Institute of Energy, Ministry of Industry and Trade, Vietnam

Technical Assistance for Power Development Plan 7 in Vietnam

FINAL REPORT

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TEPCO

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Abbreviation	Words
ACSR	Aluminum Conductor Steel Reinforced
ADB	Asia Development Bank
AFD	Agency France Development
ASEAN	Association of South-East Asian Nations
A-USC	Advanced-Ultra Super Critical
bbl	barrel
BOT	Build Operation Transfer
CBM	Calbed Methane
CCGT	Combined Cycle Gas Turbine
CCS	CO_2 Capture and Storage
cct	Circuit
CNG	Compressed Natural Gas
CPI	Consumer Price Index
DOIT	Department of Industry and Trade
DONRE	Department of Natural Resources and Environment
DSI	Development Strategy Institute
EDF2050	Economic Development Forecast Serving Study on Development for the Period up to 2050
EEC	Energy Efficiency Commitment
EIA	Environmental Impact Assessment
EOR	Enhanced Oil Recovery
EU	European Union
EVN	Vietnam Electricity
F/S	Feasibility Study
FDI	Foreign Direct Investment
GDE	Gross Domestic Expenditure
GDP	Gross Domestic Product
GFA	Grand Floor Area
GIS	Geographical Information Systems
GTCC	Gas Turbine Combined Cycle
GWh	Giga Watt Hour
ha	hectare
HCMC	Ho Chi Minh City

HPJSC	Hai Phong Joint Stock Company
HPP	Hydraulic Power Plant
I/O	Input & Output （Analysis)
IAIA	International Association for Impact Assessment
IDICO	Vietnam Urban and Industrial Zone Development Investment Corporation
IE	Institute of Energy
IEE	Initial Environmental Examination
IGCC	Integrated Coal Gasification Combined Cycle
INDUTECH	Chemical and Industrial Safety Technology Institute
IPP	Independent Power Producer
IT	Information Technology
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
JSC	Joint Stock Company
kTOE	Kilo Ton of Oil Equivalent
kV	Kilo Voltage
kWh	Kilo Watt Hour
LICOGI	Construction consulting Subsidiary under the Infrastructure Development and Construction Corporation
LILAMA	LILAMA
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MJ	Mega Joule
MOC	Ministry of Construction
MOIT	Ministry of Industry and Trade
MONRE	Ministry of Natural Resources and Environment
MPI	Ministry of Planning and Investment
MVA	Mega Volt Ampere
MW	Mega Watt
MWh	Mega Watt Hour
NA	Non Available
NAFTA	North American Free Trade Agreement
NPV	Net Present Value
ODA	Official Development Assistance

OECD	Organization for Economic Co-operation and Development
OM	Operation and Maintenance
OP8.60	Operational Policy 8.60
PDP6	Power Development Plan No6
PDP7	Power Development Plan No7
PPA	Power Purchase Agreement
PPP	Purchasing Power Parity
PPPs	Policy、Plan、Program
PSPP	Pumped Storage Power Plant
PSS	Power System Stabilizer
PSS/E	Portal-Systemic Shunt Encephalopathy
PVN	Petro Vietnam
ROW	Right of Way
S/S	Sub Station
SEA	Strategic Environment Assessment
SEA	Strategic Environment Assessment
SED2020	Scenarios of Economic Development for The Period up to 2020 and onwards
T/L	Transmission Line
TACSR	Thermal Resistant Aluminum Alloy Conductor Steel Reinforced
TKV	Vinacomin
TOE	Ton of Oil Equivalent
TPJSC	Thanh Ph Joint Stock Company
TPP	Thermal Power Plant
TWh	Tera Watt Hour
UHV	Ultra High Voltage
USC	Ultra Super Critical
VINACOMIN	Vietnam National Coal and Mineral Industries Group
VND	Vietnam Don
WB	World Bank
WTI	West Texas Intermediate
WTO	World Trade Organization
XLPE	Cross Linked Polyethylene
ZOI	Zone of direct Impact

Chapter 1 Background and Objective of the Technical Assistance

1.1 Background of the Technical Assistance

The Socialist Republic of Vietnam (Vietnam) has formulated its power development master plan every five years while aiming at systematic electric power facility development, positioning the stable power supply as one of the most crucial issues for sustainable social and economic development.

The power consumption and maximum power demand have expanded at an average annual rate of more than 10% over the past 10 years, backed by strong economic growth. Thus, the systematic implementation of power source and system development is a most pressing issue. However, the available capacity was only around 15GW while the maximum power demand was around 14GW in 2009 due to the delay of the actual implementation of power generation.

The Japan International Cooperation Agency (JICA) has carried out a series of studies to contribute the enhanced plan-making capability within the Vietnamese government's relevant sectors, such as the "Master Plan on Pumped Storage Power Project and Optimization for Peaking Power Generation in Viet Nam" from 2002 to 2004, and "The Study on National Power Development Plan for the period of 2006-2015, perspective up to 2025 in Vietnam" from 2006 to 2007, respectively.

The Vietnamese government is scheduled to formulate the 7th National Power Development Plan for the period of 2010-2030 (PDP7) by August 2010 based on the above-mentioned experience. The master plan itself is scheduled to be formulated by the Vietnamese government; however, the Institute of Energy (IE), the organization that is responsible for the formulation of the PDP7, requested JICA to dispatch Experts with expertise in power demand forecast and power system planning.

This technical assistance shall be conducted based on the aforementioned background and specifically be intended for the support of the power demand forecast and power system planning in the 7th National Power Development Plan in Vietnam.

1.2 Objective of the Technical Assistance

The objective of this technical assistance is to provide support to IE in the fields of power demand forecast and power system planning that constitute the PDP7, thus supporting the formulation of the PDP7 by the Vietnamese government.

1.3 Geographical Scope

The Study covers the entire area of the Socialist Republic of the Vietnam territory.

1.4 Members of Counterpart Personnel

- Counterpart: Institute of Energy (hereinafter, "IE")
- Relevant authorities: Ministry of Industry and Trade (hereinafter, "MOIT"), Vietnam Electricity (hereinafter, "EVN"), and EVN's subsidiary power authorities

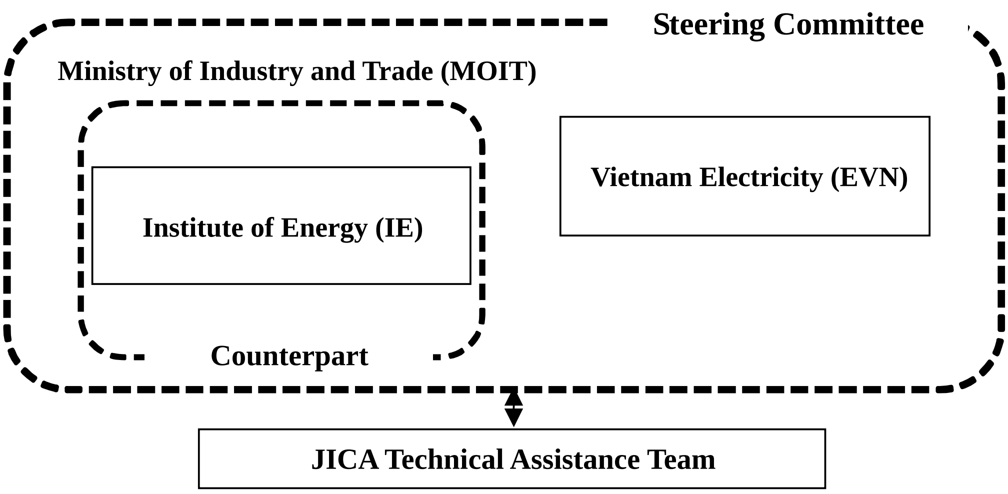


Figure 1.4-1: Structure of Steering Committee and Counterpart[1]

1.5 Scope of the Technical Assistance

The overall workflow of the portion of this technical assistance is shown below. The Study will be carried out at three stages, [A] Stage of Reviewing the Existing Plans, [B] Stage of Supporting Planning Works and the [C] Stage of Finalizing.

[1] IE belongs to MOIT although IE belonged to EVN before.

Table 1.5-1: Structure of Steering Committee and Counterpart

[A] Stage of Reviewing the Existing Plans
Preparatory Domestic Works
First Mission
First Domestic Works

[B] Stage of Supporting Planning Works
Second Mission
Second Domestic Works
Third Mission
Third Domestic Works
Fourth Mission
Fourth Domestic Works

[C] Stage of Finalizing
Fifth Mission
Fifth Domestic Works
Preparation and Submission of Final Report

1.6 Members of the Technical Assistance Team

The experts were selected as shown in Table 1.6-1. The Technical Assistance Team(TA Team) was comprised of the following three task teams under supervision of the TA Team's leader to meet the objectives of this technical assistance project, namely, cooperation with the demand forecast, system planning, and review of the environmental and social considerations in the PDP7.

Team Leader: Masaharu Yogo
System Planning Team: Masaharu YOGO, Makoto KAMIBAYASHI, Yasuharu SATO
Demand Forecast, Economic & Financial Analysis Team: Tomoyuki INOUE, Tateyuki ASAKURA, Keiichi FUJITANI
Environmental and Social Considerations: Hidehiro FUKUI

Table 1.6-1: The TA Team Formation

Position/ Area of expertise	Name
1. Team Leader/ System Planning	Masaharu YOGO
2. Demand Forecast A	Tomoyuki INOUE
3. Demand Forecast B	Tateyuki ASAKURA
4. Power System Analysis A	Makoto KAMIBAYASHI
5. Power System Analysis B	Yasuharu SATO
6. Economic & Financial Analysis	Keiichi FUJITANI
7. Environmental and Social Considerations	Hidehiro FUKUI

1.7 Record of Technical Assistant and Schedule

1.7.1 1st Mission (27th of January 2010 - 6th of February 2010)

During the 1st Mission, technical assistance was provided by the system planning team, which was comprised of three system planning experts and analysis of the TA Team from January 27th, 2010 to February 6th, 2010.

The inception report was submitted to IE and the kick-off meeting was held on January 28, 2010. In the meeting, the TA Team explained the contents of the inception report and IE agreed on them.

Introduction to the outline of TEPCO’s power system, power system planning methods, discussions on the items relevant to the questionnaire by the TA Team, data collection, and creation of the power system planning study scenarios were conducted.

1.7.2 2nd Mission (22nd of February 2010 - 21st of March 2010)

During the 2nd Mission, technical assistance was provided by the system planning team from March 1, 2010 to March 21, 2010 and by the demand forecast team, which consisted of two experts from February 22, 2010 to March 21, 2010, respectively.

The TA Team obtained the draft of the “REVIEW OF IMPLEMENTATION OF POWER DEVELOPMENT PLAN VI”, the evaluation report on the Power Development Plan 6 (PDP6) by IE (Vietnamese version). After being translated into English, the TA Team reviewed the contents of the evaluation reports.

Technical assistance items provided by each professional team of the TA Team have been summarized as follows:

(1) Contents of Technical Assistance on Power System Planning

The TA Team held an initial discussion with IE on the methodology of bulk power transmission from power plants, which constituted nuclear, coal-fired thermal, and pumped storage power stations in the Southeastern coastal area in Vietnam towards the Ho Chi Minh area. The TA Team reported the preliminary study results on the comparison between the two transmission methods; the one is the system configuration that only constitutes of 500 kV transmission lines and the other constitutes 1,000 kV or 1,100 kV (Ultra High Voltage (UHV)) transmission lines. Due to new information provided by IE that the transmission line route and the number of circuits of the interval between Vinh Tan coal-fired thermal power station (Vinh Tan CFTP) and Song May substation were already determined, both parties, IE and the TA Team, agreed that the TA Team would continue the study of the items taking the new conditions into consideration.

The TA Team reviewed the draft of the "Master plan on power development in Minh City for period to 2015, perspective up to 2020", which was formulated by IE. Considering both the scale of the future 220 kV power system and the future substation loads, The TA Team proposed installation of a new 500 kV substation within the vicinity of the center of Ho Chi Minh City. Both parties shared their common perception on the necessity of the study of this matter.

(2) Contents of Technical Assistance on Economy, Demand and Environment

The TA Team obtained a Vietnamese document of "SCENARIOS OF ECONOMIC DEVELOPMENT FOR THE PERIOD UP TO 2020 AND ONWARDS (SED2020) " that is used as the economic pre-conditions for PDP7 power demand forecasting.

The Team also had a meeting with the Ministry of Planning & Investment (MPI) and the Development Strategy Institute (DSI) for a hearing on future economic and investment plans including power and industrial sectors.

As a result, the participants of the meeting recognized that average annual economic growth rates of 7-8 % in the next ten years forecasted in SED2020 were reasonable. The sectoral approach was applied for the demand forecasting for PDP7. The study on the relationship between large-scale investments and power demand was proposed by the TA Team. In addition, the TA Team provided IE with a new version Simple E.

The TA Team translated from Vietnam version report of "Power demand forecasting for the PDP7" prepared by IE to an English version one, and collected the data used in the

IE model. The data has been entered into the PDP6 model in order to build sectoral approach methods and the latest data has been updated. By utilizing the above procedures, the PDP7 model was created.

For surveying future large scale projects, the TA Team selected a Local consultant through a bidding competition, and went over the S/W and the time schedules.

For understanding existing large scale industrial parks more deeply, the TA Team visited Thang Long I and Thang Long II industrial parks and discussed production and power consumption in the factories inside parks.

1.7.3 3rd Mission (11th of April 2010 - 28th of April 2010)

(1) Contents of Technical Assistance on Power System Planning

During the 3rd Mission, technical assistance was provided by the system planning team from April 11, 2010 to April 28, 2010.

Continued discussions on the methodology of bulk power transmission from power plants in the southeastern coastal area in Vietnam toward Ho Chi Minh area.were held between IE and the TA Team.

For the system configuration, in which Vinh Tan CFTP, Nuclear 1 power station (NCR1), and Nuclear 2 power station (NCR2) were connected, two cases of transmissions from the power stations to Ho Chi Minh City, one is the 500 kV transmission plan and the other is the 1,100 kV transmission plan, were compared with each other. The IE and the TA Team mutually agreed that the TA Team continuously execute further study and that the both parties would hold discussions on this technical assistance item in the next mission and onward.

The TA Team introduced TEPCO’s practice of underground utilization within Tokyo metropolitan area, which would contribute to the formulation of power supply planning in Ho Chi Minh City.

IE mentioned that it would not incorporate the planning of underground substations in PDP7 due to difficulty in installing underground substations in Ho Chi Minh City, where the flood level is high. The TA Team conducted a preliminary study on the required capacity of the 220 kV incoming supply system from 500 kV substations, which were on the outer ring system surrounding Ho Chi Minh City, that were listed in the future plan between the years 2020 and 2030.

The TA Team introduced the technical study items and the outline of their contents on overvoltage analyses and any abnormal phenomena peculiar to cable systems, such as resonance overvoltage, to the power system planning experts of IE. Generally, these kinds of studies are conducted during the planning of installing extra high voltage underground cable in TEPCO.

As for the examples of the effective underground utilization, the TA Team explained the outline of a variety of technologies for cost reduction, maintaining safety and reliability etc. as well as introducing TEPCO's underground equipment arrangement to the system planning experts of IE.

1.7.4 4th Mission (16th of May 2010 - 19th of June 2010)

During the 4th Mission, the system planning team and the demand forecast team respectively provided technical assistance from May 30, 2010 to June 19, 2010, and from May 16, 2010 to June 5, 2010.

(1) Contents of Technical Assistance on Power System Planning

Regarding the configuration of the transmission system for power plants in the southeastern area, the TA Team proposed to study some plans to separate the system so as to reduce the fault current level. IE agreed on the proposal.

The TA Team reported to IE on the results of cost comparison between UHV and 500 kV transmission. Upon request of the additional study on characteristics of the two options in the case of a 1) delay in power development, 2) increase in UHV construction cost, the TA Team conducted an additional study and explained the results to IE on June 14, 2010.

The TA Team showed the necessity of countermeasures to prevent capacity shortages from occurring in conductors for the Ho Chi Minh City supply system, such as the application of larger size conductors and installation of new circuits. IE agreed on the views of the TA Team.

(2) Work Contents on Economy and Power Demand

The following study and technical assistance regarding the simulation model has been implemented by the TA Team.

- Evaluation of the methodologies concerning long term economic outlook, long-term development plans and prospects for the future crude oil price in PDP7
- Sharing common concepts and methodologies, especially the sectoral approach on the power demand forecasting model for the PDP7 model building
- PDP7 model building in cooperation with IE
- Explanation of the survey results and methodologies for estimating power demand from Large Scale Projects
- Through the aforementioned tasks, the following technology transfer was rendered:
- Analyzing and forecasting Methodologies on Economic outlook
    - Explanation of the Economic Forecasting Model based on the "Slow Growth Theory" and other existng sample models
    - Calculation methods for energy intensity based on the US dollar
    - Calculation methods for GDP per capita based on the US dollar
    - Conversion methods from the real GDP at 1994 to the base year of 2005
    - Outlook for future crude oil market
    - Explanation of the crude oil price hikes in 2008 and an analysis of the impact factors to the price
    - Explanation of the calculation methods for "Purchasing Power Parity GDP per capita" and data collecting methods

- Analysis and forecasting Methodologies on Economic outlook
    - Explanation of the power demand forecasting model based on the sectoral approach prepared by the TA Team
    - Methodologies of unifying the additional power demand from the large-scale projects and ones from the econometric model
    - Survey methodologies of coal supply plan for thermal power generation in the southern area
    - Estimation of the power demand methods from the Hanoi new city plan
    - Interview surveys of the existing power supply systems in the industrial park in Vietnam. (Thang Long industrial park)
    - An analysis of the differences between power demand of PDP7 by IE and that of the TA Team

- The survey methods of large-scale projects and power demand estimation
    - Power demand estimation of industrial parks

- Power demand estimation of commercial facilities
- Power demand estimation of seaports, river ports and airports
- Power demand estimation of resort facilities
- Power demand estimation of railways and subways

(3) Work Contents on Environmental and Social Considerations

The following tasks on environmental and social considerations were implemented.

- Review of the related laws and regulations on Strategic Environmental Assessment (SEA) in Vietnam
- Review of the Impact Matrix created by IE
- Interim review of the draft SEA in PDP7

Through the aforementioned tasks, the following technology transfers were executed:

- Review of related laws and regulations on Strategic Environmental Assessment (SEA) in Vietnam
  - Explanation of good practices on SEA by international institutions on cooperation such as JICA, World Bank, OECD, ADB, EU, etc.
- Review of the Impact Matrix created by IE
  - Explanation of the check list on environmental and social considerations for the power sector (thermal, nuclear, and hydropower generation, new and renewable energy, transmission and distribution lines)
  - Revision of the Impact Matrix
- Interim review of the draft SEA in PDP7
  - Explanation of the SEA review check list created by the TA Team
  - Explanation of the review results and recommendations on the draft SEA

1.7.5 5th Mission (18 th of July 2010 - 7 th of August 2010)

PDP 7 was discussed at the JICA-sponsored Stakeholders Meeting held on 3rd August supported. The attendants are from MOIT, DOE, IE, EVN, ERAV, VINACOMIN, PETRO Vietnam, the World Bank and ADB, etc.

Government experts from DOE and ERAV raised comments regarding power transmission with UHV spanning the southeastern part of Vietnam to Ho Chi Min City.

The technical assistance regarding the notices for the study of the power system was carried out.

1.7.6 The PDP7 Implementation Schedule

IE under MOIT has been studying PDP 7 in the areas of the power demand forecast, power generation planning, power network system planning, environmental and social considerations and the economic and financial analysis from the beginning of 2010.

The report prepared by the IE is scheduled to be submitted to MOIT in September 2010. MOIT will hold consultative committees composed of experts from related organizations and submit a draft PDP 7 to the government in December 2010.

The prime minister has finally made a decision to approve of the plan. However, the approval date is uncertain. In the case of the PDP5, it took 4 or 5 months to be approved. However, in the case with the PDP6, it took over a year to be approved due to the comments from other ministries.

Table 1.7-1: The PDP7 Implementation Schedule

Year	2008	2009												2010												Notes
Month	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
Name of work																										
I. Outlines, cost estimation, methodology for PDP7																										
- Preparation of outlines and cost estimation for PDP7		■	■																							
- Establishment of PDP7 Team						■																				
- Preparation of detailed schedule					■																					
- Starting some works in advance			■	■	■																					
- Submit outlines and cost estimate to MOIT for approval		■	■	■	■	■	■																			
II. Implementation of contents																										
- Current status of national power network			■	■	■	■	■	■	■																	
- Review of PDP5 and PDP6 on implementation status				■	■	■	■	■	■																	
- Overview of society, economy and energy network					■	■	■	■	■																	
- *Workshops (1,2) on planning criteria and data collection*										■																
Power demand forecasting, Power demand profiles			■	■	■	■	■	■	■	■																
Development of econo-technical criteria for Power generation and transmission projects						■	■	■	■	■	■															
- Assessment of potential, reserve and exploitability of primary energy resources						■	■	■	■	■																
- *Workshop (3) on power demand forecasting methodology and analysis*											■															
"- Ranking priority of conventional hydropower project development						■	■	■	■																	
- Power generation development program								■	■	■	■	■	■	■	■	■										
- *Power generation development program for period 2011-2015*								■	■	■	■	■														
- *Power generation development program for periods 2016-2020 and 2021-2030*										■	■	■	■	■	■	■										
- *Workshop (4) on power generation development program and power network interconnection*																	■									
Completion of report 1 on power generation development program for period 2011-2020, submission to MOIT																		■								
- Power network development program										■	■	■	■	■	■	■	■									
- Regional power interconnection														■	■	■	■									
- Load dispatching system development program														■	■	■	■	■								
- Telecommunication system development program																■	■	■								
- Rural & mountainous power development program													■	■	■	■	■									
- *Workshop (5) on power network development program*																		■								
- Environment and environmental protection in PDP														■	■	■										
- SEA report						■	■	■	■	■	■	■	■	■	■	■	■									
- Power development-investment program														■	■	■	■	■								
- Economic-financial analysis of power development options																■	■	■	■							
- Power sector organization structure in power development up to 2030																	■	■	■							
- *Workshop (6) on improvement of national power sector organization structure*																				■						
III. Submission of PDP7 draft report to MOIT																					■					
- Supplementation, finalization and submission of final report to MOIT for approval																						■				
- Report on PDP 7 to Government																										Schedule by MOIT

Source: IE

Chapter 2 Review of PDP6

2.1 Review of Socioeconomy Outlook in PDP6

In this session, the activities of the Macro economy, Regional economy and Business Sector during the years (2006-2010) of PDP6 have been summarized after referring to the "Scenarios of Economic Development for the period up to 2020 and onwards (SED2020)". The contents of the session are parts of the SED2020 regarding the above fields and it is useful to understand the background of the current power demand in Vietnam.

2.1.1 Economic Development during the Period 1991-2008

(1) Economic Growth Rate

The average GDP growth rate was 8.2% during the period of 1991-1995, 7.0% in 1996-2000 (due to impacts of Asian monetary crisis) and 7.8% in 2001-2008. Even though it was a high growth rate during 2005-2007, it was only 6.2% in 2008 due to the impacts of the world financial crisis.

(2) Inflation is High but Under Control.

The Consumer Price Index (CPI) was 7.7%-8.3% in period of 2004-2007, and in 2008, CPI increased by 23.0% in comparison to the rate in 2007. However, the increase of CPI in 2008 is high, but the current situation is under control that contributes to a stabilization of the macro environment.

(3) Results of Open Door Policies

International trade is fast expanding with 20% in 2001-2008. Exports in 2008 accounted for around 70% of the GDP. In attracting foreign investment capital, in 2008 alone, 1,171 Foreign Direct Investment (FDI) projects registered with a total capital amount of 60.3 billion USD, increasing the total number of FDI projects to 10,981 projects with a total registered capital amount of 159.9 billion USD. The capital amount of the FDI sector accounted for over 20% of the total investment capital towards the development of the whole society.

Regarding ODA loans in the period of 2001-2008, the ODA loan committed by the international community for Vietnam is 28.5 billion USD (accumulated as of the end of 2008). Over the past eight years, ODA loans, which were released by the end of 2008 totaling 14.3 billion USD, accounted for about 50.0% of the signed agreements.

(4) People's Living Standards

The average income per capita in 2008 is an estimated total of 1,062 USD per capita, equal to 10.8 times that in 1990. In 2008, the population growth rate was 1.13%. An additional number of laborers working in the economic sectors in 2008 is estimated to be approximately 865,000 people more than in 2007. As of 2008, there are about 45.04 millions laborers working in the national economy of the whole country. The rate of unemployment in urban areas was reduced to 4.7% in 2008. The rate of poverty according to the national criteria (new criteria) is about 14.8% in 2008.

2.1.2 Legal Framework and Macro Policies

(1) Economic Growth and Export Growth

Exports are one component of the Gross Domestic Expenditure (GDE), the economic growth rate in the short term is proportional to export value. As of 2008, the share of export value accounts for around 70% of the GDP. The growth rate of exports has a large impact on the growth rate of the GDP. In recent years, the export growth rate has been equal to 2.5-3.5 times of the GDP growth rate.

(2) Role of FDI in Economic Development

The FDI contributes to a high economic development growth rate. During the period of 1995-2008, the average FDI accounted for about 22.5% of the total investment capital for the development of the whole society, with an average growth rate of 18% during the period. If there is no FDI into Vietnam, it is estimated that the average GDP growth rate would be only about 5%/year. The share of FDI in GDP had increased from 2% in 1992 to 13.3% in 2008. Exports from the FDI sector in 1995 were 1.47 billion USD, accounting for 27% of the total export value. This was changed to 27.78 billion USD in 2007, accounting for 57.2% of the total export value.

(3) Impacts of ODA

ODA is a main investment resource for the development of infrastructures in the whole country in recent years. As mentioned above, the committed amount of ODA loans is relatively high, more than 3.5 billion USD per year in over years. This capital is mainly concentrated in infrastructure projects. The role of ODA in economic growth rate is a major one. However, ODA-sponsored infrastructure projects have always taken a long time. Therefore, ODA fund's impacts on economic growth rate are slow.

(3) Low Growth in 2009

There are so many reasons for the economic reduction and low economic growth rate that occurred from 2009; those are the economic crisis, the shortage of internal efforts that are not corresponding to the foreign resources. All of these were reflected in the following factors:

- Although renovation course is continued, the field of the determination of a policy is behind.
- The reorganization or the institutional reform in respect of administration and management is behind.
- Economic entities operate not to be effective and not to match the renovation, especially in terms of globalization and economic international markets.
- Electricity potential (internal forces) is not well mobilized; economic strength, international competitions are not enhanced.

Table 2.1-1: Economic Growth Rate and Sectoral Growth Rates

	2001	2002	2003	2004	2005	2006	2007	Est. 2008
GDP growth rate	6.89	7.08	3.34	7.79	8.44	8.23	8.48	6.18
Agriculture, Forestry and fishery	2.98	4.17	3.62	4.36	4.02	3.69	3.4	4.07
Industry and construction	10.39	9.48	10.48	10.22	10.69	10.38	10.06	6.11
Services	6.1	6.54	6.45	7.26	8.48	8.29	8.68	7.18

Source: p8 in SED2020 Est: Estimation value

Source: SED2020

Figure 2.1-1: Economic Growth Rate of Vietnam in Period 2001-2008

2.1.3 Achievements in Growth Rate and Stability of Macro Economy

During the period of 2006-2007, the economic growth rate was over 8%/year. In 2008, under the influence of extenuating international factors, especially the world financial crisis, the economic growth rate stagnated at 6.2%. The GDP in 2008 increased to 1.67 times the GDP in 2001. (Current GDP in 2008 is 1,479 billion VND). During the period of 2001-2008, the economic growth rate of Vietnam was primarily based on the growth rate of the industry & construction sector whose contribution was 50% and the Service sector which was about 40%. The remaining 10% was contributed by the Agriculture and the Forestry and Fishery sector. The industry contribution during the GDP growth rate was relatively stable during this period. On the contrary, the contributions of the Agriculture, Forestry & Fishery and Service sectors varies in the direction that the shares from Agriculture and the Forestry & Fishery sector is reducing, but the shares from the service sector are increasing.

Table 2.1-2: Shares of Each Sector in Economic Growth Rate of Vietnam

(Unit: %)

Sectors	2003	2004	2005	2006	2007	2008
Total	100.0	100.0	100.0	100.0	100.0	100.0
Agriculture, forestry, fishery	108	11.8	9.7	8.8	7.6	10.9
Industry and construction	53.4	50.5	49.9	50.7	51.2	42.5
Services	35.8	37.5	40.5	40.6	41.3	46.6

Source: Socio-economic statistic data 2000-2008, General Statistics Department

2.1.4 Economic Growth by Sector

(1) Agriculture and Rural Areas

In agriculture, advanced large scale cultivation methods are applied slowly. The productivity of many plants and domestic animals is low, and is dependable on climatic conditions. Changes in the agricultural production structure and rural areas are also slow, spontaneous and not sustainable. Industrialization, agricultural and rural modernization are not performed with the right methods. Many primary agricultural, forestry and fishery products do not have brand trade names; therefore, economic effectiveness is low. Even though the production value of agricultural, forestry, fishery are highly enhanced and exceed the set targets, the production cost is increased. Therefore, the additional value of the whole sector doesn't meet the set target, because the increase of 3.8% is low in comparison with the 4.3% target. The rural infrastructure doesn't meet the requirements of rural industrialization and modernization. Rural development plans are still substandard, especially with regards to the yet to be solved problems of environmental pollution and water resources in handicraft villages.

(2) Industry

Even though the growth rate is high, the overall effect on the whole sector is not that significant; products and brand names have low competitiveness; the Growth rate of industry production in the period of 2001–2005 had been steady at 16%/year. However, added value had not matched in the five years, the average growth rate was 10.2%/year. The share of the manufacturing industry in the secondary industry was 60-70%. However, the added value was low; the industries such as garment, leather and shoes and wood export processing production have high values, but most materials are imported from foreign countries. Therefore, the added value is low.

Advanced technologies in secondary industries account for a small share, with slow technology renovation speed. So far, there are few modern technologies used in Vietnam. Facilities for the manufacturing of new materials for other industries are noticeably lacking.

The competitive capability of many industrial products is still low; the product cost is high and lacking the competitive capability with products of the same type in other countries in the region. The forecast of the developmental direction of the strategic productions is not clear.

There is no integration between the processing industry and the raw material industry. There is not enough attention paid to the development of the Agriculture sector in rural, remote areas. The industrialization of agriculture and rural areas has no roadmap and does not contribute much to alleviating poverty nor bringing about needed agricultural and economic structural changes.

(3) Commercial & Services

The Growth rate of the Commercial & service sector exceeds the planned target, but is still lower than its development potential; the share of Commercial & services in GDP and sector's effectiveness are not high; many of the sector costs are not reasonable and much higher than those of many other countries in the region. The marketing capability of enterprises is weak. Commercial & Services with high added value sub-sectors like financial and monetary services and so on are improved but its development is slow and not able to meet requirements. The services of fixed assets transaction in the market are unstable. A created environment, for the encouragement and mobilization of investment capital for the construction of infrastructure facilities in the tourism sector doesn't meet the sector's development potential. The competitiveness of service products is weak due to high prices and low service quality.

2.1.5 Significant Economic Changes

(1) Economic Structure Change

- The structure of the industry sector has significantly changed towards the direction of industrialization, modernization, mobilization and product integration of production with domestic and international markets. The production structure and product structure change by increasing the share of the processing industry in the total added values. The processing industry starts leveraging its advantages in terms of domestic material production in order to increase the value of export products.
- Commercial & Service structure has changed for the better. The traditional service sectors such as commercial, transportation, telecommunications and postal, hotels, restaurants are relatively highly developed. Some sectors with low costs such as banks, insurance and so on are relatively highly developed.

Table 2.1-3: Change of Economic Structure and Laborer Structure

(Unit: %)

	2001	2002	2003	2004	2005	2006	2007	Esti 2008
Economic structure	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Agriculture, forestry and fishery	23.04	23.03	22.54	21.81	20.97	20.4	20.3	21.99
Industry and construction	38.23	38.49	39.47	40.21	41.02	41.54	41.58	39.91
Services	38.73	38.48	37.99	37.98	38.01	38.06	38.12	38.10
Labor structure	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Agriculture, forestry and fishery	63.45	61.9	60.24	58.75	57.1	55.37	53.9	52.46
Industry and construction	14.41	15.4	16.44	17.35	18.2	19.23	19.98	20.84
Services	22.14	22.7	23.32	23.9	24.7	25.4	26.12	26.7

Source: Socio-economic statistical data 2001-2008, General Statistics Office

(2) Economic Zone Structure Change

- The Northern mountainous and midland areas have well leveraged their strengths in terms of land and forest. The industry in this area has developed suitably to its conditions such as forestry product processing, construction material production, hydropower, coal-fired power development, steel industry, mechanical manufacturing, fertilizer and so on. In that area, the present infrastructure still poses some challenges, because economic transactions through the border gates are still limited; the mining industry and hydropower are not able to promote the development of industry and the economy in general. The red river delta area has not brought into play the effectiveness of existing laborer sources and infrastructure facilities. The rate of unemployment in rural areas is still high; high quality services have not been developed and rural industries have not been planned. The economy of important areas in the Northern region has not been able to spread to other areas.
- The central Coastal area is changing the production structure towards the the mobilization of the advantages of the coastal, island area. Many economic and industrial zones have been initially developed, and these are impacting the plant variety, planting seasons and reduction of the negative impacts of natural disasters. The area has high potential but has not yet been exploited. Industries in the highland area develop slowly. The economic development has not integrated with the social development and there are many corresponding difficulties with production and lifestyles, especially for ethnic minorities.
- The South-East area has important infrastructure advantages in terms of industrial, high technology and urban zone development. The economic structure is changing positively, and increasing industries are moving in the direction of industrialization, modernization. The area has not integrated the development of infrastructure, environmental protection and urban services. Therefore, there are many problems that need to be solved. Changes of the economic structure in the Cuu Long delta area have many problems, there are no integration with provinces in the area in according to one mater plan; the socio-economic infrastructure is still weak and industrial development is slow. There are many problems with the development of human resources, development of industries in integration with environmental protection, and sustainable development. At present, area development is planning at the orientations stage; detailed planning, sector, and product development plans

are not yet clear in terms of production, investment, processing, consumption and policies.

(3) Required Plans for Economic Structure Changing

- The process of the sector structure change has not yet complied as development master plans, strategies, and roadmaps. In general, the change of structures in the past five years has been slow and partially oriented by sector and local development plans.
- Therefore, development master plans are usually not fulfilled. The structure change doesn't meet the requirements of sustainable development.
- In economic structural change, attention is mainly paid to the increase of shares of industry and services in GDP, but not enough attention is paid to the requirements of structural change in the direction of modernization, the development of technologies and advanced techniques in all the sectors.
- A small number of sectors that uses advanced technologies such as processing industry, fabricating, assembling industries have relatively high share in GDP. And speed of technology renovation in most industries is slow and at the average level.
- The services system for supporting industry is weak, insufficient and of questionable effectiveness. The share of comprehensive services in the GDP is substandard and forthcoming improvements are slow in coming. The internal structure of each sector has not changed much. In light of this, structural reform programs geared towards industry that will create improvement-oriented services is immediately required.

2.2 Review of Power Demand Forecast

The differences between the PDP6 power demand forecast and the actual power demand is shown as follows.

- PDP6 has aimed at too high of a demand
- Fund shortage of EVN
- MOIT has taken no action for rescheduling the delay of investors
- PDP6 has had difference arising from the difference of assumption of GDP growth rate between the IE scenario and Authority Scenario
- The difference between the PDP6 and actual value is PDP6=92.8 TWh, Actual=87 TWh, 6.3%) in 2009

- The main reason of the above decrease is due to World financial crisis
- EVN carried out the peak cut due to power plant construction schedule delay
- The main problems for PDP6 that are hindering complete implementation are the World financial crisis and high crude oil prices. Based on the world economy, Vietnam power demands in 2009 and 2010 were lower than the PDP6 forecasts.

Table 2.2-1: Differences between IE and Authorities

		2010	2015	2020
IE scenario	TWh	101	187	292
Authority scenario	TWh	115	288	533

Source: The TA team from PDP6 documents

EVN transferred the following 13 projects to the government due to financial constraints. (The following list shows only the names and capacities as of 2008 and some have been changed.)

Duyen Hai 2 (1,200 MW), Duyen Hai 3.1(1,000 MW), Duyen Hai 3.2 (1,000 MW), Soc Trang 3.1(1,000 MW), Soc Trang 3.2 (1,000 MW), Vinh Tan 3.1 (1,000 MW), Vinh Tan 3.2 (1,000 MW), Hai Phong 3.1 (600 MW), Hai Phong 3.2 (1,200 MW), Hai Phong 3.3 (1,200 MW), Vung Anh 3.1 (1,200 MW), Vung Anh 3.2 (1,200 MW), Quang Trach (1,200 MW)

However, after that, Duyem Hai 3.1, 3.2 and Vinh Tan 3.1, 3.2 was re-transferred to EVN.

2.3 Review of Power Development Plan

The differences between the power generation plan on PDP6 and the actual implementation schedule including their effects have been described below based on the “REVIEW OF IMPLEMENTATION OF POWER DEVELOPMENT PLAN VI” that is the PDP6 evaluation report summarized by IE at the beginning of 2010.

The power plants with a total installed capacity of 14,581 MW were scheduled to be commissioned in 2006 to 2010 according to PDP6. However, the actual total installed capacity will remain at only 9,657 MW.

Table 2.3-1 shows a comparison of the power outputs between the power generation plan in 2006 to 2010 on PDP6 and the actual implementation. The power outputs of actual installed power stations did not reach the planed power outputs resulting in only 70 % of the planned value on average.

Table 2.3-1: The Comparison of the Power Outputs between the Power Generation Plan in 2006 to 2010 on PDP6 and the Actual Implementation

	2006	2007	2008	2009	2010	2006-2010
Approval on PDP6 (MW)	861	2096	3,271	3,393	4,960	14,581
Actual Implementation (MW)	756	1,297	2,251	1789	3,564	9,657
Ratios of the actual implementation	87.8%	61.9%	68.8%	52.7%	71.9%	66.2%

Source: "Review of Implementation of Power Development Plan VI", IE, April 2010

Section 2.3.1 shows the difference between the plan and the implementation schedule categorized by each project.

Among the projects that were originally scheduled in 2006, Se San 3A#1 and Srok Phumieng began operations in 2007.

Among the projects that were originally scheduled in 2007, TD Tuyen Quang1 and TD Dại Ninh began operations in 2008 and Uong bi MR #1 began operations in 2008.

Among the projects that were originally scheduled in 2008, TD Plei Krong #1,2, TD Song Ba Hạ and Buon Kuop began operations in 2009 and TD Ban Ve #1, ND than Son Dong and ND Hai Phong I#1began operations after 2010.

Among the projects that were originally scheduled for 2009, TD Song Con 2,TD Buon Tua Sah, TD Se San 4 #1, ND Lọc dau Dung Quat, NĐ O Mon I #1 and TD nho / IPP began operations in 2009.

Moreover, the details of the projects, which were carried out between 2006-2010, are shown in the Tables 2.3-2-2.3-6. Regarding the investor of the projects, it turns out that EVN has 50% of share.

All investor procedures and processes are as follows:

(1) Formulation and Publication of the List of Projects

- Based on the master plan and planning for socio-economic development from time to time. It will be announced in January of each year and remain for 30 days
- Decision of the Prime Minister based on the submission from the Ministries
- Proposed by Investors (need to amend the master plans)
- The Prime Minister of the Government shall approve the feasibility reports and proposals for projects in the case of national important projects pursuant to a resolution of the National Assembly, projects which need to use 200 or more hectares of land, projects requiring a Government guarantee, and projects with a total investment capital of 1,500 billion VND or more.
- Ministers, heads of ministerial equivalent bodies and chairmen of provincial people's committees shall approve the feasibility reports and proposals for the projects of the remaining projects.

(2) Project Investor Appointments, Negotiations and Decisions

- Open domestic or international tendering to select an investor for any project on the announced List of Projects for which two or more investors have been registered to implement.
- Appointments can be made under certain circumstances: only one investor has registered, the project is required to be implemented in order to satisfy an urgent need to use infrastructure facilities as decided by the Prime Minister on the basis of a proposal from a ministry, branch or provincial people's committee and an evaluation report from the Ministry of Planning and Investment.
- The authorized State body shall, based on the results of the selection of the investor, hold project contract negotiations with the selected investor and decide.

(3) Contents of Project Contracts

- The objectives, scope, duration and contents of the project; and the rights and obligations of the parties in the design, construction, commercial operation and management of the project works.

- Step-in right is possible for the Lender.
- Applicability of the foreign law governing the project contract.
- Security for the obligation to enter into a project contract: no less than 2% of the total investment capital (up to 1,500 billion VND). For an amount above 1500 billion VND: 1%.

Table 2.3-2: Implementation Situation of the Projects (FY 2006)

No	Projects	Investor	Capacity (MW)			Adjusted schedule
			PDP-VI	Actual implementation	Rate (%)	
	Projects put in operation in 2006		*861*	*756*	*87.8*	
1	Add-on steam turbines PM2.1 ext.	EVN	150	150		
2	Se San 3 HPP	EVN	260	260		
3	Se San 3A#1 HPP	Song Da / IPP	54			2007
4	Srok Phumieng HPP	IDCO/IPP	51			2007
5	Imported power at 110kV from China	EVN	60	60		
6	Imported power at 220kV from China (via Lao Cai)	EVN	250	250		
7	Small HPPs	IPP	36	36		

Source: "Review of Implementation of Power Development Plan VI", IE, April 2010

Table 2.3-3: Implementation Situation of the Projects (FY 2007)

No	Projects	Investor	Capacity (MW)			Adjusted schedule
			PDP-VI	Actual implementation	Rate (%)	
	Projects put in operation in 2007		*2096*	*1297*	*61.9*	
1	Tuyen Quang #1 HPP	EVN	114			2008
2	Uong Bi Ext. #1 TPP	EVN	300			2009
3	Cao Ngan coal TPP	VINACOMIN	100	100		
4	Quang Tri HPP	EVN	64	64		
5	Se San 3A#2 HPP	S.Da Corp.	54	108		
6	Dai Ninh HPP	EVN	300			2008
	Srok Phumieng HPP	IDCO/IPP		51		
7	Ca Mau I GTCC TPP	PVN/IPP	750	750		
8	Imported power at 220kV from China (via Ha Giang)	EVN	200	200		
9	Small HPPs	IPP	214	24		

Source: "Review of Implementation of Power Development Plan VI", IE, April 2010

Table 2.3-4: Implementation Situation of the Projects (FY 2008)

No	Projects	Investor	Capacity (MW)			Adjusted schedule
			PDP-VI	Actual implementation	Rate (%)	
	Projects put in operation in 2008		*3271*	*2251*	*68.8*	
1	Tuyen Quang HPP #1,2&3 HPP	EVN	228	342		
2	Ban Ve HPP #1	EVN	150			2010
3	Plei Krong HPP #1,2	EVN	100			2009
4	A Vuong HPP	EVN	210	210		
5	Song Ba Ha HPP	EVN	220			2009
6	Buon Kuop HPP	EVN	280			2009
	Dai Ninh HPP	EVN		300		From 2007
7	Son Dong Coal TPP	VINACOMIN/IPP	220			2010
8	Hai Phong I TPP #1	Hai Phong Thermal Power JSC	300			2010
9	Nhon Trach I GTCC TI	PVN/IPP	450	450		
10	Ca Mau II GTCC TPP	PVN/IPP	750	750		
11	Small HPPs /IPP	IPP	363	199		

Source: "Review of Implementation of Power Development Plan VI", IE, April 2010

Table 2.3-5: Implementation Situation of the Projects (FY 2009)

No	Projects	Investor	Capacity (MW)			Adjusted schedule
			PDP-VI	Actual implementation	Rate (%)	
	Projects put in operation in 2009		***3393***	***1789***	***52.7***	
1	Ban Ve HPP #2	EVN	150			2010
2	Cua Dat HPP	Cua Dat HPJSC	97			2010
3	Song Con 2 HPP	Song Con HPJSC	63	63		
4	Buon Tua Sah HPP	EVN	86	86		
	Plei Krong HPP #1,2	EVN		100		From 2007
	Song Ba Ha HPP	EVN		220		From 2008
	Buon Kuop HPP	EVN		280		From 2008
5	Se San 4 HPP #1	EVN	120	120		
6	An Khe Kanak HPP	EVN	173			2010
7	Dong Nai 3 HPP #1&2	EVN	180			2010
8	Cam Pha I TPP	VINACOMIN	300			2010
	Uong Bi Ext. TPP #1	EVN		300		From 2007
9	Hai Phong I TPP #2	Hai Phong TPJST	300			2010
10	Quang Ninh I TPP #1,2	Quang Ninh TPJSC	600			2010
11	Hai Phong II TPP #1	Hai Phong TPJST	300			2010
12	Mao Khe TPP #1	VINACOMIN/IPP	220			2012
13	Nong Son TPP	VINACOMIN/IPP	30			2012
14	Dung Quat Refinery TI	PVN/IPP	104	84		
15	O Mon I TPP #1	EVN	300	300		
16	Small HPP / IPP	IPP	370	236		

Source: "Review of Implementation of Power Development Plan VI", IE, April 2010

Table 2.3-6: Implementation Situation of the Projects (FY 2010)

No	Projects	Investor	Capacity (MW)			Adjusted schedule
			PDP-VI	Actual implementation	Rate (%)	
	Projects planned to be put in operation in 2010		*4960*	*3564*	*75.3*	
1	Son La HPP #1	EVN	400	400		
	Cua Dat HPP	Cua Dat Hydropower JSC		97		From 2009
	Ban Ve HPP	EVN		300		From 2009
2	Na Le HPP (Bac Ha)	LICOGI/IPP	90	90		
	An Khe-Kanak HPP	EVN		173		
3	Srepok 3 HPP	EVN	220	220		
4	Se San 4 HPP #2&3	EVN	240	240		
5	Song Tranh 2 HPP	EVN	160	160		
6	DakR tih HPP	Construction Corporation No.1/IPP	141	141		
7	Se San 4a HPP	Se San 4a Hydropower JSC	63	63		
8	Thac Mo Ext. HPP	EVN	75			postponed
	Dong Nai 3 HPP #1&2	EVN		180		From 2009
9	Dong Nai 4 HPP	EVN	340			2011
	Son Dong Coal TPP	VINACOMIN/IPP		220		From 2008
10	Mao Khe TPP #2	VINACOMIN/IPP	220			2013
	Hai Phong I TPP #1&2	Hai Phong Thermal Power JSC		600		From 2009
	Quang Ninh I TPP #1,2	Quang Ninh Thermal Power JSC		600		From 2009
11	Quang Ninh II TPP #1	Quang Ninh Thermal Power JSC	300	300		
12	Hai Phong II TPP #2	Hai Phong Thermal Power JSC	300			2012
	Cam Pha I TPP	VINACOMIN		300		From 2009
13	Cam Pha II TPP	VINACOMIN/IPP	300			2011
14	O Mon I TPP #2	EVN	300			2013
15	Vung Ang I TPP #1	LILAMA/IPP	600			2013
16	Trach 2 TPP	PVN/IPP	750			2011
17	Sekaman 3 HPP (Laos)	Viet Lao Hydropower JSC /BOT	248			2011
18	Small HPP IPP	IPP	213	150		

Source: "Review of Implementation of Power Development Plan VI", IE, April 2010

2.4 Power Network System Plan

Table 2.4-2 shows the amounts of power network system facilities in 2000, 2005 and 2008. The total circuit length of the transmission lines in 2008 was 1,701 km and the total capacity of substations were 18,639 MVA.

Table 2.4-1: The Amounts of Power Network System Facilities in 2000, 2005 and 2008

No.	Year	2000		2005		2008	
	Volume	km	MVA	km	MVA	km	MVA
1	500 kV	1,532	2,850	3,286	6,150	3,286	7,050
2	220 kV	3,519	6,726	5,747	14,890	7,101	18,639
3	110 kV	7,909	8,193	10,874	18,609	11,751	23,872

Source: "Review of Implementation of Power Development Plan VI", IE, April 2010

The differences between the power network system plan on the PDP6 and the actual implementation schedule including their effects are described below based on the "REVIEW OF IMPLEMENTATION OF POWER DEVELOPMENT PLAN VI" that is the evaluation report of the PDP6 summarized by IE at the beginning of 2010.

Table 2.4-2 shows the differences between the plan of the transmission lines and substations on PDP6 and the actual implementation schedule in 2006 to 2010. The amount of the transmission lines and substations that were scheduled to be completed in 2010 on PDP6 reached just only 50 % of the original plan and many projects were delayed by one to three years.

The report described the following examples of the power supply interruption

The delay of the construction of some 220 kV power transmission lines and substations due to the issues for acquiring the lands for their construction lead to the overload of the 220 kV transmission lines and substations in Hung Yen and Bac Ninh areas in Hanoi city and in Ho Chi Minh city with its neighbor provinces, namely, Dong Nai, Binh Duong, Long An.

During the dry season of 2009 due to an overload of many power transmission lines in the Hanoi area, an electricity supply interruption occurred. EVN has reported to MOIT to apply the following urgent measures such as the installation of the third transformer at Ha Dong, Chem and Mai Dong 220 kV substations and speeding up the completion and upgrading some of 220-110 kV lines in order to ensure electricity supply for Hanoi city.

According to an estimation by the Institute of Energy and National Load Dispatch Center reporting to EVN in the second and third quarters of 2009, due to not putting local power generation sources in time in the South during the period 2013-2014, the South had to receive power transmitted from the North and Center at high capacity about 8-9 billion kWh/year through the existing North-Center-South 500kV interconnection line and if an accident occurs with the existing 500 kV lines or a failure of the 1 or 2 units of gas-fired TPPs, the South will be in the risk of a wide electricity shortage in these years. Therefore, it needs to carry out measures to avoid the delay schedules of power plant projects that supply electricity to the South during this period as well as some urgent solutions in order to enhance the power network for the transmission of power from the Center to the South.

Table 2.4-2: The Differences between the Plan of the Transmission Lines and Substations on PDP6 and the Actual Implementation Schedule in 2006 to 2010

Works	Planning		Perform		Rate (%)	
	Amount	Volume (MVA/km)	Amount	Volume (MVA/km)	Amount	Volume
500kV Substation New and expanded	15	8400	9	4950	60%	59%
500kV Transmission Line New and renovated	12	1339	6	549	50%	41%
220kV Substation New and expanded	87	19326	40	8938	46%	46%
220kV Transmission Line New and renovated	117	4666	52	2323	44%	50%

Source: "Review of Implementation of Power Development Plan VI", IE, April 2010

2.4.1 Review of the Investment of the Project for the Power Network System from 2005 to 2010

The details of the projects, which were carried out by 2005-2010, are shown in the Tables 2.4-3- 2.4-6. By the end of 2010, the rate of completed projects of 500 kV substations and 500 kV transmission lines are 77% and 46%, and that of 220 kV substations and 220 kV transmission lines are 47% and 44%. These figures show that 220 kV projects have been respectively delayed.

Table 2.4-3: Implementation Situation of the Projects (500 kV Substation)

NO	PROJECT	VOLUME			NOTES	SCHEDULE
I	500KV Substations in 2006-2010				Completion rate: 74 %	
1	Phu My	1	x	450	Transformer 2	2005
2	Da Nang	1	x	450	Transformer 2 – Jan 2006	2006
3	Di Linh	1	x	450	Associated with Dai Ninh - 2008	2007
4	Quang Ninh	1	x	450	Associated with Quang Ninh TPP	2009
5	O Mon	2	x	450	2007-2010	2009
6	Thuong Tin	1	x	450	Transformer 2 - 2008	2010
7	Tan Dinh	1	x	450	Transformer 2 - 2007	2010
8	Dung Quat	1	x	450		2010
9	Nhon Trach	1	x	450	Associated with Nhon Trach TPP	2010
10	Dak Nong	2	x	450	Associated with 3&4 HPP	2010
11	Son La	1	x	450	Trạm Pitong substation connecting Ban Chat HPP	2010
12	Song May	1	x	600	2007-2008	2011
13	Hiep Hoa (Soc Son)	1	x	900		2011
14	Vung Ang	1	x	450	Associated with Vung Ang I TPP	2012
15	Cau Bong	1	x	600		2014

Source: "Review of Implementation of Power Development Plan VI", IE, April 2010

The black letters are for before 2009 or are unknown, the blue letters are for before 2010, the red letters are for after 2010

Table 2.4-4: Implementation Situation of the Projects (500 kV Transmission Line)

II	500KV lines in 2007-2010				Completion rate: 46 %	
1	Nha Be - O Mon	1	x	152	2006	2007
2	Quang Ninh - Thuong Tin	2	x	152	2009 -2010	2009
3	Son La HPP- Pitoong	2	x	5	2010	2010
4	Sơn La HPP - Nho Quan	1	x	240	2010	2010
5	Branching to Dong Nai 3&4	2	x	2	2008-2009, connecting at 220kV	
6	Phu Lam – O Mon	1	x	149	2007	2011
7	Phu My - Song May	2	x	63	2008-2009	2011
8	Song May - Tan Dinh	2	x	40	2008-2009	2011
9	Pitoong - Hiep Hoa (Soc Son)	2	x	260	2010	2011
10	Vnh Tan TPP- Song May	2	x	260	Associated with Vinh Tan TPP	2012
11	Branch to Vung Ang I	2	x	16	Associated with Vung Ang I TPP	2012
12	Branch to Cau Bong	2	x	0.5		2012

Source: "Review of Implementation of Power Development Plan VI", IE, April 2010

The black letters are for before 2009 or are unknown, the blue letters are for before 2010,

the red letters are for after 2010

Table 2.4-5: Implementation Situation of the Projects (220 kV Substation)

III	220KV substations in 2006-2010				Completion rate: 47 %	
1	Cat Lai	1	x	250	Transformer 2 - 2005	2004
2	My Phuoc	2	x	250	2006 - 2008	2007
3	Dinh Vu	1	x	250		2008
4	Thanh Cong	2	x	250	Transformer 1: 2006	2008
5	Buon Kuop	1	x	125	2009	2008
6	Cao Lanh	2	x	125	Approved in plan	2008
7	Ben Tre	2	x	125		2008
8	Van Tri	1	x	250	2006	2009
9	Son Tay	1	x	250	2007-approved	2009
10	Hai Duong 1	125	+	250		2009
11	Vat Cach	1	x	125	Installed transformer 2	2009
12	Phu Ly	2	x	125		2009
13	KrongBuk	1	x	125	Changed transformer, Transformer 2 - 2011	2009
14	Tuy Hoa	1	x	125	2008	2009
15	Tao Dan	1	x	250	Transformer 2	2009
16	Phan Thiet	1	x	125	2007	2009
17	Long An	2	x	125	2006 - 2008	2009
18	Chau Doc	2	x	125	M2-2010	2009
19	O Mon	2	x	125	Associated with O Mon, Transformer 2 - 2012	2009
20	Thot Not	1	x	125		2009
21	Nhon Trach TPP	1	x	250	Invested by TPP	2009
22	Kim Dong	1	x	250	2008-Approved	2010
23	Son La town	1	x	125		2010
24	Dong Ha	1	x	125		2010
25	Tam Ky	1	x	125	2008 - Approved	2010
26	Doc Soi	1	x	125	Replacement of transformer, upgrading to 500kV	2010
27	Dak Nong	1	x	125	2010	2010
28	Nam Sai Gon	2	x	250	2006 - 2009	2010
29	Long Thanh	1	x	250	Transformer 2 - 2006	2010
30	Tan Dinh	1	x	250	Transformer 2	2010
31	Bình Long	2	x	125	2006-2010	2010
32	Mỹ Tho	1	x	125	Transformer 2 (plan approved)	2010
33	Kien Luong	1	x	125		2010
34	Tuyen Quang	1	x	125		2011
35	Hai Duong 2	1	x	250		2011
36	Bim Son	1	x	125	2008 – plan approved	2011
37	Bao Thang	1	x	250	Connecting small HPP of Lao Cai	2011
38	Thach My	1	x	125	Connecting small HPPs	2011
39	Uyen Hung	1	x	250	2008	2011
40	Xuan Loc	1	x	250	2008	2011
41	Vung Tau	2	x	250	2006 - 2008	2011
42	Thuan An	1	x	250	2009 - 2010	2011
43	Bac Lieu	1	x	125	Transformer 2	2011
44	Tra Vinh	2	x	125		2011

III	220KV substations in 2006-2010					
45	Ba Don	1	x	125		2012
46	Cu Chi	2	x	250	2008	2012
47	Phu My 2 industrial zone	1	x	250	2008	2012
48	Long Bien	1	x	250	2008	2013
49	Soc Trang	1	x	125	Plan approved	2013
50	Thuong Tin	1	x	250	2007-plan approved	2015
51	Thai Nguyen	2	x	250	Replacement of transformer, approved	
52	Viet Tri	1	x	250	Replacement of transformer	
53	Cam Pha	1	x	125		
54	Yen Bai	1	x	125	2008-2009, approved	
55	Lao Cai	1	x	125		
56	Tuyen Quang	1	x	63	In TPP	
57	Vinh Yen	2	x	125		
58	Nam Dinh	1	x	250	Replacement of transformer	
59	Hue	1	x	125	Installation of transformer 2	
60	Dung Quat	1	x	125		
61	Song May	1	x	125	2007, in Song May 500 kV substation	
62	An Duong	1	x	250	2007	
63	Xuan Mai	1	x	250	Transformer 2-2008-approved	
64	Bac Ninh	2	x	250	Replacement of transformer	
65	Bắc Giang	1	x	125	Installation of transformer 2	
66	Tam Hung	2	x	125	In Hai Phong TPP	
67	Trang Bach	1	x	125	Installation of transformer 2	
68	Quang Ninh	2	x	125		
69	Hoa Binh	1	x	125	Installation of transformer 2	
70	Thai Binh	1	x	250	Installation of transformer 2	
71	Nghi Son	1	x	125	Transformer 2 – plan approved	
72	Do Luong	1	x	125		
73	Ha Tinh	1	x	125	Installation of transformer 2	
74	Thach Khe	2	x	125		
75	Vung Ang 1	1	x	250	Not invested by NPT	
76	Than Uyen	1	x	125	Connecting small HPPs in Son La	
77	Hoa Khanh	1	x	125	Installation of transformer 2	
78	Ngu Hanh Son	1	x	125		
79	Dung Quat steel	2	x	100	Transformers 1, 2	
80	Duc Pho	1	x	125		
81	Plei Ku	1	x	125	Transformer 2 - 2010	
82	Hiep Binh Phuoc	2	x	250	2007	
83	Binh Tan	2	x	250	2006 - 2008	
84	My Xuan	1	x	250	2007	
85	Dai Ninh	1	x	63	Associated with Dai Ninh - 2008	
86	Tan Rai	2	x	125	Associated with aluminum plant	
87	Da Lat	1	x	125	2009	
88	Trang Bang	1	x	250	Transformer 2	

Source: "Review of Implementation of Power Development Plan VI", IE, April 2010
The black letters are for before 2009 or are unknown, the blue letters are for before 2010, the red letters are for after 2010

Table 2.4-6: Implementation Situation of the Projects (220 kV Transmission Line)

IV	220KV lines in 2006-2010				Completion rate: 40 %	
1	NhonTrach TPP – Cat Lai	2	x	20	Associated with Nhon Trach	2005
2	NhonTrach TPP – Nha Be	2	x	10	Associated with Nhon Trach	2005
3	Branch Vinh Yen - Vinh Yen	2	x	5		2006
4	Se San 3 - Pleiku	2	x	30		2006
5	Se San 3A – Se San 3	1	x	10		2006
6	Tuyen Quang HPP-Branch Thai Nguyen- Soc Son	2	x	170	Power purchased from China - 2007	2007
7	Tuyen Quang - Yen Bai	2	x	30	ADB	2007
8	Dai Ninh – Di Linh	2	x	39	2007-Associated with Dai Ninh	2007
9	Tan Dinh - My Phuoc	2	x	50	2006 (initial section on poles with four circuits)	2007
10	Dong Hoa - Dinh Vu	2	x	18.2		2008
11	Branch – Son Dong TPP	2	x	18	Associated with Son Dong TPP	2008
12	Branch Thai Nguyen – Soc Son - Soc Son	2	x	40	Power purchased from China- 2007	2008
13	Tuyen Quang HPP – Bac Can – Thai Nguyen	2	x	130	Approved	2008
14	Branch – A Vuong 1	2	x	15	Associated with A Vuong	2008
15	Branch A Vuong 1 – Hoa Khanh	2	x	75	Associated A Vuong	2008
16	Buon Kuop - KrongBuk	2	x	57	Associated with Buon Kuop	2008
17	Ha Song Ba – Tuy Hoa	2	x	40	2008	2008
18	Buon Kuop - Krongbuk - SeRePok 3	2	x	25	2009	2008
19	Qui Nhon – Tuy Hoa	1	x	95	2008	2008
20	Ca Mau TPP- Rach Gia	2	x	110	Associated with ca Mau TPP	2008
21	Branch Cao Lanh	2	x	3		2008
22	Branch Son Tay	2	x	1.5	2007 - Approved	2009
23	Branch Hai Duong 1 - Hai Duong 1	2	x	11		2009
24	Hai Phong I TPP- Vat Cach	2	x	19	Associated with Hai Phong I TPP	2009
25	Hai Phong I TPP - Dinh Vu	2	x	16	Associated with Hai Phong I TPP	2009
26	Vat Cach - Dong Hoa	2	x	13.5	Replacement with temperature resistant conductor (associated with Hai Phong II TPP)	2009
27	Hoanh Bo - Quang Ninh	2	x	20.3	On four-circuit line with 110kV - WB	2009
28	Cam Pha - Quang Ninh	2	x	30.9	On four-circuit line with 110kV - WB	2009
29	Trang Bach - Vat Cach	1	x	17.7	Circuit 2	2009
30	Branch Phu Ly	2	x	2.98		2009
31	Dong Hoi - Dong Ha - Hue	1	x	216	Circuit 1	2009
32	Se San 4 – Pleiku	2	x	50	2009	2009
33	Buon Tua Srah - Buon Kuop	1	x	50	2008	2009
34	Branch An Khe	2	x	5	2009	2009
35	Tuy Hoa – Nha Trang	1	x	110	2008	2009
36	Branch Long An	2	x	1		2009
37	Ham Thuan - Phan Thiet	2	x	60	2007	2009
38	Ca Mau TPP- Bac Lieu	2	x	76	Associated with Ca Mau TPP	2009
39	Thot Not - Chau Doc	2	x	69.5		2009

IV	220KV lines in 2006-2010					
40	Soc Son - Van Tri	2	x	25		2010
41	Branch Thanh Cong	2	x	10.5		2010
42	Sông Tranh 2 - Tam Kỳ	2	x	65	2009-approved	2010
43	Doc Soi Dung Quat – Dung Quat steel plant	2	x	15		2010
44	Ba Ria – Vung Tau	2	x	14	2008	2010
45	Dong Nai 3 HPP- DakNong	2	x	25	Associated with Dong Nai 3 HPP	2010
46	Dong Nai 4 HPP - DakNong	2	x	15	Associated with Dong Nai 4 HPP	2010
47	Branch Nam SG	2	x	1		2010
48	O Mon TPP - Soc Trang	1	x	73	Plan approved	2010
49	Kien Luong - Chau Doc	1	x	72		2010
50	Soc Trang - Bac Lieu	2	x	50	Plan approved	2010
51	Ninh Binh TPP- Nam Dinh	1	x	30	Shared towers with 110kV	2011
52	Branch NMĐ Mạo Khê	4	x	3	Associated with Mao Khe TPP	2011
53	Mao Khe TPP- Hai Duong 2	2	x	25	Associated with Mao Khe TPP	2011
54	Connecting A Luoi HPP	2	x	30	2010	2011
55	Branch Xuan Loc	4	x	5		2011
56	Branch Thuan An	2	x	1		2011
57	Uyen Hung – Tan Dinh	2	x	20	2008	2011
58	Vĩnh Long - Trà Vinh	2	x	70		2011
59	Dong Hoa - Thai Binh	2	x	53.6	WB	2012
60	Ha Tinh - Vung Ang	2	x	70	Associated with Vung Ang I TPP	2012
61	Vung Ang - Ba Don	2	x	45	Associated with Vung Ang I TPP	2012
62	Ba Don - Dong Hoi	2	x	40	Associated with Vung Ang I TPP	2012
63	Branch Phu My 2 Industrial zone	2	x	4		2012
64	Song May – Uyen Hung	2	x	20	2008	2012
65	Branch Cu Chi substation - Tan Dinh - Trang Bang	4	x	1	2008	2012
66	Cau Bong 500kV – Hoc Mon 220kV	2	x	10	2010	2012
67	Branch Long Biên	2	x	18		2013
68	Nam Dinh - Thai Binh	1	x	30	Circuit 2	2013
69	Cau Bong 500kV - Binh Tan	2	x	10	2010	2013
70	O Mon TPP- Thot Not	2	x	22		2014
71	Thanh Hoa - Nghi Son	2	x	52		
72	Vinh - Nghi Son	2	x	113		
73	Vinh - Ha Tinh	1	x	65.2	Circuit 2	
74	Chem - Van Tri	2	x	10	Initial section on four-circuit towers	
75	Chem - An Duong	2	x	10		
76	Pho Noi - Kim Dong	2	x	22		
77	Hai Phong II TPP - Hai Phong I TPP	2	x	0.5	Associated with Hai Phong II TPP	
78	Uong Bi Ext. - Trang Bach	2	x	17	Associated with Uong Bi ext.	
79	China - Lao Cai - Lao Cai - Yen Bai – Viet Tri	2	x	230	2006-approved	
80	China - Ha Giang - Bac Me	2	x	70	Power purchased from China-	
81	Connecting small HPPs Ha Giang	2	x	100		

IV	220KV lines in 2006-2010					
82	Bac Me - Tuyen Quang HPP	2	x	60	Power purchased from China-2007	
83	Pitoong - Son La Town	1	x	40	Circuit 2	
84	Pitoong - Huoi Quang	2	x	25		
85	Huoi Quang - Ban Chat	2	x	35		
86	Ninh Binh TPP- Hoa Lu	1	x	6	Shared towers with 110kV	
87	Branch Bim Son	2	x	2		
88	Branch Do Luong	2	x	2		
89	Vinh - Ban Ve HPP	2	x	174	ADB, AFD	
90	Ha Tinh - Thach Khe	2	x	20		
91	Than Uyen - branch Huoi Quang - Ban Chat	2	x	20	Connecting small HPP Lao Cai	
92	Bao Thang - Yan Bai	2	x	180	Connecting small HPP Lao Cai	
93	Bac Ha (NaLe) HPP - Bao Thang	1	x	30	Associated with Bac Ha HPP	
94	Hue - Hoa Khanh	1	x	110	Circuit 2	
95	Se Kaman 3 - A Vuong 1	2	x	120		
96	Branch Ngu Hanh Son substation	2	x	12		
97	Doc Soi - Duc Pho	1	x	64	Circuit 1	
98	Duc Pho - Quy Nhon	1	x	125	Circuit 1	
99	Da Lat - Da Nhim	1	x	28	Circuit 1	
100	DakTih HPP- DakNong	1	x	10	Associated with DakTih HPP	
101	DiLinh - Tan Rai	2	x	10	Associated with aluminum plant	
102	My Phuoc - Binh Long	2	x	38	2006	
103	Branch Hiep Binh Phuoc	4	x	2		
104	Branch Bình Tân	2	x	1		
105	Branch Song May - Tri An - Long Binh	4	x	5	2006	
106	Branch Song May - B.Loc - Long Binh	4	x	10	Four circuit-towers	
107	Branch Song May - Long Bình	2	x	15	Upgrading to 2 circuits	
108	Phu My - My Xuan	2	x	3	2007	
109	Phu My - Ba Ria	2	x	24.7	Increasing cross section of conductor	
110	Nhon Trach TPP - Tam Phuoc - Song May	2	x	36	Associated with Nhon Trach	
111	Nha Be - Phu Lam	2	x	15	Increasing cross section of conductor	
112	Phu Lam – Hoc Mon	2	x	19	Increasing cross section of conductor	
113	Cat Lai - Thu Duc	2	x	9	Increasing cross section of conductor	
114	My Tho - Ben Tre	2	x	21	Circuit 2	
115	O Mon - Vinh Long	2	x	40		
116	O Mon TPP- Tra Noc	2	x	10		

Source: "Review of Implementation of Power Development Plan VI", IE, April 2010
The black letters are for before 2009 or are unknown, the blue letters are for before 2010, the red letters are for after 2010

2.4.2 Issues on the Implementation of PDP6

IE summarized the causes of the delay of power development projects as follows.

- Influences of the global economic recession
- Lack of investor funds when several projects are implemented simultaneously
- The long lead time requirement for loan processing
- Inadequate management and bidding procedures due to the lack of skills of the consultants and contractors
- Steep rise in the prices of the materials due to an increase in oil prices. Six months to one year delays in supplying materials and facilities
- Lack of functions in schedule management and in securing IPP projects. Especially the new investors' lack of experience.
- Issues regarding land acquisitions and their compensation

The construction of the transmission lines and substations were delayed due to the following reasons as well as the cases concerning the construction of power plants.

- Lack of capital funds
- The investment into transmission lines and substation has scarcely proceeded where the power demand was only increased locally while not increasing so much in the surrounding neighboring areas.
- Inadequate management and lack of skills of the consultants and contractors
- Steep rise in the prices of the materials
- Difficulty has become severer with land acquisition and compensation A lack of coordination among the power sectors and relevant persons especially in large cities. (For example, insufficient coordination among the sectors make procedures difficult while the leader politically agreed with it.)

Apart from the aforementioned main causes indicated by IE, other causes can be determined.

- Too many ambitious plans in the PDP6
- Lack of funds by Vietnamese Authorities
- Ineffective countermeasures by MOIT against project delays
- The agreement on the PPAs between EVN and investors were delayed (There were issues regarding government tariff regulation)
- The contractor's fragile management base (Especially of Chinese companies)

- Substandard conditions at the construction sites of the coal thermal power plants in the south region (including the weather conditions)
- Raised the cost for resettlement (for the construction of hydropower stations)

PDP6 has been delayed due to the world economic recession, a capital fund shortage and a shortage of constructors. The important points for creating PDp7 are as follows.

- The biggest negative factor in the PDP7 is a shortage of capital funds as well as PDP6. In the case of the PDP6, the fund shortage is pointed out at the starting of the plan. For a long time, in the Vietnam power sector, EVN has exclusively supplied power to the whole country. Via the open market policy of the Vietnam government, the government wants to increase power supply capacity by using the BOT and BOO finance system.
- The power tariffs in Vietnam are lower than other countries. The low tariffs are attractive for foreign companies, it can be mentioned that the foreign companies came to Vietnam due to the low power tariffs. However there is a possibility that in the near future, low power tariffs will be suitably rearranged.
- During the PDP7, rapid power demand increase can be predicted. As a counter-measure, it has to create a power balance by considering energy and power conservation. Concretely, energy efficiency and conservation (EE&C), demand side management (DSM) and Regional well balance of the power system can be promoted.
- One of the differences between PDP6 and PDP7 is the managing authority of IE. The authority has been transferred from EVN to MOIT. Under MOIT, IE can create PDP7 in considering the regional power balance including the power demand from industrial parks and large scale commercial facilities in the whole country.
- High growth power demand in the residential sector in the PDP7 has also been forecasted. However, the demand forecast is real when compared to PDP6. When considering the government situation, Vietnam policy has not changed in that the government requests to support the ODA Loan and the technical assistance from JICA. The current power shortage in Vietnam becomes the bottleneck of their economic growth. Therefore the Japanese supports need more effort to be implemented “Just in time”.

2.4.3 Power Shortage

As described in sections 2.2 and 2.3, the implementation of both the power generation plan and the power network system plan has been delayed. The delay of the implementation of the power system facilities, remaining only at around 70% of the power generation plan from 2006 to 2010 and around 50% of the power network plan implemented, has resulted in the low reserve margin of the power system facilities against the maximum power demand.

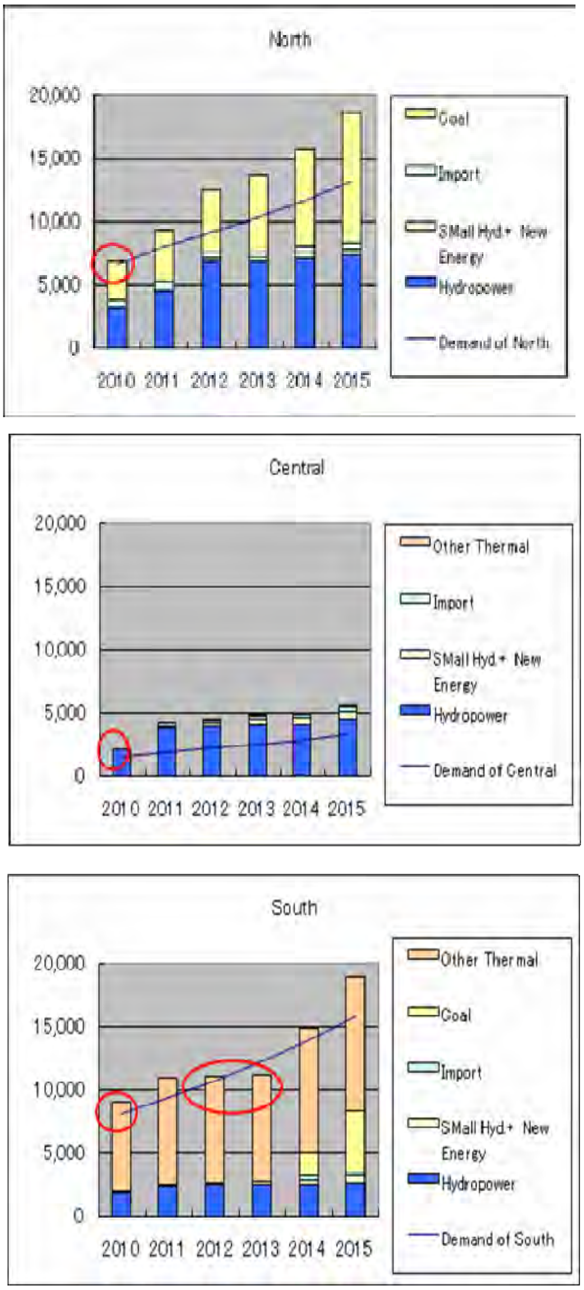
Furthermore, the water head of the Hoa Binh hydropower station (1,920 MW) was lowered down to 70-80 % of the designed value in June 2010 and the northern region suffered from a significant power shortage.

Some of the 220 kV system facilities were operated at their overloaded conditions due to the delay of the implementation of the power network facilities in the northern region such as Hanoi city, Hung Yen and Bac Ninh and the southern region such as Ho Chi Minh City, Dong Nai, Binh Duong and Long An. Especially in the dry seasons, the power supply interruptions that occurred in Hanoi due to the overloaded conditions of the 220 kV system.

The causes of the power supply interruptions can be attributed not only to the shortage of power generation but also to the management and the maintenance and the shortage of the capacities of the power transmission lines.

Fig. 2.4.1 are shown the comparison between the maximum power demand and the capacity of the power system facilities. It is expected that the low reserve margin of the power system facilities against the maximum power demand in the future at a period of water shortage.

(Unit: MW)



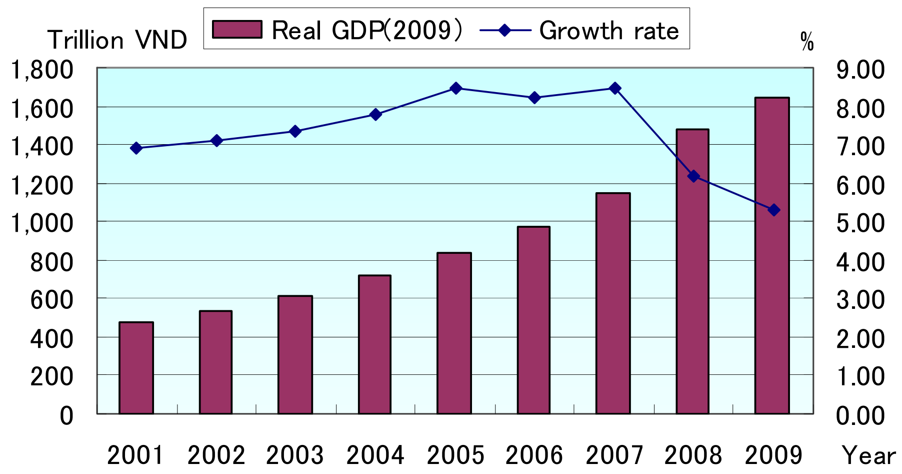
Source: Estimated by IE data

Figure 2.4-1: The Comparison between the Maximum Power Demand and the Capacity of the Power System Facilities

Chapter 3 Evaluation of the Current Power Demand Forecasts

3.1 Study on Economic Conditions in Vietnam

Remarkable economic development has been achieved in Vietnam through the adoption of the “Doi Moi (the Reform)” policy since 1986, implementing several “Socio-Economic Development Plans.” In addition, Vietnam has officially become a member of the World Trade Organization (WTO). The real GDP has on average expanded at the annual pace of 7.3% from 2001 to 2009. This is depicted in Figure 3.1-1.



Source: IMF World Economic Outlook Database (2010/04)

Figure 3.1-1: The Real GDP and Annual Growth Rate

There is a report called the SED2020 which conducted an economic conditions analysis of its own country in Vietnam. This report improved " Economic Development Forecast serving Study on Development for the period up to 2050" (EDF2050) and was drawn up in June 2009 for the creation of the PDP7.

According to Figure 3.1-1, during the period of 2001-2009, the GDP in 2009 was equal to 1.76 times the GDP in 2001; it was about 16,454 billion VND (at present price). Although the economic growth rate stagnated temporarily under the influence of the “Asian currency crisis” in 1997, it sped up gradually after that and the economic growth rates from 2001 to 2005 recovered to 7.5% of the annual average. Furthermore, it reached no less than 8% of the annual average rate from 2006 to 2007. In 2008, it was affected by the influence of the "World economic crisis" and decreased to 6.18% and drove it towards 5.32% which was the worst since 1999. But after then, it becomes better through the recovery of industry sector and there is a sign of economic recovery.

According to SED2020, if it considers the shares of each sector, during the period of 2001-2008, Vietnam's economic growth rate was mainly based on growth rate of Industry and Construction whose contribution was about 50%. Service and other contributions were about 40%. The remaining 10% was contributed by Agriculture, Forestry and Fishery. The contribution of industry and Construction to the GDP growth rate was relatively stable during this period. On the contrary, the contributions of agriculture, forestry and fishery and services and others varied in the direction that shares of agriculture, forestry and fishery were reducing, but the share of services was increasing (details in Figure 3.1-2). The agriculture, forestry and fishery sector was relatively stagnant and behind other sectors. During the period 2001-2008, the economy of Vietnam underwent important changes in terms of economic and laborer structure towards the direction of mobilizing advantages in each sector, areas. The particulars are shown in Figure 3.1-3. It turns out that they support the economy of Vietnam in Industry and Construction, Service and others.

Source: SED2020

Figure 3.1-2: The Shares of Each Sector in Economic Growth

Source: SED2020

Figure 3.1-3: The Change of Economic Structure

Moreover, FDI is increasing rapidly in Vietnam in recent years. This index shows that the country slipped out of the early stage of development preparation and went into the second step towards an economic takeoff. By the end of 2008, the amount of FDI amounted to 64 billion dollars. It had reached 4.5 times the amount of FDI currently assumed in the social economy development plan, and it can be said that economic internationalization and marketing are accelerating the inflow of FDI into Vietnam. Although the FDI to Vietnam made little increase for the "World economic crisis" in 2009, it is expected to recover again in 2010 and afterwards.

3.2 Social Economic Outlook from 2010 to 2030

"The Socio-Economic Development Strategy 2001-2010" exists as the latest public outlook with regards to Vietnam's long-term economic trend. Then, the same formal long-term outlook, as it could not be found, the EDF2050 was drawn up by the Expert group in 2005. Further, SED2020 was drawn up as Chapter 2.1 indicated.

According to SED2020, it is said that the future Vietnam economy will be greatly affected by international economic trends, especially those of Japan, the United States, EU and ASEAN like other developing countries. Therefore, the outlook of the Vietnam economy has been described in consideration of the outlook of the world economy.

The economic gap between China and the leading ASEAN countries continues to be the driving force for Vietnam's high economic growth. The economic gap (the gap of per capita GDPs) between Vietnam and other countries will not disappear easily. With regards to the long-term economic outlook of the SED2020, it assumes that around 8.0% economic growth will continue through to 2030, this projection may be summarized as below.

In addition, although it is difficult to evaluate the predicted value of SED2020 at present, it carries out by a case dividing with fast development, base and low development scenario, so the method and the contents can be evaluated.

3.2.1 Present Situation of World Economy

It is as the present conditions of the world economy are shown below. From now on, the world will become increasingly interdependent as it enters a period of peace and stability. However, given the fast pace of international events, unexpected changes may occur. Accordingly, it is predicted that developing countries will also be greatly affected by the influence of the world economy.

- The economic crisis occurred in 2007 and the economic cycle entered into a new period of restoration.
- Such a situation makes it difficult for developing countries to compete for their share of attractive resources.
- Economies in the world are becoming increasingly interdependent with escalating risks.
- Science and technology, especially information such as biological technology will continue to strongly impact the growth and change of the global economic structure.
- The deficits in the trade balance of the developed countries affect the investment capital flow to developing countries.
- Tendency of globalization, reorganization will continue and cover most fields of social, economic and inhabitable areas.

3.2.2 Prospects of World Economy

When global economic growth is considered against a background of the situation mentioned in the section 3.2.1, concerning the growth of the world economy, there is a view that is fundamentally in harmony in its optimism from the following points. Although the influence of the "World economic crisis" is not yet over, it will breathe its last breath in 2010 and from that juncture; substantial growth is to be expected.

- Growth of trading activities is on a positive upward trend

- Investment has strongly increased, especially FDI; ODA and indirect investment tends to increase.
- Financial sector has become increasingly important in promoting world economic development.
- Consumption has strongly increased, mainly in the emerging markets.
- World labor market will be affected by the globalization process and demographic changes.

3.2.3 Opportunities for Vietnamese Economy

First, the potential predominance which will contribute to the economic development of Vietnam and which Vietnam has is articulated below.

- Vietnam is located in a dynamic region of Asia with high economic growth. Therefore the growth of trading and investment activities is positive.
- With the advantages of natural resources, human resources, a stable political social situation, the international economy will contribute to Vietnam expansion; especially the big economies such as those of the US, EU, Japan who are paying more attention to Vietnam. Further, Vietnam also maintains strong relations with NAFTA, India and Korea.
- The export market will expand and more investment capital will become attracted to Vietnam, so that there will be many opportunities for international laborers to participate in Vietnam’s growth,
- The restructuring of the world economy, especially the large economies, will have a strong and positive impact on Vietnam’s economic structure.
- Vietnam will have more options of technology transfer and technology renovation.
- Opening markets and the development and completion of market rules will allow Vietnam easy access to global science and technological information and it will also enhance laborer productivity and the production efficiency of the Vietnam economy.

3.2.4 Challenges for Vietnamese Economy

Next, the challenges for the economic development of Vietnam are shown below.

- Many countries are faced with competition in the export markets, attracting capital investment, laborers and technologies, including Vietnam because of globalization

- Although internationalization has brought about development opportunities, many countries including Vietnam will be faced with competition in the export markets and will have to compete for investment capital, labour and technology.
- The rise of large developing economies such as China, India and ASEAN countries creates more fierce competition for Vietnam.
- The development Vietnamese potential is limited in terms of human resources (lack of high quality workers), weak infrastructure conditions, small economy scale, small enterprises and weak competitiveness.
- Protection and commercial barriers are still being applied by countries.
- Application of protection and commercial barriers is primarily from developed countries, big countries. Meanwhile, the competitive capacity of Vietnam's goods and services remains weak.
- An understanding and an application of the international rules of Vietnam enterprises is also weak. Vietnam enterprises will meet many difficulties in overcoming this barrier to penetrate into international markets.
- The risk of losing domestic markets exists due to having to lift the customs barrier in meeting international commitments

3.2.5 Factors of Economic Development Scenario

Based on the results of the above analysis, the factors, which are required to create the economic development scenario, have been shown below.

- Possibility to overcome the crisis, achieve stabilization and restoration of growth
- The stability of the international environment tends to speed up globalization and economic liberalization, expanded international economic relations
- Increase of investment capital (especially the FDI)
- The energy problem is solved, energy prices in the world will be stabilized, especially oil prices.

Moreover, the key strategic questions have been articulated below.

- Is it possible that Vietnam can limit the impact of the international economic crisis towards a swift recovery or a slow restoration of growth?
- Will Vietnam successfully overcome the challenges of globalization and international economic integration?
- How will the domestic factors be mobilized?

3.2.6 Fast Development Scenario for Vietnam

The economic development outlook via the fast development scenario is shown below.

- World economy will recover from the crisis in 2009 and achieve growth restoration in 2010.
- International environment is stable and favorable.
- Energy market, especially the oil market, is stable: oil price is stabilizes at a reasonable price.
- Vietnam will successfully overcome the challenges of globalization and international economic integration.
- Domestic actors will be mobilized at a high level of regulatory reform, policies, and administration.
- Comprehensive and continuous reforms are implemented, with mobilizing resources being continuous, stable and sustainable up to 2020 and the years to follow.
- Policies have been set for the promotion of the fast development of industries that create high added value and high technology toward exports.
- The problem of laborers is satisfactorily solved based on the development of high quality services and labor intensive industries.
- A technical infrastructure system is formed.
- Development of basic industries that create input to the economy will be invested based on economic capability and availability in 2020.

3.2.7 Base Scenario (Medium Development Scenario)

The economic development outlook via the medium development scenario is shown below.

- World economy will get out from the crisis in 2009 and restore growth in 2010.
- International environment is stable and favorable.
- Energy market, especially the oil market, is stable: the oil price stabilizes at a reasonable price.
- Vietnam will successfully overcome the challenges of globalization and international economic integration.
- Domestic factors will be mobilized at an average level of regulatory reform, policies and administration.

- Policies are set for the promotion of the fast development of industries which create high added value and high technology toward exports.
- Problem of laborers is satisfactorily solved based on the development of high quality services and labor intensive industries.
- Technical infrastructure system is developed at a moderate level.
- Development of selected basic industries in 2020.
- Continuous investment in the technical infrastructure system, as well as basic industries, to create a solid background for development in the next periods.

3.2.8 Low Development Scenario

The economic development outlook by the low development scenario is shown below.

- World economy will not get out from crisis in 2009 and growth restoration is slow.
- International environment is less stable.
- Energy market (especially the oil market) is not stable with escalating oil prices.
- The domestic economy, affected by the financial crisis, falls into a slump akin to the Asian financial crisis.
- Low level of regulatory reform, policies, administration reform is slow, domestic environment is not really favorable in the direction of serving economic development requirements.
- Implementation of comprehensive and continuous reforms and the creation of resources in a stable and sustainable way have been delayed for years after 2000.
- Weak development of export industries which create high added value.
- Unresolved labor problems
- Development of infrastructure system at a low level; development of selected basic industries by 2020.
- Continuous investment in the technical infrastructure system as well as basic industries to create a solid foundation for development in the next periods.

3.3 Survey on Primary Development Plan

The targets of the survey are industrial parks, commercial facilities, transportation facilities (railway, port, airport, and road), resort facilities and academic cities.

3.3.1 Large-Scale Facility Development Plan

(1) Industrial Park

This plan is the keystone of Vietnam economical development and is held up as a nationwide subject. Many industrial parks have so far been constructed with many more to be built in the future.

(a) Current Status

The number and areas of the industrial park in 2008 are shown in Table 3.3-1.

Table 3.3-1: Existing Industrial Park (2008)

District		number	area(ha)
North	Red River Delta	58	14.1
	Northern Midlands and Mountain area	14	2.3
Central	Central Coastal area	27	4.9
	Central Highlands	7	0.9
South	South East	82	27.7
	Mekong River Delta	35	7.3
	Total	223	57.3

Source: "Survey of Large-scale facility projects in Vietnam", INDUTECH, 2010

The number of working industrial parks total 145 with a square area of 36,199 ha is in this table. The percentage amount of this number is 65% and for area is 63%. The rest is under construction. The investment in the infrastructure of industrial parks is 2.4 billion USD from FDI (Foreign Direct Investment) and 86 trillion VND from the Vietnam side. Here the VND represents Vietnam Dong. 47% of the FDI has already been paid, 37.5% of domestic investment. In order to work in these industrial parks, it requires that the number of projects total 3,363 with an investment of 36,763 billion USD from FDI and 234 trillion VND from the Vietnam side. 43.1% of this total investment has already been paid from FDI, 42.8% from Vietnam.

(b) Development Plans by 2020

The development of industrial parks is controlled by the DSI (The Development Strategy Institute), which is under MPI (Ministry of Planning and Investment). The Survey result was retrieved based on the development plan document written by DSI. The total development plan and plan by district of the new industrial park is shown in Tables 3.3-2 and 3.3-3 - Table 3.3-4, respectively.

Table 3.3-2: Scale of Total Development Plan of Industrial Park by 2020

term	2010	2011-2015	2016-2020
total area (ha)	55,000-60,000	84,000-85,000	130,000-131,000
Cost for infurastructure (billion US$)		2.5-3.0	4.0-4.5
Investment(billion US$)		50-55	40-45

Source: "Survey of Large-scale facility projects in Vietnam", INDUTECH, 2010

Table 3.3-3: Development Plan of Industrial Park by District in Period 2011-2015

district		Period of 2011-2015				
		growth rate of production sales (%.year)	number	area(ha)	cost for infrastructure billion US$	investment billion US$
North	Red River Delta	13.5-14	10	2000	0.2	4
	Northern Midlands and Mountain area	13-14	34	11,000-12,000	1	18-20
Central	Central Coastal area	13-14	16	4,000-4,500	0.4	7-8
	Central Highlands	17-18		2000	0.15	0.5-10
South	South East	12-13	16	6,500-7,000	0.5-1.0	14-15
	Mekong River Delta	14	16	3,200-3,500	0.5	8.5-9.0

Source: "Survey of Large-scale facility projects in Vietnam", INDUTECH, 2010

Table 3.3-4: Development Plan of Industrial Park by District in Period 2016

district		Period of 2016-2020				
		growth rate of production sales (%.year)	number	area(ha)	cost for infrastructure billion US$	investment billion US$
North	Red River Delta	12-14	12	4000	0.4	4.3-4.5
	Northern Midlands and Mountain area	10	43	42,000-43,000	1.6-2.0	17-18
Central	Central Coastal area	13	14-15	7,800-7,900	0.7-0.8	8
	Central Highlands	>15%		500-700	0.05	0.5-1.0
South	South East	9-10	23	10,000-10,500	1	10
	Mekong River Delta	13	15	5000	0.5-0.7	5-7

Source: "Survey of Large-scale facility projects in Vietnam", INDUTECH, 2010

The detailed information of the individual plans of industrial parks should be referred to in the Survey Result Report.

(2) Commercial Facilities

The scale of Commercial facilities is small in comparison to industrial parks. The development plan by 2015 has been announced, but not for after 2016. The development plan in the north, central, south area is shown in tables 3.3-5, 3.3-6 and 3.3-7.

In the following table, m^2 refers to the square floor area, GFA stands for the grand floor area which includes the garden area etc in the scale column and “O” refers to office, “A” means apartment, “S” means shopping center, “H” stands for Hotel in the column of the facility and the column of year means the year when the facility commenced operations.

Table 3.3-5: Development Plan of Commercial Facility in the North District

district	name	location	scale	investment	year	facility
North	PVN tower	Hanoi	102 floors	1 billion US$	2015	O
North	Royal City	Hanoi	120,945 ㎡	10,000 VND milion	2013	O, A, S
North	Hanoi City Complex	Hanoi	14,094㎡, 65floors GFA 250,572.26㎡	400 million US$	2012	O, A, S
North	Grand Plaza	Hanoi	16,000 ㎡, GFA 119,500 ㎡		2010	O, S
North	The Lancaster Hanoi	Hanoi	GFA 50,900㎡	650 billion VND	2012	O, A, S
North	Tricons Tower	Hanoi	17,211 ㎡	145 million US$	2013	A, S
North	Handico Tower	Hanoi	5,376㎡, GFA 35,750㎡ 2000 persons	732 billion VND	2010	O, A, S
North	MIPEC Towers	Hanoi		1,500 billion VND	2010	O, A, S
North	Ciputra Mall	Hanoi	130,000 ㎡		2010	S
North	Vincom Plaza	Hai Phong	GFA 137,400 ㎡	1,400 billion VND	2010	O, A
North	Pearl Phương Nam Tower	Hanoi	GFA 65,250 ㎡	1,400 billion VND	2010	O
North	Habico Tower	Hanoi	4,490 ㎡, GFA 120,200 ㎡	220 million US$	2010	O, A
North	Keagnam tower	Hanoi	46,000 ㎡	500 million US$	2010	O, A
North	Long Giang building	Hanoi	11,235 ㎡	800 million VND	2013	O, A, S
North	Thanh Binh hotel	Thái Bình	10,045 ㎡, GFA 44,702 ㎡	503 million VND	2013	H, O, A, S

Source: “Survey of Large-scale facility projects in Vietnam”, INDUTECH, 2010

Table 3.3-6: Development Plan of Commercial Facility in the Central District

district	name	location	scale	investment	year	facility
Central	Lighthouse Complex Tower Nha Trang	Nha Trang		1,800 billion VND	2013	O, A, S
Central	Blooming Tower Danang	Danang	10,770 ㎡, GFA120,000 ㎡	90 million US$	2010	O, A, S
Central	Viễn Đông Meridian towers	Da Nang		180 million US$	2014	O, A, S
Central	Harmony Tower	Da Nang		850 million VND	2012	

Source: “Survey of Large-scale facility projects in Vietnam”, INDUTECH, 2010

Table 3.3-7: Development Plan of Commercial Facility in the South District

district	name	location	scale	investment	year	facility
South	City Gate Towers	HCMc		1,708 billion VND	2013	O, A, S
South	Sài Gòn M&C	HCMc	GFA 72,000 ㎡	256 million US$		O, A
South	Associates International building	HCMc	NA	1.2 billion US$	2014	O
South	Crescent Mall	HCMc	GFA 112,000㎡	200 million US$	2015	O, A, S
South	Bitexco Financial Tower		100,000 ㎡,	220 million US$	2014	O, A, S
South	Thành Công Tower 2	HCMc	65,000 ㎡, GFA 647,000 ㎡	210 million US$	NA	O, A, S
South	Tân Phong Shopping Complex	HCMc		350 million US$	2011	S
South	Vietcombank Tower	HCMc	3,200 ㎡	96.5 million US$	2013	O, A, H
South	DIC Phoenix	Bà Rịa-Vũng Tàu	27,645㎡, GFA 115,000㎡	1,620 billion VND	2012	O, A, S
South	Royal Tower	HCMc	2,775 ㎡; GFA 41,000㎡	50 million US$	2011	O

Source: “Survey of Large-scale facility projects in Vietnam”, INDUTECH, 2010

(3) Resort Facilities

The development plan of resort facilities is supposed to be approved by the local government. Almost all of the resort facilities are developed by private enterprises or investors, sometimes national enterprises may participate in the development.

Villas, golf fields, apartments and supermarkets are located around the hotel in the resort area. The survey results are shown in Table 3.3-8.

Table 3.3-8: Development Plan of Resort Facility

No	name		area	investment	year	facility	facility
1.	Ho Tram Resort	Ba Ria – Vung Tau	170 ha	4.2 billion US$	2013	Hotel, casino, entertainment, expro, …	1114 rooms
2.	Bai Dai Resort	Phu Quoc		1.64 billion US$		Hotel, villa, entertainment	2 5-star hotel and 150 villa
3.	Le Meridien Danang Resort & Spa	Da Nang	12ha; GFA-125,000 ㎡	110 million US$	2013	Hotel, villa	149 apartment, 48 villa
4.	Good Choice resort	Ba Ria – Vung Tau		1.3 billion US$			
5.	Bai Truong	Phu Quoc	155ha	800 billion VND			
6.	Son Tra	Da Nang	14ha	650 billion VND			200 villa
7.	Ngu Hang Son resort	Da Nang	20ha	80 million US$			40 villa
8.	Eden	Da Nang	34ha	180 million US$			
9.	Sài Gòn Sun Bay	Can Gio	600ha	526 million US$			
10.	Dai Ninh resort		6,600ha	4,327 million US$			6000 villa
11.	Ha Long complex	Quang Ninh		180 million US$			400 villa
12.	De Lagi	Binh Thuan	216.4ha	1,600 million VND	2015	Villa,	
13.	Blue Sapphire Resort	Ba Ria – Vung Tau	GFA: 104,970㎡	1,500 million VND	2016	Hotel, apartment, villa,…	150-room hotel, 38 villas, 132 apartments
14.	Sea Star Suite	Ba Ria – Vung Tau	3ha	600 million VND	2012		573 rooms for 1000 persons
15.	Six Senses Saigon River	Dong Nai	GFA 553,265㎡	36 million US$	2008	Apartment, villa	40 apartment, 120 villa
16.	The Long Hai	Ba Ria – Vung Tau	50,000㎡	712 million VND	2011	Apartment, villa	250 hotel rooms, 60 apartments
17.	Hotel De Royale Da Lat		190.08ha		2013	Hotel, villa	2 hotelx100 rooms, 69 villa

Source: "Survey of Large-scale facility projects in Vietnam", INDUTECH, 2010

There are now 19 golf fields. 70 golf fields are supposed to be approved by 2020. But there is no financial aid from the national budget. The new golf field is imposed to satisfy the recreation and health demands of the people in the district. Further, the maximum area is 100 ha in the case of 18 halls and work on the golf field project should begin 4 years after obtaining the license. 17 golf fields are permitted in the north district, 17 in the central and 36 in the south district. (Data source of golf field: magazine "Vietnam economic news 15/2/2010")

(4) Transportation Facilities

The transportation facility includes railway, port, airport and road facilities

(a) Railways

According to the “Vietnam economic news 15/09/2009” published by the Vietnam Economic Institute, the prime minister approved the transportation strategic plan by 2020. Based on this plan, Vietnam is supposed to have 1,100-1,200 train engines and 50,000 to 53,000 train cars by 2020. The “Vietnam economic news 30/11/2009” also stated that the prime minister approved the transportation master plan. The plan’s targets are as follows:

Ratio of transportation of passenger by train	20%
Ratio of transportation of cargo by train	14%

The total length of railway to be extended and funded is represented in Table 3.3-9.

Table 3.3-9: Plan of Transportation by Train（Unit of Fund : 100million VND）

term	length (km)	investment (billion VND)	by 2010 note	fund	by 2020 note	fund	by 2030 note	fund
A.Upgrading of existing railway	2,256	2,242		1,391		851		
B.New adding	3,056	32,610		782		21,786		10,043
C.Urban and district railway	991	42,118		32,570		32,141		6,720
D.Railway connected each city	169	3,450		0		3,450		0
E. South-North shinkannsenn	2,020	122,277			Shinkannsen	50,598	Shinkannsen	71,669
Total	8,492	202,697		34,743		108,826		88,433

Source: “Survey of Large-scale facility projects in Vietnam”, INDUTECH, 2010

(b) Development Plan of Port

There are two kinds of ports, seaports and river ports. The seaport is an important facility because it plays a great role for industrialization, modernization, safety, defense and the hub of trade in Vietnam. The master plan of transportation approved by the prime minister has the following targets.

● Investment:	360,000-440,000 billion VND	2010-2020
	810,000-990,000 billion VND	2020-2030
● Cargo capacity:	198 million ton	2010
	1,100 million ton	2020
	1600-2100 million ton	2030

The seaport system of Vietnam can be divided into the following categories: size, functions and tasks:

- National general ports, which are major ports in Vietnam's seaport system, include:

- International trans-shipment port: Van Phong-Khanh Hoa:
- International gateway ports: Hai Phong and Ba Ria- Vung Tau;

- Key regional ports: Hon Gai-Quang Ninh. Nghi Son-Thanh Hoa etc.
- Local ports: operate mainly within localities (provinces, cities).
- Specialized ports: directly serve the specified industrial park and certain particular commodities (crude oil, oil products, coal, passengers, etc.)

Table 3.3-10 represents the seaport facility development plan by district based on the capacity (maximum cargo handling quantity) as the scale. The seaport has a passenger transportation function, but it is small enough as to be practically insignificant in comparison to the transportation of the cargo that it should be neglected. The ships from the seaport have the function of transporting passengers, but this role is so minor in comparison to hauling cargo that it can be neglected.

Table 3.3-10: Development Plan of Seaport Facility

district	current（cargo capacity)（million ton)	Adding new cargo capacity (million ton)	
	2007	by 2015	by 2020
North	22	10	21
Central	9	68	133
South	15	49	64
Total	46	126	217

Source: "Survey of Large-scale facility projects in Vietnam", INDUTECH, 2010

The cargo capacity in the central district is now the least among three districts, but adding cargo capacity is the biggest. It means that the central district is paid attention to in the seaport. The master plan on the development of Vietnam's river port transport by 2020 was submitted by MOC and approved by PM in June 2008. The following are the contents contained in this plan:

- North district
  - Cargo ports: To adjust the size of seven ports and supplement the planning of 34 ports, including five new ports.
  - Passenger ports: To adjust the size of two ports and supplement the planning on four ports.
- Central district
  - To supplement the planning on six cargo ports, including one new port.

- South district
  - Cao Lanh, My Thoi and Vinh Long ports were approved. To supplement the planning on 21 cargo ports, including five new ones, and 15 passenger ports.

The total capital required for the development of the river port transport infrastructure during 2010-2020 is estimated at 36,780 billion VND. The scale of the river port is shown in Table 3.3-11.

Table 3.3-11: Development Plan of River Port (by 2020)

district	New add plan	
	cargo (million ton/year)	passsenger (million passenger/year)
North	6	1
Central	4	0
South	13	2
Total	23	3

Source: "Survey of Large-scale facility projects in Vietnam", INDUTECH, 2010

(c) Airport

In May 2009, Ministry of Transport announced the approval of the adjustment plan on airport development throughout the country that targeted 10 international airports by 2025. Especially, some international airports will be added such as Cat Bi, Chu Lai, Cam Ranh, Phu Bai, Can Tho, Phu Quoc and Long Thanh

- In the North, the Noi Bai International airport that served seven million passengers in 2008 will be expanded to server 30 million passengers. Cat Bi International Airport (Hai Phong) is planning development by 2025 with a total square area of nearly 500 ha and cost more than 1,700 billion VND that can receive two million passengers per year and 17 thousand tons of freight.
- In the Central, in addition to the existing Da Nang, Phu Bai airport, Cam Ranh and Chu Lai international airport will be built by 2025. It will contribute to transforming Central into an international trade center of the Mekong region and Asia – Pacific.
- In the South, the Phu Quoc international airport will be able to receive seven million passengers per year with construction to begin this year. The Long Thanh airport, which is the biggest in the South, is located in the Dong Nai

province is estimated to cost 5 billion USD. It will be able to receive 100 million passengers per year and five million ton of cargo.

The table 3.3-12 shows the development plan of the airport based on the number of passengers.

Table 3.3-12: Development Plan of Airport by District (Passengers Million Person)

	2015	2020	2025	2030
North	2	25	27	77
Central	8	21	23	30
South	100	100	100	100
Total	111	146	150	207

Source: "Survey of Large-scale facility projects in Vietnam", INDUTECH, 2010

(c) Road

Since the road plan is outside of the categorical scope of the facilities, this time it was not on the request list which is passed on to the local consultant. However, the results were published in the "Vietnam Economic News 11/15/2009" as follows. Although the distance published in the developmental plan was the distance of the total length of the road, the length of the distance was estimated by equally dividing the concerned district as shown in Table 3.3-13.

Table 3.3-13: Development Plan of Road by 2020 (km)

name	length(km)	north	central	south
South-North High Way	3,262	1,087	1,087	1,087
Network in North road	1,099	1,099	0	0
Highway in central	264	0	264	0
Highway in south	984	0	0	984
Road along coast	3,127	1,042	1,042	1,042
Road along boundary	4,432	1,477	1,477	1,477
Total	13,168	4,706	3,871	4,591

Source: "Survey of Large-scale facility projects in Vietnam", INDUTECH, 2010

3.3.2 Power Demand Forecasting by a Large-Scale Facility Development Plan

The large-scale facility was classified into industrial parks, commercial facilities (including resorts) and transportation facilities. The development plan was surveyed in each facility. The power demand of each facility by district and by year was estimated based on the survey results. The method of power forecasting is as follows. At first the facility whose scale and power demand was announced was picked up. By dividing the power consumption by the scale, the power consumption per unit scale was secondly estimated. This value will be referenced as “the power demand index” hereinafter. Lastly by multiplying the scale of the planned facility utilizing the power demand index, the power demand from that facility was estimated.

(1) Estimation of Power Demand Index

The power demand index should be extracted from officially published data as much as possible. For example, the Tokyo municipal in Japan announced the average energy consumption per unit floor area of the building based on usage. In the case of facilities of which the power demand is not published, such as airports, golf fields and subways, the power demand index can be retrieved by the method described above. This time the power demand of facilities was primarily searched through the internet if such information was publicly available for viewing or by officially disclosed power demand listings by sector were used.

(a) Commercial Facilities

The commercial facilities are composed of offices, shopping centers and apartments. “General survey of greenhouse gas emission in Tokyo municipal (actual data at 2000): Tokyo municipal announced” reports that the power demand index per unit floor area of the building by use and fuel is as follows (MJ is the abbreviation of Mega Joule and the unit of heat value)

- Office 788 MJ/m^2/year
- Department 1,458 MJ/m^2/year

10 years passed from the point when this value was measured. So by assuming that the energy saving was attained by 20%, the following power demand index can be obtained. (1 kWh = 3.6 MJ)

- Office 175 kWh/m^2/year
- Shopping center 324 kWh/m^2/year

(Assumption: Shopping center is equivalent to the department store.)

The area of one household is assumed to be 100 m^2. According to data of the power demand forecasting model in the 2008 Vietnam energy master plan, a total household number is 18.8 million; power demand of residential sector is 26,504 GWh/year. So the power demand index per household is 1.4 MWh/ household/year.

(b) Resort Facility

Here the resort facilities are assumed to be hotels, villas, and golf fields.

- Hotel

  The following data come from the hotel in Niigata prefecture in Japan (1996).
  - total floor area 12,890 m^2
  - power demand index 1,910 MJ/m^2/year＝424 kWh/m^2/year (assumption : energy saving rate 20％)
  - room number 309 rooms
  - 13 floors above ground first basement

  (Source: http://www.eccj.or.jp/esco/report00/02_23.html by The Energy Conservation Center, Japan)

  Assuming that the rate of the guest room area to the total floor area is 40%, the average area of one guest room comes to be 16.6 m^2. So the following power demand index can be defined as follows:
  - Power demand index1 of hotel 424 kWh/ m^2/year
  - Power demand index2 of hotel 424×16.6＝7 MWh /room/year

- **Villa**

  Assuming that a Vietnamese family lives in a villa, as described in the commercial facility, the power demand index of households is 1.4 MWh/household/year. Assuming that yearly working rate of villa is 50%, the power demand index is 0.7 MWh/villa/year.

- **Golf Field**

  According to the law of Vietnam, the maximum area of a new golf field is limited to 100ha As a sample of the same scale golf field, there is data of which the yearly power cost is reported to be 8 million yen (Source: http://www.golfdigest.co.jp/digest/column/back9/2003/20030715d.asp).

  The power cost in golf field was at that moment 16.4 Yen/kWh. So the power demand index comes to 8,000,000 / 16.4 = 489 MWh/year.

(c) Transportation Facility

The power demand from the transportation sector was 539 GWh in 2007.
(Source: IEA database). This figure includes all fields of transportation like railways, ports, airports and roads. The statistical data concerning the power consumption of each field cannot be gotten. So it is assumed that the total power consumption in the transportation sector has been divided equally into three fields as follow.

- Railway 1/3 （=180 GWh/year）
- Road 1/3 （=180 GWh/year）
- Port 1/3 （=180 GWh/year）
- Airport 0

- **Railway – Lightning in the Station**

  The current total length of railway in Vietnam is 2,256 km (Source:“Vietnam economic news 30/11/2009”). Then the power demand index comes to be 180 GWh/2,256 km =80 MWh/km.

- **Railway-- Subway**

  A subway in Bangkok city was picked up to be used as a sample

  - total length 20ｋｍ
  - number of station 18
  - area of rail yard 48 ha
  - power consumption 120 GWh/year

  (Source:
  （http://www.jica.go.jp/activities/evaluation/general_new/2008/pdf/part03_z02_03.pdf）)

  Then the following power demand index comes to 6 GWh/km.

- **Road—Gasoline Stand**

  The power demand of one gasoline stand is reported to be 30.4 MWh/year in the Japanese sample. The total power consumption of the road is 180 GWh/year, so if this consumption comes from only the gasoline stand, the total gasoline number in Vietnam comes to $180\times10^3/30.4 = 5{,}900$.

  The total road length of the road in 2007 is 160,089 km. (Source: “Vietnam statistical yearbook 2008”) Then the distance between gasoline stands comes to 27 km. Assuming that one gasoline stand is constructed per 27 km, when new roads are built in the future, the power demand index of the road – the gasoline stand comes to 30.4/27 =1.13 MWh/km.

- **Road— Street Lightning**

  Assuming that

  - Location of street light both side of road
  - Interval of street light 100 m
  - Capacity of 1 light 120 W
  - Lightning time length 12 hours

  the power demand index of road -lightning comes to 10.5 MWh/km/year

- **Port**

  Both the power demand index per cargo and passengers have been estimated as follows.

  - Total power consumption in port 180 GWh/year
  - Cargo 184,259,500 ton(Source : Vietnam statistical year book 2008)
  - Power demand index of cargo 0.98 kWh/ton/year
  - Passenger 144.5 million person (Source: Vietnam statistical year book 2008)
  - Power demand index of passenger 1.24 kWh/passenger/ year.

- **Airport**

  Japan’s Haneda airport was picked up as a sample.

  - passenger 62,876,182 persons
  - cargo 651,387 ton
  - power demand 11.9 GWh/year

  So the power demand index comes to be

  - Power demand index of passenger 0.19 kWh/person/year
  - Power demand index of cargo 18.3 kWh/ton

  (Source: http://www.ecosearch.jp/pdfdata/2007_00000318.pd')

  Assuming that the lightning of facility almost occupies the power demand in the airport; the power demand index per passenger should be used.

(2) The Power Demand Forecasting of a Large-Scale Facility

(a) Basic Method

The scale of the development plan of a large-scale facility was obtained as mentioned above in 3.3.1 and the power demand index in 3.3.2 (1). By multiplying the power demand index by the scale of the development plan, the power demand from the individual large-scale facility can be estimated in the district of the north, central and south each year up until 2030.

When the scale data at specified year, for example 2015 and 2020, is given, the data for each year between 2015 and 2020 can be estimated by interpolation in the line approximation. In contrast, the data for each year between 2020 and 2030 can be estimated by extrapolation with the half slope of the straight line between 2015 and 2020. In the case of negative value, it is forced to be 0. The following fig 3.3-1 shows the method described above.

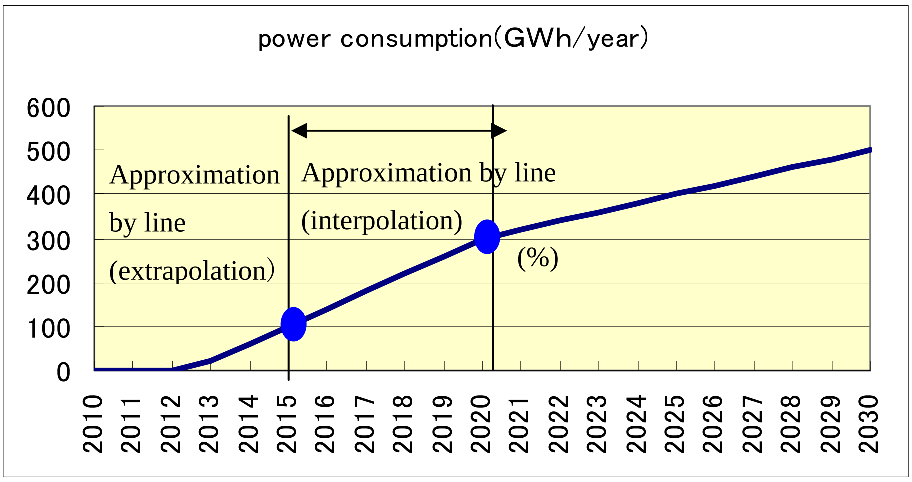


Figure 3.3-1: Interpolation and Extrapolation of Power Demand

(b) Power Demand Forecasting of Industrial Park

The power demand of each industrial park project in the north, the central and the south district in 2008, 2010, 2015, and 2020 were surveyed. The acting project in 2008 has not been treated as a new project. The reason why is because it is already included in the power demand forecasting model as a natural extension. Table 3.3-14 shows the result of the power demand forecasting by district every 5 years by assuming that the load factor is 65%.

Table 3.3-14: Power Demand of New Industrial Park (GWh/year)

	2010	2015	2020	2025	2030
North	6,045	19,045	41,635	52,929	64,224
Central	404	3,572	8,400	10,814	13,228
South	11,522	24,160	41,805	50,628	59,451
Total	17,970	46,776	91,840	114,371	136,903
Grand total	18,084	47,335	93,449	116,266	139,094
Ratio	99%	99%	98%	98%	98%

Source: Estimated

The power demand of the south district is bigger than the one in the north during 2010-2020. But the power demand in the north turned back in 2021.

The grand total refers to the total power demand from all kinds of new projects. Judging from Table 3.3-14, almost all of the power demand from new projects comes from industrial parks.

(c) Power Demand Forecasting from Commercial Facility

- General commercial facilities

  The results of this survey give only the total floor area of apartments, offices and shopping centers. So the floor area of each building is treated to be divided equally.

  Furthermore it is assumed that the increment after 2015 is of a little lower value in comparison to the increment from 2010.

Table 3.3-15: Power Demand of Commercial Facility (GWh/year)

	2010	2015	2020	2025	2030
North	53	95	120	145	170
Central	2	6	11	36	61
South	0	39	64	89	114
Total	55	141	196	271	346

Source: Estimated

- **Resort Facility**

  The resort facilities are composed of hotels, villas and apartments. The method of power demand forecasting is the same one used for commercial facilities. That is, the power demand can be estimated by multiplying the floor area of the building of the resort facility via the power demand index.

Table 3.3-16: Power Demand of Resort Facility (GWh/year)

	2010	2015	2020	2025	2030
North	0.0	0.0	0.0	0.0	0.0
Central	0.0	0.2	0.2	0.2	0.2
South	7.8	18.0	19.2	19.2	19.2
Total	8	18	19	19	19

Source: Estimated

The number of golf fields supposed to be developed is 17 in the north district, 17 in the central and 36 in the south by 2020. Assuming that the number of golf fields will be developed equally each year and that the growth rate is half to the one till 2020. The power demand of golf fields is shown in table 3.3-17.

Table 3.3-17: Power Demand of Golf Field(GWh／year)

	2010	2015	2020	2025	2030
North	0	2	8	11	14
Central	0	2	8	11	14
South	0	5	18	24	30
Total	0	10	34	46	59

Source: Estimated

The total power demand of commercial facilities, resort facilities and golf fields are shown in Table 3.3-17.

Table 3.3-18: Power Demand of (Commercial+Resort+Golf Field) (GWh/year)

	2010	2015	2020	2025	2030
North	53	97	128	156	184
Central	2	9	20	48	76
South	8	62	101	133	164
Total	63	169	249	336	423

Source: Estimated

(d) Power Demand Forecasting from Transportation Facility

- **Railway**

The length has been adopted as the scale of the railway facility. The power demand index of the general railway is different from that of subways. So the power demand is separately estimated. The power demand forecasting is shown in Table 3.3-19. The development plan will be announced by 2030

Table 3.3-19: Power Demand of Railway (GWh/year)

	2010	2015	2020	2025	2030
North	8	68	127	168	209
Central	0	34	68	114	161
South	3	54	749	771	794
Total	12	154	944	1,054	1,164

Source: Estimated

- **Sea Port Facility**

The maximum quantity of cargo has been adopted as the scale for seaport facilities. The working ratio of the seaport is assumed to be 70%. The data of the quantity of cargo in 2015 and 2020 are given, so data in other years are estimated by interpolation and extrapolation. The power demand forecasting results are as follows.

Table 3.3-20: Power Demand of Seaport (GWh/year)

	2010	2015	2020	2025	2030
North	0	10	21	26	32
Central	4	68	133	165	197
South	33	49	64	72	80
Total	37	126	217	263	308

Source: Estimated

- **River Port Facility**

The power demand can be estimated by multiplying the quantity of cargo by the power demand index for the dedicated cargo transportation and passenger number by the power demand index for the dedicated passenger transportation.

Further, it is assumed that the working ratio is 70%. Only the data in 2020 is given. So data in other years can be estimated by extrapolating.

Table 3.3-21: Power Demand of River Port (GWh/year)

	2010	2015	2020	2025	2030
North	0	3	5	6	7
Central	0	2	3	4	4
South	1	6	11	13	16
Total	2	10	19	23	27

Source: Estimated

- **Airport Facilities**

The power demand from airport facilities can be estimated by multiplying the passenger number by the power demand index of the airport. Data for 2015, 2020, 2025, and 2030 have been given, so data of each year by 2015 can be estimated by extrapolation, one for the other years by interpolation.

Table 3.3-22: Power Demand of Airport Facility (GWh/year)

	2010	2015	2020	2025	2030
North	0	0	5	5	15
Central	0	2	4	4	6
South	0	19	19	19	19
Total	0	21	28	29	39

Source: Estimated

- **Road Facility**

Available data is the only target by 2020, so data for other years can be estimated by extrapolation.

Table 3.3-23: Power Demand of Road Facility (GWh/year)

	2010	2015	2020	2025	2030
North	0	27	55	68	82
Central	0	22	45	56	67
South	0	27	53	67	80
Total	0	76	153	191	229

Source: Estimated

(3) Power Demand Forecasting Result by District and by Facility

The Table 3.3-24 shows the power demand forecasting results by district, by facility (industrial parks, commercial facilities and transportation facilities).

Table 3.3-24: Power Demand of Large-Scale Facility by District and by Facility (GWh/year)

district	kind of facility	2010	2015	2020	2025	2030
North	Industrial park	6,045	19,045	41,635	52,929	64,224
	Commercial	53	97	128	156	184
	Transportation	9	108	212	273	344
	Total	6,107	19,249	41,974	53,359	64,752
		2010	2015	2020	2025	2030
Central	Industrial park	404	3,572	8,400	10,814	13,228
	Commercial	2	9	20	48	76
	Transportation	4	128	253	344	435
	Total	410	3,709	8,672	11,205	13,739
		2010	2015	2020	2025	2030
South	Industrial park	11,522	24,160	41,805	50,628	59,451
	Commercial	8	62	101	133	164
	Transportation	37	154	896	942	988
	Total	11,567	24,377	42,803	51,703	60,603
		2010	2015	2020	2025	2030
Total	Industrial park	17,970	46,776	91,840	114,371	136,903
	Commercial	63	169	249	336	423
	Transportation	51	390	1,360	1,559	1,768
	Total	18,084	47,335	93,449	116,266	139,094
Rate of industrial part to toal		99%	99%	98%	98%	98%

Source: Estimated

Judging from the estimation using the data surveyed, the ratio of power demand from industrial parks to those from all new large-scale facilities is 98%-99%. The contribution of the large-scale commercial facilities and transportation facilities came to be low.

3.4 Methodologies and Structures Used in the Power Demand Model

In this session, Advantages and disadvantages on Methodologies and Structures regarding power demand model are first reviewed. Then, in the session of "4.5 Base concept for Power Development Plan No7 (PDP7) Model Building", new functions and concepts in the PDP7 model are described, which is not to be used in the PDP6 model.

3.4.1 Direct Method

(1) Advantage of Direct Method

- It can maintain consistency between power demand and socio-economic activities, so it is easy to explain the demand forecasted.
- The direct method connects to Input/Output (I/O) analysis, so I/O analysis holds preference over other analysis methods from the viewpoint of making input and out balance.
- The I/O analysis is useful for measuring the political measurements after implementing it.

(2) Disadvantage of Direct Method

- Much information and data (Intensities, number of registered facilities, number of factories) are required.
- Current trend is extended to the future in direct methods. This is a suitable method for short term forecasting. However, it is not easy to create a current trend change by using suitable factors for long term forecasting.

3.4.2 Indirect Method

(1) Advantage of Indirect Method

- The econometric model is one of the Indirect methods, it is possible to conduct short term and long term forecasting logically and conceptually by using the model
- The elasticity method is useful for experts in discussing the future power demand because the method is easy to understand. Especially, when the experts want to brain-storm, the method is sometimes convenient for discussion purposes. The experts of business sectors working in Japan have discussed their future business by using elasticity. They have used their

elasticity to private consumption, investments, exports and other populations besides GDP.

(2) Disadvantages

- For building econometric models, model building tools, economic theories and statistical technology are required. Further, it needs much time to nurture highly-skilled professionals in model building.
- Essentially, elasticity does not express any economic meaning. Especially, the elasticity of GDP means that the demand is in proportion to their national income. But the elasticity cannot show where and how the power is consumed. When requested to explain the meaning of the future power demand, other surveys and/or studies are required. It is difficult to know the impact from energy policies, energy conservation, industrial restructuring, energy conversion and changes of power tariffs by utilizing only elasticity.

3.4.3 Technical Comments for Building Demand Forecasting Model

The ultimate purposes of the project are to create power demand plans and power system plans etcetera. It is required that the results of the power demand forecasting models must be determined via economic activities, power demand in the regions, increase of power ratios and energy conservation policy. In the session, Technical comments for building power demand forecasting model are mentioned.

(1) Model Functions

- The following functions are discussed for the creation of future power demand in Vietnam.
- Whether or not economic activities and power demand are simultaneous.
- The power demand forecasted by each sector has to be prepared, if power tariffs by sector are applied to the consumers.
- The model can analyze the relation between the power demand and power tariffs.
- Power demand is decided by economic activity, energy conservation (power saving activities, technology improvements and the efficiency of electric appliances).
- Whether the power ratio (conversion from other energy to electric power) is effective or not.

- Regional indicators such as investment, GDP, GDP per capita and the population in the region are prepared.

(2) Technical Comments Regarding Model

- Normally forecasting equations are made during the partial test and examined for its reliability and stabilization by using statistical values (Correlation coefficient, t-values and Durbin Watson (D.W.) ratio) from the output of the regression analysis.
- In the PDP7 model, the sectoral approach is used. The demand is forecasted via the Agriculture, Industry, Commercial, Residential and other sectors, the forecasting equations are defined by energy intensity to the sectoral GDP in the Business sectors. And the energy intensity for households is used for Residential sector.
- The demand is affected by several factors such as the power tariffs, energy conservation and power ratio. The energy intensities defined as initial values are changed exogenously by the above factors.
- Power demand is calculated after forecasting the sectoral energy demand. The sectoral power ratio is used for the calculation of power demand from the energy demand.
- The setting of the High, Base and Low cases should be distinguished by the difference of the exogenous variables (main factors are GDP and crude oil price), and the same model structure (the same forecasting equations) should be used for simulating High, Base and Low cases.

(3) Technical Comments for Elasticity

- When elasticity is given bigger than ‘1’, the future trends increase rapidly. When creating future values that exceed 20 years. The elasticity has to be changed in order to become gradually small.
- The reliability of the forecasting years are said to be a half of the actual data used for regression analysis. If the actual data for 10 years is prepared, the forecasting term will be five years. In many cases, a future 20 year-period has to be forecasted for making energy and power development plans. It should be careful of using an elasticity of more than 1.0.
- Generally speaking, power elasticity to the GDP growth rate in developing countries is approximately 1.0 to 1.2, and it will be changed from 0.8 to 1.0 when the country transforms into a higher stage economy.

- The consistency of the forecasting results is evaluated by using several growth rates. It is possible to compare the growth rate to other economic indicators, other energy demands, past growth rates and so on. For calculating the growth rates, the starting year and the final year should be selected at first. The term is usually set every 5 years and every 10 years as follows for example. 2010-2015, 2016-2020 and 2021-2030.

(4) Technical Comments for Price Elasticity

- Price elasticity can be used to assess whether the demand of tax and price increases is falling or make predictions. For example, when demand is perfectly inelastic, by definition consumers have no alternative but to purchase the good or service if the price increases, so the quantity demanded will remain constant.
- Suppliers can increase the price by the full amount of the cost, and the consumer would end up paying the entirety. In the opposite case, when demand is perfectly elastic, consumers have the infinite ability to switch to alternatives if the price increases, so they would stop buying the goods or services, and the demand would fall to zero. As a result, firms cannot pass the risen prices over to the consumers, so they would be forced to bear the burden in part or whole all by themselves.
- In practice, demand is likely to be only relatively elastic or relatively inelastic, that is, somewhere between the extreme cases of perfect elasticity or inelasticity. Generally, the increased costs of elastic products are absorbed by producers. Conversely, in the case of inelastic products such as energy, the increased costs are absorbed by consumers. In the case of energy utilization, the consumers have few opportunities to avoid the increase of energy prices by switching to alternatives.

Table 3.4-1: Elasticity of Energy Price to Energy Demand in Japan

Sectors	Sub-Sectors	Elasticity Energy price to Energy Demand by Sector
All Industries		-0.411
Manufacturing	All	-0.339
	Light	-0.424
	Heavy	-0.298
	Material	-0.280
	Assembly	-0.383
Primary Industry		-0.516
Secondary Industry		-0.350
Tertiary industry		-0.499

Source "The change energy price and Energy Demand" by Mitsuo Saito Kobe University, Japan

(5) Technical Comments for Energy Intensity

- For forecasting energy intensity, Energy intensity to GDP is usually used. Energy consumption is forecasted by E=E/GDP×GDP.
- And power demand is forecasted after energy demand forecasts.
- Energy intensity estimation: E/GDP＝E/GDP-1+Changes
- Changes are affected by EE&C and introduction of more efficient equipment
- Energy demand forecasts: Energy = GDP×E/GDP
- In the event of long term forecasting, the above equation can completely be applied, in the event of short term forecasting such as for periods less than 5 years, other factors are required for explaining more precisely the difference between the actual and estimation values.
- Power ratio: Power ratio = Power consumption / Final Energy consumption × 100
- The power ratio differs by sector, as much as coal and power are used in all kinds of sectors in Vietnam, the power ratio in Vietnam is higher than other countries. Generally speaking, the power consumption per GDP increases in proportion to the GDP growth in primitive economic stages.
- Power demand: Power demand = Energy demand × Power ratio
- Power demand is one part of the energy demand in the sectors. The power demand from energy demand is determined by the power ratio. The growth rate of the power demand and energy demand have to be checked whether they are relatively in well balance among other sectors.
- Power demand forecasting equation is expressed by the followings

- Power demand =(E/GDP)×(1-T/100) ×(P/E) ×GDP＋ α
- E/GDP : Energy intensity to GDP
- 1-T/100 : Variable changed by energy price and EE&C to intensity
- P/E : Power ratio
- GDP : Real GDP
- α : Constants for adjusting forecasting error

(6) Judgment Criteria for Power Demand Forecasting Model

When a Multi regression method is used for the power demand forecasting model, the following indicators are also required as judgment criteria.

- Demand Growth rate
- Power consumption per GDP
- Power consumption per Capita
- Elasticity of Power consumption to GDP
- Power consumption share in the total energy consumption

3.4.4 Problems of Demand Forecasting Methods in Vietnam and the Recommendations

- The methods of Vietnam are in line with econometric methods including elasticity and energy intensity. However, their results have been strongly impacted by the current situation, not the future economic outlook. Therefore, their long term energy forecasting sometimes does not have an economic background and logical trends. In the PDP7, power demand forecasting has been built up under the survey of future industrial park plans and energy consumption in comparison to other countries. It can be said that the PDP7 plan has been built up under more scientific and realistic methods than the PDP6.
- Vietnam does not recognize that power demand forecasting is one part of the energy demand forecasting. General speaking, power growth is higher than GDP growth. Sometimes the primary energy growth is lower than the GDP. As the power demand forecast of the PDP7 satisfies the above trends, IE has to announce the above results to the energy and power stakeholders.
- As the next strategy for the power plan in Vietnam, the energy intensity has to be improved against climate change. Further, it is required that the energy demand forecasting model includes energy efficiency policies. The above concepts have been explained by the JICA model to the IE members.

- An economic outlook is required for building an energy demand forecasting model. Vietnam authorities are of the opinion that the GDP will increase at a high growth rate for five and ten years. Under these economic scenarios, energy and power demand will also have high growth rates. Per the recommendations of the JICA team, the analysts have to see carefully the current trends for the next 5 years. They have to forecast with the elasticity and energy intensity set by econometric methods, and they have to set some bench marks for more than 20 years of energy and power demand.
- In PDP7, the power demand is forecasted for the next ten years including new power demand from large scale projects in the whole country. For the next ten years (20 years later), Vietnam power demand is determined after referring to the power consumption per GDP and per population (power intensity) compared to Thailand, Malaysia, Indonesia, India China and Japan. The JICA team has made the technical transfer to IE.

3.5 Base Concept for PDP7 Model Building

In starting the technical transfer to IE for PDP7, the JICA team has proposed a new power demand forecasting model including changes of sectoral power intensity. That is "Sectoral Energy Intensity Model". By building the JICA model, the JICA team and the IE can compare both results. By doing so, the JICA team has considered consulting the IE model and the assumptions. Therefore, the model built by the JICA team is called the "JICA model". The forecasting results from the JICA model are called "JICA forecasting". The basic concepts are as follows;

3.5.1 GDP High Growth by Investment and Equipment

- IE asserts two kinds of demand forecasting methods, one is the "Direct method", and the other is the "Indirect Method (Econometric method)". For forecasting power demand for PDP7, we combined these two methods. Especially, sectoral energy intensities to GDP as the indirect method are used in the JICA model. In the method, power demands are basically decided by the power intensities and the GDP trend.
- The Vietnam GDP is estimated with a high growth rate of over 8% for the next 10 years. And when under such high GDP growth, the impact from high growth GDP to power demand is different by the components of GDP

expenditures. It means that the impacts of high growth rates are different in emerging countries.

- The major reason for the current high growth GDP in Vietnam is caused by the high growth of investment and equipment to factories in the Industrial sector. Further, at the same time, it increases “Capital intensity to labors (CIL)”. The phenomenon is a little bit different from the high growth GDP in China. In Vietnam, so much capital has been used for increasing factory productivity. The high CIL has consumed a huge amount of power demand in Vietnam. Under such economic environments, usually as an explanation variable, an “Investment and equipment” indicator is used for power demand forecasting in the econometric model. The current investments and equipment in Vietnam is increasing with at 12% to 14% per year, the growth rate is higher than the GDP growth rate. It is apparent that the growth rate of investment and equipment almost equals the power demand growth rate.

3.5.2 Sectoral Approach

- The sectoral approach used to be utilized in the JICA model based on energy intensities to sectoral GDP. Therefore, the power demand is calculated based on the GDP intensity and GDP trend. However, the GDP growth rate is not so much higher than the investment and equipment growth rate. Then power demand growth is under estimation compared to the investment and equipment growth rate, if energy intensities are not changed. For adjusting for the difference between the GDP growth rate and the investment growth rate, sometimes GDP intensities have to be increased intentionally to adjust for the differences.
- However, in the JICA model, GDP intensities have not been changed to adjust for the differences between power demand growth. Instead of adjusting, future new industrial zones and big commercial facilities that consume huge power are surveyed and the power demand of the projects is calculated. After that, power consumption is added to power demand as forecasted by econometric model.
- In some level developed countries, the power demand from future new projects are comparatively smaller than ones from the existing GDP size; it may be less than 5%. However, when added values from future new projects have big shares in existing countries’ GDP such as Vietnam, the econometric model cannot sometimes explain the increasing trend. Because the

econometric method is delayed for increasing demand when demand facilities rapidly increase, it means that added values from future new projects are increased rapidly.

3.5.3 Power Demand from New Coming Large Consumers

- In the case of Vietnam, the power demand in the future cannot be explained by only energy intensities to the GDP, it can be considered that the GDP growth in the SED2020 includes expanding the facilities and increasing the operation load of the existing factories. However, in current Vietnam, the additional CIL has comparatively increased with high speed, when forecasting power demand for the current Vietnam under the conditions of using energy intensities to the GDP. This is a reason why power demands from future new projects have to be added to the power demand from the econometric model.
- According to our simulation, the share of power demands from the new projects is around 11% to the power demand from the econometric model in 2020 with the share in 2030 being only 7%. According to the theory, the share will be gradually shrunk year by year.
- Generally speaking, the share of investment and equipment in the GDP is higher in the emerging countries. In current Vietnam, the share is around 40%. However, twenty and thirty years later, the share will be decreased to 35% and 30% in the GDP. Under such circumstances, the Vietnam power demand from new projects need not be added to the power demand from the econometric model built by energy intensity (to GDP) methods.

3.5.4 Procedures for Building PDP7 Model

- The Model should be designed for forecasting power demand under conditions of Energy efficiency and conservation (EE&C) policy, adding power demand from large scale projects and calculating power demand by using power ratio.
- The macro economic analysis is the main method for building the power demand model. However the power demand from the model should be added by additional power demand from large scale facilities' surveys.
- Large scale projects like industrial parks and economic zones have to be surveyed by sector and region. And additional power demand has to be estimated from the large scale projects
- The expected functions of the power demand forecasting model are as follows:

- To be able to analyze power demand in a company with changes of Vietnam economy.
- To be able to analyze power demand in a company with the power ratio.
- To be able to evaluate the effects of electric tariffs and corresponding EE&C policy
- To be able to analyze regional power demand.
- To be able to analyze the relation between nuclear power and conventional power stations.

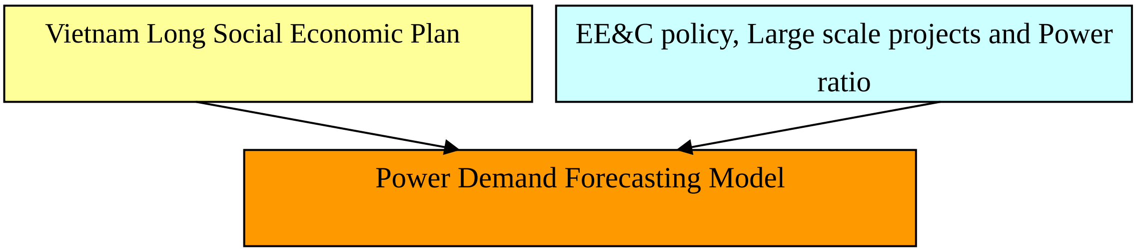


Figure 3.5-1: Procedures of Building PDP7 Model

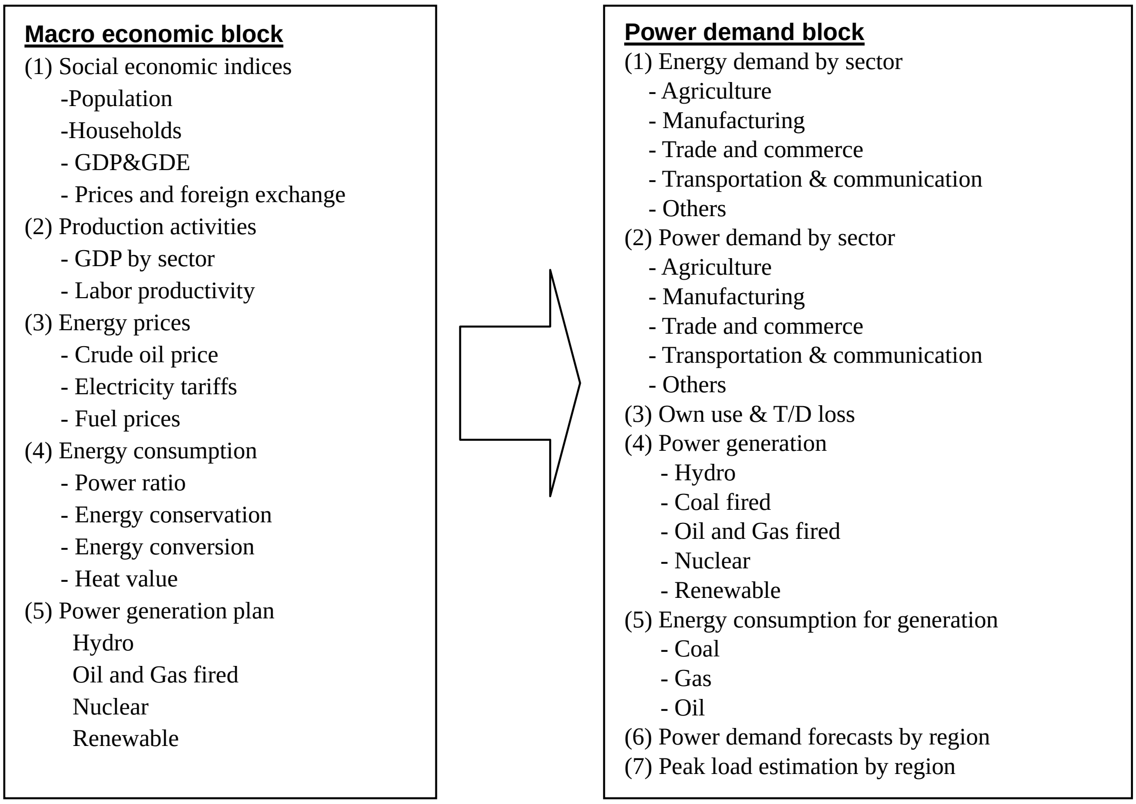


Figure 3.5-2: Outline of the Power Demand Forecasting Model

Chapter 4 Technical Assistant on Power Supply System Planning

4.1 The Study of Power Transmission from the Southeastern Part of Vietnam to Ho Chi Minh City

The technical assistance of the study of power transmission from the southeastern part of Vietnam to Ho Chi Minh City was provided based on the schedule described in section 1.7, Chapter 1. In this section, study items through technical assistance are detailed.

(1) Preliminary Study

In the southern part of Vietnam, especially the Ho Chi Minh City-oriented area, a large increase in power demand is expected to continue. On the other hand, the shoal account for the wider part of its coast water body is in the southern part of Vietnam. Hence the potential sites for power plants which need large-scale harbor improvement are limited. Under these circumstances, many large-scale power plants are focused in the same area that are about 300 km east from Ho Chi Minh City in the future plan. Accordingly, it is necessary to build the line for bulk transmission from the southeastern part of Vietnam towards Ho Chi Minh City.

In the PDP7 draft, the following power plants are planned for the coastal area of the southeastern part of Vietnam up to the year 2030.

- Van Phong coal-fired thermal power station (2,640 MW)
- Vinh Tanh coal-fired thermal power station (4,380 MW)
- Nuclear power station I (4,000 MW)
- Nuclear power station II (4,000 MW)
- Bac Ai pumpted storage power station (1,500 MW)
- Power from coal-fired power stations located in the northern part of Van Phong coal-fired thermal power station (900 MW, which is about 1/4 of its installed capacity. 3/4 of the power was considered to be consumed in Central Areas)
- A pumped storage power station located in the central area (2,400 MW)

On the other hand, the consideration of the power demand of the southeastern part of Vietnam is about 1 GW, it is necessary to transmit 20 GW maximum out of 21 GW, which is the total power output of the aforementioned power plants, to Ho Chi Minh City.

Among the power plants, the Vinh Tanh coal-fired thermal power station was excluded from the target of this study since the system configuration of the section has already been determined as 500 kV, 4cct lines. The study on the methodology of power transmission from the pumped storage power station located between the nuclear power station I and Ho Chi Minh City will separately be implemented due to proximity to Ho Chi Minh City in comparison with other power plants.

It is necessary to transmit 13 to 14 GW of power, which is the remainder after subtraction of the consumed loads in the areas where the power plants are located out of the aggregate power output of 14 to 15 GW coming from the power plants in question, to Ho Chi Minh City and its surrounding area located about 300 km away from the power source. For the target interval in question, it is considered necessary to install at least 10 circuits to maintain the system stability if the 500 kV transmission is applied to the interval even if the interval between the Vinh Tan coal-fired thermal power station and Ho Chi Minh City (500 kV Song May substation), which has already been fixed in its system configuration by the Vietnamese side and constitutes 500 kV 4cct lines, is excluded from the study. In contrast, the application of a higher voltage has a possibility of realizing efficient power transmission resulting from a lesser number of circuits and routes and a reduction in transmission line loss.

In the previous study, “The Study on National Power Development Plan for the period of 2006-2015, perspective up to 2025 in Vietnam”, conducted from 2006 to 2007, what was recommended was the study on the methodology of power transmission by applying a higher voltage level, which had the reduction potential in the number of transmission line routes and of economical transmission under the scenario of large-scale power development installation to the area ranges from the central to the south. To be more precise, it means the study of power transmission where the voltage level exceeds 500 kV with the studies focusing on application of 750 kV (Korea, South Africa, Brazil etc have applied) or UHV, whose design specification was studied in Japan for the first time and the world’s first commercial operation was recently realized in China.

As a result, the IE has already eyed the application of the voltage level above 500 kV since the previous study. In this project, through vigorous discussions, the IE and the TA Team have shared a common view on the necessity of the further study on the bulk power transmission methods from the southeastern part of Vietnam to the Ho Chi Minh area, taking into account the system configuration of both the central and southern part of Vietnam as well as conducting an economical evaluation, particularly, on both the

UHV and the 500 kV AC transmission lines.

In light of the aforementioned background, the TA Team conducted a preliminary study on the necessary number of circuits for the section between the group of power plants, including two nuclear power stations in the southeastern part of Vietnam and the Ho Chi Minh area, which consisted of either UHV or 500 kV transmission lines. The study was executed using the system diagram as of 2020, which was provided by IE during the first mission.

The TA Team explained that, by applying the UHV transmission, there was a possibility of advantages over the 500 kV transmission in terms of the following:

- Reduction in the number of routes via a reduction in the required number of circuits
- Reduction in the compensation for the right-of-way via a reduction in the number of routes
- Improvement in the system stability of the transmission line with the same number of circuits
- Reduction in the transmission line loss

Through the preliminary study, the TA Team played the role of facilitating for IE in order to grasp the big picture with regards to the project schedule, scale, contribution of the transmission line loss and construction cost to the total project costs.

The target system for the preliminary study included Van Phong coal-fired thermal power station, Bac Ai pumped storage power station, Nuclear power station I and II, Vinh Tan coal-fired thermal power station, and a 500 kV substation in Ho Chi Minh City. The background system of the substation was assumed to be an infinite bus. In this step, the UHV section was set between the Nuclear I power station and the Ho Chi Minh 500 kV substation (1,100/500 kV transformer and 1,100 kV bus model were created at the 500 kV substation as well.)

(2) Draft Study

It could be found out that an option of the UHV power transmission may be effective as well as the option of the 500 kV power transmission from the results of the preliminary study.

Thus, the study was carried out also on the option of the UHV power transmission. The criteria of the power network development plan were set out as shown below through a discussion with IE.

- It was discovered that three phase short circuit currents would rather exceed 50 kA when connecting Nuclear Power Plant I, Nuclear Power Plant II, Van Phong Coal Thermal Power Plant, VInh Tanh Coal Thermal Power Plant and Bac Ai Pumped Storage Power Plant because they are located next to each other. The countermeasure was assumed to be taken by dividing a block of those power plants into 2 or 3 blocks so as to suppress the fault currents that come from adjacent power plants.
- The power flow up to 5,000 MW was allowed for the power flow in the remaining circuits of 1,100 kV so as to keep power system stability in consideration with the N-1 faults.
- The power flow of up to 1,200 MW was allowed for the power flow in the remaining circuits of 500 kV so as to keep the power system stability in consideration with N-1 faults.
- ACSR 810 mm^2 8 bundles was applied for the conductor of 1,100 kV transmission lines
- ACSR 410 mm^2 4 bundles was applied for the conductor of 1,100 kV transmission lines
- A unit capacity of a transformer was assumed to be 2,000 MVA for a 1,100/500 kV substation

The figures 4.1-1 and 4.1-2 show the results of the system configurations in 2030 both in the case of the 500 kV system and the 1,100 kV system when the aforementioned conditions applied.

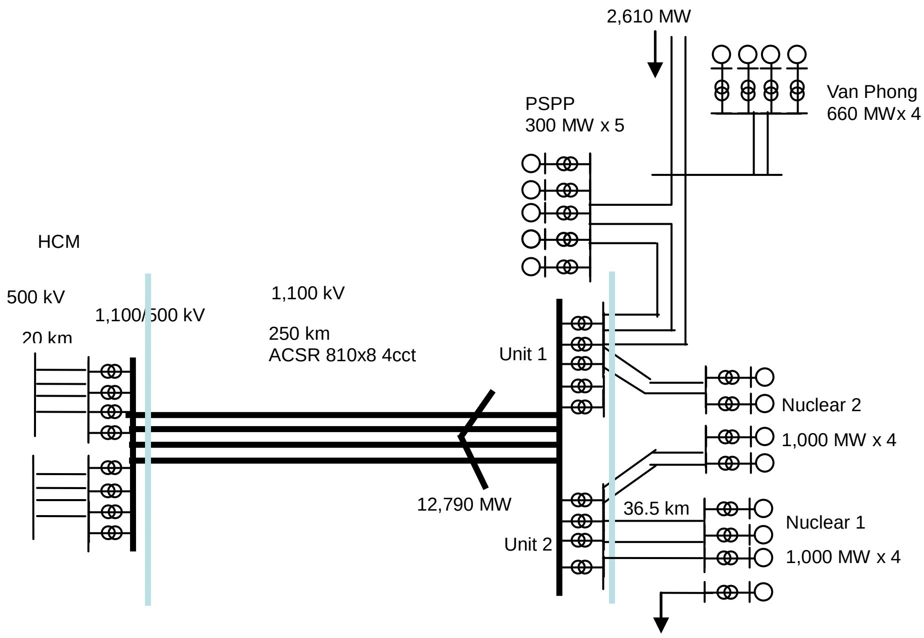


Figure 4.1-1: Case of Application of 1,100 kV(UHV) Transmission Lines（2030）

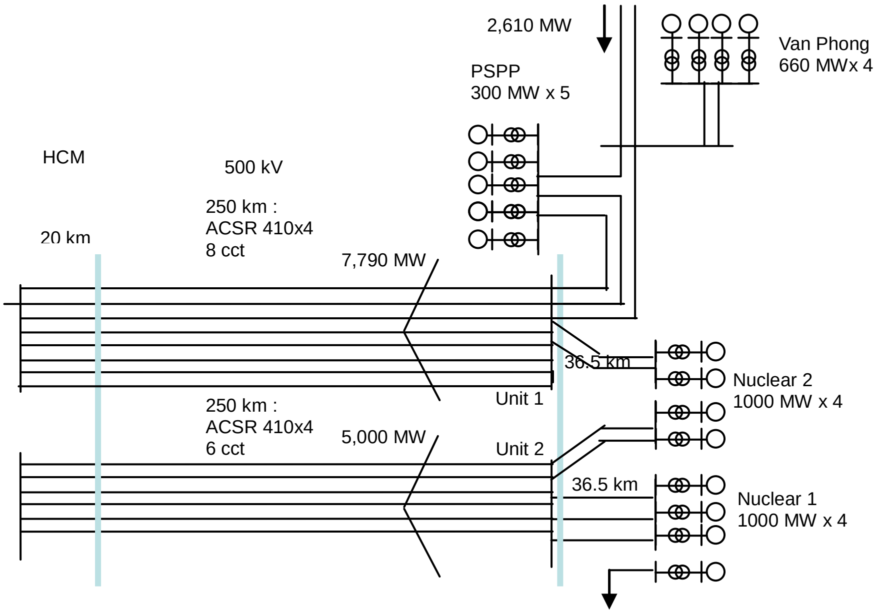


Figure 4.1-2: Case of Application of 500 kV Transmission lines（2030）

(3) Economic Comparison

The roughly estimated costs were compared for the case of the application of 500 kV transmission lines and the case of the application of 1,100 kV transmission lines in consideration of the construction schedules of the transmission lines responding to the commissioning years of the planned power plants and power transmission loss based on the conditions described below.

- The costs of the transmission lines and substations required for each year were estimated in accordance with the power development plans up to 2030. The net present value was calculated up to 2051 on the condition that the costs for each year from 2030 to 2051 were assumed to be the same as the costs in 2030.
- The unit costs of the facilities were assumed as shown in Table 4.1-1 to refer to the actual costs of the facilities installed in Vietnam and the estimated ratio of the UHV facilities to 500 kV facilities in Japan.

Table 4.1-1: Unit Cost of Facilities Used for Economic Comparison

500 kV transmissiln line	0.5 million USD/km/cct
UHV transmissiln line	1.25 million USD/km/cct
UHV substation	0.0406 million USD/MVA

- The construction cost of facilities was assumed to be required just during the commissioning year
- The ratio of the annually averaged power transmission loss to the peak loss was assumed to be 0.8 and the loss was evaluated at 0.08 USD/kWh.
- The O&M cost was assumed to be 2%.
- The costs for securing the right of way of the transmission lines were assumed as show in Table 4.1-2.

Table 4.1-2: Costs for Securing the Right of Way of the Transmission Lines Used for Economic Comparison

500 kV Transmission Lines	0.105 million USD/cct/km
UHV Transmission Lines	0.189 million USD/cct/km

(4) The Results of the Economic Comparison

The results of the economic comparison showed in Table 4.1-3 for the case with UHV transmission lines and the case with 500 kV transmission lines based on the assumptions described in (2) to (3).

Table 4.1-6 shows the annual spread of the amount of facilities and costs such as the required number of circuits of the transmission lines, power transmission loss or the construction costs.

Table 4.1-3: Economic Comparison of the Case with UHV and 500 kV Transmission Lines

(Unit: million USD)

	500 kV Transmission Lines	1,100 kV (UHV) Transmission Lines
Power Transmission Loss	1,151	358
Costs for securing the Right of Way	242	203
Construction Cost and O&M Cost	1,401	2,254
Total	2,794	2,815
Ratio	100%	101%

The power transmission losses for the cases of UHV became less than a third of the cases with 500 kV transmission lines. On the other hand, the summation of the construction costs and O&M costs for the cases of UHV was greater than for the cases with 500 kV by around 900 million USD. The total cost for the cases of UHV was a little bit smaller than the cases with 500 kV.

Table 4.1-4 summarizes the results of the comparison of the cases of UHV and 500 kV.

Table 4.1-4: Result of the Comparison of the Case of UHV and 500 kV

	500 kV	UHV
Number of Circuits (Number of Circuits in 2030)	Large (14)	Small (4)
Total Cost	Almost same as UHV	Almost same as 500 kV
Investment and O&M (Initial 5 years)	Small 1,642 million USD (1,121 million USD)	Large 2,457 million USD (1,785 million USD)
Power Transmission Loss	Large 1,151 million USD	Small 358 million USD

The required number of circuits of UHV was estimated to be much smaller than the cases of 500 kV, although there is a small difference of the total costs between both of the cases including the investment, O&M and the power transmission loss.

Table 4.1-5 shows the results of the sensitivity analysis carried out for the case of increasing power transmission loss, the delay of the commissioning years of nuclear power stations or raising the cost of the UHV.

Table 4.1-5: The Results of the Sensitivity Analysis

Cases	Total cost with the case of 500 kV	Total cost with the case of UHV
Increasing by 2% in the unit cost of power transmission loss	100 %	95 %
Delay in commissioning year of Nuclear Power Plant I by 3 ears	100 %	102 %
Delay in commissioning year of Nuclear Power Plant II by 5 years	100 %	103 %
Delay in commissioning year of Nuclear Power Plant II by 3years	100 %	102 %
Increasing by 10% in the construction cost of UHV	100 %	109 %

The total cost of the case with the UHV was not so much different than the case with 500 kV. However, the case with the UHV would have the advantage of possessing minimal influence on the environment by reducing the required number of transmission line circuits. In the event of the commissioning year delay of nuclear power plants, the UHV case would not be inferior to the 500kV case.

It will be required to carry out a study on the UHV construction costs, the methodology of its implementation and fund raising.

The IE has also carried out a study of the UHV and 500 kV power transmission in parallel with the study by the JICAT TA team. There were differences between the IE and JICA in the results of the study especially those areas covering power transmission losses. The IE estimated the loss to be lower than the JICA TA team.

- The IE used the resistance of a 20 degree Celsius of conductors while the TA team used a 90 degree Celsius.
- The IE estimated the power flow from the Van Phong coal thermal power plant, Bac Ai pumped the hydropower plant and the power plants in the northern part as 2291 MW while the TA team estimated it to be around 5,000 MW.
- The IE assumed that the nuclear power station and the Vinh Tanh coal thermal power station were connected each other while the TA team was not.

The reasons for the difference in the power transmission losses were clarified as mentioned above. The conditions and results of the studies by the TA team and IE should be compared in detail. Further, it is required to carry out the study under more rationalized conditions.

Though the tentative studies of stability, power flow and fault current levels were carried out during this TA, it is required that the case with UHV should be compared to the 500 kV via the detailed model representing the system in the south and the central part of Vietnam.

A consensus was reached in promoting the study of the way of power transmission from the southeastern part of Vietnam to Ho Chi Min City including the adoption of higher voltage levels than 500 kV at the Stake Holders Meeting held in Hanoi attended by related organizations such as MOIT, EVN and ERAV.

Table 4.1-6: Comparison of Number of Circuits, Transmission Line Loss, Construction Costs, etc. on a Year-by-year Basis

500 kV	Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031-2051
No. cct Gen. Side-HCM Uniit1		2	3	4	5	5	5	5	5	5	5	6	7	7	7	
No. cct Gen. Side-HCM Uniit2		0	0	0	2	3	3	3	4	5	5	5	5	6	7	
Loss (MW)		2	38	76	98	123	121	123	149	175	180	228	286	339	397	
Loss (mUSD/Y)		1	21	42	55	69	68	69	84	98	101	128	160	190	222	
NPV Loss (mUSD)	1,979	1	19	36	42	49	44	41	46	49	46	54	62	68	73	674
ROW (mUSD/Y)		57	28	28	85	28	0	0	28	28	0	28	28	28	28	
NPV ROW (mUSD)	264	57	26	24	66	20	0	0	16	14	0	12	11	10	9	0
Investment Gen. Side-HCM Uniit1 (mUSI		270	135	135	135	0	0	0	0	0	0	135	135	0	0	
Investment Gen. Side-HCM Uniit2 (mUSI		0	0	0	270	135	0	0	135	135	0	0	0	135	135	
OM (mUSD)		5	8	11	14	19	22	22	22	24	27	30	32	32	35	
NPV Investment + OM (mUSI	1,645	275	131	123	323	109	14	13	86	80	12	70	65	60	55	115
NPV Total (mUSD)	3,100	333	177	182	431	178	58	54	147	143	59	135	138	137	137	789
	100%															
UHV	Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031-2051
UHV S/S (MVA)			8,000	12,000	16,000	16,000	16,000	16,000	20,000	20,000	20,000	26,000	28,000	32,000	36,000	
No. cct U-design Gen. Side -HCM		2	2	2	3	3	3	3	3	3	3	4	4	4	4	
Loss (MW)		0	7	16	25	37	36	37	45	58	60	63	84	101	122	
Loss (mUSD/Y)		0	4	9	14	21	20	20	25	32	33	35	47	57	68	
NPV Loss (mUSD)	596	0	4	7	11	15	13	12	14	16	15	15	18	20	22	207
ROW (mUSD/Y)		142	0	0	71	0	0	0	0	0	0	71	0	0	0	
NPV ROW (mUSD)	226	142	0	0	55	0	0	0	0	0	0	30	0	0	0	0
Investment UHV S/S (mUSD)		0	324	162	162	0	0	0	162	0	0	243	81	162	162	
Invesetment UHV TL Gen. Side-HCM (mU		675	0	0	338	0	0	0	0	0	0	338	0	0	0	
OM (mUSD)		14	20	23	33	33	33	33	36	36	36	48	50	53	56	
NPV Investment + OM (mUSI	2,586	689	316	156	412	24	22	20	109	18	17	266	51	77	71	170
NPV Total (mUSD)	3,031	830	320	164	477	38	35	32	122	35	32	311	69	97	93	377
	98%															

Source: The TA Team

Table 4.1-7: Condition for Analyzing UHV Transmission Lines

Data

T/L UHV/500 in Japan	**2.5**		
500 kV substation in Vietnam (2x600MVA+1x250MVA (220/110 kV			
	32.2	**million USD**	
500 kV S/S in Vietnam	**0.024**	**million USD/MVA**	
500kV S/S in Japan	**Share**	**Ratio in kVA Unit Price 500kV/UHV**	
Civil	**0.13**	**1.16**	
Equipment	**0.87**	**1.97**	
Total	**1**	**1.86**	
500 kV S/S in Vietnam	**Share**	**Ratio in kVA Unit Price 500kV/UHV**	
Civil	**0.342**	**0.395**	
Equipment	**0.474**	**0.932**	
Others	**0.093**	**0.173**	
Reserve	**0.091**	**0.169**	
Total	**1**	**1.669**	
SS UHV/500 in Japan	**1.669**		
RoW D cct tower	**3,000**	**million VND/km**	
RoW S cct tower	**2,000**	**million VND/km**	
Exchange Rate	**19,050**	**VND/USD**	
500kV RoW in Japan	**21.7**	**m**	
UHV RoW in Japan	**39**	**m**	
RoW UHV/500kV per circuit n Japan			**1.797**

Line resistance

degree Celsius	20	90							
	ohm/km		No.	ohm/km/cct	MVA	pu/km/cct	**kV**	**km**	**pu/cct**
ACSR 810	0.0356	0.045767	8	0.0057209	100	2.2884E-06	**500**	**270**	**0.000617859**
ACSR 810	0.0356	0.045767	8	0.0057209	100	4.728E-07	**1,100**	**270**	**0.000127657**
ACSR 410 (Drake)	0.07167	0.092139	4	0.0230347	100	9.2139E-06	**500**	**270**	**0.002487752**

1,100/500 kV Transformer winding loss ratio

0.20%

4.2 Study on Power Supply System Planning of Ho Chi Minh City

The future power supply system for Ho Chi Minh City and its neighboring areas is comprised of the following transmission lines:

- which are connected to the nuclear, coal-fired thermal, and pumped storage power plants which have been planned to be installed from the southeastern to the south most area along the coastal area: 500 kV lines
- which form the outer ring surrounding Ho Chi Minh City and its outlying area: 500 kV lines
- which form the inner ring to supply power from the inbound 500 kV system: 220 kV

Due to the feature of the loop system configuration, the suppression of the excessive fault current (short circuit current) for the supply system for Ho Chi Minh area, which has been the center of large-scale power consumption, has been one of the biggest issues unresolved since the time of PDP6 formulation. Because of such a background, through continuous discussions with IE, the TA Team provided technical assistance on power system planning in the Ho Chi Minh area, taking into account suppression of the fault current.

Specifically, the TA Team conducted a system analysis (power flow and fault current analysis) for the target system as of 2030 and checked the soundness of the system planning in the PDP7 draft that IE is currently formulating. As a system analysis tool, the PSS/E, which the IE utilizes for its own study, is applied.

4.2.1 Suggestion of Countermeasures against Increased Fault Current for Ho Chi Minh City Supply System

As installation and/or expansion of power plants and transmission and substation facilities make progress, the fault current level of the system is likely to be increased.

In formulating its power system expansion plan, the IE has conducted a system planning study assuming the system to be in operation as a loop configuration so far. Under the system condition, the fault current of the 500 kV southern system, including those in Ho Chi Minh City, and the 220 kV system in Ho Chi Minh in 2030 is expected to considerably increase. In separating the system to a certain extent, however, the fault current analysis conducted by the TA Team revealed that, in both 500 kV and 220 kV system, the short circuit current would reach around 63 kA or more, thus by far exceeding the breaking capacities of currently used circuit breakers, 50 kA for 500 kV and 40 kA for 220 kA, respectively. Therefore, it is considered necessary to study appropriate fault current reduction countermeasures, such as upgrading the breaking capacities of circuit breakers, including replacement of existing circuit breakers, additional separation of the system, and so on.

IE has conducted the study on the application of fault current limiting devices, which utilize thyristor technologies, as one of the options for fault current reduction; however, such kind of devices have not necessarily been widely applied in other countries for a long time. Hence it is necessary to deliberately consider the reliability of the equipment itself, the impacts of malfunctions, and countermeasures in the case of the disorder of the devices.

In this project, the TA Team suggested several possible countermeasures of the system configuration and facility refurbishment, showing the examples of the southern system including Ho Chi Minh City and the 220 kV system in Ho Chi Minh City, to suppress the fault current within an allowable level.

In maintaining the loop system operation, the fault current at many substation buses exceed the allowable level of the system planning criteria. Generally, it is considered effective to open some intervals at circuit breakers until the fault current is reduced to below the criterion level*. The concept of the radial operation is shown in Figure 4.2-1.

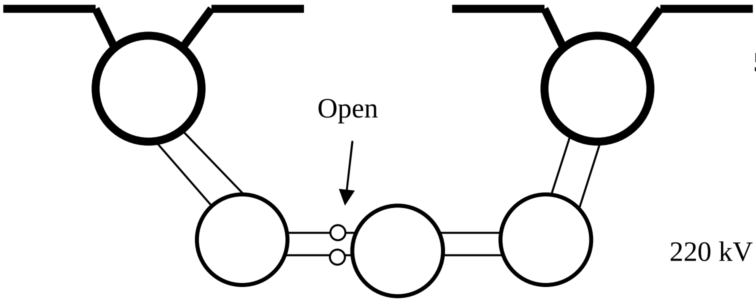


Figure 4.2-1: Concept of Radial Operation for Short Circuit Fault Reduction

* In formulating its power system expansion plan in the draft PDP7, IE has conducted a system reliability study under the condition that the system is operated as a loop system, and that the system conforms to N-2 and/or N-1 criteria. After opening the circuit breaker, the power flow conditions will change immediately, and the N-1 criteria may not necessarily be satisfied due to the change. Therefore, the evaluation of the system reliability and stability should be implemented on the basis of the system configuration of which the fault current will not exceed the predetermined level.

In this project, a detailed study was conducted for the Ho Chi Minh system based on the discussions and agreement with IE. It is expected that a similar fault current problem may occur in the northern system, especially for the Hanoi City supply system in the future.

4.2.2 Confirmation of Validity of 500 kV Outer Ring System Surrounding Ho Chi Minh Area

A power flow and fault current (three-phase short circuit current) analysis were conducted for the 500 kV outer ring system surrounding Ho Chi Minh City as of 2030, the final year of PDP7. In this analysis, the TA Team created the system model for PSS/E based on the following assumptions:

- The PSS/E data of the whole Vietnamese transmission system, which was obtained during the previous study, ”The Study on National Power Development Plan for the period of 2006-2015, perspective up to 2025 in Vietnam” was utilized.
- Both the 500 kV and 220 kV systems in both the Central (southern area than Da Nang substation) and Southern Areas in Vietnam were considered for the analysis model. The power flow from the northern area of the Da Nang substation was neglected.
- The power flow diagram of the power system in the southern area in 2030, which was provided by IE was referred to.
- Static condensers were assumed to be installed to some of the secondary side of buses (220 kV) at 500 kV substations or some of the primary side of buses at 220 kV substations in order to compensate for the bus voltages.
- The configuration of the 1,100 kV transmission (Ultra High Voltage, hereinafter UHV) system, which was discussed in the section 5.1 Study on the Methodology of the Power Transmission from Nuclear Power Stations, was incorporated.

(1) Power Flow

The power flow analysis result of the 500 kV outer ring system surrounding Ho Chi Minh City in 2030 is shown in Figure 4.2-2.

The aggregation of the power flow toward My Phuoc substation, which was assumed to be the terminal of the UHV transmission line in Ho Chi Minh City, from the power plants consisted of Nuclear power stations No.1 and 2, the Bac Ai pumped storage power station which is located north of these two nuclear power stations, Van Phong coal-fired thermal power station (CFTP), and Binh Dinh CFTP and Phu Yen CFTP, which were planned in Central Area are about 12.6 GW. The load of My Phuoc substation (incoming power flow to the secondary 220 kV system) was about 2,300 MW. The remaining power was supplied to two neighboring substations by two routes; both the Binh Duong 1 substation, whose planned location was south of My Phuoc substation, and Cu Chi 2 substation, southwest of My Phuoc substation through the 500 kV 2cct transmission lines. The type of conductors for the two intervals was the ACSR600 mm2 4 bundles. The power flow of the interval between My Phuoc substation and Binh Duong 1 substation was about 6,600 MW. In considering that the thermal rating of the conductor ACSR600mm^2 4 bundles is about 3,000 MW/cct (power factor of 0.9 was assumed), there is the possibility of constant overloading in this interval.

Under the N-1 contingency condition, no overloading occurred to the system in question except for the interval between the constantly-overloaded My Phuoc and Binh Duong 1 substations; however, further study on the system configuration would be necessary since the fault current (three-phase short circuit current) at some substations still exceed the maximum allowable level set in the system planning criteria for Vietnam, at this moment.

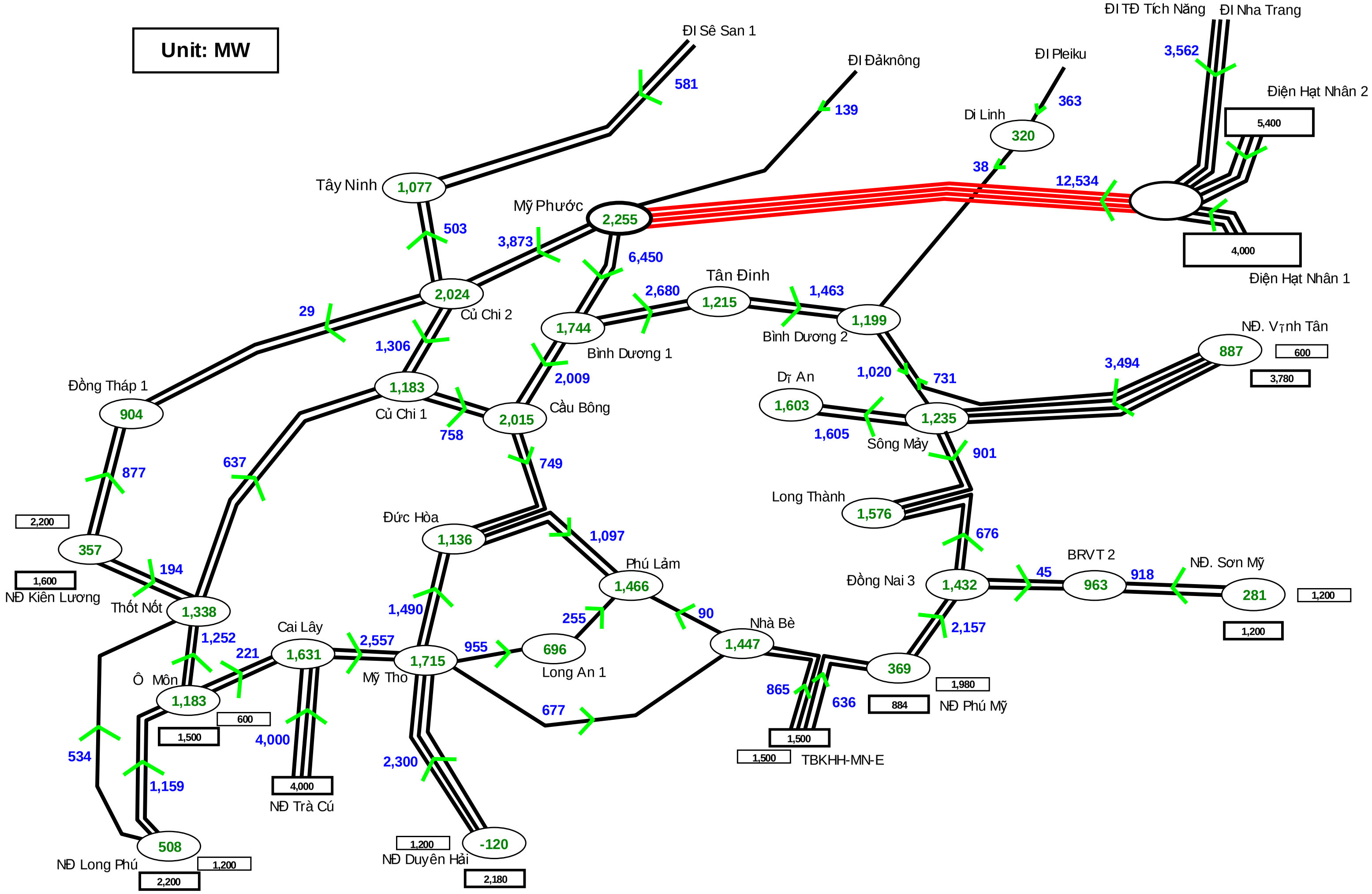


Figure 4.2-2: Power Flow of the System Applying to 1,100 kV(UHV) Transmission Line (2030)

(2) Fault Current

The three-phase short circuit fault currents at the 500 kV substations in 2030 were shown in Figure 4.2-3. Due to lack of available zero-sequence impedance data, the fault current analysis in the case of one line to the ground fault was not conducted. As mentioned in section 4.2.1, in formulating its power system expansion plan in the PDP7 draft, the IE has conducted a system reliability study under the conditions that the system is operated as a loop system, and that the system shall conform to N-1 criteria. However, under loop operational conditions, the three-phase short circuit fault currents at numerous 500 kV substation buses were way above the maximum limit of 50 kA, the criterion level. In particular, the numbers colored in red in Figure 4.2-3 indicate the circuit breakers that have exceeded the maximum breaking capacity (63 kA).

The common countermeasures against large short circuit fault currents are as follows:

- Separation of the loop to create the system configuration radial by opening at the circuit breaker
- Separation of the system at the substation bus
- Separation of the system at the power station bus by each supplying system
- Create a system impedance increase by planning new transmission lines with the same origin but different terminal, etc.

These are the methodologies from the viewpoint of modifying the system configuration. On the other hand, there are different ways to achieve the same fault current reduction purpose from the viewpoint of equipment.

- Upgrading of the breaking capacity of the circuit breakers
- Application of the fault current limiting devices, etc.

Among the aforementioned countermeasures for fault current reduction, several options were applied to alleviate the situation as an example of the trial practices as follows:

- Divide the secondary side of the 500 kV bus (220 kV) at My Phuoc substation into three to feed the following three systems independently:
    - My Phuoc-Cu Chi 2 system
    - My Phuoc-Binh Duong 1 system
    - My Phuoc-Cau Bong system (for new construction)
- In order to increase the system impedance as well as to solve the constant overloading in the interval between My Phuoc substation and Binh Duong 1 substation, which was mentioned in the section 4.2.1 (1), the installation of a

new transmission line (500 kV, 2cct) from My Phuoc substation and Cau Bong substation (ACSR600 mm^2 4 bundles) was assumed.

- With the installation of the new transmission line, the 500 kV 2cct transmission line was opened between the Binh Duong 1 substation and Cau Bong substation.
- The primary side of the buses of the following power stations were divided to independently supply power by system:
  - Kien Luong power station
  - Long Phu power station
  - TBKHH-MN-E power station

Figure 4.2-4 shows the fault current analysis results after taking the aforementioned countermeasures into account. Compared to the situation prior to taking the countermeasures, the fault currents at some substation buses decreased by tens of kA; however, there are still some substations whose fault currents are far above the allowable level, 50 kA. This result is only an example of the countermeasures against the large fault current. To determine the system configuration, it is considered necessary to implement a further study so as to be able to select target locations and/or intervals and applicable countermeasures depending on the actual situation and viability of the measures.

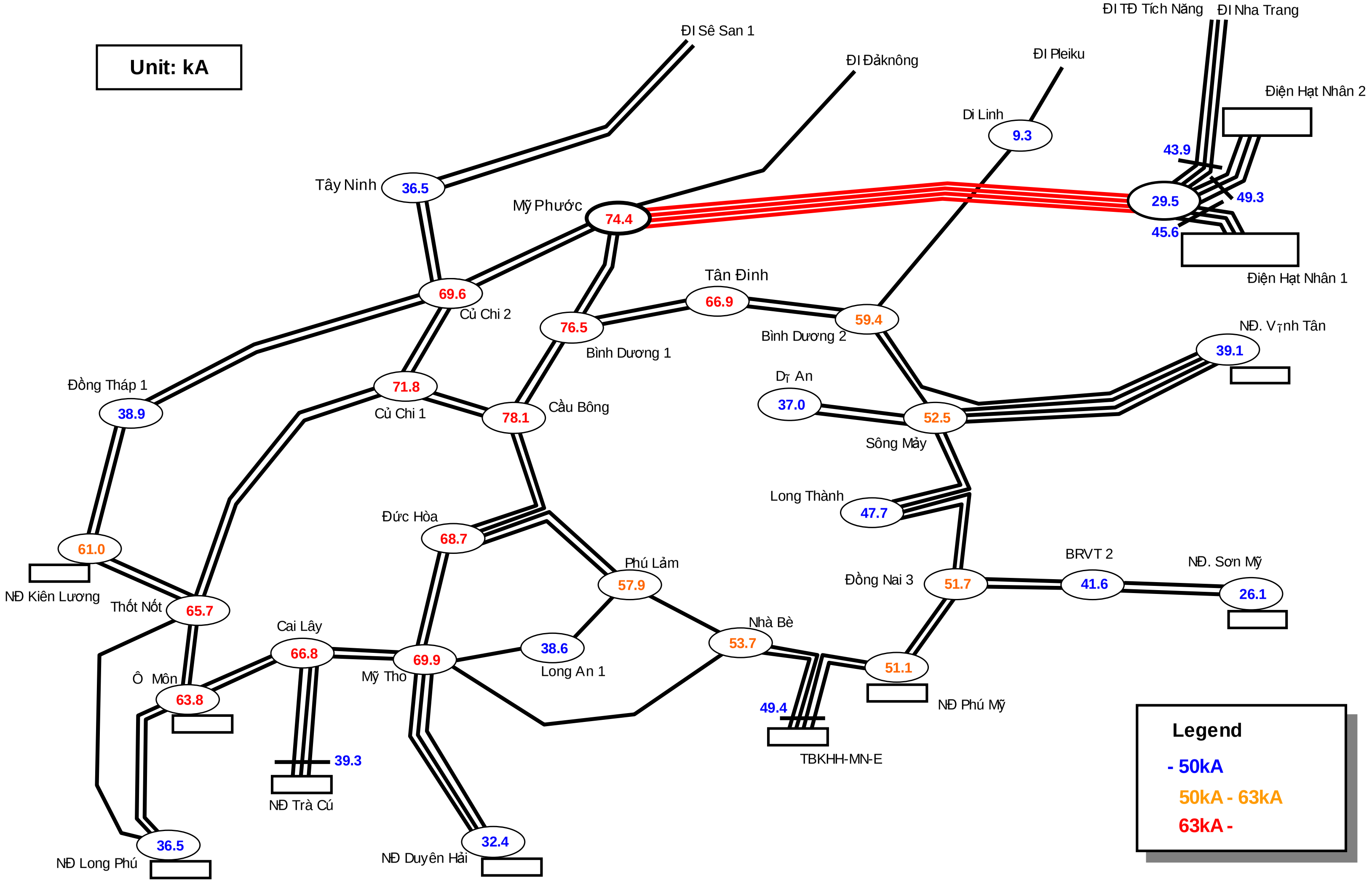


Figure 4.2-3: Three Phase Short Circuit Fault Currents at 500 kV Substations in Ho Chi Minh City and Neighboring Area (2030)

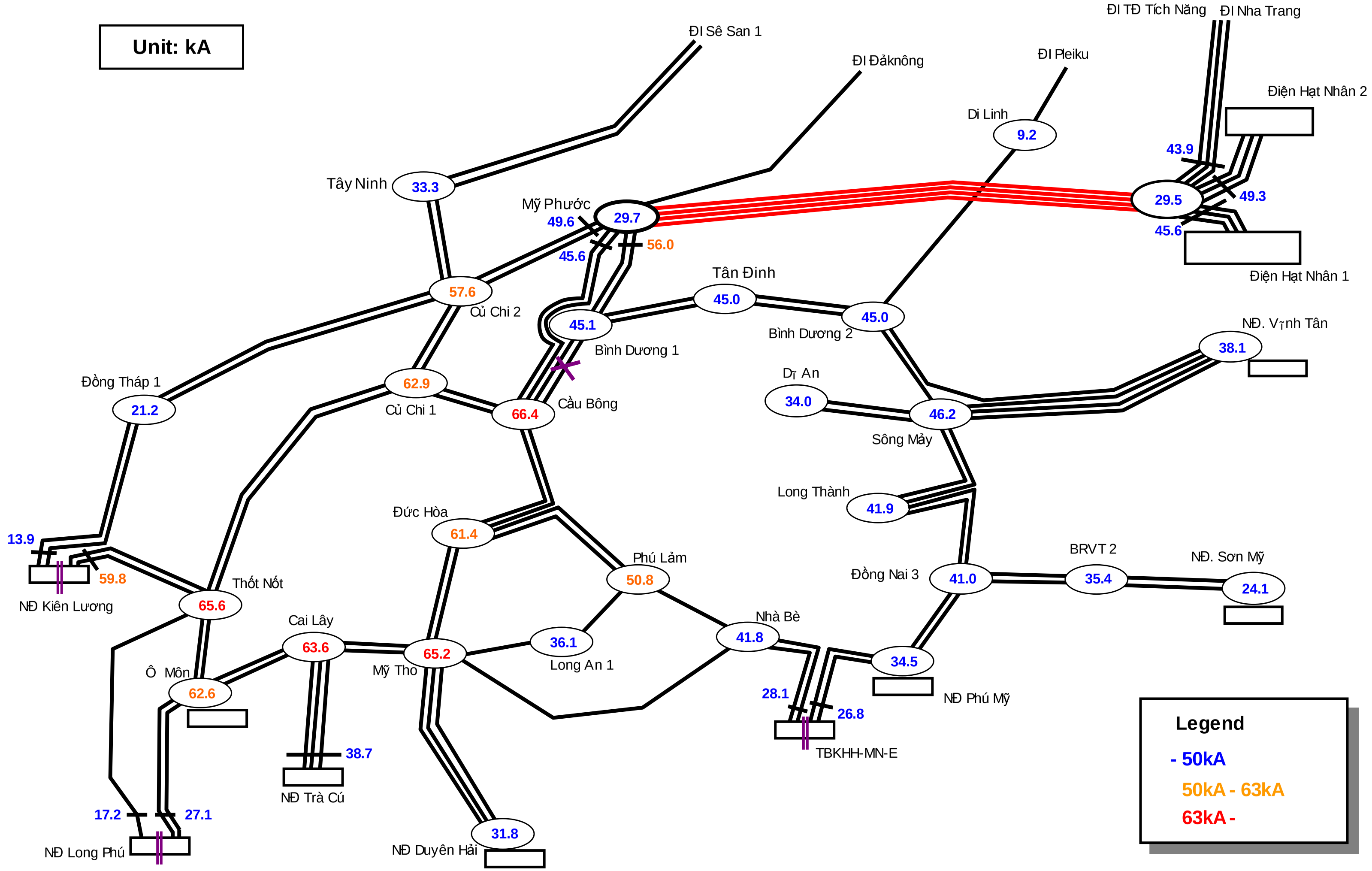


Figure 4.2-4: Three Phase Short Circuit Fault Currents at 500 kV Substations after Implementation of Countermeasure (2030)

4.2.3 Confirmation of Validity of 220 kV Inner Ring System Surrounding Ho Chi Minh Area

The 220 kV system of Ho Chi Minh City and its surrounding area has such a configuration that it supplies power to four to five 220 kV substations, including the loads of the secondary side of the 500 kV substations, from each 500 kV substation on the outer ring system. The 220 kV system has a loop configuration similar to the 500 kV outer ring system. As the supply system for the load center located in the loop, the following are the two underground transmission systems that originate from the two substations on the 220 kV loop system:

- Phu Lam substation - Dam Sen substation - Tan Son Nhat substation - Hiep Binh Phuoc substation (2cct[2], conductor type: XLPE 2500 mm^2)
- Mid point between Nha Be substation and Tao Dan substation[3] - Tan Cang substation - Thu Thiem substation - Quan 2 substation - Cat Lai substation (2cct[1] , conductor type: XLPE 2500 mm^2)

and 2 independent radial systems that supply power to each terminal substation:

- Nha Be substation - Quan 7 substation (2cct, conductor type: XLPE 2500 mm^2)
- Nam Sai Gon substation - Quan 8 substation (2cct, conductor type: XLPE 2500 mm^2)

have been planned by IE.

(1) Power Flow

The power flow of the 220 kV system in Ho Chi Minh City and its surrounding areas as of 2030 was shown in Figure 4.2-6. Under normal operation conditions, no overloading occurred to the 220 kV system.

Under N-1 contingency conditions, overloading occurred to the remaining circuits of the underground cable intervals summarized in Table 4.2-1. The power rating of the transmission capacities of the underground cables were assumed to be 460 MVA/cct (414 MW/cct) for XLPE2500 mm2, 394 MVA/cct (354 MW/cct) for XLPE1600 mm2, respectively.[4]

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[2] The number of circuits for the following intervals were set 3 in order to resolve overloading: Phu Lam substation - Dam Sen substation, mid point between Nha Be substation - Tao Dan substation - Tao Dan substation, and Cat Lai substation - Quan 2 substation

[3] Existing underground transmission line (conductor type: XLPE1600 mm^2)

[4] Power factor was assumed to be 0.9.

Table 4.2-1: Overloaded Intervals in 220 kV Underground Transmission System under N-1 Contingency Condition

Interval		Conductor Type	Power Flow of remaining Circuit (MVA)	Percentage (%)
From	To			
Branch-off between Overhead and Underground	Tao Dan substation	XLPE1600	481	122.1
Tao Dan substation	Tan Cang substation	XLPE2500	528	114.8
Thu Thiem substation	Quan 2 substation	XLPE2500	485	105.5
Nam Sai Gon substation	Quan 8 substation	XLPE2500	500	108.7

As shown in Table 4.2-1, overloading occurred to the remaining circuits of the intervals of two overhead transmission lines under the N-1 contingency condition. Where the transmission capacity of the conductor ACSR600 mm^2 2 bundles was assumed to be 800 MVA/cct. In this study model, the number of circuits of the interval between the Binh Duong 1 substation and the T.D. Mot substation was assumed 2cct; however, IE has already considered that the required number of circuits may come to 2 or 3, and it would change the number of circuits based on the detailed study to be conducted independently. Therefore, as soon as this overloading is identified by IE's study on the detailed system model created, the necessary number of circuits would be changed accordingly and the problem would also be resolved.

Table 4.2-2: Overloaded Intervals in 220 kV Overhead Transmission System under N-1 Contingency Condition

Interval		Conductor Type	Power Flow of remaining Circuits (MVA)	Percentage (%)
From	To			
Duc Hoa 3 substation	TBKHH MN-W power station	ACSR600 2 bundles	807	100.9
Binh Duong 1 substation	T.D. Mot substation	ACSR600 2 bundles	845	105.7

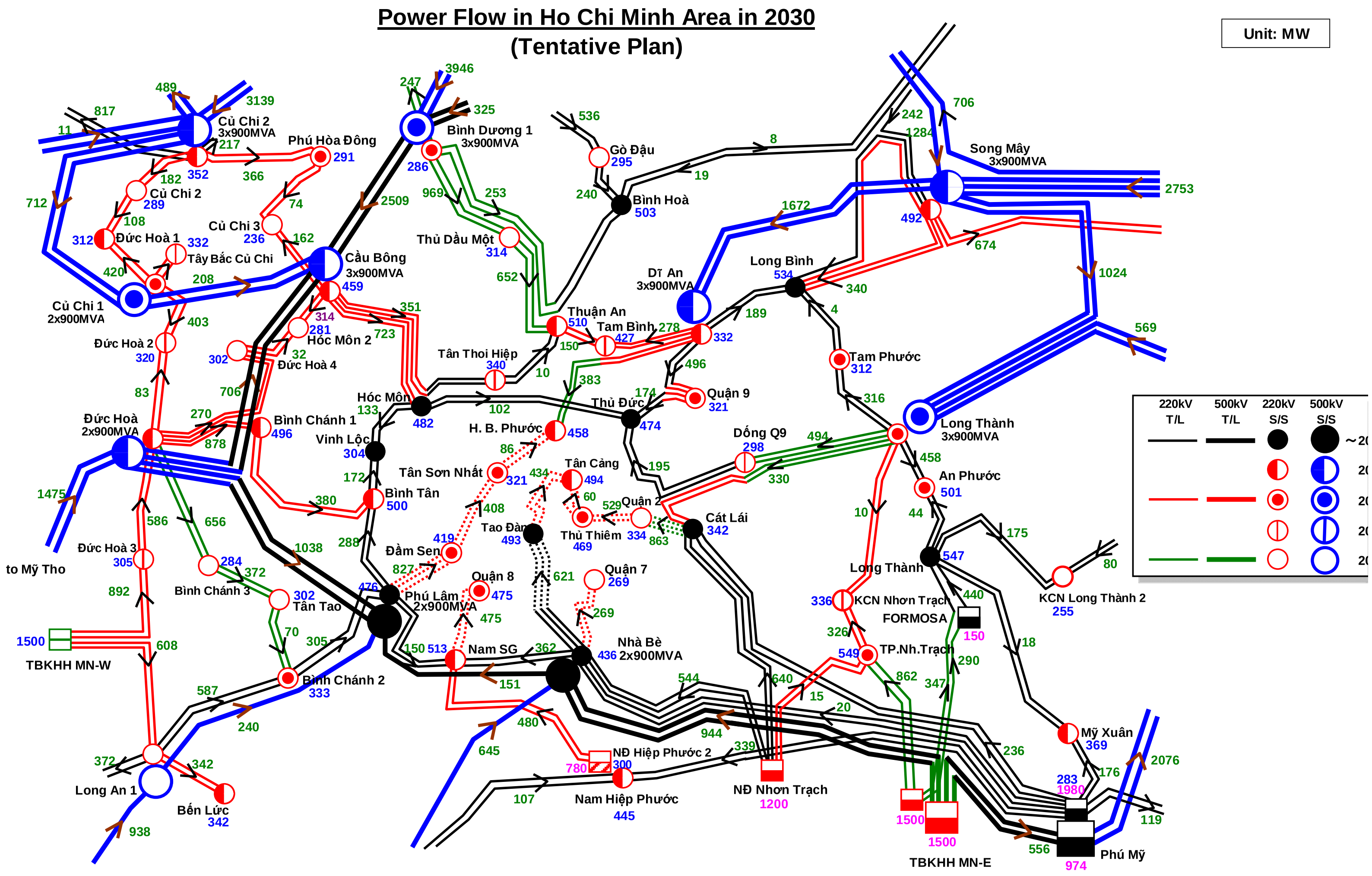


Figure 4.2-5: Power Flow of the 220 kV System in Ho Chi Minh City and its Surrounding Area (2030)

(2) Fault Current

The three-phase short circuit currents at the 220 kV substations as of 2030 are shown in Figure 4.2-5. The one line-to-ground fault currents were not calculated since there was no available data of zero sequence impedance. According to the draft PDP7, which was under planning by IE, the operations of the 220 kV system in Ho Chi Minh City was assumed to be with a loop configuration, and the system reliability was evaluated based on N-2 and/or N-1 criteria.

Besides, in the previous PDP6, the IE shed light that the short circuit fault current would range from 70 to 80 kA for the system in Ho Chi Minh City as of 2025. As the solutions of the large short circuit current, in the PDP6, IE recommended the following countermeasures:

- Change or select switch gear that can be operated with a calculated short circuit current.
- Segment bus bar in source centers, in substations.
- Install equipment that can limit the short circuit current.

(Source: 8.2.1 Calculation of short circuit currents, CHAPTERVIII, THE POWER NETWORK DEVELOPMENT PLAN, Power Development Plan 6)

Based on the fault current analysis done by the TA Team in 2030, under loop operation conditions, the three-phase short circuits at many 220 kV substation buses are expected to exceed the maximum limit of the Vietnamese system planning criteria, 40 kA, thus resulting in a much severer situation than that in 2025. In particular, the maximum calculated value was an even 102.5 kA at the Phu Lam substation.   In order to reduce the short circuit current, the loop system was opened between such intervals that have relatively smaller power flows or are balanced to form a radial system. By this method, the system was divided into several sub-systems which constituted one power station or a 500 kV source substation and three to five 220 kV substations to be fed by the source. The three-phase short circuit currents at each 220 kV substation after taking measure were shown in Figure 4.2-7. With the system segmentation, the fault currents were reduced by tens of kA. Nevertheless, the short circuit currents at some 220 kV substations that were directly connected to some power stations were still above 50 kA after the segmentation. As described in 4.2.2 (2), dividing the primary side of buses at power stations into each feeding sub-system is considered to be one of the effective options to suppress short circuit currents for such cases. This result is only an example of the system separation for fault current reduction. To determine the system configuration, it is considered necessary to conduct a detailed study taking into account the actual situation of facilities and the viability from the viewpoint of technologies and economic efficiency.

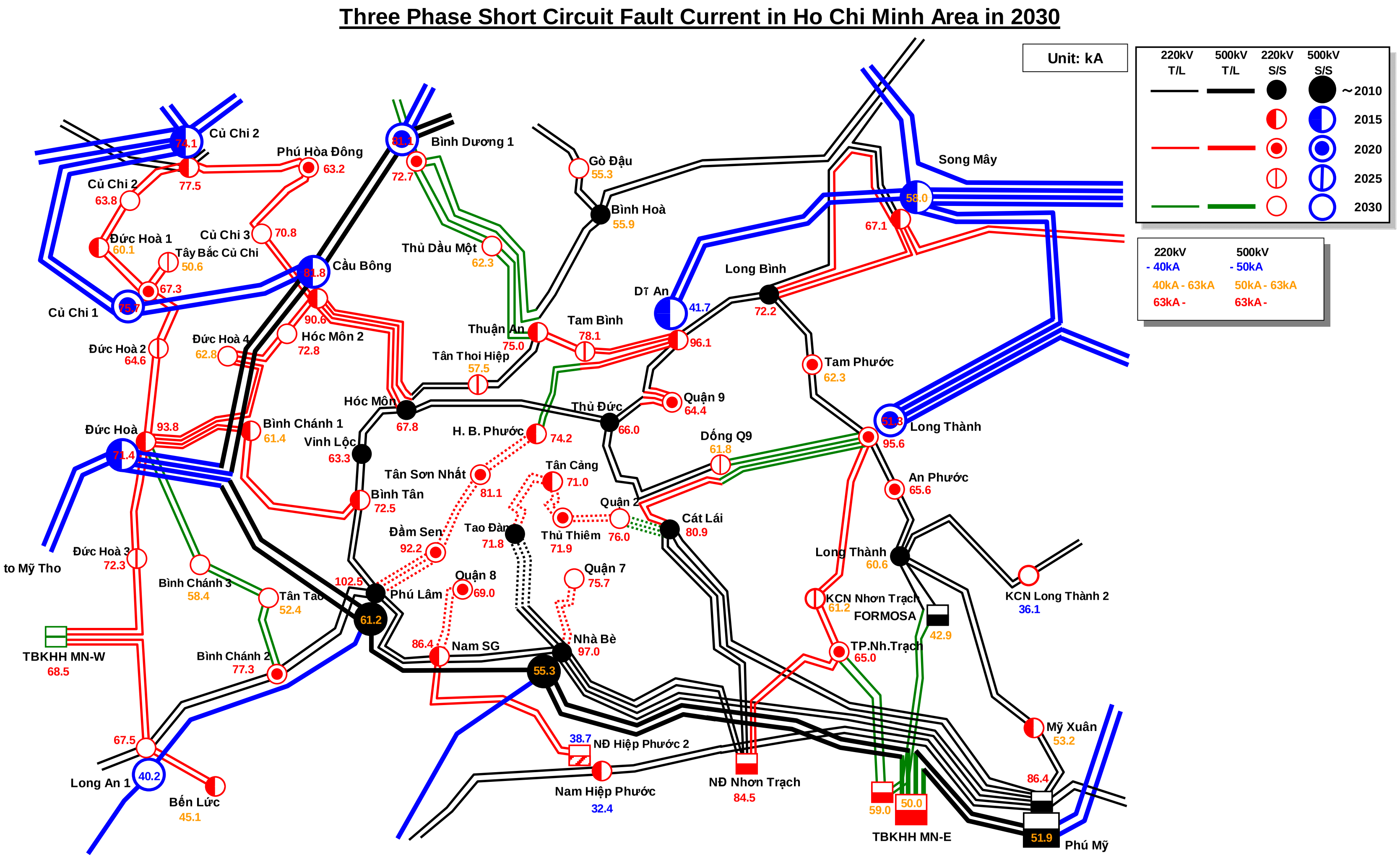


Figure 4.2-6:Three-Phase Short Circuit Fault Current at 220 kV Substations in Ho Chi Minh City and its Surrounding Area (2030)

Three Phase Short Circuit Fault Current in Ho Chi Minh Area in 2030
(System separation for fault current reduction)

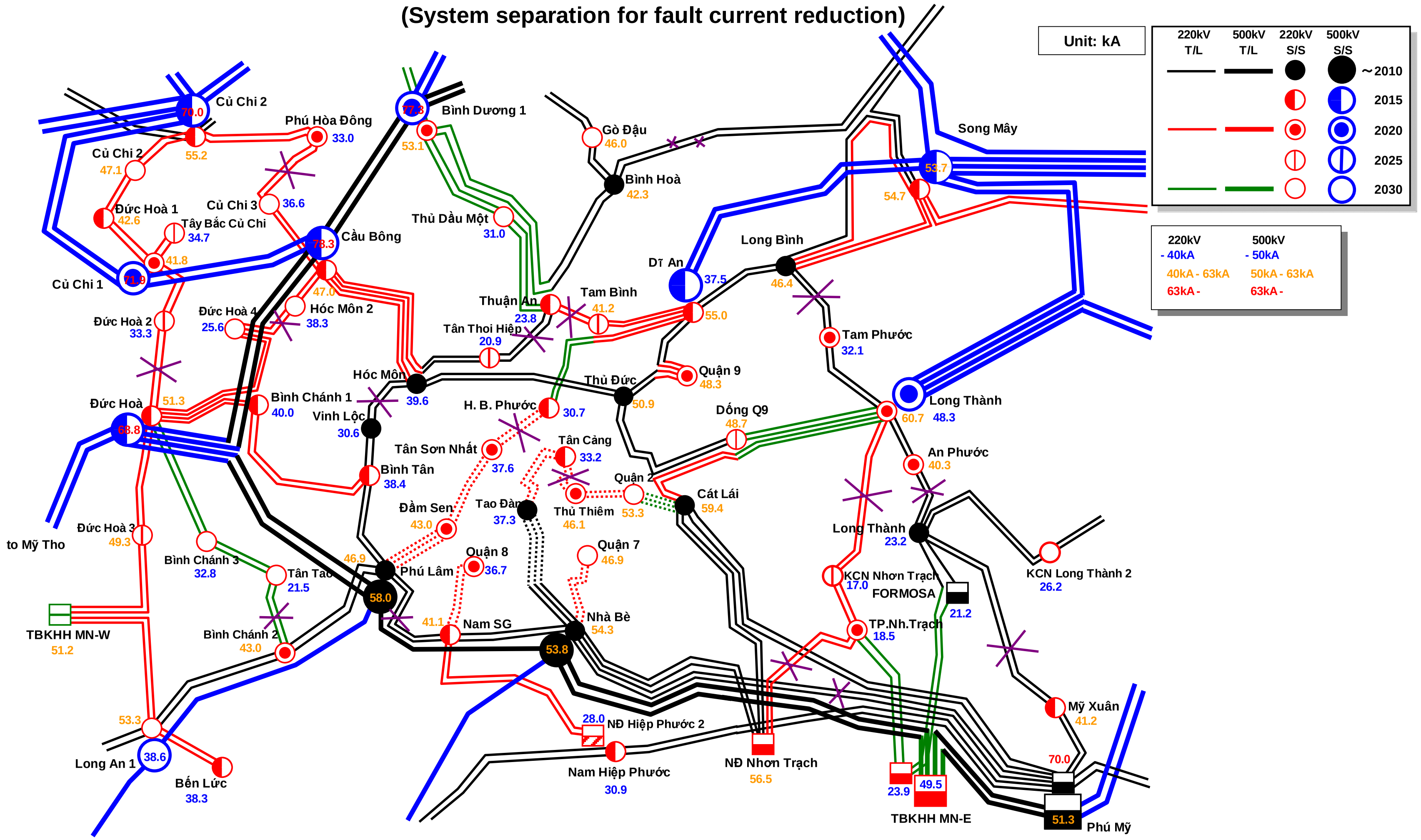


Figure 4.2-7: Three-Phase Short Circuit Fault Currents after Taking Measures (2030)

4.3 Examination of 500 kV System Including International Interconnections

The 500 kV interconnections between China and Vietnam and between Laos and Vietnam and the 220 kV interconnections between Cambodia and Vietnam are in the works. Chapter 6 describes the draft plan of interconnections by IE in and around the center and south of Vietnam.

4.4 Introduction of Technical Study Items

Some problems will arise according to the expansion of the power system due to an increase of power demand in the future. Relevant technologies were transferred by introducing some examples in Tokyo as shown below.

The specific technologies that were transferred are shown in the attached materials for the presentations.

(1) Introduction of Technical Study Items for Overvoltage which can Arise in the Underground Cable System

The study items and related contents were outlined to the system planning members of IE on overvoltage analyses and abnormal phenomena such as resonance overvoltage typically found in cable systems.

Meanwhile, the 220 kV cables of two circuits, which are 6.3 km long and a part of the 9.64 km span between Nha Be and Tao Dan, already exist in Ho Chi Minh City. Since the length of the cable is not so long, the risk of problems can be relatively low. However, some of the studies, which are supposed to be conducted essentially, might not have been conducted.

The items and contents presented in this project are the essential studies needed to confirm the specifications of the cables, auxiliary equipment and relevant facilities, and those technical studies will probably be essential before constructing underground cables.

There are some new 220 kV underground line construction plans in the PDF7 draft and 220 kV cables will become more and more prevalent in the future. If there are existing risks of overvoltage phenomena occurring at the step of F/S of each facility, in-depth studies should be conducted and countermeasures should be prepared if necessary.

(2) Introduction of Efficient Utilization of Underground in Tokyo

Power demand is very high in the Tokyo metropolitan area, where the population is very dense and the area's power system is expected to be highly reliable. Meanwhile, it takes enough premises and proper routes to construct a substation and transmission facilities. However, it is not easy to find land large enough to construct a substation in the area, and land prices are also very high. Introducing underground substations and underground cable systems to densely-inhabited areas such as the Tokyo metropolitan city is a rational power supply system not only in reliability but also from an environmental standpoint.

Power system facilities equipped underground were shown in a presentation to system planning members of the IE as examples of efficient utilization of underground space, and technologies, which reduced the total costs for the facilities while maintaining safety and reliability, were also shown to them.

As of 2010, there has not been an underground substation in Viet Nam, and there will still not be one until 2030 at the drafting stage of PDP7. From experiences in Japan, however acquiring land for the new substation will be getting harder and harder along with an increase of power demand due to urban developments, and consequently introducing an underground substation will be necessary at some point in the future even in Viet Nam. A few members of IE also have an idea that underground substations will be an option to consider especially in Ho Chi Minh City. There are two main reasons why constructing an underground substation is not feasible in Ho Chi Minh City as a whole in IE. One is excessively soft ground in the city, and the other is a very high water level caused by frequent floods. Some members of IE asked the JICA TA Team about the dimensions of the underground substations and power demand density when TEPCO constructed the first underground substation. It is true that there is no existing plan to construct an underground substation in Viet Nam, but they were very interested in obtaining relevant information.

(3) Voltage Stability

JICA TA Team introduced an example of a system collapse caused by a voltage instability which TEPCO had suffered in the past, and during the presentation, it was emphasized that voltage stability issue is very important. Countermeasures against voltage instability were also presented. Besides, reactor compensation methods were presented as countermeasures for increasing the charging capacity of underground cables, which will be necessary in urban areas like Ho Chi Minh City in the future.

Fault current is expected to keep increasing along with generation expansions in the future. System configurations of southern power system including Ho Chi Minh City were studied with regard to the fault current limitations, and as a result, it was shown that it would be effective to split the 220 kV system of Ho Chi Minh City into radial configuration in reducing the fault current, and to be necessary to prepare enough reactive power sources against lower voltage. The findings were reported to IE.

(4) Conductors used for Bulk Power Transmission Lines

The relatively larger sizes of conductors are applied for 275 kV transmission lines in Tokyo than the sizes used for 220 kV transmission lines in Vietnam. The application of those sizes of conductors is suitable for the cases of power transmission with short distance where there are not so much power limitation. For example, the four circuits are needed at the starting points of 220 kV system if the conventional sizes of the conductors are applied as show in Figure 4.2-6. On the other hand, the number of circuits can be reduced if the larger size of conductors such as TACSR 1520 mm^2 is applied. This kind of idea was raised through the discussion with IE on the power supply system planning and used for the efficient construction of power transmission lines in the future.

Chapter 5 Interim Review of Draft PDP7 Formulated by IE

5.1 Pre-conditions for Power Demand Forecasting Model

In this section, the preconditions of the Power Demand Forecasting Model prepared for making comments to power demand forecasts of IE are presented and explained. In the PDP6, power demand forecasts are weighed under social economic assumptions. In the PDP7, the additional changes of the sectoral power consumption intensities (per GDP and per population) are weighed at the time of power demand forecasting. And for the simulation, three kinds of cases such as the Base case, the High case and the Low case are prepared.

5.1.1 Case of Economic Growth

(1) Base Case

- In this scenario, a structure change is conducted at a moderate and reasonable level. In this scenario, laborers are well mobilized, with relatively high average productivity in the direction of development and shifting laborers from rural areas to the industry and service sectors.
- The growth rate of the Industry & Construction sector was around less than 9% in 2020. The Commercial & Service sector is 7-8% and Agriculture, Forestry and Fishery sector is around 3%.
- When looking at the process of the industrialization of the Vietnam economy, the GDP share of Agriculture, Forestry and Fishery sector is gradually reduced from 22% in 2010 to 17% in 2020. The shares of Industry and Service sectors are approximately 41% and 42% in 2020.

Table 5.1-1: Economic Indicators (Base case)

Item	Unit	2008	2010	2015	2020	2030
Population	Million	86	88	92	97	102
GDP (Current)	Billion USD	91	103	197	340	1,039
GDP Structure (current)	S%	100	100	100	100	100
Agri, forestry, fishery	S%	22	21.9	20.1	17.2	11.8
Industry & construction	S%	39.9	39.5	40.3	41.2	42.5
Services	S%	38.1	38.6	39.7	42.1	45.7
GDP/capita (at 2008)	USD per Capita	1,062	1,223	1,800	2,602	5,893
Japan ($34000/capita)	S%	3.1	3.6	5.3	7.7	17.3
			08-10	11-15	16-20	21-30
Total GDP	G%		5.9	7.5	8.0	8.2
Agri, forestry, fishery	G%		3.7	3.6	2.8	2.8
Industry ? construction	G%		6.3	8.8	8.8	9.1
Services	G%		6.4	7.6	8.0	8.2

Source: SED2020

Table 5.1-2: Economic Growth Rates in the Model (Base case)

(Unit: %)

Base Case

Items 1	Items 2	Unit	2008	2009	2010	2015/10	2020/15	2030/20	2020/2010
Population	Country number	Million persons	1.3	1.1	1.1	1.0	0.9	0.5	0.9
	Urban number	Million persons	2.7	3.3	3.3	3.0	2.7	1.6	2.8
Household	County Number	Million HH	1.3	1.3	1.3	1.2	1.1	0.6	1.1
	Urban number	Million HH	2.7	2.1	3.5	3.2	2.9	1.7	3.0
Economic indicators	nGDP at current price	Billion VND	29.3	19.0	12.9	15.4	14.4	15.1	14.9
	uGDP on USD base	Million USD	30.5	15.1	2.5	15.1	12.7	12.6	13.9
	uGDP per capita on USD base	USD per capita	28.9	13.9	1.4	14.0	11.7	12.0	12.8
	rGDP at 2005 price	Billion VND	6.2	5.2	7.0	7.5	8.0	8.2	7.7
	GDP deflator 2005 price	2005=100	21.4	8.0	7.0	7.0	6.0	6.0	6.5
rGDP at 2005 price	Agriculture & Forestry	Billion VND	3.9	2.9	3.3	3.3	3.1	2.2	3.2
	Mining	Billion VND	2.2	1.7	1.8	1.6	1.3	1.2	1.4
	Manufacturing	Billion VND	7.5	6.5	9.6	10.2	10.6	10.2	10.4
	Commercial & Trade	Billion VND	8.4	5.6	7.1	7.3	7.5	7.2	7.4
	Transport and communications	Billion VND	8.3	5.6	7.1	7.3	7.5	7.2	7.4
	Service & Others	Billion VND	4.4	5.0	6.1	6.2	6.2	6.2	6.2
	Total	Billion VND	6.2	5.2	7.0	7.5	8.0	8.2	7.7

Source: 2008-2009: International Financial Statistics,   2011-2030: From SED2020

Table 5.1-3: Regional Economic Outlook (Base case)

		2005	2010	2015	2020	2025	2030	20/10
Northern RGDP	Billion VND	289	398	555	804	1,190	1,785	7.3%
Industry	Billion VND	108	161	253	409	667	1,088	9.7%
Commercial	Billion VND	125	172	230	315	434	597	6.3%
Agriculture	Billion VND	56	65	72	80	89	100	2.1%
Central RGDP	Billion VND	88	124	182	278	418	634	8.4%
Industry	Billion VND	26	39	63	103	164	262	10.0%
Commercial	Billion VND	36	53	81	128	197	302	9.3%
Agriculture	Billion VND	27	32	38	47	57	70	3.9%
Southern RGDP	Billion VND	462	656	950	1,416	2,136	3,230	8.0%
Industry	Billion VND	205	305	452	689	1,059	1,628	8.5%
Commercial	Billion VND	177	253	376	573	880	1,353	8.5%
Agriculture	Billion VND	80	98	122	154	196	249	4.6%

Source: Base case model

Source: 2008-2009: International Financial Statistics, 2011-2030: From SED2020

(2) High Case

- Change of economic structure is strong, because industry and construction and services sector have fast growth.
- A high case is connected to a soon-to-be restoration of the world economy, and Vietnam's economy will also be fast restored with strong promotion of industry development in the years before and after 2020.
- There is strong change in conjunction with the fast development of the service sector. This fast development brings about human resource exploitation and increases labor productivity.
- Share of labor in agriculture will only be 36% in 2020 and 17% in 2050.

Table 5.1-4: Economic Indicators of High Case in SED2020

Item	Unit	2008	2010	2015	2020	2030
Population	Million	86	88	92	97	102
GDP (Current)	Billion USD	91	103	214	396	1,437
GDP Structure (current)	S%	100.0	100.0	100.0	100.0	100.0
Agri, forestry, fishery	S%	22.0	21.7	18.5	14.8	8.5
Industry & construction	S%	39.9	39.5	40.3	41.2	38.4
Services	S%	38.1	38.8	41.2	44.0	53.1
GDP/capita (at 2008)	USD per Capita	1,062	1,234	1,950	3,035	8,150
Japan ($34000/capita)	S%	3.1	3.6	5.7	8.9	24.0
			08–10	11–15	16–20	21–30
Total GDP	G%		6.4	9.1	9.6	9.8
Agri, forestry, fishery	G%		3.7	3.6	2.8	2.8
Industry ? construction	G%		6.7	10.4	10.4	9.9
Services	G%		7.2	9.8	10.5	10.9

Source: SED2020

Table 5.1-5: Economic Growth Rates in the Model (High Case)

(Unit: %)

Items 1	Items 2	Unit	2008	2009	2010	2015/10	2020/15	2030/20	2020/10
Population	Country number	Million persons	1.3	1.1	1.1	1.0	0.9	0.5	0.9
	Urban number	Million persons	2.7	3.3	3.3	3.0	2.7	1.6	2.8
Household	County Number	Million HH	1.3	1.3	1.3	1.2	1.1	0.6	1.1
	Urban number	Million HH	2.7	2.1	3.5	3.2	2.9	1.7	3.0
Economic indicators	nGDP at current price	Billion VND	29.3	19.8	12.4	16.7	15.7	16.5	16.2
	uGDP on USD base	Million USD	30.5	15.9	2.0	16.5	14.0	13.9	15.3
	uGDP per capita on USD base	USD per capita	28.9	14.7	0.9	15.4	13.0	13.3	14.2
	rGDP at 2005 price	Billion VND	6.2	5.2	7.0	9.1	9.6	9.8	9.3
	GDP deflator 2005 price	2005=100	21.4	8.0	7.0	7.0	6.0	6.0	6.5
rGDP at 2005 price	Agriculture & Forestry	Billion VND	3.9	2.9	3.3	4.0	3.6	2.4	3.8
	Mining	Billion VND	2.2	1.7	1.8	1.9	1.5	1.2	1.7
	Manufacturing	Billion VND	7.5	6.5	9.6	12.4	12.6	12.1	12.5
	Commercial & Trade	Billion VND	8.4	5.6	7.1	8.9	8.8	8.5	8.9
	Transport and communications	Billion VND	8.3	5.6	7.1	8.9	8.8	8.5	8.9
	Service & Others	Billion VND	4.4	5.0	6.1	7.6	7.4	7.3	7.5
	Total	Billion VND	6.2	5.2	7.0	9.1	9.6	9.8	9.3

Source: 2008-2009: International Financial Statistics by IMF, 2010: Estimation of JICA
2011-2030: From SED2020

Table 5.1-6: Regional Economic Outlook (High Case)

RGDP 2005 price

		2005	2010	2015	2020	2025	2030	20/10
Northern RGDP	Billion VND	289	398	597	931	1,498	2,452	8.9%
Industry	Billion VND	108	161	278	491	881	1,578	11.8%
Commercial	Billion VND	125	172	245	356	522	765	7.6%
Agriculture	Billion VND	56	65	74	84	95	109	2.5%
Central RGDP	Billion VND	88	124	198	327	536	886	10.2%
Industry	Billion VND	26	39	69	124	217	379	12.1%
Commercial	Billion VND	36	53	89	153	255	426	11.2%
Agriculture	Billion VND	27	32	40	51	64	82	4.7%
Southern RGDP	Billion VND	462	656	1,028	1,654	2,705	4,441	9.7%
Industry	Billion VND	205	305	491	811	1,354	2,262	10.3%
Commercial	Billion VND	177	253	408	674	1,125	1,879	10.3%
Agriculture	Billion VND	80	98	128	169	225	300	5.6%

Source: SED2020

(3) Low Case

- Industry & construction, Agriculture, Service sectors have relatively low growth rates in terms of the domestic market.
- Growth rate of industry and construction experienced incremental increases of 8.8% during the period of 2011-2015 and at about 8-9% for the following periods.
- Growth rate of agriculture is low and stable at 2.7-3.7% for the whole period.
- Growth rate of services is also at a low level, an average of 7-8% depending on the periods of up to 2050.
- Economic structure for the Low case changed with the slow pace, and it is difficult for Vietnam to achieve the targets.

Table 5.1-7: Economic Indicators (Low Case)

Item	Unit	2008	2010	2015	2020	2030
Population	Million	86	88	92	97	102
GDP (Current)	Billion USD	91	103	193	326	953
GDP Structure (Current)	S%	100	100	100	100	100
Agriculture, forestry, fishery	S%	22	22	20.5	17.9	12.9
Industry & construction	S%	40	39.7	41.2	43	46.3
Services	S%	38.1	38.3	38.3	41.3	40.8
GDP/capita (2008 price)	USD	1,062	1,216	1,762	2,495	5,408
Japan ($34000/capita)	S%	3.1	3.6	5.2	7.3	15.9
			08-10	11-15	16-20	21-30
Total GDP	G%		5.6	7.1	7.7	7.6
Agriculture, forestry, fishery	G%		3.7	3.6	2.8	2.8
Industry ? construction	G%		6.3	8.8	8.8	9.1
Services	G%		5.7	6.7	8.0	6.7

Source: SED2020

Table 5.1-8: Economic Growth Rates (Low Case)

(Unit: %)

Items 1	Items 2	Unit	2008	2009	2010	2015/10	2020/15	2030/20	2020/10
Population	Country number	Million persons	1.3	1.1	1.1	1.0	0.9	0.5	0.9
	Urban number	Million persons	2.7	2.8	2.8	2.5	2.2	1.3	2.4
Household	County Number	Million HH	1.3	1.3	1.3	1.2	1.1	0.6	1.1
	Urban number	Million HH	2.7	1.6	3.0	2.7	2.4	1.4	2.6
Economic indicators	nGDP at current price	Billion VND	29.3	19.0	12.9	15.0	14.0	14.6	14.5
	uGDP on USD base	Million USD	30.5	15.1	2.5	14.7	12.4	12.1	13.6
	uGDP per capita on USD base	USD per capita	28.9	13.9	1.4	13.6	11.4	11.5	12.5
	rGDP at 2005 price	Billion VND	6.2	5.2	7.0	7.1	7.7	7.6	7.4
	GDP deflator 2005 price	2005=100	21.4	8.0	7.0	7.0	6.0	6.0	6.5
rGDP at 2005 price	Agriculture & Forestry	Billion VND	3.9	2.9	3.3	3.1	3.0	2.0	3.0
	Mining	Billion VND	2.2	1.7	1.8	1.5	1.3	1.1	1.4
	Manufacturing	Billion VND	7.5	6.5	9.6	9.7	10.2	9.5	9.9
	Commercial & Trade	Billion VND	8.4	5.6	7.1	7.0	7.2	6.8	7.1
	Transport and communications	Billion VND	8.3	5.6	7.1	7.0	7.2	6.8	7.1
	Service & Others	Billion VND	4.4	5.0	6.1	5.9	6.0	5.8	6.0
	Total	Billion VND	6.2	5.2	7.0	7.1	7.7	7.6	7.4

Source: 2008-2009: International Financial Statistics, 2010: Estimation of JICA, 2011-2030: From SED2020

Table 5.1-9: Regional Economic Outlook (Low Case)

		2005	2010	2015	2020	2025	2030	20/10
Northern RGDP	Billion VND	289	398	546	778	1,120	1,631	6.9%
Industry	Billion VND	108	161	248	393	620	978	9.3%
Commercial	Billion VND	125	172	227	307	413	556	6.0%
Agriculture	Billion VND	56	65	72	79	88	97	2.0%
Central RGDP	Billion VND	88	124	179	268	392	576	8.0%
Industry	Billion VND	26	39	61	99	152	236	9.6%
Commercial	Billion VND	36	53	79	123	184	274	8.8%
Agriculture	Billion VND	27	32	38	46	55	67	3.7%
Southern RGDP	Billion VND	462	656	933	1,369	2,006	2,947	7.6%
Industry	Billion VND	205	305	444	665	992	1,481	8.1%
Commercial	Billion VND	177	253	369	552	825	1,231	8.1%
Agriculture	Billion VND	80	98	121	151	189	236	4.4%

Source: SED2020

5.1.2 Other Assumptions

With regard to the main factors having strong impacts on the energy demand, assumptions for each case are made as follows;

(1) Population

- In 2008, the population of Vietnam was 86.2 million people and the average population growth rate was 1.3%/year during the period of 2001-2008. The population growth rate will experience a moderate decline in the future. Further, the urban population has increased rapidly compared to the country's population.
- The population growth rate is 1.0% to 0.5% per year in the country, but growth rate in urban areas will be 3.0% in 2011-2015 and 2.7% in 2016-2020.

Table 5.1-10: Number of Population in Vietnam and Urban Area

	Unit	2010	2011	2012	2013	2014	2015	2020	2025	2030
Country	Million	88.8	89.7	90.6	91.5	92.4	93.3	97.6	100.2	102.8
Urban	Million	25.6	26.4	27.2	28.0	28.8	29.7	33.9	36.7	39.7
Urban rate	%	29%	29%	30%	31%	32%	32%	35%	37%	39%

Source: SED2020

Table 5.1-11: Number of Population in Region and Urban Area

(Unit: Million)

		2010	2011	2012	2013	2014	2015	2020	2025	2030
Northern	Region	38.0	38.3	38.7	39.0	39.4	39.7	41.3	42.1	43.0
	Urban	8.4	8.7	9.0	9.2	9.5	9.8	11.2	12.1	13.0
Central	Region	19.6	19.8	20.1	20.3	20.5	20.8	22.0	22.8	23.7
	Urban	4.5	4.6	4.7	4.8	4.9	5.0	5.5	6.2	6.9
Southern	Region	30.5	30.8	31.1	31.4	31.7	32.0	33.5	34.4	35.3
	Urban	12.4	12.6	12.9	13.2	13.5	13.8	15.3	16.2	17.1

Source: SED2020

(2) Exchange Rate

According to the Purchasing per Parity Theory (PPP theory) of the floating exchange rate system, the exchange rate between the two countries (in this study, the US and Vietnam) has been basically determined by the difference between their inflation rates.

However, a reliable exchange rate cannot be easily forecasted, though in applying the PPP theory, it is subject to various interest rate changes, economic fundamentals, foreign trade balances and so on. In this study, the future exchange rates projected in the IE Power demand model was adopted which stipulates that the VND would depreciate at an annual rate of 0.8% from 2010 to 2020 and then level off as follows.

Table 5.1-12: Exchange Rate Outlook: VND vs. USD

	2008	2009	2010	2015	2020	2025	2030
VND/USD	16,153	16,700	18,400	18,600	20,000	22,500	25,000

Source: IE Power demand model

(3) Prices and Tariffs

When the energy price rises, the energy demand becomes depressed. As there are many views and opinions on the future trend of energy prices in the world, we assume that for most of WTI's High Energy Prices for High cases, the crude oil price of around 75 USD/bbl in 2010 in the real term would reach around 140 USD/bbl by 2030. In the Base case, the price increases more moderately to around 130 USD/bbl and in Low case, the price is assumed to be around 110 USD/bbl by 2030. The prices of coal, petroleum products, natural gas and electricity tariff will also increase linked with the crude oil price. The retail prices of typical energy sources for each case are as follows:

(a) Petroleum Product Prices

At present, the petroleum product price system in Vietnam is being reviewed. Over the past one or two years, the petroleum product prices in Vietnam have increased about 30%. In the future, as prices continue to increase, the pricing system may evolve to the point where domestic prices should be decided through the market mechanism in reference to international prices. From a cost composition viewpoint, petroleum product prices consist of crude oil prices, refining costs, transportation costs and sales costs with tax and subsidy adjustments.

(b) Coal Price

The coal price is being adjusted to the international price level. At the same time, it is estimated that the future coal production cost will increase as the production system shifts from the open pit system to underground mining. Further, after an adjustment period, the domestic coal price will become linked to the international price. It is assumed that the domestic coal price shall reach the level of the international coal price by 2015.

(c) Natural Gas Price

While the natural gas prices are being determined via individual contract for each project, it is estimated that it will move closer to the international natural gas price (the CIF price of LNG traded in Asia). It is assumed that natural gas in Vietnam will reach the international level by 2015. As international natural gas prices become linked to the crude oil price, it is assumed that the natural gas price after 2015 will level off, the same as crude oil.

(d) Electricity Tariff

The current electricity tariff system applies sectoral electricity tariffs and higher tariffs for bigger consumers, together with preferential policies for rural residents. These may be reviewed by 2015 in principle to become a cost-based tariff system. It is assumed that the electric tariff would be based on two elements from the current system; future coal prices and wages in Vietnam. Concretely, the growth rate of electric tariffs will have increased 5-6% per year by 2015. After that, the electric tariffs will increase in line with increasing domestic coal prices. The aforementioned assumptions have been summarized as follows:

Table 5.1-13: Prices and Tariffs in Base Case

		Unit	2008	2009	2010	2015	2020	2025	2030
Economics	USA Inflation	%	2.6	0.0	0.0	2.0	2.0	2.0	2.0
		2010=1.00			1.00	1.10	1.22	1.35	1.49
	Exchange rate VDN/USD	Dong/USD	16,153	16,700	18,400	18,600	20,000	22,500	25,000
Oil price	IEA Crude oil export prices	USD/bbl	120	60	70	88	98	108	119
	WTI price	USD/bbl	120	70	77	97	107	119	131
Coal	Vietnam for power	1000VND/ton	405	455	542	775	920	1,143	1,402
	Vietnam for domestic	1000VND/ton	439	463	531	634	784	997	1,235
	Vietnam for export	1000VND/ton	705	737	833	940	1,113	1,367	1,646
	Vietnam Average	1000VND/ton	569	597	679	784	945	1,177	1,436
Power Tariff	Agriculture use	VND/kWh	591	636	643	813	910	1,049	1,199
	Residential use	VND/kWh	784	908	918	1,161	1,299	1,498	1,712
	Industry use	VND/kWh	858	935	945	1,217	1,373	1,600	1,847
	Commercial use	VND/kWh	1,628	1,786	1,805	2,324	2,622	3,055	3,528
	Other use	VND/kWh	923	955	965	1,221	1,366	1,574	1,800

Note1: Electric tariffs in 2009 is actual values, and 2010's values are estimated by EVN

Note2: Regarding increasing rates of electric tariffs, the tariffs in 2009 and 2010 are actual and estimation values. After 2015, electric tariffs are increased with 50% of increasing rate of domestic coal price and 15% of increasing labor productivity (it means that it is the income distribution rate of labor productivity), the increasing rate of electric tariffs is 65% to the increasing rate of domestic coal price. This is the same means to be applied elasticity of 0.65 to domestic coal price.

Source: Model

Table 5.1-14: Prices and Tariffs in High Case

		Unit	2008	2009	2010	2015	2020	2025	2030
Economics	USA Inflation	%	2.6	0.0	0.0	2.5	2.5	2.5	2.5
		2010=1.00			1.00	1.13	1.28	1.45	1.64
	Exchange rate VDN/USD	Dong/USD	16,153	16,700	18,400	18,600	20,000	22,500	25,000
Oil price	IEA Crude oil export prices	USD/bbl	120	60	70	89	101	114	129
	WTI price	USD/bbl	120	70	77	98	111	126	142
Coal	Vietnam for power	1000VND/ton	406	457	545	783	952	1,212	1,524
	Vietnam for domestic	1000VND/ton	439	463	531	635	785	998	1,237
	Vietnam for export	1000VND/ton	705	737	833	940	1,113	1,368	1,648
	Vietnam Average	1000VND/ton	569	597	679	784	945	1,179	1,438
Power Tariff	Agriculture use	VND/kWh	591	636	643	816	927	1,086	1,262
	Residential use	VND/kWh	784	908	918	1,165	1,324	1,551	1,802
	Industry use	VND/kWh	858	935	945	1,221	1,401	1,661	1,952
	Commercial use	VND/kWh	1,628	1,786	1,805	2,331	2,676	3,172	3,728
	Other use	VND/kWh	923	955	965	1,224	1,392	1,630	1,894

Source: Model

Table 5.1-15: Prices and Tariffs in Low Case

		Unit	2008	2009	2010	2015	2020	2025	2030
Economics	USA Inflation	%	2.6	0.0	0.0	1.0	1.0	1.0	1.0
		2010=1.00			1.00	1.05	1.10	1.16	1.22
	Exchange rate VDN/U	Dong/USD	16,153	16,700	18,400	18,600	20,000	22,500	25,000
Oil price	IEA Crude oil export p	USD/bbl	120	60	70	87	91	96	101
	WTI price	USD/bbl	120	70	77	95	100	105	111
Coal	Vietnam for power	1000VND/ton	402	451	536	760	859	1,016	1,186
	Vietnam for domestic	1000VND/ton	439	463	531	634	783	994	1,231
	Vietnam for export	1000VND/ton	705	737	833	940	1,111	1,364	1,642
	Vietnam Average	1000VND/ton	569	597	679	783	943	1,175	1,432
Power Tariff	Agriculture use	VND/kWh	591	636	643	809	876	977	1,082
	Residential use	VND/kWh	784	908	918	1,155	1,251	1,396	1,544
	Industry use	VND/kWh	858	935	945	1,209	1,318	1,483	1,654
	Commercial use	VND/kWh	1,628	1,786	1,805	2,310	2,517	2,832	3,159
	Other use	VND/kWh	923	955	965	1,214	1,315	1,467	1,623

Source: Model

(4) Energy Conservation

It is assumed that energy conservation may progress at the speed of current trends, and in each Case, the main industries will make substantial efforts towards energy conservation strongly backed by the Government. However, looking at the current status of preparation of the energy conservation laws and the implementation system, its achievement timing stipulated in the national strategy would be substantially delayed. In consideration of the time lag for the effect from energy conservation efforts to manifest, the study period has been divided into three steps as shown below.

Step 1: Preparation and Trial

Start a trial program by 2010, that prioritizes the organization of EE&C's implementation system and offices.

Step 2: Partial Implementation

Set forth the governmental guidelines and policies on EE&C and apply them partially to the energy users selected from each sector by 2011-2015

Step 3: Full Scale Implementation

Apply the EE&C policy and legislation to all the designated energy consumers by 2015-2030.

With the aforementioned efforts, the EE&C is applied to Industry and Commercial sectors in advance.

Table 5.1-16: Energy Conservation Rates

(Unit: %)

Agriculture	2010	2011	2012	2013	2014	2015	2020	2025	2030
Power EEC rate	0	0	0	0	0	0	0	0	0
Tariff Elasticity	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Industry									
Power EEC rate	0	0	0	0	0	-2	-2	-2	-2
Tariff Elasticity	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15
Transportation									
Power EEC rate	0	0	0	0	0	0	0	0	0
Tariff Elasticity	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10
Commercial									
Power EEC rate	0	0	0	0	0	0	0	-1	-1
Tariff Elasticity	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15
Residential									
Power EEC rate	0	0	0	0	0	0	0	0	0
Tariff Elasticity	0.00	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10

Note) Energy EEC rate: -2: Energy conservation of the sector is made at 2%/year to previous year.

Note) Price elasticity: -0.15: Energy demand is decreased at 0.15% when energy price is increased by 1%.

Source Model

(5) Energy Intensity & Power Ratio

(a) Agriculture

○Energy intensity of Total Energy in Agriculture is almost flat from 2010 to 2020.

○ Power ratio in Agriculture increases by 0.5% per year between 2010 to 2020, and the ratios are as follows;

2010: 10.5%

2015: 13.0%

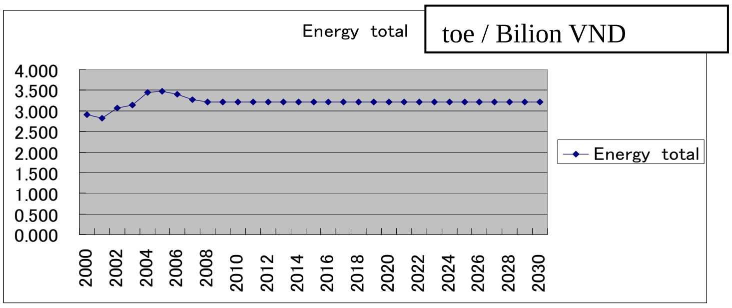
2020: 15.5%

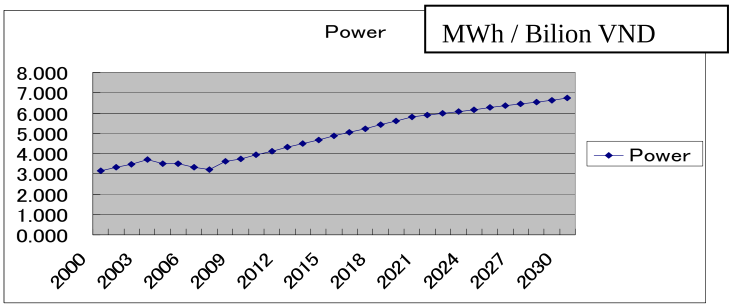
2025: 16.8%

2030: 18.0%

○Based on the ratio, the power intensity increases by 0.5% per year from 2010 to 2020.

○For creating a balance, the fossil energy intensity decreases by -0.6%.





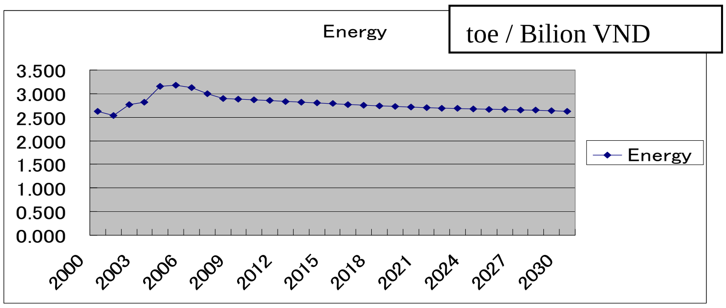


Figure 5.1-1: Intensities in Agriculture Sector

Table 5.1-17: Trends of Intensities and Power Ratio in Agriculture

Agriculture

	2005	2006	2007	2008	2009	2010	2015	2020	2025	2030
Energy total	3.477	3.408	3.270	3.207	3.207	3.207	3.207	3.207	3.207	3.207
toe/ Bil VND 2005price	0.8	-2.0	-4.1	-1.9	0.00	0.00	0.00	0.00	0.00	0.00
	2005	2006	2007	2008	2009	2010	2015	2020	2025	2030
Power Ratio	8.7	8.3	8.4	9.5	10.0	10.5	13.0	15.5	16.8	18.0
%					0.5	0.5	0.5	0.5	0.3	0.3
	2005	2006	2007	2008	2009	2010	2015	2020	2025	2030
Power	3.496	3.322	3.216	3.618	3.747	3.934	4.866	5.798	6.265	6.731
MWh/ Bil VND 2005pri	0.1	-5.0	-3.2	12.5	3.58	4.98	3.98	3.32	1.51	1.40
	2005	2006	2007	2008	2009	2010	2015	2020	2025	2030
Energy	3.173	3.125	2.994	2.901	2.885	2.869	2.789	2.709	2.669	2.628
toe/ Bil VND 2005price	0.7	-1.5	-4.2	-3.1	-0.55	-0.56	-0.57	-0.59	-0.30	-0.30

Source: Base case in the Model

(b) Industry

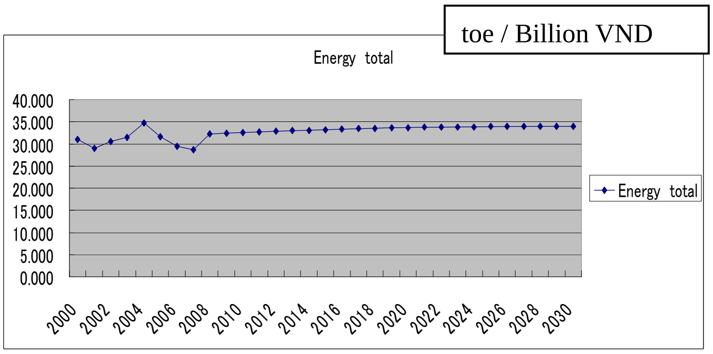
〇Energy intensity of Total Energy in Industry increases by 0.5% per year in 2010 and it gradually slows to 2027.

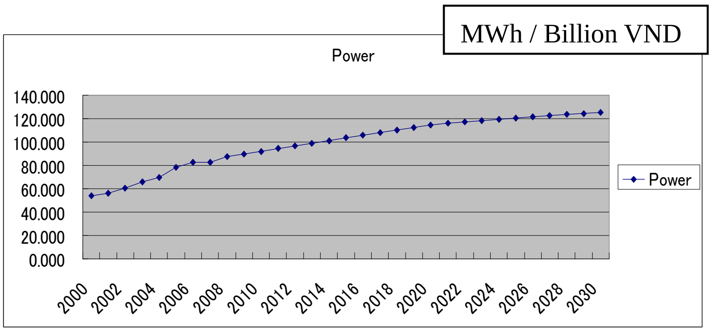
〇Power ratio in Industry increase by 0.5% per year from 2010 to 2020, and 0.3% from 2021 to 2030. The ratios are as follows:

2010: 24.3%
2015: 26.8%
2020: 29.3%
2025: 30.6%
2030: 31.8%

〇 Based on the ratio, power intensity increases by 2.6% per year in 2010 and gradually tapers off.

〇In creating the balance, the fossil energy intensity increases by 0.49% in 2010 and it is gradually tapers off.





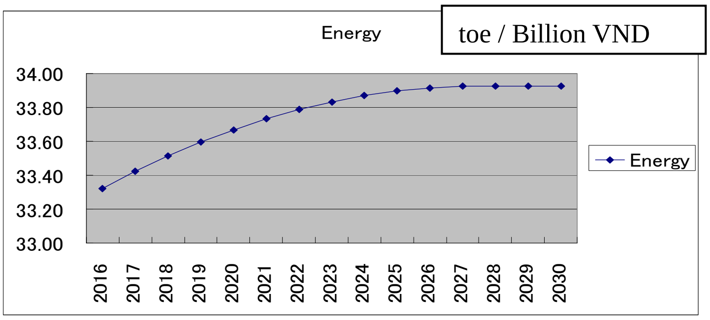


Figure 5.1-2: Intensities in Industry Sector

Table 5.1-18: Trends of Intensities and Power Ratio in Industry

Industry

	2005	2006	2007	2008	2009	2010	2015	2020	2025	2030
Energy total	31.703	29.523	28.649	32.222	32.39	32.55	33.21	33.67	33.90	33.92
toe/ Bil VND 2005price	-8.8	-6.9	-3.0	0.5	0.52	0.49	0.35	0.22	0.08	0.00
	2005	2006	2007	2008	2009	2010	2015	2020	2025	2030
Power Ratio	19.3	21.9	24.1	23.3	23.8	24.3	26.8	29.3	30.6	31.8
%					0.5	0.5	0.5	0.5	0.3	0.3
	2005	2006	2007	2008	2009	2010	2015	2020	2025	2030
Power	78.424	82.721	82.786	87.392	89.73	92.06	103.60	114.80	120.51	125.54
MWh/ Bil VND 2005price	12.4	5.5	0.1	5.6	2.67	2.60	2.26	1.96	0.91	0.79
	2005	2006	2007	2008	2009	2010	2015	2020	2025	2030
Energy	25.572	23.056	21.736	24.707	32.39	32.55	33.21	33.67	33.90	33.92
toe/ Bil VND 2005price	-11.1	-9.8	-5.7	13.7	31.09	0.49	0.35	0.22	0.08	0.00

Source: Base case in the Model

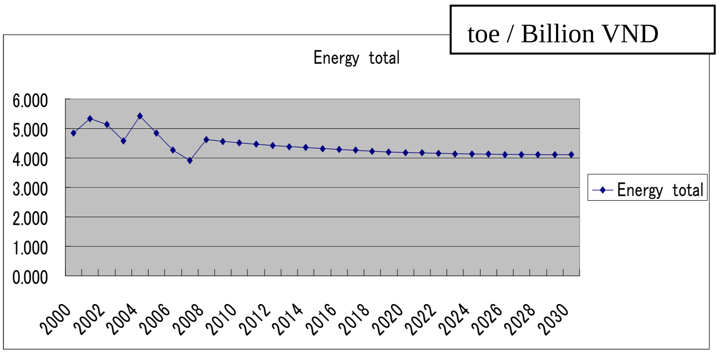
(c) Commercial &Services

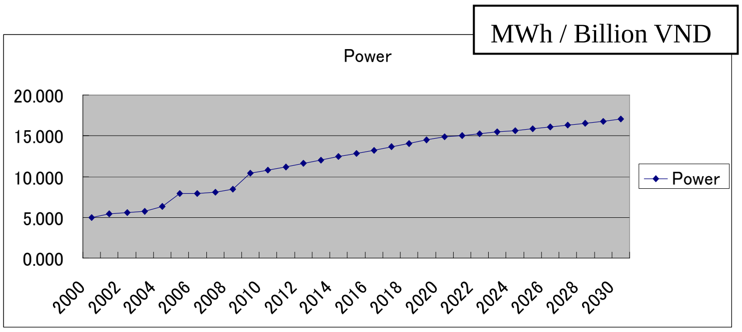
◯ Energy intensity of Total Energy in Commercial decreases by –0.1% per year in 2010 and it then gradually slows down in 2027.

◯ Power ratio in Commercial Services increases by 1.0% per year from 2010 to 2020, and 0.5% from 2021 to 2030. The ratios are as follows;
2010: 20.5%
2015: 25.5%
2020: 30.5%
2025: 33.0%
2030: 35.5%

◯Based on the ratio, the power intensity increases by 4.0% per year in 2010 and then gradually tapers off.

◯For creating the balance, fossil energy intensity decreases by –2.3% in 2010 and then gradually tapers off.





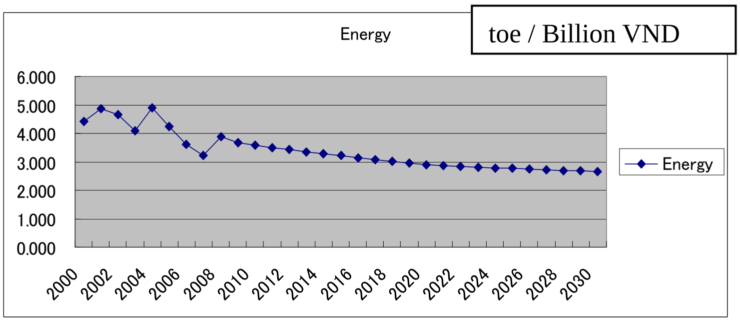


Figure 5.1-3: Intensities in Com. & Service Sector

Table 5.1-19: Trends of Intensities and Power Ratio in Commercial & Services

Commercial & Service

	2005	2006	2007	2008	2009	2010	2015	2020	2025	2030
Energy total	4.849	4.258	3.913	4.620	4.57	4.52	4.32	4.19	4.13	4.12
toe/ Bil VND 2005price	-10.6	-12.2	-8.1	-1.2	-1.15	-1.09	-0.78	-0.48	-0.18	0.00
	2005	2006	2007	2008	2009	2010	2015	2020	2025	2030
Power Ratio	12.8	15.2	17.2	18.5	19.5	20.5	25.5	30.5	33.0	35.5
%					1.0	1.0	1.0	1.0	0.5	0.5
	2005	2006	2007	2008	2009	2010	2015	2020	2025	2030
Power	7.928	7.955	8.083	8.476	10.38	10.79	12.82	14.88	15.85	17.02
MWh/ Bil VND 2005price	25.6	0.3	1.6	3.2	22.46	3.97	3.26	2.89	1.35	1.43
	2005	2006	2007	2008	2009	2010	2015	2020	2025	2030
Energy	4.229	3.613	3.238	3.891	3.67	3.59	3.21	2.91	2.76	2.65
toe/ Bil VND 2005price	-13.4	-14.6	-10.4	3.8	-5.57	-2.31	-2.10	-1.89	-0.92	-0.77

Source: Base case in the Model

(d) Residential

〇Energy intensity of Total energy in the Residential Sector (Except noncommercial) increases by 7.0% per year in 2010 and then gradually tapers off in 2030.

〇 The power ratio in the Residential increases by 1.5% in 2010 - 2015, 1.0% in 2016 - 2020 and 0.5% in 2021 - 2030 and the ratios are as follows;

2010: 58.9% (Exclude Noncommercial)
2015: 66.4%
2020: 71.4%
2025: 73.9%
2030: 76.4%

〇 Based on the ratio, the power intensity increases by 9.8% per year in 2010 and then gradually tapers off.

〇In creating the balance, the fossil energy intensity increases by 3.2% in 2010 and then gradually tapers off.

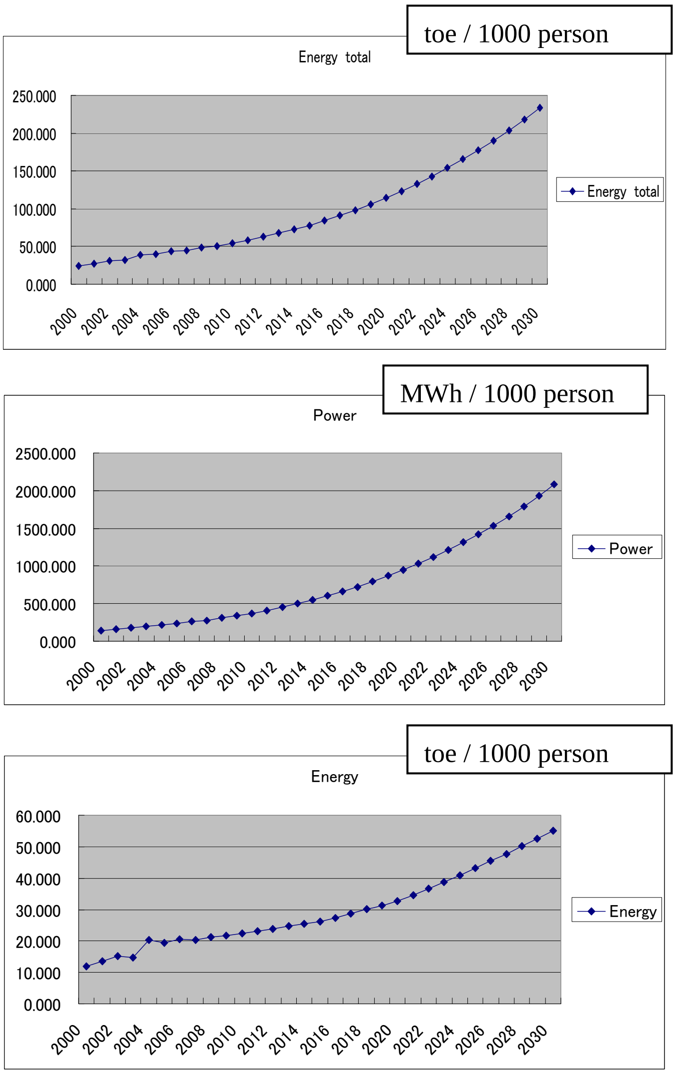


Figure 5.1-4: Intensities in Residential Sector

Table 5.1-20: Trends of Intensities and Power Ratio in Residential

Residential

	2005	2006	2007	2008	2009	2010	2015	2020	2025	2030
Energy total	39.820	43.154	44.354	48.292	50.82	54.37	77.92	114.49	165.59	233.98
toe/ 1000 person	2.8	8.4	2.8	4.9	5.23	7.00	7.46	8.00	7.66	7.16
	2005	2006	2007	2008	2009	2010	2015	2020	2025	2030
Power Ratio	51.1	52.2	54.0	55.9	57.4	58.9	66.4	71.4	73.9	76.4
%					1.5	1.5	1.5	1.0	0.5	0.5
	2005	2006	2007	2008	2009	2010	2015	2020	2025	2030
Power	236.763	261.772	278.543	313.921	339.20	372.43	601.63	950.55	1422.96	2078.76
MWh/ 1000 person	10.0	10.6	6.4	12.7	8.05	9.80	9.94	9.53	8.39	7.87
	2005	2006	2007	2008	2009	2010	2015	2020	2025	2030
Energy	19.458	20.642	20.400	21.295	21.65	22.35	26.18	32.74	43.21	55.21
toe/ 1000 person	-3.8	6.1	-1.2	4.4	1.65	3.23	2.87	4.35	5.64	4.94

Source: Base case in the Model

The aforementioned intensities are used in the Base, High and Low cases. Further, non-commercial energy is primarily used in rural areas, the volume is 20,000 ktoe in 2005, 22,000 ktoe in 2010. However, the volume in future Vietnam will gradually be decreased annually in accordance with Governmental policy.

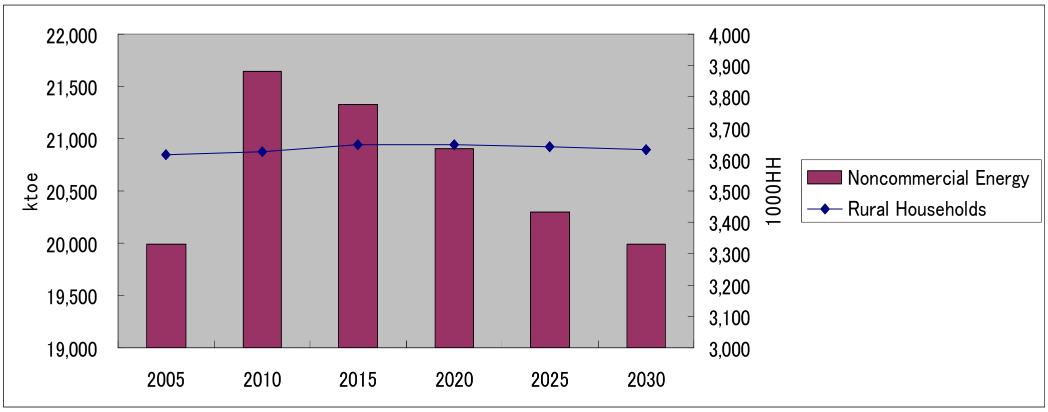


Figure 5.1-5: Non-commercial Energy Demand Forecasts

(6) Power Demand from Large Scale Projects

- In the case of Vietnam, power demand in the future cannot be explained by only energy intensities to GDP. It can be considered that the GDP growth in the SED2020 includes facility expansion and increasing the operation load of existing factories.
- In the current Vietnam, additional factory and labor capital intensity has comparatively increased with the high speed. Therefore, when forecasting the power demand for the current Vietnam under the conditions of using energy intensities to GDP, this is a reason why power demands from future new projects have to be added to power demands from the econometric model.
- However, according to the experience of economic and industry plans in Vietnam, the plan implementations usually are delayed, and power demand from new projects exceed estimates when comparing to the actual demand after commencing operations in economic and industrial zones. Therefore, it is assumed that 30% of the surveyed power demand of industrial zones and commercial facilities are realized in the current year. Further, 10% of the transportation plans are realized in the current year. (For high cases, after 2020, the achievement rate is 20% up from 10% in previous years.)

- In the following table, the "GWh in regional name" shows the surveyed potential power demand from the projects, the "Achievement rate" is the Realization rate to the potential and the "Additional" shows the additional power demand.

Table 5.1-21: Additional Power Demand from Large Scale Industrial Zones

Industrial zones

	Unit	2010	2015	2020	2025	2030
North	GWh	6,045	19,045	41,635	52,929	64,224
Acheivment Rate	%	20	30	30	30	30
North additional	GWh	1,209	5,713	12,490	15,879	19,267
Center	GWh	404	3,572	8,400	10,814	13,228
Acheivment Rate	%	20	30	30	30	30
Center additional	GWh	81	1,071	2,520	3,244	3,968
South	GWh	11,522	24,160	41,805	50,628	59,451
Acheivment Rate	%	20	30	30	30	30
South additional	GWh	2,304	7,248	12,542	15,188	17,835
Total	GWh	17,970	46,776	91,840	114,371	136,903
Acheivment Rate	%	20	30	30	30	30
Additional demand	GWh	3,594	14,033	27,552	34,311	41,071

Source: JICA survey

Table 5.1-22: Additional Power Demand from Large Scale Commercial Facilities

Commercial & Service Facilities

		2010	2015	2020	2025	2030
North	GWh	53.2	97.0	127.9	155.9	183.9
Acheivment Rate	%	20	30	30	30	30
North additional	GWh	10.6	29.1	38.4	46.8	55.2
Center	GWh	1.8	9.1	19.8	47.7	75.7
Acheivment Rate	%	20	30	30	30	30
Center additional	GWh	0.4	2.7	5.9	14.3	22.7
South	GWh	7.8	62.4	101.3	132.6	163.9
Acheivment Rate	%	20	30	30	30	30
South additional	GWh	1.6	18.7	30.4	39.8	49.2
Total	GWh	63	169	249	336	423
Acheivment Rate	%	20	30	30	30	30
Additional demand	GWh	13	51	75	101	127

Source: JICA survey

Table 5.1-23: Additional Power Demand from Large Scale Transportation Facilities

Transporttaion facilities

		2010	2015	2020	2025	2030
North	GWh	9	108	212	273	344
Acheivment Rate	%	10	10	10	20	20
North additional	GWh	1	11	21	55	69
Center	GWh	4	128	253	344	435
Acheivment Rate	%	10	10	10	20	20
Center additional	GWh	0	13	25	69	87
South	GWh	37	154	896	942	988
Acheivment Rate	%	10	10	10	20	20
South additional	GWh	4	15	90	188	198
total	GWh	51	390	1,360	1,559	1,768
Acheivment Rate	%	10	10	10	20	20
Additional demand	GWh	5	39	136	312	354

Source: JICA survey

Table 5.1-24: Total Additional Power Demand from Large Scale Projects

Total

		2010	2015	2020	2025	2030
North	GWh	6,107	19,249	41,974	53,359	64,752
Acheivment Rate	%	20	30	30	30	30
North additional	GWh	1,220	5,753	12,550	15,980	19,391
Center	GWh	410	3,709	8,672	11,205	13,739
Acheivment Rate	%	20	29	29	30	30
North additional	GWh	82	1,087	2,551	3,327	4,078
South	GWh	11,567	24,377	42,803	51,703	60,603
Acheivment Rate	%	20	30	30	30	30
North additional	GWh	2,310	7,282	12,662	15,417	18,082
Total	GWh	18,084	47,335	93,449	116,266	139,094
Acheivment Rate	%	20	30	30	30	30
Additional demand	GWh	3,612	14,122	27,763	34,724	41,551

Source: JICA survey

5.2 Future Power Demand as the Results of the Model

The JICA team is responsibility for the technical transfer of the project. The team has made clear the power demand difference between the Vietnam side and the JICA side, and the team has considered showing the difference of the preconditions and the methodologies between both sides.

5.2.1 Power Demand in Base Case

(1) Power Demand in the Country

In the Base Case, the current high power elasticity to GDP (2.1 in 2010) is expected to become gradually lower down to 1.6 in 2015, 1.4 in 2020 and 1.0 in 2030, and the elasticity will stabilize at a moderate level observed in neighboring countries after 2020.

The power demands from the JICA model are forecasted at 88 TWh in 2010, 156 TWh in 2015, and 263 TWh in 2020 and 580 TWh in 2030. The growth rates are 12.2% in 2010-2015, 10.9% in 2015-2020 and 8.5 in 2020-2025.

Additional power demand from large scale projects are the shares with 4.1% to the total demand in 2010, 9.0% in 2015, 11.1% in 2020 and 7.2% in 2030.

Regarding the comparison between JICA and IE, the IE forecast will be 170 TWh in 2015, and will be 8% higher than JICA in the year, 290 TWh in 2020, and 9% higher than JICA in that year.

In PDP6, the JICA model forecasts 257 TWh in 2020 with the IE being 292 TWh and the GDP average growth rate in 2010-2020 will be 8.5%.

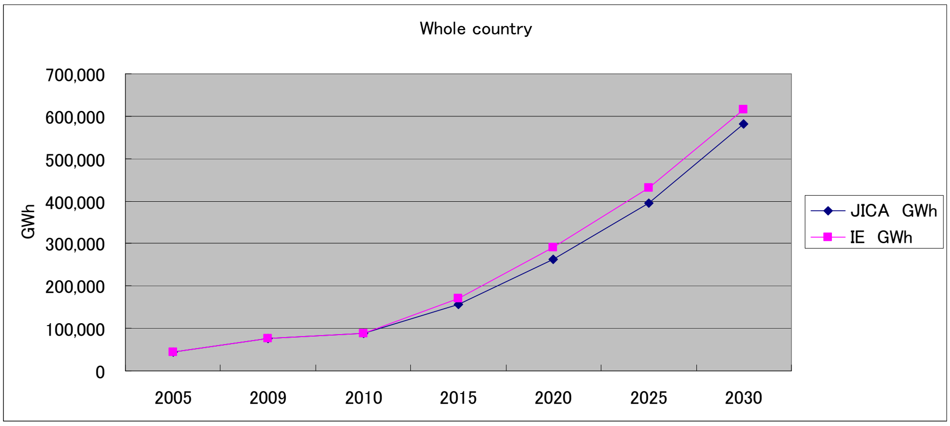


Figure 5.2-1: Power Demand Outlook in Whole Country in Base Case

Table 5.2-1: Comparison of IE vs. JICA and PDP6 vs. PDP7 in 2020

	IE	JICA (Inc. Large scale Pro.)	JICA (Exc Large scale Pro.)	GDP growth rate (2010-2020)
PDP6	292TWh	283TWh	257TWh	8.5%
PDP7	290TWh	263TWh	233TWh	7.7%

(2) Agriculture

The growth rate of power demand is higher than other energies in this sector. Incidentally, the power ratio of the agricultural sector will gradually grow from 10.5% in 2010 to 15.5% in 2020.

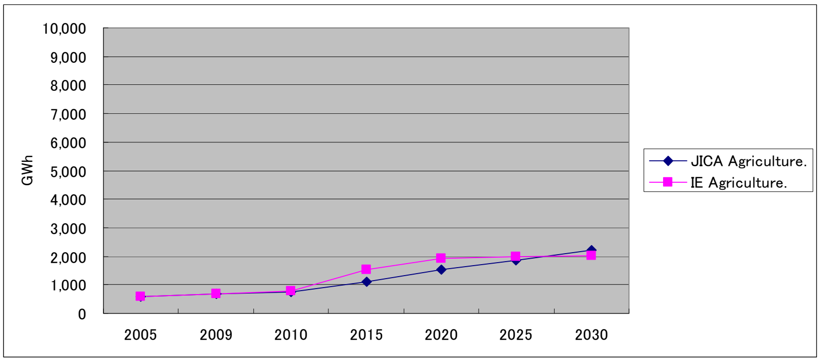


Figure 5.2-2: Power Demand of IE and JICA in Agriculture Sector

(3) Industry

The industry sector is the main sector to lead the future Vietnamese economy, and its power demand will show the highest growth among sectors. Meanwhile the growth rate of the power demand is generally high. There is a possibility that natural gas demand may increase, once the gas infrastructure such as pipelines and a delivery network are developed, replacing the demand for coal, petroleum products and Power.

In this study, Gas demand within the Industry sector plays a minor role. It can be estimated what gas used in the most of the factories will take after 2020.

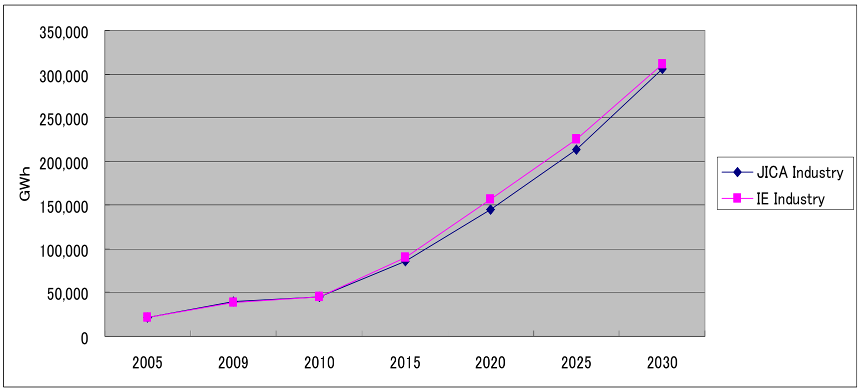


Figure 5.2-3: Power Demand of IE and JICA in Industry Sector

The future power intensity to the industrial GDP will increase due to the infusion of high technologies, increasing investment and equipment into the sector. However after 2020, the focus will shift to a reductive trend caused by EE&C.

The power intensity in the industrial sector of Vietnam is 10 times greater than that of Japan's. This means that power utilization in the industrial sector is less efficient than in Japan. There are currency conversion problems from the Vietnam Dong to the USD. When the Vietnam GDP is converted to the USD by using a PPP exchange rate, (In 2008, the PPP exchange rate: 1 USD =6,150 VND, Market exchange rate: 1 USD=16,150 VND), Based on the PPP exchange rate, Industrial power intensity is 1/3 in comparison to the GDP converted by the market exchange rate). The industrial Power intensity in PPP is not 10 times Japan's, but 4-5 times Japan's.

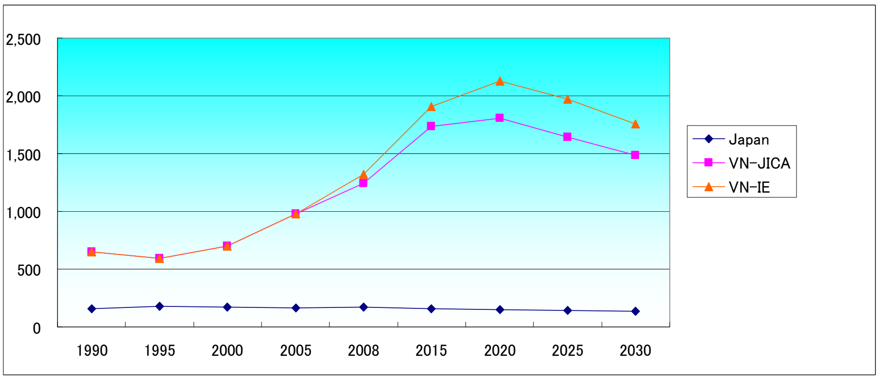


Figure 5.2-4: Power Intensities of Industry Sector

(4) Commercial

The growth rate of the electricity demand in the commercial sector is the highest out of the final energies. An specific feature of the Commercial sector is the power ratio to the increase which is from 20% in 2010 to 30% in 2020.

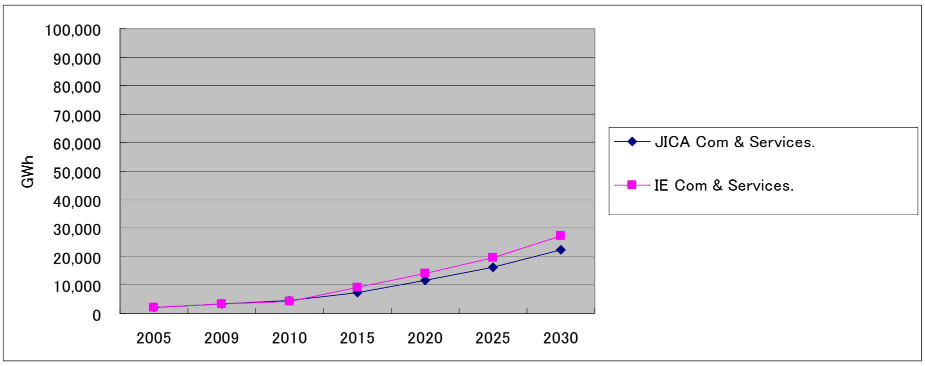


Figure 5.2-5: Power Intensities of IE and JICA in Commercial Sector

The power intensity of commercial and service sector is around two times that of Japan. When the Vietnam GDP is converted to the PPP exchange rate, the intensity becomes around half of Japan. In light of the future of Vietnam's economy, it is a suitable position for the power intensity converted to the PPP exchange rate.

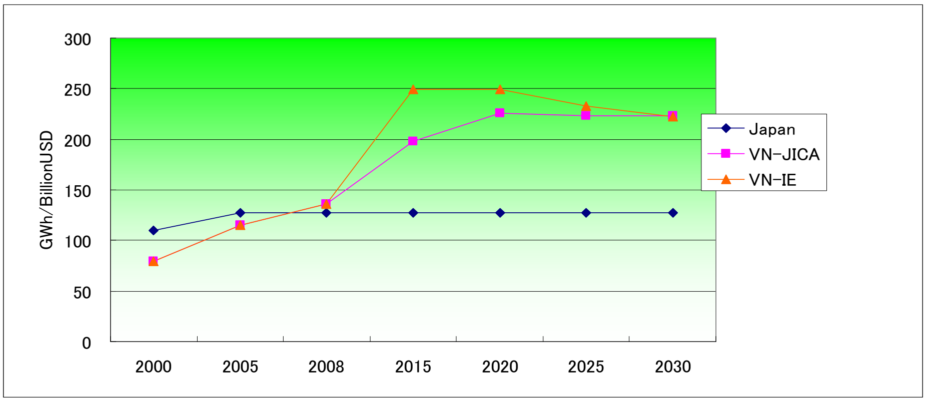


Figure 5.2-6: Power Intensities of IE and JICA in Commercial Sector

(5) Residential

In the residential sector, the future power demand is forecasted due to the following methods.

(a) It is generally said that the energy demand in the residential sector increases at 2% per year in many counties. (In Emerging and Developing countries)

(b) Renewable energies like woods and charcoals have the share of 80% of the energy consumption of the residential sector. Further urbanization is enhancing the whole country (population growth rate of the whole country is estimated at 1% in the future, however the population in urban area is estimated at 2%)

(c) There is the possibility that renewable combustion energies like woods and charcoals will be reduced by urbanization and government regulation.

(d) When considering the substitution of the above renewable energies and electricity, there are alternatives like electricity, LPG and natural gas. However, there is no plan of natural gas supply to the residential sector in the current Vietnam.

(e) Commercial energies currently used in the residential sector are mainly briquette、 electricity and LPG. It has been estimated that the energies as commercial energy increase in the residential sector in the future.

(f) Based on the above consideration, the following assumptions have been adopted as exogenous variables under the JICA model.

- Energy consumption in the residential sector will be increased by 2% over the next 20 years.
- The consumption of woods and charcoal will be reduced.
- The power ratio will be increased in the sector. (power ratio = power / whole energies)
- LPG consumption share in fossil energies will be increased.

(g) Under the above assumption, the power demand in the residential sector will increase at 10.8% per year from 2010 to 2020.

The residential sector utilizes a lot of wood and charcoal energies. However, the energies will be reduced by Governmental policies, and the wood and charcoal are to be replaced by the LPG and electricity. According to the model, power demand in the residential sector is forecasted at 11% per year. The share of electricity in the residential sector has increased,

LPG is used in the industry, commercial and residential sectors. Over the past 5 years, the growth rate has been relatively high (around 30% per year). In the future, LPG demand will increase in the three sectors.

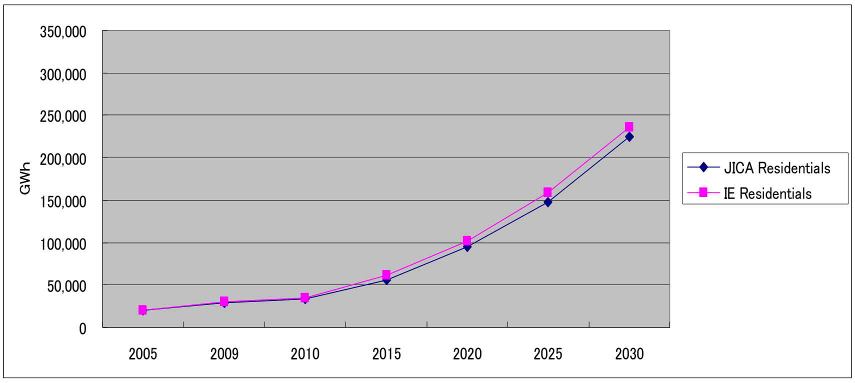


Figure 5.2-7: Power Demand of IE and JICA in Residential Use

Power demand per household is one third of Japan's in 2008. Further, the power demand per household reached 80% in 2008. However households in Japan utilize not only electricity but also LPG and natural gas. When the power demand is per household between two countries, it cannot be said that the figure is always correct.

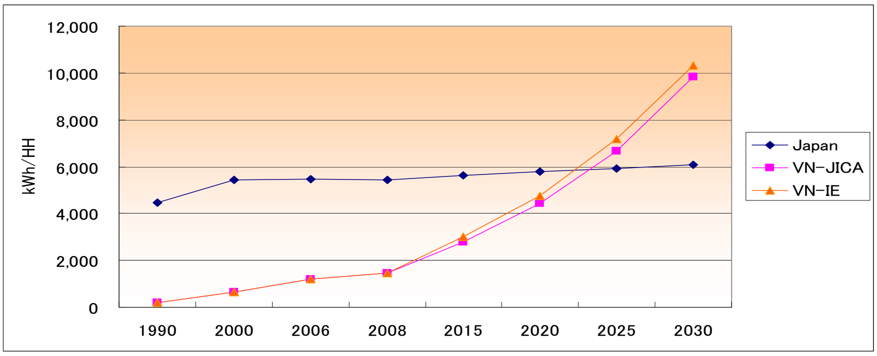


Figure 5.2-8: Power Intensities of IE and JICA in Residential Use

The following figure is the final energy consumption per household within the residential sector. The energy consumption rate including wood and charcoal per household will be 1.4 times that of Japan's in 2020. As the heat efficiency of wood and charcoal is estimated at around half of the energy used in commercial enterprises, the final energy consumption per household in Vietnam will almost equal Japan's in 2020.

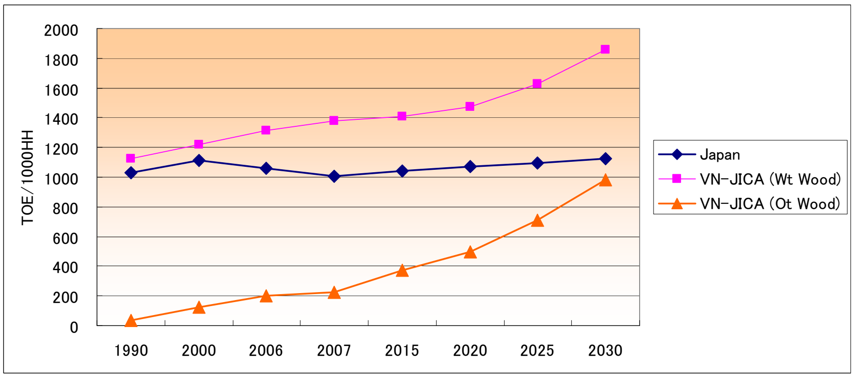


Figure 5.2-9: Energy Intensities of IE and JICA in Residential Use

The final energy demand in the residential sector increased at 2-3% annually under the condition that the growth rate of population and households are less than 1% per year. That is the reason why companies with increasing incomes have increasing energy consumption rates. The growth rate of the final energy consumption in the residential sector has been forecasted at 1.3% in 2010-2020. It is the total growth rate of the reduction of wood and charcoal consumption and increasing LPG and Electricity consumption.

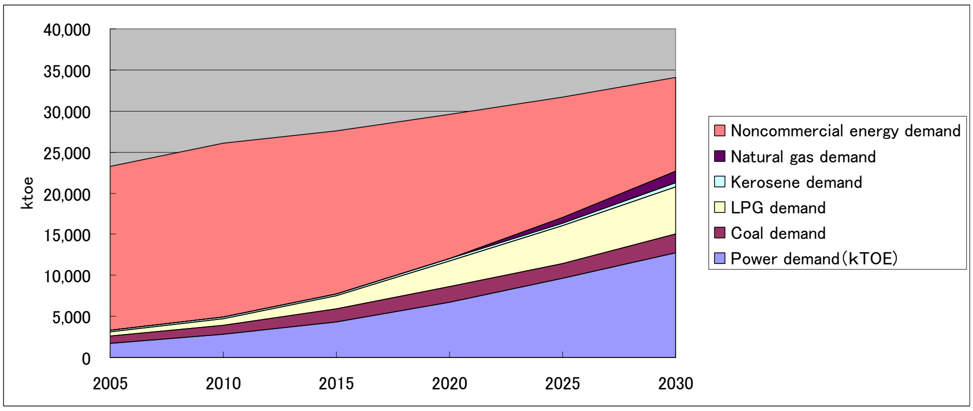


Figure 5.2-10: Energy Demand in Residential Use

(6) Transportation and Others

The growth rate of diesel oil is the highest among energy consumption within the transportation sector, while that of gasoline is rather moderate as it is being offset by the increase of passenger cars and the peaking out of motorbikes. While electricity demand may reflect an increase in the construction of subways in HCMN and Hanoi cities in the future, the power demand of other sectors will increase at a 1.2 elasticity to the GDP.

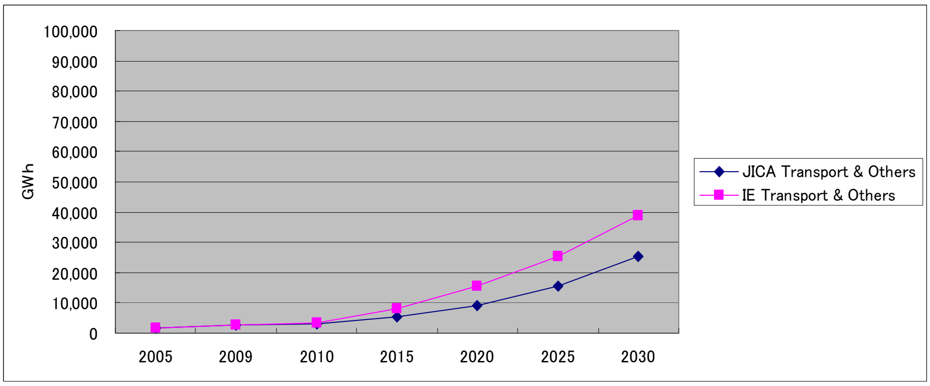


Figure 5.2-11: Power Demand of IE and JICA in Others

(7) Power Demand in Northern Region

The power demand in Northern provinces was achieved within the range of 80-95% of the forecast demand in PDP6. By the impact of the world financial crisis, the filling levels of the industrial zones are below expectations. However, some provinces such as Hai Phong, Hai Duong Province have matched the forecast, even Ninh Binh province grow faster than forecasted. In PDP7, it can be considered that the growth rate of the power demand in the Northern region is a little bit less than the growth rate of the power demand in the country.

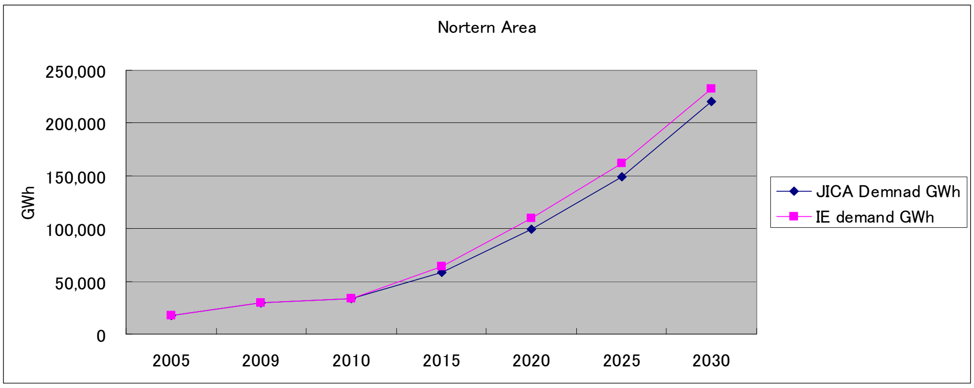


Figure 5.2-12: Power Demand in Northern Area

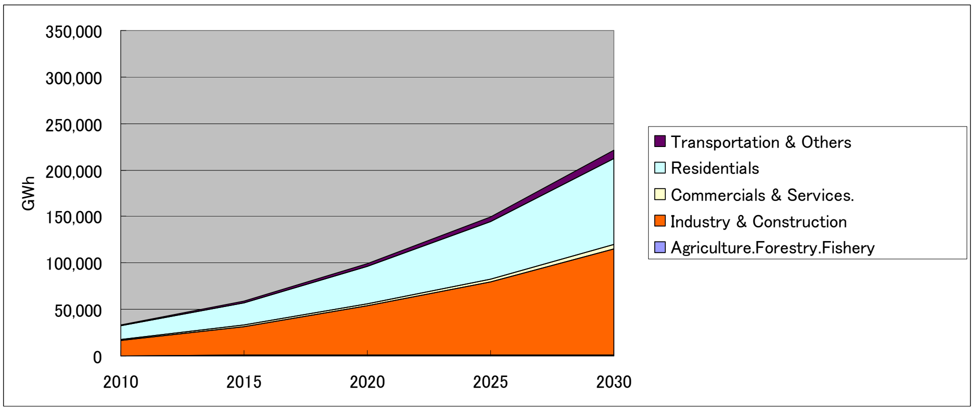


Figure 5.2-13: Power Demand by Sector in Northern Area

(8) Power Demand in Central Region

Some provinces have formed industrial and commercial centers, hotels and resort areas along the sea. However, because of the recent world financial crisis, there were fewer investors than plans before the crisis to start operations. The rest have not yet been implemented, and also the infrastructure in the economic zones and industrial parks has not been perfected, so that electricity demand was not so high during PDP6. However, in projecting the next 10 years, it is expected that the power demand in the Central region will drastically increase due to the fact that the Central region is so much lower than the other regions.

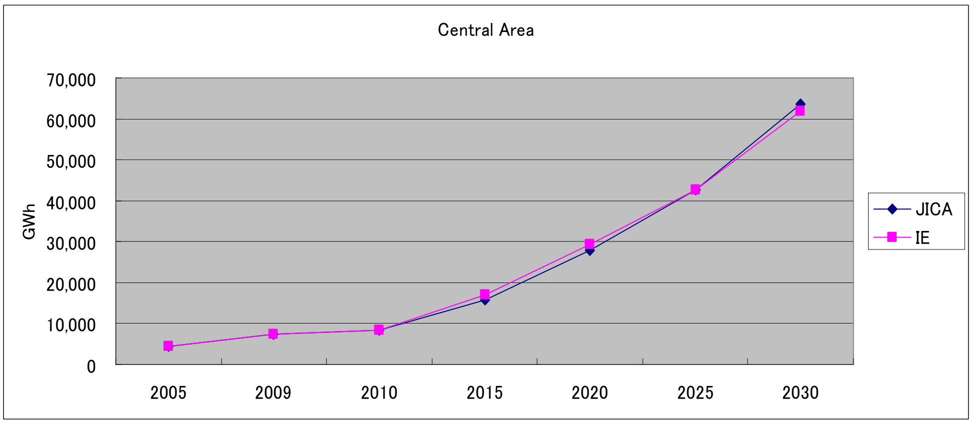


Figure 5.2-14: Power Demand in Central Area

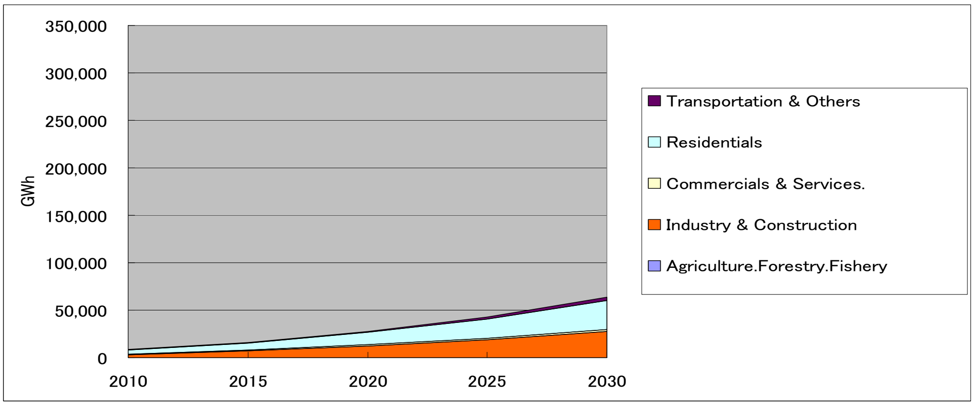


Figure 5.2-15: Power Demand by Sector in Central Area

(9) Southern Region

Power demand in the southern provinces has increased dramatically, a number of provinces in the region have a high growth rate such as HCM City (12%), Dong Nai (19%), Long An (20%), Vung Tau (21%) and Binh Duong (37%) in 2001-2005. In PDP6, it is expected that the provinces will achieve high electricity growth in 2006-2010, because, as the southern region has had many industrial zone plans, additional power demand has been expected during PDP6. Due to the impact of the world financial crisis, so many projects were either stopped or delayed. Therefore electricity growth has been lower than expected in PDP6. However, during PDP7, it is expected that the power demand in the Southern region will increase as much as the average growth rate in the country.

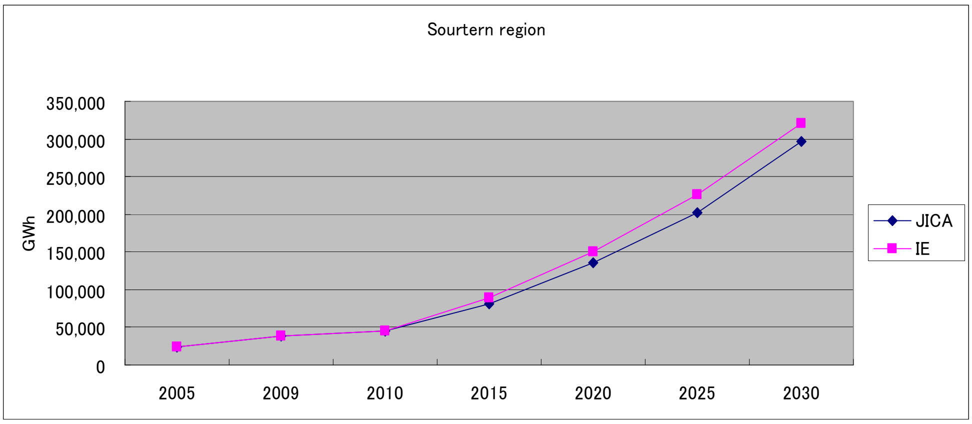


Figure 5.2-16: Power Demand in Southern Area

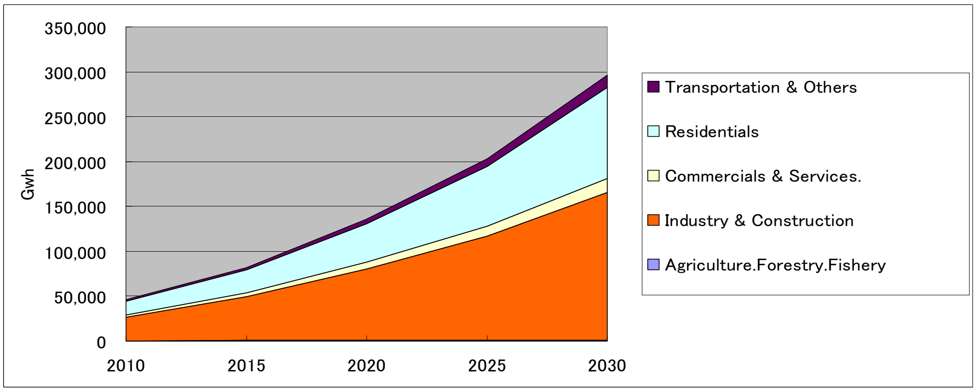


Figure 5.2-17: Power Demand by Sector in Southern Area

5.2.2 Power Demand in the High Case

The Power demand for the High case is substantially active in all sectors such as Industry, Commercial and Residential. However, it is questionable if the current high GDP growth rates would continue for such a long period as 20 years. There is a possibility that energy conservation may evolve faster than estimated. When any symptoms of such high economic growth are discovered, counter policies must be advanced promptly. The power demand grows 3.5 fold from 2010 to 2020. (3.0 fold in the Base case) As the highest case is calculated here for an extremely high economic growth rate, the outcome may indicate some criteria in the viewpoint of energy supply policies.

(1) Power Demand in the Country

The power demand for the Base case in 2020 will be 262 TWh, the High case will be 305 TWh being 16% higher than the Base case.

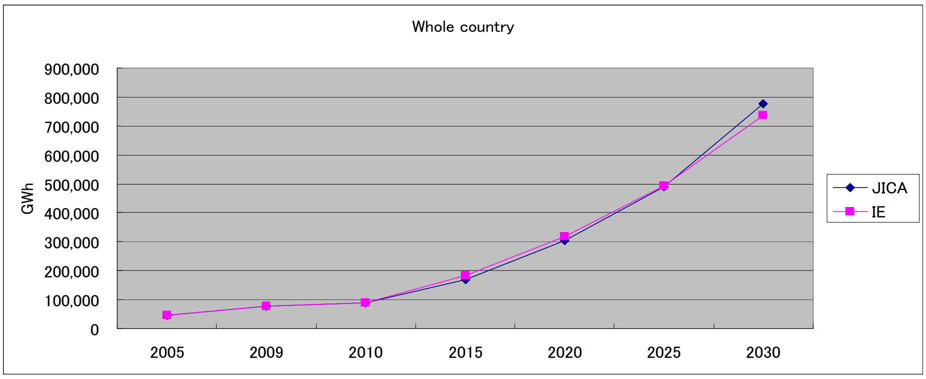


Figure 5.2-18: Power Demand in the Country

(2) Power Demand in Agriculture Sector

Power demand in the Base case in 2020 will be 1.5 TWh (1,534 GWh) and 1.6 TWh (1,626 GWh), which is 6% higher than the Base case.

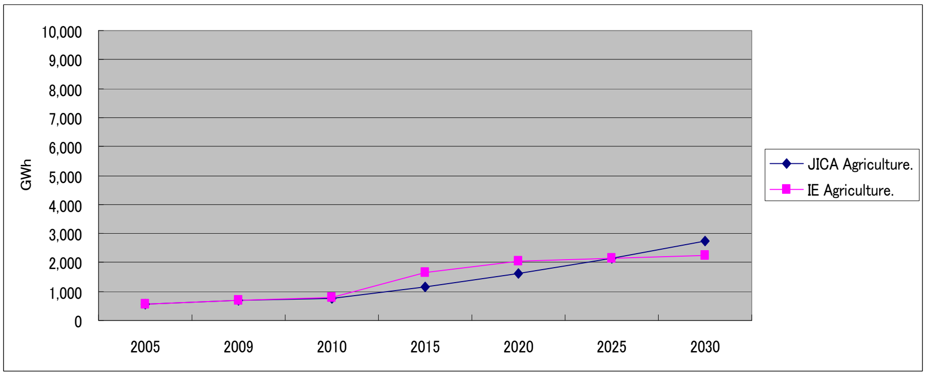


Figure 5.2-19: Power Demand in Agriculture Sector

(3) Power Demand in Industry Sector

Power demand in the Base case in 2020 will be 145 TWh and 169 TWh in the high case which is 17% higher than the Base case.

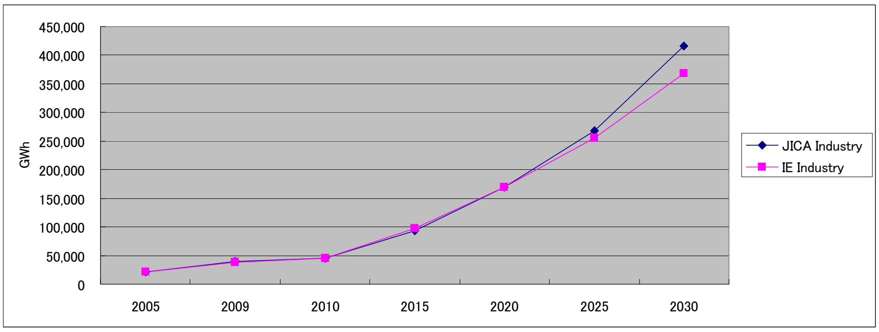


Figure 5.2-20: Power Demand in Industry Sector

(4) Power Demand in Commercial Sector

Power demand in the Base case in 2020 will be 11.7 TWh and will be 13.3 TWh for the high case which is 14% higher than the Base case.

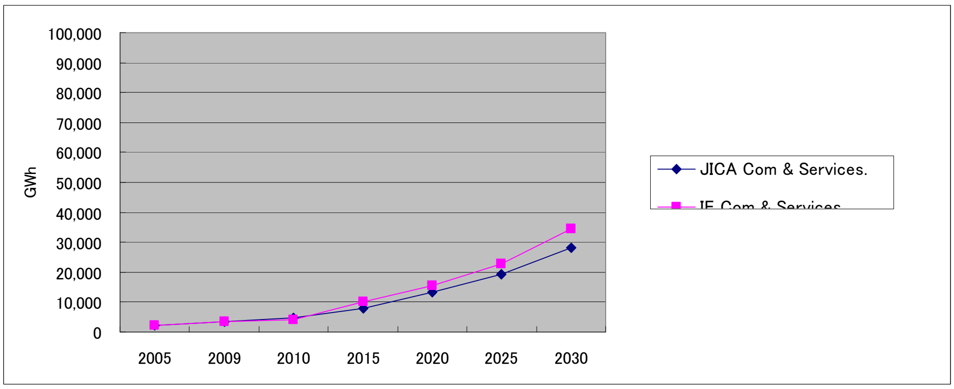


Figure 5.2-21: Power Demand in Commercial Sector

(5) Power Demand in Residential Sector

Power demand in the Base case in 2020 will be 95.0 TWh and 110.2 TWh in the high case which is 16% higher than the Base case.

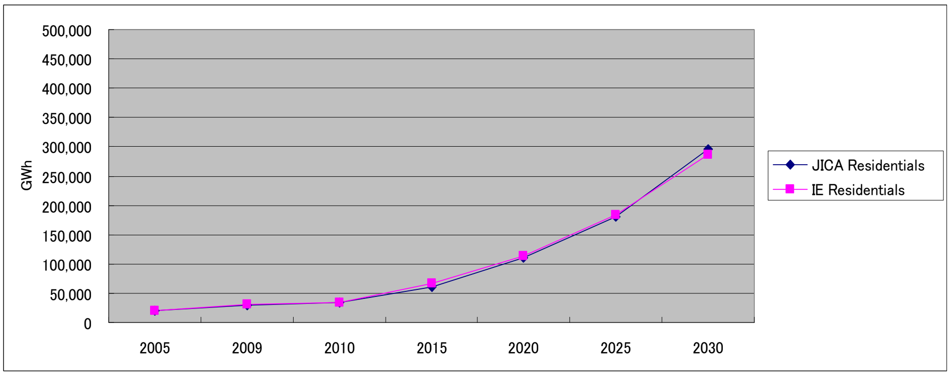


Figure 5.2-22: Power Demand in Residential Use

(6) Power Demand in Northern Region

Power demand in the Base case in 2020 will be 99.3 TWh and 114.5 TWh in the high case which is 15% higher than the Base case.

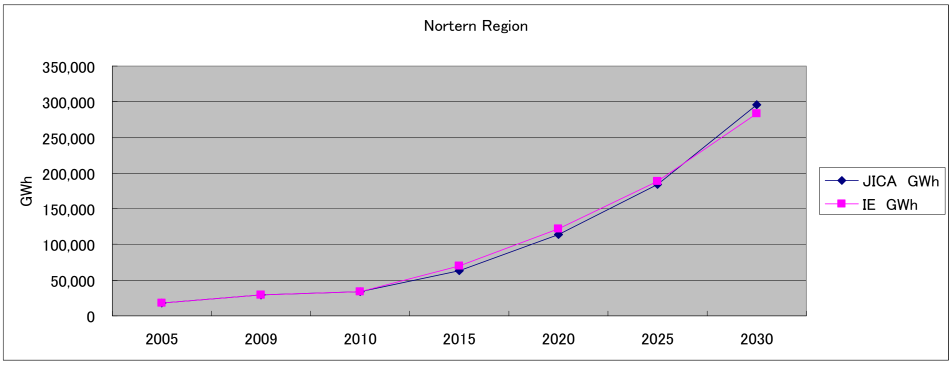


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Figure 5.2-23: Power Demand in Northern Region

(7) Power Demand in Central Region

Power demand in the Base case in 2020 will be 27.8 TWh and 32.75 TWh in the high case which is 18% higher than the Base case.

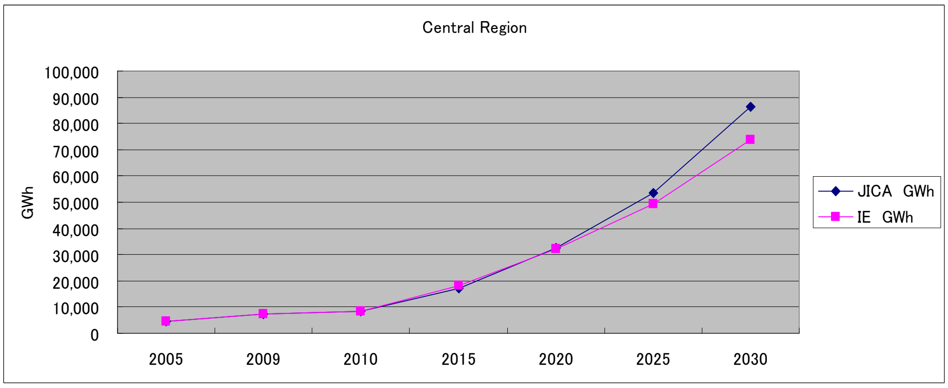


Figure 5.2-24: Power Demand in Central Region

(8) Power Demand in Southern Region

Power demand in the Base case in 2020 is 135.5 TWh and in the High case is 157.7 TWh which is 16% higher than the Base case.

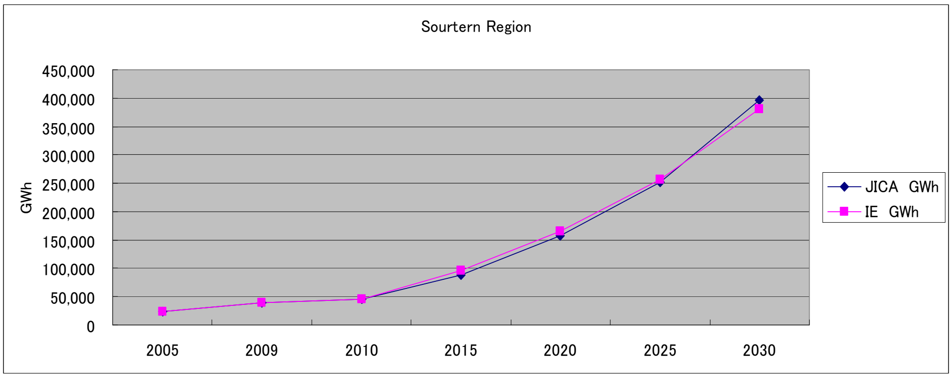


Figure 5.2-25: Power Demand in Southern Region

5.2.3 Power Demand in Low Case

The Power demand in the Low case increased 2.7 fold from 2010 to 2020 (3.0 fold in the Base case). The power demand will increase to around 90 TWh in 2010 to 240 TWh in 2020. The probability of this happening is escalated given the occurrence of government budget crises especially in the EU after world financial crisis. During such times, it is important to refrain from excessive investment and to have to delay from building infrastructures.

(1) Power Demand in the Country

The power demand in the Base case in 2020 will be 262 TWh and in the Low case will be 240 TWh which is 8% lower than in the 2020 Base case.

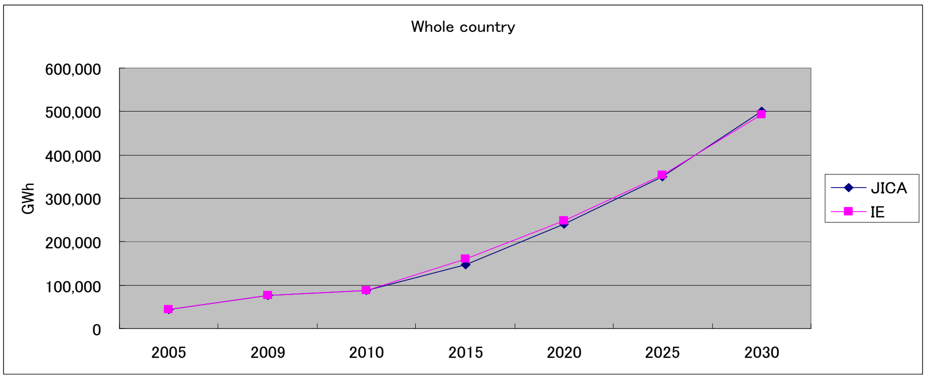


Figure 5.2-26: Power Demand in the Country

(2) Power Demand in Agriculture Sector

Power demand in Base case in 2020 is 1.5 TWh（1,534 GWh）and in the Low case is 1.5 TWh (1,515 GWh). It is 1% lower than the Base case in 2020.

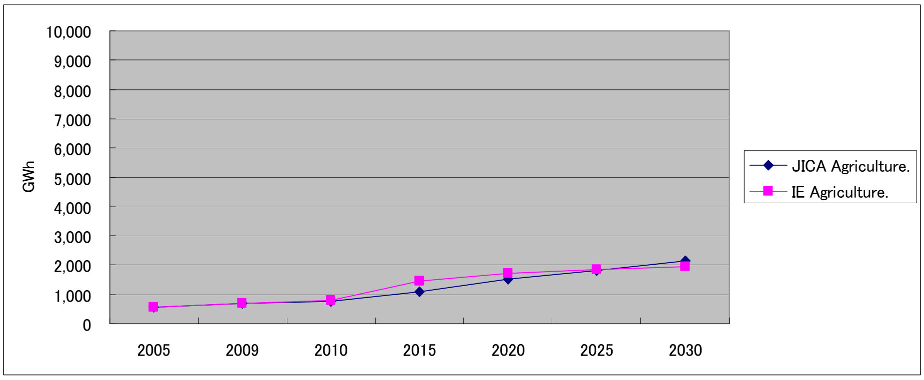


Figure 5.2-27: Power Demand in Agriculture Sector

(3) Power Demand in Industry Sector

The power demand in the Base case in 2020 will be 145 TWh and for the Low case will be 132 TWh. It is 9% lower than the Base case in 2020.

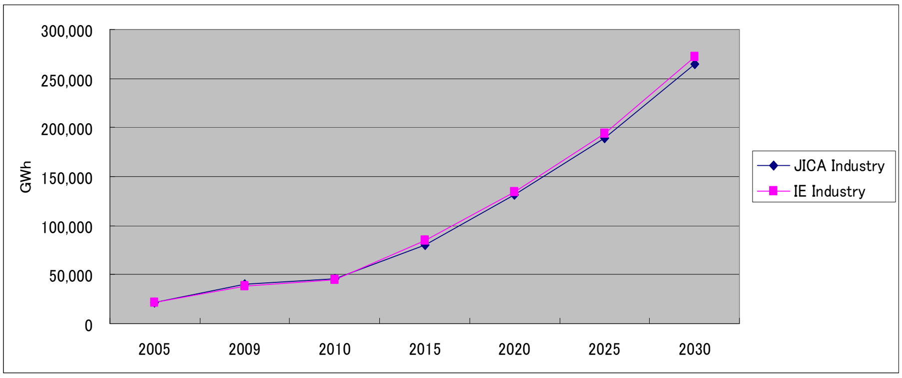


Figure 5.2-28: Power Demand in Industry Sector

(4) Power Demand in Commercial Sector

Power demand in the Base case in 2020 is 11.7 TWh and in the Low case is 10.6 TWh which is 9% lower than the Base case in 2020.

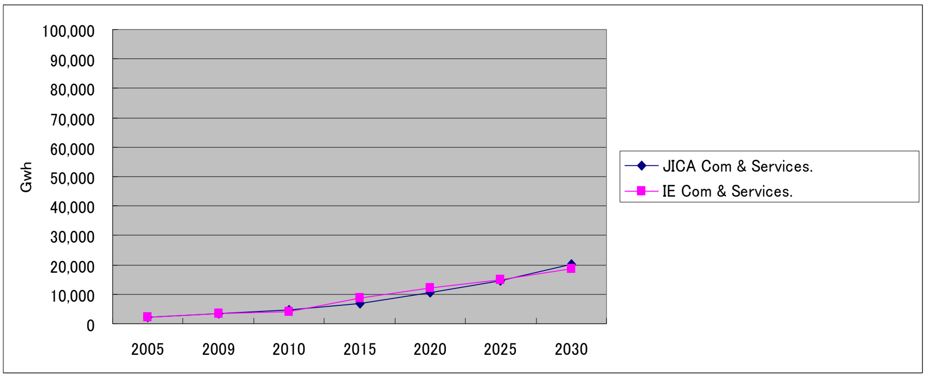


Figure 5.2-29: Power Demand in Commercial Sector

(5) Power Demand in Residential Use

Power demand in the Base case in 2020 will be 94.5 TWh and in the Low case will be 87.2 TWh which is 8% lower than the Base case in 2020.

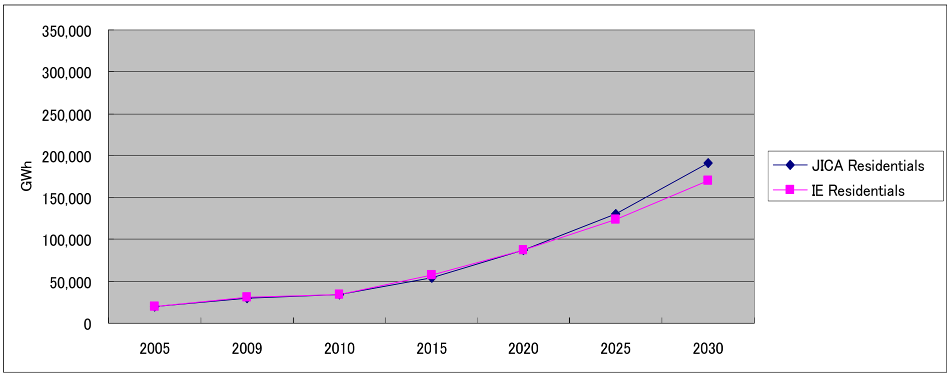


Figure 5.2-30: Power Demand in Residential Use

5.2.4 Maximum Power Demand

The following table shows the actual maximum power demand based on the data from IE. (Unit is MW)

Table 5.2-2: Maximum Power Demand

	1996	1997	1998	1999	2000	2001	2002
Maximum power demand(MW)	3177	3595	3875	4329	4890	5655	6552
	2003	2004	2005	2006	2007	2008	2009
Maximum power demand(MW)	7408	8,283	9,255	10,187	11,286	12,636	13,867

The maximum power demand forecast is as follows. (Unit is GW)

Table 5.2-3: Maximum Power Demand Forecast

	2010	2015	2020	2025	2030
Maximum power demand forecast by IE(GW)	16	31	52	77	110
Maximum power demand forecast by JICA TA Team(GW)	18	29	47	71	104

5.2.5 Summary List for Power & Energy Demand

(1) Power and Energy by Sector

Table 5.2-4: Base Case: Power and Energy by Sector

Base case			2009	2010	2011	2012	2013	2014	2015	2020	2025	2030	2020/10	2030/20
Power	(1)Agriculture	GWh	661	764	828	894	963	1,034	1,108	1,534	1,845	2,200	7.2	3.7
demand	(2)Industry	GWh	38,504	45,551	54,160	61,564	69,624	78,409	86,273	145,140	213,342	306,293	12.3	7.8
	(3)Commercials & Service	GWh	3,512	4,621	5,101	5,612	6,162	6,755	7,370	11,718	16,165	22,323	9.8	6.7
	(4)Residentials	GWh	30,532	33,944	37,571	41,587	46,032	50,954	56,288	94,971	147,807	224,588	10.8	9.0
	(5)Others	GWh	2,837	3,137	3,461	3,815	4,268	4,764	5,303	9,183	15,520	25,391	11.3	10.7
	Total	GWh	76,046	88,017	101,121	113,473	127,050	141,917	156,341	262,545	394,678	580,795	11.5	8.3
Shares	(1)Agriculture	%	0.9	0.9	0.8	0.8	0.8	0.7	0.7	0.6	0.5	0.4		
	(2)Industry	%	51.5	52.6	54.4	55.0	55.6	56.0	55.9	55.9	54.5	53.1		
	(3)Commercials & Service	%	8.3	8.8	8.5	8.3	8.2	8.1	8.1	8.0	8.0	8.2		
	(4)Residentials	%	40.1	38.6	37.2	36.6	36.2	35.9	36.0	36.2	37.4	38.7		
	(5)Others	%	3.7	3.6	3.4	3.4	3.4	3.4	3.4	3.5	3.9	4.4		
	Total	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
Elasticity	to GDP		1.9	2.1	2.1	2.1	2.0	1.8	1.6	1.4	1.0	1.0	1.5	1.0
Indicators	Population	Mil persons	87	88	89	90	91	92	93	97	99	102	0.9	0.5
	GDP on US$ 2005 price	Mil $ at 2005	68,997	73,827	79,334	85,253	91,613	98,447	105,791	155,442	230,092	340,592	7.7	8.2
	GDP/Person	US$ /person	792	838	892	949	1,009	1,074	1,143	1,606	2,316	3,339	6.7	7.6
	Power demand per person	kWh/person	873	999	1,136	1,263	1,400	1,548	1,689	2,713	3,972	5,694	10.5	7.7
	Power demand per GDP	kWh/US$	1.10	1.19	1.27	1.33	1.39	1.44	1.48	1.69	1.72	1.71	3.5	0.1
			2009	2010	2011	2012	2013	2014	2015	2020	2025	2030	2020/10	2030/20
Energy demand	(1)Agriculture	KTOE	598	628	643	664	685	707	729	848	951	1,049	3.0	2.1
with Power	(2)Industry	KTOE	13,486	14,682	16,373	18,042	19,860	21,927	23,695	35,706	51,332	72,012	9.3	7.3
with Noncommercial	(3)Commercials & Service	KTOE	1,832	1,867	1,958	2,054	2,156	2,274	2,395	3,177	4,031	5,155	5.5	5.0
	(4)Residentials	KTOE	26,109	26,432	26,762	27,121	27,512	27,939	28,396	31,634	35,977	42,451	1.8	3.0
	(5)Others	KTOE	9,272	9,633	10,172	10,721	11,292	11,918	12,568	16,703	22,384	30,358	5.7	6.2
	Total	KTOE	51,296	53,242	55,908	58,603	61,507	64,765	67,784	88,068	114,674	151,025	5.2	5.5
Shares	(1)Agriculture	%	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.0	0.8	0.7		
	(2)Industry	%	26.3	27.6	29.3	30.8	32.3	33.9	35.0	40.5	44.8	47.7		
	(3)Commercials & Service	%	3.6	3.5	3.5	3.5	3.5	3.5	3.5	3.6	3.5	3.4		
	(4)Residentials	%	50.9	49.6	47.9	46.3	44.7	43.1	41.9	35.9	31.4	28.1		
	(5)Others	%	18.1	18.1	18.2	18.3	18.4	18.4	18.5	19.0	19.5	20.1		
	Total	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
Indicators	Population	Million persons	87	88	89	90	91	92	93	97	99	102	0.9	0.5
	GDP on US$ in 2005	Million US$	68,997	73,827	79,334	85,253	91,613	98,447	105,791	155,442	230,092	340,592	7.7	8.2
	GDP Person	US$/person	792	838	892	949	1,009	1,074	1,143	1,606	2,316	3,339	6.7	7.6
	Energy demand per person	TOE/person	0.59	0.60	0.63	0.65	0.68	0.71	0.73	0.91	1.15	1.48	4.2	5.0
	Energy demnad per GDP 2005	TOE/US$1000	0.74	0.72	0.70	0.69	0.67	0.66	0.64	0.57	0.50	0.44	-2.4	-2.4

Table 5.2-5: High Case: Power and Energy by Sector

High case			2009	2010	2011	2012	2013	2014	2015	2020	2025	2030	2020/10	2030/20
Power	(1)Agriculture	GWh	661	764	834	907	984	1,063	1,146	1,626	2,131	2,727	7.8	5.3
demand	(2)Industry	GWh	38,504	45,551	55,121	63,729	73,279	83,890	93,788	168,994	268,556	416,663	14.0	9.4
	(3)Commercials & Service	GWh	3,512	4,621	5,174	5,771	6,423	7,136	7,886	13,255	19,306	28,081	11.1	7.8
	(4)Residentials	GWh	30,532	33,944	38,161	42,901	48,227	54,211	60,808	110,158	180,537	295,693	12.5	10.4
	(5)Others	GWh	2,837	3,137	3,522	3,949	4,493	5,098	5,769	10,765	19,610	34,612	13.1	12.4
	Total	GWh	76,046	88,017	102,812	117,258	133,405	151,398	169,396	304,798	490,139	777,775	13.2	9.8
Shares	(1)Agriculture	%	0.9	0.9	0.8	0.8	0.7	0.7	0.7	0.5	0.4	0.4		
	(2)Industry	%	51.5	52.6	54.4	55.1	55.7	56.1	56.0	56.0	55.2	53.9		
	(3)Commercials & Service	%	8.3	8.8	8.5	8.3	8.2	8.1	8.1	7.9	7.9	8.1		
	(4)Residentials	%	40.1	38.6	37.1	36.6	36.2	35.8	35.9	36.1	36.8	38.0		
	(5)Others	%	3.7	3.6	3.4	3.4	3.4	3.4	3.4	3.5	4.0	4.5		
	Total	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
Elasticity	to GDP		1.9	2.1	2.1	2.0	1.9	1.7	1.5	1.3	1.0	1.0	1.4	1.0
Indicators	Population	Mil persons	87	88	89	90	91	92	93	97	99	102	0.9	0.5
	GDP on US$ 2005 price	Mil US$ 2005 b	68,997	73,827	80,552	87,891	95,898	104,634	114,166	180,382	288,138	460,265	9.3	9.8
	GDP/Person	US$ /person	792	838	905	978	1,057	1,142	1,233	1,864	2,900	4,512	8.3	9.2
	Power demand per person	kWh/person	873	999	1,155	1,305	1,470	1,652	1,830	3,149	4,933	7,625	12.2	9.2
	Power demand per GDP	kWh/US$	1.10	1.19	1.28	1.33	1.39	1.45	1.48	1.69	1.70	1.69	3.5	0.0
			2009	2010	2011	2012	2013	2014	2015	2020	2025	2030	2020/10	2030/20
Energy demand	(1)Agriculture	KTOE	598	628	653	679	706	733	760	908	1,033	1,153	3.8	2.4
with Power	(2)Industry	KTOE	13,486	14,682	16,696	18,755	21,037	23,651	26,016	42,409	66,111	100,223	11.2	9.0
with Noncommercial	(3)Commercials & Service	KTOE	1,832	1,867	1,987	2,113	2,249	2,402	2,562	3,590	4,807	6,471	6.8	6.1
	(4)Residentials	KTOE	26,109	26,432	26,806	27,219	27,678	28,186	28,743	32,842	38,626	48,327	2.2	3.9
	(5)Others	KTOE	9,272	9,633	10,321	11,045	11,820	12,681	13,605	19,936	30,483	48,921	7.5	9.4
	Total	KTOE	51,296	53,242	56,462	59,811	63,490	67,653	71,686	99,685	141,061	205,095	6.5	7.5
Shares	(1)Agriculture	%	1.2	1.2	1.2	1.1	1.1	1.1	1.1	0.9	0.7	0.6		
	(2)Industry	%	26.3	27.6	29.6	31.4	33.1	35.0	36.3	42.5	46.9	48.9		
	(3)Commercials & Service	%	3.6	3.5	3.5	3.5	3.5	3.6	3.6	3.6	3.4	3.2		
	(4)Residentials	%	50.9	49.6	47.5	45.5	43.6	41.7	40.1	32.9	27.4	23.6		
	(5)Others	%	18.1	18.1	18.3	18.5	18.6	18.7	19.0	20.0	21.6	23.9		
	Total	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
Indicators	Population	Million persons	87	88	89	90	91	92	93	97	99	102	0.9	0.5
	GDP on US$ in 2005	Million US$	68,997	73,827	80,552	87,891	95,898	104,634	114,166	180,382	288,138	460,265	9.3	9.8
	GDP Person	US$/person	792	838	905	978	1,057	1,142	1,233	1,864	2,900	4,512	8.3	9.2
	Energy demand per person	TOE/person	0.59	0.60	0.63	0.67	0.70	0.74	0.77	1.03	1.42	2.01	5.5	6.9
	Energy demnad per GDP 2005	TOE/US$1000	0.74	0.72	0.70	0.68	0.66	0.65	0.63	0.55	0.49	0.45	-2.6	-2.1

Table 5.2-6: Low Case: Power and Energy by Sector

Low case			2010	2011	2012	2013	2014	2015	2020	2025	2030	2020/10	2030/20
Power	(1)Agriculture	GWh	764	827	891	959	1,028	1,100	1,515	1,811	2,149	7.1	3.6
demand	(2)Industry	GWh	45,206	52,200	58,802	65,961	73,729	80,541	131,776	188,829	264,360	11.3	7.2
	(3)Commercials & Service	GWh	4,531	4,941	5,377	5,843	6,344	6,860	10,556	14,659	20,327	8.8	6.8
	(4)Residentials	GWh	33,738	37,013	40,610	44,560	48,898	53,557	87,192	130,735	191,411	10.0	8.2
	(5)Others	GWh	3,137	3,448	3,786	4,220	4,692	5,203	8,876	14,463	23,136	11.0	10.1
	Total	GWh	87,377	98,429	109,466	121,542	134,691	147,261	239,916	350,498	501,383	10.6	7.6
Shares	(1)Agriculture	%	0.9	0.8	0.8	0.8	0.8	0.7	0.6	0.5	0.4		
	(2)Industry	%	52.6	53.9	54.5	55.1	55.5	55.4	55.6	54.4	53.2		
	(3)Commercials & Service	%	8.8	8.5	8.4	8.3	8.2	8.2	8.1	8.3	8.7		
	(4)Residentials	%	38.6	37.6	37.1	36.7	36.3	36.4	36.3	37.3	38.2		
	(5)Others	%	3.6	3.5	3.5	3.5	3.5	3.5	3.7	4.1	4.6		
	Total	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
Elasticity	to GDP		2.0	2.0	2.1	1.9	1.7	1.6	1.3	1.0	1.0	1.4	1.0
Indicators	Population	Mil persons	88	89	90	91	92	93	97	99	102	0.9	0.5
	GDP on US$ 2005 price	Mil US$ 2005	73,827	79,061	84,667	90,669	97,098	103,982	150,394	216,715	312,281	7.4	7.6
	GDP/Person	US$ /person	838	889	942	999	1,059	1,123	1,554	2,181	3,062	6.4	7.0
	Power demand per person	kWh/person	992	1,106	1,218	1,339	1,469	1,591	2,479	3,528	4,915	9.6	7.1
	Power demand per GDP	kWh/US$	1.18	1.24	1.29	1.34	1.39	1.42	1.60	1.62	1.61	3.0	0.1
			2010	2011	2012	2013	2014	2015	2020	2025	2030	2020/10	2030/20
Energy demand	(1)Agriculture	KTOE	628	640	660	681	701	722	836	930	1,022	2.9	2.0
with Power	(2)Industry	KTOE	14,681	16,197	17,756	19,449	21,395	23,038	34,220	48,087	66,025	8.8	6.8
with Noncommercial	(3)Commercials & Service	KTOE	1,867	1,951	2,040	2,134	2,247	2,362	3,112	3,892	4,910	5.2	4.7
	(4)Residentials	KTOE	26,505	26,849	27,217	27,612	28,036	28,484	31,512	35,167	40,334	1.7	2.5
	(5)Others	KTOE	9,633	10,138	10,650	11,178	11,763	12,367	16,175	20,947	27,264	5.3	5.4
	Total	KTOE	53,314	55,776	58,323	61,054	64,141	66,974	85,855	109,023	139,555	4.9	5.0
Shares	(1)Agriculture	%	1.2	1.1	1.1	1.1	1.1	1.1	1.0	0.9	0.7		
	(2)Industry	%	27.5	29.0	30.4	31.9	33.4	34.4	39.9	44.1	47.3		
	(3)Commercials & Service	%	3.5	3.5	3.5	3.5	3.5	3.5	3.6	3.6	3.5		
	(4)Residentials	%	49.7	48.1	46.7	45.2	43.7	42.5	36.7	32.3	28.9		
	(5)Others	%	18.1	18.2	18.3	18.3	18.3	18.5	18.8	19.2	19.5		
	Total	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
Indicators	Population	Million persons	88	89	90	91	92	93	97	99	102	0.9	0.5
	GDP on US$ in 2005	Million US$	73,827	79,061	84,667	90,669	97,098	103,982	150,394	216,715	312,281	7.4	7.6
	GDP Person	US$/person	838	889	942	999	1,059	1,123	1,554	2,181	3,062	6.4	7.0
	Energy demand per person	TOE/person	0.61	0.63	0.65	0.67	0.70	0.72	0.89	1.10	1.37	3.9	4.4
	Energy demnad per GDP 2005	TOE/US$1000	0.72	0.71	0.69	0.67	0.66	0.64	0.57	0.50	0.45	-2.3	-2.4

(1) Power Demand by Region

Table 5.2-7: Base Case: Power Demand by Region

Power Demand in Base case

			2009	2010	2011	2012	2013	2014	2015	2020	2025	2030	2020/10	2030/20
<Northern region >	Total	GWh	29,445	33,723	38,501	43,048	48,039	53,497	58,872	99,266	149,274	220,740	11.4	8.3
	Agriculture.Forestry.Fisher	GWh	337	378	410	442	475	509	543	727	828	930	6.8	2.5
	Industry & Construction	GWh	14,228	16,088	19,112	21,739	24,596	27,708	30,560	52,956	78,647	114,586	12.7	8.0
	Commercials & Services.	GWh	983	1,307	1,420	1,534	1,655	1,783	1,912	2,767	3,492	4,406	7.8	4.8
	Residentials	GWh	12,931	14,793	16,296	17,955	19,787	21,809	23,994	39,727	61,212	92,554	10.4	8.8
	Transportation & Others	GWh	966	1,157	1,263	1,378	1,527	1,688	1,863	3,088	5,096	8,262	10.3	10.3
<Central region >	Total	GWh	7,426	8,473	9,715	11,034	12,493	14,100	15,714	27,788	42,557	63,643	12.6	8.6
	Agriculture.Forestry.Fisher	GWh	64	68	72	77	81	86	91	120	144	171	5.9	3.6
	Industry & Construction	GWh	2,892	3,175	3,839	4,517	5,255	6,061	6,803	12,430	18,627	27,134	14.6	8.1
	Commercials & Services.	GWh	356	473	523	577	637	702	770	1,273	1,788	2,512	10.4	7.0
	Residentials	GWh	3,812	4,385	4,863	5,394	5,987	6,647	7,368	12,720	19,832	30,230	11.2	9.0
	Transportation & Others	GWh	302	371	418	469	533	604	682	1,245	2,166	3,597	12.9	11.2
<Southern region >	Total	GWh	39,175	45,821	52,906	59,390	66,518	74,320	81,755	135,491	202,847	296,412	11.5	8.1
	Agriculture.Forestry.Fisher	GWh	289	318	346	376	407	440	474	687	873	1,100	8.0	4.8
	Industry & Construction	GWh	22,702	26,288	31,208	35,308	39,774	44,640	48,910	79,753	116,068	164,572	11.7	7.5
	Commercials & Services.	GWh	2,073	2,841	3,158	3,501	3,870	4,271	4,688	7,678	10,885	15,405	10.5	7.2
	Residentials	GWh	12,790	14,765	16,412	18,237	20,259	22,497	24,925	42,524	66,763	101,804	11.2	9.1
	Transportation & Others	GWh	1,321	1,608	1,781	1,969	2,209	2,472	2,758	4,850	8,258	13,532	11.7	10.8
<Total of Regions>	Total	GWh	76,047	88,017	101,121	113,473	127,050	141,917	156,341	262,545	394,678	580,795	11.5	8.3
	Agriculture.Forestry.Fisher	GWh	690	764	828	894	963	1,034	1,108	1,534	1,845	2,200	7.2	3.7
	Industry & Construction	GWh	39,822	45,551	54,160	61,564	69,624	78,409	86,273	145,140	213,342	306,293	12.3	7.8
	Commercials & Services.	GWh	3,412	4,621	5,101	5,612	6,162	6,755	7,370	11,718	16,165	22,323	9.8	6.7
	Residentials	GWh	29,534	33,944	37,571	41,587	46,032	50,954	56,288	94,971	147,807	224,588	10.8	9.0
	Transportation & Others	GWh	2,589	3,137	3,461	3,815	4,268	4,764	5,303	9,183	15,520	25,391	11.3	10.7

Table 5.2-8: High Case: Power Demand by Region

Power Demand in High case

			2009	2010	2011	2012	2013	2014	2015	2020	2025	2030	2020/10	2030/20
<Northern region >	Total	GWh	29,445	33,723	39,091	44,374	50,271	56,837	63,487	114,490	184,511	295,674	13.0	10.0
	Agriculture.Forestry.Fisher	GWh	337	378	412	447	483	519	556	754	927	1,103	7.1	3.9
	Industry & Construction	GWh	14,228	16,088	19,426	22,453	25,811	29,544	33,097	61,324	98,859	156,652	14.3	9.8
	Commercials & Services.	GWh	983	1,307	1,435	1,567	1,707	1,857	2,009	3,025	3,962	5,172	8.8	5.5
	Residentials	GWh	12,931	14,793	16,536	18,487	20,673	23,123	25,814	45,804	74,378	121,540	12.0	10.3
	Transportation & Others	GWh	966	1,157	1,282	1,420	1,598	1,794	2,010	3,582	6,386	11,208	12.0	12.1
<Central region >	Total	GWh	7,426	8,473	9,894	11,438	13,177	15,129	17,144	32,669	53,457	86,298	14.4	10.2
	Agriculture.Forestry.Fisher	GWh	64	68	73	78	83	88	94	127	164	209	6.5	5.1
	Industry & Construction	GWh	2,892	3,175	3,922	4,706	5,577	6,548	7,477	14,684	23,815	37,543	16.5	9.8
	Commercials & Services.	GWh	356	473	531	595	666	745	830	1,464	2,178	3,232	12.0	8.2
	Residentials	GWh	3,812	4,385	4,942	5,572	6,286	7,094	7,993	14,907	24,515	40,329	13.0	10.5
	Transportation & Others	GWh	302	371	426	488	566	653	750	1,487	2,784	4,986	14.9	12.9
<Southern region >	Total	GWh	39,175	45,821	53,827	61,445	69,957	79,433	88,765	157,638	252,171	395,803	13.2	9.6
	Agriculture.Forestry.Fisher	GWh	289	318	349	383	418	456	496	744	1,039	1,415	8.9	6.6
	Industry & Construction	GWh	22,702	26,288	31,772	36,571	41,892	47,798	53,214	92,986	145,882	222,469	13.5	9.1
	Commercials & Services.	GWh	2,073	2,841	3,208	3,610	4,050	4,534	5,046	8,766	13,166	19,677	11.9	8.4
	Residentials	GWh	12,790	14,765	16,684	18,842	21,267	23,994	27,001	49,448	81,643	133,824	12.8	10.5
	Transportation & Others	GWh	1,321	1,608	1,813	2,040	2,329	2,651	3,008	5,695	10,440	18,418	13.5	12.5
<Total of Regions>	Total	GWh	76,047	88,017	102,812	117,258	133,405	151,398	169,396	304,798	490,139	777,775	13.2	9.8
	Agriculture.Forestry.Fisher	GWh	690	764	834	907	984	1,063	1,146	1,626	2,131	2,727	7.8	5.3
	Industry & Construction	GWh	39,822	45,551	55,121	63,729	73,279	83,890	93,788	168,994	268,556	416,663	14.0	9.4
	Commercials & Services.	GWh	3,412	4,621	5,174	5,771	6,423	7,136	7,886	13,255	19,306	28,081	11.1	7.8
	Residentials	GWh	29,534	33,944	38,161	42,901	48,227	54,211	60,808	110,158	180,537	295,693	12.5	10.4
	Transportation & Others	GWh	2,589	3,137	3,522	3,949	4,493	5,098	5,769	10,765	19,610	34,612	13.1	12.4

Table 5.2-9: Low Case: Power Demand by Region

Power Demand in Low case

			2009	2010	2011	2012	2013	2014	2015	2020	2025	2030	2020/10	2030/20
<Northern region >	Total	GWh	29,445	33,505	37,541	41,592	46,019	50,835	55,515	90,658	132,385	189,990	10.5	7.7
	Agriculture.Forestry.Fisher	GWh	337	378	409	441	473	506	540	721	821	922	6.7	2.5
	Industry & Construction	GWh	14,228	15,984	18,440	20,771	23,297	26,039	28,506	47,910	69,350	98,450	11.6	7.5
	Commercials & Services.	GWh	983	1,282	1,376	1,472	1,573	1,680	1,787	2,513	3,209	4,090	7.0	5.0
	Residentials	GWh	12,931	14,703	16,057	17,540	19,165	20,944	22,850	36,523	54,222	78,963	9.5	8.0
	Transportation & Others	GWh	966	1,157	1,259	1,369	1,511	1,666	1,832	2,992	4,783	7,565	10.0	9.7
<Central region >	Total	GWh	7,426	8,412	9,512	10,692	11,990	13,411	14,820	25,346	37,650	54,662	11.7	8.0
	Agriculture.Forestry.Fisher	GWh	64	68	72	76	81	85	90	119	141	166	5.7	3.4
	Industry & Construction	GWh	2,892	3,148	3,725	4,327	4,982	5,693	6,336	11,224	16,391	23,279	13.6	7.6
	Commercials & Services.	GWh	356	465	508	554	605	660	718	1,145	1,615	2,274	9.4	7.1
	Residentials	GWh	3,812	4,360	4,792	5,269	5,796	6,379	7,009	11,660	17,505	25,698	10.3	8.2
	Transportation & Others	GWh	302	371	416	465	526	594	667	1,198	1,998	3,245	12.4	10.5
<Southern region >	Total	GWh	39,175	45,460	51,376	57,182	63,533	70,445	76,926	123,911	180,463	256,731	10.5	7.6
	Agriculture.Forestry.Fisher	GWh	289	318	345	374	404	436	470	675	849	1,060	7.8	4.6
	Industry & Construction	GWh	22,702	26,074	30,036	33,704	37,682	41,998	45,699	72,643	103,089	142,631	10.8	7.0
	Commercials & Services.	GWh	2,073	2,784	3,057	3,350	3,665	4,004	4,355	6,898	9,835	13,964	9.5	7.3
	Residentials	GWh	12,790	14,675	16,164	17,801	19,599	21,574	23,698	39,010	59,008	86,751	10.3	8.3
	Transportation & Others	GWh	1,321	1,608	1,773	1,953	2,182	2,433	2,704	4,686	7,682	12,325	11.3	10.2
<Total of Regions>	Total	GWh	76,047	87,377	98,429	109,466	121,542	134,691	147,261	239,916	350,498	501,383	10.6	7.6
	Agriculture.Forestry.Fisher	GWh	690	764	827	891	959	1,028	1,100	1,515	1,811	2,149	7.1	3.6
	Industry & Construction	GWh	39,822	45,206	52,200	58,802	65,961	73,729	80,541	131,776	188,829	264,360	11.3	7.2
	Commercials & Services.	GWh	3,412	4,531	4,941	5,377	5,843	6,344	6,860	10,556	14,659	20,327	8.8	6.8
	Residentials	GWh	29,534	33,738	37,013	40,610	44,560	48,898	53,557	87,192	130,735	191,411	10.0	8.2
	Transportation & Others	GWh	2,589	3,137	3,448	3,786	4,220	4,692	5,203	8,876	14,463	23,136	11.0	10.1

5.3 Power Development Plan

The realization of the PDP6 has been delayed due to the shortage of capital funds, poor project management experiences and problems of land preparation. However, the problems are not due to the power development plan, but most of them are technical problems in the implementation stage.

Therefore, the big changes of methodologies for building PDP7 are not required. However, the measures for avoided power shortage up to 2015 must be considered.

However, if the large scale power projects are delayed, it is feared that the power balance in the neighboring regions will collapse. In PDP7, significant concerns are how to create a power system plan to maintain the power balance in the regional power system and make enough grid networks among the regions.

The power development plan in PDP7 has been created by the MOIT and IE. The first draft was completed by IE in April 2010. Further, the final draft will be submitted to MOIT in September 2010.

The power development plan has been described based on the first draft version of the power development plan by the IE in July 2010 as follows:

Table 5.3-1 shows the regional power demand forecast and the power development plan from 2011 to 2015. As can be seen from the data of reserve margins, the reserve margin of the south region from 2012 to 2013 is extremely small. For this reason, power shortage in the southern region was expected. It was proposed that the power transmission from the northern and the central regions where there is enough power generation to the south region.

IE mentioned that the reinforcements of the transmission lines in order to transmit power from the power generation sites in the central region to the south should be urgently proceeded with because there was limited power transmission capacity between the central and the south as described in Chapter 2 “Review in PDP6”.

Se San 4, Se San 4A, Sre Pok 4, Buon Tau sa, Dak Tih and Dong Nai 3,4 (Their total capacity is 2,400 MW) will be commissioned in 2010 and 2011. However, there will be a limit to the existing power transmission lines of 1,300 MW between the 500 kV Pleiku substation and Ho Chi Minh City. Thus, a plan was made regarding the increase in the power transmission capacity from the central to the south region by 600 MW-700 MW via the construction of a 220 kV transmission line of Buon Kuop – Dak Nong and Dak Nong – Phuoc Long – Binh Long.

Apart from those countermeasures, the following was proposed.

- The power transmission capacity would be increased by replacing the series capacitors of 1000 A to 2000 A on the 500 kV transmission lines from the north to south.
- The power from the 220 kV Tay Nguen hydropower station would be sent to the 500 kV system during the wet seasons by adding the third transformers in the 500 kV Pleiku substation and the power would be transmitted to the southern regions through the 500 kV system.
- The power transmission capacity from the central to the south would be increased via the installation of the second circuit from the Pleiku 500 kV substation to the Cu Chi 500 kV substation (or My Phuoc 500 kV substation).

However, power generation in the central region will be largely shared by hydropower and there will be a fear of a decreased capacity to supply power due to the dry seasons.

Table 5.3-1: Regional Power Demand Forecast and the Power Development Plan from 2011 to 2015

(Unit: MW)

		2011	2012	2013	2014	2015
Country						
	Summation of Peak Demand	19,263	21,909	24,922	28,349	32,211
	Available Capacity	24,417	27,881	29,466	35,347	43,030
	Total Peak Demand	18,406	21,035	23,958	27,189	30,803
North						
	Peak Demand	7,992	9,049	10,247	11,603	13,111
	Available Capacity	9,271	12,385	13,575	15,596	18,646
	Hydropower	4,405	6,791	6,831	7,107	7,357
	SMall Hyd.+ New Energy	161	299	329	429	429
	Import	670	440	440	535	535
	Coal	4,035	4,855	5,975	7,525	10,325
	Other Thermal	0	0	0	0	0
	Nuclear	0	0	0	0	0
Central						
	Peak Demand	1,912	2,185	2,498	2,855	3,269
	Available Capacity	4,242	4,472	4,817	4,967	5,500
	Hydropower	3,693	3,843	4,038	4,038	4,421
	SMall Hyd.+ New Energy	197	247	397	547	697
	Import	248	248	248	248	248
	Coal	0	0	0	0	0
	Other Thermal	104	134	134	134	134
	Nuclear	0	0	0	0	0
South						
	Peak Demand	9,359	10,675	12,177	13,891	15,831
	Available Capacity	10,904	11,024	11,074	14,784	18,884
	Hydropower	2,343	2,413	2,413	2,413	2,553
	SMall Hyd.+ New Energy	153	203	253	403	553
	Import	0	0	0	290	290
	Coal	0	0	0	1,800	4,860
	Other Thermal	8,408	8,408	8,408	9,878	10,628
	Nuclear	0	0	0	0	0

Source: IE (2010.7)

Figure 5.3-1 to 5.3-3 shows the regional power generation plan categorized by generation types. The power generation plans were made aiming at the power supply-demand balance. Some of the units of the Van Phuong Coal Thermal Power Plant and the imported energy from Laos to the central region in Vietnam were counted as power generation in the southern region.

As seen from the data in 2015, the hydropower stations and coal power stations both equally share the power generation in the northern area. 40% of hydropower station generation occurs primarily in the central area and gas thermal power stations comprise 60% of the remaining power generation in the southern area.

Hydropower stations are situated mainly in the northern area to the central, coal thermal power stations are in the northern area and the gas thermal power stations are situated primarily in the south. However, the limitation of the amount of development of the conventional reservoir type hydropower station and gas thermal power stations up to 2020 will lead to an increase in the amount of development of other types of power stations.

Imported power energy will increase after 2015. The import of energy from the hydropower stations in China and Laos in the northern region and the energy from the hydropower stations in Cambodia have been planned.

The installation of nuclear power stations after 2020 have been planned for the southern region.

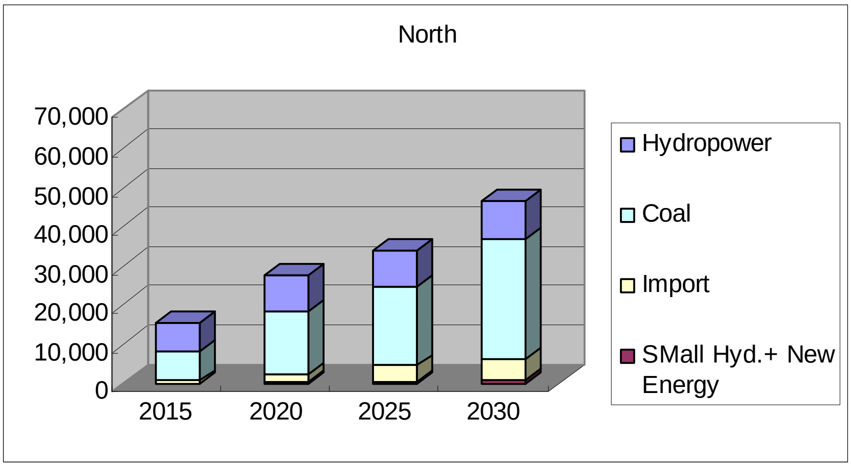
There have been no clear plans for the rehabilitation of the existing thermal power plants. Some coal thermal power plants such as Uong Bi, Ning Binh and Thu Duc have planned to stop their operations by 2020 due to deterioration expectations.

Figures 5.3-4 to 5.3-6 show the planned capacities of the hydropower stations and the amount of renewable energy categorized by each region. The amount of the development of the conventional large reservoir type hydropower stations will reach their limit by 2020. The pumped storage hydropower plants were planned in the north and the south after 2020 and their installed capacities will be 1,200 MW for the north and 3,600 MW for the south.

The capacity of renewable energy developed in the northern area will be 200 MW by 2030. These will be covered mainly by the distributed solar power panels although some small wind turbines have been planned for the small islands because the north area normally has weak wind weather conditions and does not seem suitable for wind turbine generation. Other small biomass thermal generations have also been planned. On the other hand, there are plenty of potential sites for wind turbine generation in the Ninh Tuan province and Binh Tuan Province around the site for nuclear power stations in the south east of Vietnam. The wind velocity of those areas is nine m/s which is sufficient for the wind turbine generation near this site. Almost all the 700 MW of renewable energy will be covered by solar power energy.

Table 5.3-2 lists the power generation projects.

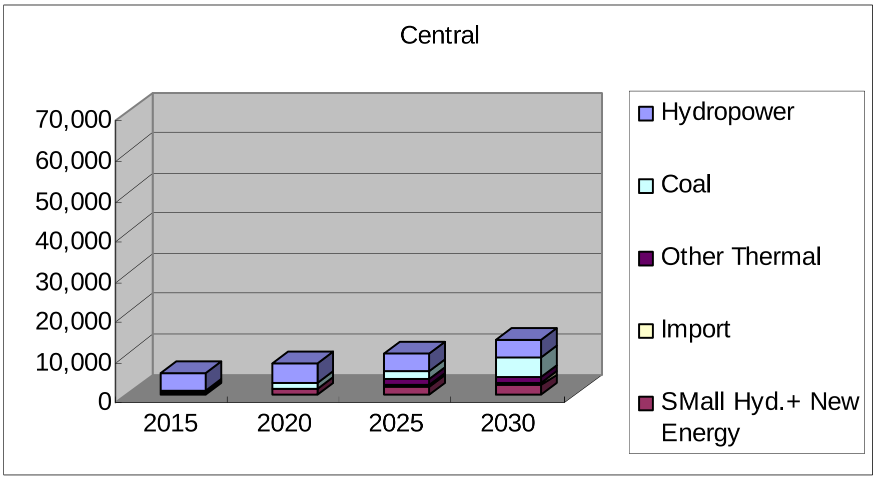
(Unit: MW)



Source: IE (2010.4)

Figure 5.3-1: Installed Capacity in Power Generation Plan for the North Area

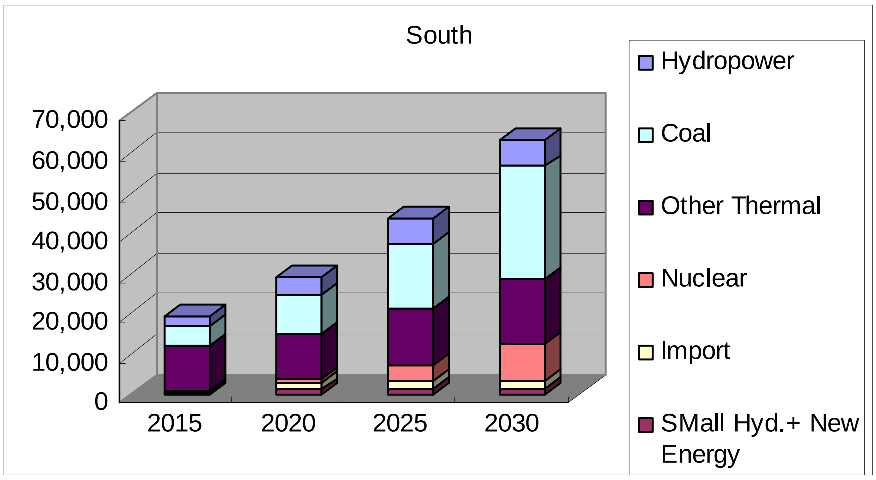
(Unit: MW)



Source: IE (2010.4)

Figure 5.3-2: Installed Capacity in Power Generation Plan for the Central Area

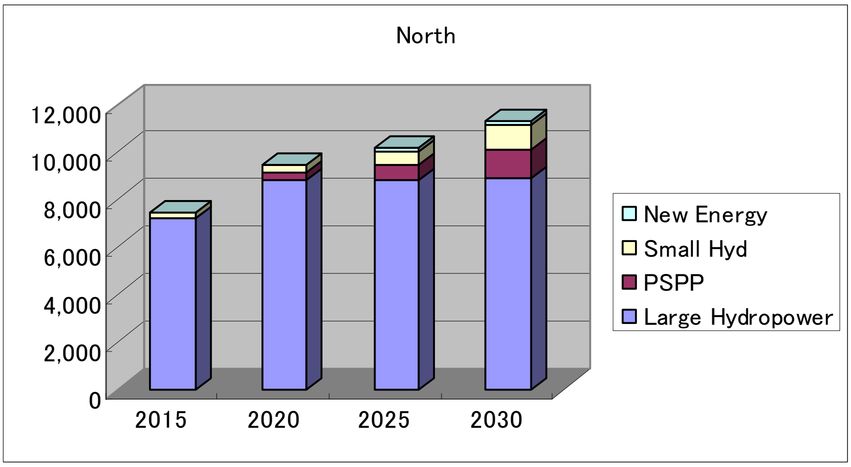
(Unit: MW)



Source: IE (2010.4)

Figure 5.3-3: Installed Capacity in Power Generation Plan for the South Area

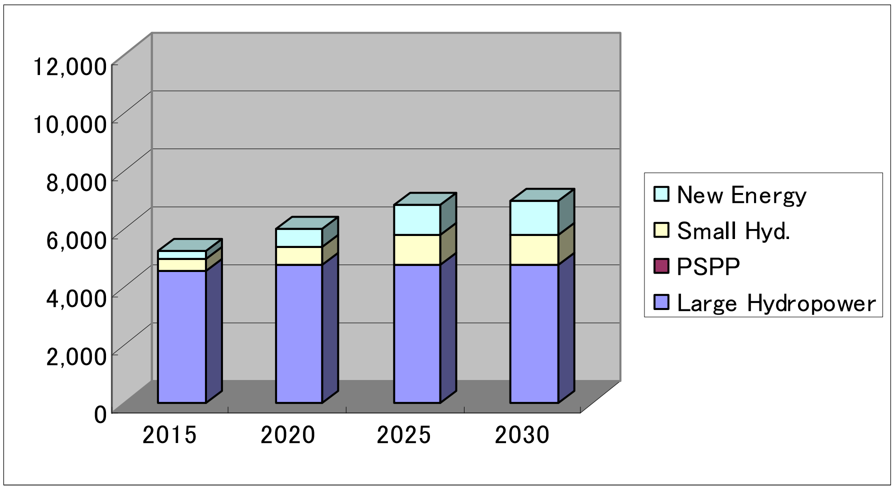
(Unit: MW)



Source: IE (2010.4)

Figure 5.3-4: Installed Capacity of Hydropower Stations and Renewable Energy for the North Area

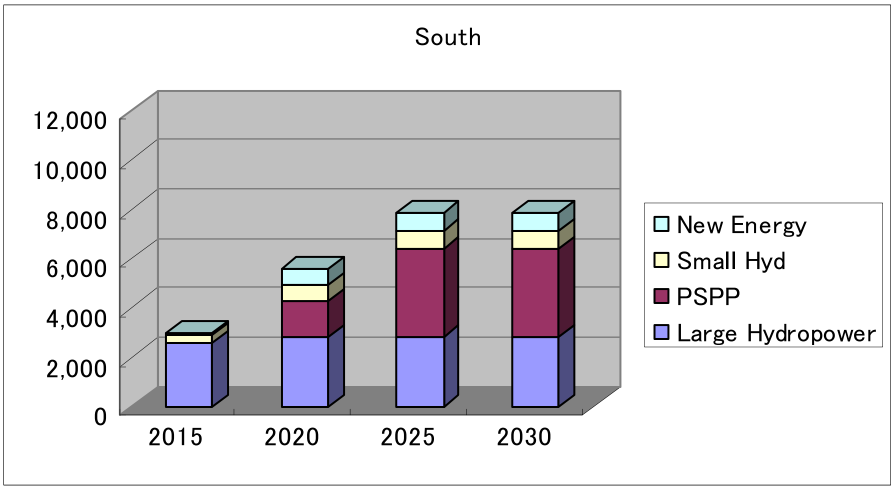
(Unit: MW)



Source: IE (2010.4)

Figure 5.3-5: Installed Capacity of Hydropower Stations and Renewable Energy for the North Area

(Unit: MW)



Source: IE (2010.4)

Figure 5.3-6: Installed Capacity of Hydropower Stations and Renewable Energy for the South Area

Table 5.3-2: The List of Power Generation Plan

(Unit: MW)

		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
North (1/2. Hydro + Coal (1))																					
I.	**Hydropower+Import**	**5,236**	**7,530**	**7,600**	**8,071**	**8,321**	**8,921**	**9,617**	**9,807**	**10,182**	**10,666**	**12,216**	**12,436**	**13,036**	**13,586**	**14,736**	**15,736**	**16,236**	**16,236**	**16,236**	**16,236**
I.a	**Hydropower**	**4,405**	**6,791**	**6,831**	**7,107**	**7,357**	**7,957**	**8,653**	**8,653**	**8,738**	**9,150**	**9,450**	**9,520**	**9,520**	**9,820**	**10,120**	**10,120**	**10,120**	**10,120**	**10,120**	**10,120**
1	**Thác Bà**	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
2	**Hoà bình**	1920	1920	1920	1920	1920	1920	1920	1920	1920	1920	1920	1920	1920	1920	1920	1920	1920	1920	1920	1920
3	**Tuyên Quang**	342	342	342	342	342	342	342	342	342	342	342	342	342	342	342	342	342	342	342	342
4	**Bản vẽ**	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
5	**Sơn La**	1200	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400
6	**Cửa Đạt**	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97
7	**Bản Chát**	0	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220
8	**Nậm Chiến**		196	196	196	196	196	196	196	196	196	196	196	196	196	196	196	196	196	196	196
9	**Tà Thàng**	0	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
10	**Nho Quế III**	0	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110
11		80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
12		0	0	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
13	**Khe Bố**	0	0	0	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96
14	**Huội Quảng**	0	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560
15	**Hủa Na**	0	0	0	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180
16	**Lai Châu**	0	0	0	0	0	600	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200
17	**Hồi Xuân**	0	0	0	0	0	0	96	96	96	96	96	96	96	96	96	96	96	96	96	96
18	**Trung Sơn**	0	0	0	0	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250
19	**Bảo Lâm**	0	0	0	0	0	0	0	0	0	112	112	112	112	112	112	112	112	112	112	112
20	**Hương Sơn 1**	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
21	**Văn Chấn**	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
22	**Cốc San**	0	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
23	**Ngòi Phát**	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
24	**Nậm Chiến 2 (32MW)**	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
25	**Thái An**	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
26	**Su Pán**	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
27	**Na Le**	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
28	**Nhạn Hạc**	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
29	**Bắc Mê**	0	0	0	0	0	0	0	0	45	45	45	45	45	45	45	45	45	45	45	45
30	**Nho Quế I**	0	0	0	0	0	0	0	0	40	40	40	40	40	40	40	40	40	40	40	40
31	**Nho Quế II**	0	0	0	0	0	0	0	0	0	0	0	70	70	70	70	70	70	70	70	70
32	**TĐ TN**	0	0	0	0	0	0	0	0	0	300	600	600	600	900	1200	1200	1200	1200	1200	1200
I.b	**SMall Hyd.+ New Energy**	**161**	**299**	**329**	**429**	**429**	**429**	**429**	**529**	**629**	**629**	**779**	**929**	**1129**	**1129**	**1229**	**1229**	**1229**	**1229**	**1229**	**1229**
1	**Nậm Mu**	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
2	**Na Lơi**	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
3	**Hố Hô**	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
4	**Suối Sập**	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
5	**Bản Cốc**	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
6	**Nậm Chim**	0	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
7	**Nậm Đông**	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
8	**Minh Lương**	0	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
9	**Hồ Bốn**	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
10	**Séo Cung Hô**	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
11	**Chu Linh**	0	0	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
12	**TDN mien Bac**	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27
13	**TĐN mói MB**	0	100	100	200	200	200	200	300	400	400	500	600	800	800	800	800	800	800	800	800
	renewable	0	0	0	0	0	0	0	0	0	0	50	100	100	100	200	200	200	200	200	200
I.c	**Import**	**670**	**440**	**440**	**535**	**535**	**535**	**535**	**625**	**815**	**887**	**1987**	**1987**	**2387**	**2637**	**3387**	**4387**	**4887**	**4887**	**4887**	**4887**
1	**Nậm Mô (Lào)**	0	0	0	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95
	Nậm Mô 1(Lào)	0	0	0	0	0	0	0	0	0	72	72	72	72	72	72	72	72	72	72	72
2	**Import China -110kV-220kV**	670	440	440	440	440	440	440	440	440	440	440	440	440	440	440	440	440	440	440	440
3	**Import China 500kV**														250	1000	2000	2500	2500	2500	2500
	500kV China 1														250	250	250	250	250	250	250
	500kV China 2															250	250	250	250	250	250
	500kV China 3															250	250	250	250	250	250
	500kV China 4															250	250	250	250	250	250
	500kV China 5																250	250	250	250	250
	500kV China 6																250	250	250	250	250
	500kV China 7																250	250	250	250	250
	500kV China 8																250	250	250	250	250
	500kV China 9																	250	250	250	250
	500kV China 10																	250	250	250	250
4	**Luong Pra Bang (Lao)**	0	0	0	0	0	0	0	0	0	0	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100
5	**Nam Xam 2**	0	0	0	0	0	0	0	90	90	90	90	90	90	90	90	90	90	90	90	90
6	**Nam Xam 1**	0	0	0	0	0	0	0	0	40	40	40	40	40	40	40	40	40	40	40	40
7	**Nam Xam 3**	0	0	0	0	0	0	0	0	150	150	150	150	150	150	150	150	150	150	150	150
8	**Nam Theun 1**	0	0	0	0	0	0	0	0	0	0	0	0	400	400	400	400	400	400	400	400
II.	**Thermal (Coal)**	**4,035**	**4,855**	**5,975**	**7,525**	**10,325**	**13,025**	**14,625**	**15,925**	**17,260**	**18,045**	**18,440**	**18,440**	**19,640**	**20,840**	**22,640**	**25,040**	**27,440**	**30,140**	**33,440**	**37,440**
1	**Phả Lại 1**	**400**	**400**	**400**	**400**	**400**	**400**	**400**	**400**	**400**	**400**	**400**	**400**	**400**	**400**	**400**	**400**	**400**	**400**	**400**	**400**
		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
2	**Phả Lại 2**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**
		300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
		300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
3	**Uông Bí**	**105**	**105**	**105**	**105**	**105**	**105**	**105**	**105**	**105**	**105**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
		55	55	55	55	55	55	55	55	55	55	0	0	0	0	0	0	0	0	0	0
		50	50	50	50	50	50	50	50	50	50	0	0	0	0	0	0	0	0	0	0
4	**Uông Bí MR1&2**	**300**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**
	Uông Bí MR I	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
	Uông Bí MR II	0	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
5	**Ninh Bxnh**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
		25	25	25	25	25	25	25	25	25	25	0	0	0	0	0	0	0	0	0	0
		25	25	25	25	25	25	25	25	25	25	0	0	0	0	0	0	0	0	0	0
		25	25	25	25	25	25	25	25	25	25	0	0	0	0	0	0	0	0	0	0
		25	25	25	25	25	25	25	25	25	25	0	0	0	0	0	0	0	0	0	0
7	**Na Dương**	**110**	**110**	**110**	**110**	**110**	**110**	**160**	**210**	**210**	**210**	**210**	**210**	**210**	**210**	**210**	**210**	**210**	**210**	**210**	**210**
		55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55
		55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55
		0	0	0	0	0	0	50	50	50	50	50	50	50	50	50	50	50	50	50	50
		0	0	0	0	0	0	0	50	50	50	50	50	50	50	50	50	50	50	50	50
8	**Cao Ngạn**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
		50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
		50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50

Source: IE (2010.7)

(Unit: MW)

		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
North (2/2. Coal (2))																					
10	**Hải Phòng**	**600**	**600**	**900**	**1,200**	**1,200**	**1,200**	**1,200**	**1,800**	**2,400**	**2,400**	**2,400**	**2,400**	**2,400**	**2,400**	**3,000**	**3,600**	**3,600**	**3,600**	**3,600**	**3,600**
	Hai Phong I#1	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
	Hai Phong I#2	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
	Hai Phong II #1	0	0	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
	Hai Phong II #2	0	0	0	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
	Hai Phong III #1	0	0	0	0	0	0	0	600	600	600	600	600	600	600	600	600	600	600	600	600
	Hai Phong III #2	0	0	0	0	0	0	0	0	600	600	600	600	600	600	600	600	600	600	600	600
	Hai Phong III #3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	600	600	600	600	600	600
	Hai Phong III #4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	600	600	600	600	600
11	**Cẩm Phả**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**
	Cẩm phả 1	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
	Cẩm phả 2	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
11	**An Khánh**	**0**	**0**	**0**	**0**	**0**	**0**	**50**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
	An Khánh #1	0	0	0	0	0	0	50	50	50	50	50	50	50	50	50	50	50	50	50	50
	An Khánh #2	0	0	0	0	0	0	0	50	50	50	50	50	50	50	50	50	50	50	50	50
12	**Quảng Ninh**	**900**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**
	Quang Ninh I #1	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
	Quang Ninh I #2	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
	Quang Ninh II #1	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
	Quang Ninh II #2	0	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
13	**Sơn Động**	**220**	**220**	**220**	**220**	**220**	**220**	**220**	**220**	**220**	**220**	**220**	**220**	**220**	**220**	**220**	**220**	**220**	**220**	**220**	**220**
		110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110
		110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110
14	**Mạo Khê**	**0**	**220**	**440**	**440**	**440**	**440**	**440**	**440**	**440**	**440**	**440**	**440**	**440**	**440**	**440**	**440**	**440**	**440**	**440**	**440**
	Mao Khe I-220MW	0	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220
	Mao Khe II-220MW	0	0	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220
	Lục Nam	**0**	**0**	**0**	**50**	**50**	**50**	**50**	**50**	**50**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
	Lục Nam 1-50MW	0	0	0	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
	Lục Nam 2-50MW	0	0	0	0	0	0	0	0	0	50	50	50	50	50	50	50	50	50	50	50
15	**Nghi Sơn**	**0**	**0**	**0**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**1800**	**1800**	**1800**	**1800**	**1800**	**1800**	**1800**
	Nghi Son #1	0	0	0	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
	Nghi Son #2	0	0	0	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
	Nghi Son II #1	0	0	0	0	0	0	0	0	0	0	0	0	0	600	600	600	600	600	600	600
	Nghi Son II #2	0	0	0	0	0	0	0	0	0	0	0	0	0	600	600	600	600	600	600	600
16	**Mông Dương**	**0**	**0**	**0**	**0**	**2200**	**2200**	**2200**	**2200**	**2200**	**2200**	**2200**	**2200**	**2200**	**2200**	**2200**	**2200**	**2200**	**2200**	**2200**	**2200**
	Mong Duong I #1	0	0	0	0	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
	Mong Duong I #2	0	0	0	0	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
	Mong Duong II #1	0	0	0	0	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
	Mong Duong II #2	0	0	0	0	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
17	**Vũng Áng**	**0**	**0**	**600**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**2400**	**2400**	**2400**	**3000**	**3600**	**3600**	**3600**	**3600**
	Vung Ang I #1	0	0	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
	Vung Ang I #2	0	0	0	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
	Vung Ang II #1	0	0	0	0	0	0	0	0	0	0	0	0	600	600	600	600	600	600	600	600
	Vung Ang II #2	0	0	0	0	0	0	0	0	0	0	0	0	600	600	600	600	600	600	600	600
	Vung Ang III #1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	600	600	600	600	600
	Vung Ang III #2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	600	600	600	600
18	**Thăng Long I**	**0**	**0**	**0**	**0**	**0**	**300**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**	**600**
19	**Cẩm thịnh**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**135**	**270**	**270**	**270**	**270**	**270**	**270**	**270**	**270**	**270**	**270**	**270**
	Cẩm thịnh 1	0	0	0	0	0	0	0	0	135	135	135	135	135	135	135	135	135	135	135	135
	Cẩm thịnh 2	0	0	0	0	0	0	0	0	0	135	135	135	135	135	135	135	135	135	135	135
19	**Thai Binh**	**0**	**0**	**0**	**0**	**600**	**1800**	**1800**	**1800**	**1800**	**1800**	**1800**	**1800**	**1800**	**1800**	**1800**	**1800**	**1800**	**1800**	**1800**	**1800**
	Thai Binh I #1	0	0	0	0	0	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
	Thai Binh I #2	0	0	0	0	0	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
	Thai Binh II #1	0	0	0	0	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
	Thai Binh II #2	0	0	0	0	0	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
20	**Hai Duong**	**0**	**0**	**0**	**0**	**0**	**600**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**
	Hai Duong #1	0	0	0	0	0	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
	Hai Duong #2	0	0	0	0	0	0	600	600	600	600	600	600	600	600	600	600	600	600	600	600
21	**Quang trach**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**600**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**2400**	**2400**	**2400**	**2400**	**2400**	**2400**
	Quang Trach I #1	0	0	0	0	0	0	0	600	600	600	600	600	600	600	600	600	600	600	600	600
	Quang Trach I #2	0	0	0	0	0	0	0	0	600	600	600	600	600	600	600	600	600	600	600	600
	Quang Trach II #1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	600	600	600	600	600	600
	Quang Trach II #2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	600	600	600	600	600	600
22	**Nam Dinh**	**0**	**0**	**0**	**0**	**0**	**600**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**2400**	**2400**	**2400**	**2400**	**2400**
	Nam Dinh I #1	0	0	0	0	0	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
	Nam Dinh I #2	0	0	0	0	0	0	600	600	600	600	600	600	600	600	600	600	600	600	600	600
	Nam Dinh II #1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	600	600	600	600	600
	Nam Dinh II #1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	600	600	600	600	600
23	**Quynh Luu**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**600**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**
	Quynh Luu I #1	0	0	0	0	0	0	0	0	0	600	600	600	600	600	600	600	600	600	600	600
	Quynh Luu I #2	0	0	0	0	0	0	0	0	0	0	600	600	600	600	600	600	600	600	600	600
24	**Bac Giang**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**300**	**300**	**300**
25	**Cong Thanh**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**300**	**300**
26	**Đầm Hà**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1800**	**2400**	**2400**	**2400**
	Dam Ha #1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	600	600	600	600
	Dam Ha #2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	600	600	600	600
	Dam Ha #3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	600	600	600	600
	Dam Ha #4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	600	600	600
27	**New Coal**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1800**	**4800**	**8800**
	Than moi MB 600 #1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	600	600	600
	Than moi MB 600 #2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	600	600	600
	Than moi MB 600 #3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	600	600	600
	Than moi MB #1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	1000
	Than moi MB #2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	1000
	Than moi MB #3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	1000
	Than moi MB #4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000
	Than moi MB #5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000
	Than moi MB #6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000
	Than moi MB #7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000

Source: IE (2010.7)

(Unit: MW)

		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Central																					
I.	**Hydropower+Import**	**4,138**	**4,338**	**4,683**	**4,833**	**5,366**	**5,590**	**5,875**	**6,075**	**6,285**	**6,335**	**6,725**	**6,725**	**7,055**	**7,055**	**7,055**	**7,055**	**7,055**	**7,055**	**7,055**	**7,055**
I.a	**Hydropower**	**3693**	**3843**	**4038**	**4038**	**4421**	**4531**	**4616**	**4616**	**4726**	**4726**	**4726**	**4726**	**4726**	**4726**	**4726**	**4726**	**4726**	**4726**	**4726**	**4726**
1	**Yaly**	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720
2	**S«ng Hinh**	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
3	**Vĩnh Sơn**	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66
4	**Sê San 3**	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260
5	**Sê San3A**	108	108	108	108	108	108	108	108	108	108	108	108	108	108	108	108	108	108	108	108
6	**Quảng Trị**	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64
7	**Pleikrong**	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
8	**Sông Ba Hạ**	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220
9	**A Vương**	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
10	**Bình Điền**	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
11	**Buôn Kuốp**	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280
12	**Buôn Tua Sa**	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
13	**La Ngâu**	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38
14	**Hương Sơn**	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54
15	**EaKrông Hnang (65MW)**	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
16	**An Khê-Ka Nak**	173	173	173	173	173	173	173	173	173	173	173	173	173	173	173	173	173	173	173	173
17	**Sêrêpok 3**	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220
18	**Sông Côn 2**	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53
19	**Sê San 4**	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360
19	**Sê San 4A**	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63
20	**Sông Tranh 2**	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160
22	**ĐakDrinh**	0	0	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125
23	**Sông Boung 4**	0	0	0	0	165	165	165	165	165	165	165	165	165	165	165	165	165	165	165	165
28	**Đak Mi 4**	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210
24	**A Luoi**	0	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
25	**Sông Boung 2**	0	0	0	0	108	108	108	108	108	108	108	108	108	108	108	108	108	108	108	108
26	**Sêrêpok 4**	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
27	**Sêrêpok 4A**	0	0	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
28	**Thượng Kon Tum**	0	0	0	0	110	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220
29	**Vĩnh Sơn II (110MW)**	0	0	0	0	0	0	0	0	110	110	110	110	110	110	110	110	110	110	110	110
30	**Sông Boung 5**	0	0	0	0	0	0	85	85	85	85	85	85	85	85	85	85	85	85	85	85
1.a	**SMall Hyd.+ New Energy**	**197**	**247**	**397**	**547**	**697**	**747**	**947**	**1147**	**1247**	**1297**	**1597**	**1597**	**1747**	**1747**	**1747**	**1747**	**1747**	**1747**	**1747**	**1747**
	Small hyd.	147	147	247	347	447	447	547	647	647	647	847	847	947	947	947	947	947	947	947	947
1	Suèi Vµng	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
2	Ry Ninh	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
3	Dray Hling	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28
4	H'chan	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
5	H'mun	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
6	Ea Rong Rou	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28
8	Small HPPs	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
10	New small HPPs			100	200	300	300	400	500	500	500	700	700	800	800	800	800	800	800	800	800
	renewable	50	100	150	200	250	300	400	500	600	650	750	750	800	800	800	800	800	800	800	800
1.b	**Import**	**248**	**248**	**248**	**248**	**248**	**312**	**312**	**312**	**312**	**312**	**402**	**402**	**582**	**582**	**582**	**582**	**582**	**582**	**582**	**582**
1	**Sê Ka man 3 (Lào)**	248	248	248	248	248	248	248	248	248	248	248	248	248	248	248	248	248	248	248	248
2	**Sê Ka man 4 (Lào)**	0	0	0	0	0	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64
3	**Hạ Sê San 1 (CPC)**	0	0	0	0	0	0	0	0	0	0	90	90	90	90	90	90	90	90	90	90
4	**Hạ Sê San 3 (CPC)**	0	0	0	0	0	0	0	0	0	0	0	0	180	180	180	180	180	180	180	180
II.	**Thermal**	**104**	**134**	**134**	**134**	**134**	**134**	**794**	**1454**	**1454**	**1904**	**2204**	**2654**	**3104**	**3404**	**4004**	**4664**	**5324**	**5324**	**5324**	**5324**
2	**ND Than Nong Son**	**0**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
3	**Loc dau Dung Quat**	**104**	**104**	**104**	**104**	**104**	**104**	**104**	**104**	**104**	**104**	**104**	**104**	**104**	**104**	**104**	**104**	**104**	**104**	**104**	**104**
2.b	**Coal Cent.**	**0**	**0**	**0**	**0**	**0**	**0**	**660**	**1320**	**1320**	**1320**	**1620**	**1620**	**1620**	**1920**	**2520**	**3180**	**3840**	**3840**	**3840**	**3840**
1	**Van Phong #3**	0	0	0	0	0	0	660	660	660	660	660	660	660	660	660	660	660	660	660	660
2	**Van Phong #4**	0	0	0	0	0	0	0	660	660	660	660	660	660	660	660	660	660	660	660	660
3	**Cente Coal 300 #1**	0	0	0	0	0	0	0	0	0	0	300	300	300	300	300	300	300	300	300	300
4	**Cente Coal 300 #2**	0	0	0	0	0	0	0	0	0	0	0	0	0	300	300	300	300	300	300	300
5	**Cente Coal 300 #3**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	300	300	300	300	300	300
6	**Cente Coal 300 #4**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	300	300	300	300	300	300
7	**Cente Coal 660 #1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	660	660	660	660	660
8	**Cente Coal 660 #2**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	660	660	660	660
3.b	**CCGT Central**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**450**	**450**	**900**	**1350**	**1350**	**1350**	**1350**	**1350**	**1350**	**1350**	**1350**
1	**CCGT Central 1**	0	0	0	0	0	0	0	0	0	450	450	450	450	450	450	450	450	450	450	450
2	**CCGT Central 2**	0	0	0	0	0	0	0	0	0	0	0	450	450	450	450	450	450	450	450	450
3	**CCGT Central 3**	0	0	0	0	0	0	0	0	0	0	0	0	450	450	450	450	450	450	450	450
	Nuclear PPs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1350**	**2700**	**2700**
	ĐHN m.Trung 1-1350MW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1350	1350	1350
	ĐHN m.Trung 2-1350MW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1350	1350

Source: IE (2010.7)

(Unit: MW)

		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
South (1/2. Hydro + Thermal (1))																					
I.	Hydropower+Import	2496	2616	2666	3106	3396	3752	4002	4202	4702	5402	5902	6002	6102	6802	7552	7552	7552	7852	8452	8752
I.a	Hydropower	2343	2413	2413	2413	2553	2659	2659	2659	2959	3559	3859	3859	3859	4459	5059	5059	5059	5359	5959	6259
1	Đa Nhim	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160
2	Trị An	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
3	Thác Mơ	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
4	Hàm Thuận	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
5	Đa Mi	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177
6	Cần Đơn	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72
7	Srok Phu Miêng	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
8	Bắc Bình	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
9	Đại Ninh	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
10	Đak Rtih	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72
11	Đồng Nai 3+4	520	520	520	520	520	520	520	520	520	520	520	520	520	520	520	520	520	520	520	520
	Đồng Nai 3	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180
	Đồng Nai 4	340	340	340	340	340	340	340	340	340	340	340	340	340	340	340	340	340	340	340	340
12	Đồng Nai 2	0	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
13	Đồng Nai 5	0	0	0	0	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
14	Đồng Nai 6	0	0	0	0	0	106	106	106	106	106	106	106	106	106	106	106	106	106	106	106
15	Đa Dâng 2 (34MW)	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
16	Đam Bri	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72
17	Pump Storage PP	0	0	0	0	0	0	0		300	900	1200	1200	1200	1800	2400	2400	2400	2700	3300	3600
1.a	SMall Hyd.+ New Energy	153	203	253	403	553	603	853	903	1103	1203	1403	1503	1603	1703	1853	1853	1853	1853	1853	1853
1	Da Dâng Da Chomo	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
2	Bảo Lộc-Dasiat	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37
3	New Small HPPs	100	100	100	200	300	300	500	500	600	600	700	700	700	700	700	700	700	700	700	700
4	Renewable	0	50	100	150	200	250	300	350	450	550	650	750	850	950	1100	1100	1100	1100	1100	1100
1.b	Import	0	0	0	290	290	490	490	640	640	640	640	640	640	640	640	640	640	640	640	640
1	Sê Ka man 1 (Lào)	0	0	0	290	290	290	290	290	290	290	290	290	290	290	290	290	290	290	290	290
2	Hạ Sê San 2 (Campuchia) 50	0	0	0	0	0	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
3	Sê Kông 3 (Cambodia)	0	0	0	0	0	0	0	150	150	150	150	150	150	150	150	150	150	150	150	150
II.	Thermal (incl. Nuclear)	8408	8408	8408	11678	15488	19298	20888	22838	25133	27061	28721	31671	34621	37571	41921	44721	48321	50921	55921	59921
1	Phú Mỹ	3890	3890	3890	3890	3890	3890	3890	3890	3890	3890	3890	3890	3890	3890	3890	3890	3890	3890	3890	3890
	Phú Mỹ 2-1	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450
	Phú Mỹ 2-1 MR	440	440	440	440	440	440	440	440	440	440	440	440	440	440	440	440	440	440	440	440
	Phú Mỹ 4	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450
	Phú Mỹ 1	1090	1090	1090	1090	1090	1090	1090	1090	1090	1090	1090	1090	1090	1090	1090	1090	1090	1090	1090	1090
	Phú Mỹ 2-2	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720
	Phú Mỹ 3	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720
	Đạm Phú Mỹ	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
2	Nhon Trach	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200
	Nhon Trach I CC	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450
	Nhon Trach II CC	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750
3	NĐ Thủ Đức	153	153	153	153	153	153	153	153	153	0	0	0	0	0	0	0	0	0	0	0
	Thu Duc #1 ST	33	33	33	33	33	33	33	33	33	0	0	0	0	0	0	0	0	0	0	0
	Thu Duc #2 ST	60	60	60	60	60	60	60	60	60	0	0	0	0	0	0	0	0	0	0	0
	Thu Duc #3 ST	60	60	60	60	60	60	60	60	60	0	0	0	0	0	0	0	0	0	0	0
4	TBK Thủ Đức	119	119	119	119	119	119	119	119	119	0	0	0	0	0	0	0	0	0	0	0
	Thu Duc #4 GT	23	23	23	23	23	23	23	23	23	0	0	0	0	0	0	0	0	0	0	0
	Thu Duc #5 GT	15	15	15	15	15	15	15	15	15	0	0	0	0	0	0	0	0	0	0	0
	Thu Duc #6 GT	15	15	15	15	15	15	15	15	15	0	0	0	0	0	0	0	0	0	0	0
	Thu Duc #7 GT	33	33	33	33	33	33	33	33	33	0	0	0	0	0	0	0	0	0	0	0
	Thu Duc #8 GT	33	33	33	33	33	33	33	33	33	0	0	0	0	0	0	0	0	0	0	0
5	Bà Rịa	370	370	370	370	370	370	370	370	370	370	370	370	370	370	370	370	370	370	370	370
	Ba Ria GT #1	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	Ba Ria GT #2	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	BaRiaC/C#1GT3x37.5ST56	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160
	Ba Ria C/C#2 GT3x37.5MW,	170	170	170	170	170	170	170	170	170	170	170	170	170	170	170	170	170	170	170	170
6	NĐ Cần Thơ	120	120	120	120	120	120	120	120	120	0	0	0	0	0	0	0	0	0	0	0
7	TBK Cần Thơ	30	30	30	30	30	30	30	30	30	0	0	0	0	0	0	0	0	0	0	0
8	Formosa	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
9	Ô Môn	330	330	330	1410	2160	2910	2910	2910	2910	2910	2910	2910	2910	2910	2910	2910	2910	2910	2910	2910
	Ô Môn I #1-FO	330	330	330	330	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0
	Ô Môn I #2-FO	0	0	0	330	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0
	Ô Môn I #1-Gas	0	0	0		330	330	330	330	330	330	330	330	330	330	330	330	330	330	330	330
	Ô Môn I #2-Gas	0	0	0		330	330	330	330	330	330	330	330	330	330	330	330	330	330	330	330
	Ô Môn II (BOT)	0	0	0	0	0	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750
	Ô Môn III	0	0	0	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750
	Ô Môn IV	0	0	0	0	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750
10	Ca Mau	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
	Ca Mau I CC	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750
	Ca Mau II CC	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750	750
12	Hiệp Phước	375	375	375	765	765	765	1155	1155	780	780	780	780	780	780	780	780	780	780	780	780
	Hiep Phuoc #1-125MW	125	125	125	125	125	125	125	125	0	0	0	0	0	0	0	0	0	0	0	0
	Hiep Phuoc #2-125MW	125	125	125	125	125	125	125	125	0	0	0	0	0	0	0	0	0	0	0	0
	Hiep Phuoc #3-125MW	125	125	125	125	125	125	125	125	0	0	0	0	0	0	0	0	0	0	0	0
	Hiep Phuoc II (CCGT)	0	0	0	390	390	390	390	390	390	390	390	390	390	390	390	390	390	390	390	390
	Hiep Phuoc II (CCGT)	0	0	0	0	0	0	390	390	390	390	390	390	390	390	390	390	390	390	390	390
13	Amata+Vedan+Bourbon	109	109	109	109	109	109	109	109	109	109	109	109	109	109	109	109	109	109	109	109
14	Diesel	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62
15	New CCGT	0	0	0	0	0	0	0	750	1500	2250	2250	3000	3750	4500	5250	5250	5250	5250	5250	5250
	South CCGT (E) 1	0	0	0	0	0	0	0	750	750	750	750	750	750	750	750	750	750	750	750	750
	South CCGT (E) 2	0	0	0	0	0	0	0	0	750	750	750	750	750	750	750	750	750	750	750	750
	South CCGT (E) 3	0	0	0	0	0	0	0	0	0	750	750	750	750	750	750	750	750	750	750	750
	South CCGT (E) 4	0	0	0	0	0	0	0	0	0	0	0	750	750	750	750	750	750	750	750	750
	South CCGT (E) 5	0	0	0	0	0	0	0	0	0	0	0	0	750	750	750	750	750	750	750	750
	South CCGT (W) 1	0	0	0	0	0	0	0	0	0	0	0	0	0	750	750	750	750	750	750	750
	South CCGT (W) 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	750	750	750	750	750	750
17	Nuclear PPs	0	0	0	0	0	0	0	0	0	1000	2000	3000	4000	5000	6000	7000	8000	8000	8000	8000
	Nuclear #1-Phuoc Dinh 1	0	0	0	0	0	0	0	0	0	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
	Nuclear #2-Phuoc Dinh 2	0	0	0	0	0	0	0	0	0	0	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
	Nuclear #3-Vinh Hai 1	0	0	0	0	0	0	0	0	0	0	0	1000	1000	1000	1000	1000	1000	1000	1000	1000
	Nuclear #4-Vinh Hai 2	0	0	0	0	0	0	0	0	0	0	0	0	1000	1000	1000	1000	1000	1000	1000	1000
	Nuclear #5-Phuoc Dinh 3	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	1000	1000	1000	1000	1000	1000
	Nuclear #6-Phuoc dinh 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	1000	1000	1000	1000	1000
	Nuclear #7-Vinh Hai 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	1000	1000	1000	1000
	Nuclear #8-Vinh Hai 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	1000	1000	1000

Source: IE (2010.7)

(Unit: MW)

		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
South (2/2. Thermal (2))																					
17	Coal South	0	0	0	1800	4860	7920	9120	10320	12240	12840	13500	14700	15900	17100	19700	21500	24100	26700	31700	35700
	South Coal 2 (Vinh Tan II #1)	0	0	0	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
	South Coal 5 (Vinh Tan II #2)	0	0	0	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
	South Coal 2 (Vinh Tan I #1)	0	0	0	0	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
	South Coal 5 (Vinh Tan I #2)	0	0	0	0	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
	South Coal 660 #1 (Vinh Tan	0	0	0	0	0	0	0	0	660	660	660	660	660	660	660	660	660	660	660	660
	South Coal 660 #2 (Vinh Tan	0	0	0	0	0	0	0	0	660	660	660	660	660	660	660	660	660	660	660	660
	South Coal 660 #3 (Vinh Tan	0	0	0	0	0	0	0	0	0	0	660	660	660	660	660	660	660	660	660	660
	South Coal 3 (Duyen Hai I #1	0	0	0	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
	South Coal 4 (Duyen Hai I #2	0	0	0	0	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
	South Coal 11 (Duyen Hai II #	0	0	0	0	0	0	0	600	600	600	600	600	600	600	600	600	600	600	600	600
	South Coal 12 (Duyen Hai II #	0	0	0	0	0	0	0	600	600	600	600	600	600	600	600	600	600	600	600	600
	South Coal 13 (D.Hai III,1)	0	0	0	0	0	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
	South Coal 14 (D.Hai III,2)	0	0	0	0	0	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
	South Coal 15 (D.Hai III,3)	0	0	0	0	0	0	600	600	600	600	600	600	600	600	600	600	600	600	600	600
	Van Phong #1-660MW	0	0	0	0	660	660	660	660	660	660	660	660	660	660	660	660	660	660	660	660
	Van Phong #2-660MW	0	0	0	0	0	660	660	660	660	660	660	660	660	660	660	660	660	660	660	660
	South Coal 7 (Long Phu I #1)	0	0	0	0	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
	South Coal 8 (Long Phu I #2)	0	0	0	0	0	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
	South Coal 21 (Long Phu II #	0	0	0	0	0	0	0	0	0	0	0	600	600	600	600	600	600	600	600	600
	South Coal 22 (Long Phu II #	0	0	0	0	0	0	0	0	0	0	0	600	600	600	600	600	600	600	600	600
	S.Coal 1M #1 (Long Phu III,1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	1000	1000	1000	1000	1000
	S.Coal 1M #2 (Long Phu III,2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	1000	1000	1000	1000	1000
	South Coal 18 (Song Hau I #1	0	0	0	0	0	0	0	0	600	600	600	600	600	600	600	600	600	600	600	600
	South Coal 19 (Song Hau I #2	0	0	0	0	0	0	0	0	0	600	600	600	600	600	600	600	600	600	600	600
	South Coal 25 (Long an #1)	0	0	0	0	0	0	0	0	0	0	0	0	0	600	600	600	600	600	600	600
	South Coal 26 (Long an #2)	0	0	0	0	0	0	0	0	0	0	0	0	0	600	600	600	600	600	600	600
	South Coal 9 (Kien Giang I #1	0	0	0	0	0	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
	South Coal 10 (Kien Giang I #	0	0	0	0	0	0	600	600	600	600	600	600	600	600	600	600	600	600	600	600
	South Coal 23 (Kien Giang II	0	0	0	0	0	0	0	0	0	0	0	0	600	600	600	600	600	600	600	600
	South Coal 24 (Kien Giang II	0	0	0	0	0	0	0	0	0	0	0	0	600	600	600	600	600	600	600	600
	South Coal 27 (Kien Giang III	0	0	0	0	0	0	0	0	0	0	0	0	0	0	600	600	600	600	600	600
	South Coal 28 (Kien Giang III	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	600	600	600	600	600
	South Coal 29 (Son My I #1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	600	600	600	600	600
	South Coal 30 (Son My I #2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	600	600	600	600	600
	South Coal 31 (Son My II #1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	600	600	600	600
	South Coal 32 (Son My II #2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	600	600	600
	S. Coal 1M #3 (Tra Cu I,1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	1000	1000	1000
	S. Coal 1M #4 (Tra Cu I,2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	1000	1000	1000
	S. Coal 1M #5 (Tra Cu II,1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	1000	1000
	S. Coal 1M #6 (Tra Cu II,2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	1000	1000
	New S. Coal 1M #7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	1000
	New S. Coal 1M #8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	1000
	New S. Coal 1M #9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	1000
	New S. Coal 1M #10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	1000
	New S. Coal 1M #11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	1000
	New S. Coal 1M #12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000
	New S. Coal 1M #13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000
	New S. Coal 1M #14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000
	New S. Coal 1M #15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000

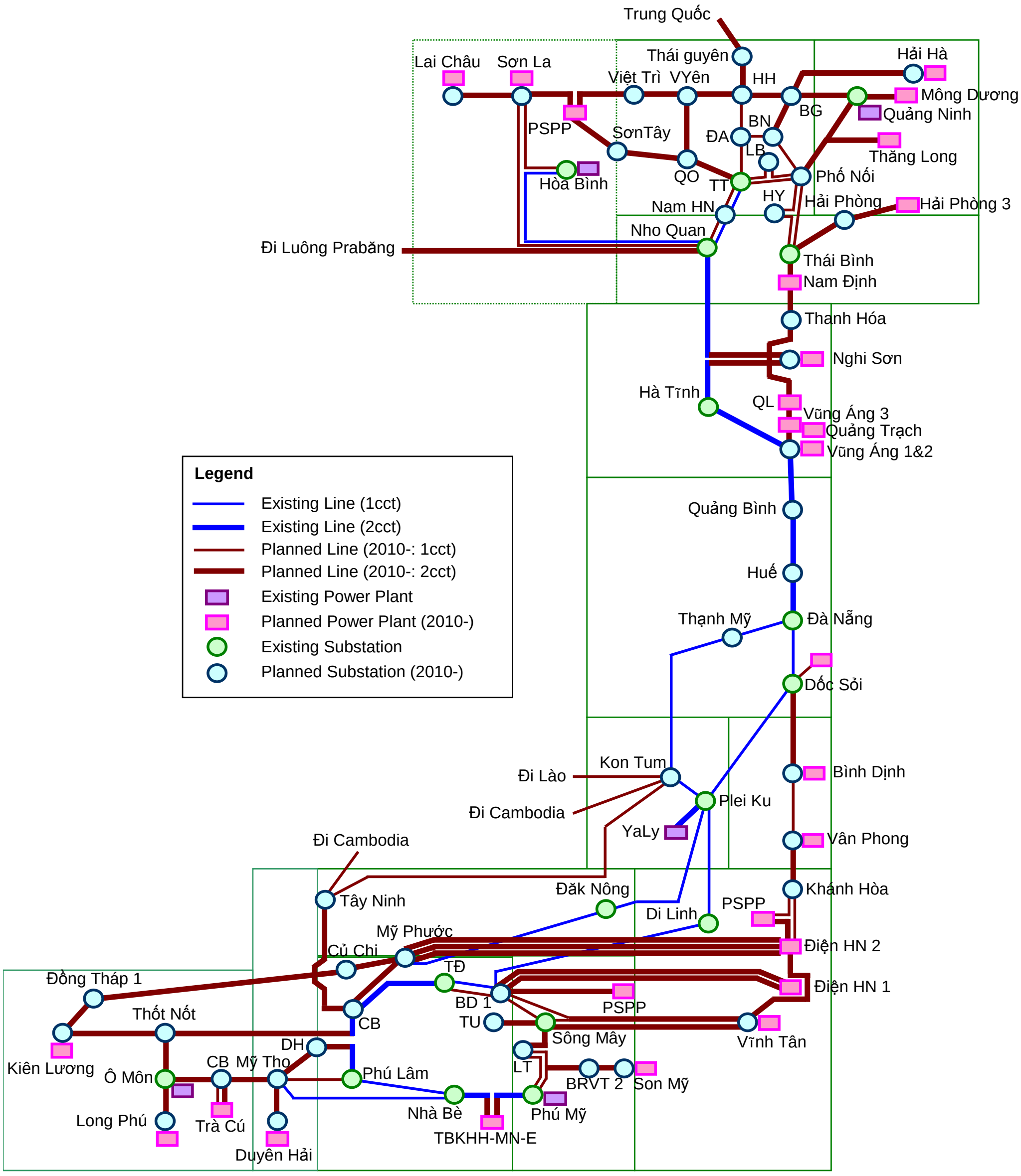
Source: IE (2010.7)

5.4 Power Network System Plan

The basic policies of the power network system plans are as follows.

- The power generation should be planned so as to maintain the regional power supply-demand balance. Thus, the 500 kV interconnections between the north and the central area will not be reinforced. However, the 500 kV interconnection between the central to the south will need to be reinforced because there will be an abundance of power generation capacity such as the many potential sites for hydropower stations and the candidate sites for the coal thermal power stations with the sea ports in the central area and the potential sites for the hydropower stations in the southern area while the power demand in those regions will not become so high. The surplus power in those regions will be planned to be supplied to the southern area with 500 kV transmission lines reinforced between the central and the south regions where much power demand will be expected.
- The 500 kV system surrounding Ho Chi Minh City should be constructed into a ring-shaped configuration as much as possible. The 220 kV transmission lines should be fed from the multiple 500 kV substations to the inner side of Ho Chi Minh City.
- It is expected that the fault currents in the Ho Chi Minh system would exceed the nominal fault making capacity of the circuit breakers due to the increase in the fault currents in the Ho Chi Minh system in the latter years in PDP7. Thus, the system with 220 kV transmission lines feeding power to the Ho Chi Minh City should be separately operated as the radial form system in order to suppress the fault currents.

The status of creating the power network system plan as of July 2010 is described below. Figure 5.4.1 shows the power system map of the 500 kV system plan up to 2030 prepared by IE as of July 2010



*The Case assumed that 500kV transmission lines were applied to the interval between Điện HN 2 and Mỹ Phước.

Source: The TA Team

Figure 5.4-1: Power System Map of the 500 kV System Plan by IE up to 2030

(1) Power Network System Plan in the North

The power supply ability of Hanoi City in 2009 was 1040 MW from Pha Lai thermal power station, 1,920 MW from Hoa Binh hydropower station and 342 MW from other power sources.

There are two 500 kV substations, the Hoa Binh hydropower station and the Thuong Tin substation supplying power to the city through 220 kV transmission lines. It will be required to largely reinforce the 500 kV and 220 kV system in order to supply power to Hanoi City from the Son La hydropower station and the coal thermal power station at the sea coast area in the northeastern part of Vietnam.

IE is now making a comparison among the scenarios of power network system plans in Hanoi City. Basically, all the plans include the 500 kV substation installed in the outskirts of Hanoi City as follows.

- The 500 kV substations to be installed by 2015: Vie Tri 、Hiep Hoa、Quang Ninh、Pho Noi
- The 500 kV substations installed from 2016 up to 2015: Dan Phuong installed in the northwestern area in Hanoi or Quoc Oai, and Dong Anh installed in the eastern part of Hanoi

The number of 500 kV substations is not so much different from the plan in PDP6. However, Dan Phuong or Quoc Oaithe has been planned in the western part of Hanoi instead of Tay Hanoi which was proposed in the northern part of Hanoi.

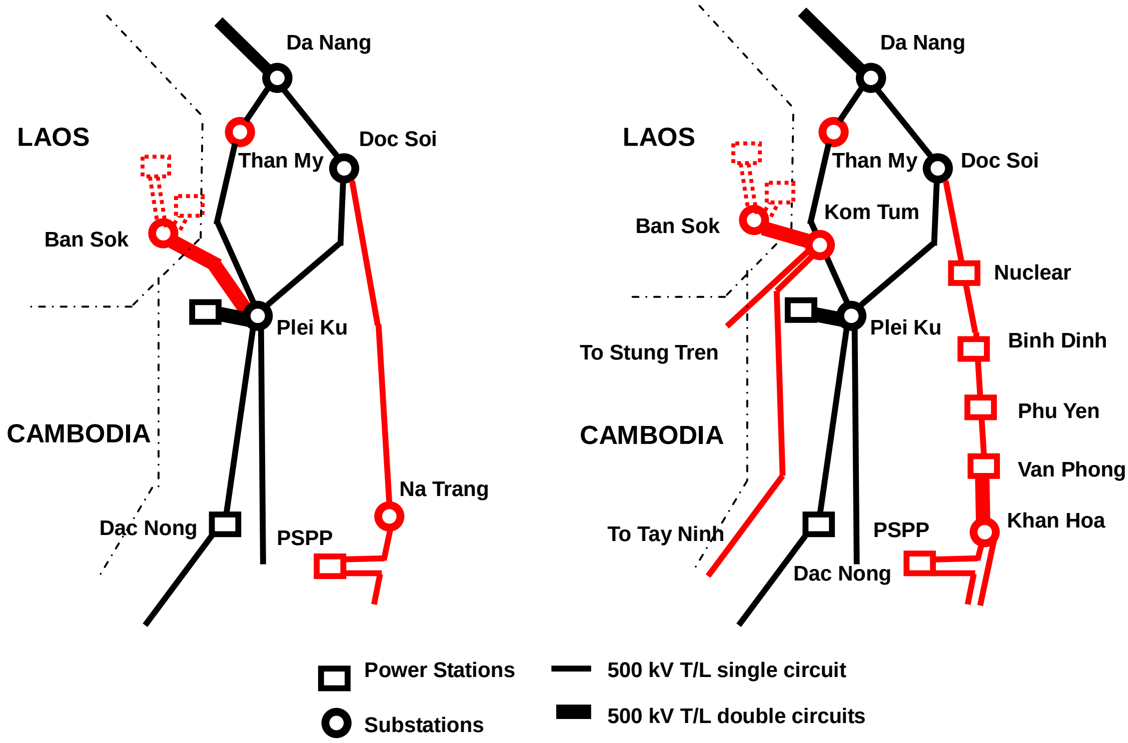
The 500 kV interconnections from China to Hiep Hoa in the northern area to Hanoi and from Luang Prabang in Laos to the Nho Quang substation have been planned. However, the detailed specifications of those transmission lines has not been determined yet.

(2) Power Network System Plan in the Central

There were plans to install a 500 kV substation (Ban Sok substation) in Laos and the construction of 500 kV double circuit transmission lines to the Pleiku substation in the central area of Vietnam in order to supply power from the multiple hydropower stations in Laos in the master plan and the pre feasibility study by ADB after PDP6.

On the other hand, in PDP7, there are plans to install a 500 kV substation (Kom Tum substation) in the central area of Vietnam in order to collect power from the hydropower stations in Laos with 500 kV transmission line.

The 500 kV transmission line from the 500kV Kom Tum substation to Ho Chi Minh has been planned along with the 500 kV lines along the sea cost area from Doc Soi because of the increase in the power flow from the central area to the south and the north due to the multiple large coal thermal power plants that have been planned to be constructed in the central area.



Draft plan of 500 kV system in the Central in PDP6

Draft plan of 500 kV system in the Central in PDP7

Red colored lines indicates the planned facilities

Figure 5.4-2: The Draft Plan of the 500 kV Power Network System of the Central Area in Comparison of PDP6 and PDP7

(3) Power Network System Plan in the South

Chapter four described the status of making plans for the power network system from the southeast area of Vietnam to Ho Chi Minh City. IE is now in the process in formulating its plans.

5.5 Environmental and Social Consideration

5.5.1 Outline of the Review

In accordance with the relevant Vietnamese laws and regulations, a Strategic Environmental Assessment (hereinafter referred to as “SEA”) has been conducted as the environmental and social consideration of the PDP7.

SEA is an environmental assessment which aims at the Policy, Plan and Program (hereinafter referred to as "PPPs"), and it can investigate a broader range of mitigation measures from an earlier stage, compared to the Environmental Impact Assessment (hereinafter referred to as "EIA"), which aims at individual projects.

Considering that most of the requirements of international cooperation agencies are a SEA application to a Master Plan etc., it is important to improve the quality of SEA in accordance with international good practices.

Consequently, the study team prepared the SEA review checklist, based on relevant Vietnamese laws and regulations and the good practice of the development cooperation agencies etc. The study team implemented an interim review of the draft SEA report of the PDP7 based on the checklist.

5.5.2 Laws and Regulations Related to SEA in Vietnam

(1) Law on Environmental Protection

The basic law on SEA is the Law on Environmental Protection, revised in 2005, and it mandates the SEA for the following strategies, planning and plan (Article 14).

1. National socio-economic development strategies, planning and plans.
2. Strategies, planning and plans for the development of branches or sectors on a national scale.
3. Socio-economic development strategies, planning and plans of provinces, centrally run cities or regions.
4. Planning for land use, forest protection and development; exploitation and utilization of other natural resources in the inter-provincial or inter-regional areas.
5. Planning for the development of key economic regions.
6. General planning of inter-provincial river watersheds.

The agencies assigned to formulate strategies and plans mentioned in Article 14 have to conduct SEA (Article15).

SEA reports are to be evaluated by an "Appraisal Council", which will be established by the agency with legal authority to approve the target strategies and plans and the Ministry of Natural Resources and Environment (hereinafter referred as "MONRE") shall organize an appraisal council for the strategies and plans which are subject to approval by the National Assembly, the Government or the Prime Minister (Article 17).

The PDP7 is subject to the approval of the Prime Minister. Therefore, the SEA of the PDP7 will be evaluated by the appraisal council established by MONRE.

(2) Other Related Laws and Regulations

The provisions on the SEA of the Law on Environmental Protection are supported by the key related laws and regulations as follows.

(a) Decree No.80/2006/ND-CP (August 2006)

The Decree guides the procedures of the SEA report submission (Article 9) and appraisal (Article 10) arrangements and includes a time limit for the appraisal as follows (Article 12).

- Strategies and Plans to be approved by the National Assembly, the Government and the Prime Minister/ Inter-branch and Inter-province strategies and plans: 45 working days after receipt of the complete and valid dossier

- Other Strategies and Plans: 30 working days after the receipt of a complete and valid dossier

(b) Circular No.05/2008/TT-BTNMT (December 2008)

The Circular, which repeals the Circular No. 08/2006/TT-BTNMT (September 2006), provides detailed guidance and instructions on the implementation of the Law on Environmental Protection provisions relating to the SEA.

(c) General Technical Guideline for Strategic Environmental Assessment (MONRE, 2008)

The General Technical Guideline for the Strategic Environmental Assessment (MONRE, 2008) explains the steps and approaches of the SEA and it will be regularly reviewed on the basis of SEA implementation experiences.

In the aforementioned guidelines, for those responsible for conducting an SEA, the internal review criteria for the SEA report has been explained as follows.

Table 5.5-1: Internal Review Criteria for SEA Report

Addressing key issues

- The purpose and objectives of the plans, policies and programmes (PPPs) are made clear.
- Links with other related PPPs are identified and clearly explained.
- Environmental issues that are relevant to the PPPs are identified
- The assessment focuses on significant issues.
- Reasons are given for eliminating issues from further consideration.

Alternatives

- Realistic alternatives of the PPPs are considered and the reasons for choosing them are explained.
- Alternatives include "environmental impact minimum case" and/or "no action" scenarios.
- The environmental impacts (both adverse and beneficial) of each alternative are identified and compared.
- Inconsistencies between the alternatives and other relevant PPPs are identified and explained.
- Reasons are given for selection or elimination of alternatives.

Baseline information

- Relevant aspects of the current state of the environment and their likely evolution without the PPPs are described.
- Environmental characteristics of the areas probably to be significantly affected are described, including areas wider than the physical boundary of the PPPs area where it is likely to be affected by the PPPs plan.

Prediction and evaluation of likely significant environmental impacts

- Both positive and negative impacts are considered, and the duration of impacts (short, medium or long-term) is addressed.
- Likely secondary, cumulative and positive impacts are identified where practicable.
- Multi-relationships among impacts are considered where practicable.
- The prediction and evaluation of impacts are in compliance with relevant applicable standards, regulations, and thresholds

Uncertainties

- Methods used to carry out the SEA are described with explanation on uncertainties (if any).
- Deficiencies in background information or methods are explained.

Mitigation measures

- Measures envisaged preventing, reducing and offsetting any significant adverse impacts of implementing the PPPs are indicated.
- Points to be taken into account in project consents are identified.

SEA Report

- Is clear and concise in its layout and presentation.
- Uses simple, clear language and avoids or explains technical terms.
- Uses maps and other illustrations where appropriate.
- Explains the methodology used.
- Explains who was consulted and what methods of consultation were used.
- Identifies sources of information, including expert judgment and matters of opinion.
- Contains a non-technical summary covering the overall approach to the SEA, the objectives of the PPPs, the main alternatives considered, and any changes to the PPPs resulting from the SEA.
- Technical, procedural and other difficulties encountered are discussed; assumptions and uncertainties are made explicit.

Management of SEA process

- The SEA is carried out as an integral part of the PPPs making process.
- Relevant authorities and the public concerned are consulted in ways and at times which give them an early and effective opportunity within appropriate time frames to express their opinions on the draft PPPs and the SEA Report.

Source: MONRE (2008): General Technical Guideline for Strategic Environmental Assessment

5.5.3 Interim Review of the SEA of the PDP7

(1) Review Checklist

For the interim review of the SEA of the PDP7 draft, the study team prepared the SEA review checklist as follows, based on "Basic Research on Introduction of SEA"(JICA, 2005), the relevant Vietnamese laws and regulations, and the good practices of the development cooperation agencies etc. (for the details of the good practices, please refer to Appendix 3).

Table 5.5-2: SEA Review Checklist Prepared by Study Team

1. Description of the Plan and the Baseline Conditions

1.1 Description of the Plan

- Is the purpose of the plan clear?
- Have the related strategies, policies and plans (e.g. environmental objectives) been reviewed and do they line up with the plan's purpose?

1.2 Baseline Environmental Conditions

- Have current environmental conditions (natural, social and pollution aspects) been described?
- Are there significant data and information deficiencies? How can these be patched up?

2. Identification and Evaluation of Key Impacts

2.1 Scoping

- Are impacts scoped in a systematic and explicit manner to ensure that all relevant issues (e.g. natural, social and pollution) are covered?
- Are the stakeholders consulted in appropriate ways at appropriate times on the scope of the SEA Report?

2.2 Impact Assessment

- Is the methodology of evaluation explained? Are the impacts evaluated quantitatively, when possible?
- Has the impact assessment been implemented, in accordance with the stages of the plan (e.g. Master Plan: IEE (Initial Environmental Examination), Feasibility Study: EIA (Environmental Impact Assessment))
- Are the spatial and temporal extent of the impact, cumulative impact and positive impact described?
- Where there are uncertainties in assessing the impacts and assumptions have been made, have they been explained?

3. Alternatives, Mitigation Measures, Monitoring and Recommendations

3.1 Alternatives

- Are alternatives (Including No-Action and Best Practicable Environmental Option, where appropriate) investigated in accordance with the stage of the plan?
- Are the alternatives evaluated in the natural, social and pollution aspects? Are their reasons given for the selection or elimination of alternatives?
- Are the assumptions and uncertainties in the alternatives explained?
- Are the stakeholders consulted in appropriate ways and at appropriate times on the investigation of the alternatives?

3.2 Mitigation Measures

- Are mitigation measures (Including cost, duration and method, etc.) investigated in accordance with the stages of the plan?

3.3 Monitoring

- Are measures proposed for monitoring, including the responsibilities, schedule and budget etc.?

3.4 Recommendations

- Have the recommendations on natural, social and pollution issues been proposed?
- Are there specific points within the process to develop the plan where the SEA can have influence over decisions or design?

4. Consultation

4.1 Report

- Has the layout of the report enabled the reader to be able to easily and quickly find necessary data and information? Have the external data sources been acknowledged?

- In order to facilitate the readers' understanding of the report's contents, have the table of contents, abbreviations, glossary, list of references and figures been used in the report?
- Has a non-technical summary of the main findings of the report been prepared in the target reader's local language?

4.2 Disclosure

- Has the report been disclosed to the public in a proper way? Has explanation material for the public (e.g. brochure) been prepared?

4.3 Review and Permits

- Has the report been independently reviewed?
- If necessary, has the report been approved by the relevant government authorities?
- If conditions are imposed on the approval of the report, have they been satisfied?

4.4 Consultation

- Have the stakeholders been consulted in appropriate ways and at appropriate times, and how has their opinions affected the plan?
- Does the consultation pay attention to public involvement?
- Does the consultation pay particular attention to certain vulnerable groups or persons, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples?

Source: The TA Team

(2) Outline of the SEA of the PDP7

The SEA of the PDP7 is to be implemented by the SEA team, which consists of international and domestic experts (mainly IE), as follows, and the independent SEA report will be produced (Not a part of the PDP7 report).

As of July 2010, the SEA team has been implementing phase 2, and the results of phases 1 were explained and consulted during the 1st stakeholder consultation workshop held on 12-13 July, 2010.

And the SEA report is planned to be submitted to MONRE late 2010.

Phase 1: Scoping

Phase 2: Data Collection and Baseline Analysis (Ongoing, as of June 2010)

Phase 3: 1st Stakeholder Consultation Workshop (July 2010)

Phase 4: Impact Analysis and Scoring (August – September 2010)

Phase 5: Mitigation Measures and Recommendations (August – September 2010)

Phase 6: 2nd Stakeholder Consultation Workshop (October 2010)

Phase 7: Reflection of the results of the SEA in the PDP7 (October 2010)

Phase 8: Submission of the SEA report to MONRE for review and comments

Also, the SEA of the PDP7 has been supported by the Technical Assistance of Asian Development Bank, and it covers the areas where the Vietnamese side needs support, as follows.

- SEA and Scenarios Analysis
- Social Impact and Development

- Climate Change
- Geographical Information Systems
- Biodiversity and Environmental Assessment

(3) Interim Review Result

The interim review was implemented based on the draft SEA report of the PDP7 (as of June 2010) (please refer to Appendix 3) and discussions with the IE expert.

(a) "1. Description of the Plan and the Baseline Conditions"

- "1.1 Description of the Plan"
  - Review Items
    - Is the purpose of the plan clear?
    - Have the related strategies, policies and plans (e.g. environmental objectives) been reviewed and do they line up with the plan's purpose?
  - Review Results
    - The main purpose of the plan will be described in "1.2.1 Brief summary of PDP7 (p.14)".
    - The consistency with related policies (Master plans of Socio-economic development, infrastructure development and national parks, etc.) will be assessed in "1.2.2 Assess the suitability of policies and national development (p.14-15)".
  - Recommendations
    - The purpose of the plan should be cleared in the "1.2.1 Brief summary of PDP7 (p.14)".
    - The consistency of related policies should be assessed in "1.2.2 Assess the suitability of policies and national development (p.14-15)".

- "1.2 Baseline Environmental Conditions"
  - Review Items
    - Have current environmental conditions (natural, social and pollution aspects) been described?
    - Are there significant data and information deficiencies? How can these be patched up?
  - Review Results

- ✧ The current environmental conditions will be described in "2.1 Current Status of Natural, Environmental and Socio-economic conditions (p.18-20)".
- ✧ The SEA team has been collecting information on the current environmental conditions (as of July 2010). Therefore, significant data and information deficiencies have NOT been confirmed yet.

➢ Recommendations

- ✧ Current environmental conditions should be described in "2.1 Current Status of Natural, Environmental and Socio-economic conditions (p.18-20)".
- ✧ It should be confirmed whether or not there are any significant data and information deficiencies and "how can these be filled" should be explained, if any.

(b) "2. Identification and Evaluation of Key Impacts"

- "2.1 Scoping"

➢ Review Items

- ✧ Are impacts scoped in a systematic and explicit manner to ensure that all relevant issues (e.g. natural, social and pollution) are covered?
- ✧ Are the stakeholders consulted in appropriate ways at appropriate times on the scope of the SEA Report?

➢ Review Results

- ✧ The main environmental impacts of the PDP7 are described in the "Introduction 3.3 Implementation and discussion (p.6-9)" (Table 5.5-3).
- ✧ Based on the primary environmental impacts of the PDP7, the Impact Matrix for each type of development project (hydro power, thermal power, nuclear power, new and renewable energy and transmission lines) has been prepared in order to implement the Initial Environmental Examination (hereinafter referred to as "IEE") of the development projects of the PDP7. The study team reviewed the Impact Matrix referring to international good practices, and added some items to be evaluated (Appendix 3). Further, the study team prepared a list of the Impact Matrix in order to avoid the lack

of evaluation items and show the propriety of the scoping at a glance (Appendix 3).

- ✧ The Impact Matrix will be sent to the provinces (mainly "Department of Natural Resources and Environment" (hereinafter referred to as "DONRE") and "Department of Industry and Trade" (hereinafter referred as "DOIT")), where the development projects of the PDP7 will be located, in order to collect the information and opinions on development projects.
- ✧ The main environmental impacts of the PDP7 were explained and discussed during the 1st stakeholder consultation workshop held on 12-13 July, 2010.

➢ Recommendations

- ✧ Based on the opinions of the Impact Matrix from the provinces and the results of the 1st stakeholder consultation workshop, the main environmental impacts of the PDP7 should be revised, if necessary.

Table 5.5-3: Main Environmental Impacts Identified in the Draft SEA Report of the PDP7

(1) Number of displaced households
(2) Impacts to livelihood
(3) Cultural impacts
(4) Impacts to biodiversity
(5) Impacts to natural resources
(6) Impacts to hydrology
(7) Impacts to climate change
(8) Air pollution
(9) Solid waste
(10) Impacts/ risks from radiation
(11) Landscape and environmental pollution
(12) Impacts to geology

Source: Draft SEA report of the PDP7 (as of June 2010)

- "2.2 Impact Assessment"

➢ Review Items

- ✧ Is the methodology of evaluation explained? Are the impacts evaluated quantitatively, when possible?
- ✧ Has the impact assessment been implemented, in accordance with the stages of the plan (e.g. Master Plan: IEE (Initial Environmental Examination), Feasibility Study: EIA (Environmental Impact Assessment))

- ✧ Are the spatial and temporal extent of the impact, cumulative impact and positive impact described?
- ✧ Where there are uncertainties in assessing the impacts and assumptions have been made, have they been explained?

- ➢ Review Results
  - ✧ The methodology of evaluation has been explained in the "Introduction 3.2. Approach Method (p.4-6)" and "Introduction 3.3. Implementation and Discussion (p.6-11)" (Table 5.5-4, Table 5.5-5).
  - ✧ The impacts of the development projects of the PDP7 will be quantified and their economic value will be calculated as much as possible (phase 4 of Table 5.5-4).
  - ✧ The impacts of the development projects of the PDP7 will be assessed using Geographical Information Systems (hereinafter "GIS"), based on existing information. Therefore, the assessment method is considered to be the equivalent of IEE.
  - ✧ Regarding the spatial extent of the impact, the Zone of direct Impact (e.g. Thermal power: Areas affected by hot waste water and effluent gas, Hydro power: 20m in radius of the project site) (hereinafter referred as "ZOI") will be identified and in addition to the impact in ZOI, the wider indirect impact beyond ZOI will be evaluated (Phase 4 of Table 5.5-4).
  - ✧ Regarding the temporal extent of the impact, there are no descriptions.
  - ✧ Regarding the cumulative impact, alternative scenarios will be rated by totalizing the score of the development projects which comprise the scenarios and compared with each other. (phase 4 of Table 5.5-4).
  - ✧ Regarding the positive impact, "Change in income from agriculture and industry" and "New opportunities for jobs and incomes" will be evaluated (Table 5.5-5).
  - ✧ The uncertainties will be evaluated in "6.2.2 Comments on reliability of applied methodologies (p.33)" and "6.3 Comments on detail and reliability of report (p.33)".

- Recommendations
  - Environmental Impact should be assessed in accordance with the Tables 5.5-4 and 5.5-5.
  - The score criteria of each impact (phase 4 of Table 5.5-4) is a vital part of SEA. Therefore, it should be defined through the consensus-building between the stakeholders.
  - When possible, the duration of the impact (e.g. temporary, several years, several decades, 100 years, 1000 years, over 1000 years) should be considered in the score criteria.
  - Regarding the cumulative impact, the total scores with respect to each region (north, central and south) and fuel types (e.g. Coal. Oil and Gas) of the alternative scenarios should be calculated.
  - The uncertainties should be evaluated in "6.2.2 Comments on reliability of applied methodologies (p.33)" and "6.3 Comments on detail and reliability of report (p.33)".

Table 5.5-4: Methodology of the SEA of the PDP7

Phase 1: Scoping - Set up the SEA team (18 domestic experts (12 from IE and 6 from other organizations) and 3 international experts) as an implementation body of the SEA - Identify the main environmental impacts of the PDP7 (Table 5.5-3) - Select the alternative scenarios (3 Demand-Supply Scenarios (high, base and low demand cases) and 1 Best Environmental Scenario (considering national policies for Energy Efficiency, Renewable Energy and Greenhouse Gas Reduction)) - Define the role and scope of GIS analysis Phase 2: Data Collection and Baseline Analysis - Set up necessary environmental and social indicators for GIS analysis (Table 5.5-5), including the identification of the ZOI (e.g. Thermal power: Areas affected by cooling water and effluent gas, Hydro power: 20km in radius of the project site) - Data collection (based on existing information) - Grasp the current environmental and social condition of the area affected by the development projects (Baseline Analysis) - Preparation of the Impact Matrix for the development projects (hydro, thermal, nuclear, new and renewable and transmission lines) Phase 3: 1st Stakeholder Consultation Workshop - 1st Stakeholder Consultation Workshop (Explanation and Discussion of the results of phase 1 and 2) - Consultation with the Provinces (Sending Impact Matrix to provinces (DONRE and DOIT) where the development projects of the PDP7 will be located, in order to receive information and opinion on the development projects) Phase 4: Impact Analysis and Scoring - Integration of the results of phase 3 into GIS - Using GIS, the positive and negative impacts (Table 5.5-5) of the development projects (including both inside/outside of ZOI) are quantified (e.g. number of displaced households and loss of agricultural area) - Calculate "Economic Value" of the quantified impacts above, as much as possible - The quantified impacts are rated based on the principle of the score criteria below

3 = Major direct negative impacts where mitigation measures are not possible 2 = Major direct negative impacts where mitigation measures are possible 1 = Small, indirect negative impacts 0 = No impacts -1 = Possible positive benefits - Specific score criteria for each impact are defined by the SEA team and the consultation with the stakeholders - Rate the development projects by totalizing the score of each impact and make the environmental priority order list of the development projects (rank the development projects in ascending order in the total score) - Rate the alternative scenarios by totalizing the score of the development projects which comprise the scenarios, and evaluate them comparatively Phase 5: Mitigation Measures and Recommendations - Consider the mitigation measures for the impacts - Consider the recommendations on the PDP7 - Preparation of the draft SEA report Phase 6: 2nd Stakeholder Consultation Workshop - 2nd Stakeholder Consultation Workshop (Explanation and Discussion of the draft SEA report and discussion of the feasibility of the recommendations) Phase 7: Reflection of the results of the SEA in the PDP7 - Results of the SEA is reflected to PDP7 Phase 8: Submission of the SEA report to MONRE for approval - SEA report is completed and submitted to MONRE for approval

Source: Draft SEA report of the PDP7 (as of June 2010)

Table 5.5-5: Environmental and Social Impact Indicators of the SEA of the PDP7

1. Environmental Indicators Investment cost for power development and supply Cost of biodiversity loss: marine ecosystem and forest ecosystem, ecosystem service Degradation in water quality Air pollution and green house gas Cost of damage caused by climate change Cost of environmental mitigation measures 2. Social Indicators Number of displaced household Cost for land use impacts - Impacts to income due to loss of agricultural area - Forest Cost of change in water using purposes Not ensure food safety Lost of income from resources Rise of poverty rate Change in income from agriculture and industry (decrease/increase) Aquacultural value in river and sea (upstream and downstream) Impact to human health caused by air quality New opportunities for jobs and incomes

Source: Draft SEA report of the PDP7 (as of June 2010)

(c) "3. Alternatives, Mitigation Measures, Monitoring and Recommendations"

- "3.1 Alternatives"
  - Review Items
    - Are alternatives (Including No-Action and Best Practicable Environmental Option, where appropriate) investigated in accordance with the stage of the plan?
    - Are the alternatives evaluated in the natural, social and pollution aspects? Are their reasons given for the selection or elimination of alternatives?
    - Are the assumptions and uncertainties in the alternatives explained?
    - Are the stakeholders consulted in appropriate ways and at appropriate times on the investigation of the alternatives?
  - Review Results
    - The future environmental condition without the PDP7 will be forecasted in the "2.2 forecasting change in environmental components (p.20)".
    - The alternative scenarios (3 Demand-Supply scenarios (high, base and low demand) and the Best Environmental Scenario (considering national policies for Energy Efficiency, Renewable Energy and Green House Gas Reduction)) will be evaluated.
    - The alternative scenarios will be evaluated based on the natural, social and pollution indicators (Table 5.5-5).
    - The uncertainties will be evaluated in the "6.2.2 Comments on reliability of applied methodologies (p.33)" and "6.3 Comments on detail and reliability of report (p.33)".
    - The results of the evaluation of the scenarios will be explained and discussed in the 2nd stakeholder consultation workshop.
  - Recommendations
    - Future environmental conditions without the PDP7 should be forecasted in "2.2 Forecasting change in environmental components (p.20)".
    - Alternative scenarios should be evaluated based on the natural, social and pollution indicators (Table 5.5-5).

- ✧ The uncertainties should be evaluated in "6.2.2 Comments on reliability of applied methodologies (p.33)" and "6.3 Comments on detail and reliability of report (p.33)".
- ✧ The results of the 2nd stakeholder consultation workshop should reflect the evaluation of the scenarios.

- "3.2 Mitigation Measures"
  - ➢ Review Items
    - ✧ Are mitigation measures (Including cost, duration and method, etc.) investigated in accordance with the stages of the plan?
  - ➢ Review Results
    - ✧ The mitigation measures will be investigated in "5.1 Suggest Environmental Preventive and Mitigation Measures (p.30)".
  - ➢ Recommendations
    - ✧ The mitigation measures should be investigated in "5.1 Suggest Environmental Prevention and Mitigation Measures (p.30)".
    - ✧ Generally, in the environmental priority order list of the development projects (phase 4 of Table 5.5-4), the priorities of coal thermal power plants and large-scale hydro power plants with resettlement tend to be low. However, the importance of these plants is high for stable electricity supply, and for now, it is difficult to replace them by other means (e.g. electricity import and renewable energy). Further, the reduction of greenhouse gases by large-scale hydro power plants is considerable. Therefore, it is necessary to utilize these plants effectively with mitigation measures such as follows.
    - ✧ Coal thermal power plants: (1)Implementation of adequate mitigation measures for air pollution (e.g. electric precipitation and desulfurization)

      (2)Introduction of high efficiency coal thermal power generation technologies (e.g. USC (Ultra Super Critical), A-USC (Advanced USC) and IGCC (Integrated coal Gasification Combined Cycle)) and adequate operation and maintenance for maintaining high efficiency

      (3)Introduction of economically feasible CCS (CO2 capture and storage) combined with EOR (Enhanced Oil Recovery).
    - ✧ Large-scale hydro power plants with resettlement: Implementation of adequate mitigation measures for resettlement (Avoidance,

Reduction and Compensation) and rearranging the cascade of river to reduce the scale of dams (e.g. divide a large scale dam into some middle-small scale dams)

- "3.3 Monitoring"
  - Review Items
    - ✧ Are measures proposed for monitoring, including the responsibilities, schedule and budget etc.?
  - Review Results
    - ✧ The monitoring measures will be proposed in "5.2 Environmental Management and Monitoring Programme (p.31)".
  - Recommendations
    - ✧ The monitoring measures should be proposed in "5.2 Environmental Management and Monitoring Programme (p.31)".
    - ✧ Monitoring measures of all development projects will be prepared in the EIAs. Therefore, the monitoring plan of the SEA of the PDP7 should include the following items, with a focus on the effectiveness of the SEA and the cumulative impact of the PDP7.
    - ✧ Effectiveness of the SEA: Reflection of the recommendations of the approved PDP7 and the implementation of the mitigation measures
    - ✧ Cumulative Impact of the PDP7: Utilization of the environmental index (e.g. Total CO_2 emission from power sector)

- "3.4 Recommendations"
  - Review Items
    - ✧ Have the recommendations on natural, social and pollution issues been proposed?
    - ✧ Are there specific points within the process to develop the plan where the SEA can have influence over the decisions or the design?
  - Review Results
    - ✧ The recommendations on the natural, social and pollution issues will be proposed in the "Conclusions and Recommendations (p.34)".
    - ✧ The feasibility of the recommendations will be examined via consultation with the stakeholders (especially related governmental agencies) in the 2nd stakeholder consultation workshop.

- In consideration of the results of the 2nd stakeholder consultation workshop, the recommendations of the SEA will be reflected to the PDP7.

- Recommendations
  - The recommendations of natural, social and pollution issues should be proposed in the "Conclusions and Recommendations (p.34)".
  - The feasibility of the recommendations should be examined in the 2nd stakeholder consultation workshop, and the recommendations should be reflected to the PDP7 as appropriate.

(d) "4. Consultation"

- "4.1 Report"
  - Review Items
    - Has the layout of the report enabled the reader to be able to easily and quickly find necessary data and information? Have the external data sources been acknowledged?
    - In order to facilitate the readers' understanding of the report's contents, have the table of contents, abbreviations, glossary, list of references and figures been used in the report?
    - Has a non-technical summary of the main findings of the report been prepared in the target reader's local language?

  - Review Results
    - Since the SEA report has not been completed yet, it is difficult to evaluate the layout etc.
    - According to the "The General Technical Guideline for Strategic Environmental Assessment (MONRE, 2008)", preparation of the non-technical summary is recommended. However, a non-technical summary is not in the works at the moment..

  - Recommendations
    - The layout of the report should enable the reader to be able to easily and quickly find necessary data. External data sources should be acknowledged.
    - In order to facilitate the readers' understanding of the report's contents, a table of contents, abbreviations, glossary, list of references and figures should be used in the report.

    - ✧ The preparation of a non-technical summary should be considered.

- "4.2 Disclosure"
  - ➢ Review Items
    - ✧ Has the report been disclosed to the public in a proper way? Has explanation material for the public (e.g. brochure) been prepared?
  - ➢ Review Results
    - ✧ During the SEA report preparation, the SEA report will be disclosed to the stakeholders such as relevant government agencies. However, it will NOT be disclosed to the public.
    - ✧ According to the IE expert, there are NO rules and regulations regarding the disclosure of SEA reports. However, since approved EIA reports are disclosed to the public in Vietnam, the disclosure of the approved SEA report will be considered.
  - ➢ Recommendations
    - ✧ Disclosure of the approved SEA report to the public should be considered.
    - ✧ In general, the public is less inclined to participate in the PPPs process, because the PPPs are more abstract and there impact is less specific compared to a project and the EIA. However, it is difficult to collect the informations and opinions which possibly affect the PPPs (e.g. Natural Environment (endangered species, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)), Social Environment (resettlement, impacts on culture and lifestyles)), because a SEA is basically implemented based on existing data/documents and limited stakeholders (e.g. local authorities). Therefore, it is important to collect the opinions from the public concerning PPPs (especially vulnerable groups and persons) and have them reflected in the PPPs, when and where appropriate. Therefore, it is desirable to consider a disclosure of a draft of the SEA report to the public and a reception of opinions during the SEA process.

- "4.3 Review and Permits"
  - ➢ Review Items
    - ✧ Has the report been independently reviewed?

    - ✧ If necessary, has the report been approved by the relevant government authorities?
    - ✧ If conditions are imposed on the approval of the report, have they been satisfied?
  - ➢ Review Results
    - ✧ According to the "Law on Environmental Protection", MONRE shall organize an "Appraisal Council" for the SEA report of strategies and plans which are subject to approval by the National Assembly, the Government or the Prime Minister. Submission of the PDP7 SEA report to MONRE is scheduled for late 2010.
  - ➢ Recommendations
    - ✧ The SEA report should be reviewed and approved in accordance with relevant Vietnamese laws and regulations.
    - ✧ If certain conditions are to be met for the approval of the report, they should be satisfied.

- "4.4 Consultation"
  - ➢ Review Items
    - ✧ Have the stakeholders been consulted in appropriate ways and at appropriate times, and how has their opinions affected the plan?
    - ✧ Does the consultation pay attention to public involvement?
    - ✧ Does the consultation pay particular attention to certain vulnerable groups or persons, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples?
  - ➢ Review Results
    - ✧ Consultations have been planned as follows; Stakeholder consultation workshop (twice), Sending the impact matrix to the provinces where the development projects will be located.
    - ✧ In the draft SEA report, there are no descriptions regarding attention being paid to public involvement and vulnerable groups or persons in the consultations.
  - ➢ Recommendations
    - ✧ The consultations with stakeholders should be implemented as planned.
    - ✧ Special consideration should be given to public involvement and vulnerable groups or persons during the consultations.

5.5.4 Conclusions and Recommendations

The interim review was implemented based on the draft SEA report of the PDP7 and the discussion with the IE expert, using the SEA review checklist prepared by the Study Team.

The SEA team has been conducting the SEA, in accordance with the SEA methodology and the contents of the SEA report prepared by the SEA team. As of June 2010, the SEA was in the environmental and social data collection stage. After that, impact assessment, mitigation measures and recommendations etc. will be implemented and the SEA report will be submitted to MONRE late 2010.

As mentioned, since the consideration of the mitigation measures and recommendations etc. (so-called "results of SEA") have NOT been implemented yet, the interim review focused on the propriety of the SEA implementation plan, such as the SEA methodology and the contents of the SEA report. The SEA implementation plan has almost covered the review items of the SEA review checklist prepared by the Study Team, and no major adjustments have been deemed necessary. However, in comparison to the international good practices for SEA etc. there are some points that have been taken into account. Therefore, the SEA should be implemented in consideration of the following recommendations.

IE reported to the TA team that some recommendations in this report will be incorporated into the SEA report because they are very useful.

(1) Mitigation Measures for Coal Thermal Power Plants and Large-Scale Hydro Power Plants

Generally, under the environmental priority order list of the development projects (phase 4 of Table 5.5-4); the priorities of coal thermal power plants and large-scale hydro power plants with resettlement tend to be low. However, the importance of these plants is high for stable electricity supply, and for now, it is difficult to replace them by other means (e.g. electricity import and renewable energy). Further, the reduction of greenhouse gases via large-scale hydro power plants is worth taking into consideration. Therefore, it is necessary to utilize these plants effectively with the following potential mitigation measures:

(a) Coal Thermal Power Plants

- Implementation of adequate mitigation measures for air pollution (e.g. electric precipitation and desulfurization)
- Introduction of high efficiency coal thermal power generation technologies (e.g. USC, A-USC and IGCC) and adequate operation and maintenance for maintaining high efficiency
- Introduction of economically feasible CCS combined with EOR.

(b) Large-Scale Hydro Power plants with Resettlement

Implementation of adequate mitigation measures for resettlement (Avoidance, Reduction and Compensation) and rearranging a cascade of river to reduce the scale of the dams (e.g. divide a large scale dam into some middle-small scale dams).

(2) Monitoring Measures

Monitoring measures for each development project will be prepared in the EIAs. Therefore, the monitoring plan of the SEA of the PDP7 should include the following items, with a focus on the effectiveness of the SEA and the cumulative impact of the PDP7.

(a) Effectiveness of the SEA

Reflection of the recommendations in the approved PDP7 and the implementation of the mitigation measures

(b) Cumulative Impact of the PDP7

Utilization of the environmental index (e.g. Total CO_2 emission from power sector)

(3) Disclosure to the Public

In general, the public is less inclined to participate in the PPPs process, because PPPs are more abstract and their impact is less pronounced in comparison to a project and EIA. However, it is difficult to collect information and opinions which possibly affect the PPPs (e.g. Natural Environment (endangered species, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)), Social Environment (resettlement, impacts on culture and lifestyles)), because a SEA is basically implemented based on existing data/documents and limited stakeholders (e.g. local authorities). Therefore, it is important to collect the opinions from the public concerning PPPs (especially vulnerable groups and persons) and have them reflected in the PPPs, where appropriate. Therefore, it is desirable to consider a disclosure of the draft SEA report to the public and proactively receive opinions during the SEA process.

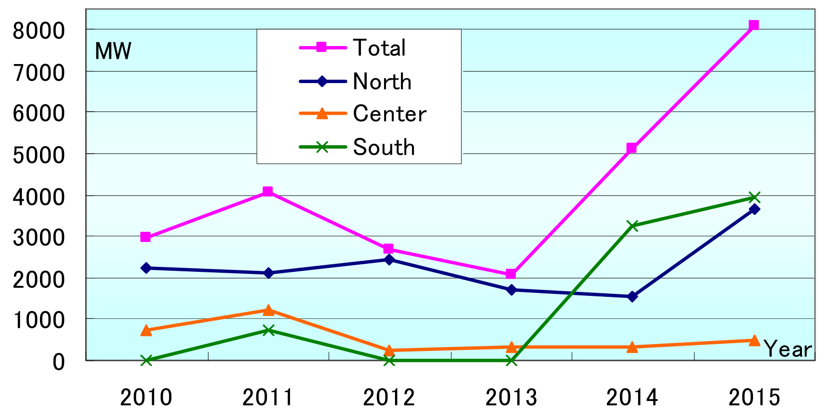
5.6 Information on Investment in Candidate Projects

At present, the IE is creating PDP7 under the direction of MOIT. Although some progress has been made with the power supply plan, since the demand estimate has not yet been decided, it has not yet resulted in a decision. However, the formulation of a system plan for which a draft is shown is called for inside. The candidate project described below is created based on the draft in IE. Therefore, the schedule might be able to change.

5.6.1 Development Plan of the Candidate Project by 2010 to 2015

The 2010 to 2015 candidate projects were created via the following methods.

- Assessment of the status of the construction of power plants according to the announcement of meetings of the State Steering Committee on PDP VI.
- EVN's reports on the status of the plan implementation and the work tasks for the months in 2009.
- Information concerning the progress of power plant construction within the EVN and outside the power sector which contains updated data serving the preparation of the PDP VII.



Source: IE (as of June 2010)

Figure 5.6-1: Scheduled Power Generation Capacity According to Area

The total capacity to be put into operation during the period 2011- 2015 was 24,964 MW, an average of over 4,160 MW/year. However, during the four years of 2010-2013, only about 11,753 MW will be put into operation, an average of 2,938 MW/year. In the meantime, the demand will continue to grow and a risk of delay will exist. Therefore, it is predicted that the electric power will be tight.

The aforementioned Figure indicated that during the four year 2010-2013, in the northern part it will be put into comparatively stable operations, meanwhile in the northern part there will be only 720 MW (Nhon Trach 2) added and during the beginning of mission of the plant being carried out in the south, there will be only 480 MW added

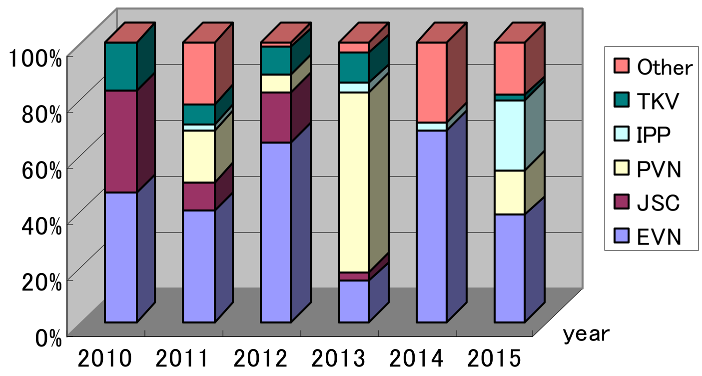
5.6.2 Schedule and Investor of the Candidate Project by 2010 to 2015

About the investor of the projects, it turns out that EVN has a 50.6% share. Especially, since this portion will increase to over 60% in 2012 and 2014, it can be said that EVN is the primary investor of Electric Power Development in Vietnam. Further, the yearly investment situation is depicted in Fig. 5.6-2. As an independent business entity, the rate of PVN is large and is scheduling to invest 1325 MW in 2013, which would be a 64% stake for the year. Moreover, although the rate of JSC is comparatively high till 2012, it turns out that the rate of IPP becomes high up until and even after the year 2013. If the deregulation of Vietnam proceeds smoothly, it is predicted that many future IPPs will be added to the development.

EVN, PVN, IPP and etc. are players (investors and developers) in the power generation market. There is no clear division of roles between the EVN, PVN, IPP and etc. in generation. While the EVN is a monopoly for big hydropower development and nuclear power and EVN has an exclusive role for development.

For the promotion of IPP in the future, the reform of regulation, policies and administration is required. Further, in order to prevent the delay of project implementation, mechanisms for controlling and ensuring adherence to the schedule of IPP projects is required.

The candidate project and investor details from 2010 to 2015 are shown in tables 5.6-2-5.6-3 by year.



Source: IE (as of June 2010)

Figure 5.6-2: Scheduled Power Generation Capacity According to Investors

Table 5.6-1: Schedule of the Operating Project (FY2010)

No.	Name of power plant	Capacity (MW)	Schedule in PDP VI	Developer
	Operation in 2010	**2962**		
1	HPP Sơn La #1	400	2010	EVN
2	HPP Cua Dat	97	2009	Cua Dat Hydropower JSC
3	HPP Ban Ve	300	2009	EVN
5	HPP Srepok 3	220	2100	EVN
6	HPP Se San 4 #3	120	2010	EVN
7	HPP Song Tranh 2 #1	95	2010	EVN
8	HPP Preikrong #2	50	2010	EVN
9	HPP Dong Nai 3#1&2	180	2009	EVN
10	TPP than Son Dong	220	2008	TKV
11	TPP Hai Phong I #1	300	2009	Hai Phong Thermal Power JSC
12	TPP Cam Pha I	300	2009	TKV
12	TPP Quang Ninh I	600	2009	Quang Ninh Thermal Power JSC
13	HPP Sre Pok 4	80	2012	Dai Hai JSC

Source: IE

Table 5.6-2: Schedule of the Operating Project (FY2011)

No.	Name of power plant	Capacity (MW)	Schedule in PDP VI	Developer
	Operation in 2011	**4062**		
1	Sơn La #2,3	800	2011	EVN
2	HPP Nam Chien	200	2011	Song Da Corporation
3	HPP Nho Que 3	110	2013	CTCP Bitexco
4	HPP Na Le (Bac Ha)	90	2010	LICOGI/IPP
5	HPP Khe Bo #1	50	2011	Power JSC
6	HPP Song Tranh 2 #2	95	2010	EVN
7	HPP An Khe #2	80	2008	EVN
8	HPP Se San 4a	63	2010	Se San 4a Hydropower JSC
9	HPP Dak My 4	190	2011	IDICO
10	HPP Se Kaman 3	250	2010	CTCP Viet Laos
11	HPP DakR tih	144	2010	Construction Corporation No.1
12	HPP Dong Nai 4	340	2010	EVN
13	TPP Hai Phong I #2	300	2009	Hai Phong Thermal Power JSC
14	TPP Cam Pha II	300	2009	TKV
15	TPP Quang Ninh II #1	300	2009	EVN
16	Nhon Trach 2	750	2011	PVN

Source: IE

Table 5.6-3: Schedule of the Operating Project (FY2012)

No.	Name of power plant	Capacity (MW)	Schedule in PDP VI	Developer
	Operation in 2012	**2670**		
1	Sơn La #4,5,6	1200	2012	EVN
2	HPP Ban Chat	220	2011	EVN
3	HPP Hua Na	180	2012	PVN
4	HPP Khe Bo #2	50	2011	Power JSC
5	HPP A Luoi	170	2011	Central region power JSC
7	TPP Nong Son	30	2009	TKV
6	TPPMao Khe #1	220	2009-2010	TKV
8	TPP Uong Bi MR #2	300	2011	EVN
9	TPP Quang Ninh II #2	300	2009	Quang Ninh Thermal Power JSC

Source: IE

Table 5.6-4: Schedule of the Operating Project (FY2013)

No.	Name of power plant	Capacity (MW)	Schedule in PDP VI	Developer
	Operation in 2013	**2059**		
1	HPP Ba Thuoc II	80	-	-
2	HPP Sre Pok 4a	64	-	Dai Hai JSC
3	HPP Dak Rinh	125	2011	PVN
4	HPP Dong Nai 2	70	2012	IPP
5	Hai Phong 2 #1	300	2009-2010	EVN
6	TPP Mạo Khe #2	220	2009-2010	TKV
7	TPP Vung Ang I	1200	2010	PVN

Source: IE

Table 5.6-5: Schedule of the Operating Project (FY2014)

No.	Name of power plant	Capacity (MW)	Schedule in PDP VI	Developer
	Operation in 2014	**5135**		
1	Huoi Quang	520	2012	EVN
2	Ba Thuoc I	40	-	-
3	Nam Mo (Lao)	95	2012	IPP
4	Se Ka man 1 (Lao)	290	2012	CTCP Viet Laos
5	TPP Hai Phong 2 #2	300	2009-2010	EVN
6	TPP Nghi Son 1	600	2011-2012	EVN
7	TPP Luc Nam #1	50	-	IPP
8	TPP Vinh Tan 2	1200	2013-2014	EVN
9	Duyen Hai (Tra Vinh) 1 #1	600	2012-2013	EVN
10	TPP O Mon I #2	300	2010	EVN
11	Hiep Phuoc 2 #1 (CCGT)	390	-	Hiep Phuoc PC (de nghi)
12	O Mon III (CCGT)	750	2014	EVN

Source: IE

Table 5.6-6: Schedule of the Operating Project (FY2015)

No.	Name of power plant	Capacity (MW)	Schedule in PDP VI	Developer
	Operation in 2015	**8076**		
1	Trung Sơn	250	2012	EVN
2	Thuong Kon tum	220	2013	CP VS-S.Hinh
3	Song Bung 4	156	2012	EVN
4	Song Bung 2	100	2013	EVN
5	Dong Nai 5	140	2012	TKV
6	Mong Duong 1	1000	2011-2012	EVN
7	Mong Duong 2	1200	2011-2012	AES (BOT)
8	Hai Duong #1	600	-	Jak Behad (BOT)
9	Thai Binh II #1	600	-	PVN
10	Vih Tan 1	1200	2011	CSG (BOT)
11	O Mon IV (CCGT)	750	2014	EVN
12	Duyen Hai (Tra Vinh) 1 #2	600	2012-2013	EVN
13	TPP Long Phu 1 #1	600	2013-2014	PVN
14	TPP Van Phong #1	660	-	Sumitomo(BOT)

Source: IE

Chapter 6 Analysis of Risk Factors Related to Power Development Planning

6.1 Risk Factors on Primary Energy and Power Tariffs

The increase of coal prices in Vietnam continues in concert with the globalization of energy market. In 2010, the coal price for power plants in Vietnam is $30/ton. However, the same quality coal price in international markets is $60/ton. The current coal price in the domestic market is lower than international coal prices. The following situations can be considered in the future.

- Power tariffs in Vietnam will be increased in concert with domestic coal prices.
- Coal fired power plants are planned in the southern region in Vietnam. The coal is imported from somewhere. At that time, as the coal price is the international market coal price, the power tariff is higher than the domestic power generation cost. Such high tariffs will impact industrial power tariffs from EVN.
- The current low power tariffs from EVN are sometimes lower than the generation costs of the power system supplied by EVN. It is unclear how many years this uneconomical phenomenon will continue.

When considering the aforementioned situation in Vietnam, it can be considered that the EVN power tariffs will moderately increase in the near future. At the same time, the power consumers will make efforts towards energy conservation and energy conversion from power to other energies.

6.2 Risk Analysis Regarding the Development of Power Network System

Risk factors regarding the development of the power network system can be summarized as follows.

- The shortage of the capacities of the transmission lines and substations due to unexpected power demands.
- Transmission lines and substations delays due to lack of investment and issues regarding its management
- Construction delays due to land acquisition issues

The construction delay of the transmission lines and substations in the bulk power can be tentatively alleviated by operating the switching of loads although the reliability of the power supply may be undermined because the power network system is normally constructed so as to cover the power supply even if a single unit of transformers or a single circuit of transmission lines dropped. However, if the duration and the areas of delay in construction are expanded, risks leading to a large power supply interruption may occur.

Thus, the following points should be noticed.

- The power network system should be planned and constructed in consideration of N-1 criteria. It should be also noticed that the redundancy of the capacity of transmission lines can not only maintain the high power supply reliability level but also reduce the power loss in the transmission lines and sometimes cost quite effectively.
- Land acquisition negotiations should be started earlier with a sure grasp of the points of the issues

6.3 Power Shortage Prevention when Plants for Base Power Sources are Delayed

Nuclear power plants are used for base power sources. Reservoir type hydropower stations, coal and other fuel-fired power plants and importing power energy from foreign countries are considered as alternatives for the nuclear power plants from the viewpoints of the roles of base power sources. However, the amount of the development of the reservoir type hydropower stations will reach a limit in Vietnam and there is uncertainty regarding the development of hydropower sources in the neighboring countries of China, Laos and Cambodia. Therefore, the options may be narrowed to ensure a considerable amount of the coal and other fuel thermal power stations as countermeasures against power shortages due to the delay of the development of nuclear power stations. On the other hand, if all of the power shortage due to the delay of the nuclear power plants were covered only by the coal thermal power plants, the coal thermal power plants would share 60 -70 % of the power generation in the southern region of Vietnam and it would increase the risk that fuel supply reliability would be undermined owing to much depending upon a single type of fuels. Thus, although the new sites for thermal power plants are needed, it would be desirable to study the adoption of not only the coal but also other fuels including LNG for the thermal power plants in preparation for the delay of the nuclear power plants.

The parallel development of multiple sites while increasing the number of their power units in accordance with the increase in power demand would be effective countermeasures against the delay of nuclear power plants as it would be easy to advance the commissioning years of the portion of the coal thermal power plants in the southern area of Vietnam in 2020 to 2030.

6.4 Risk Factors and their Countermeasures

The risk factors regarding power system development described in this section and 2.4.2 may cause the delay of the implementation of projects in the future. The methods of avoiding delay and preventing power supply interruptions have been considered as follows.

- Avoiding scattered investment and focusing on urgent projects
- Selecting/promoting the project cannot be delayed under any circumstances
- Carefully checking the regional power demand forecasts over the next five years
- The developers engaged in delayed but important projects being changed if necessary
- Issues such as fund raising or land acquisitions being solved in cooperation among the ministries and the power sector

Chapter 7 Lesson Learned and Recommendation for Further Support in the Same Field

7.1 Lesson Learned and Recommendation to Vietnam's Counterpart

7.1.1 Power Demand Forecasting

(1) Power Demand and Energy Demand

Electricity is one of the energies that include noncommercial energies. Therefore, when companies forecast future power demand, electricity also has to be accounted for. Further, the power ratio among the energies is always testified to during the targeted years.

(2) About Power Demand Growth Rate from 2010 to 2015

The biggest difference between the IE and JICA is the growth rate between 2010 and 2015 with the IE at 14.2% and JICA at 12.2%. Due to the business depression which occurred from 2009 to 2010, there is the possibility that Vietnam's economy may recover rapidly during the latter half of 2010. Power demand is also expected to increase rapidly. Under these conditions, as large scale projects are promoted strongly, JICA power demand forecasts will be adjusted upward.

(3) About Industrial Energy Intensity to GDP

The industrial total energy intensity to the GDP increases from 2010 to 2015. However, the Japanese energy intensity within the Industrial sector relatively is lower than the estimated industrial intensity in Vietnam. Under the JICA model, the effects of energy conservation within the industry sector appeared from 2015. Therefore, energy intensity in the Industry sector was on an upward swing until 2015. Further, as an additional condition, the power ratio of the industry sector increased from 2010 to 2030.

(4) Energy Demand in Residential Sector

Current total energy demand in the Residential sector rose 1.8% from 2010 to 2020, actually a higher growth rate of around 2% during those years would be more accurate. Based on this model, residential energy demand increased by 2.4% from 2010 to 2030, which is the reason why the growth rate of commercial energy for residential usage has increased more rapidly than the decline of noncommercial energies.

(5) Economic Outlook

When looking at SED2020, the analysis of the past economic trends is sufficient. However the economic forecasting methods are not clear. IE is utilizing some forecasting tools for analyzing energy consumption and forecasting energy demand. The authorities in charge of the economic outlook have to introduce various kinds of economic analysis, forecasting tools and software.

(6) Energy Mix and New Resources for Power

Currently, energy business persons and energy experts have some idea of the new energies for future energy mix which comprise Geothermal power plants, Solar heater thermal plants, Coal gasification plants, CBM utilization, CNG utilization, Hydro-methane utilization, Shale gas utilization and so on. Currently, it is well known that Vietnam energy authorities are studying the basics regarding Nuclear power plants, However, this is one of them that should be discussed by the energy authorities. In “Renewable energy master plan”, the aforementioned new technologies and new energies should be under discussion. In order to ensure Vietnam’s energy security, it is necessary that energy diversification be discussed in the future.

7.1.2 Power Network System Plan

IE has basic skills required for carrying out power system analysis and recognizes the importance of establishing criteria for power system planning. It is recommended that IE take notice of the following technical issues through the works with the power system analysis and power system planning.

(1) Countermeasure against Increase in Fault Currents

The fault current values increase in areas of high power demand density. The countermeasures against these fault currents have to be planned from the perspective of new methodologies because they would have emerged from the different system characteristics of the power system that was not experienced when the system didn’t have so many fault currents. The operation of dividing the power system into a 230 kV or a 500 kV system at certain degrees can be observed in many places throughout the world as the power system configuration to supply power to those areas with high power demand densities. These can be considered to be effective countermeasures for the system in Ho Chi Minh City and Hanoi City. On the other hand, it is feared that the voltage drops or weak power supply reliabilities occur in the event of a fault occurring at a transformer or a circuit. The countermeasures for those issues shall also be examined in the light of a comparison of several cases.

(2) Study of Power System Stability

The stability of the power network system of Vietnam should be carefully studied in light of the further expansion of the international interconnections and the domestic bulk power system along with the long power network with 1,500 km in Vietnam. Especially, given that the low frequency of the long term oscillation of power generator angles would occur in this kind of system. The installation of the PSS (power system stabilizer) is an effective way to suppress this oscillation by putting the signals for damping in the generator's exciters. It is recommended that the tuning parameters and the suitable locations for this installation be studied.

(3) Losses of Power Transmission Lines and Distribution Systems

The comparison of UHV and the 500 kV systems could serve to clarify that the costs of transmission line losses in Vietnam were relatively high because of the low cost of the power network system facilities in comparison with the cases in Japan. Thus, there is a high possibility of an effective power network loss reduction occurring by revising the conductor specifications applied to power transmission lines and distribution system such as applying the large size conductors. It is recommended that the methodologies for loss reduction be studied.

(4) Overvoltage Analyses for Underground Cables

JICA TA Team gave a presentation regarding overvoltage studies on underground transmission systems. It was because these studies were considered necessary to the plans for a 500 kV underground substation in Ho Chi Minh City and 500 kV cables to transmit power to the substation in the first place, but the PDP7 does not include any 500 kV underground substations and 500 kV underground cable systems as of its drafting stage. Meanwhile, 220 kV cable systems will expand in the future. The knowledge and skill level of the contents introduced at this presentation were quite high and cannot be transmitted in a didactic manner. These knowledge and skills will be effectively transferred via technical supports for specific feasibility studies, such as a long 220 kV underground cable plan.

(5) Studies for Voltage Support and Voltage Stability

When the JICA TA Team gave a presentation about the 1987 system collapse which occurred at Tepco due to voltage instability, the IE members appeared very interested and seemed to recognize voltage stability as a very important issue. They were already aware of a low-voltage problem at the tail ends of the system under the condition of a radial configuration, and were thinking that some countermeasures would have to be applied in order to solve this problem. Given their awareness of the importance of the issue, it is expected that the IE would be able to independently solve the voltage problem which occurs due to the shortage of reactive power Nevertheless, providing technical support based on experiences in Japan will help a great deal to solve the problem. On the other hand, problems that arise especially those due to excess reactive power, which may be caused by long underground cables is to be expected in the future and should be studied thoroughly when necessary.

(6) The Study of the Plan and its Implementation regarding the Power Transmission from the Southeastern Part of Vietnam to Ho Chi Min City

As described in Chapter 4, it is necessary to study the higher voltage levels and compare them with 500 kV as a more effective way of power transmission from the southeastern part of Vietnam with the amount of power generation to Ho Chi Min City because the large system loss and the large number of circuits are to be expected if the 500 kV power transmission system that has been adopted for the power system of Vietnam as the highest voltage levels is applied.

(7) The Smart Grid

It is believed that the distribution network of Vietnam has a high loss rate on the whole and the quantity of the power line facilities insufficient, therefore it is in poor condition.

In order to point to the smart grid and power distribution automation, fundamental conditions, such as enough power line facilities which can be changed in the event of accidents, the sufficient capacity of power lines and transformers, the correct information of customer and the progress of the data management of power line facilities, have to be required.

Therefore, in order to investigate the installation of the smart grid system, it is necessary to check the conditions of the distribution network, the formation of the distribution network, the availability factor of the power line facilities and the conditions of management for the power line facilities, and to examine whether it is fully acceptable to install an efficient system such as the smart grid and power distribution automation.

Moreover, it is necessary to check the conditions of the installation of the generator for private use and the needs of the installation of renewable energy and an efficient system in an industrial complex, and to examine an applicable system regarding application to the distribution network in an industrial complex.

7.2 Lesson Learned and Recommendation to JICA

7.2.1 Merits and Demerits of the Partial Assistance/Supports

In the previous PDP6, the JICA TA team provided the counterparts with full support in the areas of the power demand forecast, power generation planning, power network system planning, environmental and social considerations and economic and financial analysis.

In this PDP7, the IE made plans and the JICA TA team focused on the supports in the areas of power demand forecasts and the power network system planning.

The demerit was that the loss of the supporting procedures that occurred via duplicated studies that had to be carried out base on the revised data and information after conducting the study based on the tentative presumption because some of the data and information could not be obtained on time and the schedule of providing the technical support and the planning procedure did not always match.

It was difficulty to obtain information about the whole planning works during a short period of time. This served to limit the contents of the technical support to a certain degree.

The merits were that the necessary technical supports could be offered in a short time and that the burden of the counterparts to accept the support was considered not heavy.

7.2.2 Recommendations

(1) Policy/Upper Level Planning

One of the issues regarding the energy policy of Vietnam is the current status which depends too much on power electricity. The establishment of an optimum energy mix of fuels such as coal, oil, gas and electricity in Vietnam from a long term viewpoint is required. IE placed importance on its study and requested technical cooperation on the optimum energy mix study during this TA project. Although this kind of study can be categorized under the “Energy Master Plan in Vietnam”, IE seemed to expect the project to be in the form of TA.

(2) Power Generation

PDP7 clarifies the massive introduction of renewable energy power plants, confirmation of the specific location of nuclear power plants, some of the large thermal power plants and pumped storage hydro power plants with the revision of the route of interconnections and the amount of imported energy. IE has been using the PDPATII software that was developed by TEPCO and transferred to IE through JICA projects to analyze the power demand supply balancing to make power generation plans. IE requested the new version of PDPATII. It can be considered that IE will still have to utilize the power demand supply balancing simulation software such as PDPATII to reflect the introduction of renewable energy or the revision of the power trade plans through interconnections as mentioned above in order to make power generation plans. The continuous support will be required by the technical transfer regarding the optimal power generation plans responding to a change in the circumstances.

Although the delay issues connected to the implementation of the power generation projects are almost the issues after completion of their plans, the TA, concerning the way to avoid the risk factors by reviewing the planning can be considered such as selecting earlier multiple developing sites and reconsidering the risks by lowering the power outputs of the hydropower plants and renewable energy.