing operation hours for the existing diesel facilities, is evaluated for application of appraisal by ERC.

5.5 Promotion of practical electrification

- DOE submits PEP to Congress of the Philippines on 15th of Sep. Parallel to this, the new MEDP list and the existing SPUG facility list are opened to QTP (Qualified Third Parties) and Distribution Utilities.
- If QTP can assist financially, electrification will be promoted using QTP funds and will be deleted from the MEDP list. If QTP do not participate, SPUG assumes care of the barangays on the MEDP list and prepares MEP (Missionary Electrification Plan) using the universal charge. CAPEX and OPEX will be included in this plan.
- MEP is submitted to ERC to obtain approval for UC use. At this stage, when ERC approves UC, practical rural electrification is promoted.
- If UC is not approved by ERC, MEP will be returned to DOE and will be prioritized again as MEDP project. At this stage, barangays that are rejected by DOE are listed again in the following year's MEDP.

6. Basic Data Collection and database

In planning, generally, collected data are on the power system situation and village survey data. This chapter explains the forms and methods of data collection, etc.

6.1 Basic data collection

(1) Situation of power sector

The data of the related power sector are used to verify the situation of electrification and the electrification plan in the country concerned, and to select a project site. The data of electricity fees and organizations will become reference for considering the formation of a project.

1) Power facilities

The existing power facilities introduced by the government or the private sector are surveyed.

- Generation :type and capacity of facilities
- Grid Network :capacity, network diagrams of transmission and distribution, electrified area by grid (including future plan)
- Costs :generating cost, cost of extending transmission and distribution lines.

2) Future plans

The expansion plans of power facility that will be constructed in 5 years by the government or by the private sector.

- Generation : type and capacity of facilities
- Grid Network : capacity, network diagrams of transmission and distribution, electrified area by grid (including future plan).

3) Management organization

The system, personnel and managing conditions of the organizations that supply power is surveyed.

- System : organization chart, location of branch, related organizations
- Personnel : the number of employees and engineers
- Managing conditions : businesses, income and expenditure, wages

- Training : method, program

4) Electricity fees

The rules of power supply, contracts, electricity fees and collection method are surveyed.

- Rules and contract : contents of rules and contract, action in the case of non-payment.
- Electricity fees : sums of each contract, reasons for and method of fee setting.
- Fee collection : collector, period.

b. Data collection methods

Some methods to collect data are shown below. Data is usually collected by Methods 1) and 2).

- 1) Directly from an organization that supplies power
- 2) From a governmental organization that manages power sector organization or makes an electrification plan
- 3) From a local governmental organization

(2) Village society data

Village society data could be reflected to consider a general view of the project, such as selection of project candidate areas, system design, management organization, and fee setting.

a. Data item

1) Statistic data

- Population, number of households, electrification rate, income level, etc.

2) Situation of rural area village

- Location of houses, number of rooms in a house, organizations in the village, main industry, etc.

3) Use of electricity and lighting:

- Use of independent power sources, conditions of electric appliances and lighting equipment, etc.

4) Residents request

- Residents request the local governmental organization or the electric authority, usage hours of electric appliances, affordable electricity fees

b. Data collection methods

There are several methods of collecting data as follows. The data can usually be collected by Method 1). Methods 2) and 3) will be used to obtain detailed data.

- 1) Data that have been compiled as statistical data.
- 2) Interviews with or questionnaire surveys of the local organizations concerned.
- 3) Interviews with or questionnaire surveys of several villages selected at random.

c. Data collection format

Regarding information and data collection for power sector, DDP data collection format is applied. Whereas, village social data is a different point of view and these data are reflected to study number of potential customer, demand forecast etc. Therefore, common format for data collection is needed to prepare. Through this study, we found that NEA has a useful format. The following materials indicate sample formats which NEA use for barangay survey.

Fig 6.1 Social baseline data collection format by NEA (No.1)

National Electrification Administration			
Survey on Barangay Profiling/Identification of Energy Resource in a Barangay			
EC NAME: _____			
A. General Characteristics			
Name of :	Barangay _____	Municipality _____	Province _____ Region _____
Brgy. Classification :	Inland _____	Upland _____	Coastal _____ Island _____
Total land area :	sq. km. _____	Number of Households :	Total Population :
No. of Sitios in the barangay :	_____	No. of Houses :	_____
Presence of :	School/s _____	Health/Medical Center _____	Other Public Bldg/s. _____
B. Socio-Economic Information			
Transportation :	Jeep _____ Tricycle _____ Motorcycle _____ Boat _____ Animal _____ Others _____	Major Produce :	Rice _____ Corn _____ Coconut _____ Vegetables _____ Fruits _____ Others _____
Livelihood Activities :	Grain Mill _____ Copra Drying _____ Vulcanizing, Motor Shop _____ Furniture Making _____ Handicrafts _____ Fishing _____ Others _____	Recreational :	Movie House _____ Billiard/Pool _____ Pvt VCR _____ Beerhouse _____ Videoke _____ Others _____
Local Organizations :	_____ Government _____ NGO _____ Cooperatives _____ Women _____ Youth _____ Religious _____ Others	Water Supply :	_____ Stream _____ River _____ Lakes _____ Wells _____ Stand Pipe System _____ Others
Livestock & Poultry :	_____ Swine/Pig _____ Cattle _____ Chicken _____ Duck _____ Others	Financial/Commercial Org'ns.:	_____ Banks _____ Cooperatives _____ Pawnshops _____ Groceries _____ Markets _____ Others
Educational Inst.	_____ Day Care _____ Elementary _____ High School	_____ College _____ Vocational _____ Others	
C. Energy Supply/Availability			
Kms. away from the nearest tapping point : _____			
No. of gensets installed :	_____	Capacity :	_____
		No. of Households Served :	_____

Commonly Used Source/s of Energy (At present) :

Charcoal : _____	Cooking	LPG : _____	Cooking	Genset : _____	Water Pump
_____	Lighting	_____	Lighting	_____	Lighting
_____	Ironing	_____	Others	_____	Appliance Operation
_____	Others	_____		_____	Others
_____				_____	
_____				_____	
Kerosene : _____	Cooking	Dry Cell _____	Lighting	Batteries : _____	Biomass, _____
_____	Lighting	_____	Appliance Operation	_____	Cooking
_____	Others	_____	Others	_____	Coconut _____
_____		_____		_____	Ironing
_____		_____		_____	Husks, _____
		_____		_____	Lighting
		_____		_____	etc. : _____
		_____		_____	Others
Fuel : _____	Cooking	Wet Cell _____	Lighting		
_____	Lighting	Batteries : _____	Appliance Operation		
_____	Others	_____	Others		
_____		_____			
		_____		Wood : _____	Cooking
				_____	Lighting
				_____	Others

Potential Sources of Energy in the Barangay :

Type	No. of Units	Capacity
Diesel/Generator	_____	_____
Solar PV System	_____	_____
Wind System	_____	_____
Micro Hydro	_____	_____
Biomass, etc.	_____	_____
Others	_____	_____

Fig 6.2 Social baseline data collection format by NEA (No.2)

(3) Other rural electrification projects

If rural electrification projects in the country concerned or neighbor countries are carried out, the system configurations and management conditions of these projects are investigated. The problems and subjects of these projects are also investigated. The other projects are useful as reference in every aspect. In particular, electricity fees of the other projects are an important factor in evaluation for setting fees.

- 1) Project content: Policy, objectives, system configuration, scope of the plan
- 2) Management system : Organization concerned, personnel, location of branch, services to be provided
- 3) Raising funds :Sources, proportion, kinds, repayment plan
- 4) Fees: Fee setting, fee collection method, refund target
- 5) Engineer training: Organization, program of implementation, situation
- 6) Management condition: Income and expenditure of the project
- 7) Subjects: Problems and subjects experienced through the project.

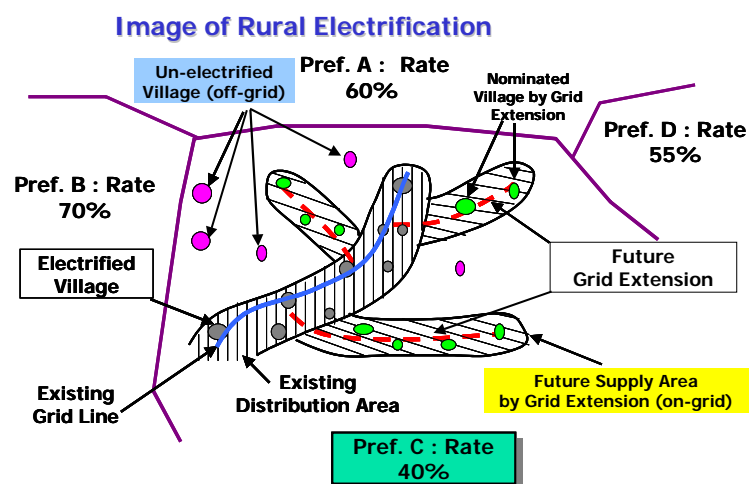
6.2 Database

Basically, the objective of the rural electrification project is to electrify unenergized areas, thus all unenergized areas in the Philippines are candidates. Therefore, selecting and prioritizing candidates are issues to be considered. Moreover, if the current situation is unenergized, the area has recently been electrified. Thus, duplication of future plans and postponement of the existing plan must be avoided. On the other hand, the management of actual project promotion is also important. Here, the current situation of the database and the map to manage project promotion is described.

(1) Concept for electrification promotion

Basic concept of rural electrification promotion is described below.

- 1) Select prefecture (municipality) with a lower rate of electrification than the administrative unit.
- 2) Write the existing power system on a map of the selected prefecture (municipality). The areas electrified by distribution lines are colored.
- 3) Write plan of the transmission and distribution line on the above-mentioned map, according to the expansion plans, for the next 3 years. The target barangays for grid extension are indicated in green circle.
- 4) Uncolored areas in the map are candidate areas for missionary electrification. The target barangays for off-grid electrification are indicated in red circle.



As a result, for planning and promoting rural electrification, exact location of the target barangay

and exact root of the distribution network is important.

(2) Map for project management and planning

The rural electrification project is required to prepare future plans, and in parallel, it is necessary to manage actual project promotion. From these points of view, a map that manages project promotion including the electrification rate visually is a useful tool and database for DOE.

Through this project, the study team prepared a nationwide map using different colors to indicate the electrification rate by municipality level. During this survey, the study team found a nationwide map that indicates barangay boundaries. Therefore, the study team will select some sample areas and make distribution network roots as a sample based on the NEA chronicle.

Finally, the study team will transfer these maps to DOE and ask to DOE to complete this map for the database.

1) Electrification rate management by municipality level

The electrification rate can be viewed for each EC or municipality as shown in Fig. 6.3. Based on this map, the nationwide differential of electrification rate can be grasped, and the preparation of the plan to correct this differential will be studied.

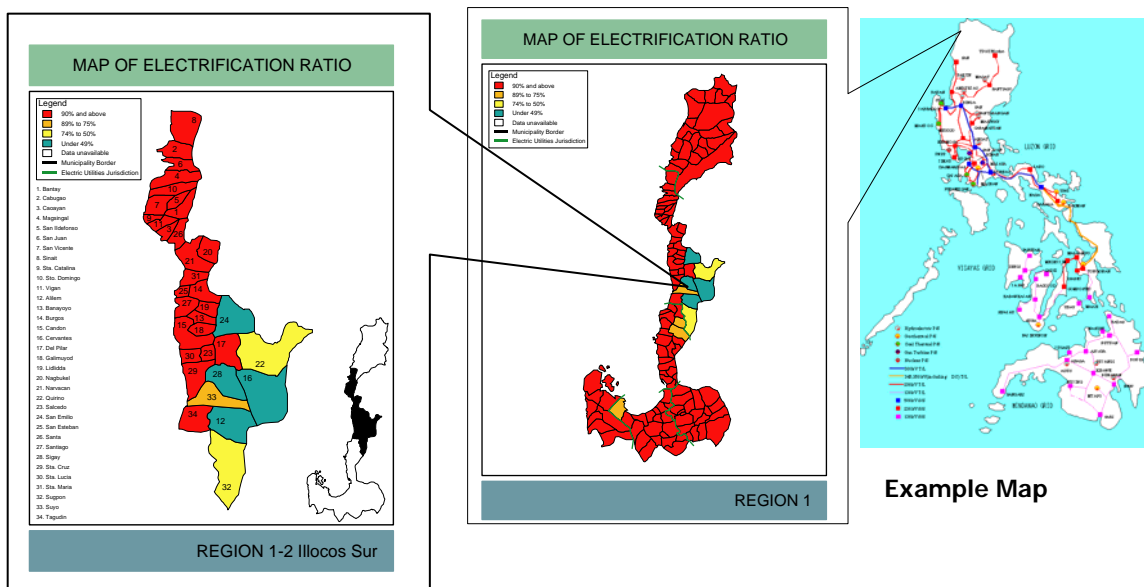


Fig. 6.3 Map for the management of electrification rate by ECs and municipalities

2) Electrification situation by barangay level

Using Fig. 6.4, more precise project management such as the electrification situation at barangay level can be realized. Also, color of every barangay can be changed according to an electrification condition, for example, categorized as follows.

- Electrified by on-grid or off-grid
- How many houses are electrified?
(% of household electrification rate) etc

In parallel, the baseline data of a barangay which is collected utilizing the above-mentioned baseline data collection format can be added and reviewed in the right-hand table in Fig 6.2.

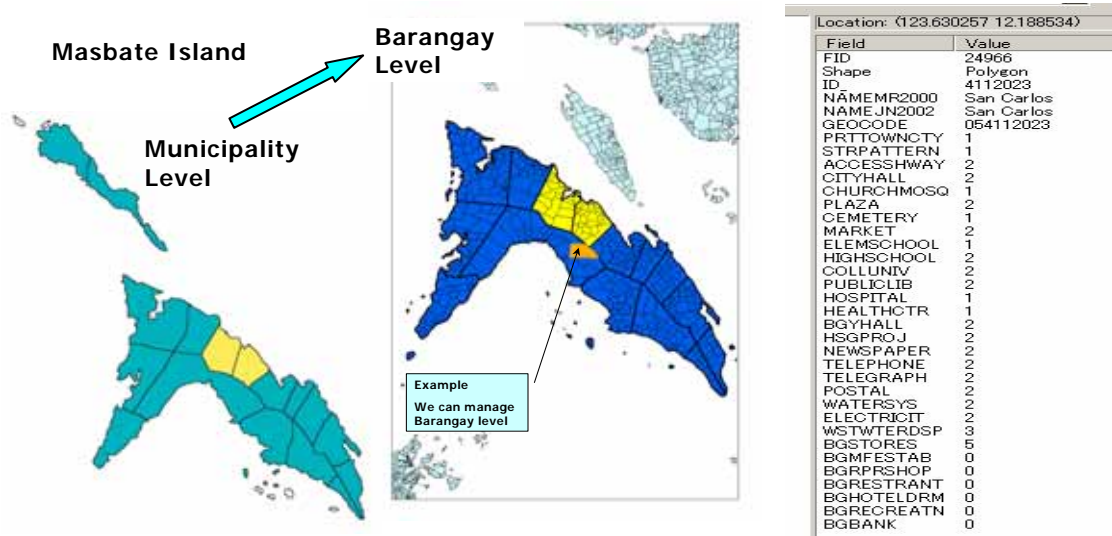


Fig. 6.4 Map for management of electrification rate by barangay

3) Example map with grid network

Based on the mentioned-above basic concept, to prepare electrification plan, it is important to know exact location of barangay and grid network system. According to this idea, the study team picked up Masbate and prepared a sample map with distribution lines in MASELCO franchise area. The example map of Masbate is described in Fig 6.5(a) and 6.5(b). This also makes the relation between the location of the barangay and grid network easy to understand. Here, an example for selecting electrification method using two figures is mentioned.

Fig. 6.5(a) Map for management of electrification rate by barangay with grid line

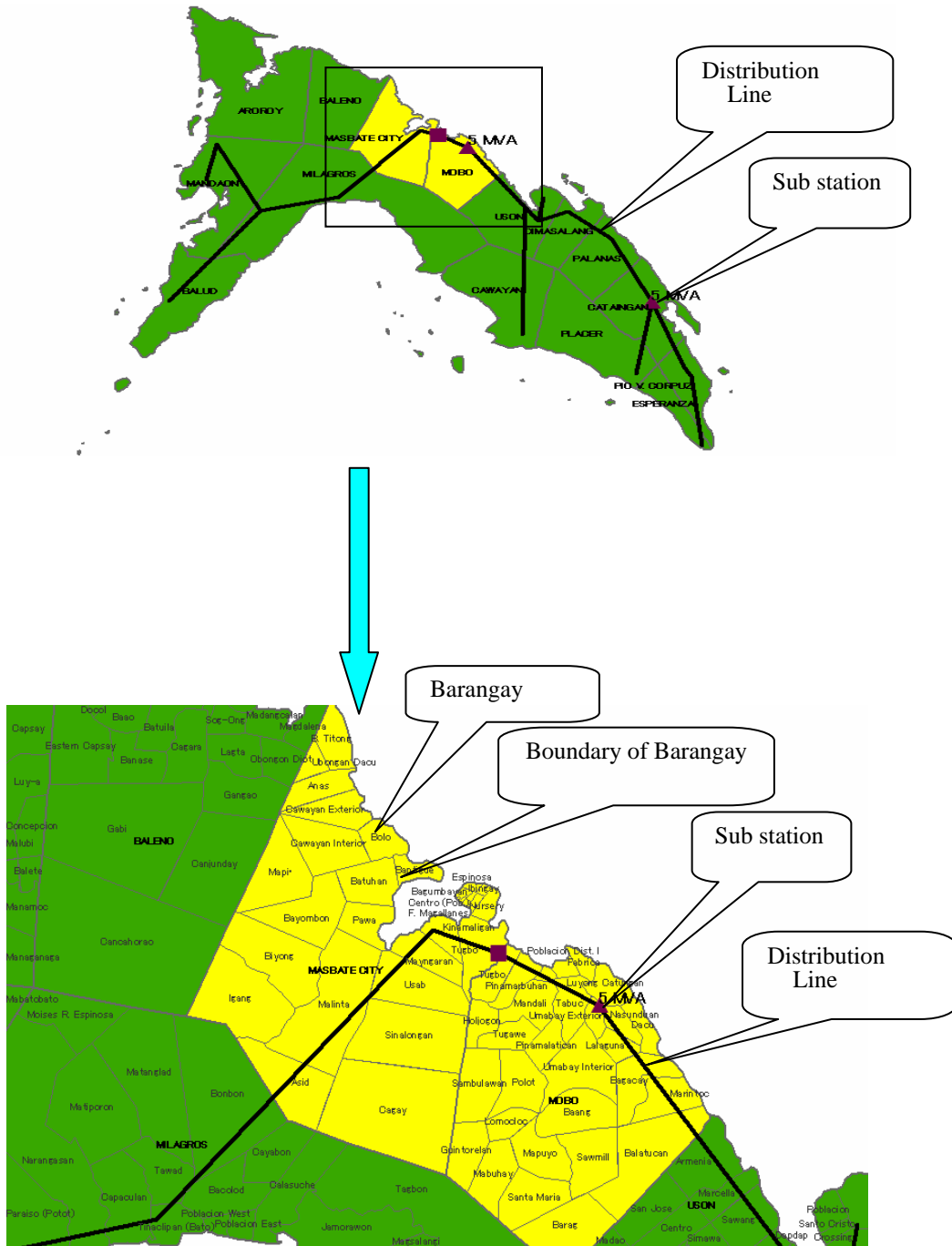


Fig. 6.5(b) Map for management of electrification rate by barangay with grid line

a) Preparation of electrification plan

First, lower electrification municipalities are nominated to give priority for electrification. In Fig

6.5(a), green area is a lower electrification rate, which is less than 49%, than yellow area, which is 50 to 74%. Therefore, technically, municipalities in green area are given priority. From the point of view of the electrification procedure, municipality which is far from grid network is a candidate for introducing individual power system such as PV system. Whereas, municipality, which is close to grid or already grid was passed is a candidate for grid extension. From this point of view, for example, municipality Aroroy is the candidate for individual system and municipality Uson is the candidate for grid extension.

Secondly, in Fig 6.5(b), same point of view can be applied for barangay electrification. Regarding unenergized barangay, the barangay which is far from grid line is a candidate for installation of individual system. If the barangay is close to a grid line, grid extension is applied for electrification. One of method to select electrification method is economic comparison, which will be mentioned in the following chapter.

The study team adds some more information in this example GIS database such as specification of substation and distribution lines etc.

As the study team mentioned, these maps contribute not only to the investigation of future electrification plans after barangay electrification but also to practical project management. Detail instruction manual for this GIS database is attached as Annex.

(2) Potential of renewable energy

The rural areas of the Philippines such as islands and mountainous areas are difficult to access. Therefore; it is difficult to promote electrification by grid extension. In this case, the introduction of individual power systems utilizing renewable energy is useful for electrification of these areas. Here, insolation, rainfall and wind energy data are indicate and describe the utilization idea. Possibly, it is also need to collect indigenous energy such as biomass. It is better to collect these data for as long as possible, but at least 5 years is required.

1) Wind power (Source: Wind Energy Resources Atlas of the Philippines)

The assumption and methods for converting wind resources to wind energy potential are based on the report of [Wind Energy Resources Atlas of the Philippines] and listed in the following table. Each square kilometer on the map has an annual average wind power density, in W/m^2 , at 30m-height. If the wind power density was less than $200W/m^2$, these grid cells (square kilometer) have insufficient wind potential for the economic development of utility-scale wind energy. Although the areas with $100-200 w/m^2$ are not economical for utility-scale, these areas have the

potential for isolated use of small wind for rural electrification. There is estimated to be more than 10,000 km² of windy land area with a good-to-excellent wind resource potential. These windy areas could support more than 70,000 MW of potential installed capacity, delivering more than 195 billion kWh per year. According to the figure, there are 47 provinces out of 73 in the Philippines with at least 500 MW of wind potential and 25 provinces with at least 1,000 MW of wind potential. If we consider the areas that have a moderate wind resource potential or that have a good wind resource for rural power applications, the estimated total land area reaches more than 25,000 km². This land could support over 170,000 MW of potential installed capacity, delivering 361 billion kWh per year. The figure shows 51 provinces out of 73 with at least 1,000 MW of wind potential and 64 provinces with at least 500 MW of wind potential.

Philippines – Wind Power Potential

Good to excellent Wind Resource at 30m (Utility scale)

Wind resource Utility Scale	Wind Power W/m ²	Wind Speed m/s	Total Area km ²	Total Cap installed MW	Total Power GWh/yr
Good	300 - 400	6.4 - 7.0	5,541	38,400	85,400
Excellent	400 – 500	7.0 – 8.0	2,841	19,700	52,200
Excellent	500 - 700	8.0 – 8.8	2,258	15,600	47,900
Excellent	700 – 1,250	8.8 – 10.1	415	2,900	9,700
Total			11,055	76,600	195,200

Moderate to excellent Wind Resource at 30m (Utility scale)

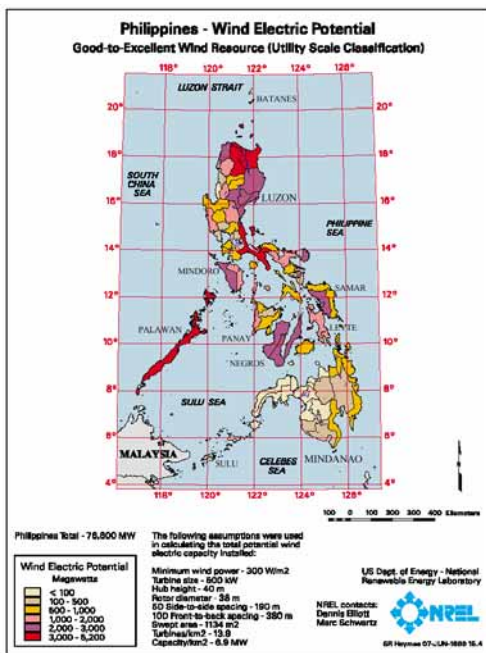
Wind resource Utility Scale	Wind Power W/m ²	Wind Speed m/s	Total Area km ²	Total Cap installed MW	Total Power GWh/yr
Moderate	200 - 300	5.6 – 6.4	14,002	97,000	165,800
Good	300 - 400	6.4 - 7.0	5,541	38,400	85,400
Excellent	400 – 500	7.0 – 8.0	2,841	19,700	52,200
Excellent	500 - 700	8.0 – 8.8	2,258	15,600	47,900
Excellent	700 – 1,250	8.8 – 10.1	415	2,900	9,700
Total			25,057	173,600	361,000

* Wind speeds are based on a Weibull K value of 2.0

[Assumptions]

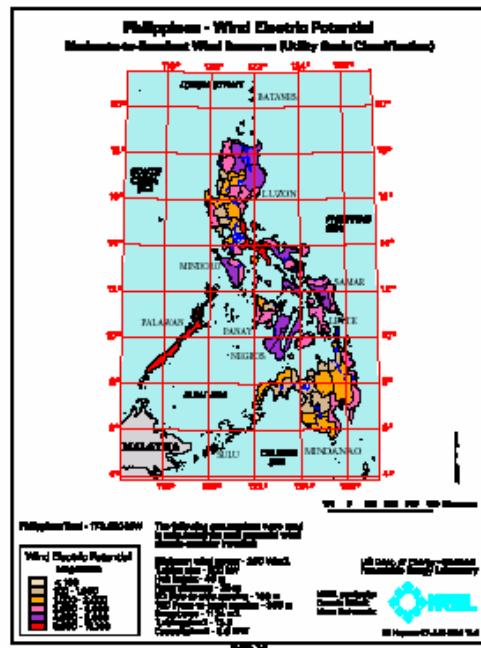
Turbine Size : 500 kW Hub Height : 40 m Rotor Diameter : 38 m

Turbine Spacing : 10D by 5D Capacity/km² : 6.9MW



(Good-to-Excellent)

Fig. 6.6 Average Wind Energy



(Moderate-to-Excellent)

Fig. 6.7 Average Wind Energy

2) Insolation (Source: Assessment of Solar Resources in the Philippines)

Regarding insolation, the yearly average is 4.5 ~ 5.5 kWh/m² in the Philippines. It is 50% or higher than the average of Japan, which is about 3.5 kWh/m². This data indicates that availability of the PV system is one of the useful methods for promoting electrification of barangays, which are located far from the grid line. Figure 6.8 indicates annual average and Figure 6.9 indicates the difference between the dry and rainy season.

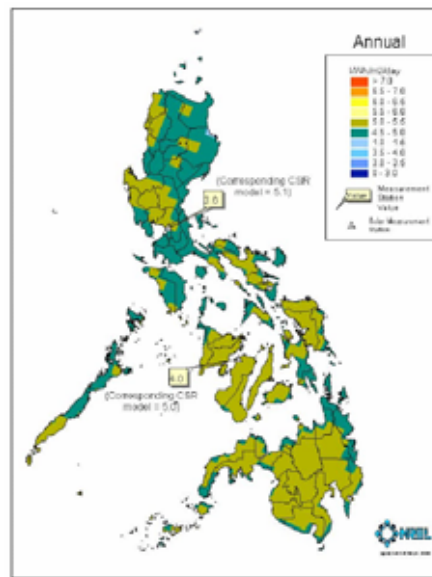


Fig. 6.8 Annual average of Isolation

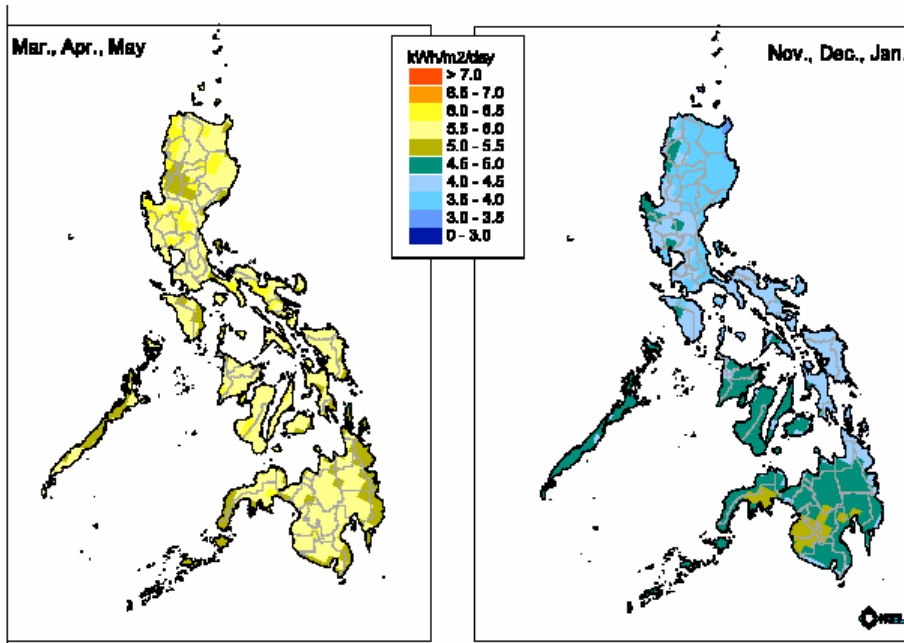


Fig. 6.9 Difference between dry and rainy season

3) Rainfall

The southern part of the Mindanao area and Parawan has lower rainfall than the other areas. However, the average of the other areas is relatively high, and these areas have the potential for introducing micro-hydro systems depending on the geographical condition.

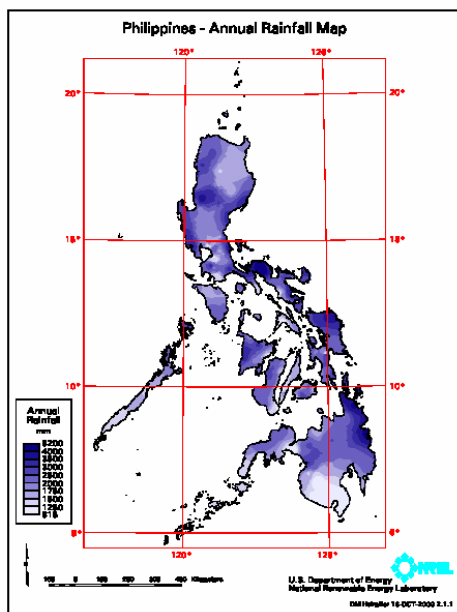


Fig.6.10 Annual rainfall

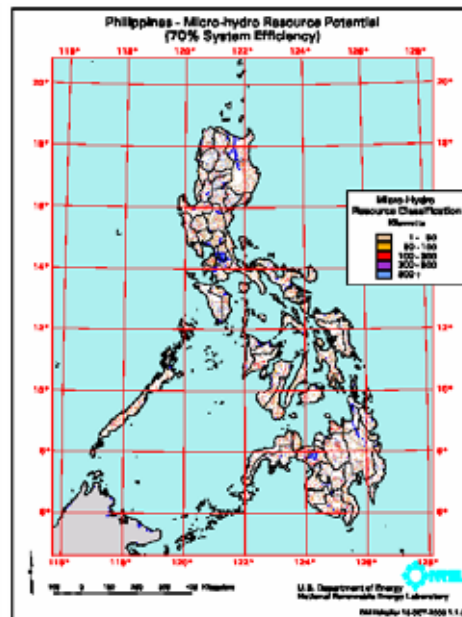


Fig.6.11 Micro-Hydro Resource Potential

Data on renewable energy potential, the map of the existing grid network and the location of energized barangays are compared. These works are useful for utilizing renewable energy for rural electrification.

Detail renewable energy resources which includes insolation, rainfall and wind power studied by USAID are transferred to DOE by electronics files.

(3) Inventory of renewable energy utilization system

We need to know the location, capacity, application, installed date and current situation, etc of the inventory of the RE utilization system. The following table is a sample of data format. DOE needs to prepare this kind of format for information collection.

MICRO-HYDROPOWER PROJECTS IN THE CORDILLERAS							
REGION	LOCATION	APPLICATION	CAPACITY (kW)	PROPONENT	DATE COMMISSIONED	STATUS	
CAR	Dulao, Malibcong, Abra	Lighting	7.500	DLSU		Operational	
	Gacab, Malibcong, Abra	Lighting	20.000	DLSU		Operational	
	Mallag, Kabugao, Apayao	Battery Charging	-		08/07/96	Not Operational	
	Capuyoan, Buguias, Benguet	Battery Charging	0.100		09/15/95	Operational	
	Gadang, Kapangan, Benguet	Battery Charging	0.100		09/18/96	Operational	
	Gadang, Kapangan, Benguet	Battery Charging	0.100		09/18/96	Operational	
	Camandag, Asipulo, Ifugao	Coffee Milling	.0500	PRRM	09/14/99	Operational	
	Bangaan, Banaue, Ifugao	Rice Milling	3.000	PRRM	10/01/99	Operational	
	Batad, Banaue, Ifugao	Battery Charging	0.100		11/15/99	Operational	
	Cambulo, Banaue, Ifugao	Battery Charging	0.070		04/09/92	Operational	
	Ubuag, Hingyon, Ifugao	Battery Charging	0.030		05/01/94	Operational	
	Umalbong, Hingyon, Ifugao	Battery Charging	0.060		08/01/95	Operational	
	Abatan, Hungduan, Ifugao	Lighting	20.000	PRRM	07/23/00	Operational	
	Abatan, Hungduan, Ifugao	Battery Charging	0.100		04/01/97	Operational	
	Ba-ang, Hungduan, Ifugao	Lighting	3.000	BSU-ANEC	04/29/97	Operational	
	Ba-ang, Hungduan, Ifugao	Battery Charging	0.750	BSU-ANEC	04/12/97	Operational	
	Bokiawan, Hungduan, Ifugao	Battery Charging	0.300	PRRM	02/15/97	Operational	
	Gode, Hungduan, Ifugao	Lighting	3.000	PRRM	05/10/97	Operational	
	Magsok, Hungduan, Ifugao	Lighting	40.000	PRRM		Under construction	
	Polod, Hungduan, Ifugao	Battery Charging	0.100		04/01/95	Operational	
	Tiwan, Hungduan, Ifugao	Rice Milling	4.500		08/01/96	Operational	
	Inwaloy, Mayoyao, Ifugao	Battery Charging	0.100		09/05/95	Operational	
	Magulon, Mayoyao, Ifugao	Battery Charging	0.100		11/13/95	Operational	
	Binablayan, Tinoc, Ifugao	Lighting	0.750		12/31/95	Operational	
	Poblacion, Tinoc, Ifugao	Lighting	5.000	BSU-ANEC	01/02/98	Operational	
	Balantoy, Balbalan, Kalinga	Battery Charging	0.100		06/11/96	Operational	
	Balbalasang, Balbalan, Kalinga	Lighting	25.000	SIBAT	01/25/01	Operational	
	Bulalayaw, Balbalan, Kalinga	Lighting	7.500	KSAC-ANEC	Feb. 2000	Operational	
	Dalayap, Balbalan, Kalinga	Lighting	3.000	KSAC-ANEC		Under construction	
	Dao-angan, Balbalan, Kalinga	Lighting	20.000	DAIMI/DOE		Under construction	
	Gawa-an, Balbalan, Kalinga	Lighting	10.000	DAIMI/DOE		Operational	
	Poswoy, Balbalan, Kalinga	Lighting	25.000	DAIMI/DOE		Under construction	
	Pantikian, Balabahn, Kalinga	Lighting	25.000	DOE-KASC-ANEC		For implementation	
	Seseacan, Balbalan, Kalinga	Lighting	8.000	KSAC-ANEC		Operational	
	Salgeseg, Balbalan, Kalinga	Lighting	30.000	LGU-Municipal		For implementation	
	Western Uma, Lubuagan, Kalinga	Lighting	20.000	DAIMI/DOE		Under construction	
	Lower Uma, Lubuagan, Kalinga	Lighting	15.000	DAIMI/DOE		Requires add'l. funding	
	Upper Uma, Lubuagan, Kalinga	Lighting	10.000	DAIMI/DOE		Under construction	
	Ableg, Pasil, Kalinga	Lighting	3.000	KSAC-ANEC(demo project)	1999	Operational	
	Bulanao, Tabuk, Kalinga	Lighting	3.000	SIBAT/Pastoral Council	1998	Operational	
	Guilayon, Tabuk, Kalinga	Lighting	2.000	KSAC-ANEC(Thesis)		Not Operational	
	Dananao, Tinglayan, Kalinga	Lighting	30.000	SIBAT	1999	Operational	
	Ngibat, Tinglayan, Kalinga	Lighting	5.000	MRDC	01/01/93	Operational	
	Sumadel, Tinglayan, Kalinga	Lighting	50.000	LGU-Barangay		Requires add'l. funding	
	Balintaungan, Bauko, Mt. Province	Battery Charging	0.100		12/30/95	Operational	
	Poblacion, Natonin, Mt. Province	Lighting	1.200		01/01/91	Operational	
	Poblacion, Natonin, Mt. Province	Battery Charging	0.100		11/01/95	Operational	
	TOTAL			346.550	kW		

(4) Unenergized barangay list

For preparation of electrification plan, it is important to grasp exact situation of unenergized barangay for barangay electrification planning. To apply this, through this study, the study team got unenergized barangay list from NEA. An example of list is shown below. The electronics file is transferred to DOE.

NATIONAL ELECTRIFICATION ADMINISTRATION
 REGION VI - GUIMARAS ELECTRIC COOPERATIVE, INC. (GUIMELCO)
 PROPOSED BARANGAY ENERGIZATION SCHEDULE (2002-2005)
 As of June 2002

YEAR	NO.	TAPPING POINT		BARANGAY CLASSIFICATION	FEASIBILITY (Road Network, Transportation, Security, etc.)	BARANGAY	MUNICIPALITY	CONGRESS DISTRICT	IDENTIFIED CONN.	INITIAL CONN.	KMS.	
		SITIO/BRGY	POINTING/SCHED OF EN								3-Ph	2-Ph
2002	1	ALEGRIA		COASTAL		SAN ISIDRO	SIBUNAG	LONE	313	22		5.10
	2	BUBOG		COASTAL		SABANG	SIBUNAG	LONE	291	25		5.00
	3	SEBASTE		COASTAL		BUBOG	SIBUNAG	LONE	129	33		1.30
	4	SEBASTE		COASTAL		SEBARIO	SAN LORENZO	LONE	232	45	2.20	
	5	LINGUAN		INLAND		SAPAL	SAN LORENZO	LONE	265	12		
	6	SUPANG		INLAND		SAN PEDRO	BUENAVISTA	LONE	136	12		
	7	NAZARETH		INLAND		TINADTARA	BUENAVISTA	LONE	244	23		
	8	MABINI		INLAND		TAMINLA	BUENAVISTA	LONE	131	12		
						Sub-total			1,741	184	2.20	11.40
2003	POPS	SAN ROQUE		COASTAL		LAPAZ	NUEVA VALENTIN	LONE	360	58		
						Sub-total			360	58	0.00	0.00
2004	1	TANGLAD		INLAND		AYANGAN	SIBUNAG	LONE	215	28		
	2	MILLAN		INLAND		TANGLAD	SIBUNAG	LONE	150	23		
	3	SEBARIO		COASTAL		IGCAUAYAN	SAN LORENZO	LONE	204	23		3.00
						Sub-total			569	74	0.00	3.00
2005	1			ISLAND		INAMPOLO	SIBUNAG	LONE	43	32		
	2			ISLAND		GUIWANON	NUEVA VALENTIN	LONE	312	27		
	3			ISLAND		PANOBOLO	NUEVA VALENTIN	LONE	159	32		
						Sub-total			514	91	0.00	0.00
	14					Grand Total			3,184	407	2.20	14.40

- a) Every year, these lists need to revise by reflecting a result of practical project promotion. This revised list is a material for preparing electrification plan.
- b) Already electrified barangays are needed to delete their name from the unenergized barangay list. On parallel, this information is reflected into the GIS mapping database review.
- c) Information of unenergized barangays which are nominated to electrify is checked their situation such as location, social condition etc using GIS database. .

These works are useful to evaluate SPUG's list and to prepare MEDP and DDP.

7. Selection of optimum electrification procedure

Regarding rural electrification, grid extension and individual systems such as PV, Micro-hydro, Biogas and Diesel are considered to electrify. The method adopted is considered for the nominated area. To do this, the parameters, which are scale of the target village, and demand and distance from the grid line are first set. In general, based on power-generated cost, economic feasibility is compared among electrification methods and the optimum method that has the least generated cost is selected. Here, the basic concept of the economic evaluation in selecting the electrification method is explained using a sample case of PV and grid. Detailed information is given in another version.

1) Basic concept for selection

When plant and equipment investment is to be made, economic analysis is very important. When a decision is made and once a facility is constructed, facilities whose funds have been invested cannot be replaced even if an unexpected event should happen. Hence, in developing a facility plan that provides the basis of investment, various conditions should comprehensively be identified and considered. In this case, economic analysis is used in fields where certain quantifiable aspects of alternative facility plans are examined. One feature of this analysis is that, under a given condition, all costs, which are needed in planning alternative facilities, are identified to produce case studies, and where the total sum of the present values of these costs is minimal, it is judged to be optimal. Aspects that cannot be quantified are considered to make the final plan.

For example, when planning a complicated power source development, demands are assumed, and to keep constant supply reliability, various factors for new power sources such as hydro, thermal and nuclear power plants are provided. According to these assumptions, a new power source is set up to satisfy the reliability considering repair and maintenance plans. The sum of the present values of the fixed cost for the new power source and the fuel expenses of the new and existing facilities is the lowest, and the case is considered the best mix of power source development.

2) Basic concept for economic evaluation

When investment in equipment (including the purchase of a house, etc.) is to be made by a person or an enterprise, funds are procured from a bank, etc. With a person, this investment provides security as compensation. With an enterprise, the investment provides profitability as compensation. Procured funds must be repaid

within the predetermined term. There are various repayment methods including the fixed installment method, fixed percentage method, and methods with some exceptions. In any case, the total sum of the present values of the payments within the term at interest rate “i” is the same. For example, if procured funds “A” are paid back immediately, the repayment is “A.” In extreme cases, if repayment is to be made after “n” years, the present value of the repayment at the time is $A \times (1 + i)^n / (1 + i)^n = A$, and there is no difference. However, the repayment at the time is necessarily $A \times (1 + i)^n$ that includes interest. In an economic calculation, it is convenient to use a method in which the annual repayment plus interest is the same every year throughout the repayment term. In this case, the total sum in present value “A” for “n” years of repayment period is given by

$$A = \sum_{n=1}^n \frac{a}{(1 + i)^n} = \frac{(1 + i)^n - 1}{(1 + i)^n i} a$$

and “a” is given by

$$a = \frac{(1 + i)^n i}{(1 + i)^n - 1} A$$

Coefficient $(1 + i)^n i / ((1 + i)^n - 1)$ is called the Capital Recovery Factor (hereinafter called CRF). A PV system comprises various components having different lives, such as the PV module, inverter, controller and battery. Hence the annual cost of each component is calculated by applying different CRF, which reflect the different lives of various components, and the facility cost of the PV system is determined by calculating these annual costs. When inflation “f” is taken into consideration, $(1 + f)^n$ that considers inflation for the period of replacement of each component should be reflected in the initial acquisition cost. In addition to these, personnel expenses and repair and maintenance expenses are needed to operate and manage PV system. Normally, the former facility cost is fixed and is called the fixed cost. The latter expenses fluctuate depend on the conditions of respective components and are called variable costs. All fixed and variable costs relating to the PV system should be identified and calculated for the useful life of the major component, here, 20 years of useful life of the PV module. The annual expenses comprising the fixed costs and the variable costs are converted to the present value by applying interest rate “i.” Then the total sum of expenses over the useful life is obtained. When this total sum of expenses is multiplied by CRF, the annual expenses equalized over the useful life are obtained.

Interest rate “i” usually changes depending on business fluctuation. When business activity revives and there is fear of inflation, interest rate “i” rises. When business activity slackens, interest rate “i” is reduced to encourage investment in equipment. It is therefore important to invest with due attention to interest rate trends.

A) Assumption of demand

The electric appliances used in rural area are mostly fluorescent lamps and TVs. The capacity of these electric appliances and duration time are indicated in the table and the load pattern is indicated in the figure

Electric appliances and duration

	Appliances	[W] (a)	No (b)	Avarage Duration (c)	Eff. (d)	[Wh]
Night	Flourescent	9	3	2	1.0	54.0
	TV	24	1	2	1.0	48.0
	Night Total	-	-	-	-	102.0

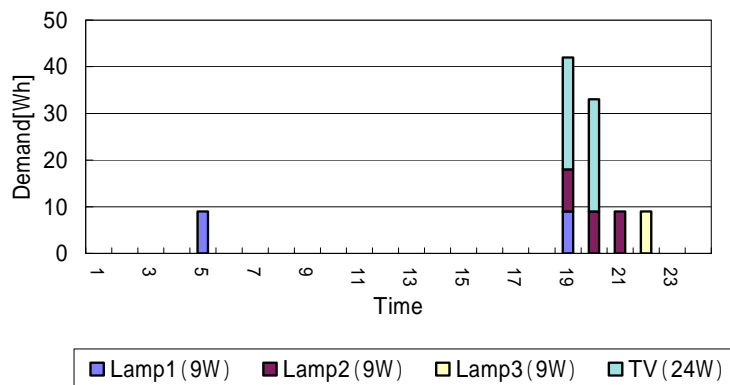


Fig. 7.1 Assumption of daily power usage pattern

2) Calculation of power generated cost

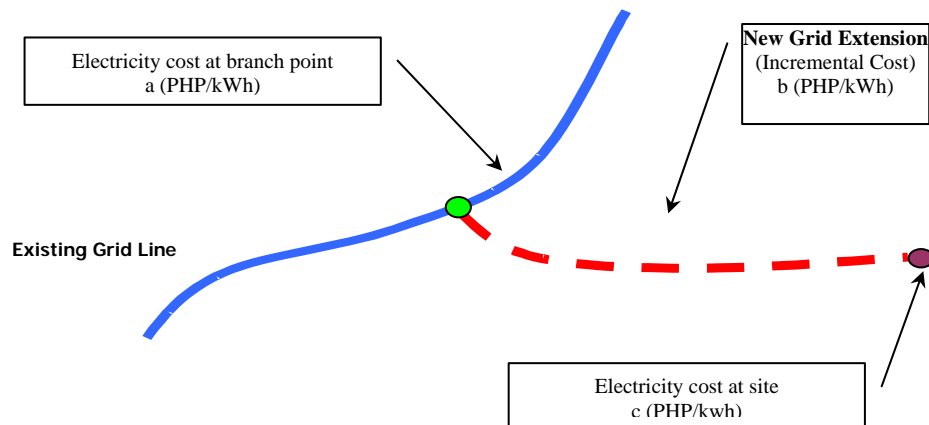
Here, for example, based on the generated cost, the PV system and grid extension are economically compared. To compare generated cost, the same amount of demand is assumed for both generation systems.

A) Grid extension

Assumption is indicated in the following table.

Grid Extension + Mini Grid			
Grid unit cost	475 P1000/km		Yellow-boxed figures are variables.
Length of Grid extension	25.0 km		
Grid extension cost	11,875 P1000		
Annual maintenance cost	10% of Grid cost 1187.5 P1000		Electricity cost at branch point
Electricity cost	0.004 P1000/kWh		
Transformer CIF (10kVA)	0 P1000	estimated	
Transformer tax	0	46% of CIF	
Transformer market price	0 P1000		
Annual demand/household	37 kWh/year		
Total demand	6,329.1 kWh/year		
Daily demand	0.102 kWh/day		
No of household	170 households		
Length of distribution line per hh	0.05 km	estimated	
Distribution cost	238 P1000/km	estimated	
Service wire cost (20m)	1.5 P1000		
Distribution loss	8%		
Discount rate	6.5%	estimated	
Calculation term	20 years		

<Image of generated cost for grid extension>



$$C \text{ (PHP/kWh)} = a \text{ (PHP/kWh)} + b \text{ (Incremental cost) (PHP/kWh)}$$

Based on this assumption, the generated cost is calculated using 20 years' total cost and is shown in the following table. According to the results, in the case of 25 km of grid extension and 102 Wh/day of demand, the power-generated cost is 0.37P1000/kWh.

Generated cost for grid extension

	PW factor	Initial	Maintenance Elect. Cost	Total	Total PW	Demand	Demand PW
0	1.00	12,142		12,142	12,142		
1	0.94		1,188	25	1,213	1,139	6,329
2	0.88		1,188	25	1,213	1,069	6,329
3	0.83		1,188	25	1,213	1,004	6,329
4	0.78		1,188	25	1,213	943	6,329
5	0.73		1,188	25	1,213	885	6,329
6	0.69		1,188	25	1,213	831	6,329
7	0.64		1,188	25	1,213	780	6,329
8	0.60		1,188	25	1,213	733	6,329
9	0.57		1,188	25	1,213	688	6,329
10	0.53		1,188	25	1,213	646	6,329
11	0.50		1,188	25	1,213	607	6,329
12	0.47		1,188	25	1,213	570	6,329
13	0.44		1,188	25	1,213	535	6,329
14	0.41		1,188	25	1,213	502	6,329
15	0.39		1,188	25	1,213	472	6,329
16	0.37		1,188	25	1,213	443	6,329
17	0.34		1,188	25	1,213	416	6,329
18	0.32		1,188	25	1,213	390	6,329
19	0.30		1,188	25	1,213	367	6,329
20	0.28		1,188	25	1,213	344	6,329
					25,505	P1000	69,737

$$25,505/69,737 = 0.37P1000/kWh$$

In the assumption table, according to the location and geographical condition of a targeted barangay, every cost for grid extension such as extension cost per km needs to review. This work is required to every barangay which is nominated for electrification.

B) PV system

In the case of the PV system, introduction of the SHS base is described below.

Module unit cost	0.1500	P1000/W		
Module cost	1,178	P1000		
Trans cost for module	79	P1000	System efficiency	60%
Insurance for module	5.98	P1000	Irradiation	4 kWh/m ² /day
Total system capacity	7,853	W		
Total module cost (CIF)	1,263	P1000		
Tax for module	126	P1000	Consecutive cloud da	3 days
Total module price	1,389	P1000	Depth of discharge	70%
System capacity/household	46	W	Battery voltage	12 V
Battery unit cost (200Ah)	14.00	P1000/piece	Day time demand	30% of daily demand
Battery lifetime	3	years	Other material costs	10% of system cost (CIF)
No of battery	29	pieces	Installation cost	20% of system cost (CIF)
Total battery cost	407	P1000		
Controller unit cost	0.35	P1000/Amp	Transportation cost	0.01 P1000/W for module from Europe
Controller capacity	628	Amp	Transportation cost	0.0025 P1000/W for controller from Europe
Controller cost	220	P1000	Transportation cost	0.0025 P1000/W for inverter from Europe
Trans cost for controller	20	P1000	Insurance ratio	0.5075% for module & controller
Insurance for controller	1.12	P1000		
Total controller cost (CIF)	241	P1000	Tax for module	10%
Tax for controller	10	P1000	Tax for controller	4%
Total controller price	250	P1000	Tax for inverter	4%
Controller lifetime	10	years		
Inverter unit cost	0.05	P1000/W		
Inverter capacity	7,853	W		
Inverter cost	393	P1000		
Trans cost for inverter	20	P1000		
Insurance for inverter	2.0	P1000		
Total inverter cost (CIF)	414	P1000		
Tax for inverter	17	P1000		
Total inverter price	431	P1000		
Inverter lifetime	10	years		
Annual maintenance cost	1%	of system cost (CIF)		
System cost (CIF)	2,324	P1000	(module, battery, controller, inverter)	
Other iron materials and cable	232	P1000		
Installation cost	465	P1000		
Total system cost (CIF)	3,021	P1000		
Total system cost (CIF)/Wp	0.38	P1000/Wp		

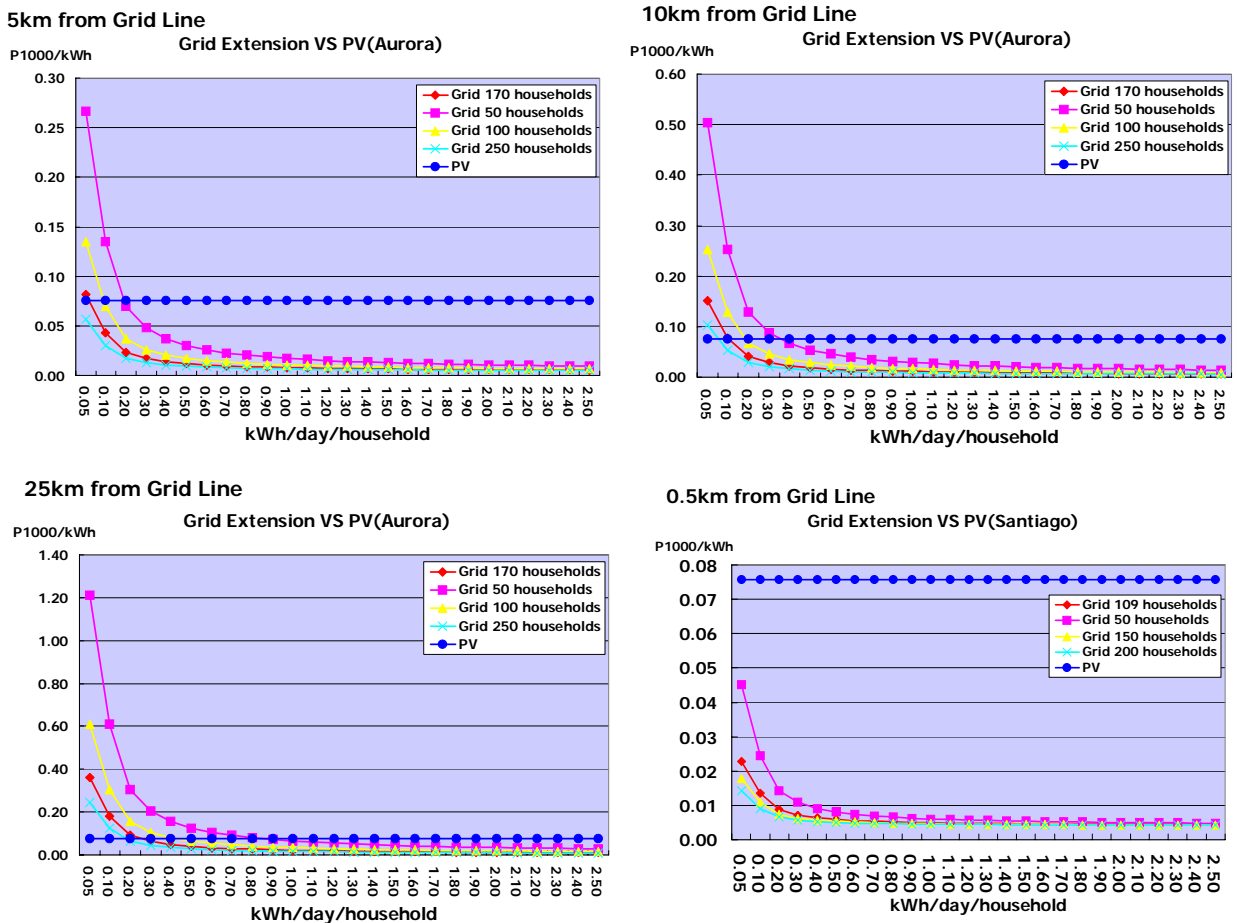
In the case of PV system, when daily consumption is assumed as 102wh/day, the power-generated cost is 0.08P1000/kWh.

	PW factor	Initial	Maintenance Total	Total PW	Demand	Demand PW
0	1.00	3,440		3,440	3,440	
1	0.94		23	23	22	6,329
2	0.88		23	23	20	6,329
3	0.83		23	23	19	6,329
4	0.78	406.5	23	430	334	6,329
5	0.73		23	23	17	6,329
6	0.69		23	23	16	6,329
7	0.64	406.5	23	430	277	6,329
8	0.60		23	23	14	6,329
9	0.57		23	23	13	6,329
10	0.53	406.5	23	430	229	6,329
11	0.50	681	23	704	352	6,329
12	0.47		23	23	11	6,329
13	0.44	406.5	23	430	190	6,329
14	0.41		23	23	10	6,329
15	0.39		23	23	9	6,329
16	0.37	406.5	23	430	157	6,329
17	0.34		23	23	8	6,329
18	0.32		23	23	7	6,329
19	0.30	406.5	23	430	130	6,329
20	0.28		23	23	7	6,329
				5,282	P1000	69,737 kWh

$$5,282/69,737 = 0.08P1000/kWh$$

C) Sensitivity analysis

So far, based on the demand for PV system application, the power-generated cost is compared among the alternative systems. However, the assumption of the generated cost for each system to calculate the generated cost is not the same. For example, in the case of grid extension, distance from the grid was assumed to be 25 km at first; however, the generated cost was changed because of the amount of demand and the distance from the grid line. The power-generated cost is compared between the PV system and grid extension when demand changes. In addition, the power-generated cost is compared between both systems when demand is constant and the distance from grid line changes.



According to this figure,

Number of customers: 170

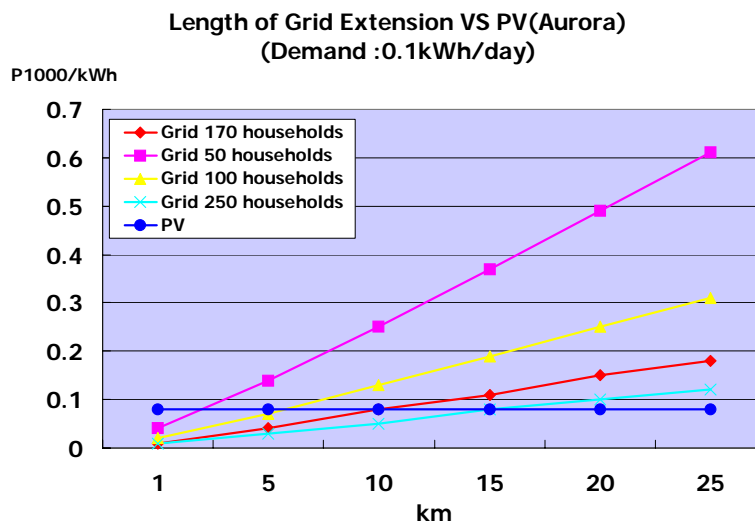
In the case of 25 km of grid extension, 0.3 kWh/day of power consumption is the breakeven point between the PV system and grid extension. When the distance is down to 10 km, the breakeven point between the PV system and grid extension is 0.1kWh/day. In

the case of 5 km, the breakeven point is 0.07kWh/day. For 500 m, the PV system has no advantage.

Number of customers: 50 houses

In the case of 25 km of grid extension, 0.8 kWh/day of power consumption is the breakeven point between the PV system and grid extension. When the distance is down to 10 km, the breakeven point between the PV system and grid extension is 0.4kWh/day. In the case of 5 km, the breakeven point is 0.2kWh/day. For 500 m, the PV system has no advantage.

Even when the distance from the existing grid line to the village is small, if the number of households in the village is small, the generating cost by grid extension will be expensive and the PV system has an advantage. If distance grows, the generating cost will increase in proportion to the distance. In the figure when the demand is fixed at 102Wh/day/house, the relation between grid extension and the PV system is described based on the number of customers.

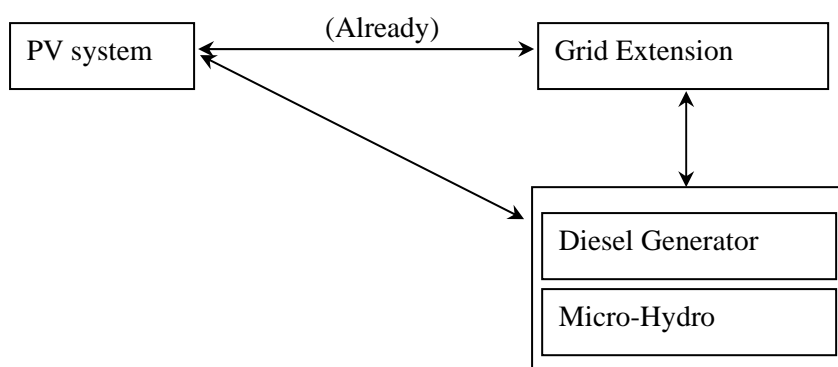


Generation cost comparison between grid extension and PV system

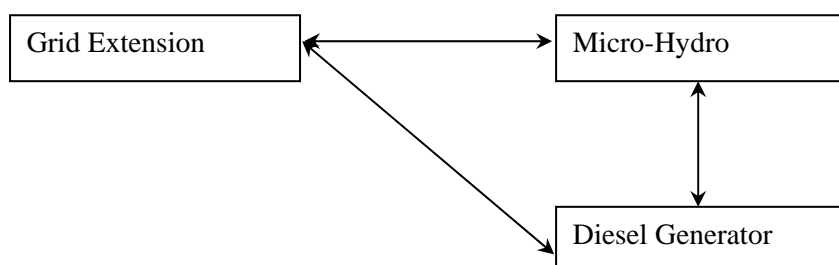
d) Options

A procedure of a comparison grid extension and PV system which is mentioned above is an example of the economic comparison. We are going to prepare the following procedure option.

<Relatively small demand>



<Relatively larger demand than PV system>



(The result of this comparison will be indicated in one graph.)

<Demand forecast in rural areas >

Regarding the basic concept of demand forecast in rural areas, NEA and SPUG create the next 10-year demand forecast based on the previous 5 years of sales data. However, growth of the number of customers is not taken into account; only the average demand growth per customer is considered. This concept applies to the customer who receives power from the NPC network or the customer that assumes the same demand growth as that of a big island EC. However, this method cannot be applied to small-scale unenergized areas because insufficient baseline data have been collected for those areas. Therefore, for the demand forecasts of missionary areas, the following points are currently being considered.

- Within 5 years of the project term, 25% of all customers in the target area will be electrified.

In barangays where houses are built together, according to economic feasibility, diesel generation, wind power and hybrid, and micro hydro are options for electrification. Lighting, radio and fans, which satisfy the basic needs of the customer, are used for 4 to 6 hours and the maximum peak load is assumed to be about 100 W.

- In barangays where houses are built apart, SHS (Solar Home System) is useful. The

capacity of the PV system assumes that 25% of customers use the 75 W PV system and 75% of customers use the 50 W system. About 4 hours of supply is considered for both PV systems. 300 W of BCS (Battery Charge Station) can charge for a battery for 20 customers. BCS and SHS can be interdependent.

Currently, the following criteria are considered as a yardstick.

Number of customers is less than 30 : SHS

Number of customers is 30 to 60 : parallel use of SHS and BCS

More than 60 customers and total grid length is less than 4 km :
parallel use of mini grid system and BCS

8 Training

Renewable energy systems used as individual power sources can stop not only due to faults in the components but also due to simple problems such as loose connections and defective contacts. Even if the problems are simple, if troubleshooting and repairing methods are not known, stoppage of the system over a long period may result. Therefore, it is very important to train engineers to maintain the long-term, stable operation of the systems.

[Points of engineer training]

(1) Establishment of engineer training programs

In promoting renewable energy system projects, it is important to train engineers within the country. Various methods may be used to train engineers. However, it is desirable to train engineers stage-by-stage depending on the roles and levels of the engineers. To this end, it is important to establish engineer-training programs for the respective levels and train engineers according to the programs.

(2) Selection of appropriate engineers

Engineers who operate and maintain the systems must have adequate basic capability depending on the system style and the required technical level. It is also important to select engineers who work diligently. Training engineers who have knowledge of electricity can be simplified, and more advanced technical training can be given. However, it should be noted that even if their technical level is high, engineers who are not diligent may execute inspection and maintenance carelessly, and the quality of maintenance management services for customers may deteriorate.

(3) Training of instructors

To train engineers within the country, it is necessary to have instructors who can train these engineers. In the initial stage of a project, expert engineers may be invited from overseas as trainers. However, to execute sustainable training for engineers, it is important to train instructors within the country.

(4) Implementation of follow-up training

The technical level of the engineers improves through the actual operation and maintenance. However, knowledge and technical capability that are not frequently used may deteriorate. To maintain the technical capability of engineers at a certain level and to provide the latest technical information, it is important to give the engineers not only initial training but also periodical follow-up training.

[Method of Training Engineers]

(1) Attending overseas training programs

Some international organizations and manufacturers have developed engineer-training programs for renewable energy systems and have been extensively inviting engineers to these training programs. Some countries have programs for inviting trainees as a part of technical cooperation. The engineers are dispatched and attend these training programs to receive training. It is desirable to dispatch engineers who are appropriate for the training course.

(2) Invitation of overseas expert engineers

Overseas experts and trained engineers of the country are invited through technical training and lectures. Some international organizations and countries have programs for dispatching experts as a part of their technical cooperation. Therefore, it is possible to use these programs. In receiving experts, it is important to clarify what is needed as contents of technology transfer and technical guidance.

(3) Education at training organizations

Engineers are trained at the organizations that have training courses. There are two aspects for training organization. One is to establish training centers. The other is to utilize existing training centers and colleges. It is desirable for training courses to establish not only courses for engineers but also courses for instructors to train instructors.

(4) On-the-job training

At the project site village, technical training is executed through installation, inspection on completion, operation and maintenance using the actual system. This on-the-job training has variety of practical contents, and engineers can be deepen their understanding of the renewable energy system.

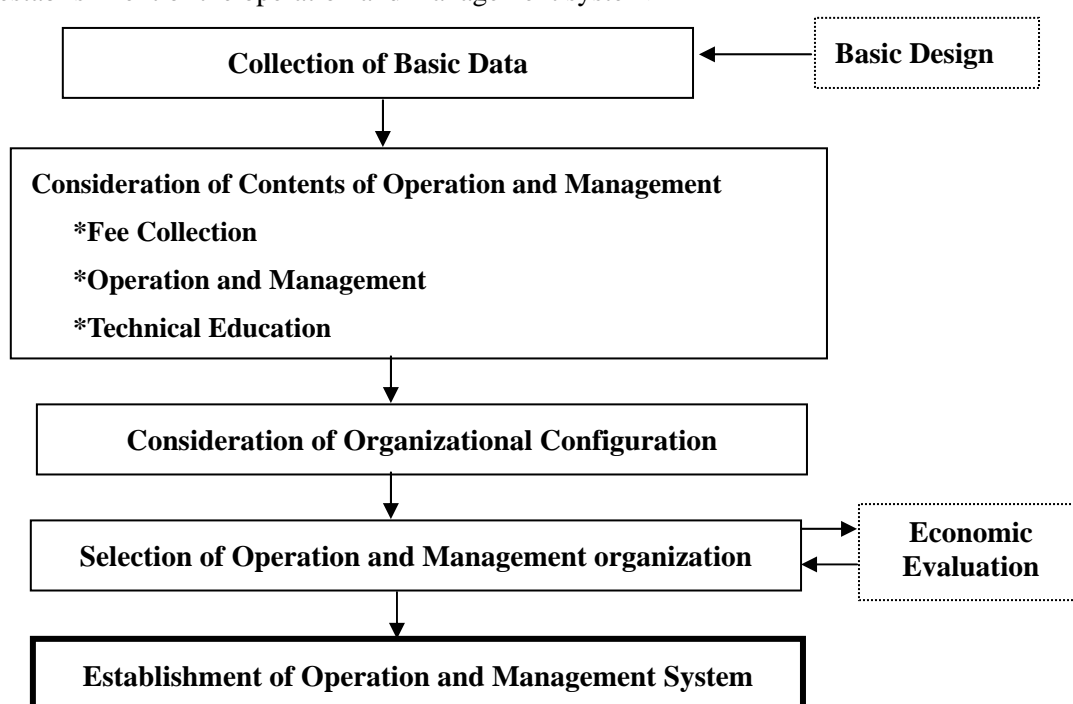
9 Establishment of the Operation and Management System

For example, to sustain the stable and proper operation of PV systems, it is necessary to make periodical maintenance. It is also necessary to establish an organization system to support system operation in case faults and problems, supply replacement parts and collect fees. To properly execute maintenance and fee collection, etc., , it is important to provide technical training to engineers and users.

To develop a sustainable project, it is necessary to clarify the roles of the

organizations concerned from the viewpoint of project management, system maintenance, fee collection, fund management and engineer training. It is also necessary to establish a management system in which all the concerned organizations are coordinated with each other. For the establishment of management organizations, first, a management procedure that is suitable for the project based on the basic data is studied. Then suitable organization for operation and management is selected, and eventually the operation and management system is established.

< Flow of establishment of the operation and management system >



[Points of establishing an operation and management system]

- (1) Development of a system that meets the social system
Collection of fees and provision of various services are widely practiced and are not limited to PV system projects. If the operation and management system is developed by the following existing systems and rules, the operation and management system will be able to provide services that can be easily appreciated by users. If there are organizations within each village and organizations supervising these villages, it will be effective to use these organizations for maintenance and fee collection.
- (2) Selection of an appropriate operation and management organization

To implement the operation and management of PV systems that are installed in rural areas, it is important to select an operation and management organization that can carry out operation management speedily and properly. Regarding candidates for such an operation and management organization, governmental organizations and existing power enterprises, NGOs, cooperatives, and private enterprises are considered for participation. The cost can be reduced to utilize the existing organization rather than to establish a new organization.

(3) Transfer of some duties to the infrastructure organizations

The operation and management is implemented by each stage, which are the central stage, the local stage and village levels. If engineers of the central level or the local level operate and manage, high quality services can be provided. On the other hand, the time and the area of activity of these engineers are limited, and their services will generate higher costs. If problems occur in rural areas, response to problems may be delayed. If engineers of the local level or the village level directly carry out operation and management, there can be a quick response to any problem, and costs can be reduced, although their services are limited.

Operation management at the village level may be difficult in some cases, depending on the configuration of the system and the condition of the village. However, it is desirable that operation and management organization at village level be established.



Manual
for
the Power Development Plan
Preparation
(DDP)

Section 6 Distribution Development Plan

1.Introduction

This summary presents the Distribution Development Plan (DDP) of DUs in line with its mandated responsibilities under Republic Act 9136, and the Electric Power Industry Reform Act (EPIRA).

The preparation of DDP follows an iterative process of simulation to determine the appropriate additions, expansions, and rehabilitation of the distribution backbone that would meet the planning criteria referred to as the performance indices used by the utilities to assess the future reliability of the distribution system.

2.Framework

DOE's Electric Power Industry Management Bureau (EPIMB), as part of its mandate, will review the list of distribution development projects to encourage the private sector to prepare project proposals in a competitive environment and provide indicative timetables to ensure sufficient lead times in the construction of power facilities.

DOE's review of DDPs will consider consistency with general and specific policies for the energy sector, the assumptions used in formulating these plans, and the consistency of these plans with national and regional resource assessments, development programs, and project timetables of various energy upstream activities.

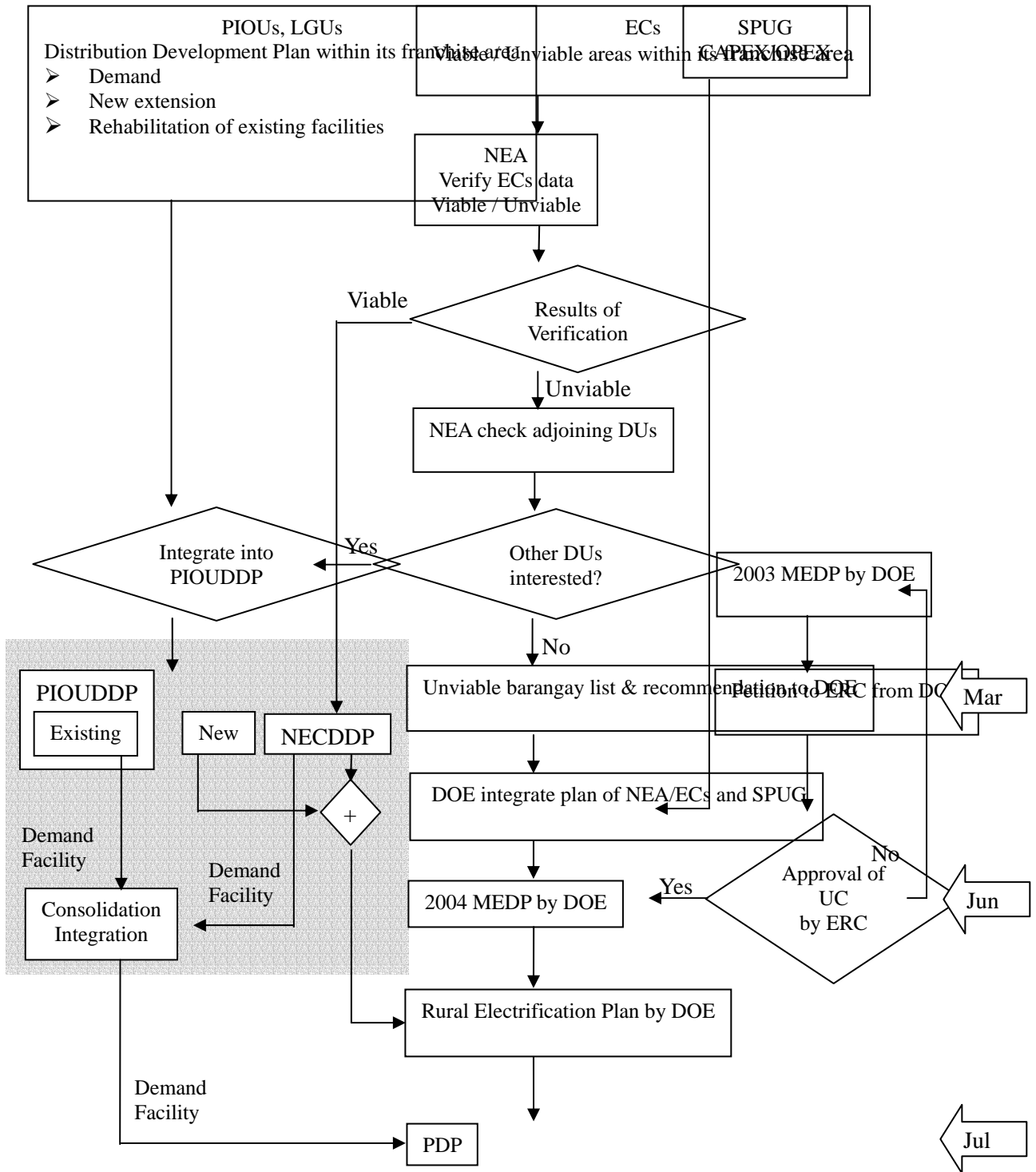
EPIMB will also use the data described in DDP submitted by each distribution utility for the following purposes.

- To validate electricity demand forecasts at the macro level in the next ten years
- To simulate a power supply plan based on the demand forecasts and produce an indicative plant line-up

After evaluating the results of the simulations, DOE, if necessary, requests further clarification and/or amendments from the concerned distribution utilities. EPIMB will recommend DOE's approval and the adoption of DDPs and their integration with PDP/PEP no later than June 30 of each year.

The integrated PDP/PEP will be submitted to Congress on or before September 15th every year.

The workflow to prepare DDP is described as follows.



Each item of data gathered from each DU based on the workflow is integrated into the following three sections: Existing Facilities, Long-term Vision and Investment Requirement. In addition, the data are divided into three main areas (LUZON, the VISAYAS and MINDANAO), and the total is integrated into the Philippines. The data of the distribution and the sub-transmission lines are in circuit kilometers in accordance with each of the voltage levels listed. Moreover, the data of substation transformers are in accordance with each of the sizes listed.

The current data of the distribution, the sub-transmission lines and the substation transformers are integrated into [3. Existing Facilities].

The forecasted data are integrated into [4. Long-term Vision] in which expansions plans are integrated into [4.1 Expansions] and rehabilitation plans are integrated into [4.2 Rehabilitation]. Furthermore, the data of demand are integrated into [4.3 Demand Forecast] as the sales lists in mega watt-hours. Finally, the data of critical conditions, for example, unbalanced demand and supply, are integrated into [4.4 Critical Conditions] as facilities lists.

Capital expenditure is integrated into [5. Investment Requirement] as each list. All amounts are to be expressed in units of a million pesos.

3.Existing Facilities

- The existing data of facilities is understood.
- Comparison between areas and comparison between voltage classes are conducted.
Compared with the data of last year, the rate of expansion is analyzed for every area and for every voltage class.
- Furthermore, the reasons are considered and documented.

Table3-1. Summary of Existing Facilities (Lines)

	Area	Amount (Ckt-kms)
LUZON	230 kV and over	
	138 kV and less than 230 kV	
	115 kV and less than 138 kV	
	69 kV and less than 115 kV	
	34.5 kV and less than 69 kV	
	13.8 kV and less than 34.5 kV	
	6.2 kV and less than 13.8 kV	
	2.4 kV and less than 6.2 kV	
VISAYAS	230 kV and over	
	138 kV and less than 230 kV	
	115 kV and less than 138 kV	
	69kV and less than 115 kV	
	34.5 kV and less than 69 kV	
	13.8 kV and less than 34.5 kV	
	6.2kV and less than 13.8 kV	
	2.4kV and less than 6.2 kV	
MINDANAO	230 kV and over	
	138 kV and less than 230kV	
	115 kV and less than 138kV	
	69 kV and less than 115 kV	
	34.5 kV and less than 69 kV	
	13.8 kV and less than 34.5 kV	
	6.2 kV and less than 13.8 kV	
	2.4 kV and less than 6.2 kV	
PHILIPPINES	230 kV and over	
	138 kV and less than 230 kV	
	115 kV and less than 138 kV	
	69 kV and less than 115 kV	
	34.5 kV and less than 69 kV	
	13.8 kV and less than 34.5 kV	
	6.2 kV and less than 13.8 kV	
	2.4 kV and less than 6.2 kV	

- The existing data of facilities is understood.
- Comparison between areas and comparison between voltage classes are conducted.
Compared with the data of last year, the rate of expansion is analyzed for every area and for every voltage class.
- Furthermore, the reasons are considered and documented.

Table3-2. Summary of Existing Facilities (Transformers)

	Area	Amount (MVA)
LUZON	Transformer Capacity, 100 and over	
	Transformer Capacity, 50 and less than 100	
	Transformer Capacity, 25 and less than 50	
	Transformer Capacity, 10 and less than 25	
	Transformer Capacity, less than 10	
VISAYAS	Transformer Capacity, 100 and over	
	Transformer Capacity, 50 and less than 100	
	Transformer Capacity, 25 and less than 50	
	Transformer Capacity, 10 and less than 25	
	Transformer Capacity, less than 10	
MINDANAO	Transformer Capacity, 100 and over	
	Transformer Capacity, 50 and less than 100	
	Transformer Capacity, 25 and less than 50	
	Transformer Capacity, 10 and less than 25	
	Transformer Capacity, less than 10	
PHILIPPINES	Transformer Capacity, 100 and over	
	Transformer Capacity, 50 and less than 100	
	Transformer Capacity, 25 and less than 50	
	Transformer Capacity, 10 and less than 25	
	Transformer Capacity, less than 10	

4.Long-term Vision

4.1 Expansions

- The data of expansion plans for every fiscal year is understood.
- The difference in the amount of construction for every fiscal year is documented. Comparison between areas is conducted.
- The difference in the amount of construction for every area is documented. Comparison between voltage classes is conducted.
- The difference in the amount of construction for every voltage class is documented. The rate of expansion is analyzed for every area and for every voltage class.
- Furthermore, the reasons are considered and documented.

Table4-1. Summary of Expansions (2003-2007) (Ckt-kms)

Area		2003	2004	2005	2006	2007
LUZON	230 kV-and over					
	138 kV-230 kV					
	115 kV-138 kV					
	69 kV-115 kV					
	34.5 kV-69 kV					
	13.8 kV-34.5 kV					
	6.2 kV-13.8 kV					
	2.4 kV-6.2 kV					
	Sub-Total					
VISAYAS	230 kV-and over					
	138 kV-230 kV					
	115 kV-138 kV					
	69 kV-115 kV					
	34.5 kV-69 kV					
	13.8 kV-34.5 kV					
	6.2 kV-13.8 kV					
	2.4 kV-6.2 kV					
	Sub-Total					
MINDANAO	230 kV-and over					
	138 kV-230 kV					
	115 kV-138 kV					
	69 kV-115 kV					
	34.5 kV-69 kV					
	13.8 kV-34.5 kV					
	6.2 kV-13.8 kV					
	2.4 kV-6.2 kV					
	Sub-Total					
PHILIPPINES	230 kV-and over					
	138 kV-230 kV					
	115 kV-138 kV					
	69 kV-115 kV					
	34.5 kV-69 kV					
	13.8 kV-34.5 kV					
	6.2 kV-13.8 kV					
	2.4 kV-6.2 kV					
	Sub-Total					

- The data of expansion plans for every fiscal year is understood.
- The difference in the amount of construction for every fiscal year is documented. Comparison between areas is conducted.
- The difference in the amount of construction for every area is documented. Comparison between voltage classes is conducted.
- The difference in the amount of construction for every voltage class is documented. The rate of expansion is analyzed for every area and for every voltage class.
- Furthermore, the reasons are considered and documented.

Table4-2. Summary of Substation Capacity (Transformers, 2003-2007) (MVA)

Area		2003	2004	2005	2006	2007
LUZON	Transformer Capacity, 100 and over					
	Transformer Capacity, 50 and less than 100					
	Transformer Capacity, 25 and less than 50					
	Transformer Capacity, 10 and less than 25					
	Transformer Capacity, less than 10					
VISAYAS	Transformer Capacity, 100 and over					
	Transformer Capacity, 50 and less than 100					
	Transformer Capacity, 25 and less than 50					
	Transformer Capacity, 10 and less than 25					
	Transformer Capacity, less than 10					
MINDANAO	Transformer Capacity, 100 and over					
	Transformer Capacity, 50 and less than 100					
	Transformer Capacity, 25 and less than 50					
	Transformer Capacity, 10 and less than 25					
	Transformer Capacity, less than 10					
PHILIPPINES	Transformer Capacity, 100 and over					
	Transformer Capacity, 50 and less than 100					
	Transformer Capacity, 25 and less than 50					
	Transformer Capacity, 10 and less than 25					
	Transformer Capacity, less than 10					

4.2 Rehabilitation

- The data of rehabilitation plans for every fiscal year is understood.
- The difference in the amount of construction for every fiscal year is documented. Comparison between areas is conducted.
- The difference in the amount of construction for every area is documented. Comparison between voltage classes is conducted.
- The difference in the amount of construction for every voltage class is documented. The rate of rehabilitation is analyzed for every area and for every voltage class.
- Furthermore, the reasons are considered and documented.

Table4-3. Summary of Rehabilitation (2003-2007) (Ckt-kms)

Area		2003	2004	2005	2006	2007
LUZON	230kV-and over					
	138kV-230kV					
	115kV-138kV					
	69kV-115kV					
	34.5kV-69kV					
	13.8kV-34.5kV					
	6.2kV-13.8kV					
	2.4kV-6.2kV					
Sub-Total						
VISAYAS	230kV-and over					
	138kV-230kV					
	115kV-138kV					
	69kV-115kV					
	34.5kV-69kV					
	13.8kV-34.5kV					
	6.2kV-13.8kV					
	2.4kV-6.2kV					
Sub-Total						
MINDANAO	230kV-and over					
	138kV-230kV					
	115kV-138kV					
	69kV-115kV					
	34.5kV-69kV					
	13.8kV-34.5kV					
	6.2kV-13.8kV					
	2.4kV-6.2kV					
Sub-Total						
PHILIPPINES	230kV-and over					
	138kV-230kV					
	115kV-138kV					
	69kV-115kV					
	34.5kV-69kV					
	13.8kV-34.5kV					
	6.2kV-13.8kV					
	2.4kV-6.2kV					
Sub-Total						

- The data of rehabilitation plans for every fiscal year is understood.
- The difference in the amount of construction for every fiscal year is documented. Comparison between areas is conducted.
- The difference in the amount of construction for every area is documented. Comparison between voltage classes is conducted.
- The difference in the amount of construction for every voltage class is documented. The rate of rehabilitation is analyzed for every area and for every voltage class. Furthermore, the reasons are considered and documented.

Table4-4. Summary of Decommissioning (Transformers, 2003-2007) (MVA)

Area		2003	2004	2005	2006	2007
LUZON	Transformer Capacity, more than 100					
	Transformer Capacity, 50 and less than 100					
	Transformer Capacity, 25 and less than 50					
	Transformer Capacity, 10 and less than 25					
	Transformer Capacity, less than 10					
VISAYAS	Transformer Capacity, more than 100					
	Transformer Capacity, 50 and less than 100					
	Transformer Capacity, 25 and less than 50					
	Transformer Capacity, 10 and less than 25					
	Transformer Capacity, less than 10					
MINDANAO	Transformer Capacity, more than 100					
	Transformer Capacity, 50 and less than 100					
	Transformer Capacity, 25 and less than 50					
	Transformer Capacity, 10 and less than 25					
	Transformer Capacity, less than 10					
PHILIPPINES	Transformer Capacity, more than 100					
	Transformer Capacity, 50 and less than 100					
	Transformer Capacity, 25 and less than 50					
	Transformer Capacity, 10 and less than 25					
	Transformer Capacity, less than 10					

4.3 Demand Forecast

- Demand forecasting for every fiscal year is analyzed. Comparison between areas is conducted. The difference in the demand for every area is documented.
- Every kind of demand is compared. The difference in the kinds of demand is documented. The rate of expansion is analyzed for every kind of every area and demand.
- Furthermore, the reasons are considered and documented.
- These Sales data are from the distribution level and do not include Sales in Transmission.

Table4-5. Summary of Demand Forecast (2003-2007) (MWH)

Area		2003	2004	2005	2006	2007
LUZON	Direct Sales to Customers					
	Utility's Energy Consumption					
	Electricity Purchased or Generated					
VISAYAS	Direct Sales to Customers					
	Utility's Energy Consumption					
	Electricity Purchased or Generated					
MINDANAO	Direct Sales to Customers					
	Utility's Energy Consumption					
	Electricity Purchased or Generated					
PHILIPPINES	Direct Sales to Customers					
	Utility's Energy Consumption					
	Electricity Purchased or Generated					

Table4-6. Summary of Demand Forecast (2008-2012) (MWH)

Area		2008	2009	2010	2011	2012
LUZON	Direct Sales to Customers					
	Utility's Energy Consumption					
	Electricity Purchased or Generated					
VISAYAS	Direct Sales to Customers					
	Utility's Energy Consumption					
	Electricity Purchased or Generated					
MINDANAO	Direct Sales to Customers					
	Utility's Energy Consumption					
	Electricity Purchased or Generated					
PHILIPPINES	Direct Sales to Customers					
	Utility's Energy Consumption					
	Electricity Purchased or Generated					

4.4 Supply Forecast

- Supply forecasting for every fiscal year is analyzed. Comparison between areas is conducted. The difference in the demand for every area is documented.
- Every electric power demand is measured by the capacity with which it can be supplied. The difference in the capacity that can be supplied the amount of electric power is documented. The rate of expansion and the capacity that can be supplied for electric power are analyzed in every area.
- Furthermore, the reason is documented.
- These Supply data are from the distribution level and do not include Supply in Transmission.

Table4-7. Summary of Total Supply Forecast (2003-2012) (KW, MWH)

Area		2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
LUZON	Capacity										
	Energy										
VISAYAS	Capacity										
	Energy										
MINDANAO	Capacity										
	Energy										
PHILIPPINES	Capacity										
	Energy										

Table4-8. Summary of Supply-Demand Surplus Forecast (2003-2012) (KW, %, MWH)

Area		2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
LUZON	Capacity										
	Capacity Margin										
	Energy										
VISAYAS	Capacity										
	Capacity Margin										
	Energy										
MINDANAO	Capacity										
	Capacity Margin										
	Energy										
PHILIPPINES	Capacity										
	Capacity Margin										
	Energy										

4.5 Critical Conditions

- Prediction of the amount of short supply for every fiscal year is analyzed. Comparison between areas is conducted. The difference for every area is documented.
- With reserve power reductions and insufficient power supply, it is expected to be that supply will be difficult to grasp.
- Furthermore, the reasons are documented.
- The data of higher voltage systems are checked. Furthermore, to design evasion measures, adjustment is necessary with the people concerned.

Table4-9. Summary of Critical Conditions (2003-2007)

Area		2003	2004	2005	2006	2007
LUZON	Sub-transmission Banks Critically Loaded (MVA)					
	Distribution Lines Critically Loaded (Ckt)					
VISAYAS	Sub-transmission Banks Critically Loaded (MVA)					
	Distribution Lines Critically Loaded (Ckt)					
MINDANAO	Sub-transmission Banks Critically Loaded (MVA)					
	Distribution Lines Critically Loaded (Ckt)					
PHILIPPINES	Sub-transmission Banks Critically Loaded (MVA)					
	Distribution Lines Critically Loaded (Ckt)					

Table4-10. Summary of Critical Conditions (2008-2012)

Area		2008	2009	2010	2011	2012
LUZON	Sub-transmission Banks Critically Loaded (MVA)					
	Distribution Lines Critically Loaded (Ckt)					
VISAYAS	Sub-transmission Banks Critically Loaded (MVA)					
	Distribution Lines Critically Loaded (Ckt)					
MINDANAO	Sub-transmission Banks Critically Loaded (MVA)					
	Distribution Lines Critically Loaded (Ckt)					
PHILIPPINES	Sub-transmission Banks Critically Loaded (MVA)					
	Distribution Lines Critically Loaded (Ckt)					

5. Investment Requirement

- The amount of investment for every fiscal year is understood.
- Every comparison between areas and contents of construction is compared. Compared with the amount of investment that was scheduled for last year, the rate of change is analyzed between areas or for every construction content. Furthermore, the reasons are documented.

Table5-1. Summary of Investment Requirement (2003-2007) (Million PHP)

Area		2003	2004	2005	2006	2007	Total
LUZON	Distribution/ Sub-transmission	Local					
		Foreign					
	Substation	Local					
		Foreign					
	Electrification	Local					
		Foreign					
Sub-total	Local						
	Foreign						
VISAYAS	Distribution/ Sub-transmission	Local					
		Foreign					
	Substation	Local					
		Foreign					
	Electrification	Local					
		Foreign					
Sub-total	Local						
	Foreign						
MINDANAO	Distribution/ Sub-transmission	Local					
		Foreign					
	Substation	Local					
		Foreign					
	Electrification	Local					
		Foreign					
Sub-total	Local						
	Foreign						
PHILIPPINES	Distribution/ Sub-transmission	Local					
		Foreign					
	Substation	Local					
		Foreign					
	Electrification	Local					
		Foreign					
Total	Local						
	Foreign						

