Vietnam
Vietnam Electricity

FINAL REPORT

PREPARATORY SURVEY
ON
O MON III COMBINED CYCLE POWER PLANT
CONSTRUCTION PROJECT
IN
VIETNAM

June 2012

JAPAN INTERNATIONAL COOPERATION AGENCY

NEWJEC INC.

Location of O Mon Power Complex

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Abbreviations

AC	Alternating Current
ADB	Asian Development Bank
BCC	Business Co-operation Contract
BOT	Build-Operate -Transfer
CCGT	Combined Cycle Gas Turbine
CDM	Clean Development Mechanism
CECF	Central Electrical Control Room
CIF	Cost, insurance and freight
CGM	Competitive Generation Market
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CPI	Consumer Price Index
CPP	Central Processing Platform
CTTP	Cantho Thermal Power Company Limited = EVNTPC CAN THO
CW	Cooling Water
DC	Direct Current
DCC	O Mon District Compensation Committee
DCQ	Daily Contract Quantity
DLN	Dry Low NOx
DMS	Detailed Measurement Survey
DO	Distillate Fuel Oil
DONRE	Department of Natural Resource and Environment
DP	Delivery Point
DSCR	Debt Service Coverage Ratio
EHS	Environment, Health and Safety
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EMoP	Environmental Monitoring Plan
EMP	Environmental Management Plan
EOH	Equivalent Operation Hours
EPC	Engineering, Procurement and Construction
ERAV	Electricity Regulatory Authority of Vietnam
EVN	Vietnam Electricity
EPZ(s)	Export Processing Zone(s)
EZ(s)	Economic Zone(s)
FDP	Field Development Plan
FEED	Front End Engineering Design
FID	Final Investment Decision
FIRR	Financial Internal Rate of Return
FOB	Free on Board
F/S	Feasibility Study
FSO	Floating Storage Offloading
GDC	Gas Distribution Center

GDP	Gross Domestic Product
Genco(s)	Generation Corporation(s)
GNI	Gross National Income
GSPA	Gas Sales and Purchase Agreement
GSA	Gas Sales Agreement
GSO	General Statistics Office of Vietnam
GTA	Gas Transportation Agreement
GTG	Gas Turbine Generator
HHV	Higher Heating Value
HOA	Heads of Agreement
HRSG	Heat Recovery Steam Generator
HSFO	High Sulfur Fuel Oil
HWL	High Water Level
ICB	International Competitive Bidding
IDC	Interest During Construction
IFC	International Finance Corporation
IE	Institute of Energy
IEC	International Electrotechnical Commission
IP	Industrial Park
IPP	Independent Power Producer
ISO	International Organization for Standardization
JETRO	Japan External Trade Organization
JICA	Japan International Cooperation Agency
JSC	Joint Stock Company
KfW	Kreditanstalt für Wiederaufbau
LFS	Landfall Station
LHV	Lower Heating Value
LIBOR	London Inter-Bank Offered Rate
LNG	Liquid Natural Gas
LPC	Levelised Production Cost
LQ	Living Quarters
MARD	Ministry of Agriculture and Rural Development
MOC	Ministry of Construction
MDCQ	Maximum Daily Contract Quantity
MDMSP	Metering Data Management Services Provider
MOECO	Mitsui Oil Exploration Co. Limited
MOF	Ministry of Finance
MOFI	Ministry of Fishery
MOH	Ministry of Health
MOIT	Ministry of Industry and Trade
MOLISA	Ministry of Labour, Invalids and Social Affairs
MONRE	Ministry of Natural Resources and Environment
MOST	Ministry of Science and Technology
MOSTE	Ministry of Science, Technology and Environment
NH_3	Ammonia

NO_2	Nitrogen Oxide
NT	National Power Transmission Corporation
ODA	Official Development Assistance
OPGW	Optical Fiber Stranded Grounding Wire
PDP6	Sixth Power Development Master Plan
PDP7	Seventh Power Development Master Plan
PECC2	Power Engineering Consulting Company No.2
PECC3	Power Engineering Consulting Company No.3
PHC	Pre-stressed High Strength Concrete
PL	Gas Pipeline
PPA	Power Purchase Agreement
PPTA	Project Preparation Technical Assistance
PSC	Product Sharing Contract
PTSC	PetroVietnam Technical Service Company
PTTEP	PTT Exploration and Production Public Company Limited of Thailand
PVC	PetroVietnam Construction
PVN	Petrovietnam (Vietnam Oil and Gas Group)
RAP	Resettlement Action Plan
ROE	Return on Equity
SCADA	Supervisory Control and Data Acquisition
SEDP	Social and Economic Development Plan
SMO	System and Market Operator
SO_2	Sulfur Dioxide
SPC	Southern Power Corporation
STG	Steam Turbine Generator
TOR	Terms of Reference
TOSA	Tie-in Operation & Service Agreement
UPS	Uninterruptible Power Supply
USGS	United States Geological Survey
VAT	Value Added Tax
VCGM	Vietnam Competitive Generation Market
WACC	Weighted Average Cost of Capital
WB	World Bank
WHP	Well Head Platform
WL	Water Level
WTO	World Trade Organization
WTP	willingness to pay

Units

bbl	Barrel (1 bbl = 159 liter)
BSCM	Billion Standard Cubic Feet
BTU	British Thermal Unit
GW	Gigawatt (=1,000 MW = 1,000,000 kW)
GWh	Gigawatt – hour (=1,000 MWh = 1,000,000 kWh)
hPa	Hectopascal (1 hPa = 1 milibar)
Hz	Hertz
km	Kilometer
km^2	square kilometer
kV	Kilo Volt
kVA	Kilo Volt Ampere
kW	kilowatt
kWh	Kilowatt - hour
m	meter
m^3	cubic meter
mm	millimeter
MMBTU	= 1,000,000 BTU
MMSCF	Million Standard Cubic Feet
MMSCF	Million Standard Cubic Feet per day
MMSCM	Million Standard Cubic Meter
MPa	Mega Pascal (= 10.197 kgf/cm^2)
MW	Megawatt (= 1,000 kW)
MWh	Megawatt – hour (= 1,000 kWh)
NCM	Normal Cubic Meter
s	second
SCM	Standard Cubic Meter
USD	United States Dollar(1 USD = 21,000 VND as Dec. 2011)
V	Volt
VND	Viet Nam Dong

CHAPTER 1

BACKGROUND OF THE STUDY

CHAPTER 1 BACKGROUND OF THE STUDY

1.1 BACKGROUND OF THE STUDY

In recent years, Vietnam has recorded high Gross Domestic Product (GDP) growth rate of approximately 8%. Accordingly, the power demand has increasing at the annual average rate of 13.5% for the last 5 years from 2005 to 2009, and the peak demand is also increased from 10,500 MW in 2005 to 13,800 MW in 2009, i.e., 1.3 times increase in 5 years. Although this growth trend was affected by the recent worldwide financial and economic crisis, it is forecasted to soar again toward high economic growth as the mid and long term trend. In the 7th Power Development Master Plan (PDP7) approved in 2011, it is planned to develop the total of nearly 50,000 MW of power source in a decade from 2011 to 2020. However, many of the power development and investment projects planned in the 6th Power Development Master Plan (PDP6) are delayed in its implementation at present. Accordingly, the power supply balance in Vietnam is affected by such delay, and the rotational power interruption is forced to be implemented at the peak time of power demand. Such being the situation, to meet the power demand in Vietnam, in the PDP7, the power import from the neighbouring countries and/or the development of renewable energy are studied and considered. For the stable supply of power, Unit No.1 of the first Nuclear Power Station in Vietnam is expected to be commissioned in the year 2020.

The energy resources are unevenly distributed in Vietnam. The main energy sources for power generation in the northern part are hydro and coal, while in the southern part it is the natural gas. The total installed capacity of the whole country in 2010 is 21,297 MW, and hydroelectric power plants occupy 34.8%. Toward the year 2030, the Government of Vietnam commits to increase the proportion of the thermal power plants.

Under these circumstances, the Government of Vietnam has requested the Yen Credit to the Japanese Government for the construction of 750 MW combined cycle power plant and related facility at O Mon Site in Can Tho Province of the southern part of Vietnam to improve the power supply capacity in the region, to contribute to the acceleration of economic growth and to strengthen the international competitiveness. In response to this request, Japan International Cooperation Agency (JICA) on behalf of the Japanese Government decided to conduct the study on the necessity and validity of the Project, and the Consultant, namely, NEWJEC Inc. was appointed to carry out the Study on its behalf.

1.2 OBJECTIVE OF THE STUDY

The objectives of the Study are to review the Feasibility Study (F/S) of the Project carried out by the fund of the implementing agency, i.e., Vietnam Electricity (EVN) and to verify the feasibility of the Project to be implemented by the Yen Credit by collecting and analyzing the detailed information, etc.

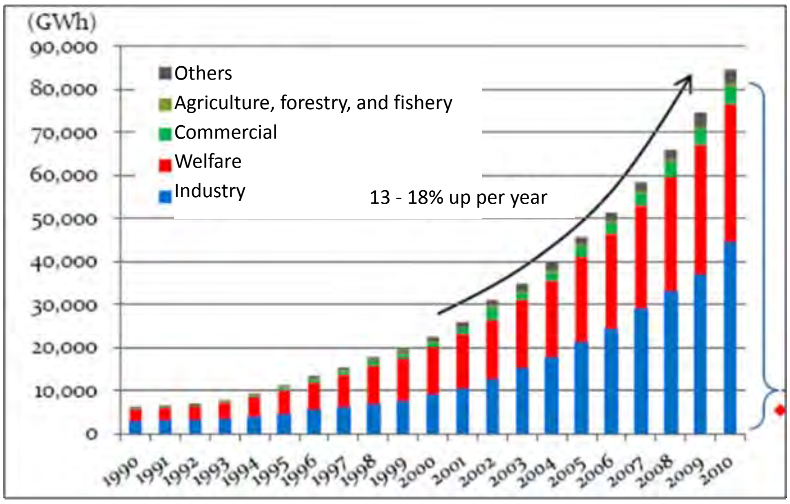
CHAPTER 2

ISSUES AND CURRENT STATUS OF POWER SECTOR IN VIETNAM

CHAPTER 2 ISSUES AND CURRENT STATUS OF POWER SECTOR IN VIETNAM

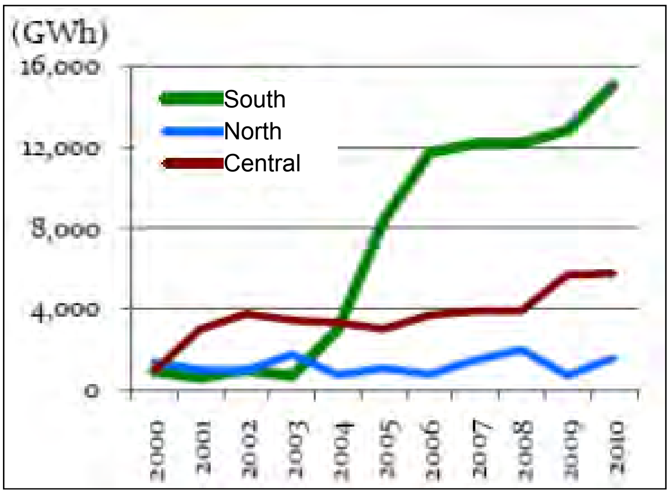
2.1 IMPLEMENTATION PROGRESS OF THE PDP6

GDP growth rate in Vietnam from the year 2006 onwards has increased by 6 ~ 7%[1] per annum compared to the previous year and Vietnam has achieved remarkable economic growth recently. In parallel with the economic growth, power consumption has also been stably increased by 6 ~ 8% per annum as shown in Fig. 2.1-1. Especially power consumptions for household and industry have increased remarkably. Focusing on the regional base, power delivery to the Southern region is distinguished compared to Northern and Central regions as shown in Fig. 2.1-2 and the Southern region is supposed to be the largest power demand area in Vietnam.



Source: "Power Sector Survey 2011", June 2011, by JETRO Hanoi Center

Fig. 2.1-1 Growth Rate of Power Consumption in Vietnam



Source: "Power Sector Survey 2011", June 2011, by JETRO Hanoi Center

Fig. 2.1-2 Power Delivery from 500kV Substations

1 Source: "Statistical Yearbook of Vietnam 2010", Statistical Publishing House

In order to meet the increase of power demand as mentioned above, the Government of Vietnam developed the PDP6 from 2006 toward 2015 and has reinforced and extended the power facilities. However, as shown in Table 2.1-1, the implementation of the plan has achieved about 70% as of December 2010. If the plan had been implemented 100%, the installed capacity in Vietnam 2010 would be 25,797 MW instead of 21,297 MW as indicated in Table 2.1-2. In respect to the power source composition, hydropower plants account for one third or 34.8%, coal-fired thermal power plants account for 18.5%, oil and gas-fired thermal power plants account for 38.8%, small hydropower plants and renewable energy account for 3.2%, and power import accounts for 4.7% as shown in Table 2.1-3. In respect to the regional base, the installed capacity in the Northern region occupies 38.9% of the total installed capacity in Vietnam, 16.4% for the Central region and 44.7% for Southern region, and the installed capacity in the Southern region is the largest one compared to other regions.

Concerning the implementation ratio of the power system in the PDP6, it achieved only 46% in quantity base and 50% in capacity base as shown in Table 2.1-4.

Table 2.1-1 Actual Progress of Power Source Development in the PDP6

	2006	2007	2008	2009	2010	2006-2010
By Prime Minister's Decision on the PDP6 (MW)	861	2,096	3,271	3,393	4,960	14,581
Actual Installed (MW)	756	1,297	2,251	2,136	3,641	10,081
Percentage of Implementation	87.8%	61.9%	68.8%	63.0%	73.4%	69.1%

Source: Information by Institute of Energy (IE) dated on December 8, 2011

Table 2.1-2 Power Source Composition as of 2010 end

Year 2010	Unit	Hydropower and PSPP	Coal Thermal	Oil/Gas Thermal & CCGT	Small HPPs + Renewable	Nuclear PPs	Import	Total
Installed Capacity	MW	7,411	3,940	8,264	682	0	1,000	21,297
Power Composition	%	34.8%	18.5%	38.8%	3.2%	0.0%	4.7%	100.0%

Source : The Study Team prepared based on “Vietnam Power Development Plan Period (2011-2020)” provided by IE.

Table 2.1-3 Installed Capacity by Regional Base

Region	North	Central	South	Total
Installed Capacity (MW)	8,278	3,496	9,523	21,297
Percentage (%)	38.9	16.4	44.7	100.0

Source : “Vietnam Power Development Plan Period (2011-2020)”, IE

Table 2.1-4 Actual Progress of Power System Reinforcement and Extension in the PDP6

2006 ~ 2010	Plan		Actual		%	
	Quantity	MVA-km	Quantity	MVA-km	Quantity	Capacity
500 kV Sub-stations						
New add. & expansion	16	8,400	9	4,950	56%	59%
500 kV Lines						
New add. & expansion	12	1,339	6	549	50%	41%
220 kV Sub-stations						
New add. & expansion	87	19,326	40	8,938	46%	46%
220 kV Lines						
New add. & expansion	117	4,666	52	2,323	44%	50%
Total	**232**	**33,731**	**107**	**16,760**	**46%**	**50%**

Source : Information by IE dated on December 8, 2011

Institute of Energy (IE) belonging to Ministry of Industry and Trade (MOIT), which prepared the PDP6, analyzed why the implementation ratio of PDP6 was low. IE's analysis[2] is as follows;

- Long time to negotiate loans
- Lack of capital
- Lack of experience and ability on bidding, Consultant, Engineering, Procurement and Construction (EPC) Contractors and Project Management Units
- In case of Chinese EPC contractor, the project is always delayed
- Long time of Power Purchase Agreement (PPA) negotiation due to the low power tariff (the average power tariff as of March 2011 was 1,242 VND/kWh or about 6.2 US¢/kWh)
- Coordination between investor and local offices was not well done

Addition to the low implementation ratio of power source with about 70% in the PDP6, unusual draught occurred in 2010. Actual generation energy was reduced by 3.2% or to 93,946 GWh in comparison with the planned generation energy of 97,010GWh in 2010. Especially, generation energy by hydropower plants is reduced by 18.2%. Generation energy of 93,946 GWh in 2010 has increased by about 13%[3] only compared to 82,807 GWh produced in 2009, and caused frequent planned blackouts in Northern and Southern regions.

Japan External Trade Organization (JETRO) Ho Chi Minh Office held the seminar titled "Current Power Situation and Projection in Vietnam" on December 15, 2012 and a lot of Japanese firms (about one hundred firms) operating in the Industry Parks (IP) in the Southern region participated in the seminar because they have much interested in the current power situation and projection due to suffering from power supply shortage.

2 Besides the IE's analysis, World Bank listed the three reasons such as "lack of Contractor's capability", "Delayed payment to the Contractor", and "lack of management capability of EVN".

3 If generation energy had been produced as planned, generation energy in 2010 would be increased by 17% compared to the generation energy in 2009.

Table 2.1-5 Comparison of Generation Energy between 2010 and 2009

Type of Power Plants		Installed Capacity (MW)	Generation in 2010 (GWh)		Generation in 2009	2010	Capacity Factor		
			Plan (a)	Actual (b)		(b) / (a)	2010 (a)	2009 (b)	(a) - (b)
A.	Hydropower	7,530	**29,131**	**23,837**	**27,007**	**81.8%**	**36.1%**	**40.9%**	**-4.8%**
B.	Coal-fired thermal plants	2,745	**12,820**	**12,638**	**9,823**	**98.6%**	**52.6%**	**40.9%**	**11.7%**
C.	Oil & gas-fired thermal plants	3,636	**20,060**	**22,622**	**20,117**	**112.8%**	**71.0%**	**63.2%**	**7.8%**
D.	Diesel plants	285	**68**	**58**	**54**	**85.9%**	2.3%	2.2%	0.1%
F.	IPP and BOT	6,131	**34,931**	**34,791**	**25,805**	**99.6%**	**64.8%**	**48.0%**	**16.8%**
Total		20,327	97,010	93,946	82,807	96.8%			

Note : Installed capacity and its total area a little different from IE data and EVN data. This table is focusing on just generation energy.

Source : EVN's data provided by December 9, 2011

2.2 DEVELOPMENT OF POWER UTILITIES IN THE PDP7

2.2.1 Development Plan of Power Utilities

(1) Development of Power Sources

The Government of Vietnam prepared the PDP7 after the PDP6 and proceeds to develop the power sources from 2011 to 2020. According to the PDP7, power supply and demand balance for the regional base are shown in Table 2.2-1. Northern region and central region are expected to have rather high reserve margin[4], say 19.9% to 47.9% for the northern region and 124.5% to 71.8% for the central region, for the period from 2011 to 2015. On the other hand, the reserve margin at the southern region is estimated to become minus (-7.0% in 2013 and -7.6% in 2014), which w ill cause the severe power supply shortage.

As shown in Table 2.2-2, hydropower plants will decrease from 34.8% in 2010 to 25.5% in 2020. On the other hand, coal-fired thermal plants will increase from 18.5% in 2010 to 43.9% in 2020 and coal-fired thermal plants are planned to occupy the lager part in the power source composition in the PDP7. And power supply will more depend on thermal plants except nuclear plants from 57.3% in 2010 to 61.5% in 2020 in future.

4 Reserve margin(%) is defined as {Installed Capacity (MW) / Power Demand (MW) -1} × 100

Table 2.2-1 Power Supply-Demand Balance in the PDP7

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
North												
Demand	MW		7,902	8,948	10,132	11,474	12,965	14,343	15,869	17,557	19,425	21,528
Installed Capacity	MW	8,278										
New Capacity	MW		1,195	2,077	2,047	2,272	3,306	2,604	3,233	2,600	2,635	884
Available Capacity	MW		9,473	11,550	13,597	15,869	19,175	21,779	25,012	27,612	30,247	31,131
Balance	MW		1,571	2,602	3,465	4,395	6,210	7,436	9,143	10,055	10,822	9,603
Reserve Margin			19.9%	29.1%	34.2%	38.3%	47.9%	51.8%	57.6%	57.3%	55.7%	44.6%
Central												
Demand	MW		1,912	2,185	2,498	2,855	3,269	3,626	4,021	4,459	4,945	5,486
Installed Capacity	MW	3,496										
New Capacity	MW		797	292	275	393	364	592	639	500	480	1,160
Available Capacity	MW		4,293	4,585	4,860	5,253	5,617	6,209	6,848	7,348	7,828	8,988
Balance	MW		2,381	2,400	2,362	2,398	2,348	2,583	2,827	2,889	2,883	3,502
Reserve Margin			124.5%	109.8%	94.6%	84.0%	71.8%	71.2%	70.3%	64.8%	58.3%	63.8%
South												
Demand	MW		9,359	10,675	12,177	13,891	15,831	17,556	19,496	21,650	24,042	26,686
Installed Capacity	MW	9,523										
New Capacity	MW		1,381	270	150	1,510	3,825	4,856	2,770	2,510	2,705	3,758
Available Capacity	MW		10,904	11,174	11,324	12,834	16,659	21,515	24,285	26,795	29,500	33,258
Balance	MW		1,545	499	-853	-1,057	828	3,959	4,789	5,145	5,458	6,572
Reserve Margin			16.5%	4.7%	-7.0%	-7.6%	5.2%	22.6%	24.6%	23.8%	22.7%	24.6%
Whole Country												
Demand	MW		19,173	21,808	24,807	28,220	32,065	35,525	39,386	43,666	48,412	53,700
Installed Capacity	MW	21,297										
New Capacity	MW		3,373	2,639	2,472	4,175	7,495	8,052	6,642	5,610	5,820	5,802
Available Capacity	MW		24,670	27,309	29,781	33,956	41,451	49,503	56,145	61,755	67,575	73,377
Balance	MW		5,497	5,501	4,974	5,736	9,386	13,978	16,759	18,089	19,163	19,677
Reserve Margin			28.7%	25.2%	20.1%	20.3%	29.3%	39.3%	42.6%	41.4%	39.6%	36.6%
Breakdown of Available Capacity												
Hydropower & PSPP	MW	7,411	10,674	12,875	13,477	14,032	15,142	16,430	17,502	17,502	17,987	18,699
Coal Thermal	MW	3,940	4,185	4,635	6,105	8,805	13,655	18,555	23,175	26,595	29,695	32,205
Oil/Gas Thermal & CCGT	MW	8,264	8,362	8,362	8,362	9,082	9,832	11,332	11,332	11,722	12,127	12,935
Small HPPs + Renewable	MW	682	511	749	1,149	1,349	1,749	1,849	2,499	2,849	3,249	3,699
Nuclear PPs	MW	0	0	0	0	0	0	0	0	0	0	2,000
Import	MW	1,000	938	688	688	688	1,073	1,337	1,337	2,487	3,617	3,839
Total	MW	21,297	24,670	27,309	29,781	33,956	41,451	49,503	55,845	61,155	66,675	73,377
			ok	ok	ok	ok	ok	ok	300	600	900	ok
New Additional Capacity												
Hydropower & PSPP	MW	0	3,263	2,201	602	555	1,110	1,288	1,072	0	485	712
Coal Thermal	MW	0	245	450	1,470	2,700	4,850	4,900	4,620	3,420	3,100	2,510
Oil/Gas Thermal & CCGT	MW	0	98	0	0	720	750	1,500	0	390	405	808
Small HPPs + Renewable	MW	0	-171	238	400	200	400	100	650	350	400	450
Nuclear PPs	MW	0	0	0	0	0	0	0	0	0	0	2,000
Import	MW	0	-62	-250	0	0	385	264	0	1,150	1,130	222
Total	MW	0	3,373	2,639	2,472	4,175	7,495	8,052	6,342	5,310	5,520	6,702

Source: The Study Team develops based on the IE's information on December 8, 2011.

Table 2.2-2 Future Power Source Composition in the PDP7

Year 2010	Unit	Hydropower and PSPP	Coal Thermal	Oil/Gas Thermal & CCGT	Small HPPs + Renewable	Nuclear PPs	Import	Total
Installed Capacity	MW	7,411	3,940	8,264	682	0	1,000	21,297
Power Composition	%	34.8%	18.5%	38.8%	3.2%	0.0%	4.7%	100.0%

Year 2015	Unit	Hydropower and PSPP	Coal Thermal	Oil/Gas Thermal & CCGT	Small HPPs + Renewable	Nuclear PPs	Import	Total
Installed Capacity	MW	15,142	13,655	9,832	1,749	0	1,073	41,451
Power Composition	%	36.5%	32.9%	23.7%	4.2%	0.0%	2.6%	100.0%

Year 2020	Unit	Hydropower and PSPP	Coal Thermal	Oil/Gas Thermal & CCGT	Small HPPs + Renewable	Nuclear PPs	Import	Total
Installed Capacity	MW	18,699	32,205	12,935	3,699	2,000	3,839	73,377
Power Composition	%	25.5%	43.9%	17.6%	5.0%	2.7%	5.2%	100.0%

Source : The Study Team develops based on IE's information

Table 2.2-3 shows the power source development plan from 2011 to 2020 and the following findings are observed by Table 2.2-3.

- Hydropower plants and power import will increase from 2,496 MW in 2011 to 5,737 MW in 2020 and 3,241 MW will be newly developed. 3,241 MW consists of small hydropower plants and renewable energy of 1,150 MW (35.5%), power import of 640 MW (19.7%), and hydropower plants and pumped storage power plants of 1,451 MW (44.85). Operation of pumped storage power plants is planned to commence in 2019 and the installed capacity will be 900 MW (27.8%) in 2020.

- Thermal plants will increase from 8,408 MW in 2011 to 27,521 MW in 2020 and 19,113 MW will be newly developed. 19,113 MW consists of O Mon 2, 3 and 4 thermal plants of 2,250 MW (11.8%), new coal-fired thermal plants of 12,840 MW (67.2%), and nuclear plants of 2,000 MW (10.5%). New coal-fired thermal plants are to be developed from the year 2014 and 600 MW and more are to be developed annually. Especially, 3,000 MW of coal-fired thermal plants are to be developed in 2016.

- Table 2.2-4 shows the expected power source composition in 2020 provided that the all power sources will be developed as planned based on the PDP7. The power source in 2020 will consists of hydropower and power import of 17.2%, thermal plants including gas-fired, coal-fired and nuclear plants of 82.7%. And power supply will more depend on thermal plants from 77.1% in 2010 to 82.7% in 2020 in future.

Table 2.2-3 (1/2) Power Source Development Plan in the PDP7 for Southern Region (2011-2020)

TT	Target / Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
	Demand in the South	**9359**	**10675**	**12177**	**13891**	**15831**	**17556**	**19496**	**21650**	**24042**	**26686**
	Total available Cap. in peak month	**10904**	**11174**	**11324**	**12834**	**16659**	**21515**	**24285**	**26795**	**29500**	**33258**
	Balance	**1545**	**499**	**-853**	**-1057**	**828**	**3959**	**4789**	**5145**	**5458**	**6572**
	Reserved South	***16.5%***	***4.7%***	***-7.0%***	***-7.6%***	***5.2%***	***22.6%***	***24.6%***	***23.8%***	***22.7%***	***24.6%***
I.	**Hydropowers+Import**	**2496**	**2616**	**2766**	**2956**	**3631**	**3987**	**4237**	**4437**	**4937**	**5737**
1	Đa Nhim	160	160	160	160	160	160	160	160	160	160
2	Trị An	400	400	400	400	400	400	400	400	400	400
3	Thác Mơ	150	150	150	150	150	150	150	150	150	150
4	Hàm Thuận	300	300	300	300	300	300	300	300	300	300
5	Đa Mi	177	177	177	177	177	177	177	177	177	177
6	Cần Đơn	72	72	72	72	72	72	72	72	72	72
7	Srok Phu Miêng	51	51	51	51	51	51	51	51	51	51
8	Bắc Bình	35	35	35	35	35	35	35	35	35	35
9	Đại Ninh	300	300	300	300	300	300	300	300	300	300
10	Đak Rtih	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
	Đồng Nai 3	180	180	180	180	180	180	180	180	180	180
	Đồng Nai 4	340	340	340	340	340	340	340	340	340	340
12	Đa Dâng 2	0	70	70	70	70	70	70	70	70	70
13	Đam Bri	0	0	0	140	140	140	140	140	140	140
14	Đồng Nai 6	0	0	0	0	135	135	135	135	135	135
	Đồng Nai 6A	0	0	0	0	0	106	106	106	106	106
	Phú Tân 2	0	0	0	0	60	60	60	60	60	60
	Thanh Sơn	0	0	0	0	40	40	40	40	40	40
15	Đa Dâng 2 (34MW)	34	34	34	34	34	34	34	34	34	34
16	Đam Bri	72	72	72	72	72	72	72	72	72	72
17	Hydropower PSPP	0	0	0	0	0	0	0		300	900
1.a	**Small Hydropower+Renewable**	**153**	**203**	**353**	**403**	**553**	**603**	**853**	**903**	**1103**	**1303**
1	Da Dâng Da Chomo	16	16	16	16	16	16	16	16	16	16
2	Bảo Lộc-Dasiat	37	37	37	37	37	37	37	37	37	37
3	TĐN New South	100	100	200	200	300	300	500	500	600	700
4	Wind powers+Renewables	0	50	100	150	200	250	300	350	450	550
1.b	**Import**	**0**	**0**	**0**	**0**	**290**	**490**	**490**	**640**	**640**	**640**
1	Sê Ka man 1 (Lào)	0	0	0	0	290	290	290	290	290	290
2	Hạ Sê San 2 (Campuchia) 50%	0	0	0	0	0	200	200	200	200	200
3	Sê Kông (Campuchia)	0	0	0	0	0	0	0	150	150	150
II.	**Thermals**	**8408**	**8558**	**8558**	**9878**	**13028**	**17528**	**20048**	**22358**	**24563**	**27521**
1	**Phú Mỹ CCGT**	**3890**	**3890**	**3890**	**3890**	**3890**	**3890**	**3890**	**3890**	**3890**	**3890**
	Phú Mỹ 2-1	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
	Phú Mỹ 4	450	450	450	450	450	450	450	450	450	450
	Phú Mỹ 1	1090	1090	1090	1090	1090	1090	1090	1090	1090	1090
	Phú Mỹ 2-2	720	720	720	720	720	720	720	720	720	720
	Phú Mỹ 3	720	720	720	720	720	720	720	720	720	720
	Phu My fertilizer	20	20	20	20	20	20	20	20	20	20
2	**Nhơn Trạch**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**
	Nhon Trach I CCGT	450	450	450	450	450	450	450	450	450	450
	Nhon Trach II CCGT	750	750	750	750	750	750	750	750	750	750
3	**Thermal Thủ Đức**	**153**	**153**	**153**	**153**	**153**	**153**	**153**	**153**	**153**	**0**
4	**Gas turbine Thủ Đức**	**119**	**119**	**119**	**119**	**119**	**119**	**119**	**119**	**119**	**0**
	Thu Duc #4 GT	23	23	23	23	23	23	23	23	23	0
	Thu Duc #5 GT	15	15	15	15	15	15	15	15	15	0
	Thu Duc #6 GT	15	15	15	15	15	15	15	15	15	0
	Thu Duc #7 GT	33	33	33	33	33	33	33	33	33	0
	Thu Duc #8 GT	33	33	33	33	33	33	33	33	33	0
5	**Bà Rịa**	**370**	**370**	**370**	**370**	**370**	**370**	**370**	**370**	**370**	**370**
	Ba Ria GT #1	20	20	20	20	20	20	20	20	20	20
	Ba Ria GT #2	20	20	20	20	20	20	20	20	20	20
	BaRiaC/C#1GT3x37.5ST56	160	160	160	160	160	160	160	160	160	160
	Ba Ria C/C#2 GT3x37.5MW, ST1x62M	170	170	170	170	170	170	170	170	170	170
6	**Thermal Cần Thơ**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**0**

Table 2.2-3 (2/2) Power Source Development Plan in the PDP7 for Southern Region (2011-2020)

TT	Target / Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
	Demand in the South	**9359**	**10675**	**12177**	**13891**	**15831**	**17556**	**19496**	**21650**	**24042**	**26686**
	Total available Cap. in peak month	**10904**	**11174**	**11324**	**12834**	**16659**	**21515**	**24285**	**26795**	**29500**	**33258**
	Balance	**1545**	**499**	**-853**	**-1057**	**828**	**3959**	**4789**	**5145**	**5458**	**6572**
	Reserved South	***16.5%***	***4.7%***	*-7.0%*	*-7.6%*	***5.2%***	***22.6%***	***24.6%***	***23.8%***	***22.7%***	***24.6%***
7	**Gas turbine Cần Thơ**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**0**
8	**Formosa**	**150**	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**
9	**Ô Môn**	**330**	**330**	**330**	**660**	**1410**	**2910**	**2910**	**2910**	**2910**	**2910**
	Ô Môn I #1-FO	330	330	330	330	0	0	0	0	0	
	Ô Môn I #2-FO	0	0	0	330		0	0	0	0	
	Ô Môn I #1-Gas	0	0	0		330	330	330	330	330	330
	Ô Môn I #2-Gas	0	0	0		330	330	330	330	330	330
	Ô Môn II (BOT)	0	0	0	0	0	750	750	750	750	750
	Ô Môn III	0	0	0	0	750	750	750	750	750	750
	Ô Môn IV	0	0	0	0	0	750	750	750	750	750
10	**Cà Mau**	**1500**	**1500**	**1500**	**1500**	**1500**	**1500**	**1500**	**1500**	**1500**	**1500**
	Ca Mau I CCGT	750	750	750	750	750	750	750	750	750	750
	Ca Mau II CCGT	750	750	750	750	750	750	750	750	750	750
11	**Hiệp Phước**	**375**	**375**	**375**	**765**	**765**	**765**	**765**	**765**	**780**	**780**
12	**Amata+Vedan+Bourbon**	**109**	**109**	**109**	**109**	**109**	**109**	**109**	**109**	**109**	**109**
13	**Diesel**	**62**	**62**	**62**	**62**	**62**	**62**	**62**	**62**	**62**	**62**
14	**New CCGT**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**390**	**780**	**1560**
	CCGT Sơn Mỹ I #1	0	0	0	0	0	0	0	390	390	390
	CCGT Sơn Mỹ I #2	0	0	0	0	0	0	0	0	0	390
	CCGT Sơn Mỹ I #3	0	0	0	0	0	0	0	0	390	390
	CCGT Sơn Mỹ I #4	0	0	0	0	0	0	0	0	0	390
15	**Nuclear PPs**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2000**
	Nuclear #1-Phuoc Dinh 1	0	0	0	0	0	0	0	0	0	1000
	Nuclear #3-Vinh Hai 1	0	0	0	0	0	0	0	0	0	1000
16	**South Coal**	**0**	**0**	**0**	**600**	**3000**	**6000**	**8520**	**10440**	**12240**	**12840**
	South Coal 2 (Vinh Tan II #1)	0	0	0	600	600	600	600	600	600	600
	South Coal 5 (Vinh Tan II #2)	0	0	0	0	600	600	600	600	600	600
	South Coal 2 (Vinh Tan I #1)	0	0	0	0	0	600	600	600	600	600
	South Coal 5 (Vinh Tan I #2)	0	0	0	0	0	600	600	600	600	600
	South Coal 660 #1 (Vinh Tan III	0	0	0	0	0	0	660	660	660	660
	South Coal 660 #2 (Vinh Tan III	0	0	0	0	0	0	0	660	660	660
	South Coal 3 (Duyen Hai I #1)	0	0	0	0	600	600	600	600	600	600
	South Coal 4 (Duyen Hai I #2)	0	0	0	0	600	600	600	600	600	600
	South Coal 11 (Duyen Hai II #1)	0	0	0	0	0	0	0	0	600	600
	South Coal 12 (Duyen Hai II #2)	0	0	0	0	0	0	0	0	600	600
	South Coal 13 (D.Hai III,1)	0	0	0	0	0	600	600	600	600	600
	South Coal 14 (D.Hai III,2)	0	0	0	0	0	600	600	600	600	600
	South Coal 15 (D.Hai III,3)	0	0	0	0	0	0	600	600	600	600
	Coal Van Phong #1-660MW	0	0	0	0	0	0	660	660	660	660
	Coal Van Phong #2-660MW	0	0	0	0	0	0	0	660	660	660
	South Coal 7 (Long Phu I #1)	0	0	0	0	600	600	600	600	600	600
	South Coal 8 (Long Phu I #2)	0	0	0	0	0	600	600	600	600	600
	South Coal 18 (Song Hau I #1)	0	0	0	0	0	0	600	600	600	600
	South Coal 19 (Song Hau I #2)	0	0	0	0	0	0	0	600	600	600
	South Coal 9 (Kien Giang I #1)	0	0	0	0	0	0	0	0	600	600
	South Coal 10 (Kien Giang I #2)	0	0	0	0	0	0	0	0	0	600

Source: Information by IE on December 8, 2011.

Table 2.2-4 Power Source Composition (2011 & 2020)

Year 2011	Unit	Hydropower and PSPP	Coal Thermal	Oil/Gas Thermal & CCGT	Small HPPs + Renewable	Nuclear PPs	Import	Total
Installed Capacity	MW	(9,463)	-	3,300	8,408	-	1090	3,335
Power Composition	%	-283.7%	0.0%	99.0%	252.1%	0.0%	32.7%	100.0%
Year 2020	**Unit**	**Hydropower and PSPP**	**Coal Thermal**	**Oil/Gas Thermal & CCGT**	**Small HPPs + Renewable**	**Nuclear PPs**	**Import**	**Total**
Installed Capacity	MW	(28,576)	600	3,152	27,521	12,840	1090	16,627
Power Composition	%	-171.9%	3.6%	19.0%	165.5%	77.2%	6.6%	100.0%

Source : The Study Team developed based on the PDP7

(2) Power System Extension and Reinforcement

Fig. 2.2-1 shows the power system for whole Vietnam, and Table 2.2-5 and Table 2.2-6 shows the power system extension and reinforcement plan relating to 500 kV transmission line and 500 kV substations.

Fig. 2.2-2 and Fig.2.2-3 shows the power system at the periphery of O Mon Power Complex and Ho Chi Minh City. After the implementation of O Mon 3 power plant, power generated by O Mon 3 power plant will be delivered to Mekong Delta and South-east area, which centers on Ho Chi Minh City, via Thot Not substation and My Tho substation.

Fig. 2.2-1 Power System for Whole Vietnam

Source : EVN Corporate Profile 2009-2010

Table 2.2-5 500 kV Transmission Line Extension Plan (2012 - 2015)

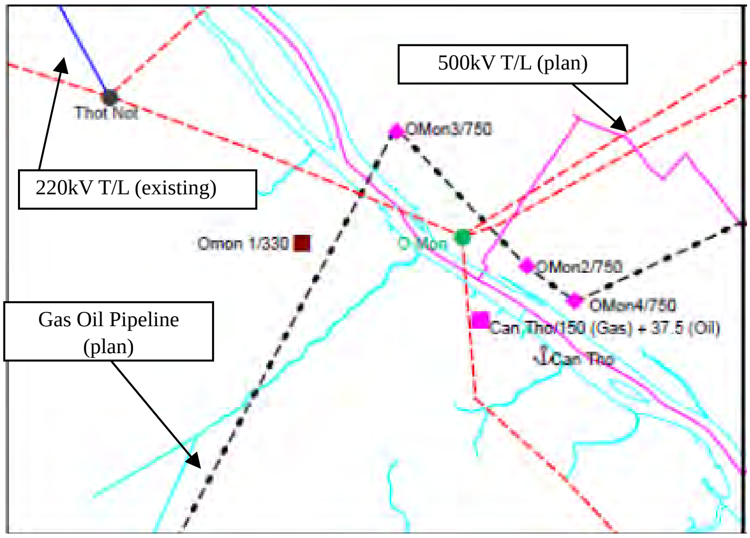
No.	Project Name	Curcuit x Length(km)	Expected Operation Year
1	Son La - Hiep Hoa line	2 x 286	2012 - 2015
2	Quang Ninh - Hiep Hoa line	2 x 140	2012 - 2015
3	Quang Ninh - Mong Duong line	2 x 25	2012 - 2015
4	Pho Noi - Quang Ninh & Thuong Tin line	4 x 10	2012 - 2015
5	Vung Ang - Ha Tinh & Da Nang line	4 x 18	2012 - 2015
6	Son La - Lai Chau line	2 x 180	2012 - 2015
7	Nho Quang - Ha Tinh line : Upgrading capacitor	2000 A	2012 - 2015
8	Pleiku - My Phuoc - Cau Bong line	2 x 437	2012 - 2015
9	HatXan - Pleiku line	2 x 92	2012 - 2015
10	Ta Tinh - Da Nang line : Upgrading capacitor	2000 A	2012 - 2015
11	Song May - Tan Dinh line	2 x 41	2012 - 2015
12	Phu My - Song May line	2 x 66	2012 - 2015
13	Vinh Tan - Song may line	2 x 235	2012 - 2015
14	Cau Bong connection branches	4 x 1	2012 - 2015
15	Duc Hoa connection branches	4 x 8	2012 - 2015
16	Son May - Tan Uyen line	2 x 22	2012 - 2015
17	My Tho - Duc Hoa line	2 x 60	2012 - 2015
18	Duyen Hai - My Tho line	2 x 113	2012 - 2015
19	Long Phu - O Mon line	2 x 84	2012 - 2015
20	O Mon - Thot Not line	2 x 16	2012 - 2015
21	My Tho connection branches	4 x 1	2012 - 2015
22	Pleiku - Dak Nong - Phu Lam & Pleiku - Di Linh - Tan Dinh line : Upgrading capacitor	2000 A	2012 - 2015
20	Phu My 4 - Phu My line : Upgrading conductor	-	2012 - 2015

Source: Data provided by EVN on December 8, 2011

Table 2.2-6 500 kV Substation Extension and Reinforcement Plan (2012 - 2015)

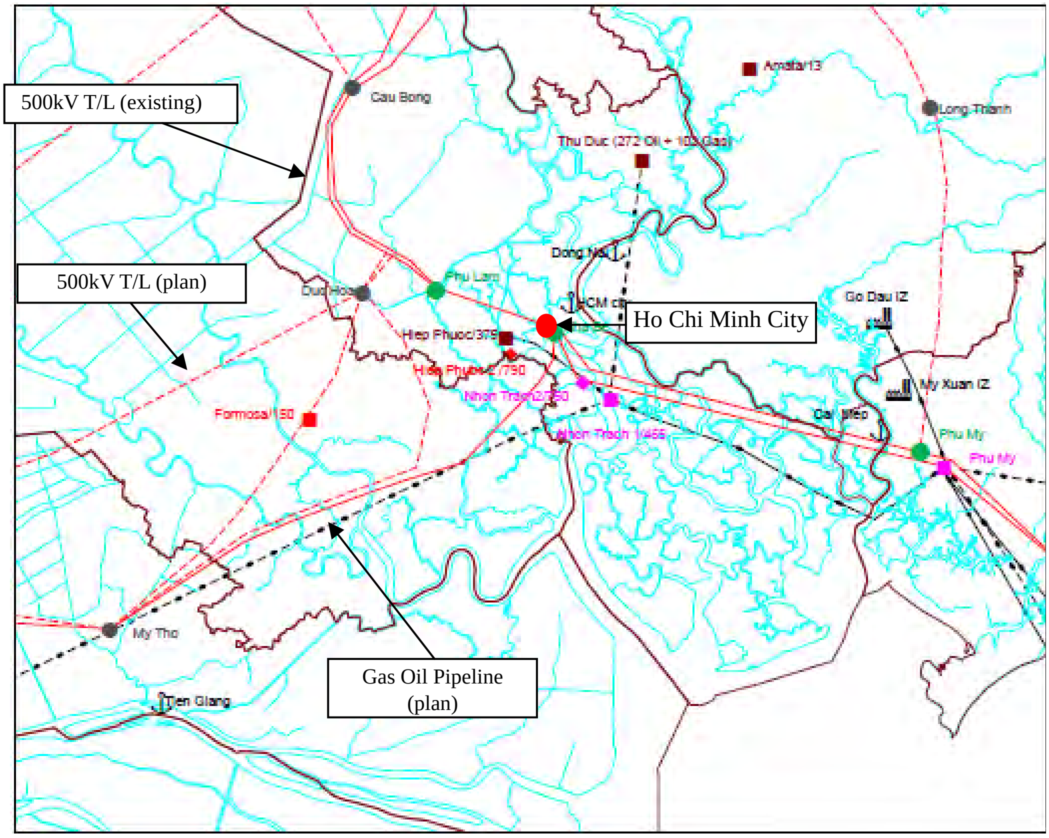
No.	Project Name	Capacity (MVA)	Expected Operation Year
1	Pho Noi Substation	2 x 600	2012 - 2015
2	Viet Tri Substation	1 x 450	2012 - 2015
3	Vung Ang Substation	2 x 450	2012 - 2015
4	Quang Ninh Substation (unit 2)	1 x 450	2012 - 2015
5	Lai Chau Substation	1 x 450	2012 - 2015
6	Thanh My Substation	2 x 450	2012 - 2015
7	Phu Lam Substation (replacing transformer)	2 x 900	2012 - 2015
8	Song May Substation	1 x 600	2012 - 2015
9	Cau Bong Substation	2 x 900	2012 - 2015
10	Duc Hoa Substation	1 x 900	2012 - 2015
11	Tan Uyen Substation	1 x 900	2012 - 2015
12	O Mon Substation (unit 2)	1 x 450	2012 - 2015
13	Tan Dinh Substation (replacing transformer)	1 x 900	2012 - 2015
14	Thot Not Substation	1 x 600	2012 - 2015
15	My Tho Substation	1 x 900	2012 - 2015
16	Long Phu Substation	1 x 450	2012 - 2015
17	Duyen hai Substation	1 x 450	2012 - 2015
18	Vinh Tan Substation	2 x 450	2012 - 2015

Source: Data provided by EVN on December 8, 2011



Source: JETRO Vietnam Energy Map 2010

Fig. 2.2-2 Power System at Periphery of O Mon Power Complex



Source: JETRO Vietnam Energy Map 2010

Fig. 2.2-3 Power System at Periphery of Ho Chi Minh City

2.2.2 Actual Achievement and Future Development Plan of Independent Power Producer (IPP) Power Stations in the PDP7

(1) Actual Achievement of IPPs Power Stations

As shown in Table 2.2-7, IPPs and Built-Operate-Transfer (BOT) power stations account for 32.3% out of total installed capacity in whole Vietnam and play an important role on the power supply. Table 2.2-8 shows the breakdown of IPPs and BOTs power station by regional base. Installed capacity of each power plant type is hydropower plants with 1,216 MW, coal-fired thermal plants with 1,196 MW, gas-fired thermal plants with 4,288 MW, diesel plants with 14 MW and other oil-fired thermal plants with 399 MW. Petro Vietnam (PVN) and VINACOMIN play an important role on development of gas-fired thermal plants and coal-fired thermal plants respectively. Hydropower plants are widely distributed to the northern, central and southern regions. On the other hand, coal-fired thermal plants are mainly distributed to the northern region and gas-fired thermal plants are mainly distributed to the southern region.

Table 2.2-7 Owner of Power Plants (as of December 2011)

Owner	Installed Capacity (MW)	%
Vietnam Electricity (EVN)	11,168	50.7%
EVN JSC.	3,748	17.0%
Local & Foreign Developers	7,113	32.3%
Total	22,029	100.0%

Source : Data provided by EVN on December 8, 2011

Table 2.2-8 List of IPPs and BOTs Power Plants (as of December 2011)

Existing IPP Project List as of Dec.31, 2011

I. Hydripow er Plant

No.	Pow er Plant	Region	Installed Capacity (MW)	Ow ner
1	Cửa Đạt	N	97	Local IPP
2	Nậm Chiến 2	N	32	Local IPP
3	Bản Cốc	N	18	Local IPP
4	Hương Sơn	N	34	Local IPP
5	Mường Hum	N	30	Local IPP
6	Bình Điền	C	44	Local IPP
7	Hương Điền	C	54	Local IPP
8	Sông Côn	C	63	Local IPP
9	EaKrông Hnang	C	64	Local IPP
10	Sêrêpok 4	C	80	Local IPP
11	Sê San 4A	C	63	Local IPP
12	Đa Dâng 2	S	34	Local IPP
13	Cần Đơn	S	78	Local IPP
14	Srok Phu Miêng	S	51	Local IPP
15	Đak Rtih	S	144	Local IPP
16	Za Hung	N/A	30	Local IPP
17	Others total	-	300	Local IPP

V. Diesel

No.	Pow er Plant	Region	Installed Capacity (MW)	Ow ner
1	Amata	S	14	Foreign IPP

Source: Data provided by EVN on December 8, 2011.

IPP Project List as of Dec.31, 2011

II. Coal-fired Themal Plant

No.	Pow er Plant	Region	Installed Capacity (MW)	Ow ner
1	Na Duong	N	111	Vinacomin
2	Cao Ngạn	N	115	Vinacomin
3	Cẩm phả	N	600	Vinacomin
4	Sơn Động	N	220	Vinacomin
5	Formosa	S	150	Local IPP

Note: N; North, C;Central, S;South, N/A; Not Available

III. Oil-fired Themal Plant

No.	Pow er Plant	Region	Installed Capacity (MW)	Ow ner
1	Hiệp Phước	S	375	Foreign IPP
2	Bourbon	S	24	Foreign IPP

IV. Combined/ Open cycle gas turbine

No.	Pow er Plant	Region	Installed Capacity (MW)	Ow ner
1	Nhon Trach I	S	465	Petro Vietnam
2	Nhon Trach II	S	750	Petro Vietnam
3	Cà Mau I	S	750	Petro Vietnam
4	Cà Mau II	S	750	Petro Vietnam
5	Phú Mỹ 2-2	S	740	Foreign IPP
6	Phú Mỹ 3	S	740	Foreign IPP
7	Ve Dan	S	72	Foreign IPP
8	Đạm Phú Mỹ	S	21	Foreign IPP

(2) Future Development Plan in the PDP7

Table 2.2-9 shows the future development plan by IPPs, BOTs and Joint Stock Company (JSC). IPPs , BOTs and JSC are expected to develop power plants amounting to 11,795 MW in northern region, 715 MW in central region and 14,190 MW in southern region up to the year 2020. Table 2.2-10 is developed by the Study Team based on the Table 2.2-1 and Table 2.2-9, and shows percentages of power source development by IPPs, BOTs and JSC out of the total power source development by regional base. In 2020, the percentages of development by IPPs, BOTs and JSC will occupy about 51% of whole Vietnam development, consisting of 50% in northern region, 13% in central region and 60% in southern region approximately. However, as shown in Table 2.2-9, since some projects are not defined concrete developers and described as just BOT, it still remains a concern whether power source development by IPPs, BOTs and JSC will be implemented as planned in the PDP7. If the development by IPPs, BOTs and JSC cannot achieve the percentages listed in Table 2.2-10, Power supply-demand balance, especially for the southern region with low reserve margin, will become worse.

Table 2.2-9 Power Source Development Plan[5] by IPPs, BOTs and JSCs (2011~2020)

No.	Power Plant	Installed Capacity (MW)	Plant Type	Region	Operation Year	Project Owner
1	Nậm Chiến #1	100	HP	N	2011	Song Da Group
2	Na Le (Bac Ha) #1,2	90	HP	N	2011	LICOGI
3	Nậm Chiến #2	100	HP	N	2011	Song Da Group
4	Nho Quế III #1,2	110	HP	N	2011	BITEXCO
5	Cẩm phả II	300	TH	N	2011	VINACOMIN
6	Hủa Na #1,2	180	HP	N	2012	Hua Na Hydropower Plant Stock Company
7	Khe Bố #1,2	100	HP	N	2012	Electricity Stock Company
8	An Khánh I #1	50	TH	N	2012	An Khan Thermal Power Plant Stock Company
9	Mao Khe #1, 2	440	TH	N	2012	VINACOMIN (2012, 2013)
10	Bá Thước 2 #1,2	80	HP	N	2013	IPP
11	Nậm Na 2	66	HP	N	2013	IPP
12	Vung Ang I #1	600	TH	N	2013	PVN
13	An Khánh I #2	50	TH	N	2013	An Khan Thermal Power Plant Stock Company
14	Nậm Na 3	84	HP	N	2014	IPP
15	Vung Ang I #2	600	TH	N	2014	PVN
16	Thai Binh II #1	600	TH	N	2014	PVN
17	Yên Sơn	58	HP	N	2015	Binh Minh Construction & Tourism Stock Company (70 MW)
18	Nậm Mô (Laos)	95	HP	N	2015	IPP
19	Thai Binh II #2	600	TH	N	2015	PVN
20	Mong Duong II #1,2	1200	TH	N	2015	AES/BOT
21	Lục Nam 1	50	TH	N	2015	IPP
22	Hai Duong #1	600	TH	N	2016	Jack Resource - Malaysia /BOT
23	Thăng Long #1	300	TH	N	2017	Thang Long Thermal Power Plant Stock Company
24	Hai Duong #2	600	TH	N	2017	Jack Resource - Malaysia /BOT
25	Nghi Son II #1,2	1200	TH	N	2017	BOT
26	Quang Trach I #1	600	TH	N	2018	PVN
27	Nam Dinh I#1	600	TH	N	2018	Tai Kwang - Korea/BOT
28	Thăng Long #2	300	TH	N	2018	Thang Long Thermal Power Plant Stock Company
29	Nam Xam #1,2 (Laos)	130	HP	N	2019	Sai Gon Invest
30	Na Duong II #1,2	100	TH	N	2019	VINACOMIN
31	Quang Trach I #2	600	TH	N	2019	PVN
32	Nam Dinh I#2	600	TH	N	2019	Tai Kwang - Korea/BOT
33	Bảo Lâm	112	HP	N	2020	Song Da Group (120 MW)
34	Nam Xam 3 (Laos)	150	HP	N	2020	Sai Gon Invest
35	An Khánh II #1	150	TH	N	2020	An Khan Thermal Power Plant Stock Company
36	An Khánh II #2	150	TH	N	2020	An Khan Thermal Power Plant Stock Company
37	Lục Nam 2	50	TH	N	2020	IPP
40	Sê San 4A	63	HP	C	2011	Se San 4A Hydropower Plant Stock Company
41	Đak Mi 4	190	HP	C	2011	IDICO
42	Thượng Kon Tum	220	HP	C	2014	Vinh Son - Song Hinh Electricity Construction Company
43	Sêrêpok 4A	64	HP	C	2015	Buon Don hydropower Plant Stock Company
44	Đak Mi 2	98	HP	C	2016	IPP
45	Vinh Son II	80	HP	C	2019	IPP
46	Đam Bri	72	HP	S	2011	IPP (75 MW)
47	Đak Rtih	72	HP	S	2011	Construction Company No.1 (144 MW)
48	Nhon Trach II	750	TH	S	2011	PVN
49	Đồng Nai 2	70	HP	S	2012	IPP
50	Formosa 2	150	TH	S	2012	Formosa Hung Nghiep Ltd Company
51	Đồng Nai 5	140	HP	S	2014	VINACOMIN (145 MW)
52	Đồng Nai 6	135	HP	S	2015	Duc Long Gia Lai Company
53	Sê Ka man 1 (Lào)	290	HP	S	2015	Viet Lao Stock Company
54	Long Phu I #1	600	TH	S	2015	PVN
55	Đồng Nai 6A	106	HP	S	2016	Duc Long Gia Lai Company
56	Hạ Sê San 2 (Campuchia) 50%	200	HP	S	2016	EVN - BOT
57	Long Phu I #2	600	TH	S	2016	PVN
58	Vinh Tan I #1,2	1200	TH	S	2016	CSG/BOT
59	Ô Môn II	750	TH	S	2016	BOT
60	Van Phong I #1	660	TH	S	2017	Sumitomo - Hanoinco/ BOT
61	Vinh Tan III #1	660	TH	S	2017	Vinh Tan 3 Energy Stock Company/ BOT
62	Song Hau I #1	600	TH	S	2017	PVN
63	Sê Kông (Campuchia)	150	HP	S	2018	Song Da Group (205 MW)
64	Van Phong I #2	660	TH	S	2018	Sumitomo - Hanoinco/ BOT
65	Song Hau I #2	600	TH	S	2018	PVN
66	Sơn Mỹ I #1, 2, 3	1170	TH	S	2018	(IP-Sojitsu - Pacific)/BOT (2018, 2020, 2019)
67	Vinh Tan III #2	660	TH	S	2018	Vinh Tan 3 Energy Stock Company/ BOT
68	Duyen Hai II #1	600	TH	S	2019	Janakusa/ BOT
69	Duyen Hai II #2	600	TH	S	2019	Janakusa/ BOT
70	Kien Giang I #1	600	TH	S	2019	Tan Tao
71	Sơn Mỹ I #4,5	780	TH	S	2020	(IP-Sojitsu - Pacific)/BOT (2020, 2022)
72	Kien Giang I #2	600	TH	S	2020	Tan Tao

5 The Table is prepared by the Study Team based on "Annex i, issued with decision 1208/QD-TTg dated July 21st 2011by the Prime Minister" and "Power Balance in PDP7, IE". Installed capacity described in Project Owner is quoted from "Annex i". "HP" means hydropower plants and "TH" means thermal power plants.

Table 2.2-10 Percentage of IPPs, BOTs and JSCs in the PDP7

	Region / Year	2015	2020
(1)	North Region		
	Planned new installed capacity in PDP7 (MW)	10,897	22,853
	New installed capacity by IPP, BOT, JSC (MW)	5,553	11,795
	Development ratio by IPP, BOT and JSC scheme	51.0%	51.6%
(2)	Central Region		
	Planned new installed capacity in PDP7 (MW)	2,121	5,492
	New installed capacity by IPP, BOT, JSC (MW)	537	715
	Development ratio by IPP, BOT and JSC scheme	25.3%	13.0%
(3)	South Region		
	Planned new installed capacity in PDP7 (MW)	7,136	23,735
	New installed capacity by IPP, BOT, JSC (MW)	2,279	14,190
	Development ratio by IPP, BOT and JSC scheme	31.9%	59.8%
(4)	Whole Vietnam		
	Planned new installed capacity in PDP7 (MW)	20,154	52,080
	New installed capacity by IPP, BOT, JSC (MW)	8,369	26,700
	Development ratio by IPP, BOT and JSC scheme	41.5%	51.3%

2.2.3 Issues on Power Sector based on the PDP7

Issues on Power Sector in Vietnam based on the PDP7 are deemed to be as follows.

(1) Issues analyzed in the PDP6

Issues analyzed by IE in respect to the implementation of the PDP6 as described in Section 2.1 still remains in the PDP7, because those issues have not been yet solved basically. Especially procurement of fund to develop power facilities seems to be the serious issue. In the PDP6, the total developing capacity for the 5 yeas from 2006 to 2010 was 14,581 MW. On the other hand, the total developing capacity for the 5 years from 2011 to 2015 is expected to be 20,154 MW as shown in Table 2.2-10 and becomes 38% more in comparison with the PDP6. EVN has to arrange and procure the developing fund accounting for 60% of the total fund by their own and/or by utilizing the international finance institutions, provided that the remaining 40% of the total fund will be procured by IPPs, BOTs and JSCs.

Table 2.2-11 shows the planned power plants already committed by international finance institutions and by lateral cooperation. The number of committed power plants seem to be still less in terms of necessary developing capacity. “Negotiation and conclusion with the international finance institutions had been delayed due to the huge investment cost for the development” pointed out by IE in the evaluation of the PDP6 is also observed in the PDP7.

Table 2.2-11 List of Power Plants committed by International Finance Institutions and Bilateral Cooperation

Name of Power Plant	Region	Finance Source	Operation Year in the PDP7
Mong Duong Thermal 1 Power Plant 1)	North	ADB	2016
Huoi Quang Hydropower Power Plant 1)	North	AFD	2015
Nghi Son 1 Thermal Power Plant 1)	North	JICA	2013
Vinh Tan 2 Thermal Power Plant 1)	South	China	2014
Trung Son Hydropower Plant 2)	North	WB	2016
O Mon IV Thermal Power Plant 3)	South	ADB	2016
O Mon III Thermal Power Plant	South	JICA (plan)	2015
Duyen Hai III 1 Thermal Power Plant 4)	South	China	2016
Duyen Hai III 3 Thermal Power Plant 4)	South	China	2017

Source: 1) EVN Corporate Profile 2009-2010 2) Asian Development Bank (ADB) Website
3) World Bank (WB) Website 4) EVN

2.3 IMPLEMENTATION PLAN OF O MON 4 AND O MON 5 POWER PLANTS

2.3.1 Implementation Plan of O Mon 4 Power Plant

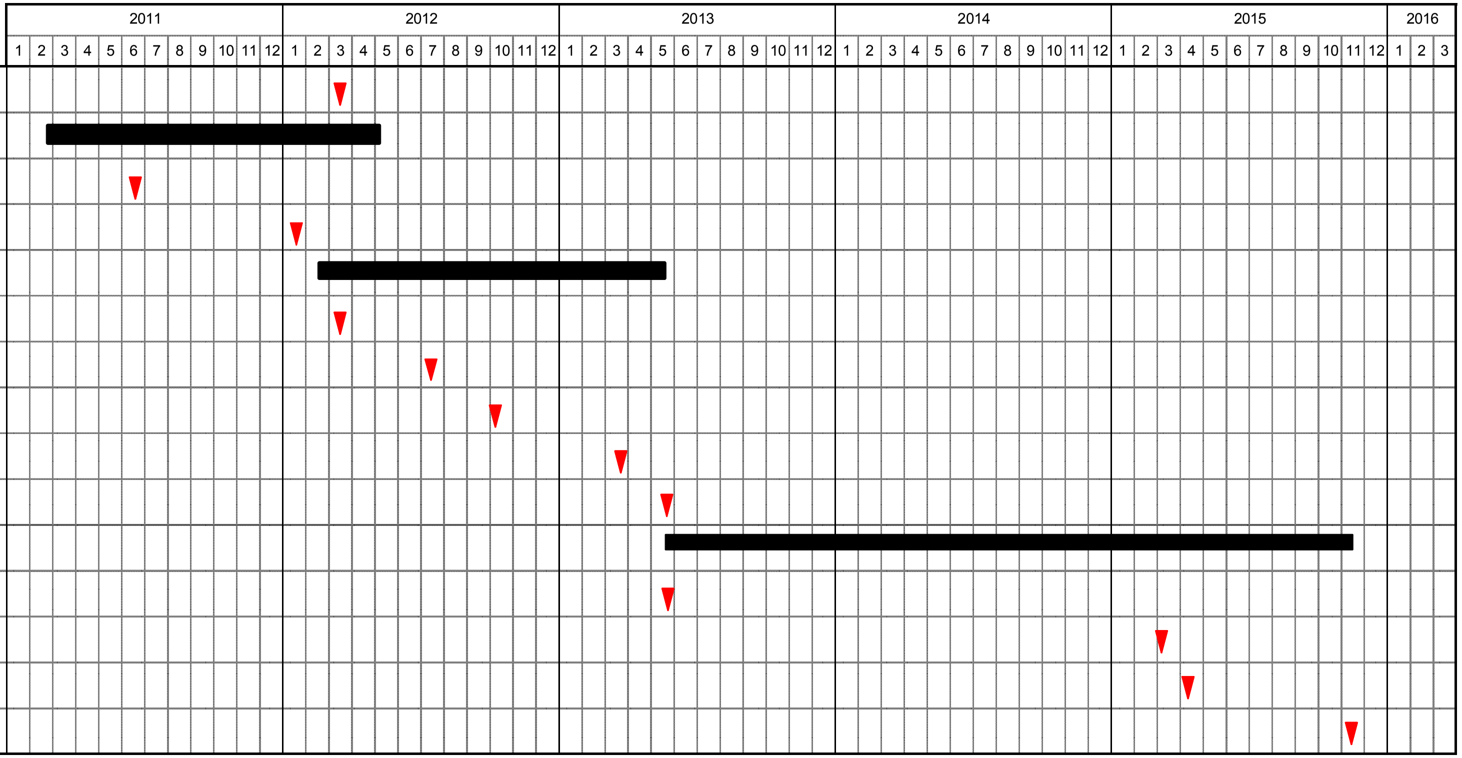
O Mon 4 power plant was approved by the board of Asian Development Bank (ADB) on November 25, 2011 and under the internal procedure for the approval by the Government of Vietnam. Table 2.3-1 shows the implementation schedule for O Mon 4 power plant informed by Cantho Thermal Power Company Limited (CTTP) in December 2011, which was already approved by the EVN. According to the implementation schedule, the construction work will begin in May 2013 and completes in November 2015. The construction period is estimated for 30 months.

2.3.2 Implementation Plan of O Mon 5 Power Plant

O Mon 5 power plant is not included in the list of power plants in the PDP7, although the F/S Report describes the development of O Mon 5 power plant. EVN informed in the meeting on February 2, 2012 that the development of O Mon 5 power plant had never been discussed in the Government level and just proposed idea by Power Engineering Consulting Company No.2 (PECC2), who prepared the F/S Report. Therefore, there is no development plan for O Mon 5 power plant.

Table 2.3-1 Implementation Plan of O Mon 4 Power Plant

No.	Item	Date / Duration
1	**Effectiveness of Loan Agreement**	Mar-12
3	**International Consultant Service**	
3.1	Issuance of RFP for international consultant	Jun.17, 2011
3.2	Contract signing of inernational consultant	Jan.20, 2012
4	**EPC Package / Bidding Process inc. PQ**	**14.9 months**
4.1	Notice of invitation for EPC Contractor for PQ	Mar.16, 2012
4.2	Issuance of Bidding Document	Jul.14, 2012
4.3	Bid opening	Oct.12, 2012
4.4	Contract signing of EPC Contrator	Mar.27, 2013
4.5	L/C opening and contract effectiveness	May.26, 2013
5	**EPC Package / Implementaion Process**	**29.7 months**
5.1	Ground breaking	May.27, 2013
5.2	Gas turbine #1 commissioning	Mar.09, 2015
5.3	Gas turbine #2 commissioning	Apr.09, 2015
5.4	Operation of whle combined cycle power plant	Nov.16, 2015



Source: TPC CAN THO dated on December 12,2011

2.4 CURRENT STATUS AND FUTURE PLAN OF EVN REORGANIZATION

EVN's reorganization is under process in parallel with the reform of Power Sector in Vietnam, such as establishment of power market. Fig. 2.4-1 shows the EVN organization chart as of the end of 2011.

(1) Generation

At present, EVN is managing and operating 24 power generation companies under the forms of dependent accounting generation companies; independent accounting Generation Companies (Gencos) with 100% charter capital held by EVN (independent accounting member company and one member limited liability company); Generation JSCs having EVN's major shares. With total installed capacity of approximately 13,934 MW, these power plants contribute up to 63.3% of the whole system's installed capacity.

In preparation for the start up of a competitive power generation market under the Government's instruction, a restructuring project is being carried out to transform generation units into independent Gencos. Thereby, all Gencos under the approved roadmap are tasked with investment for promoting electricity generation and sales. EVN will directly be in charge of managing strategic and multi-purpose hydropower plants and investing in nuclear power projects.

(2) Transmission

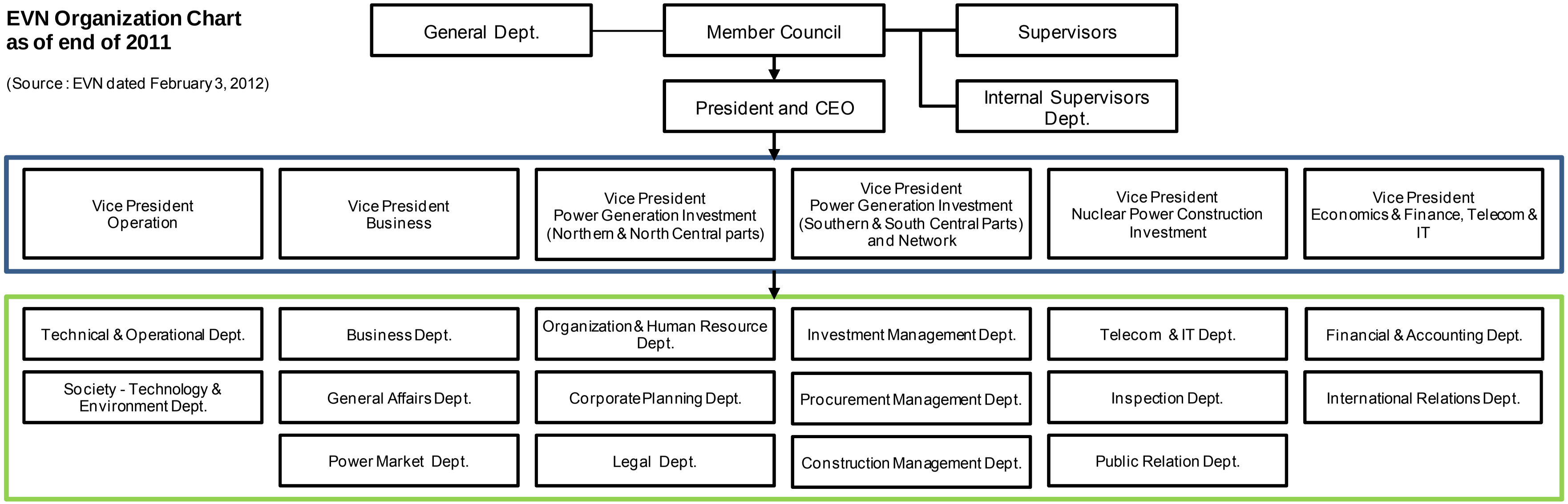
Established upon the incorporation of units in charge of power transmission investment and management, National Power Transmission Corporation (NT) established in July 2008 with 100% charter capital held by EVN is responsible for centralizing resources and consistently monitoring transmission networks as well as developing national power transmission system.

(3) Distribution

With a view to enhancing capacity of distribution units and promoting customer services, 5 distribution corporations with 100% charter capital held by EVN were founded in the form of mother-daughter companies during 2010 upon the restructuring of 11 distribution companies under EVN. Member units under 5 distribution corporations are scheduled to transform into one member-limited liability companies aiming at a higher level of decentralization, enhanced operational efficiency and better services in power distribution and commercial business.

(4) Roadmap of EVN Reorganization

EVN submitted the EVN's restructuring plan to MOIT in December 2011 and the plan has not been approved by the MOIT as of February 2012. Due to the above reason, the roadmap for EVN's restructuring was not provided to the Study Team. EVN informed the Study Team that EVN's restructuring would never affect the implementation of O Mon 3 power plant because 3 Gencos to be established would be still under control of EVN.



Dependent Units

1. Hoa Binh Hydro Power Company
2. Tri An Hydro Power Company
3. Ialy Hydro Power Company
4. Quang Tri Hydro Power Company
5. Tuyen Quang Hydro Power Company
6. Dai Ninh Hydro Power Company
7. Buon Kuop Hydro Power Company
8. Se San Hydro Power Company
9. Son La Hydro Power Company
10. Dong Nai Hydro Power Company
11. Ban Ve Hydro Power Company
12. Song Tranh Hydropower Company
13. An Khe - Ka Nak Hydro Power Company
14. Electric Power Trading Company
15. National Load Dispatch Center
16. Center of Power Electric Information
17. EVN Building Investment and Business Management Board
18. Nuclear Power Project Management Board

Dependent Unit

19. Hydro Power Project Management Board No.1
20. Hydro Power Project Management Board No.2
21. Hydro Power Project Management Board No. 3
22. Hydro Power Project Management Board No.4
23. Hydro Power Project Management Board No.5
24. Hydro Power Project Management Board No. 6
25. Hydro Power Project Management Board No.7
26. Son La Hydro Power Project Management Board
27. Song Bung 2 Hydro Power Project Management Board
28. Song Bung 4 Hydro Power Project Management Board
29. Thermal Power Project Management Board No.1
30. Thermal Power Project Management Board No.2
31. Thermal Power Project Management Board No.3
32. Vinh Tan Thermal Power Project Management Board

Non - Business Units

1. Electric Power University
2. Hochiminh City Electric Engineering College
3. Central Electric Engineering College
4. Electric Vocational College

Daughter Companies

1. Can Tho Thermal Power OMC Limited.
2. Phu My Thermal Power OMC Limited
3. Thu Duc Thermal Power OMC Limited.
4. Uong Bi Thermal Power OMC Limited.
5. Trung Son Thermal Power OMC Limited.
6. Northern Power Corporation
7. Central Power Corporation
8. Southern Power Corporation
9. Hanoi City Power Corporation
10. Ho Chi Minh City Power Corporation
11. National Power Transmission Corporation
12. EVN Telecom
13. Central Aria Electrical Mechanical JSC
14. Thu Duc Electrical Mechanical JSC
15. Electrical Mechanical JSC
16. Dong Anh Electrical Equipment Manufacturing JSC
17. Power Engineering Consultant JSC No.1
18. Power Engineering Consultant JSC No.2
19. Power Engineering Consultant JSC No.3
20. Power Engineering Consultant JSC No.4

Daughter Companies

21. Thac Mo Hydro Power JSC
22. A Vuong Hydro Power JSC
23. Song Ba Ha Hydro Power JSC
24. Ban Ve Hydro Power JSC
25. Thu Bon Hydro Power JSC
26. An Khe - Ka Nak Hydro Power JSC
27. Se San 4 Hydro Power JSC
28. Srepok Hydro Power JSC
29. Dong Nai Hydro Power JSC
30. Vinh Son - Song Hinh Hydro Power JSC
31. Thac Ba Hydro Power JSC
32. Da Nhim - Ham Tuan - Da Mi Hydro Power JSC
33. Pha Lai Thermal Power JSC
34. Ninh Bin h Thermal Power JSC
35. Ba Ria Thermal Power JSC
36. Hai Phong Thermal Power JSC
37. Quang Ninh Thermal Power JSC
38. EVN Finance JSC
39. EVN International JSC

Affiliates

1. Central Hydro Power JSC
2. Vietnam Power Development JSC
3. Se San 3A Hydro Power Investment & Development JSC
4. Vinh Tan 3 Energy JSC
5. Nhon Trach 2 PV Power JSC
6. Vietnam - Laos Power JSC
7. An Binh Commercial Joint Stock Bank
8. Global Insurance JSC
9. An Binh Security JSC
10. Saigon - Vina Real Estate JSC
11. EVN - Land Nha Trang Real Estate JSC
12. Central Power Real Estate JSC
13. Vietnam Electricity Power Investment & Construction JSC
14. Thuan Binh Wind Power JSC

Fig. 2.4-1 Organization of EVN (end of 2011)

2.5 POWER SECTOR REFORM ROADMAP

(1) Electricity Regulatory Authority of Vietnam (ERAV)

ERAV established[6] in 2005 under MOIT is responsible for the reform of Power Sector in Vietnam.

Based on the "Development Strategy for the period of 2004-2010 with vision to 2020" [7] and "Electricity Law" imposed in 2004, the reform of power sector is under process to overcome the lack of investment capital and inefficient performance of power sector by introducing power market. ERAV's main tasks are (a) power market development and regulation, (b) electricity price management and regulation, (c) electricity activities licensing and (d) inspection and dispute resolution in electricity activities.

(2) Establishment of Power Market

As the roadmap for the establishment of power market is shown in Fig. 2.5-1, the power market will consist of 3 stages, such as (a) Competitive Generation Market (CGM), (b) electricity wholesale market and (c) electricity retail market. And each stage has a pilot operation and a full operation. The CGM started in July 1, 2011 and completes in 2014.

Power plants, of which installed capacity is 30 MW or more except BOTs power plants, are required to participate in the Vietnam Competitive Generation Market (VCGM). Overall structure of CGM is shown in Fig. 2.5-2. System and Market Operator (SMO)[8] announces the required amount of generation energy for the next day by one hour basis, and Gencos make a bid[9] for SMO. SMO issues and dispatches order to Gencos in lower tender price order until the required power and energy are satisfied (spot market). Generated power and energy are transferred to the regional power corporations via NT and supplied to consumers by the regional power corporations. The regional power corporations pay electricity charge to the Single Buyer[10] in exchange of power receipt and the Single Buyer also pays electricity charge to Genco based on spot price in CGM and capacity payment stipulated in PPA concluded between Genco and EVN. The capacity payment accounts for 90 ~ 95% of total payment to Genco currently, but weight of the capacity payment is planned to be reducing gradually and the weight of spot price in CGM is planned to be increasing in future.

Metering Data Management Service Provider (MDMSP), of which services are recording power volume of transaction and providing such information to the Single Buyer and Genco, is also planned to be established in CGM. Since VCGM has just started and is now under pilot operation, the evaluation of VCGM has not been done yet. And a blueprint of an overall structure for future electricity market and electricity retail market has not been prepared yet

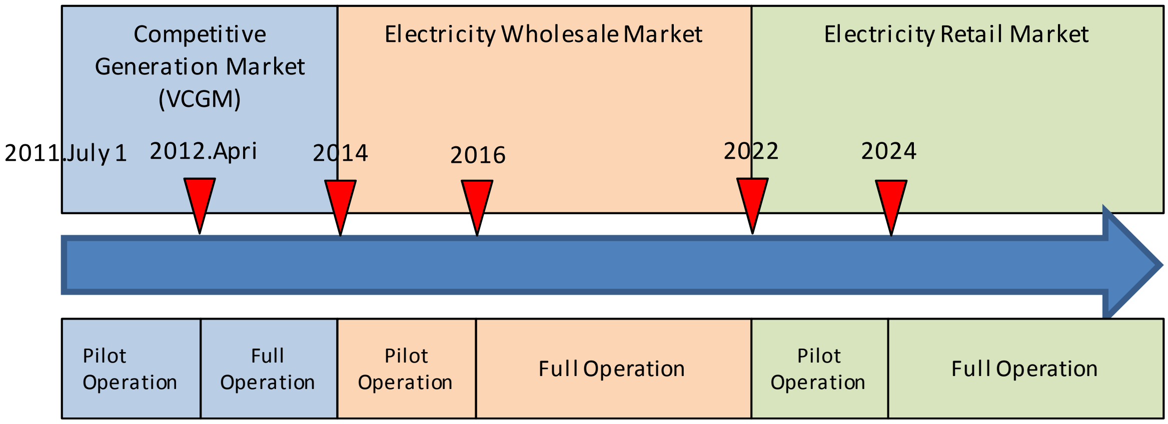
6 The Prime Minister's Decision (No.258/2005/QD-TTg), approved on October 19, 2005

7 Approved by the Prime Minister on October 5, 2004

8 National Load Dispatching Center (NLDC) under EVN plays the role of SMO at present and will be an independent organization in future.

9 The capped tender price for thermal power plants is the total amount of variable cost at 100% load and average start-up cost, and the minimum tender price is 1 VND/kWh. In case of hydropower plants, the capped tender price is 110% of the water value and the minimum tender price is 0 VND/kWh.

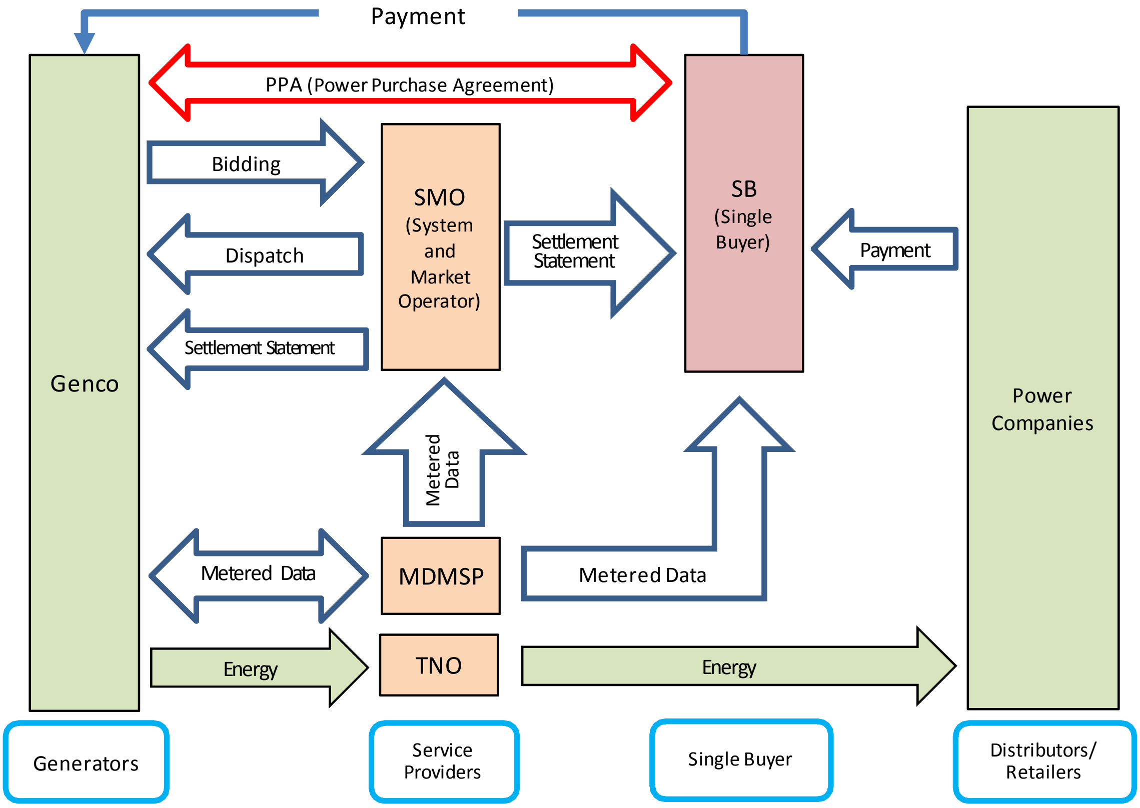
10 EVN is nominated as a single buyer for a time.



VCGM: Vietnam Competitive Generation Market

Source: Information by ERAV dated December 8, 2011

Fig. 2.5-1 Roadmap for Establishment of Power Market



Note: MDMSP; Metering Data Management Service Provider, TNO; National Power Transmission Corporation

Source: "Vietnam Competitive Generation Market, VCGM Overview", ERAV

Fig. 2.5-2 Overall Structure for Competitive Generation Market (CGM)

2.6 CURRENT SITUATION ON REVISION OF POWER TARIFF

(1) Revision of Power Tariff

Retail price of power tariff for consumers was amended by MOIT Degree (No.05/2011/TT-BCT) on March 1, 2011 and the average retail power tariff is resulted in 1,242 VND/kWh[11]. Table 2.6-1 shows the new retail power tariff structure. The retail power tariff in Table 2.6-1 is applicable to the consumers connected to the national grid. For the consumers not connected to the national grid, the retail price is set by the above degree as 1,863 VND/kWh for the minimum and 3,105 VND/kWh for the maximum.

Table 2.6-1 New Retail Power Tariff Structure

I	Retail Prices of Electricity for the Manufacturing Sector			
	STT	Subject to the Application Price		VND/kWh
	1	Electricity tariffs at voltage levels of 110 kV and above		
		a)	Normal hours	1,043
		b)	Off-peak hours	646
		c)	Peak hours	1,862
	2	Electricity tariffs at voltage levels from 22 kV to below 110 kV		
		a)	Normal hours	1,068
		b)	Off-peak hours	670
		c)	Peak hours	1,937
	3	Electricity tariffs at voltage levels from 6 kV to below 22 kV		
		a)	Normal hours	1,093
		b)	Off-peak hours	683
		c)	Peak hours	1,999
	4	Electricity tariffs at voltage levels lower than 6 kV		
		a)	Normal hours	1,139
		b)	Off-peak hours	708
		c)	Peak hours	2,061
II	Retail Prices of Electricity for Irrigation			
	STT	Subject to the Application Price		VND/kWh
	1	Electricity tariffs at voltage level from 6 kV and above		
		a)	Normal hours	956
		b)	Off-peak hours	497
		c)	Peak hours	1,415
	2	Electricity tariffs at voltage levels lower than 6 kV		
		a)	Normal hours	1,023
		b)	Off-peak hours	521
		c)	Peak hours	1,465
III	Retail Prices of Electricity for Administration Career			
	STT	Subject to the Application Price		VND/kWh
	1	Hospitals, Child Care, Preschool, School		
		a)	Electricity tariffs at voltage levels of 6 kV and above	1,117
		b)	Electricity tariffs at voltage levels lower than 6 kV	1,192
	2	Public Lighting		
		a)	Electricity tariffs at voltage levels of 6 kV and above	1,217
		b)	Electricity tariffs at voltage levels lower than 6 kV	1,291
	3	Administrative Units and Business		
		a)	Electricity tariffs at voltage levels of 6 kV and above	1,242
		b)	Electricity tariffs at voltage levels lower than 6 kV	1,291

IV	Retail Prices of Electricity for Business			
	STT	Subject to the Application Price		VND/kWh
	1	Electricity tariffs at voltage levels of 22 kV and above		
		a)	Normal hours	1,713
		b)	Off-peak hours	968
		c)	Peak hours	2,955
	2	Electricity tariffs at voltage levels from 6 kV to below 22 kV		
		a)	Normal hours	1,838
		b)	Off-peak hours	1,093
		c)	Peak hours	3,067
	3	Electricity tariffs at voltage levels lower than 6 kV		
		a)	Normal hours	1,862
		b)	Off-peak hours	1,142
		c)	Peak hours	3,193
V	Retail Prices of Electricity for Household			
	STT	Subject to the Application Price		VND/kWh
	1	For 50 kWh (for poor and low income)		993
	2	For 000 ~ 100 kWh (for regular household income)		1,242
	3	For 101 ~ 150 kWh		1,304
	4	For 151 ~ 200 kWh		1,651
	5	For 201 ~ 300 kWh		1,788
	6	For 301 ~ 400 kWh		1,912
	7	For 400 kWh and above		1,962

Definition of Normal, Peak and Off-peak hours

1	Monday ~ Saturday	
	1) Normal hours	
		04:00 ~ 09:30 (5.5 hours)
		11:30 ~ 17:00 (5.5 hours)
		20:00 ~ 22:00 (2.0 hours)
	2) Peak hours	
		09:30 ~ 11:30 (2.0 hours)
		17:00 ~ 20:00 (3.0 hours)
	3) Off-peak hours	
		22:00 ~ 04:00 (6.0 hours)
2	Sunday	
	1) Normal hours	
		04:00 ~ 22:00 (18.0 hours)
	2) Off-peak hours	
		22:00 ~ 04:00 (6.0 hours)

Source: MOIT Decree No.05/2011/TT-BCT effected on March 1, 2011

(2) Market-based Electricity Sales Price Adjustment

Prior to the competitive generation market starting from July1, 2011, the market-based electricity sales adjustment by the Prime Minister's Decision (No.24/2011/QD-TTg)[12] was put into force on June 1, 2011. According to the new decision, EVN was newly empowered in respect to setting power tariff structure to a certain extent, although the setting of power tariff structure had been a fully approved matter by the Prime Minister before the issuance of the new decision. And the establishment of price stabilization fund was also stipulated in the new decision. The relevant articles in the new decision are as follows;

11 Source: "MOIT Degree No.05/2011/TT-BCT", increase rate of 15.28 %

12 Approved by the Prime Minister on April 15, 2011

1) Principles of market-based electricity sale price adjustment (Article 4)

- In a fiscal year, electricity sale price can be only adjusted when there are changes to the basic input parameters (fuel cost, exchange rate and generation mix, which are out of control of generation companies) which are different from the ones used for calculating the current electricity sale price.

- The interval between 2 consecutive adjustments shall be 3 months as a minimum.

2) Mechanism and jurisdiction for adjusting electricity sale price (Article 5)

- In case the fuel price, foreign exchange rate at the point of calculation change compared to the parameters which were used to calculate the current electricity price and the generation mix changes compared to the generating plan approved by MOIT which cause sale price at the point of calculation increase compared to the current electricity price with the following levels:
  a. 5% then EVN is allowed to increase the electricity sale price at the corresponding level after having registered with and being approved by MOIT. Within 5 working days, MOIT is responsible to reply so that EVN can apply implementation. In case after 5 working days, MOIT does not reply, EVN is allowed to increase the sale price 5% and report to MOIT and Ministry of Finance (MOF) for monitoring.
  b. Over 5%, EVN shall report to the MOIT and send the proposal to MOF for appraisal. Within 5 working days after receiving the proposal from EVN, MOF is responsible for appraising and send its opinion to MOIT. MOIT is responsible for consolidating opinions and report to Prime Minister for review and approval after 5 working days after receiving the appraisal opinion from MOF.
  After 15 working days since the day MOIT submitted Prime Minister its recommendation, in case that the Prime Minister has not yet issued a response, EVN is allowed to increase the current sale price of 5%.

- At a point of calculation, in case fuel price, foreign exchange changes compared to the parameters used to determine the current electricity sales price and the generation mix changes to the generating plan approved by MOIT, which cause the current sale price at the point of calculation decreases from 5% and up in comparison with the current sale price, EVN decides to adjust the electricity sale price by the corresponding level and concurrently reports to MOIT for monitoring.

3) Price stabilization fund (Article 6)

- Price stabilization fund is formed for the purpose of electricity price stabilization.

- Sources for the Price stabilization fund are taken from electricity sale price and are included into electricity production and business costs.

4) Inspection, supervision of the electricity sale price adjustment (Article 7)

- MOIT inspects and supervises the implementation of electricity sale price adjustment. If necessary, MOIT sends EVN a formal instruction in writing to request EVN temporarily to halt the increase of electricity sales price or the adjustment for the subsequent adjustment. MOIT is allowed to invite independent consultants to inspect the dossier of electricity sales price adjustment.

- MOF monitors the implementation of electricity price adjustment; co-ordinates with MOIT to check the reasonability, eligibility of the differences of costs in comparison with the calculated figures in the electricity sale price proposal after having obtained data from consolidated financial reports and audited financial reports.

5) Implementation effect (Article 9)

- This Decision takes effect from 1/6/2011.

2.7 CURRENT SITUATION ON OTHER INTERNATIONAL DONORS' SUPPORT FOR POWER SECTOR IN VIETNAM (WORLD BANK AND ASIAN DEVELOPMENT BANK)

Table 2.7-1 and Table 2.7-2 show the projects in Power Sector in Vietnam supported by ADB and World Bank (WB) as of February 2012.

ADB supports 5 projects at present, such as (a) Mong Duong 1 Thermal Power Project - Project 1, (b) Power Transmission Investment Program, (c) Northern Power Transmission (Sector) Project, (d) Renewable Energy Development and Network Expansion and Rehabilitation for Remote Communes and (e) O Mon 4 Combined Cycle Power Plant Project. The 5 projects consist of 2 power source development projects and 3 transmission line related projects including others. Out of the 5 projects, 4 projects are on schedule and 1 project (Renewable Energy Development and Network Expansion and Rehabilitation for Remote Communes) is behind the schedule for 3 months due to the environmental related issue.

WB supports 7 projects at present and all projects are on schedule. The breakout of the 7 projects is (a) one power source development project such as VN-Trung Son Hydropower Project, and the remains are transmission line related projects such as Second Transmission and Distribution Project and rural electrification projects and so on. According to WB's information on February 3, WB has an intention to support the transmission line related projects and rural electrification projects within the limited financial source and has no plan to support the power source development in future.

And WB informed the Study Team that projects requesting for assistance by international financial institutes submitted by the Government of Vietnam were not discussed among the international financial institutions on which institute would support the projects, and EVN prepared projects list for each international financial institution in advance.

Table 2.7-1 (1/2) Current Situation for Power Sector in Vietnam (ADB)

Project No.	Project Name	Amount [Proposed]	Description	Outputs	Board Approval	Executing Agency	Current Situation as of Feb.2012
39595- 02	Mong Duong 1 Thermal Power Project - Project 1	USD 27.86 million	The main objective of the proposed project is to expand the generating capacity of Electricity of Viet Nam (EVN) in order to help mitigate shortage of power in Northern Viet Nam and to support industrial and economic growth. The Project provides for the construction of four units of 250 MW circulatory fluidized bed (CFB) generating units and the common facilities for another 1,000 MW to 1,200 MW installed generating capacity utilizing domestic coal as fuel. This constitutes as Phase 1 of the first stage development program envisaged to establish in two phases and increase the generating capacity of this new power station to 2,200 MW. The 2,000 MW Mong Duong Thermal Power Project will a mine mouth based power plant.	Recruitment of Implementation consultants Design Bidding Evaluation of EPC Packages Construction, installation testing and commissioning of Unit 1 by October 2013 and Unit 2 by May 2014 Implementation of environmental and social plans for: Implement EMP from Dec 2007 (ongoing) Implement resettlement plan Tranche 2 from Dec 2009	2-Oct-07	Viet Nam Electricity	On Shedule (ended by 2014)
42039- 04	Power Transmission Investment Program (MFF)	USD 730.00 million	The investment program will enhance the capacity of the transmission network to balance power loads in northern, central, and southern Viet Nam. It will (i) expand the electricity transmission infrastructure by constructing and upgrading 500 kilovolt (kV) and 220 kV transmission lines and associated substations, (ii) improve the operational effectiveness and efficiency of the National Power Transmission Corporation, and (iii) support the implementation of the investment program.	Component 1: Expanded Transmission Network Component 2: Improved Operational Effectiveness and Efficiency of NPT Component 3: Project Implementation Support	16-Dec-11	National Power Transmission Corporation	On schedule. Tranche 1: 2011-2015 Tranche 2: 2012-2013 Tranche 3: 2013/2014-2017 Tranche 4: 2016-2019
32273- 01	Northern Power Transmission (Sector) Project	USD 120.00 million	The objectives of the Project are to (i) expand and strengthen EVN's transmission system in the north to improve system reliability and quality; and (ii) improve the efficiency of the power sector by supporting restructuring and commercialization of EVN. The Project will support the power sector reform efforts by ensuring that EVN's generation units are corporatized and its four transmission units are merged into one prior to the establishment of a 'single-buyer' model of operation for EVN in 2007.	Expanded and upgraded 500 kV and 220 kV transmission systems Expanded and upgraded supervisory control and data acquisition (SCADA) and telecommunications system	13-Dec-04	Viet Nam Electricity	In three-month grace period (ended by March 31 2012)

Source : ADB Webiste and EVN

Table 2.7-1 (2/2) Current Situation for Power Sector in Vietnam (ADB)

Project No.	Project Name	Amount [Proposed]	Description	Outputs	Board Approval	Executing Agency	Current Situation as of Feb.2012
42182- 01	Renewable Energy Development and Network Expansion and Rehabilitation for Remote Communes Sector Project (Formerly Renewable Energy for Remote Communes Sector Project)	USD 151.00 million	The primary objective of the sector Project is to develop rural electrification and renewable energy in Viet Nam to benefit ethnic minority communities inhabiting remote and poorer parts of the country. The Renewable Energy Development and Network Expansion and Rehabilitation for Remote Communes Sector Project consists of two investment components: (i) mini-hydropower plants in mountain provinces, and (ii) network expansion and rehabilitation of distribution networks serving poor provinces.	1. Installation of 5 to 10 mini-hydropower plants to electrify mountainous communes. 2. Electrification of 1,000 villages through grid expansion.	30-Mar-09	Northern Power Corporation Southern Power Corporation Central Power Corporation	In progress with delay due to difficulties in safeguard policy expediment (environment, resettlement, compensation and ethnic minority people) Expected completion year 2015
43400- 01	O Mon 4 Combined Cycle Power Plant Project	USD 309.89 million	The project will construct a 750-megawatt (MW) combined cycle gas turbine (CCGT) power plant at the O Mon thermal power complex. The project is in O Mon district in the city of Can Tho, about 250 kilometers south of Ho Chi Minh City. The project will help Viet Nam meet the fast-growing demand for electricity to foster socioeconomic development and industrialization in the south, particularly in the Mekong Delta. The project is part of the least-cost Seventh Master Power Development Plan approved by the Government of Viet Nam in 2011.	CCGT O Mon IV power plant operational Common facilities for O Mon IV and O Mon III operational Capacity of the Implementing Agency strengthened	25-Nov-11	Viet Nam Electricity	On schedule Expected completion year: 2016

Source : ADB Webiste and EVN

Table 2.7-2 (1/2) Current Situation for Power Sector in Vietnam (World Bank)

Project ID	Project Name	Total Project Cos	Description	Approval Date (Closing Date)	Implementing Agency	Current Situation as of Feb. 2012
P084773	VN-Trung Son Hydropower Project	411.72 Millin USD	The objective of the Trung Son Hydropower Project for Vietnam is to improve, or at least restore, livelihoods and living standards of affected households and villages while allowing them to maintain their cultural identity. There are four components to the project. The first component of the project is dam and ancillary construction. Construction of main dam and appurtenant structures, supply and installation of hydraulic mechanical and electro-mechanical equipment, access roads, bridges, borrow pits and quarries, power supply lines for construction and provision of supporting consultant services. The second component of the project is transmission line. Construction of the transmission line to evacuate power from the plant during the operation phase. The third component of the project is social and environment impact management. Implementation of the resettlement, livelihoods and ethnic minorities' development program, the public health action plan and the environment management plan. The fourth component of the project is capacity development and scale-up. Building of Vietnam Electricity (EVN) capacity to prepare hydropower projects to international standards.	2011/4/26 (2017/12/31)	ELECTRICITY OF VIETNAM	On shchedule
P114875	Second Transmission and Distribution Project Additional Financing	180 Million USD	The objective of the Additional Financing for the Second Transmission and Distribution Project is to assist the borrower in developing efficient electricity transmission and distribution system, thus enabling the timely evacuation of power from new electricity generation plants to growing load centers and the maintenance of system security and reliability and power quality; and contribute to the restructuring of the borrower's power sector. The additional financing will scale up the transmission system expansion and reinforcement subcomponent of the project so as to support efficient development of Vietnam's power transmission system. This subcomponent comprises 500 kilovolt (kV) and 220kV transmission lines and substations. A small amount of additional financing (US$0.50 million) will be added to component 3 - transition to market - to upgrade the capacity of the newly established National Power Transmission Company (NPT) to efficiently plan and finance its investment program and operations in a financially sustainable manner. The project development objective is to support the efficient development of Vietnam's transmission and distribution system.	2011/3/29 (2014/06/30)	VIETNAM ELECTRICITY	On shchedule
P103238	Vietnam Renewable Energy Development Project	318.05 Million USD	The objective of the Renewable Energy Development Project for Vietnam is to increase the supply of electricity to the national grid from renewable energy sources on a commercially, environmentally, and socially sustainable basis. There are three components to the project. The first component of the project is renewable energy investments. The second component of the project is regulatory development. This component will provide technical assistance for developing the regulatory infrastructure and building the requisite capacities of MOIT, the electricity regulatory authority of Vietnam, and other relevant government agencies for renewable energy development particularly for grid-connected electricity generation projects not exceeding 30 MW. The third component of the project is pipeline development. This component will support activities to facilitate the development of further renewable energy projects contributing directly to building a pipeline of renewable energy projects.	2009/5/5 (2014/06/30)	MINISTRY OF INDUSTRY AND TRADE	On shchedule

Source : ADB Webiste and EVN

Table 2.7-2 (2/2) Current Situation for Power Sector in Vietnam (World Bank)

Project ID	Project Name	Total Project Cost	Description	Approval Date (Closing Date)	Implementing Agency	Current Situation as of Feb. 2012
P099211	Rural Distribution Project	206.28 Million USD	The objective of the Rural Distribution Project is to improve the reliability and quality of medium voltage service to targeted retail electricity distribution systems. There are seven components to the project.	2008/5/22 (2013/06/30)	ELECTRICITY OF VIETNAM	On shchedule
P084871	Second Transmission and Distribution Project	212.27 Million USD	The objective of the Second Transmission and Distribution Project for Vietnam is the efficient development of Vietnam's transmission distribution system. The project consists of the following components: Component 1) will build new, or reinforce existing, 500, 220 and 1 l0kV transmission and distribution lines and substations. Component 2) consists of (i) the supply and installation of a supervisory control and data acquisition and energy management system (SCADA/EMS) for the national load dispatch center (NLDC) with integral market and meter management systems; (ii) replacement of the existing VietPool Interim Market System with a full-function market management system; and (iii) improving the telecommunications backbone to support the new systems. Component 3) will provide support to Electricity of Vietnam (EVN) to develop its transmission business as a separate entity and establishment of an internal power market, with particular focus on: (i) enabling it to manage power market operations; (ii) reviewing future investments in transmission and regional interconnections; (iii) developing a generation expansion investment plan; (iv) preparing a business plan; and (v) providing training and support in development of a power market.	2005/7/28 (2014/06/30)	MINISTRY OF INDUSTRY/ELECTRICITY CORPORATION OF VIETNAM	On shchedule
P074688	Second Rural Energy Project	324.25 Million USD	The objective of the Additional financing for Second Rural Energy Project is to improve access to good quality, affordable electricity services to rural communities in an efficient and sustainable manner, to support Vietnam's efforts towards socioeconomic development. The global environment objective is to reduce greenhouse gas emissions by improving and sustaining the energy efficiency of local distribution utilities. The additional credit will help finance the costs associated with: (a) completion of the original project activities as a result of an unanticipated financing gap. It will enable completion o f the original target of about 1,200 communes, compared with the current expectation of about 968; and (b) implementation of expanded activities that will scale up the project's impact and development effectiveness by increasing the number of communes from 1,200 to 1,500. As a result of the two uses of the additional financing, an estimated 532 communes or about 5 50,000 households will receive access to good quality, affordable electricity.	2004/11/18 (2014/06/30)	MINISTRY OF INDUSTRY, ELECTRICITY OF VIETNAM	On shchedule
P066396	System Efficiency Improvement, Equitization & Renewables Project	347.9 Million USD	The objective of the Project is to improve the overall efficiency of power system services, particularly to the poor in rural areas, by optimizing the transmission systems, and upgrading sub-transmissions, and medium voltage distribution lines for rural electrification.	2002/6/25 (2012/12/31)	ELECTRICITY OF VIETNAM (EVN)/MINISTRY OF INDUSTRY (MOI)	On shchedule

Source : ADB Webiste and EVN

CHAPTER 3

NECESSITY OF THE PROJECT

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3.1 POSITION OF O MON 3 POWER PLANT IN THE PDP7

According to the PDP7, O Mon 3 power plant is planned to be put into operation in 2015 and the reserve margin in the southern region will be recovered to 5.2% in combination with implementation of other power plants. However the reserve margin of 5.2% seems still low in comparison with the average reserve margin of 8% in Japan. Therefore, once the similar drought as well as 2010 occurs in 2015, the southern region will be suffered from power supply shortage due to the less generation energy by hydropower plants, even though O Mon 3 power plant starts the operation.

On the other hand, EVN expected as of December 2011 that O Mon 3 power plant could be put into operation in 2016. The contribution of O Mon 3 power plant to the reserve margin of 22.6% in 2016 is demonstrated in Table 3.1-1. If O Mon 3 cannot be put into operation in 2016, power supply will decrease by 3.5% and the reserve margin will decrease to 18.3%.

And as mentioned in Section 2.2, the concrete developer for O Mon 2 has not been fixed yet at present. Therefore, commencement of commercial operation of O Mon 2 power plant in 2016 as scheduled in the PDP7 seems to be impossible. According to CTTP's information, O Mon 2 power plant is expected to be put into operation in 2017. If O Mon 3 power plant cannot be put into operation in 2016 and operation of O Mon 2 power plant is delayed in 2017, the reserve margin in the southern region in 2016 will reduced to 14.0%. The reserve margin of 14.0 % seems absolutely insufficient for Vietnam which largely depends on power generation produced by hydropower plants because severe planned blackout occurred in the northern and southern regions in 2010 in spite of the average reserve margin of 38.1 %[1] for whole country in 2010.

Based on the above discussion, if the operation of O Mon 3 power plant is delayed in 2017, the southern region will be suffered from power supply shortage in 2016 and power supply shortage in the southern region will continue from the year 2012 to 2016.
For the above reason, O Mon 3 power plant will play the important role in the PDP7.

Table 3.1-1 Contribution of O Mon 3 Power Plant (750 MW) in 2016

Operation of O Mon 2	O Mon 3 power plant	Power Demand	Power Supply	Reserve Margin
Year 2016	With operation	17,556 MW	21,515 MW (100 %)	22.6 %
	Without operation	17,556 MW	20,765 MW (96.5 %)	18.3 %
Year 2017	With operation	17,556 MW	20,765MW (100 %)	18.3 %
	Without operation	17,556 MW	20,015 MW (96.4 %)	14.0 %

1 According to IE's information, the peak demand in 2010 was 15,416 MW and installed capacity was 21,297 MW. Therefore, the reserve margin in 2010 was 38.1 %.

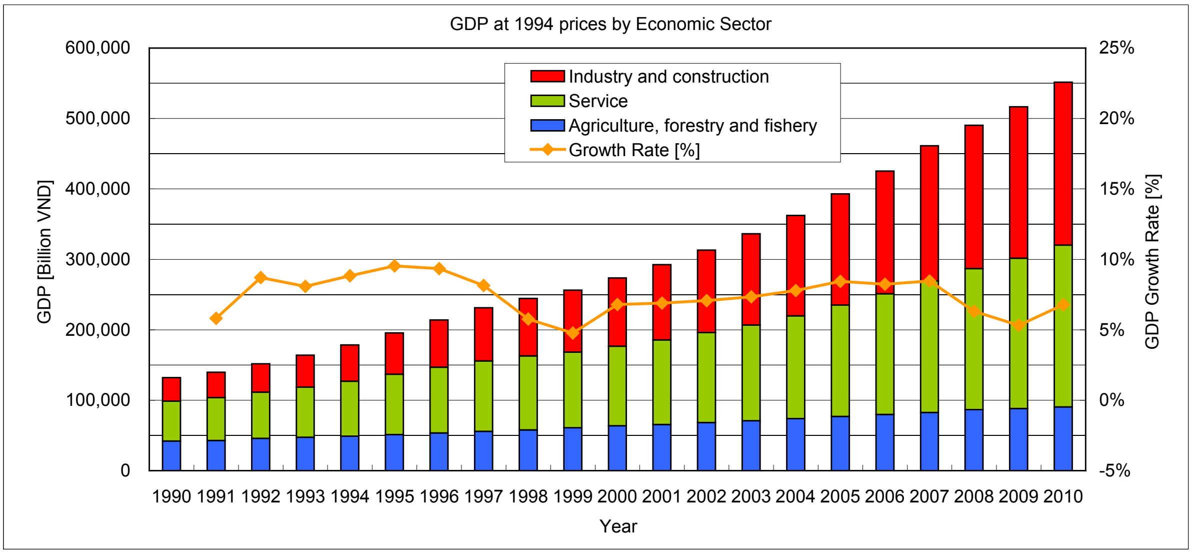
3.2 ECONOMIC CONDITION OF THE SOUTHERN AND MEKONG DELTA REGIONS

3.2.1 Economic Condition of Vietnam

(1) Economic Trend of Vietnam

Vietnam has experienced rapid economic growth of 7 to 9% after 1990's under "Doi Moi" policy (Renovation) focusing on market oriented economic management. Furthermore, Vietnam attracts worldwide attention after joining to World Trade Organization (WTO) as the 150th member in 2007. As for the economical relation between Japan and Vietnam, economic relation will be expected to expand more than ever after the conclusion and validation of Economic Partnership Agreement (EPA) in 2008.[2]

As shown in Fig. 3.2-1, the high economic growth rate (GDP) has been maintained except 1999 of which growth rate was less than 5% in GDP and its growth by economic sector indicate that the growth of the Industry & Construction Sector is remarkable to be the leader of the economy.



Unit: Billion VND

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Industry and construction	58,550 30%	67,016 31%	75,474 33%	81,764 33%	88,047 34%	96,913 35%	106,986 37%	117,125 37%	129,399 38%	142,621 39%	157,867 40%	174,259 41%	192,065 42%	203,554 42%	214,799 42%	231,336 42%
Service	85,698 44%	93,240 44%	99,895 43%	104,966 43%	107,330 42%	113,036 41%	119,931 41%	127,770 41%	136,016 40%	145,897 40%	158,276 40%	171,391 40%	186,562 40%	200,317 41%	213,601 41%	229,660 42%
Agriculture, forestry and fishery	51,319 26%	53,577 25%	55,895 24%	57,866 24%	60,895 24%	63,717 23%	65,618 22%	68,352 22%	70,827 21%	73,917 20%	76,888 20%	79,723 19%	82,717 18%	86,587 18%	88,166 17%	90,613 16%
Total	195,568	213,834	231,265	244,597	256,273	273,667	292,536	313,248	336,243	362,436	393,032	425,374	461,345	490,459	516,567	551,610
Growth Rate [%]	9.5%	9.3%	8.2%	5.8%	4.8%	6.8%	6.9%	7.1%	7.3%	7.8%	8.4%	8.2%	8.5%	6.3%	5.3%	6.8%

Source: GSO (General Statistics Office of Vietnam)

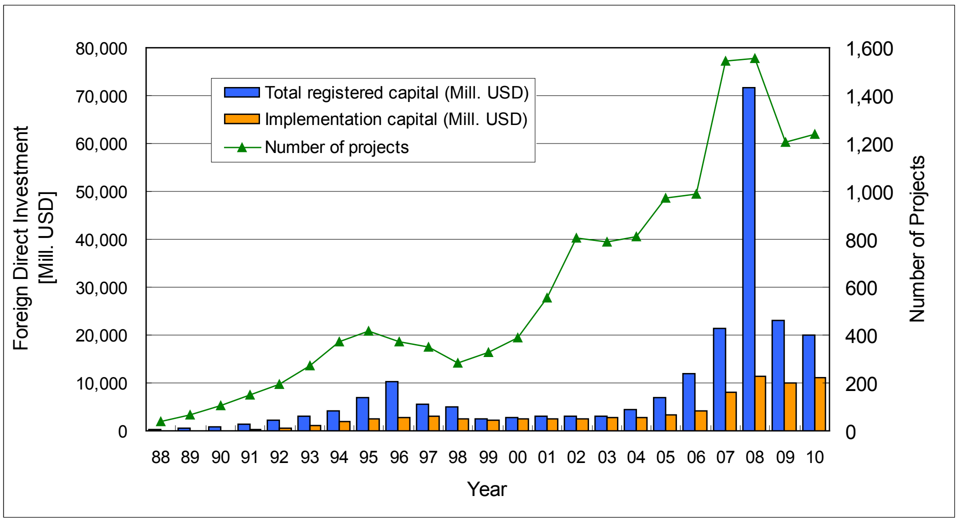
Fig. 3.2-1 Economic Growth of Vietnam

2 JETRO Ho Chi Minh Office "Industry Analysis of Vietnam", 2010

(2) Foreign Direct Investment (FDI)

FDI to Vietnam increased rapidly to reach 10,000 million USD (registered capital) in 1996 in the context of legislation of Foreign Investment Law in 1988 and removing the economic sanctions by USA. After 1997, with the exception of some periods due to Asian currency crisis, FDI has been increasing rapidly. This is because that receiving FDI was ready for the Vietnam side by reviewing and improving of the legal system, development of IPs, and preparation of receiving foreign companies. Furthermore, foreign investors paid considerable attention to offset the risk and to avoid excessive concentration of China.

Accession to WTO in 2007 accelerated FDI to reach 71.7 billion USD of registered capital and 11.5 billion USD of implementation capital in 2008 as shown in Fig.3.2-2. Though FDI decreased rapidly in 2009 due to Lehman's fall to 21.5 billion USD of registered capital in 2009, it seems to be recovered after 2010.[3]



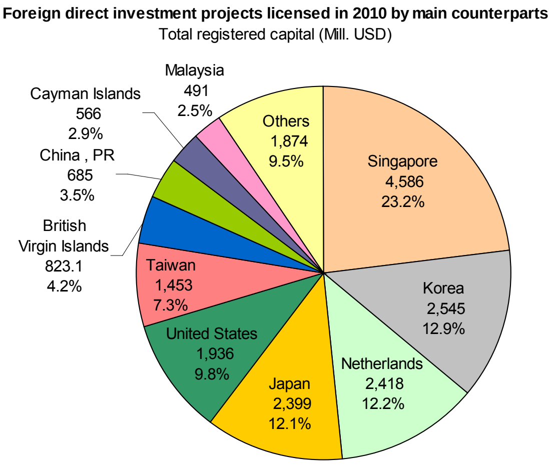
Source: GSO

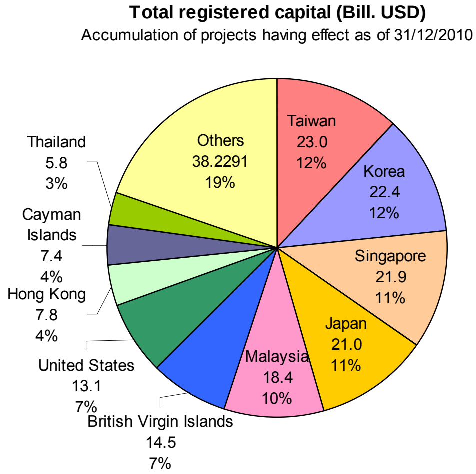
Fig. 3.2-2 FDI to Vietnam

(3) FDI from Each Country

Among the total of FDI to Vietnam on the base of registered capital of 19.8 billion USD in 2010, the largest amount of FDI comes from Singapore followed by Korea, Netherland, and Japan as the larger investment countries (Fig.3.2-3(1)). Fig. 3.2-3(2) shows the FDI accumulated until December 2010 and indicates that the largest amount of Taiwan is followed by Korea, Singapore, and Japan.

[3] JBIC: Investment Environment in Vietnam, 2011





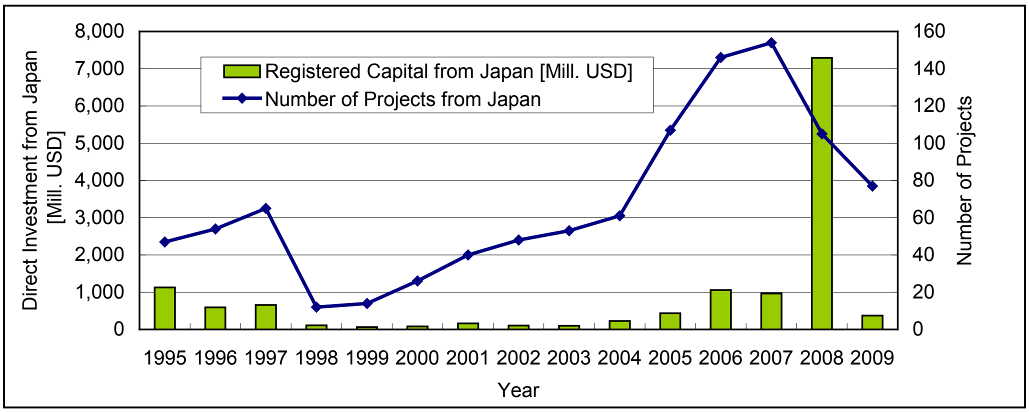
Source: GSO

Fig. 3.2-3 (1) FDI in 2010 by Main Countries

Fig. 3.2-3(2) Accumulated FDI by Main Countries as of December 2010

(4) Direct Investment from Japan

Direct investment from Japan to Vietnam has increased after legislation of Vietnam Investment Law and recommencement of Official Development Assistance (ODA) in 1990's. Though investment stayed stagnant for a while in the effect of Asian Currency Crisis, investment from Japan increased rapidly after around 2004 on the background of establishment of IPs and preparation of receiving Japanese companies (Fig.3.2-4).



Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total Registered Capital [Mill.USD]	6,524	8,497	4,737	3,658	1,567	1,989	2,192	1,558	1,914	2,222	4,002	7,570	17,885	71,726	21,482
Registered Capital from Japan [Mill. USD]	1,130	591	657	108	62	81	164	102	100	224	437	1,056	965	7,288	373
Number of Projects from Japan	47	54	65	12	14	26	40	48	53	61	107	146	154	105	77
Proportion of Japan to Total Investment [%]	17.3%	7.0%	13.9%	3.0%	4.0%	4.1%	7.5%	6.5%	5.2%	10.1%	10.9%	13.9%	5.4%	10.2%	1.7%

Source: JETRO, Ministry of Planning and Investment (MPI), GSO

Fig. 3.2-4 Trend of Direct Investment from Japan

3.2.2 Economic Condition of the Southern and Mekong Delta Regions

Most of the FDI to Vietnam has been coming to the Southern Region from the period of investment boom started after 1990's to 2000. One of the reasons is that infrastructures such as roads and electricity were developed earlier than other regions from the period of the Vietnam War by the United States of America. Furthermore, the most important reason is that preparation for receiving FDI was made from the earlier period by improving industrial infrastructures and developing IPs and Export Processing Zones (EPZs) so that investors can start new business easily. As shown in below, the Southern Region plays the most important role in the economy and industry, while shortage of electricity is one of the most important issues.

(1) Population, Income and Consumption per Capita

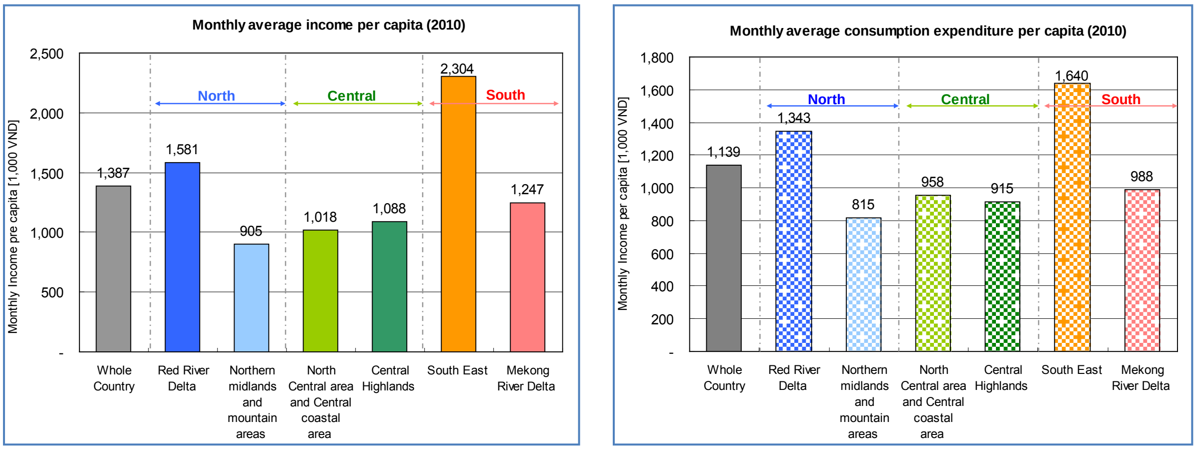
As shown in Table 3.2-1, the population in whole Vietnam is approximately 87 million, including 30 million each in the Northern and the Southern Regions and 24 million in the Central Region. The Population density of the Southern Region is the highest as 497 persons/km^2 while those of the Northern and Central Regions are 266 persons/km^2 and 160 persons/km^2, respectively. As shown in the Fig. 3.2-5, the income and consumption of the Southern Region is the highest, and it can be said that the Southern Region is attractive also for the market.

Table 3.2-1 Trend of Population for Each Region

Average population by province (Thousand persons)												
	Population Density (2010)	Area (km^2) (*)	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total	263	331,051	78,621	79,538	80,467	81,436	82,392	83,311	84,219	85,119	86,025	86,928
	(person/km^2)	*(100%)*	*(100%)*	*(100%)*	*(100%)*	*(100%)*	*(100%)*	*(100%)*	*(100%)*	*(100%)*	*(100%)*	*(100%)*
North	266	116,402	28,572	28,873	29,177	29,489	29,775	30,013	30,233	30,471	30,692	30,939
	(person/km^2)	*(35%)*	*(36%)*	*(36%)*	*(36%)*	*(36%)*	*(36%)*	*(36%)*	*(36%)*	*(36%)*	*(36%)*	*(36%)*
Central	160	150,526	22,673	22,850	23,021	23,203	23,377	23,528	23,677	23,835	23,985	24,150
	(person/km^2)	*(45%)*	*(29%)*	*(29%)*	*(29%)*	*(28%)*	*(28%)*	*(28%)*	*(28%)*	*(28%)*	*(28%)*	*(28%)*
South	497	64,124	27,376	27,815	28,270	28,745	29,240	29,770	30,308	30,813	31,349	31,839
	(person/km^2)	*(19%)*	*(35%)*	*(35%)*	*(35%)*	*(35%)*	*(35%)*	*(36%)*	*(36%)*	*(36%)*	*(36%)*	*(37%)*

(*) Area data as of 01 January 2009 according to Decision No. 2097b/QD-BTNMT dated 29 October 2009 of Minister of the Ministry of Natural Resources and Environment.

Source: GSO



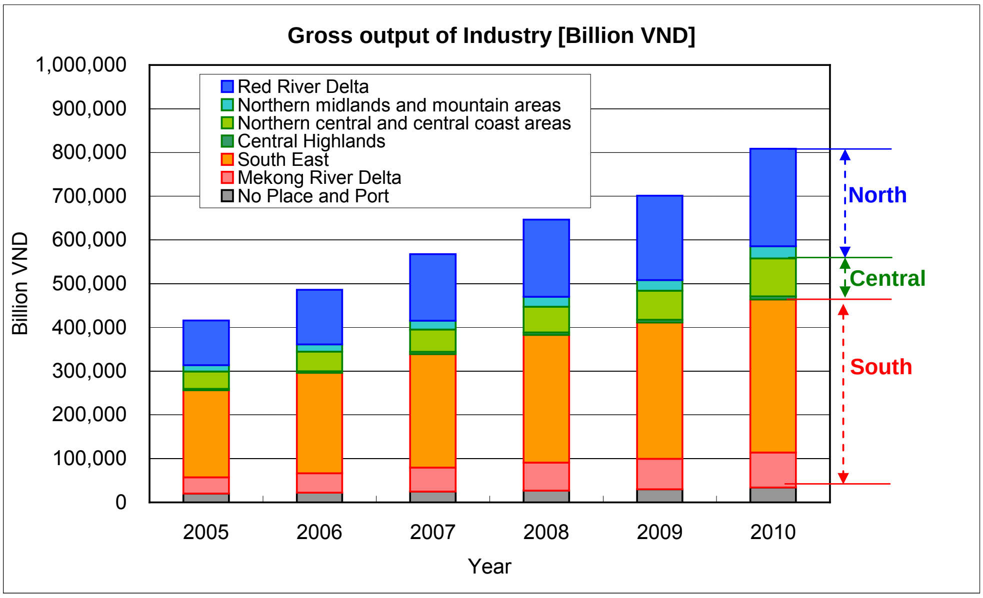
Source: GSO

Fig. 3.2-5 Monthly Average Income per Capita for Each Region and Monthly Average Consumption per Capita for Each Region

(2) Gross Output of Industry

Gross output of industry has been increasing every year as shown in Fig.3.2-6. Among that the output of industry in the Southern Region is more than 50% (53% in 2010) of the total output. This indicates that the Southern Region plays the most important roles for industries which lead the Vitamin economy.

	Gross output of Industry 2009 at Constant 1994 Prices (Bill.VND)						
		2005	2006	2007	2008	2009	2010
	Total	415,895.8	485,896.0	567,448.3	646,353.0	701,183.8	808,745.4
		(100%)	*(100%)*	*(100%)*	*(100%)*	*(100%)*	*(100%)*
	North (A ~ B)	116,798.1	141,346.0	172,132.9	199,089.3	217,006.5	251,079.0
		(28%)	*(29%)*	*(30%)*	*(31%)*	*(31%)*	*(31%)*
A	Red River Delta	102,314.4	124,573.0	152,283.6	176,474.9	192,753.7	223,179.1
B	Northern midlands and mountain areas	14,483.5	16,772.8	19,849.0	22,614.1	24,252.5	27,899.6
	Central (C ~ D)	42,881.5	48,577.9	56,117.1	64,553.6	73,126.4	93,885.7
		(10%)	*(10%)*	*(10%)*	*(10%)*	*(10%)*	*(12%)*
C	Northern central and central coast areas	39,374.5	44,503.0	51,223.3	58,605.5	66,734.4	86,484.1
D	Central Highlands	3,506.9	4,074.8	4,893.7	5,948.0	6,391.9	7,401.5
	South (E ~ F)	236,297.2	273,651.5	314,600.9	356,098.7	380,942.3	429,577.2
		(57%)	*(56%)*	*(55%)*	*(55%)*	*(54%)*	*(53%)*
E	South East	198,896.8	229,296.0	259,909.2	291,716.4	311,715.6	349,591.7
F	Mekong River Delta	37,399.9	44,355.0	54,691.2	64,381.8	69,226.3	79,985.1
G	No Place and Port	19,919.8	22,321.5	24,598.3	26,612.3	30,109.4	34,204.3
		(5%)	*(5%)*	*(4%)*	*(4%)*	*(4%)*	*(4%)*



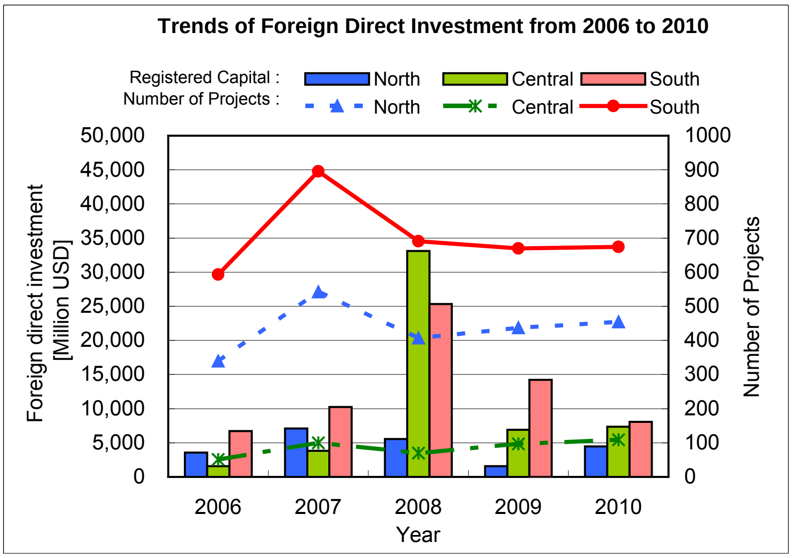
Source: GSO

Fig. 3.2-6 Gross Output of Industry for Each Region

(3) FDI for Each Region

Recent trend of FDI for each region is shown in Fig.3.2-7. FDI for the Southern Region is the highest 54 % of the total 1,200 projects and 41% of the total 2 billion USD in 2010. FDI for the Southern Region is the highest not only the project number but also the registered capitals.

The Southern Region has been the most important region for FDI because of improved infrastructures and development of numbers of IPs available for foreign enterprises. The accumulated number of project and total capital until 2010 shown in Fig. 3.2-8 indicate that the Southern Region is overwhelming to the other regions in both number of projects and investment amount.



Number of projects

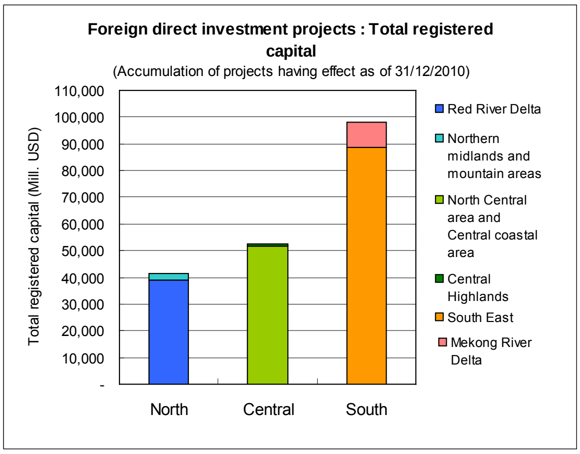
	North	Central	South
2006	339 (34%)	51 (5%)	593 (60%)
2007	542 (35%)	100 (7%)	896 (58%)
2008	407 (35%)	70 (6%)	691 (59%)
2009	437 (36%)	97 (8%)	670 (56%)
2010	454 (37%)	109 (9%)	674 (54%)

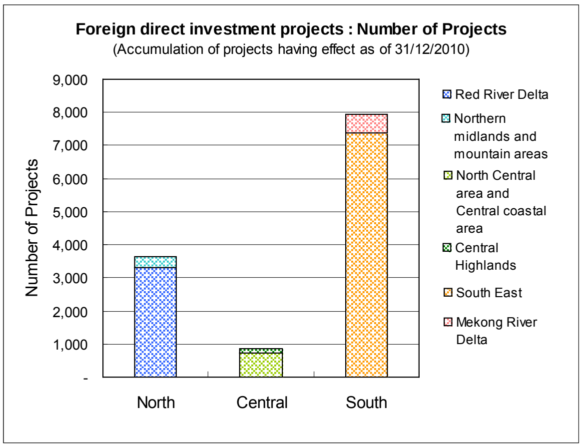
Total registered capital (Mill. USD)

	North	Central	South
2006	3,578 (30%)	1,575 (13%)	6,734 (57%)
2007	7,094 (34%)	3,829 (18%)	10,244 (48%)
2008	5,553 (9%)	33,108 (52%)	25,334 (40%)
2009	1,580 (7%)	6,912 (30%)	14,220 (63%)
2010	4,475 (23%)	7,341 (37%)	8,070 (41%)

Source: GSO

Fig. 3.2-7 FDI for Each Region (2006 - 2010)





Source: GSO

Fig. 3.2-8 FDI accumulated until 2010 for Each Region
(Left: Registered Capital, Right: Number of Projects)

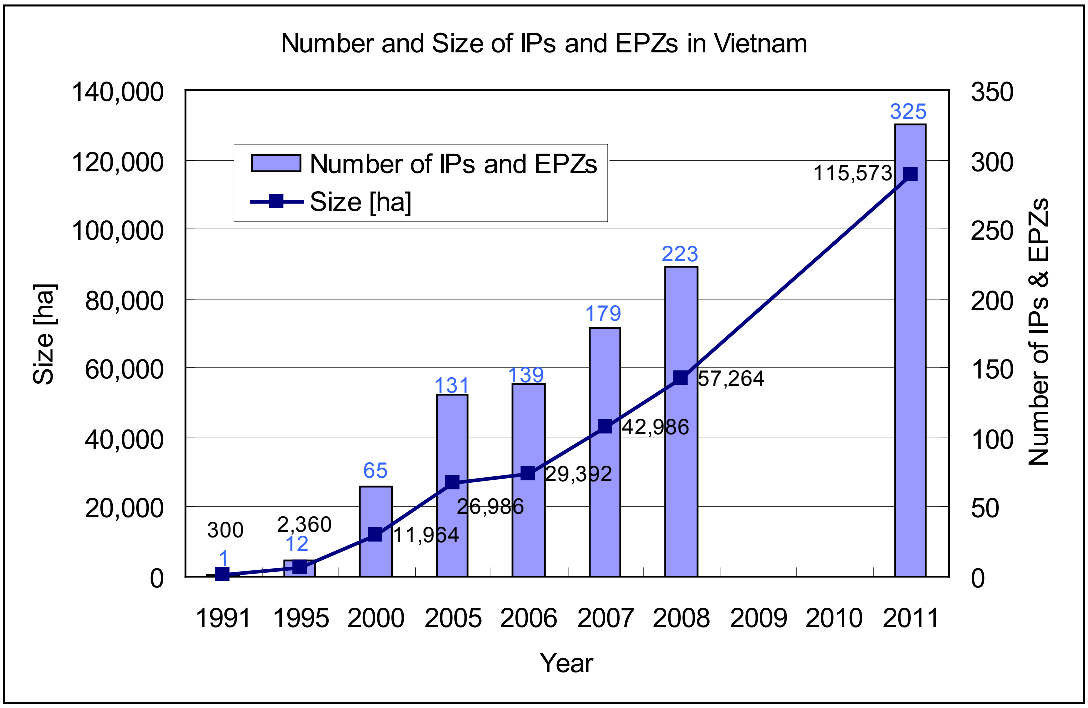
3.3 OVERVIEW OF IPS AND JAPANESE COMPANIES IN THE SOUTHERN REGIONS

3.3.1 Overview of IPs in Vietnam

Vietnam government established the system of IPs, EPZs, and High-Tech Parks - collectively means IPs -, to promote investment for industrial products, exports, and high-tech products. Companies in these Industrial Zones for manufacturing and related service business of industrial products, exports and high-tech products are given preferential treatment for corporate income taxes, export taxes and import taxes.

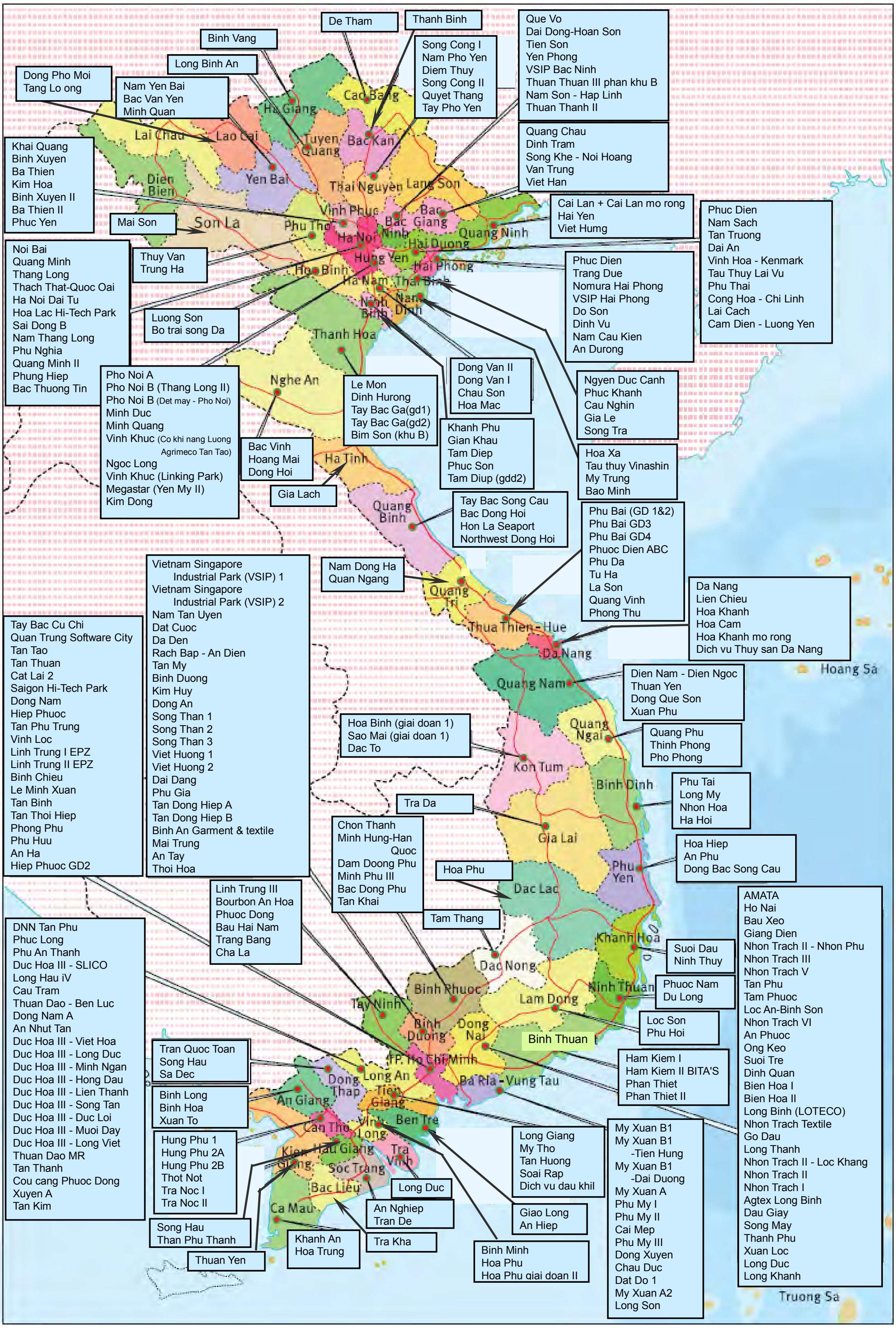
The number and size of IPs have been increasing as shown in Fig.3.3-1. As for electricity supply, IPs were suffered from power shortage and planned blackout in 2010 due to drought from the previous year though electricity were to be distributed to IPs preferentially.

Fig.3.3-1 shows distribution map of IPs.



Source: The Study Team prepared based on MPI "Vietnam's IPs, EPZs and Economic Zones (EZs)" (2009)

Fig. 3.3-1 Number and Size of IPs in Vietnam



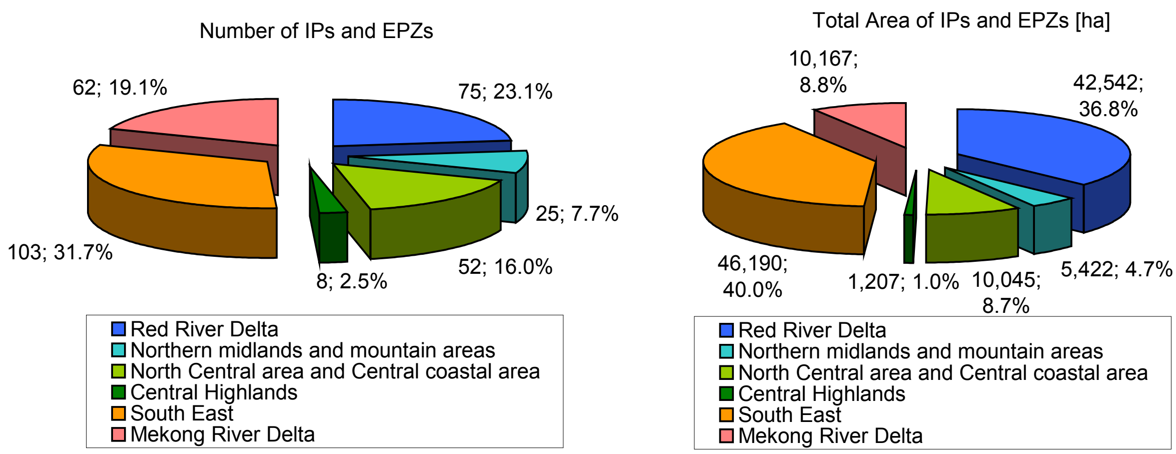
Source: The Study Team prepared based on MPI "Vietnam's IPs, EPZs and EZs"(2009)

Fig. 3.3-2 Distributions of IPs

3.3.2 IPs in the Southern Region

(1) Interregional Comparison of IPs

Numbers and sizes of IPs for each region are shown in Fig.3.3-3. The number and size of the Southern Region is the largest of all the region while 50.8% in the number (Northern 30.8%, Central 18.5%) of the total, and 48.8% in the size (Northern 41.5%, Central 9.7%). Of the Southern Region, Southern eastern region covers 31.7% in the number and 40.0% in the size, the Mekong region covers 19.1% and 8.8% respectively.



Source: MPI, JETRO

Fig. 3.3-3 Number and Size of IPs and EPZs of Each Region

(2) Overview of IPs in the Southern Region

There are IPs, EPZs and High-tech Parks in the Southern Region, 60% of them are concentrated in Ho Chi Minh City, Dong Nai Province and Binh Duong Province. Though electricity for these IPs has been supplied by EVN, planned blackout was executed in some areas due to power shortage in 2010.

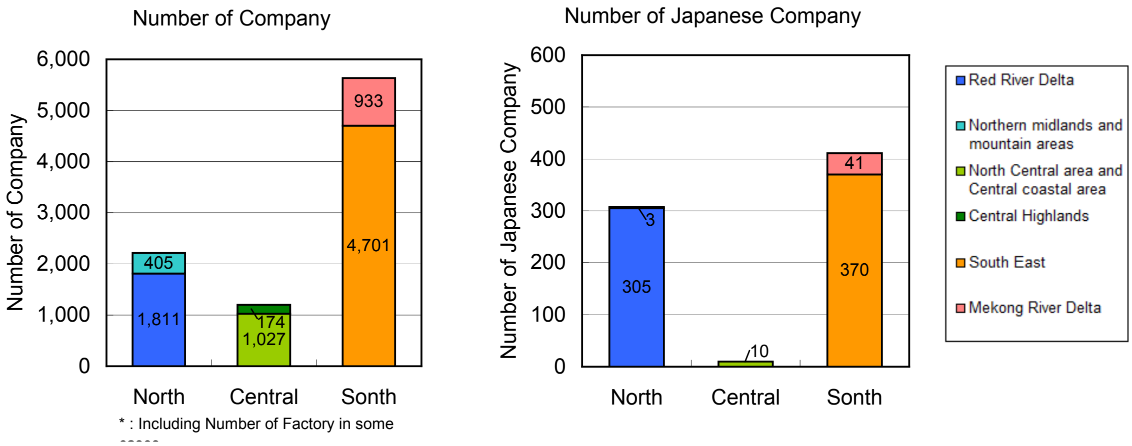
(3) Current Situation of Japanese Companies in the Southern Region

Fig.3.3-4 indicates that number of companies of IPs locate in the Southern Region is the largest. The number of Japanese companies is the largest in the Southern Region. These facts indicate that the Southern Region plays quite important role for industrial production in Vietnam.

The list of IPs in the Southeastern and Mekong Delta Region is shown in Table 3.3-1. This list was updated in the Study Team based on the list provided by Ministry of Planning and Investment (MPI) and information from JETRO. According to this list as of February 2012, the number of IPs is 103 in the Southeast, 62 in the Mekong Delta, and 165 in total of the Southern Region. The number of the company in the IPs in the Southern Region is the largest, 4,701 companies, including 411 Japanese companies.

As for the electricity demand and supply, blackout took place so often especially in the IPs in the Southern Region in the period of power shortage in 2010 due to water shortage. The same information was also obtained in the interviews not only at MPI but also JETRO Ho Chi Minh

Office. One of the most important and basic issue for the IPs in the Southern Region is the problem of electricity supply. Developing new power source in the Southern Region is important and prioritized issues for developing IPs and economy in Vietnam. JETRO Ho Chi Minh Office held a seminar on December 15, 2011 relating to "Current Status of the Power Supply and its Vision in Vietnam", and about 100 Japanese firms participated in the seminar. This fact indicates that how Japanese firms take much interest in the current shortage of power supply in the Southern Region.



Source: MPI, JETRO

Fig. 3.3-4 Numbers of Companies in IPs of Each Region (Left: Total, Right: Japanese)

Table 3.3-1 List of IPs in the Southern Region (1/3)

		Industrial Zone	Year of Establishment	Total Area [ha]	Industrial Area [ha]	Leased Area [ha]	Number of Company*	Japanese Company	Soure ce
		South					**5,634**	**411**	
		South East		46,190 ha			**4701**	**370**	
1		**Binh Phuoc**					**82**	**0**	
	1	Chon Thanh	2003	120	73	41	21		2,3
	2	Minh Hung-Han Quoc	2007	194	132	122	52		3
	3	Dam Doong Phu	2008	72	44				3
	4	Minh Phu III	2008	292	178	49	2		3
	5	Bac Dong Phu	2010	184	126	26	5		3
	6	Tan Khai	2010	46	34	4	2		3
2		**Tay Ninh**					**234**	**13**	
	1	Linh Trung III	2002	203	132	101	139	13	1,3
	2	Bourbon An Hoa	2010	1,020	760	15	12		1,3
	3	Phuoc Dong	2010	3,276	2,190	1,418	6	0	1,3
	4	Bau Hai Nam		191	114	0			1
	5	Trang Bang	1999	191	133	131	75		2,3
	6	Cha La	2009	43	32	20	2		3
3		**Binh Duong**					**1697**	**150**	
	1	Bau Bang	2007	2,000	100	300	40	6	1,3
	2	My Phuoc I ~ IV	2002	4,200	1,700	1,300	340	37	1,2,3
	3	Ascendas-Protrade Singapore Tech Park		500	500				1
	4	Dong An II	2007	158	101	60	22	2	1,3
	5	Vietnam Singapore Industrial Park (VSIP) 1	1996	500	483	483	241	59	1,2,3
	6	Vietnam Singapore Industrial Park (VSIP) 2	2004	6,345	1,345	445	170	38	1,3
	7	Nam Tan Uyen	2005	331	204	185	86	2	1,3
	8	Dat Cuoc	2007	212	131	67	30	1	1,3
	9	Da Den		274	166	75	34	1	1
	10	Rach Bap - An Dien	2005	279	188	10	6	1	1,2,3
	11	Tan My		117	100	10	5		1
	12	Binh Duong	1997	17	14	14	12		2,3
	13	Kim Huy	2006	214	145	76	11		2,3
	14	Dong An	1996	139	93	93	147		2,3
	15	Song Than 1	1995	178	140	140	211		2,3
	16	Song Than 2	1996	279	217	214	128	3	2,3,4
	17	Song Than 3	2007	534	327	141	23		2,3
	18	Viet Huong 1	1996	36	25	25	69		2,3
	19	Viet Huong 2	2004, 2007	250	169	123	29		2,3
	20	Dai Dang	2005	274	166	74	33		2,3
	21	Phu Gia	2007	133	86	17	2		2,3
	22	Tan Dong Hiep A	2001	53	37	37	18		2,3
	23	Tan Dong Hiep B	2002	163	103	86	32		2,3
	24	Binh An Garment & textile	2004	26	19	19	5		2,3
	25	Mai Trung	2005	51	35	22	3		2,3
	26	An Tay	2007	500	335				3
	27	Thoi Hoa	2004	202	135				3
4		**Dong Nai**					**1049**	**94**	
	1	AMATA	1994, 2002	494	314	298	124	55	1,2,3
	2	Ho Nai	1998, 2007	497	301	139	90		1,2,3
	3	Bau Xeo	2006	500	328	307	25		1,2,3
	4	Giang Dien	2008	529	325		2		1,2,3
	5	Nhon Trach II - Nhon Phu	2006	183	126	65	19		1,2,3
	6	Nhon Trach III	1997	688	461	323	57	7	1,2,3
	7	Nhon Trach V	2003	302	205	184	18		1,2,3
	8	Tan Phu	2007	54	35		1		1,2,3
	9	Tam Phuoc	2003	323	215	215	54		1,2,3
	10	Loc An-Binh Son	2010	498	336		1		1,3
	11	Nhon Trach VI	2005	315	220		1		1,2,3
	12	An Phuoc	2003	130	91		4		1,2,3
	13	Ong Keo	2008	823	503	425	14		1,2,3
	14	Suoi Tre		50	29	13	5		1
	15	Dinh Quan	2004	54	38	45	14		1,3
	16	Bien Hoa I	2000	335	248	248	80	3	1,2,3
	17	Bien Hoa II	1995	365	261	261	120	12	1,2,3
	18	Long Binh (LOTECO)	1996	100	72	72	48	13	1,3

Source; 1. JETRO
2. MPI "Vietnam's Ips, EPZs and Ezs, Ideal Places for Manufacturing Base, A guide for Investing in Vietnma7S Ips, EPZs and Ezs"
3. "Tinh Ninh Hoat Dong Cua Cac Khu Cong Nghiep Viet Nam Den Nam 2011" (Operating Industrial Zones by 2011 in Viet Nam), provided by MPI in Feb.3, 2012.
4. ASEAN-Japan Center WEB page (http://www.asean.or.jp/ja/asean/know/country/vietnam/invest/industrialestate)

* including Numbers of Factories in some cases

Table 3.3-1 List of IPs in the Southern Region (2/3)

		Industrial Zone	Year of Establishment	Total Area [ha]	Industrial Area [ha]	Leased Area [ha]	Number of Company*	Japanese Company	Source
	19	Nhon Trach Textile	2003	184	121	96	35		2,3
	20	Go Dau	1955	184	137	137	28	2	2,3,4
	21	Long Thanh	2003	488	283	224	79	1	2,3,4
	22	Nhon Trach II - Loc Khang	2006	70	43	27	3		2,3
	23	Nhon Trach II	1997, 2005	347	257	257	61		2,3
	24	Nhon Trach I	1995	430	311	279	85		2,3
	25	Agtex Long Binh	2007	43	28	26	10		2,3
	26	Dau Giay	2008	331	206	1	2		2,3
	27	Song May	1988, 2007	474	334	135	57		2,3
	28	Thanh Phu	2006	177	124	58	8		2,3
	29	Xuan Loc	2006	109	64	40	2	1	2,3,4
	30	Long Duc	2007	283	183		1		2,3
	31	Long Khanh	2008	264	169		1		3
5		**Ba Ria - Vung Tau**					**264**	**9**	
	1	My Xuan B1	1998	226	158	55	5		1,2,3
	2	My Xuan B1-Tien Hung	2007	200	140	30	4		1,3
	3	My Xuan B1-Dai Duong	2006	139	138	94	13		1,3
	4	My Xuan A	1996, 2002	304	228	198	34	3	1,2,3
	5	Phu My I	1998	945	651	586	60	1	1,2,3
	6	Phu My II	2001	620	373	198	34	3	1,2,3
	7	Cai Mep	2002	670	414	80	11		1,2,3
	8	Phu My III	2007	942	803				1,2,3
	9	Dong Xuyen	1996	161	128	126	68	1	1,2,3
	10	Chau Duc	2008	1,556	1,066	13	3		1,2,3
	11	Dat Do 1	2009	496	496	301	0		1,3
	12	My Xuan A2	2001, 2007	422	292	277	30	1	2,3,4
	13	Long Son	2008	1,250	890	440	2		2,3
6		**TP. Ho Chi Minh**					**1375**	**104**	
	1	Tay Bac Cu Chi	1997	220	141	141	44		1,2,3
	2	Quan Trung Software City		43		28	32	28	1
	3	Tan Tao	1996, 2000	392	220	181	268		1,2,3
	4	Tan Thuan	1991	300	195	165	171	66	1,2,3
	5	Cat Lai 2	2003	117	82	82	60		1,2,3
	6	Saigon Hi-Tech Park		913	458	111	53	5	1
	7	Dong Nam	2010	343	287	180	6	0	1,3
	8	Hiep Phuoc	1996, 2008	311	222	222	95	1	1,2,3
	9	Tan Phu Trung	2004	590	359	91	60	1	1,2,3
	10	Vinh Loc	1997	203	115	115	121		2,3
	11	Linh Trung I EPZ	1992	62	42	42	30	3	2,3,4
	12	Linh Trung II EPZ	1997	62	44	44	41		2,3
	13	Binh Chieu	1998	27	21	21	20		2,3
	14	Le Minh Xuan	1997	100	66	66	181		2,3
	15	Tan Binh	1997, 2009	130	90	87	164		2,3
	16	Tan Thoi Hiep	1997	28	20	20	29		2,3
	17	Phong Phu	2002	163	88				2,3
	18	Phu Huu	2006	114	74				2,3
	19	An Ha		124					3
	20	Hiep Phuoc GD2	2008	597	285				
		Mekong River Delta		10,167 ha			**933**	**41**	
1		**Long An**					**474**	**30**	
	1	Duc Hoa III - Resco	2008	296	206	60	5		1,3
	2	Duc Hoa III - Anh Houng	2008	55	41	14	5		1,3
	3	Duc Hoa III - Thai Hoa	2008	100	70	30	26		1,3
	4	Tan Duc	2005	275	194	168	110	5	1,3
	5	Nhut Chanh	2007	106	74	59	17		1,2,3
	6	Long Hau	2006	249	152	100	84	22	1,3
	7	Vinh Loc-Ben Luc	2008	226	148	70	20		1,3
	8	Duc Hoa I	1999	70	47	47	74		1,3
	9	DNN Tan Phu	2011	105	74	10	3	0	1,3
	10	Phuc Long	2010	80	51	12	2		1,3
	11	Phu An Thanh	2008	392	392	50	7	1	1,3

Source; 1. JETRO   * including Numbers of Factories in some cases
2. MPI "Vietnam's Ips, EPZs and Ezs, Ideal Places for Manufacturing Base, A guide for Investing in Vietnma7S Ips, EPZs and Ezs"
3. "Tinh Ninh Hoat Dong Cua Cac Khu Cong Nghiep Viet Nam Den Nam 2011" (Operating Industrial Zones by 2011 in Viet Nam), provided by MPI in Feb.3, 2012.
4. ASEAN-Japan Center WEB page (http://www.asean.or.jp/ja/asean/know/country/vietnam/invest/industrialestate)

Table 3.3-1 List of IPs in the Southern Region (3/3)

		Industrial Zone	Year of Establishment	Total Area [ha]	Industrial Area [ha]	Leased Area [ha]	Number of Company*	Japanese Company	Soure ce
	12	Duc Hoa III - SLICO	2008	196	138	0			1,3
	13	Long Hau iV		117	82	3			1
	14	Cau Tram	2007	78	54	6	5		2,3
	15	Thuan Dao - Ben Luc	2003	114	74	74	10		2,3
	16	Dong Nam A	2009	396	296	179	1		2,3
	17	An Nhut Tan	2008	120	81	2	1		2,3
	18	Duc Hoa III - Viet Hoa	2008	83	52	26	7	2	3
	19	Duc Hoa III - Long Duc	2010	175	114				3
	20	Duc Hoa III - Minh Ngan	2010	147	114	0			3
	21	Duc Hoa III - Hong Dau	2008	100	66	7	2		3
	22	Duc Hoa III - Lien Thanh	2008	92	64				3
	23	Duc Hoa III - Song Tan	2008	307	235				3
	24	Duc Hoa III - Duc Loi	2009	110	64				3
	25	Duc Hoa III - Muoi Day	2010	114	89				3
	26	Duc Hoa III - Long Viet	2011	87	50				3
	27	Thuan Dao MR	2011	190	134				3
	28	Tan Thanh	2010	296	204				3
	29	Cou cang Phuoc Dong	2011	129	83				3
	30	Xuyen A	1997	306	199	94	82		3
	31	Tan Kim	2004	104	67	36	13		3
2		**Tien Giang**					**61**	**1**	
	1	Long Giang	2007	540	378	92	11	1	1,3
	2	My Tho	1997	79	58	58	28		2,3
	3	Tan Huong	2004	197	138	81	22		2,3
	4	Soai Rap	2006	285					3
	5	Dich vu dau khi	2008						3
3		**Ben Tre**					**12**	**10**	
	1	Giao Long	2005	102	66	53	9	5	2,3
	2	An Hiep	2008	72	48	38	3	5	2,3
4		**Tra Vinh**					**26**	**0**	
	1	Long Duc	2005	100	62	62	26		2,3
5		**Vinh Long**					**24**	**0**	
	1	Binh Minh	2007	162	132	54	7		1,2,3
	2	Hoa Phu	2007	122	92	92	17		2,3
	3	Hoa Phu giai doan II	2010	130	91				3
6		**Dong Thap**					**57**	**0**	
	1	Tran Quoc Toan	2002	56	39	9	5		1,2,3
	2	Song Hau	2006	66	45	31	5		1,2,3
	3	Sa Dec	1997	134	100	40	47		2,3
7		**An Giang**					**15**	**0**	
	1	Binh Long	2007	29	19	14	6		2,3
	2	Binh Hoa	2009	132	100	40	9		2,3
	3	Xuan To	2005	57	32	11	4		2,3
8		**Kien Giang**					**0**	**0**	
	1	Thuan Yen	2009	141	91	17			3
9		**Can Tho**					**201**	**0**	
	1	Hung Phu 1	2004	270	262	26	5		1,2
	2	Hung Phu 2A	2009	134	114	21	4		3
	3	Hung Phu 2B	2009	63	44	15			3
	4	Thot Not	2008	150	102	49	10		3
	5	Tra Noc I	1995	135	112	112	122		2,3
	6	Tra Noc II	1998	155	121	115	60		2,3
10		**Hau Giang**					**18**	**0**	
	1	Song Hau	2007	291	282	175	6		2,3
	2	Than Phu Thanh	2009	201	149	74	18		3
11		**Soc Trang**					**31**	**0**	
	1	An Nghiep	2005	251	163	140	31		1,2,3
	2	Tran De		120	95				1
12		**Bac Lieu**					**4**	**0**	
	1	Tra Kha	2007	65	45	31	4		3
13		**Ca Mau**					**10**	**0**	
	1	Khanh An	2007	360	290	25	2		1,2,3
	2	Hoa Trung	2009	352	229	15	10		3

Source; 1. JETRO
* including Numbers of Factories in some cases
2. MPI "Vietnam's Ips, EPZs and Ezs, Ideal Places for Manufacturing Base, A guide for Investing in Vietnma7S Ips, EPZs and Ezs"
3. "Tinh Ninh Hoat Dong Cua Cac Khu Cong Nghiep Viet Nam Den Nam 2011" (Operating Industrial Zones by 2011 in Viet Nam), provided by MPI in Feb.3, 2012.
4. ASEAN-Japan Center WEB page (http://www.asean.or.jp/ja/asean/know/country/vietnam/invest/industrialestate)

(4) Planning Projects of IPs

Following to the current active development, IPs will be developed also in the future. 10 expansion projects (increasing 2,000 ha) and 42 new development projects (increasing 13,600 ha) are planned up to 2015 (Table 3.3-2 and Table 3.3-3) according to the Prime Minister Decision No. 1107/ 2006/QD-TTg. Therefore, demand of electricity will also increase more and more in the future.

Table 3.3-2 List of IPs in the Southern Region to be expanded up to 2015

No.	Names of IPs	Localities	To be-expanded area (ha)
1	Dinh Quan IP	Dong Nai	150
2	Viet Huong II IP	Binh Duong	140
3	Chon Thanh IP	Binh Phuoc	255
4	My Xuan A2 IP	Ba Ria-Vung Tau	90
5	My Xuan B1 (Dai Duong) IP	Ba Ria-Vung Tau	146
6	Hiep Phuoc IP	Ho Chi Minh City	630
7	Northwestern Cu Chi IP	Ho Chi Minh City	170
8	Trang Bang IP	Tay Ninh	163
9	Thuan Dao IP	Long An	200
10	Tan Kim IP	Long An	56

Source: Prime Ministers Decision No. 1107/ 2006/QD-TTg

Table 3.3-3 (1) List of IPs to be formed up to 2015 (Southeast)

No.	Names of IPs	Localities	Projected area up to 2015 (ha)
1	Tan Phu IP	Dong Nai	60
2	Ong Keo IP	Dong Nai	300
3	Bau Xeo IP	Dong Nai	500
4	Loc An-Binh Son IP	Dong Nai	500
5	Long Duc IP	Dong Nai	450
6	Long Khanh IP	Dong Nai	300
7	Giang Dien IP	Dong Nai	500
8	Dau Giay IP	Dong Nai	300
9	My Phuoc 3 IP	Binh Duong	1,000
10	Xanh Binh Duong IP	Binh Duong	200
11	An Tay IP	Binh Duong	500
12	Southern Dong Phu IP	Binh Phuoc	150
13	Tan Khai IP	Binh Phuoc	700
14	Minh Hung IP	Binh Phuoc	700
15	Dong Xoai IP	Binh Phuoc	650
16	Northern Dong Phu IP	Binh Phuoc	250
17	Long Huong IP	Ba Ria-Vung Tau	400
18	Phu Huu IP	Ho Chi Minh City	162
19	Tram Vang IP	Tay Ninh	375

Source: Prime Ministers Decision No. 1107/ 2006/QD-TTg

Table 3.3-3(2) List of IPs to be formed up to 2015 (Mekong Delta)

No.	Names of IPs	Localities	Projected area up to 2015 (ha)
1	Cau Tram (Cau Duoc) IP	Long An	80
2	My Yen-Tan Buu-Long Hiep (Ben Luc) IP	Long An	340
3	Nhat Chanh IP	Long An	122
4	Duc Hoa III IP	Long An	2,300
5	Thanh Duc IP	Long An	256
6	An Nhat Tan IP	Long An	120
7	Long Hau IP	Long An	142
8	Tan Thanh IP	Long An	300
9	Southern Tan Lap IP	Long An	200
10	Northern Tan Lap IP	Long An	100
11	Soai Rap Ship IP	Tien Giang	290
12	An Hiep IP	Ben Tre	72
13	Hau River IP	Dong Thap	60
14	Binh Minh IP	Vinh Long	162
15	Hung Phu 2 IP	Can Tho	226
16	Binh Long IP	An Giang	67
17	Binh Hoa IP	An Giang	150
18	Thanh Loc IP	Kien Giang	100
19	Vuot Canal IP	Kien Giang	100
20	Hau River IP	Hau Giang	150
21	Tran De IP	Soc Trang	140
22	Dai Ngai IP	Soc Trang	120
23	Tra Kha IP	Bac Lieu	66

Source: Prime Ministers Decision No. 1107/ 2006/QD-TTg

3.4 CURRENT SITUATION ON POWER FACILITIES AND POWER BALANCE IN MEKONG DELTA

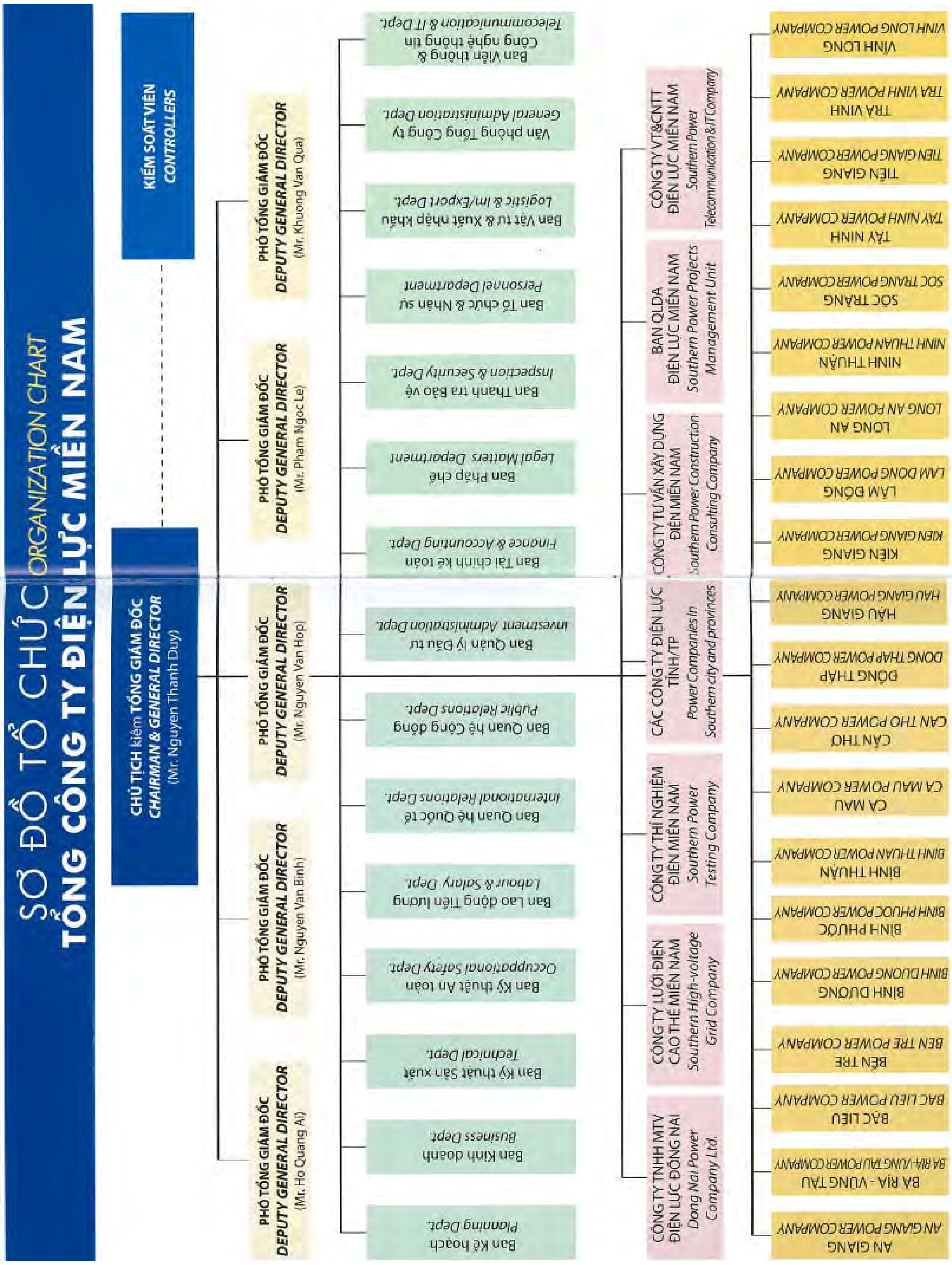
3.4.1 Power Supply to the Southern Region in Vietnam

Generated power is transferred to 5 regional power corporations under EVN via 500 kV and 220 kV transmission lines. There are two power corporations in the southern region. One is Southern Power Corporation (SPC) and the other is Ho Chi Minh Power Corporation. The former supplies power to the whole southern region (18 provinces) except Ho Chi Minh City and parts of central region (3 provinces[4]) and the latter supplies power to Ho Chi Minh City. SPC provides power to consumers via 20 power companies distributing to the provincial level and one power company[5] with independent accounting.

Fig. 3.4-1 shows the organization chart of SPC and Fig. 3.4-2 shows the power grid of SPC.

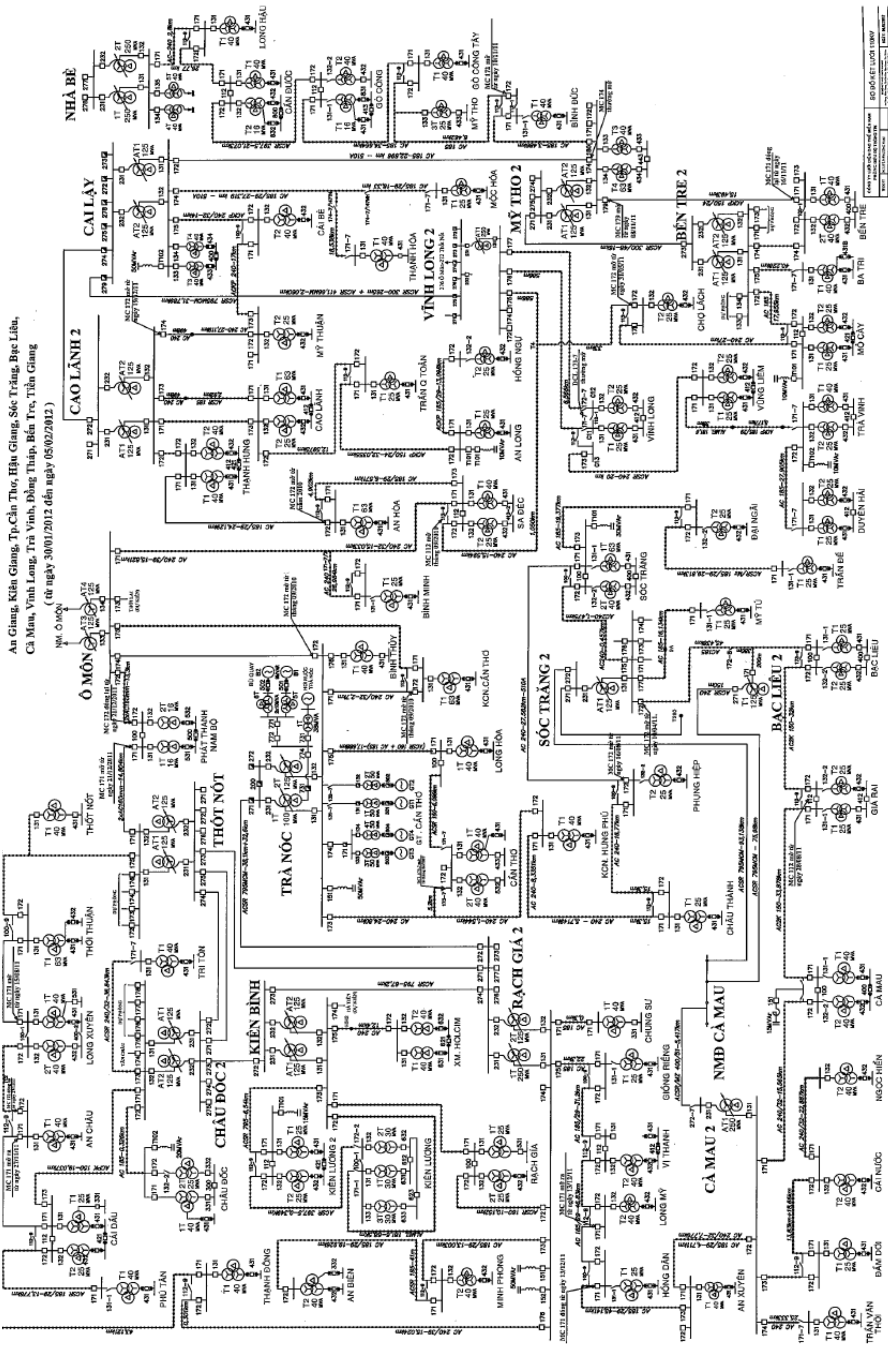
4 Lam Dong Province, Ninh Thuan Province and Binh Thauan Province

5 Dong Nai Power Company Ltd.



Source: "Southern Power Corporation 2005-2010"

Fig. 3.4-1 Organization Chart of SPC



Source: SPC

Fig. 3.4-2 Power Grid of SPC

3.4.2 Power Balance of SPC's Supply Area

Table 3.4-1 shows the list of 220/110 kV substations and their transformer capacity (kVA) owned by SPC. For example, the total capacity of transformers of 10615.2 MVA in 2011 means the maximum power supply capacity from the upper power grid (500/220 kV) basically. On the other hand, the peak demand in 2011 was 5,087 MW or 5,191 MVA. Therefore, the peak demand accounts for 49% of the maximum power supply capacity of 10615.2 MVA and the power balance is kept well, if sufficient power had been supplied from the upper grid. However, the sufficient power is not supplied from the upper grid in actual fact due to the absolute shortage of power resources under present and a lot of blackouts as to be described in Section 3.4.4 occur in the area of SPC.

Table 3.4-1 (1) Power Balance of SPC Area for Last 5 Years

No	Province	Name of Substation	Transformer	Capacity [MVA]				
				2007	2008	2009	2010	2011
1	An Giang	Châu Đốc 2	1			125	125	125
			2					125
2	Cần Thơ	Thốt Nốt 2	1				125	125
			2				125	125
		Trà Nóc	1	100	100	100	100	100
			2	125	125	125	125	125
		Ô Môn	3		125	125	125	125
			4		125	125	125	125
3	Kiên Giang	Kiên Bình	1				125	125
			2				125	125
		Rạch Giá 2	1	250	250	250	250	250
			2	125	125	125	125	125
4	Cà Mau	Cà Mau 2	1	250	250	250	250	250
5	Bạc Liêu	Bạc Liêu 2	1	125	125	125	125	125
6	Sóc Trăng	Sóc Trăng 2	1			125	125	125
7	Đồng Tháp	Cao Lãnh 2	1			125	125	125
			2					125
8	Vĩnh Long	Vĩnh Long 2	1	125	125	125	125	250
			2	125	125	125	125	125
9	Bến Tre	Bến Tre 2				125	125	125
						125	125	125
10	Tiền Giang	Cai Lậy	1	125	125	125	125	125
			2	125	125	125	125	125
		Mỹ Tho 2	1	125	125	125	125	125
			2	0			125	125
11	Long An	Long An 2	1				125	125
			2				125	250
		Nhà Bè		30	35	40	45	50
		Phú Lâm		40	45	60	70	80
12	Tây Ninh	Trảng Bàng 2	1	250	250	250	250	250
			2	250	250	250	250	250
13	Bình Dương	Mỹ Phước	1	250	250	250	250	250
		Tân Định	3	0	0	0	0	250
			4	250	250	250	250	250
		Bình Hòa	1	250	250	250	250	250
			2	250	250	250	250	250
			5	0	0	0	0	250
			110kV	103	103	126	126	126

Table 3.4-1 (2) Power Balance for Last 5 Years of SPC Area

No	Province	Name of Substation	Transformer	Capacity [MVA]				
				2007	2008	2009	2010	2011
14	Bình Phước	Bình Long 2	1					125
			2					125
		TĐ S.P.Miêng	1	30	30	30	30	30
			2	30	30	30	30	30
		TĐ Cần Đơn	1	48.5	48.5	48.5	48.5	48.5
			2	48.5	48.5	48.5	48.5	48.5
		TĐ Thác Mơ	1	88	88	88	88	88
			2	88	88	88	88	88
		TĐ Đăk Glun	1					10.6
			2					10.6
15	Đồng Nai	NM Trị An	1	63	63	63	63	125
			2	63	63	63	63	125
		Long Bình	1	250	250	250	250	250
			2	250	250	250	250	250
			3	0	0	0	0	250
		Long Thành	1	250	250	250	250	250
			2				250	250
			110kV	300	300	300	300	300
		Xuân Lộc	1					250
16	Lâm Đồng	Bảo Lộc	1	63	63	63	63	63
			2	125	125	125	125	125
			110kV	40	40	40	40	40
		NM Đa Nhim	9	63	63	63	63	63
			10	63	63	63	63	63
		NM BauXit Lâm Đồng	1					40
			2					40
		TĐ Bảo Lộc	1			16	16	16
			2			16	16	16
		TĐ Đa Dâng 2	1				23	23
			2				23	23
17	Ninh Thuận	TĐ Sông Pha	1	10	10	10	10	10
		TĐ Sông Ông	1	4	4	4	4	4
18	Bình Thuận	TĐ Bắc Bình	1			20	20	20
			2			20	20	20
		TĐ Đại Ninh	3	63	63	63	63	63
		Phan Thiết 2	1				125	250
		TĐ Hàm Thuận	3	63	63	63	63	63
19	BRVT	Gas Bà Rịa (220kV)	1	125	125	125	125	125
		Gas Bà Rịa (110kV)	1	25	25	25	25	25
			2	25	25	25	25	25
			3	50	50	50	50	50
			4	50	50	50	50	50
			8	50	50	50	50	50
			10	88	88	88	88	88
		NM Phú Mỹ	5	250	250	250	250	250
			6	250	250	250	250	250
	EVN SPC	Sum of Capacity [MVA] (a)		6189	6449	7189	8500	10615.2
		Demand of EVN SPC [MW] (b)		3544	3852	4197	4558	5087.26
		Ratio [%] ((b)/0.98/(a))		58%	61%	60%	55%	49%

Source :SPC

3.4.3 Power Energy Sales in SPC Supply Area

Table 3.4-2 shows sold energy (MWh) in 2011 for 21 provinces including direct sales by SPC. The total sold energy in 2011 was 32,307 GWh. The sold energy to industry and construction was 20,451 GWh and accounts for 63.3% of the total sold energy. For the provincial basis, the sold energy to Binh Duong Province and Dong Nai Province, of which provinces have a lot of industry parks, is remarkable in comparison with the other provinces and the both provinces occupy 37.9% of the total sold energy.

Table 3.4-3 shows the growth rate of sold energy for 21 provinces. The average growth rate for the period from 2006 to 2010 was 16.04% and three provinces such as Binh Phuoc Province of 23.16 %, Ba Ria-Vung Tau Province of 21.12% and Binh Thuan Province of 21.46% in the Central region exceed 20% of grow rate.

Table 3.4-2 Sold Energy in SPC Area (2011)

No	Province/ Daughter's Company	Total Sales in 2011 (MWh)	Consumers				
			Agriculture	Industry and Construction	Restaurant and Hotel	Household	Others
1	Binh Phuoc	577,092	368	224,972	10,601	321,003	20,148
2	Binh Thuan (Central)	1,146,199	11,050	579,243	74,683	459,685	21,538
3	Lam Dong (Central)	659,521	60,251	170,629	31,318	361,087	36,236
4	Binh Duong	5,102,239	870	4,082,492	108,711	836,256	73,910
5	Tay Ninh	1,111,159	10,788	626,379	16,985	418,146	38,861
6	Hau Giang	326,543	1,010	112,873	4,935	193,632	14,093
7	Long An	1,857,227	6,928	1,252,574	40,616	515,377	41,732
8	Dong Thap	1,240,906	72,682	666,397	16,162	451,183	34,482
9	Tien Giang	1,308,036	23,039	677,031	26,845	542,483	38,638
10	Ben Tre	604,521	10,417	186,685	15,760	365,935	25,724
11	Vinh Long	525,882	468	186,800	16,326	299,568	22,720
12	Can Tho	1,401,890	2,378	796,885	65,833	461,985	74,809
13	An Giang	1,316,509	64,755	525,192	34,849	658,234	33,479
14	Kien Giang	975,492	18,040	406,244	38,839	475,977	36,392
15	Ca Mau	709,299	9,148	296,006	24,314	360,030	19,801
16	Vung Tau	1,867,206	32,853	1,080,147	108,467	573,860	71,879
17	Tra Vinh	411,394	549	140,897	11,028	247,158	11,762
18	Soc Trang	629,878	51,246	223,380	14,685	305,519	35,048
19	Ninh Thuan (Central)	355,725	70,093	89,763	12,078	167,512	16,279
20	Bac Lieu	445,876	8,739	157,358	8,930	249,115	21,734
21	Dong Nai	7,133,198	122,566	5,615,771	82,839	1,171,396	140,626
22	VP-EVNSPC	2,601,060	-	2,353,511	-	-	247,549
	Toal	32,306,852	578,238	20,451,229	764,804	9,435,141	1,077,440

Source : SPC

Table 3.4-3 Growth Rate of Sold Energy in SPC Area (2006 – 2010)

No.	Province/ Daughter's Company	Growth Rate of kWh Sales (%)					Average
		2006	2007	2008	2009	2010	2006-2010
1	Binh Phuoc	18.57	16.92	15.08	20.93	41.40	23.16
2	Binh Thuan (Central)	16.98	17.48	17.87	21.04	21.81	21.46
3	Lam Dong (Central)	13.73	8.60	9.05	10.06	9.55	9.31
4	Binh Duong	23.71	28.54	15.04	11.27	14.45	17.14
5	Tay Ninh	24.49	12.16	11.64	30.14	18.66	17.92
6	Hau Giang	14.63	10.05	9.80	14.16	10.19	11.04
7	Long An	20.75	23.72	14.27	19.94	19.12	19.21
8	Dong Thap	13.16	15.96	22.07	22.56	17.70	19.54
9	Tien Giang	14.68	12.37	14.66	13.25	14.13	13.60
10	Ben Tre	15.02	6.61	9.40	12.44	22.49	10.73
11	Vinh Long	9.70	14.63	13.24	18.64	8.69	13.75
12	TP Can Tho	16.60	18.65	18.88	13.45	11.96	15.69
13	An Giang	13.78	11.94	14.82	15.85	11.15	13.42
14	Kien Giang	10.66	33.19	10.61	8.69	6.68	14.32
15	Ca Mau	12.39	5.64	12.03	13.89	12.15	10.88
16	Ba Ria -Vung Tau	29.70	25.39	24.26	15.55	19.54	21.12
17	Tra Vinh	11.67	9.44	14.19	19.16	13.83	14.10
18	Soc Trang	14.01	14.37	8.74	8.85	8.29	10.04
19	Ninh Thuan (Central)	8.53	7.39	11.43	25.78	18.33	15.52
20	Bac Lieu	12.56	7.31	11.03	17.36	13.11	12.14
21	Dong Nai	18.90	16.82	14.70	9.54	18.56	14.85
Total		18.24	18.89	15.24	14.20	15.89	16.04

Source: SPC

3.4.4 Blackout in SPC Area

Table 3.4-4 shows number of times of blackouts, and hours of blackouts in SPC area for the past 3 years. The forced blackouts (forced outage) of 206 times occurred in 2010 and far exceeded 63 times in 2009 and 13 times in 2011 because 206 times in 2010 include the blackouts caused by the actuation of voltage protection relay (110 kV ± 5%) detecting the rapid drop of the voltage due to the instant stop of the operation of the hydropower plants. And some blackouts occurred due to the troubles at power plants and failures of transferring power to lower grid (110 kV) because of overload of upper grid and substations.

Planned blackouts continuously occurred in the last three years, such as 345 times in 2009, 341times in 2010 and 340 times in 2011 due to the absolute lack of power sources. The hours per one time blackout are 7 hours (or 420 minutes) for all planned blackouts. The number of blackouts, such as 340 ~ 345 times means that the blackout occurs almost every in a place within the jurisdiction area of SPC. The planned blackout of 7 hours starts from 8:00 a.m. to 16:00 p.m. except 12:00 ~ 13:00 and the operation hour of manufactures is subject to the above blackout time. And about 150 MW is saved per one blackout.

Table 3.4-4 Number of Times and Hours of Blackout in SCP Area (Last 3 Years)

Year	Forced Blackout			Planned Blackout		
	Times	Hours (minutes)	Hours per one time (minutes)	Times	Hours per one time (minutes)	Hours per one time (minutes)
2009	63	20,910	332	345	144,900	420
2010	206	87,626	425	341	143,220	420
2011	13	1,842	142	340	142,800	420

Source: SPC

CHAPTER 4

CONFIRMATION ON PROJECT SCOPE AND VALIDITY

CHAPTER 4 CONFIRMATION ON PROJECT SCOPE AND VALIDITY

4.1 FUEL SUPPLY PLAN

4.1.1 Development Scheme of Block B&52 Gas Project

The project is planned to supply gas exploited from Block B&52 to O Mon Power Complex via Ca Mau Power Station through undersea and aboveground gas pipeline.

As shown in Fig. 4.1-1, the length of undersea gas pipeline is about 250 km, that of aboveground gas pipeline is about 150 km respectively, and total gas pipeline length is about 400 km.

Development scheme of Block B&52 is shown in Fig.4.1-2.

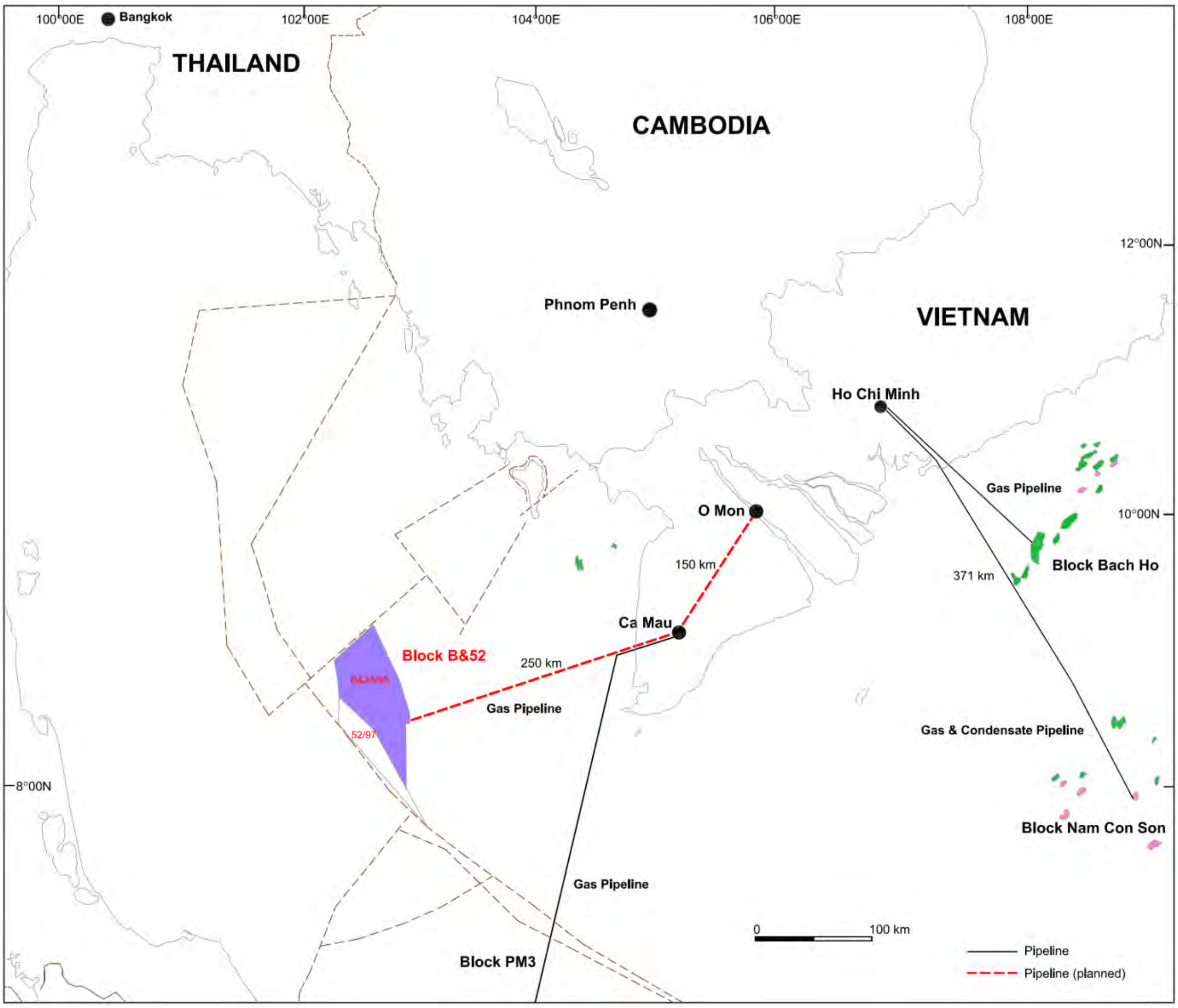


Fig. 4.1-1 Location Map of Block B&52

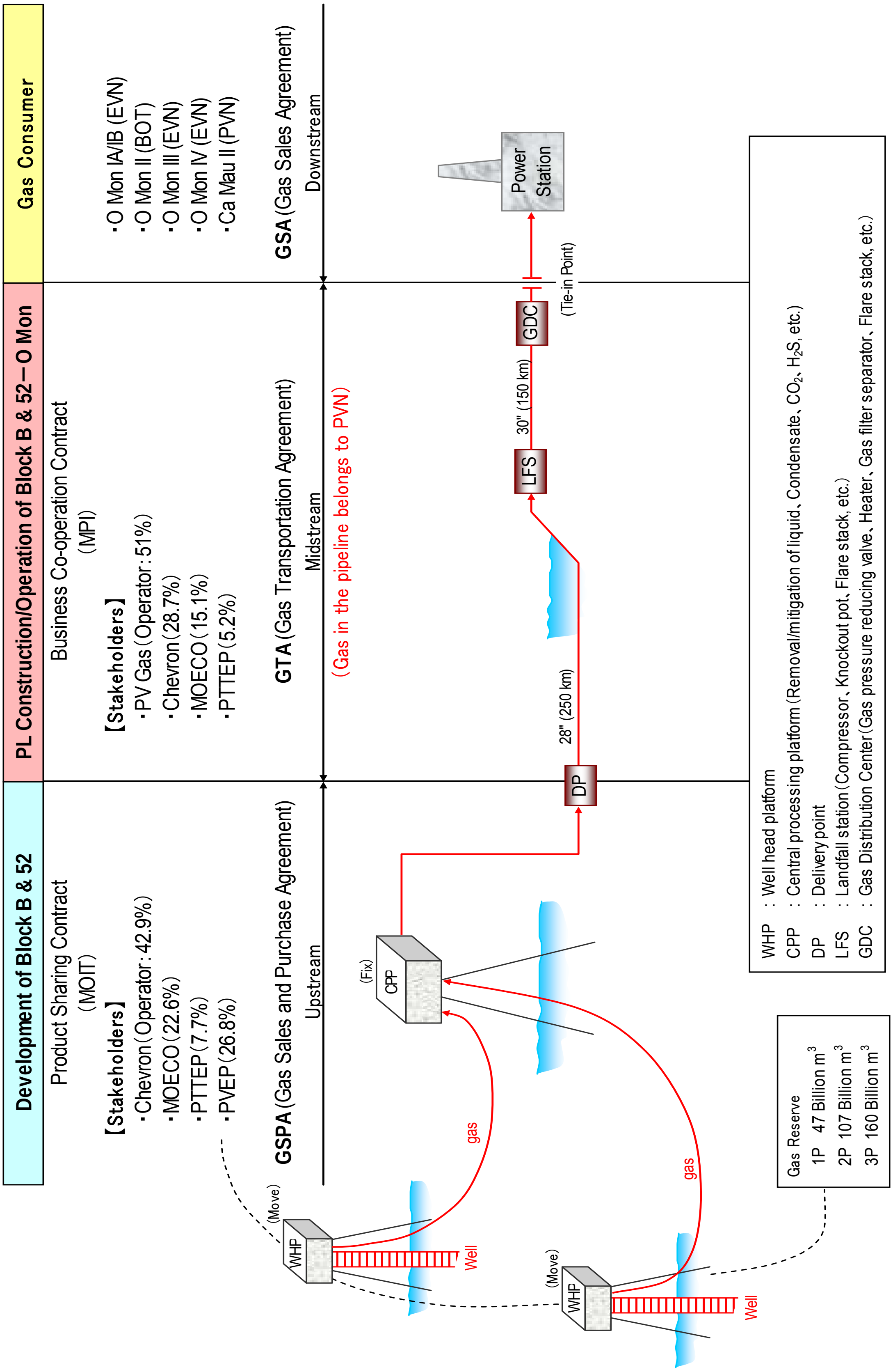


Fig. 4.1-2 Development Scheme of Block B&52

Chevron Vietnam is the operator of the upstream Block B&52 Gas Project, offshore southwest Vietnam. The company's co-ventures include Mitsui Oil Exploration Co. Limited (MOECO) of Japan, PTT Exploration and Production Public Company Limited (PTTEP) of Thailand and PVEP Corporation (one of subsidiaries of PVN). Shares of the Block B&52 Gas Project are 42.9%, 22.6%, 7.7%, 26.8% respectively.

According to the F/S Report by PECC2, gas reserve is 47 billion m^3 as 1P, 113 billion m^3 as 2P and 160 billion m^3 as 3P respectively. However, 2P is revised slightly downward to 107 billion m^3 (3.78 Trillion cubic feet) by the investigation of JICA Project. Furthermore, 107 billion m^3 is upstream production and 100 billion m^3 (3.5 Trillion cubic feet) will be delivered to midstream gas pipeline.

Exploitation of Block B&52 is carried out based on Project Sharing Contract (PSC) under control of MOIT. Exploited gas will be supplied to PVN after the conclusion of Gas Sales Purchase Agreement (GSPA) between PVN and Chevron.

PV Gas (one of subsidiaries of PVN) is the operator of the midstream gas pipeline construction & operation Project. The company's co-ventures include Chevron, MOECO of Japan, PTTEP of Thailand. Shares of the gas pipeline project are 51%, 28.7%, 15.1%, 5.2% respectively.

Construction and operation of the gas pipeline is implemented based on BCC (Business Co-operation Contract) under control of MPI, and will be commenced after the conclusion of GTA (Gas Transfer Agreement) between PVN and PVN Gas.

Gas in the gas pipeline belongs to PVN.

Downstream gas consumers of Block B&52 are O Mon 1A (330 MW), O Mon 1B (330 MW) O Mon 3 (> 750 MW), Mon 4 (> 750 MW), those are operated by EVN, O Mon 2 operated by BOT and Ca Mau II (750 MW) operated by the subsidiary company of PVN.

O Mon 1A is now running by heavy fuel oil and Ca Mau II is running by gas from PM3, therefore, after gas from Block B &52 is available, the heavy fuel oil and gas from PM3 will be converted to gas from Block B &52.

Gas supply to aforementioned power plant is conducted based on Gas Sales Agreement (GSA) between EVN and PVN.

Gas for Ca Mau I and Ca Mau Fertilize Plant is supplied from PM3, and even if gas is shortfall in the future, PVN will try to supply gas from other gas sources than Block B&52.

Gas supply for Tra Noc Power Station is canceled due to small gas consumption that cannot compensate the construction cost of gas pipeline to the Power Station. Gas supply for O Mon 5 is also canceled because there is no concrete construction plan in the national power development plan for the time being.

The most important thing in Fig. 4.1-2 is that exploitation of gas from Block B&52, construction of the gas pipeline and construction of the power plants should be completed simultaneously.

4.1.2 Milestones on Development of Gas from Block B&52

PSC for B&48/95 and PSC for 52/97 were effectuated in May 1996 and October 1999, respectively.

Through the declaration of gas discovery and the setting of joint development area, Head of Agreement (HOA) for GSPA and GTA was concluded among PVN, Block B&52 development consortium member (Chevron, MOECO, PTTEP and PVEP) and gas pipeline construction & operation consortium member (PV Gas, Chevron, MOECO and PTTEP) in July 2009.

The content of HOA is as follows;

1) Front End Engineering Design (FEED) for upstream exploitation and Gas Pipeline (PL) to be commenced
2) Negotiation on terms and conditions of GSPA and GTA to be started
3) Explicit statement on Final Investment Decision (FID) conditions
4) Negotiation on PL BCC (Gas Pipeline Business Co-operation Contract) to be started

PL BCC was agreed in February 2010 that stipulates the right and obligation in terms of ownership, design, construction and operation of PL.

FEED was completed in March 2011, and gas price formula, Daily Contract Quantity (DCQ) and Standard gas calorific values, etc. were agreed.

During JICA 1st mission on December 2011, there was information of “gas price is recently submitted to the Government of Vietnam. The approval from the Government is expected within this year and GSA will hopefully be concluded 1st Quarter of next year”.

However, during JICA 2nd mission on February 2012, the Study Team is informed that the Government of Vietnam has not yet approved the gas price due to higher its price compared with precedent gas prices.

Gas price is explained in Section 4.1.5.

The steps from now on to conclusion of FID are anticipated as follows;

1) Board Agreement of each developer (consortium member) of Block B&52
2) Agreement on GSPA, GTA and GSA
3) Approval of Field Development Plan (FDP) by the Government of Vietnam
   (Approval by MOIT → Approval by the Prime Minister)
4) Endorsement by the Government of Vietnam (concurrence with the Prime Minister)
   Payment bond, Conversion guarantee (VND → USD), Performance Guarantee, etc.
5) Duty exemption treatment for the gas pipeline
6) Extension of PSCs
7) Conclusion of FID

Consortium member will independently select the bank for loan. After the loan agreements, Block B&52 exploitation work and the gas pipeline construction work will be put into practice.

Installation work period of the gas pipeline is estimated at about 42 months. Construction work period for upstream facilities such as Central Processing Platform (CPP), Well Head Platform (WHP) is within 42 months.

Installation works of the gas pipeline will be conducted by Vietsovpetro, PVC and PetroVietnam Technical Service Company (PTSC). Construction works of upstream facilities are divided into two portions;

1) CPP, Living Quarter (LQ) and Floating Storage Offloading (FSO) are implemented by International Competitive Bidding (ICB)
2) WHP and Infield Pipeline are implemented by the direct negotiation with PTSC (EPC Contract)

Table 4.1-1 shows the milestones on development of Block B&52.

Table 4.1-1 Milestones on Development of Block B&52

Year/Month	Milestone	Remarks
1996/05	Issuance of PSC for Block B&48/95	PSC
1999/10	Issuance of PSC for Block 52/97	
2002/05	Declaration of gas discovery	
2003/02	Setting of Joint Development Area	
2007/09	Joint Development Agreement/ Utilization Agreement	
2009/07	FEED HOA/PL HOA	Agreement on main commercial and technical terms to start the basic design.
2010/02	Pipeline BCC	Agreement of right/obligation on design, construction and operation of gas pipeline.
2011/03	Completion of FEED	Agreement of gas price formula, gas supply quantity, standard gas calorific value, etc. in GSPA.
After 2012/02	FID	Steps to conclusion of FID and loan agreements with banks; 1) Board Agreement of each consortium member 2) Conclusions of GSPA, GTA and GSA 3) Approval of FDP from Vietnamese Government Approval by MOIT → Approval by the Prime Minister 4) Endorsement from Vietnamese Government (Concurrence with the Prime Minister) Payment bond, Conversion guarantee (VND → USD), Performance guarantee, etc. 5) Duty exemption treatment for the gas Pipeline 6) Extension of PSCs 7) Conclusion of FID
	Loan agreements with Banks	Consortium member will independently select the bank for loan.
	Implementation of Works	Construction period of gas pipeline is about 42 months. Contractors are Vietsovpetro, PVC and PTSC. Construction period of off-shore platforms is within 42 months. Construction works are divided by two. - CPP, LQ and FSO are determined by ICB - WHP and Infield pipeline is determined by direct negotiation (EPC) with PTSC

4.1.3 Gas Supply and Demand Balance

(1) Gas User of Block B&52

Gas from Block B&52 is exclusive to be used for O Mon 1A/1B, 2, 3, 4 and Ca Mau II. Gas is planned to be supplied by the following conditions.

1) O Mon 4 is commissioned on November 2015
2) O Mon 3 is commissioned on October 2016
3) O Mon 2 is commissioned on October 2017
4) Ca Mau II consumes gas from Block B&52 from October 2015
5) Gas is not supplied to Tra Noc and O Mon 5
6) O Mon 1A/1B are heavy fuel oil/gas dual firing units, therefore, if gas is short, these units will use heavy fuel oil.

Loan Agreement of O Mon 4 financed by the loan from ADB and Kreditanstalt für Wiederaufbauk, Germany (KfW) is almost concluded among the relevant governments, and the selection of Consultant is ongoing by EVN. On the other hand, Investors of O Mon 2 developed by BOT haven't yet appeared so far.

(2) Expected Output of O Mon 2, 3 and 4 Power Stations

While the output of O Mon 2, 3 and 4 power stations is planned to be 750 MW (at site conditions) by F/S of PECC2 in 2009, the latest power output of F type gas turbine combined cycle (2-2-1) exceeds 850 MW (at ISO rating) because the gas turbine technology has been rapidly progressing these days.

During JICA 2nd mission on February 2012, the Study Team explained expected output of O Mon 2, 3 and 4 based on responses from major gas turbine manufacturers.

However, as the Study Team could get "Gas Turbine World 2012 GTW Handbook this March 7" that describes officially recognized gas turbine and its combined cycle specifications as 2011 version, the Study Team revised Table 4.1-2 based on the handbook.

Major revisions from our previous explanation are as follows;

1) KA26-2 (2011) is added in Alstom
2) 209FB (2011) is added in GE
3) M701 F5 is added in MHI

Expected COD of these models are as follows;

1) KA26-2 (2011)[1] : Late 2014 in Thailand
2) 209FB (2011) : 2015 in France
3) M701F5[2] : 2016 in Japan

As there seems to be no operating hours as complete set of the model during the forthcoming bidding period for O Mon 3, although key components such as Compressor, Combustor and Turbine of some models have already operational experiences as component wise, the Study Team excludes these 3 models from this F/S.

Reflecting the slight up-rating of other models, the latest output of F type gas turbine combined

1 Two (2) years operational experience for Combustor and Turbine in the Spanish project
2 Operational experiences for Compressor & Combustor as G type and Turbine as J type

cycle, candidate for O Mon 2, 3 and 4 power stations is divided into 850 MW class and 950 MW class (ISO rating).

Table 4.1-2 Specifications of Latest F Type Gas Turbine Combined Cycle (ISO Rating)

Manufacturer	ALSTOM (2011)		GE (2011)		MHI (2011)		SIEMENS (2011)
Model	KA26-2 (2006)	KA26-2 (2011)	209FB (2003)	209FB (2011)	M701F4	M701F5	SCC5-4000F
Year First Machine	1996	1996	2003	2011	1992	1992	1995
Plant Output (MW)	870.0	935.0	913.6	1,025.6	958.8	1,053.3	853.0
Plant Efficiency (%)	59.0	59.5	59.7	61.1	60.2	61.2	58.5
Heat Rate (kJ/kWh)	6102	6050	6027	5892	5981	5883	6158
Gas Turbine Output (MW)	-	-	592.5	678.3	639.8	708.0	576.0
Steam Turbine Output (MW)	-	-	337.3	360	319.0	345.3	272.0
Gas Turbine Type/Number.	GT26 (2006)/2	GT26 (2011)/2	9FB (2003)/2	9FB (2011)/2	M701F4/ 2	M701F5/ 2	SGT5-4000F 2
Heat Recovery Steam Generator (HRSG) Type	Triple Pressure Reheat		Reheat*		Triple Pressure Reheat		Triple Pressure Reheat

* may be triple pressure

Source: Gas Turbine World 2012 GTW Handbook

(3) Estimated Gas Consumption of F Type Gas Turbine Combined Cycle

Table 4.1-2 is based on ISO rating (15°C). The output and efficiency of gas turbine combined cycle is varied by ambient conditions (temperature, pressure and humidity). Among these ambient conditions, temperature is the key affecter. The output and efficiency are declined in accordance with temperature rise. Table 4.1-3 shows our preliminary estimated specifications of F type gas turbine combined cycle at the site conditions (30°C), and expected annual gas consumptions (6,000 operational hours) based on the site conditions.

Table 4.1-3 Expected Specifications of Latest F Type Gas Turbine Combined Cycle (Site Conditions)

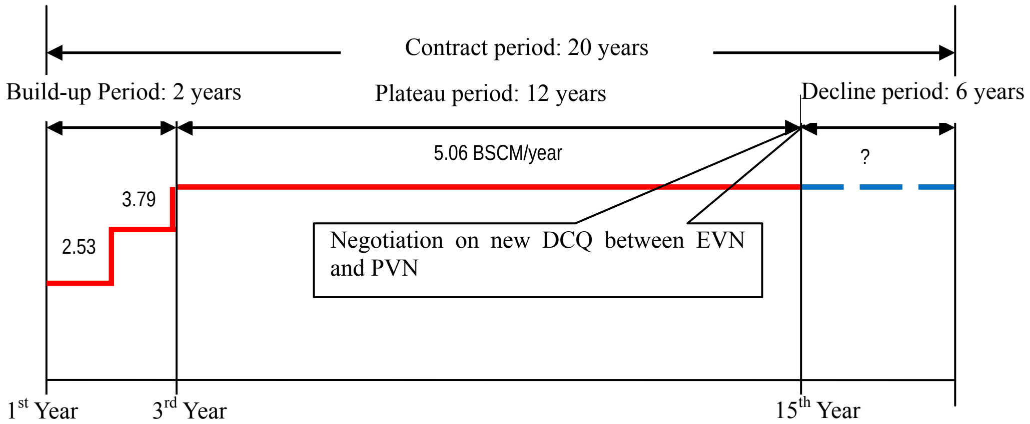
Gas Turbine Model		Alstom GT26 (2006)	GE 9FB	Mitsubishi M701F4	Siemens SGT5-4000F
Plant Formation		2-2-1	2-2-1	2-2-1	2-2-1
Output of GT (2 units)	MW	528.5	536.7	577.3	521.1
Output of ST (1unit)	MW	290.6	318.1	300.3	268.6
Auxiliary Power & TR Loss	MW	16.4	17.1	17.6	15.8
Net Output		802.7	837.7	860.0	773.9
Heat Rate (LHV)	kJ/kWh	6,249	6,278	6,242	6,435
Efficiency (LHV)	%	57.6	57.3	57.7	55.9
Estimated Gas Consumption (6000 hours) BNCM	Billion Nm^3	0.97	1.02	1.04	0.97
Estimated Gas Consumption (6000 hours) BSCM	Billion Sm^3	1.02	1.08	1.10	1.02

Two following cases are considered as annual gas consumption (6000 Hours);

1) 1.02 Billion Sm^3 as 850 MW class (ISO rating)
2) 1.10 Billion Sm^3 as 950 MW class (ISO rating)

(4) Gas supply from Block B&52

Gas supply from Block B&52 is envisaged below;



Annual gas supply of 5.06 BSCM/year during the plateau period is derived from DCQ (490 MMSCF) specified in GSPA and GSA.

$$13.88\ MMSCM\ (490\ MMSCFD) \times 365 = 5.06\ BSCM/year$$

Maximum Daily Contract Quantity (MDCQ) is also stipulated in GSPA and GSA with 117.35% swing.

$$MDCQ = 13.88\ MMSCM\ (490\ MMSCF) \times 1.1735 = 16.29\ MMSCM$$
$$Annual\ MDCQ = 16.29\ MMSCM \times 365 = 5.94\ BSCM/year$$

DCQ is subject to “Take or Pay” contract, but MDCQ is not.

After commencement of gas consuming from Block B&52, EVN has right to purchase gas between DCQ and MDCQ. As long as gas consuming is above DCQ, EVN can keep away from “Take or Pay” contract. On the other hand, PVN has obligation to supply gas to EVN up to MDCQ.

As DCQ and MDCQ are specified by calorie supply based on higher calorific value of 870 BTU/scf, if gas calorific value is higher than 870 BTU/scf, supply gas quantity is lower than DCQ, and vice versa.

The plateau period is defined by another method in which it becomes shorter. The details are specified in Section 4.1.4 “Study on Plateau Period”.

(5) Gas Supply and Demand Balance

As the output of O Mon 2, 3 and 4 power stations will be determined from now on through ICB, etc., the following 4 cases are studied to analyze gas supply and demand balance.

1) 850 MW class (ISO rating) F type gas turbine combined cycle is applied to all 3 power stations
2) 850 MW class F type gas turbine combined cycle is applied to 2 power stations and 950 MW class (ISO rating) F type gas turbine combined cycle is applied to 1 power station
3) 850 MW class F type gas turbine combined cycle is applied to 1 power station and 950 MW class F type gas turbine combined cycle is applied to 2 power stations
4) 950 MW class F type gas turbine combined cycle is applied to all 3 power stations

(a) Table 4.1-4 and Table 4.1-5 shows the results of case 1)

During the plateau period, while gas supply to O Mon 1A is about 82% of required gas quantity, gas supply to O Mon 1B, 2, 3, 4 and Ca Mau II is satisfied.
If EVN chose MDCQ, gas supply exceeds the demand except 1st year.

(b) Table 4.1-6 and Table 4.1-7 shows the results of case 2)

During the plateau period, while gas supply to O Mon 1A is about 68% of required gas quantity, gas supply to O Mon 1B, 2, 3, 4 and Ca Mau II is satisfied.
If EVN chose MDCQ, gas supply exceeds the demand except 1st year.

(c) Table 4.1-8 and Table 4.1-9 shows the results of case 3)

During the plateau period, while gas supply to O Mon 1A is about 55% of required gas quantity, gas supply to O Mon 1B, 2, 3, 4 and Ca Mau II is satisfied.
If EVN chose MDCQ, gas supply exceeds the demand except 1st year.

(d) Table 4.1-10 and Table 4.1-11 shows the results of case 4)

During the plateau period, while gas supply to O Mon 1A is about 42% of required gas quantity, gas supply to O Mon 1B, 2, 3, 4 and Ca Mau II is satisfied.
If EVN chose MDCQ, gas supply exceeds the demand except 1st year.

Based on the aforementioned analysis, either of following countermeasures to be taken to meet the gas demand;

1) Gas deficiency is made up by heavy fuel oil that can be used in O Mon 1A/1B
2) Adoption of MDCQ

Countermeasure of 1) seems to be realistic solution because the plateau period is shortened by 1 year in case of 2).

With regard to utilization of Liquefied Natural Gas (LNG) in case of gas deficiency, the study is out of consideration in this F/S because it’s realization is unknown for the time being due to tremendous investment cost of the LNG terminal and high LNG price.

Table 4.1-4 Gas Supply- Demand Balance Sheet in 2015 - 2027

(850 MW x 3/DCQ Basis)

Ô Môn IV starts commissioning from 04/2015 and commercial operation from 11/2015
Cà Mau 2 starts operating by Lot.B&52 Gas from 10/2015

(standard billion m3)

	1 st year	2nd year	3rd year	4	5	6	7	8	9	10	11	12
NĂM (year)	10/2015-10/2016	10/2016-10/2017	10/2017-10/2018	10/2019	10/2020	10/2021	10/2022	10/2023	10/2024	10/2025	10/2026	10/2027
CUNG (supply)	**2.53**	**3.79**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**
CẦU (demand)	**2.53**	**3.79**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**
Cà Mau 2 (750 MW)	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Ô Môn IA (330 MW)	0.00	0.24	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
Ô Môn IB (330 MW)	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Ô Môn II (850 MW)			1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02
Ô Môn III (850 MW)		1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02
Ô Môn IV (850 MW)	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02
Ô Môn V	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
CUNG - CẦU (balance)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

O Mon I-A,B will be flexible operated (gas and/or heavy fuel oil) to ensure the maximum reliability and availability of O Mon Complex.
Gas quantity marked in red shows the case that gas is not enough for 0.60 Billion m3 in O Mon I-A,B

Table 4.1-5 Gas Supply- Demand Balance Sheet in 2015 - 2027

(850 MW x 3/MDCQ Basis)

Ô Môn IV starts commissioning from 04/2015 and commercial operation from 11/2015
Cà Mau 2 starts operating by Lot.B&52 Gas from 10/2015

(standard billion m3)

	1 st year	2nd year	3rd year	4	5	6	7	8	9	10	11	12
NĂM (year)	10/2015-10/2016	10/2016-10/2017	10/2017-10/2018	10/2019	10/2020	10/2021	10/2022	10/2023	10/2024	10/2025	10/2026	10/2027
CUNG (supply)	**2.97**	**4.45**	**5.94**	**5.94**	**5.94**	**5.94**	**5.94**	**5.94**	**5.94**	**5.94**	**5.94**	**5.94**
CẦU (demand)	**2.97**	**4.15**	**5.17**	**5.17**	**5.17**	**5.17**	**5.17**	**5.17**	**5.17**	**5.17**	**5.17**	**5.17**
Cà Mau 2 (750 MW)	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Ô Môn IA (330 MW)	0.44	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Ô Môn IB (330 MW)	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Ô Môn II (850 MW)			1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02
Ô Môn III (850 MW)		1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02
Ô Môn IV (850 MW)	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02
Ô Môn V	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
CUNG - CẦU (balance)	**0.00**	**0.30**	**0.77**	**0.77**	**0.77**	**0.77**	**0.77**	**0.77**	**0.77**	**0.77**	**0.77**	**0.77**

O Mon I-A,B will be flexible operated (gas and/or heavy fuel oil) to ensure the maximum reliability and availability of O Mon Complex.
Gas quantity marked in red shows the case that gas is not enough for 0.60 Billion m3 in O Mon I-A,B

Table 4.1-6 Gas Supply- Demand Balance Sheet in 2015 - 2027

(850 MW x 2 + 950 Mw x 1/DCQ Basis)

Ô Môn IV starts commissioning from 04/2015 and commercial operation from 11/2015
Cà Mau 2 starts operating by Lot.B&52 Gas from 10/2015

(standard billion m3)

	1 st year	2nd year	3rd year	4	5	6	7	8	9	10	11	12
NĂM (year)	10/2015-10/2016	10/2016-10/2017	10/2017-10/2018	10/2019	10/2020	10/2021	10/2022	10/2023	10/2024	10/2025	10/2026	10/2027
CUNG (supply)	**2.53**	**3.79**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**
CẦU (demand)	**2.53**	**3.79**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**
Cà Mau 2 (750 MW)	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Ô Môn IA (330 MW)	0.00	0.16	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41
Ô Môn IB (330 MW)	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Ô Môn II (850 MW)			1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02
Ô Môn III (950 MW)		1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Ô Môn IV (850 MW)	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02
Ô Môn V	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
CUNG - CẦU (balance)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

O Mon I-A,B will be flexible operated (gas and/or heavy fuel oil) to ensure the maximum reliability and availability of O Mon Complex.
Gas quantity marked in red shows the case that gas is not enough for 0.60 Billion m3 in O Mon I-A,B

Table 4.1-7 Gas Supply- Demand Balance Sheet in 2015 - 2027

(850 MW x 2 + 950 MW x 1)/MDCQ Basis)

Ô Môn IV starts commissioning from 04/2015 and commercial operation from 11/2015
Cà Mau 2 starts operating by Lot.B&52 Gas from 10/2015

(standard billion m3)

	1 st year	2nd year	3rd year	4	5	6	7	8	9	10	11	12
NĂM (year)	**10/2015-10/2016**	**10/2016-10/2017**	**10/2017-10/2018**	**10/2019**	**10/2020**	**10/2021**	**10/2022**	**10/2023**	**10/2024**	**10/2025**	**10/2026**	**10/2027**
CUNG (supply)	**2.97**	**4.45**	**5.94**	**5.94**	**5.94**	**5.94**	**5.94**	**5.94**	**5.94**	**5.94**	**5.94**	**5.94**
CẦU (demand)	**2.97**	**4.23**	**5.25**	**5.25**	**5.25**	**5.25**	**5.25**	**5.25**	**5.25**	**5.25**	**5.25**	**5.25**
Cà Mau 2 (750 MW)	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Ô Môn IA (330 MW)	0.44	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Ô Môn IB (330 MW)	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Ô Môn II (850 MW)			1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02
Ô Môn III (950 MW)		1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Ô Môn IV (850 MW)	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02
Ô Môn V	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
CUNG - CẦU (balance)	**0.00**	**0.22**	**0.69**	**0.69**	**0.69**	**0.69**	**0.69**	**0.69**	**0.69**	**0.69**	**0.69**	**0.69**

O Mon I-A,B will be flexible operated (gas and/or heavy fuel oil) to ensure the maximum reliability and availability of O Mon Complex.
Gas quantity marked in red shows the case that gas is not enough for 0.60 Billion m3 in O Mon I-A,B

Table 4.1-8 Gas Supply- Demand Balance Sheet in 2015 - 2027

(850 MW x 1 + 950 Mw x 2/DCQ Basis)

Ô Môn IV starts commissioning from 04/2015 and commercial operation from 11/2015
Cà Mau 2 starts operating by Lot.B&52 Gas from 10/2015

(standard billion m3)

	1 st year	2nd year	3rd year	4	5	6	7	8	9	10	11	12
NĂM (year)	10/2015-10/2016	10/2016-10/2017	10/2017-10/2018	10/2019	10/2020	10/2021	10/2022	10/2023	10/2024	10/2025	10/2026	10/2027
CUNG (supply)	**2.53**	**3.79**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**
CẦU (demand)	**2.53**	**3.79**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**	**5.06**
Cà Mau 2 (750 MW)	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Ô Môn IA (330 MW)	0.00	0.16	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
Ô Môn IB (330 MW)	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Ô Môn II (950 MW)			1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Ô Môn III (950 MW)		1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Ô Môn IV (850 MW)	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02
Ô Môn V	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
CUNG - CẦU (balance)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

O Mon I-A,B will be flexible operated (gas and/or heavy fuel oil) to ensure the maximum reliability and availability of O Mon Complex.
Gas quantity marked in red shows the case that gas is not enough for 0.60 Billion m3 in O Mon I-A,B

Table 4.1-9 Gas Supply - Demand Balance Sheet in 2015 - 2027

(850 MW x 1 + 950 MW x 2)/MDCQ Basis)

Ô Môn IV starts commissioning from 04/2015 and commercial operation from 11/2015
Cà Mau 2 starts operating by Lot.B&52 Gas from 10/2015

(standard billion m3)

	1 st year	2nd year	3rd year	4	5	6	7	8	9	10	11	12
NĂM (year)	10/2015-10/2016	10/2016-10/2017	10/2017-10/2018	10/2019	10/2020	10/2021	10/2022	10/2023	10/2024	10/2025	10/2026	10/2027
CUNG (supply)	**2.97**	**4.45**	**5.94**	**5.94**	**5.94**	**5.94**	**5.94**	**5.94**	**5.94**	**5.94**	**5.94**	**5.94**
CẦU (demand)	**2.97**	**4.23**	**5.33**	**5.33**	**5.33**	**5.33**	**5.33**	**5.33**	**5.33**	**5.33**	**5.33**	**5.33**
Cà Mau 2 (750 MW)	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Ô Môn IA (330 MW)	0.44	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Ô Môn IB (330 MW)	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Ô Môn II (950 MW)			1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Ô Môn III (950 MW)		1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Ô Môn IV (850 MW)	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02
Ô Môn V	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
CUNG - CẦU (balance)	**0.00**	**0.22**	**0.61**	**0.61**	**0.61**	**0.61**	**0.61**	**0.61**	**0.61**	**0.61**	**0.61**	**0.61**

O Mon I-A,B will be flexible operated (gas and/or heavy fuel oil) to ensure the maximum reliability and availability of O Mon Complex.
Gas quantity marked in red shows the case that gas is not enough for 0.60 Billion m3 in O Mon I-A,B

Table 4.1-10 Gas Supply - Demand Balance Sheet in 2015 - 2027

(950 Mw x 3/DCQ Basis)

Ô Môn IV starts commissioning from 04/2015 and commercial operation from 11/2015
Cà Mau 2 starts operating by Lot.B&52 Gas from 10/2015

(standard billion m3)

	1 st year	2nd year	3rd year	4	5	6	7	8	9	10	11	12
NĂM (year)	10/2015-10/2016	10/2016-10/2017	10/2017-10/2018	10/2019	10/2020	10/2021	10/2022	10/2023	10/2024	10/2025	10/2026	10/2027
CUNG (supply)	2.53	3.79	5.06	5.06	5.06	5.06	5.06	5.06	5.06	5.06	5.06	5.06
CẦU (demand)	2.53	3.79	5.06	5.06	5.06	5.06	5.06	5.06	5.06	5.06	5.06	5.06
Cà Mau 2 (750 MW)	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Ô Môn IA (330 MW)	0.00	0.08	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Ô Môn IB (330 MW)	0.52	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Ô Môn II (950 MW)			1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Ô Môn III (950 MW)		1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Ô Môn IV (950 MW)	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Ô Môn V	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
CUNG - CẦU (balance)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

O Mon I-A,B will be flexible operated (gas and/or heavy fuel oil) to ensure the maximum reliability and availability of O Mon Complex.
Gas quantity marked in red shows the case that gas is not enough for 0.60 Billion m3 in O Mon I-A,B

Table 4.1-11 Gas Supply - Demand Balance Sheet in 2015 - 2027

(950 MW x 3)/MDCQ Basis)

Ô Môn IV starts commissioning from 04/2015 and commercial operation from 11/2015
Cà Mau 2 starts operating by Lot.B&52 Gas from 10/2015

(standard billion m3)

	1 st year	2nd year	3rd year	4	5	6	7	8	9	10	11	12
NĂM (year)	10/2015-10/2016	10/2016-10/2017	10/2017-10/2018	10/2019	10/2020	10/2021	10/2022	10/2023	10/2024	10/2025	10/2026	10/2027
CUNG (supply)	**2.97**	**4.45**	**5.94**	**5.94**	**5.94**	**5.94**	**5.94**	**5.94**	**5.94**	**5.94**	**5.94**	**5.94**
CẦU (demand)	**2.97**	**4.31**	**5.41**	**5.41**	**5.41**	**5.41**	**5.41**	**5.41**	**5.41**	**5.41**	**5.41**	**5.41**
Cà Mau 2 (750 MW)	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Ô Môn IA (330 MW)	0.36	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Ô Môn IB (330 MW)	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Ô Môn II (950 MW)			1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Ô Môn III (950 MW)		1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Ô Môn IV (950 MW)	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Ô Môn V	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
CUNG - CẦU (balance)	**0.00**	**0.14**	**0.53**	**0.53**	**0.53**	**0.53**	**0.53**	**0.53**	**0.53**	**0.53**	**0.53**	**0.53**

O Mon I-A,B will be flexible operated (gas and/or heavy fuel oil) to ensure the maximum reliability and availability of O Mon Complex.
Gas quantity marked in red shows the case that gas is not enough for 0.60 Billion m3 in O Mon I-A,B

4.1.4 Study on Plateau Period

(1) Definition of the Plateau Period of Block B&52

The plateau period shall end on the earlier of the following 2 cases;

(a) December 31st of the contract year during which the 12th anniversary of the end of the build-up period occurs

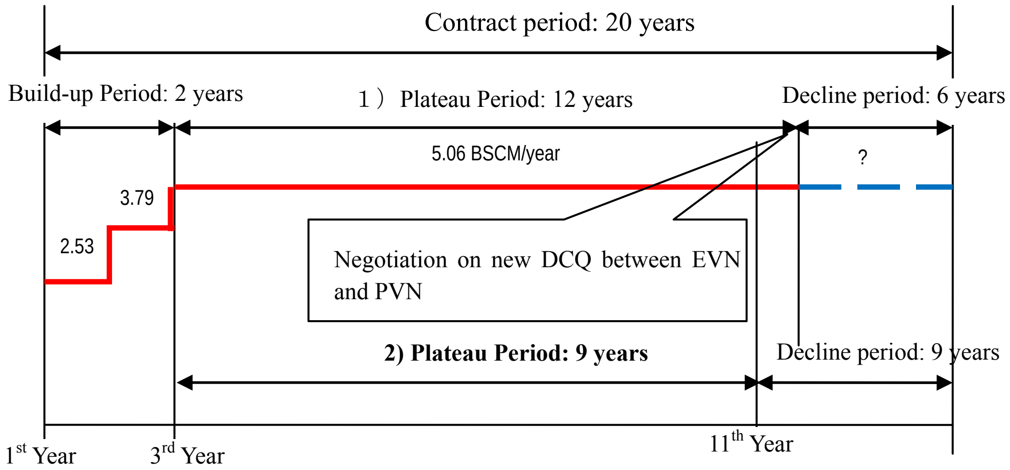
(b) December 31st of the contract year in which the sellers have sold to the buyer the accumulative quantity of sales gas equal to at least 50% of the current field reserve.

Based on the 2P of 100 BSCM (available reserve to midstream), the plateau period defied by (b) is calculated as follows;

$$(50 - 2.53 - 3.79)/5.06 = 8.6 \rightarrow 9 \text{ years}$$

Therefore, the end of the plateau period is 2 + 9 = 11th year from the start of gas supply.

In case of O Mon 3, as gas supply will start from 2nd year, the end of the plateau period is 10th year from the start of gas supply.



In case that EVN consumes full gas of MDCQ, the plateau period defied by (b) is calculated as follows;

$$(50 - 2.53 - 3.79)/5.94 = 7.4 \rightarrow 8 \text{ years}$$

Therefore, the end of the plateau period is 2 + 8 = 10th year from the start of gas supply.

In case of O Mon 3, as gas supply will start from 2nd year, the end of the plateau period is 9th year from the start of gas supply.

(2) Plateau Period of the Past Project

Attachment 4.1-1 shows the pertinent clause in GSPA of Block Nam Con Son developed by British Petroleum. The gas is supplied to PM-1 F type combined cycle plant (1,090 MW).

Definition of the end of the plateau period is same as that in GSPA of Block B&52, i.e. consisting of 2 cases.

Although the end of the plateau period derived from gas 50 % consumption cannot be calculated because DCQ is unknown for us, another condition stipulates that the plateau period is 11th anniversary of the commissioning date.
Therefore, definition of the end of the plateau period is similar for both GSPA.

(3) Information about Gas Stable Supply to O Mon Power Complex

1) PVN's obligation in GSA

It is a sentence in GSA that if gas from Block B&52 to O Mon Power Complex is short, PVN obliges to supply gas from other gas sources.

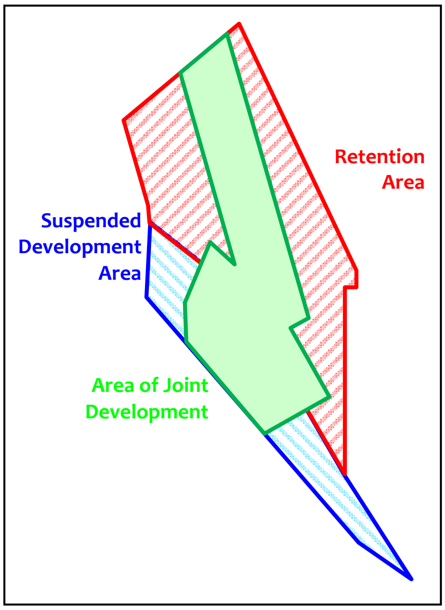
2) Unexploited area of Block B&52

As shown in the right side drawing, the portion of Joint Development Area is about 1/3 of Block B&52.

2 wells will be tested in suspended Development Area in 2012.

On the other hand, wells in Retention Area will be tested after the Conclusion of FID.

It is a possibility that the plateau period is improved by the results of these test wells.



Attachment 4.1-1

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5.2.8 Minimum Plateau Period

If the end of the Plateau Period is earlier than both of:

(i) the Day on which twenty nine (29) billion Standard Cubic Metres of Sales Gas have been delivered under this Agreement and the Other Agreements, and

(ii) the eleventh (11th) anniversary of the Commissioning Date,

then during the remaining period from the end of the Plateau Period until the earlier of the events described in paragraphs (i) and (ii) above:

(a) the DCQ and MDCQ for the Plateau Period as specified in Articles 5.2.3 and 5.3 (iii) respectively, shall continue to apply, notwithstanding the preceding provisions of this Article 5.2, and

(b) for the purposes only of the classification of Shortfall Gas in accordance with Article 13, the sum of the Buyer's Proper Nominations aggregated each Contract Year (or part thereof) during such remaining period shall not exceed two decimal seven (2.7) billion Standard Cubic Metres (or the appropriate portion thereof, as the case may be).

5.3 Maximum Daily Contract Quantity

There shall be established a Maximum Daily Contract Quantity ("MDCQ") which shall be the maximum daily quantity of Sales Gas which the Buyer may nominate for deliveries in aggregate by the Sellers. Subject to Article 10.5, the MDCQ shall be as follows:

(i) First Contract Year

From the Start Date until the end of the First Contract Year, the MDCQ each Day shall be nine decimal five two two (9.522) million Standard Cubic Metres;

4.1.5 Gas Price

(1) Information about the Gas Price

Gas price submitted to the Government of Vietnam for their approval at the end of last year is 9 ~ 10 USD/MMBtu. The Government has not yet approved due to higher its price compared with precedent gas prices.

On the other hand, IE prepared F/S on "Economic analysis between the gas fired combined cycle plant and the coal fired conventional power plant" financed by Chevron.

Conclusions of F/S are as follows;

1) The gas fired combined cycle plant is superior to the coal fired conventional power plant based on the gas price submitted to the Government
2) Little impact to the whole power tariff is anticipated even if the gas price submitted to the Government is adopted

The F/S Report has submitted to MOIT, EVN and PVN.

(2) Formula for the Gas Price

1) GSPA

Initial gas price is escalated with 1) two previous quarter of Consumer Price Index (CPI)[3] and 2) previous quarter of High Sulfur Fuel Oil (HSFO)[4].

2) GTA

Initial transportation price is escalated with two previous quarter of CPI.

3) GSA

GSA = GSPA + GTA + PVN administration cost.

4.1.6 Gas Specifications

Table 4.1-12 shows 7 sorts of gas from Block B&52. Some of gas contain inert gas (N_2 + CO_2) more than 20% that gas turbine manufactures can barely use as fuel gas.

PVN recommended adopting 893 in the table as design purpose whose detail specifications are described in Table 4.1-13.

3 Arithmetic average of American consumer price index
4 Arithmetic average of all Singapore HSFO 180 cst 3.5 % S

Table 4.1-12 Gas Specifications of Block B&52

Anticipated Sales Gas Compositions
HCDP 7.2C (45F), Water 7 Ib/MMscfd

		Within LOI Specifications						
	HCDP	**45.07F**	**44.97F**	**44.66F**	**45.06F**	**44.59F**	**44.61F**	**44.98F**
	Cal's HHV	**856**	**866**	**879**	**893**	**949**	**1,014**	**1,050**
Component		Mol %	Mol %	Mol %	Mol %	Mol %	Mol %	Mol %
C1	Methane	71.5500	77.1600	73.1400	80.4884	84.9397	66.4000	74.2251
C2	Ethane	2.8100	2.9400	2.9100	2.7368	3.0212	6.2100	5.0397
C3	Propane	1.4700	0.3200	1.5200	0.2997	0.4152	5.4200	4.5097
iC4	Isobutane	0.4200	0.1100	0.4400	0.0964	0.1318	1.1300	1.3076
nC4	n-Butane	0.3300	0.0800	0.3500	0.0698	0.1066	1.0300	0.8459
iC5	Isopentane	0.1600	0.0800	0.2100	0.0631	0.0742	0.2700	0.2834
nC5	n-Pentane	0.0900	0.0400	0.1400	0.0265	0.0366	0.1500	0.1552
C6	Hexane	0.0900	0.1400	0.0900	0.1232	0.1452	0.0600	0.0580
C7	Heptane	0.0600	0.1235	0.0450	0.1269	0.0794	0.0150	0.0130
C8+	Octane+	0.0190	0.0025	0.0200	0.0045	0.0160	0.0000	0.0100
N2	Nitrogen	2.9900	1.8700	2.7100	2.0158	2.1286	2.5600	5.3679
CO_2	Carbon dioxide	20.0000	17.1200	18.4100	13.9367	8.8900	16.7400	8.1680
H_2O	Water vapour	0.0147	0.0147	0.0147	0.0147	0.0147	0.0147	0.0147
Total		**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Inert		23.0	19.0	21.1	16.0	11.0	19.3	13.5
MW		23.4	21.9	23.0	21.0	19.7	24.6	22.2
SG (60F, 14.696 psia)		0.81	0.76	0.79	0.72	0.68	0.85	0.76
LHV (Btu/scf)		773	781	794	806	856	920	951
HHV (Btu/scf)		856	866	879	893	949	1,014	1,050
Wobbe Index at 60F		953	997	988	1050	1,152	1,101	1,202
Modified Wobbe Index at 60F		37.7	39.4	39.1	41.5	45.6	43.8	47.7
Sample Point No.		1	2	3	4	5	6	7

Table 4.1-13 Detailed Gas Specifications of 893

No.	Property		Unit (HCDP cal's GHV)	Typical Value (45.06F 893)	Min. Value (Recommended Range for Bid)	Max. Value (Recommended Range for Bid)	Contractually Committed
I	**Composition**						
1.a	Methane	CH4	% mol	80.4884%	66.4%	95%	
1.b	Methane	CH4	& of total reactance		82.3%	100%	**Yes** (> 82% of total reactants)
2	Ethane	C2H6	% mol	2.7368%	1%	8%	
3	Propane	C3H8	% mol	0.2997%	0%	6%	
4	i-Butane	C4H10	% mol	0.0964%	0%	3%	
5	n-Butane	C4H10	% mol	0.0698%	0%	3%	
6	i-Pentane	C5H12	% mol	0.0631%	0%	0.4%	
7	n-Pentane	C5H12	% mol	0.0265%	0%	0.3%	
8	Hexane	C6H14	% mol	0.1232%	0%	0.2%	
9	Heptane	C7H16	% mol	0.1269%	0%	0.2%	
10	Octane plus	(C8+)	% mol	0.0045%	0%	0.1%	
11	Nitrogen	N2	% mol	2.0158%	0%	8%	**Yes**
12	Carbon dioxide	CO2	% mol	13.9367%	0%	20%	20% CO_2 in the first 5 contract years, after that consider to increase up to 21%
13	Water vapor	H20	% mol	0.0147%	0%	0.0147%	**Yes**
14	Helium	He	% mol	0.00%	0%	0%	
15	Oxygen	O2	% mol	0.00%	0%	0.1%	**Yes**
16	Hydrogen	H2	% mol	0.00%	0%	0%	
17	Carbon monoxide	CO	% mol	0.00%	0%	0%	
18	Other components		% mol	0.00%	0%	0%	
19	**Total**		**% mol**	**100.00%**	**N/A**	**N/A**	
20	Sum of higher hydrocarbons	C2+	% mol	3.5468%			
21	Total inert		% mol	15.9526%	0%	23.0%	**Yes**
22	Variation of C2+		% mol		0%	17.0%	
II	**Gas Conditions (at power plant - Provided by PV Gas)**						
1	Pressure at TP		Barg		40	60	**Yes**
2	Pressure variation		%				
3	Temperature at TP		°C		+10°C above HCDP and 10°C above Water dew point	60	**Yes**
III	**Physical Properties**						
1.b	Hydrocarbon Dew Point at 60 bar (870 psig)		°C	1.7		7.2	**Yes**
2	Hydrocarbon Dew Point at Cricondentherm		°C	7.3			
3	Water dew point at 60 bar (870 psig) based on water content 7 Ib/MMscf		°C	-2.6			
4	Hydrocarbon Dew Point at 60 bar (870 psig)		F	35			
5	Hydrocarbon Dew Point at Cricondentherm		F	45.06			
6	Water dew point at 60 bar (870 psig) based on water content 7 Ib/MMscf		F	27.2			
7	MW			20.97			
8	SG			0.72			
9	Density at 60F		Ib/ft3	0.055			
10	Density at 15°C		kg/m^3	0.89			
11	Higher Heating Value (HHV)		BTU/scf	893	850	1,050	**Yes**
12	Lower Heating Value (LHV)		BTU/scf	806	773	951	
13	Absolute Limit of Wobbe Index at 60F (LHV/SG^0.5)		BTU/scf	947	858	1,140	**Yes**
14	Operating Gas Wobbe Index Range for Period From First Gas to the End of 5th Contract Year		BTU/scf		858 (953 - 10%)	1,048 (953 + 10%)	**Yes**
15	Operating Gas Wobbe Index Variation Range Relative to Midpoint		%		-10%	+10%	**Yes**
16	Option to Change Wobbe Index Range with Respect to Midpoint, Subject to Proper Notification				No change permitted in first five (5) years of operation, commencing from the Start Date	Seller has the option to request a change in Wobbe Index range three (3) times in the first 20 years of the project and a total of four (4) times over the life of the project. The fourth (4th) change, if required, will be subject to mutual agreement by the Parties, based on Block B field conditions at that time.	**Yes**

4.1.7 Location of Gas Distribution Center and Tie-in Point of the Gas Pipeline

(1) Location of the Gas Distribution Center

Gas distribution center planned to be constructed by PV Gas is located at about 300 m south as the crow flies from the main gate of O Mon Power Complex.
The area is about 7.5 ha, and resettlement of the inhabitants within the area has been completed.

Photo 4.1-1 shows the area for the gas distribution center and Photo 4.1-2 shows the view from the area for the gas distribution center to O Mon Power Complex.

(2) Tie-in Point of the Gas Pipeline

Tie-in point of the gas pipeline at the premises of O Mon Power Complex is located adjacent the oil jetty as shown in Fig. 4.1-3.

Photo 4.1-1 Area for Gas Distribution Center

Photo 4.1-2 View from the Area to O Mon Power Complex

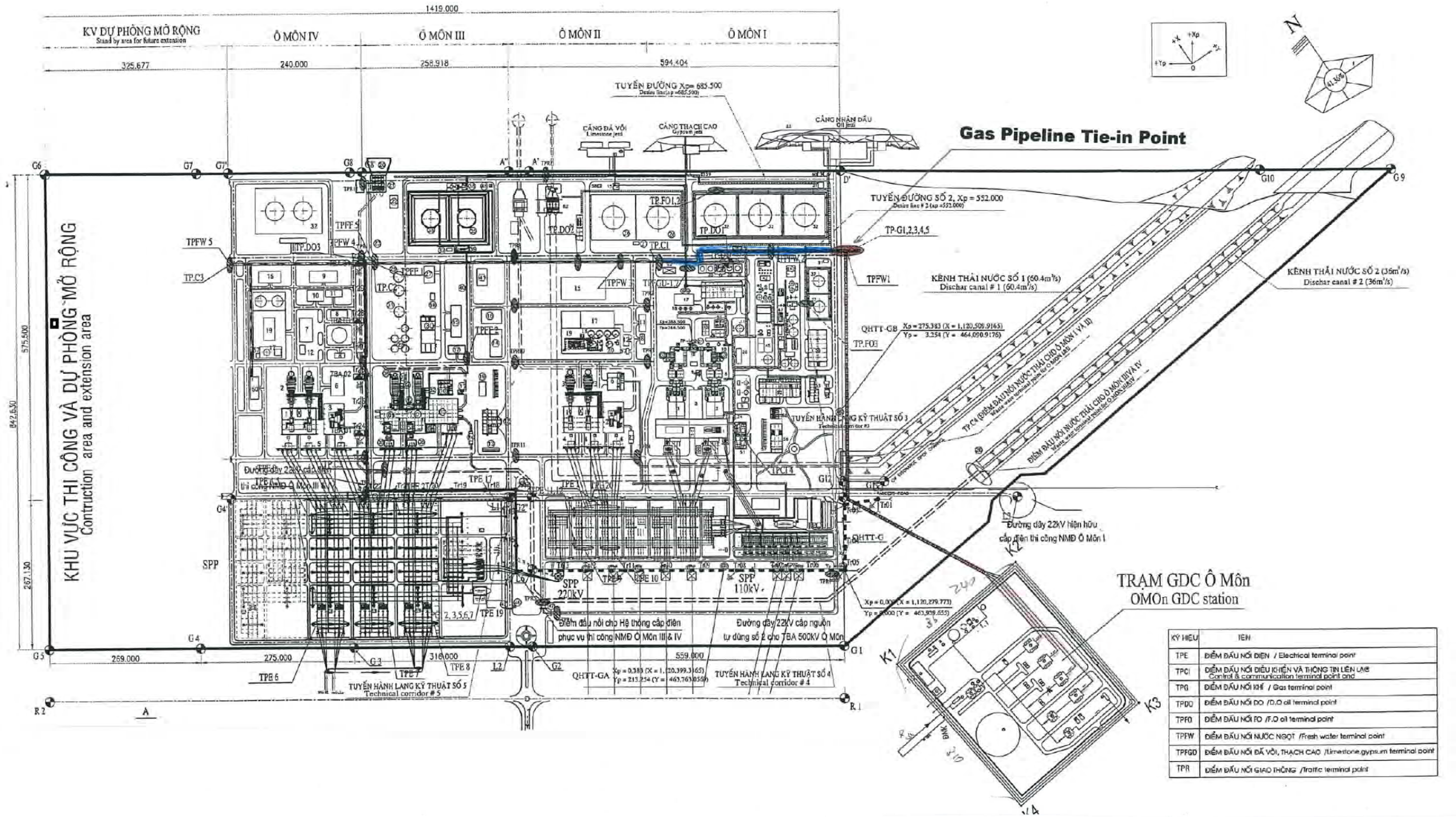

Fig. 4.1-3 Tie-in Point of the Gas Pipeline

4.1.8 Emergency Fuel (Diesel Oil)

(1) Specifications of Diesel Oil

Diesel oil is used as the start-up fuel in O Mon 1A. The amount of diesel oil per one start-up is about 43 ton.
Specifications of diesel oil are specified in Table 4.1-14.

(2) Price of Diesel Oil

Present price is 20,350 ~ 24,619 VND/litter (0.97 ~ 1.18 USD/litter) at 15°C.

(3) Sellers of Diesel Oil and Delivery Methods to O Mon Power Complex

Domestic distributors such as Petrolimex supply diesel oil imported from Singapore to O Mon Complex. Diesel oil storage facilities are located at Can Tho city and Ho Chi Min city, and diesel oil is delivered to the site through about 500 DWT barges in 1 day from Can Tho city and in 3 days from Ho Chi Min city.

Although Dung Quat oil refinery plant is put into operation, there is no plan to use it at O Mon Power Complex for now.

(4) Unloading of Diesel Oil at O Mon Power Complex

Diesel oil is unloaded by 1 oil unloading arm (400 m^3/h capacity) at the jetty and delivered to the diesel oil tanks at the premises of O Mon Power Complex.

Table 4.1-14 Diesel Oil Specification

Characteristic	Unit	Specific Value	Range
Compositions (% weight)			
Carbon	%	86.19	85.3 - 86.5
Hydrogen	%	13.11	12.6 - 13.8
Nitrogen	%	0.1	
Oxygen	%	0.1	
Sulfur	%	0.5	1.0 Max
Moisture	%	0	
Ash content	%	0	0.01 Max
Total	%	100	
High heating value (HHV)	kJ/kg	45,225	44,800 - 46,050
Low heating value (LHV)	kJ/kg	42,600	
Kinematic viscosity at 40°C	cSt		1.3 - 5.5
Flash point	°C		50 Min
Pour point	°C		-6 Max
Water and Sediment	% Vol		0.05 Max
Conradson Carbon Residue (10% day)	% Wt		0.35
Distillation - 90% vol. recovered	°C		282 - 338
Metal corrosion (V + Pb + Zn + Ni)	ppm		1 Max

4.2 OVERALL PLAN

4.2.1 Construction Plan of the Project

(1) Current Status of Power Plants Construction in O Mon Power Complex

Construction plan of power plants in O Mon power complex is planned as shown in Table 4.2-1. The commercial operation of O Mon 4 power plant is planned to be one year earlier than that of O Mon 3 power plant and the total installed capacity in O Mon Power Complex becomes 2,160 MW in 2016.

Table 4.2-1 Construction Plan of Power Plants in O Mon Power Complex

Power Plant	Generation Type	Capacity	Operation Year	Remarks
O Mon 1	Conventional	660 MW	1A Unit in 2009 1B Unit in 2014	1B :JICA Finance
O Mon 2	Combined Cycle	750 MW	2016	BOT Project Operation year is based on the PDP7
O Mon 3	Combined Cycle	750 MW	2016.11	The latest plan approved by EVN JICA Finance (plan)
O Mon 4	Combined Cycle	750 MW	2015.11	The latest plan approved by EVN ADB Finance
O Mon 5	-	-	-	Construction plan was cancelled.

(2) Breakdown of Land Area and Main Facilities for Power Plants in O Mon Power Complex

The total land area of O Mon Power Complex is 191 ha (including open space, road out side of the fence and housing for staff, etc.).

The Study Team obtained the data and CAD drawings as shown in Fig. 4.2-1 and Fig. 4.2-2 from CTTP and all facilities and land area relating to the O Mon power complex are confirmed as shown in Table 4.2-2.

Table 4.2-2 Breakdown of Land Area by Facilities Base of Power Plants

(unit : ha)

	Total Land Area	Main Equipment and Facilities									
		Generation Facilities		Fuel Facilities		Switchyard		Other Facilities		Green Space	
O Mon 1	32.4535	3.0863	9.5%	3.1201	9.6%	4.6275	14.3%	18.0749	55.7%	3.5447	10.9%
O Mon 2	14.2632	3.7235	26.1%	2.1676	15.2%	—	—	7.3925	51.8%	0.9796	6.9%
O Mon 3	52.0171	2.6665	5.1%	1.9212	1.3%	9.5710	18.4%	32.1113	61.7%	5.7471	11.1%
O Mon 4	13.812	2.3248	16.8%	2.0465	14.8%	—	—	6.7208	48.7%	2.7199	19.7%

Source : CTTP

Contents of Confirmation

<Land Area of O Mon 3 Power Plant>

(1) The land area of O Mon 3 is the most spacious among O Mon 1 to O Mon 4 in the O Mon Power Complex. The land area of O Mon 3 is 3.8 times of that of O Mon 4.

(2) The land area of O Mon 3 is divided into the following 3 blocks excluding the 220/500kV switchyards area (9,571ha).(See Fig. 4.2-1)

1) O Mon3 KV1 (14.905ha) - Power generation equipment & facilities compartment.
2) O Mon3 KV2 (12.8905ha) - Open space on the south side of 220kV Switchyard.
3) O Mon3 KV3 (14,6502ha) - Open space on the ground of the planned Cooling Water (CW) Discharge Culvert.

(3) The administration building/guard house/gates (main & sub) are installed in O Mon 3 and are used as the common facilities of O Mon 3 and O Mon 4.

(4) The 220kV Control Room has already been installed in the 220kV/110kV switchyard on the south of O Mon 1 & O Mon 2.

(5) The ratio of the current greening plan of O Mon 3 is 11%. But there is sufficient open space for the green tract of land area to be expanded in O Mon Power Complex.

(6) Materials and Equipment Yard during the construction of O Mon 2, 3, 4 are planned as follows (See Fig. 4.2-2).

1) O Mon 2: O Mon KV2
2) O Mon 3: 1/2 Area of the open space on the west side of O Mon 4 (Front Side of Hau River)
3) O Mon 4: 1/2 Area of the open space on the west side of O Mon4 (West Side of 500kV Switchyard)

<Others>

(1) The Area No.1 & No.2 of Staff Apartment are planned outside of the fence.

(2) The open space for Storage & Construction are planned in the east side of O Mon 1.

(Note) Switchyards:
- O Mon 1and O Mon 2are connected to 220kV/110kV switchyard.
- O Mon 3and O Mon 4are connected to 500kV switchyard.

Fig. 4.2-1 Land Area for O Mon 3 Power Plant

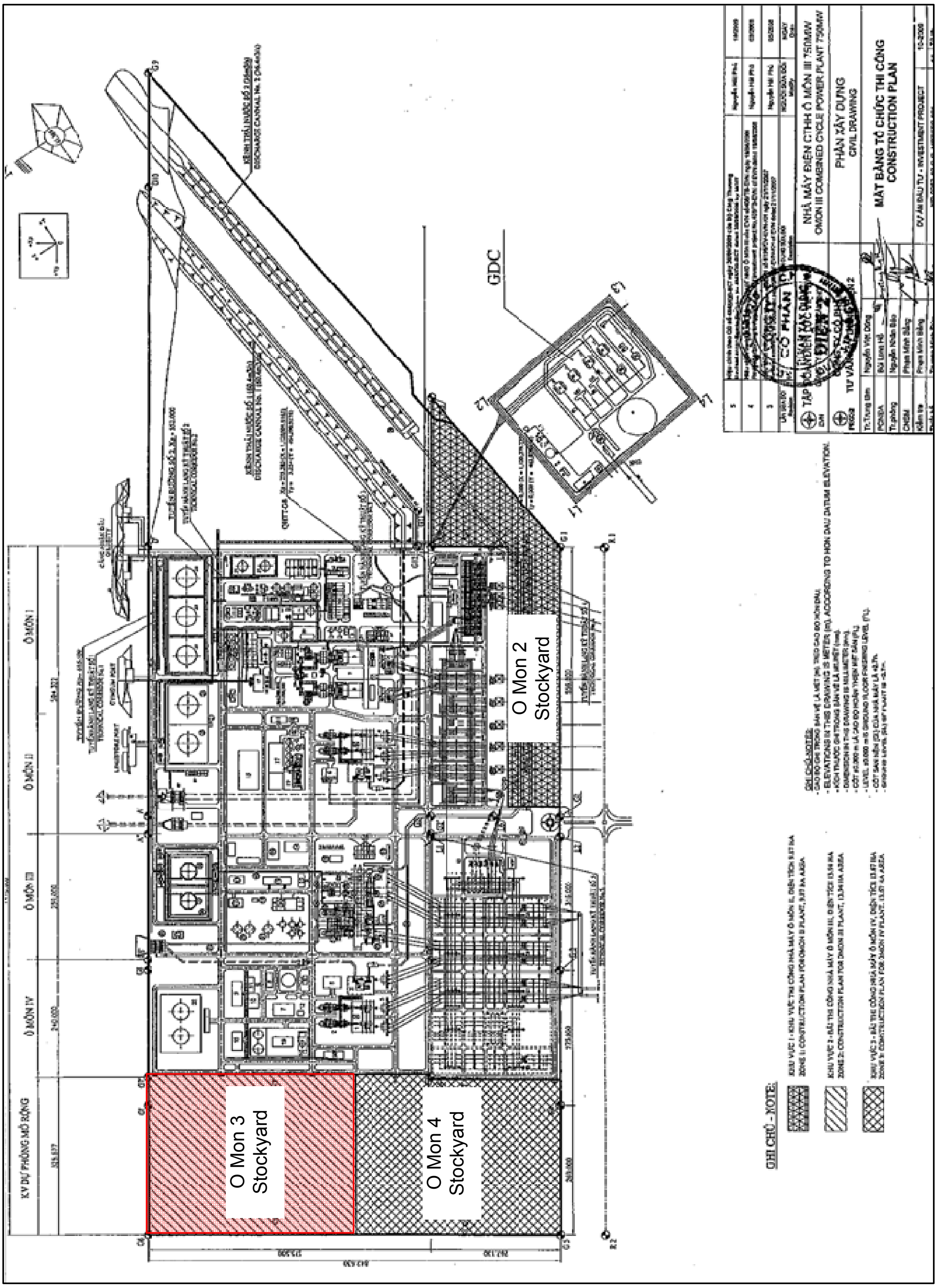

Fig. 4.2-2 Layout of Temporary Stockyard in O Mon Power Complex

(3) Confirmation on Layout of O Mon 3 Power Plant

Layout of O Mon 3 power plant is confirmed by the drawing provided by CTTP as shown in Fig. 4.2-3. According to Fig. 4.2-3, O Mon power plant is to be constructed in O Mon 3 KV1 and consists of the following 4 areas.

Area 1: located between Area 2 and Area 4 and the following facilities are arranged.
- main plant housing of the two Gas Turbine Generators (GTGs) and one Steam Turbine Generator (STG);
- HRSGs and the two main stacks, and the two by pass stacks;
- three main transformers and the two Aux. transformers;
- pipe rack;
- control building of STG, GTG;
- sampling house;
- center control building;
- feed water pump station and the sampling house;
- siphon pit and the CW discharge culvert;
- diesel generator station.
- administration building;
- motorbike shed;
- canteen;

Area 2: located between Area 1 and Area 3 and the following facilities are arranged.
- water demineralizing area;
- waste treatment;
- filtered water tanks;
- demineralizing water tank;
- water treatment control building house;
- fire pump station;
- garage;
- warehouse;
- workshop;
- fire truck station;
- pipe sleeper.

Area 3: located Hau River on the front of O Mon 3 and the following facilities are arranged.
- CW inlet canal
- CW pump station and CW supplying pipe
- Oil measurement station
- Distillate Fuel Oil (DO) storage tanks
- Oil protection embankment
- Oil separator tank
- Oil recovery tank
- DO pump station
- fuel gas treatment and supply plant.
- Pipe sleeper
- watch tower

Area 4: located between Area 1 and Access Road No.2 and the following facilities are arranged.
- CW discharge culvert
- CW discharge channel

- guard house
- main gate
- aux. gate
- 220kV/500kV switchyards:

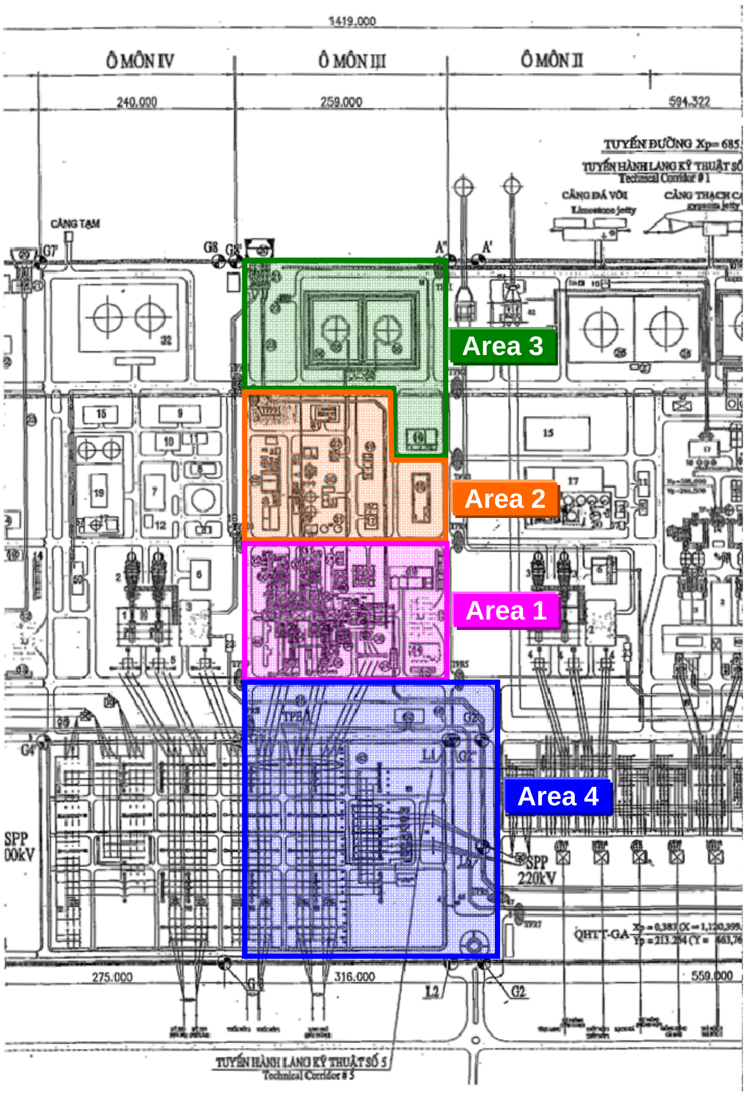

Fig. 4.2-3 Arrangement of Area 1 ~ Area 4 for O Mon 3 Power Plant

4.2.2 Specifications for Facilities Planning

Based on the specification of facilities planning in Table 4.2-3, Construction plan for O Mon 3 power plant was reviewed.

Table 4.2-3 Specification and Confirmation of Facilities Planning for O Mon 3

No.	Specifications of Facilities Planning	Contents of Confirmation
1	Main Characteristics	Design overview of the main facilities
2	Construction details	Outline of specifications of main equipment &facilities
3	Efficient layout of power plant equipment & facilities	(1) Layout of the main power generation equipment &facilities (2) Layout of the ancillary facilities
4	Consideration for the surrounding residential (Environmental Measures)	(1) Air pollution measures equipment, (2) Thermal effluent measures equipment (3) Drainage measures equipment (4) Noise preventive measures equipment (5) Greening measures
5	Safety equipment and disaster prevention	(1) Security Facilities (2) Fire Fighting equipment and facilities
6	Consideration for the conditions of topography and geology of the site;	Risks of topography, geology, earthquakes and others
7	Environmental evaluation to the natural, consideration for the landscape	(1) Intake and discharge method of condenser CW (2) Presence or absence of scenic spots
8	- Possibility of the common equipment facilities - construction status of the common equipment & facilities	(1) Possibility of the common equipment & facilities (2) Progress of the construction of the common equipment & facilities
9	Connection to the transmission grid	Status of the 500kV switchyards
10	Appropriate leveling , Foundation plan	Current status of the embankment and foundation plan
11	Access road to O Mon 3	Progress of the construction of access road No.2
12	Layout plan of temporary facility for construction work	Unloading Jetty/Construction power/CTTP & Consultant site office/Contractor site office

The result of review is shown in Table 4.2-4.

Table 4.2-4 Result of Review based on Specifications of Facilities Planning

No.	Items	Contents of Confirmation
1	**Main characteristics of O Mon 3 power plant ;**	

Source : O Mon Combined Cycle Power Project Feasibility Study Report,Sep,2010,PECC2

Name of Power Plant	O Mon 3 Combined Cycle Power Plant.
Location	Thoi Loi Hamlet, Phuoc Thoi Commune, O Mon District, Can Tho City, Vietnam.
Scale of Capacity	Min.750MW
Configuration	Configuration of 2-2-1, Gas Turbine Unit is F Type Technology: Gas turbine for Combine Cycle Power Plant.
Fuel	Gas from B&52, through the B&52-O Mon Gas pipe line. D.O.-Back up fuel, DO storage tanks (10,600 m^3 × 2 tanks).
Cooling Water	CW take from Hau river and drainage far away to Hau River with discharge volume of 18 m^3/s.
Fresh water	The fresh water for construction and operation are planned to supply and treat from Hau River.
Transmission voltage level	500kV
Annual average operation hours	6,000 hours/year
Design operation hour	6,500 hours/year
Economic life of plant	25 years

2 Specifications of Main Equipment &Facilities;

Outline of specifications of main equipment and facilities

Source: O Mon Combined Cycle Power Project Feasibility Study Report,Sep.2010,PECC2

(1) Main buildings

No.	Facilities Name	Quant.	length (m)	Width (m)	Height (m)
1	Gas Turbines Building	1	86	19	25.2
2	Steam Turbine Building	1	49.5	42	25.2
3	Electrical Control Building	1	24	24	10.28
4	Diesel Generation Station	1			
5	Administration Building	1	42	25.2	14.8
6	Bypass Stack, HRSG and Main Stack	2 2	Dia.6.8 Dia.6.8		30 40
7	Canteen	1	25	12	4

(2) Auxiliary Buildings

No.	Facilities Name	Quant.	length (m)	Width (m	Height (m)
1	Warehouse	1	36	24	12.6
2	Workshop	1	56	18	13.8
3	Vehicle maintenance and garage building	1	34	12	5.7
4	Motorbike shed	1	30	6	2.2

(3) Fuel Oil/Gas Supply System

No.	Facilities Name	Quant.	length (m)	Width (m)	Height (m)
1	Fuel Oil Pipeline	1system			
2	Fuel Gas Pipeline	1system			
3	DO Tank &Bound Foundation	2	130	105	2.0
4	Fuel Oil Counter Station	1	52	17	6.7

No.	Items	Contents of Confirmation

No.	Facilities Name	Quant.	length (m)	Width (m)	Height (m)
5	Fuel Oil Pump House	1	18	7.2	4,2
6	Fuel Oil Recovery Sump	1	9	4	4.5
7	Fuel Gas Treatment & Distribution Station	1	30	14.4	4.2

(4) Water Treatment and Drainage Systems

No.	Facilities Name	Quant.	length (m)	Width (m)	Height (m)
1	Pre-treatment Water Treatment Plant	1system	85	37	
2	Demineralized Water Treatment Plant	1system			
3	Portable Water Tank Foundation	2	16	16	1.4
4	Demineralized Water Tank Foundation	2	11.6	11.6	1.0
5	Storm Water Drainage System	1system			
6	Water Treatment Building	1system	60	30	
7	Oily, Chemical Water	1system			
8	Drainage System	1system			

(5) Electrical System

No.	Facilities Name	Quant.	length (m)	Width (m)	Height (m)
1	500kV Switchyard	1	263	234	
2	220kV Switchyard	1	118	40	
3	House to put the Control Panel for 500kV Switchyards	1	10	8	3.0
4	Main Transformer System	3	17	14	10
5	Auxiliary Transformer	4	18	5	4.5
6	Cable Trench and Duct Bank System	1system			

(6) Fire-Fighting System

No.	Facilities Name	Quant.	length (m)	Width (m)	Height (m)
1	Fire Fighting Pump Station	1	12	7.2	5.5
2	Fire Fighting Water Pipeline	1system			

(7) Road System

No.	Facilities Name	Quant.	length (m)	Width (m)	Height (m)
1	Plant Internal Road	1system			
2	Plant External Road	1system			

(8) Security System

No.	Facilities Name	Quant.	length (m)	Width (m)	Height (m)
1	Perimeter Fence	1system			3.0
2	Main Gate	1			
3	Security tower	1	4.8	4.8	9
4	Guard House	1	6	4	4

<table>
<tr><th>No.</th><th>Items</th><th>Contents of Confirmation</th></tr>
<tr><td></td><td colspan="2">(9) CW System
<table>
<tr><th>No.</th><th>Facilities Name</th><th>Quant.</th><th>length (m)</th><th>Width (m)</th><th>Height (m)</th></tr>
<tr><td>1</td><td>CW Intake Head</td><td>1</td><td></td><td></td><td></td></tr>
<tr><td>2</td><td>Pipeline to CW Pump Station</td><td>1</td><td>Dia.3.0m</td><td></td><td></td></tr>
<tr><td>3</td><td>CW Pump House</td><td>1</td><td></td><td></td><td></td></tr>
<tr><td>4</td><td>Pipeline from CW Pump to Condenser</td><td>1</td><td>Dia.3.0m</td><td></td><td></td></tr>
<tr><td>5</td><td>CW Discharge Culvert</td><td>1line</td><td></td><td>4.5</td><td>4.5</td></tr>
<tr><td>6</td><td>CW Discharge Open Channel</td><td>1</td><td></td><td></td><td></td></tr>
<tr><td>7</td><td>Chlorination Plant Building</td><td>1</td><td>1</td><td>8</td><td>66</td></tr>
</table></td></tr>
<tr><td>3</td><td>Efficient layout of power plant equipment & facilities</td><td>O Mon 3 will be arranged in one package related to the equipment& facilities in the following Area 1 from Area 4. It has become effective arrangement considering operation & monitoring of the equipment、root of patrol inspection and maintenance space, etc.</td></tr>
<tr><td>3.1</td><td>Layout of the main power generation equipment & facilities</td><td>Area1: Open Cycle GTG (2 sets) Combined Cycle STG (1set) are arranged indoor to account for operation& monitoring of the equipment and maintenance.
In addition, Those equipment are arranged close to Center control building, a diesel generator building
- HRSGs and main stacks/by-pass stacks are arranged on the north side of GTG building. As for those facilities, the installation and the space maintaining are considered.
Area2: Arrange in one package BOP facility of water facilities, drainage facilities and fire fighting water facilities .Those arrangements are made considering the operation& monitoring of equipment and the route of patrol inspection.
Area3: Arrange in one package CW intake facilities & DFO storage facilities. Those arrangements are considering the operation& monitoring of equipment and the root of patrol inspection.
Area4: - The control room of 220kV/500kV switchyards has already been installed.
- The root of the installation of CW discharge culvert/CW discharge channel will be arranged considering the working space.</td></tr>
<tr><td>3.2</td><td>Layout of the ancillary facilities</td><td>The ancillary facilities will be arranged considering day shift members engaged in Area 4 from Area1 maintenance place and safety& security.
Area1: - Administration building, Motorbike shed and Canteen are efficiently arranged close to the Main power building.
Area2: - Warehouse/Workshop of maintenance facility and garage are efficiently arranged in one package.
Area3: - Watch tower will be arranged as the safety &security facility on the front of Hau River as the safety & security facility.
Area4: - Guard House and Gate (Main & Sub) will be arranged at the entrance of O Mon 3 as the safety & security facility.</td></tr>
<tr><td>4</td><td>Consideration for the surrounding residential (Environmental measures)</td><td>(1) The site of O Mon 3 was procured without problems in accordance with the law.
(2) As for air pollution/thermal effluent/waste water/noise etc. it was confirmed that the following measures were taken for the facilities to comply with the value of environmental standards.</td></tr>
</table>

No.	Items	Contents of Confirmation
	Air pollution measures equipment	(1) Main Stack: 40m high × 2sets. (2) By pass Stack: 30m high × 2sets.
	Thermal effluent measures equipment	(1) Deep water intake: Condenser CW (18m^3/h) to take in water from the front of Hau River of O Mon 3. Condenser CW intake will be shared with O Mon 4. (2) CW discharge: CW discharge culvert and CW discharge channel No.2 in the south side of O Mon 3 using the common facilities of O Mon 3 &O Mon 4.(Total Volume Capacity: 36m^3/h)
	Drainage measures equipment	(1) Wastewater treatment facility (Design capacity: Max 50m^3) will be arranged in the south of Demineralizing Area. (2) Regular volume of wastewater per day from O Mon 3 is about 999m^3/day (41m^3/h). In addition, the position of wastewater outlet of O Mon 3 is undetermined. (After determining the Contractor, the position of drain outlet will)
	Noise preventive measures equipment	(1) Gus-turbine, generator/Steam-turbine, generator will be installed in the turbine buildings. (2) The following equipment to install the silencer. - Exhaust Pipes of Gas Turbines - Exhaust Pipes of Ancillary System - Air Intake of Air Compressor (3) Limit noise levels - Substation :105dB(A) - Air filter of compressor :105dB(A) - Noise level at100m far from noise source :60 dB(A) (Note) Allowable noise level in resident area is 75dB(A)from6h~18h, 75dB(A)and18h~22h, and50dB(A)from22h~6h.
	Greening measures	(1) Greening of the current planning area is 5.747 ha. Greening rate is 11%. *Expansion of green area space is sufficient.
5	**Safety equipment and disaster prevention**	Confirmation of the following equipment & facilities. (1) Security Facilities; 1) The perimeter fence work around the O Mon Power Complex is currently conducted by CTTP. 2) Guard house × 1 Gate (main & sub)and security tower ,etc. are arranged as common facilities with O Mon 4 (2) Fire fighting system ; 1) Fire truck station & fire pump station 2) Water loop pipeline for fire fighting, in addition, fire fighting water piping is connected to O Mon 3 and O Mon 4 (tie-point is undecided) 3) Fire-fighting engines: - Water fire-engine - Chemical-water fire engine 4)Sprinkler System - Oil tank cooling system - CO_2 system 5) Other equipment - Fire alarm system - Portable CO_2 bottles and Dry chemical bottles etc.

No.	Items	Contents of Confirmation
6	**Consideration for the conditions of topography and geology**	(1) O Mon Power Complex is geologically stable. There is no particular problem because of lower risk of earthquake. (2) O Mon 3 is located at an appropriate altitude, and the cost can be compressed. In addition, the overall cost of foundation work is appropriate.
7	**Evaluation to the natural environment and consideration for the landscape**	(1) As a result of the comparison of One-through Cooling System and Cooling Tower System, the Study Team adopts One-through Cooling System because it has little impact on the river from practical aspect. (2) Because there are no scenic spots around the O Mon Power Complex, there is no particular need of consideration for landscape.
8	Construction status and possibility of the common equipment & facilities are as follows. In addition, the common equipment & facilities of O Mon 3 are involved in the following 15.	

Common equipment & facilities related to O Mon 3

No.	Common Equipment & Facilities	To be used for	New	Existing
1	Administration Building	O Mon 3 & O Mon 4	○	
2	500KV Switchyards(Common Civil work)	O Mon 3 & O Mon 4	○	
3	500KV Stations (including Switchyard Control House)	O Mon 3 & O Mon 4		○
4	CW Intake and CW Pump Station	O Mon 3 & O Mon 4	○	
5	CW Discharge Culvert	O Mon 3 & O Mon 4	○	
6	CW Discharge Channel No.2	O Mon 3 & O Mon 4	○	
7	Construction Power	O Mon 3 & O Mon 4	○	
8	DO Unloading Jetty	O Mon 1 ~ O Mon 4		○
9	Piping Rack & Sleeper for DO/Gas	O Mon 1 ~ O Mon 4	○	
10	220kV Switchyard & 220kV Control Room	O Mon 1 ~ O Mon 2		○
11	Pire fighting Trucks	O Mon 3 & O Mon 4	○	
12	220kV Relay Control Room	O Mon 1 ~ O Mon 2	○	
13	Guard House & Gate(main & sub)	O Mon 3 & O Mon 4	○	
14	Circle Fire Fighting Piping System	O Mon 3 & O Mon 4	○	
15	Watch Tower	O Mon 1 ~ O Mon 4	○	

No.	Items	Contents of Confirmation
9	**Connection to the transmission grid**	(1) 500kV Switchyards (3lines of GTG-1/GTG-2/STG-1) is the common facilities of O Mon 3 & O Mon 4. (2) It was confirmed that the preceding works of the civil work& control house, etc. had already been carried out in 500kV Switchyards.
10	**Appropriate leveling, Foundation plan**	(1) The leveling plan is also in EL.2.70m as with O Mon 1 and Embankment will be completed in 2012 up to the height plan. (2) The foundation plan has been established based on the geological survey & the results of O Mon 1.
11	**Access road to O Mon 3**	(1) The access road up to the entrance of O Mon 3 in the south side of 500kV switchyard from National Road No.91 through access road No.2 has been planned. In addition、Access Road No.2 land acquisition is completed by EVN, It is currently under construction. (Scheduled for completion in April, 2012).
12	**Layout plan of temporary facility construction work pertaining to power plant**	(1) Unloading berth: The temporary unloading berth is available that is installed near the existing Jetty No.1.

No.	Items	Contents of Confirmation
		There is a space of the temporary unloading berth along Hau River on the front of O Mon 3& O Mon 4. (2) Temporary construction power: New transmission line has been planned for O Mon 3 & O Mon 4、has been installed on the south side of O Mon 1 & O Mon 2. (3) Site office of CTTP & Consultant: The construction personnel plan of O Mon 3 will be fixed and the site office will be planned on Hau River side of the northwest side of O Mon 4. (4) Site office of Contractor: The Contractor is undetermined. In principle, the selection of the Contractor's site office is done by Contractor.

4.2.3 Required Water Amount for O Mon Power Plant

(1) Confirmation on Water Sources for O Mon 3 Power Plant

It is confirmed that well water and underground water are used for only construction stage, and CW for condenser and fresh water for the power plant in operation stage are provided by the Hau River facing to O Mon 3 power plant.

< Note >

Fresh water is used to Make-up Water (Make-up water for plant)/Demineralizing Water (Pure water) / Filtered Water below (General service water)

- Make-up Water : Make-up water used for the purpose of power generation. (The flow volume during power generation and unrecovered auxiliary steam volume)
- Demineralizing : Demineralizing water used for cooling and maintenance of water auxiliary equipment, water pressure tests, cleaning of deionizer and other works.
- Filtered Water : Filtered water used for cooling and maintenance of auxiliary equipment, water pressure tests, cleaning of deionizer, living water, fire-fighting water, site spring water and other works.

(2) Required CW Volume for Condenser and Fresh Water for Power Plants

Required amount of CW for condenser provided by the Hau River is shown in Table 4.2-5 and required amount of fresh water for power plants is shown in Table 4.2-6.

Table 4.2-5 Required CW and its Specification

Item / P/S	Water Source : Hau River (m^3/h)	Specification				
		Capacity (MW)	Technology	Temperature Increase (°C)	Water heat Capacity (k/kg°C)	Total demand CW (m^3/s)
O Mon 1	52,000	660	Conventional Steam PP	7	4.19	**30.2**
O Mon 2	64,800	750	CCPP	7	4.19	**18**
O Mon 3	**64,800**	**750**	**CCPP**	7	**4.19**	**18**
O Mon 4	64,800	750	CCPP	7	4.19	**18**
Total	246,400	2,910	—	—	—	**84.2**

Source : CTTP

Table 4.2-6 Required Fresh Water for Power Plants

No.	Specification		O Mon 1		O Mon 2	O Mon 3	O Mon 4	Total
1	Capacity	MW	660		750	750	750	2,910
2	Water demand for Construction Phase	m^3/day	2,640		3,000	3,000	3,000	11,640
3	Water demand for Operation Phase	m^3/day	4,000		1,449	1,449	1,449	8,489
4	Total demand	m^3/day	6,640		4,449	4,449	4,449	20,129
5	Operation scheduled for		(Unit 1) 2/2009	(Unit 2) 3/2012	—	12/2015	4/2015	—

Source : CTTP

(3) Amount of Daily Fresh Water Intake for Each Power Plant and Storage Facilities

Daily intake amount of fresh water from the Hau River and storage facilities are shown in Table 4.2-7.

Table 4.2-7 Daily Intake Amount from the Hau River and Outline of Storage Facilities

Item / P/S	Water Source: Hau River (m^3/day)	Storage Facilities		
		Make-up Water Storage Tank	Demineralizing Storage Tank	Filtered Water Storage Tank
O Mon 1 660MW Conventional	1,254,640	1,200 m^3 × 1 tank 300 m^3 × 1 tank	2,000 m^3 × 2 tanks	3,000 m^3 × 2 tanks 150 m^3 × 1 tank
O Mon 2 750MW CCPP	1,559,649	—	—	—
O Mon 3 750MW CCPP	**1,559,649**	*** m^3 × 1 tank**	**1,600 m^3 × 1 tanks**	**1,200 m^3 × 2 tanks**
O Mon 4 750MW CCPP	1,559,649	—	2,000 m^3 × 2 tanks	2,000 m^3 × 2 tanks

* Storage capacity shall be decided by O Mon 3 contractor

Source : CTTP

Preprocession of fresh water from the Hau River is done by Pre-Treatment System.

< Note >

In accordance with Article 13 of Decree No.149/2004/ND-CP dated July 27,2004 relating to the Regulation on issuing permits of survey, exploitation and usage of water source and water discharge, it is stipulated that:

1) The Ministry of Natural Resource and environment will issue, extend the permit validity, modify or annul validity of the permit or forfeit the permit in the following case:
   (a) The important projects of exploitation and usage of water as approved by Prime Minister;
   (b) Project of survey and exploit the underground water with 3,000 m^3/day flow rate;
   (c) Survey and exploit the surface water for cultivation with 2 m^2/second or higher flow rate;
   (d) Survey and exploit the surface water for power generation with 2,000kW or above;
   (e) Survey and exploit the surface water for other purposes with 50,000 m^3/day flow rate or higher;
   (f) Discharge to the water source with the flow rate of 5,000 m^3/day or much more.

2) Province People’s committee will issue, extend the permit validity, modify or annual validity of the permit or forfeit the permit in other cases not mentioned above.

4.3 MECHANICAL EQUIPMENT

4.3.1 Selection of Type of Power Plant

The F/S Report made by PECC2 studied the optimum type of power plant for O Mon 3. The following three types of power plant were compared.

- Open cycle gas turbine power plant
- Gas turbine combined power plant
- Conventional boiler – steam turbine power plant

The comparison study was done in many aspects such as initial investment costs, installation areas, operation and maintenance costs, availability of fuels, and environmental impacts.

In the conclusion, the gas turbine combined cycle power plant using natural gas as main fuel was selected as the most preferable power plant for O Mon 3 from the reasons of the most economical, the minimum environmental impact, etc.

Furthermore, its shorter installation period than the conventional power plant was evaluated for resolving critical circumstances of shortage of electricity supply in Vietnam.

For selecting the gas turbine power plant, the availability and low price of natural gas for a long time are the most important point. If these requirements are secured, the selection of gas turbine combined plant is the most reasonable conclusion without any discussion.

4.3.2 Plant Configuration and Generation Capacity

(1) Plant Configuration

In gas turbine combined plants, there are two type configurations; i.e.

- Single shaft arrangement, in which the gas turbine, steam turbine and associated generator are connected in line through one shaft
- Multi-shaft arrangement, in which the gas turbine and the steam turbine are arranged separately, i.e. each turbine has an own generator.

The F/S Report compared these two type arrangements in the aspects of investment cost, power generation efficiency, flexibilities of operation, etc.

Generally, these both types are common and have a lot of experiences, and no significant difference in the cost, efficiency and technical points. If pointed out the difference between two types, the difference is only of commencement timing of commercial operation of gas turbine.

The completion time of gas turbine pant and gas turbine combined plant is usually 18 months and 32 months respectively, because the bottoming plant (HRSG and steam turbine) requires a longer completion time than gas turbine's one. In case of multi-shaft gas turbine plant, the gas turbine and bottoming plant can be constructed separately, and then the gas turbine can commence its commercial operation as a simple cycle operation prior to the completion of bottoming plant. That means that the owner can make electricity supply earlier by 2-stage construction of gas turbine and bottoming plant.

However, for enabling the simple cycle operation of gas turbine, a bypass stack is required to be installed between gas turbine and HRSG; that results in some additional cost.

The F/S Report says;

"Should it is built up in one phase, single-shaft configuration will be selected to improve the economy of the project, Should it is the case of two phases, multi-shaft configuration will be proposed for selection, single-shaft configuration or multi-shaft configuration to be consider in Bidding evaluation stage."

And no apparent conclusion is not provided. However, the layout and other technical and financial studies were carried out on the basis of multi-shaft configuration.

In case that a multi-shaft configuration is applied, as explained the next section, the plant will consist of two gas turbines, 2 HRSGs and 1 steam turbine; i.e. 2-2-1 configuration.

(2) Plant Generation Capacity

According to the PDP7, the capacity of O Mon 3 power plant was planned to be 750MW.

The F/S Report selected F type gas turbines as the most preferable one for O Mon 3 power plant. The capacity range of F type gas turbines is around 250 – 300 MW. Then, the required generation capacity will be attained by installing two gas turbines in 2-2-1 configuration.

In the world gas turbine market, there are four gas turbine manufacturers which can supply F type gas turbines; i.e. Alstom, GE, MHI and Siemens. Although some manufacturers among them have developed new gas turbine models called as "G" or "H" type gas turbine, of which capacities and efficiencies are much higher than those of F type gas turbine, the F/S Report selected F type gas turbines because of its longer term experiences in commercial operation (higher reliability) and engineer's and operator's technical capabilities in Vietnam. At present this selection is really reasonable.

The generation capacity of the gas turbine combined cycle plant is solely determined by the selected gas turbine model. In the F/S Report, the net generation capacity of the combined cycle plant using F type gas turbines manufactured by the above four manufacturers is assumed to be ranging from 740 to 770 MW.

While the gas turbine technologies have improved continuously, therefore, even if the model is the same, its capacity as well as its efficiency have already increased from the time with the F/S Report was issued.

Then, the Study Team confirmed EVN the criteria of selection of gas turbines and the required power generation range. His intension was confirmed as follows;

- F type gas turbine
- Equivalent Operation Hours (EOH) more than 8,000 hrs
- Power output is larger than 750 MW, and no upper limitation

Then, the Study Team assumes the range of power generation on the basis of the latest information of gas turbine performance as follows.

Table 4.3-1 shows the latest ISO base performance of F type gas turbine derived from 2011 edition of Gas Turbine World Handbook. And Table 4.3-2 shows the expected power generation, efficiency and natural gas demand of combined cycle plant designed at site conditions of O Mon Power Complex.
(The performance shown in Table 4.3-2 is not presented by the manufacturers but expected one only.)

Table 4.3-1 Performance of Gas Turbines (Natural Gas Fired, ISO Condition)

Candidate Gas Turbine Model		Alstom GT26	GE 9FB	MHI M701F4	Siemens SGT5-4000F
Year admitted	Year	1994	2003	1992	1995
Power Generation	kW	296,400	298,174	324,300	289,000
Heat Rate (LHV)	kJ/kWh	9,091	9,342	9,027	9,128
Efficiency (LHV)	%	39.6	38.5	39.9	39.4

Table 4.3-2 Expected Performance of Combined Cycle Plant (Natural Gas Fired, Site Conditions (*))

Candidate Gas Turbine Model		Alstom GT26	GE 9FB	MHI M701F4	Siemens SGT5-4000F
Plant Configuration		2-2-1	2-2-1	2-2-1	2-2-1
Gas Turbine (2 units)	MW	528.5	536.7	577.3	521.1
Steam Turbine (1 unit)	MW	290.6	318.1	300.3	268.6
Auxiliary Power	MW	16.4	17.1	17.6	15.8
Net Power Output	MW	802.7	837.7	860.0	773.9
Net Heat Rate (LHV)	kJ/kWh	6,249	6,278	6,242	6,435
Net Efficiency (LHV)	%	57.6	57.3	57.7	55.9

(*) Site Conditions:

Site Conditions:	Ambient temperature	30°C
	Relative humidity	80 %
	Atmospheric pressure	1,013 mbar
	CW temperature	30°C

From the above, the expected net power output of O Mon 3 power plant will be ranging from 770 to 860 MW. And yearly natural gas demand based on plant capacity factor of 68.5% (100% load × 6,000 hrs) will be around 0.97 ~ 1.04 Billion Nm^3/year as standard fuel of 870 BTU/SCF.

The study on the relation of the above assumed gas demand and supply quantity by GSA is referred in Section 4.1.

4.3.3 Specification of Main Equipment

(1) Gas Turbine

The required specifications described in the F/S Report are as follows:

- F type gas turbines supplied by four major suppliers (Alstom, GE, MHI and Siemens) with over 8,000 EOH in commercial operation
- Dual fuel type; natural gas as main fuel and diesel oil as back-up fuel
- Indoor installation
- Equipped with Dry Low NOx (DLN) combustor
- Bypass damper and stack are provided for enabling simple cycle operation of gas turbine

The above requirements are ordinary and not special ones.

In addition an applicability of inlet air cooling system was studied for an augmentation measure for power output at high temperature atmospheres. However, this technology is rather new and it requires a big amount of demineralized water. In addition its operation experience in F type gas turbine is not so many. Then the F/S Report advised that the application of this cooling system should be investigated more and be reconsidered in bidding stage.

This air cooling system have been usually installed in the existing plant and supplied by a company specializing in manufacturing this kind cooling system other than gas turbine suppliers. Therefore, when this cooling system is inquired in Bidding, it is doubtful whether the EPC contractor can guarantee the performance of the whole plant including such inlet air cooling system. Therefore, to judge to install such system including in the plant proposed, existing of the precedent of performance guarantee involving the air cooling system should be reviewed in the future.

(2) Steam Cycle and HRSG

1) Steam Cycle

For steam cycle of the combined cycle plant the F/S Report selected 3-pressure/reheat cycle because of its high efficiency.

Generally, when a fuel price is high, a steam cycle with higher efficiency, such as 3-pressure reheat, has a benefit in economical evaluation, on the contrary, when a fuel price is relatively low, a simple steam cycle, such as dual-pressure or non-reheat cycle is superior for the sake of its lower investment cost. However, the price of natural gas has been continuing to go up and furthermore escalation in future is presumed. Considering such economical circumstances in the world, the selection of the steam cycle with higher efficiency like a 3-steam pressure/reheat can be considered reasonable and preferable in spite of its complexity in system and higher initial investment cost.

The F/S Report requires installing 100 % capacity turbine bypass system for each pressure level of steam. These systems are effective for start and stop operation and as pressure relieving device.

2) HRSG

In the F/S Report, the following several types of HRSG were studied and evaluated:

- With or without supplementary firing system
- Horizontal or vertical flue gas flow
- Natural circulation or forced circulation of boiler water

[Supplementary firing]

Supplementary firing can compensate a reduction of steam flow during low load operation of gas turbine in hot season. However, the F/S Report concluded that the supplementary firing system is not necessary from the reasons that the efficiency of the whole plant is reduced by supplemental firing and this power plant is not required a function of covering peak-load.
The supplementary firing is very effective for the following plants:

- Cogeneration plant, in which a constant flow of process/heating steam is required to regardless of gas turbine load
- The plant with large difference in power output between hot and cold seasons

However, both of the above situations are not applied to O Mon power plant. Thus the supplementary firing system is considered unnecessary.

[Horizontal or vertical flue gas flow]

Each type HRSG has both a strong point and a weak point, but there is no critical deficiency on both types. And many horizontal gas flow and vertical gas flow type HRSGs have been installed and successfully operated. So, the F/S Report accepts both types of HRSG. This conclusion is fair and reasonable on condition that the bidder has a lot of experiences of the proposed type of HRSG.

[Natural circulation or forced circulation of boiler water]

In the F/S Report, "horizontal gas flow HRSG with natural circulation" and "vertical gas flow HRSG with forced circulation" were compared. However, many of "vertical gas flow HRSG with natural circulation" have been used worldwide.

Some major HRSG suppliers, such as MHI, CMI[5], Babcock-Hitachi, KHI[6], can supply the vertical gas flow-natural circulation type HRSG as one of their standard design.

Natural circulation type has no circulation pump; therefore it has a lot of benefits as listed below against the forced circulation type;
- Simpler system
- Installation cost and operation energy saving
- Easier operation and maintenance

Therefore, "vertical gas flow HRSG with natural circulation" should also be accepted on condition that the supplier has a plenty of and long period of experience in the same type HRSG in the past.

(3) Steam Turbine

Regarding the turbine proper, only "three-pressure/reheat type and double casing" are specified but no other special requirements and comparison were described.

As for the condensate system, feedwater system, vacuum system, etc. no special requirement other than standard constructions was provided.

4.3.4 Plant Auxiliary Equipment

(1) Fuel Gas Supply System

Fuel gas will be supplied from Gas Distribution Center of PVN, which is located near O Mon power complex, through an individual pipeline to each power plant of O Mon 1 to 4.

From the gas flow meter for trading, which is provided by PVN, fuel gas is transferred to the gas turbines through an emergency stop valve, gas cleaning equipment and pressure regulator. This system is usual and has no special requirement.

(2) Fuel Oil Supply System

Fuel oil (diesel oil) is back-up fuel when fuel gas supply is interrupted.

The fuel oil will be unloaded from a ship with the existing oil unloading system and transferred to each power plant with branching through the common oil pipeline.

5 Cockerill Maintenance & Ingénierie, Belgium
6 Kawasaki Heavy Industries, Ltd., Japan

Each power plant has an individual oil storage system. O Mon 3 power plant is planned to have 2 of 10,600 m^3 capacity storage tank, of which capacity corresponds to a demand of oil for 7 days at full load operation of the plant.

The fuel oil is supplied to the gas turbines passing through oil filters, transfer pumps and pressure accumulator. This system is usual and has no special requirement.

(3) Feed Water Supply System

Regarding fresh water supply source in construction stage, the F/S Report suggested the Hau River, but for normal operation after construction, suggested a possibility of Tra Noc Water Plant in addition to the Hau River.

Then the Study Team asked CTTP a possibility of water supply from Tra Noc Water Plant. CTTP confirmed "The water supply from Tra Noc Water Plant may be one option for construction stage, but for normal operation, the Hau River is a possible single supply source".

Considering a big amount of water flow of the Hau River, there would be no limitation in quantity of water usage. Therefore, the opinion of CTTP is considered reasonable.

Specified pre-treatment plant (coagulation, sedimentation equipment and filter) is acceptable. However, the demineralized water plant is planned to be a combination of Reverse Osmosis filter and mixed bed polisher. For water treatment to treat fresh water in power plant, a water treatment system in combination of 2-bed/3-tower ion exchanger and mixed bed polisher is regular. And the existing O Mon 1 also applies this type of the system. Therefore, it is required to explain clearly the reason why Reverse Osmosis filter is selected.

(4) Circulating CW System

Fresh water pumped from the Hau River is used for circulating CW.

Water intake and discharge culvert are common for O Mon 3 and 4 power plant. This equipment will be built in construction of preceding project among O Mon 3 and 4. (at the present schedule it would be constructed by O Mon 4)

Two of 50% capacity circulating water pumps are planned to be installed, and no stand-by pump will be provided. Since this pump is of very large capacity and expensive, and even when one pump is stopped accidentally the power plant can continue to operate by the remaining pump at lower load. Therefore, this selection seems to be reasonable from economical consideration.

There is no description about a tube cleaning device of the turbine steam condenser in the F/S Report. It is recommended that a ball type tube cleaning device should installed.

(5) Closed CW System

The F/S Report describes that the required CW for gas turbine system, steam turbine system and other ancillary equipment (except for steam turbine condenser) is supplied from this closed CW system. If the plant is constructed in single stage, the above scheme is acceptable. However, in case that the plant is constructed in two-stage, i.e. gas turbine simple cycle system and bottoming system, the CW for the gas turbines is necessary to be supplied from other independent CW system.

(6) Waste Water Treatment System

Pre-treatment of waste water (water/oil separation, primary neutralization, sewage treatment, etc.) will be done by each power plant (O Mon 1 to 4), however, it is not clear whether the final treatment (aeration, final neutralization, sedimentation, etc) is done by individual treatment system or by the common system, because the F/S Report describes "the collected waste water is pumped to the waste water treatment area and treated on the common waste water treatment system".

It is usual that the final treatment is carried out by a system commonly used for several power plants, however, for this case, reviewing the capacity of the existing final water treatment plant is necessary. On the other hand, there is some information that, according to the regulation of Vietnam, it is not permitted to discharge own waste water to the other areas or plants; information from CTTP. So the detail coverage of this regulation should also be reviewed.

(7) Compressed Air Supply System

According to the plan described in the F/S Report, 2 units of 100% capacity compressor will supply total required air for both of instrumentation air and plant service air. However, this arrangement is not preferable for supplying the air to instruments at steady pressure condition. Because a demand of the service air is intermittent and large amount use, that may cause a pressure fluctuation of the air supply system. Therefore the compressed air supply system should be divided into the instrument air and plant service air supply systems. And both systems should have 2 units of 100% capacity compressor. In addition, for making a reliability of instrumentation air system higher, provision of interconnecting line from service air to instrumentation air system is recommended; passing through this line back-up air will be supplied from the service air to instrumentation air in emergency.

(8) Fire Prevention and Protection System

In the F/S Report, the fire water supply system and fire-truck will be common for O Mon 3 and 4. However, the engineer of CTTP has an intension that each plant of O Mon 3 and 4 has an individual water supply system and fire-truck for higher reliability.
This issue should be discussed and confirmed again before bidding.

(9) Ventilation and Air Conditioning System

There is no comment.

(10) H_2 Gas Generation System

There is no comment.

(11) Auxiliary Steam System

There is no description about auxiliary steam system, however, it is recommended that the auxiliary steam should be supplied from the existing plant O Mon 1.

(12) Cranes and Hoists

There is no comment.

4.4 ELECTRICAL EQUIPMENT

4.4.1 Specification of Electrical Equipment

(1) Generator

The F/S Report specifies the generator as follow;

- Type of the generator	:	Synchronous generator
- Capacity	:	300 ~ 320MVA
- Power factor	:	0.85(Lag) ~ 0.9(lead)
- Insulation level	:	F class (allows B class temperature rise)
- Cooling	:	Air cooled or Hydrogen cooled
- Type of exciter	:	Static exciter

1) Generator capacity

As discussed in mechanical section of this report, the generator capacity tends to be larger than the above, due to the latest progress of gas turbine technology.

The generator has no technical restriction to cover the latest gas turbine capacities, even if, the lager capacity than 300~320 MVA is applied.

2) Cooling of the generator

The F/S Report accepts to apply the manufacturer's standard design of the cooling system whether air cooling or hydrogen cooling.

However, in general, generators of 200~250 MVA class or over are believed that it is economical to apply hydrogen cooling system because of its high cooling efficiency, even if it has to be provided with hydrogen generator, hydrogen gas storage system, CO_2 gas equipment to replace hydrogen gas in maintenance, etc.

3) Type of exciter

The F/S Report studies only static exciter, however, brushless exciter is applied in many projects, because of its price and easy maintenance since no maintenance of brush is required.
Static exciter has an advantage in quick response to sudden load change and in smaller installation space due to shorter rotor size of generator.
Static exciter has no brush, so that easiness of maintenance is the same as brushless exciter.
Th F/S Report considers quick response is advantageous.
Many other projects generally apply synchronous generator, same range of power factor, F class insulation level.
EVN's selection of generator specification is reasonable.

(2) Transformers

The F/S Report considers that 3 transformers, 2 main transformers for GTGs and 1 main transformer for STG, are considered. This means that there is no start-up transformer.

The main transformers are to be step-up generator output voltage up to 500kV to export generated power output to the national power grid.

During the start-up of the unit, the main transformers introduce power from the national grid to feed 6.6kV switchgears via auxiliary transformer for the house loads.

When the gas turbine is ready to start, the generator circuit breaker is closed to feed the power to start-up as a motor to drive the compressor of the gas turbine and purge the combustor and ignition follow.

Three generator transformers of 2 GTGs and 1 STG export the generated power to the national grid after stepped-up the generated voltage up to 500kV.

This is commonly applied system in the latest combined cycle power plant.

The F/S Report specifies the specifications of transformers as follow;

- Type ; Three phases, two windings, oil immersed, outdoor
- Vector group ; YNd11
- Rated voltage ; generator output voltage(manufacturer's standard)/500kV
- Lightning impulse withstand voltage ; 1,800kV
- Switching impulse withstand voltage ; 1,175kV
- With on-load tap changer
- Cooling ; ONAN/ONAF or ONAN/ONAF/ODAF
- Noise level ; Less than 70 dB

The above mentioned type, vector group and rated voltage are normally used in power plants. On-load tap changer is also normally applied in generator transformers.

Lightning impulse withstand voltage, switching impulse withstand voltage and power frequency withstand voltage are in accordance with International Electrotechnical Commission (IEC) 76.

The F/S Report says that the manufacturer can offer his standard system, from ONAF/ONAF (70%/100%) or ONAN/ONAF/ODAF (40%/70%/100).

It is understandable that EVN will accept the manufacturer's standard design of cooling system. However, in case of failure of cooling fans or cooling pumps, the generator output would be restricted to 70% or 40%.

It is recommendable to apply ONAN/ONAF than ONAN/ONAF/ODAF, because, in the worst case, the generator output will be limited to 40% in case of ONAN/ONAF/ODAF versus 70% in case of ONAN/ONAF.

Regarding the noise level of 70dB studied in the F/S Report, discussion with the manufacturer during the contract negotiation should considered.

(3) Emergency Power Supply System

The emergency power supply system is composed of emergency diesel generator, battery chargers, batteries, inverters, emergency Alternating Current (AC) distribution board and Direct Current (DC) distribution board.
O Mon 3 combined cycle power plant is supposed to operate only when the national power grid is active, so that the black start is not required.

That means the capacity of the emergency diesel generator is not required for the capacity to start any one (1) gas turbine when all AC power fail, but to have enough capacity to shut down the unit safely.

The F/S Report specifies the emergency diesel generator as;

- Diesel engine
  - Fuel ; Distillate oil
  - Cooling system ; Radiator

- Generator
  - Type ; Synchronous, rotating magnetic field, cylinder rotor, solidly coupled with engine shaft
  - Rated voltage ; 0.4kV
  - Capacity ; 1,000kVA
  - Power factor ; 0.85
  - Insulation level ; Class F (Class B insulation design temperature rise)
  - Cooling system ; Air
  - Excitation system ; Static excitation

The rated current of the generator with the capacity of 1,000kVA and voltage of 0.4kV is approximately 1,500A.

The rated current of 1,500A may be irrational for the emergency diesel generator of this size from the viewpoint of design.

Only 1 set of emergency generator for O Mon 3 (gas turbine × 2 + steam turbine × 1) may need 1,000kVA capacity of emergency loads. Each of the emergency loads has not so large capacity that can be fed from 0.4kV power supply system.

To cope with this technical problem, there are two options;

1) 3 diesel generator for each gas turbine & STG shall be planned instead of 1 in order to reduce the rated current of individual generator

2) The generator output voltage shall be 6.6kV. In this case, additional 6.6kV switchgear and auxiliary transformer shall be designed.

The Study Team would recommend three diesel generators with 0.4kV output, each 1 for each generator.
Cost impact owing to above modification is minor.

As for the excitation system, brushless excitation system is recommendable, instead of static excitation. That's why the emergency generator is operated when all power fail. During this failure, there is no stable power supply to support the static exciter.

DC power supply system

DC power supply system is composed of 2 systems, one is AC power being converted to DC power by battery chargers, the other is directly supplied from batteries.

Normally, battery charger output is fed to DC loads and battery output becomes the battery charger to back-up fails when it failed.

The DC power is used for DC motors, control systems, emergency lightings, protection relays, instrumentations, alarms, communication systems, fire alarm system, Uninterruptible Power Supply (UPS) system, etc.

The DC power supply systems are individually designed for gas turbine system, steam turbine system and power plant complex.

The DC power supply systems are divided into DC 220V for DC power drive and DC 24V (or 48V) for electronics use such as control system, computer system and communication systems.

The F/S Report plans that 24V (or 48V) should be divided from DC220V busbar by DC/DC converters.

The Study Team would recommend an option to install independent DC 24V (or 48V) battery system and DC 220V battery system from the viewpoints of noise and voltage fluctuations in addition to the plan in the F/S Report.

1) The auxiliary power system

The auxiliary power supply systems are devices to provide electric power to equipment/ plants.

The F/S Report divides the systems into 6.6kV switchgears, 0.4kV switchgears and 220V switchgears.

The 6.6kV switchgears are to provide electric power to other plants, lower voltage switchgears and motors of 200kW or more.

The 0.4kV switchgears are to provide electric power of less than 200kV to motors other auxiliary equipment or plants.

The 220V switchgears are to provide electric power to small motors, lighting system, instruments/control systems and small auxiliaries or devices.

(4) Switchgear Equipment

The F/S Report plans to install 6.6kV, 0.4kV and 220V systems for all gas turbine systems and steam turbine system.

However, there is no large auxiliary equipment in gas turbine plant which needs to be fed from 6.6kV power supply. Therefore, the 6.6kV switchgears for gas turbine plants can be deleted.

The 6.6kV switchgear is required only for steam turbine plant.

Cost impact due to deletion of the 6.6kV switchgears from gas turbine plant is small.

(5) Power Supply System during Start-up

Unit start-up is processed with generator circuit breaker open.

500kV power will be introduced from switchyard to generator transformer and to auxiliary transformer for the preparation of 0.4kV power for house load.

Preparation of start-up of gas turbine is processed by this 0.4kV power source.

After all the preparation of all start-up processes are ready, generator circuit breaker for GTG is closed to drive the generator as a motor.

Directly connected compressor to generator shaft starts sending combustion air to the combustor of the gas turbine.

If the field circuit of the generator is excited through a static exciter, the generator will generate electric power to provide energy through 500kV switchyard to national grid.

The F/S Report specifies that the type of generator circuit breaker is of SF_6 circuit breaker. Although SF_6 gas has an adverse impact to green house effect, this type of circuit breaker has the most reliable and high performance in present technology.

(6) Protection System (Relay, Interlock)

Normally, combined cycle power plant is so interlocked that something abnormal happens in steam turbine plant, high temperature exhaust gas from gas turbine is relieved to atmosphere through the bypass stack and gas turbine keeps its simple cycle operation.

If the exhaust gas cannot be released, the unit has to be tripped.

The former part of the F/S Report shows negative stand on the necessity of this interlock, however, the latter part describes that it is indispensable.

Without the interlock, even sound gas turbine cannot be operated if steam turbine fails. With the interlock, gas turbine can keep operation as simple cycle even though the output and efficiency become slightly lower.

For O Mon 3 project, the bypass stack must be installed.

The interlock system described in the F/S Report is generally reasonable.
EVN should discuss the detail interlocks with the manufacturer during the contract negotiation

(7) Lighting and Small Power System

Lighting and small power system are composed of normal and emergency lighting systems and small power supply system.
Normal lighting system includes indoor and outdoor lighting system for security, internal fences, perimeter fences, internal roads, corridors, stairs, etc.

Emergency lighting system which illuminates essential equipment and area is used by switching the power to the battery supply system when AC lighting power fails.

Small power supply system includes normal socket and industry socket which is provided for maintenance such as drills, welders, etc.

The F/S Report requests that the following lighting fittings should be provided;

- Fluorescent lamps for indoor lighting
- Mercury high pressure luminaries
- Mercury high pressure luminaries
- 250W high pressure sodium floodlight for switchyard and heat recovery steam generator(HRSG)

From the viewpoint of energy saving, fluorescent lamp, mercury high pressure luminaries and 250W high pressure sodium floodlight should be substituted by LED lamps and halogen gas lamps.

LED lamps need some longer time for start-up, but have no problem for use.

Halogen gas lamps have more natural and softer color tone than mercury high pressure lamps and high pressure sodium lamps.

They have higher illumination and smaller energy consumption.

(8) Cables and Cabling Works (Power, Control and Instrumentation)

Cables are to connect systems to supply electric energy. They are;

From main transformer to 500kV switchyard
From generator terminals to main transformer or auxiliary transformer
From auxiliary transformer to 6.6kV switchgears
From 6.6kV switchgear to HV motors or 0.4kV switchgears
From 0.4kV switchgear to each loads
Control and Instrumentation
Communication
Special cables

The F/S Report does not mention about cables and/or cabling works except isolated phase bus duct which connects between generator terminals and transformers.

The main transformer will be connected to 500kV switchyard with overhead Aluminum Conductor Steel Reinforced.

The generator terminals will be connected to the main and auxiliary transformers with isolated phase bus duct.

Isolated phase bus duct is composed of aluminum bus, joints, insulators, aluminum duct, etc.
It is insulated to ensure safety for human beings.

Cross linked polyethylene insulated cables should lie on trays in a concrete trench from auxiliary transformer to 6.6kV switchgears.

The Cross linked polyethylene insulated cables should be flame retardant, rodent proof in accordance with IEC 332 and IEC 502.

Cable sizes should be determined in such a manner that the normal conductor temperature should not exceed 90°C, short time short circuit conductor temperature should not exceed 230°C and voltage drop should be within 5% of the nominal voltage.

The conductor temperature is designed not to decrease insulation performance of the material.

From the 6.6kV switchgears to the large motors and the 0.4kV switchgears and from 0.4kV switchgears to each load, cables should also lie on cable tray in underground concrete trench or on cable tray above ground.

Control and instrumentation cables should lie apart from power cables in order to avert electric noise.
Cables should be of flame retardant and rodent proof in accordance with IEC 332 and IEC 502.

Instrumentation cables should be of pair twisted and copper or steel tape shielded.

4.4.2 Control System

The F/S Report proposes that distributed control system should be applied for the control system of O Mon 3 power plant which is widely used as a modern control system in power plants. This proposal is reasonable.

EVN's design philosophies as mentioned below are proper.

In the combined cycle power plant, the energy is mainly generated by the gas turbine in combination with HRSG and a condensing turbine plant.

The electrical grid demand should be controlled by the gas turbines which play the leading roles. O Mon 3 combined cycle power plant is designed to combine 2 gas turbines and 1 steam turbine. In this case, if 1 gas turbine fails, the steam turbine output will be decreased to meet the heat of the other gas turbine's exhaust gas.

If the steam turbine fails, the exhaust gas of the gas turbines will be interlocked to be switched off to the bypass stack and transferred to simple cycle operation.

The gas turbine/HRSG of O Mon 3 should be designed for electrical dispatch load operation as normal operation regimes. O Mon 3 will contribute to the frequency control of the grid and therefore both gas turbines should be equipped with selectable frequency support and should operate with a Block Dispatch Load Controller.

The HRSG is the connecting link between gas turbine and steam turbine and the steam turbine always follows the load of the connected gas turbine sets.

Auxiliaries like the high pressure (HP), medium pressure (MP) and low pressure (LP) bypass stations of HRSG should control the HP, MP and LP outlet steam pressure during start up, shut down and steam turbine disturbance or stand still. During normal operation, the HP, MP and LP bypass stations are closed and their function should insure that the low steam pressure is not rising over the sliding maximum value. The LP bypass station will automatically start to control the LP steam pressure after the pressure reaches its limit.

Plant Master Control functions should be implemented to reduce the operator workload. This function should be connected to Plant Master Coordinator.

The Plant Master Coordinator should coordinate and interlock the operation modes of all block of main units. The Plant Master Coordinator should also coordinate and sequence the unit control levels during start up and shut down of block main units and associated process areas.

(1) Control Mode of the Gas Turbine Sets

1) Speed control mode

Speed control mode is automatically selected during start up, shut down, generator synchronization and island operation.

2) Block dispatch load control mode

The electrical load delivery should be determined by the operating gas turbine sets in accordance with a target given to the operators by the dispatching center.

This control mode should include grid frequency support, which starts acting immediately upon frequency deviations after selection.

Each gas turbine control should be designed so that load rejections from full load to house load are possible.

3) Unit load control mode

For special cases, the unit load control mode of gas turbine can be selected by the operator. In this mode, the gas turbine governor shall use its internal load set point, which is normally tracked upon the external set point from the dispatch load control. The electrical load output of the gas turbine is then determined upon the internal load target set by the operator. Bumpless switching between the load modes shall be ensured by tracking the load ratio setting at dispatch load controls. This control mode shall also include grid frequency support.

4) Island load control mode

The island load control mode shall be automatically selected for the gas turbines in case both respective 500kV circuit breakers are tripped and the respective generator circuit breaker remains closed.

(2) Control Mode of the Steam Turbine Set

1) Admission pressure control mode

In the admission pressure control mode, the steam turbine follows the gas turbine/HRSG sets by controlling the steam pressure at the common HP steam bus bar. The steam flow and the generator load depend on the firing rates of the gas turbine units in accordance with the plant load target set by the operator. The turbine control system shall be capable of sliding pressure operation, where the steam pressure upstream of the turbine is not kept constant but varies proportionally with loads. The sliding pressure reduces the throttling losses in the turbine. On the other hand, steam pressure changes shall be done slowly in a way that they do not disturb the HP drum level control of the HRSG.

2) Unit load control mode

The unit load control mode will be mainly used in the start up and shut down procedures. During these procedures the steam turbine cannot follow the gas turbine/HRSG sets and therefore this mode will be used after synchronization until HP bypass system is closed or it is used to reduce the turbine load before shut down. While the load control mode is selected admission pressure controller functions as limit controller for HP minimum pressure.

3) Speed control mode

The speed control mode is used during start and warm up until synchronization.

EVN's design concept of control is that all modulating and sequence control shall be capable of manual operation. The manual control mode shall inhibit automatic action, but protection shall always activate and override both manual and automatic controls.

Switching to manual or automatic control modes must be bumpless for the control process.

EVN's design concept is proper and many power plants apply the same concept, however, it must be prudentially considered how far the protection override the manual operation. During the contract negotiation, this must be discussed with the manufacturer.

For example, in the case that 1 of 2 auxiliaries fails, the load must be immediately reduced to some level to which the remaining auxiliaries can support. In this process, who or which has the priority, operator or the protection system.

Once in the past, a civil aviation pilot maneuvered to avoid accident, but some protection signal contradicted against his maneuvering ending up with disastrous result.

Concept of control in the central control room
It is proper, as Chapter 7.25.8 Control rooms and equipment mentioned in the F/S Report, that the power block of O Mon 3 shall be controlled from the central control room. As for the control of the 500kV switchyard, it should be managed from the existing control board installed in the control room of 500kV switchyard after the software of control system is modified to meet addition of O Mon 3 equipment.

F/S Report proposes, in Chapter 7.25.10, Central Electrical Control Room (CECR) should be expanded from the 500kV switchyard control room or new construction next to this control building or next to the central control room in the control building of the power plant.

This concept of control of the 500kV switchyard seems to contradict the existing control system of the 500kV switchyard.

This idea seems that the control of the 110/220/500kV switchyard and communication between O Mon power complex and A0/A2 shall be done in the CECR.

This description contradicts the following concept;

Chapter 7.21.2, 500kV switchyard control system of the F/S Report, says that the switchyard control system will be extended from the existing switchyard control system. All new provision shall be designed in accordance with the existing control system.

Chapter 5 of 7.25.12, Configuration of the plant control system of the F/S Report, mentions that the switchyard will be controlled at the central control room.

This concept also contradicts the above description of 7.21.2.

Existing control configuration is that the 110/220kV switchyard is controlled in the control room separately located near the switchyard.

The 500kV switchyard is controlled in the independent control room located in the 500 kV switchyard area. (Refer to attached Photo 4.4-1 Control board of 500kV switchyard)

The 500kV switchyard control system must be extended from the existing switchyard control system as mentioned in Chapter 7.21.2, 500kV switchyard control system of the F/S Report.

The switchyard must be controlled from 1 control room and monitored with 1 display by 1 operator.

It is very dangerous to operate 1 switchyard from two separate control rooms such as central control room and CECR.

Control of 500kV switchyard from central control room of O Mon 3 is not recommendable.

Photo 4.4-1, overview of control board of 500kV switchyard, shows general view of existing control board of the 500kV switchyard.

Photo 4.4-2, display of 500kV switchyard control board, shows diagram of the present 500kV switchyard.

The left hand of the display shows the space for O Mon 3 extension.

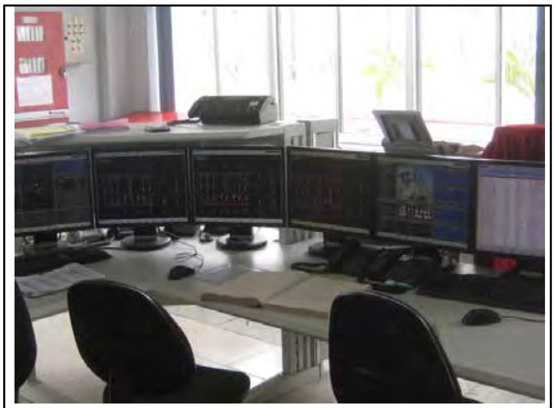

Photo 4.4-1 Control Board in 500 kV Switchyard

Photo 4.4-2 Display of Control Board

4.4.3 Switchyard

O Mon power complex is planned with four power plants, O Mon 1, O Mon 2, O Mon 3 and O Mon 4, and there are the 500kV switchyard, the 220kV switchyard and the 110kV switchyard as their common equipment. The generated power of the power plants is transferred to the power transmission system via the switch yards. The location of switchyards in O Mon power complex is shown in Fig. 4.4-1.

Currently, O Mon 1 power plant is connected to the 220kV switchyard and it is connected to the 500kV switchyard and the 110kV switchyard through 500/220kV transformer and 220/110kV transformer and the generated power of the O Mon 1 power plant is transferred to the power transmission system via each switchyard. The single line diagrams showing the present connection state of each switchyard is shown in Fig. 4.4-2 and Fig.4.4-3. In addition, connection to 220kV switchyard for O Mon 1B power plant and O Mon 2 power plant and connection to 500kV switchyard for O Mon 3 power plant and O Mon 4 power plant is planned respectively. The planned single line diagrams are shown in Fig. 4.4-4 and Fig.4.4.5.

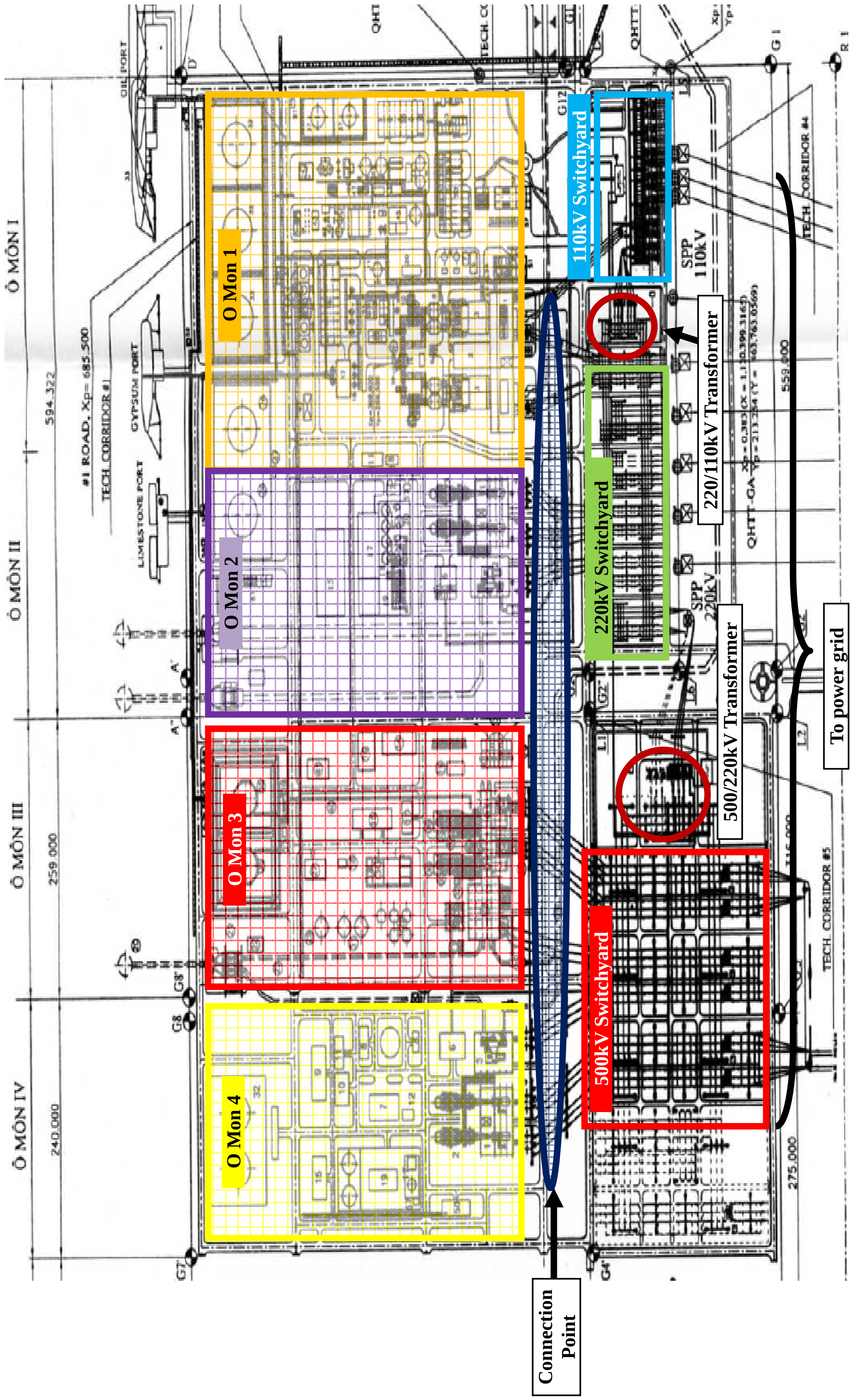

Fig. 4.4-1 Switchyards in O Mon Power Complex

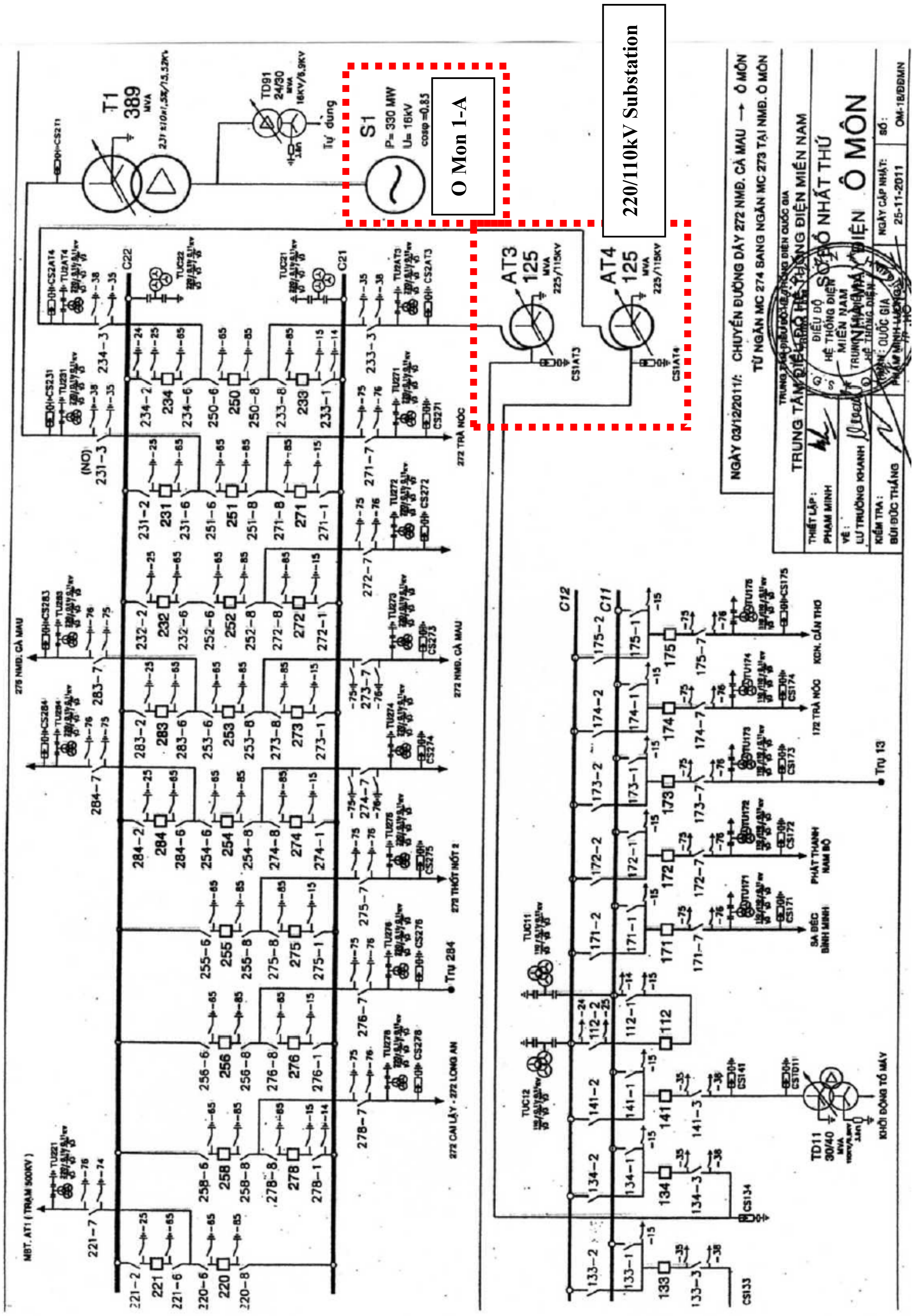

Fig. 4.4-2 Single Line Diagram for 220kV Switchyard and110kV Switchyard

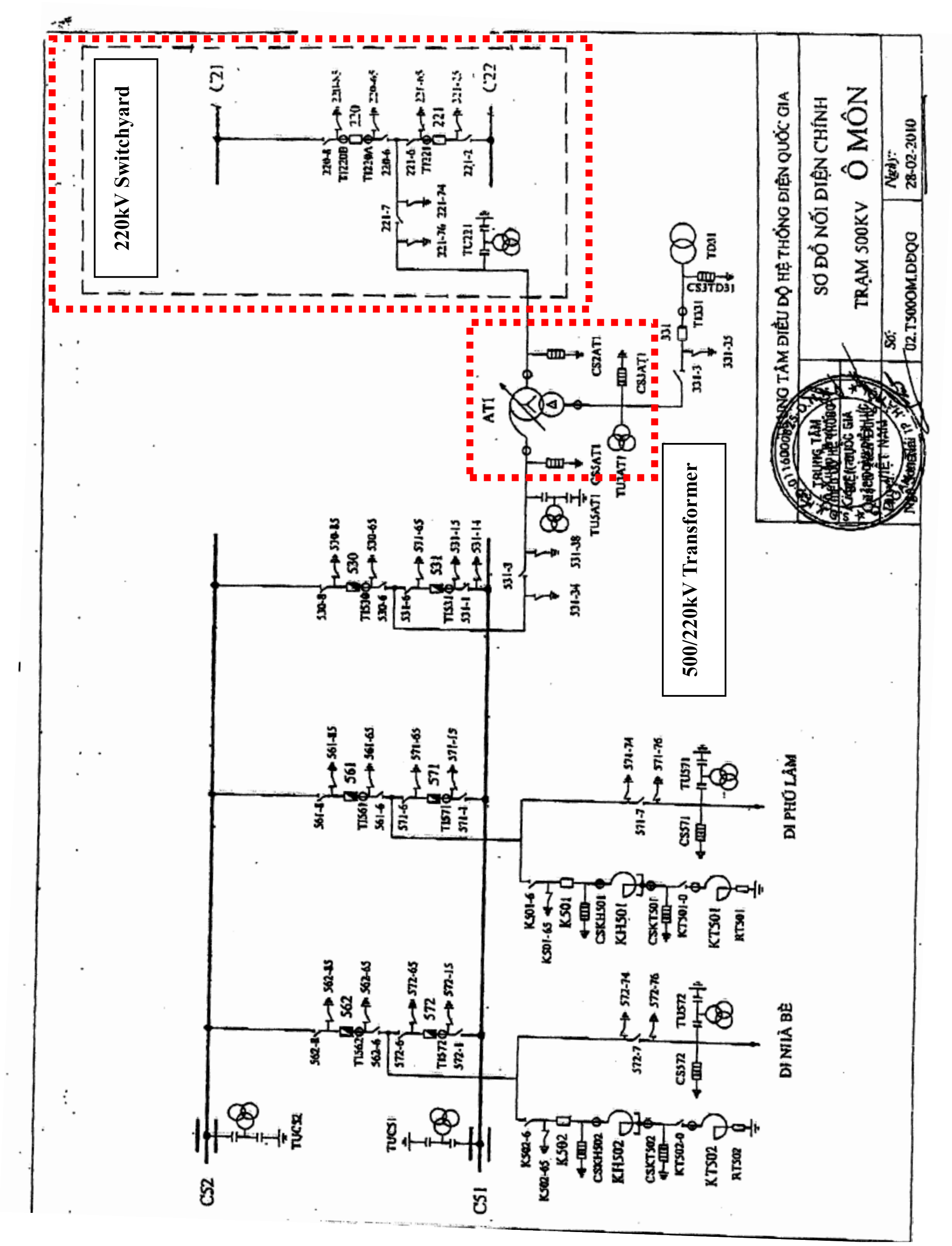

Fig. 4.4-3 Single Line Diagram for 220kV Switchyard and 500kV Switchyard

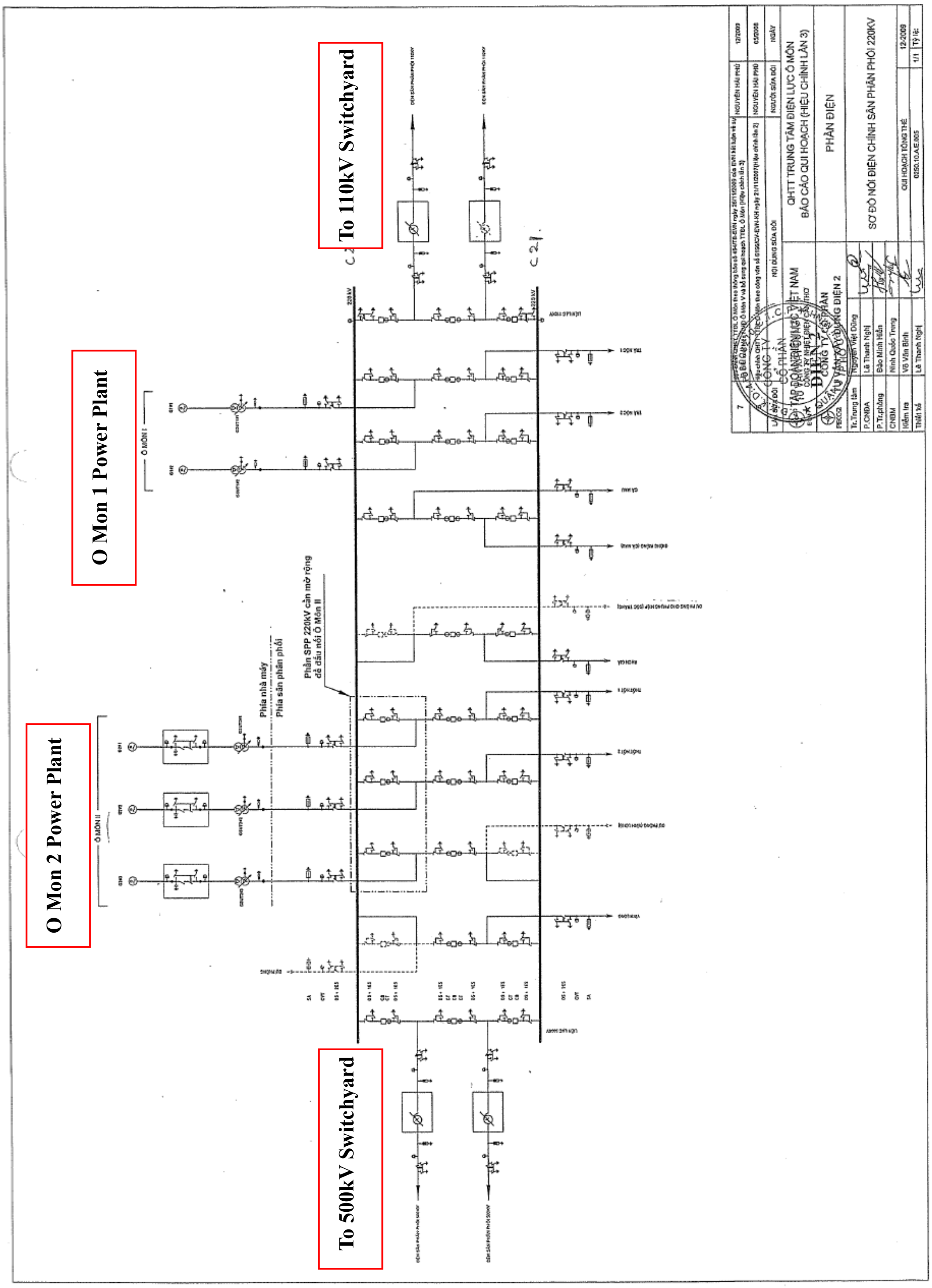

Fig. 4.4-4 Single Line Diagram for 220kV Switchyard (Future Plan)

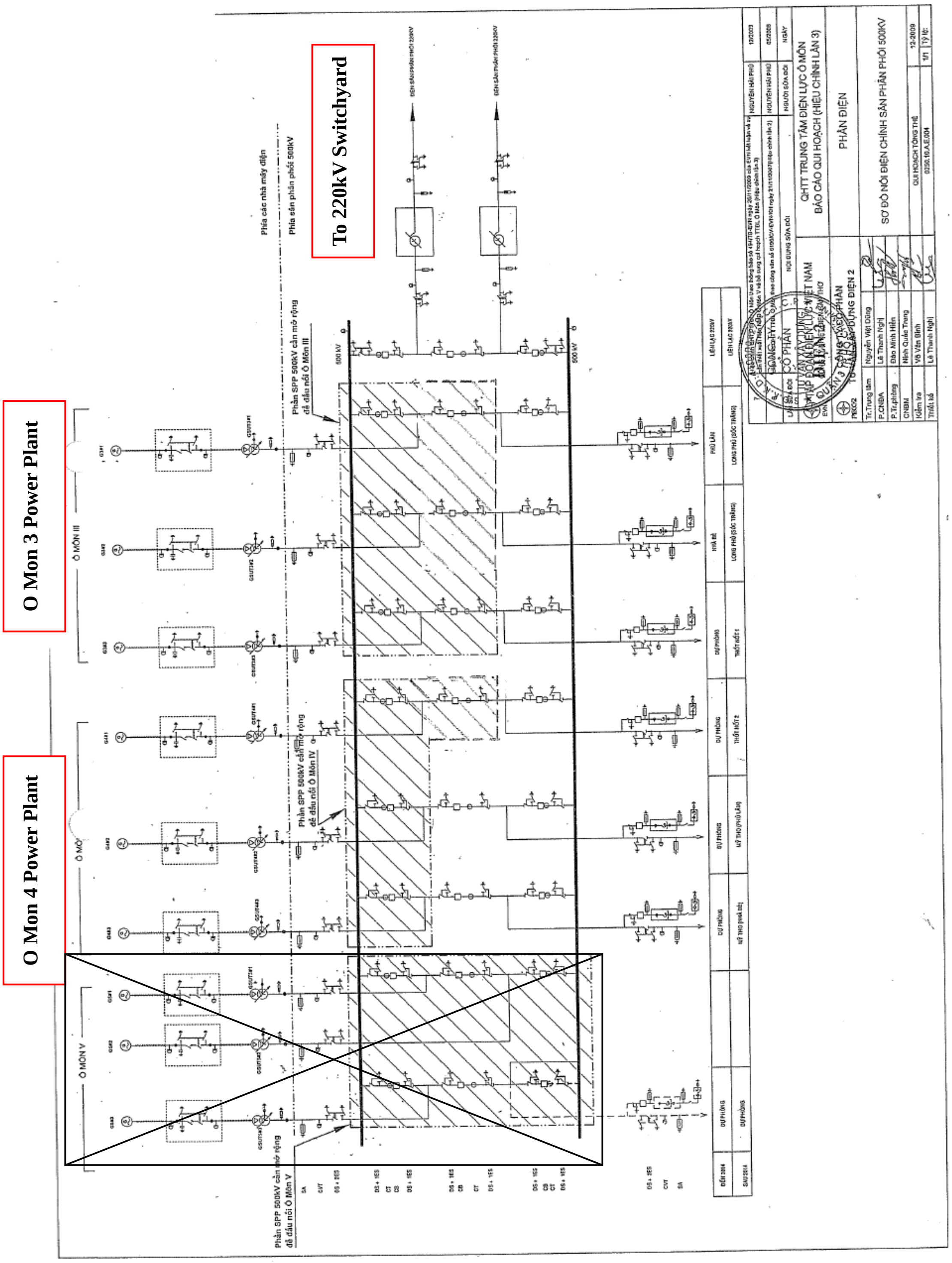

Fig. 4.4-5 Single Line Diagram for 500kV Switchyard (Future Plan)

4.4.4 Communication System

To exchange operation data between power plant and outside system, parts of power plant each other and between power plant and National load dispatch center (A0) and Southern Regional load dispatch center (A2), it is necessary to have a communication and data transmission system which are effective and suitable with the latest technology servicing for information technology at present as well as oriented technology in the future. For this purpose, Supervisory Control and Data Acquisition (SCADA) system is widely used.

The operation data by using gateways to connect to Computerized Control Systems (DCS) of power plant and switchyard shall be transmitted to load dispatch centers (A0 & A2) through Optical Fiber Stranded Grounding Wire (OPGW) of transmission lines. This transmission process is dealt with SCADA system installed in the electrical control room in the 500kV switchyard

The F/S Report suggests the following options for the transmission media;

- Copper wire: Twin cable, coaxial cable, etc.
- Power Line Carrier
- OPGW
- VHF/UHF/Viba

At present, OPGW is in operation, so that there is no other option available.

The F/S Report suggests that VHF/UHF should have many disadvantages of capacity, distance and influence of the environment, weather, etc. so that this solution should not be applied to data transferring.

The F/S Report also suggests that power line carrier solution should be applied to some special power transmission line for telecommunication and other important power transmission line for teleprotection because of reliability and transfer time of the protection signal.

It is reasonable that the solution of OPGW should be applied firstly because of its advantage in the ring system, development of technology and the reduction of cost. The best solution for transferring data is OPGW.

The work of O Mon 3 project is just to connect the operation data by non-metallic cable to the existing junction box of OPGW and ODF (IDF) in the equipment room. There will be no need to install new additional communication line.

Photo 4.4-3, SCADA system installed in the Electrical Control Room in the 500kV switchyard, shows the SCADA system in operation at present.

Photo 4.4-3
SCADA System installed in the Electrical Control Room in 500kV Switchyard