THE SOCIALIST REPUBLIC OF VIETNAM
ELECTRICITY OF VIETNAM(EVN)
INSTITUTE OF ENERGY(IE)

THE STUDY
ON
NATIONAL POWER DEVELOPMENT PLAN FOR THE PERIOD OF 2006-2015, PERSPECTIVE UP TO 2025
IN
VIETNAM

FINAL REPORT

MAY 2006

JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)

TOKYO ELECTRIC POWER Co.,Inc.
TOKYO ELECTRIC POWER SERVICES Co.,Ltd

E D
J R
06-086

PREFACE

In response to a request from the Government of Socialist Republic of Vietnam, the Government of Japan decided to conduct a study on National Power Development Plan for the Period of 2006-2015, Perspective up to 2025 in Vietnam and entrusted to the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Masayuki Ito of Tokyo Electric Power Co., Inc. and consists of Tokyo Electric Power Co., Inc. and Tokyo Electric Power Services Co., Ltd. between May, 2005 and May, 2006.

The team held discussions with the officials concerned of the Government of Vietnam and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Vietnam for their close cooperation extended to the study.

May 2006

Tadashi IZAWA,
Vice President
Japan International Cooperation Agency

May 2006

Tadashi IZAWA
Vice President
Japan International Cooperation Agency
Tokyo, Japan

Letter of Transmittal

We are pleased to submit to you the report of the Study on National Power Development Plan for the Period of 2006-2015, Perspective up to 2025 in Vietnam. The report reflects the comments made by the Electricity of Vietnam and related institutions in the Socialist Republic of Vietnam, as well as the advice of the related institutions of the Government of Japan.

This report presents appropriate power development planning and recommendations on power system development from the view point of financial perspective and environmental and social considerations in Vietnam. We firmly believe that it will contribute to ensure the cheap and stable power supply by the least cost development planning and environmentally friendly development by introducing Strategic Environmental Assessment, and will help promote the rise in standards of living and industrial development in the country.

We wish to take this opportunity to express our sincere gratitude to the officials concerned of JICA, Ministry of Foreign Affairs and Ministry of Economy, Trade and Industry. We would also like to express our gratitude to the officials concerned of the Government of Vietnam, Electricity of Vietnam, JICA Vietnam Office and Embassy of Japan in the Socialist Republic of Vietnam for their cooperation and assistance throughout our field survey.

Very truly yours,

Masayuki Ito
Team Leader,
The Study on National Power Development Plan for the Period of 2006-2015, Perspective up to 2025 in Vietnam

Location of the Socialist Republic of Vietnam

THE STUDY ON
NATIONAL POWER DEVELOPMENT PLAN
FOR
THE PERIOD OF 2006-2015, PERSPECTIVE UP TO 2025
IN VIETNAM

FINAL REPORT

Contents

List of Tables

List of Figures

ACRONYMS / ABBREVIATIONS

ADB	:	Asian Development Bank
AFC	:	Automatic Frequency Control
AFTA	:	ASEAN Free Trade Area
ASEAN	:	Association of Southeast Asian Nations
BOD	:	Board of Directors
BOM	:	Board of Management
BOT	:	Build -Operate-Transfer
CC	:	Combined Cycle
CDM	:	Clean Development Mechanism
C/P	:	Counterpart
DO	:	Diesel Oil
DOE	:	Department of Energy
DSCR	:	Debt Service Coverage Ratio
DSM	:	Demand Side Management
DSS	:	Daily Start and Stop
DWT	:	Dead Weight Tonnage
EGAT	:	Electricity Generating Authority of Thailand
EIA	:	Environmental Impact Assessment
EL	:	Elevation
EVN	:	Elctricity of Vietnam
FO	:	Furnace Oil
FPD	:	Forest Protection Department
F/S	:	Feasibility Study
GDP	:	Gross Domestic Product
GMS	:	Greater Mekong Sulregaion
GT	:	Gas Turbine
HPP	:	Hydro Power Plant
IE	:	Institute of Energy
IEA	:	International Energy Agency
IEE	:	Initial Envelopmental Evaluation
IES	:	Initial Envelopmental Study
IGA	:	Inter Goverment Agreement
IMPACT	:	Integrated & Multi-purpose Package of Advanced Computational Tools for power system engineering
IPP	:	Independent Power Producer
JBIC	:	Japan Bank for International Cooperation
JETRO		Japan External Trade Organization
JICA	:	Japan International Cooperation Agency
LOLE	:	The Loss Of Load Expectation
M/P, MP	:	Master Plan
MARD	:	Ministry of Agriculture and Rural Development
MOI	:	Ministry of Industry

ACRONYMS / ABBREVIATIONS

MOF	:	Ministry of Finance
MONRE	:	Ministry of Natural Resources and Environment
MOSTE	:	Ministry of Science Technology and Environment
MPI	:	Ministry of Planning and Investment
NCMPC	:	Ho Chi Minh Power Company
NEDO	:	New Energy and Industrial Technology Development Organization
NGO(s)	:	Non-Government Organization(s)
NLDC	:	National Load Dispatching Centers
NTFP	:	Non-Timber Forest Products
ODA	:	Official Development Assistance
OE	:	Oil Equivalent
OECF	:	The Overseas Economic Cooperation
OJT	:	On the Job Training
Pre-F/S	:	Preliminary Feasibility Study
P/S	:	Power Station
PDPAT Ⅱ	:	Power Development Planning Assist Tool
PECC1	:	Power Engineering Counsulting Company 1
PLN	:	Perusahaan Umum Listrik Negara
PP	:	Power Purchase
PSPP	:	Pumped Storage Power Plant
PSS/E	:	Power System Simulator for Engineering
RETICS	:	Reliability Evaluation Tool for Inter-Connected System
SCADA	:	Supervisory Control and Data Acquisition
SEA	:	Strategic Enviromental Assessment
SFR	:	Self Financing Ratio
SHM	:	Stakeholder Meeting
Son La PMB	:	Son La Hydropower Project Management Board
S/S	:	Substation
ST	:	Steam Turbine
TA	:	Technical Asistance
TEPCO	:	Tokyo Electric Power Company
TEPSCO	:	Tokyo Electric Power Services Co., Ltd.
T/L	:	Transmission Line
TOU	:	Time-Of-Use
VEEA	:	Vietnam Electricity Engineering Association
WASP	:	Wien Automatic System Planning Package
WB	:	The World Bank
WSS	:	Weekly Start and Stop
WTI	:	West Texas Intermediate
WWF	:	World Wide Fund for Nature

UNITS

Prefixes

μ	:	micro-	=	10^{-6}
m	:	milli-	=	10^{-3}
c	:	centi-	=	10^{2}
d	:	deci-	=	10^{9}
da	:	deca-	=	10
h	:	hecto-	=	10^{2}
k	:	kilo-	=	10^{3}
M	:	mega-	=	10^{6}
G	:	giga-	=	10^{9}

Units of Length

m	:	meter
km	:	kilometer

Units of Area

m^2	:	square meter
km^2	:	square kilometer

Units of Volume

m^3	:	cubic meter
l	:	liter
kl	:	kiloliter

Units of Mass

kg	:	kilogram
t	:	ton (metric)
DWT	:	Dead Weight Tonnage

Units of Energy

kcal	:	kilocalorie
kWh	:	kilowatt-hour
ktoe		Kilo ton oil equivalent (toe)
MWh	:	megawatt-hour
GWh	:	gigawatt-hour
Btu	:	British thermal unit

Units of Heating Value

kcal/kg	:	kilocalorie per kilogram
Btu/kWh	:	British thermal unit per kilo watt hour

Units of Temperature

℃	:	degree Celsius or Centigrade

Units of Electricity

W	:	watt
kW	:	kilowatt
MW	:	megawatt
GW	:	gigawatt
A	:	ampere
V	:	volt
kV	:	kilovolt
kVA	:	kilovolt ampere
MVA	:	megavolt ampere
MVar	:	megavar (mega volt-ampere-reactive)
Ω	:	ohm

UNITS

Units of Time

s	:	second
min	:	minute
h	:	hour
d	:	day
m	:	month
y	:	year

Units of Flow Rate

m/s	:	meter per second
m^3/s	:	cubic meter per second

Units of Currency

VND	:	Vietnam Dong
US$/USD	:	US Dollar

Exchange Rate

1 US$	=	VND 15,830	As of May 2005
1 US$	=	VND 15,825	As of September 2006
1 US$	=	VND 15,844	As of January 2006

CHAPTER 1

INTRODUCTION

Chapter 1 Introduction

1.1 Background

Stable power supply is considered a top priority issue in order to support sustainable socio-economy development in the Socialist Republic of Viet Nam (hereinafter referred to as "Vietnam"). Vietnam has prepared a master plan of power system development every five years and aimed at deliberate development of the power systems.

Both electric power consumption and maximum demand in Vietnam have grown at the rates of more than 10% per year for the last 10 years. Therefore, development of power sources and transmission systems based on the plan has been an urgent and important issue in Vietnam.

Nevertheless, the 5th power development master plan has several important problems, as the JICA study report "Master plan study on PSPP and optimization for peaking power generation" pointed out, namely, there is inconsistency between demand and supply of primary energy and unevenly distributed domestic primary energy is not taken into consideration properly. Therefore, it is required that adequate consideration of primary energy should be taken in order to secure the long-term stable power supply. Furthermore, international power exchange with the neighboring countries should be taken into consideration and incorporated into the next 6th master plan.

Under the circumstances, Electricity of Vietnam (EVN) requested the Government of JAPAN of carrying out a development study on 6th master plan of power sector to be prepared by March 2006.

Accordingly, a preliminary study mission for project formulation was dispatched in December 2004 and discussed the requested development study with the Government of Vietnam. Based on the discussion, the S/W of "The Study on National Power Development Plan for the period of 2006-20015, perspective up to 2005 in Vietnam" (hereinafter referred to as "the Study") was agreed upon with EVN, which was named as the counterpart of the Study.

1.2 Objectives and Scope of the Study

1.2.1 Objectives

In order to meet growing power demand, EVN has a mission for preparing the national power development plan in the period of 2006-20015 perspective up to 2025 (hereinafter referred to as "PDP 6th") that will be approved by the Government of Vietnam.

In order to enhance the preparation of PDP 6th that will ensure stable power supply for a long term, EVN has required technical assistance from JICA.

The Study aims at assisting EVN to prepare PDP 6th.

1.2.2 Geographical Scope

The study area is the whole of Vietnam.

1.2.3 Study Area and Scope

According to the S/W and M/M signed between EVN and JICA on February 4, 2005, the Study had been carried out jointly by JICA and EVN in the following items of many necessary works for preparing Draft of PDP 6th.

1) Review of implementation of 5th master plan
2) Preparation of PDP 6th
   a. Power demand forecast
   b. Primary energy source for power development
   c. Optimization of power generation development plan
   d. Optimization of power network development plan
   e. Financial and economic analysis
3) Environmental and social considerations
4) Finalization of PDP 6th
5) Capacity development
6) Holding Workshop
7) Assistance for execution of stakeholder meeting
8) Participation of working group and steering committee

1.3 Methodologies of the Study

1.3.1 Composition of the Study Team and Study Flow

The Study Team can be divided into two groups and four fields as shown in Figure 1-3-1. The studies in each field closely cooperate in preparing PDP 6th. In order to reflect comments of related organizations, W/S was held at each study stage.

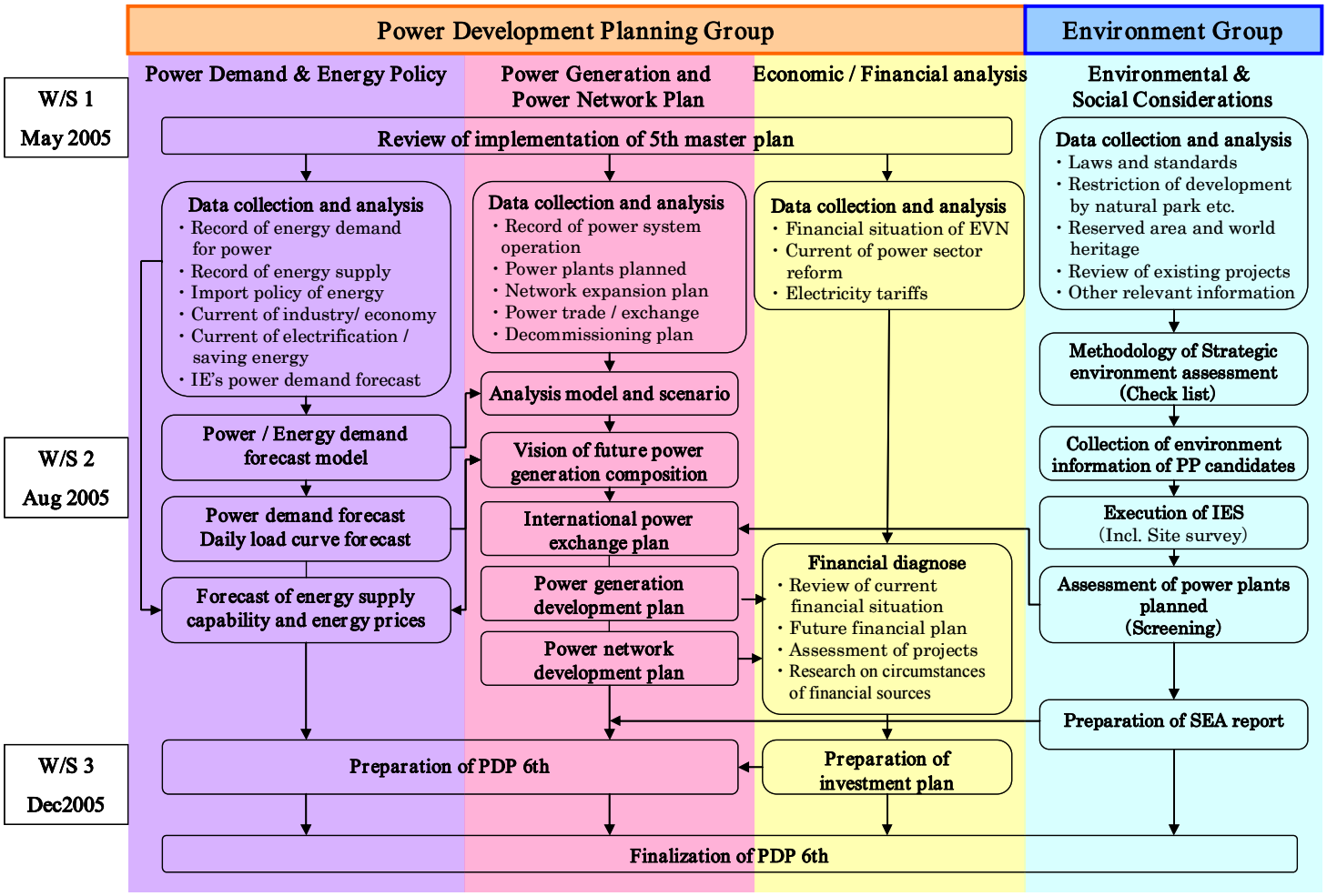


Figure 1-3-1 Study Flow

1.3.2 Work Schedule

The Study had been carried out from May 2005 to May 2006. Table 1-3-1 shows work schedule of the Study.

Table 1-3-1 Work Schedule

year	2005												2006		
Month	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6
Overall schedule		1st study in Preparation in japan		2nd study in VN 1st study in	Japan	3rd study in VN		1st study in Japan	4th study in					3rd study in Japan	
Report & Workshop		Ic/R			It/R				Df/R(draft)		Df/R			F/R	
Task		1st WS			2nd WS				3rd WS						
Preparation in Japan															
1) Collection of relevant data and information		□													
2) Preparation of the inception report		□													
3) Preparation of 1st work shop (1)		□													
1st study in Vietnam															
1) Explanation and discussion on the inception report		■													
2) Participation in working groups		■													
3) Preparation for 1st workshop(2) and The 1st workshopS		■													
4) Review of implementation of 5th master plan		■													
5) Preparation of PDP 6th (Stage1)															
a. Building the power demand forecasting model		■													
b. Model design for dairy load curve forecasting			■												
c. Model building on dairy load curve and explanation			■												
d. Drafting a fuel supply program		■													
e Drafting a scenario for the unbalanced energy supply		■													
f. Checking of the data and validity of verification for PGDP		■													
g. Establishment of the power development scenarios		■													
h. Establishment of power development vision		■													
i. Consideration on interconnection with neighboring countries			■												
g. Evaluation of power plant candidates			■												
k. Preliminary power network planning		■													
l. Reviewing of financial plan		■													
m.Information collection/organization on operation system of electric power business in Viet-Nam and trends of electricity tariffs			■												
n. Complilation of law, regulations and standard related to socio-environment assessment		■													
o.Investigation on the relation between Power Development Policy of Vietnam and Socio-environmental Consideration		■													
p. Study of the SEA check point and drawing up the check list.		■													
q. Examination and selection of execution method for SEA		■													
r. Local sub-contractor selection procedure		■													
s. Implementation of the first site investigation and analysis			■												
6) Preparation of the interim report		■	■												
1st study in Japan															
1) Submission of the interim report				□											
2) Preparation of the 2nd work shop (1)				□											
2nd study in Vietnam															
Explanation and discussion on the interim report				■											
2) Preparation of the 2nd work shop (2) and the 2nd work shop				■											
3) Follow-up the environmental and social considerations carried out by sub-contract				■											
3rd study in Vietnam															
1) Preparation of PDP 6th (Stage2)															
a. Review the power demand forecasting						■									
b. Preparation the manuals and explanation for PDF						■									
c. Review of drafted fuel supply program and scenario for unbalanced energy supply						■	■								
d. Study of the integration with the national energy policy							■								
e.Review of power development scenarios and vision for power development						■	■								
f. Making priority oder to the candidates of power development							■	■							
g. Establishment of long term power development plan for 20 years															
h.Revision of preliminary power network planning						■	■								
i. Optimal power network planning							■								
j. Research on circumstances of financial sources							■								
k. Development of investment plan for the next 20 years							■	■							
l.Development of long-term financial planning								■							
m. Arrangement and analysis of the results of sub-contracted investigation						■									
n. Execution of IEE、2nd site survey						■									
o.Socio- environmental evaluation of proposed power development site							■								
p. Preparation of SEA reporto. Preparation of SEA report							■								
2) Preparation of technology transfer seminar on the tools for generation development planning and transmission system analysis								■							
3) Preparation of the draft final report (draft)							■	■							
2nd study in Japan															
3) Submission of the draft final report (draft) to Counter part								□							
2) Preparation of 3rd work shop (1)								□							
4th study in Vietnam															
1) Explanation and discussion on the draft final report (draft)									■						
2) Preparation of 3rd work shop (2) and The 3rd work shop									■						
3) Finalization of PDP6th										■					
4) Preparation and Submission of the draft final report											■				
3rd study in Japan															
1) Preparation and Submission of the final report														□	

Notes ■ : Study in Vietnam □ : study in Japan

1.4 Organization and Progress of the Study

1.4.1 Members of Counterpart Personnel

In order to explain the Inception Report, which had been submitted to IE in advance, the Study Team headed by Mr. Masayuki ITO held a kick-off meeting with IE on May 17,2005 respectively.

IE agreed that the study would be carried out team working group by Working Group that it would assign appropriate counterpart personnel for each Working Group as follows;

・Power demand forecast WG　：(Energy Economics and Demand Forecast Dept.)
Mr. Tran Manh Hung, (Task leader), Mr. Tran Minh Khoa, Mrs. Le Nguyet Hang
Mrs. Nguyen Khoa Dieu Ha, Dr. Quoc Khanh
・Power sources & networks plan WG：(Power System Development Planning Dept.)
Mr. Nguyen Anh Tuan (Task leader) , Mr. Tran Duc
・Economic & financial analysis WG：(Energy Economics and Demand Forecast Dept.)
Mr. Tran Manh Hung(Task leader), Mrs. Tiet Minh Tuyet, Dr. Quoc Khanh
・Socio-environment consideration WG：(Thermal Power and Environment Dept.)
Dr. Hoang Tien Dung(Task leader), Ms. Nguyen Thi Thu Huyen, Mrs. Le Minh Ha

1.4.2 Members of the Study Team

The Study Team members participated in the following 4 Working Groups respectively and worked collaboratively.　And the Study Team comprised the following members.

・Power demand forecast WG：Tomoyuki INOUE, Akira MINOYAMA
・Power sources & networks plan WG：Masayuki ITO, Yasuhiro YOKOSAWA, Masaharu YOGO
・Economic & financial analysis WG：Shinichi AOYAMA
・Socio-environment consideration WG：Hisamitsu OKI

Masayuki ITO	Leader／Power Development Planning
Tomoyuki INOUE	Power demand forecast
Akira MINOYAMA	Energy policy
Yasuhiro YOKOSAWA	Power Development Planning
Masaharu YOGO	System Planning
Shinichi AOYAMA	Economic and Finance
Hisamitsu OKI	Social and Environment
Tetsuya TERAUCHI	Coordinator

1.4.3 Progress of the Study

Figure1-4-1 and Table1-4-1 show the assignment schedule for the study and the work programs respectively.

Table 1-4-1 Work Program

Work stage	Main work
Preparation in Japan Early May 2005	1) Collection of relevant data and information 2) Preparation of the inception report 3) Preparation for 1st work shop (1)
1st study in Vietnam Mid. May 2005 ～Late Jun. 2005	1) Explanation and discussion on the inception report 2) Participation in Working groups 3) Preparation for 1st work shop(2) and The 1st work shop 4) Review of implementation of 5th master plan 5) Preparation of PDP 6th（Stage1） a. Building the power demand forecasting model b. Model design for daily load curve forecasting c. Model building on daily load curve and explanation d. Drafting a fuel supply program e. Drafting a scenario for the unbalanced energy supply f. Checking of the data and validity of verification for PGDP g. Establishment of the power development scenarios h. Establishment of power development vision i. Consideration on interconnection with neighboring countries j. Evaluation of power plant candidates k. Preliminary power network planning l. Reviewing of financial plan m. Information collection/organization on operation system of electric power business in Vietnam and trends of electricity tariffs n. Compilation of laws, regulations and standards related to socio-environment assessments o. Investigation on the relation between Power Development Policy p. Study of the SEA check point and drawing up the check list q. Examination and selection of execution method for SEA r. Local sub-contractor selection procedure s. Implementation of the first site investigation and analysis 6) Preparation of the interim report
1st study in Japan Early July 2005	1) Submission of the interim report 2) Preparation for the 2nd work shop (1)

Work stage	Main work
2nd study in Vietnam Mid. July 2005 ～Late July 2005	1) Explanation and discussion on the interim report 2) Preparation for the 2nd work shop (2) and the 2nd work shop 3) Follow-up of the environmental and social considerations carried out by sub-contractors.
3rd study in Vietnam Mid. Sep. 2005 ～Late Oct. 2005	1) Preparation of PDP 6th（Stage2） a. Review of the power demand forecasting b. Preparation of the manuals and explanation for PDF c. Review of drafted fuel supply program and scenario for unbalanced energy supply d. Study of the integration with the national energy policy e. Review of power development scenarios and vision for power development f. Making priority order to the candidates of power development g. Establishment of long term power development plan for 20 years base on the least cost method h. Revision of preliminary power network planning i. Optimal power network planning j. Research on circumstances of financial sources k. Development of investment plan for the next 20 years l. Development of long-term financial planning m. Arrangement and analysis of the results of sub-contracted investigation n. Execution of IEE and 2nd site survey o. Socio-environmental evaluation of proposed power development site p. Preparation of SEA report 2) Preparation of technology transfer seminar on the tools for generation development planning and transmission system analysis 3) Preparation of the draft final report（Ver.1）
2nd study in Japan Early Nov.2005 ～Mid. Nov. 2005	1) Submission of the draft final report(Ver.2) 2) Preparation for the 3rd work shop (1)
4th study in Vietnam Late. Nov. 2005 ～Early Dec.2005	1) Explanation and discussion on the draft final report (Ver.2) 2) Preparation for 3rd work shop (2) and The 3rd work shop 3) Confirmation of the draft final report (Ver.2)
3rd study in Japan Late.Dec.2005	1) Preparation and Submission of the final report (Ver.3) 2) Preparation for Stakeholder Meeting (SHM)

Work stage	Main work
5th study in Vietnam Mid Jan. 2006 ～Late. Jan. 2006	1) Explanation and discussion on the draft final report (Ver.3) 2) Preparation for SHM (2) and SHM 3)Confirmation of the draft final report (Ver.3)
4th study in Japan Late.Feb.2006	1) Preparation and Submission of the draft final report
6th study in Vietnam Early Mar. 2006 ～Mid. Mar. 2006	1) Explanation and discussion on the draft final report 2) Finalization of PDP6th
5th study in Japan Late May. 2006	1) Preparation and Submission of the final report

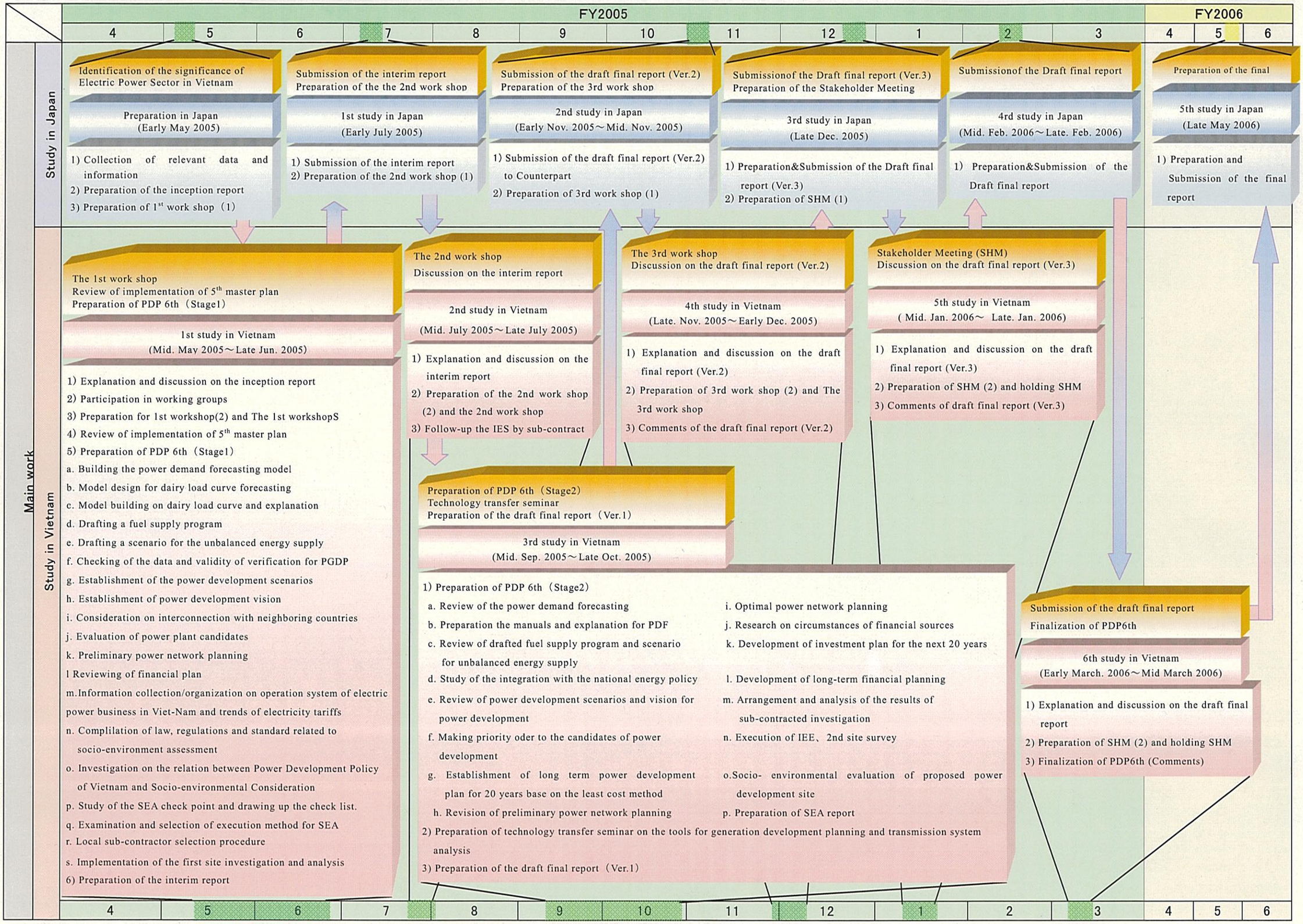


Figure 1-4-1 Time-Series Study Flow

CHAPTER 2

REVIEW OF IMPLEMENTATION OF 5th MASTER PLAN

Chapter 2 Review of Implementation of 5th Master Plan

2.1 Evaluation of Demand Forecasts

2.1.1 Overview of Current Socio-Economic Situation

GDP growth rate in 2004 was 7.7%. In the growth rate, agriculture, Forestry & Fishery sector contributed 3.4%, Industry & Construction sector was 10.3% and Service sector was 7.5%. This is the year with the highest growth rate in the period 2000-2004.

Table 2-1-1 GDP Growth Rates for the Whole Country in 2000-2004 (Unit: %)

Year	2000	2001	2002	2003	2004
Total	**6.8**	**6.9**	**7.0**	**7.2**	**7.7**
Agriculture, forestry & Fishery	4.6	3.0	4.1	3.2	3.4
Industry & Construction	10.1	10.4	9.4	10.3	10.3
Services	5.3	6.1	6.5	6.6	7.5

Sources: Vietnam year book 2003 and data from IE

According to Table 2-1-3 "The Shares of Power Consumption", the power consumption share of agriculture, forestry and fishery sector declined from 1.6% in 2003 to 1.4% in 2004. It increased from 43.6% to 45.2% with industry and construction sector, and decreased from 45.9% to 44.5% with Management & Residential sector.

In the several past years, the economic growth rate of industry and construction sector was much higher than that of average growth rate of the whole country. The economic growth rate of services sector was about the same as the average value of the whole economy of the country. Since the growth rate of the agriculture, forestry and fishery sector is relatively low, the economic share of these sectors declined strongly. The share slightly decreased in the services sector and strongly increased in the industry and construction sector.

2.1.2 Current Situation of Power Consumption in the Period 2000-2004

(1) Power Consumption

The power consumption data for the period 1996-2004 in the Table 2-1-2 indicate that the power sales increased 3 times in this period of years, with average growth rate of about 14.5%/year, especially a high growth rate of 15.3%/year in the period 2000-2004.

In 2004, the total power sale amounted to 39.6 billion kWh.

Table 2-1-2 Power Consumption (Unit: GWh)

Item	1996	1997	1998	1999	2000	2001	2002	2003	2004
Industry &Construction	5,503	6,163	6,781	7,590	9,088	10,394	12,681	15,202	17,891
Agriculture, Forest & Fishing	643	691	715	582	428	478	506	555	547
Management & Residential Use	6,136	7,221	8,849	10,020	10,986	12,646	14,333	15,991	17,618
Commerce,& Others	1,092	1,228	1,380	1400	1,895	2,227	2,708	3,087	3,541
Sales Power	13,375	15,303	17,725	19,550	22,404	25,858	30,228	34,835	39,596
Growth (%)	19.44	14.41	15.83	10.30	14.60	15.42	17.0	15.0	13.5
Per capita (kWh/year)	177	200	233	255	289	338	379	432	483
Loss (%)	19.3	18.2	16.09	15.53	14.03	14.0	13.4	12.7	12.2

Source: Institute of Energy - EVN

Table 2-1-3 The Shares of Power Consumption (Unit: %)

Item	1996	1997	1998	1999	2000	2001	2002	2003	2004
Industry &Construction	41.1	40.3	38.4	38.7	40.6	40.4	42.0	43.6	45.2
Agriculture, Forest & Fishing	4.8	4.5	4.0	3.0	1.9	1.9	1.7	1.6	1.4
Management & Residential Use	45.9	47.2	49.7	51.1	49.0	49.1	47.4	45.9	44.5
Commerce,& Others	8.2	8.0	7.9	7.2	8.5	8.6	9.96	8.86	8.9

Source: Institute of Energy – EVN

(2) Peak Demand

The Peak demand increased 2.6 times from 3,177 MW in 1996 to 8,283 MW in 2004, reaching an average growth rate of 12.7%/year. In 2002, the peak demand growth rate was 15.9%, the highest in the whole period. According to the statistical data of National Load Dispatch Center for the period 2001-2004, the national power grid had to shed relatively large amount of load in some peak hours, due to shortage of power supply capacity. Normally, the peak cut-off is performed between June and August (the water level of reservoirs of hydro power plants is lowered for the flood control) or in November when the power consumption of the system is maximal.

Table 2-1-4 Peak Demand in the Period 1996 - 2004

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004
Peak (MW)	3,177	3,595	3,875	4,328	4,893	5,655	6,552	7,408	8,283
Growth rate (%)	13.6	13.2	7.8	11.7	13.1	15.6	15.9	13.1	11.8

Source: National Load Dispatch Center

(3) Power Consumption Shares by Sector in the Period 1996-2004

With the common trends of economic development, the percentage of power consumed by industry and commercial services has increased and that of the primary sector like agriculture has decreased. The power consumption shares of four main sectors, e.g. industry & construction, agriculture - forestry & fishery, management & residential and commercial & other activities are presented in Figure 2-1-1.

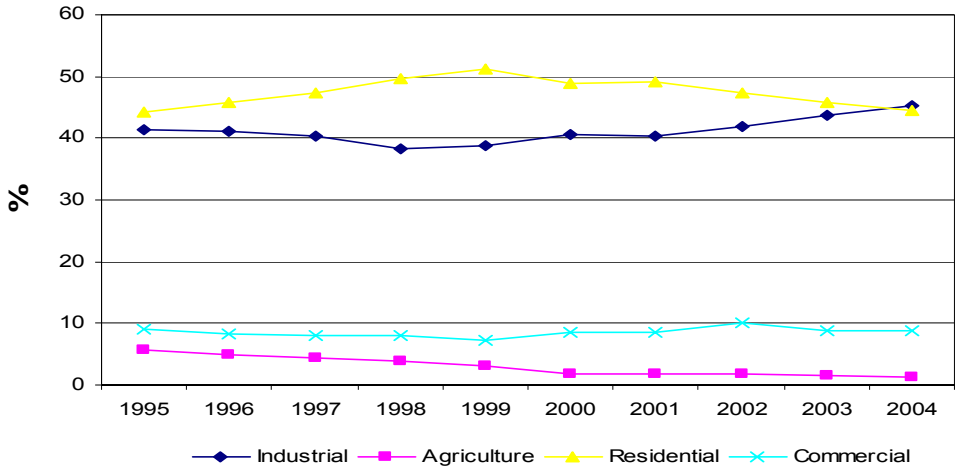


Figure 2-1-1 Power Consumption Share by Sectors

(4) Power Consumption in Industry

The share of power consumption of the industry sector in the period 1996-2004 was in the range of 38% to 45%, of which the lowest was recorded in 1998 and the highest in 2004. In the period of 1998-1999, the power consumption in the industry sector was so low due to the Asian economic crisis that the foreign direct investment decreased much. However, after the crisis, the industry sector has been rapidly restoring. With rapid increase of capital resources for investment, the Government continuously improved investment environment by applying improvement measures for management, administration procedures and promotion of trade agreements, so that the industrial zones, export processing zones and big plants have been formed. The share of industrial power consumption reached 45.2% in 2004, which is the highest value recorded in the period 1996-2004.

(5) Power Consumption in Agricultural Sector

Electric power is used mainly for irrigation pumping stations in the agricultural sector, and the share of power consumption in this sector is relatively small. The power consumption in this sector tends to decrease from 1996 to 2004. Its share declined from 4.8% in 1996 to 1.4% in 2004. Apart from development of the irrigation pumping stations for expansion of cultivation, the shifting of land use from paddy production to fish cultivation made power consumption increase.

(6) Power Consumption in Residential and Administration

Power consumption in residential sector has strongly increased due to development of market economy. The number of electric appliances used in the urban residential areas significantly increased. The Government paid much attention to electrify the rural, mountainous areas for production development and improving life quality of the people. This is the reason why power consumed in the residential sector has rapidly increased. The average growth rate of power consumption in the residential sector was 15.8 %/year in the period 1996-2004. In the power consumption structure, residential power consumption accounts for 45 - 51 %, the highest of 51.1 % in 1999 and 44.5 % in 2004.

(7) Power Consumption in Commerce, Hotels, Restaurants and Other activities

This sector consumed small amount of power, only 7-9% of the total power consumption but its growth rate is very high, about 15.8 %/year in the period 1996-2004.

(8) Distribution and Transmission Losses

The power losses in power transmission and distribution has decreased significantly in the period 1996-2004, from 19.3% in 1996 to 12.2% in 2004. This is due to decrease of technical and non-technical losses. In order to reduce non-technical losses, the power sector installed electricity meters at consumers, reinforced power supply and management system, and made rehabilitation and expansion of transmission and distribution networks, especially in the big cities such as Hanoi, Hai Phong, Ho Chi Minh city etc.

2.1.3 Power Load Curve of the Power System in the Period 1996-2004

(1) Load Curve of the Whole Country System

The characteristics of load curve of the whole country system are as follows:

- Power growth rate in the daytime (from 8 hr. to 17 hr, 16.0% up per year) is higher than that in the peak hours (from 18 hr. to 22 hr, 13.0% up per year) by 3.0%/year on average growth rate.

- The ratio between peak demand and off-peak demand (Pmin/Pmax) of the power system has also increased from 0.45 in 1996 and 0.48 in 2004 in winter season.
- The daily peak load (at 10hr. a.m.) tends to increase, and it is higher than the evening peak in summer season from the year of 2003. That means, maximum peak load of the power system tends to shift from evening (at 18-19 hr.) to day time peak (10 hr. a.m.), forming two peaks. The typical daily load curves of the whole country's power system in the summer and the winter during the period 1996-2004 are presented in Figure 2-1-2.

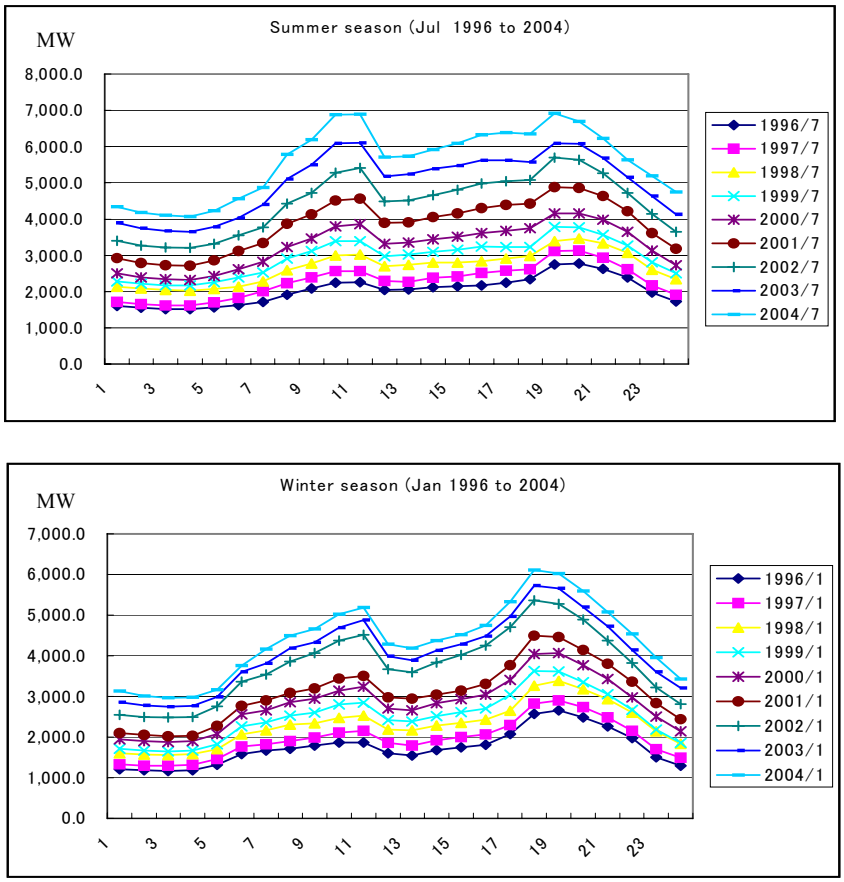


Figure 2-1-2 Load Curves of the Whole Country System 1996 - 2004

(2) Load factor

The annual load factor of the power system in the whole country is in the range of 0.61-0.64 and tends gradually to increase year by year in the period 1996-2004. Evolution of load factors of the whole country is presented in the table 2-1-5. According to the statistical data of load factors in the north, central and south regions in the period of 1996-2004, the annual load factor of the south power system is the highest in the regions, and then it is followed by the central and the north

power systems. In 2004, load factor is of 69% in the south power system, 60% in the central power system and 58% in the north power system.

Table 2-1-5 Load Factors of the Whole System in the Period of 1996-2004

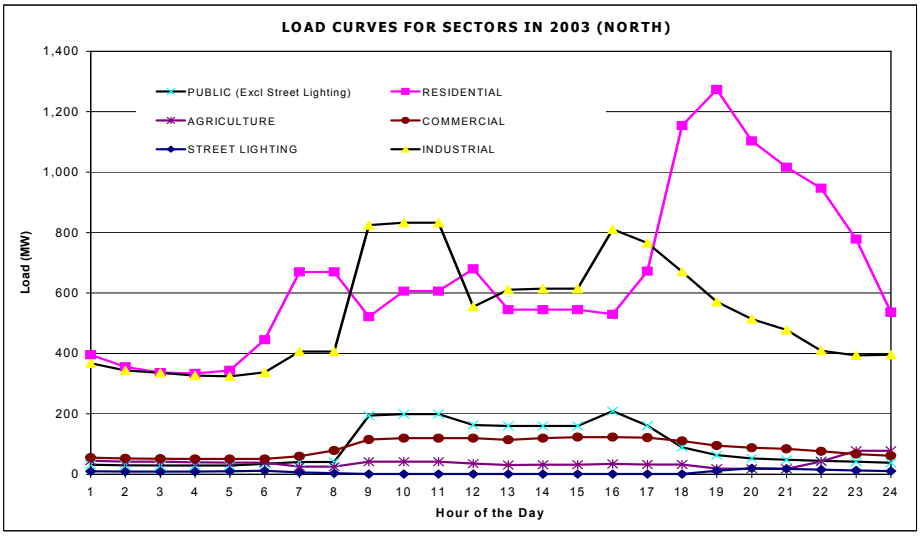
Year	1996	1997	1998	1999	2000	2001	2002	2003	2004
Load factor (LF)	0.608	0.61	0.642	0.622	0.627	0.621	0.632	0.635	0.639

(3) Assessment of Shifting Peaks and Off- Peaks

In the period of 1996-2004, the peak load of the power system occurred in the evening (18-19 hr.), the demand for lighting is dominant. The load curve analysis for the whole country and regions indicates that daily peak load of the power system tends to be higher. The following reasons are considered for this shifting:

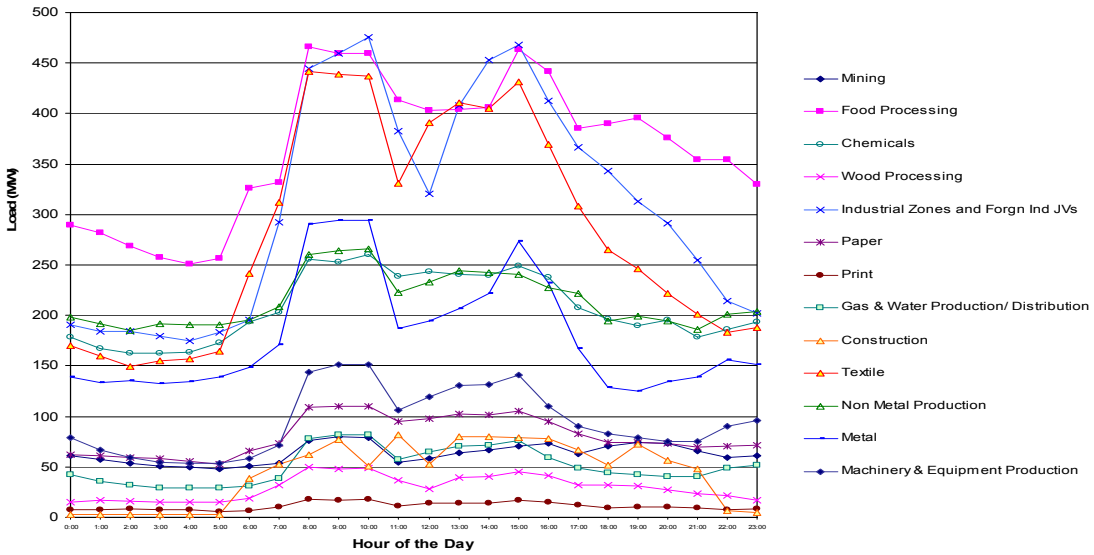
a. Change of Power Consumption Structure in the Power System

Regarding three big sectors of power loads such as industrial, residential and commercial & services, the share of industrial load increased from 38% in 1996 to 45% in 2004, meanwhile residential load decreased from 50% to 45 % and commercial & services increase from 3.5% to 9.1%. The peak demand is at 10 hr. a.m. for the industry sector, and at 18 hr. (in winter) and 19 hr. (in summer) for the residential use. Commercial load rapidly increases, contributing to the increase of daily peak of the system. The Figure 2-1-3 illustrates the load curve of the whole country in 2003 by load components.



Source: Institute of Energy

Figure 2-1-3 Sector Load Curves in 2003



Source: Institute of Energy

Figure 2-1-4 Load Curve of Industrial Segments in 2003

b. Change of Working Regimes of the Small Industries Consuming Much Power

These industries mainly comprise food processing (18.4%), textile (15.0%), cement (11.4%), chemical (11.0%) and metallurgy (10.0%). In general, load curves of sectors are relatively similar to large power consumption in daily hours (8-16 hr.) and consumption in evening peak hours has decreased. Therefore, the aggregate load curve of small industries has the shape that has highly increased in the day time (8-16 hr.) and reaches maximum value at 10 hr. a.m. and the curve is flatter in the evening peak hours and night hours. Load curves of sub-sectors are presented in the Figure 2-1-4.

c. Results of Application of Some DSM Programs

Regarding lighting program, the residential lighting accounts for large share in peak load of the power system. Therefore, reducing residential lighting electricity as well as lighting power will make sense in reduction of peak load of the power system. In this DSM project, the lighting program was carried out at pilot scale (changing existing lamps (50-70W) with compact lamps (15-20W)), changing 40W fluorescent lamps with 32-36W fluorescent lamps). In the future, the program will be implemented with bigger scale, and it will be expected better results in future.

Table 2-1-6 Number of TOU Meters Installed and Measured Power

Years	Energy Sales(MWh)				Number of TOU
	Off-peak	Peak	Low	Total	
2000	**2,480.0**	**523.8**	**1,006.4**	**4,010.2**	**3,526**
Industrial	2,379.9	494.8	974.6	3,849.3	3,226
Commercial	100.1	29.1	31.8	160.9	300
2001	**3,550.9**	**739.2**	**1,394.1**	**5,684.2**	**4,695**
Industrial	3,389.2	692.1	1,345.7	5,426.9	4,323
Commercial	161.7	47.1	48.4	257.3	372
2002	**5,525.6**	**1,169.7**	**2,039.4**	**8,734.7**	**15,900**
Industrial	5,196.8	1,075.7	1,956.2	8,228.6	14,266
Commercial	328.9	93.9	83.2	506.1	1,634
2003	**8,779.6**	**1,856.5**	**3,096.5**	**13,732.7**	**29,974**
Industrial	8,259.4	1,707.1	2,964.0	12,930.5	25,507
Commercial	520.2	149.5	132.5	802.2	4,467

2.1.4 Assessment of Power Demand Forecast in Master Plan

(1) Review of Power Demand in the Period of 2000-2004

Based on statistical data in the report on power generation and consumption in the period 2000-2004 by EVN, the review and comparison with power demand forecast in the Master Plan V (PDP5th) were performed. The Figure 2-1-5, 2-6 and Table 2-1-7, 2-1-8 show the results of the above power demand comparison.

Table 2-1-7 Comparison between Forecast (PDP5th) and Actual Data

Year	Energy Sales (GWh)				Peak (MW)			
	Actual	Forecasted in PDP5th			Actual	Forecasted in PDP5th		
		Low	Base	High		Low	Base	High
2000	22,404	21,394	21,394	21,394	4,893	4,477	4,477	4,477
2001	26,851	23,651	23,844	24,068	5,655	4,902	4,942	4,988
2002	30,234	26,165	26,597	27,112	6,552	5,381	5,470	5,576
2003	34,841	28,978	29,706	30,593	7,408	5,920	6,069	6,250
2004	39,596	32,103	33,192	34,550	8,283	6,510	6,731	7,006

Table 2-1-8 Differences between Forecast and Actual Values

Year	Energy Sales (%)			Peak (%)		
	Low	Base	High	Low	Base	High
2000	-4.5	-4.5	-4.5	-8.5	-8.5	-8.5
2001	-11.9	-11.2	-10.4	-13.3	-12.6	-11.8
2002	-13.5	-12.0	-10.3	-17.9	-16.5	-14.9
2003	-16.8	-14.7	-12.2	-20.0	-18.1	-15.6
2004	-18.9	-16.2	-12.7	-21.4	-18.7	-15.4

Refer: (Forecast – Actual)/ Actual *100

(GWh)

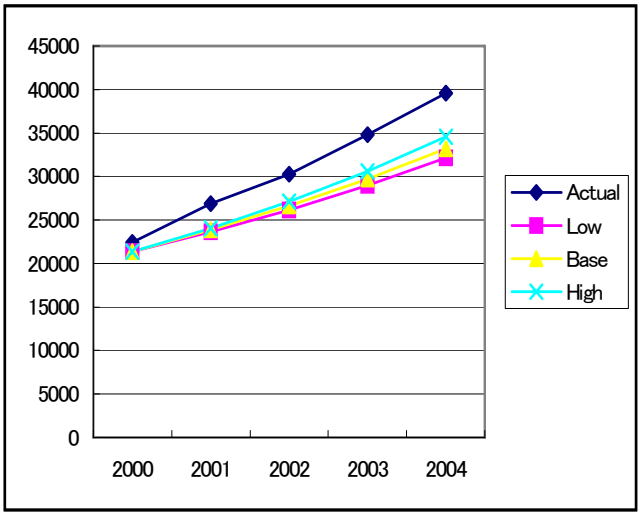


Figure 2-1-5 Comparison of Actual Power Sales Forecast in PDP5th (High, Base Low)

(MW)

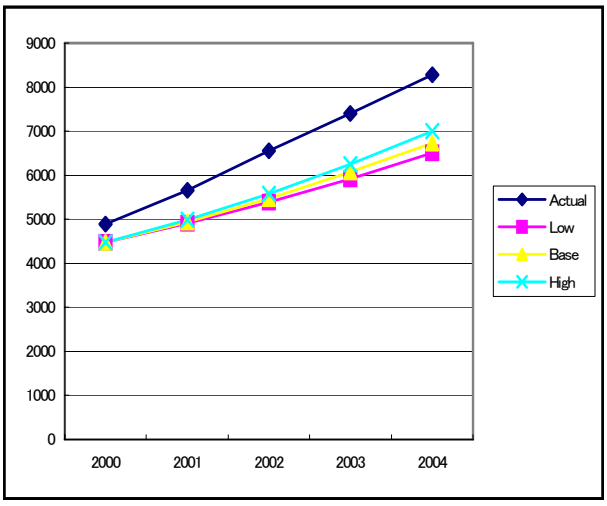


Figure 2-1-6 Comparison of Actual Peak Demand Forecast in PDP5th (High, Base, Low)

(2) Reasons for Deviation in Power Demand Forecast in Master Plan

The actual values of power demand in the period 2000-2004 are higher than the forecast values in all cases (High, Base, Low) of the PDP5th, the high case has the smallest difference in the comparison. For the long-term forecasting by the "elasticity method", the "elasticity" in PDP 5th was forecasted lower than actual records (table 2-1-9). Therefore, the forecast value of power sales and peak power are lower than actual data in the past years.

Table 2-1-9 Scenario of Socio-Economic Growth

Scenario	Low	Base	High
Period	2001-2010	2001-2010	2001-2010
Actual		7.2%	
PDP5th	6.5%	7.4%	8.0%

Table 2-1-10 Elasticity of GDP to Sales Power

Scenario	1999-2000	2001-2005	Note
Actual	2.15	2.13*	The period up to 2004
PDP5th	1.82	1.62	

(3) Reasons for Increase of Power Consumption

Study on statistical data of power consumption in the period 2000-2004 and evolution of power demand growth rates in each power company and each province indicates the following reasons for the increase of power consumption in this period.

- Extension of power transmission and distribution power networks, making increase of electrification level and capability to supply power to the areas;
- Number of industrial zones, export processing zones and industrial networks is increased. Industrial zones and enterprises involved in production, business and constructing infrastructures are much increased;
- Some big factories in steel, cement, food processing, chemical plants have been put into operation;
- The fishery and ship building factories tend to be developed strongly.

(4) Power Demand Growth by Region

a. North Region

The north region consists of 28 cities and provinces, and its power supply is managed by Power Company 1, Hanoi Power Company and Hai Phong Power Company. According to the statistical data of power consumption in the period 2000-2003, the power consumption growth rate in the whole region was 16.3%, in which PC1 occupied 18% and Hanoi PC 14 %. The provinces with high growth rates in four years (2000-2003) are: Hung Yen (30.7%/year), Vinh Phuc (29%/year), Thai Nguyen (23%), Quang Ninh (20%), Nghe An (22%), Bac Ninh (19.5%). Apart from them, 10 provinces in the PC1 have growth rates higher than 15%. The growth rates of power consumption in the above mentioned provinces will be still high in the coming several years.

In the period 2000-2003, industrial zones, export processing zones and industrial parks were invested and strongly developed. Based on the potential of each province, industrial zones, export processing zones and handicraft villages were planned. Most of the industrial zones and export processing zones are located in the big urban areas such as Hanoi, Hai Phong, Quang Ninh in the north. It is anticipated that there will be 107 industrial zones added including big plants such as Thach Khe iron ore, Nghi Son refinery and Nghe An metallurgy in the north region by 2010, and the industries will consume power of 753 MW

b. Central Region

The central region consists of 12 provinces managed by PC3. The provinces in the central region have high rate of investment and growth rate of power consumption. In the period 2002-2003, the growth rate was 15%/year. Many provinces have the growth rates at 15-17%/year. Dac Lac has growth rate of 24.25%/year. However, in the whole period of 2000-2003, the average growth rate of the whole region reached only 8%/year. Quang Nam has the highest growth rate (19.21%/year) in the region. In some years to come, the power demand in the central region will be increased because many industrial zones and export processing zones will be developed, especially Dung Quat oil refinery. It is anticipated that there will be 67 industrial zones added in the central region by 2010, the industries will bring power consumption of 933 MW (including Dung Quat industrial zone).

c. South Region

The south region consists of 21 provinces and their power supply is managed by PC2, Ho Chi Minh city PC and Dong Nai PC. According to the statistical data in the period 2000-2003, the power consumption growth rate in the whole region was 18.31 %, the highest in the whole country, with PC2 (22%), Dong Nai PC (20.21%), and Ho Chi Minh city PC (15.03%). In PC2, some provinces have very high growth rates such as Binh Duong (54%), Bac Lieu (37%), Binh Thuan (25%) and Vung Tau (25.5%). The highest growth rate was recorded in the industrial sector, followed by residential and commercial sectors. It is anticipated that there will be 90 industrial zones added in the south region by 2010, including some big plants such as Dong Nai cement, Lam Dong aluminum metallurgy. The industries will bring power consumption of 1093 MW.

2.2 Energy Sector

2.2.1 Organization

The power sector and the coal sector were under jurisdiction of Ministry of Energy (MOE) until 1994, while oil and gas was directly controlled by the State.

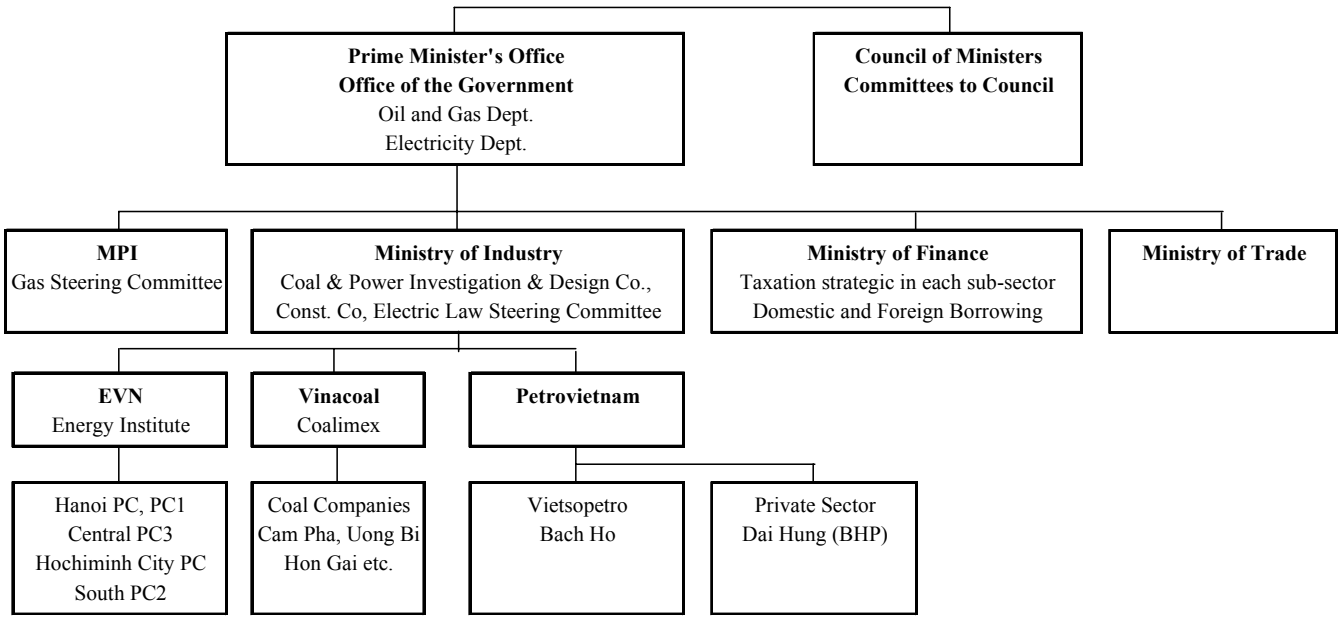
According to the government ordinance dated 27 January 1995, Electricity of Vietnam (EVN) as well as Vietnam Coal Cooperation (Vinacoal) was established as State-owned enterprises. In the meantime, Ministry of Industry (MOI) was combined with the former MOE, Ministry of Heavy Industry and Ministry of Light Industry, and reformed to be the relevant authorities for power sector and coal sector. Later, the oil and gas sector (Petrovietnam) also decided to be under the control of MOI by the Decree issued 28 October 2003.

Until recently, energy development plan and/or master plan by type was carried out by each energy sector but without a synthetic energy policy or energy plan in the national level. Now MOI

submitted a national energy strategy and policy for the government's approval and aiming acquisition of approval at the end of 2005.

Recent organization of energy sector shown in Figure 2-2-1

By the Decree number 219/2003/QD-TTG issued on 28 October 2003 prescribed that EVN proposal on structure reform from 2003 to 2005 has been approved.



Source: Fueling Vietnam's Development – New Challenges for the Energy Sector, 1998.12, WB, partially revised

Figure 2-2-1 Organization of the Energy Sector of Vietnam

2.2.2 Energy Resources

(1) Hydropower

a. Reserves

In the revised 5th MP, total exploitable potential of hydropower in the whole country was considered to be 17,700 MW with energy of 82.0 TWh. After that, some more examination done and Study on KHCN09 "Establishment of stable energy strategy and policy", exploitable potential was revised to be 20,560 MW with energy of 83.42 TWh, of which, 9,990 MW 38 TWh in north (54%), 7,700 MW 21.8 TWh in the central (30%) and 2,870 MW 11.6 TWh in south (16%), shown an unevenly distributed hydropower potential in the north.

Feasible potential of hydropower on each main river basin is shown in Table 2-2-1 below;

Table 2-2-1 Feasible Potential of Hydropower

River Basin	Capacity (MW)	Energy (TWh)
Lo-Gam-Chay River	1,470	5.81
Da River	6,960	26.96
Ma River	890	3.37
Ca River	520	2.09
Vu Gia-Thu Bon River	1,120	4.29
Tra Khuc-Huong River	480	2.13
Ba River	670	2.70
Se San River	1,980	9.36
Srepok River	700	3.32
Dong Nai River	2,870	11.64
Sub Total	17,660	71.67
Total	20,560	83.42

Source: IE "Overall evaluation on Vietnam Primary Energy Source", Nov. 2003

Comparison of hydropower development plan in 5th MP, Revised 5th MP and Pre 6th MP during 2001 to 2010 is shown in Figure 2-2-2. Development of large scaled hydropower with total capacity of 3,342 MW was intended with the 5th MP in this period, and on the Revised 5th MP, the middle and small scaled hydropower under 100 MW was taken into consideration and total capacity was revised to be 5,646 MW, an increase of 69% to the original plan. And in the Pre 6th MP, 2.3 times of hydropower in the 5th MP will be developed with a total capacity of 7,626 MW. In the Pre 6th MP, No.1 unit of Son La hydropower plant will be operated with a two years' advanced schedule from 2012 to 2010.

Following the development schedule of pre 6th.MP, then in 2010, 51% of total feasible potential of hydropower with capacity of 10,546 MW will be reached.

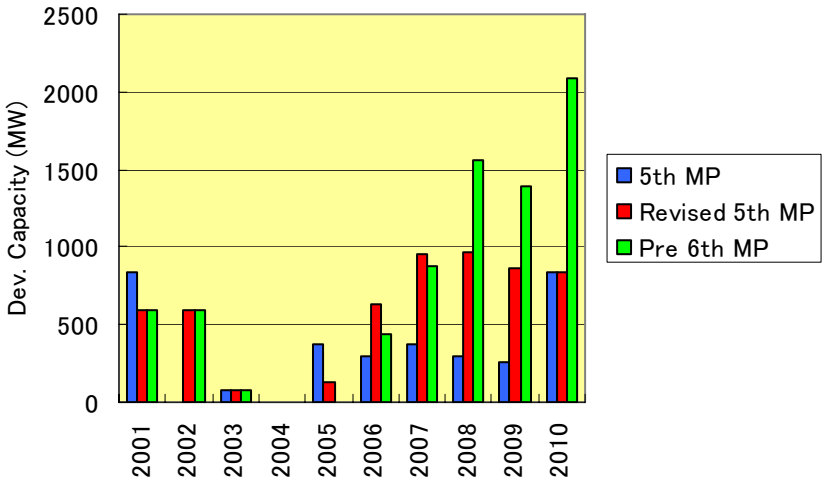


Figure 2-2-2 Comparison of Hydropower Development Plan (2001-2010)

b. Development Plan

Hydropower is a clean and renewable energy resource. Though sizeable up-front costs are needed for development, this energy is cheap and stable for more than one hundred years, once put in operation, and out of influence of the exchange rate fluctuations as no fuel costs are incurred. Therefore, EVN intends to promote positive development within the framework of economical efficiency, making practical use of the abundant potential hydropower.

According to the Revised 5th MP, a total of 12,135MW hydropower was planned to develop from 2003 to 2020, of which the north region covers 54%, the central 29%, and the south 17%. This results in developing 78% of the feasible hydropower potential of 16,080MW by 2020.

(2) Oil, Gas

a. Reserves

The Vietnam continental shelf contains an abundant reserve of hydrocarbon. In 1986 Vietsovpetro, in a joint venture of Vietnam and the former-Soviet Union, the two companies began to exploit crude oil in the Bach Ho field of Cuu Long Basin, 120 km south west of Vung Tau. After that, through investments from Western countries, more oil and gas have been explored and exploited in Rong, Dai Hung, Rang Dong and Ruby fields of Cuu Long Basin. In addition to these fields, several big-reserve fields have been discovered such as Malay-Tho Chu basin in the southwest offshore; Nam Con Son Basin 200 km the south east offshore from Cuu Long Basin; and Song Hong Basin in the North region as well. From the end of 2002, Lan Tay field in Nam Con Son Bain began to supply gas to O Mon gas-fired thermal power plant.

Oil and gas distributions are located unevenly. Oil fields are mainly concentrated in Cuu Long basin. Natural gas distributions are found in Nam Con Son, May Lay-Tho Chu and Song Hong basins.

In accordance with the report of Petrovietnam on " Strategy on Vietnam Oil and Gas Sector Development up to 2015 and prospective to 2025", reserves of oil and gas will be 2,920-3,250 MCMOE, of which, 60% is supposed to be gas. Reserves in each basin are shown in Table 2-2-3.

Table 2-2-2 Oil and Gas Reserves in Each Basin (MCMOE)

Basin	Song Hong	Phu Khanh	Cuu Long	Nam Con Son	Malay - Thu Chu	Tu Chinh-Vung May
Potential	650-750	370-500	250	650	150	850-950
Remark	Mainly gas, high CO2	Mainly gas, high CO2	Mainly petroleum	Petroleum & gas	Mainly gas	Mainly gas

At the end of 2004, proven reserves of 1,150MCMOE in the continental shelf with the depth up to 200m, (containing about 750MCMOE of oil and 400 BCM of gas) are estimated, in which, there are reserves of gas 250 BCM in Song Hong Basin containing a high rate of CO2 in a level of 60-90%, and can not be exploited with the present technology.

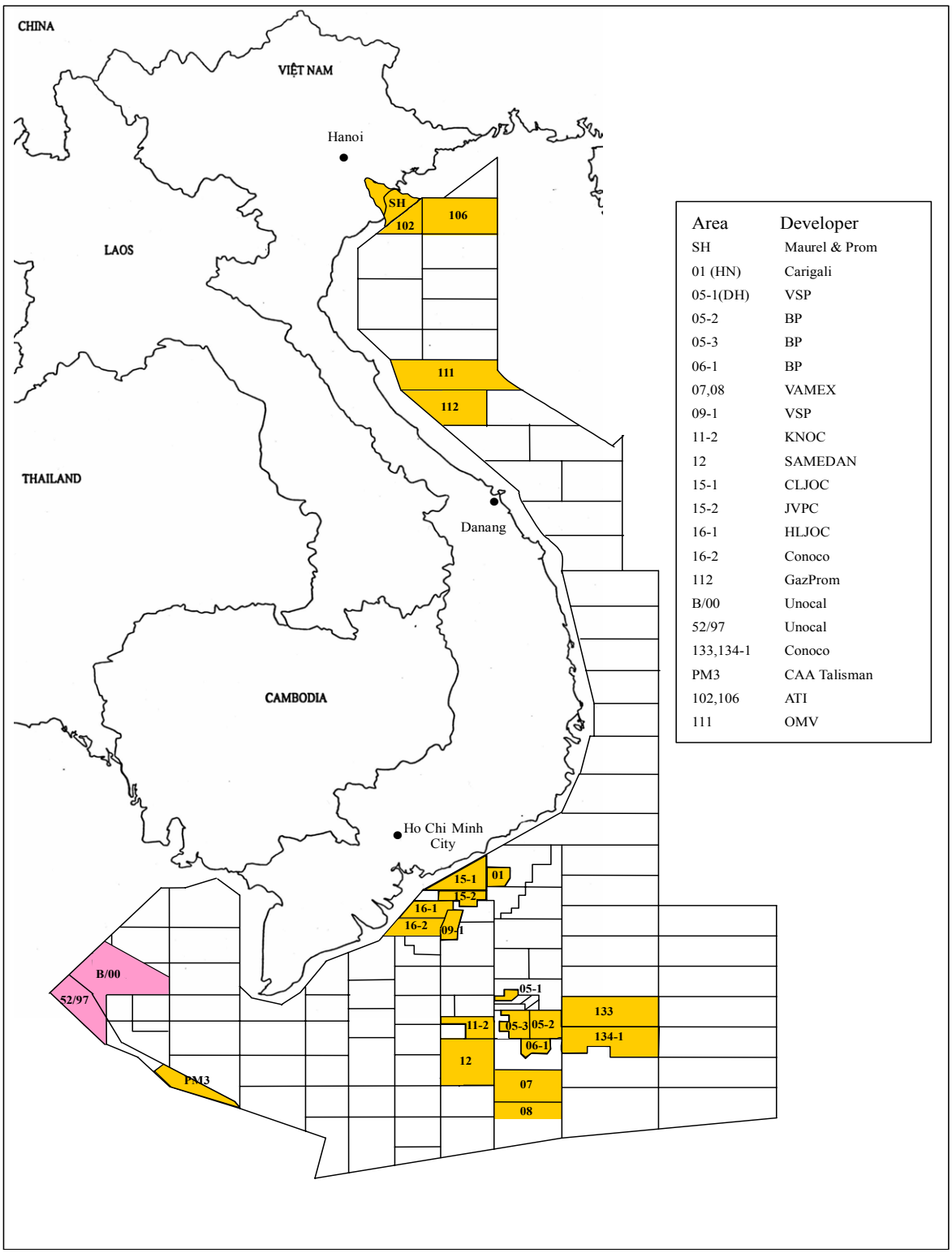
According to the 5th Master Plan of Vietnam Power Development, the residual deposits of hydrocarbon, inferred so far, were 390 million tons of oil and 617 BCM of gas.

Distribution of oil and gas resources shown in Figure 2-2-3 and the exploitation at present shown in Table 2-2-3 as followings;

Table 2-2-3 Gas Development Situation

Basin	Block	Developer	2P Reserves (BCM)	Annual Supply Capability	Supply & Development Plan	Remark
Cuu Long	9-1 (Bach Ho)	Vietsovpetro JV (PetroVietnam 50%, Nestro 50%)	20	1.5	PM 2-1, Ba ria, LPG	Associated Gas under production
	9-1 (Rong)					
	01,02 (Ruby, Emerald)	Petronas Carigali/ PVEP	25.5	1		Expected first gas in 2005
	15-2 (Rang Dong)	JVPC/ Conoco/ PVEP	9	0.5		Associated Gas under production
Nam Con Son	06-1(Lan Tay, Lan Do)	ONGC (India),BP	57	2.7	Phu My 1 Phu My 2-2 Phu My 3 Phu My 4	First gas planned 2003
	11-2 Rong Doi, Rong Doi Tay, Rong vi dai	KNOC (Korea), Mobil	30	1.3	Phu My 2-2	Under development
	05-3 (Moc Tinh)	BP/Conoco	20	1.3	No plan	Under projection
	05-2 (Hai Thach)	BP	47	1-2	No plan	Under appraisal & development
Malay-ThoChu (Southwest offshore)	B, 48/95, 52/97	Unocal MOECO PV (PVSC)	90	2-4	Depending on gas market	Under appraisal & development
	PM-3 CAA	Petrronas, PV-Co owners (50:50)	50%*52	50%*2.5	Power & Fertilizer complex in Ca Mau	First gas to VN by the end 2005
Song Hong	Thai binh (Tra Ly River), D14, Tien Hai C	Maural & Prom (France), Petro Vietnam	4	0.08	Local Industry	Operation partially
Total			328.5	12.6-15.6		

Source: Petrovietnam 2003



Source: Guideline for Foreign Investment in Petroleum Projects of Vietnam, Petrovietnam

Figure 2-2-3 Petroleum Resources

b. Actual Production

At the end of 2004, eight fields of oil and gas have been developed and explored with total out put of 188.6 million tons of oil equivalent, of which, 169.9 million tons of crude oil and 18.67 billion m3 of gas has been conducted ashore and supplied to power generation and other demands.

Actual production of oil and gas shown I Table 2-2-4 and Table 2-2-5 as followings;

Table 2-2-4 Actual Production of Crude Oil (million tons)

Field	Commissioning Time	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Bac Ho	6/1986	0.04	0.28	0.69	1.52	2.70	3.96	5.50	6.31	6.90	6.60	7.97	9.41	10.91	11.60	11.99	12.77	13.51
Rong	12/1994									0.01	0.11	0.25	0.02	0.09	0.53	0.60	0.55	
Dai Hung	10/1994									0.15	0.96	0.58	0.37	0.53	0.36	0.25	0.14	0.12
Bunga Kakwa*	7/1997												0.15	0.28	0.33	0.35	0.37	0.39
Rang Dong	8/1998													0.42	1.35	1.55	2.14	3.07
Ruby	10/1998													0.09	1.05	1.12	1.03	
Total		**0.04**	**0.28**	**0.69**	**1.52**	**2.70**	**3.96**	**5.50**	**6.31**	**7.06**	**7.67**	**8.80**	**9.95**	**12.32**	**15.22**	**15.86**	**17.00**	**17.09**

* Output of Bunga Kakwa field (Vietnamese share = 50%)

Table 2-2-5 Actual Production of Gas (million m3)

Field	Commissioning Time	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Bac Ho	6/1995										183.0	290.0	540.0	1018.0	1413.6	1700.0	1704.0	1650.0
Thien Hai"C	12/1981	154.8	37.2	35.5	16.4	5.6	28.0	19.3	23.0	25.3	23.5	23.0	22.0	21.0	21.3	21.5	20.0	20.0
Rang Dong	End of 2002																	380.0
Lan Tay	End of 2003																	225.0
Total		**154.8**	**37.2**	**35.5**	**16.4**	**5.6**	**28.0**	**19.3**	**23.0**	**25.3**	**206.5**	**313.0**	**562.0**	**1039.0**	**1434.9**	**1721.5**	**1724.0**	**2275.0**

Source: Petroleum and gas magazine, June 2002 and Scientific and Technological Conference 2000 "Nganh dau khi truoc them the ky 21"
Figures of 2002 provided by Institute for Petroleum and Gas

c. Development Plan

Table 2-2-6 shows the exploitation plan of the oil and gas sector indicated in the 5th M/P. As of the end of 2002, the total capacity of oil thermal power plants excluding IPP was only 198MW, which is total of the capacity of Thu Duc Power Plant (165MW) and Can Tho Power Plant (33MW), both of which have to import FO for operation. The only planned oil thermal plant is O Mon TPP No.1 with the capacity of 600MW. However, gas will be used on completion of the pipe-line from gas potential in the southeast offshore to O Mon in 2010.

On the other hand, along with the rapid increase of gas production, a total of 10,483MW gas thermal power plant is under planning between 2003 and 2020. Excluding Quang Tri power plant (720MW) in the central region, all the planned gas thermal power plants are located in the south region, and none is proposed in the north region. The current gas supply price is approximately US$1.8/mmbtu at the platform, excluding transfer costs through pipelines.

The development plan did not change at present.

Table 2-2-6 Petroleum Exploitation Plan (Unit: million m^3 OE)

	2000	2005	2010	2020
Oil Production	16.5	17.6-18	20.6-21.6	11-18
Gas Production	1.5	6.7	11.5-13.5	14-18

Source: Institute of Energy, 2003

(3) Coal

a. Reserves

Vietnam's coal reserves lie principally in Hon Gai graben in Quang Ninh, which extends about 125km from Uong Bi in the west to Cai Bau in the east. Though the coal deposits are geologically young, intense tectonic pressure had changed bituminous coal to semi-anthracite or anthracite. Coal reserves of 300m below the surface were estimated at 3.8 billion tons on the Revised 5th MP as shown in Table 2-2-7, and most of which are anthracite with high calorific value and low sulfur content (semi-anthracite and anthracite account for 85%, lignite 5% and peat 10%). By the coal evaluation in January 2005, proven reserves of coal are revised to 5.4 billion tons, and adding the estimated reserves, the total reserves will be 12.3 billion tons (refer to Table 2-2-8).

Table 2-2-7 Coal Reserves (2003) (Unit: million ton)

	Certainty of exploration				Exploitation	
Mine area	A+B+C1+C2	A+B	C1	C2	Open pit	Underground
Cam Pha	1,316.05	267.99	623.00	425.06	237	991
Hong Gai	526.91	37.31	247.77	241.83	54	513
Uong Bi	1,328.98	79.99	682.00	566.99	22	1,392
Interior	636.59	53.44	427.71	155.44	172	93
Binh Minh Khoai Chau	145.96		122.91	23.05		119
Total	**3,808.53**	**438.73**	**1,980.48**	**1,389.32**	**881**	**3,109**
Type of coal						
Anthracite	3,238.20	395.31	1,595.91	1,246.98	388	2,980
Long frame (Lignite)	215.23	42.84	149.56	22.83	97	121
Fat coal	6.91	0.58	6.18	0.15		7
Peat	348.19		228.83	119.36	396	

Source: Vinacoal M/P, 2003

Table 2-2-8 Proven and Probable Reserves (2005) (Unit: Million tons)

No	Region	Reserves grade			
		Total	A+B+C_1	C_2	P
I	**Quang Ninh province**	**9,673,410**	**1,828,021**	**1,997,946**	**5,847,443**
1	Cam Pha area	3,165,239	840,995	836,094	1,488,150
2	Hon Gai area	1,858,010	255,079	368,222	1,234,709
3	Uong Bi area	4,650,161	731,947	793,630	3,124,584
II	Local area	2,608,322	913,838	702,484	992,000
1	Binh Minh – Khoai Chau	1,581,000	525,000	564,000	492,000
2	Other areas	1,027,322	388,838	138,484	500,000
	Total	**12,281,732**	**2,741,859**	**2,700,430**	**6,839,443**

Source: Vinacoal M/P, 2003

Moreover, significant coal deposits have been discovered in the Red river basin. According to the study of NEDO completed in Jan. 2003, 1.64 billion tons inferred potential of sub-bituminous was discovered within the area of 950 km^2 about 1,200m below the surface as shown in Table 2-2-9. Among these, potential measured reserve is 51 million tons within 400m below the surface. The average coal quality is: moisture 18%, ash 7%, volatile 36-37%, calories 5,000kcal/kg, sulfur 0.5%.

Table 2-2-9 Red River Coal Reserves (Unit: 1000 ton)

Seam	K.S Syncline - Binh Ninh Anticline				F.K.Fault - K.S Syncline	Binh Ninh Anticline.- Binh	Gross Total
	Middle				West	East	
	Measured	Indicated	Inferred	Total	Inferred	Inferred	
	< 400m	400-800m	800-1200m		< 1200m	< 1200m	
V17	38,520	86,697	72,734	197,951	15,756	8,789	222,496
V15	52,369	94,889	64,671	211,929	17,573	20,030	249,532
V14	88,664	131,867	73,434	293,965	34,216	19,738	347,919
V4	88,055	86,563	53,516	228,134	14,874	21,042	264,050
V3	243,602	164,478	81,222	489,302	42,123	23,826	555,251
Gross Total	511,210	564,494	345,577	1,421,281	124,542	93,425	1,639,248

Source: Red River Delta Project, January 2003, NEDO

b. Actual Production

Coal sector has a 120 years history in coal development and exploitation. At the end of 2004, total actual production from the beginning reached 333.5 million tons, of which, during 1995 to 2004 after Vinacoal established, production were 131,1 million tons, shared 39% of total actual

production (Table 2-2-10). And the ration of underground mines was increased year by year from 26% in 1995 to 36% in 2004.

Table 2-2-10 Actual Coal Production 1995-2004 (Unit: Thousand tons)

No	Items	Year of exploitation					
		1995	2000	2001	2002	2003	2004
1	Rough coal	9,369	12,200	14,589	17,078	19,979	27,100
	Of which: - Open pit	6,932	7,889	9,585	10,981	12,975	17,400
	- Underground mining	2,437	4,311	5,004	6,074	6,947	9,700
2	Washed coal	8,116	11,053	12,849	15,425	18,499	23,500
3	Consumed coal	7,592	11,520	13,046	14,833	18,825	24,000
	Of which: - For export	2,782	3,095	4,197	5,536	6,468	10,500
	- Domestic demand	4,809	8,425	8,849	9,297	12,357	13,500

Source: Vinacoal "Report on Vietnam Coal Evaluation", Jan. 2005

c. Development Plan

Coal exploitation plan between 2003 and 2005 (High Case) is shown in Table 2-2-11. The exploited quantity of coal has largely increased about twice as much at the time of revised 5th.MP. The average coal price (ex-works price) in 2002 was VND319/kg and the price for power generation is as low as VND305/kg to VND332/kg. In addition, the coal sector is a completely domestic industry, so that coal price is set up in local currency and stable out of influence of exchange rate fluctuation. Since coal is mainly used for the power and cement sectors, exhaustion of coal resources is not so much of a concern as the possibility of exhaustion of gas. And coal-fired thermal power plant may be given high priority as a base power supply source, and will be positively developed giving sufficient environmental and social consideration.

Table 2-2-11 Coal Exploitation Plan (Unit:10^6 ton)

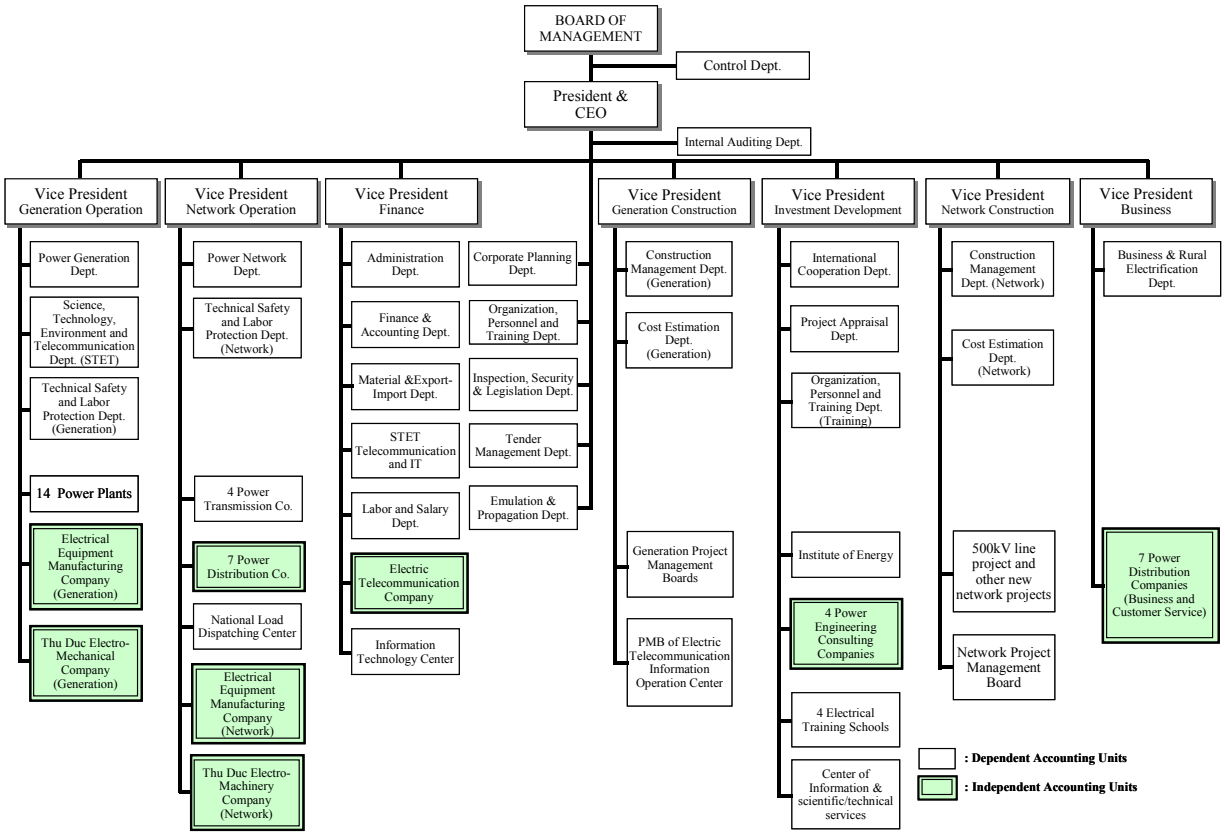
	2000	2005	2010	2015	2020	2025
2003 plan	10.5-11.0	16	24	27	30	-
2005 plan	-	31.7	45.2	50.8	54.4	52.7

Source: upper, Vinacoal M/P, 2003 lower, Report on Vietnam Coal Evaluation, 2005

2.3 Power System Development

2.3.1 Organization

Under the MOI, which formulates development policy of the power sector, EVN solely manages the whole power sector from generation to transmission and distribution (Figure 2-2-1). Except the decision of large-scale investment and tariff setting, EVN possesses authority of the sector management. EVN generates electric power through the dependent units (National Load Dispatch Center, power plants, and 4 regional transmission companies), and wholesales the power to 7 regional distribution companies (Dong Nai PC, Hai Phong PC, Hanoi PC, HCMC PC, PC1, PC2, PC3), which are the independent-accounting units of EVN. The decision making in EVN is handled by the Board of Management and Board of Directors.



Source: EVN

Figure 2-3-1 Organizational Structure of EVN

2.3.2 Situation on the Present Balance of Supply and Demand

(1) Power Development Plan

The Team will review the existing methodology and data base (such as construction costs and operation conditions of each planned power plant site) for drafting a power development plan. The progress of planned power plant development will be checked and the difference from the revised 5th MP will be made clear.

a. Methodology of Power Development Plan

EVN adopted WASP IV as a simulation tool for power development. The tool that was developed by the International Atomic Energy Agency (IAEA) is used for a simulation of balance between supply and demand. The tool has been disseminated widely in the world. However, WASP IV cannot simulate the balance between supply and demand of interconnected systems. WASP IV cannot simulate the balance between supply and demand in Vietnamese interconnected systems.

b. Present Situation on Power Development Plan

①Existing Power Plants and Revised 5th Master Plan

The amount of power plant is shown in the Table2-3-1. The Vietnamese system is divided into two systems that are the system including Ha Noi city and the system including Ho Chi Minh city. There is a difference of fuel type of main power source between the northern and southern systems in Vietnam due to uneven distribution. This difference is caused by the unevenly distributed power resource in Vietnam. The difference of power source composition affects the economical operation in each of the system.

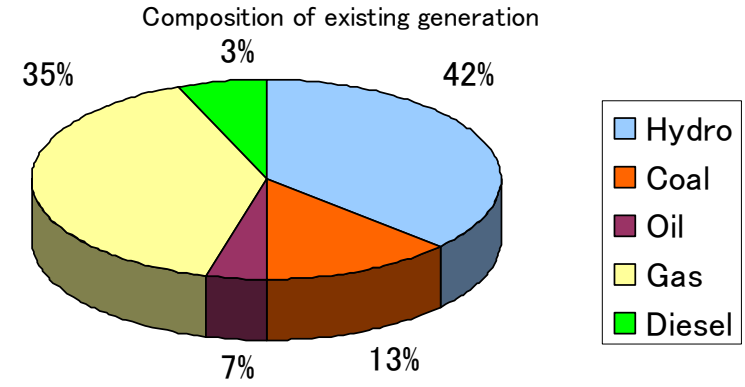
Table 2-3-1 List of Existing Power Plants

as of end of 2004

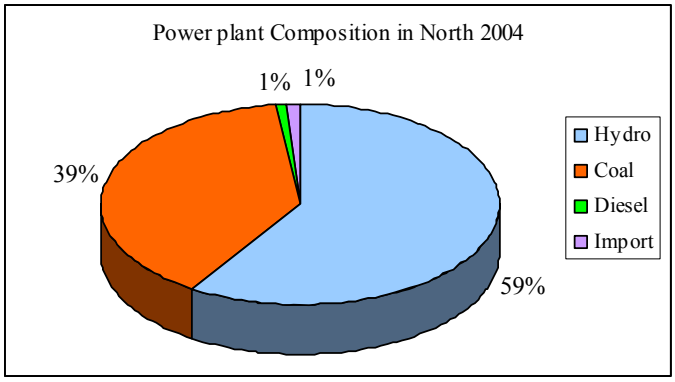
	Type	Name	Unit Capacity (MW)	Unit No.	Total Capacity (MW)	Available Capacity (MW)	Year of Commissioning
North	Hydro	Hoa Binh	240	8	1,920	1,920	1989-1994
		Thac Ba	40	3	108	120	1970-1973
		Hydro Total			2,028	2,040	
	Coal Thermal	Pha Lai 1(coal)	110	4	440	400	1983-1986
		Pha Lai 2(coal)	300	2	600	600	2002
		Uong Bi(coal)	55	2	105	105	1975-1977
		Ninh Binh(coal)	25	4	100	100	1974-1976
		Coal Total			1,245	1,205	
	Sub Total				3,273	3,245	
Central	Hydro	Vinh Son	33	2	66	66	1994
		Song Hinh	35	2	70	70	2000
		Ialy	180	4	720	720	2001-2002
		Hydro Total			856	856	
	Sub Total				856	856	
South	Hydro	Tri Ah	100	4	400	440	1988-1989
		Da Nhim	40 x 4		160	160	1963-1964
		Thac Mo	75	2	150	150	1995
		Ham Thuan	150	2	300	300	2001
		Da Mi	88	2	175	175	2001
		Hydro Total			1,185	1,225	
	Oil Thermal	Thu Duc(DO)	33, 66 x 2		165	153	1966-1973
		Can Tho(FO)	35	1	35	33	1975
		Oil Total			200	186	
	Gas Thermal	Can Tho(GT)	38	4	150	136	1996-1999
		Thu Duc(GT)	23.4, 14.7, 37.5 x 2		126	89	1968-1992
		Baria(C/C)	23.4 x 2, 37.5 x 6, 58 x 2		399	322	1991-2001
		Phu My 1(C/C)	240 x 3, 370		1,138	1,110	2000-2001
		Phu My 2-1(C/C)	145 x 2, 140 x 2, 162		804	730	1997-1999, 2003
		Phu My 4(C/C)			468	448	2004
		Gas Total			3,085	2,835	
	Sub Total				4,470	4,246	
Diesel and small hydoropower plants					454	140	
IPP/BOT	South	Phu-My 3(C/C)	230 x 2, 260		733	690	2003
	South	Phu-My 2-2(C/C)	231 x 2, 260		733	0	2005
	South	Can Don(Hydro)	39	2	78	78	2003
	South	Hiep Phuc(FO)	125	3	375	375	
		Bourbon(DO)			24	24	
	North	Nomura(DO)			58	0	
		Amata(DO)			13	13	
		Vedan(FO)			72	72	
		Na Loi	3	3	9	9	
	North	Nam Mu	4	3	12	12	
	North	Na Duong	55	2	110	0	
	South	Formosa	160	1	160	155	
		Mua TQ	42	1	42	42	
		IPP Total			2,419	1,470	
Total					11,472	9,957	

Source: NLDC Statistical report

Composition of power sauces in the Vietnamese whole system



Northern system



Central and Southern system

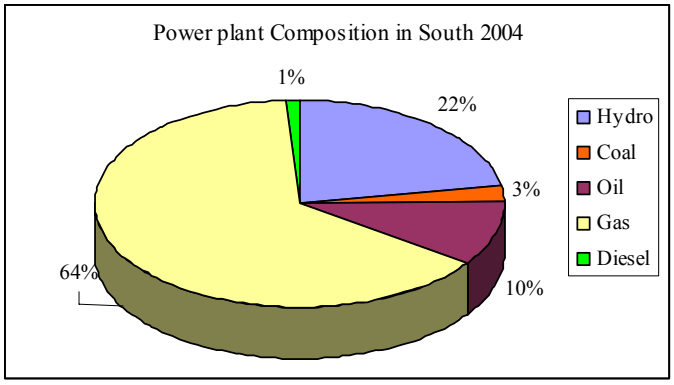


Figure 2-3-2 Present Composition of Power Source

The composition of power source of each system in 2010, the year of planning horizon of the revised 5th master plan, consists of hydropower and coal thermal in the North system, and gas thermal power in the South system. The relationship between the supply reliability and the reserve margin in each system becomes varied under the influence of the characteristics of each system

under this power source composition and the limit of interconnecting capacity of the 500kV transmission line which connects the north and south systems.

Table 2-3-2 Revised 5th Master Plan (1)

Year of Commission	Name of plant	Unit No.	Type	Fuel	Installed Capacity (MW)	Region
2004	Phu My 2-2(CCGT)-BOT	1	GT	Gas	230	South
	Phu My 2-2(CCGT)-BOT	2	GT	Gas	230	South
	Na Duong-IPP	1	ST	Coal	50	North
	Na Duong-IPP	2	ST	Coal	50	North
	Phu My 2-2(CCGT)-BOT	3	ST	Gas	260	South
	Phu My 4	3	ST	Gas	150	South
2005	Se San 3	1	Hydro	Hydro	130	Central
	Cao Ngan-IPP	1	ST	Coal	50	North
	Cao Ngan-IPP	2	ST	Coal	50	North
	Phu My 2-1 Ex.	6	ST	Gas	140	South
	Uong Bi Ex.	1	ST	Coal	300	North
2006	Ca Mau(CCGT)-IPP	1	GT	Gas	240	South
	Ca Mau(CCGT)-IPP	2	GT	Gas	240	South
	Bac Binh-JV	1	Hydro	Hydro	35	South
	Bao Loc	2	Hydro	Hydro	23	South
	Binh Dien	1	Hydro	Hydro	20	Central
	Dai Nga	1	Hydro	Hydro	20	Central
	Dak Rti'h	1	Hydro	Hydro	72	Central
	Eak Rong Rou	1	Hydro	Hydro	34	Central
	La Ngau	1	Hydro	Hydro	38	South
	Ngoi Bo	1	Hydro	Hydro	20	North
	Ngoi Phat	1	Hydro	Hydro	35	North
	Nhan Hac&Ban Coc	1	Hydro	Hydro	32	North
	Se San 3	2	Hydro	Hydro	130	Central
	Se San 3A(Poko)-IPP	1	Hydro	Hydro	100	Central
	Srok Phu Mieng	1	Hydro	Hydro	54	South
	Tra Som	1	Hydro	Hydro	24	South
	Tuyen Quang(Na Hang)	1	Hydro	Hydro	114	North
	Ca Mau(CCGT)-IPP	3	ST	Gas	240	South
	Cam Pha 1-IPP	1	ST	Coal	300	North
	Hai Phong-JV	1	ST	Coal	300	North
	O Mon 1	1	ST	FO	300	South

Table2-3-3 Revised 5th Master Plan (2)

Year of Commission	Name of plant	Unit No.	Type	Fuel	Installed Capacity (MW)	Region
2007	Nhon Trach	1	ST	Gas	300	South
	A Vuong	2	Hydro	Hydro	170	Central
	Coc San-Chu Linh	1	Hydro	Hydro	70	North
	Da Dang Dachamo	1	Hydro	Hydro	16	Central
	Dai Ninh	1	Hydro	Hydro	150	South
	Dak Rinh	1	Hydro	Hydro	100	Central
	Dan Sach	1	Hydro	Hydro	6	South
	Na Le	2	Hydro	Hydro	90	North
	Quang Tri(Rao Quan)	2	Hydro	Hydro	70	Central
	Thac Muoi	1	Hydro	Hydro	53	North
	Tuyen Quang(Na Hang)	2	Hydro	Hydro	114	North
	Tuyen Quang(Na Hang)	3	Hydro	Hydro	114	North
	Hai Phong-JV	2	ST	Coal	300	North
	Ninh Binh Ex.	1	ST	Coal	300	North
	O Mon 1	2	ST	FO	300	South
2008	Nhon Trach	2	ST	Gas	300	South
	Ban La	2	Hydro	Hydro	300	North
	Buon Kuop	1	Hydro	Hydro	140	Central
	Cua Dat-IPP	1	Hydro	Hydro	97	North
	Dai Ninh	2	Hydro	Hydro	150	South
	Eak-Rong Huang	1	Hydro	Hydro	65	Central
	Iagrai	1	Hydro	Hydro	9	Central
	Nam Mu	1	Hydro	Hydro	11	North
	Plei Krong	1	Hydro	Hydro	110	Central
	Song Hieu	1	Hydro	Hydro	5	North
	Thac Mo Ex.	1	Hydro	Hydro	75	South
	Nam Mo (Laos)		Purchase	Laos	100	North
	Quang Ninh-JV	1	ST	Coal	300	North
	Uong Bi Ex.	2	ST	Coal	300	North
2009	An Khe-Ka Nak	1	Hydro	Hydro	163	Central
	Boun Kuop	2	Hydro	Hydro	140	Central
	Buon Tua Srah	1	Hydro	Hydro	85	Central
	Dong Nai 4	1	Hydro	Hydro	270	South
	Song Tranh 2	1	Hydro	Hydro	120	Central
	Srepok 3	1	Hydro	Hydro	180	Central
	Quang Ninh-JV	2	ST	Coal	300	North
2010	O Mon 2(CCGT)-JV	1	GT	Gas	250	South
	O Mon 2(CCGT)-JV	2	GT	Gas	250	South
	Ban Chat	1	Hydro	Hydro	200	North
	Dong Nai 3	1	Hydro	Hydro	240	South
	Song Ba Ha	1	Hydro	Hydro	125	Central
	Song Con 2	1	Hydro	Hydro	70	Central
	Upper Kon Tun	1	Hydro	Hydro	110	Central
	Se Kaman 3 (Laos)		Purchase	Laos	250	Central
	Nghi Song	1	ST	Coal	300	North

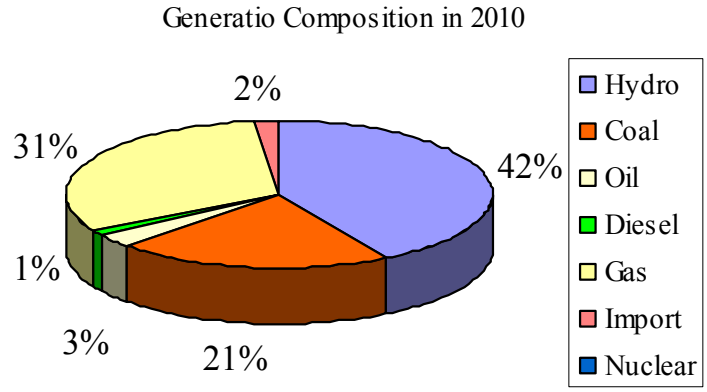


Figure 2-3-3 Power Source Composition in Vietnam System in 2010

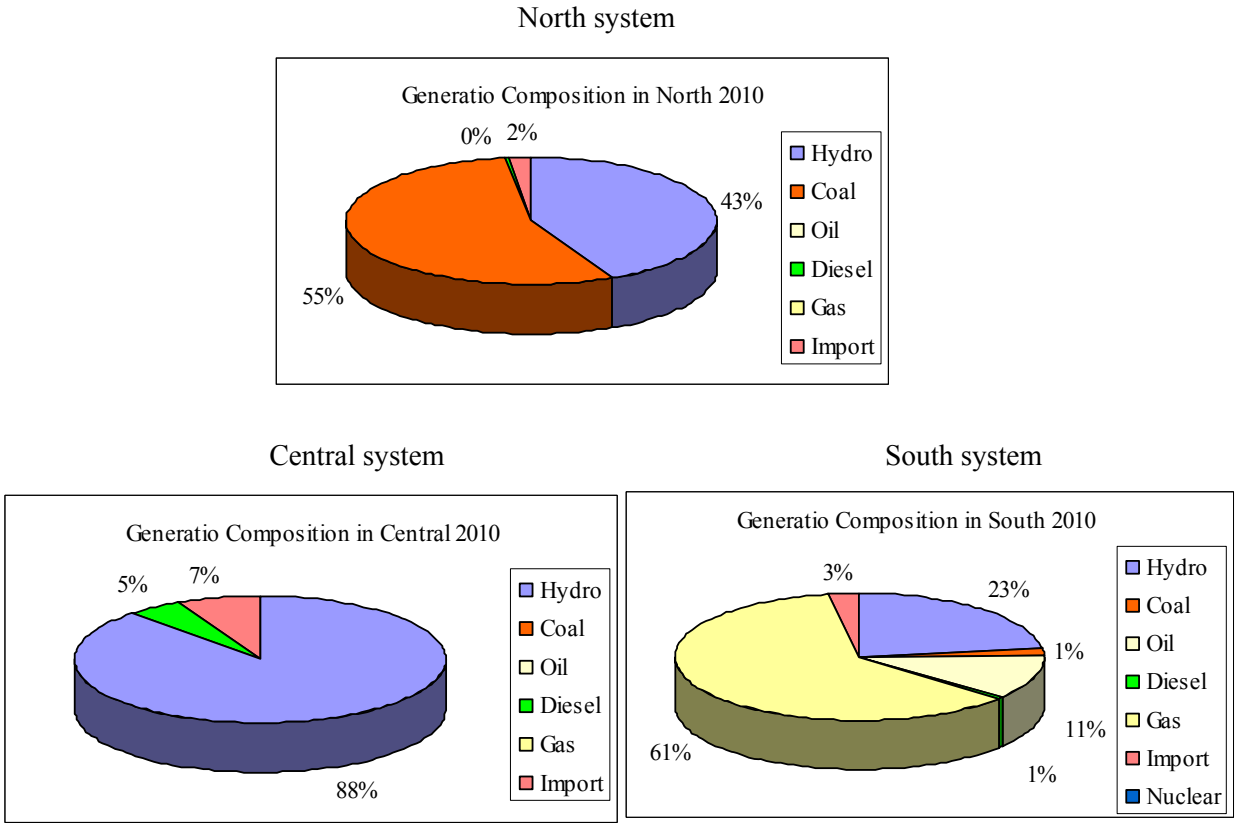


Figure2-3-4 Composition of Power Sources in North, Central and South Vietnam in 2010

②System Reliability of the Revised 5th Master Plan

According to the report, "Master Plan Study on Pumped Storage Power Project and Optimization for Peaking Power Generation in Vietnam" conducted in 2004, the required system supply reliability is different between the case where the Vietnamese system is regarded as a single system and the case where the system is divided into North and South. The system reliability by the Revised 5th MP in 2020 is quoted in Figure 2-3-5 to 2-3-7 from the report, specifying the cases

where the Vietnamese system is regarded as a single system, and the case where the system is divided into the North and the Central/South systems.

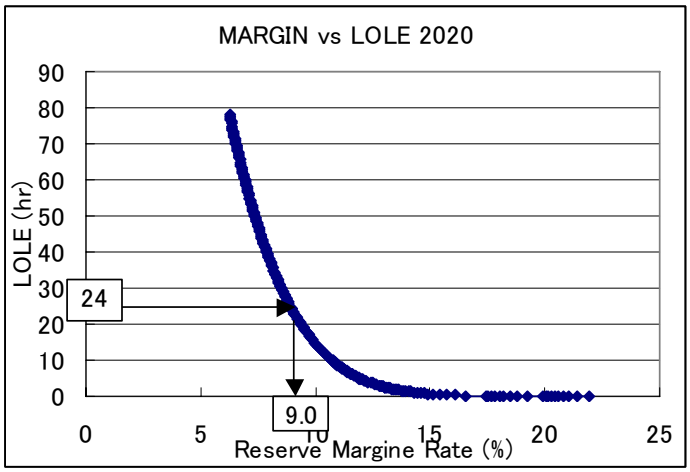


Figure2-3-5 Relation between System Reliability and Reserve Margin of Whole System in 2020

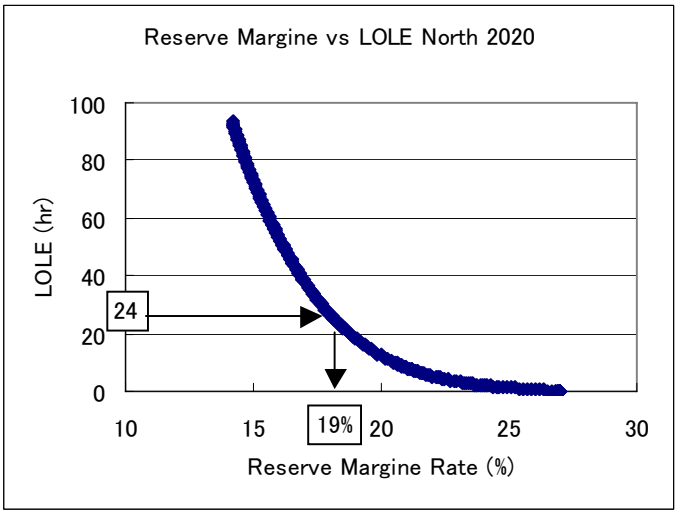


Figure2-3-6 Relation between System Reliability and Reserve Margin of North System in 2020

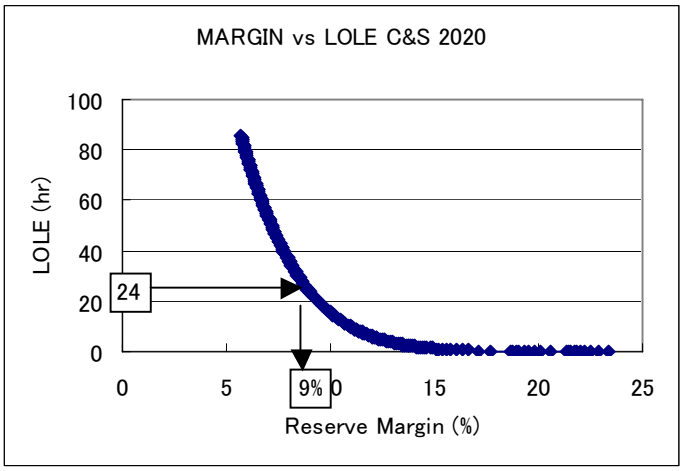


Figure 2-3-7 Relation between System Reliability and Reserve Margin of Central & South System in 2020

Nine percent of reserve margin is necessary to satisfy the reliability criteria, LOLE 24-hour, for the Whole system in Vietnam. The necessary reserve margin will be different when the system is treated as the divided systems considering the limitation of interconnected 500kV transmission line. Being affected by the water flow fluctuation, the North system needs 19% of reserve margin to meet the reliability criteria. The Central and South system needs 9% of reserve margin to secure the reliability criteria.

The balance between supply and demand in the revised 5th master plan until 2010 is shown in the following table below. Where the demands in 2003 and 2004 are actual records, the demand in 2005 is tentative records and the demand in 2010 is the forecast of the revised 5th master plan.

Table 2-3-4 Balance between Supply and Demand of the Revised 5th Master Plan

	2003		2004		2005		2010	
	North	C&S	North	C&S	North	C&S	North	C&S
Demand (MW)	3,111	4,165	3,453	4,759	3,830	5,398	6,153	9,639
Firm Capacity (MW)	3,232	4,953	3,331	6,160	3,574	7,372	7,601	12,368
Reserve Margin (MW)	121	788	-122	1,401	-256	1,974	1,448	2,729
Reserve Margin Rate (%)	3.9	18.9	-3.5	29.4	-6.7	36.6	23.5	28.3
LOLE (hour)	66	58	86	12	41	2	1	0

Depending on the revised 5th master plan, the supply firm capacity is sufficient to meet the reliability criteria, if there is no limitation of 500kV interconnecting transmission line. However, the supply firm capacity is insufficient in the North system when the limitation of 500kV

interconnection is considered. This shortage is caused by the uneven development of power plants in previous few years. The firm supply capacity can be secured by the planning horizon 2010 in the revised 5th master plan.

③Present Condition of System Reliability

Power development of North system is delayed from original schedule with some Coal thermal power project. Power development of South system is also delayed on the hydropower project. Thus, generally, the system reliability reduced from the planning level in the revised 5th master plan.

Table 2-3-5 Present Situation of Power Development (MW)

	2005			2010		
	5th MP	Actual	Diff.	5th MP	Pre6MP	Diff.
North	500	200	-300	5,125	8,092	2,967
C&S	1,140	,1010	-130	7,919	8,168	249
Total	1,640	1,210	-430	13,044	16,260	3,216

Power development of 300MW is expected to be delayed in the North system by 2005. Power development of 130MW is expected to be delayed in the Central & South system. The development delay is equal to 7.8% of reserve margin in the North system and 2.4% of reserve margin in the Central & South system. The power development plan is being modified considering the present situation. According to the modifying plan, the pre 6th MP, the additional power development over 3000MW tries to be added in the revised 5th master plan. Actual records in previous three years of balance between supply and demand are shown in Table 2-3-6 below.

Table2-3-6 Actual Balance Supply vs. Demand

	2003		2004		2005	
	North	C&S	North	C&S	North	C&S
Demand (MW)	3,111	4,165	3,453	4,759	3,830	5,398
Firm Capacity (MW)	3,169	4,933	3,288	6,321	3,392	7,341
Reserve Margin (MW)	58	768	-165	1,562	-438	1,943
Reserve Margin Rate (%)	1.9	18.4	-4.8	32.8	-11.4	36.0
LOLE (hour)	72	61	62	4	115	2

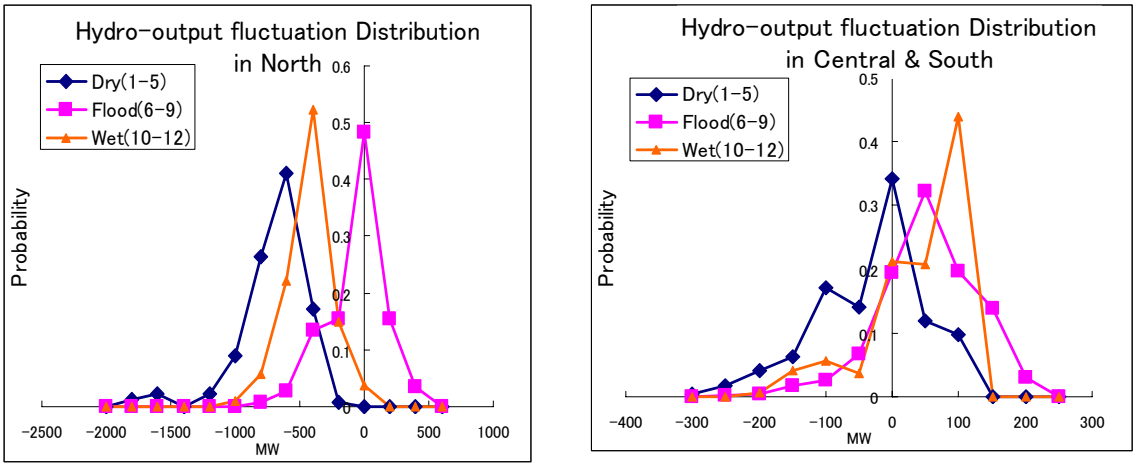
The system reliability of the North system in 2005 cannot secure the system reliability criteria, LOLE 24-hour, due to the delay of power development in spite of the capacity reinforcement as installing the second line of the North to South transmission line (500MW). The system reliability

of the Central & South system can clear the system reliability criteria owing to little development delay, and the system reliability is less than one tenth of the system reliability criteria, the same as the reliability level of a developed country.

The system reliability in the North system can improve with power exchange through the interconnection between the North and South system. The reserve margin of 310MW is required to secure the system reliability criteria in the North system. However, the reserve capacity in the North system in 2005 is estimated as minus 438MW. Total 748MW of power supply from the South system through the interconnection is necessary to secure the system reliability criteria in the North system. The reserve margin of 1300MW is required to secure the reliability criteria in the South system. The reserve margin in the South system in 2005 is estimated as 1943MW. This reserve capacity is not enough to secure the reserve margin of both systems to meet the criteria, which is required as 2,048MW of reserve capacity.

④Water Flow Fluctuation

The report, "Master Plan Study on Pumped Storage Power Project and Optimization for Peaking Power Generation in Vietnam" conducted in 2004, indicated that the actual output from hydro power plant at the peak demand recording time was less than the planning firm capacity during 1996 to 2001. The hydropower output distribution due to the water flow fluctuation, taking the planned capacity as a standard is illustrated in Figure 2-3-8.



North system　　Central & South system

Figure 2-3-8　Probability Distribution of Hydropower Output

The firm capacity at peak demand recording time should be examined carefully, especially in the North system where over 60% of the power supply depends on the hydropower.

⑤Least Cost Power Development Plan Considering Unevenly Distributed Power Resources

According to the report, "Master Plan Study on Pumped Storage Power Project and Optimization for Peaking Power Generation in Vietnam" conducted in 2004, the revised 5th master plan was not arranged to the plan of resource supply plan. The resources such as Coal, Gas and hydropower are unevenly distributed between the north and the south of Vietnam. Coal and hydropower potentials are distributed in the North. Gas potential is distributed in the South. The unevenly distributed resources affect the least cost power development plan. Coal thermal power and hydropower are cheaper fuel cost resources of generation, and are suitable for base load suppliers. Whether hydropower projects have advantage for peaking operation or base load supply, it is depending on its geological and water-in-flow conditions also and output difference between dry and rainy seasons. Gas thermal power is of lower construction costs and higher fuel price than other sources, and is suitable for the middle and peak load suppliers. This means that the northern systems lack middle load supply, and the southern systems want the base load source. The power development plan considering the unevenly distributed resource is required for the most economical power equipment formation and its operation by each system respectively.

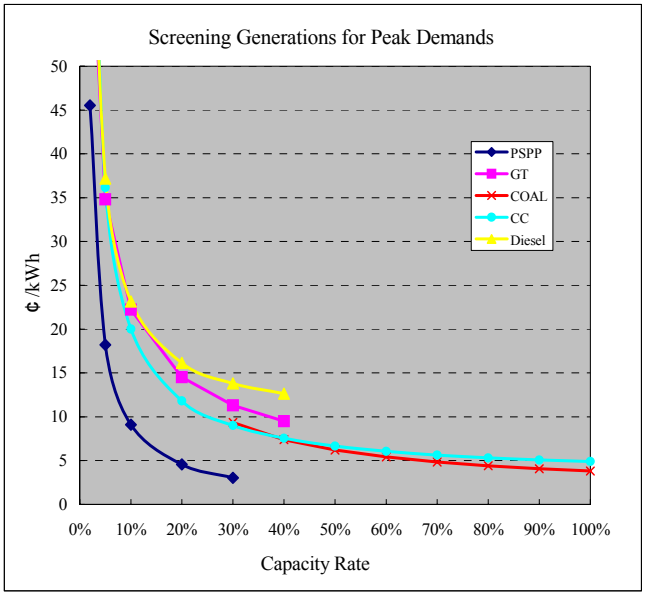


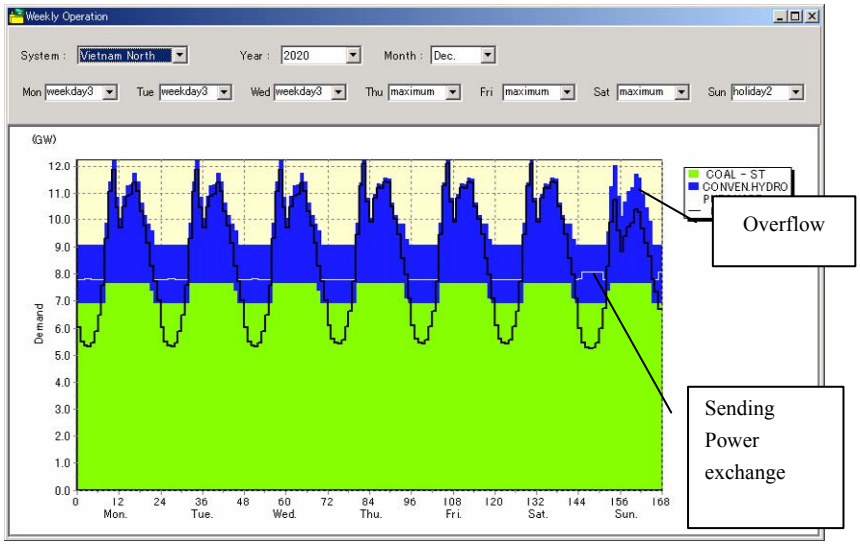
Figure 2-3-9 Relation Generation Cost vs. Plant Factor in the Revised 5th MP

The limitation of 500kV interconnection between the North and South systems also affects the economical operation. The coal thermal power uses the grained coal for their boilers. The solid fuel is difficult to treat controlling generation output, as compared with liquid or gas fuel. The coal thermal power plant may operate to meet 80% capacity factor from economical and technical operation requirements. When the hydropower operate full day in rainy season, the output from the

coal thermal power in an off-peak time will not sufficiently reduce to meet the off-peak demand. The surplus power in the off-peak time sometimes causes an overflow in hydropower station especially in the rainy season. The surplus power could be utilized in the South system, if the capacity of interconnection line were large enough to evacuate the power.

The distance between the load centers of the North and South systems is 1500km long. The long distance invites high costs of transmission construction. Examination is required to find which scenarios are the most economical, a reinforcement of the interconnection for transmitting power from a generation that is developed near resources or transport of fuel to a load center in the South.

Example of Operation Simulation in the North System



Example of Operation Simulation in the Central & South Systems

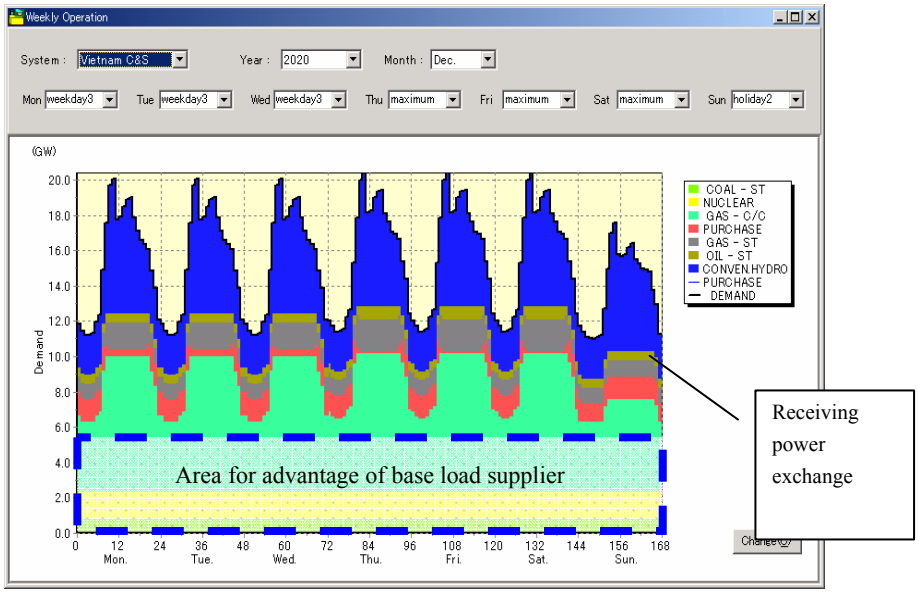


Figure 2-3-10 Example of Operation Simulation

c. Issues of the Revised 5th MP

Issues of the revised 5th master plan are described in the following four items based on the examination and analysis of actual balance between supply and demand.

①Limitation of 500kV Interconnection Capacity

An error is detected in the revised 5th master plan in establishing the target resource capacity to be developed required for satisfying the system reliability criteria, because the master plan was drawn with the premise of a one single system instead of divided systems due to the interconnection limitation.

②Countermeasures for Delay of Power Development Project

No countermeasure could be taken to a delay, if occurred, in the implementation of the plan, as the risk of delay is not taken into consideration for the development of target resource capacity. This is inviting a decline of supply reliability.

③Water Flow Fluctuation

Actual outputs from hydropower plant at the time of peak demand record is less than the planned 90% probability output of firm capacity from hydropower plants. The actual output is less than the planned firm capacity in rainy and flood seasons, which reduces considering rule curve of reservoir. The difference between actual output and planned firm capacity is necessary to examine an actual supply power in the daily operation.

④Cooperation between Electric Power Development and Energy Resource Development

Installation of a lot of gas combined cycle thermal power plants are planned in later years in the revised 5th master plan. However, the gas consumption of the power plants and the supply of gas in future are not arranged to meet together. The combined cycle thermal plant has 20 years lifetime in Vietnam. Checking of feasibility of fuel supply is required for the case where gas combined cycle thermal equipment to be introduced in later years is operated in its full life.

The scenarios are selected considering the issues and constraints in the 6th MP study. The most economical power development plan should be sought through the evaluation of risks in the scenarios. The scenarios should be evaluated and considered especially from energy security aspect. The power import from neighboring countries, steep rise of fuel prices, the development capacity and effects of constraints in BOT operation shall also be considered in the selected scenarios.

2.3.3 Review of Transmission System Development Plan

Figure 2-3-7 shows the total circuit lengths of the transmission lines from year 1990 to 2003. The total length of the 500 kV lines made no change from 1995 to 2003 except for adding the branch lines to Yali hydro power station. The total lengths of 220 kV and 110 kV transmission lines have been steadily increased. However, the 5th MP has pointed out deficiency of capacity of 110 kV transformers, malfunction with old type circuit breakers and protection devices. The voltage of the medium voltage system has been unified to 22 kV (33 kV in the mountain sides) in order to enhance supply capability and reduction of losses.

Table 2-3-7 Transition of Total Circuit Length of Transmission

Year	1990	1995	1999	2003
500 kV	—	1,487	1,532	1,530
220 kV	1,359	2,272	3,257	4,649
66 kV, 110 kV	4,265	6,069	7,493	8,965 (only 110 kV)

Source: the 5th MP and EVN Annual Report

The first 500 kV system in Vietnam was completed in 1994. Table 2-3-8 shows the outline of those 500 kV transmission lines. The transmission lines were constructed from Hoa Binh hydropower station in the north area to Phu Lam substation in the south area with one circuit of about 1,500 km. The transmission capacity is 900 MVA, or, about 800 MW.

Table 2-3-8 500 kV 1st Transmission Lines

Interval	Distance	Number of Circuits	Conductor	Commission MM YY
Hoa Binh – Ha Tinh	341 km	1	ACSR 330 mm *4	April 1994
Ha Tinh -Da Nang	390 km	1	ACSR 330 mm *4	April 1994
Da Nang – Plei Ku	259 km	1	ACSR 330 mm *4	April 1994
Pleiku - Phu Lam	496 km	1	ACSR 330 mm *4	April 1994
Total	**1,486 km**	-	-	
Yaly - Plei Ku	20.2 km	2	ACSR 330 mm *4	1999

Source: Vietnam Single Line Diagram 2003, EVN

The plan of adding another route of the 500 kV transmission lines and doubling circuits was made in the 5th MP. After that, the plan was reviewed through the Revised 5th MP in March 2003 in order to put up with the increase in power demand and enhancing system efficiency. Table 2-3-9 shows the plan and the present situation of construction of 500 kV transmission lines in the revised 5th MP. The main revision was the moving forward of the original construction schedule of the 500 kV transmission lines between Phu My and Phu Lam, Plei Ku and Phu Lam, Plei Ku and Da Nang, Ha Tinh and Tuong Tin. The transmission lines were constructed almost on schedule as shown in

Table 2-3-9. The completion of the transmission route from Da Nang to Ha Tinh connected Phu Lam in the south to Ha Tinh in the north with double circuits.

Table 2-3-10 shows the revised 5th MP and the present situation of the construction of 500 kV transformers. The extension of Nha Be and Phu My substation has been a little lagged behind in comparison with the revised 5th MP.

Table 2-3-9 Power Network to be Constructed in the Period of 2002 – 2010

Works	No.of line x km	Length	Year scheduled in Revised 5th MP	Present actual situation as of 2005
Plei Ku-Phu Lam (2nd line)	1 x 547	547	2003	Completed
Phu My – Nha Be	2 x 49	98	2003	Completed
Nha Be – Phu Lam	1x16	16	2003	Completed
Nha Be-O Mon	1x180	180	2005	Cai Lay-O Mon Sep 2005 2009 Designed for 500 kV now under operation of 220 kV
Plei Ku-Doc Soi-Da Nang	1x300	300	2004	Completed
Da Nang-Ha Tinh	1x390	390	2nd quarter/2005	Completed (May 2005)
Ha Tinh-Tuong Tin	1x335	335	2005-2006	Not yet
Branch to Nho Quang 500 kV station	2 x 30	60	2005	2005
Subtotal		1,926		
Branch to Dong Nai	2x20	40	2008-2009	-
Quang Ninh-Thuong Tin	1x110	110	2007-2008	-
Phu Lam –O Mon	1x170	170	2006-2007	-
Phu My-Nhon Trach	1x30	30	2008-2009	-
Song May-Nhon Trach	1x 20	20	2009	-
Song May-Tan Dinh	1x30	30	2009-2010	-
Subtotal		400		

Table 2-3-10 Transformers to be Constructed in the Period of 2002-2010

Works	No. of works x MVA	Capacity MVA	Year scheduled in Revised 5th MP	Present actual situation as of 2005
Nha Be	2x600	1,200	2004	Dec 2005
Phu My	2x450	900	2003	One was completed, another is Dec 2005
Da Nang	1x450	450	Transformer2 2004	
O Mon	1x450	450	2005-2006	2007
Tanh Dinh	1x450	450	2005-2006	-
Thuong Tin	1x450	450	2005-2006	-
Nho Quang	1x450	450	2005-2006	2005
Subtotal		4,350		
Thuong Tin	1x450	450	Tranformer2 2007	
Tan Dinh	1x450	450	Transformer2	
Doc Soi	2x450	900	2006-2008	
Di Linh	1x450	450	Synchronizing with Dai Ninh Power Plant	
Nhon Trach	1x450	450	2008	
Quang Ninh	1x450	450	2007-2009	
Song May	1x600	600	2008-2009	
Omon	1x450	450	Transformer2	
Subtotal		4,200		

Reinforcement of system reliability, reduction of electricity losses, facilitation of the operation of power plants both in dry and wet seasons, reinforcement of regional power supply, conversion of the existing medium voltage networks into the 22 kV voltage and condition maintenance of rural electrification are mentioned as the objectives of the study in the 5th MP. The requirements for power network system were high abundance, flexibility, stability and safety of electricity supply, ensuring electricity quality (voltage and frequency) for the country's socio-economic development.

The PSS/E made in USA and the SDO made in former Soviet Union were used as system analysis tools. The scope of the plan drawn in the 5th MP was the 110 kV, 220 kV and 500 kV system up to year 2015 and the 220 kV and 500 kV system up to year 2020.

Concerning The 500 kV AC was determined for use in the bulk power network system as the highest voltage and an adequate transmission method. As is often the case with long distance power transmission, DC transmission is sometimes superior to AC transmission. However, DC transmission lines have difficulty with t-off branches from the technical aspects and their t-off branches would cost more than AC transmission lines. The 5th MP described that DC transmission lines were not suitable for the Vietnamese system that required some t-branch offs on the way of transmission lines. However, adoption of DC transmission lines could be considered for the interregional connection to the neighboring countries.

The 5th MP pointed out the needs of studies of the countermeasures against the excess of fault current over 40 kA resulting from the system analysis about the fault current around Thu Duc, Phu Lam and Tanh Dinh in the north and the south 220 kV and 110 kV systems. The countermeasures were considered to be installation of the circuit breakers with larger capacity or splitting buses. The 5th MP pointed out the needs of the studies of the voltage maintenance because there were few var-compensators in the bulk power transmission system except for a 200 MVAR capacitor of Phu Lam and utilization of a retired power generator as a synchronous var-compensator with 48 Mvar in Uong Bi.

The series capacitors were planned to be installed in some 500 kV transmission system in order to realize the stable power transmission from Sonla hydropower station and the southern nuclear power station. However, there may be requirements of the study of the effects on the generator-shaft distortional oscillation by series capacitors. System stability seemed to have been checked in the 5th MP through the 1LG-O-C (After occurrence of a single-circuit ground-fault , opening of a single circuit breaker and re-closing), however, severer and more generally assumed

faults such as 3LG-O (After occurrence of a three-phase ground-fault and opening of three-phase circuit breakers) have to be applied for checking system stability.

Figure 2-3-11 shows the power transmission system in 2020 of the 5th MP. The power flows between the north and the south along with the 500 kV transmission lines were planned as shown in Table 2-3-11. In 2020, power flows were predicted to be from north to south both in wet and dry seasons. The maximum permissible power flow with stable operation of the north-south 500 kV transmission lines will be 1,300 MW when double circuits are completed.

Table 2-3-11 Planned Power Flows of North to South 500 kV Transmission Lines

	Year 2010	Year 2020
Wet season	Form north to south 800 MW - 1,000 MW	From north to south 800 - 1,100MW
Dry season	From south to north 200MW - 500 MW	From north to south 500 - 800MW

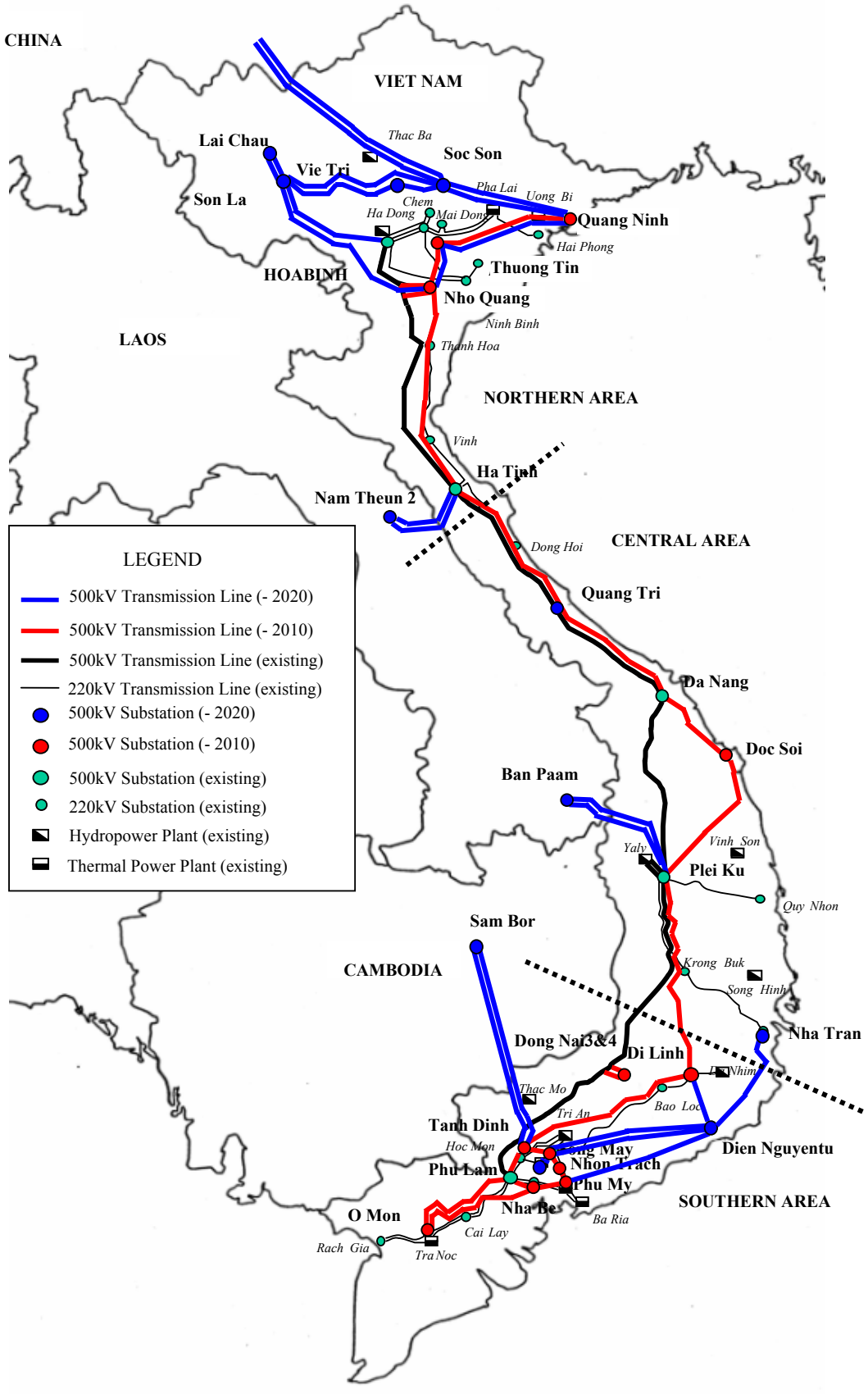


Figure 2-3-11 Power Transmission System in 2020 of the 5th MP

2.4 Current Economic / Financial Circumstances

The important element to facilitate an implementation of the master plan formulated by this survey is the financial ability of EVN in addition to the feasibility of businesses described in the master plan. Therefore, the JICA team studied the following items.

- Fluctuation of electricity tariff level which has a great influence on the fund raising for investment in power equipment;
- Grasping of the current financial status of EVN by studying its financial statements for the last five years;
- Grasping the forecasted financial statement which was prepared by EVN; and
- Trend of the electricity restructuring, such as the private investment in BOT and IPP and the future conversion of EVN power companies into Equities Company and EVN into a holding company that also functions as a bureau of an exclusive national conductive company.

2.4.1 Electricity Tariff

(1) Fluctuation of the Electricity Tariff Level

The electricity tariff fluctuated from 1997 as shown in Appendix 2-1. The tariff was revised four times since 1997 to increase but at a limited level. The package rate at a weighted average level increased from 5.2 ¢ to 5.6 ¢ in September ,2002. After that, the tariff level has not been raised until now.

(2) Fluctuation of the EVN Overall Electricity Rate

The overall rate of electricity actually sold fluctuated from 1997 as follows. This overall electricity rate[1] is obtained by dividing the actual sales[2] by the electricity actually sold (kWh). Accordingly, it is influenced by the structure of users and the charge collection rate, unlike the electricity tariff indicated in item (1) above.

Since 1997, the overall electricity rate has been increasing little by little presumably because of the increase of electricity tariff and improvement of collection rate. The values converted in cent (¢) show a slight fluctuation year by year under the influence of exchange fluctuation.

---

[1] Generally, it is used as the unit price at which the electricity is actually sold. The Tokyo Electric Power Company, Inc. ("TEPCO") calculates it in the following formula.

Overall electricity rate = (income from electricity sales less amount in arrear) divided by (electricity sold less electricity for business and construction works)

[2] The ENV sales include those of services and commodities in addition to those of electricity, but the sales used for calculation of overall electricity rate is obtained by deducting the value-added tax (VAT) from the EVN sales that only pertain to the electricity sales.

Table 2-4-1 Fluctuation of Overall Electricity Rate

	1997	1998	1999	2000	2001	2002	2003
Overall electricity rate (VND)	615	647	645	675	678	707	783
Overall electricity rate (¢)	5.25	4.93	4.62	4.73	4.58	4.63	5.04

Source: EVN internal data

(3) Future Electricity Tariff Level

The electricity tariff scheme designed by EVN is submitted by the Ministry of Industry to the prime minister for approval after coordination with relevant ministries. This coordination is intended for the multidimensional evaluation by the relevant ministries of an influence of the electricity tariff hike over the society and economy, because the electricity tariff has a material social and economic effect in Vietnam. From the Vietnamese economic situation, future coordination with relevant ministries is expected to be difficult. Consequently, it is difficult in the current situation to increase the electricity tariff in future.

Meanwhile, a trial calculation says that the package rate must be increased to 7 ¢ in consideration of the financial situation of EVN[3]. Continuous upward rigidity of electricity tariff in future may render ENV short of fund.

2.4.2 EVN Financial Situation

(1) Primary Financial Values

The primary financial values in the consolidated financial statements[4] of EVN Group from 2000 to 2004 fluctuated as follows. The consolidated financial statements are shown in Appendix 2-2.

[3] Specifically, EVN calculates the tariff level required for maintaining its Self Financing Ratio (SFR) at a certain level. The SFR is, in general, an index to show how long the necessary investing fund was raised from the stable fund. EVN calculates the SFR in the following formula SFR = Profit/Average investing fund in three years (actual amount of previous year, estimated amount of current year, and estimated amount of next year)

[4] The financial statements were prepared in accordance with the International Accounting Standard (IAS). EVN prepares the financial statements in accordance with the Vietnamese accounting standard and annually discloses them in the Annual Report, while separately preparing the financial statements in accordance with the IAS and submitting them to the relevant authorities, such as WB and ADB. There is little discrepancy between both statements, because the Vietnamese accounting standard is formulated from time to time in accordance with the IAS, but the Vietnamese accounting standard is incomplete (32 standards will be finally issued but, as of May 2005, only 22 standards are issued) and some points for which no Vietnamese accounting standard is issued cannot be compared with the IAS. For example, the deffered tax accounting cannot be compared with the IAS at present, because the relevant Vietnamese standard to be introduced in the fiscal 2005 is not yet issued.

（※1）Closing date :31 December

(※2) Audited by Deloitte Touche Tohmatsu

Table 2-4-2 Balance Sheet Item (Unit: Billion VND)

	2000	2001	2002	2003	2004
Total Assets	60,035	63,924	76,174	87,716	98,439
Non-current assets	48,844	51,204	58,545	65,735	74,236
Current assets	11,191	12,720	17,629	21,981	24,203
Equity	27,897	28,747	34,154	36,749	40,540
Long-term borrowings	25,565	26,601	32,640	39,349	45,308
Current Liabilities	6,572	8,576	9,380	11,595	12,533

Source: EVN

Table2-4-3 Income Statement Items (Unit: Billion VND)

	2000	2001	2002	2003	2004
Net sales	16,510	19,209	23,565	30,245	34,530
Cost of sales	(13,574)	(15,958)	(19,087)	(21,886)	(26,451)
Gross profit	2,936	3,250	4,477	8,358	8,078
Profit from operations	1,947	2,127	3,110	2,880	4,940
Net profit before tax	1,397	1,540	2,328	1,848	3,627
Profit after tax	882	999	1,650	1,828	3,331

Source: EVN

Table2-4-4 Cash Flow Statement Items (Unit: Billion VND)

	2000	2001	2002	2003	2004
Net cash flows from operating activities	7,311	6,739	8,412	10,903	10,654
Net cash flows from investing activities	(13,696)	(9,206)	(9,913)	(13,522)	(16,232)
Net cash flows from financing activities	7,772	3,426	4,640	4,680	4,954
Net increase in cash	1,387	959	3,139	2,062	(623)
Bank balance and cash at beginning of the year	5,306	6,693	7,653	10,792	12,855
Bank balance and cash at end of the year	6,693	7,653	10,792	12,855	12,232

Source: EVN

(2) Primary Values Financially Analyzed

The primary values financially analyzed in the consolidated financial statements of EVN Group from 2000 to 2004 fluctuated as follows.

Table 2-4-5 Solvency

	2000	2001	2002	2003	2004
1)Current Ratio（%）	170	148	187	189	193
2)Stockholders' Equity Ratio（%）	46	42	45	42	41
3)Cash Flow（Billion VND）	6,693	7,653	10,792	12,855	12,232

Source: JICA team calculates

Table 2-4-6 Profitability Ratio

	2000	2001	2002	2003	2004
4)Return on Total Assets (%)	1.5	1.6	2.2	2.1	3.4
5)Return on sales（%）	5.4	5.2	7.0	6.0	9.6
6)Gross Profit to Sales (%)	17.8	16.9	19.0	27.6	23.4
7)Profit from Operation to Sales (%)	8.5	11.1	13.2	9.5	14.3
8)Total Assets Turnover	0.28	0.30	0.31	0.34	0.35

Source: JICA team calculates

(3) Summary of Financial Outline

a. Net sales have doubled in the last five years with steady sales growth.

b. The profitability indices of Table 6 show the stable profitability for the last five years.

c. Results from items (1) and (2) above show the stable profit for the last five years.

d. At present, a significant part of the investment can be covered by cash income from the operating activities.

e. The Stockholder's Equity Ratio remains at a good level as an apparatus industry though it tends to fall because of the increasing trend of borrowings. For reference, TEPCO marked 16.2% of the Stockholder's Equity Ratio in the year ended March 31, 2004.

(4) Profitability

a. High Profitability from Operating Activities

For the last five years, the net sales increase led to the profit increase. The main reason is the high profitability from operating activities as indicated by 19%, 27.6% and 23.4% of the Gross Profit to Sales in 2002, 2003 and 2004 respectively. Specifically, suppressed increase of the cost of sales, including fuel cost, together with the increase of net sales, contributed to the profit increase at present.

Recently, the fixed asset increase from refurbishment of old facilities and addition of new facilities in Russia and China tends to cause the depreciation increase. Despite the increasing depreciation, the profitability remains at a high level, which means that the cash flow is increasing sufficiently to cover the depreciation increase. See Figure2-4-1 below.

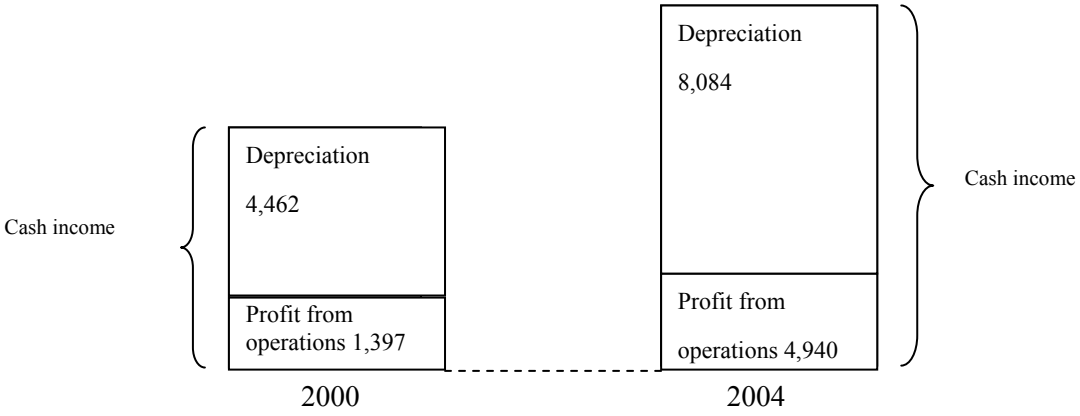


Figure 2-4-1 Relationship between Profit from Operations and Cash Flow

The depreciation is the cost for the purpose of profit and loss calculation without cash expenditure. Accordingly, the cash income less profit from operations can be simply considered as the depreciation. In other words, the fact that the profit from operations remains at a certain level despite the increase of depreciation year by year means that the cash flow increases year by year more steadily than the depreciation increase.

The above analysis shows the current sound financial situation with the yearly increase of free cash flow[5].

The free cash flow is considered as the reserve fund for future investment in plant and equipment. At present, increase of the free cash flow serves effectively for future investment, but even its current increase rate may not cover the estimated large amount of investment in plant and equipment required to cope with the increase of electricity demand in Vietnam. That's why the electricity tariff needs to be increased in spite of high profitability.

b. Increase in Sales of Electricity

The changes of 1) Sales of Electricity, 2) Power Sales, and 3) Electricity Rate fluctuated from 2000 to 2004 are shown as follows. The Sales of Electricity is obtained by multiplying the Power Sales by the Electricity Rate. The fact that the Power Sales and the Electricity Rate increased by

[5] The free cash flow means the free fund at corporate manager's disposal. It generally is computed as follows among various other formulae. Today's managerial challenge is to maximize the free cash flow for enhancing the corporate value and to distribute it as properly as possible.
Free cash flow = Cash flow from operating activities – Cash flow to maintain the current business

77% (39,597／22,398） and 18% (795／676) respectively in five years shows that the Sales of Electricity increase is primarily attributable to the Power Sales increase. In order to procure the fund to cope with the increase of the investment in plant and equipment in future, however, more increase of the Sales of Electricity is required and, to this end, the Electricity Rate increase is indispensable.

Table 2-4-7 Other Ratio

	1999	2000	2001	2002	2003	2004
1)Sales of Electricity(Billion VND) ※1	14,124	15,135	17,540	21,474	27,480	31,503
2)Power Sales (Million kWh)	19,531	22,398	25,843	30,257	34,885	39,597
3)Electricity Rate(VND/kWh) ※2	723	676	678	710	788	795

Source: JICA team calculates, EVN annual report

Note: ※1 Sales of Electricity obtained by deducting the sales of commodities and services from the P/L, Net sales(30,245 Billion VND).

※2 1)÷2)

c. Foreign Exchange Losses

In the 2003 section of Table 2-4-6, the Gross Profit to Sales shows the profitability as high as 27.6%, while the Profit from Operation to Sales marks 9.5%, down from the previous year. This is because 4,157BillionVND was recorded as the foreign exchange losses in the income statement of 2003. The foreign exchange losses fluctuated from 2000 to 2004 is as follows.

Table2-4-8 Fluctuation of Foreign Exchange Losses (Billion BND)

	2000	2001	2002	2003	2004
1) Foreign exchange losses	153	245	313	4,157	1,088

Source: EVN

The above Table shows that the foreign exchange risk partly became obvious in the EVN financial status in 2003. The foreign exchange fluctuation must be carefully noted, because the foreign exchange risk occupies a significant part of the EVN's management risks in future too, as a large part of EVN borrowings are in the foreign currencies. The borrowings are in the following currencies as of the end of 2003 and 2004.

Table 2-4-9 Currencies for the Borrowings (Billion VND)

	End of 2003	End of 2004
Japanese Yen	21,958	24,965
US Dollar	11,011	12,712
Vietnamese Dong	6,872	7,564
Euro	1,038	1,815
Korea Won	648	743
Other	414	549

Source:EVN

Note: All currencies except the Vietnamese VND are converted into VND with the exchange rate at the end of 2003 and 2004.

(4) Solvency

a. Current Ratio

The Current Ratio that shows the short-term solvency is stable for the last five years. Though 1999 marks 276%, even higher than other years, the short-term solvency of this year is not exceptionally good, because the Materials which should have been included in the fixed assets were included in the Inventories in the current assets. Good cash flow with high profitability as aforesaid contributes to the stability of the current ratio for the last five years.

b. Stockholders' Equity Ratio

The Stockholders' Equity Ratio that shows the long-term solvency remains at high level, but tends to fall, which is not a bad phenomenon because such falling is one of the characteristics of an organization in the expansion phase. This situation is inevitably caused by the investment by ENV in plant and equipment funded by the borrowings in order to cope with a sharp growth of electricity demand in Vietnam. However, the increase of borrowing balance causes the increase of interest cost and also the increase of foreign exchange risk, because a large portion of the borrowings is in foreign currencies. The plan for investment in plant and equipment must be reviewed while considering those financial issues in a general view.

The current Vietnamese situation is similar to that of Japan in a decade from 1955 when the investment in plant and equipment was urgently needed. For reference, the Stockholders' Equity Ratio of TEPCO fluctuated from 1955 to 2003 as follows.

Table 2-4-10 Fluctuation Stockholders' Equity Ratio of TEPCO

	1955	1965	1975	1985	1995	2003
Stockholders' Equity Ratio (%)	54.5	28.4	17.1	12.1	10.1	16.2

Source: TEPCO data

2.4.3 EVN Financial Projection

The forecasted financial statement up to 2010 prepared by EVN is as per Appendix 2-3. The forecasted balance sheet is not yet prepared as of June 2005.

Primary financial values are as follows.

Table 2-4-11 Primary Financial Values in the Income Statement (Unit: Million USD)

	2004	2005	2006	2007	2008	2009	2010
Net sales	1,971	2,230	2,512	2,826	3,171	3,553	3,975
Cost of sales	1,806	2,073	2,452	2,703	3,131	3,469	3,944
Electricity purchase	320	536	727	981	1,262	1,545	1,694
Depreciation	524	546	609	591	732	818	967
Interest cost	82	93	107	135	177	216	270
Profit before tax	77	135	60	123	40	84	31
Net profit (after tax)	18	57	1	45	29	16	22

Source: EVN

Table 2-4-12 Primary Financial Values in the Cash Flow (Unit: Million USD)

	2004	2005	2006	2007	2008	2009	2010
Fund raising	1,508	1,833	2,385	2,776	2,847	2,917	2,843
・Internal fund	699	877	937	1,086	1,016	1,135	1,324
・Government subsidy	23	32	34	27	0	0	0
・Borrowings	786	924	1,414	1,663	1,831	1,782	1,518
Fund operation	1,508	1,833	2,385	2,776	2,847	2,917	2,843
・Power plant	547	891	1,319	1,645	1,644	1,595	1,278
・Transmission and distribution equipment	628	590	592	526	480	463	470
・Other	109	0	0	0	0	0	0
・JV	9	51	64	83	71	39	33
・Repayment	214	300	410	522	652	819	1,061

Source: EVN

(1) Summary of Future Financial Outline

- The net sales will increase thanks to the growing demand, while the net profit remains unchanged because increase of the cost of sales, such as electricity purchase, is larger than that of the net sales.
- As to the cash flow, the borrowings will be increasing with peak in 2008 to cope with the increase of investment in power generation facilities.

(2) Profitability

Non-growth of net profit and decline in profit are anticipated in future, because the increase of cost of sales will be larger than that of net sales.

The net sales are anticipated continuously to increase from 2004 onward too because of a growing demand, but the net sales remain at the same level and restrain the growth accordingly.

Table 2-4-13 Net Sales

	2004	2005	2006	2007	2008	2009	2010
1) Overall electricity rate (¢/kWh)※1	5.00	4.93	4.93	4.93	4.93	4.93	4.93
2) Power sales (mil.kWh)	39,683	45,205	50,931	57,291	64,288	72,026	80,586
3) Net sales (mil.USD)※2	1,971	2,230	2,512	2,826	3,171	3,553	3,975

Source: EVN

Note) ※1 0verall electricity rate (¢/kWh) is not including VAT

※2 1)×2) Rounding of fraction may make the product slightly discrepant.

Meanwhile, the cost of sales, that is, the electricity purchase, depreciation and interest cost are anticipated sharply to increase as shown in Table2-4-11. The electricity purchase, among others, presumably will have a significant effect on the finance. EVN estimates that the IPP and BOT proportion to the yearly power generation is as follows.

Table 2-4-14 Power Generation and IPP, BOT

	2004	2005	2006	2007	2008	2009	2010
1)Power generation(mil.kWh)	46,317	52,260	58,577	65,510	73,181	81,806	91,353
2) IPP,BOT(mil.kWh)	6,296	11,759	14,680	19,802	25,251	28,271	30,908
3) Proportion (%) 2)/1)	13.6%	22.5%	25.1%	30.2%	34.5%	34.6%	33.8%

Source: EVN

(3) Cash Flow

As to the cash flow, the actual increase of depreciation will be internally reserved as the internal fund for investment, but the investment in power generation facility will increase more than that and the exceeding portion will be covered by the borrowings. Accordingly severer fund management is anticipated in 2007 onward.

2.5 Relevant Measures and Policy

2.5.1 Power Sector Reform

(1) Electricity Sector Restructuring in the Fifth Electricity MP

The concept of the electricity sector restructuring in the fifth electricity MP approved by the prime minister in June 2001 is as follows. The details are explained in the JBIC electricity sector survey ordered to TEPCO and conducted from April of this year.

a. Three principles of electricity sector restructuring

- Creation of competitive environment in the power generation sector
- Restructuring of a national or public organization into a private organization
- Establishment of legal system relating to the electricity sector

b. Reorganization of EVN

Gradual restructuring of the electricity sector aiming at market economization (organization of Power Market)

- Development of legal system relating to the utility business, establishment of (independent) system operating organization, and formulation of system operating rules
- Change of EVN power plant into a financially independent organization
- Supply of electricity by BOT and IPP providers at low costs

c. Restructuring of Power Generation Sector

1) Grouping of Power Plants

EVN power plants will be grouped to organize multiple power companies. Companies so organized will be competitive in price with other IPP.

2) Reorganization of Power Generation Sector

First stage: Setting of competitive internal trading price consisting of power generation and fixed costs for future independence in the power generation sector.

Second stage: EVN power plants will be restructured into financially independent organizations.

Third stage: Electricity market will be established.

3) Reorganization of the Transmission Sector

The transmission sector will shift to an independent national power transmission company in future and will be responsible for planning and operating the system in the

wholesale pool market and the retail pool market which are newly established and for establishing the supply-demand balance of the entire system in an integrated fashion.

4) Reorganization of the Distribution Sector

The retail pricing will be fixed by adding up the power generation, transmission and other costs.

The National Energy Management Body will be responsible for deciding the retail pricing and revision for the purpose of the stable power supply to customers at low costs.

5) Utilization of Private Enterprises

6) Improvement of EVN Financial Management Ability

- Independent accounting of EVN member companies, such as power plants, transmission sectors and distribution companies
- Function of the above companies as a "profit center"

(2) Electricity Law

Development of the Vietnamese electricity sector requires the achievement of the development plan of the fifth electricity MP and, with the same importance, the establishment of the electricity law, which has been adjusted within the government and is scheduled to be enforced in July 2005. The electricity law itself, however, is the basic law that only sets forth basic provisions, and enforcement rules to this basic law must be established for actual operation. In addition, a regulatory body must be installed in the MOI after establishment of the electricity law in order to consider the concept and policies to implement the electricity sector restructuring.

(3) Concept of Electricity Sector Restructuring

The purpose of the electricity sector restructuring is to introduce the principle of competition in the sector and to establish the complete competition market as a goal. Accordingly, the electricity sector restructuring will be gradually promoted in the order of the following stages: Single Buyer Model as a current target; Limited Wholesale Model as a mid-term target; and Competitive Retail Model as a final target (different model names may be used depending on the type of report). In any way, this sector restructuring indispensably needs the organizational separation of EVN as well as the establishment of regulatory body and electricity tariff system.

(4) Organizational separation of EVN

The current EVN affiliated units are as follows as of the end of 2003.

15 Independent accounting entities

8 Power Companies (PC)
1 Power Telecommunication Company
1 Electrical Equipment Company
4 Power Engineering Consulting Companies
1 Duc Mechanical and Engineering Company

26 Dependent accounting entities…

14 Power Stations
4 Transmission Companies
8 Support Units and Administration Units

13 Construction/Project Management Units

The regulatory body will study the future EVN organizational structure in comparison with the current one after establishment of the electricity law as aforesaid. Currently, it is planned that the power generation, transmission and distribution sectors will be restructured as follows.

a. Power Generation Sector

In the 14 power plants, the thermal power plants will finally be an independent organization and delegate full authority to the power plants which will be responsible for operation. Meanwhile, the hydraulic power plant will remain to be a member of EVN, because it has multiple functions including flood control and irrigation and cannot give priority to power generation. Specific studies will be made for each of 14 power plants as to what it should be and the following restructuring is planned at present.

3 Power Station

- Tri An Hydro Power Plant
- Hoa Binh Hydro Power Plant
- Yaly Hydro Power Plants)

} remain dependent accounting entities.

7 Power Station

- Thac Ba Hydro Power Plant
- Thac Mo Hydro Power Plant
- Ham Thun-Da Mi- Da Nhim Hydro Power Plant
- Pha Lai Thermal Power Plant
- Uong Bi Thermal Power Plant
- Ninh Binh Thermal Power Plant
- Ba Ria Thermal Power Plant

} will shift to independent accounting entities.

1 Power Station

- Song Hinh Hydro Power Slant → will shift to equities company.

3 Power Stations

- Phu My Thermal Power Plant
- Thu Duc Thermal Power Plant
- Can Tho Thermal Power Plant

} will shift to Ltd. Company.

Also there is a plan to group some plants in order to reduce the gaps among regions and between new plants and old ones, whereby equalizing the ability of each group.

It is a long-term goal that all power plants will become equities companies, but, for the time being, all of the aforesaid 14 power plants will be consolidated for accounting, through ownership by EVN of majority of the stocks of the power generation facilities who are expected to be equities companies.

b. Transmission Sector

In the transmission sector, the current one NLDC, three RLDC and four transmission companies are expected to be regrouped into one NLDC and one transmission company. This transmission company is expected be a state owned company like the current EVN.

c. Distribution Sector

Eight power (distribution) companies will separate from EVN to be equities companies in the end. However, there is a regional gap in the current financial ability of these power (distribution) companies, that is, the wholesale price from EVN to each PC shows a gap of more than 300 VND between the lowest 615 VND (Ninh Binh) and the highest 950VND (Ho Chi Minh). In such a

situation, it is difficult for all PCs to be equities companies independent from the EVN group both in name and reality.

d. Other Sectors

Four Power Engineering Companies will separate from EVN to be equities companies.

The above is a restructuring outline of the power generation, transmission and distribution sectors, all of which are expected to remain in the EVN group for the time being under EVN, who will own the majority of their stocks.

CHAPTER 3

POWER DEMAND FORECAST

Chapter 3 Power Demand Forecast

3.1 Social Economic Plan

Energy demand and social economic activities have strong correlation with each other. Generally, the social economic outlook is established before energy demand is forecasted. It is considered that social economic indicators are preconditions for energy demand forecasting. The official long-range social economic outlook in Vietnam does not exist at present. But fortunately the expert group in Vietnam studied "ECONOMIC DEVELOPMENT FORECAST SERVING STUDY ON ENERGY DEVELOPMENT FOR THE PERIOD UP TO 2050". In the JICA study, the social economic outlook is used as the precondition for the energy and power demand forecast. The report is also used as the preconditions for the power demand forecast studied by the Institute of Energy - EVN.

3.1.1 International Context

(1) International Economy

Even though the common tendency in the world is toward peace and cooperation on development, according to the assessment of experts and organizations, the international environment of today is rapidly changing, and the international political situation is uncertain, complicated and demands more difficult steering for developing countries:

a) After the Asian financial crisis, the world economy has recovered and expanded, but developing countries are required to present an attractive economic basis, and the Government is compelled to conduct difficult management;
b) The deficiency in financial balance of industrialized countries such as Japan affects capital flow into the developing countries;
c) The expansion in the amount of the world trade is a matter to be welcomed, but it may accompany dangers for lesser powers;
d) Innovation, especially of IT and biotechnology, is deemed powerful enough to lead the world economy;
e) Globalization and reorganization tendencies are promoting and covering most aspects of socio-economic activities and are widening the relationship among countries both bilaterally and multi-laterally.

As like all other developing countries, Vietnam will also be affected by the above-mentioned international context. Especially in the period 2006-2010, it is deemed that direct influence of this situation will be actualized and escalate in the Vietnamese economy due to Vietnam's cooperation relationship with 3 large economies, i.e. Japan, the United States and the EU.

(2) Foreign Direct Investment (FDI)

FDI flow to Vietnam has remained sluggish due to the financial crisis in Asia, but it is gradually increasing along with the economic recovery. This is a favorable tendency to be anticipated also in the future. The status of the world and Vietnam concerning foreign investment can be summed up as follows:

a) The globalization and commercialization process is facilitating FDI flows to developing countries.
b) But due to severe competition, 70 % of FDI will be concentrated to a few countries, and the low-income countries will receive only 7 %;
c) FDI leads to increased total investment capital in developing countries, however, the impact of FDI is not always positive for the host countries;
d) FDI is steadily increasing in Vietnam, but the competition for attracting FDI will be continuously severe, because this is a market with a population of 1.3 billion and open policy. India is a potential competitor in this regard;
e) FDI activities yield much profit for recipient countries as a result of cheap labor force in production and efficient transport to markets. For that reason, assistance investments in infrastructure and advanced technologies are required;
f) International investment companies apply global investment strategies. They are selecting and investing in the most optimum countries in terms of removing taxation barriers and productivity. Together with globalization, these companies will procure services such as research and development, marketing, accounting, engineering, etc.

3.1.2. Factors of Vietnam Economic Growth

(1) Capital

a. According to the forecast, the increase of FDI is 5-7 % in the period 2001-2010. Unless positive innovation is implemented in the investment environment, such investments cannot be anticipated.
b. Increase of ODA is anticipated by 4-6 % for the period up to 2010, but this rate may not be maintained in the subsequent period because: (i) the committed amount is declining; (ii) the ODA committed in the previous period is implemented in the period up to 2010; (iii) after 2020, Vietnam will be higher developed and not included in the list of countries receiving ODA.
c. Total investment capital for the whole society: in order to ensure the economic growth rate, the activation of internal resources plays a particularly important role. It is anticipated that increase of investment in the period up to 2010 is 6-8%, of which the local share is 60 %. In

the following period the local capital share must be higher in order to maintain investment growth rate.

d. The experience from recent years indicates that the investment from inhabitants has been more important. The investment from resident Vietnamese in foreign countries is relatively large (about US$ 4 billion in 2004). This is an important capital resource to be activated.

(2) Technology

According to analysis, the degree of contribution of technology to economic growth was about 1.2 % in the past. The technological development investment in the developed countries during the 60s, 70s and 80s accounted for 1.6-2.0 % per year in terms of the growth for GDP, which was higher than that of present Vietnam. This indicates that increase of technological development investment is required in Vietnam in the future. .

(3) High Growth Rate of Economy

According to the experience of many countries, it is difficult to maintain a high growth rate of 9-10 % for a period of 20 years. The Southeast Asian countries reached only a level of just over 7 %.

3.1.3 Economic Development Scenarios

The socio-economic development forecast scenarios for the period up to 2050 can be considered based on the following factors:

(1) Scenario Presumptions

- The international environment is stable with economic globalization and liberalization, and international economic relationships are widened. The balance of international payments of Vietnam after 2006 moves without any major problems.
- The investment flows (especially FDI) are positive.
- Technological development and innovation are continued but will not bring about big changes in the society and economy.
- Energy issues are solved, and oil prices in the world are stable.

(2) Strategy Factors (selection of development models)

- Assume that Vietnam integration is successful, overcoming the challenges of globalization and international economic integration (joining WTO in 2005, successful implementation of AFTA commitments etc.);
- Vietnamese economy will meet initial difficulties due to its international commitments for

AFTA, WTO etc., but the economy will recover and develop toward high growth rates.

- The positive factors within the country are pointed out as follows:
  (i) Drafting of high-level policies, regulatory reforms and administration reforms will be effectively implemented.
  (ii) The wide-ranging reforms currently in progress will be sustainable up to 2050.

- Selected development models:
  + The following economic reforms will be implemented for promotion of the export-oriented economy and development of labor-intensive industry:
  (i) Infrastructure investment aiming at high added value of agricultural products, however, urbanization and rural infrastructure development are still slow.
  (ii) Promotion of development in services, especially in tourism, commerce, and finance.
  (iii) Expansion of production sectors substituting import and maintenance of the domestic markets. .
  (iv) The economic infrastructure facilities, basic industries that create inputs for the whole national economy, will be invested in based on the economic potential (capital, human resources etc.) and accumulation made in 2020, setting the base for sustainable development in the next period. According to this model, the economy will be rapidly developed in the period up to 2020, then becomes stable and sustainable in the next period.

  + Objectives for making Vietnam basically become an industrialized country by 2020:
  (i) Invest in and develop infrastructure systems. Basically the transport, telecommunication, water supply systems etc. will be realized.
  (ii) Conduct initial development in main industries (such as metallurgy, chemical, machinery, information technology etc.), meeting requirements of economic development;
  (iii) Relatively develop agriculture and rural areas for urbanization. The period up to 2020 will require intensive investment, bringing in little immediate benefits but setting the base for strong development in the next period.

(3) High Growth Rate Scenario

This scenario is designed based on the following assumptions:

- The international situation is stable (see above section)
- Vietnamese integration is successful, overcoming the challenges of globalization and international economic integration (entering WTO in 2005, successful implementation of AFTA commitments etc.);

- The positive factors within the country are activated at high levels:
  i) Policy, regulatory reform, administration reform are well implemented.
  ii) Comprehensive renovation is continuously implemented, creating resources, stability and sustainability for the period up to 2020 and the following years up to 2050.
- The policies are set for rapid promotion of industries, which have high added values, and promotion of exports.
- Labor issues in service business, travel business and labor-intensive industriess are solved.
- Infrastructure systems are basically accomplished.

(4) Slow Growth Rate Scenario

This scenario is designed based on the following assumptions:

- The international situation is less stable (markets, economic relationships are not really stable).
- Vietnam meets unfavorable conditions in integration into international economy because of challenges and risks from globalization and international economic integration (the economy faces big difficulties after entering WTO in 2005 and implementation of commitments for AFTA in 2006 etc.).
- The positive factors within the country are activated at low levels:
  i) Policy, regulatory reform, and administrative reform to meet requirements of economic development are slowly implemented in the unfavorable internal conditions.
  ii) Comprehensive renovation is slowly implemented, creating resources, stability and sustainability for the period after 2020 and the following years up to 2050.
- The industries for export, which have high added values, are moderately developed.
- Labor issues are not completely solved.
- Infrastructure systems are developed at low level.

(5) Anticipated Scenario; Base Growth Rate Scenario

There is an opinion that many capital funds are required in order to implement the high growth scenario. It can be considered that the same policies and reforms in high growth scenario are not implemented. The situation is considered as another scenario. The scenario is defended as the “Base growth rate scenario.” The assumptions of the “Base growth rate scenario” are the same ones as the high growth scenario, but it is assumed that some assumptions of them are realized.

3.1.4 Economic Outlook by Scenario

(1) High Growth Rate Scenario

The scenario with high economic growth rate is determined with growth rate of 7.5 % for the period 2001-2005 and 8.5 % for the period 2006-2010. The conditions are very favorable. The integration is successful and Vietnam becomes an industrialized country by 2020. Growth rate is 8.5 % for the period 2011-2020 and 8.0 % for 2021-2030.

The industries and construction sector are relatively developed, with average growth rate of 10 % for the period up to 2020. Development of agriculture is stable with a growth rate of 2-3.5 %. Services have rapid development. The average growth rate of services is above 7 %.

The economic structure is strongly changed because of high growth rates of industries, construction and services. The share of agriculture in GDP is reduced to 10.8 % in 2020 and 3.2 % in 2050. By 2050 the economic structure is as follows: share of industry is 46.6 %, services 50.2 %, agriculture 3.2 %.

(2) Low Growth Rate Scenario

The analysis and calculations indicate that there are many challenges for all countries including Vietnam for maintaining high economic growth rates for long term economic development in the period up to 2020 (and years after 2020) . If management and operation of the national economy are not good, the policy environment will not be improved to encourage investment activities (within the country and from overseas), local resources will not be activated enough, economic activities will be ineffective, international economic integration will be unsuccessful, and the economic growth rate will be very low. In such context, growth rates are 6.0 % in the period 2006-2010; 7.0 % in 2011-2020; 7.0 % in 2021-2030 and 5 % in the next period. Average growth rate over the whole period is about 6.3 %.

In this scenario, growth rates of industry, construction, agriculture and services are low. Industry and construction reach a growth rate of 8.0 % in the period 2006-2010, then over 8 %, then are reduced to 6-7 % at the end of the period. Development of agriculture is stable at a low level, and average growth rate is of 2.5 % over the whole period. Development of services is also at a low level with average growth rate of 5.6 % for the whole period up to 2050.

(3) Base Growth Rate Scenario

The economic growth rates are anticipated as follows: over 7.5 % for the period 2006-2010; about 7.2 % for 2011-2020; and about 7.0 % for 2021-2030.

In this scenario, the development of agriculture is maintained at a similar level to that of the high development scenario, while the growth rates of industry and service sectors are lower than the High Growth Rate Scenario.

(4) General Comments

In general, the period 2006-2010 is one of rapid development (except unsuccessful integration cases, causing large economic changes). Initiating from a low growth development period (1997-2003), the economy of the country may attain rapid economic development speed around 2020 and then will be stable at high, average or low growth rates depending on each scenario.

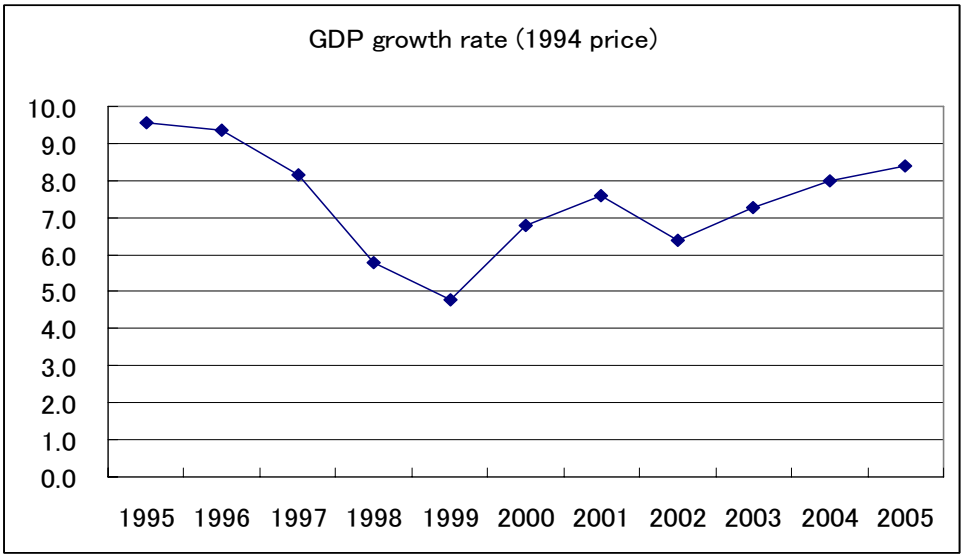


Figure 3-1-1 The Growth Rate of Real GDP (1995 - 2005)

.

Table 3-1-1 Economic Forecast (High Case)

No	Item	Unit	2004	2005	2010	2015	2020	2030
I	Population	Mill. Person	82.07	83.22	87.77	93.01	97.85	105.41
II	GDP (At Constant 1994 P	Bill. VND	362,092	390,814	586,878	884,179	1,329,501	2,870,294
1	Agriculture, Forest & Fish	Bill. VND	73,309	75,802	90,028	104,368	120,991	154,878
2	Industry & Construction	Bill. VND	142,601	157,574	265,522	427,625	688,694	1,557,127
3	Service	Bill. VND	146,182	157,438	231,328	352,186	519,816	1,158,288
III	GDP (At Present Price)	Bill. VND	713,071	808,440	1,549,231	2,968,159	5,666,719	19,705,072
1	Agriculture, Forest & Fish	Bill. VND	155,144	169,434	264,501	403,031	614,115	1,358,121
2	Industry & Construction	Bill. VND	285,864	330,446	697,603	1,407,554	2,840,022	10,078,719
3	Service	Bill. VND	272,063	308,560	587,127	1,157,574	2,212,582	8,268,231
IV	Share of Economic Secto	%	100.0	100.0	100.0	100.0	100.0	100.0
1	Agriculture, Forest & Fish	%	21.8	21.0	17.1	13.6	10.8	6.9
2	Industry & Construction	%	40.1	40.9	45.0	47.4	50.1	51.1
3	Service	%	38.2	38.2	37.9	39.0	39.0	42.0
V	GDP per capita	USD	550	604	1002	1652	2736	8058
	Exchange Rate	VND/USD	15785	16077	17621	19313	21168	23200
VI	GDP							
	GDP (At Current Prices)	Bill. USD	45.2	50.3	87.9	153.7	267.7	849.3
	GDP (At Constant 1994 P	Bill. USD	32.9	35.6	53.5	80.4	120.9	260.9
VII	**Growth Rate**		**2004-2005**	**2006-2010**	**2011-2020**	**2021-2030**	**2031-2040**	**2041-2050**
1	Population		1.40%	1.07%	1.09%	0.75%	0.52%	0.32%
2	GDP (At Constant 1994 Prices)		8.0%	8.5%	8.5%	8.0%	7.0%	6.3%
	Agriculture, Forest & Fishery		3.4%	3.5%	3.0%	2.5%	2.0%	2.0%
	Industry & Construction		10.5%	11.0%	10.0%	8.5%	7.0%	6.0%
	Service		7.7%	8.0%	8.4%	8.3%	7.5%	6.9%

Table 3-1-2 Economic Forecast (Base Case)

No	Item	Unit	2000	2004	2005	2010	2015	2020	2030
I	Population	Mill. Person	77.64	82.07	83.22	87.77	93.01	97.85	105.41
II	GDP (At 1994 Price)	Bill. VND	273,666	362,092	390,814	564,536	794,802	1,125,208	2,213,455
1	Agriculture, Forest & Fishery	Bill. VND	63,717	73,309	75,802	87,875	101,871	118,096	151,173
2	Industry & Construction	Bill. VND	96,913	142,601	157,574	253,775	376,344	558,111	1,150,285
3	Service	Bill. VND	113,036	146,182	157,438	222,886	316,587	449,000	911,996
III	GDP (At Present Price)	Bill. VND	441,646	713,071	808,440	1,490,615	2,672,715	4,812,107	15,281,132
1	Agriculture, Forest & Fishery	Bill. VND	108,356	155,144	169,434	258,174	393,390	599,424	1,325,632
2	Industry & Construction	Bill. VND	162,220	285,864	330,446	666,741	1,238,758	2,301,526	7,445,381
3	Service	Bill. VND	171,070	272,063	308,560	565,701	1,040,567	1,911,157	6,510,120
IV	Share of Economic Sectors	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1	Agriculture, Forest & Fishery	%	24.5	21.8	21.0	17.3	14.7	12.5	8.7
2	Industry & Construction	%	36.7	40.1	40.9	44.7	46.3	47.8	48.7
3	Service	%	38.7	38.2	38.2	38.0	38.9	39.7	42.6
V	GDP per capita	USD	404	550	604	964	1488	2323	6249
	Exchange Rate	VND/USD	14094	15785	16077	17621	19313	21168	23200
VI	GDP								
	GDP (At Present Price)	Bill. USD	31.3	45.2	50.3	84.6	138.4	227.3	658.7
	GDP (At 1994 Price)	Bill. USD	24.9	32.9	35.6	51.0	72.3	102.3	201.2
VIII	**Growth Rate**		**2001-2004**	**2004-2005**	**2006-2010**	**2011-2020**	**2021-2030**	**2031-2040**	**2041-2050**
1	Population		1.40%	1.40%	1.07%	1.09%	0.75%	0.52%	0.32%
2	GDP (At 1994 Price)		7.3%	8.0%	7.6%	7.2%	7.0%	6.5%	5.0%
	Agriculture, Forest & Fishery		3.6%	3.4%	3.0%	3.0%	2.5%	2.0%	1.8%
	Industry & Construction		10.1%	10.5%	10.0%	8.2%	7.5%	6.5%	5.1%
	Service		6.6%	7.7%	7.2%	7.3%	7.3%	7.1%	5.2%

Table 3-1-3 Economic Forecast (Low Case)

No	Item	Unit	2000	2004	2005	2010	2015	2020	2030
I	Population	Mill. Person	77.64	82.07	83.22	87.77	93.01	97.85	105.41
II	GDP (At 1994 Price)	Bill. VND	273,666	362,092	390,814	527,322	733,991	1,029,461	2,025,105
1	Agriculture, Forest & Fishery	Bill. VND	63,717	73,309	75,802	90,028	104,368	120,991	154,878
2	Industry & Construction	Bill. VND	96,913	142,601	157,574	231,528	348,139	523,481	1,183,582
3	Service	Bill. VND	113,036	146,182	157,438	205,765	281,485	384,989	686,645
III	GDP (At Present Price)	Bill. VND	441,646	713,071	808,440	1,395,039	2,474,142	4,411,528	13,920,509
1	Agriculture, Forest & Fishery	Bill. VND	108,356	155,144	169,434	264,501	403,031	614,115	1,358,121
2	Industry & Construction	Bill. VND	162,220	285,864	330,446	608,292	1,145,920	2,158,719	7,660,900
3	Service	Bill. VND	171,070	272,063	308,560	522,246	925,192	1,638,694	4,901,488
IV	Share of Economic Sectors	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1	Agriculture, Forest & Fishery	%	24.5	21.8	21.0	19.0	16.3	13.9	9.8
2	Industry & Construction	%	36.7	40.1	40.9	43.6	46.3	48.9	55.0
3	Service	%	38.7	38.2	38.2	37.4	37.4	37.1	35.2
V	GDP per capita	USD	404	550	604	902	1377	2130	5692
	Exchange Rate	VND/USD	14094	15785	16077	17621	19313	21168	23200
VI	GDP								
	GDP (At Present Price)	Bill. USD	31.3	45.2	50.3	79.2	128.1	208.4	600.0
	GDP (At 1994 Price)	Bill. USD	24.9	32.9	35.6	47.6	66.7	93.6	184.1
VIII	**Growth Rate**		**2001-2004**	**2004-2005**	**2006-2010**	**2011-2020**	**2021-2030**	**2031-2040**	**2041-2050**
1	Population		1.40%	1.40%	1.07%	1.09%	0.75%	0.52%	0.32%
2	GDP (At 1994 Price)		7.3%	8.0%	6.2%	7.0%	7.0%	6.5%	5.0%
	Agriculture, Forest & Fishery		3.6%	3.4%	3.5%	3.0%	2.5%	2.0%	2.0%
	Industry & Construction		10.1%	10.5%	8.0%	8.5%	8.5%	7.0%	6.0%
	Service		6.6%	7.7%	5.5%	6.5%	6.0%	6.5%	3.4%

3.2 Power Demand Forecast

The objectives of this chapter are to analyze changes in power demand characteristics estimated in the future in Vietnam, and to prepare an appropriate 6th power master plan. To put it concretely, the actual facts of the past power demand are analyzed and grasped. Further, power demand forecasting models up to 2025 are built up by incorporating the aforementioned social economic development plan, energy consumption trends, and power demand trends by sector, and demand trends by region, etc. At the same time, daily load curves and peak demand are studied.

3.2.1 Concept of the Power Demand Forecast

(1) Viewpoint of the Forecasting

The power demand of Vietnam has displayed characteristics of favorable economic growth since the year 2000, difference of demand types by region, and a rapid increase in daytime demand. The Study Team analyzes the past changes of power demand trends and the actual facts, and grasp constitutional factors for forecasting the future power demand of this country.

These changes in power demand can be considered to reflect the changes of social economic structure following the economic development of Vietnam, as power demand means the results of economic and social activities. In this connection, the JICA Team will study the development stages of Vietnam and analyze the actual situation of the power demand structure as an outcome of social economic activities. The power demand forecasting models to be developed are as stated below.

i) Models linked to the social economic development plan

The aforementioned "Economic Development Forecast Serving Study on Energy Development for the Period up to 2050" is considered as the preconditions for the models. The models forecast the power demand in line with the "High Case," "Base Case" and "Low Case" in the development plan.

ii) Power demand forecast by region and its characteristics

Vietnam is elongated from north to south, and has regionally different power demand characteristics. The Team grasps these characteristics, and implement power demand forecast by dividing Vietnam into the North Region, the Central Region and the South Region.

iii) Power demand forecast incorporating energy price effects

Increase in the price of crude oil brings about increase in the price of natural gas and petroleum products. Generally speaking, energy saving activities are conducted when the prices of fuel oil products and gas rise. The saving effect that accompanies increases in prices is reflected in the power demand forecast.

iv) The power demand forecasted by the total energy consumption in sectors

This power demand forecast study is also responsible for relating electric power to primary energy. Therefore, the Team does not only forecast power demand, but also forecasts the total energy demand volume by sector, and calculates the power demand by sector from the proportion of the power occupying total energy. At the time of calculation, the electrification ratio by sector of the neighboring countries is adopted for reference.

v) Daily load curve

Daily load curve and peak demand are important information for making power development plan. The JICA Team will take the data of neighboring countries as reference, and establish a forecast model by using the present daily load curves of Vietnam, Asian countries (Malaysia, Thailand, the Philippines and Indonesia) and Japan on the assumption that the Vietnamese daily load curve will follow the curves of these countries.

vi) Matching the primary energy supply and energy consumption in power stations

Compatibility of energy supply with the primary energy consumption in power stations is sought in this Study. Accordingly, this is a model that can forecast the consumption trends and import and export trends of the primary energies in order to facilitate analyses to be done after the power demand forecasts. Introduction of oil refinery plants is closely related to the supply of fuel oil and diesel to be used for thermal power generation. This model can also analyze the trends of these matters from the power demand forecasts.

(2) Output of the study from the power demand forecasting model

The "difference among the regional demand structure" and the "changes of the daily load curves", etc. can be named as the characteristics of Vietnamese power demand. Thus, mere analysis of one month-data and one year–data of consumption quantity is not enough; rather, grasping of monthly and yearly peak demands or, furthermore, of consumption patterns is needed. In the Study, the following items are forecasted:

i) Energy and power demand by economic scenario (High, Base, Low Cases) and by region (North, Central, South). The time span is from 2005 to 2025;

ii) Power demand by sector (agriculture, forestry and fishery sector, industrial sector, commercial sector, transportation sector, and residential use);

iii) Daily load curve, load factor and peak demand by region; and

iv) Import and export of energy by economic activity.

The model building technologies have already been developed and transferred to Vietnam counterparts in a previous JICA project, i.e. “Master plan study on PSPP and optimization for peaking power generation.” In the project, the model should be improved in terms of its

suitability, operability and convenience.

3.2.2 Structure of the Power Demand Forecasting Model

(1) Annual Power Consumption Forecast

The functions of the model expected by the project are as follows:

i) To simulate the relations among economy, energy and power demand;
ii) To analyze the policy agendas including energy price impact, increasing electrification ratio and fuel conversion of power stations;
iii) To evaluate energy saving;
iv) To analyze differences between the North, Central and South regions; and
v) To make the energy balance between power demand and primary energy.

In the model, the economic indicators that are expressed by the Government and the related organizations are used as external variables, and the other indicators that are not expressed are calculated as internal variables in the model. In the power demand forecasting block of the model, the power demand is forecasted as one of the areas of energy demand in the sectors. After that, power generation energy and fuel consumption for power supply and energy demand supply balance are estimated.

Energy data and economic data are selected from the sources that the Institute of Energy can collect. And the required data such as real GDP and relative energy prices are calculated in the model. By doing so, the data formatted by the primary data are stored.

Generally speaking, econometric models are built up as the aggregate of regression and definition equations. And the statistic and economic logical tests are examined. For building the model, the following tests are executed:

i) Evaluation of power demand forecasting equations
- Determination coefficient(more than 0.85)
- T-value test of regression coefficient (More than 2.0)
- Durbin Watson ratio （1＜DW<3）
- Sign test of the regression coefficient

ii) Evaluation of macro economic forecast
- Real GDP growth rate
- GDP per person（US$ base）
- Labor productivity growth rate
- Unemployment rate

iii) The evaluation of the energy demand forecast

- Energy demand growth rate
- Energy consumption per GDP（GDP elasticity）
- Energy consumption per person
- Electrification ratio

For building the above model, the econometric method is applied according to the above outline, and the model can be classified into two blocks, i.e. the macro economic block and power demand block. The classification clarifies the relation between economic trends and power demand trends.

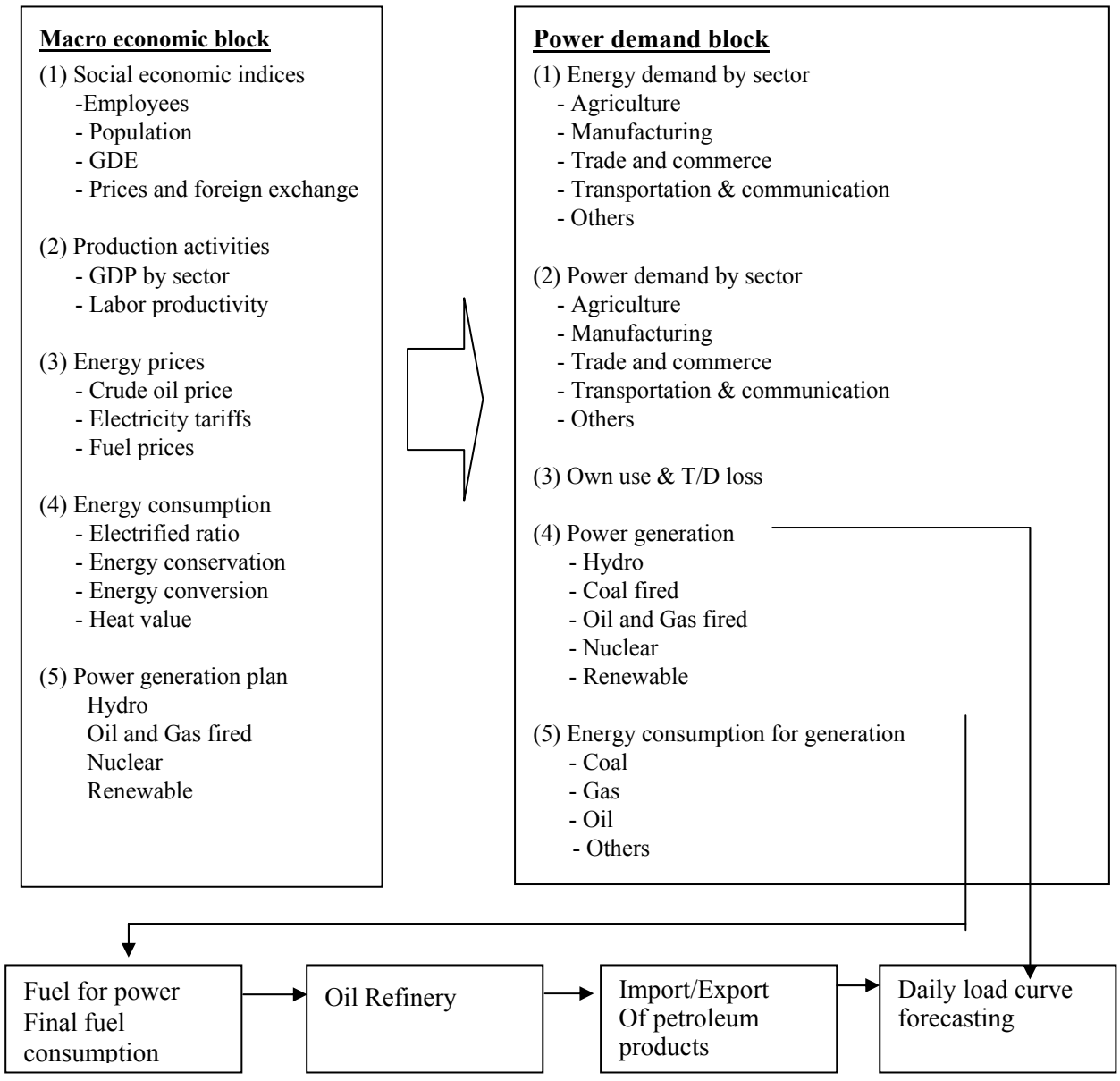


Figure 3-2-1 Outline of the Power Demand Forecasting Model

<Consistency on sectoral power shares to IE power demand >

In the model, sectoral power demand is forecasted as the electric power demand share to the total energy demand in the sector. The share is defined by referring to the sectoral "power ratio" of the neighbor countries.

The Institute of Energy - EVN (IE) has staff to forecast power demand for PDP 6th by econometric methods. The power demand forecasting of the Study Team needs to have consistency with power demand forecasting of IE. Then both sides have enough discussion to decide the sectoral power ratio. The sectoral power ratios that are selected in the model are decided by power demand forecasting of IE.

The (electric) power demand forecasting equations built by IE are follows;
Power demand in Manufacturing = a* Manufacturing GDP + b*1998 Dummy + c
Power demand in Residential = a* GDP / electricity customers + b* Electricity customers + c
Power demand in Commercial = a* Commercial GDP + b* Power demand in Com.(-1) + c
Power demand in Agriculture = a* Agriculture GDP + b*Power demand in Agri.(-1) + c
Power demand in Other = a* GDP /Population + b* Power demand in Other(-1) + c

Note : (-1) is a value of previous year

< Consistency with power demand to Five year-PDP in Vietnam>

The Vietnam government approves the power demand forecasting for the next five years (2006 – 2010). For keeping the consistency between the power demand of the next five years and PDP 6th, the power demand in the model is forecasted assuming the power demand growth rates of the three years, 2006, 2007 and 2008. By the operation, the consistency of the power demand in 2006, 2007 and 2008 is kept between the five-year plan and PDP 6th. The values in 2006, 2007 and 2008 are as follows;

Cases	Power demand in five year plan (2006～2008)	Social Economic scenarios
High	18%	High growth rate scenario
Base	17%	High growth rate scenario
Low	16%	Base growth rate scenario

(2) Daily Load Curve Forecasting

The daily load curve in Vietnam is witnessing a major shift in terms of rapidly increasing daytime demand. Neighbor countries such as Thailand and Japan have already moved to the developed country type, which shows peak demand during daytime in the summer season, instead of the developing country type, which shows peak demand in the evening. In Vietnam, the daily load curve is shifting from the nighttime type to the daytime type, and the power consumption characteristics are expected to change into a developed country type with economic development.

The procedures of the daily load curve forecasting built by the JICA Team are as follows;

i) Collection of the daily load curve data to be forecasted

- The power dispatched data classified by North, Center and South regions
- The hourly data from 1996 to 2004

ii) Explanation variable data

- Population by region
- GDP by region
- Temperature by region
- Humidity by region
- Electrification ratio by region

iii) Classification of daily load curve data as a unit in forecasting

- 3 days peak data in a month
- Weekday data (From Monday to Saturday)
- Holiday data (Sunday and national holidays)

iv) Making forecasting equations by regression analysis

- Annual daily load curve forecasted by regression analysis
- Daily load curve forecasted for weekdays and holidays
- Daily load curve forecasted for peak demand days,

Table 3-2-1 Number of the Data Required for Forecasting Daily Load Curve

Region	Explanation variable	Dependent variable	Forecast result of daily load curve
North Central South	GDP by region Temp By region Humidity by region Electrification	3 day peak demand type Weekday demand type Holiday demand type	DLC of the whole country DLC of three regions DLC of types

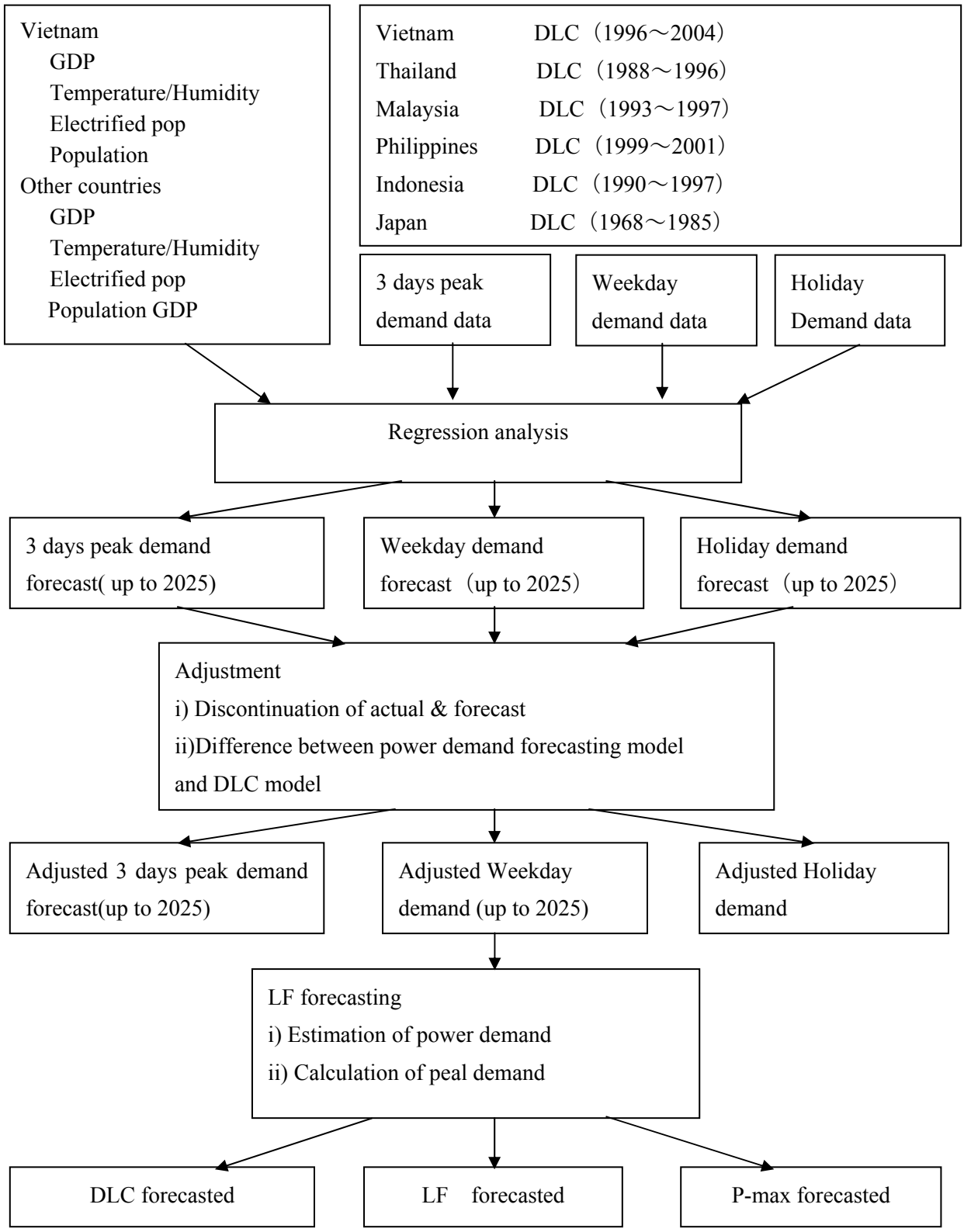


Figure 3-2-2 Outline of Daily Load Curve Forecasting Model

A huge amount of data as mentioned above are used for calculation of the daily load curve forecasting model. Thus, high compatibility between the data and regression analysis is demanded for appropriate application of the data. For the model building, the Study Team uses Simple-E. The software is an econometric model-building engine that develops a small econometric model. By using Simple-E, it is expected to increase productivity.

<Daily load curve forecasting by aggregation method>

IE tries to forecast the daily load curve by the aggregation method. In the project, daily load curves are forecasted by the regression analysis method and aggregation method. After comparing the results of the daily load curve forecasting, one of them is selected for PDP 6th by the Study Team.

In the Study, the following three daily load curves are prepared for PDP 6th.

Daily Load Curve Forecasting by Regression Analysis
(A) Monthly daily load curves from 2005 to 2025 are forecasted by regression analysis.
(B) Monthly power demands from 2005 to 2025 are forecasted.
(C) Monthly peak demands from 2005 to 2025 are forecasted (=(A) * (B))

Daily Load Curve Forecasting by Aggregation Method
(D) Monthly daily load curves from 2005 to 2025 are forecasted by using daily load curves in 2004.
(E) Monthly power demands from 2005 to 2025 are forecasted. (Annual power demand is shared out to monthly demand)
(F) Monthly peak demands from 2005 to 2025 are forecasted (=(D) * (E))

Daily Load Curve Forecasting by Combination of Regression Analysis and Aggregation Method
(F) Monthly daily load curves come from the aggregation method.
(B) Monthly power demands come from regression analysis
(G) Monthly peak demands up to 2025 are forecasted (=(F) * (B))

3.2.3 Power Demand Forecasting

(1) Preconditions

The following economic preconditions are prepared for the power demand forecasting model.

＜Base Case＞

The high economic scenario that is mentioned in the social economic plan is applied to the Base Case of power demand forecasting. The procedures of power demand forecasting are as follows: i) Forecasting the sectoral energy demand, ii) Calculating power demand by power ratio, and iii) Considering the energy conservation factor. However, power demand from 2006 to 2008 is set with growth rate of 17% for keeping consistency to the five-year power development plan.

＜High Case＞

Under the same condition of the Base Case, power demand from 2006 to 2008 is set with growth rate of 18%.

＜Low Case＞

The economic scenario with high possibility in social economic plan is applied to the Low Case of power demand forecasting. And power demands from 2006 to 2008 are set with growth rate of 16% for keeping consistency to the five-year power development plan.

Power demand up to 2025 is forecast under the above three cases, and the preconditions in the three cases are as follows.

i) Population growth rate

The growth rate of population in the past five years is 1.4% per year. In future the growth rate is forecasted as 1.1%, however after 2020, it is 0.8%.

Cases	Unit	2005/2000	2010/2005	2015/2010	2020/2015	2025/2020
High Case	%	1.4	1.1	1.1	1.1	0.8
Base Case	%					
Low Case	%					

（Source）ECONOMIC DEVELOPMENT FORECAST SERVING STUDY ON ENERGY DEVELOPMENT FOR THE PERIOD UP TO 2050

ii) Exchange rate

The exchange rate to US$ is decided by the inflation gap between USA and Vietnam. (6% inflation in Vietnam - 3% inflation in USA =3% devaluation of Don.). In the model, the exchange rate is quoted from the social economic plan.

Cases	Unit	2005	2010	2015	2020	2025
High Case	Don/$					
Base Case	Don/$	16,077	17,621	19,313	21,168	21,168
Low Case	Don/$					

（Source）Ditto

iii) GDP growth rate

According to the social economic plan, GDP growth rate from 2005 to 2015 is comparatively higher than the further years. However, the GDP growth rate after 2015 is rather stable.

Cases	Unit	2005/2000	2010/2005	2015/2010	2020/2015	2025/2020
High Case	%	7.4	8.5	8.5	8.5	8.0
Base Case	%	7.4	8.5	8.5	8.5	8.0
Low Case	%	7.4	7.6	7.2	7.2	7.0

（Source）Ditto

iv) Crude oil price（WTI）

Since it appears that high crude oil prices will continue in the next 2 or 3 years, it is considered that WTI crude oil price is kept at $60/bbl from 2005 to 2008 (Vietnam crude oil price is $50/bbl). After 2009, the crude oil price is predicted as $40/bbl. (Vietnam crude oil price is $30 - $35/bbl).

Cases	Unit	2004	2005	2006	2007	2008	2009		2025
High Case	bbl/$								
Base Case	bbl/$	40	60	60	60	60	40	・・・	40
Low Case	bbl/$								

（Source）Discussion in the Working Group

v) Power ratio of agriculture sector (Power / Sector total energies)

The power ratio of the agriculture sector is defined as power demand divided by energy demand in the agriculture sector. The ratios in neighboring countries are as shown in Table 3-2-2. The Philippines with 10.1% and China with 13.7% are outstanding. The current power ratio in Vietnam is the middle position between China and the Philippines.

Cases	Unit	2005	2010	2015	2020	2025
High Case	%	11.2	19.0	23.5	28.1	34.5
Base Case	%	11.2	18.4	22.8	27.4	33.8
Low Case	%	11.2	17.9	21.1	24.1	28.8

（Source）Decision by the Working Group after referring to other counties

Table 3-2-2 Power Ratio of the Agriculture Sector in Neighbor Countries

	1995	1996	1997	1998	1999	2000
Japan	2.7	2.8	2.9	3.0	3.2	2.1
Taiwan	1.7	1.8	2.1	2.3	2.3	2.1
Australia	1.5	1.5	1.5	1.5	1.5	1.5
Korea	0.9	1.0	0.9	1.0	1.1	1.2
China	12.8	13.2	13.5	12.8	13.7	13.7
Thailand	0.6	0.6	0.5	0.7	0.5	0.5
Philippines	19.8	16.7	18.1	13.8	20.1	10.1

(Source) APEC Data Base

vi) Power ratio of industrial sector

The power ratios of the industrial sector in neighboring countries are as shown in Table 3-2-3. The Philippines with 32% and Japan and Taiwan with 26% respectively are outstanding. The Vietnam power ratio in 2005 is 15.9% including renewable energies, and 22% excluding renewable energies. It is the same as current Malaysia.

Cases	Unit	2005	2010	2015	2020	2025
High Case	%	15.9	24.3	31.1	35.3	38.7
High Case	%	15.9	23.4	29.6	33.8	36.1
Base Case	%	15.9	23.2	29.3	33.5	35.6

（Source） Decision by the Working Group after referring other counties

Table 3-2-3 Power Ratios of Industrial Sector in Neighbor Countries

	1995	1996	1997	1998	1999	2000
Japan	26.5	26.8	27.1	27.4	26.7	26.6
Taiwan	22.1	22.2	22.9	23.3	24.4	26.2
Australia	20.3	19.9	20.0	21.4	21.9	22.0
Indonesia	12.4	11.9	14.3	13.8	13.9	12.9
Korea	19.0	19.6	19.4	19.2	19.4	20.0
China	5.1	5.3	5.5	5.8	6.0	6.1
Thailand	22.7	20.6	22.5	22.4	23.9	25.4
Malaysia	18.0	19.8	21.4	21.4	23.1	22.2
Philippines	19.7	19.7	20.2	26.9	20.4	31.7

(Source) APERC Data Base

vii) Power ratio of transportation sector

Hardly any electricity is used in the current transportation sector in Vietnam. However, as subway is planned in Ho Chi Min city in future, it is considered that power consumption in the transportation sector will increase as shown in the following table.

Cases	Unit	2005	2010	2015	2020	2025
High Case	%	0.5	0.5	0.8	1.3	2.0
Base Case	%					
Low Case	%					

（Source） Decision by the Working Group after referring to other counties

viii) Power ratio of commercial sector

It is predicted that power demand will increase greatly in the commercial sector in future. The power ratio is set after referring to power ratios of neighbor countries and the power demand of IE.

Cases	Unit	2005	2010	2015	2020	2025
High Case	%	11.3	22.3	26.4	30.9	37.1
Base Case	%	11.3	21.7	25.6	30.0	34.9
Low Case	%	11.3	20.8	26.0	31.4	37.9

（Source） Decision by the Working Group after referring to other counties

The power ratios of commercial sector and residential use in neighbor countries are as shown in the following table. Power ratios of Thailand with 71% and Taiwan with 67% are outstanding. The country temperatures are so high that the sectors use air-conditioners. In future, since Vietnam will also use air conditioners so much, it is considered that the power ratio of these sectors will become this high.

Table 3-2-4 Power Ratios of Commercial and Residential Sectors in Neighbor Countries

	1995	1996	1997	1998	1999	2000
Japan	43.9	43.9	45.4	47.1	47.8	44.8
Taiwan	64.5	63.6	65.9	66.2	65.8	67.2
Australia	52.3	53.0	53.7	54.4	55.3	55.5
Indonesia	3.8	4.3	4.8	5.3	5.4	5.8
Korea	18.0	19.3	21.0	25.7	24.0	27.6
China	6.3	7.0	8.0	9.5	10.0	10.0
Thailand	70.5	70.3	72.6	75.0	72.2	71.2
Malaysia	55.2	49.7	65.0	68.2	61.0	63.4
Philippines	39.0	40.6	47.2	45.2	43.7	40.0

(Source) APERC Energy Data Base (Note) Excluding renewable energies

ix) Power ratio for residential use

Power ratio for residential use in Vietnam is as shown in the following table. The ratio (11% in 2005) is not so big, because the total energy demand for residential use contains renewable

energies (The shares of renewable energies in residential use is 70～80%). In 2005, power ratio for residential use excluding renewable energies is 35%. The power ratio of residential use in 2025 is 28% in the following table. However power ratio of residential use excluding renewable energies is 60 to 70% in 2025. The level is the same as the current Thailand and Malaysia.

Cases	Unit	2005	2010	2015	2020	2025
High Case	%	11.3	17.9	23.3	26.5	28.9
Base Case	%	11.3	17.2	22.3	25.5	27.7
Low Case	%	11.3	16.7	21.6	24.8	27.1

（Source） Decision by the Working Group after referring to other counties

x) Transmission and distribution loss

Regarding transmission and distribution loss, the prediction values of EVN are selected.

Cases	Unit	2005	2010	2015	2020	2025
High Case	%					
Base Case	%	11.5	10.3	9.3	8.5	7.5
Low Case	%					

（Source） EVN estimation

xi) Own use rate

It is possible to set own use rate by power generation equipment type. After making tentative generation plan, the averaged own use rates are calculated.

Cases	Unit	2005	2010	2015	2020	2025
High Case	%	3.5	3.5	3.4	4.0	4.5
Base Case	%	3.5	3.5	3.4	4.0	4.5
Low Case	%	3.6	3.6	3.4	4.1	4.6

(Sources) Generation schedule in the model

Table 3-2-5 (Reference) Own Use Rate Estimation (Base, High Case)

Generation types	O/U	Unit	2005	2010	2015	2020	2025
Power from Hydro	0.5%	GWh	17,706	46,754	74,177	79,127	90,953
Nuclear power	5.0%	GWh				12,264	12,264
Power from Thermal (Coal)	7.0%	GWh	7,977	29,035	38,152	81,454	146,977
Power from Thermal (FO)	5.0%	GWh	1,210	4,207	4,207	4,207	4,207
Power from Gas turbine (FO)	5.0%	GWh	2,222	2,222	2,222	2,222	2,222
Power from Gas turbine (GAS)	4.5%	GWh	27,078	39,263	65,911	82,310	86,409
Power from Gas steam	5.0%	GWh	285	285	285	285	285
Power from Diesel	5.0%	GWh	47	47	47	47	47
Total generation		GWh	56,524	121,813	185,000	261,915	343,364
Total own use		GWh	1,999	4,293	6,214	10,588	15,410
Own use rate		%	3.5	3.5	3.4	4.0	4.5

(Source) Own use rate by generation type comes from PDP 5th

Table3-2-6 （Reference）Own Use Rate Estimation（Low Case）

Generation types	O/U	Unit	2005	2010	2015	2020	2025
Power from Hydro	0.5%	GWh	17,706	46,754	74,177	79,127	90,953
Nuclear power	5.0%	GWh				12,264	24,528
Power from Thermal (Coal)	7.0%	GWh	7,977	29,035	38,152	81,454	146,977
Power from Thermal (FO)	5.0%	GWh	1,210	4,207	4,207	4,207	4,207
Power from Gas turbine (FO)	5.0%	GWh	2,222	2,222	2,222	2,222	2,222
Power from Gas turbine (GAS)	4.5%	GWh	27,078	39,263	65,911	82,310	86,409
Power from Gas steam	5.0%	GWh	285	285	285	285	285
Power from Diesel	5.0%	GWh	47	47	47	47	47
Total generation		GWh	56,524	121,813	185,000	261,915	355,628
Total own use		GWh	2,054	4,371	6,346	10,753	16,196
Own use rate		%	3.6	3.6	3.4	4.1	4.6

（Sources）Own use rate by generation type comes from PDP 5th

xii) GDP by region

The regional GDP (North, Center and South) comes from the source of "ECONOMIC DEVELOPMENT FORECAST SERVING STUDY ON ENERGY DEVELOPMENT FOR THE PERIOD UP TO 2050". As features, the growth rate of the Center is the highest, next is the North and third is the South. It is expected that the growth rate of the South region, which is comparatively well developed, will be lower, whereas that of the Center region, which is comparatively undeveloped, will be higher.

＜North＞

Cases	Unit	2005/2000	2010/2005	2015/2010	2020/2015	2025/2020
High Case	%	7.9	8.6	8.8	8.7	8.7
Base Case	%	7.9	8.6	8.8	8.7	8.7
Low Case	%	7.9	7.8	7.3	7.4	7.4

（Source）ECONOMIC DEVELOPMENT FORECAST SERVING STUDY ON ENERGY DEVELOPMENT FOR THE PERIOD UP TO 2050

＜Central＞

Cases	Unit	2005/2000	2010/2005	2015/2010	2020/2015	2025/2020
High Case	%	8.2	8.7	8.9	9.2	9.2
Base Case	%	8.2	8.7	8.9	9.2	9.2
Low Case	%	8.2	7.9	7.6	8.0	8.0

（Source）Ditto

＜South>

Cases	Unit	2005/2000	2010/2005	2015/2010	2020/2015	2025/2020
High Case	%	7.7	8.3	8.3	8.2	8.2
Base Case	%	7.7	8.3	8.3	8.2	8.2
Low Case	%	7.7	7.4	6.8	6.9	6.9

（Source）Ditto

(2) Power Demand Forecast (Base Case)

a. Power demand forecast for whole country

In the high growth scenario, the power demand increases by 11.2% from 2005 to 2025, and the power demand reaches 381,000GWh in 2025 from 46,000GWh in 2005. The growth rate from 2005 to 2008 is 16.6%, and 16.1% from 2005 to 2010. Then it undergoes a higher growth rate in the first half of the period.

The elasticity to GDP in the periods is 2.0 in 2007 and 2008, 1.8 in 2009 and 1.7 in 2010. The high trend of GDP elasticity with 1.9 in 2005 continues up to 2010. However as the elasticity is forecasted as 1.3 in 2015, the high elasticity falls by 2015.

The trends of the growth rates and elasticity are as follows;

Table 3-2-7 Power Demand Forecasting (2005-2010) Unit: GWh

	2005	2006	2007	2008	2009	2010	2010/05
Power Demand	46,000	54,000	63,000	73,000	85,000	97,000	16.1%
Growth rate	15.2 %	16.5%	17.1%	16.9%	15.7%	14.5%	
Elasticity	1.9	1.9	2.0	2.0	1.8	1.7	1.9

(Source) Data from Base Case model

Table 3-2-8 Power Demand Forecasting (2005 - 2025) Unit: GWh

	2005	2010	2015	2020	2025	
Power Demand	46,000	97,000	165,000	257,000	381,000	11.2%
	2005/00	2010/05	2015/10	2020/15	2025/20	2025/05
Growth rate	15.2 %	16.1%	11.2%	9.3%	8.2%	
Elasticity	2.1	1.9	1.3	1.1	1.0	1.3

（Source）Data from Base Case model

Table 3-2-9 Power Demand Forecast by Sector（2005 - 2010） Unit: GWh

	2005	2006	2007	2008	2009	2010
Agriculture	658	750	878	1,026	1,137	1,229
Industry	20,909	24,790	29,405	34,815	40,439	46,325
Commercial	2,022	2,469	3,017	3,673	4,763	6,168
Residential	20,173	23,198	26,537	30,288	34,155	38,042
Other	2,235	2,384	2,917	3,556	4,361	5,354
Total	45,997	53,591	62,754	73,359	84,854	97,118

（Source）Data from Base Case model

Table 3-2-10 Power Demand Forecast by Sector（2005-2025）Unit：GWh

	2005	2010	2015	2020	2025	2025/05
Agriculture	658	1,229	1,624	2,061	2,611	7.1%
Industry	20,909	46,325	81,559	131,066	199,296	11.9%
Commercial	2,022	6,168	10,528	17,319	27,550	14.0%
Residential	20,173	38,042	59,777	85,629	119,109	9.3%
Other	2,235	5354	11,487	21,211	32657	14.3%
Total	45,997	97,118	164,975	257,286	381,223	11.2%

（Source）Data from Base Case model

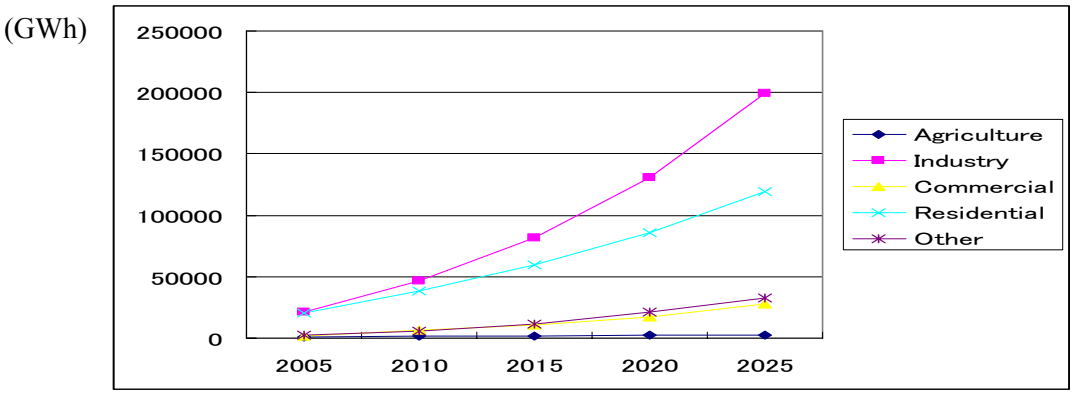


Figure 3-2-3 Power Demand Forecast by Sector（2005 - 2025）Base Case

The power demand of PDP 5th (Base Case) and revised PDP 5th (Base Case) compared to PDP 6th are as shown in the following table and figure. In 2020, the power demand in PDP 5th is 147,000GWh, and 179,000 in Revised PDP 5th. In Base Case of PDP 6th, the power demand is 257,000GWh and it is 44% higher than the revised PDP 5th.

Table3-2-11 Power Demand Forecast and Comparison with PDP 5th Unit：GWh

Projects	2005	2010	2015	2020	2025
PDP 6th (Base Case)	45,997	97,118	164,975	257,286	381,223
PDP 5th (Base Case)	37,116	61,572	95,747	146,555	
Revised PDP 5th(Base Case)	44,944	80,486	124,203	178,568	

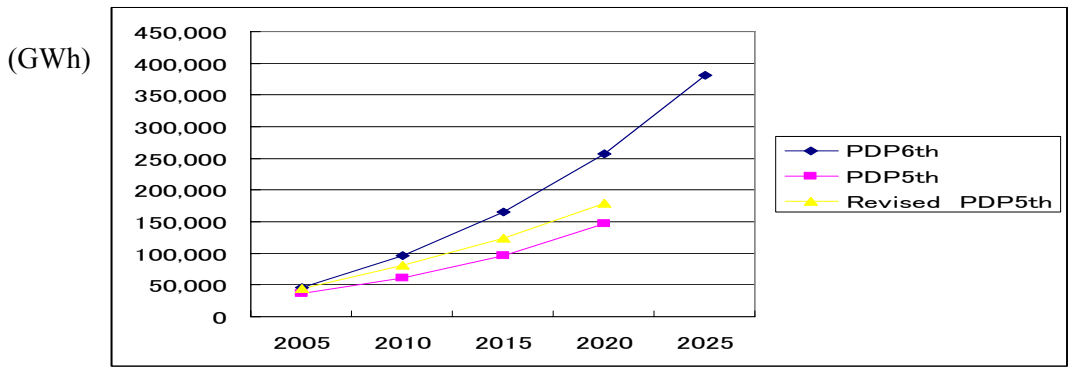


Figure 3-2-4 Comparing PDP 6th to PDP 5th and Revised PDP 5th (Base Case)

b. Regional Power Demand Forecast

It is predicted that the power demand shares by region (North, Center and South) do not change drastically up to 2025. The growth rate of power demand in the Center region is relatively higher than other regions. Then the share of the Center region becomes 10.8% in 2025 from 10.1% in 2005. And also the share of the North region is predicted with a little increase in 2025.

Table 3-2-12 Power Demand Forecast by Region Unit:GWh

	2005	2010	2015	2020	2025	25/05
North	17,686	36,657	63,401	100,441	151,283	11.3%
Center	4,647	9,703	16,549	26,477	41,286	11.5%
South	23,664	50,758	85,025	130,367	188,654	10.9%
Total	45,997	97,118	164,975	257,286	381,223	11.2%

(Source) Data from Base Case model

Table 3-2-13 Power Demand Shares by Region Unit:%

	2005	2010	2015	2020	2025	Different
North	38.5	37.7	38.4	39.0	39.7	+1.2%
Center	10.1	10.0	10.0	10.3	10.8	+0.7%
South	51.4	52.3	51.5	50.7	49.5	-1.9%
Total	100.0	100.0	100.0	100.0	100.0	

(Source) Data from Base Case model

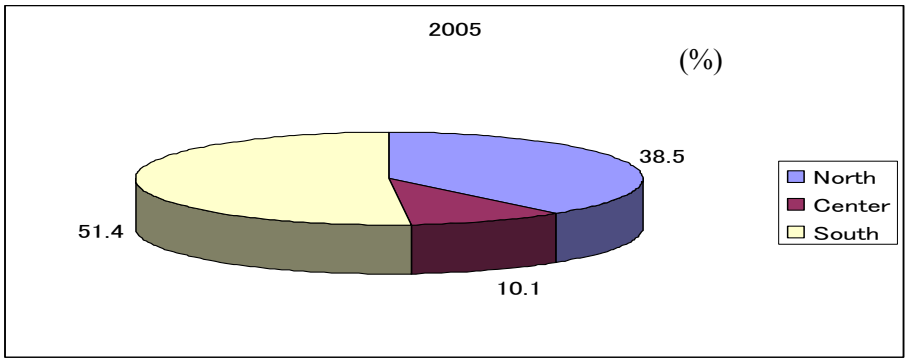


Figure3-2-5 Power Demand Shares by Region (Base Case 2005)

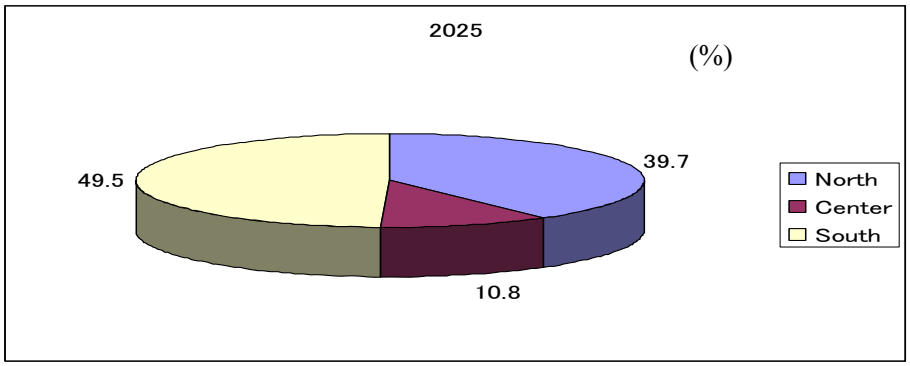


Figure 3-2-6 Power Demand Shares by Region (Base Case 2025)

(3) Power Demand Forecast (High Case)

a. Power demand forecast for whole country

When power demand from 2006 to 2008 is assumed as 18%, the average growth rate from 2005 to 2025 is 11.4%. The power demand increases from 46,000GWh in 2005 to 399,000GWh in 2025.

The elasticity to GDP is 2.2 in 2007, 2.1 in 2008, 1.9 in 2009 and 1.8 in 2010. It is considered that the high growth trends in 2005 continue up to 2010. However, the elasticity after 2015 decreases to 1.2. This elasticity is reasonable.

The power demand growth rates of commercial and other sectors are 14.2% and 15.7% respectively, higher than the rate of the industrial sector of 12.2%.

The trends of the growth rates and elasticity are as follows.

Table 3-2-14 Power Demand Forecast（2005 - 2010） Unit：GWh

	2005	2006	2007	2008	2009	2010	10/05
Power Demand	45,682	54,088	63,986	75,568	87,993	101,148	
Growth rate	15.2 %	18.4%	18.3%	18.1%	16.4%	15.0%	17.2%
Elasticity	1.9	2.2	2.2	2.1	1.9	1.8	2.0

（Source）High Case power demand model

Table3-2-15 Power Demand Forecast（2005 - 2025） Unit：GWh

	2005	2010	2015	2020	2025	
Power Demand	45,682	101,148	172,355	267,561	398,554	
	2005/00	2010/05	2015/10	2020/15	2025/20	2025/05
Growth rate	15.2 %	17.2%	11.2%	9.2%	8.3%	11.4%
Elasticity	2.1	2.0	1.3	1.1	1.0	1.4

（Source）High Case power demand model

Table3-2-16 Sectoral Power Demand Forecast (2005 - 2010） Unit：GWh

	2005	2006	2007	2008	2009	2010
Agriculture	658	757	895	1,057	1,176	1,272
Industry	20,909	25,022	29,985	35,866	41,921	48,201
Commercial	2,022	2,492	3,076	3,784	4,907	6,354
Residential	20,173	23,415	27,061	31,203	35,443	39,656
Other	2,235	2,402	2,969	3,658	4,546	5,665
Total	45,997	54,080	63,986	75,568	87,993	101,148

（Source）High Case power demand model

Table 3-2-17 Sectoral Power Demand Forecast (2005 - 2025) Unit : GWh

	2005	2010	2015	2020	2025	25/05
Agriculture	658	1,272	1,672	2,109	2,658	7.2
Industry	20,909	48,201	84,958	135,398	208,316	12.2
Commercial	2,022	6,354	10,828	17,719	28,750	14.2
Residential	20,173	39,656	62,412	88,692	123,089	9.5
Other	2,235	5,665	12,485	23,643	35,741	15.7
Total	45,997	101,148	172,355	267,561	398,554	11.4

(Source) High Case power demand model

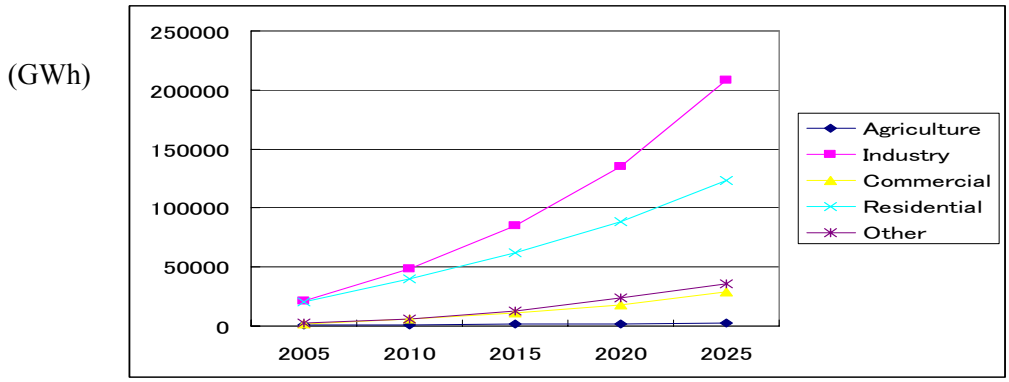


Figure 3-2-7 Power Demand by Sector in High Case

The power demands of PDP 5th (High Case) and Revised PDP 5th (High Case) that are compared to PDP 6th are shown in the following table and figure. In 2020, the power demand in PDP 5th is 177,000GWh, and is 221,000 in the Revised PDP 5th. In High Case of PDP 6th, the power demand is 268,000GWh and is 21% higher than the Revised PDP 5th.

Table3-2-18 Power Demand Forecast and Comparison with PDP 5th Unit : GWh

Projects	2005	2010	2015	2020	2025
PDP 6th (High Case)	45,682	101,148	172,355	267,561	398,554
PDP 5th (High Case)	39,066	68,538	111,066	176,696	
Revised PDP 5th(High Case)	44,944	85,678	144,057	221,723	

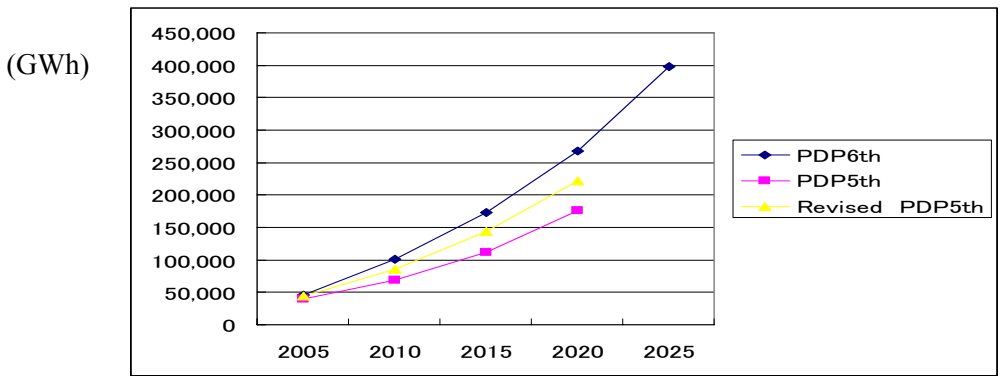


Figure 3-2-8 Comparing PDP 6th to PDP 5th and Revised PDP 5th (High Case)

b. Regional power demand forecast（High Case）

It is predicted that the power demand shares by region (North Center and South) do not change up to 2025. The growth rate of power demand in the Center is relatively higher than the other regions. Then the share of the Center becomes 10.4% in 2025 from 10.1% in 2005.

Table 3-2-19 Regional Power Demand Unit：GWh

	2005	2010	2015	2020	2025	25/05
North	17,686	38,069	65,282	101,760	152,328	11.4%
Center	4,647	10,057	16,977	26,710	41,367	11.6%
South	23,664	53,022	90,096	139,091	204,859	11.4%
Total	45,997	101,148	172,355	267,561	398,554	11.4%

（Source）High Case power demand model

Table 3-2-20 The Composition Ratio of Regional Power Demand （%）

	2005	2010	2015	2020	2025	Difference
North	38.5	37.6	37.9	38.0	38.2	-0.3
Center	10.1	9.9	9.8	10.0	10.4	+0.3
South	51.4	52.4	52.3	52.0	51.4	0.0
Total	100.0	100.0	100.0	100.0	100.0	

（Source）High Case power demand model

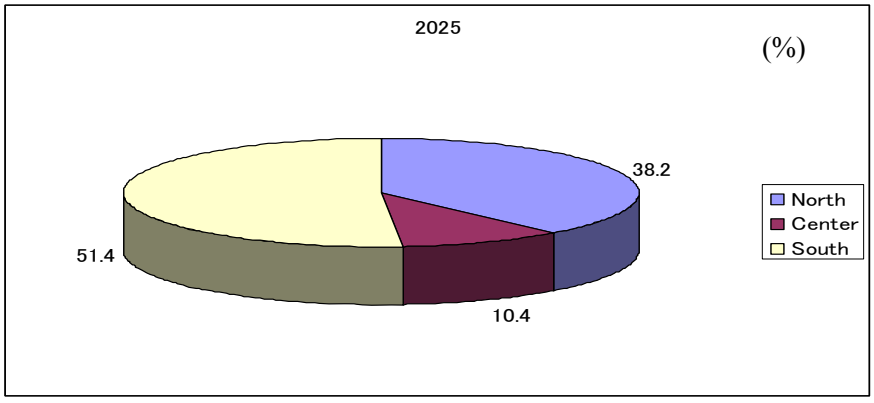


Figure3-2-9 The Regional Power Demand Composition Ratio (High Case 2025）

(4) Power Demand Forecast (Low Case)

a. Power demand forecast for whole country

In the economic scenario with high possibility, the power demand increases by 10.0% from 2005 to 2025, and the power demand reaches 309,000GWh in 2025 from 46,000GWh in 2005. The growth rate from 2006 to 2008 is 16%, and 14.9% from 2005 to 2010.

The elasticity to GDP in the periods is 2.0 in 2007, 2.0 in 2008, 1.9 in 2009 and 1.7 in 2010. The trend of GDP elasticity in 2005 continues up to 2010. However the elasticity is forecasted to decline to 1.4 in 2015.

Regarding sectoral power demand, the power demand growth rates of commercial and other sector are 14.4% and 12.7% respectively, higher than the rate of industrial sector of 10.8%.

The trends of the growth rates and elasticity are as follows;

Table 3-2-21 Power Demand (2005 - 2025) Unit : GWh

	2005	2006	2007	2008	2009	2010	10/05
Power demand	46,000	53,000	62,000	71,000	81,000	92,000	
Growth rate	15.4 %	16.8%	16.0%	15.2%	14.1%	13.1%	14.9%
Elasticity	1.9	2.2	2.1	2.0	1.9	1.7	2.0

(Source) Power demand forecast in Low Case

Table3-2-22 Sectoral Power Demand (2005 - 2010) Unit : GWh

	2005	2006	2007	2008	2009	2010
Agriculture	658	746	866	997	1,092	1,168
Industry	20,909	24,684	29,005	33,841	38,825	44,055
Commercial	2,022	2,458	2,976	3,570	4,489	5,636
Residential	20,173	23,099	26,176	29,442	32,744	36,042
Other	1,921	2,369	2,872	3,451	4,176	5,047
Total	45,682	53,356	61,894	71,301	81,327	91,949

(Source) Power demand forecast in Low Case

Table 3-2-23 Power Demand (2005 - 2025) Unit : GWh

	2005	2010	2015	2020	2025	
Power demand	46,000	97,000	147,000	216,000	309,000	
	2005/00	2010/05	2015/10	2020/15	2025/20	2025/05
Growth rate	15.3%	15.0%	9.8%	8.1%	7.3%	10.0%
Elasticity	2.1	2.0	1.4	1.1	1.0	1.4

(Source) Low Case power demand model

Table 3-2-24 Sectoral Power Demand (2005 - 2025) Unit : GWh

	2005	2010	2015	2020	2025	25/05
Agriculture	658	1,168	1,443	1,716	2,065	5.9%
Industry	20,909	44,055	73,391	111,653	163,798	10.8%
Commercial	2,022	5,636	9,292	14,511	22,410	14.4%
Residential	20,173	36,042	53,838	73,751	98,129	8.2%
Other	1,921	5,047	8,935	14,802	22,109	12.7%
Total	45,682	91,949	146,899	216,433	308,511	10.0%

(Source) Low Case power demand model

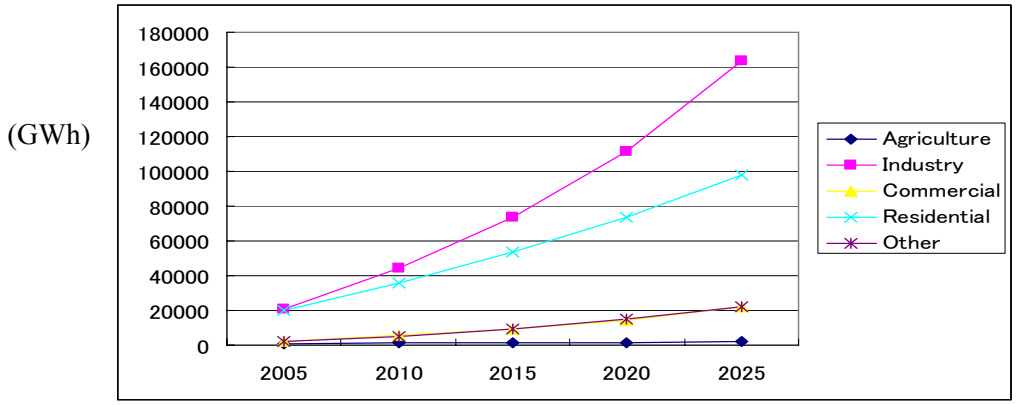


Figure 3-2-10 Power Demand by Sector (Low Case)

b. Regional power demand forecast（Low Case）

It is predicted that the power demand shares by region (North Center and South) do not change drastically up to 2025. The growth rate of power demand in the Center region relatively is higher than the other regions. Then the share of Center region becomes 10.7% in 2025 from 10.1% in 2005.

Table 3-2-25 Regional Power Demand Unit：GWh

	2005	2010	2015	2020	2025	25/05
North	17,555	34,655	55,509	81,932	117,184	10.0%
Center	4,609	9,273	14,790	22,219	32,988	10.3%
South	23,519	48,021	76,600	112,282	158,339	10.0%
Total	45,682	91,949	146,899	216,433	308,511	10.0%

Table 3-2-26 The Shares of Regional Power Demand (%)

	2005	2010	2015	2020	2025	Different
North	38.4	37.7	37.8	37.9	38.0	-0.4
Center	10.1	10.1	10.1	10.3	10.7	+0.6
South	51.5	52.2	52.1	51.9	51.3	-0.2
Total	100.0	100.0	100.0	100.0	100.0	

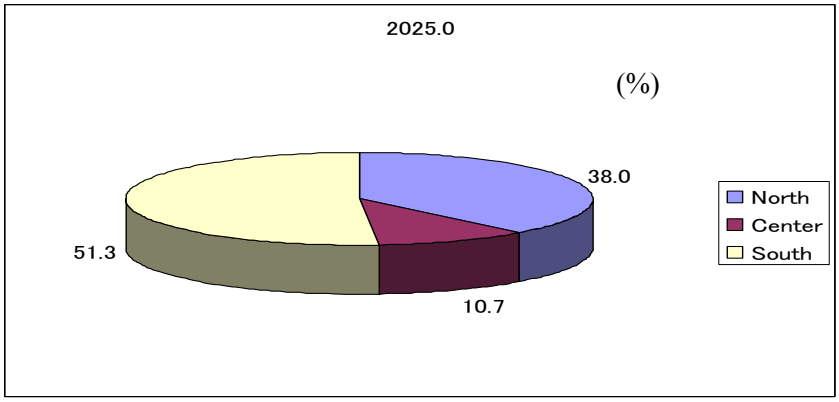


Figure 3-2-11 The Shares of Regional Power Demand (Low Case 2025)

(5) Comparison of power demand forecasting in the cases

a. Comparison of the total power demand

The table and graphs of power demand forecasting in High, Base and Low cases are as follows;

Table 3-2-27 Comparison of Power Demand Forecasting

Power demand		2005	2010	2015	2020	2025	
	High	46,000	101,000	172,000	268,000	399,000	
	Base	46,000	97,000	165,000	257,000	381,000	
	Low	46,000	97,000	147,000	216,000	309,000	
Difference From Base	High	0	+4.1%	+4.2	+4.3%	+4.7%	
	Base	0	0	0	0	0	
	Low	0	0	-10.9%	-16.0%	-19.0%	
Growth rate		2005/00	2010/05	2015/10	2020/15	2025/20	2025/05
	High	15.2 %	17.2%	11.2%	9.2%	8.3%	11.4%
	Base	15.2 %	16.1%	11.2%	9.3%	8.2%	11.2%
	Low	15.3%	15.0%	9.8%	8.1%	7.3%	10.0%

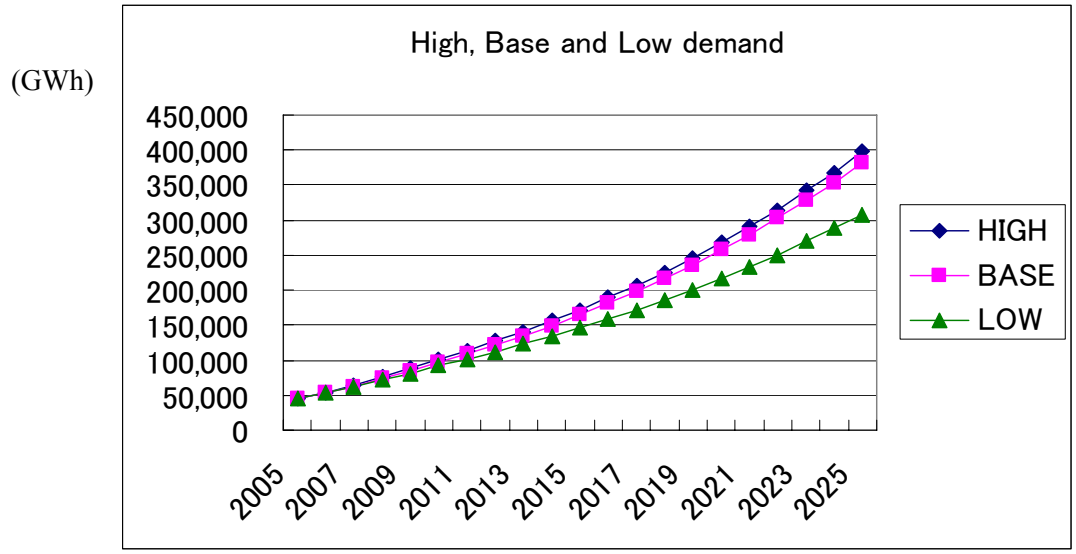


Figure 3-2-12 Comparison of Power Demand Forecasting

b. Comparison of peak demand in the cases (Refer to Chapter3.3)

The table and figure of comparison of the peak demand in High, Base and Low cases are follows;

Table 3-2-28 Comparison of Peak Demand

Peak demand		Unit	2005	2010	2015	2020	2025	
	High	MW	9,900	20,800	33,800	50,200	73,600	
	Base	MW	9,900	20,000	32,000	48,000	71,000	
	Low	MW	9,900	18,900	28,700	40,500	57,300	
Difference from Base	High	%	0	4.0	5.6	4.6	3.7	
	Base	%	0	0.0	0.0	0.0	0.0	
	Low	%	0	-5.5	-10.3	-15.6	-19.3	
Growth rate			2005/00	2010/05	2015/10	2020/15	2025/20	2025/05
	High	%	18.7	16.1	10.2	8.2	7.9	10.6
	Base	%	18.7	15.2	10.1	8.3	8.1	10.4
	Low	%	18.7	13.9	8.7	7.1	7.2	9.2

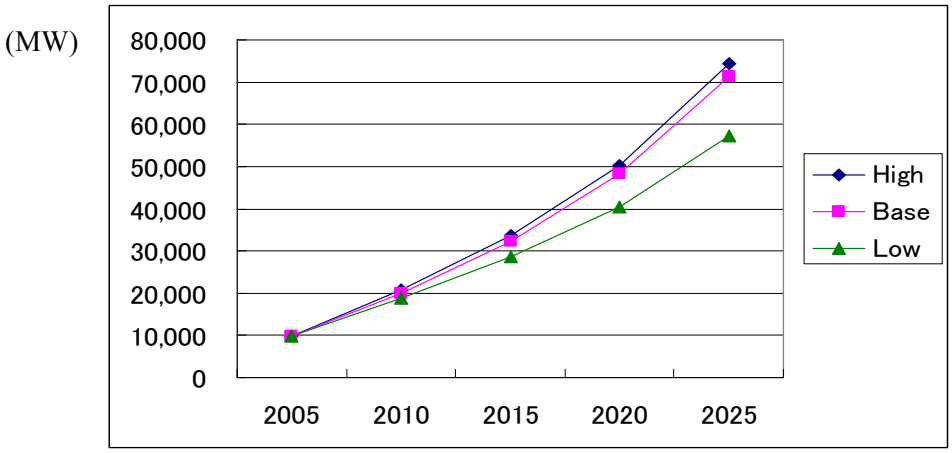


Figure 3-2-13 Comparison of Peak Demand

3.3 Daily Load Curve Forecast

3.3.1 The Methods of Daily Load Curve Forecast

As aforementioned, the daily load curve in the current Vietnam shows a peak demand at 11 o'clock in the morning, after that, the maximum peak demand appears at 19 o'clock in the evening. But recently, the growth rate of power demand in the daytime tends to surpass that of power demand in the nighttime in proportion to increasing power demand in the industrial sector. As a result, the difference between daytime power demand and nighttime power demand becomes narrower year by year.

Adding to the above outstanding trends, there are many cases of peak demand of the daily load curve seen to shift from the nighttime to the daytime as in Thailand and Malaysia, etc. It is considered that the same phenomenon will also occur in Vietnam in future.

But the daily load curve in a country depends on its culture, temperature and other complicated factors. It is difficult to forecast the daily load curve exactly by the current technologies. Then in the Study, the daily load curve forecast is implemented under the assumption of several economic and natural preconditions and using regression analysis. The daily load curve is forecasted with classification of North, Central and South as each of these regions has a different daily load curve shape.

The forecast study flow of the daily load curve is already shown and the methods of the regression analysis are as follows:

i) The daily load curves are classified into 24-hourly data.
ii) The hourly power demand is estimated with GDP, population, temperature and other parameters possessing high relationship with power demand.
iii) The future daily load curves are estimated by the regression equations. And the aggregation of the equations forms the daily load curve.
iv) The daily load curve data are classified into the following categories:
    - Peak demand data : top three days with peak demand in a month;
    - Weekday data: weekdays without national holidays and peak demand days; and
    - Holiday data : Sundays and national holidays

As some Asian countries have experiences that the peak demand of their daily load curve moved from the nighttime to the daytime, the regression analysis for Vietnam daily load curve forecast contains the daily load curve data from the countries as explanation variables.

The suitable data are selected under the following conditions:

i) Candidate countries are located near Vietnam;
ii) Candidate countries have similar weather conditions to the North and the South region of Vietnam; and
iii) Candidate countries have the experience of daily load curve shifting.

As a result, Thailand, Malaysia, the Philippines, Indonesia and Japan are selected. Thailand had the experience of peak demand shift from the nighttime to the daytime in the mid 1990's, and Malaysia had the same experience at the beginning of 1990's

3.3.2 Preconditions for Forecasting Daily Load Curve

The preconditions of the explanation variables (GDP, Temperature, Humidity, Population and Electrified Population) are as follows;

(1) North GDP

＜Agriculture sector＞

Cases	Unit	2005/2000	2010/2005	2015/2010	2020/2015	2025/2020
High Case	%	2.3%	2.5%	2.2%	2.6%	2.1%
Base Case	%	2.3%	2.5%	2.2%	2.6%	2.1%
Low Case	%	2.3%	2.0%	2.2%	2.6%	2.1%

(Source) ECONOMIC DEVELOPMENT FORECAST SERVING STUDY ON ENERGY DEVELOPMENT FOR THE PERIOD UP TO 2050

＜Industrial sector＞

Vases	Unit	2005/2000	2010/2005	2015/2010	2020/2015	2025/2020
High Case	%	11.5%	11.8%	10.6%	10.3%	8.8%
Base Case	%	11.5%	11.8%	10.6%	10.3%	8.8%
Low Case	%	11.5%	10.8%	8.8%	8.5%	7.8%

(Source) Ditto

＜Service sector＞

Cases	Cases	2005/2000	2010/2005	2015/2010	2020/2015	2025/2020
High Case	%	7.7%	8.2%	8.9%	8.2%	8.4%
Base Case	%	7.7%	8.2%	8.9%	8.2%	8.4%
Low Case	%	7.7%	7.4%	7.4%	7.3%	7.4%

(Source) Ditto

(2) Central Region

＜Agriculture sector＞

Cases	Cases	2005/2000	2010/2005	2015/2010	2020/2015	2025/2020
High Case	%	5.7%	5.4%	4.7%	4.4%	3.8%
Base Case	%	5.7%	5.4%	4.7%	4.4%	3.8%
Low Case	%	5.7%	4.9%	4.7%	4.4%	3.8%

(Source) Ditto

＜Industrial sector＞

Cases	Unit	2005/2000	2010/2005	2015/2010	2020/2015	2025/2020
High Case	%	11.2%	12.0%	11.2%	11.8%	10.8%
Base Case	%	11.2%	12.0%	11.2%	11.8%	10.8%
Low Case	%	11.2%	10.9%	9.4%	9.9%	9.7%

(Source) Ditto

＜Service sector＞

Cases	Unit	2005/2000	2010/2005	2015/2010	2020/2015	2025/2020
High Case	%	8.0%	8.6%	9.5%	9.1%	9.5%
Base Case	%	8.0%	8.6%	9.5%	9.1%	9.5%
Low Case	%	8.0%	7.8%	8.0%	8.2%	8.5%

(Source) Ditto

(3) South Region

＜Agriculture sector＞

Cases	Unit	2005/2000	2010/2005	2015/2010	2020/2015	2025/2020
High Case	%	3.9%	3.6%	2.9%	2.7%	2.1%
Base Case	%	3.9%	3.6%	2.9%	2.7%	2.1%
Lowe Case	%	3.9%	3.0%	2.9%	2.7%	2.1%

(Source) Ditto

＜Industrial sector＞

Cases	Unit	2005/2000	2010/2005	2015/2010	2020/2015	2025/2020
High Case	%	9.8%	10.4%	9.5%	9.5%	7.9%
Base Case	%	9.8%	10.4%	9.5%	9.5%	7.9%
Low Case	%	9.8%	9.4%	7.7%	7.7%	6.9%

(Source) Ditto

＜Service sector＞

Cases	Unit	2005/2000	2010/2005	2015/2010	2020/2015	2025/2020
High Case	%	7.3%	7.8%	8.5%	7.8%	8.0%
Base Case	%	7.3%	7.0%	7.0%	7.0%	7.0%

(Source) Ditto

(4) Temperature and Humidity（℃、%）

The same temperature and humidity data are set in High Case, Base Case and Low Case. The values are as follows;

＜North Region＞

Month	1	2	3	4	5	6	7	8	9	10	11	12
℃	17.9	18.0	21.0	24.7	27.6	29.4	29.6	28.9	27.8	25.8	22.3	18.7
%	86.3	84.7	85.4	83.9	81.7	78.6	76.7	79.0	83.6	86.3	86.1	87.1

(Source) IE

＜Center Region＞

Month	1	2	3	4	5	6	7	8	9	10	11	12
℃	22.0	22.3	24.6	26.6	28.1	29.2	29.6	28.8	27.4	26.1	24.4	22.2
%	86.3	84.7	85.4	83.9	81.7	78.6	76.7	79.0	83.6	86.3	86.1	87.1

(Source) IE

＜South Region＞

Month	1	2	3	4	5	6	7	8	9	10	11	12
℃	24.4	25.3	26.8	27.6	27.2	26.3	25.9	25.8	25.8	25.6	25.0	24.1
%	78.0	74.7	73.4	78.0	83.4	86.7	88.3	88.3	88.4	88.6	86.0	82.4

(Source) IE

3.3.3 Daily Load Curve Forecasts and Characteristics

The principal conclusions to be led from the results of the current daily load curve forecast are as follows;

i) In each region, the trend continues, in which the peak demand in the daytime becomes higher than peak demand in the nighttime year by year. A daytime peak and a nighttime peak appear in 2005. In 2010, the daily load curve shows a daytime peak type, which records the P-max at around 11 o'clock in the summer season.

ii) After 2010, the daytime power demand between 14:00 – 16:00 increases, and Vietnam may approach a developed country type, which indicates two peaks on both sides of the noon recess.

iii) The load shapes by type keeps mostly the same proportion as now of daily load curve shapes in peak day, weekday and holiday types.

iv) Annual load factors are 0.62 in 2005, 0.64 in 2010, 0.66 in 2015, 0.69 in 2020 and 0.69 in 2025.

v) The details of daily load curve by type are attached in Appendix 3-1. And those of the regional daily load curve are attached in Appendix 3-2.

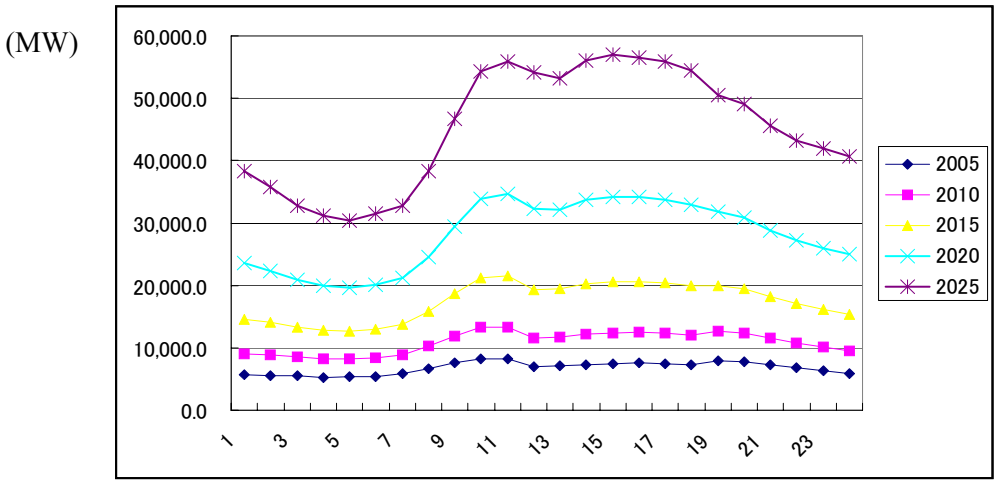


Figure 3-3-1 Daily Load Curve in July from 2005 to 2025 (Base Case)

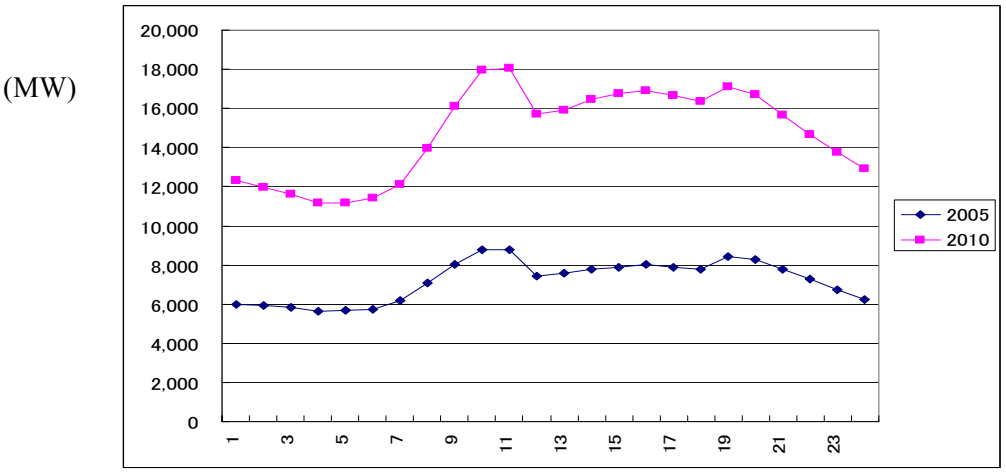


Figure 3-3-2 Daily Load Curve in July, 2005 and 2010 (Base Case)

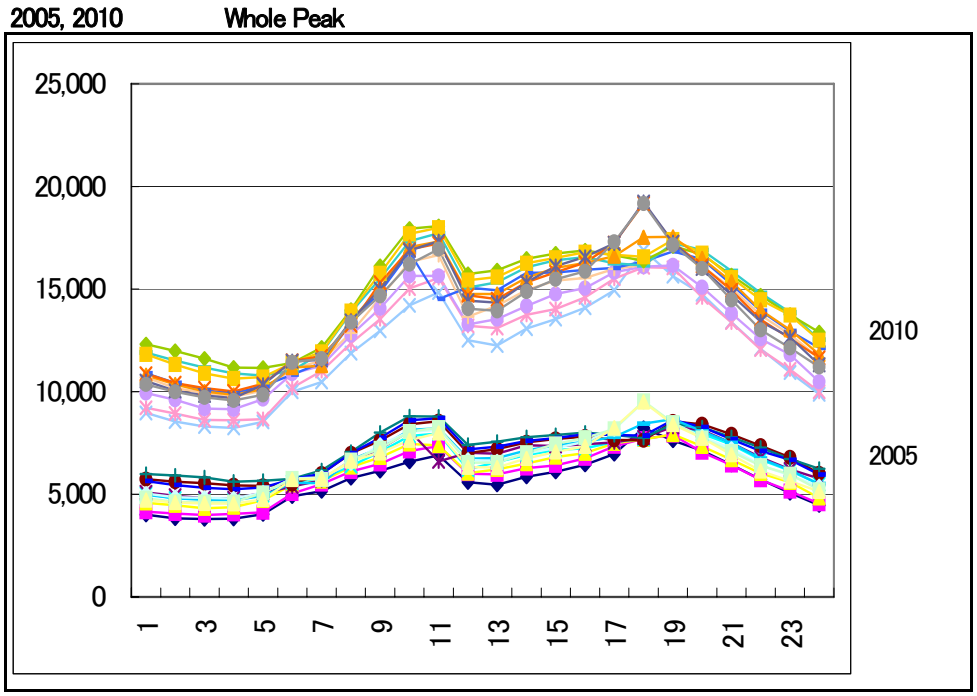


Figure 3-3-3 Daily Load Curve by Month in 2005-2010 (Base Case)

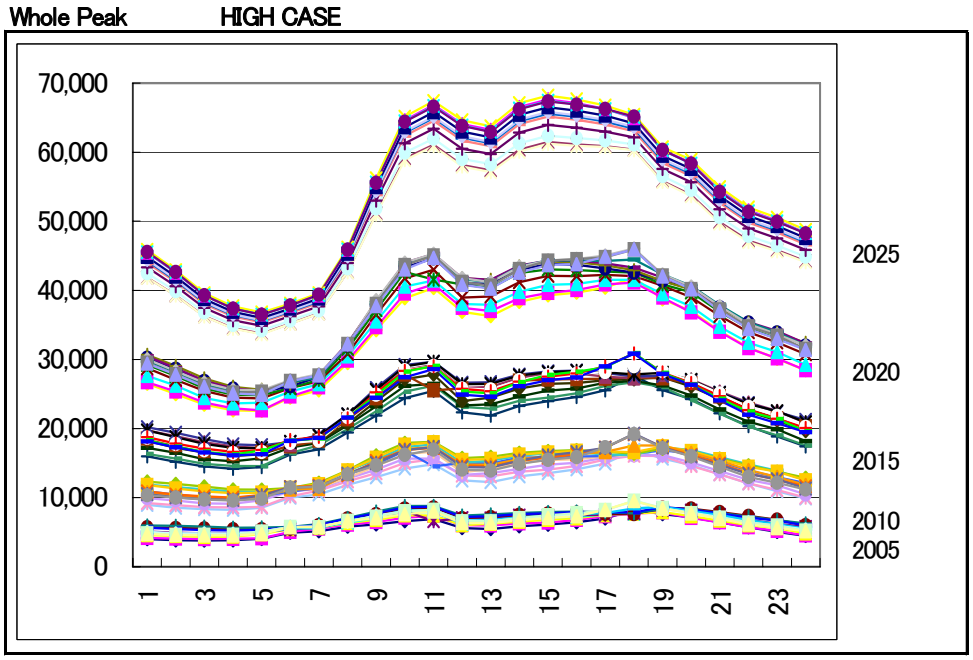


Figure 3-3-4 Daily Load Curve by Month from 2005 to 2025 (Base Case)

3.3.4 Peak Demand Forecasting (Regression Analysis)

(1) Peak Demand of Base Case

The following table shows annual peak demand in the whole country. As the target of the comparison, PDP 5th and Revised PDP 5th are selected. And annual peak demands by region are shown in the following table.

Table 3-3-1 Comparison of Peak Demand (Base Case)

	Plan	Unit	2005	2010	2015	2020	2025
Peak demand	PDP 6th	MW	9,859	19,998	32,354	48,298	71,153
	PDP 5th	MW	7,797	12,003	18,197	27,204	
	R-PDP 5th	MW	9,199	15,256	22,575	31,432	
Growth rate	PDP 6th	%	18.7	15.2	10.1	8.3	8.1
	PDP 5th	%	10.1	9.0	8.7	8.4	
	R-PDP 5th	%	12.0	10.6	8.2	6.8	

(Source) PDP 5th , Revised PDP 5th and power demand forecasting model

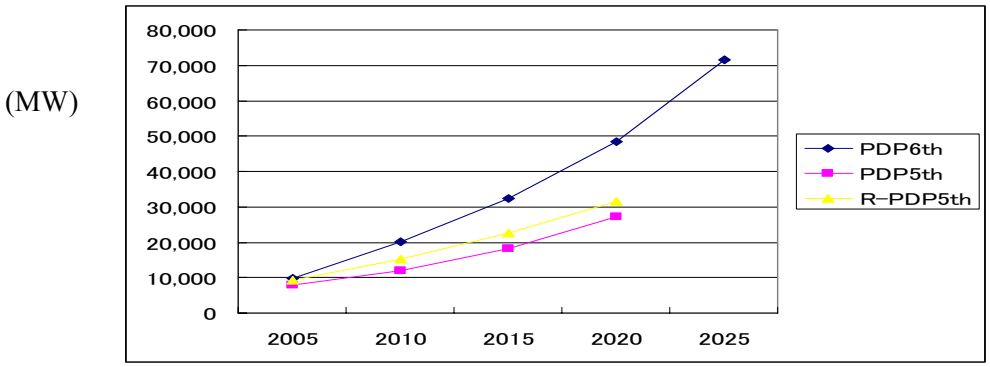


Figure 3-3-5 Comparison of Peak Demand (Base Case)

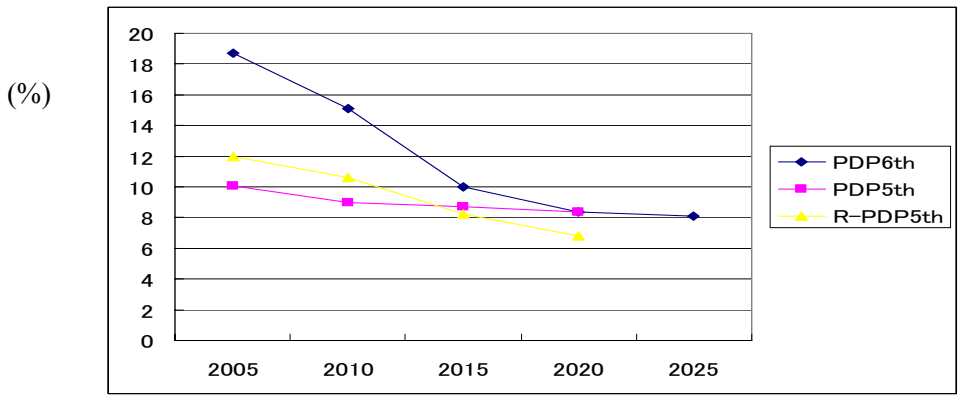


Figure 3-3-6 Growth Rate of Peak Demand (Base Case)

(2) Peak Demand of High Case

The following table shows annual peak demand of the High Case in the whole country. The comparison is done in the same way as in Base Case.

Table3-3-2 Comparison of Peak Demand in High Case

	Plan	Unit	2005	2010	2015	2020	2025
Peak demand	PDP 6th	MW	9,859	20,830	33,805	50,233	73,622
	PDP 5th	MW	7,838	12,982	20,703	32,376	
	R-PDP 5th	MW	9,199	16,241	26,184	39,139	
Growth rate	PDP 6th	%	18.7	16.1	10.2	8.2	7.9
	PDP 5th	%	6.6	10.6	9.8	9.4	
	R-PDP 5th	%	12.0	12.0	10.0	8.4	

（Sources） Report of PDP 5th and Revised PDP 5th

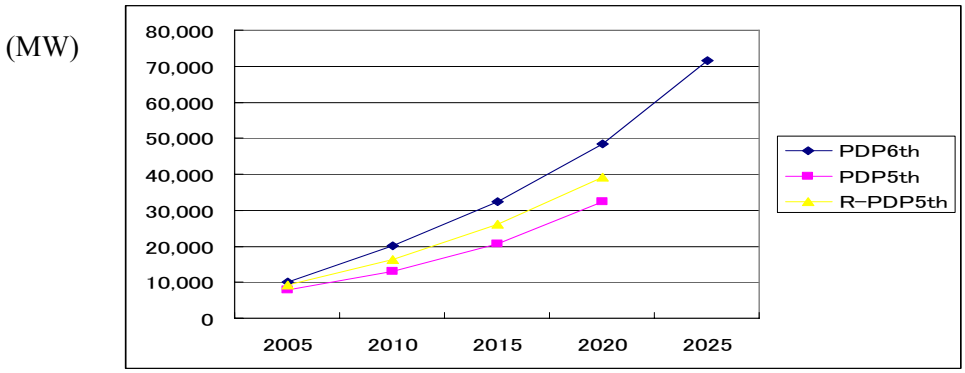


Figure 3-3-7 Comparison of Peak Demand (High Case)

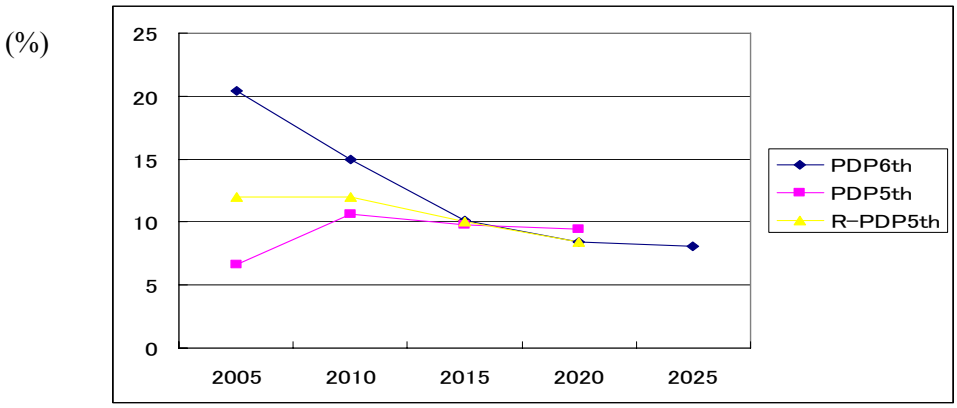


Figure 3-3-8 Comparison of Growth Rate of Peak Demand (High Case)

(3) Peak Demand of Low Case

The following table shows annual peak demand of Low Case in the whole country. The Base Cases of PDP 5th and revised PDP 5th are selected in order to compare Low Case of PDP 6th.

Table3-3-3 Comparison of Peak Demand in Low Case

		Unit	2005	2010	2015	2020	2025
Peak demand	PDP 6th	MW	9,859	18,897	28,720	40,481	57,303
	PDP 5th	MW	7,797	12,003	18,197	27,204	
	R-PDP 5th	MW	9,199	15,256	22,575	31,432	
Growth rate	PDP 6th	%	18.7	13.9	8.7	7.1	7.2
	PDP 5th	%	10.1	9.0	8.7	8.4	
	R-PDP 5th	%	12.9	10.6	8.2	6.8	

（Sources） Report of PDP 5th and Revised PDP 5th

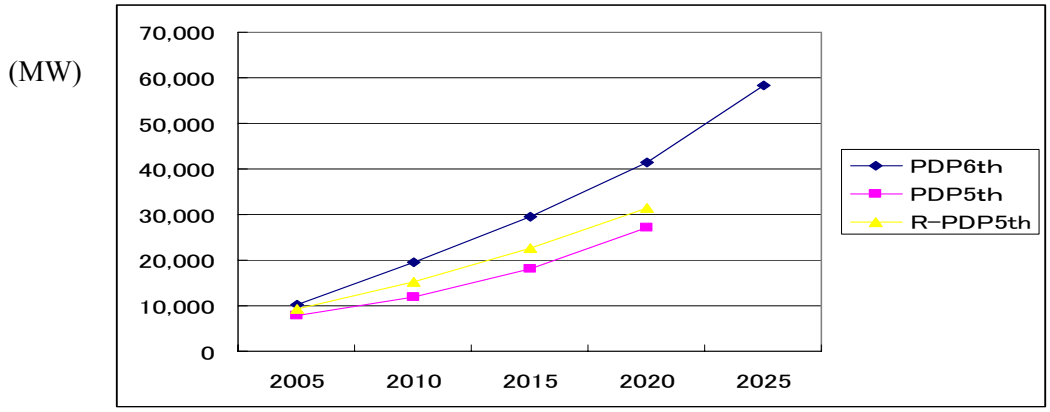
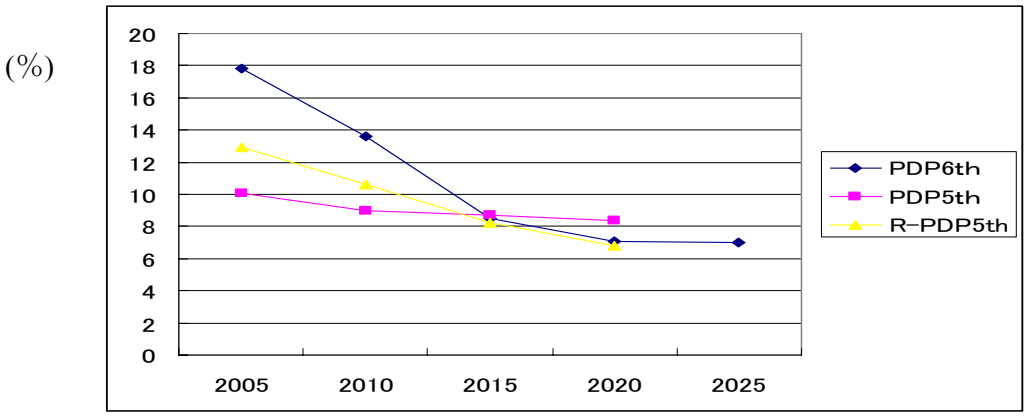


Figure3-3-9 Comparison of Peak Demand (Low Case)



Fihure3-3-10 Comparison of Growth Rate of Peak Demand（Low Case）

3.3.5 Daily Load Curve and Peak Demand by other Methodologies

(1) Daily Load Curve Forecasting by Aggregation Method

By aggregation method, the future daily load curves are forecasted under the assumption that the pattern of daily load curves in 2004 continues to be similar up to 2025. As the aggregation method does not forecast the monthly power demand, the future monthly demand is forecasted under the assumption that the monthly power demand pattern in 2004 is kept up to 2025.

By using the estimated monthly demand (2005, 2010, 2015, 2020 and 2025) and daily load curve in 2004, the future daily load curve is calculated. It is calculated for the future daily load curves of Weekday type, Holiday type and Peak-day type. The following figure shows daily load curve of Peak-day type.

The aggregation method cannot forecast daily load curve taking into account the changes to move from developing country type to developed country type. However, it is useful as methodology for easily finding the future peak demand.

Accordingly, the daily load curve forecasted by the aggregation method is applied to the study on power generation development plan.

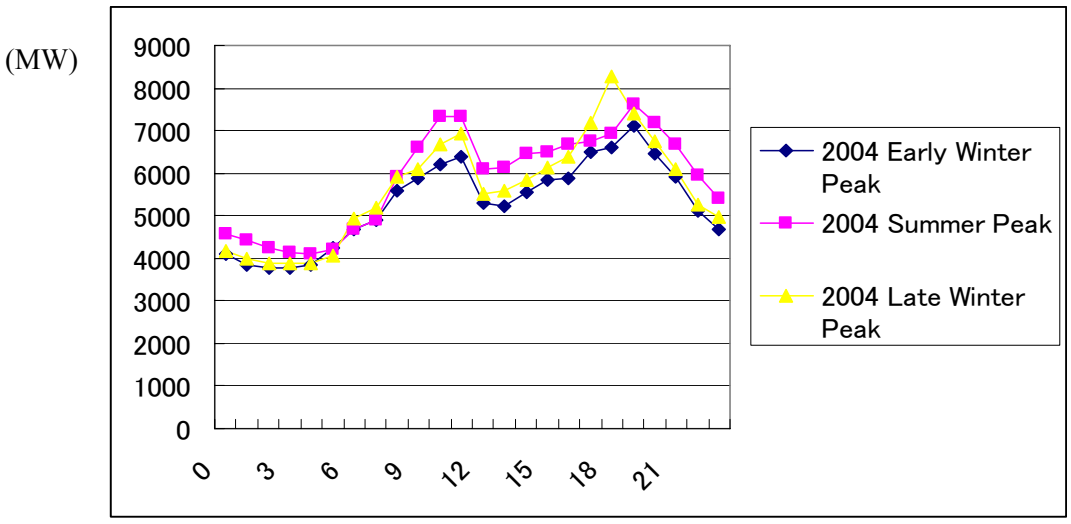


Figure 3-3-11 Actual Daily Load Curve in 2004

(Note: Peak demand trends in early winter, summer and late winter)

(2) Comparison of daily load curve forecast

a. Daily load curve in 2005（Aggregation and Regression ）

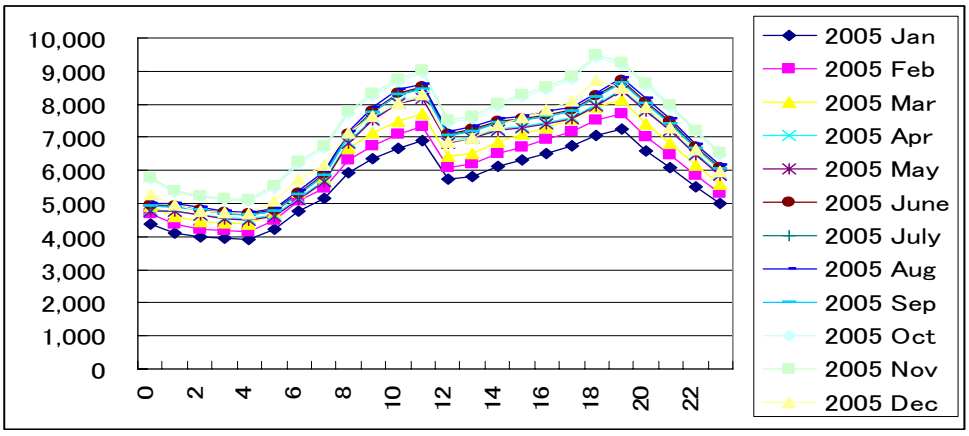


Figure 3-3-12 2005's DLC by Aggregation (Base Case)

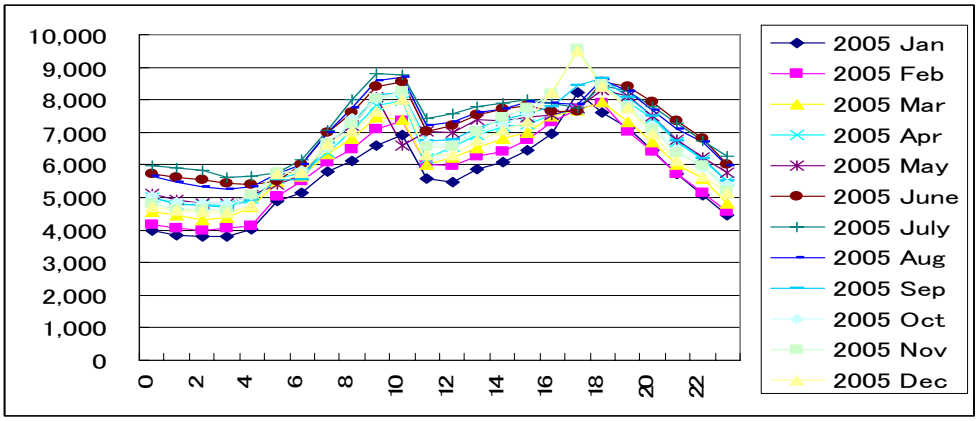


Figure 3-3-13 2005's DLC by Regression Analysis (Base Case)

b. Daily load curve in 2010（Aggregation and Regression ）

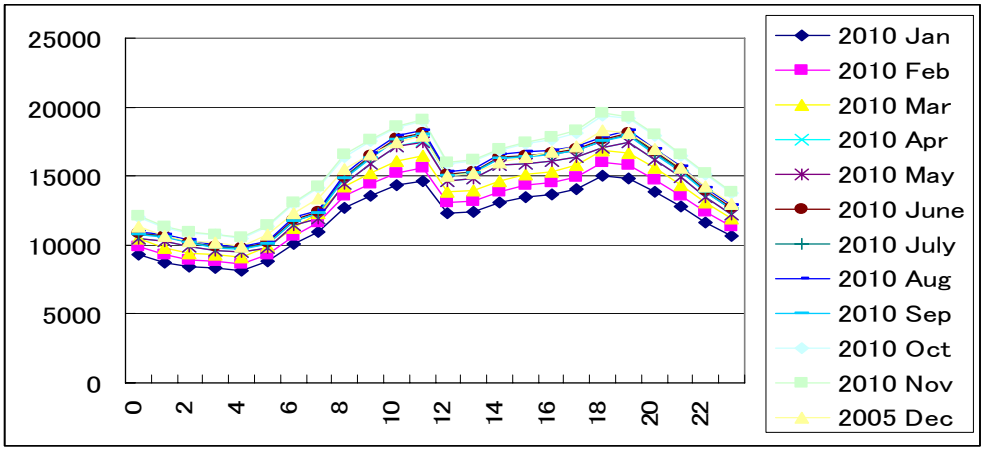


Figure 3-3-14 2010's DLC by Aggregation Method (Base Case)

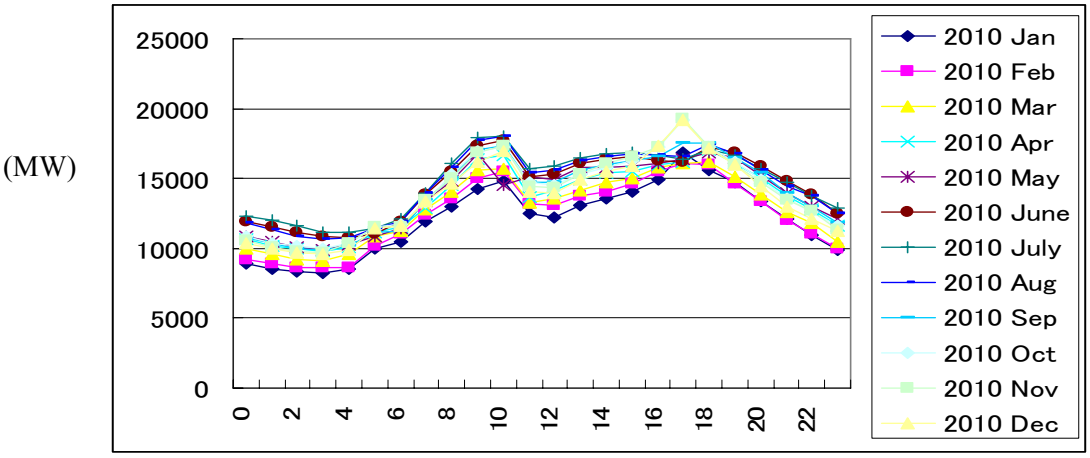


Figure 3-3-15 2010's DLC by Regression Analysis (Base Case)

c. Daily load curve in 2015（Aggregation and Regression ）

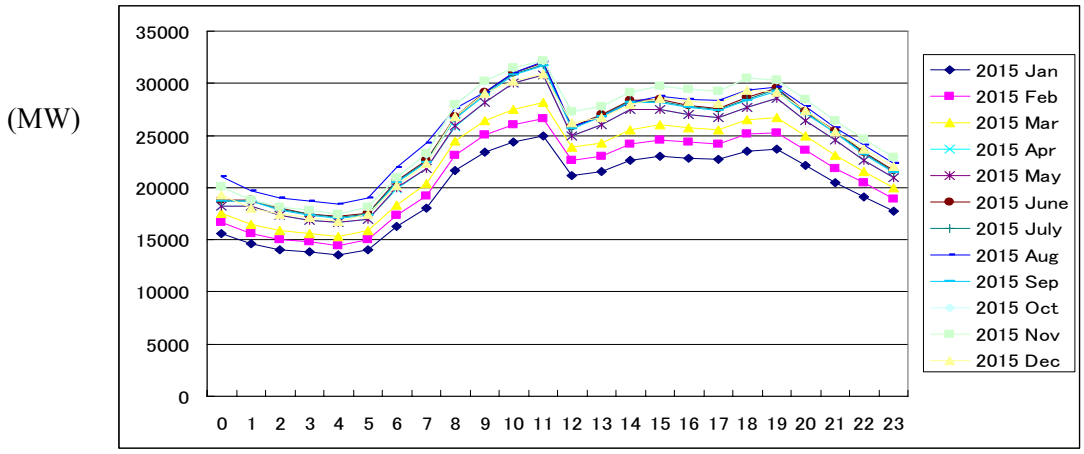


Figure 3-3-16 2015's DLC by Aggregation Method (Base Case)

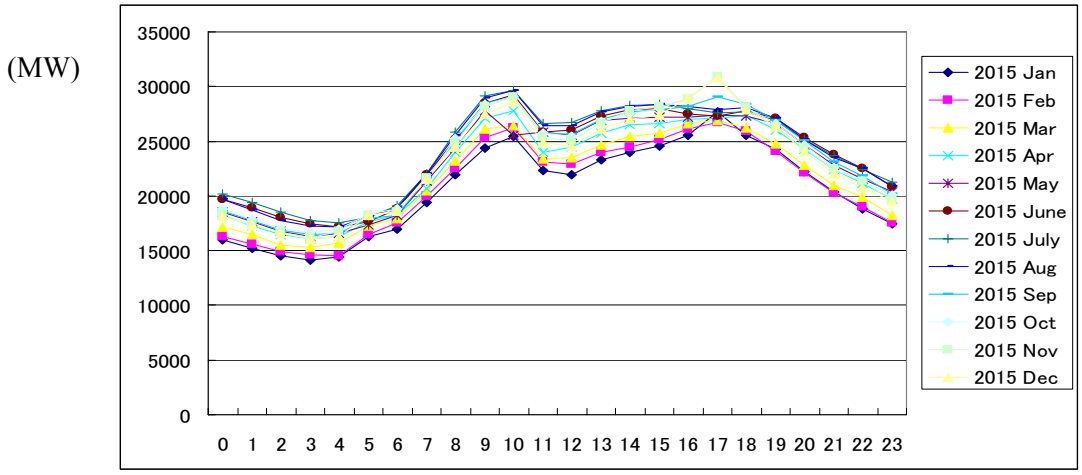


Figure 3-3-17 2015's DLC by Regression Analysis (Base Case)

d. Daily load curve in 2020（Aggregation and Regression ）

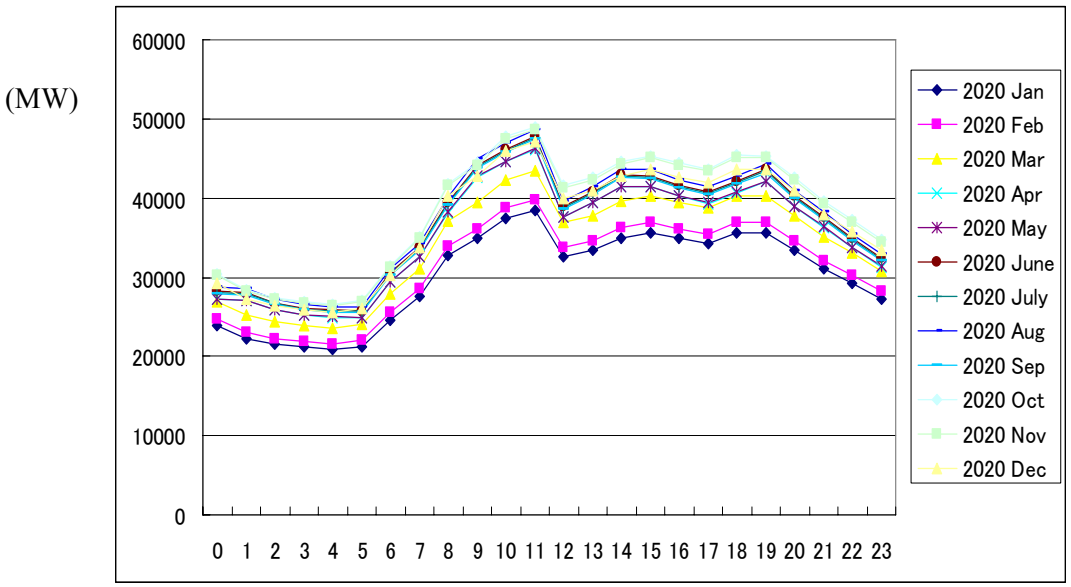


Figure3-3-18　　2020's DLC by Aggregation Method (Base Case)

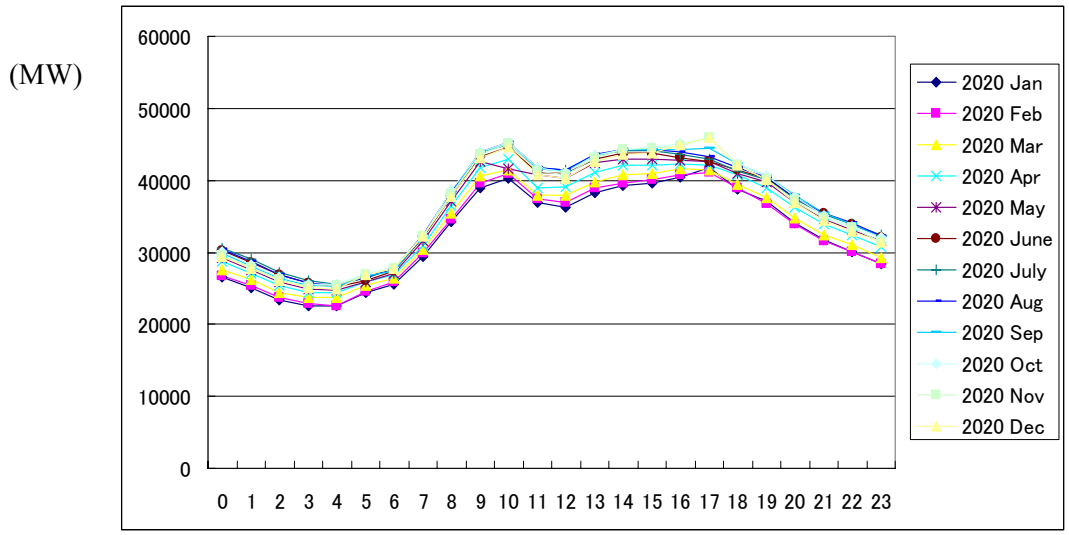


Figure3-3-19　2020's DLC by Regression Analysis (Base Case)

e. Daily load curve in 2025（Aggregation and Regression ）

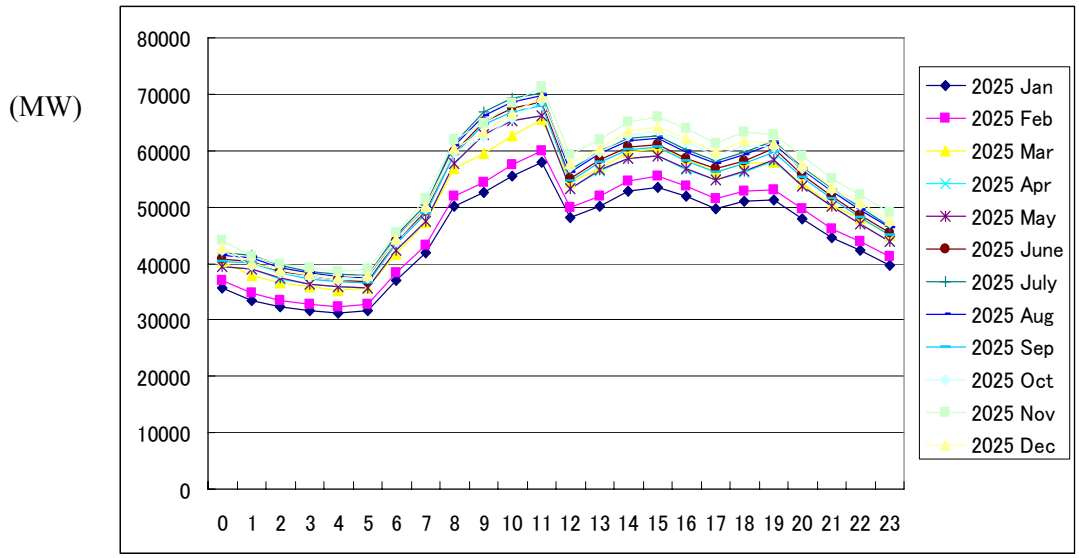


Figure3-3-20　　2025's DLC by Aggregation Method (Base Case)

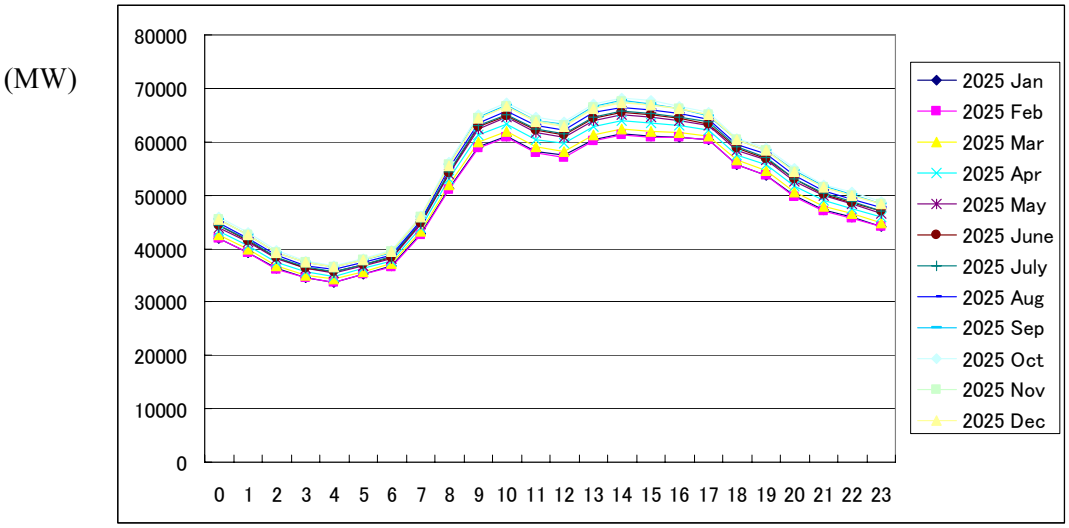


Figure3-3-21　　2025's DLC by Regression Analysis (Base Case)

(3) Comparison of Peak Demand Forecasting

Future peak demands (2005, 2010, 2015, 2020, 2025) forecasted by the aggregation and regression methods are show in the following table. The peak demands in Regression method are revised from the top three day average peak demand to the estimated one day peak demand.

Peak demands by the aggregation method and regression analysis frequently appear in November. The maximum value of the peak demand in 2005 is 9,859MW by regression analysis, in 2010 it is 19,937MW by the Regression method, and in 2015 it is 32,255MW by the Regression method. 2020's value is 48,972MW by the aggregation method and 2025's value is 71,416MW by the aggregation method.

Table3-3-4 Comparison of Peak Demand in Size and Month

	Aggregation	Regression
2005	18:00 Nov 9,512MW	17:00 Nov 9,859 MW
2010	18:00 Nov 19,533MW	17:00 Nov 19,937 MW
2015	11:00 Nov 32,196MW	17:00 Nov 32,255 MW
2020	10:00 Oct 48,972MW	17:00 Nov 48,215 MW
2025	11:00 Nov 71,416MW	14:00 Oct 71,176 MW

（Sources）Base Case Model and Report from Institute of Energy EVN

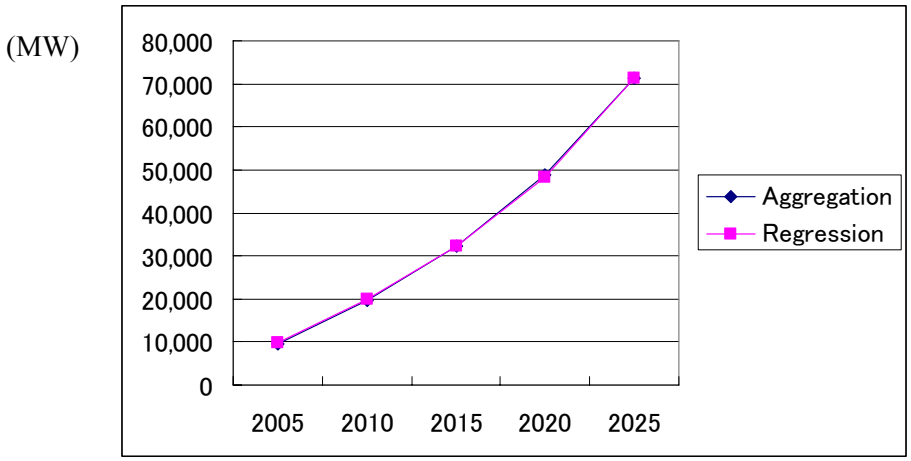


Figure 3-3-22 Peak Demand Trends of the two Methods (Base Case)