Institute of Energy, Ministry of Industry and Trade, Vietnam

Technical Assistance for Power Development Plan 7 in Vietnam

FINAL REPORT
（Summary）

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JAPAN INTERNATIONAL COOPERATION AGENCY
Tokyo Electric Power Company, Inc.

S-1 Background and Objective of the Technical Assistance

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, on the "Master Plan on Pumped Storage Power Project and Optimization for Peaking Power Generation in Vietnam" 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 PDP7, requested JICA to dispatch Experts with expertise in power demand forecasting and power system planning.

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

S-2 Review of PDP6

Review of the Socioeconomic Outlook in PDP6

(1) Economic Development in the Period 1991-2008

The average Gross Domestic Product (GDP) growth rate was 8.2% during the period of 1991-1995, 7.0% in 1996-2000, 6.2% due to the world financial crisis in 2008, and below 8% throughout the period between 2001 and 2008 as a whole. The average income per capita in 2008 was estimated as being 1,062 USD (as stated in U.S. dollars for that year) per capita, equal to about 10 times that amount in 1990. Exports in 2008 accounted 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 was equivalent to 2.5-3.5 times the GDP growth rate. The share of Foreign Direct Investment (FDI) within the GDP increased from 2% in 1992 to 13.3% in 2008. The committed amount of ODA loans was more than 3.5 billion USD per year over 8 years. The economic recession and low economic growth rate from 2009 in Vietnam resulted from a limited movement in structural reform as a whole; a slow promotion of reform in administration and management reform; inefficient operations and a delay in the reform of economic entities in terms of globalization and the facilitation of economic international markets; delays in structural reforms for the electric power industry; poor improvement in terms of economic and international competitiveness.

(2) Economic Growth by Sector

- Agriculture, Forestry, and Fishery
  Advanced large scale cultivation method is slow in application and not sustainable. Rural infrastructure doesn't meet the requirements needed to achieve rural industrialization and modernization.
- Industry
  Although the growth rate is high, the effect of the whole sector has not improved. Advanced technologies in the secondary industry account for a small share, with the slow speed of technology renovation. So far, there has been no integration between the processing industry and the raw material industry. The industrialization of agriculture, formulation of the roadmap, or structural reform plan in rural areas has not been achieved so far.

- Commercial & Services

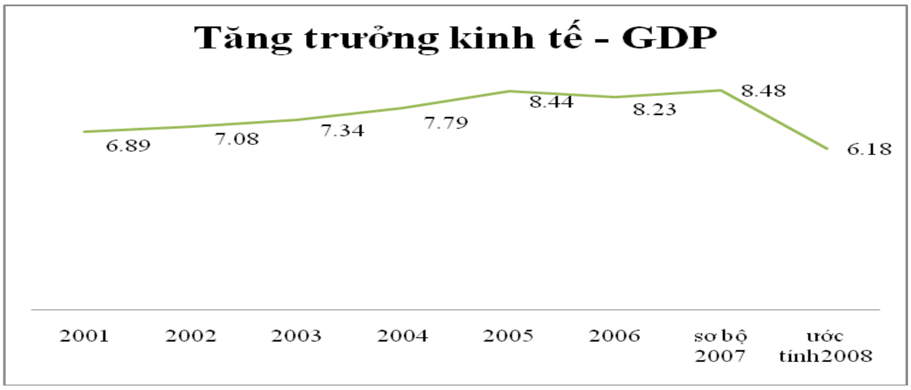
  The growth rate of the Commercial & service sector exceeds the planned target, but still lower than the inherent development potential; the share of Commercial & Services in the GDP and the effectiveness of the secctor are not high.

(3) Anticipated Economic Structure Changing

- Compliance to the process of sector structure change via development master plans, strategies, and roadmaps has yet to be conducted. In general, structural changes over the past five years has been slow and partially oriented by sector and local development plans.
- In economic structure change, attention is mainly paid to the increase of the share of industry and services in the GDP, but not enough attention has been paid to the requirements of structural change in the direction of modernization, development of technologies and advanced techniques in all the sectors.
- Although the processing and assembly industries use relatively advanced technologies, the speed of technological innovation in many industrial sectors is slow and at an average level.
- The services system for the support of industry is weak, insufficient and less effective. The share of comprehensive services in the GDP is low and improvements normally proceed at a snaillike pace. The service sector is low cost, but the speed of development is too slow to meet demands.

Table S2-1: 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: "Review of Implementation of Power Development Plan VI", IE, April 2010

Figure S2-1: Procedures of Building PDP7 Model

Review of Power Demand Forecast

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

- 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 the actual value is PDP6=92.8 TWh, Actual=87 TWh, 6.3%) in 2009.
- EVN carried out peak cuts due to delays in the power generation development schedule.
- The main problems behind why the PDP6 was not implemented completely are the World financial crisis coupled with high crude oil prices. In fact, Vietnamese power demands in 2009 and 2010 were lower than PDP6 forecasts.

Review of Power Development Plan

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 9,657 MW. Table S2-2 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 planned power outputs resulting in only 70 % of the planned value on average.

Table S2-2: 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

Power Network System Plan

Table S2-3 shows the amounts of power network system facilities in 2000, 2005 and 2008. The total circuit length of the transmission lines in 2008 were 1,701 km and the total capacity of the substations was 18,639 MVA.

Table S2-4 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 the substations that were scheduled to be completed in 2010 on PDP6 reached just only 50 % of the original plan and many projects were delayed one to three years.

Table S2-3: Amounts of Power Network System Facilities in 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

Table S2-4: 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

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 these cases concerning the construction of power plants.

- Lack of capital funds
- The investment into transmission lines and substations 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 regards to land acquisition and compensation. There is a lack of coordination among the power sectors and

relevant persons especially in the large cities. (For example, insufficient coordination among the sectors makes procedures difficult while the leader politically agreed to it.)

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

- Too many ambitious plans in the PDP6
- Lack of Vietnamese authorities funds
- 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 southern region (including weather conditions)
- Raised the cost for resettlement (for the construction of hydropower stations)

PDP6 has been delayed due to the world economic recession, capital fund shortage and the shortage of constructors. The important points for creating PDP7 are as follows.

- The biggest negative factor in the PDP7 is the shortage of capital funds as well as PDP6. In the case of the PDP6, the fund shortage is pointed out at the start 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 utilizing the BOT and BOO finance system.
- The power tariffs in Vietnam are lower than those of 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 in the near future that the 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 power balance in considering energy and power conservation. Concretely, energy efficiency and conservation (EE&C), demand side management (DSM) and the Regional well balance of 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 make PDP7 in considering the regional power balance including power demand from industrial parks and large scale commercial facilities in the whole country.

- High growth power demand in the residential sector in PDP7 has also been forecasted. However, the demand forecast is real when compared to PDP6. When considering the government situation, the 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 a bottleneck of their economic growth. Therefore the Japanese supports need more effort to be implemented "Just in time".

S-3 Evaluation of the Current Power Demand Forecasts

Social Economic Outlook from 2010 to 2030

The economic gap with China and 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 cannot be eliminated easily. With regards to the long-term economic outlook of SCENARIOS OF ECONOMIC DEVELOPMENT FOR THE PERIOD UP TO 2020 AND ONWARDS （SED2020）[1], it is assumed that around an 8.0% economic growth rate will continue until 2030.

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.

Survey on Primary Development Plan

(1) Large-Scale Facility Development Plan

New industrial park development plan up to 2020 is as follows:

- 2010-2015 92sites Total area: 84,000-85,000 ha
- 2016-2020 108sites Total area: 130,000-131,000 ha

The commercial facility development plan of 29 sites by 2015 and the resort facility development plan of 17 sites by 2016 have been announced. 70 golf courses have been planned to be approved by 2020. The target plan of railway development by 2020 is as follows:

- Train Engine 1,100-1,200 units
- Train Car 50,000-53,000 units
- Ratio of Transportation of Passenger by Train 20%
- Ratio of Transportation of Cargo by Train 14%

[1] SED2020 was made by the staff of the related ministries such as the Development Strategy Institute for promoting the economic development of Vietnam. Although it has not been approved by the government, it is considered to be one of the primary long term plans in Vietnam where no other long term economic plans have officially been approved by the government.

The port development plan has been summarized as follows:

● 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

As for the adjustment of the airport development plan, an expansion of 10 international airports by 2025 has been approved. As for the road development, 13,168 km of new road construction is in the works.

(2) Power Demand Forecasting of Large-Scale Facilities

The power consumptions per unit scales will be estimated based on a variety of information sources. These values have been defined as “the power demand index”. Multiplying the scale of the planned facility by the power demand index gives the power demand from that facility. The power consumption for each year was estimated based on a particular year by either interpolation or extrapolation due to unavailable data for every year excepting 2015 and 2020. As for the power demand for industrial parks, the data in the report, “Survey of Large scale development projects in Vietnam”, was utilized.

Methodologies and Structures used in Power Demand Model

(1) Direct Method and Indirect Method

- Direct method can be kept consistent between the power demand and socio-economic activities. It is useful for associating input with output, and for measuring the political measurement after implementing it. Direct methods are more suitable for short term forecasting. However, it is not easy to change current trends by utilizing suitable factors for long term forecasting.
- The Econometric model is one of the indirect methods. It is possible to conduct short term and long term forecasting logically and conceptually by utilizing the model. Model building tools, economic theory and statistical technology are required in order to build econometric models. Further, much time must be invested in order to nurture highly-skilled model building professionals.

(2) Technical Comments for Building Demand Forecasting Model

(a) Functions of the Model to be Discussed Prior to Making Future Power Demand

- Economic activities and power demand are inextricably linked to each other or not.
- If power tariffs by sector are to be applied to consumers, power demand forecasts per sector must be prepared.
- The model can analyze the relation between power demand and power tariffs.
- Power demand is determined based on economic activity, energy conservation (power saving activities, technology improvement and efficiency of electric appliances).
- Whether the power ratio (conversion from other forms of energy to electric power) is effective or not.
- Regional indicators such as investments, GDP, GDP per capita and the population in the region are prepared.

(b) Technical Comments Regarding the Model for PDP7

- Whether the partial test using statistic values from the output of regression analysis is conducted or not.
- Whether the demand is forecasted by sectors (Agriculture, Industry, Commercial, Residential and Other sectors) or not.
- Whether the initial values are changed exogenously by power tariff, energy conservation and power ratio or not.
- The setting of High, Base and Low cases should be distinguished by the difference of the exogenous variables.

(c) Technical Comments for Power Elasticity

- The elasticity has to be changed to become gradually small when the elasticity level given is bigger than ‘1’. Care must be taken when the elasticity level exceeds 1.0.
- Generally speaking, power elasticity to the GDP growth rate will change from 0.8 to 1.0 when the developing countries achieve a high stage in their economic growth.

- It is possible to compare the growth rate to other economic indicators, other energy demands, past growth rates and so on.

(d) Technical Comments for Price Elasticity

- Price elasticity can be used to assess whether the demand connected to tax and price increases is falling or not.
- Price elasticity may differ depending on the cases and the price increases and/or decreases.
- When demand is perfectly inelastic, consumers have no alternative but to purchase the goods or services if the of the price increases. From a consumer perspective, electricity is perfectly inelastic.
- When demand is perfectly elastic, consumers have an infinite ability to switch to other alternatives if the price increases.
- In the event of inelastic products, increased costs are absorbed by consumers.

(e) Judgment Criteria for Power Demand Forecasting Model

When the Multi regression method is utilized 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 of the total energy consumption

Base Concept for PDP7 Model Building

(1) Sectoral Approach

- In the JICA model for PDP7, power demand is calculated based on the GDP intensity and GDP trend. However energy intensity excepting non-commercial energy is used for the residential sector. (Number of households in Urban area is used as an explanation variable)
- The GDP growth rate is not so much higher than the investment and equipment growth rate. Further, the power demand growth forecasted by the GDP is lower than the ones for investment and equipment providing that the energy intensities have not changed.

- In the JICA model, the initial energy intensity is used at the time of the Baseline calculation. It means that the power demand forecasted is under the expansion of the current economy.
- Unusual demand expansion by increasing the operation load and investment and equipment can be covered by the ordinary GDP growth rate. However, the scale of the GDP for the current Vietnam economy is rather smaller, otherwise Investment and Equipment has a high growth rate. Under these conditions, the power demand is affected by future large scale projects.
- Under the JICA model, the GDP intensities have not undergone adjustments to take into account the differences between the power demand growths. Instead of conducting adjustments, future new industrial zones and big commercial facilities to consume huge power are surveyed and the power demand of the projects is calculated. In other words, based on new equipment investment that cannot be clarified utilizing a predictive formula, the power demand is extracted from large scale project surveys.

(2) Procedures for Building PDP7 Model

- The Model should be designed for forecasting the power demand adhering to the conditions of Energy efficiency and conservation (EE&C) policy, adding power demand from large scale projects and calculating power demand by utilizing a power ratio.
- The macro economic analysis is the main method used in the building of a power demand model; however the power demand from the model should be added via additional power demand from the large scale facilities survey.
- Large scale projects like industrial parks and economic zones have to be surveyed by sector and region. Additional power demand has to be estimated from large scale projects.
- The expected functions of the power demand forecasting model are as follows:
  - To be able to analyze power demand in the company while monitoring changes in the Vietnam economy.
  - To be able to analyze the power demand of a company utilizing the power ratio.
  - To be able to evaluate the effects of electric tariffs and 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.

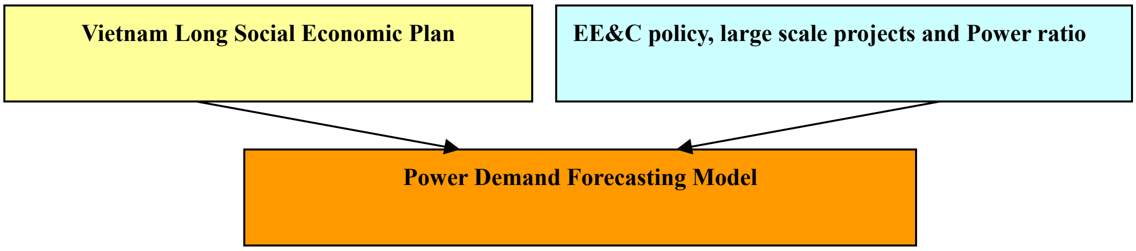


Figure S3-1: Procedures of Building PDP7 Model

S-4 Technical Assistant on Power Supply System Planning

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

In the southern part of Vietnam, especially the Ho Chi Minh City area, a large increase in power demand is expected to continue. On the other hand, there is a shoal account for a wider part of its coastal water body in the southern part of Vietnam. Hence, potential sites for power plants needing large-scale harbor improvement are limited. Under these circumstances, many large-scale power plants are concentrated in the same area located 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, out of 21GW, the total power output of the power plants planned in the coastal area of the southeastern part of Vietnam up to the year 2030, in consideration of the power demand of the southeastern part of Vietnam is about 1GW and it is necessary to transmit a maximum of 20 GW to Ho Chi Minh City.

In the previous study titled, "The Study on National Power Development Plan for the period of 2006-2015, perspective up to 2025 in Vietnam", which was conducted from 2006 to 2007, it was recommended that a study be conducted on the methodology of power transmission by applying higher voltage levels, which have the potential to reduce the number of transmission line routes and economical transmission under the installation scenario of large-scale power development to the area ranging from the central to the southern regions. IE has already looked into the application of the voltage level above 500 kV since the previous study.

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 Ho Chi Minh area, which was comprised of either UHV or 500 kV transmission lines, was conducted. The costs of the transmission lines and substations required for each year were estimated in accordance with the power development plans for 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.

Table S4-1: 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 UHV circuits was estimated to be much smaller than the case of 500 kV. Although there is a small difference between the total costs of both of the cases including investment, O&M and power transmission losses.

A sensitivity analysis was carried out for cases of increasing power transmission loss, delays of the commissioning years of nuclear power stations or raising the cost of UHV. The total cost of the case with UHV was not so much different from the case with 500 kV; however, the case with UHV would have the advantage of having little influence on the environment by reducing the required number of transmission line circuits. In case the commissioning year of nuclear power plants is delayed, the case with UHV would not be inferior to the case of 500 kV.

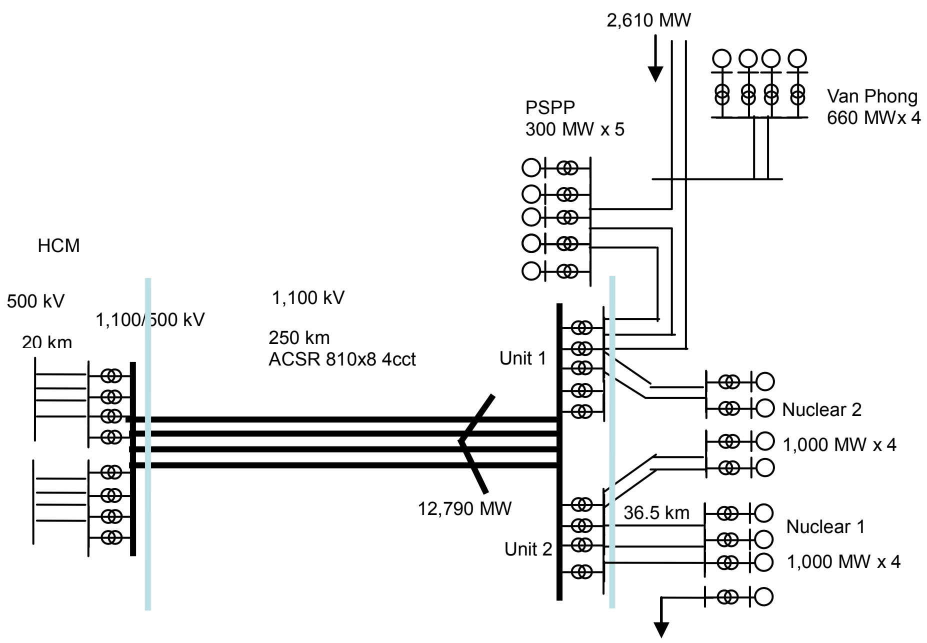


Figure S4-1: Case of Application of 1,100 kV (UHV) Transmission lines (2030)

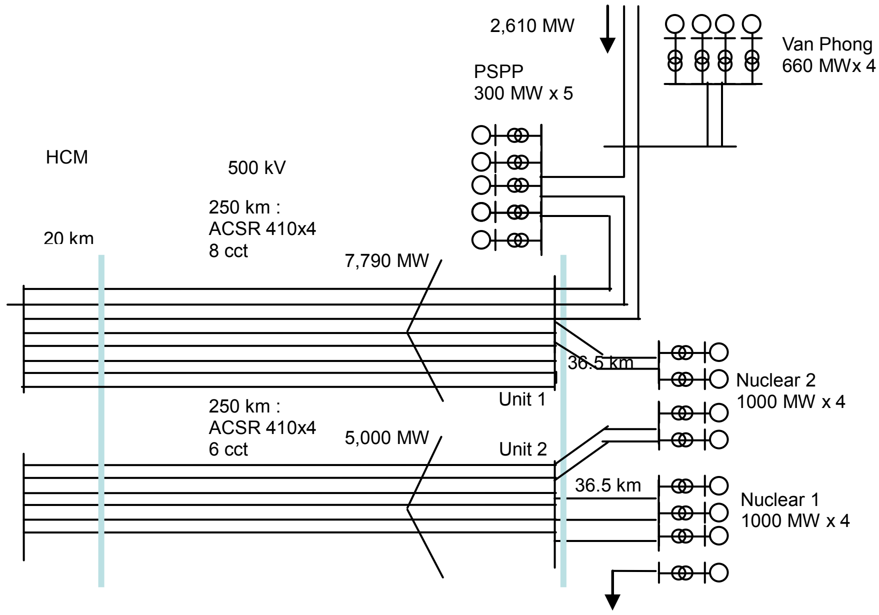


Figure S4-2: Case of Application of 500 kV Transmission Lines (2030)

Study on Power Network System in Ho Chi Min City

This section describes the results of a series of power system analyses, conducted as a part of the technical assistance for power system planning taking into account the suppression of excessive fault currents on the Ho Chi Minh City supply system as of 2030.

(1) 500 kV Future System

The total power flow from the power plants that were planned in the southeastern region of Vietnam toward My Phuoc substation, which was assumed to be the terminal of the UHV transmission line in Ho Chi Minh City, was about 12.6 GW. The load of My Phuoc substation was about 2,300 MW. The remaining power was supplied to both Binh Duong 1 substation and Cu Chi 2 substation through the 500 kV 2cct transmission lines. The power flow of the interval between My Phuoc substation and Binh Duong 1 substation was about 6,600 MW. In consideration of the planned conductor's thermal rating, 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 aforementioned constantly-overloaded interval; however, further study of the system configuration would be necessary since the fault currents at some substations still exceed the maximum allowable level set in the system planning criteria of Vietnam.

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 order to alleviate the situation, among the typical countermeasures for fault current suppression, such options as bus separation and modification of the system configuration were applied on a trial basis. Compared to the situation prior to executing the countermeasures, the fault currents at some substation buses were reduced by tens of kA. To determine the system configuration, however, it is considered necessary to conduct a further study of the selection of target locations and/or intervals and applicable countermeasures depending on the actual situation and viability of the measures.

(2) 220 kV Future System

Under loop operation conditions, the three-phase short circuit currents at many 220 kV substation buses were expected to exceed the maximum limit of Vietnamese system planning criteria, 40 kA. In order to reduce the short circuit current; the loop system was opened between some intervals in order to form the radial system. Based on this method, the system was divided into several sub-systems. With the system segmentation, the fault currents were reduced by tens of kA in some locations. To determine the system configuration, however, it is considered necessary to conduct a detailed study taking into account the actual situation of the facilities and variability from the perspectives of technology and economic efficiency.

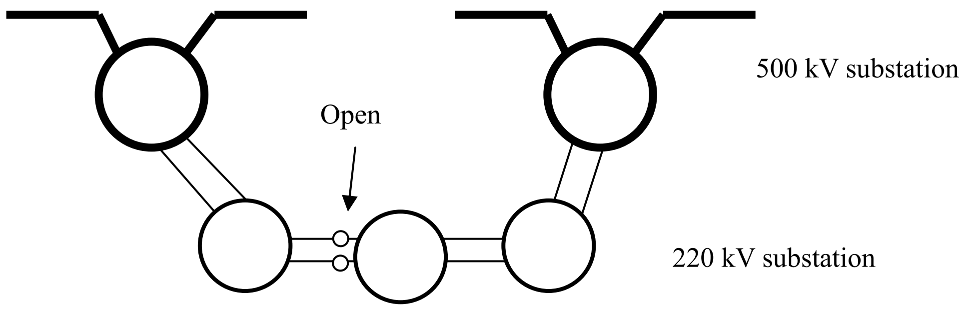


Figure S4-3: Concept of Radial Operations for Short Circuit Fault Reduction

Three Phase Short Circuit Fault Current in Ho Chi Minh Area in 2030

(System separation for fault current reduction)

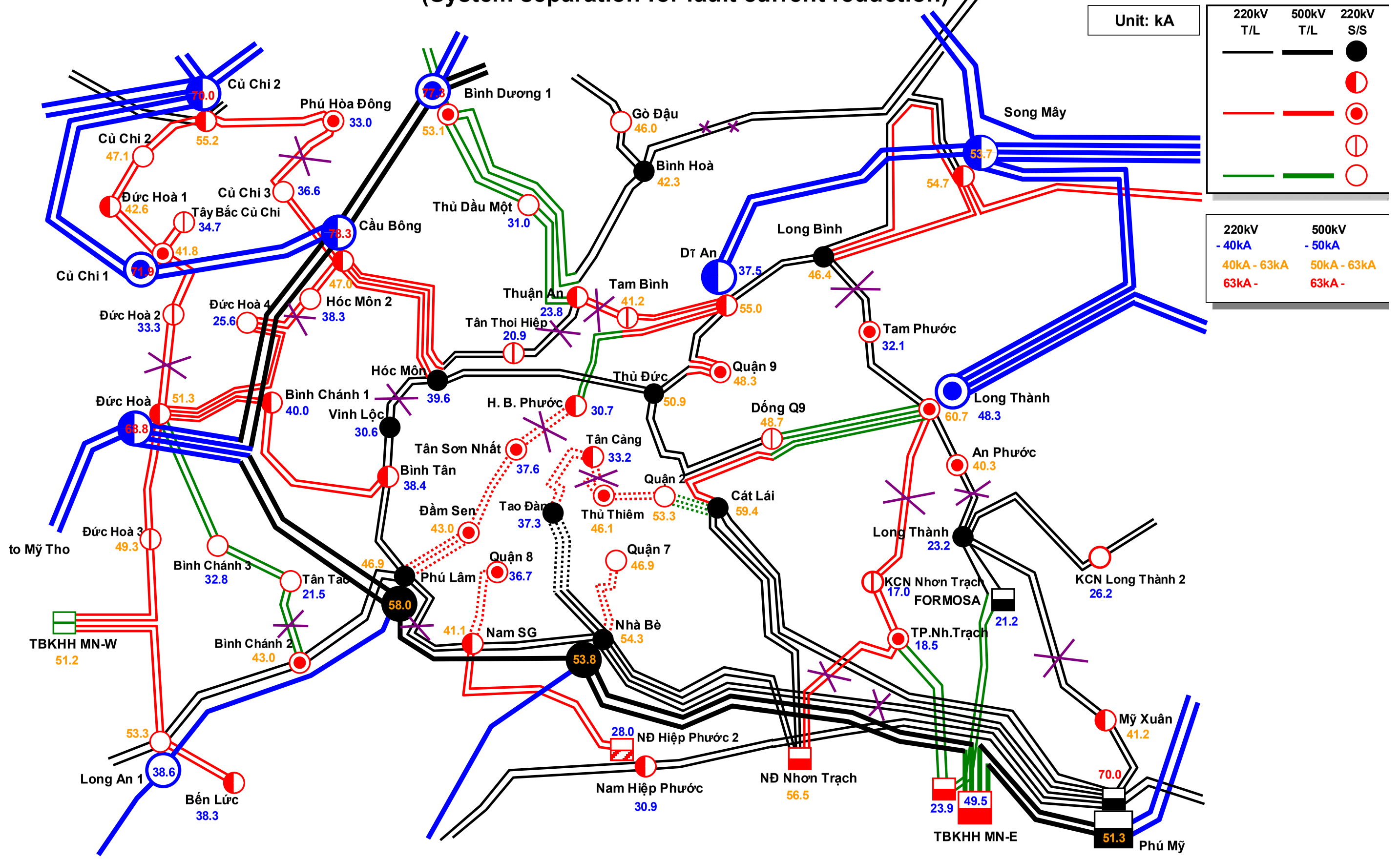


Figure S4-4: Three-Phase Short Circuit Fault Currents after Taking Measures (2030)

Introduction of Technical Study Items

Some problems will arise with the expansion of power system due to an increase in future power demand. Relevant technologies were transferred by introducing some of the following Tokyo examples:

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

(2) Introduction of Efficient Utilization of Tokyo’s underground

(3) Voltage Stability

(4) Conductors Used for Bulk Power Transmission Lines

S-5 Interim Review of Draft PDP7 Formulated by IE

Pre-conditions for Power Demand Forecasting Model

(1) Base Case Economic Growth

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

(2) High Case Economic Growth

- Economic structural changes are quite robust because industry and construction and the service sector has been experiencing rapid growth.
- The high case is connected to the imminent restoration of the world economy, and it is predicted that Vietnam's economy will also recover quite quickly with a strong thrust towards industrial development in the years before and after 2020.

(3) Low Case Economic Growth

- Economic structural changes have been robust because industry and construction and the services sector has been experiencing fast growth.
- The high case is connected to the imminent restoration of the world economy, and it is predicted that the Vietnamese economy will also quickly recover leading to a strong thrust towards industrial development in the years before and after 2020.

Future Power Demand as the Results of the Model

(1) Power Demand in the Country

(a) Power Demand in Base Case

In the Base Case, the current high power elasticity to GDP (2.1 in 2010) is expected to gradually decrease 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 estimated growth rates are 12.2% in 2010-2015, 10.9% in 2015-2020 and 8.5 in 2020-2025. The 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.

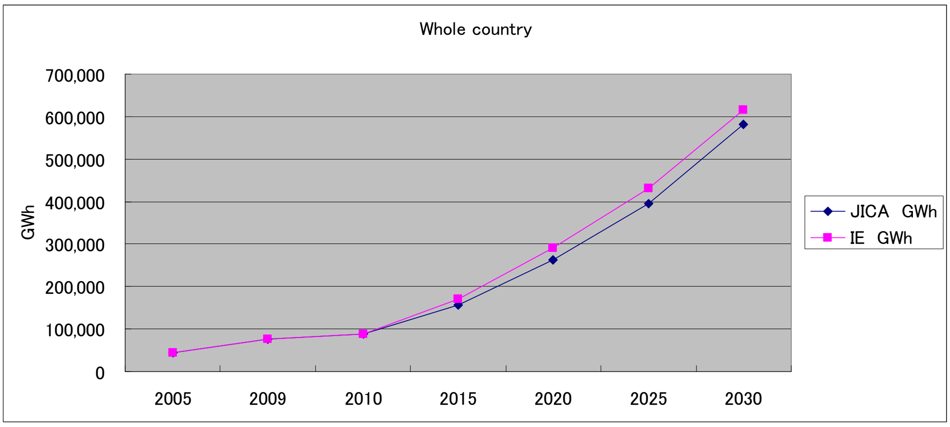


Figure S5-1: Power Demand Outlook in Whole Country in Base Case

(b) Power Demand in High Case

There is a possibility that energy conservation may evolve faster than estimated if a high power demand continues for an extended period of time. The power demand grows 3.5 fold from 2010 to 2020. (3.0 fold in Base case). The outcome may indicate some criteria from the perspective of energy supply policies.

(c) Power Demand in Low Case

The Power demand in the Low case will be 2.7 fold from 2010 to 2020 (3.0 fold in Base case), as it is quite probable of occurring when government budget crises occur, especially in the EU after the global financial crisis.

(2) Power Demand by Sectors

- Power demand in the industry sector will achieve the highest growth among all the sectors. Utilization of gas in the industry sector will facilitate the replacement of the demand for coal, petroleum products and Power. In the study, gas demand in the industry sector is included a little. It can be estimated that gas usage in most of the factories will become prevalent after 2020. Future power intensity to the industrial GDP will also be increased due to the introduction of advanced technologies and increasing infusion of investments and equipment into the sector. However, after 2020, the intensity will be turn over to a reductive trend caused by EE&C.
- The growth rate of electricity demand in the commercial sector is the highest of the final energies. The specific feature of the Commercial sector is the power ratio increase from 20% in 2010 to 30% in 2020. Power demand in 2010 was forecasted at 4.6 TWh (IE forecasts power demand with 4.2 TWh), and it will increase to 12 Twh in 2020 (IE forecasts it with 14 TWh). The average grow rate reached 10% from 2010 to 2020. (IE forecasts 13%)
- The residential sector utilizes a lot of wood and charcoal energies. However, these resources are to be reduced by governmental policies, and the wood and charcoal are to be replaced by LPG and electricity. According to the model, power demand in the residential sector is forecasted at 11% per year. The share of electricity in residential sector has increased. LPG is used in the industrial, commercial and residential sectors. Over the past 5 years, the growth rate has skyrocketed. In the future, LPG demand will increase across all three sectors.

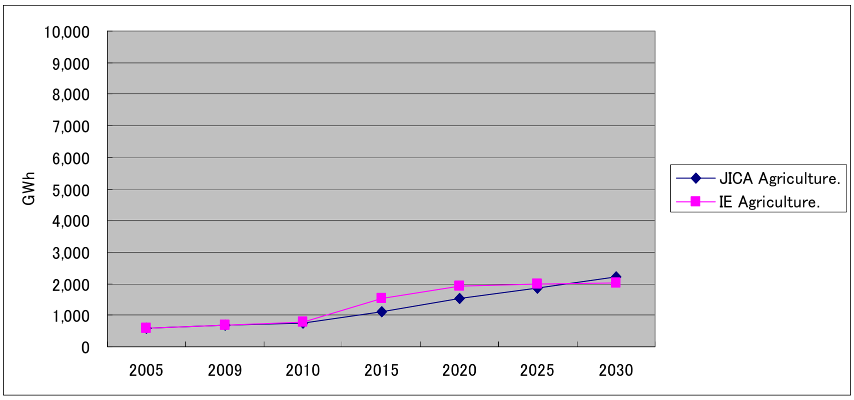


Figure S5-2: Power Demand of IE and JICA in the Agriculture Sector

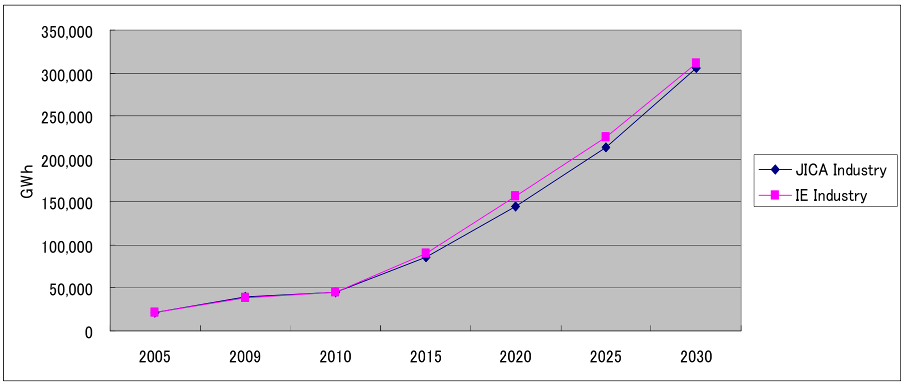


Figure S5-3: Power Demand of IE and JICA in the Industry Sector

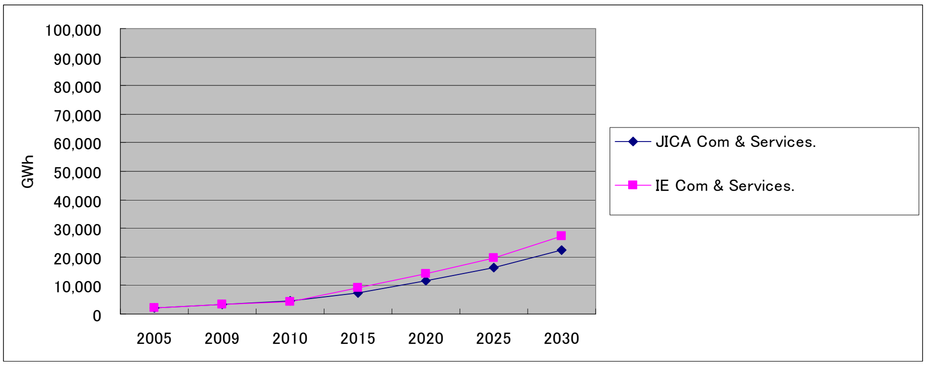


Figure S5-4: Power Intensities of IE and JICA in the Commercial Sector

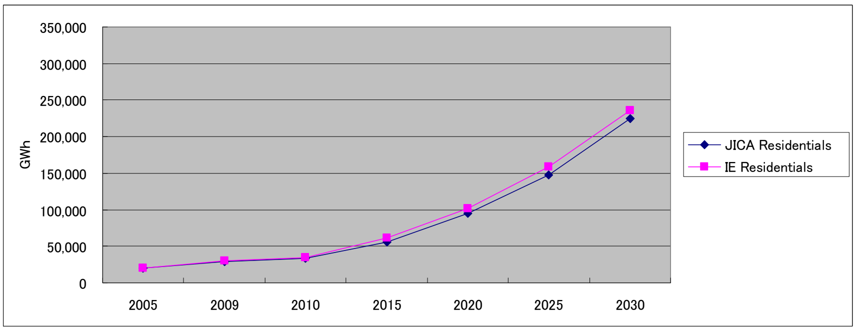


Figure S5-5: Power Demand of IE and JICA in the Residential Use

Power Development Plan

Figures 5.3-1 to 5.3-3 in the main report show the regional power generation plan categorized by generation types.

As seen from the data in 2015, the hydropower stations and coal power stations both equally share power generation in the northern area. The hydropower station's generation share lies largely in the central area. Gas thermal power stations share 60% of the power generation in the southern area.

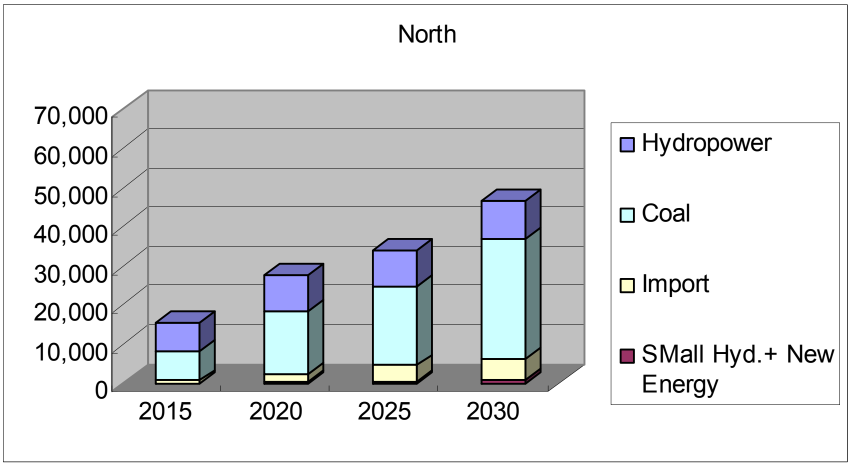
Hydropower stations are situated mainly in the northern to the central area, coal thermal power stations are in the north area and the gas thermal power stations are situated mainly in the south. However, the developmental limitations of the conventional reservoir type hydropower station and gas thermal power stations by 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 regions and the energy from the hydropower stations in Cambodia have been planned.

The installation of nuclear power stations installed in the southern region has been planned for after 2020.

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 expected deterioration.

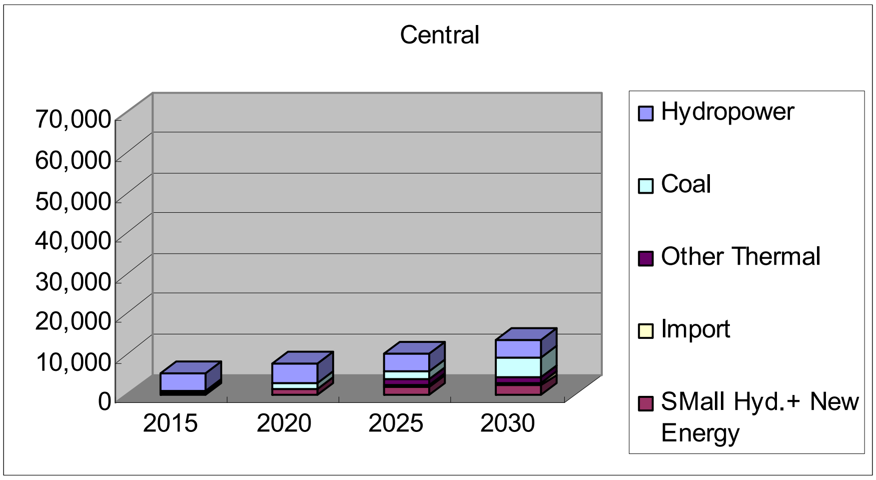
(Unit: MW)



Source: IE (2010.4)

Figure S5-6: Installed Capacity in the Power Generation Plan for the Northern Area

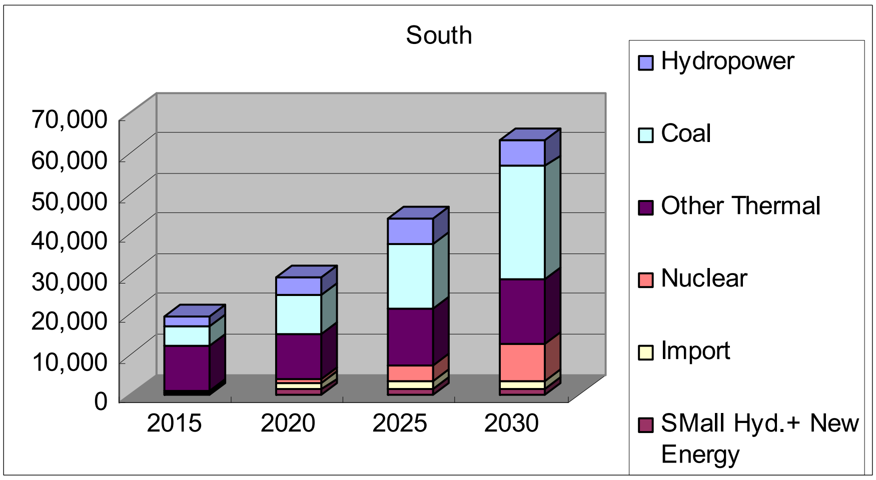
(Unit: MW)



Source: IE (2010.4)

Figure S5-7: Installed Capacity in the Power Generation Plan for the Central Area

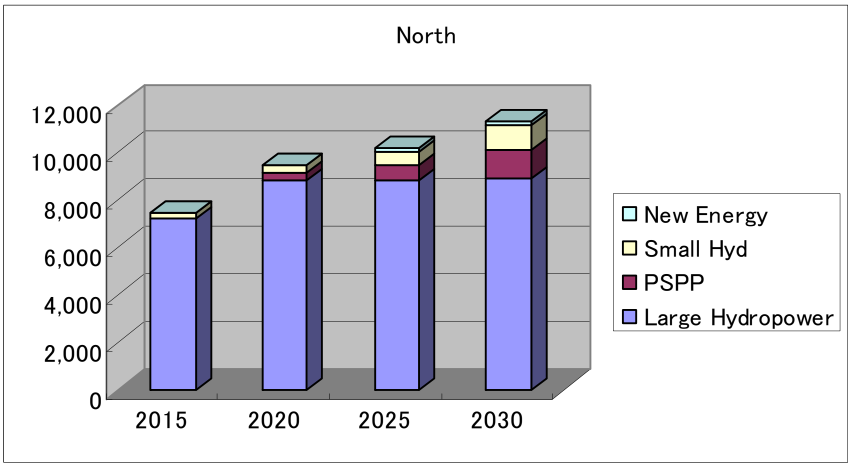
(Unit: MW)



Source: IE (2010.4)

Figure S5-8: Installed Capacity in the Power Generation Plan for the Southern Area

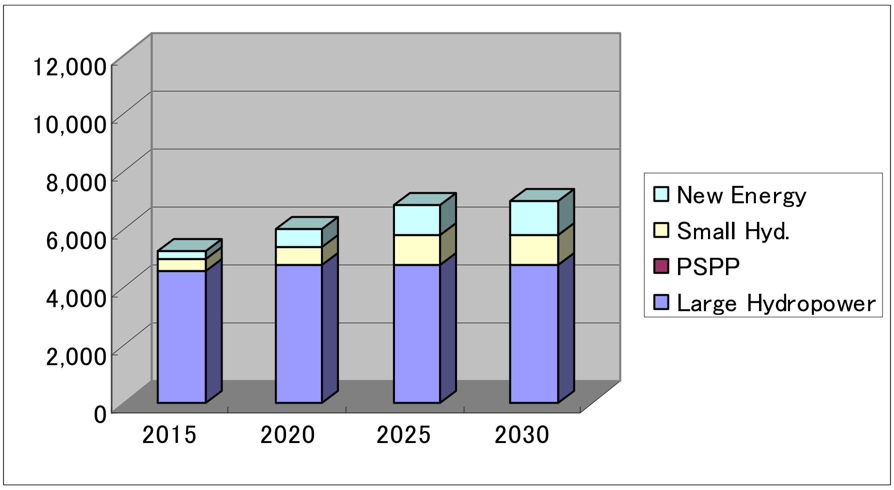
(Unit: MW)



Source: IE (2010.4)

Figure S5-9: Installed Capacity of Hydropower Stations and Renewable Energy for the Northern Area

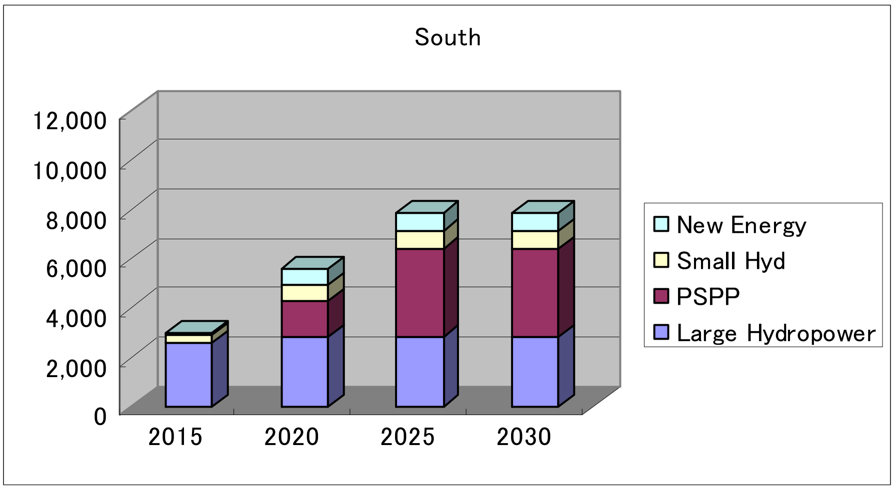
(Unit: MW)



Source: IE (2010.4)

Figure S5-10: Installed Capacity of Hydropower Stations and Renewable Energy for the Northern Area

(Unit: MW)



Source: IE (2010.4)

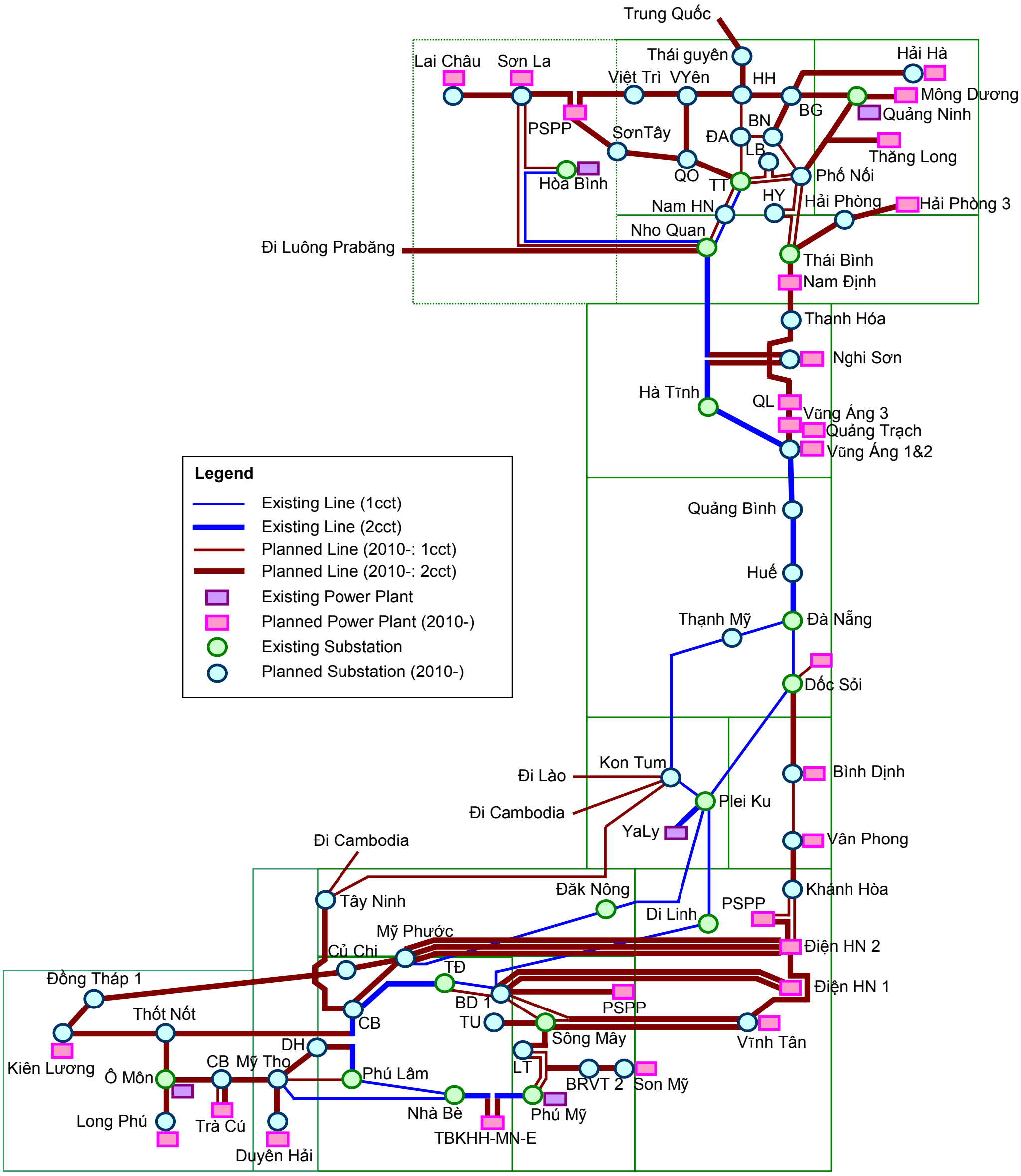
Figure S5-11: Installed Capacity of Hydropower Stations and Renewable Energy for the Southern Area

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 areas will not be reinforced. However, the 500 kV interconnection between the central to the north will need to be reinforced because there will be plenty of power generation capacity comprised of the many potential sites for hydropower stations and the candidate sites for the coal thermal powerstations 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 are planning to be supplied to the southern area by 500 kV transmission lines reinforced between the central and the south regions where much power demand is expected.
- The 500 kV system surrounding Ho Chi Minh City should be constructed in 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 understood 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 a radial form system to suppress the fault currents.



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

Source: The TA Team

Figure S5-12: Power System Map of the 500 kV System Plan by IE up to 2030

Environmental and Social Considerations

An interim review was implemented based on the draft SEA (Strategic Environment Assessment) PDP7 report and discussion with an IE expert, utilizing the SEA review checklist prepared by the Study Team (Table S5-1).

The SEA team has been conducting SEA, in accordance with the SEA methodology and the contents of the SEA report prepared by the SEA team. As of July 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 (Ministry of Natural Resources and Environment) late 2010.

As mentioned above, 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 major adjustments have been deemed NOT necessary. However, in comparison to the international good practices for SEA etc., there are some points that need to be taken into account. Therefore, the SEA should be implemented in consideration of the following recommendations.

(1) Mitigation Measures for Coal Thermal Power Plants and Large-scale Hydro Power Plants

Generally, in the environmental priority order list of development projects, coal thermal power plants and large-scale hydro power plants with resettlement tend to be relegated to the bottom of the pecking order. 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 imports and renewable energy). Further, the reduction of greenhouse gases via large-scale hydro power plants is worth considering. Therefore, it is necessary to utilize these plants effectively with the following mitigation measures:

(a) Coal Thermal Power Plants

- Implementation of adequate mitigation measures for air pollution (e.g. electricity precipitation and desulfurization)
- 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

- Introduction of economically feasible CCS (CO2 capture and storage) combined with EOR (Enhanced Oil Recovery)

(b) 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 the dam (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 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 (Policy, Plan and Program) process, because the PPPs are more abstract and their impact is less specific compared to a project and 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 lifestyle)), because a SEA is basically implemented based on existing data/documents and limited stakeholders (e.g. local authorities). Therefore, it is important to collect opinions from the public concerning PPPs (especially vulnerable groups and persons) and have them reflect in the PPPs, where appropriate. Therefore, it is desirable to consider a disclosure of the draft SEA report to the public and a reception of opinions during the SEA process.

Table S5-1: 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) JICA TA Team

Information on Investment in Candidate Projects

Now, the IE is creating PDP7 under the direction of MOIT. Although progress has been made with the power supply plan, since the demand estimate has not yet been decided, it has not yet resulted in decision. However, internal authorities are calling for a draft to be produced as it is needed for the formulation of a system plan. The candidate project described below is created based on the draft in IE. Therefore, the fact that the schedule may be subject to change should be made clear.

(1) Development Plan of the Candidate Projects by 2010 to 2015

The candidate project from 2010 to 2015 was created via the following methods.

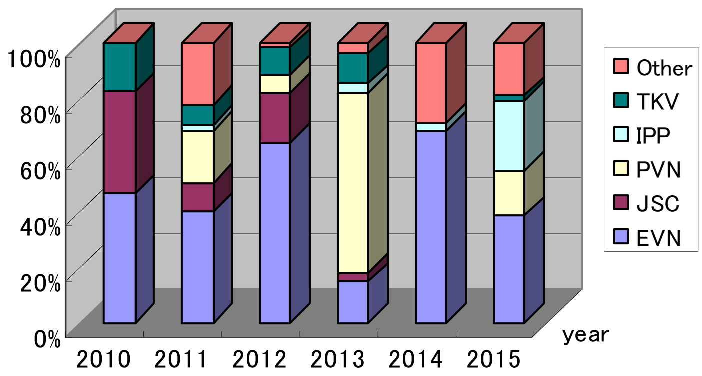
- Assessment of the status of the construction of the power plants according to the announcement of State Steering Committee meetings on PDP VI
- EVN's reports on the status of the plan implementation and work tasks for the months in 2009
- Information regarding the progress of the power plants' construction within the EVN and outside the power sector which contains updated data for the preparation of the PDP VII

Total capacity to be put into operation during the period 2011- 2015 is 24,964 MW, an average of over 4,160 MW/year. However, in four years, 2010-2013, only about 11,753 MW will be put into operation, an average of 2,938 MW/year. In the meantime, demand will continue being extended and the risk of delay will be a remaining factor. Hence, it is predicted that electric power will be tight.

(2) Details and Investors of the Candidate Projects by 2010 to 2015

Regarding project investors, it turns out that EVN has a 50.6% share. Given that its shares will exceed 60% in 2012 and 2014, it can be said that EVN is the main investor behind Electric Power Development in Vietnam. Next, the yearly investment situation is shown in Figure S5-13. As an independent business entity, the rate of PVN is large and has an investment of 1,325 MW scheduled for 2013, which occupies 64% of the investment for that year. Moreover, although the rate of JSC is comparatively high until

2012, it turns out that the rate of IPP peaks in 2013 and even afterwards will continue its upward trend. When the deregulation of Vietnam is achieved, it is predicted that many future IPPs will be added to the development.



Source: IE (as of June 2010)

Figure S5-13: Scheduled Power Generation Capacity by Investors

S-6 Analysis of Risk Factors Related to Power Development Planning

Risk Analysis regarding the Development of Power Network System

Risk factors regarding the development of the power network system can be summarized as show in the following:

- Shortage of the capacities of the transmission lines and substations due to too much unexpected actual power demands
- Delay in transmission line and substation projects due to lack of investment and management issues
- Delay in construction due to land acquisition issues

Thus, the following points should be noticed:

- The power network system should be planned and constructed in consideration of N-1 criteria. The fact that the redundancy of the capacity of transmission lines are capable of not only maintaining a high power supply and reliability level but can also reduce power loss in the transmission lines while being cost effective should be made aware.
- Land acquisition negotiations in conjunction with a firm grasp of the issues at hand should be conducted in advance.

Power Shortage Prevention when Plants for Base Power Sources are Delayed

One potential countermeasure that can be utilized to prevent power shortages due to the developmental delay of nuclear power stations is to ensure that a considerable amount of coal power plants as well as other fuel thermal power stations are available. On the other hand, if all of the power shortages that occur due to the delay of the nuclear power plants are covered only by coal thermal power plants, it would increase the risk of the fuel supply reliability owing to a singular dependence on one single type of fuel. Therefore, it would be desirable to study the adoption of not only coal but also other fuels including LNG for thermal power plants.

The parallel development of multiple sites coupled with increasing the number of their power units according to the increase in the power demand is also an effective countermeasure in dealing with nuclear power plant delays.

S-7 Lesson Learned and Recommendation for Further Support in the Same Field

Lesson Learned and Recommendation to Vietnam's Counterpart

【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) The Power Demand Growth Rate between 2010 and 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 aggressively promoted, JICA power demand forecasts will be adjusted upward.

(3) About Industrial Energy Intensity to GDP

The industrial total energy intensity to the GDP will increase from 2010 to 2015. However, the Japanese energy intensity within the Industrial sector is relatively 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, the energy intensity in the Industry sector was on an upward swing until 2015. Further, as an additional prerequisite, the power ratio of the industry sector increased from 2010 to 2030.

(4) Energy Demand in Residential Sector

The current total energy demand in the Residential sector rose 1.8% from 2010 to 2020, actually at a higher growth rate of around 2% during those years would be more accurate. Based on this model, the 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. The 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 the 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 the “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.

【Power Network System Plan】

IE has the 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) Countermeasures against an 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 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 voltage drops or weak power supply reliabilities may 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 the 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 the 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

The 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 will 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 the 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 is 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 thought on the whole, that the distribution network of Vietnam has a high loss rate and the quantity of the power line facilities is 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, sufficient capacity of power lines and transformers, correct customer information and data management progress of power line facilities, must be required.

Therefore, in order to investigate the installation of the smart grid system, it is necessary to check on the conditions of the distribution network, the formation of the distribution network, the availability factor of power line facilities and the conditions of management for 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 installation conditions of the generator for private use and the installation needs of renewable energy and an efficient system in an industrial complex, and to examine an applicable system about application to the distribution network in an industrial complex.

Lesson Learned and Recommendation to JICA

【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 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 the plans and the JICA TA team focused on the support of the areas of power demand forecast and the power network system planning.

The demerit was that the loss of the supporting procedures occurred by the duplicated studies that had to be carried out based 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 technical support and the planning procedures did not always match.

The difficulty in obtaining information about the whole planning works during the short period of time limited the contents of the technical support to a certain degree.

The merits were that the necessary technical supports could be offered within the short time and the burden of the counterpart to accept the support was not considered to be great.

【Recommendations】

(1) Policy/Upper Level Planning

One of the issues regarding Vietnam's energy policy is that it currently is overly dependent on power electricity. The establishment of the optimum energy mix of the 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 the technical cooperation on the optimum energy mix study during this TA project. Although this kind of study can be categorized as the "Energy Master Plan in Vietnam", the IE seemed to expect the project 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 the pumped storage hydro power plants with the revision of the route of interconnections and the amount of the imported energy. IE has been using that PDPATII software that was developed by TEPCO and transferred to IE through the JICA projects to analyze the power demand supply balancing to create power generation plans. IE requested the new version of PDPATII. It can be considered that IE will still have to utilize 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 create power generation plans. This continuous support will be required via the technical transfer regarding the optimal power generation plans responding to the 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.