Socialist Republic of Vietnam

Vietnam Oil and Gas Corporation (Power Plant Project)

Vietnam National Coal and Mineral Industries Group
(Imported Coal Transshipment Terminal)

Socialist Republic of Vietnam

Preparatory Survey for Song Hau 1 Coal Fired Power Plant Project and its related common infrastructures

(PPP Infrastructure Project)

March 2012

Japan International Cooperation Agency

(JICA)

Sumitomo Corporation

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JR
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【Power Plant Project】

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Abbreviation

AC	Alternating Current
ADB	Asian Development Bank
AIS	Air Insulated Switchgear
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AVR	Automatic Voltage Regulator System
B/S	Balance Sheet
BTG	Boiler-Turbine-Generator
C/P	Counterpart
CC	Cross Compound
CCR	Central Control Room
CFPP	Coal-Fired Power Plant
CIF	Cost, Insurance and Freight
COD	Commercial Operation Date
CV	Calorific Value
DC	Direct Current
DCS	Distributed Control System
DO	Diesel Oil
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EPC	Engineering, Procurement and Construction Contract
FC	Foreign Currency Portion
FGD	Flue Gas Desulfurization
FIRR	Financial Internal Rate of Return
FOB	Free On Board
FY	Fiscal Year
GCB	Gas Circuit Breaker
GIS	Gas Insulated Switchgear
GLS	Generator Load Switch
I&C	Instrumentation and Control
Ic/R	Inception Report
IPB	Isolated Phase Bus
IPP	Independent Power Producer
ISO	International Standard Organization
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
LA	Lightening Arrester
LC	Local Currency Portion
LCD	Liquid Crystal Display
LDC	Load Dispatch Center
MOM	Minutes of Meeting
MP	Master Plan
MW	Mega Watt
NOx	Nitrogen Oxide
O&M	Operation and Maintenance

OEM	Original Equipment Manufacturer
PCFPP	Pulverized Coal Fired Power Plant
PLC	Plogrammable Logic Controller
PPA	Power Purchase Agreement
PSS	Power System Stabilizer
PSS/E	Power System Simulator for Engineering
RUS	Rated Ultimate Strength
S/S	Substation
SC	Super Critical
SCADA	Supervisory Control and Data Acquisition
SIAGA	Emergency Load Shedding
SubCPP	Sub-critical Power Plant
TC	Tandem Compound
TOR	Terms of Reference
TPP	Thermal Power Plant
USC	Ultra Supper Critical
USCPP	Ultra Supper Critical Power Plant
USD	United States Dollar
VAT	Value Added Tax
WB	World Bank

Unit

Prefixes

μ	:	micro- = 10^{-6}
m	:	milli- = 10^{-3}
c	:	centi- = 10^{-2}
d	:	deci- = 10^{-1}
da	:	deca- = 10
h	:	hecto- = 10^{2}
k	:	kilo- = 10^{3}
M	:	mega- = 10^{6}
G	:	giga- = 10^{9}

Units of Length

m	:	meter
mm	:	millimeter
cm	:	centimeter
km	:	kilometer
in	:	inch
ft	:	feet
yd	:	yard

Units of Area

cm^2	:	square centimeter
m^2	:	square meter
km^2	:	square kilometer
ft^2	:	square feet (foot)
yd^2	:	square yard
ha	:	hectare

Units of Volume

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

Units of Mass

g	:	gram
kg	:	kilogram
t	:	ton (metric)
lb	:	pound

Units of Density

kg/m^3	:	kilogram per cubic meter
t/m^3	:	ton per cubic meter
mg/m^3N	:	milligram per normal cubic meter
g/m^3N	:	gram per normal cubic meter
ppm	:	parts per million
μg/scm	:	microgram per standard cubic meter

Units of Pressure

kg/cm^2	:	kilogram per square centimeter (gauge)
lb/in^2	:	pound per square inch
mmHg	:	millimeter of mercury
mmHg abs	:	millimeter of mercury absolute
mAq	:	meter of aqueous
lb/in^2, psi	:	pounds per square inches

atm	:	atmosphere
Pa	:	Pascal
bara	:	bar absolute

Units of Energy

kcal	:	kilocalorie
Mcal	:	megacalorie
MJ	:	mega joule
TJ	:	tera joule
kWh	:	kilowatt-hour
MWh	:	megawatt-hour
GWh	:	gigawatt-hour
Btu	:	British thermal unit

Units of Heating Value

kcal/kg	:	kilocalorie per kilogram
kJ/kg	:	kilojoule per kilogram
Btu/lb	:	British thermal unit per pound

Units of Heat Flux

$kcal/m^2h$	:	kilocalorie per square meter hour
Btu/ft^2H	:	British thermal unit per square feet hour

Units of Temperature

deg	:	degree
°	:	degree
C	:	Celsius or Centigrade
°C	:	degree Celsius or Centigrade
F	:	Fahrenheit
°F	:	degree Fahrenheit

Units of Electricity

W	:	watt
kW	:	kilowatt
A	:	ampere
kA	:	kiloampere
V	:	volt
kV	:	kilovolt
kVA	:	kilovolt ampere
MVA	:	megavolt ampere
Mvar	:	megavar (mega volt-ampere-reactive)
kHz	:	kilohertz

Units of Time

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

Units of Flow Rate

t/h	:	ton per hour
t/d	:	ton per day
t/y	:	ton per year
m^3/s	:	cubic meter per second
m^3/min	:	cubic meter per minute
m^3/h	:	cubic meter per hour
m^3/d	:	cubic meter per day

lb/h	:	pound per hour
m^3N/s	:	cubic meter per second at normal condition
m^3N/h	:	cubic meter per hour at normal condition

Units of Conductivity

μS/cm	:	microSiemens per centimeter

Units of Sound Power Level

dB	:	deci-bell

Units of Currency

VND	:	Vietnam Dong
USD	:	US Dollar
¥	:	Japanese Yen

Chapter 1 Preface

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Chapter 1 Preface

1.1 Background of the study

In recent years, Vietnam has recorded high growth rate of around 8% in its Gross Domestic Product (GDP), and with it, power demand in last five years from 2006 to 2010 has been increased by an average annual rate of 14% and peak demand has been also increased 1.6 times from 10,187MW to 16,048MW. Though the GDP growth rate in short term was slightly slow-downed it is expected that Vietnam will recover high economic growth rate in the long and medium terms (According to expectation of International Monetary Fund (IMF) (as of April 2010), GDP growth rate of 7.2% in 2013 will be expected). Vietnamese 7th National Power Development Master Plan (hereinafter referred to as "PDP7"), approved in 2010, and predicts that the power demand will increase annually by 13% to 2020 and requires electric power development of around 45,500MW in total. However, since almost investment plans for the power development described in the PDP6 delay and this situation will cause electric power supply shortage and are forced to rolling planned outage in the peak demand hours.
The energy resource is unevenly distributed in overall Vietnam, and the energy sources of the power plants are hydro and coal in the northern region and natural gas in the southern region. According to PDP7, the development of the coal fired power plants are planned in short-term, and the development of the nuclear power plant and electricity for pumped storage hydroelectric power plant are planned in the long and medium terms. As of 2010, Vietnam has total power generating capacity of 21,586MW of which the hydroelectric power plants account for 35%. The ratio of the coal fired power plants is scheduled to be increased in the future.
According to Japan's Country Assistance Plan for Vietnam (July 2009), the assistance to the power sector, especially development of "core power generating facilities", has been taken up as one of the strategic fields in the stable resource and energy supply field and this project fully complies with such program. Moreover, the power supply capacity will be reinforced as one of these key disciplines in "Economic Growth Promotion and International Competitiveness Reinforcement" which is one of four Japanese key strategic fields to Vietnam.
Based on the above situation, this project is perfectly consistent with the strategic field of Japanese government and JICA. Moreover, the development policy of Vietnamese government points out the necessity of stable power supply for its sustainable economic growth. Therefore, the necessity for executing this project is regarded as being extremely high.

1.2 Objectives of the Study and Scope of the Study

1.2.1 Objectives of the Study

Song Hau 1 coal fired power plant and its related common infrastructures such as coal terminal construction project in South Vietnam is being planned by Sumitomo Corporation and Vietnam Oil and Gas Corporation (Petro Vietnam). This Preparatory Survey is to conduct a project formation study on this framework.

1.2.2 Scope of the Study (Power Plant Project Portion)

The following works are conducted in this Preparatory Survey (power plant project portion).

(1) Confirmation of Background and Necessity
- Confirmation of the policies and development plan related to power sector
- Confirmation of organization of power sector in Vietnam
- Confirmation of other power plant development plans and operation situations in

benefit region

(2) Verification of basic plan, related to Song Hau 1 coal fired power plant development plan
- Study of basic plan and specification
- Study of carbon dioxide MVR (Monitorable, Verifiable, and Reportable data)

(3) Study of the fuel supply plan
(4) Study of the appropriateness for development of the Project under PPP scheme
(5) Cinfirmation of the environmental and social consideration and study of the measures to be proposed

1.2.3 Duration of the Study

Schedule of the Study is shown in the next page.

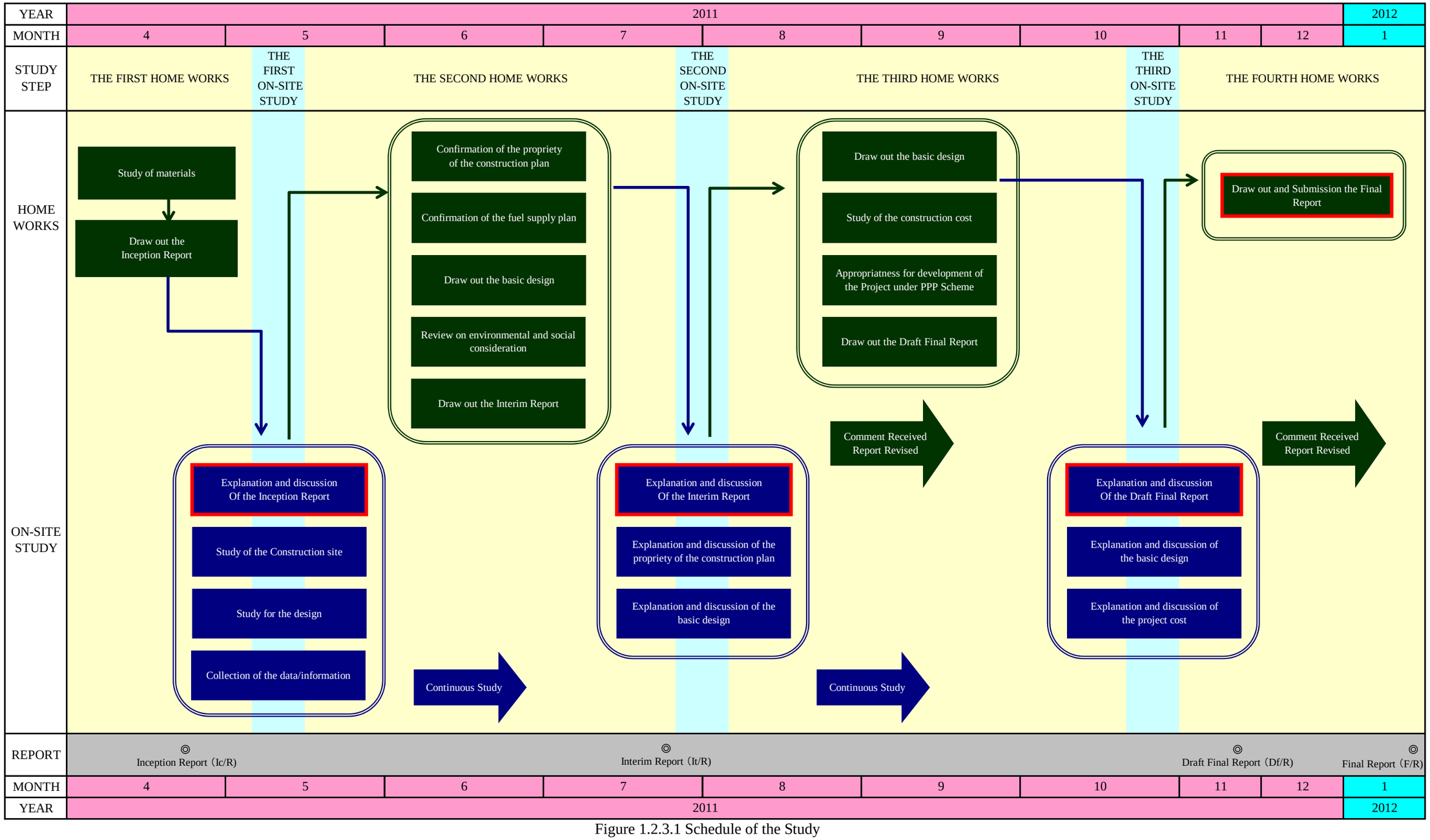

Figure 1.2.3.1 Schedule of the Study

1.3 Assignment of the Study Team

Table 1.3.1 shows the assignment for each expert of the Team.

Table 1.3.1 Formation of the Team

Name	Assignment
Hiroki HONDA	Leader
Hideyuki OKANO	Sub Leader (Technical)
Masamichi SHOJI	Power Sector Expert & Power Plant Expert B
Hideki ASAYAMA	Power Plant Expert A
Toru KAMO	Power Plant Expert C
Akira KOJIMA	Civil Expert (Harbor Facilities)
Hiroshi IWAKI	Civil Expert (Power Plant)
Hisayuki DOI	Fuel Expert
Shigeru KANAYA	Environmental Expert
Yoshihiko TAOKA	Economic and Financial Analyst
Kumi OTSUKA	Analyst for PPP (*) Scheme 1
Takayuki SAITO	Analyst for PPP (*) Scheme 2

(*) PPP: Public Private Partnership

Chapter 2 Power sector in Vietnam

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Chapter 2 Power sector in Vietnam

2.1 Policy and plan at power sector in Vietnam

There are MOIT (Ministry of Industry and Trade), MPI (Ministry of planning and investment) and MOF (Ministry of finance) as the power sector administration.
MOIT was established by integration into MOC (Ministry of commerce) and MOI (Ministry of Industry). MOIT controls industry, trade, energy and power sector and be in charge of drawing up master plans and to authorize to enterprise in industry, trade, energy and power sector. MOIT confirms new PDP (Power Development Master Plan) by the agency and announces projects under the PDP in the power sector. PDP announces Vietnamese power development plan every five years.
PDP6 (Power Development Master Plan 6) was approved by Prime Minister in July 2007 and provides for power development plan from 2006 to 2015. PDP7 (Power Development Master Plan 7) was announced in July 2011. PDP sets COD (Commercial Operation Date) every single year and plan for power development.
On the other side, total power demand in 2020 is forecasted as 329.4TWh and new power development is planned. However actual execution rate based on PDP6 is low as 55.4% in 2009 and 45.8% in 2010. Lack of rainfall is supposed to cause power shortage. In addition to that delay of the actual execution rate based on PDP6 is also the major factor of power shortage.
MPI organizes the economic plan and project of assistance and investment from foreign countries.
MOF organizes country's finance and budget and coordinates government guarantee for export credit and public loan through DAF (Development assistance fund).
There is EVN (Electricity of Vietnam) group as the electric power administrator.
EVN was established as public company to manage power sector in 1995 and organizes power stations, transmission and distribution equipment. EVN holds power stations, transmission line companies, distribution companies and load dispatch centers. EVN was a public company until June 2010. Now EVN is organized as a corporation by exclusive owner, the government from July 2010.

2.2 Power supply system in Vietnam

Figure 2.2.1 shows direct companies under EVN, subsidiaries under EVN and nonprofit organizations in EVN Organization.

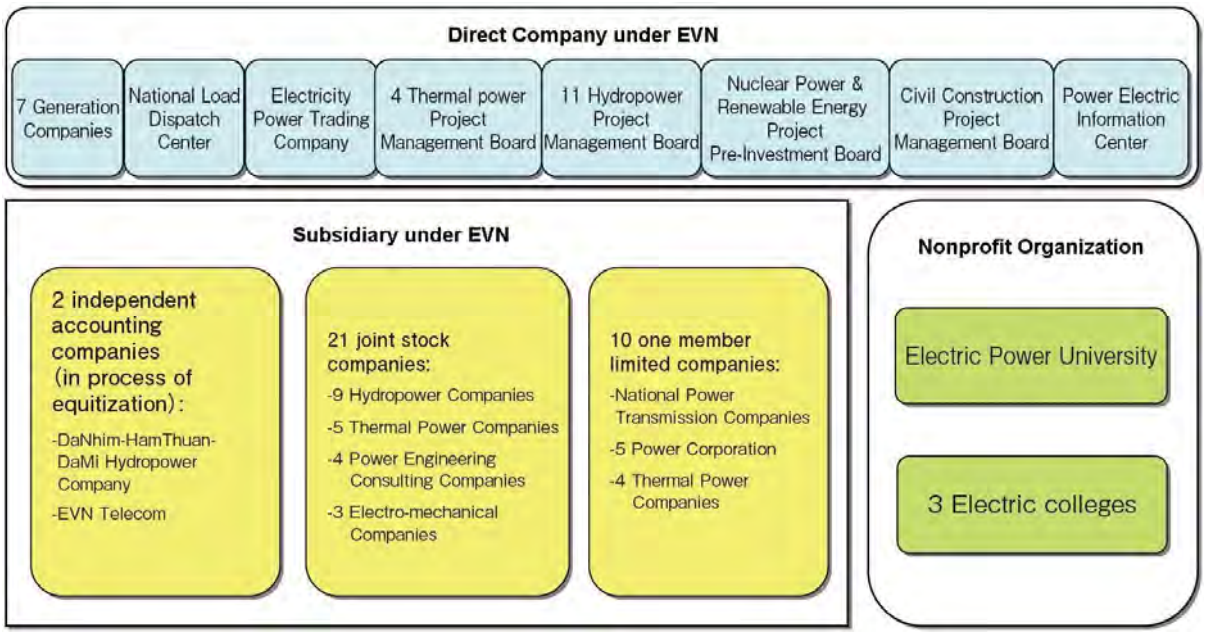

Figure 2.2.1 EVN Organization
Source：EVN Corporate Profile 2008-2009

Figure 2.2.2 shows power supply structure. EVN had managed all power plants, transmission lines and distribution equipment. From now on, national company except EVN or foreign-affiliated company will own the equipment and the number of IPP or BOT project is increasing.

Domestic power stations are divided into EVN and IPP owns ones. EVN owns 67.8% (10,634MW) and IPP owns 32.2% (5,044MW) in total generation capacity. EVN has to deal with tight power demand so that import electric power from China. EVN's subsidiary company PC (Distribution Company) supplies power to consumers by hydropower or diesel generator.

EVN's power stations are now going to be joint stock companies.

Some of the joint stock companies like as Vinh Son-Song Hinh Hydropower Company are listed on stock exchange. Also IPP are divided into 1) 100% foreign capital, 2) combination of foreign and domestic capital, 3) 100% domestic capital and 4) joint venture with EVN. There are Vinacomin and Petro Vietnam as domestic capital in electric power market.

For the future, to expand IPP or BOT business, it is significant to raise electricity bill, early execution of bidding and profitability of power generation business in the deregulation market.

NLDC (National load dispatch center) manages power system and NPT (National Transmission Company) manages transmission line. PTC1, PTC2, PTC3 and PTC4 were integrated and established in July 2008.

Viet Pool, subject for power stations by EVN is organized from 2004. Viet Pool is preparation for single buyer market and still temporary one. Electric power deal between EVN and power stations is based on PPA (Power Purchase Agreement). Therefore both make adjustments to coordinate between deal prices by Viet Pool and contract price by PPA. Bidding to Viet Pool by supplier is limited to 5% in amount of generation.

Distribution business is organized by five PCs (distribution companies). Five PCs are integrated and established in February 2010. PC purchase electricity from EVN and the purchase price is different by each PC. Retail price of electricity is fixed by government.

Around nine-thousand small distribution companies so called commune exist at remote area. Communes are established for electrification and buy the electricity from PC and sale consumer at approved price by local committee.

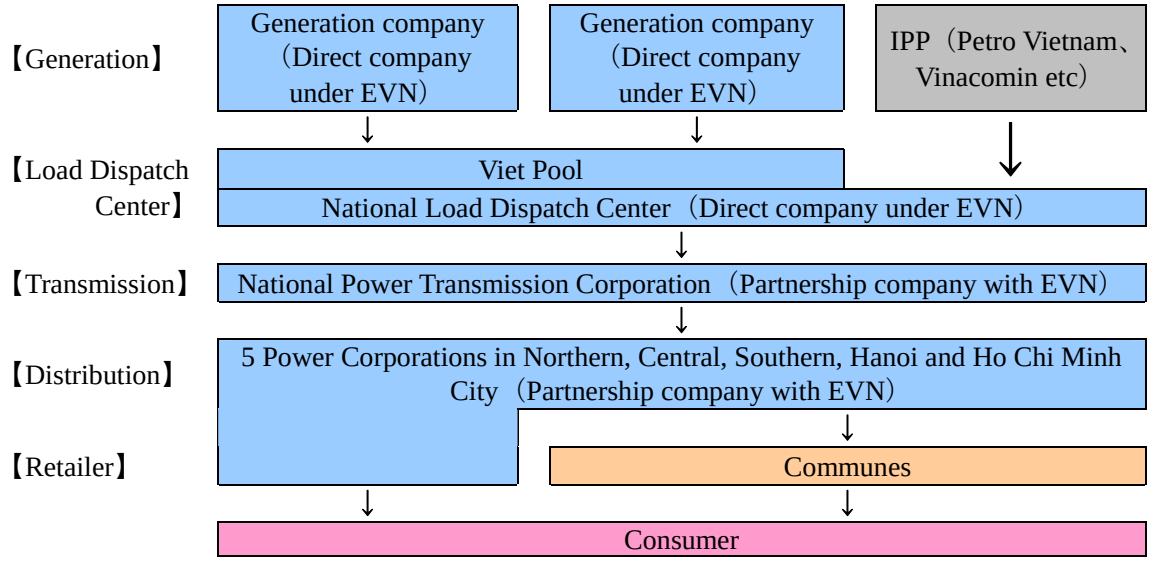

Figure 2.2.2 Power supply structure
Source：EVN Corporate Profile 2008-2009

Table 2.2.1 shows transition of Electricity generation, Electricity sales, Electricity loss and Peak demand.

Table 2.2.1 Electricity generation, Electricity sales, Electricity loss and Peak power

Year	Electricity generation		Electricity sales		Electricity loss [%]	Peak demand[MW]
	[GWh]	Growth rate [%]	[GWh]	Growth rate [%]		
2000	26,562	11.8	22,397	14.3	14.5	4,898
2001	30,608	15.2	25,843	15.4	14.2	5,665
2002	35,801	17.0	30,257	17.1	13.4	6,470
2003	40,825	14.0	34,885	15.3	12.2	7,366
2004	46,201	13.2	39,696	13.8	12.1	8,283
2005	52,050	12.7	44,921	13.2	11.8	9,255
2006	59,013	13.4	51,350	14.3	11.1	10,187
2007	66,773	13.1	58,438	13.8	10.6	12,299
2008	74,224	11.2	65,890	12.8	9.2	13,700
2009	84,786	14.2	74,821	13.6	9.7	13,952
2010	97,335	14.8	85,670	14.5	10.2	16,048

Source：EVN, IE

Peak demands increase from 4,898[MW] in 2000 to 16,048 [MW] in 2010 and the annual average is 13.7% for the term.
In comparison to peak demand in 2000, peak demand in 2010 is 3.3 times.
Total electricity generations by EVN and IPP increase from 26,562[GWh] in 2000 to 97,335 [GWh] in 2010 and the annual average is 13.7% for the term.
Electricity sales by EVN increase from 22,397 [GWh] in 2000 to 85,670 [GWh] in 2010 and the annual average is 14.4% for the term. In comparison to electricity sales in 2000, electricity generation in 2010 is 3.7 times. However EVN executes on rotation power cut recently so that electricity sales don't reflect the actual power demand. Therefore potential power demand is supposed to be 15-16% increase on average a year.

Table 2.2.2 shows each generation capacity and Table 2.2.3 shows each electricity generation.

Table 2.2.2 Each generation capacity

Unit：MW

Year	Hydro	Coal	Oil	Gas	Diesel	IPP	Total
2000	3,343	645	198	1,152	397	547	6,281
2001	4,154	645	198	2,322	296	612	8,227
2002	4,187	1,245	198	2,322	296	612	8,860
2003	4,154	1,245	198	2,489	288	1,521	9,895
2004	4,155	1,245	198	2,939	285	2,518	11,340
2005	4,155	1,245	198	2,939	285	2,518	11,340
2006	4,583	1,245	198	3,107	285	2,939	12,357
2007	4,647	1,545	198	3,107	285	3,668	13,450
2008	5,499	1,545	198	3,107	285	5,044	15,678
2009	—	—	—	—	—	—	—
2010	—	—	—	—	—	6,359	21,586

Source：EVN

Table 2.2.3 Each electricity generation

Unit : GWh

Year	Hydro	Coal	Oil	Gas	Diesel	IPP	Total
2000	14,551	3,135	1,137	5,866	240	1,633	26,562
2001	18,210	3,218	1,117	5,840	96	2,127	30,608
2002	18,198	4,881	1,019	9,502	92	2,109	35,801
2003	18,971	7,223	891	12,131	45	1,564	40,825
2004	17,635	7,015	602	14,881	42	6,026	46,201
2005	16,130	8,125	678	16,207	43	10,867	52,060
2006	19,096	8,808	600	17,906	54	12,550	59,013
2007	20,833	8,926	740	19,425	77	16,772	66,773
2008	23,860	8,931	610	19,638	52	21,133	74,224
2009	—	—	—	—	—	—	84,786
2010	—	—	—	—	—	50,546	97,335

Source：EVN

Total generation capacity is 21,586MW in Vietnam late in 2010. EVN owns 70.5％ (15,227MW) and IPP owns 29.5％ (6,359MW) in the total generation capacity.
In comparison to 2000, generation capacity by EVN is 2.7 times in 2010.
Oil power station has never been constructed for last 10 years. Instead of the fact, Hydro, combined cycle and coal-fired power station have been constructed for last 10 years. As the result, EVN owns hydro (35.08%), coal (9.85%), oil (1.26%), gas turbine (19.82%) and diesel (1.82%) late in 2008. Power demand in south was tight. Therefore combined cycle power plants which can be built for short-term have been constructed.
Also IPP have developed combined cycle power plants such as Phu My 2.2 (720MW) and Phu My (3720MW) and coal-fired power plants such as Na Duong (100MW) and Cao Ngan (100MW). As the result, total generation capacity became 5,044MW late in 2008.

Figure 2.2.3 shows power generation from each power station (2001-2009).
Availability at large-scale power plants didn’t decline in 2009. The cause of frequent blackout in South Vietnam was supposed to be shortage of power generation capacity because of the delay of power development progress in PDP6.

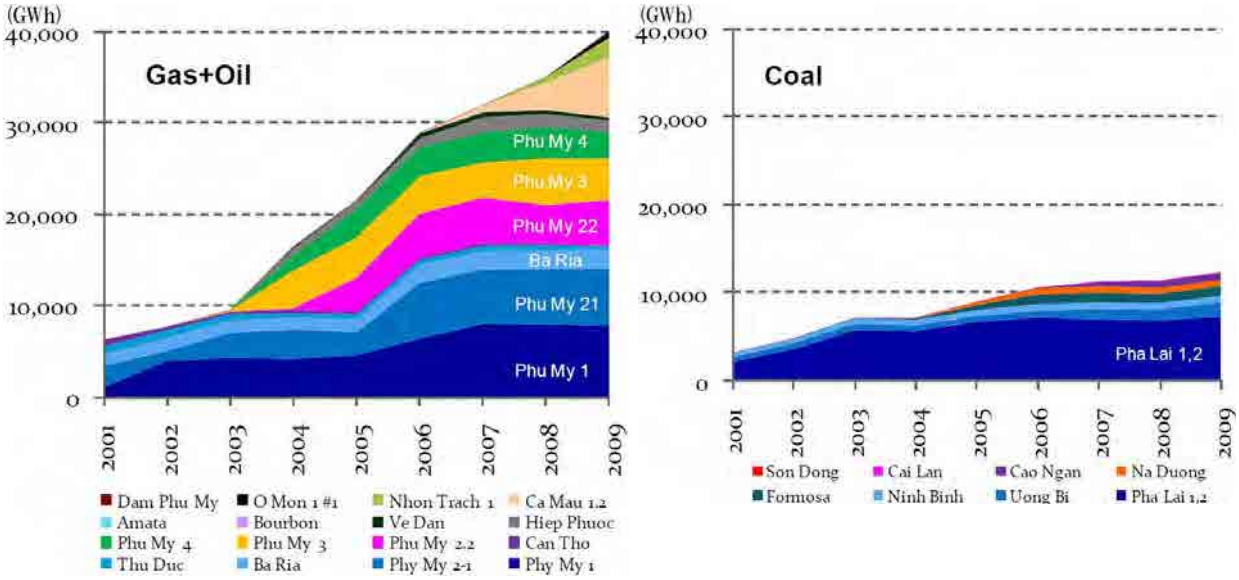

Figure 2.2.3 Power generation from each power station (2001-2009)
Source：EVN Annual Report 2009／JETRO

There is a plan on PDP6 that total generation capacity shall be 25,879MW in 2010, 42,341MW in 2015 and 60,611MW in 2020. However MOIT announced that power development plan on PDP6 is difficult to accomplish late in November 2010. According to MOIT, total generation capacity will be still 20,900MW in 2010 and 22,500MW in 2011. The cause of power development plan's delay is supposed to be following points.

- Budget shortage of developer for power plant development plan and construction phase
- Long-term of construction by bidding process and inexperience for schedule management
- Failure of contractor selection by government
- Long-term for building site-condemnation
- Shortage of contractor's project management ability
- Rising prices of fuel

Table 2.2.4 shows the power demand forecast on PDP6 and PDP7.

Table 2.2.4 Power demand forecast on PDP6 and PDP7

Power demand			Actual	Planned		
			2005	2010	2015	2020
PDP6	Sales	TWh	44.9	97.1	165.0	257.3
	Generation	TWh	52.1	112.7	190.0	294.0
	Peak	MW	9,255	19,117	31,495	47,607
	Capacity	MW	11,340	25,879	42,341	60,611
PDP7	Generation	TWh	52.1	100	194	329
	Peak	MW	9,255	15,416	30,803	52,040
	Capacity	MW	11,340	21,297	41,235	66,839

Source：EVN

According to the PDP6, power demand will increase 17-20% on average from 2006 to 2015 and

be tight although new power stations are developed. In comparison to 2005, electricity sales will be 5.7 times, electricity generation will be 5.6 times and peak demand will be 5.1 times in 2020.

Table 2.2.5 shows PDP6 execution rate.
Eight coal-fired power plant constructions in 2009 were planned in PDP6. However any plants didn't go to COD. There are a lot of future issues such as finance, smooth operation for bidding process and investment improvement by electricity bill raise.

Table 2.2.5 PDP6 execution rate

Year	2006	2007	2008	2009	2010
Approved capacity [MW]	861	2,096	3,271	3,393	4,960
Implemented capacity [MW]	756	1,297	2,251	1,879	2,272
PDP6 execution rate [%]	87.8	61.9	68.8	55.4	45.8

Source : JETRO

BOT power plant construction by foreign capital isn't progressing because retail electricity price is limited lower by government. Retail electricity price in Vietnam is 970.9 don / kWh (5.4 cent / kWh) late in 2009. Foreign companies offer electricity sales price at 8 to 10 cent / kWh for PPA negotiation period. On the other hand, EVN offers electricity purchase price at 4 to 6 cent / kWh for PPA negotiation period. To make a breakthrough this situation and prompt to join power market by foreign companies, retail electricity price of raise by government is hoped.
Coal-fired power plant development-condition is following.
Coal-fired power plant-constructions as base load are scheduled in north territory. COD for Son Dong (220MW), Mao Khe (2,270MW), Cam Pha 1・2 (600MW), Uong Bi (300MW), Thai Binh 1 (600MW) and Vung Ang 1 (1,200MW) is scheduled by 2010. COD for Quang Ninh 2 (600MW), Nghi Son 1・2 (1,800MW), Mong Duong 1・2 (2,200MW) and Vung Ang 2 (1,200MW) is scheduled after 2010.
Coal-fired power plant-constructions as base load are also scheduled in south territory. COD for Vinh Tan (2,400MW), Son My (2,400MW), Duyen Hai 2 (1,200MW), Long Phu 1・2 (2,400MW) and Kien Giang (2,400MW) is scheduled and supposed to use imported coal.
PDP6 is fixed by Prime Minister in July 2007 and for power development plan from 2006 to 2015.
Execution rate of PDP6 doesn't grow in December 2010. Especially power development except hydropower makes slow progress. The cause of power development plan's delay is supposed to be location-condition, financial issue and the quality of EPC contractor by Chinese company.

MOIT announced the tight demand would have continued for five years because of the delay of domestic power development.

2.3 Related laws and regulations of power projects in Vietnam

2.3.1 Regulation of power project investment

(1) Development of Power source by private sectors
In order to comply with the high economic growth and the significant increase in energy demand, the Government of Vietnam (GOV) has promoted the development of the new power sources to keep up with this demand and secure the stable energy supply. GOV encourage the investment by domestic and foreign capitals, since the related investment cannot be covered by the national budget or ODA from foreign countries including Japanese Yen Credit.

GOV announced the Investment Law (Law of general investment No.59/2005/QH11) and Enterprise Law (Low No.60/2005/QH11), those came into effect on July 1, 2006, and enforcement Decree (Decree No.108/2006/ND-CP dated September 22, 2006, and Decree No.108/2009/ND-CP dated November 27, 2009). By the announcement of Laws and regulation, detailed application of related laws and the forms of investment became clarified, and foreign investors became easily make direct investment by various investment forms.

(2) Investment form on Power Project

The form of direct investment by the foreign capitals are explained in the clause 2.2, and there are BOT contract, BTO contract, and BT contract as the general form of contracts to be utilized on the infrastructure projects including power sector. Details of each contract are specified as below.

Table 2.3.1.1 Concept of BOT, BTO and BT forms

Contract Form	Description
BOT	A form of investment signed between a competent state body and an investor for the construction and commercial operation of an infrastructure facility for a definite duration; upon the expiration of such duration, the investor shall transfer such facility to the Vietnamese State without any refunds.
BTO	A form of investment signed between a competent state body and an investor for the construction of an infrastructure facility; upon the completion of construction, the investor shall transfer such facility to the Vietnamese State; the Government shall grant the investor the right to commercially operate such facility for a definite duration in order to recover investment capital and gain profits.
BT	A form of investment signed between a competent state body and an investor for the construction of an infrastructure facility; upon the completion of construction, the investor shall transfer such facility to the Vietnamese State; the Government shall create conditions for the investor to execute other projects in order to recover investment capital and gain profits or pay the investor under agreements in the BT contract.

Source : Investment Law- Article 3 ”Surrounding of investment in Vietnam”（JBIC）

It is allowed in Vietnam to invest in the power generation projects by state enterprise other than EVN (IPP) and foreign capitals (BOT). It is difficult for foreign capitals to invest in the projects without guarantee by GOV, however, even BOT project, which is subject to the provision of GOV guarantee, has not been implemented as scheduled in the present situation.

(3) The Electricity Law

The latest Electricity Law of Vietnam (hereinafter referred to as “the Law”) came into effect on July 2005. It aims to stimulate the development and diversify forms of investment in the power sector, to encourage economical use of electricity, to protect the country’s electricity infrastructure and to develop a competitive electricity market. The Law is composed of 10 chapters with 70 articles. The key points of the Law related to PPP project are as follows.

【Policies for Development of Power Source 】

The Article 4 refers to electricity development policies. It defines that the policies aims to

develop electricity activities in a sustainable manner on the basis of optimum exploitation of all resources and to satisfy the electricity demands with stable. Also the policies should guide to construct and develop the electricity market in the principle of competition with the State regulation to improve the efficiency in electricity activities. On the other hand, it is stated that the State shall make monopoly of electricity transmission and moderation of the national electricity system, construction and operation of big power plants which have particularly great significances in the socio-economic development, national defense and security.

【Participation of Foreign investors】
In terms of participation of foreign investors in electricity activities, the Article 8 addresses that the State encourages and creates favorable conditions for foreign individuals and organizations to participate in electricity activities in the country. Investors including foreign individuals and organizations require comply with the provisions of the law on investment, construction and environmental protection.

【Electricity Tariff】
For electricity tariff, the Law sets forth the following policies:

- Encouraging all economic sectors to invest in electricity development at a reasonable profit, to economize on energy resources, to use new environmentally friendly forms of energy and recycled energy and to contribute to socio-economic development, especially in rural, mountainous and island regions,
- Encouraging the economical and efficient use of electricity,
- Applying the mechanism of price compensations between groups of customers, and gradually reduce and eliminate the cross-subsidy,
- Ensuring the right of entities purchasing and selling electricity on the electricity market to make their own decisions on the price of purchase and sale of electricity within the electricity tariff stipulated in the state regulation.

According to the Law, the preparation and adjustment of electricity tariff will be based on the following factors: electricity tariff policies, conditions for the socio-economic development of the country, income of people, the relation between electricity supply and demand, costs of electricity generation and trading, reasonable profits for electricity business entities, and the levels of development of the electricity market.

The Law also ensures that the electricity buyer make timely and fully payment to the electricity seller acceding to the electricity tariff approved by the competent State authorities.

Despite of the legislative framework, the current tariff cannot cover costs of electricity generation, transmission and distributions and is still far below the “reasonably profitable” level.

【Permission of Electricity Operation】
For obtaining permission of electricity operation, organizations or individuals needs to satisfy the following conditions:

- The feasibility of project or plan for electricity operation,
- The submission of complete application file, and
- Professional management capability for electricity operation.

【Rights and Obligation of Electricity Generation Organizations】
The rights granted to the electricity generation organizations by the Law are as follows:

- Conducting electricity generating activities and other activities stated in the permission,
- Connecting to the national electricity system when satisfying technical conditions and standards,
- Selling electricity to the electricity buyers in accordance with definite contracts in the electricity market,

At the same time, the electricity generation organizations are required to fulfill the following obligations:

- Complying with regulations, standards on operating power plants and electricity grids,
- Complying with modes of operation, directing and controlling orders of the organizations regulating or supervising the national electricity system,
- Notifying promptly to the relevant organizations when incidents occurred,
- Cutting off or reducing the generation volume in case of threatening the safety of people equipment without any other solutions,
- Complying with regulations on the electricity market and other relevant regulations,
- Complying with regulations of the law on environment protection,
- Reporting on the readiness to generate electricity, the capacity reserve and the situation of implementation of the operational mode of power plants as requested by any regulating agencies,
- Investing in transformer stations, meters and electricity lines connecting to meters for the electricity buyer, unless otherwise agreed with electricity transmission and distribution organizations or the electricity buyer.

(4) Situation of Legal arrangement for PPP regulations in Vietnam
The Prime Minister Decision (Decision No. 71-2010-QD-TTg), which approved the investment on the infrastructure investment by the form of PPP (Public Private Partnership), was established on November 9, 2010, and it was in force on January 15, 2011. The Decision is a provisional rule which will be temporally applied to the pilot projects selected by each sector for time being until GOV announce an official Decree. The related sectors are stipulated in the following table. During the implementation, any problems arising shall be submitted to the Prime Minister for his consideration and decision, by which the regulation will be improved by try and error.

Table 2.3.1.2 Applicable Sector and Criteria for PPP Project

Applicable Sectors	Criteria for Selection
■ Roads, road bridges and tunnels, and ferry landings for road traffic, ■ Railways, and railway bridges and tunnels, ■ Traffic in urban areas, ■ Airports, seaports and river ports, ■ Clean water supply systems, ■ Power plants, ■ Health (hospitals), ■ Environment (waste treatment plants), ■ Other projects for infrastructure development and/or provision of public services as decided by the Prime Minister.	■ Importance, scale, and urgent needs for development in accordance with the Decision 412 of the Prime Minister dated April 11 of 2007, ■ Return on capital for investor from realistic revenue sources, ■ Advantage of technology, managerial and operational experience of the private sector and effective utilization of financial capacity of the private sector ■ Other criteria as decided as the Prime Minister

Source: Prime Minister Decision No. 71-2010-QD-TTg dated on November 9, 2010

Main points of this Decision are as follows;

【Implementation body of PPP Project in the State side】

Authorized body will enter into and implement project contract for PPP project. They can be any ministry, ministerial equivalent body, government body, or people's committee of province or city under central authority. They need to establish a specialized section or appoint its technical unit to act as coordinator in order to implement all necessary works relevant to the project as well as execution of their obligation in accordance with the provisions in the project contract.

【State Participation】
For the PPP project, the State will participate through equity participation, investment incentives and relevant financial policies aiming to increase feasibility of the project. The total value of the State participation must not exceed 30% of the total investment capital of a project, unless otherwise decided by the Prime Minister.

The capital invested by the State can be used for project costs, construction of subsidiary structures, arrangement of compensation, site clearance and resettlement, or other works in necessary cases.

【Responsible Ministries and State Organizations】
For the PPP project, responsible ministries and state organization are shown in the table 2.3.1.3

Table2.3.1.3 Responsible Ministries and State Organizations

Ministry/State Organization	Main Responsibilities
Ministry of Planning and Investment	■ Coordination with relevant bodies ■ Provision of guidelines for implementation ■ Preparation of central budgets ■ Coordination to mobilize non-refundable ODA from bilateral and multilateral donors ■ Organizing investment promotion activities
Ministry of Finance	■ Participation in evaluation of project proposals ■ Participation in evaluation of the State participation in any one project ■ Supervision of the schedule for capital contribution
Ministry of Justice	■ Participation in providing an opinion on the applicability on foreign law to e proposed in tender invitation documents ■ Participation in negotiation and provision of opinions on other legal issues in project contracts
State Bank	■ Provision of opinions on level of guarantee of foreign currency, matters related to capital sources, foreign exchange control and other matters regarding the State participation
Authorized State Bodies	■ Preparation of plans on development investment capital for projects ■ Preparation of project proposals ■ Preparation of feasibility study reports ■ Tendering for selection of investors, negotiation, finalization, signing and implementation of project contracts

【Project Cycle】
The authorized state bodies need to prepare project proposal containing the following items:

- Proposed schedule, output, location, measurements of the construction area, items of works and land use requirements,
- Compliance of the project with the sectors and criteria for selection of projects,
- Analysis and preliminary selection of technology and technical aspects,
- Proposed schedule for construction works, duration of operation, and method of the investors for organizing management and commercial operation of facilities,
- Preliminary determination of all types of fees and charges for goods and services,
- Conditions and method for handing over and receiving facilities,
- Estimated total investment capital,
- Analysis of overall effectiveness of the project, including its necessity, advantages and socio-economic efficiency of implementing the project by the PPP investment.

In this Decision 71, investors also can formulate project proposal in accordance with the same procedure as above.

Both the project proposals from the Authorized State Bodies and the investors shall be submitted to the Ministry of Planning and Investment (MPI), to be included in the List of Project. After obtaining the approval by the Prime minister, the List of Project will be publicly

announced.

Based on the approved List of project, the Authorized State Bodies will select a consultant for the feasibility study (F/S) by open tender to perform the F/S. Considering the result of the reviewing the F/S report by Ministry of Planning and Investment and ministry of Finance, the Prime minister will decide the State financial participation, investment guarantee and other matters.

After approval of the F/S, Authorized State Bodies will hold an international or domestic open tender to select investors to implement the proposed project. After selection of the winner and issuance of the certificate of investment, the selected investor and Authorized State Body will mutually sign on the project contract officially.

The project cycle for PPP project is as follows:

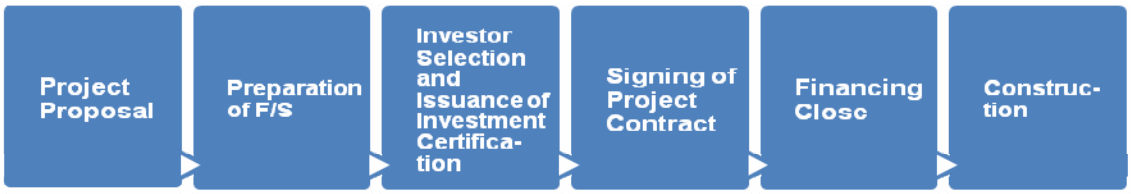

Chart 2.3.1.1 Projct Cycle of PPP Project.

2.4 Past, Present and Short Term Future PPP/IPP Investment Projecs by Japanese and Other Foreign Countries

2.4.1 Present Situation of PPP Investment

As stated in Clause 2.3.1 (4), legal framework for the investment scheme under PPP form has being in the trial status, no infrastructure project is realized at this moment. However, some projects are newly proposed as the pilot projects by MPI recently and the discussions among the relative authorities are expected to be more active for the selection of the projects to be realized.

2.4.2 Present Situation of IPP Investment

(1) BOT Form
The power projects under BOT form which are currently in operation, planning and construction are as listed below tables.

Table 2.4.2.1 Power Projects in Operation under BOT Form

Project	Project Company (Sponsor)
Phu My 2-2（Ba Ria-Vung Tau Province） 715MW Gas Fired Power Plant	Mekong Energy Company TEPCO、EDF、Sumitomo Corporation
Phu My 3（Ba Ria-Vung Tau Province） 717MW Gas Fired Power Plant	Phu My 3 BOT Power Company Ltd. Kyuden International Corporation、Sojitz、BP Holdings BV(UK)、SembCorp Utilities Pte Ltd. (Malaysia)

Table 2.4.2.2 Power Projects under Construction/Planning in BOT Form

Project	Project Owner
Hai Duong 2（Hai Duong Province） 1,200MWCoal Fired Power Project	Jaks Resources Bhd（Malaysia）、EVN、Vinacomin
Mong Duong 2（Quang Ninh Province） 1,200MWCoal Fired Power Project	AES Corporation（U.S.A.）、POSCO（Korea）、China Investment（China）
Nghi Son 2（Thanh Hoa Province） 1,200MW Coal Fired Power Project	The Sponsor is planned to be selected through an international competitive bidding process from the pre-qualified applicants of Japan, U.S.A., Europe etc.
Van Phong 1（Khanh Hoa Province） 1,200MWCoal Fired Power Project	Sumitomo Corporation
Vinh Tan 1（Binh Thuan Province） 1,200MWCoal Fired Power Project	Vinacomin、China Southern Power Grid（China）
Vinh Tan 3（Binh Thuan Province） 1,800MWCoal Fired Power Project	EVN、One Energy、Pacific Corporation
O Mon 2（Can Tho Province） 750MW Gas Fired Power Plant	The Sponsor is planned to be selected through an international competitive bidding process from the applicants.

(2) IPP Form

The power projects under non-BOT form which are currently in operation, planning and construction are as listed below tables.

Table 2.4.2.3 Power Projects in Operation under IPP Form

Project	Project Owner
Ca Mau 1（Ca Mau Province） 750MW Gas Fired Power Plant	Petrovietnam
Ca Mau 2（Ca Mau Province） 750MW Gas Fired Power Plant	Petrovietnam
Nhon Trach 1（Dong Nai Province） 450MW Gas Fired Power Plant	Petrovietnam
Cam Pha 1（Quang Ninh Province） 300MWCoal Fired Power Project	Vinacomin
Cam Pha 2（Quang Ninh Province） 300MWCoal Fired Power Project	Vinacomin

Table 2.4.2.4 Power Projects under Construction/Planning in IPP Form

Project	Project Owner
Quynh Lap 1（Nghe An Province） 1,200MWCoal Fired Power Project	Vinacomin
Nhon Trach 2（Dong Nai Province） 750MW Gas Fired Power Plant	Petrovietnam JSC
Vung Ang 1（Ha Tinh province） 1,200MW Coal Fired Power Project	Petrovietnam
Vung Ang 2（Ha Tinh province） 1,200MW Coal Fired Power Project	Vung Ang II Thermal Power JSC
Quang Trach 1（Quang Binh Province） 1,200MW Coal Fired Power Project	Petrovietnam

Project	Project Owner
Thai Binh 2（Thai Binh Province） 1,200MW Coal Fired Power Project	Petrovietnam
Long Phu 1（Soc Trang Province） 1,200MW Coal Fired Power Project	Petrovietnam
Long Phu 2（Soc Trang Province） 1,200MW Coal Fired Power Project	IDICO - MOC
Long Phu 3（Soc Trang Province） 2,000MW Coal Fired Power Project	Petrovietnam
Song Hau 1（Hau Giang Province） 1,200MW Coal Fired Power Project	Petrovietnam
Duyen Hai 2（Tra Vinh Province） 1,200MW Coal Fired Power Project	Janakusa Corporation（Malaysia）
Mao Khe（Quang Ninh Province） 440MW Coal Fired Power Project	Vinacomin
Hai Phong 1（Hai Phong Province） 600MW Coal Fired Power Project	Vinacomin
Hai Phong 2（Hai Phong Province） 1,200MW Coal Fired Power Project	Vinacomin
Hai Phong 3（Hai Phong Province） 1,200MW Coal Fired Power Project	Vinacomin
Kien Giang 1（Kien Giang Province） 1,200MW Coal Fired Power Project	ITA Group（Vietnam）

2.5 Existing power plant and power development plan at benefit area

Table 2.5.1 shows demand of output and the commercial power in the South.
Commercial power in the South accounts for over 50% of whole country's power output and the rate is getting rising. The growth rate of power in the South in the period of 2000 - 2010 was 15.2%, higher than average level of the whole country. Maximum output of the South raises average of 470 MW/year.

Table 2.5.1 Demand of output and the commercial power in the South

Year	2006	2007	2008	2009	2010
Commercial power (GWh)	27,156	30,823	34,837	39,175	45,724
Maximum output (MW)	5,007	5,794	6,258	7,001	8,169

Table 2.5.2 shows output for installed power output belonging to the power system in the South in 2009

Table 2.5.2 Output for installed power output belonging to the power system in the South in 2009

Type	Hydropower	Coal-fired thermal power	Gas + oil thermal power	Total
Installed output (MW)	1614	1002	6599	9295
Percentage (%)	17.5	10.8	71.6	100.0

Table 2.5.3 shows list of existing power station in the South.

Table 2.5.3 List of existing power station in the South

Name of Station	Owner	Type	COD	Fuel	Installed output [MW]	Available output [MW]
Thu Duc	EVN		1966-1973	oil	153	150
Tra Noc	EVN		1975	oil	33	30
O Mon 1	EVN		2009	oil	330	330
Hiep Phuoc	Hiep Phuoc power company			oil	375	375
Bourbon				oil	70	70
Thu Duc	EVN	CCGT	1999	Gas and oil	119	119
Ba Ria	EVN	CCGT	1989-1994	Gas and oil	370	370
Phu My 2,1 & 2,1 extension	EVN	CCGT	1997-1999	gas	880	880
Phu My 1	EVN	CCGT	2001	gas	1101	1090
Phu My 4	EVN	CCGT	2004	gas	450	450
Tra Noc	EVN	CCGT		Gas and oil	150	120
Nhon Trach 1	PVN	CCGT		gas	450	450
Ca Mau I	PVN	CCGT		gas	750	750
Ca Mau II	PVN	CCGT		gas	750	750
Vedan		CCGT		gas	27	27
Phu My 3	Phu My 3 BOT company	CCGT		Gas	720	720
Phu My 2-2	Mekong Energy	CCGT		Gas	720	720

Table 2.5.4 shows Power Plant List and the Availability in the South in Vietnam.

Table 2.5.4 Power Plant List and the Availability in the South in Vietnam 1/2

No.	Name of Station	Owner	Type of Station	Year of Initial Operation	Type of Fuel	Installed gross output [MW]	Available gross output [MW]	2005					2006				
								Annual Generation [GWh]	Operating Hours [hrs]	Outage hours [hrs]	Capacity Factor [%]	Availability Factor [%]	Annual Generation [GWh]	Operating Hours [hrs]	Outage hours [hrs]	Capacity Factor [%]	Availability Factor [%]
1	Thu Duc GT	EVN	GT	1966-1973	oil	170	153	35	328	1293	2.4%	85.2%	32	8701	133	2.1%	98.5%
	Thu Duc	EVN	Conventional	1965	oil	102	89	549	5370		61.4%		472	8562		52.8%	
2	Tra Noc GT (Can Tho)	EVN	GT	1975	oil	37.5	33	128	1173	1363	39.0%	84.4%	128	7923	885	39.0%	89.9%
	Tra Noc (Can Tho)	EVN	Conventional	1974	oil	150	132	142	4718		10.8%		109	7752		8.3%	
3	O Mon 1	EVN	Conventional	2009	oil	330	330										
4	Phu My 2,1 & 2,1 extension	EVN	CCGT	1997-1999	gas	949	860	3639	7708	1052	43.8%	88.0%	6110	8285	475	73.5%	94.6%
5	Phu My 1	EVN	CCGT	2001	gas	1140	1090	7172	7914	846	71.8%	90.3%	6415	7513	1247	64.2%	85.8%
6	Phu My 4	EVN	CCGT	2004	gas	468	440	3013	6456	2304	73.5%	73.7%	3211	8402	358	78.3%	95.9%
7	Nhon Trach 1	PVN	CCGT	2009	gas	465	450										
8	Ca Mau I & Ⅱ	PVN	CCGT	2007	gas	1542	1500										
9	Hiep Phuoc	Hiep Phuoc power company	Conventional	1998	oil	375	375	1424			43.3%		955			29.1%	
10	Bourbon	Bourbon	Conventional		biomass	24	24	43			20.5%		57			27.1%	
11	Ba Ria	JSCo.	CCGT	1989-1999	gas	388	334	2204	6725	511	64.8%	94.2%	2024	8222	538	59.5%	93.9%
12	Vedan	Vedan	CCGT		gas	72	72	463			73.4%		514			81.5%	
13	Phu My 3	Phu My 3 BOT	CCGT	2004	Gas	740	743	4442			68.5%		4110			63.4%	
14	Phu My 2-2	Mekong Energy	CCGT	2005	Gas	740	715	3719			57.4%		4855			74.9%	
15	Nhon Trach 2	PVN	CCGT	2011	gas	750	750										
16	Formasa	Taiwan IPP	Conventional		coal												

Note
1) Data source : IE
2) Capacity Factor = Annual Power Energy Generation (MWh) x 100 / (Installed Capacity (MW) x 8,760 hours)
3) Availability Factor = (8,760 hours - Outaged Hours) x 100 / 8,760 hours

Table 2.5.4 Power Plant List and the Availability in the South in Vietnam 2/2

No.	Name of Station	2007					2008					2009					2010				
		Annual Generation [GWh]	Operating Hours [hrs]	Outage hours [hrs]	Capacity Factor [%]	Availability Factor [%]	Annual Generation [GWh]	Operating Hours [hrs]	Outage hours [hrs]	Capacity Factor [%]	Availability Factor [%]	Annual Generation [GWh]	Operating Hours [hrs]	Outage hours [hrs]	Capacity Factor [%]	Availability Factor [%]	Annual Generation [GWh]	Operating Hours [hrs]	Outage hours [hrs]	Capacity Factor [%]	Availability Factor [%]
1	Thu Duc GT	70	8735	318	4.7%	96.4%	17	8734	206	1.1%	97.6%	11			0.7%		81	8734	558	5.4%	93.6%
	Thu Duc	603	8049		67.5%		583	8022		65.2%		358			40.1%		496	8022		55.5%	
2	Tra Noc GT (Can Tho)	137	8565	190	41.7%	97.8%	94	8048	601	28.6%	93.1%	29			8.8%		54	8558	192	16.4%	97.8%
	Tra Noc (Can Tho)	151	8608		11.5%		63	8608		4.8%		14			1.1%		22	8608		1.7%	
3	O Mon 1											616			21.3%		1048	8472	288	36.3%	96.7%
4	Phu My 2,1 & 2,1 extension	5975	8085	675	71.9%	92.3%	6056	7969	791	72.8%	91.0%	6232			75.0%		7207	8652	108	86.7%	98.8%
5	Phu My 1	8034	8520	240	80.4%	97.3%	7987	8156	604	80.0%	93.1%	7848			78.6%		7942	8268	492	79.5%	94.4%
6	Phu My 4	3209	8703	57	78.3%	99.3%	3438	8434	326	83.9%	96.3%	2821			68.8%		3412	8451	309	83.2%	96.5%
7	Nhon Trach 1				0.0%		589			14.5%		2159			53.0%		3575			87.8%	
8	Ca Mau I & Ⅱ	691			5.1%		2994			22.2%		6560			48.6%		9361			69.3%	
9	Hiep Phuoc	1726			52.5%		1464			44.6%		1319			40.2%		1696			51.6%	
10	Bourbon	69			32.8%		43			20.5%		49			23.3%		49			23.3%	
11	Ba Ria	1982	8479	281	58.3%	96.8%	2074	8569	191	61.0%	97.8%	2180			64.1%		2370	8470	290	69.7%	96.7%
12	Vedan	534			84.7%		395			62.6%		340			53.9%		407			64.5%	
13	Phu My 3	3883			59.9%		5121			79.0%		4582			70.7%		5813			89.7%	
14	Phu My 2-2	5004			77.2%		4222			65.1%		4959			76.5%		5282			81.5%	
15	Nhon Trach 2																				
16	Formasa																				

Note
1) Data source : IE
2) Capacity Factor = Annual Power Energy Generation (MWh) x 100 / (Installed Capacity (MW) x 8,760 hours)
3) Availability Factor = (8,760 hours - Outaged Hours) x 100 / 8,760 hours

Figure 2.5.1 shows Availability Factor of TPP in South Vietnam 2005-2010.
Availability factor of TPP in South Vietnam is tending upward. Concerning availability factor, data of all EVN and IPP Ba Ria TPP are acquired. Each capacity factor is generally high so that availability factor of IPP is supposed to be also high.

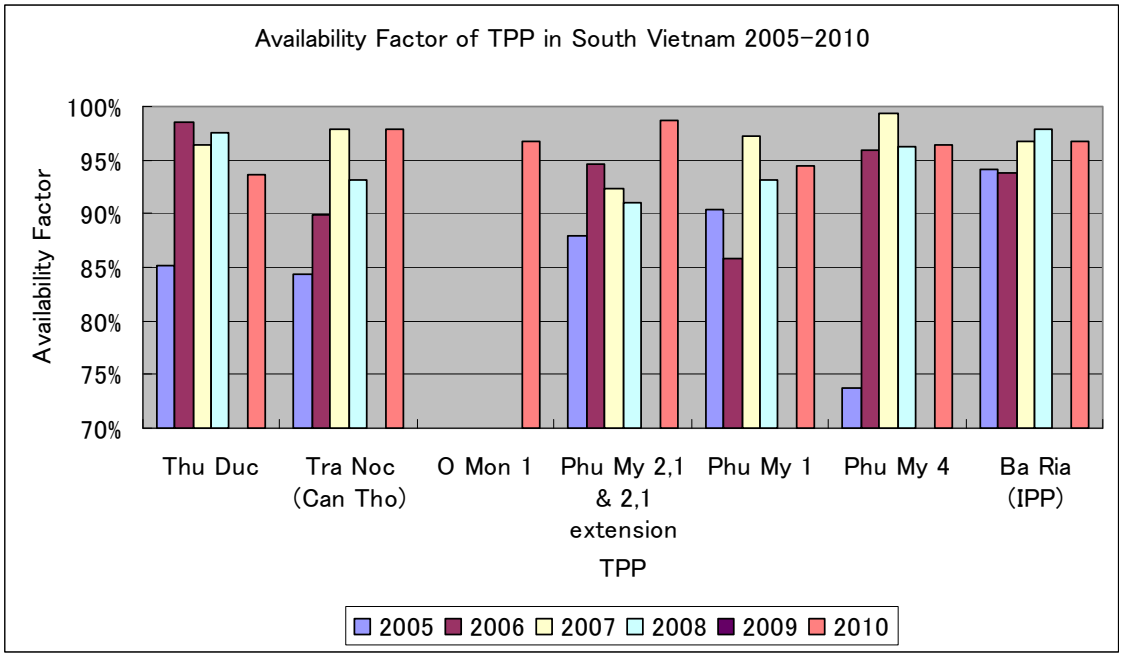

Figure 2.5.1 Availability Factor of TPP in South Vietnam 2005-2010
Source: IE

Figure 2.5.2 shows Capacity Factor of EVN TPP in South Vietnam 2005-2010 and Figure 2.5.3 shows Capacity Factor of IPP TPP in South Vietnam 2005-2010.
Capacity factor of both EVN and IPP TPP in South Vietnam is tending upward. EVN TPP operating management is supposed to be following.

Base operation	: Phu My 2.1&2.2, 1, 4
Middle operation	: Thu Duc, Tra Noc GT(Can Tho), O Mon 1
Peak operation	: Thu Duc GT, Tra Noc

IPP TPP operating management is supposed to be following.

Base operation	: All TPP except Hiep Ohuoc and Bourbon
Middle operation	: Hiep Ohuoc and Bourbon

Capacity factor of IPP TPP is generally high such as 60-90 % so that capacity factor of Song Hau 1 shall be higher than them.

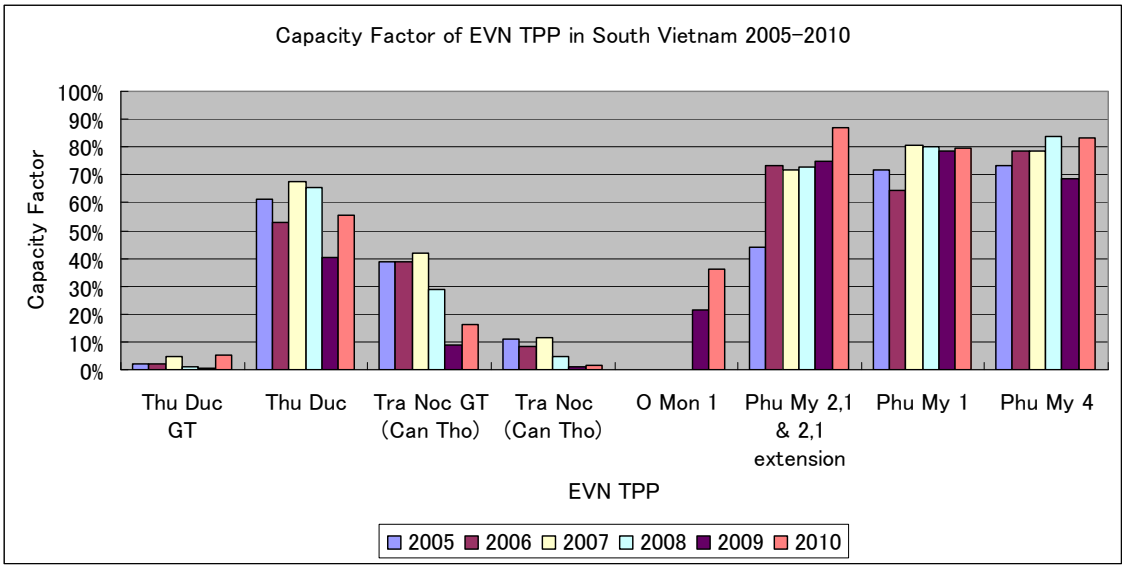

Figure 2.5.2 Capacity Factor of EVN TPP in South Vietnam 2005-2010
Source: IE

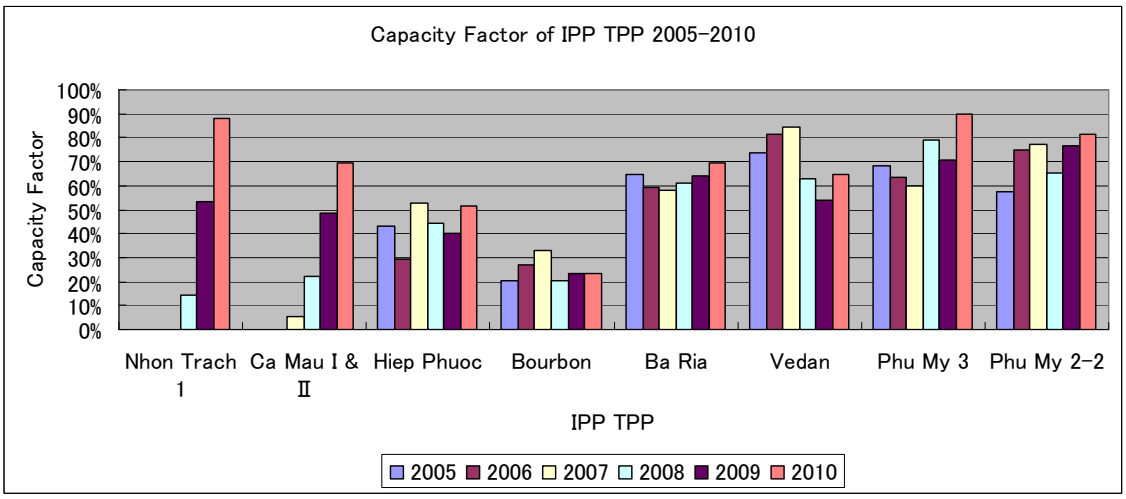

Figure 2.5.3 Capacity Factor of IPP TPP in South Vietnam 2005-2010
Source: IE

Table 2.5.5 shows forecasted power consumption demand of the whole country in basic scheme. Forecasting that the demand for commercial power will increase by 15.8% per year for the period of 2006 - 2010 and 18.7% per year for the period of 2011-2015. Respectively power production will reach 109 TWh in 2010 and 257 TWh in 2015. Average growth will be 11.6% per year for the period of 2016 - 2020 and 9.8% per year for the period of 2021 - 2025.

Table 2.5.5 Forecasted power consumption demand of the whole country in basic scheme (17%)

Region	2010		2015		2020		2025	
	GWh	MW	GWh	MW	GWh	MW	GWh	MW
North	36,864	6,581	93,279	15,915	157,727	25,994	232,782	36,969
Central	9,013	1,515	25,139	3,332	44,202	5,333	69,545	7,199
South	49,662	8,150	122,290	20,644	201,526	34,056	290,014	49,748
Total	95,539	16,246	240,708	39,891	403,455	65,328	592,341	93,915

According to the forecast, the load with the growth rate of 17% per year, the output demand in 2010, 2015, 2020 respectively are: 18167 MW, 39891 MW and 65328 MW. In order to meet the above load demand, in the next time, many plants will be constructed all over the country with the power structure as follows:

Table 2.5.6 Structure of total power output by 2020, basic scheme

Unit : MW

Year	Hydro	Coal	Gas	Renewable	Nuclear	Imported	Total
2010	8,830	5,905	9,034	1,502	-	758	26,029
2015	15,746	27,405	12,034	2,757	-	2,250	60,192
2020	18,146	65,005	18,784	3,257	1,000	5,724	111,916

Source : EVN

Table 2.5.7 shows load zoning and output allocation of the power plants in Western region of the South

According to balance of output, the appearance of Song Hau 1 power plant -2 x 600MW in the period of 2012 - 2014 is the most suitable time because it will settle the power shortage matter in the South. If Song Hau 1 Power Plant does not appear in the period 2015 - 2016, the power system in the South will be supported from other regions through 500-kV North - South line and 220-kV lines in the region. However, with such too big output volume above, other regions cannot meet the demand, on the other hand, the transmission of big output volume above will cause transmission lose in the system.

Through calculating the output balance in the Western region of the South in the period 2010 - 2020, it shows that the Southern region of Hau River is redundant of output of about 2,889 MW in 2015; 5,020 MW in 2016 and 9,980 MW in 2020.

Table 2.5.7 Load zoning and output allocation of the power plants in Western region of the South

Unit : MW

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Load	1,234	1,431	1,627	1,823	2,020	2,216	2,471	2,726	2,981	3,236	3,490
Power Supply Total	1,980	1,980	2,310	2,310	3,660	5,460	8,010	9,210	9,810	12,410	14,410
Long Phu 1					600	1,200	1,200	1,200	1,200	1,200	1,200
Long Phu 2							600	1,200	1,200	1,200	1,200
Long Phu 3										1,000	1,000
Can Tho	150	150	150	150	150						
O Mon 1	330	330	660	660	660	660	660	660	660	660	660
O Mon 2					750	750	750	750	750	750	750
O Mon 3						750	750	750	750	750	750
O Mon 4							750	750	750	750	750
Ca Mau 1	750	750	750	750	750	750	750	750	750	750	750

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Ca Mau 2	750	750	750	750	750	750	750	750	750	750	750
Kien Luong 1							600	1,200	1,200	1,200	1,200
Kien Luong 2									600	1,200	1,200
Kien Luong 3											1,000
Song Hau 1						600	1,200	1,200	1,200	1,200	1,200
Song Hau 2										1,000	2,000
Plant's consumption	129	129	150	150	238	355	521	599	638	807	937
Redundancy (+)	617	420	533	337	1,402	2,889	5,018	5,885	6,191	8,367	9,983

Source：EVN

Figure 2.5.4 shows South development plan Table 2.5.5 shows South development plan (Surrounding area of Can Tho).

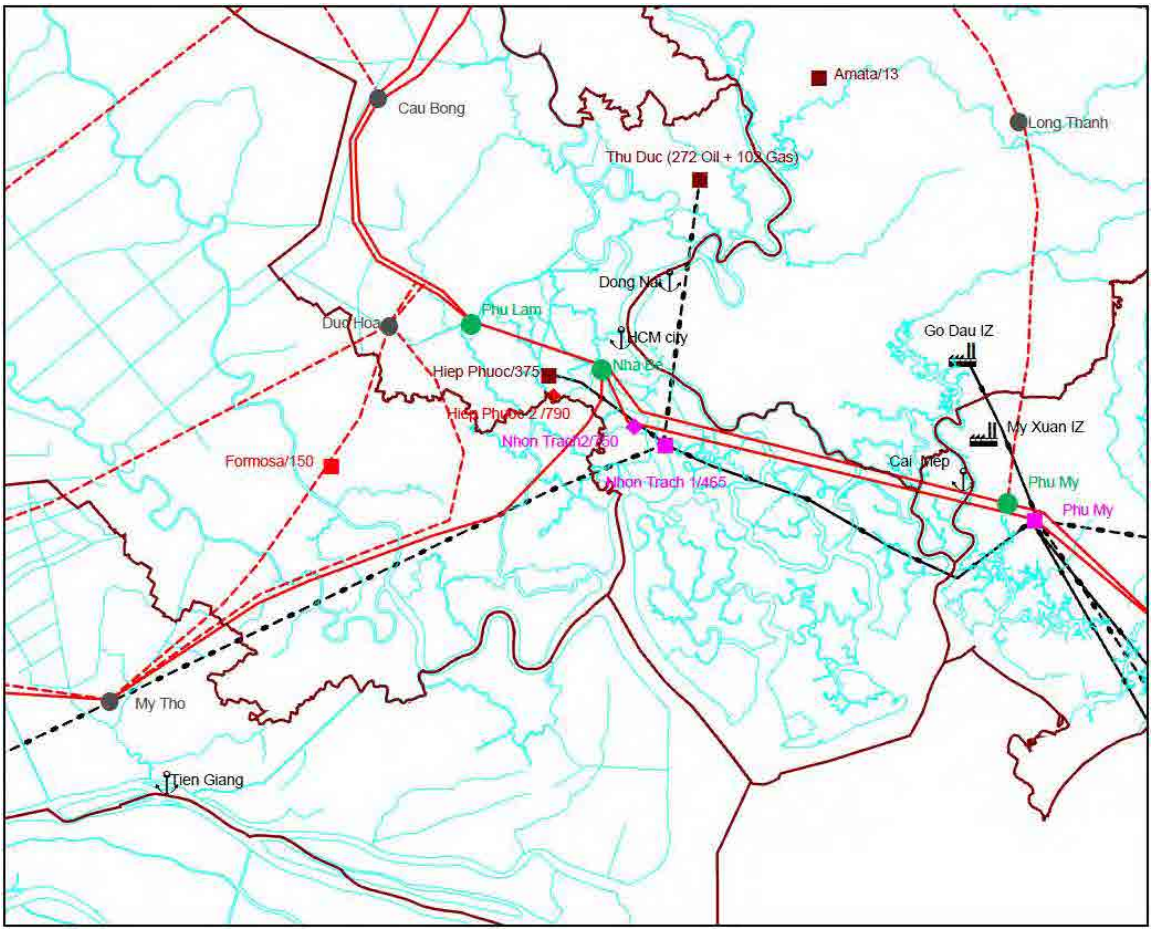

Figure 2.5.4 Southern development plan

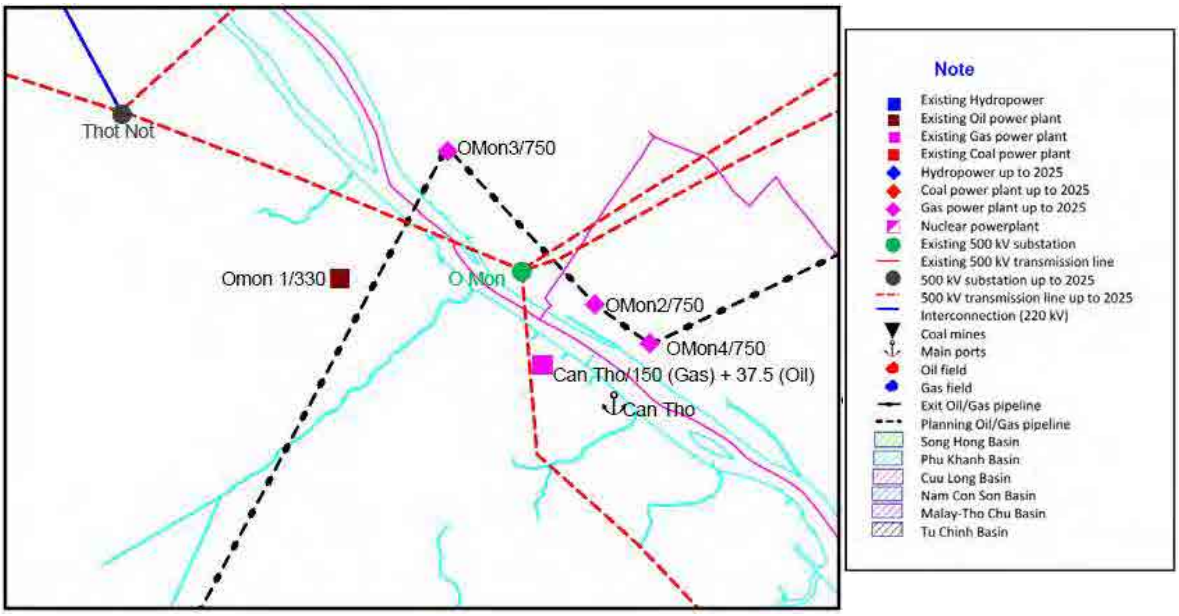

Figure 2.5.5 Southern development plan (Surrounding area of Can Tho) Source: JETRO

Table 2.5.8 shows List of power plants expected to be in operation in the period of 2011-2030 on PDP7.
COD of Song Hau 1-1 is supposed to be 2017 and COD of Song Hau 1-2 is supposed to be 2018 on updated PDP7. Also COD of following Song Hau 2-1 is supposed to be 2027, Song Hau 2-2 is supposed to be 2028 and Song Hau 3-1&2 are supposed to be 2029 on updated PDP7.

Table 2.5.8 Power development plan on PDP7

No	Power Plant Name	Installed capacity (MW)	Owner/Developer
	Projects to be in operation in 2011	4,187	
1	Son La HPP #2,3,4	1,200	EVN
2	Nam Chien HPP #1	100	Song Da Group
3	Na Le (Bac Ha) HPP #1,2	90	LICOGI
4	Ngoi Phat HPP	72	IPP
5	A Luoi #1,2	170	Central Power JSC.
6	Song Tranh 2 HPP #2	95	EVN
7	An Khe Kanak HPP	173	EVN
8	Se San 4A HPP	63	Se San 4A hydropower JSC.
9	Dak My 4 HPP	190	IDICO
10	Se Kaman 3 HPP (Laos)	250	Viet Lao JSC.
11	Dak Rtih HPP	144	Construction Corp. No.1
12	Dong Nai 3 HPP #2	90	EVN
13	Dong Nai 4 HPP #1	170	EVN

No	Power Plant Name	Installed capacity (MW)	Owner/Developer
14	Uong Bi Ext. TPP #2	300	EVN
15	Cam Pha 2 TPP	300	Vinacomin
16	Nhon Trach 2 C/C GT	750	PVN
	Wind power + Renewable energy	30	
	Projects to be in operation in 2012	2,805	
1	Son La HPP #5,6	800	EVN
2	Dong Nai 4 HPP #2	170	EVN
3	Nam Chien HPP #2	100	Song Da Group
4	Ban Chat HPP #1,2	220	EVN
5	Hua Na HPP #1,2	180	Hua Na hydropower JSC.
6	Nho Que 3 HPP #1,2	110	Bitexco JSC.
7	Khe Bo HPP #1,2	100	Electricity power JSC.
8	Ba Thuoc 2 HPP #1,2	80	IPP
9	Dong Nai 2 HPP	70	IPP
10	Dam Bri HPP	75	IPP
11	An Khanh 1 TPP #1	50	An Khanh thermal power JSC.
12	Vung Ang 1 TPP #1	600	PVN
13	Formosa TPP #2	150	Hung Nghiep Formosa Co., Ltd.
	Wind power + Renewable energy	100	
	Projects to be in operation in 2013	2,105	
1	Nam Na 2 HPP	66	IPP
2	Dak rinh HPP #1,2	125	PVN
3	Sre Pok 4A	64	Buon Don hydropower JSC.
4	Hai Phong 2 TPP #1	300	EVN
5	Mao Khe TPP #1,2	440	Vinacomin
6	An Khanh 1 TPP #2	50	An Khanh thermal power JSC.
7	Vung Ang 1 TPP #2	600	PVN
8	Nghi Son 1 TPP #1	300	EVN
9	Nong Son TPP	30	Vinacomin
	Wind power + Renewable energy	130	Hai Phong TP JSC
	Projects to be in operation in 2014	4,279	
1	Nam Na 3 HPP	84	IPP
2	Yen Son HPP	70	Binh Minh Construction & Tourism JSC.
3	Thuong Kon Tum HPP #1,2	220	Vinh Son-Song Hinh hydropower JSC
4	Dk Re HPP	60	Thien Tan Hydropower JSC.
5	Nam Mo HPP (Laos)	95	IPP

No	Power Plant Name	Installed capacity (MW)	Owner/Developer
6	Hai Phong 2 TPP #2	300	EVN
7	Nghi Son 1 TPP #2	300	EVN
8	Thai Binh 2 TPP #1	600	PVN
9	Quang Ninh 2 TPP #1	300	EVN
10	Vinh Tan 2 TPP #1,2	1,200	EVN
11	O Mon 1 TPP #2	330	EVN
12	Duyen Hai 1 TPP #1	600	EVN
	Wind power + Renewable energy	120	
	Projects to be in operation in 2015	6,540	
1	Huoi Quang HPP #1,2	520	EVN
2	Dong Nai 5 HPP	145	Vinacomin
3	Dong Nai 6 HPP	135	Duc Long Gia Lai Company
4	Se Kaman 1 HPP (Laos)	290	Viet Lao JSC.
5	Quang Ninh 2 TPP #2	300	EVN
6	Thai Binh 2 TPP #2	600	PVN
7	Mong Duong 2 TPP #1,2	1,200	AES/BOT
8	Luc Nam TPP #1	50	IPP
9	Duyen Hai 3 TPP #1	600	EVN
10	Long Phu 1 TPP #1	600	PVN
11	Duyen Hai 1 TPP #2	600	EVN
12	O Mon 3 C/C GT	750	EVN
13	Cong Thanh TPP #1,2	600	Cong Thanh thermal power JSC.
	Wind power + Renewable energy	150	
	Projects to be in operation in 2016	7,136	
1	Lai Chau HPP #1	400	EVN
2	Trung Son HPP #1,2	260	EVN
3	Song Bung 4 HPP	156	EVN
4	Song Bung 2 HPP	100	EVN
5	Dak My 2 HPP	98	IPP
6	Dong Nai 6A HPP	106	Duc Long Gia Lai Company
7	Hoi Xuan HPP	102	IPP
8	Se Kaman 4 HPP (Laos)	64	BOT
9	Ha Se San 2 HPP (50% by Cambodia)	200	EVN-BOT
10	Mong Duong 1 TPP #1	500	EVN
11	Thai Binh 1 TPP #1	300	EVN
12	Hai Duong TPP #1	600	Jak Resource-Malaysia/BOT
13	An Khanh 2 TPP #1	150	An Khanh thermal power JSC.

No	Power Plant Name	Installed capacity (MW)	Owner/Developer
14	Long Phu 1 TPP #2	600	PVN
15	Vinh Tan 1 TPP #1,2	1,200	CSG/BOT
16	Duyen Hai 3 TPP #2	600	EVN
17	O Mon 4 C/C GT	750	EVN
18	O Mon 2 C/C GT	750	BOT
	Wind power + Renewable energy	200	
	Projects to be in operation in 2017	6,775	
1	Lai Chau HPP #2,3	800	EVN
2	Se Kong 3A, 3B HPP	105+100	EVN
3	Thang Long TPP #1	300	Thang Long thermal power JSC.
4	Mong Duong 1 TPP #2	500	EVN
5	Thai Binh 1 TPP #2	300	EVN
6	Hai Duong TPP #2	600	Jak Resource-Malaysia/BOT
7	Nghi Son 2 TPP #1,2	1,200	BOT
8	An Khanh 2 TPP #2	150	An Khanh thermal power JSC.
9	Van Phong 1 TPP #1	660	Sumitomo-Hanoinco/BOT
10	Vinh Tan 6 TPP #1	600	EVN
11	Vinh Tan 3 TPP #1	660	Vinh Tan 3 Energy JSC.
12	**Song Hau 1 TPP #1**	**600**	**PVN**
	Wind power + Renewable energy	200	BOO/BOT
	Projects to be in operation in 2018	7,842	
1	Bao Lam HPP	120	Song Da Group
2	Nam Sum 1 HPP (Laos)	90	Sai Gon Invest
3	Se Kong HPP (Laos)	192	EVN-BOT
4	Na Duong 2 TPP #1,2	100	Vinacomin
5	Luc Nam TPP #2	50	IPP
6	Vung Ang 2 TPP #1	600	VAPCO/BOT
7	Quang Trach 1 TPP #1	600	PVN
8	Nam Dinh 1 TPP #1	600	TaiKwang-Korea/BOT
9	Van Phong 1 TPP #2	660	Sumitomo-Hanoinco/BOT
10	**Song Hau 1 TPP #2**	**600**	**PVN**
11	Son My 1 C/C GT #1,2,3	1,170	(IP-Sojizt-Pacific)/BOT
12	Duyen Hai 2 TPP #1	600	Janakuasa/BOT
13	Vinh Tan 3 TPP #2	660	Vinh Tan 3 Energy JSC.
14	Vinh Tan 6 TPP #2	600	EVN
15	Import from China	1,000	Upon negotiation
	Wind power + Renewable energy	200	IPP

No	Power Plant Name	Installed capacity (MW)	Owner/Developer
	Projects to be in operation in 2019	7,015	
1	Bac Ai PSPP #1	300	EVN
2	Phu Yen East PSPP #1	300	Xuan Thien Ninh Binh Company
3	Nam Sum 3 (Laos)	200	Sai Gon Invest
4	Vinh Son 2 HPP	80	IPP
5	Vung Ang 2 TPP #2	600	VAPCO/BOT
6	Quang Trach 1 TPP #2	600	PVN
7	Nam Dinh 1 TPP #2	600	TaiKwang-Korea/BOT
8	Thang Long TPP #2	300	Thang Long thermal power JSC.
9	Quang Tri TPP #1	600	IPP/BOT
10	Duyen Hai 2 TPP #2	600	Janakuasa/BOT
11	Duyen Hai 3 TPP #3 (Extension)	600	EVN
12	Kien Luong 1 TPP #1	600	Tan Tao Company
13	Son My 1 C/C GT #4,5	780	(IP-Sojizt-Pacific)/BOT
	Hiep Phuoc TPP stopped	-375	
14	Import from China	1,000	Upon negotiation
	Wind power + Renewable energy	230	IPP
	Projects to be in operation in 2020	5,610	
1	Phu Yen East PSPP #2,3	600	Xuan Thien Ninh Binh Company
2	Bac Ai PSPP #2,3	600	EVN
3	Nam Mo 1 HPP (Nam Kan - Laos)	72	EVNI
4	Quang Tri TPP #2	600	IPP/BOT
5	C/C GT in the Center (Quang Tri or Quang Ngai)	450	
6	Ninh Thuan 1 NPP #1	1,000	EVN
7	Ninh Thuan 2 NPP #1	1,000	EVN
8	Vinh Tan 3 TPP #3	660	Vinh Tan 3 Energy JSC.
9	Kien Luong 1 TPP #2	600	Tan Tao Company
	Thu Duc TPP stopped	-272	
	Wind power + Renewable energy	300	IPP

Source: PDP7

2.6 Restriction for the Direct Investment by Foreigners

In 2006, the Vietnam Government issued Decree No. 108/2006/ND-CP setting out the detailed regulations and guidance on the implementation of the Investment Law. Under this Decree, the sectors in which investment is prohibited and the sectors subject to conditional investment,

which is applicable to the foreign investors as listed below;

(1) The sectors in which investment is prohibited
1) Projects prejudicial to national defence, national security and public interests.
2) Projects detrimental to historical and cultural relics, moral principles, fine customs and traditions of Vietnam
3) Projects having adverse impacts to the public health, causing destruction of national resources or environment
4) Projects of treatment of toxic wastes entering Vietnam from abroad; production of toxic chemicals or use of toxic agents subject to prohibition under international treaties
5) Other investment projects subject to prohibition from investment in accordance with the laws

(2) The sectors subject to conditional investment
1) Radio and television broadcasting.
2) Production, publication and distribution of cultural products.
3) Exploitation and processing of minerals.
4) Establishment of infrastructure for telecommunication network, broadcast transmission and provision of telecommunication and Internet services.
5) Development of public postal networks; provision of postal services and courier services.
6) Construction and operation of river ports, seaport, airports and air terminals.
7) Passenger and goods transportation by railway, aviation, road, sea, and internal waterway.
8) Fishing.
9) Production of tobacco.
10) Real estate business.
11) Investment in import, export and distribution sectors
12) Education and training.
13) Hospitals and clinics.
14) Other investment fields subject to Vietnam's commitment to limited market access to foreign investors under international treaties to which Vietnam is a member.

Investment in construction of new power plants and power distribution and transmission is categorized as the sectors subject to the investment incentives and BOT Decree No. 108/2009/ND-CP issued by Vietnam Government on November 27, 2009 expressly encourages the investment in the infrastructure facilities such as roads, rail, air and sea ports, water and waste plants, power plants and transmission with various incentives for investors to undertake BOT project such as exemption from applicable land use fees or land rent, exemption from import duties on goods imported to implement the project, reduction of corporate income tax etc.
Under such circumstances, foreign investment in Vietnam's power sector is not legally registered.

Chapter 3 Site conditions

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Chapter 3 Site conditions

3.1 General

The Song Hau 1 Coal-fired Thermal Power Plant site located in the Song Hau Industrial Zone Area and along the Hau River. The site is situated about 12 km of downstream to the Hau River from the Can Tho City, about 66 km iof upstream to the Hau River from the Dinh An estuary, and about 180 km to the south of Ho Chi Minh City. The site belongs to the Song Hau Thermal Power Complex Center in the Chau Thanh Region of Hau Giang Province, and the premises are bordered as follows:

North-East : Hau river
South-East : Nga Bat ditch
South-West : Giao Hoang ditch (200m ahead)
North-West : Song Hau 2 Power plant

3.2 Site ambient environment

3.2.1 Economy

Industry: The site is located close to the Cai Cui Port and paper manufacturing companies, and development efforts are being made in the Song Hau Industrial Zone Area.
Agriculture: The major part of the agriculture is supported by rice cultivation and fruit garden. Farm products are cultivated.
Husbandry: Stock raising of cows and poultry can be observed.

3.2.2 Society

Population: Population density is not uniform. Densely populated areas are found close to the highway and two channels. Many of the inhabitants support their family by agriculture including rice cultivation, fruit gardening and husbadry and fowl.
Culture: The level of living and culture around the site is improving due to development of electricity system and road network. The inhabitants attach greater importance to the public culture. Festivals are held frequently. The inhabitants consist of Buddhists, Protestants, Catholics and many others. Their local entertainments include sports, movies and artistic activities which are very active.
Education: The cultural level of the people is rising. Schools and educational institutes are upgraded and the educational environment is improving. A compulsory educational program is adopted, and many inhabitants are literate.

3.2.3 Transportation

The Nam Song Hau road is the main road to the site. The site is accessible from the Nga Sau Town through an unpaved road.
This area is also accessible through several roads along the Hau River. Major water channels include the Hau River, Nga Bat Canal and Cai Cui chanel. The unpaved roads running along the canal are frequently used for land transportation. In the rainy season, the unpaved roads are muddy and slippery.

(1) Road network
In the whole Hau Giang province, there are only 02 National Highways (NH) passing through,

with narrow pavement, with difficult circulating capacity:
- National Highway 1A passing through Chau Thanh A and Phung Hiep districts is the trunk line connecting Hau Giang province to all provinces in the whole country. At present, this road is narrow with or vehicle lanes only, with pavement of 7m, bed of 12m, that does not meet the requirement of traffic, accidents regularly happen.
- National Highway 61 passing through districts Chau Thanh A - Phung Hiep - Long My - Vi Thuy - Vi Thanh Town, is the sole access point connecting the National Highway 1A to the province center (Vi Thanh Town). At present, this road has not been attained Standard of Grade III of delta road, its pavement attains 5m only (not enough for 2 vehicle lanes). This is a significant obstacle in traveling of Hau Giang province to the provinces in the whole country.

The provincial road network is rather long and evenly spreading throughout the province. However, its quality is still poor (more than 50% are crushed stone roads and earth roads, the remainder are asphalt roads 3.5m). Most of the provincial road network just attains Grade VI - V delta road.

Most of district road network is crushed stone roads and earth roads with the temporary bamboo - wood bridge system.

Most of commune road network is crushed stone roads and earth roads with the temporary bamboo - wood bridge system.

(2) Waternetwork

Hau Giang province has an abundant and diverse river - channel - ditch system. The waterway network in the province area has the total length of 724km, of which:

- Managed by the central Government : 96km;
- Managed by the province : 223km;
- Managed by the districts : 405 km.

(3) Seaport system

The seagoing ship waterway lane Project for heavy - load ships enter into the Hau river, designed by the International Consultancy Company SNC - Lavalin (Canada) and formulated by the seaport Engineering Consulting Joint Stock Company (Port Coast - Vietnam) approved by the Ministry of Transport & Communication at the Decision No. 3744/QD-BGTGT dated 30/11/2007 has some main contents as follows:
- Name of the project: Investment Project for building waterway lane for heavy - load ships enter into the Hau river.
- Employer: Vietnam Navigation Department
- Objective of project investment: building a seagoing ship waterway lane with draft depth T = 8m for (full - load 10,000 DWT and low load 20,000 DWT) ships ingoing and outgoing from the Hau river, to transport goods serving the Mekong delta with the volume of 21 - 22 million T/year (imported goods), and container cargo of 450,000 - 500,000 TEU/year for the period 2010 - 2020.
- Implementation progress: 4 years (2008 - 2011).

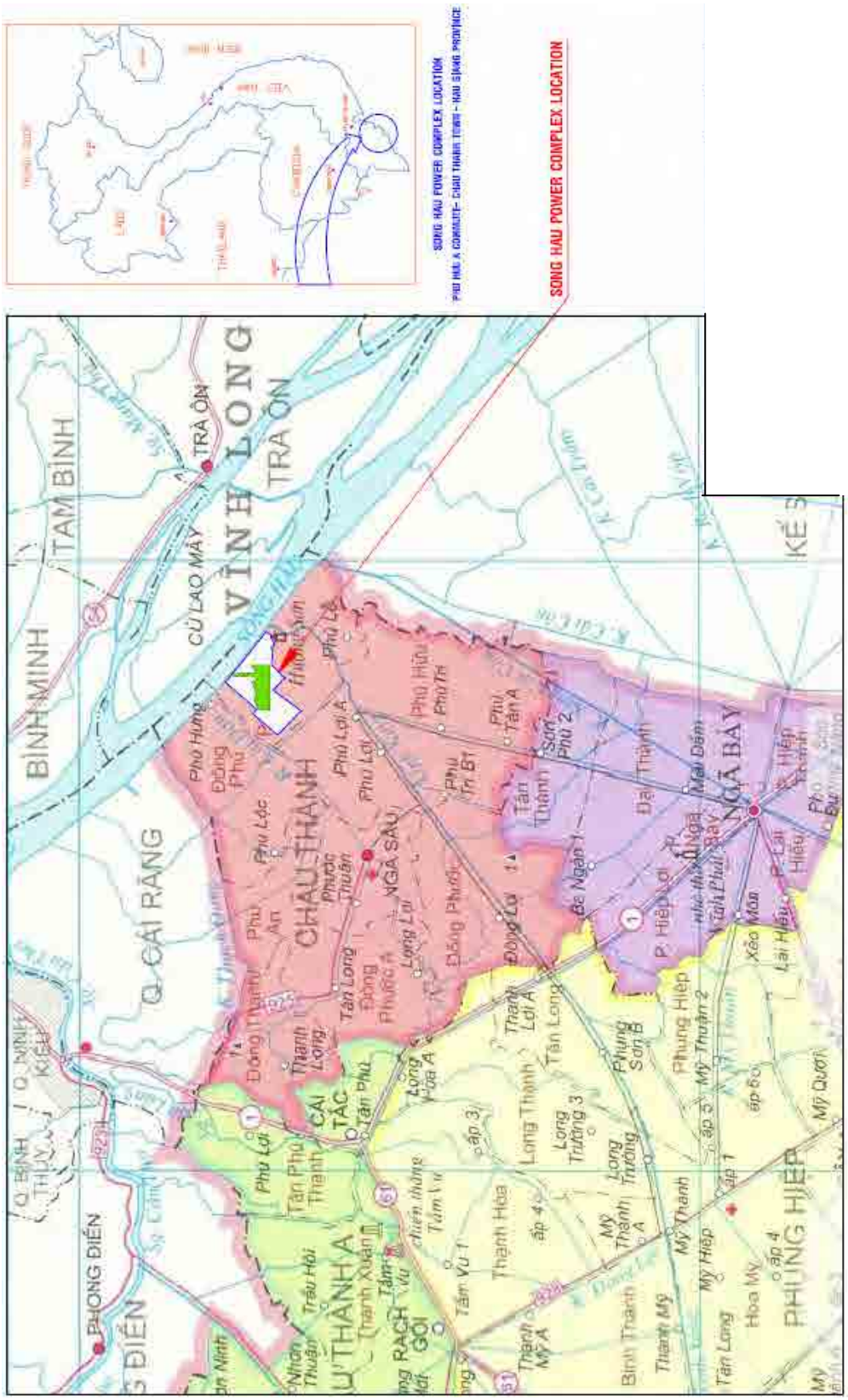

Figure 3.2.3.1 Site Area Map (No.1)

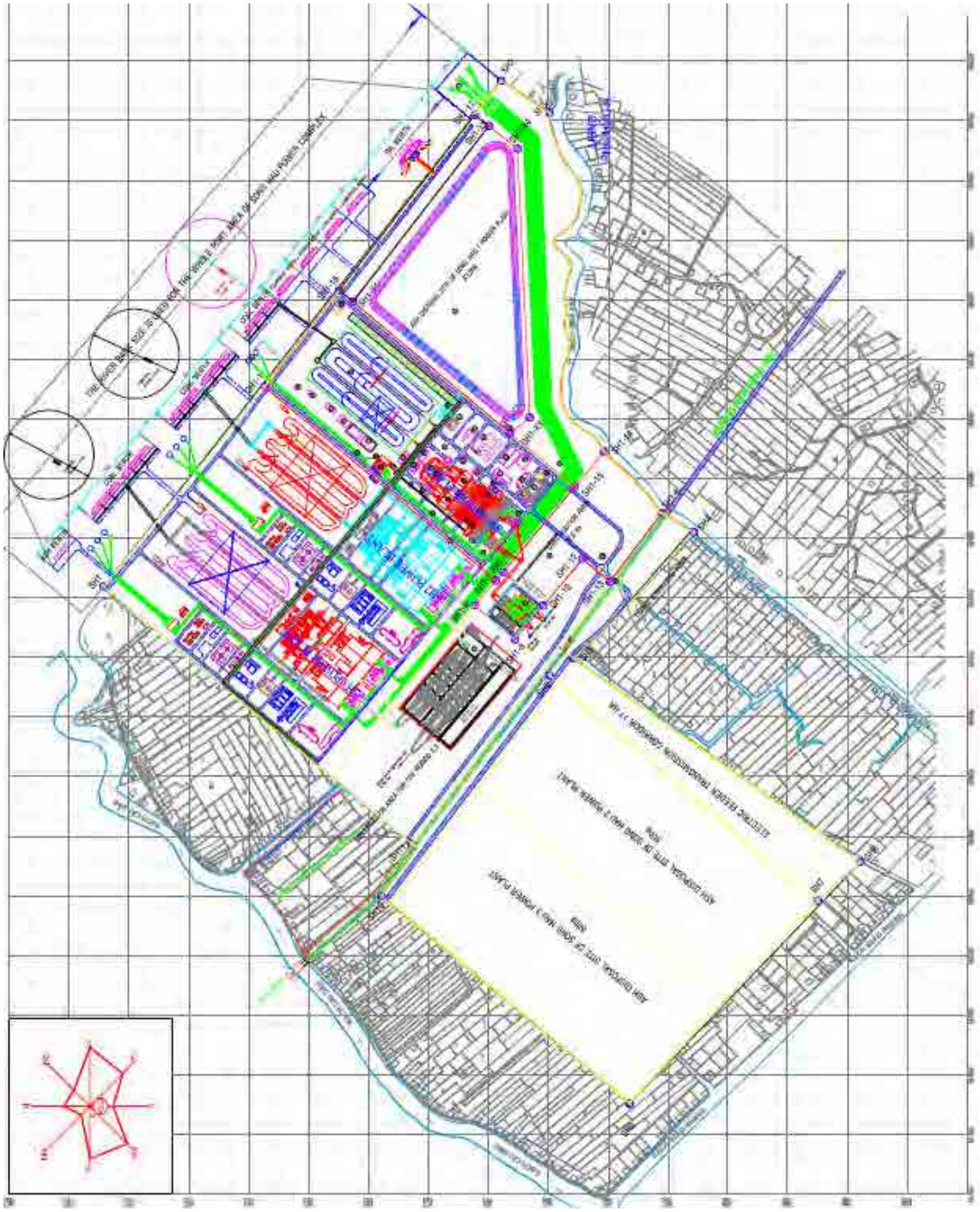

Figure 3.2.3.2 Site Area Map (No.2)

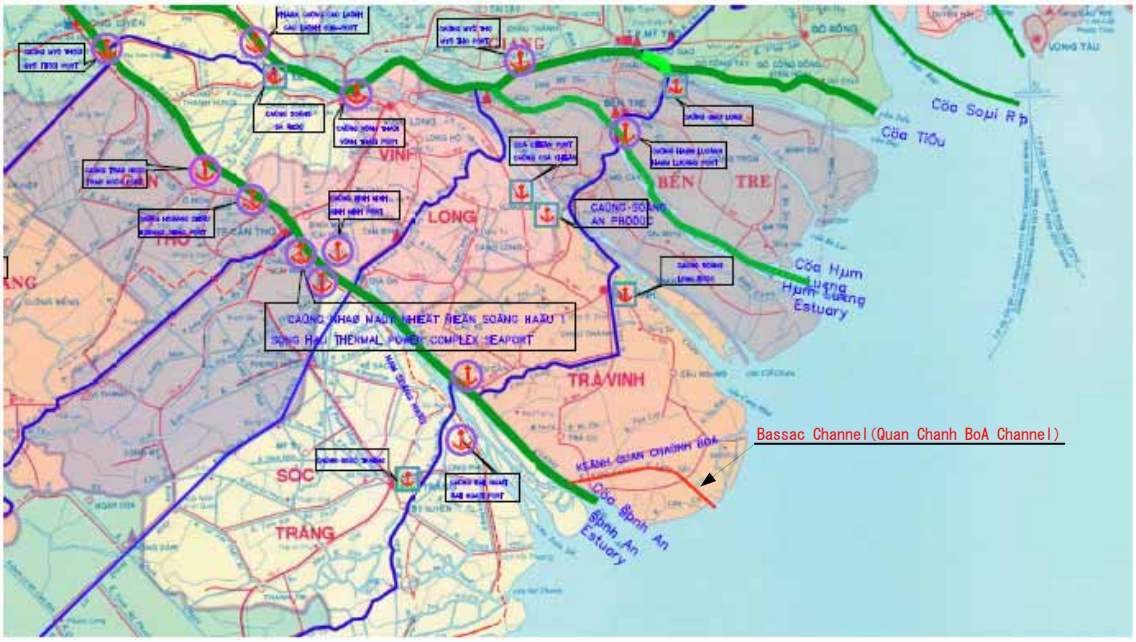

Figure 3.2.3.3 New Seagoing ship waterway lane

3.3 Site conditions

3.3.1 General

Table 3.3.1.1 Song Hau site conditions

1	Project location	Song Hau power plant is located in Phu Huu A commune, Chau Thanh district, Hau Giang province. It is about 12km from Can Tho city downstream to Hau river. To build a power plant with capacity of 5,200 MW with 445 ha will be affected and about reclaim about 360 ha for construction.
2	Topography	Topography is rather flat; average slope is less than 2%, Existing land use condition: It has been mainly used to plant rice and fruit tree. The interlacing ditch and canal system devides location into small parts; elevation varies from +0.4m to +1.9m. At this moment, Song Hau power complex are in land grading and leveling for construction site and infrastructure for Song Hau 1 power plant. The infrastructure construction project is process under decision No 5337/QĐ – DKVN date 17 June 2010. Grading finishing level of Song Hau 1 are: -Main power plant area: +3.20m HD; -Coal storage area: +2.75 HD; -Construction preparation site: +2.55 HD. Grading sand will be compacted to k = 0.9.
3	Geology	Geological condition is quite stable with four clay layers with the depth up to 100m. To enforce the foundation with pilling work and soil embankement work are necessary to construct the foundation of power plant.

Table 3.3.1.2 Current land use in Song Hau site

N^{o}	Land in the Power Center area	Area (ha)
1	Residential land	15.0
2	Dry land	113.2
3	Paddy land	7.5
4	Fruit tree land	297.2
5	Special - purpose land	6.0
6	Other land	6.1
	Total natural area	445.0

3.3.2 Topography

The site is located in the Mekong Delta, topography is rather falt. The natural ground level is within ±0 through 3 meters from sea level, and the maximum slope does not exceed 2%. Further, the site is separated by canals and ditches.
The site is mostly occupied by the agricultural area and inhabited area, which are concentrated on the sides of the canal. The area is characterized by a very high density of trees. Since the site is located on both sides of the Hau River, it is subjected to the impact of tide level of the Hau River. The Hau River is subjected to fluctuation in tide level twice a day. The tide level is the highest in October is the lowest in May.

3.3.3 Hydrometeorology

3.3.3.1 Meteorological conditio

(1) Temperature and humidity
The annual average temperature of 26.7°C (1978-2008) and a maximum temperature of 36.7°C (observed in May 1983) were observed in the Can Tho Observatory close to the site. There is not much difference in terms of monthly temperature. The maximum temperature normally occurs in April (average temperature: 28.3°C), and the minimum temperature in January (average temperature: 25.4°C). The difference in temperature is only 2.9°C. The maximum temperature in the history of observation is 36.7°C, and the minimum temperature is 17.0°C.

Table 3.3.3.1.1Atmospheric temperature features at Can Tho (1978-2008)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Tave	25.4	26.0	27.2	28.3	27.9	27.2	26.8	26.7	26.7	26.7	26.6	25.5	26.7
Tmax	35.5	34.7	36.0	36.7	35.2	34.5	34.2	34.1	33.6	33.5	33.0	33.0	36.7
Tmin	17.8	18.4	17.7	21.8	22.0	21.4	21.4	21.1	22.2	21.2	19.3	17.0	17.0

In which:
Tave : Average temperature (°C) ;
Tmax : Maximum temperature (°C) ;
Tmin : Minimum temperature (°C) .

The annual average relative humidity is 84%. The humidity is lower in the dry season from January through April, and the average monthly humidity is approximately 80%. In the rainy season, the average humidity is in the range from 80 through 89%. The minimum relative humidity of 36% was registered in January 1995 and March 1996. The minimum relative humidity fluctuates from 36 through 55% throughout the year.

Table 3.3.3.1.2 Features of relative humidity in The Can Tho Station (1978-2008)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Uave(%)	81	80	78	80	85	87	88	88	89	88	85	83	84
Umin(%)	36	42	36	39	43	50	55	54	53	53	49	40	36

In which:
Uave : Rerlative Average humidity (%).
Umin : Relative Minimum humidity (%).

(2) Rainfall and storm
a. Rainfall
The site is characterized by tropical climate. The rainy season prevails from May through

November. The maximum rainfall is recorded in September and October. The dry season continues from December through April of the following year. The annual average rainfall is 1615 mm. A total rainfall of approximately 93% is recorded in the rainy season, and a total rainfall of approximately 7% is registered in the dry season. The following table shows the data on rainy days during the period from 1911 through 2008 recorded at the Can Tho Observatory.

Table 3.3.3.1.3 Rainfall, number of rainy days at Can Tho in the period (1911-2008)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
X (mm)	11.8	3.72	16.3	46.2	170	203	229	217	257	291	147	42.2	1615
Rainy days	2	1	1	4	14	17	19	19	20	19	12	5	132
≧0 (mm)	3	2	3	7	18	22	24	23	24	23	16	.9	174
≧1 (mm)	1	0	1	4	13	15	17	18	18	18	10	4	119
≧5 (mm)	0	0	1	2	8	10	11	11	12	12	7	2	76
≧10 (mm)	0	0	0	1	5	7	7	7	8	9	5	1	50
≧20 (mm)	0	0	0	1	2	3	4	4	4	5	2	0	25
≧50 (mm)	0	0	0	0	1	1	1	0	1	1	0	0	5
≧75 (mm)	0	0	0	0	0	0	0	0	0	0	0	0	0

(*) In this period, some years were interrupted

b. Maximum rainfall for a period

The following table illustrates the rainfall intensity in Can Tho City. The rainfall intensities per year and day are given by data from 1911 through 2008. The rainfall intensities for 10, 20, 30, 60 minutes and for 6 and 12 hours are given by data from 1978 through 2008.

Table 3.3.3.1.4 Maximum rainfall (mm) for every design period at Can Tho

Period	10’	20’	30’	60’	6hr	12hr	1day	1year
N	31	31	31	31	31	31	76	76
Mean	20.3	30.8	40.4	59.6	82.7	87.5	88.7	1615
Cv	0.30	0.26	0.25	0.27	0.29	0.28	0.39	0.19
Cs	0.60	0.60	0.75	0.71	0.90	0.70	1.65	0.25
P=0.1%	44.4	62.5	82.4	126.7	186.2	188.0	276.7	2674
P=0.5%	39.3	55.9	73.3	112.4	162.9	166.5	228.0	2478
P=1%	37.0	52.9	69.2	105.9	152.4	156.7	206.8	2385
P=3%	33.2	47.8	62.2	.94.9	135.1	140.2	172.7	2224
P=5%	31.2	45.2	58.8	89.5	126.5	132.1	156.7	2141
P=10%	28.4	41.5	53.8	81.6	114.3	120.2	134.5	2016
P=20%	25.1	37.2	48.3	72.8	110.9	106.9	111.7	1869
P=50%	19.7	30.0	39.1	58.1	79.2	84.7	79.6	1602
P=75%	15.9	25.1	33.0	48.3	65.5	69.8	63.4	1402

c. Storm

During the period from 1979 through 2008, the site was subjected to eight rainstorms. The following table shows the impact of the rainstorm and tropical low pressure.

Table 3.3.3.1.5 Statistic of storms affecting to Song Hau 1 area (1979-2008)

No	Year	Date	Name & identified number of storm	Affected area	Wind grade near storm center	Strong Wind	
						Velocity (m/s)	Direction
1	1979	08/09		Phu Yen – Khanh Hoa	7-8	19	SW
2	1980	09/03		Binh Dinh	6-7	14	SW
3	1981	08/05		Binh Dinh	7	12	SSE
4	1982	09/07	HOPE	Khanh Hoa – Dong Nai	6-7	14	W
5	1983	10/11	HERBERT	Ba Ria – Vung Tau	6-7	11	SW
6	1987	11/19	NAURY/8721	Khanh Hoa – Dong Nai	7-8	9	NW
7	1990	10/03	IRA/9022	Khanh Hoa – Dong Nai	6	8	W
8	1996	11/16	ERNIE/9625	Ba Ria – Vung Tau	7	10	E
9	1997	11/02	LIDA/9726	Bac Lieu – Ca Mau	8	14	SSE
10	1998	11/20	DAWN/9813	Phu Yen – Khanh Hoa	8	10	W
11	1998	12/11	NONAME/9813	Ca Mau – Kien Giang	7	12	E
12	1999	10/23	Tropical cyclone	Ca Mau – Kien Giang	6	10	E
13	2004	11/24	MUIFA/0404	Cau Mau coastal area - Kien Giang	8	10	E
14	2006	10/05-06	DURIAN/0609	Ben Tre – Tra Vinh	10-11	23	NE
15	2008	11	Tropical cyclone	Offshore of the South of Central Viet Nam	6		

d. Number of thunder days

The area around the site is often visited by thunderstorms. Thunderstorms occur with particular frequency in the rainy season from May through November. They occur 98 days through a year.

Table 3.3.3.1.6 Monthly thunder days per year in Can Tho (1978-2008)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
N	1.8	1.5	3.2	6.7	15.3	11.6	11.0	8.8	13.0	15.1	7.2	2.1	98

e. Wind

The site is little affected by a rainstorm. The maximum wind velocity is lower than that in other port areas in Vietnam.

The following describes the result of calculating the design maximum wind velocity and wind direction based on the data of the Can Tho Observatory during the period from 1979 through 2000:

Table 3.3.3.1.7 Maximum designed windy velocity (m/s) at Can Tho Station (1979-2008)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Years	30	30	30	30	30	30	30	30	30	30	30	30	30
Maen	8.90	9.30	9.30	10.4	13.0	14.7	14.6	15.1	13.1	10.8	10.0	8.90	19.1
Cv	0.30	0.25	0.28	0.55	0.42	0.48	0.29	0.33	0.44	0.40	0.39	0.29	0.29
Cs	1.40	0.52	1.22	1.80	0.55	1.34	0.18	1.50	1.42	1.50	1.40	0.85	1.70
P=1%	17.6	15.6	17.6	30.4	27.9	37.3	25.1	31.8	31.9	25.1	22.8	16.4	38.1
P=2%	16.1	14.7	16.2	26.7	25.8	33.4	23.7	28.8	28.6	22.6	20.6	15.3	34.6
P=4%	15.2	14.2	15.4	24.5	24.5	31.1	22.9	27.1	26.7	21.1	19.3	14.6	32.6
P=10%	12.4	12.4	12.8	17.9	20.3	24.0	20.1	21.8	20.8	16.5	15.3	12.4	26.4
P=20%	10.7	11.2	11.2	14.1	17.4	19.7	18.2	18.6	17.1	13.7	12.8	10.9	22.7
P=25%	10.2	10.8	10.7	12.8	16.4	18.2	17.4	17.5	15.9	12.8	12.0	10.4	21.5
P=50%	8.27	9.13	8.82	8.79	12.5	13.2	14.5	13.9	11.8	9.73	9.15	8.54	17.6

Table 3.3.3.1.8 Maximum desingned windy velocity (m/s) of 8 directions at the Can Tho Station (1979-2008)

Direction	N	NE	E	SE	S	SW	W	NW	Max
Years	30	30	30	30	30	30	30	30	30
Maen	10.7	9.4	11.3	9.7	10.0	16.4	16.1	11.9	18.9
Cv	0.49	0.34	0.31	0.47	0.66	0.32	0.36	0.47	0.30
Cs	1.50	0.84	0.70	2.10	3.50	2.40	0.85	0.85	1.60
P=1%	28.1	18.8	21.2	26.5	37.9	38.0	33.0	28.3	38.2
P=2%	25.0	17.4	19.7	23.2	31.3	33.8	30.4	25.7	34.7
P=4%	23.2	16.5	18.8	21.3	27.6	31.3	28.8	24.2	32.7
P=10%	17.6	13.7	16.0	15.7	17.2	24.2	23.8	19.4	26.5
P=20%	14.3	11.9	14.1	12.4	12.1	20.2	20.5	16.2	22.8
P=25%	13.2	11.3	13.4	11.4	10.7	19.0	19.4	15.1	21.5
P=50%	9.41	8.99	10.9	8.28	7.28	15.4	15.3	11.1	17.5

The wind direction around the site differs according to the season. In the rainy season, the wind blows mainly from the west and southwest. In the dry season, the wind blows mainly from the east and southeast, and the site is affected by the monsoon of the Southeast Asia. In terms of annual percentage, the rate of occurrence of the east wind and southeast wind is 9.3 through 11.1%. The rate of occurrence of the west wind and southwest wind is 2.5 through 4.9%. The following table shows the rate of occurrence of winds in terms of direction during the period from 1978 through 2008 as observed at the Can Tho Observatory.

Table 3.3.3.1.9 Windy directions and frequencies at Can Tho weather station (1979-2008)

Direction	N	NE	E	SE	S	SW	W	NW	Max
P(%) All year	4.9	4.4	11.1	9.3	4.8	10.2	9.7	2.5	43.0
P(%) Rainy season	3.8	3.1	3.7	3.3	5.3	16.5	15.9	3.1	45.4
P(%) Dry season	6.6	6.3	21.5	17.6	4.0	14	1.0	1.5	40.1

In which:
N: North; NE: North East;
E: East; SE: South East;

S: South; SW: South West;
W: West; NW: North West;
Max: Maximum wind speed of all directions

f. Evaporation

There is a clear distinction at the site between the rainy season and dry season. The amount of evaporation is inversely proportional to the precipitation. The following table shows the evaporation data of the Can Tho Observatory:

Table 3.3.3.1.10 Monthly evaporation (mm) per year at Can Tho weather station (1979-2008)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Ztotal	88.5	92.0	111	100	78.0	68.1	67.0	65.5	57.6	56.1	70.4	79.3	934
Zmax	5.60	6.00	6.10	6.20	5.60	5.40	4.80	5.20	4.10	5.80	5.40	5.50	6.20
Zmin	2.86	3.25	3.58	3.34	2.52	2.27	2.16	2.11	1.92	1.81	2.35	2.56	2.56

In which:
Ztotal: Average monthly evaporation (mm);
Zmax: Maximum daily evaporation (mm);
Zmin: Minimum daily evaporation (mm);

g. Sunny hours

The maximum sunshine hours at the Can Tho Observatory are 11.8 hours, as observed in July. The total monthly sunshine hours in March and April are the longest.

Table3.3.3.1.11 Sunny hours recorded at Can Tho in period of 1979-2008.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Smax (h)	11.1	11.1	11.4	11.4	11.5	11.7	11.8	11.7	11.2	11.1	11	11.2	11.8
Total (h)	242	246	279	255	209	167	176	163	160	163	185	207	2452

In which:
Smax : the monthly maximum sunny hours per year (h);
Total : the monthly total sunny hour per year (h);

h. Atmospheric pressure

The annual average atmospheric pressure is approximately 1,009 mb. There is not much difference in terms of monthly average. The maximum and minimum atmospheric pressures exhibit the similar trend. The following table shows the atmospheric data during the period from 1978 through 2008 as observed by the Can Tho Observatory.

Table 3.3.3.1.12 Atmospheric pressure (mb) at the Can Tho station (1978 - 2008)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Pave	1011	1011	1010	1009	1008	1008	1008	1008	1008	1009	1010	1011	1009
Pmax	1018	1017	1019	1014	1012	1013	1013	1014	1014	1015	1016	1017	1019
Pmin	1005	1004	1003	1003	1004	1003	1003	1000	1001	1004	1004	1005	1000

In which:
Pave : Average atmospheric pressure (mb);
Pmax : Maximum atmospheric pressure (mb);
Pmin : Minimum air pressure (mb);

3.3.3.2 Hydrological condition

(1) Characteristic of river flow

The Hau Giang Province constitutes a river/canal system spanning 2,300 km. The fluctuation in the tide level of the Haw River is characterized by much river flow under the influence of flood and tide level. The South China Sea is characterized by two fluctuations in tide level every day on an irregular basis.

During the dry season from December through June, this place is affected by the tide level in the South China Sea. In the rainy season from July through November, this site is placed under the influence of the water level in the Mekong River. Synchronously with the flood and tide level, the river flow fluctuates.

(2) Tidal characteristic

The water level of the Haw River in Can Tho and the area on the periphery of the site is clearly affected by the tide level. A peak water level occurs twice a day.

The average minimum water level occurs in May, and the average maximum water level occurs in October and November. The following table shows the river water level mode on the periphery of the site and the maximum water level data in the rainy season.

Table 3.3.3.2.1 Water level at Can Tho gauging station, period of 1977-2008 (cm)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Have	34	22	11	1	-6	-3	17	36	59	78	72	52	31
Hmax	159	152	151	132	135	134	153	169	189	203	199	179	203
Hmin	-142	-151	-157	-162	-175	-173	-164	-124	-92	-60	-63	-112	-175
Margin	301	303	308	294	310	307	317	293	281	263	262	291	378

* Note: Water level in this report followed the Hon Dau elevation system – in Hai Phong.

In which:

Haver. : Average water level (cm);

Hmax : Maximum water level (cm);

Hmin : Minimum water level (cm);

Table 3.3.3.2.2 Maximum water level per hour (flood season) at Can Tho station 1997-2008 (cm)

October								
Year/Hour	4	5	6	7	17	18	19	20
1997	172	178				176	175	160
1998	154	163	163			167	159	156
1999	175	176	176		176	179	177	166
2000	171	170	171				171	170
2001	189	190				188	183	166
2002	181	193	195				195	187
2003	180	181			181	180	171	166
2004	185	188				189	183	175
2005	192	193			194	186	169	154
2006	185	191	195			192	189	180
2007	188	197	197		198	200	201	
2008		188	198	189		197	200	198
November								
Year/Hour	4	5	6	7	17	18	19	20
1997	158				165	184	181	176
1998	149	153					153	149
1999	174					172	171	161

2000	165	170	170			171	173	166
2001	183					177	173	159
2002	180	185	177		185	186	179	173
2003	165	167					155	154
2004	158					151	149	146
2005	162	167				172	170	166
2006	199				197	192	180	168
2007		188	185	179		197	200	198
2008		187	191	188		193	187	189

(3) Regional flooded properties

The following table shows the design water level of average, maximum, and minimum at Can Tho station.

Table 3.3.3.2.3 Designed average annual water level at Can Tho station, Unit : (cm)

P(%)	0.5	1	2	4	5	10	20	25	Period
Hbq.p	60	57	54	51	49	44	40	38	1977-2008
N(year)	200	100	50	25	20	10	5	4	
P(%)	50	75	80	85	90	95	97	99	Period
Hbq.p	31	24	22	21	18	15	13	9	1977-2008
N(year)	2	1.3	1.25	1.18	1.11	1.05	1.03	1.01	
P(%)	0.5	1.	2	4	5	10	20	25	Period
Hbq.p	61	58	56	55	53	50	46	45	1994-2008
N(year)	200	100	50	25	20	10	5	4	
P(%)	50	75	80	85	90	95	97	99	Period
Hbq.p	40	35	34	32	30	28	26	23	1994-2008
N(year)	2	1.3	1.25	1.18	1.11	1.05	1.03	1.01	

Table 3.3.3.2.4 Maximum Designed Hmax maximum water level at Can Tho station, Unit : (cm)

P(%)	0.5	1	2	4	5	10	20	25	Period
Hmax.p	230	223	215	210	204	196	186	182	1977-2008
N(year)	200	100	50	25	20	10	5	4	
P(%)	50	75	80	85	90	95	97	99	Period
Hmax.p	170	159	156	154	150	146	143	139	1977-2008
N(year)	2	1.3	1.25	1.18	1.11	1.05	1.03	1.01	
P(%)	0.5	1.	2	4	5	10	20	25	Period
Hmax.p	229	224	219	215	211	204	197	197	1994-2008
N(year)	200	100	50	25	20	10	5	4	
P(%)	50	75	80	85	90	95	97	99	Period
Hmax.p	184	174	172	170	167	163	160	155	1994-2008
N(year)	2	1.3	1.25	1.18	1.11	1.05	1.03	1.01	

Table 3.3.3.2.5 Minimum Designed Hmin minimum water level at Can Tho station, Unit : (cm)

P(%)	0.5	1	2	4	5	10	20	25	Period
Hmin.p	-89	-96	-103	-108	-113	-122	-132	-135	1977-2008
N(year)	200	100	50	25	20	10	5	4	
P(%)	50	75	80	85	90	95	97	99	Period
Hmin.p	-148	-159	-162	-165	-168	-173	-176	-181	1977-2008
N(year)	2	1.3	1.25	1.18	1.11	1.05	1.03	1.01	
P(%)	0.5	1.	2	4	5	10	20	25	Period
Hmin.p	-83	-90	-97	-101	-106	-114	-122	-124	1994-2008
N(year)	200	100	50	25	20	10	5	4	
P(%)	50	75	80	85	90	95	97	99	Period
Hmin.p	-134	-141	-142	-144	-145	-147	-148	-150	1994-2008
N(year)	2	1.3	1.25	1.18	1.11	1.05	1.03	1.01	

In which
Hbq.p : Average annual water level (cm);
Hmax.p: Maximum designed water level (cm);
Hmin.p : Minimum designed water (cm)
N : repeated cycle (year);

(4) Designed water level at Song Hau 1 position
Designed water level at Song Hau 1 recorded according to the documents of Can Tho station. The result as following:

HSongHau 1 = (HCan Tho - 47.546)/0.8642 (cm)

Relational coefficient: R = 0.9668 ;

Table 3.3.3.2.6 Designed average annual water level at Song Hau 1 Power plant : (cm)

P(%)	0.5	1	2	4	5	10	20	25	Period
Hbq.p	61	58	56	55	53	50	46	45	1994-2008
N(year)	200	100	50	25	20	10	5	4	
P(%)	50	75	80	85	90	95	97	99	Period
Hbq.p	40	35	34	32	30	28	26	23	1994-2008
N(year)	2	1.3	1.25	1.18	1.11	1.05	1.03	1.01	

Table 3.3.3.2.7 Designed Hmax at Song Hau 1 Power plant : (cm)

P(%)	0.5	1	2	4	5	10	20	25	Period
Hbq.p	229	224	219	215	211	204	197	194	1994-2008
N(year)	200	100	50	25	20	10	5	4	
P(%)	50	75	80	85	90	95	97	99	Period
Hbq.p	184	174	172	170	167	163	160	155	1994-2008
N(year)	2	1.3	1.25	1.18	1.11	1.05	1.03	1.01	

Table 3.3.3.2.8 Designed Hmin at Song Hau 1 Power plant : (cm)

P(%)	0.5	1	2	4	5	10	20	25	Period
Hbq.p	-89	-96	-103	-108	-113	-122	-132	-135	1977-2008
N(year)	200	100	50	25	20	10	5	4	
P(%)	50	75	80	85	90	95	97	99	Period
Hbq.p	-148	-159	-162	-165	-168	-173	-176	-181	1977-2008
N(year)	2	1.3	1.25	1.18	1.11	1.05	1.03	1.01	

In which
Hbq.p : Average annual water level (cm);
Hmax.p: Maximum designed water level (cm);
Hmin.p : Minimum designed water (cm)
N : repeated cycle (year);

(5) Water river temperature

According to data at Can Tho weather station recorded from 1978 to 2008 showed:

- Minimum water temperature is December: 22.7oC
- Maximum water temperature is May: 33.1 oC
- Average water temperature is 29.3 oC

Table 3.3.3.2.9 River water temperature characteristics at Can Tho weather station (1978-2008, Unit: °C)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Ave tem.	28.2	28.5	29.4	30.4	30.7	30.3	29.6	29.0	29.3	29.5	29.1	28.2	29.3
Max tem.	32.0	32.4	32.0	32.8	33.1	32.7	32.2	32.0	32.0	31.9	31.9	31.8	33.1
Min tem.	25.2	25.7	26.5	27.7	27.6	27.2	25.9	26.0	26.9	27.0	22.8	22.7	22.7

(6) River flow

The site is located only 12 km from the Haw River estuary. Due to the short distance, there is no need of worrying about the impact of flood. There is no observatory at the site. The following table shows the flow of the Haw River at the Can Tho Observatory during the period from 1997 to 2008.

Table 3.3.3.2.10 Water flow at Can Tho station, period 1997-2008, Unit: (m3/s).

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Ave	3618	2215	1376	1096	1622	3754	7001	11215	13453	12431	9381	5769	6077
Max-down	16200	15500	15100	13600	15200	15700	21000	23200	24000	22200	20400	18400	24000
Max-up.	-12300	-13800	-15300	-15500	-15700	-12600	-11600	-7450	-5610	-5490	-9740	-11400	-15700

The river flow changes the direction four times a day. The annual average flow rate at the Can Tho Observatory is 2.02 m/s in terms of downstream flow, and -1.26 m/s in terms of upstream flow

Table 3.3.3.2.11 Water flow velocity at Can Tho station, period 1997-2008, Unit: (m/s).

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Max-down	1.35	1.25	1.2	1.31	1.3	1.36	1.75	1.89	1.99	2.02	1.58	1.41	2.02
Max-up	-1.02	-1.13	-1.18	-1.23	-1.26	-1.13	-0.94	-0.8	-0.4	-0.38	-0.68	-1.02	-1.26

(7) SEDIMENT

The site is affected by the tide level. The river bed has a slight inclination, and the river flow is not very fast. So the annual sediment around the site has a serious impact. Although there is not sediment observatory in the vicinity, the Chau Doc Observatory is located approximately 115 km upstream of the site. The following table shows the data having been measured in this Observatory since 1996.

Table 3.3.3.12 Suspended sediment content (g/m3) at Chau Doc (1996 – 2007)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ave						140	188	194	137	74	61	65
Max						226	452	1317	1000	187	155	90
Min						79	82	54	39	21	33	45

Notes: Sediment not measured from Jannuary to May

(8) Historical Flood

Flood trace 1 (VL-01) near the flushing gate area, investigated in the population at N_O 69, Phu Xuan hamlet, Phu Huu A commune, time maintaining flood about 1 hour.

Flood trace 2 (VL-02) between two the flushing gate areas and the intake area, investigated in the population at N_O 163, Phu Binh hamlet, Phu Huu A commune.

Flood trace 3 (VL-03) at the intake, investigated in the population at N_O 151, Phu Binh hamlet, Phu Huu A commune.

All three flood traces were linked from elevation bench mark of grade IV (State bench mark).

Table 3.3.3.2.13 Investigating water level of flood peak in areas of thermal power plant Song Hau 1

N^0	Elevations (m)	appearing time	Locations
VL-01	2,254	Super typhoon No.5 in 1997	Flushing gate area
VL-02	2,233	1997/11	
VL-03	2,208	Year 1997	Intake area

3.3.3.3 Geological condition

(1) Seismic condition

The site is located close to a fault which in slightly subjected to the influence of the Haw River. This fault runs 450 km from northwest to southeast at a depth of 15 through 20 kilometer. The sliding runs in the north-south direction. This fault was very active in the Caenozoic Era. An earthquake of magnitude 4.8 with its epicenter at a depth of h=15 km with Io = 6(MSK64) was recorded in October 1, 1964. Another earthquake of magnitude 4.4 with its epicenter at a depth of h=15 km with Io = 5-6(MSK-64), was recorded in September 21, 1969. They are reported to have been caused by faults.

According to the Vietnamese local bedrock acceleration distribution based on the TCXDVN 375:2006, the bedrock acceleration speed in the area of Chau Thanh, Hau Giang Province is R = 0.0456 g.

(2) Sedimentation and erosion

According to the result of bathymetric survey in the area of harbor facilities, the river bed in front of the power plant forms a steep slope caused by river erosion. On the other side of the river, however, the slope is gradual due to the sediment.

(3) Subsidence and uneven subsidence

Ground conditions surrounding the site are very soft. The layer of mud and clay located at the surface layer is soft in particular. This requires consideration to be given to the differential settlement due to ground settlement and loading in the designing phase.

(4) Construction material corrosion due to salt water
According to the result of underground water survey conducted at the time of boring survey, a weak reaction was recorded for alkali corrosion and carbon corrosion. This does not require particular consideration at the time of construction work.

(5) Soil layer condition
The Song Hau 1 Coal-fired Thermal Power Plant area is based on an almost flat ground. Judging from the 200,000:1 scale topographic map of the An Bien -Soc Trang (C-48-XXII) area, on-the-spot survey, geographical survey and the result of the test, the stratum structure from the surface of the site area to a depth of 100 meters is very simple, and is made up of the sediments of Holocene Epoch (amQIV) and Pleistocene Epoch (amQIII). The stratum classification is given below:

Table 3.3.3.3.1 Syatum classification by borling survey result

		Layer1	Layer 2	Layer 3	Layer 4
Moisture	W (%)	59.33	33.36	29.22	
Density	γ w (g/cm^3)	1.594	1.809	1.864	
Unit weight	ρ (g/cm^3)	2.71	2.72	2.72	
Void ratio	ε_0	1.714	1.254	0.905	
Plasticity	B	0.99	0.53	0.35	
Cohension	C (kg/cm^2)	0.07	0.35	0.31	
Anngle of internal friction	ϕ_0	4° 26’	15° 02’	14° 59’	
Compression cofficient	a1-2 (kg/cm^2)	0.152	0.074	0.027	
Module of elasticity	E1-2 (kg/cm^2)	18.4	55.0	75.4	
SPT	N_{30}	<1	12	20	>70

3.4 Current Site condition

The following describes the current situation of the planned site for construction of the Song Hau 1 Coal-fired thermal power plant at the time of the first local survey: Except for the common discharge channel area and part of the planned construction area for the Song Hau 1 Coal-fired Thermal Power Plant ash disposal site, deforestation and relocation of the agricultural land and inhabitants have been completed in almost all the relevant area. The land preparation work for creating a land level suited for formation of a power plant will be completed in the first half of this fiscal year. Similarly, the land preparation and infrastructural upgrading and development subsequent to relocation of the inhabitants have been almost completed. The fill-up ground used for land preparation is made up of the material sampled from the Haw River approximately 80 km upstream of the site. The local status is shown in the Photo.

Photo 3.4.1 Song Hay 1 site (from Nam Song Hau Road)

Photo 3.4.2 Song Hau 1 site (Information board)

Photo 3.4.3 Song Hau 1 site (from south-west end of Power plant area)

Photo 3.4.4 Song Hau 1 site (from nouth-east end of coal strage area)

Photo 3.4.5 Steel pipe of Embankment material for Soil preparation work

Photo 3.4.6 Hau River (in front of Song Hau 1 site)

Chapter 4 Basic Design of the Power Plant

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Chapter 4 Basic Design of the Power Plant

4.1 Outline of the Project

This project is intended for preparing the Song Hau 1 coal fired power plant, which is planned to be constructed in the Chau Thanh district of the Hau Giang province in the south of Vietnam, the terminal for imported coal, which is an infrastructure around the coal fired power plant, and power transmission lines.
The place at which the power plant is planned to be constructed is the Phu Huu A commune in the Chau Thanh district of the Hau Giang province, which is about 180 km away from Ho Chi Minh City toward the south and about 12 km away from Can Tho City toward the south. This place is located beside the Hau River, about 66 km away from the Dinh An mouth. Song Hau power complex with a total output of 5,200 MW is planned to be constructed at this location.
Song Hau power complex is divided into three phases: the Song Hau 1 coal fired power plant (Phase1: 600 MW × 2 units), which is investigated in this project, the Song Hau 2 coal fired power plant (Phase2: 1,000 MW × 2 units), which is not investigated in this project, and the Song Hau 3 coal fired power plant (Phase3: 1,000 MW × 2 units), which is also not investigated in this project.
At the Song Hau 1 coal fired power plant, the use of a super critical power plant is planned with the aim of more efficient power generation.
Coal used as fuel is coal imported from Indonesia or Australia, which will be carried with vessels in the 3,000 DWT class to 10,000 DWT class by passing through a new channel under construction and Hau River through the coal terminal planned in this project.

4.2 Scope of Works

The scope of works of Song Hau1 coal fired power plant (600 MW x 2) is as follows.

(1) Boiler and auxiliaries

(2) Environmental protection facilities

(3) Steam turbine and auxiliaries

(4) BOP
- Fuel and ash handling system
- Limestone and gypsum handling system
- Compressed air supply system
- Hydrogen generation system
- Cooling water system
- Water treatment system, waste water treatment system
- Fire protection system

(5) Electrical equipment
- Generator and auxiliaries
- Transformers

(6) Instrumentation and control equipment

(7) Civil and structure facilities
- Site clearance
- Foundations
- Buildings
- Roads
- Drainage

(8) Harbor facilities
- Coal unloading berth
- Limestone unloading berth
- Gypsum loading berth
- Ash loading berth
- Oil unloading berth
- Materials and equipment unloading berth

(9) Others
- Temporary buildings

4.3 Plot Plan

Figure 4.3.1 shows the plot plan of Song Hau 1 coal fired power plant, the berths for ships locate on right bank of Hau river, toward the South-West, Coal Storage Yard, Main Power plant area, 220kV Sub-station are located. The ash pond area is located between power plant and the cooling water discharge channel.

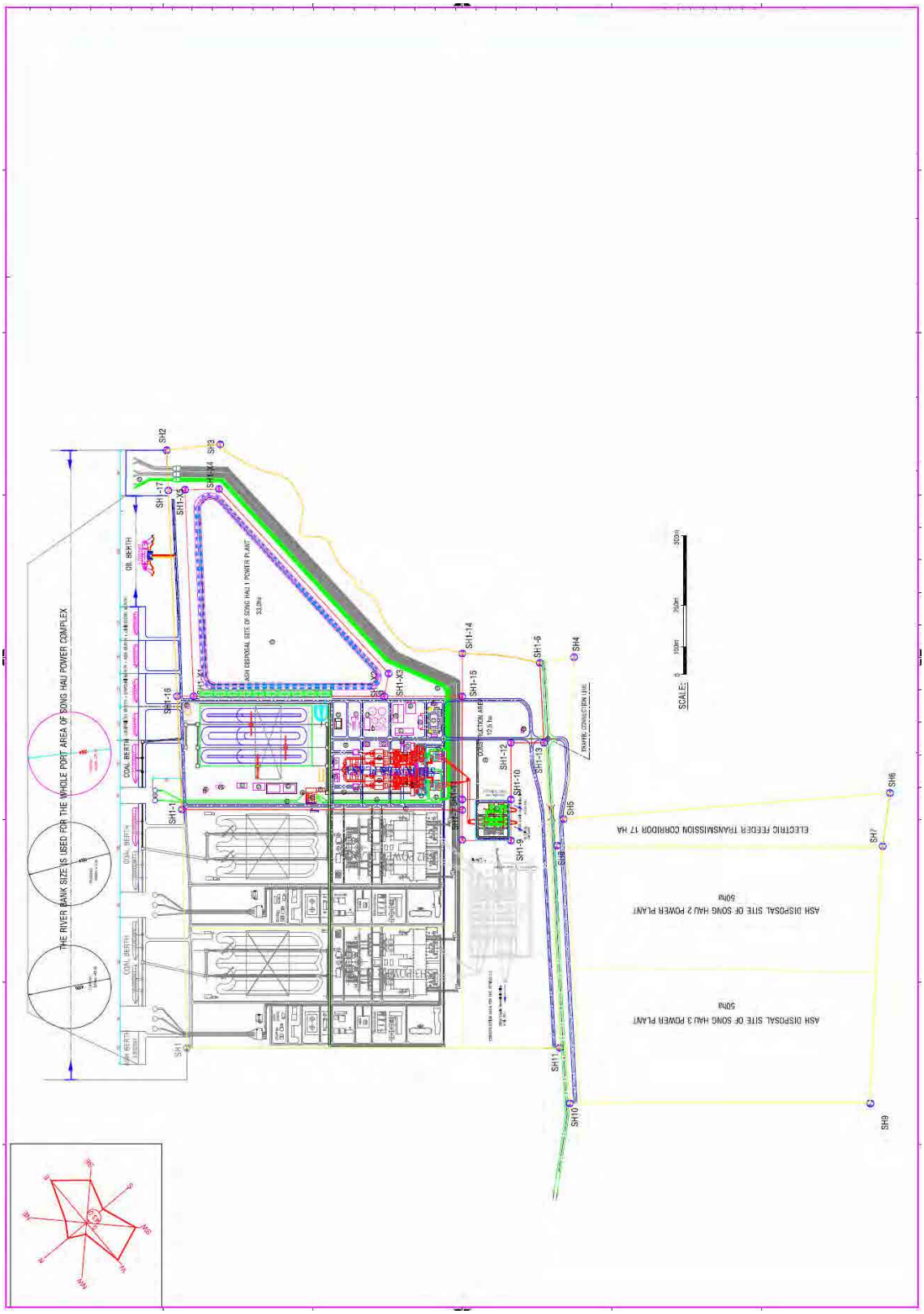


Figure 4.3.1 Plat plan

4.4 Plant Design Considerations

4.4.1 Boiler and Auxiliary Equipment

4.4.1.1 Selection of boiler technology and heat cycle

(1) Basic principles in selection of technology
The following basic principles are proposed in analyzing and selecting technology for the main equipment:

- The technology must be suitable to the imported steam coal that is bituminous coal.
- The technology must have efficiency high enough to attain economic effectiveness compared with the investment cost and the imported coal price.
- The technology must ensure the environmental requirements according to the Standard of Vietnam.
- The technology must prove to have high reliability and economical operation through practical operation in the world or in the country.
- The technology must support to make the most of ash becoming additive for cement, construction material in order to increase economical effectiveness for the project, reduce pollution and investment cost because large quantity of ash must be stored.

(2) Selection of coal combustion technology
Power plants using pulverized coal fired boiler with unit generation capacity of 600MW or more have been proved through practical operation about their reliability, sustainability and economical effectiveness.
On the other hand, power plants using fluidized bed boiler have not been practically verified at the unit capacity of 600MW. Fluidized bed boiler has superiority only for low quality fuel such as coal with low volatile matter, high sulfur content, and low heat value.
The source of coal used for Song Hau 1 Power Plant is imported coal with high quality, so it will be favorably and economically operating with pulverized coal fired boiler.
On this basis, it is recommended to select pulverized coal fired boiler for Song Hau 1 Power Plant.

Coal used is type of high or medium content of volatile matter, therefore selected firing system is direct firing system thanks to its operational flexibility and low investment cost. In the direct firing system, coal is supplied from the coal bunker via the coal feeder to the coal mill. From the coal mill, coal is transferred directly to the burner without the transfer bunker as in the indirect firing system.
The firing system is capable of supplying heat input at boiler maximum continuous rating (BMCR) with coal, and 30% of the boiler rated load with oil. The firing system comprises: coal bunkers & feeders, coal mills, pulverized coal piping system, coal burners, oil ignition system,

The firing system comprising low NOx burners, over fire air ports and bowl type coal pulverizers is designed for the specified fuel with sufficient margines and ensuring low NOx emission as well as low emissions of unburned combustibles. Coal/oil burners are arranged at lower part of furnace in form of opposite firing firing. (Note: #3)

(Note) Sharp marks such as (#1) ~ (#7) show that these descriptions have connections with the comments attached in the last page of paragraph 4.4.2. The same note shall apply hereinafter.

(3) NOx reduction technology:
Song Hau 1 thermal power plant uses imported Bituminous coal with the volatile matter higher than 10%. According to the natinal technical regulation on emission of thermal power industry (QCVN 22: 2009/BTNMT), allowable NOx content in exhaust gas is 650 mg/Nm3. However, this value needs to be adjusted by the capacity coefficienct (Kp) and the regional coefficienct (Kp). Therefore, the allowable value adjusted for Song Hau 1 power plant is 455 mg/N-m^3 (#6). In case measures to reduce NOx are not applied such as fuel combustion system of the conventional boiler, NOx content can be in a range from 984mg/N-m^3 to 1,968mg/N-m^3. Therefore, it is necessary to take measures to reduce NOx content in exhaust gas.

To increase NOx reduction efficiency, low NOx combustion technology i.e. low NOx burners and two-stage firing (over fire air ports) are often combined with in a pulverized coal fired boiler. Finally, de-NOx efficiency of these technologies can reach 65% to 80% as comparing with not applying NOx reducing technologies, equivalent to NOx emission from 394 mg/N-m3 to 689 mg N-m3 with coal having 25% to 45% volatile matter.

The exthaust gas dispersion calculation of the Song Hau power complex of 5,200MW shows that, though the power plants in the power complex are assumed to apply low NOx combustion technology and satisfy the flue gas emission regulation (QCVN 22: 2009/BTNMT), since total capacity of the power plants in the power complex is high, therefore NOx content in the exthaust gas still does not satisfy the ambient air quality regulation (QCVN 05:2009/BTNMT). Therefore, in the Song Hau power complex, the low NOx combustion technology (Low NOx burners and over fire air ports) as well as the installation of Selective Catalytic NOx Reduction system (SCR) shall be applied to meet the environmental regulations.

However, according to calculation of NOx emission during operation phase of the 2x600MW Song Hau 1 only (presented in detail in the EIA of the Song Hau 1 power plant project), in this phase, the Song Hau 1 power plant will not install the SCR, because in this phase, total capacity of the power complex is not high, NOx content in atomosferic air at the ground level satisfies the requirement of QCVN 05:2009/BTNMT(0.2µg/m3 for 1 hour, 0.1µg/m3 for 24 hours). The installation of SCR will be considered in developing Song Hau 2 and Song Hau 3 power plants. (#6)

(4) Selection of steam conditions (parameters)
Presently in the world there are 2 popular thermal power Unit technologies based on steam conditions used: sub-critical pressure steam plant and supercritical pressure steam plant.
Furthermore, there are 3 types of boiler water and steam side design widely used in the world for pulverized coal fired thermal power plant: natural circulation boiler, forced circulation boiler and once - through boiler.
In steam thermal power technology, the higher the steam pressure and temperature, the higher the Unit output is. However, the increase in steam pressure and temperature also makes investment cost increase. Therefore, selection of steam conditions should be taken into consideration.
Economic benefits are compared between supercritical and subcritical power plants in condition of fuel price of 80 USD/T for coal with high calorific value of 6,200kcal/kg. The result shows that:

- Although investment cost is higher, because the present fuel price increases high, the advantage of efficiency is superior to investment cost. Therefore, solution of supercritical pressure power plant is more profitable.
- The present trend of power production in the world is to increase efficiency to compensate for the trend of increasing fuel price; and at the same time to reduce

exthaust gas emission for the purpose of environmental protection.

- Steam parameter that is proposed to select is supercritical pressure, corresponding to this steam pressure, only once - through boiler is suitable. It is recommended to select supercritical steam once - through boiler with the following technical characteristics:
  + Steam pressure : 250 bar - 285 bar (#2)
  + Main steam temperature : 540°C - 600°C (#2)
  + Reheated steam temperature : 560°C - 600°C (#2)

4.4.1.2 Major specifications of boiler and auxiliary equipment

(1) Overview

Song Hau 1 Power Plant is the first power plant of Song Hau Power Complex and consists of two thermal power generation units having rated power output of 2 x 600MW.

Each unit is designed with one boiler; each boiler includes auxiliary equipment and systems as follows:

- Boiler proper
- Supporting structural steel (boiler frame, rail, stair)
- Air heater
- Pulverized coal firing system
- Distillate oil (DO) firing system
- Combustion air & flue gas system
- Electrostatic precipitator
- Flue gas desulfurization system
- Flue gas denitrification system
- Auxiliary boiler (one set for 2 units)
- Chemicals supply and dosing system
- Sampling system
- Nitrogen sealing system
- Soot blowing system
- Bottom ash & fly ash removal system
- Hoists, crane & elevator

(2) Boiler major specifications

Boilers selected for Song Hau 1 Power Plant are pulverized coal fired supercritical pressure once-throu boilers. The boilers are designed to use bituminous coals imported from Indonesia or Australia. In order to be suited to various types of coal imported from the international market, the boiler must be designed according to the coal range large enough to the easily suited to the type of coal available in the market. (#1)

Song Hau 1 PP will be designed according to block diagram including 02 Units. Each Unit includes 01 boiler and 01 steam turbine, rated power output of each Unit is 600MW.

Basic characteristics of the boilers are as follows:

- Type of boiler : Radiant reheat, supercritical variable pressure once - through boiler, outdoor type with roof
- Quantity : 02 boilers
- Main steam system:
  + Main steam flow at BMCR : 1,750T/h - 1,900T/h
  + Minimum once-through flow : 25%
  + Main steam pressure at BMCR : 250 bar - 280 bar (abs) (#2)
  + Main steam temperature at BMCR : 540°C - 600°C (#2)

- Reheat system:
  + Reheat steam flow at BMCR : 1,500T/h - 1,590T/h
  + Reheater outlet steam pressure at BMCR : 55-60 bar (abs)
  + Reheater outlet steam temperature at BMCR : 560-600°C (#2)
- Feed water temperature at BMCR : 275°C - 318°C
- Fuel:
  + Main Fuel : Bituminous coal (#1)
  + Ignition and support fuel : Distillate oil (30%)
- Firing System : Pulverized coal direct firing with pressurized mills, and Low NOx burners with OFA ports
- Drafting system : Balanced draft system
- Primary air system : Cold primary air system
- Water separator drain recovery system for unit start and low load operation : Boiler water circulation pump system
- Steam temperature control method:
  + Main steam temperature control : Feed water /fuel flow ratio and spray
  + Reheat steam temperature control : Flue gas distribution damper, gas recirculation (#5), and spray for emergency
- Minimum boiler output with coal firing : 30%
- Maximum boiler output with support oil firing : 30%
- Designed coal:
  + Coal type (ASTM Coal Rank) : High volatile C Bituminous (#1)
  + High heat value (adb) : 5,500 - 6,100 kcal/kg (adb)
  + Inherent Moisture (adb) : 10 - 14%
  + Ash content (adb) : 10 - 15%
  + Volatile Matter (adb) : 25 - 42%
  + Sulfur (adb) : 0.5 - 0.8%
  + Grindability (HGI) : 45 - 50

(3) Specifications of Boiler and Axiliaty Equipment

a. Boiler proper

Boiler is of supercritical once - through Benson type, two pass boiler (or also called two separate flue gas paths).

Evaporator is designed with vertical tube configuration using internally ribbed tubes (#3). The evaporator design configuration simplifies manufacturing and installation as well as ensures flexible operation thank to reducing minimum load. Moreover, Benson boiler with the vertical tube evaporator may use coals with wide coal range without being limited in operation.

The boiler is designed with start-up and low load operation system. The steam - water separator is arranged at downstream side of the evaporator. Separated water at low load operation is running into the water collecting vessel, from here water is pumped back to the economizer.

The boiler is installed with superheater and reheater of tube bundle type heat exchangers. Superheater is divided into 3 stages and reheater two stages and the both systems are arranged in 2 trains to eliminate steam temperature differences at the outlet of the systems.

The boiler is designed in two pass configuration. Superheater and reheater located in the high flue gas temperature area such as the furnace upper area and the horizontal flue gas pass are of

pendant type heat exchangers, and those located in the rear flue gas pass area, where the gas flow is down flow, are of horizontal type heat exchangers. The economizer is arranged at the end of the second gas pass.

The boiler is designed with the coal firing system, including low NOx burners and a medium speed bowl mill. The coal firing system is designed for a definite coal range with a margin large enough to ensure generating low NOx as well as low boiler loss due to unburned carbon. Coal / oil burners are installed on the lower part of the furnace and arranged in opposite firing configuration. (#4)

In order to meet the requirement of start - up and low load operation, the boiler is designed with the DO firing system. Oil burner is arranged at the center of the coal burner.

In order to discharge bottom ash, an ash extraction and grinder system is supplied. The ash extraction system combines advantage of ash extraction without consuming water as well as good quality ash that may be reused.

The boiler is designed for outdoor installation, with weather cover for the boiler top, roof for coal bunker, covering part for coal tripper and burners area.

i) Evaporator

Evaporator design with vertical tube configuration using internally ribbed tubes simplifies manufacturing and installation as well as ensures flexible operation thank to reducing minimum load.
The selected evaporator configuration is the vertical tube configuration. (#3) The spiral tube configuration solution is accepted as a competitive solution.

ii) Furnace water – walls

The evaporator of once - through Benson boiler includes water - walls made of internally ribbed vertical tubes arranged in the flame area of the furnace; water - walls are made of smooth tubes arranged in the heat radiation area above the furnace and in the convection heat area.

iii) Water / steam separator

The boiler is designed with start-up and low load operation system. The steam - water separator is arranged at downstream side of the evaporator. Separated water at low load operation is running into the water collecting vessel, from here water is pumped back to the economizer.

iv) Superheater

Behind the evaporator, the superheater is arranged on the horizontal pass and the second rear pass. The superheater is divided into 3 stages and separated into 2 parallel branches in order to balance the temperature difference in flue gas through the boiler section.

v) Reheater

The reheater is in form of absorbing convection heat and combined absorbing of convection and radiant heat. Tubes are in form of horizontal and suspended tube bundles. In order to optimize steam reheating, steam from turbine will enter into the horizontal tube bundle before passing through the suspended tube bundles arranged on the horizontal flue pass at rear of the final superheater stage in the flue pass direction. Like the header connected to the cold reheat steam pipe, 2 reheat headers is connected to the steam pipe of IP turbine.

vi) Economizer

In order to increase capacity of transferring heat to feed water, the economizer is designed with finned tubes. The fins are vertical on the tubes, but no spirally finned tubes.

vii) Steam temperature control

- Superheater temperature control

The system includes 2 spray attemperator stages designed for the superheater temperature control. The first spray attemperator stage is installed at the downstream side of the first superheater stage. The second spray attemperator stage is installed at the upstream side of the final superheater stage. Each spray attemperator system includes 2 attemperators, each for 01 branch of steam pipe (superheater or reheat has 2 parallel branches).

The first attemperator stage is operating as a preliminary temperature control to maintain the temperature of steam entering into the final superheater stage not exceeding the allowable range, and the second spray attemperator finally controls the temperature of steam leaving the final stage superheater at the rated level. The spray attemperator stage is designed so that water spray must completely vapored before steam entering into the following pass.

- Reheater temperature control

Reheat temperature control solution normally proposed to select is spray attemperation due to its operational reliability, quick response and low maintenance cost. However, the boiler efficiency lightly reduces when using feed water for spray attemperation. The temperature control solution by flue gas recirculator or damper combined with spray attemperation is accepted as the competitive scheme (#5).

b. Coal firing system

Coal used is of medium or high volatile coal (#1), so the coal firing system selected is the direct firing system due to its operational flexibility and low investment cost.

The coal firing system includes:

- Coal bunkers and feeders
- Coal mills
- Pulverized coal / air mixture pipe
- Coal burners
- Oil ignition system

The quantity of coal mills is five (5) or six (6) including one (1) stand-by mill depending on the boiler manufacturer. All mills excluding a stand-by mill will supply enough coal for the boiler to operate at the boiler maximum continuous rating. In case firing the worst coal, stand-by mill may be put into operation to meet the requirement.

The quantity of coal bunkers is same as of coal mills. The capacity of coal bunkers is designed so that the boiler can operate for 12 hours at BMCR without using a stand-by bunker.

The burner is designed according to the form of opposite firing and arranged under the furnace, in front and at rear of the boiler. (#4) Three stages of burners are arranged in front of the boiler, and 2 stages in rear of the boiler. Each burner stage is connected to one certain coal mill.

Each boiler has light oil burners installed at the coal burner center. In order to meet the requirement of starting and low load operation, oil ignition system capacity is selected at the level of 30% BMCR.

Light oil atomization is performed by mechanical method (injection pump and atomizer). (#7)

c. Combustion air and flue gas system

Combustion air and flue gas system is designed as 2 parallel trains and based on balanced draft furnace.

The system includes:

- Combustion air system
- Flue gas system
- Sealing & cooling air system

d. Soot blowing system

When slag and ash are deposited on the steam generator tubes and walls, that normally reduces heat exchanging capacity of the steam generator as well as causes the head loss of the flue gas system. In addition long slagging on the upper part of the furnace may fall down, damaging lower equipment. In order to avoid the phenomena state above, furnace soot blowers are arranged at the following positions: the upper part of the furnace, horizontal flue pass, second flue pass, and air heaters.

- Short retractable furnace wall soot blowers
- Long retractable furnace wall soot blowers
- Long retractable soot blowers in superheater & reheater area.
- Long or semi-retractable soot blowers in economizer area
- Traveling lances for the air heaters
- Fixed nozzle soot blower for SCR.

e. Hoists, cranes, and elevators system

In order to serve maintenance and repair, hoists, cranes, and elevators are installed at the following positions:

- Forced draft fans, primary air fans, and induced draft fans,
- Coal pulverizer area,
- Air heater & SCR (if necessary)
- ESP,
- FGD eliminator.
- Each boiler is equipped with one elevator for man and materials.

f. Nitrogen sealing air system

During shutdown period, air in pressure areas of the boiler must be replaced by Nitrogen to avoid corrosion. Superheaters, reheaters and economizer are protected against corrosion by pressurized Nitrogen.

g. Auxiliary boiler

Since Song Hau 1 Power Plant is the first Power Plant in the Power Complex, one (1) set of auxiliary boiler is designed to supply auxiliary steam required for starting the Unit. The auxiliary boiler output must ensure sufficient steam to start one unit of the power plant. The auxiliary boiler is fired with DO.

h. Boiler supporting steel structure

Boiler supporting steel structure includes frame, steel pole, and auxiliary equipment, as well as enclosure part and boiler roof. Other structures such as hangers, supports are included in the boiler supporting steel structure.

Boiler supporting steel structure must be designed so that it can withstand its own dead load, the equipment weight, ducts load, enclosing wall load as well as dynamic load caused by wind,

operating equipment and earthquake.
In addition the boiler supporting steel structure also includes: operating platforms, walkways, stairs and handrails.

i. Chimney
The chimney is designed for 2 Units with separate smoke pipeline for each Unit. Flue gas leaving the electrostatic precipitator (ESP) with temperature of about 150°C is led into the gas-gas heat exchanger (GGH) before entering into the wet FGD. Smoke escapes from the FGD with low temperature (about 58°C), that will be raised to about 80°C thank to the GGH before entering into the chimney.
The selected chimney height is 200m to meet requirement of waste gas dispersion according to QCVN05: 2009/BTNMT.
The chimney includes reinforced concrete casing with function of covering, bearing load for 2 steel chimneys with internal diameter of 6,200mm for the smoke velocity of about 20m/s - 25m/s.

- 01 lightning - protection system designed according to IEC standard includes lightning rod, earth wire and grounding system.
- 01 aviation warning signal light system.
- 01 elevator used for maintenance with the load of about 500kg
- 01 waste gas inspection holes system.

4.4.2 Environmental Protection Facilities

(1) Overview
Flue gas from the air heaters shall be treated to meet the requirements of the Vietnum national environmental regulations.

Following equipments are expected to be installed for each unit of Song Hau 1 power plant:

- Electrostatic Precipitators (ESP) : 2 sets x 50% capacity
- Flue gas desulfurization system (FDG) : 1 set x 100% capacity
- Flue gas NOx reduction system : 2 sets x 50% capacity

As for the NOx reduction system, since the NOx emission during operation with the Song Hau 1 power station only satisfies the regulations by the low NOx combustion system (low NOx burners and over fire air), the NOx reduction system will not be installed. The installation of selective catalistic NOx reduction system will be considered as the Song Hau 2 power station and Song Hau 3 power staion to be put into operation.

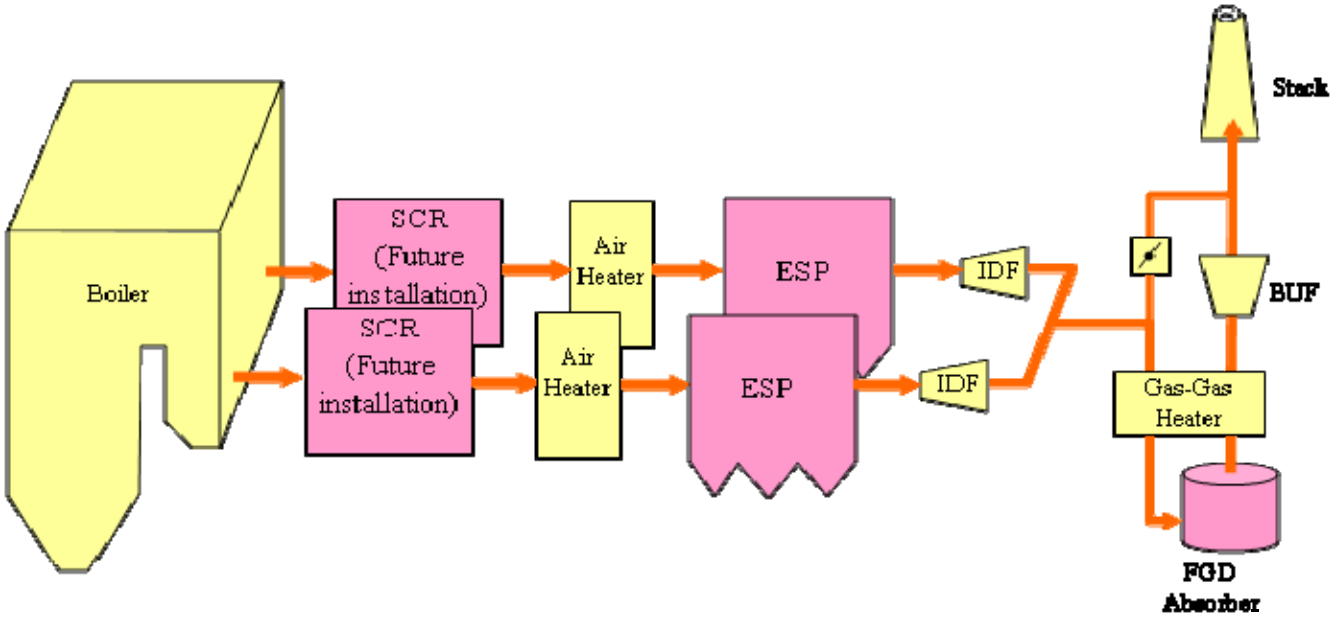


Figure 4.4.2.1 Outline of flue gas treatment system

(2) Electrostatic precipitator (ESP)
Combustion products in boiler blown to the stack include dusts. Normally, dust concentration in flue gas is in a range from 10,000 to 40,000 mg/Nm3 with particle size lower than 80 micron.
Based on national emission standards for thermal power industry (QCVN22: 2009/BTNMT), permissible dust emission value at the stack outlet shall be less than 140 mg/Nm3. Therefore, dust collection measure shall be installed.

Based on technical – economic analysis, electrostatic precipitator (ESP) is selected in Song Hau 1 thermal power plant, because this system has more advantages than others. This ESP is the most common and efficient dust collection system in coal-fired thermal power plants for its very high dust collecting efficiency of up to 99.9%. Particulate concentration in flue gas leaving ESP is less than 100mg/Nm3.

Technical specification of ESP system applied for Song Hau 1 thermal power plant is as follows:

- Type : Electrostatic Precipitator
- Quantity : 2sets x 50% capacity for each boiler
- Flue gas flow : 2,537,600kg/h for each boiler
- Inlet flue gas temperature : ~150ºC
- Efficiency : ≥ 99.0%

(3) Flue gas desulfurization system
Coal used in the power plant has sulphur content of 0.53~0.86%. With application of pulverized coal-fired boiler technology (PC), the calculated maximum SO_2 emission (in BMCR) is around 1,980 mg/Nm^3. But the permissible SO_2 emission value to be applied for the power plant is 510 mg/ Nm^3 in compliance with the natinal emission standards for thermal power industry

(QCVN22: 2009/BTNMT). Accordingly, the power plant must be equipped with FGD absorber in flue gas duct.
Based on economic and technical analysis, the Flue Gas Desulfurization (FGD) system of wet limestone type with a minimum efficiency of 80% will be selected for Song Hau 1 thermal power plant.
Flue gas emission from boiler will be taken into the SOx absorer, where sulphur oxide in the flue gas contacts with absorptive liquid, limestone slurry, and turns into calcium sulfate, then finally is oxidized in the system and separated from the system to become calcium sulphate, i.e. gypsum.
The absorption and oxidation reactions are described as follows:

$$CaCO_3 + SO_2 + 1/2H_2O = CaSO_3.1/2\ H_2O + CO_2$$

$$CaSO_3.1/2\ H_2O + 1/2\ O_2 + 3/2\ H_2O = CaSO_4.2\ H_2O$$

With the application of FGD as described above, maximum SO_2 concentration in flue gas of the power plant is 396 mg/Nm^3, in compliance with the permissible environmental standard value 510 mg/Nm^3 (QCVN22: 2009/BTNMT).
The gypsum of milky powder type is discharged to ash slurry discharging pump station. The plant is equipped with gypsum squeezing system to collect dry gypsum for selling.

(4) Denitrification system (SCR)
Coal to be supplied to the plant has nitrogen content of 1.14%. With the application of pulverized coal-fired boiler technology (PC), as calculated, the maximum NOx emission (at BMCR) is about 1760 mg/Nm3, when not applying NOx reducing measures in the coal combustion system. The permissible NOx content in compliance with QCVN22: 2009/BTNMT is 455 mg/Nm3. Accordingly, some measure is required to reduce NOx emission and ensure the environmental standard permissible to the power plant.

Low NOx combustion process mitigates NOx formation during pulverized coal firing by using low NOx burners, over fire air system, etc. These measures can ensure NOx concentration at 450 mg/Nm3 for coal having 35%-45% volatile matter and meet the pollutant emission regulation QCVN22: 2009/BTNMT without installation of de-NOx system (SCR).

However, in case capacity of the power plant is high, emission rate required is lower than the above mentioned standard to satisfy the ambient air quality standard QCVN 05:2009/BTNMT. Song Hau 1 Power Plant is located in Song Hau 1 Power Complex. The design output of the whole Song Hau 1 Power Complex is 5,200 MW which is the largest in Vietnam until the present time. Thus, the calculation and forecast of exhaust gas emission concentration of Song Hau 1 Power Plant has been considered and forecasted more the exhaust gas emission concentration to the environment in case that Song Hau 1 Power Center operates at a full output (3 Song Hau 1, 2 and 3 Power Plants operate at the same time) in order to ensure QCVN 05:2009/BTNMT.

According to the result of exhaust gas dispersion calculation, the following is recommended for exhaust gas treatment of Song Hau 1 Power Plant:

- When Song Hau 1 Power Plant only starts operation in Song Hau Power Center, Song Hau 1 Power Plant installs only the dust precipitator (ESP) with efficiency of 99% and SO_2 reduction system (FGD) with efficiency of 80%. NOx reduction system (SCR) is not installed, however, the air intake fan system, electrical system,

control system are designed and selected to provide for the subsequent stages after the installation of SCR.

- When Song Hau 2 Power Plant is installed, Song Hau 1 Power Plant shall install SCR with efficiency of 65% in addition to ESP with efficiency of 99% and FGD with efficiency of 80%. However, this SCR only operates with the treatment efficiency of 40% (together with Song Hau 2 Power Plant to operate the SCR system with the treatment efficiency of 40% by reducing Catalytic module and reducing volume of injected NH_3 compared to the treatment efficiency of 65%.
- When Song Hau 1, 2, and 3 Power Plants operate, 3 power plants shall operate ESP with efficiency of 99%, FGD with efficiency of 80% and SCR with efficiency of 65% to meet the environmental code QCVN 22:2009/BTNMT at the chimney mouth and QCVN 05:2009/BTNMT on surrounding air quality.

Comment on FS report of boilers and auxiliary equipment and environmental protection facilities

The above descriptions in paragraph 4.4.1 and 4.4.2 provide overviews of the Construction Investment Report prepared by PECC3 on the 2 x 600MW-boilers and auxiliary equipment and environmental protection facilities in Song Hau 1 Coal Fired Thermal Power Plant (hereinafter refer to as "FS report").
Each program for facilities has been studied in an appropriate manner in conformance to the siting conditions of the Song Hau 1 Thermal Power Plant based on the performances of the state-of-the-art, world-class coal-fired boiler for power generation. The specifications on individual equipment have been selected appropriately and in details in this FS report.

Before starting the engineering stage for determining the specifications for the coming bid, the following describes some hints and suggestions regarding the supercritical pressure pulverized coal fired once-through boiler to be adopted in Song Hau 1 Power Plant, based on the experience of the field-proven Japanese thermal power plants:

- Coal properties
- Steam conditions on power generation facilities (boiler and turbine generator)
- Boiler furnace wall tube
- Boiler combustion method
- Reheat steam temperature control method
- Denitrification facility (SCR)
- Light oil burner atomizing method

(1) Coal properties

a. Design coal properties

From the FS report, boilers and auxiliary equipment for Song Hau 1 Power Plant will be designed to use bituminous coals imported from Indonesia and Australia. On the other hand, the boilers are requested to be designed according to the various types of coals available in the international market.
There are various kinds of pulverized coal fired boilers from anthracite and lignite; however, there is no boiler which can use the all kinds of coals. A bituminous coal fired boiler should be used with only bituminous coal, a subbituminous coal fired boiler with only subbituminous coal, and a lignite fired boiler with only lignite. Unless otherwise, the boiler may not be operated normally due to troubles with abnormal high or low steam temperature, slugging in furnace and fouling in rear gass pass heat exchangers.
Unless specific properties are proposed by the party in charge of procuring coal, there is no way for a boiler manufacturer to take any action. Accordingly, ten Japanese power utilities importing coal from many countries of the world have supplied the boiler manufacturers with information on the properties of all types of coal that may be purchased. They have already submitted a list on the properties of 150 types of coal produced in Indonesia, Australia, U.S.A., Canada, South Africa, Colombia and many other countries. From this list, the boiler manufacturers have picked up the type of coal that cannot possibly be used, and have requested the power utilities to exclude them from the list. The Song Hau 1 Power Plant planning to use the coal imported from overseas countries is also recommended to adopt this Japanese method.

b. Subbituminous coal

The types of coal to be utilized in the Song Hau 1 Power Plant can be classified as follows in conformance to the ASTM standards: Both the design coal and best coal is classified as the bituminous coal, particularly as the high volatile C bituminous coal. The worst coal is classified as the subbituminous coal, particularly as the subbituminous A coal.

Table 4.4.2.1 ASTM Coal Rank of Song Hau 1 Design Coals

	Design coal	Best coal	Worst coal
Gross Calorific Value (air dry basis, kcal/kg)	5,932	6,127	5,617
Gross Calorific Value (Moist, mineral-matter-free, kcal/kg)	6,498	7,050	6,301
Fixed carbon -dry, mineral matter free basis (%)	49.2	47.2	46.8
ASTM Coal Rank	High volatile C bituminous coal	High volatile C bituminous coal	Subbituminous A coal

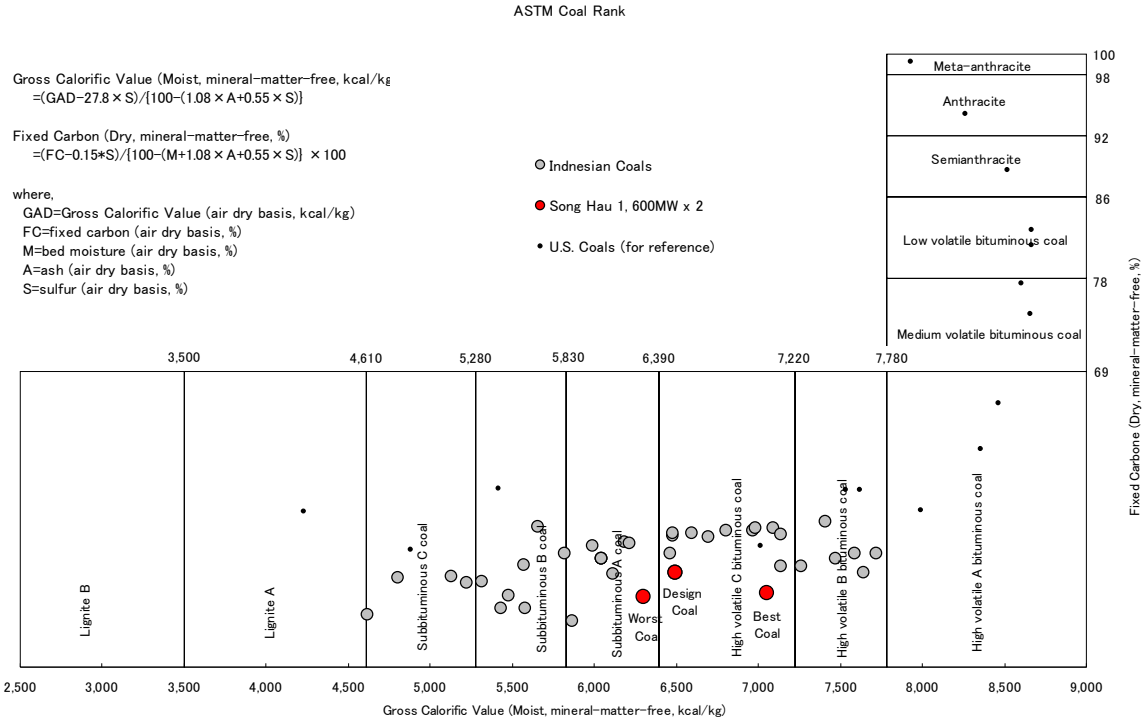


Figure 4.4.2.2 ASTM Coal Rank of Song Hau 1 Design Coals

The subbituminous coal has a lower melting point of ash than the bituminous coal, and is characterized by severer slugging tendency and fouling tendency.
It would be a good policy not to design a boiler for these two types of coals having such different properties wherever possible. Thus, the types of coal should be selected after a careful study has been made to determine if use of such types of coal is absolutely essential or not.

The Figure 4.4.2.3 illustrates the comparison sample of the furnace sizes of three (3) boilers sized for 660 MW burning different types of coals in the slagging tendency. Furnace (a) is designed to burn a bituminous coal with a low slagging tendency. The furnace (b) is designed to burn a sub-bituminous coal of which slagging tendency is high. The depth of this furnace is increased by some 10 % compared with the furnace (a). The furnace (c) is designed to burn severe slagging lignite. Its furnace depth is further increased by some 12 % compared with the furnace (b). The Table 4.4.2.2 shows the quantified size differences of the three (3) boilers. From the Figure 4.4.2.3 and Table 4.4.2.2, it can be seen that the boiler size is changeable

depending upon the slagging tendency of the ash of coal to be fired for the same capacity of the boiler. This means that the boiler can't be designed unless the property of coal is specifically given.

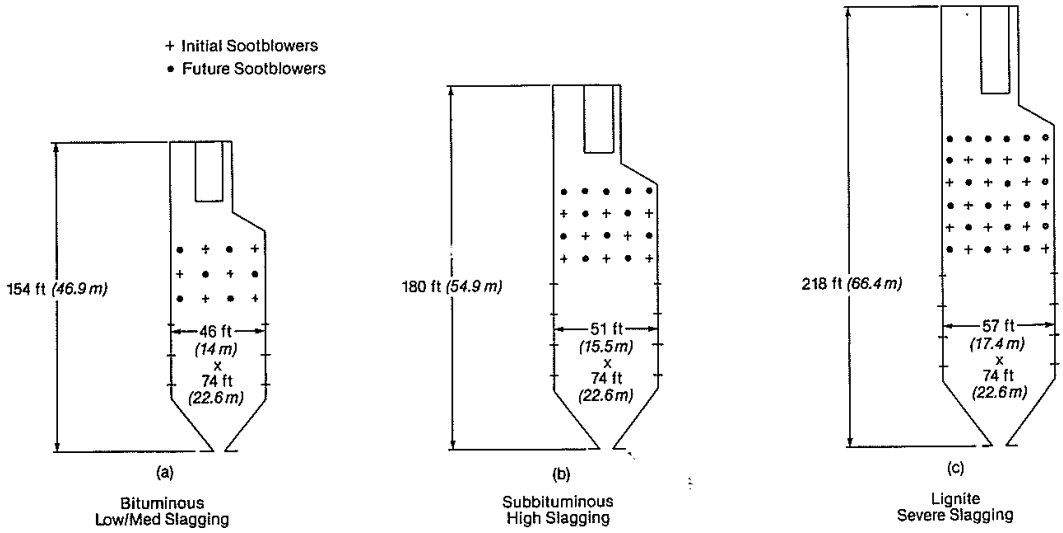


Figure 4.4.2.3 Influence of Slagging Tendency on Furnace Size
(Data Source: Steam of the Babcock & Wilcox Company)

Table 4.4.2.2 Furnace Size with Slagging Tendency of Coal

Type of Furnace	(a)	(b)	(c)
Coal Rank	Bituminous	Sub-bituminous	Lignite
Slagging Tendency	Low/Med	High	Severe
Furnace Plan Area	1.0	1.11	1.24
Furnace Surface	1.0	1.18	1.60
Number of Soot Blowers	30	36	70

(Data Source: Steam of the Babcock & Wilcox Company)

(2) Steam conditions on power generation facilities (boiler and turbine generator)
In the FS report, the boiler and turbine for the Song Hau 1 Power Plant are recommended to have a main steam pressure of 250 through 280 barg, a main steam temperature of 540 °C through 600 °C, and a reheat steam temperature of 560 °C through 600 °C.
Wide tolerances are assigned to the steam conditions. If these conditions are used in the inquiry of the bid, bidders will offer power generation facilities characterized by a great variety of steam conditions. This will complicate the evaluation work after the bidding.

To narrow the scope of the steam conditions, the following gives the steam conditions having been adopted in the pulverized coal-fired boilers for power generation in Japan, for reference purposes.

（Figure 4.4.2.4） Main Steam Press vs. Unit Generation Capacity
（Figure 4.4.2.5） Capacity, Steam Temperature vs. Year in Commercial Operation

Figure 4.4.2.4 shows the relationship between the unit generation capacity and turbine inlet main steam pressure in the pulverized coal-fired power plants put into commercial operation in and after 1959. 38 units out of total 74 coal fired units are so called supercritical units of which main steam pressures are 241 barg or higher. This supercritical condition is adopted in all the units with unit capacity of 360 MW or more. The maximum unit capacity is 1,050 MW.

Figure 4.4.2.5 shows the relationship between the commercial operation year and unit capacity in all of the 38 supercritical units. Further, this diagram uses a color identification method to show the units having a main steam and reheat steam temperature of 566/566 °C or below, those of 593/593 °C, and those of 600/600 °C.
Seventeen (17) units of supercritical pulverized coal fired units with a conventional steam temperature of 566/566 °C or less were manufactured since 1981, and the final commercial operation was commenced in 1995. After that, this type of unit has not been built.
The Ultra Super Critical (USC) stream conditions of 593 °C were adopted for the first time in the unit which was put into commercial operation in 1993; however, 593 °C was adopted only for the reheat steam temperature. In 1997, the unit of 593/593 °C together with the main steam and reheat steam was put into commercial operation. Further, the unit of 600/600 °C commenced commercial operation in 1998. Including the units of 593/593 °C and the units of 600/600 °C, a total of thirteen (13) units have started commercial operation since 1997. Two units are currently under construction.
Based on these performances, the major steam conditions for the state-of-the-art coal-fired thermal power generation facilities in Japan can be described as follows. From the worldwide perspective, the 600 °C steam temperature is commonly utilized. We recommend use of these steam conditions in the Song Hau 1 Power Plant faculties.

Table 4.4.2.3 Steam conditions recommended for Song Hau 1 Power Plant

Main steam pressure (at steam turbine inlet)	245 through 250 barg
Main steam temperature (at steam turbine inlet)	600 °C
Reheat steam temperature (at steam turbine inlet)	600 °C (through 610 °C)

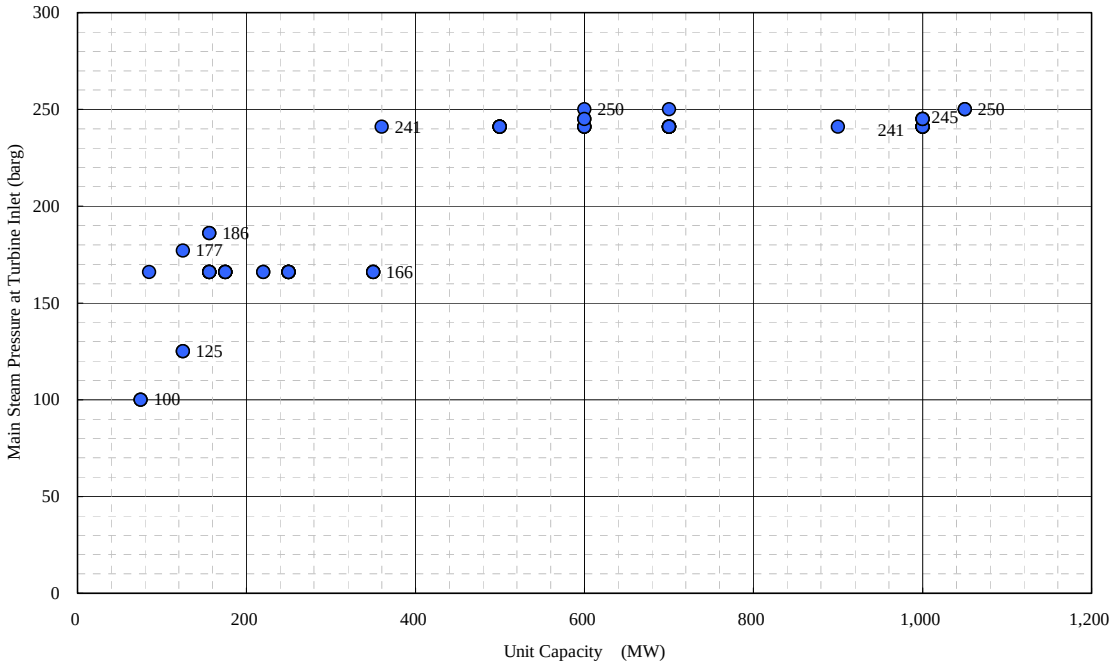


Figure 4.4.2.4 Main Steam Press vs. Unit Capacity

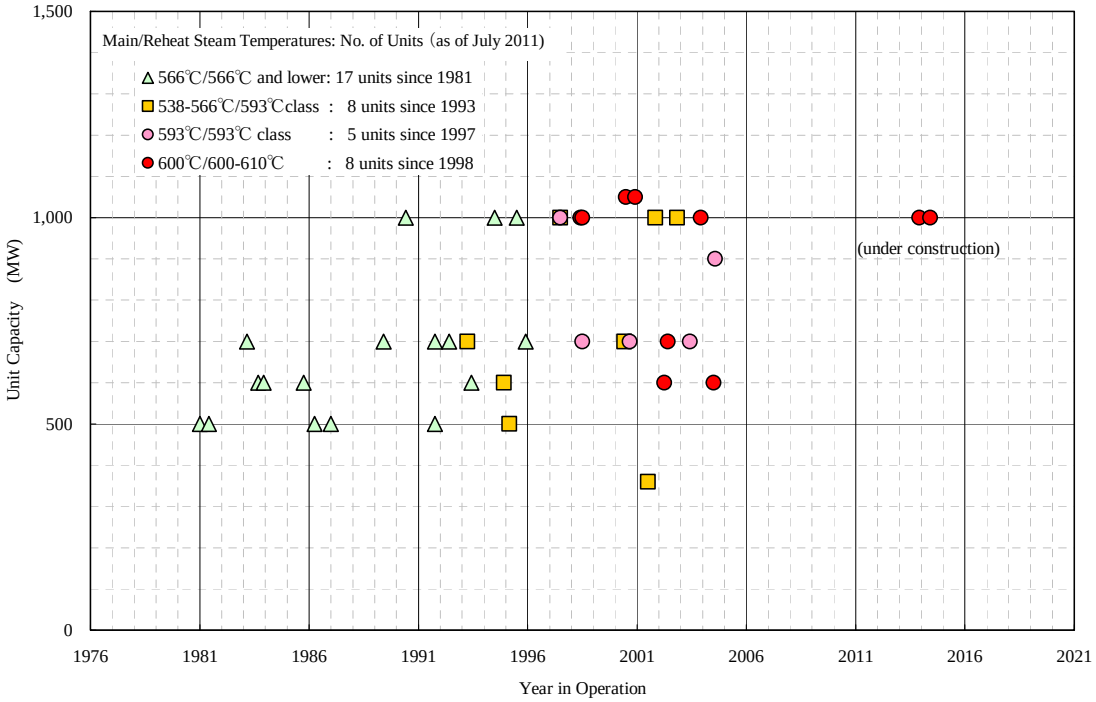


Figure 4.4.2.5 Unit Capacity and Main/Reheat Steam Temperatures vs. Operation Year

(3) Boiler furnace wall tube

The membrane wall constituting the furnace wall of the supercritical pressure variable pressure type once-through boiler is available in two types; a spiral tube type and a perpendicular riser

tube type. In the FS report, it is recommended to check for manufacturers and to select a perpendicular riser tube type which is technically superior. However, only one manufacturer is capable of producing a perpendicular riser tube type boiler. Accordingly, restriction to this particular type alone should be avoided.

(4) Boiler combustion method

In the SF report, adoption of an opposite firing method has been determined. In the combustion method for a large-capacity pulverized coal-fired boiler, the corner firing method as well as the opposite firing method have been field-proven in many cases. Similarly to the case of the boiler furnace wall tube in (3), restriction to one particular type should be avoided. Table 4.4.2.4 shows the world's top level boiler manufacturers and furnace wall tube structures and combustion method adopted by these manufacturers. It should be noted that there is no manufacturer whose favorite boiler is of vertical tube furnace wall and opposite firing.

Table 4.4.2.4 Boiler manufacturers and their favorite boiler type

Manufacturer	Company M	Company H	Company I	Company A
Type of Furnace wall	Virtical tube	Spiral tube	Spiral tube	Spiral tube
Type of Combustion	Corner firing	Opposite firing	Opposite firing	Corner firing

(5) Reheat steam temperature control method

In the 1980s when construction of the large-capacity coal-fired boiler started in Japan, the pulverized coal fired boiler was also provided with gas recircuration fan. Similarly to the case of oil- or gas-fired boiler, this was intended to implement reheat steam temperature control and to reduce NOx emission. However, a dust precipitator had to be installed to protect the gas recirculation fan from fly ash errosion, and construction costs were required. Not only that, the effect of gas recirculation on reheat steam temperature control and reduction of NOx was not so high in the pulverized coal fired boiler as that in the oil-fired boiler or gas-fired boiler,.and an increase in the unburnt combustible was found out. Accordingly, after early 1990s, no gas recirculation fan was installed in the pulverized coal fired boilers.

The FS report recommends use of a combination of the gas recirculation method or damper method with spray attemperating method. According to the performances in Japan, however, use of the damper control method and spray attenperation method (for emergency) is preferred.

(6) Denitrification facility (SCR)

In the FS report, at the time of constructing the Song Hau 1 Power Plant (2 x 600 MW), the requirements of the environmental regulation can be met by the low-NOx combustion technique alone such as use of low-NOx burners and overfire air, without installing a denitrification facility. Accordingly, when the Song Hau 2 Power Plant (2 x 1000 MW) and Song Hau 3 Power Plant (2 x 2000 MW) are constructed, the necessary measures such as retrofitting with a denitrification facility will be taken.

NOx concentration in the flue gas at the denitrification facility inlet is estimated at 450 mg/Nm3. Figure 4.4.3.5 shows the result of predicting the NOx emission concentration for various types of coals when the Japanese low-NOx combustion technique is adopted. It can be seen, therefore, that this value for the design coals is considered as appropriate.

According to the atmospheric dispersion calculation of exthaust gas conducted based on above-mentioned NOx concentration, a denitrification facility having a denitrification efficiency

of 30% has to be installed when the Song Hau 2 Power Plant has been constructed, and a denitrification facility having a denitrification efficiency of 65 % has to be installed when the Song Hau 3 Power Plant has been constructed. The measures to be taken in each phase are clearly analyzed.

In preparing the Tender Specifications in near future, it is necessary to specifically study how to handle the work of retrofitting with a denitrification facility. Retrofitting with denitrification facilities has been performed in Japan in many cases. In Japan, retrofitting has been made for the boilers where retrofitting had not been considered in the initial construction stage.
However, in the case of Song Hau 1 Power Plant, it is clear that the retrofitting work will be necessary in three through six years. When the Song Hau 1 Power Plant is constructed, preparation should be made to facilitate the subsequent retrofitting work in the initial phase, for the foundation, supporting steel frame, boiler pressure parts, and gas duct where modification works around the boiler are required. From the very beginning, careful planning should be paid to reduce the unit shutdown period for the retrofitting work and to minimize the overall investment.
The unit shutdown period of about six months may be required for the retrofitting work. In an extreme case, a denitrification facility should be installed in the beginning to ensure that mere insertion of a denitrification catalyst will be sufficient. If this arrangement is adopted, the period of the unit shutdown will be restricted to about one month and the overall costs will be drastically cut down. It is recommended to study such work procedures in details.

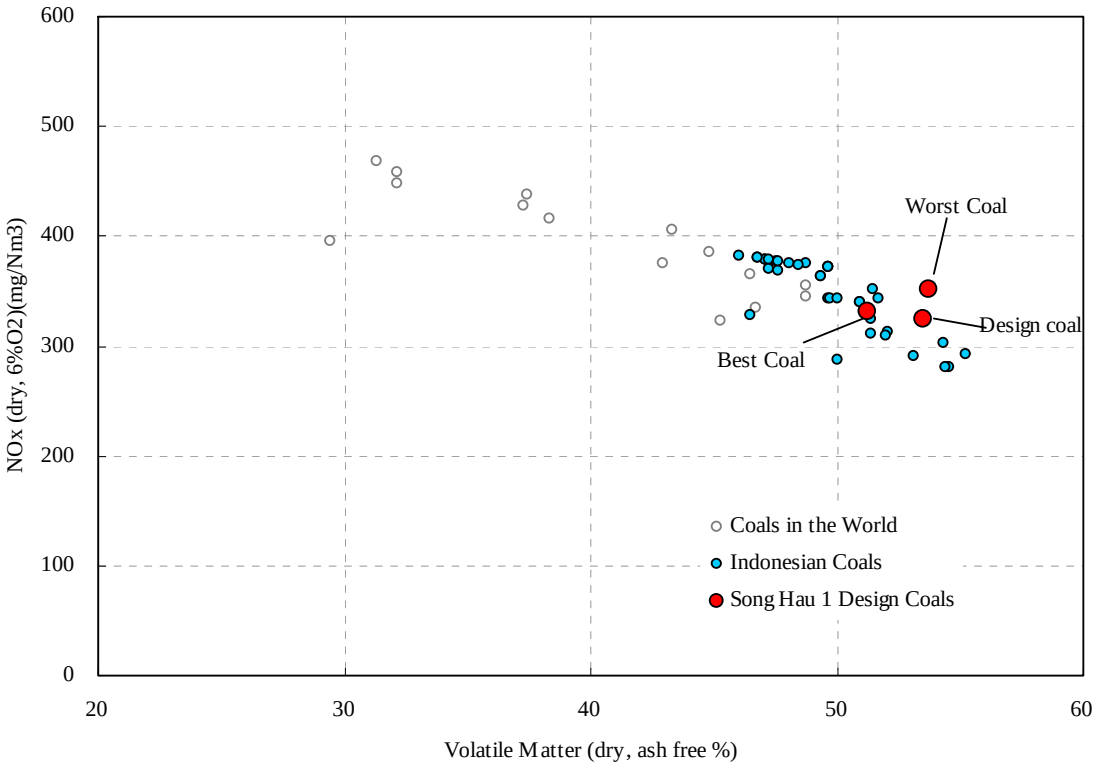


Figure 4.4.2.6 Expected NOx Emission of PC Boiler with LNB and OFA

(7) Light oil burner atomizing method
In the FS report, pressure atomizing method is incorporated in the planned light oil burner and

light oil ignition torch of atomizing type. However, in Japan, a steam atomizing method is used for the light oil burner. Use of steam atomizing method is also recommended in the Song Hau 1 Power Plant.
The pressure atomizing method does not require use of steam at the time of startup. In this respect, this method is superior to the steam atomizing method. However, combustibility is poor at the time of cold startup and black smoke is produced in some cases. Black smoke is emitted from the stack before the electrical dust precipitator becomes chargeable. The steam atomizing method is superior in oil atomizing properties to the pressure atomizing method and production of black smoke can also be reduced. For this reason, this method has been adopted in Japan.

4.4.3 Steam Turbine and Auxiliaries

4.4.3.1 Key Specification of Steam Turbine equipment

According to Construction Investment Report (CIR) made by PECC3, key specifications of steam turbine are as follows.

1) Type of Steam Turbine:4 casing, Reheat Extraction Condensate Tandem-Compound turbine
2) Steam Turbine Rated Output: 600 MW
3) Rotation Speed: 3000 min^{-1}
4) Steam Pressure (at main stop valve): 25.0 – 28.0 MPa
5) Main Steam Temperature (at main stop valve): 540 - 600 degree Celsius
6) Reheat Steam Temperature (at reheat stop valve): 560 - 600 degree Celsius
7) Exhaust Pressure 0.074 bar
8) Governer Control: Electrical Hydraulic Governer
9) Condenser Tube Material: Titanium Gr2 (Plate : Titan clad)
10) Steam Turbine Bypass System:High and Low Pressure Bypass are provided. Capacity is not specified
11) Cooling Water Temperature at Condenser Inlet: 30 degree Celsius
12) Maximum Cooling Water Temperature Rise: 7 degree Celsius

There are two major types of steam turbine for generation equipment. One of them is tandem compound steam turbine and the other one is cross compound steam turbine.

In Japan, Tokyo Electric Power Company adopts cross compound steam turbine and Kansai and Chubu Electric Power Company adopt tandem compound steam turbine.

Cross compound steam turbine has two (2) shafts and comprises of a steam turbine and generator on each shaft. Larger space is required and operation such as two shaft synchronization is complex than tandem compaound steam turbine.

In Japan, tandem compaound steam turbine has many experiences over 20 years in western electric power companies. A tandem compaound steam turbine has the advantage of less space and easy operation than a cross compound steam turbine because a tandem compaound steam turbine has single shaft and comprises of one steam turbine and generator.
In the past, many cross compound steam turbine are employed for large turbine because there is a technical problem such as shaft vibration and less reliability on a tandem compaound steam turbine.

Recently, since technical problem such as shaft vibration on a tandem compaound steam turbine had been resolved by development of computer analying technology and has many experiences in the world, it is judged that a tandem compaound steam turbine has sufficient generation capability, reliability and proof strength.

In CIR, four (4) casing tandem compaound steam turbin is recommended. In the meantime, high pressure and medium pressure combined turbine had been developed and many three (3) casing a tandem compaound steam turbine is employed in the world.

In Japanese modern ultra-supercritial pressure coal fired power plant, two (2) casing tandem compaound steam turbine which comprises one high and medium pressure casing and one low pressure casing because long last turbine brade has been developed.

4.4.3.2 Steam Turbine Auxiliaries

(1) Condenser
In this plant, it is planned that titanium tube as condenser tube material is used because titanium has wear and corrosion resistance and titanium clad plate is used for condenser plate material.

Though it is considered that stainless steel tube which has good heat conductivity is used for condenser tube, it may be said that titanium tube and titanium clad plate which are superior in wear resistance is proper because chlorine gas is injected to cooling water and silt is included in cooling water.

(2) Main Turbine Control System
Digital Electro Hydroulic Control (D-EHC) which utilizes high pressure control oil and has many experiences in Japan and World is reliable and it is judged that adoption of D-EHC is proper.

(3) Auxiliary Equipment
a. Boiler Feed Pump
Three (3) sets of motor driven boiler feed pumps (BFP) or two (2) sets of turbine driven boiler feed pumps plus one (1) set of motor driven boiler feed pump will be installed.

In case of turbine driven BFP, mechanical loss and throttle loss at BFP pump outlet valve by the fluid coupling can be reduced and it is possible to improve efficiency of auxiliary power because it is not necessary to equip with the fluid coupling to control rotation speed.
Almost of large scale thermal power plants in Japan adopts two (2) sets of turbine driven boiler feed pumps plus one (1) set of motor driven boiler feed pump.

b. Condensate Pump
Three (3) sets of condensate pumps having a 50% capacity per pump are adopted. In recet year, many large scal coal fired thermal power plants in Japan adopt two (2) sets of condensate pump having a 100% capacity per pump.
So, it is recommended that two (2) sets of 100% capacity or three (3) sets of 50% capacity condensate pump are adopted.

c. Condenser Vacuum System
It is planned two (2) sets of motor driven ring type vacuum pump having a 100% capacity are installed. It is judged that such plan is justified due to high redundancy

d. Condensate Polisher

In case of adopting once-through boiler, it is very important to control boiler water quality than drum type boiler. Condensate polisher plant will be installed to keep high water quality.
Two (2) sets of condensate polisher having a capacity of 50% per polisher will be installed in this plant. In Japan, Four (4) sets (one set is standby) of condensate polisher having a capacity of 33% per polisher are installed in same capacity plant.
Four (4) sets (one set is standby) of condensate polisher having a capacity of 33% per polisher is recommended because regeneration and maintenance of tower is required.

4.4.3.3 Cooling Water System

(1) Intake Water System

Intake water system comprises the intake tower which is located at about 7m depth in Hau river, two (2) barried intake pipes at river bed and cooling water pump pit. Cooling water flow is devided into 4 sections and each 2 sections is connected to a condenser of each unit. Screen and CW pump are installed at each section. It seems that the plan is justified.

(2) Cooling water screen

Bar screen is equipped at the inlet of pump pit to protect large floating abstacles and traveling screen will be installed to prevent the floating abstacles and aquatic life at the down stream.
Each section has 50% capacity, but each screen should have a capacity to treat for 2 sections.
Cooling water pump supplies cooling water to each condenser. Stop logs are provided for each pump pit to inspect and perform maintenance on each traveling screen. Cathodic protection equipment is provided in the intake pit to prevent electrical erosion of each metallic equipment.
Obstacles catched at the traveling screen are collected in the abstacles collection box through tray by spray water of screen wash pump and spray water will be back to pump pit. It is planned that abstacles in the abstacles collection box will be taken by person.

(3) River Water Pump

Water pumps which will be installed at river water pump pit are as follows.

a. Screen wash pump : 3 x 50% or 2 x 100%
b. Cooling water chlorination equipment pump : 2 x 50% per unit
c. Potable submerged pump : 2 sets for discharging water in pump pit
d. Cooling water pump : 2 x 50% per unit (Total 4)
e. Additional cooling water pump : 2 x 100% per unit (Total 4)

(4) Main Cooling Water System

This system comprises cooling water pumps and cooling water pipes. Cooling water pump has a capacity of 50% per pump and two (2) sets of pumps per each unit will be provided. One cooling water pipe connects a condenser and outer surface of embedded parts is covered by concrete and inner surface of cooling water pipe in the pump pit and turbine room is coated by tar epoxy. This plan is proper.

(5) Auxiliary (Closed Cycle) Cooling Water Screen

Closed Cycle Cooling Water (CCCW) system will be adopted for cooling bearings of fans and pumps and air compressor. This system is called secondary cooling water and fresh water is used for this system. Secondary cooling water is cooled by secondary cooling water cooler and is circulated by auxiliary cooling water pump. Expansion tank or stand pipe is installed at high place to keep constant supply pressure in this system.

Specifications of each equipment are as follows.

a. Auxiliary cooling wate pump : 2 x 100% per unit
b. Secondary cooler : 2 x 100% per unit
c. Secondary cooling water circulating pump : 2 x 100% per unit
d. Secondary cooling water expansion tank or standpipe : One per unit

Primary cooling water which cool secondary cooling water is supplied to secondary cooling water cooler by river water booster pump installed at downstream of main cooling water pump.

(6) Cooling Water Chlorination Plant

Chlorine gas is injected to cooling water to prevet adhesion of aquatic organization from inner suface of the cooling water pipes.
Water is fed from screen wash pump (3 x 50% capacity) which is installed to supply spray water for washing travelling screen of intake facility or is fed from booster pump (2 x 100% capacity)..
Chlorine gas bombe and chlorinator, etc are installed on chlorine gas house.
Above plan is proper, but it is recommended that detail design should be made taking account of the following matters.

- Take consideration arrangement and number of chlorine injection nozzle in order to inject chlorine gas to cooling water system effectively.
- Chlorine injection concentration is determined upon adhesion condition (many or small) of aquatic organization and chlorine gas consentration at the outlet of condenser and capacity of chlorination plant should be determined to adjust this concentration.

4.4.4 Water Treatment System

Hau river is water source for Song Hau coal fired power plant and river water as raw water is supplied to condenser for cooling, plant and miscellaneous water and demineralized water plant. After water is coagulated, sedimented and filtered in the coagulation and sedimentation tank and filtration equipment, filtered water is fed to fire fighting equipment, potable water treatment plant and demineralized water plant.
Outline of each water treatment system are summarized below.

4.4.4.1 Pre-treatment System

Since water quality in Hau river is high turbidity and low Ca^2, media filter will be installed to treat them. Especially, in dry season, since turbidity in river water become high, sand sedimentation is required at upstream of filtration.

1) Sand sedimentation pond
2) Raw water pump : 3 x 50% = 3 x 310 m^3/h
3) Coagulation and sedimentation tank : 2 x 50% = 2 x 1,500 m^3
4) Coal, sand and gravel media filter : 2 x 50%
5) Filtered water pump : 2 x 100%
6) Filtered water tank : 2x 7,500 m^3

4.4.4.2 Potable Water System

Fresh water which is produced in the pre-treatment plant is storaged in the filtered water tank,

and then is fed to the tank installed at high place, and is fed to each place such as service building, etc. Soduim hypochlorite is injected to the piping between pump and the high plance tank to sterilize.
The potable water system comprises the following equipment/

1) Potable water pump : 2 x 15 m^3/h, pressure 10 bar.
2) Soduim hypochlorite tank ; tank capacity is 20 days in maximum loading
3) Water level control system : startup and stop of potable water pump
4) Measuring Instruments : residual chlorine, pH, temperature and pressure, etc.
5) Blending station will be installed if this facility is necessary to install by WHO's regulation.

Above-mentioned specifications of each equipment are equivalent to potable water equipment which is installed in Japanese thermal power plants.

4.4.4.3 Demineralization Plant

Demineralization plant in this power plant comprises RO (Riverese Osmosis) combined with ion exchange mixbed tower or RO (Riverese Osmosis) combined with Electro ionization.

(1) Capacity of Demineralization Plant : 2 x 50% = 2 x 40 m^3/day

(2) Specification of each equipment
   a. Primary Cartridge Filter : 1 micron
   b. Demineralization filtration
      - Spiral wound element RO filter module
      - Designed flux of each filter module: 16 - 18 GFD
      - Number of filter modules of each filter: 4
      - Number of filter beds: 2 or 3
      - Input water quality: TDS < 500 mg/l
      - Output water quality: TDS < 25 mg/l
      - Recovery factor: 80%
   c. Electro - deionizer
      - Input water quality: TDS < 25 mg/l
      - Quantity of deionizing stacks in EDI: 15 x 3.4 m^3/h
      - Output flow: 34.1 - 68.1 m^3/h
      - Recovery factor: 80%

Though capacity and number of demineralization plant is 2 x 50% in CIR made by PECC3, 2 x 100% of demineralization plant is recommended because 50**%**of demineralized water is only produced in case that one train of demineralization plant is uner maintenance.

4.4.4.4 Waste water treatment plant

Waste water treatment plant comprises the following three (3) waste water treatment system. Waste water from each system is collected to retension tank or neutralizing pit and then is jointlly treated.

(1) Oil contaminated waste water treatment system

Oil contaminated waste water is collected from the turbine hall, transformer yard, then pumped into the oil water separator for treatment. After separating oil, the remaining water is pumped

into the retention tank, waiting for treatment.
Oil contaminated waste water treatment system includes:

a. Oil - water drain pits and drain pumps,
b. Oil separators,
c. Oil collecting pit,
d. Oil separated water collecting pit,
e. Oil separated water pumps.

(2) Industrial sewage treatment system

The system collects and treats industrial sewage during the production process.
Sewage from drain pits of the air heater, ESP, common drain pits of Units, sewage of boiler washing is pumped into the pre-retention tank, here sewage is aerated by air blower to evenly mix and create reaction. Sewage is continued pumping through the neutralizing basin for sedimentation by flocculation method. Here sewage is neutralized by chemicals and coagulated by special purpose chemicals. After treating, sedimentary mud is pumped into the slurry pit to pump to the ash disposal site. Clarified water will be filtered through the sand - gravel - activated carbon filter for the final neutralization before discharging into the environment.

(3) Coal yard and conveyor sewage treatment system

Rain water, water leaking from wet coal, washing water in coal yard are collected into the sedimentation basin. Here coal sludge is recovered and sewage is pumped into the neutralizing and sedimentation basin. Sewage after treating will be discharged out wards through the cooling water channel.

(4) Domestic sewage treatment system

The domestic sewage treatment system is designed according to civil treatment technology.

On the other hand, waste water treatment system in Japanese coal fired power plant generally adopts the system as per shown in Figure 4.4.4.4.1

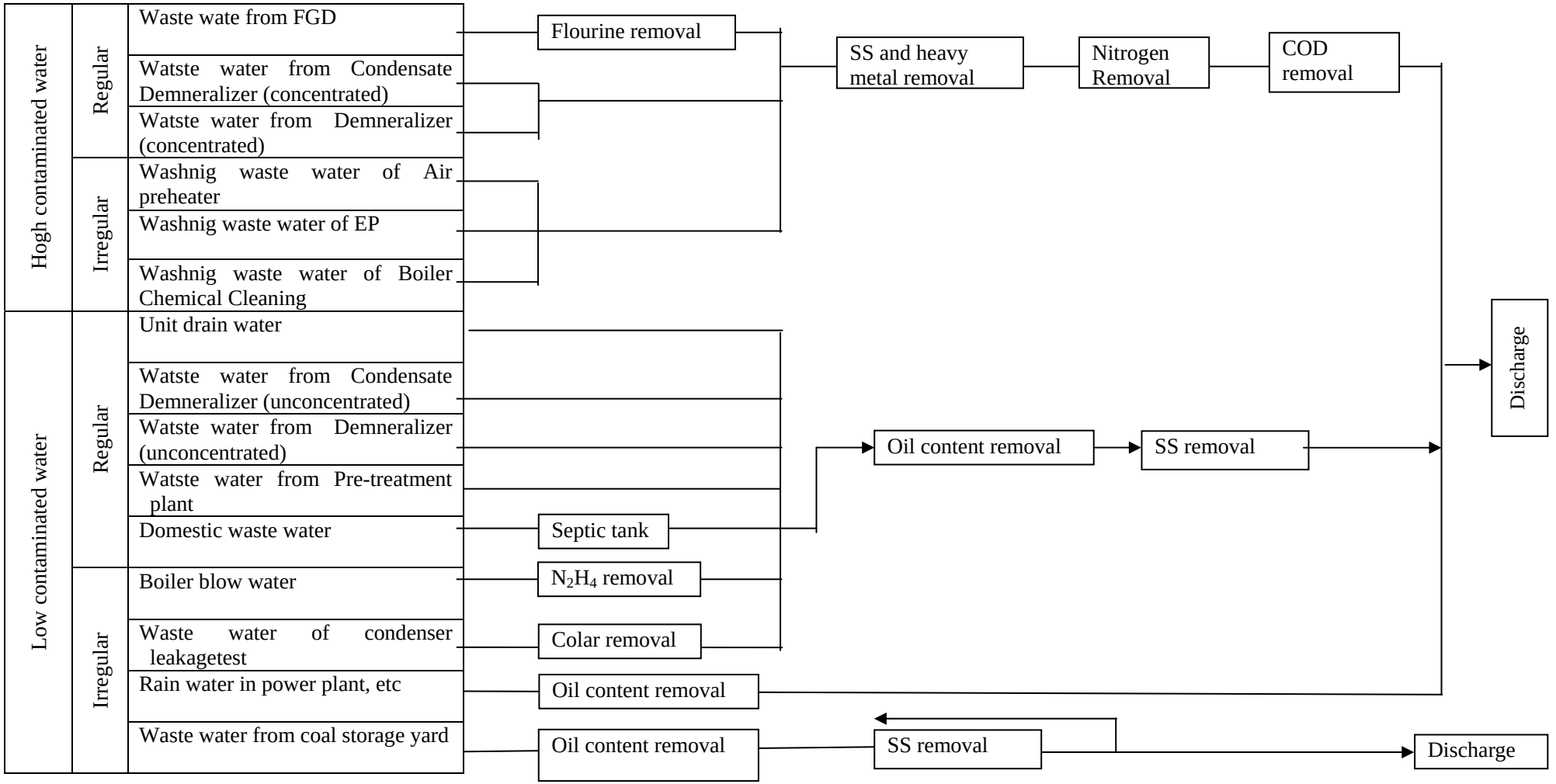


Figure 4.4.4.4.1 Flow diagram of Waste water treatment system

4.4.5 Fuel and Ash Handling Systems

4.4.5.1 Coal Handling System

At the Song Hau 1 coal fired power plant, coal imported from Indonesia or Australia is planned to be used. Although, at a power plant of this size, large vessels in the 60,000 DWT (Panamax) class or higher are usually used to carry coal, this power plant is located beside the river and depth at the mouth of the river is shallow, so only 3,000 DWT class vessels can be used in the current situation. To solve this problem, a Quan Chanh Bo channel is currently planned to be constructed. When the new channel is constructed, vessels up to the 10,000 DWT class will be capable of being used.
Imported coal will be transported to the coal terminal with large vessels, after which the coal will be loaded onto 3,000 DWT - 10,000 DWT class vessels and transported to the power plant through the Quan Chanh Bo channel and the Hau River. At the power plant, the coal will be unloaded by the unloader installed on the berth 120 m apart from the boundary of the power plant site, and the unloaded coal will be carried by a conveyor to the coal yard. The coal at the coal yard will be placed on a conveyor by the reclaimer at the coal yard, and will be supplied to the boiler.

The specifications and recommended plans for the currently planned equipments are as listed below.

Table 4.4.5.1.1 Comparison of specifications of equipments

Equipment	Draft[*1]	Recommended plan
Unloader	Type: Continuous chain bucket unloader Capacity/Number: 850 t/h × 2 sets	Type: Continuous chain bucket unloader Capacity/Number: 850 t/h × 2 sets
Receiving conveyor	1,700 t/h × 2 sets	1,700 t/h × 2 sets (Max: 2,000 t/h)
Coal yard	350,000 ton (for 30 days)	387,000 ton (for 30 days)
Stacker/reclaimer	1,700 t/h / 850 t/h × 2 sets	1,700 t/h / 850 t/h × 3 sets (Max: 2,000 t/h)
Discharge conveyor	850 t/h × 2 sets	850 t/h × 2 sets (Max: 1,000 t/h)

Note:*1 Construction Investment Report created by PECC3/PCC

The grounds on which the specifications of the equipments have been determined are indicated below.

(1) Coal consumption
[Design conditions]

- ✓ Gross power output (ECR) 1,200 MW (2 × 600 MW)
- ✓ Gross power output ratio (BMCR/ECR) 1.05
- ✓ Gross thermal efficiency 40.61% (HHV basis)
- ✓ Coal calorific value (designed coal) 5,932 kcal/kg (HHV, air dry basis)
- ✓ Total moisture (designed coal) 28% (as received)
- ✓ Inherent moisture (designed coal) 14% (air dry basis)
- ✓ Average annual operating time converted to the rated output 6,500 hours

- Coal calorific value (HHV, as received) = 5,932 kcal/kg x (100 % – 28 %) / (100 % – 14 %) = 4,966.32 ≈ 4,966 kcal/kg
- Coal consumption in one hour (MCR) = 600,000 kW x 1.05 x 2 units x 860 kcal/kWh x (100 / 40.61) / 4,966 kcal/kg / 1,000 = 537.31 ton/hour ≈ 537.4 ton/hour
- Coal consumption in one hour (ECR) = 600,000 kW x 2 units x 860 kcal/kWh x (100 / 40.61) / 4,966 kcal/kg / 1,000 = 511.72 ton/hour ≈ 511.7 ton/hour
- Coal consumption in one day (MCR) = 537.4 ton/hour x 24 hour/day = 12,897.6 ton/day
- Coal consumption in one year (ECR) = 511.7 ton/hour x 6,500 hour = 3,326,050 ton/year

(2) Selection of the unloader type

Unloader types can be broadly classified into the grab type and the continuous type. Table 4.4.5.1.2 compares the grab type unloader and the continuous chain bucket unloader. The continuous chain bucket unloader is superior to the grab type unloader in various points such as the unloading efficiency, dust protection, operability, and maintainability, except for the costs. Although, at a power plant of this size, large vessels in the 60,000 DWT class are usually used to carry coal, this power plant is located beside the river and the water depth is shallow, so only 3,000 DWT class vessels can be used in the current situation. (After the constructing of the Quan Chanh Bo channel is completed, vessels up to the 10,000 DWT class can be used.)

In this project, therefore, using a continuous chain bucket unloader, which unloading efficiency is highgr than grab type, is recommended by taking into account that the high frequency of coal transportation by small vessels in a whole year.

[Study conditions]

✓ Annual coal consumption	3,326,050 ton/year
✓ Coal transporting vessel capacity	10,000 DWT class
✓ Loading efficiency of the coal transporting vessel	0.9
✓ Coefficient of meteorological impact	0.8 (hypothesized)

The number of coal transporting vessels necessary in a year is as follows:

- Number of coal transporting vessels necessary in a year = 3,326,050 ton/year / (10,000 DWT x 0.9) = 369.56 vessel /year ≈ 370 vessel /year

The number of days in a year on which coal can be unloaded is as follows:

- Number of days in a year on which coal can be unloaded = 365 day/year x 0.8 = 292 day/year

Therefore, coal needs to be received at a high frequency of 1.27 vessels (= 370 vessels/292 days) in one day. For this reason, coal unloading must be carried out even at night.

Table 4.4.5.1.2 Comparison of unloader types

	Grab type unloader	Continuous chain bucket unloader
Unloading efficiency	Base	Better
Protection of dust	Base	High
Operability	Base	Easier
Maintainability	Base	Easier
Construction cost	Base	High
Evaluation	Base	Better

- Unloader type Continuous chain bucket unloader

(3) Nominal capacity of the unloader

[Study conditions]

- ✓ Coal transporting vessel capacity 10,000 DWT class
- ✓ Loading efficiency of the coal transporting vessel 0.9
- ✓ Number of berths 1
- ✓ Optimum berth occupation ratio 0.5
- ✓ Unloading efficiency 75%
- ✓ Work preparation time 1.75 hour (hypothesized)
- ✓ Number of coal transporting vessels necessary in a year 370 vessel /year
- ✓ Number of days in a year on which coal can be unloaded 292 day/year

- Number of hours in a year during which work is possible = 292 day/year x 24 hour/day x 0.5 = 3,504 hour/year
- Number of work hours per vessel = 3,504 hour/year / 370 vessel/year = 9.47 hour/vessel
- Nominal capacity of the unloader = (10,000 DWT x 0.9) / ((9.47 hour – 2 hour) x 0.75) = 1,606.4 ton/hour ≈ 1,700 ton/hour

The number of unloaders to be installed is set to 50% x 2 unloaders for the reason described below.

- Since an unloader with a capacity of 1,700 t/h is slightly large for a 10,000 DWT class, its unloading efficiency may become low.
- Even if one unloader fails, although time is taken, the unloading of coal can be continued.
- Usually, two unloaders are installed for one coal transporting vessel.

- Nominal capacity of the unloader 850 ton/hour
- Number of unloaders to be installed 2

(4) Nominal capacity of the receiving conveyor

From the viewpoint of reliability improvement, it is recommended that two receiving conveyors, each of which has 100% capacity and one of which is spare, be installed. Accordingly, the nominal capacity of the receiving conveyor needs to match the nominal capacity of the two unloaders. The bucket of the unloader may be fully filled due to the effect of a small collapse in the vessel warehouse, and excessive discharging may be carried out for an instant. This is called a peak ratio. Although its value varies depending on the manufacturer, it is usually 110% of the nominal capacity. Therefore, the nominal capacity of the receiving conveyor is calculated as

follows:

- Nominal capacity of the receiving conveyor = 850 ton/hour x 2 units = 1,700 ton/hour
- Maximum capacity of the receiving conveyor = 850 ton/hour x 2 units x 110 % = 1,870 ton/hour ≈ 2,000 ton/hour

➢ Nominal capacity of the receiving conveyor 1,700 ton/hour (max: 2,000 ton/hour)
➢ Number of receiving conveyors to be installed 2

(5) Nominal capacity of the coal yard

The amount of stored coal is planned so that coal for 30 days can be ensured under the condition that two units are continuously operated. In Vietnam, indoor coal yards for 15 days are generally planned as countermeasures against rain as in the case of the Pha Lai 2 coal fired power plant (600 MW). For a power plant with a large capacity as in this project, however, the installation of an indoor coal yard for 15 days results in a high investment cost. To suppress the investment cost, therefore, it is recommended that the indoor coal yard capacity be seven days. According to the PEEC3's report, when wet coal is stored indoors, usually it can be spontaneously dried within three days. Therefore, the coal indoor storage capacity of seven days is adequate for operation.

The necessary coal storage capacity is calculated as follows:

- Necessary coal storage capacity = 537.4 ton/hour × 24 hour × 30 day = 386,928 ton ≈ 387,000 ton

The coal yard is configured with three piles as shown below.

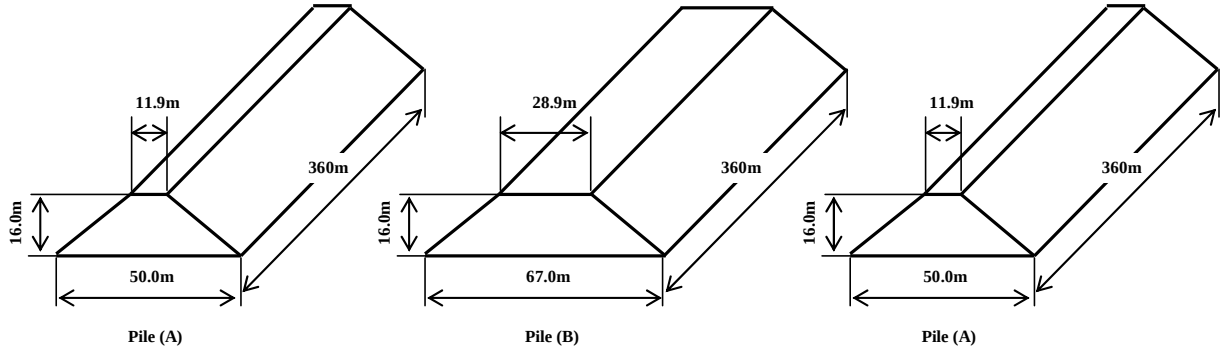


Figure 4.4.5.1.1 Stored coal shape

The amount by which coal in the above stored coal shape can be stored is calculated to 389,765 tons as follows:

- Pile (A) capacity = (11.9 + 50.0) × 16.0 × 360.0 × 1/2 = 178,272 m^3
- Pile (B) capacity = (28.9 + 67.0) × 16.0 × 360.0 × 1/2 = 276,192 m^3
- Specific gravity of coal = 0.8 ton/m^3
- Stored coal efficiency = 0.77
- Amount by which coal can be stored = (178,272 × 2 + 276,192) × 0.77 × 0.8 = 389,765.376 > 387,000 ton

➢ Nominal capacity of the coal yard 387,000 ton

Of this capacity, coal for seven days is recommended to be stored under a roof.

- Coal storage capacity under a roof = 537.4 ton/hour × 24 hour × 7 day = 90,283.2 ton

(6) Nominal capacity of the stacker/reclaimer

a. Number of stackers/reclaimers

The number of stackers/reclaimers to be installed needs to be determined by considering that the following two situations occur at the same time.

- ✓ Boiler operation
- ✓ Coal unloading

In this project, as many as 389 coal transporting vessels are required in a year, so at least one stacker/reclaimer is assumed to be always operating to receive coal. At least one stacker/reclaimer is also required to operate the boiler. Since the operation frequency of these two stackers/reclaimers is very high, it is recommended that a total of three stackers/reclaimers including one spare stacker/reclaimer be installed.

- ➢ Number of stackers/reclaimers to be installed 3

b. Nominal capacity of the stacker

The nominal capacity of the stacker must be the same as the nominal capacity of the receiving conveyor.

- ➢ Nominal capacity of the stacker 1,700 ton/hour (max: 2,000 ton/hour)

c. Nominal capacity of the reclaimer

Under the condition that two reclaimers will be operated for 12 hours, the nominal capacity of the reclaimer was set to a capacity that is sufficient for transporting coal that is used to operate the two units for one day. Then, even if one reclaimer fails, the remaining reclaimer will be capable of being operated for 24 hours and the operation of the two units will not be impeded. In addition, the capacity for one reclaimer can be reduced. The capacity of the nominal capacity of the reclaimer is calculated as follows:

[Study conditions]

- ✓ Coal consumption in one day 12,897.6 ton/day
- ✓ Reclaimer operation time 12 hour
- ✓ Number of operated reclaimers 2
- ✓ Unloading efficiency 75%

- Nominal capacity of the reclaimer = 12,897.6 ton/day / 12 hours / 2 units / 0.75 = 716.533 ton/hour ≈ 850 ton/hour

- ➢ Nominal capacity of the reclaimer 850 ton/hour

(7) Nominal capacity of the discharge conveyor

Two discharge conveyors will be installed so as to match the number of operated reclaimers. Therefore, the nominal capacity of the discharge conveyor needs to match the nominal capacity of one reclaimer. The bucket of the reclaimer may be fully filled due to the effect of a small collapse of piles at the coal yard, and excessive discharging may be carried out for an instant. This is called a peak ratio. Although its value varies depending on the manufacturer, it is usually

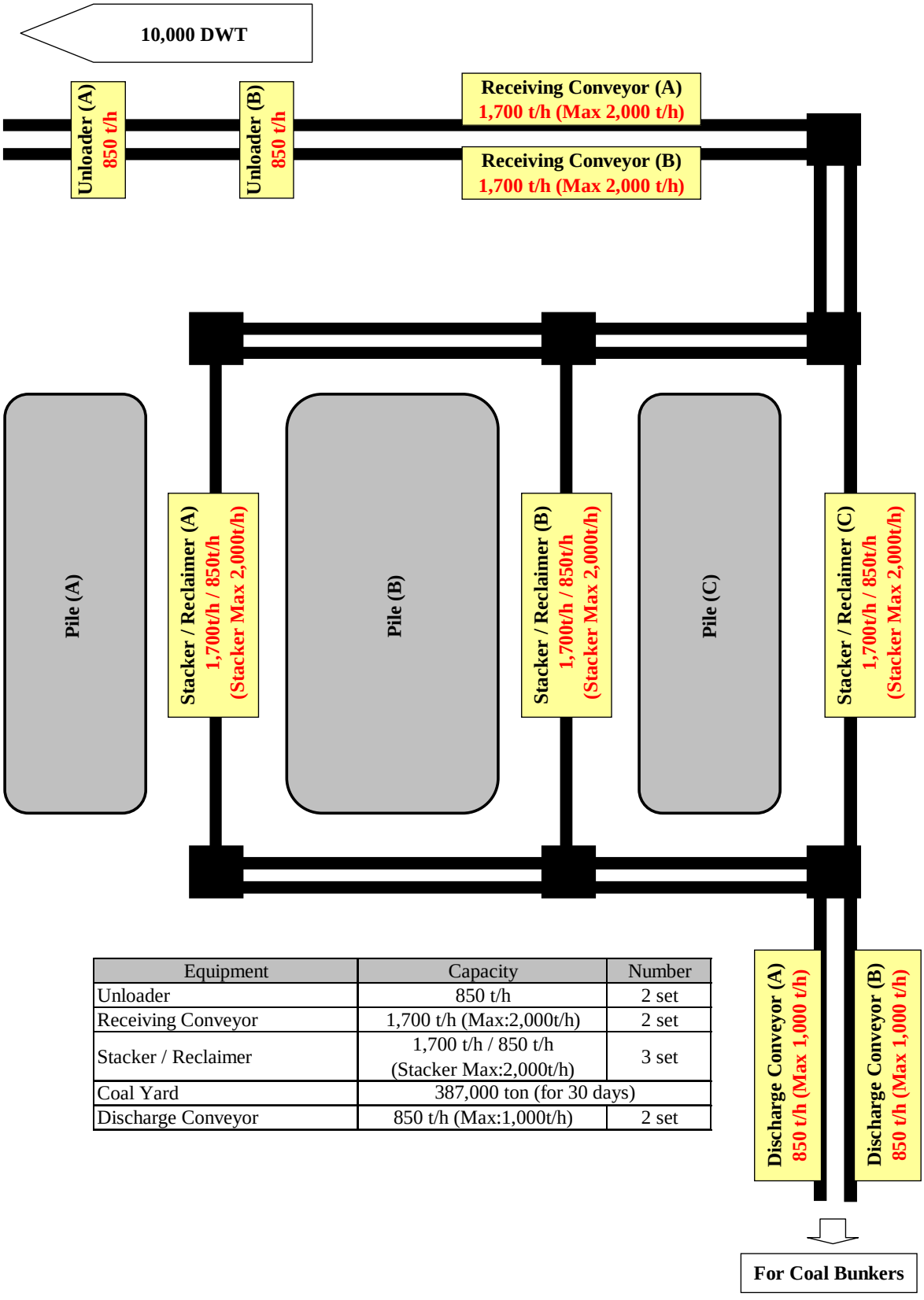
110% of the nominal capacity. Therefore, the nominal capacity of the discharge conveyor is calculated as follows:

- Nominal capacity of the discharge conveyor = 850 ton/hour × 1 set = 850 ton/hour
- Maximum capacity of the discharge conveyor = 850 ton/hour × 110 % = 935 ton/hour ≈ 1,000 ton/hour

- Nominal capacity of the discharge capacity 850 ton/hour (max: 1,000 ton/hour)）
- Number of discharge conveyors to be installed 2

When the nominal capacity of the unloader is made to match the nominal capacity of the reclaimer and the nominal capacity of the discharge conveyor, it also possible to transport coal unloaded from a coal transporting vessel directly to the boiler.

(8) Flow diagram of coal unloading and discharge system
Figure 4.4.5.1.2 shows the flow diagram of coal unloading and discharge system.



Equipment	Capacity	Number
Unloader	850 t/h	2 set
Receiving Conveyor	1,700 t/h (Max:2,000t/h)	2 set
Stacker / Reclaimer	1,700 t/h / 850 t/h (Stacker Max:2,000t/h)	3 set
Coal Yard	387,000 ton (for 30 days)	
Discharge Conveyor	850 t/h (Max:1,000t/h)	2 set

Figure 4.4.5.1.2 Flow diagram of coal unloading and discharge system

4.4.5.2 Ash Handling System

Figure 4.4.5.2.1 shows an example of ash distribution in individual parts of a coal fired boiler. In general, the ash included in coal is collected at individual parts in a gas flow as schematically shown below, from when coal is burnt in the boiler until the flue gas is expelled from a stack.

- Molten ash by coal combustion falls and is collected on the bottom hopper of the boiler furnace. The collected ash is called a clinker. In general, about 10% to 20% of the entire amount of ash is collected at this bottom hopper.
- Part of the combustion ash suspended in the flue gas falls and is collected at the bottom hoppers of the air heater and of the economizer located downstream of the boiler flue gas flow. The combustion ash is called cinder ash. In general, at least 5% of the entire amount of ash is collected at these bottom hoppers.
- Combustion ash collected by the electrostatic precipitator is collected at the bottom hopper of the electrostatic precipitator. The combustion ash is called fly ash. In general, at least 80% to 90% of the entire amount of ash is collected at this bottom hopper.

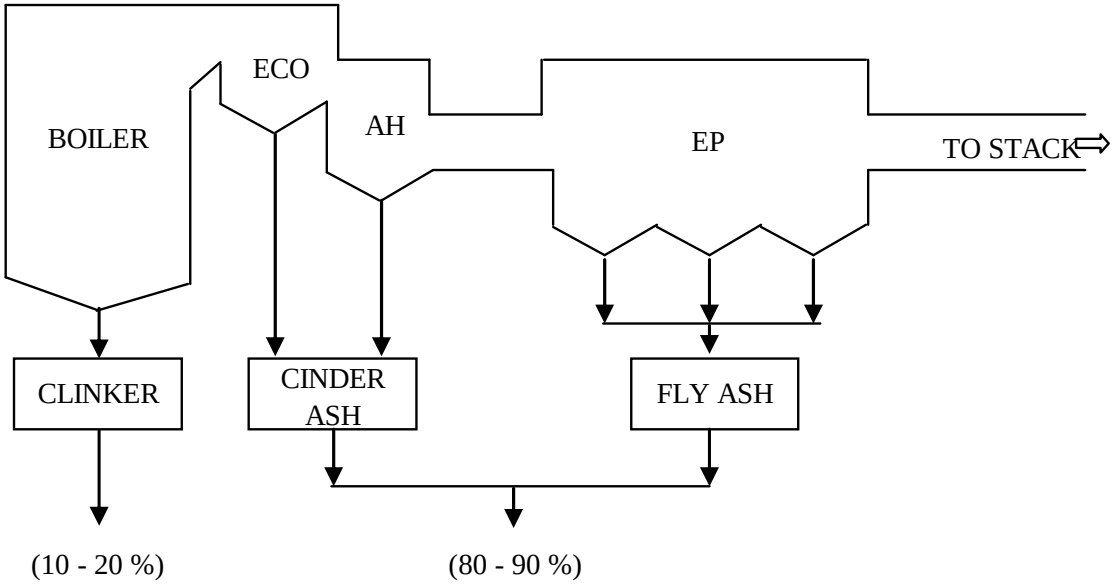


Figure 4.4.5.2.1 Places where coal ash is generated and generation ratio

The collected coal ash is generally transported and handled by the following two main ash handling systems. Figure 4.4.5.2.2 outlines the ash handling systems.

- System that handles clinker, which has dropped to the bottom hopper of the boiler (bottom ash handling system)
- System that handles cinder ash, which has dropped to the bottom hoppers of the economizer and air heater, and also handles fly ash, which has dropped to the bottom hopper of the electrostatic precipitator (fly ash handling system)

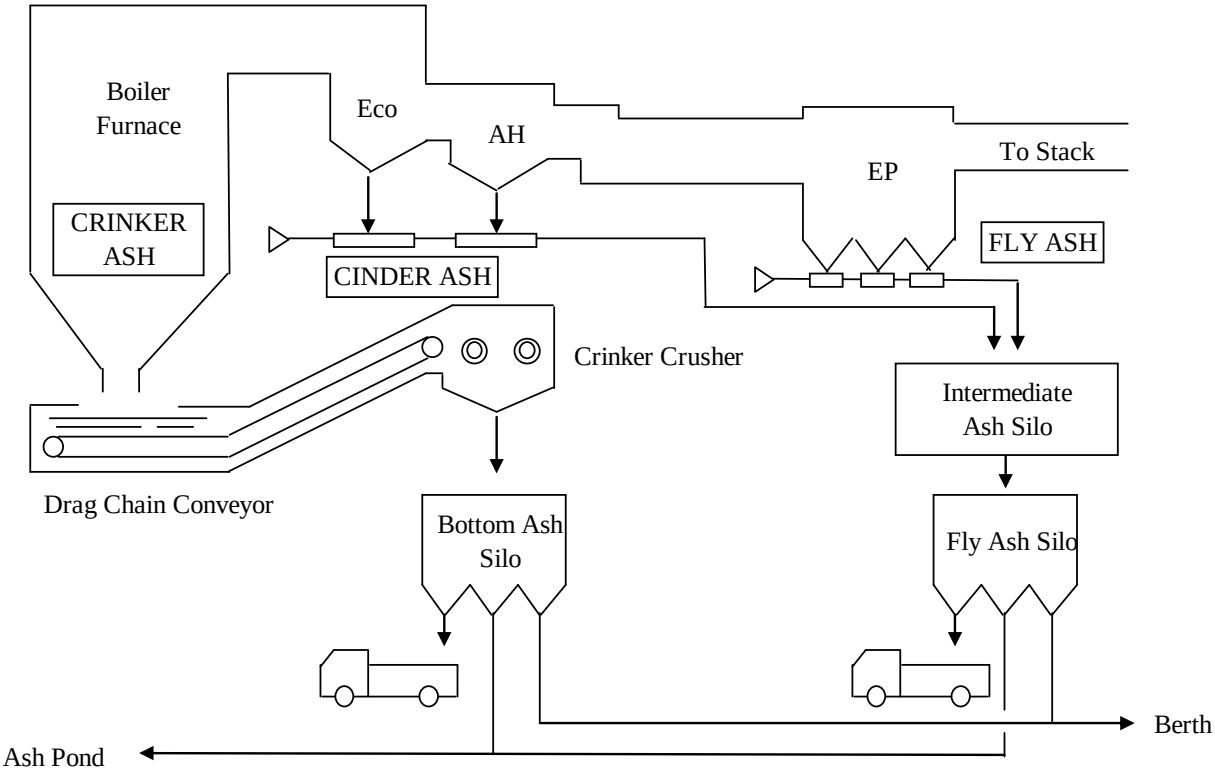


Figure 4.4.5.2.2 Ash handling systems

The ash handling systems that are planned at present and a recommended plan are as follows:

Table 4.4.5.2.1 Comparison of ash handling systems

Ash handling system	Draft*1	Recommended plan
Bottom ash handling system	Air sealed conveyor system or water sealed chain conveyor system	Water sealed chain conveyor system
Fly ash handling system	Vacuum system	Vacuum system or Vacuum-pneumatic system
Ash transportation system	Draft*1	Recommended plan
When ash is not recycled (from each silo to ash pond)	Slurry system or dry system	Dry system

Note:*1 Construction Investment Report created by PECC3/PCC

The grounds on which the systems have been determined are indicated below.

(1) Bottom ash handling systems

Sealing systems at the bottom of the boiler can be broadly classified into the air sealed system and the water sealed system. The air sealed system is superior to the water sealed system from the viewpoint of the environment because drainage water is not generated. However, the track record of using the air sealed system is lower than that of the water sealed system. To maintain

stable operation of the boiler, the sealed section at the bottom of the boiler is very important. Therefore, the water sealed system, which has a high track record of usage and is highly reliable, is recommended.
The water sealed bottom ash handling systems are classified into the chain conveyor system and the slurry system. In the slurry system, ash in the form of slurry is transported to the ash pond, so much water is used. In the chain conveyor system, water is used only at the sealed section at the bottom of the boiler, so less water is used in comparison with the slurry system. Therefore, the water sealed chain conveyor system is recommended as the bottom ash handling system in this project.

In the bottom ash handling system, clinker, which has dropped to the bottom hopper of the boiler, is handled. The clinker on the bottom hopper of the boiler is discharged by the water sealed chain conveyor. The grain diameter of the clinker is adjusted by the clinker crusher and is then transported by the conveyor to the bottom ash silo.

(2) Fly ash handling systems
Fly ash handling systems are generally classified into the vacuum system, the pneumatic system, and the vacuum-pneumatic system. The vacuum system is superior to the pneumatic system from the viewpoint of the environment because ash is less likely to fly to the outside. However, the vacuum system is suitable for short-distance transportation, and cannot be used for long-distance transportation. Therefore, the vacuum-pneumatic system, which is suitable for long-distance transportation, is often used at large thermal power plants. The distance that can be the transportation by the vacuum system depends on the shape and layout of the equipments such as the economizer, air heater and electrostatic precipitator, and detailed route of ash transported pipe. Therefore, the fly ash handling system will be further considered in the detailed design stage.
Accordingly, the vacuum system or the vacuum-pneumatic system is recommended in this project.

This system handles cinder ash, which has dropped to the bottom hoppers of the economizer and air heater, and also handles fly ash, which has dropped to the bottom hopper of the electrostatic precipitator. In case of applying the vacuum-pneumatic system, the cinder ash and fly ash are transported to the intermediate silo in a vacuum state. These ashes are then transported from the intermediate silo to the fly ash silo by compressed air. In case of applying the vacuum system, the cinder ash and fly ash are directly transported to the fly ash silo in a vacuum state.

(3) Reuse of ash
Combustion ash, which is a by-product of coal combustion, can be reused as follows:

- ✓ Clinker
  - ・ Roadbed material
- ✓ Fly ash
  - ・ Raw material of cement
  - ・ Concrete admixture
  - ・ Pavement material
  - ・ Fertilizer

It is recommended in this project as well that the generated ash is reused as much as possible. The effective use of ash reduces environmental loads and prolongs the life of the ash pond.

(4) Ash transportation systems

The ash stored in the bottom ash silo and fly ash silo is planned to be basically reused. If the ash cannot be reused, it will be transported to the ash pond and will be buried. Transportation to individual places is described below. The dry type transportation system, which is superior from the viewpoint of the environment, is recommended.

a. When ash is recycled (ash is transported from each silo to a recycle company)

- Transportation by truck
- Ash is transported to berth by compressed air, loaded on a 3,000 DWT class vessel, and transported.

Berth used for ash transportation are planned as a facility shared throughout the Song Hau Power Complex.

b. When ash is not recycled (ash is transported from each silo to the ash pond)

- Transportation by conveyor or truck

(5) Nominal capacity of the ash pond

The nominal capacity of the ash pond is planned so that ash for 30 years is stored when the two units are operated for 6,500 hours in a year. The amount of discharged ash is calculated as follows:

[Study conditions]

- ✓ Coal consumption (designed coal, ECR) 511.7 ton/hour (HHV, as received)
- ✓ Ratio of unburnt coal in ash (amount of unburnt coal / amount of generated ash) 5%
- ✓ Total moisture in coal (designed coal) 28% (as received)
- ✓ Ash in coal (designed coal) 6.7% (as received), (8.0% air dry basis)

- Amount of ash discharged in one hour = 511.7 ton/hour × 0.067 (1 + (0.05 / (1 – 0.05)) = 36.08 t/h ≈ 36.1 t/h
- Amount of ash discharged in one year = 36.1 t/h × 6,500 hour = 234,650 ton/year
- Total amount of ash discharged in 30 years = 234,650 ton/year × 30 year = 7,039,500 ton

An ash accepting company is not determined at present. According to the track record at the Pha Lai 2 coal fired power plant, about 70% of ash could be recycled. It is recommended that an ash accepting company be selected as soon as possible and be reflected in the basic plan.

- ➢ Amount of ash discharged in one year 234,650 ton
- ➢ Total amount of ash discharged in 30 years 7,039,500 ton

4.4.5.3 Fuel Oil Supply System

(1) Types of fuel oil

Fuel oil is used for ignition at the start of the units and for heating. The fuel oil generally used is diesel oil or heavy oil. In this project, the use of diesel oil is recommended in consideration of the following:

- Types of fuel should be minimized.
- Easy-to-use fuel should be used.

- Heavy oil is inexpensive in comparison with diesel oil, but heavy oil requires additional systems such as a warming system.
- Since fuel oil is used only for a short time from when the units are started until a load of about 30% is reached, the use of heavy oil is not economic.

➢ Type of fuel oil Diesel oil

(2) Fuel oil transportation method

Fuel oil is transported from a storage facility at Can Tho City by using vessels in the 1,000 DWT class to 3,000 DWT class. Berth used to unload diesel oil are planned as a facility shared throughout the Song Hau Power Complex.

➢ Transportation method Vessels up to the 3,000 DWT class

(3) Nominal capacity of the fuel tank

The specifications of the fuel tank planned at present and a recommended plan are as follows:

Table 4.4.5.3.1 Specifications of the fuel tank

Equipment	Draft[*1]	Recommended plan
Fuel tank	1,000 m^3 × 2 sets (1,000 m^3 / 0.88 kg / l/80% = 1,420 kl × 2 sets)	1,600 kl × 2 sets

Note:*1 Construction Investment Report created by PECC3/PCC

The grounds on which the nominal capacity of the fuel tank has been determined are indicated below.

The nominal capacity of the fuel tank is planned so that continuous operation for 30 hours is possible under a 30% MCR load. Even if there is no coal in one day, this capacity enables operation to be continued under a 30% load. Installation of two tanks is recommended in consideration of tank inspection. The nominal capacity of the fuel tank is calculated as follows:

[Study conditions]

- ✓ Gross power output (ECR) 1,200 MW (2 × 600 MW)
- ✓ Gross power output ratio (BMCR/ECR) 1.05
- ✓ Gross thermal efficiency 40.61% (HHV basis)
- ✓ Diesel oil calorific value 10,796 kcal/kg (HHV)
- ✓ Specific gravity of diesel oil 0.88 kg/l
- ✓ Continuous operation time 30 hour (at 30% MCR)
- ✓ Oil storage efficiency 80%
- ✓ Number of fuel tanks installed 2

- Heat input from fuel (Gcal/h) = 1,200,000 kW × 1.05 × 860 kcal/kWh / 0.4061 / 10^6 = 2,669 Gcal/h
- Diesel oil consumption (kg/h) = 2,669 Gcal/h × 30% / 10,796 kcal/kg × 10^6 = 74,167 kg/h
- Diesel oil consumption (kl/h) = 74,167 kg/h / 0.88 kg / l / 1,000 = 84.3 kl/h
- Required capacity of the diesel oil tank (kl) = 30 hour × 84.3 kl/h = 2,529 kl
- Nominal capacity of the diesel oil tank (kl) = 2,529 kl / 0.8 / 2 set = 1,580.6 kl ≈ 1,600 kl

➢ Nominal capacity of the fuel oil tank 1,600 kl

- Number of fuel tanks installed 2

4.4.6 Limestone and Gypsum Handling Systems

The limestone system unloads limestone, which is used in the FGD, from vessels, stores unloaded limestone, and supplies it to the FGD. The gypsum handling system stores gypsum generated by the FGD and loads the gypsum into carrying vessels. The limestone unloading berth, limestone unloader, gypsum discharging berth, and gypsum loading facility are planned to be shared throughout the Song Hau Power Complex.

4.4.6.1 Limestone Handling System

The specifications and recommended plans for the currently planned equipments are as listed below.

Table 4.4.6.1.1 Comparison of specifications of equipments

Equipment	Draft*1	Recommended plan
Limestone unloader	Ave: 125 t/h, Max: 250 t/h × 1 set	250 t/h × 1 set
Limestone receiving conveyor	250 t/h × 1 set	250 t/h × 1 set (Max: 300 t/h)
Limestone silo	1,500 m^3 × 2 sets (for 14 days)	1,500 m^3 × 2 sets (for 15 days)

Note:*1 Construction Investment Report created by PECC3/PCC

Basically, the current specifications can be considered to be adequate.
The grounds on which the specifications of the equipments have been determined are indicated below.

(1) Limestone consumption
The limestone consumption of the designed coal is as follows:

[Study conditions]
- ✓ Coal calorific value (designed coal) 4,966 kcal/kg (HHV, as received)
- ✓ Sulfur in coal (designed coal) 0.51% (as received), (0.61 % air dry basis)
- ✓ Desulfurization efficiency 80%
- ✓ Purity of limestone 96%
- ✓ Molecular weight of limestone 100
- ✓ Molecular weight of sulfur 32
- ✓ Excess limestone ratio 5%

- Coal consumption in one hour (MCR) = 600,000 kW × 2 units × 1.05 × 860 kcal/kWh × (100 / 40.61) / 4,966 kcal/kg / 1,000 = 537.4 ton/h
- Coal consumption in one hour (ECR) = 600,000 kW × 2 units × 860 kcal/kWh × (100 / 40.61) / 4,966 kcal/kg / 1,000 = 511.7 ton/h
- Limestone consumption in one day (MCR) = 537.4 ton/h × 0.0051 × (100 / 32) × 0.8 × (100 / 96) × 1.05 × 24 hour = 179.86 ton/day ≈ 180 ton/day
- Limestone consumption in one year (ECR) = 511.7 ton/h × 0.0051 × (100 / 32) × 0.8 × (100 / 96) × 1.05 × 6,500 hour = 46,382.8 ton/year

(2) Nominal capacity of the limestone unloader

[Study conditions]

- ✓ Limestone transporting vessel capacity — 3,000 DWT class
- ✓ Loading efficiency of the limestone transporting vessel — 0.9
- ✓ Unloader type — Grab type
- ✓ Unloading efficiency — 60%
- ✓ Actual working time — 20 hours (hypothesized)

- Nominal capacity of the limestone unloader = (3,000 DWT × 0.9) / (20 hour × 0.6) = 225 ton/hour ≈ 250 ton/hour

This system is less frequently operated in comparison with the coal unloader, and even if this facility fails, a movable crane can be used for unloading as an immediate measure. Therefore, only one limestone unloader having a 100% capacity is planned to be installed.

- ➢ Nominal capacity of the limestone unloader — 250 ton/hour
- ➢ Number of limestone unloader to be installed — 1

(3) Nominal capacity of the limestone receiving conveyor

The idea for the nominal capacity of the limestone receiving conveyor is the same as that for the coal conveyor. Only one limestone receiving conveyor having a 100% capacity is planned be installed to match the number of unloaders installed upstream. Even if the limestone receiving conveyor fails, transportation by truck is possible, so one limestone receiving conveyor is adequate.

- Nominal capacity of the limestone receiving conveyor = nominal capacity of the limestone unloader = 250 ton/hour
- Maximum capacity of the limestone receiving conveyor = 250 ton/hour × 110% = 275 ton/hour ≈ 300 ton/hour

- ➢ Nominal capacity of the limestone receiving conveyor — 250 ton/hour (Max:300 ton/hour)
- ➢ Number of limestone receiving conveyors installed — 1

(4) Nominal capacity of the limestone silo

The nominal capacity of the limestone silo is planned to be the same as the maximum capacity of the limestone transporting vessels. Designed coal for 15 days can be ensured as calculated below.

- Number of days during which operation is possible when a 3,000 DWT class transporting vessel is used = 3,000 DWT × 0.9 / 180 ton/day = 15 day

If a 3,000 DWT class transporting vessel is used, therefore, limestone needs to be received once every 15 days. If the Song Hau 2 coal fired power plant and the Song Hau 3 coal fired power plant are expanded in the future, the approximate coal consumption is calculated as follows:

- Approximate limestone consumption in one day (in the future) = 180 ton/day × 5,200 MW / 1,200 MW = 780 ton/day
- Number of days during which operation is possible when a 3,000 DWT class transporting vessel is used = 3,000 DWT × 0.9 / 780 ton/day = 3.46 day

As indicated above, if a 3,000 DWT class transporting vessel is used, the number of days during which operation is possible is shortened, but this is not a problem in operation.
Installation of two limestone silos, each having a 50% capacity, is recommended in consideration of silo inspection.

[Study conditions]
- ✓ Bulk specific gravity of limestone 1.4 ton/m^3
- ✓ Maximum capacity of limestone transporting vessels 3,000 DWT class
- ✓ Storage capacity 80%
- ✓ Number of limestone silos to be installed 2

- Nominal capacity of the limestone silo = 3,000 ton / 1.4 ton/m^3 / 80% / 2 sets = 1,339.3 m^3 ≈ 1,500 m^3

- ➢ Nominal capacity of the limestone silo 1,500 m^3
- ➢ Number of limestone silos to be installed 2

4.4.6.2 Gypsum Handling System

The specifications and recommended plans for the currently planned equipments are as listed below.

Table 4.4.6.2.1 Comparison of specifications of equipments

Equipment	Draft[*1]	Recommended plan
Gypsum loading equipment	Ave: 125 t/h, Max: 250 t/h × 1 set	250 t/h × 1 set (Max: 300 t/h)
Gypsum receiving conveyor	250 t/h × 1 set	250 t/h × 1 set (Max: 300 t/h)
Gypsum storage house	1,500 ton × 1 set (for 3 days)	3,000 ton × 1 set (for 7 days)

Note:*1 Construction Investment Report created by PECC3/PCC

The grounds on which the specifications of the equipments have been determined are indicated below.

(1) Amount of gypsum generated
[Study conditions]
- ✓ Coal calorific value (designed coal) 4,966 kcal/kg (HHV, as received)
- ✓ Sulfur in coal (designed coal) 0.51% (as received), (0.61 % air dry basis)
- ✓ Desulfurization efficiency 80%
- ✓ Purity of gypsum 94%
- ✓ Molecular weight of gypsum 172
- ✓ Molecular weight of sulfur 32
- ✓ Moisture content in gypsum 10%

- Coal consumption in one hour (MCR) = 600,000 kW × 2 units × 1.05 × 860 kcal/kWh × (100 / 40.61) / 5,050 kcal/kg / 1,000 = 537.4 ton/h
- Coal consumption in one hour (ECR) = 600,000 kW × 2 units × 860 kcal/kWh × (100 / 40.61) / 4,966 kcal/kg / 1,000 = 511.7 ton/h

- Amount of gypsum generated in one day (MCR) = 537.4 ton/h × 0.0051 × (172 / 32) × 0.8 × (100 / 94) × (100 / 90) × 24 hour = 334.3 ton/day ≈ 350 ton/day
- Amount of gypsum generated in one year (ECR) = 511.7 ton/h × 0.0051 × (172 / 32) × 0.8 × (100 / 94) × (100 / 90) × 6,500 hour = 86,271.8 ton/year

(2) Reuse of gypsum

Gypsum, which is a by-product from the FGD, can be reused as follows:

- Cement material
- Board material

It is recommended in this project as well that the generate gypsum is reused as much as possible. If the gypsum cannot be reused, it will be transported to the ash pond and will be buried. It is recommended that a gypsum accepting company be selected as soon as possible and be reflected in the basic plan. The effective use of gypsum reduces environmental loads and prolongs the life of the ash pond.

(3) Nominal capacity of the gypsum storage house

The nominal capacity of the gypsum storage house is planned to be 3,000 tons, which is the same as the maximum capacity of gypsum transporting vessels. Designed coal for seven days will be capable of being stored.

- Number of days for which designed coal can be stored when a 3,000 DWT class transporting vessel is used = 3,000 DWT × 0.9 / 350 ton/day = 7.71 day

Therefore, when a transporting vessel is arranged once every seven days, gypsum can be handled. If the Song Hau 2 coal fired power plant and the Song Hau 3 coal fired power plant are expanded in the future, the approximate amount of gypsum generated is calculated as follows:

- Approximate amount of gypsum generated in one day (in the future) = 350 ton/day × 5,200 MW / 1,200 MW = 1,516.6 ton/day
- Number of days for which designed coal can be stored when a 3,000 DWT class transporting vessel is used = 3,000 DWT × 0.9 / 1,516.6 ton/day = 1.78 day

As indicated above, if a 3,000 DWT class transporting vessel is used, the number of days for which gypsum can be stored is shortened, but this is not a problem in operation.

Unlike silos, which are inspected with their interior being emptied, the gypsum storage house is assumed to be subjected only to visual inspection, so installation of one gypsum storage house having a 100% capacity is recommended.

- Nominal capacity of the gypsum storage house = maximum capacity of gypsum transporting vessels = 3,000 ton

- Nominal capacity of the gypsum storage house 3,000 ton
- Number of gypsum storage houses to be installed 1

If the capacity of the gypsum storage house is for three days as indicated in the draft, discharging by a gypsum transporting vessel must be carried out once every three days. Since the gypsum discharging berth is shared throughout the Song Hau Power Complex, if the Song Hau 2 coal fired power plant and the Song Hau 3 coal fired power plant are completed, gypsum transporting vessels will become hard to arrange. Therefore, the gypsum storage house is

recommended to have a capacity for seven days, as described above.

(4) Nominal capacities of the gypsum reclaimer, gypsum discharge conveyor, and gypsum loading equipment

The gypsum discharged by the reclaimer from the gypsum storage house will be carried by the discharge conveyor to a gypsum transporting vessel. Since the gypsum loading equipment is less frequently used in comparison with the coal conveyor, only one set of gypsum loading equipment having a 100% capacity is planned to be installed. Even if the limestone receiving conveyor fails, transportation by truck is possible, so one set of gypsum loading equipment is adequate.

[Study conditions]

- ✓ Gypsum transporting vessel capacity 3,000 DWT class
- ✓ Loading efficiency of the gypsum transporting vessel 0.9
- ✓ Actual working hours 12 hours

- Nominal capacities of the gypsum reclaimer, gypsum discharge conveyor, and gypsum loading equipment = (3,000 DWT × 0.9) / 12 hour = 225 ton/hour ≈ 250 ton/hour
- Maximum capacity of the gypsum reclaimer and gypsum loading equipment = 250 ton/hour × 110% = 275 ≈ 300 ton/hour

- ➢ Nominal capacity of the gypsum reclaimer 250 ton/hour
- ➢ Nominal capacity of the gypsum discharge conveyor 250 ton/hour (Max: 300 ton/hour)
- ➢ Nominal capacity of the gypsum loading equipment 250 ton/hour (Max: 300 ton/hour)
- ➢ Number of gypsum loading equipment to be installed 1

4.4.7 Electrical Equipment

Figure 4.4.7.1 shows Generator and auxiliary power system.
The main electric connection diagram is the diagram of connecting generator block to the main transformer and unit auxiliary transformers though the insulated phase bus bar tube.
The generator circuit breaker is installed between the generator and the branch turning to the unit auxiliary transformer. The unit auxiliary transformer is of 3 -winding type, its primary side is connected to the insulated phase bus bar tube. This diagram allows the auxiliary system to be supplied power from the electric grid when the generator is not operating.
Main electric equipment is following.
- Insulated phase bus bar
- Generator terminal circuit beaker and systems
- Auxiliary transformers 21kV / 10.5 kV / 10.5 kV; 220 / 10.5 kV / 10.5 kV, 10.5 kV / 0.72kV and 10.5 kV / 0.42 kV.
- Auxiliary electric system of 10.5 kV, 690 kV, 400V; emergency power supply system, DC / UPS system
- Stand-by diesel generator
- Relay protection system, measuring system
- Lighting and small power supply system
- Earthing and lightning - protection system

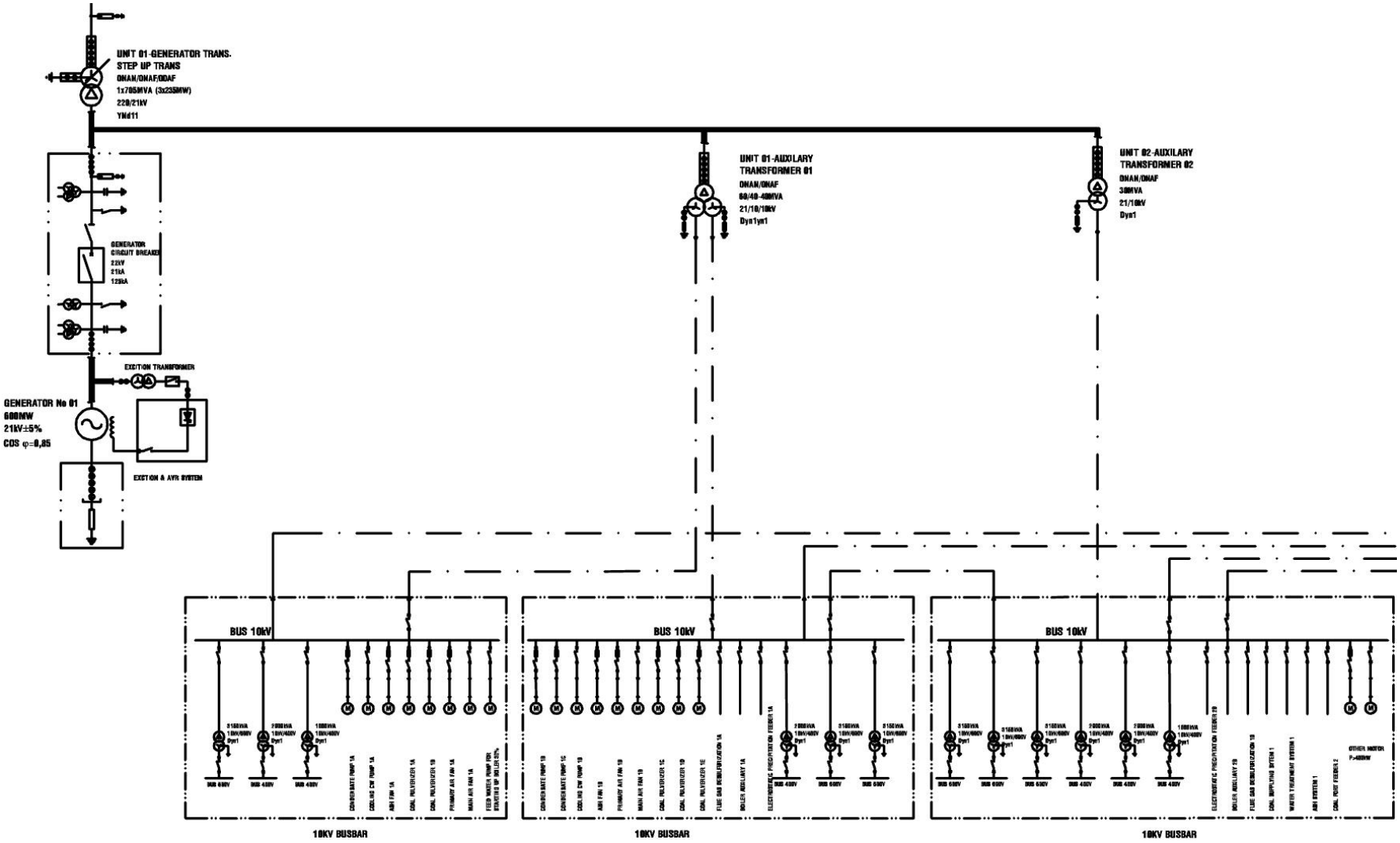


Figure 4.4.7.1 Generator and auxiliary power system

Specification for generator and important transformers are following.

Table 4.4.7.1 Specification for generator

Item	Specification
Rated capacity	600MW
Quantity	2
Rated frequency	50Hz
Type	rotating magnetic field, two poles, cylinder rotor, synchronous, completely shielded type
Rated Voltage	21kV (or depending on the Manufacturer)
Cooling	Rotor and steel core: by Hydrogen
	Stator: by Hydrogen or water
Excitation system	static excitation

According to power factor (0.85), generator capacity shall be approximately 710MVA.

Table 4.4.7.2 Specification for main transformer

Item	Specification
Power	705MVA (or 3 x 235MVA)
Quantity	2
Rated frequency	50Hz
Type	3 phases, 2 windings, 50Hz, oil-immersed, outdoor, step - up
Wire connection type	YNd11
Excitation system	static excitation
Voltage ratio	21kV/220kV
Tap changer	±10 x 1% Automatically control the OLTC of the HV side
Cooling	ONAN/ONAF/ODAF (50%/70%/100%)

Table 4.4.7.3 Specification for unit auxiliary transformer A

Item	Specification
Power	60 / 40-40MVA
Quantity	2
Rated frequency	50Hz
Type	3 phases, 50Hz, oil-immersed, outdoor
Wire connection type	Dyn1yn1
Voltage ratio	21kV/10kV/10kV
Tap changer	±5%, with voltage tap: ± 2x2.5%
Cooling	ONAN/ONAF (70%, 100%)

Table 4.4.7.4 Specification for unit auxiliary transformer B

Item	Specification
Power	30MVA
Quantity	2
Rated frequency	50Hz
Type	3 phases, 50Hz, oil – immersed, step – down transformer
Wire connection type	Dyn1yn1
Voltage ratio	21kV/10kV/10kV
Tap changer	±5%, with voltage tap: ± 2x2.5%
Cooling	ONAN/ONAF (70%, 100%)

・HV 10kV auxiliary power system
HV 10kV auxiliary will be supplied via 02 unit auxiliary transformers from 21kV Voltage level to 10kV Voltage level.
The 10kV system supply for following equipments:
− Motors with power not less than 400kW such as: Boiler feed water pump, cooling water pump, oil pump, air fans, etc...
− Auxiliary transformers (10kV/0.4kV) of the power plant

・LV 690kV auxiliary power system
The 690V auxiliary will be supplied from MV 10kV auxiliary via 10/0.69kV auxiliary transformer.
LV 690V system supply for following equipments:
－Motors: 200kV≤P≤400kW.
－LV switchboard

・LV 400V auxiliary power system
The 400V auxiliary will be supplied from MV 10kV auxiliary via 10/0.4kV auxiliary transformer.
The 0.4kV system supply for following equipments:
－Motors: P<200kW
－LV switchboard
－BOP equipments, substation control equipments motors of CB, lighting, HVAC, small power…

・Protection relay system
Following tables show Generator main circuit protections relay system by report (Song Hau 1 Power Plant - 2x600MW Construction investment Project／Volume 1: Main Clarification／Chapter 6: Technical solutions／6.3.5.2. Design philosophy) and figures (Song Hau 1 Thermal Power Plant - 2x600MW／Relay Protection Diagram／Symbols & Legend of Protective Devices・Measurement and Protection System／Unit 01 Protection Schematic Diagram).
Also Figure 4.4.7.2 shows Generator main circuit.

Table 4.4.7.5 Generator main circuit protections relay system

Name on report	Figure
Generator differential protection	87
Stator earth fault protection	59GN//64GN
Excitation loss protection	40
Generator magnetic circuit saturation protection	24
Reverse power protection	32
Rotor earth fault protection	64F
Low impedance protection	50//51GN
Negative sequence current protection	46
Generator over current protection	51V
Over / under voltage protection	59/27
Generator frequency increase / decrease protection	81
Phase shift angle protection	
Generator out-of-step protection	78
Voltage balance inspection	60

Name on report	Figure
Synchronization inspection	25
Generator overload protection	49G
Circuit-breaker stripping circuit monitoring	50BF
Other necessary protection to ensure safety for generator in case of fault	21

Table 4.4.7.6 Main transformer protections relay system

Name on report	Figure
Vectorial overcurrent protection	67
Differential protection	87
Transformer high - voltage winding zero sequence current differential protection	87
Transformer overload protection	49
High - voltage protection	59
Vapour protection	
Oil flow protection	96
Overcurrent and quick - break overcurrent protection	51
Overcurrent and earth fault overcurrent protection	50
Oil temperature and winding temperature protection	26O/26W
Voltage controller overvoltage protection	
Oil level protection	96
Other necessary protections to ensure safety for transformer in case of fault	

Table 4.4.7.7 Unit auxiliary transformer protections relay system

Name on report	Figure
Winding short-circuit protection (transformer differential protection)	87
Overcurrent and earth fault overcurrent protection	
Earth fault protection	
Vapour protection	
Oil temperature and winding temperature protection	
Voltage controller overvoltage protection	
Oil level protection	
Oil pressure protection	63
Low voltage winding neutral earth fault protection	

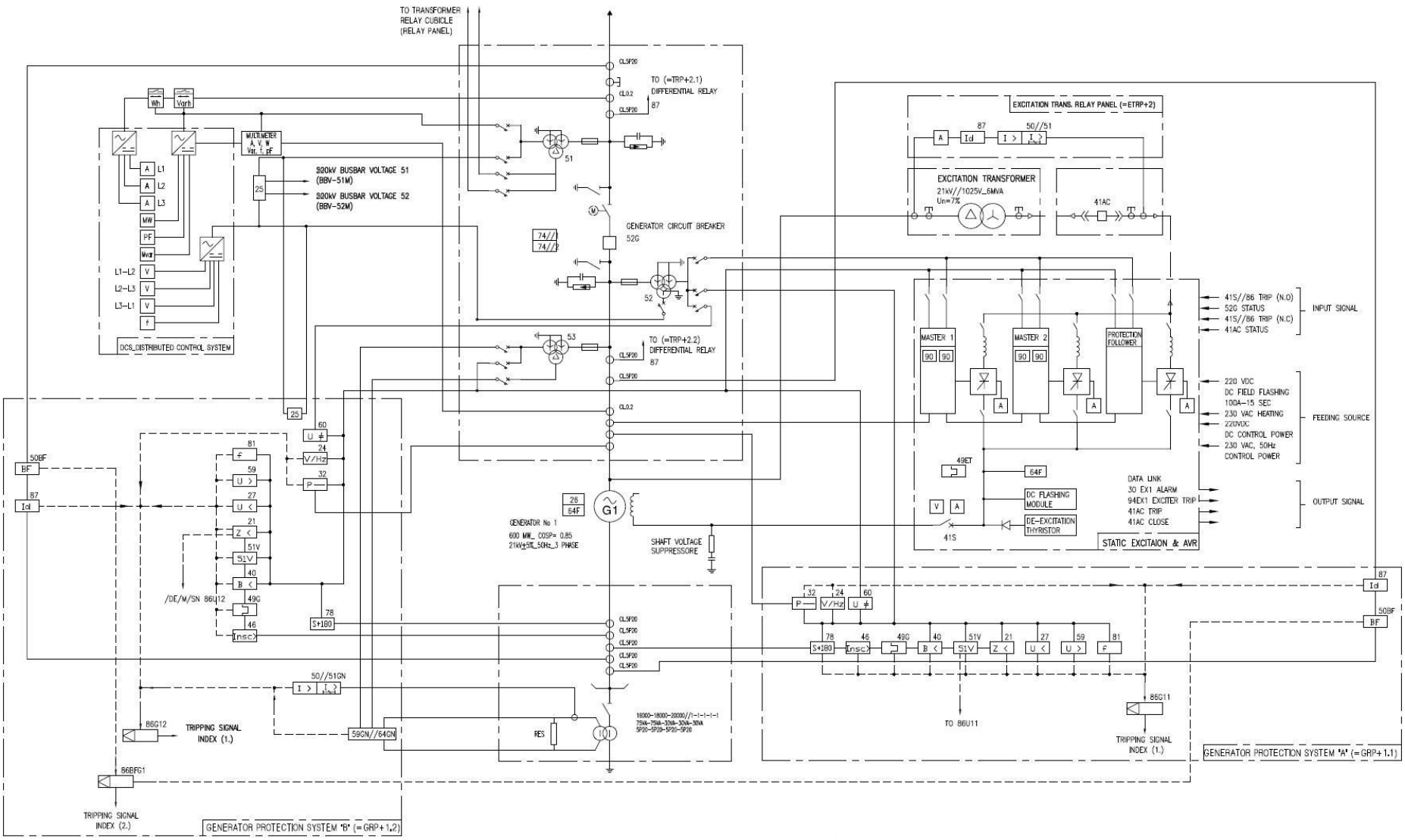


Figure 4.4.7.2 Generator main circuit

4.4.8 Instrument and Control System

DCS (Distributed Control System) for Song Hau 1 is a standard type for large scale coal-fired power plant. DCS adopts a reliable ICMS (Integrated Control & Monitoring system). ICMS is composed of UCMS (Unit Control & Monitoring system) for power station equipment and SCMS (Station Control & Monitoring system) for common equipment. Control and monitoring targets of UCMS and SCMS are following.

Table 4.4.8.1 Integrated Control & Monitoring system

Integrated Control & Monitoring system (ICMS)	
Unit Control & Monitoring system (UCMS)	Station control & monitoring system (SCMS)
・ Turbine and boiler ・ Boiler controllers ・ Auxiliary system for starting boiler ・ Circulation water system and circulation water pumping station ・ Condensate and feed water system ・ Turbine controllers include interface to the digital - hydraulic control system (D-EHG), and the turbine - generator Unit ・ Turbine starting run ・ Boiler protecting system ・ Turbine protecting system ・ Electronic precipitator system (ESP) ・ FGD system, limestone crushing system, and gypsum dewatering system ・ Electric systems ・ Communication with electric cabinet system and protection relay system ・ Equipment connection according to Standard protocols such as Modbus, Profibus and Foundation Fieldbus ・ Generator automation & protection system	・ Waste water system ・ Water treatment system ・ Ash pumping system ・ Coal supply and distribution system ・ Hydrogen preparation system ・ Compressed-air system ・ Electric systems ・ Heavy oil filling and storing system ・ Fire water pumping house ・ Fire indicator panel (FIP) ・ Diesel power generation station ・ Communicating with electric cabinet system and protection relay system ・ Equipment connections according to Standard protocol, such as Modbus, Profibus and Foundation Fieldbus ・ Circulation water pumping station ・ Chlorine house. ・ Communicating with station yard control system.

Figure 4.4.8.1 shows DCS.

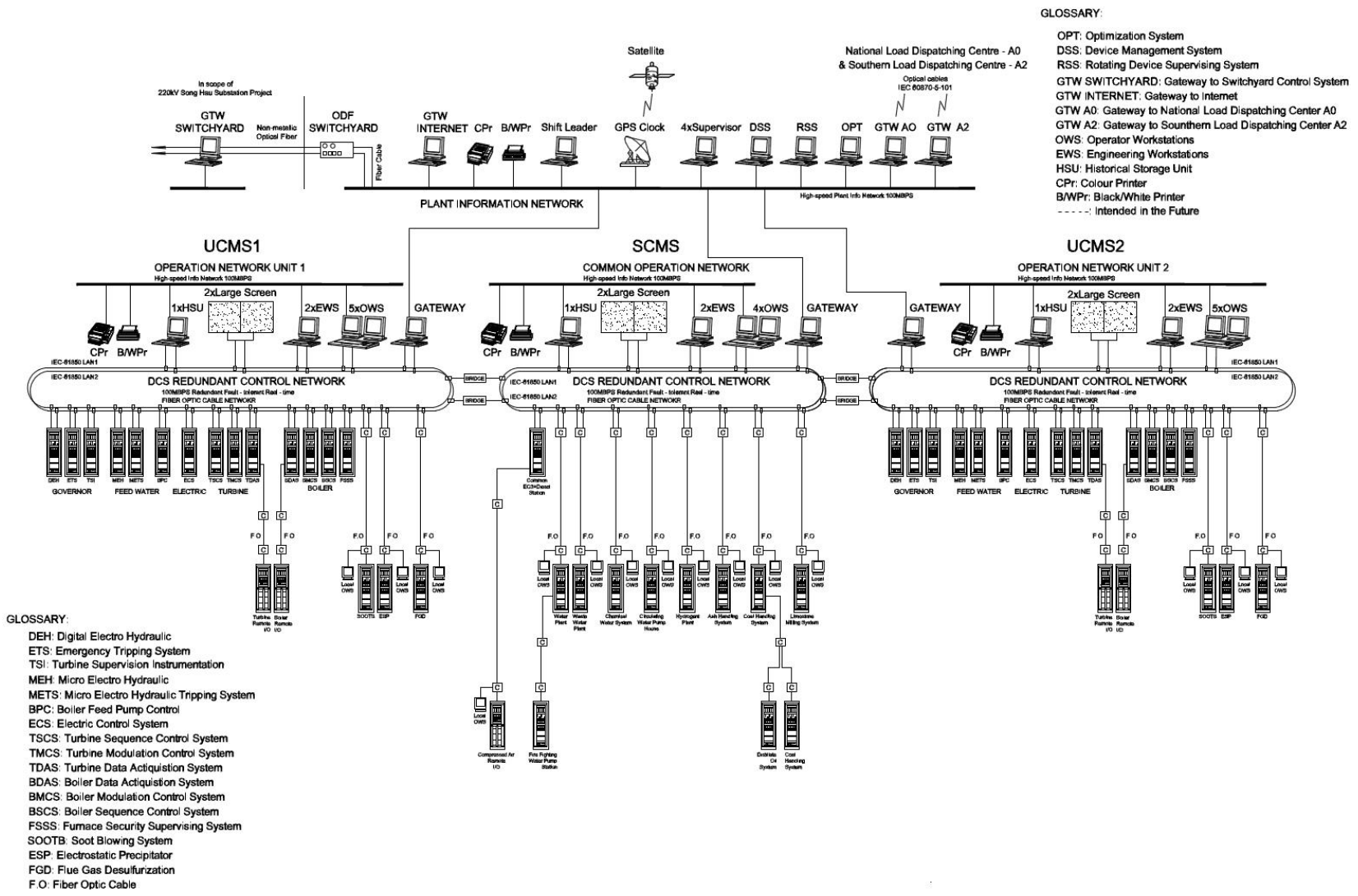


Figure 4.4.8.1 DCS

(1) Plant Interlock System

The main function of the system is monitoring the validity of the trip and interlocks signals and response to the valid trip and interlock signal immediately so that an exact action can be attained. The plant systems with this type of interlock shall be boiler, turbine and generator.

Following figure shows the Basic BTG Interlock concept. Turbine and generator tripped automatically when boiler tripped (MFT: Master Fuel Trip).

Figure 4.4.8.2 Basic BTG Interlock

Figure 4.4.8.3 shows Basic Flow under Normal Operation and Figure 4.4.8.4 shows Basic flow under MFT.

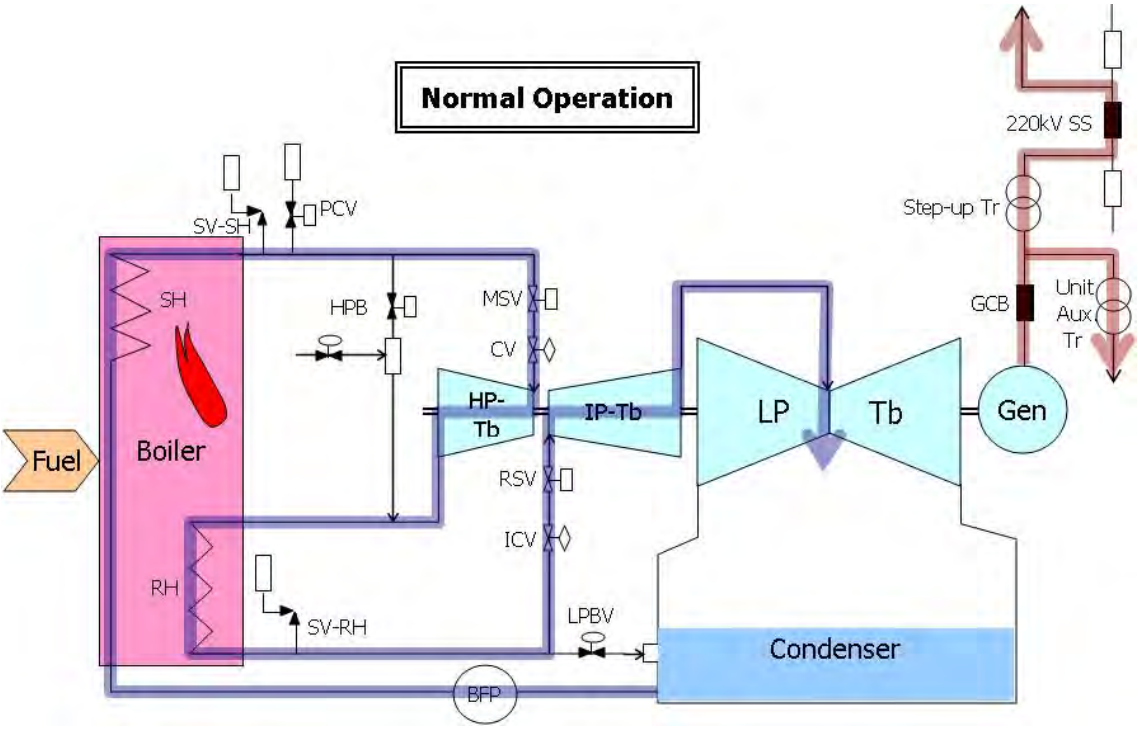


Figure 4.4.8.3 Basic Flow under Normal Operation

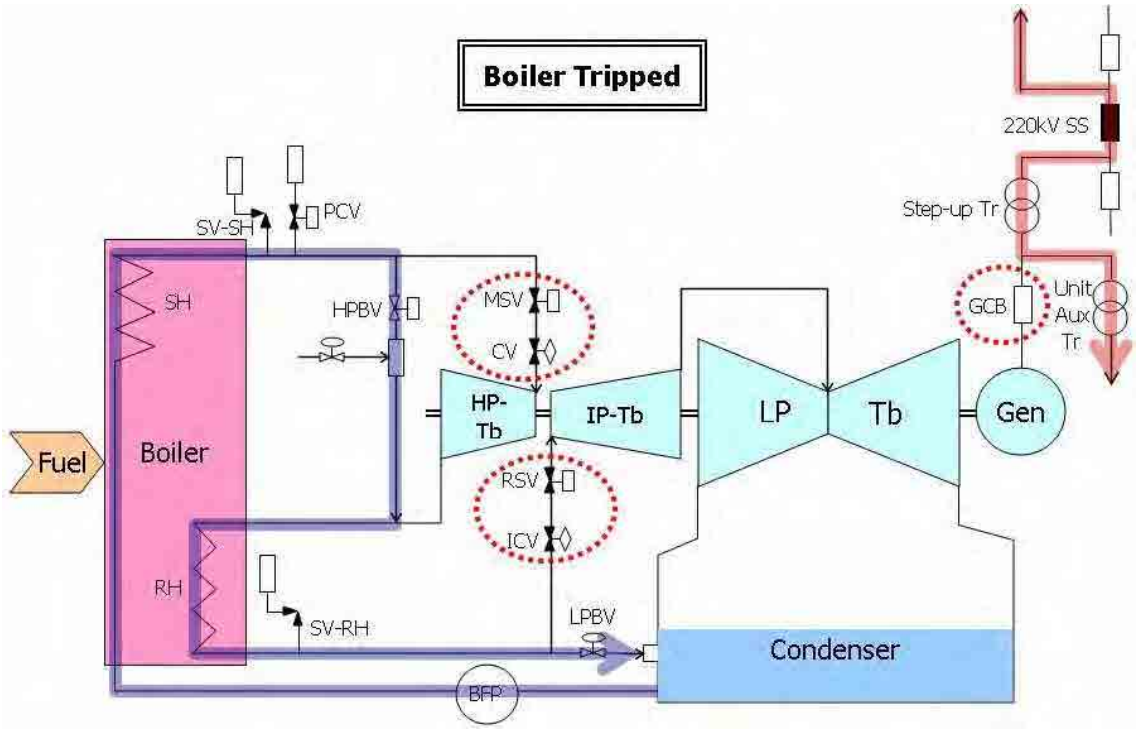


Figure 4.4.8.4 Basic flow under boiler tripped

(2) FCB (Fast Cut Back) Operation

Purpose of Fast Cut Back (hereinafter referred to as "FCB") System is to accomplish re-synchronization speedily without boiler trip when a generator circuit breaker is opened by accident in the EVN grid system.

The plant without FCB and turbine bypass system cannot be put in island operation because it is necessary to perform MFT (Master Fuel Trip) to avoid damage to the boiler reheater element since it is impossible to decrease the fuel flow to a minimum level.

In case the plant is isolated from the EVN grid system and put to island operation, it is necessary to promptly decrease the fuel flow to the boiler until the fuel flow to the boiler reaches the minimum level using FCB function.

It is necessary to decrease fuel and feed water flow rapidly to correspond to load for success of FCB

The plant can contribute to load demand by success of FCB. However success ratio of FCB of coal-fired power plant is low because it is difficult to decrease fuel and feed water flow rapidly. The following is an example of FCB failure.

An accident in the EVN grid system happens:
→CV closed
→No steam to Reheater
→Reheater protection relay's action
→MFT (Boiler Trip)

To avoid MFT action from reheater protection, it is necessary to decrease fuel. However rapid mill cut is difficult for coal-fired power plant. As the result, the best solution shall be to have enough capacity in the turbine bypass line.

Table 4.4.8.2 shows the capacity of turbine bypass and the merit / demerit.

Table 4.4.8.2 Capacity of turbine bypass and the merit / demerit

Plan	Plan A	Plan B
Capacity of turbine bypass	To Install 100% MCR Capacity of HP/LP Turbine Bypass	To Install 65% MCR Capacity of HP/LP Turbine Bypass
Merit	No need to decrease fuel rapidly	Economical (No need to install 100% capacity for pipes and valves and reconsider capacity for Condenser, CWP and BFP)
Demerit	Not economical (Need to install 100% capacity for pipes and valves and reconsider capacity for Condenser, CWP and BFP)	Need to decrease fuel rapidly

Following figure shows boiler and turbine load in case of Plans A and B.
It is necessary to have 100% capacity of turbine bypass line in case of Plan A. On the other hand, it is necessary to have 65% capacity of turbine bypass line in case of Plan B.

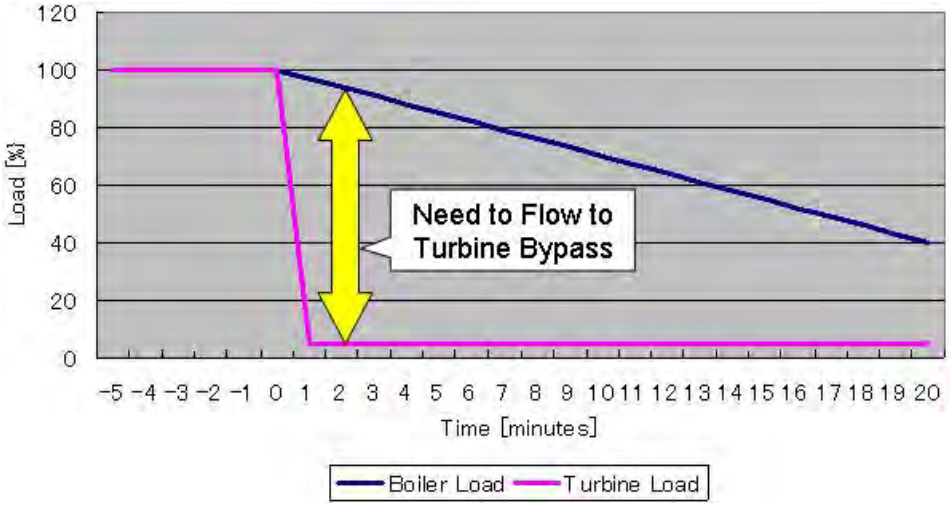


Figure 4.4.8.5 Boiler and turbine load in case of Plan A

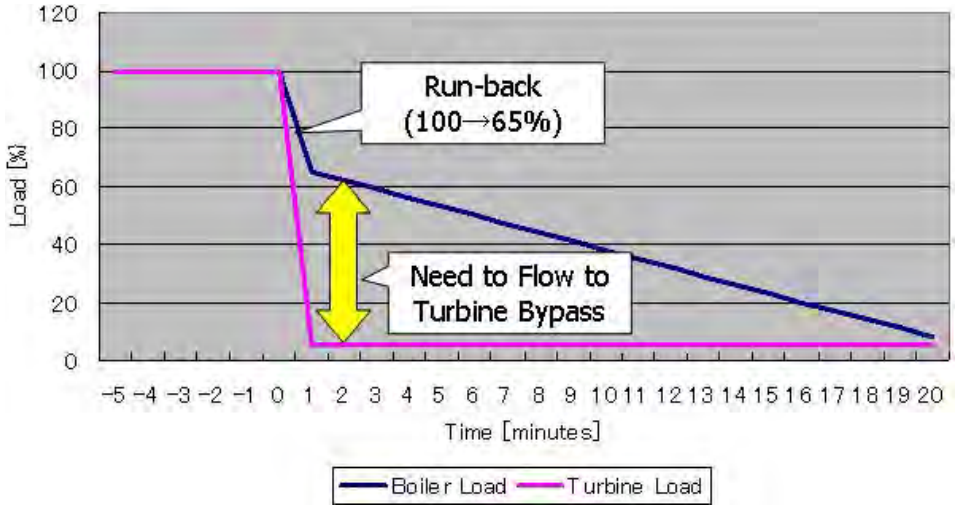


Figure 4.4.8.6 Boiler and turbine load in case of Plan B

Following figure shows the EVN Grid System Interlock (EVN grid system accident related to SONG HAU 1→FCB→BTG single operation / House load operation) concept. Generator is isolated by EVN grid system however generator, turbine and boiler still operated and decrease fuel and feed water flow rapidly to avoid action of reheater protection, then moved to BTG single operation (House load operation) until normal operation of EVN grid system and re-synchronization. Finally the plant accomplishes re-synchronization and control load from EVN LDC.
Boiler tripped automatically when the operation fails in FCB.

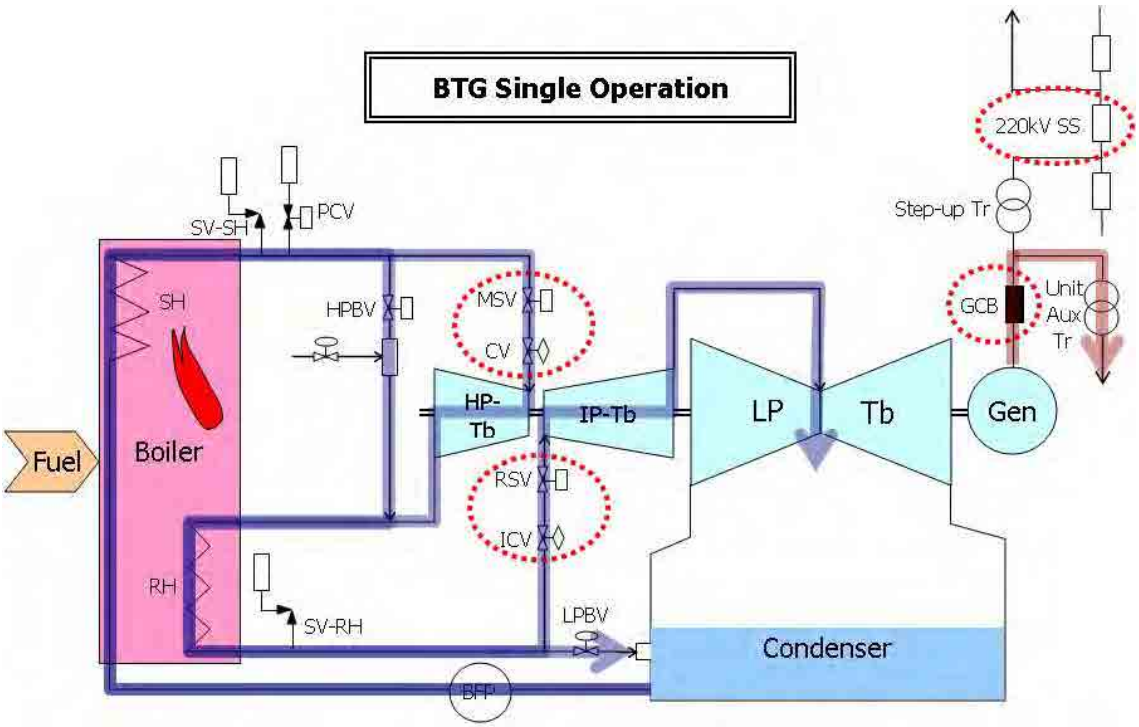


Figure 4.4.8.7 Basic flow under BTG single operation

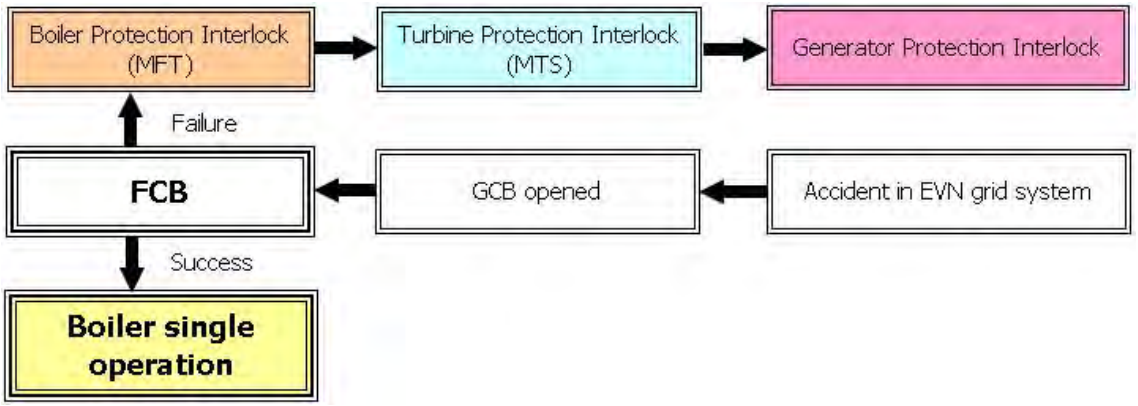


Figure 4.4.8.8 EVN Grid System Interlock
(EVN grid system accident related to Song Hau 1 FCB→BTG single operation)

Table 4.4.8.3 shows the merit and demerit of FCB function introduce. If the plant equips FCB function and can be put in island operation. Then the plant will be able to supply electric power rapidly in case of emergency situation.
However supercritical or ultra-supercritical coal-fired power plant, the turbine bypass system is usually provided only for start-up (30% B-MCR capacity) because of the additional cost and low success ratio of FCB. Therefore the introduction of FCB function is not absolutely necessary for Song Hau 1.

Table 4.4.8.3 Comparison to FCB Function

		Plant with FCB Function	Plant without FCB Function
Operation	When EVN Power System Trouble happened	BTG or Boiler Single Operation	Plant Tripped
	After the Trouble	Ready to Synchronization to EVN Power System	To take long time for restarting the plant
System (Turbine Bypass) Capacity		65 to 100% (to avoid MFT from Reheater protection)	30% (to control main steam for start-up)
Merit / Demerit		Contribution load demand from EVN LDC by success of FCB / Additional cost	Reasonable cost / Low success ratio of FCB

4.4.9 Switchyard

220kV outdoor switchyard is located between Song Hau 1 and 220kV transmission line manages power system. 220kV switchyard adopts one and half bus system. Connections in 220kV switchyard are following.

- 01 main transformer bay of Unit 1 of Song Hau 1 Power Plant
- 01 main transformer bay of Unit 2 of Song Hau 1 Power Plant
- 02 feeder bays outgoing to Can Tho 220kV station.
- 02 double-circuit feeder bays connected to Cai Lay - CA0 Lanh line.

It is not clear if connection line with 500kV substation and 220/500kV transformer shall be equipped or not. They differ from each figure. If there is the connection line, then it is necessary to consider bus capacity and the length, the number of 220/500kV transformer and the capacity.

Power flows 549.6MW in 2025 section in power flow analysis so that two 220/500kV transformers are needed.
Figure 4.4.9.1 shows Main connection of Song Hau Power Plant. There are two 220/500kV transformers in this figure.

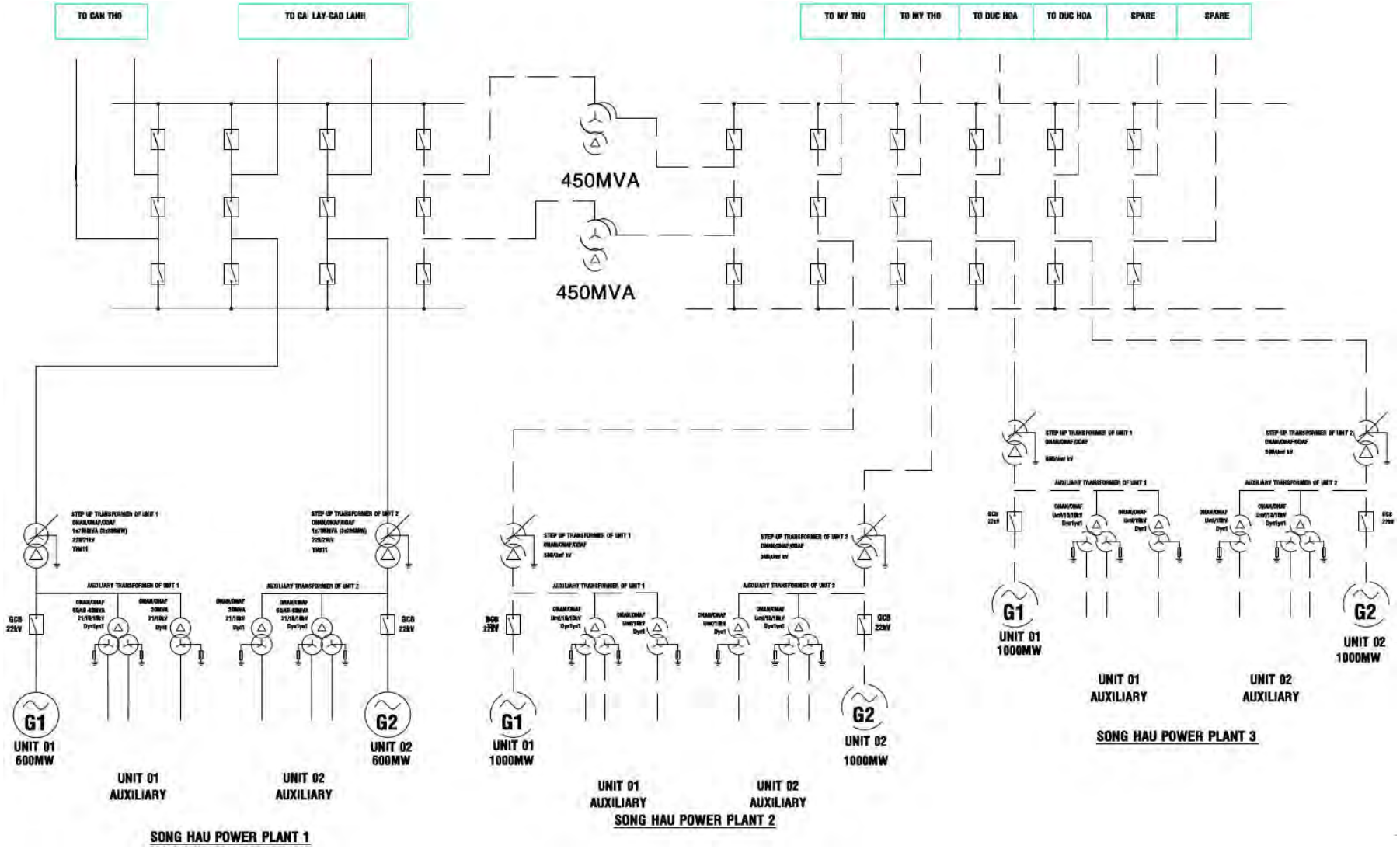


Figure 4.4.9.1 Main connection of Song Hau Power Plant

Table 4.4.9.1 Circuit-breaker and switch disconnector 220kV switchyard

Item	Circuit-breaker	Switch disconnector
Rated voltage	245kV	245kV
Rated current	2,500A	2,500A
Short - circuit withstand current	50kA	50kA
Short - circuit withstand current time	1s	1s
Quantity	9	9

Table 4.4.9.1 shows Circuit-breaker and switch disconnector 220kV switchyard.
Rated current for circuit-breaker and switch disconnector is 2,500A. However current flow is assumed to be 3,150A in case. Therefore Rated current for middle circuit-breaker and switch disconnector in 220kV substation shall be over 3,150A. To allow for future operation and maintenance management, all circuit-breakers and switch disconnectors in 220kV substation shall be over 3,150A.

Figure 4.4.9.2 shows 220kV Substation operating pattern 1. Current flow in 220kV substation is 1,575A（< 2,500A）and there is no problem for the open and close operation.

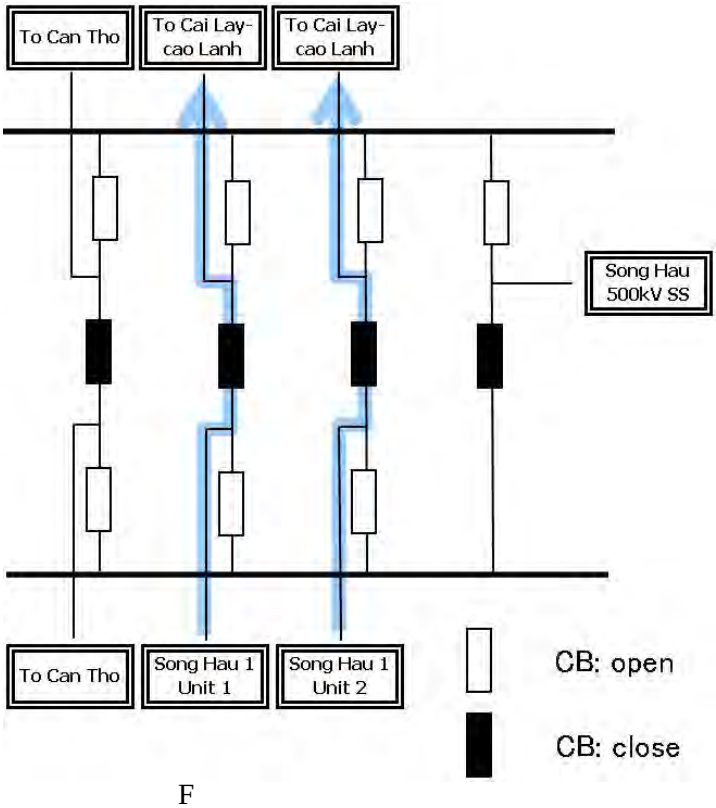


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Figure 4.4.9.2 220kV Substation operating pattern 1

Figure 4.4.9.3 shows 220kV Substation operating pattern 2. Current flow in 220kV substation is 3,150A（> 2,500A）and there is a problem for the open and close operation.

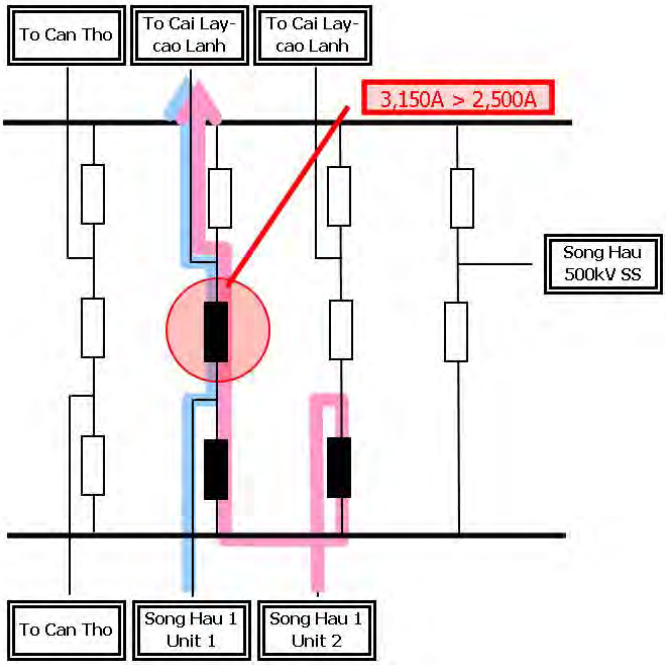


Figure 4.4.9.3 220kV Substation operating pattern 2

Figure 4.4.9.4 shows 220kV Substation operating pattern 3. Current flow in 220kV substation is also 3,150A（> 2,500A）and there is a problem for the open and close operation.

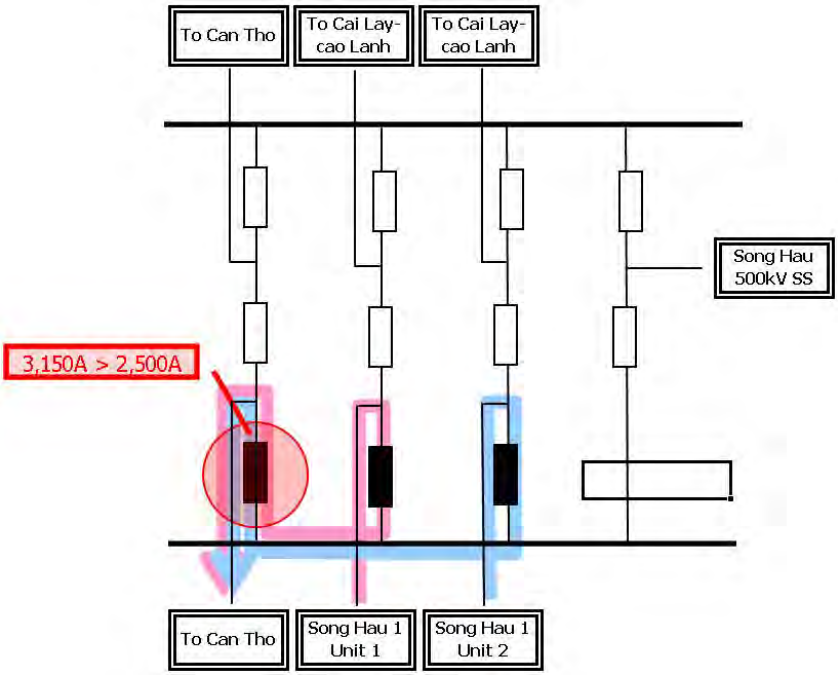


Figure 4.4.9.4 220kV Substation operating pattern 3

4.4.10 Harbor Facilities

To plan harbor facilities, it is important to assure a water depth for planned vessels in front of the planned site of the power plant and to maintain the water depth for a long period of time. The situation of Hau River in the vicinity of the planned site is such that the river width is 900 m and the flow axis of the river largely snakes toward the planned site of the power plant (right bank) from the upstream to the downstream and the water depth is about 20 m, which is the result of the depth measurement. Therefore, it can be thought that the water depth for the planned vessels is adequate and there is no fear for a long period of time that earth and sand deposit.
As harbor facilities, the following four berths are planned.

- Coal unloading berth (10,000 DWT, one berth)
- Limestone unloading berth (3,000 DWT, one berth)
- Gypsum loading berth (3,000 DWT, one berth)
- Materials and equipment unloading berth (3,000 DWT, one berth)

These berths are independently planned. Their structures are of a bridge type in the direct touch-down method. The base is formed by a combination of straight PHC piles and inclined PHC piles.
The planned pile in the direct touch-down method is the PHC pile. The material of the planned pile causes the pile capacity to be exceeded. In this case, two methods are conceivable; one of them is to change the touch-down method and the other is to exchange the PHC pile with a steel pipe pile.
In view of arrangement of steel pipe piles in Vietnam and costs, when the touch-down method is changed from the direct touch-down method to the pile fender method, the touch-down force can be reduced, so the use of the PHC pile becomes possible.
The pile fender method has been used at the EVN (CTTP) O Mon Power Plant as well, which is located upstream of Hau River. Since there are a construction track record and an operation track record of the pile fender method, the method can be considered to have no problem.
The following items have not been solved at present.

- Coal unloading berth --- Coal properties and method of transportation from the coal terminal
- Limestone unloading berth --- Lime quality in the desulfurization facility depending on the coal properties and amount of lime used
  Method of transporting lime from the lime supply source (Ha-tinh or its vicinity) (When a canal in the internal land is used for transportation, 500-ton barge vessels are used. When the open sea is used, however, vessels in classes of up to about 3000 DWT are used for transportation due to the deposited earth and sand within about 20 km of the Denan Mouth of Hau River.)
- Gypsum loading berth --- Gypsum quality depending on the coal properties, amount of production, and business partner

Therefore, all harbor facilities including the berth structure, connection bridges, shipping routes, and staying places would have to be reconsidered as soon as the above items are solved and vessel specifications, the required number of vessels (entrance frequency), etc. are clarified.

4.4.11 Civil Equipments

4.4.11.1 Design condition

For the soil conditions, hydrometeorological conditions and hydrological conditions, see Chapter 3.
Seismic load
The Song Hau Thermal Power Plant is located in the Chau Thanh area of Hau Giang Province. Seismic loads will be set in conformance to the aseismic requirements for each of the facilities, based on the TCXDVN 375(2006) which is the Vietnamese standards.

4.4.11.2 Development area for Song Hau 1 Coal Fired Thermal Power Plant

The Song Hau Complex Center will be developed in three phases. The first phase includes the development of an area of 139.5 hectares for the facilities of the Song Hau 1 Coal-fired Thermal Power Plant and Complex Center. In the second phase, the area of 114 hectares will be developed for the Song Hau 2 Coal-fired Thermal Power Plant. In the final third phase, the area of 114 hectares will be developed for the Song Hau 3 Coal-fired Thermal Power Plant. The land compensation and relocation of the inhabitants will be based on the national law of Vietnam.
The following describes the facilities to be installed in the area developed in the first phase:

- Main Power Block Fuel, and support area : 42ha
- 220kV switch yard : 2.5ha
- Discharge culvert : 20.7ha
- Ash pond for Song Hau 1 power plant : 33ha
- Shared technical line and support facilities : 4.5ha
- Construction preparation and storage area : 12.5ha
- Common area : 24.3ha

4.4.11.3 Land reclamation and Design Ground level

The ground level will be determined for each area in conformance to the specifications and application requirements, based on the result of the past hydrological survey, with consideration given to the rainwater drainage plan, operability and economic viability.

- Power Plant Area : +3.20m
- Coal Strorage Area : +2.75m
- Construction preparation and storage area : +2.55m

The current ground requires filling to a depth of approximately 2 meters on average. The sand of the Hau river bed located 80 km upstream of the site will be used as the ground filling material.
The planned ground level + 2.75 m in the coal yard area may not be much different from the rainwater drainage slope on the boundary between the power plant area and coal yard area. This makes it necessary to design a drainage channel and manhole for avoiding overflow of the waste water due to shortage of drainage capacity.
The ground level will be determined based on the river water level to be assumed in future, in conformance to the result of the above-mentioned hydrological survey. The Hau River estuary is currently in the process of dredging for the purpose of maintaining the navigation route. A new bypass channel “Quan Chanh Bo Channel” for detouring the estuary is currently under construction for large-sized vessels navigation. If dredging of the Hau River estuary is

suspended or reduced in scale after completion of a new channel construction, impact may be given to river profile and water level. To avoid this, subsequent river plans will have to be reviewed at relevant positions.

4.4.11.4 Revetment

The following revetment structures are commonly utilized:

- Steel sheet pile structure (made of concrete or steel)
- Gravity structure (concrete block, concrete caisson)
- Protection armor (gabion filled with pebbles or gabion) structure

The area surrounding the site is a soft ground (where SPT:N-value is approximately 0 in the standard penetration test) to a depth of 15 meters from the ground surface. This requires the revetment structure to be designed with consideration given to measures against circular rupture. The steel sheet pile structure provides the optimum revetment structure for the soft ground layer where a circular rupture may occur, from the viewpoint of construction cost and workability.The steel sheet pile structure revetment is characterized by the structural stability and reliability greater than those of the protection armor structure revetment. As compared with the gravity structure revetment, the steel sheet pile structure revetment is less affected by the impact of circular rupture, and ensures a higher degree of economic viability.
The steel sheet pile structure is available in two types -- one is made of concrete and the other is made of steel. The steel sheet pile structure made of steel is the optimum when consideration is given to the convenience of material procurement, structure reliability and workability.
In the PECC3 report, the steel sheet pile plus geotextile structure is studied as a revetment structure. There is no problem when improvement of ground stability and protection against circular rupture are considered under normal conditions. However, even when an impermeable material is used as the geotextile, if a working failure has occurred to the connection between the sheets, the steel sheet pile revetment may allow the fine-grained soil to be discharged into the river due to the fluctuation in the river water level caused by river flow and tide level. Accordingly, it would be effective to use the steel sheet pile structure in combination with the DMM (ex. CDM) using the cement-based solidifying agent, which has been field-proven in the Aumont Thermal Power Plant. Further, the height of the parapet on the upper portion of the revetment should be determined by giving to the wave height resulting from the wind upstream of the river. The following shows the method for calculating the wave height resulting from the wind upstream of the river: "S.M.B.(Sverdrup, Munk and Bretschneider) method adopted in the Japanese harbor technological standard (Wilson 1995)".

$$\frac{gH_{1/3}}{U^2} = 0.30\left[1 - \frac{1}{\left\{1 + 0.04\left[\frac{gF}{U^2}\right]^{1/2}\right\}^2}\right]$$

where $H_{1/3}$: Significant wave height (m)
U: Wind velocity (m/sec.)
F: Fetch length (m)
g : Gravity acceleration (m/sec.2) (9.81 m/sec.2)

4.4.11.5 Soil Improvement

The river sand of the Hau River located approximately 80 km upstream of the site is used as the banking materials used in the site preparation for power plant. A heavy machine will be used for compacting the embankment with a spreading depth of 30 cm. Before starting this work, the type of rolling compaction heavy machinery and the number of rolling compactions should be checked by using a test embankment so as to ensure sufficient degree of compactness. Further, this work should be placed under a high-quality work management by RI measurement and others. Even if sufficiently high-quality work management has been implemented, the younger embankment ground and lower layer includes the soft clay ground to a depth of approximately 15 m, where "N" is nearly equal to 0. Settlement and consolidation settlement will occur immediately due to natural load or live load. The following figure shows time-consolidation curve of the relevant ground.

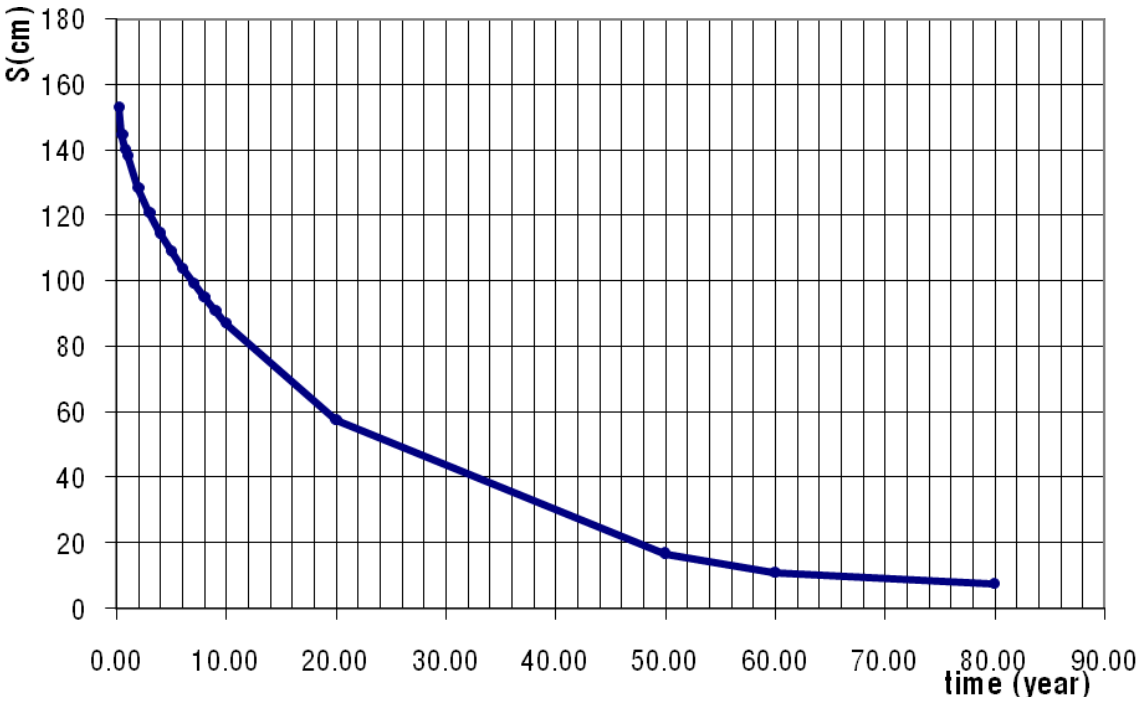


Figure 4.4.11.5.1 Time-consolidation curve of the relevant ground

If consolidation settlement occurs over a long span of time, the structures may be damaged by ground settlement; hence the operation of the power plant may be adversely affected.
Accordingly, prior to construction of the Song Hau 1 Coal-fired Thermal Power Plant, preparation for the site area should be started quickly by using embankments, and ground improvement work should be implemented quickly for consolidation promotion measures and ground enforcement.
According to the current program, PECC3 have proposed two programs by reference to the previous examples in the Soil improvement method recently adopted in the Thermal Power Plant in the southern part of Vietnam to solve the soft ground problem.

Table 4.4.11.5.1 Soil improvement method

	Soil improvement Alt.1	Soil Improvement Alt.2
Power Block, Switch yard	Sand Compaction method + Surcharge method	Vacuum Consolidation method + Surcharge method
Road , Landscapearea	Plastic Board Drain method + Surcharge method	Plastic Board Drain method + Surcharge method
CW intake & discharge system	DMM（CDM）	DMM（CDM）

With respect to the method for improving the soft ground, the costs and process configuration are important factors, but it is more important to study with careful consideration given to the target ground and the facility structures including the load conditions.
Thus, ground improvement at the sites of greatly differing ground conditions does not always bring about the optimum safety, quality or economic viability.
Further, in the area where the plastic boarding draining method is adopted, the pipe foundation is being studied as a foundation for buildings and tanks. A sufficient distance should be ensured, with careful consideration given to the working precision between the plastic boarding material and pile foundation.

4.4.11.6 Foundation Structure

Under the current site ground conditions, soft ground is present to a thickness of 15 through 20 meters. The ground immediately below the structures is not capable of providing a sufficient bearing capacity to support many structures. Accordingly, the pipe foundation structure has to be adopted.
The optimum foundation structure type of the foundation structures should be selected according to the target facility structure, ground conditions, loading, the degree of importance of the facilities and related laws. The ground improvement measures will be taken as described in 4.4.11.5. The following structures are taken for the facilities where sufficient bearing capacity cannot be ensured: The PHC pile foundation structure is adopted for the large-sized load structure. The in-situ pile driven foundation structure is used for the smokestack of extreme weight, and the RC pile foundation structure is used for the medium-sized load structure.

4.4.11.7 Stack

The Song Hau 1 Coal-fired Thermal Power Plant has a smokestack with a height of 200 meters. This is the result of studying the atmospheric proliferation prediction and economic viability. The outer sleeve of the smokestack is mad of reinforced concrete. The smokestack has a diameter of 26.6 meters on the ground level, and 16.6 meters on the crown of the smokestack. The concrete is 800 mm through 300 mm high. Exhaust gas pipes are formed of two steel pipes each having an internal sleeve diameter of 6,200 mm with an average plate thickness of 15 mm. In-situ pile driven foundation structure is used as the foundation structure.

4.4.11.8 Intake and Discharge system

(1) Intake Mouth
The Song Hau 1 Coal-fired Thermal Power Plant having an area of 40 hectares is located on the right bank of the Hau River. The width of the Hau River in front of the site is approximately 900

meters and the river flows approximately in a straight line. The flow on the right bank (power plant) is faster.
The coal unloading berth, coal receiving berth, gypsum issuing berth and unloading yard will be built along the Hau River in front of the site.
The water intake mouth position is located between the coal unloading berth specifically designed for the Song Hau 1 Coal-fired Thermal Power Plant and the coal unloading berth specifically designed for the Song Hau 2 Coal-fired Thermal Power Plant. The water intake method at the perpendicularly deep layer far in the offing 105 meters from the revetment will be adopted in order to ensure that the peripheral environment such as vessel navigation, use of piers and ecosystem will not be adversely affected. When this method is adopted, water is taken from the deep layer which is immune to weather. This arrangement ensures stabilized water temperature, and minimizes the possibility of collecting the rubbishes floating in the river. The water intake speed is approximately 0.2 m/s, and the vessel navigation, use of piers and river bed sand will not be adversely affected.

(2) Intake and Discharge channel
The steel or FRP-made intake water pipe is used for the inlet channel. The more economical pipe diameter will be determined with consideration given to the pump running cost by the flow speed inside the intake water pipe in addition to the intake water pipe construction cost. For the discharge channel, a steel or FRP-made discharge pipe is used up to the siphon pit, and a box culvert structure is adopted from the siphon pit and after. Similarly to the case of the inlet channel, more economical pipe diameter and internal dimensions are determined.
The crown height of the box culvert must be -10 cm with respect to LWL of the Hau River to avoid water hammering.
Where discharge channels run parallel to one another in the Song Hau Complex power plant, a discharge channel is built using an independent box culvert.
As discussed with reference to 4.4.11.5, the DMM(CDM) is adopted in the discharge channel ground improvement measures. This ensures soil bearing capacity and workability of the soft ground at the time of excavation. Thus, where discharge channels run parallel to one another, ground improvement measures should be taken in preference, for the benefit of subsequent power plants to be built in future.
Although there is no problem when the Song Hau 1 Coal-fired Thermal Power Plant is constructed, the transmission cable connecting between the main transformer and switching station of the power plant holds the discharge overhead in the present planning. During the subsequent construction of coal-fired Thermal Power Plant discharge channel of the Song Hau 2 and 3 to be built in future, the transmission line for the Song Hau 1 Coal-fired Thermal Power Plant will have been installed. Thus, sufficient overhead working space may not be ensured, and the general construction method may not be utilized due to working restrictions resulting from limited overhead space. This may raise the construction cost. Accordingly, if there are total economic advantages, adoption of the OF cable and cable trench should be studied for use in the transmission cable connecting between the power plant MTr and switching station.

(3) Discharge Outlet
The water discharge port should be located downstream from the boundary of the power plant site area as far as possible from the boundary, to avoid possible impact of the warm waste water recycling of the Thermal Power Plant. The distance between the water intake position and water discharge port will be approximately 1 kilometer. In the water discharge system, a special-purpose discharge pipe is used to discharge water of the deep layer. The discharge flow velocity will be approximately 1.8 m/s so as to reduce the warm waste water proliferation area.

(4) Water flow

In the PECC3 report, the water intake low is set at 56 m^3/s. At present, the major equipment manufacturer for determining the water intake flow is not yet determined. Accordingly, based on the principle of "Safety First", study should be made at a water intake flow rate of 64 m^3/s having been used previously at the time of working out the program in the supercritical coal-fired thermal power plant. When consideration is given to water intake and water discharge at the deep layer (discharge flow velocity 1.8 m/s), the measures for avoiding warm waste water recycling have been studied. Although there may be no difference even if there is a slight increase in water intake flow for which simulation is implemented at present, analysis should be made for verification, based on the principle of "Safety First".

4.4.11.9 Coal storage area

The coal yard is located in a place sandwiched between the power plant and the Hau River. The coal yard will be used as the facility for storing the coal for 30 days to be used at a full capacity in the power generation facilities. In the ground improvement measures for coal yard area, the CDM construction method to a depth of approximately 20 meters will be adopted. Further, in the measures against rainfall for the coal yard, construction of an indoor coal yard for storing coal for 7days is included in the program. An in-situ pile driven foundation structure as a foundation structure type will be required.

4.4.11.10 Ash pond area

The ash pond area forms a triangular site area of approximately 33 hectares. The Song Hau 1 Coal-fired Thermal Power Plant is located on the northwest. A common discharge channel is situated on the south, and the Song Hau thermal power harbor facilities are located on the northeast.

This area is approximately 60 meters apart from the Hau River revetment. To prevent heavy metals of the ash from flowing into the river, reliable seepage control measures should be taken.

The ash disposal site will be constructed approximately 16 meters above the soft ground. Ground improvement and seepage control measures will be taken to prevent the ash from flowing out of the ash disposal site.

In the seepage control measures, an ash disposal site earth dam HDPE sheet (1.5 mm) and bentonite-based seepage control mat (5 mm) will be provided. In the measures against soft ground, the CDM ground improvement will be implemented.

In the PECC3 report, with consideration given to the proven performances of the existing Vietnamese Coal-fired Thermal Power Plant, the reuse of ash is set at 70 percent. Since the imported coal and ash destination are not yet determined and the coal property is unclear at present, further candidates for the ash disposal site should be included in the program.

4.5 Operation and maintenance

4.5.1 Operating Condition

Operating conditions are classified as start-up, normal operation, 220kV bus bar short - circuit, Load shedding, overload, normal stopping and emergency stopping.

Figure 4.5.1.1 shows Normal operation case and Figure 4.5.1.2 shows Start-up / shutdown case.

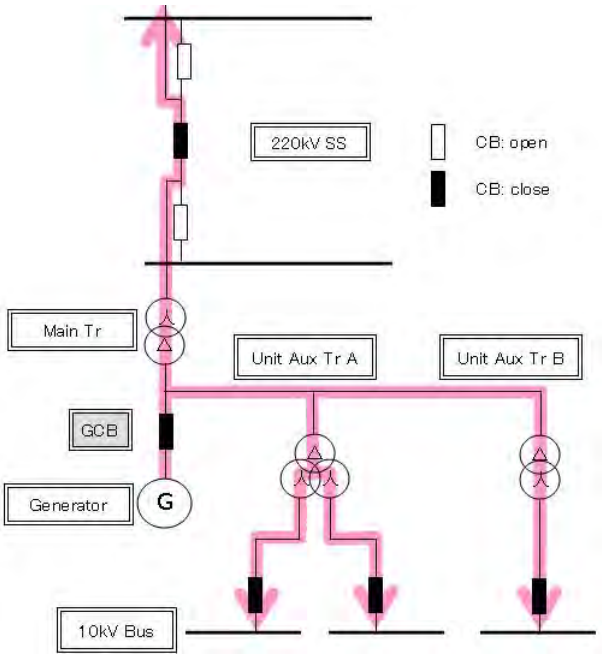


Figure 4.5.1.1 Normal operation case

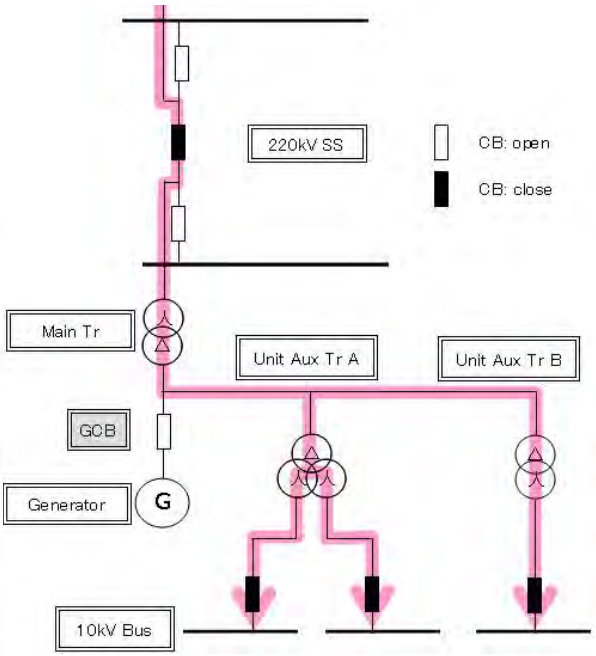


Figure 4.5.1.2 Start-up / shutdown case

・Start-up case

In order to start-up, the system will take power supply from the 220kV station through main transformers and unit auxiliary transformers. After starting the generator will be synchronized to the grid, through the generator terminal circuit-breaker when having sufficient condition of synchronization to the grid.

Power receiving before synchronization: 220kV Substation - 220kV - Main transformer - 21kV - Unit auxiliary transformer - 10kV – 10kV Unit bus

Power sending after synchronization: Generator - 21kV – GCB - 21kV - Main transformer - 220kV - 220kV Substation

Grid synchronization will be performed at the generator terminal circuit-breaker or at circuit breakers at the 220kV substation side in both automatic and manual modes. GCB is normally used as a synchronizing circuit breaker. Circuit breaker at the 220kV substation is used for synchronization after BTG single operation by FCB. Therefore it is important to examine that if FCB (Fast Cut Back) shall be adopted for this plant or not. (Reference: 4.4.9 Instrument and control system)

・Normal operation case

During the process of normal load operation, the auxiliary system will be supplied power from the generator through unit auxiliary transformers. Common load of the Plant can be connected to the auxiliary system of the Units.

Power receiving: Generator - 21kV – GCB - 21kV - Unit auxiliary transformer - 10kV – 10kV Unit bus

Power sending: Generator - 21kV – GCB - 21kV - Main transformer - 220kV - 220kV Substation

・220kV bus bar short - circuit

In case the generator is synchronized to the grid, the permissible maximum time of 3 phase short-circuit at the 220kV bus bar is 0.1s. If this time lasts long, the generator must be separated

from the gird.

・Load shedding
The system allows shedding load at any time and must ensure that during the load shedding will not cause adverse effect to the operation of the turbine - generator system and the auxiliary system. Therefore it is important to examine that if FCB (Fast Cut Back) shall be adopted for this plant or not.

・Overload
In addition to the normal load operation mode, the turbine - generator is allowed operating at overload mode. Therefore, the generator and electric equipment are designed with capacity of operating at overload mode (current, temperatures… increase). Overload mode of the generator depends on the turbine MCOR at VWO mode, reference value is 5%.

・Normal stopping
Turbine generator is stopped by gradually reducing the volume of steam and steam parameters, at the same time allowing steam running by-pass the condenser and reducing the generator output, separating the generator from the electric network of interrupting the generator terminal circuit-breaker, and control by DCS. During the stopping process, power supply must be ensued for the auxiliary system without interruption.

・Emergency stopping
In case of emergency stopping, in order to ensure safe stopping, power supply of the auxiliary system will be supplied from the emergency accumulator and diesel generator system.

4.5.2 Operation Plan

(1) Philosophy of the plant operation
Song Hau 1 Power Plant (2 x 600MW) will be a large thermal power plant connected to the Natural electric system, under the management and dispatching of the National Load Dispatch Center (A0) and the Southern Load Dispatch Center (A2). Therefore, the operation and maintenance regime of the plant must be calculated conforming to the characteristic of the electric system and is subject to the management of A0 and A2.
The operation management of Song Hau 1 Power Plant should consider the following requirements:

- The number of unit shutdown times in 01 operating year / including planned shutdown and shutdown according to the dispatching of A0 and A2, obligatory shutdown due to breakdown.
- The plant efficiency,
- Electricity production cost.

The equipment life is also a factor that should be considered. Normally, the life of a coal - fired thermal power plant is about 25 - 30 years. However, through practical experience in shows that if the plant is maintained well, its life may attains 40 years.
The operation regime of Song Hau 1 Power Plant must be based on the following factors:

- The plant is operating in the base run mode, continuous operating for 24 hours/day, 7days/week. The designed operating time (average annual operating time converted to the rated output) Tmax = 6,500 h/year.
- Due to the weather characteristic of our country, the power plant should be continuously

operating in dry season.
- The plant must be ready to operate at high level and the shutdown rate must be obligatorily low.
- The designed efficiency of the plant will be maintained for a long time.

Table 4.5.2.1 shows available hours and unavailable hours. Available hours are set as 6,500 h/year (Availability: 74.2%). To have a good grasp of power plant management and keep the maintenance, it is necessary to communicate to Load Dispatch Centers and set the target of Reserve shutdown hours, Planned outage hours and Unplanned outage hours (Forced outage hours and Maintenance outage hours)

Table 4.5.2.1 Available hours and unavailable hours

<table>
<tr><td rowspan="5">Period hours
8,760 hours</td><td rowspan="2">Available hours</td><td colspan="2">Service hours: 6,500 h/year</td></tr>
<tr><td colspan="2">Reserve shutdown hours</td></tr>
<tr><td rowspan="3">Unavailable hours</td><td colspan="2">Planned outage hours</td></tr>
<tr><td rowspan="2">Unplanned outage hours</td><td>Forced outage hours</td></tr>
<tr><td>Maintenance outage hours</td></tr>
</table>

Source: IEEE Standard Definitions for Use in Reporting Electric Generating Unit Reliability, Availability and Productivity

Availability target for coal-fired power plant is set as 83-90% in Operation and effect indicator by JBIC (October 2002).

(2) Function of control rooms

The system what is controlled and supervised by UCMS shall be controlled and supervised in central control room. The system what is controlled and supervised by SCMS shall be controlled and supervised in coal supply system control room or auxiliary system control room. The system what is controlled and supervised by SCMS shall be supervised in central control room.

Table 4.5.2.2 Control and monitoring at each control room

<table>
<tr><th rowspan="2">control room</th><th>PECC3's suggestion</th><th colspan="2">Recommendation</th></tr>
<tr><th>Control & supervision</th><th>Control</th><th>Supervision</th></tr>
<tr><td>Central control room</td><td>Turbine, generator and boiler
220kV substation
fuel feeding system (coal & oil)
water and sewage treatment system
ash discharge system
flue gas treatment
other auxiliary systems</td><td colspan="2">Turbine, generator and boiler
220kV substation
fuel feeding system (coal & oil)</td></tr>
<tr><td></td><td></td><td>water and sewage treatment system
ash discharge system
flue gas treatment
other auxiliary systems</td></tr>
<tr><td>Coal supply system control room</td><td>Coal storing and supplying system</td><td colspan="2">Coal storing and supplying system</td></tr>
<tr><td>Auxiliary system</td><td>Ash discharge system, flue gas treatment system (SCR ESP, FGD)</td><td colspan="2">Ash discharge system, flue gas treatment system (SCR ESP, FGD)</td></tr>
</table>

control room	PECC3's suggestion	Recommendation	
	Control & supervision	Control	Supervision
control room	water treatment system sewage treatment system 220kV substation	water treatment system sewage treatment system 220kV substation	

4.5.3 Maintenance Plan

(1) Maintenance strategy

In order to manage maintenance effectively, a detailed job management system should be established.

- Minimizing breakdown level of equipment
- Minimizing the number of shutdowns of the Plant
- Shortening the Plant shutdown time
- Increasing the capacity of detecting and anticipating the development of treat down
- Minimizing the repairing time
- Increasing working efficiency of the workers
- Minimizing equipment storage time
- Minimizing the quantity of materials and spare parts reserved for emergency case
- Minimizing paper work
- Minimizing maintenance cost

(2) Maintenance plan

Table 4.5.3.1 shows maintenance plan.

Table 4.5.3.1 Maintenance plan

maintenance	works
Regular maintenance	daily works, such as adding oil and grease, checking the operating situation of equipment, measuring and sampling
Preventive maintenance	checking, repairing, replacing based on forecasting before a component or equipment is broken down causing hindrance for production
Appointed maintenance	repairing, replacing based on the parameters that are measured during the process or regular maintenance for permissible criteria such as vibration, temperatures, wear and tear rate
Emergency maintenance	repairing or replacing components for equipment or equipment assembly to overcome the breakdown, put the system back to the state of normal operation
Overhaul maintenance	Repairing, adjusting, replacing components for equipment or equipment assembly. Equipment, equipment assembly for overhaul must be separated from the system
Shutdown maintenance	maintenance requires shutdown for implementation
Changing design	the works must be implemented to change the design of an equipment assembly or a system in order to raise the operating performance of the plant

Table 4.5.3.2 shows maintenance plan system.

Maintenance plan shall be organized by the period.

Table 4.5.3.2 Maintenance plan system

State		Maintenance	Service
Available hours	Service hours	Daily Maintenance	adding oil and grease, checking the operating situation of equipment
	Reserve shutdown hours	Temporary / Overhaul maintenance	Unplanned Overhaul Temporary repairing and replacing
Unavailable hours	Unplanned outage hours		
	Planned outage hours	Overhaul maintenance	Planned Overhaul Planned repairing and replacing

Figure 4.5.3.1 shows Equipment check flow under operation and shutdown.

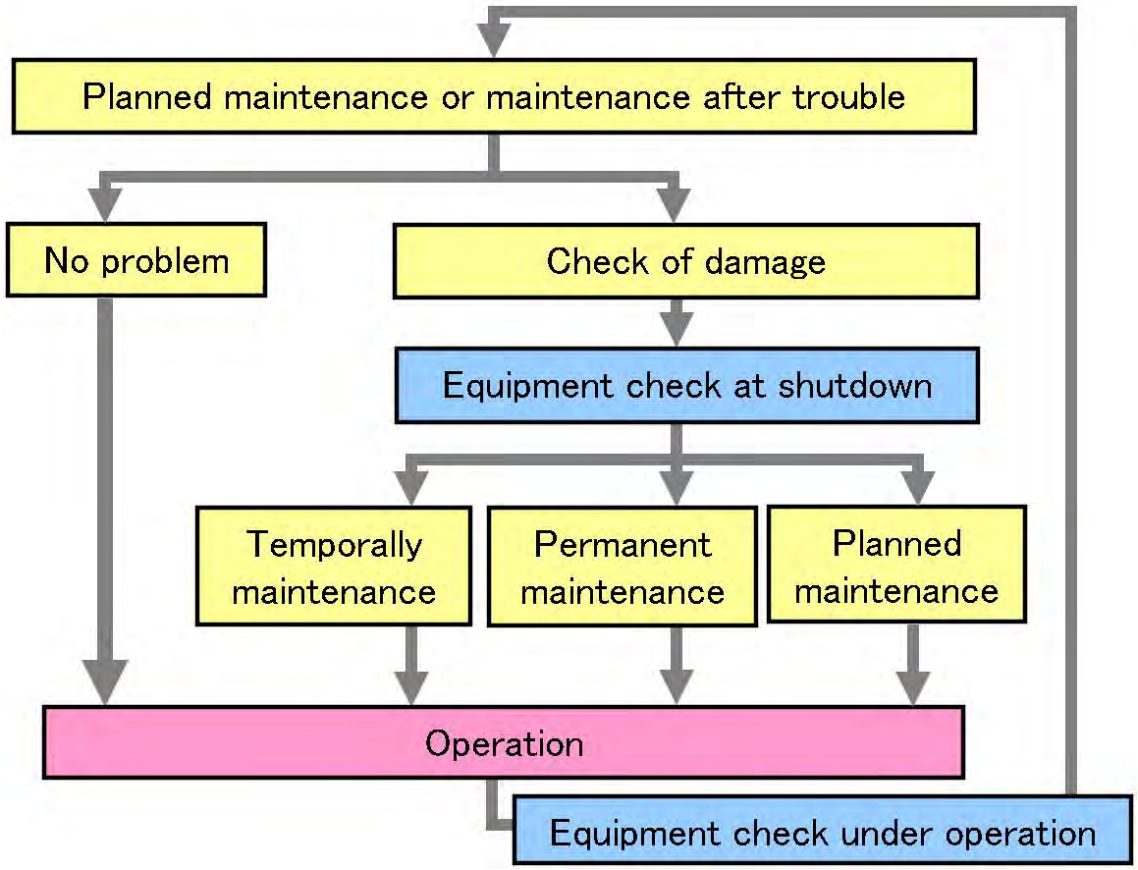


Figure 4.5.3.1 Equipment check flow under operation and shutdown

4.6 Transportation Plan

The total weight of the construction materials and equipment at the Song Hau 1 coal fired power plant (600 MW × 2 units) is about 15,000 tons. The method of transporting these construction materials and equipment is important when processes in the project are considered. Materials and equipment related to mechanical and electrical are prepared from overseas and materials and equipment related to civil and building works are prepared in Vietnam. General transportation plans in which the method of transporting materials and equipment to the power plant site is considered are described below.

(1) Transportation plan for Heavy/ Long Equipment

The weights of the main equipment to be transported to the coal fired power plant (600 MW) are as listed below.

Table 4.6.1 Heavy / Long Equipment Weights

Equipment name	Weight (tons)/ length (m)	Transportation beam (tons)	Dolly (tons)	Total weight (tons)
Generator Stator	285.0/9.7	10.0	108.2	403.2
Turbine Integrated into HP	228.0/9.0	10.0	79.4	317.4
LP Rotor	97.0/10.0	0.0	78.2	175.2
HP Heater	93.0/9.25	0.0	68.5	161.5
LP Casing (lower)	35.0/7.3	5.0	25.0 (trailer)	65.0
Deaerator	83.0/15.8	0.0	69.7	152.7
Main Transformer	340.0/14.5	0.0	117.0	457.0

These heavy / long equipments are basically prepared from overseas and transported. In projects throughout the Mekong Delta, in view of the unloading from cargo vessels, procedures for customs clearance, etc., procedures for custom clearance will be taken at Saigon Port in Ho Chi Minh City, after which these items will be reloaded from the cargo vessels to barge and transported to the power plant site through the canal in the Mekong Delta. As for the sizes of the barge, the 1,000 ton class may be necessary for generator stators and main transformers and 500 to 300 ton classes may be necessary for other equipment. About one week will be taken for transportation. In roll-off at the power plant site, a temporary unloading jetty will be provided within the site, and the items will be carried from the barge directly to the site by using a dolly and will be then installed, with the water level of the Hau River taken into consideration. Therefore, it is important to create transportation plans by sufficiently considering procedures for customs clearance in Ho Chi Minh City, ransportation in the Mekong Delta, and the water level of the Hau River. When generator stators are transported on temporary roads within the site, the roads need to be about 15 meters wide. A force of 7 ton/m^2 must have been assured as the bearing force of the soil.

(2) Transportation plan for materials and equipment related to construction of civil and building works

a. Materials and equipment related to construction of civil works

The main materials and equipment in civil works are piles, reinforcing iron bars, and other materials used in construction of foundation. As for piles, the PHC pile with a diameter of 600 mm is the foundation pile for the main equipment. The factory in which PHC piles are manufactured is located in the vicinity of Ho Chi Minh City. PHC piles are transported by barge through the canal in the Mekong Delta or another route. In preparation construction before the start of the construction, a temporary unloading jetty needs to be installed within the power plant site. Piles will be unloaded from the barge and reloaded on trailers by using cranes and will be transported to the pile stock yard in the site. Therefore, a transportation plan needs to be created in consideration of processes including the manufacturing and curing of piles. Reinforcing iron bars are also transported in almost the same method as for PHC piles, so a plan needs to be created in consideration of the number of days taken for transportation. Other materials and equipment are mainly transported by trailers and other means on roads, so a transportation plan needs to be created in consideration of the maximum allowable vehicle

weights (20 to 30 tons) of the bridges across the rivers near the power plant site.

b. Materials and equipment related to building works

The main materials and equipment in building works are steel frames for buildings. The factory in which steel frames are manufactured is located in the vicinity of Ho Chi Minh City. Therefore, as in the case of piles, steel frames are transported by barge through the canal in the Mekong Delta or another route. Of the steel beams, main columns and main beams are important structural materials, so sufficient care must be taken so that they are not damaged due to a collapse of cargo piles that is caused by lateral waves from other vessels travelling through the canal.

c. Other materials and equipment

Inner flues of stacks and circulating water pipe, which are materials and equipment used in civil constructions, also need to be transported to the site in a planned manner. Although these materials are not so heavy, their bore diameters are large, occupying a large area in storage. Since the carry-in time of these materials may be the same as that of materials and equipment in mechanical and electric constructions, a carry-in plan needs to be created in consideration of the storage yard.

This completes the description of the general transportation plans. Storage of materials and equipment also need to be carefully planned. Important materials and equipment related to machines and electricity will be stored in a temporary warehouse, but other packages will be directly stored outdoors. To store large quantities of materials and equipment for a long period of time, a very large storage area is required. Another problem is that since it rains heavily in the rainy season, if packed materials and equipment are stored directly on the soil, equipment may rust etc. It is desirable that the storage area be paved with, for example, crushed stones to prevent direct contact with the soil.

4.7 Project Schedule

4.7.1 Project Schedule

According to Vietnamese 7th National Power Development Plan (hereinafter referred to as “PDP7”), Commercial operation date (hereinafter referred to as “COD”) for Song Hau 1 coal fired power plant power is scheduled as follows;

Table 4.7.1.1 Schedule of COD

Power Plant	COD (MP7)
Song Hau 1 unit #1	2017
Song Hau 1 unit #2	2018

Though the detailed construction schedule of Song Hau 1 & 2 CFPP is not disclosed, if the first unit starts to construct in 2012 and second unit starts to construct in 2013, construction period for each unit is 5 years or more. Therefore it seems that Song Hau 1 & 2 CFPP can be put into commercial operation in 2017 and 2018 considering 6 months soil improvement.

For reference, the construction schedule of 600MW coal fired power plant in Japan is shown in Figure 4.7.1.1.

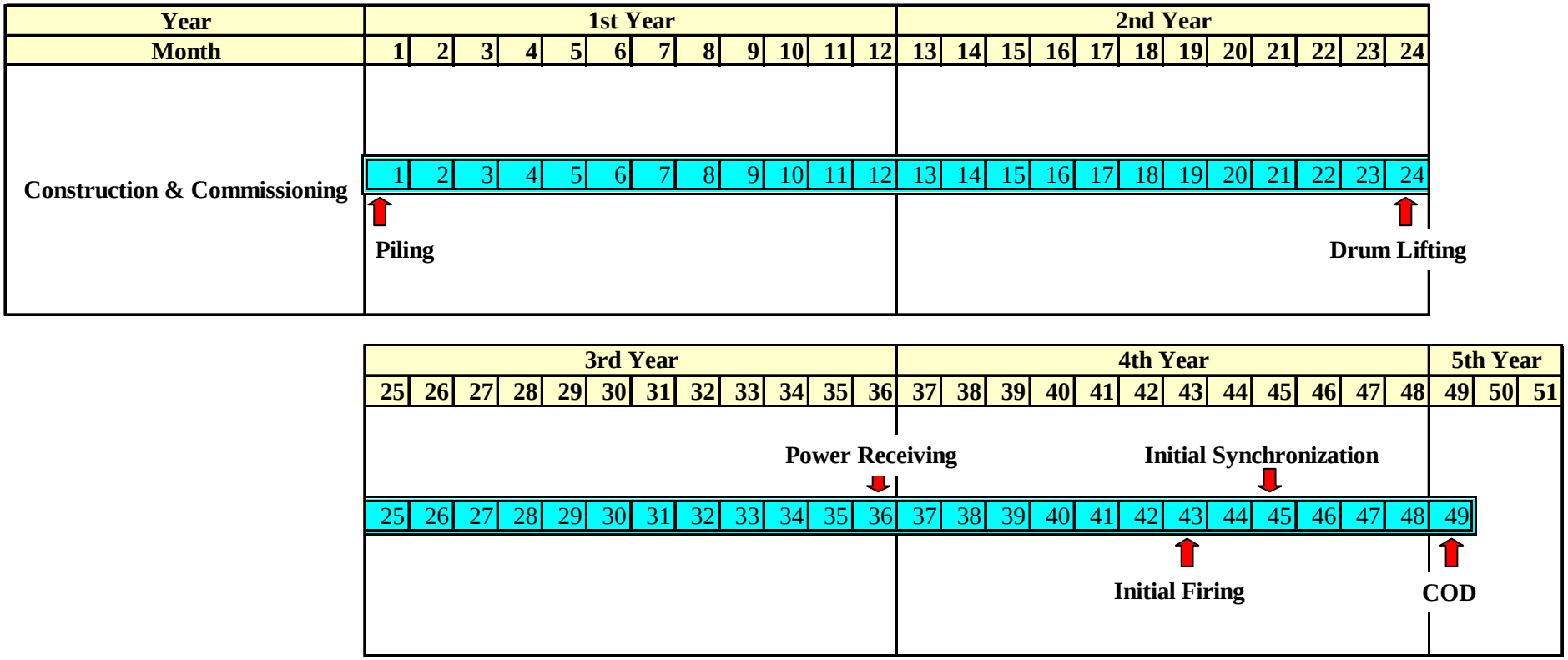


Figure 4.7.1.1 Construction Schedule

4.7.2 Recommendation to Management of Construction Schedule

To manage the construction schedule of the large-scale power plant project, it proposes following.

(1) Appointment of Experienced Consultant
In Vietnam, most of company who is concerned power industry has not experienced construction of the large-scale coal fired power plant of 600MW or more. Therefore, it is recommended that PVN appoints the consultant in the foreign country who has abundant experiments about the construction management of the large-scale coal fired power plant.

(2) Recommendation of Turn-key Contract
Power plant equipment and facility are often placed an order for reduction in cost separately in Vietnam. In such case, construction work will be delayed because it takes time to coordinate each equipment and facility. The delay of the construction work will occur to delay the power supply. Therefore, it is recommended to adopt turn-key contract as much as possible to minimize the delay of construction and to reduce the interface for each equipment and facility.

4.8 Project Cost

Table 4.8.1 shows estimated project cost by PVN. Total project cost is estimated 1,633,227,398 USD and unit construction price is estimated 1,361 USD par kW.

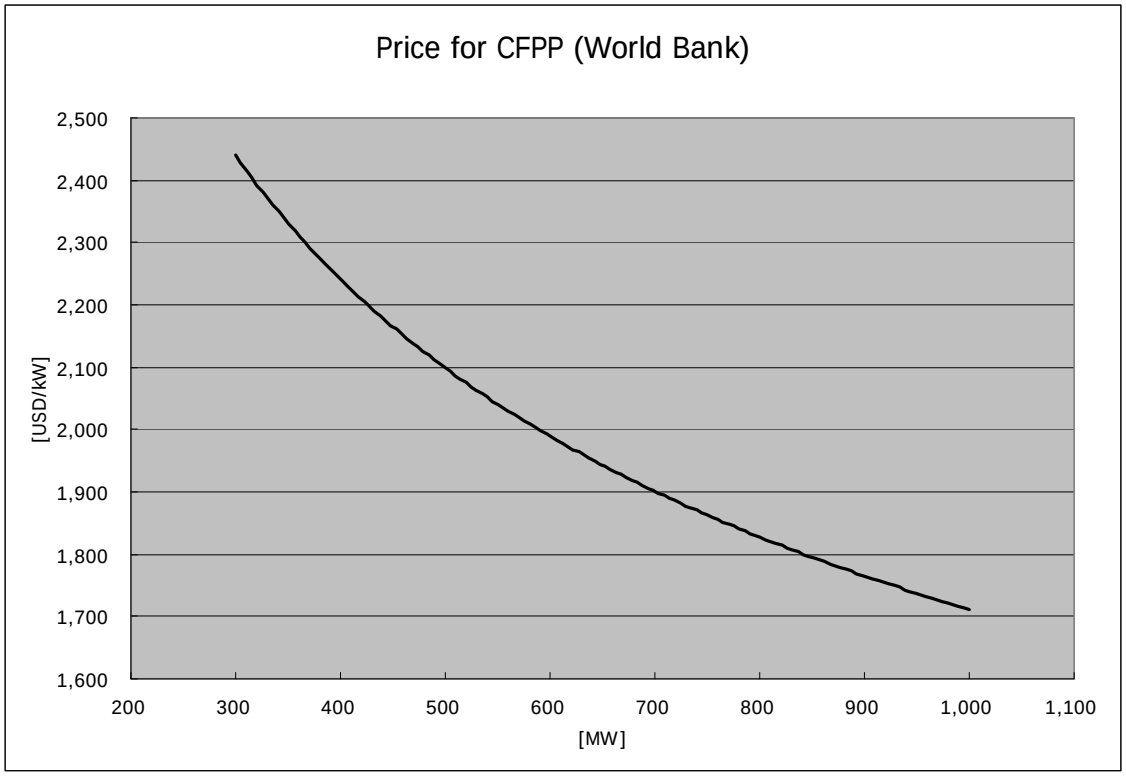
Table 4.8.1 Estimated Project Cost

No.	Items	Total investment cost (after tax)			
		The part in VND	The part in USD	equivalent to VND	equivalent to USD
1	Construction cost	4,178,640,750,648	142,077,889	7,113,685,777,288	344,355,009
2	Equipment cost	994,086,344,672	794,566,187	17,408,234,631,010	842,687,319
3	Compensation, support and resettlement cost	Calculated in item 8 (Infrastructural project)			
4	Administrative cost	92,332,807,499	0	92,332,807,499	4,469,591
5	Construction investment consulting cost	96,659,645,921	20,353,523	517,122,727,132	25,032,565
6	Other cost	148,707,105,626	151,680,433	3,282,121,487,358	158,878,957
7	Contingency	696,669,650,940	171,836,112	4,001,454,324,074	193,699,987
7.1	Contingency for volume of work raised	551,042,665,437	110,867,803	2,596,344,012,641	125,682,254
7.2	Contingency for inflation	145,626,985,503	60,968,309	1,405,110,311,433	68,017,732
*	Sub-total	6,207,096,305,305	1,280,514,144	32,414,951,754,361	1,569,123,427

No.	Items	Total investment cost (after tax)			
8	Cost allocated from the infrastructure project	1,324,259,824,575	0	1,324,259,824,575	64,103,971
*	TOTAL	7,531,356,129,880	1,280,514,144	33,739,211,578,936	1,633,227,398

(source) Decision No. 2824/QĐ-DKVN (05 April, 2011)
Exchange rate: 1 USD = 20,658 VND

For reference figure 4.8.1 shows the trend of construction price for coal fired power plant based on the World Bank's report "Study of Equipment Price in the Energy Sector" established in 2009. According to this report, in case of 600MW coal fired power plant, the construction cost is estimated 1,989 USD par kW.



(source) Study of Equipment Prices in the Power Sector / The International Bank for Reconstruction and Development / THE WORLD BANK GROUP / 2008
Figure 4.8.1 Trend of EPC price for CFPP

Moreover, construction cost of coal fired power plant (660MW x 2) in Indonesian is 1,797 USD par kW.

Table 4.8.2 Comparison of project cost

	Song Hau 1	World bank	Indonesia
Unit price	1,361 USD/kW	1,989 USD/kW	1,797 USD/kW

Chapter 5 Fuel Supply Plan

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Chapter 5 Fuel Supply Plan

5.1 Amount of coal resource in Vietnam

The total coal resources estimate in Vietnam is 49.8 billion tons as of January 2010. Most of the coal resources concentrate in the north. The largest coal production area in Vietnam is Quang Ninh, where the coal resources are estimated at 4.3 billion tons. Although the Red River Delta coal basin is also assumed to have coal resources of 37.8 billion tons, development is not carried out at present because geological mining conditions are complex. From the viewpoint of coal types, anthracite coal is dominant. Subbituminous coal and lignite have been also confirmed.

5.2 Predicted coal supply and demand in Vietnam

Table 5.2.1 shows the coal supply and demand balance prediction in Vietnam. In view of an increase in coal demand at coal fired power plants the construction of which is planned, since the amount of coal demand will exceed the amount of coal supply in 2015 or later, it will be indispensable to rely on imported coal.

Table 5.2.1 Coal supply and demand balance prediction

Unit: million tons

Year	2010	2015	2020	2025	2030
1. Total coal supply	45	58	70 - 80	85 - 100	90 - 110
2. Total coal demand	26	58 - 68	93 - 114	135 - 162	204 - 241
a. At power plants	10	32 - 42	61 - 80	99 - 120	162 - 190
Domestic coal	10	27	40	60	90
Imported coal	-	5 - 15	21 - 40	39 - 60	72 - 100
b. Others	16	27	32 - 34	36 - 42	42 - 51

Source: Energy Institute, Ministry of Industry and Trade

5.3 Coal supply plan

5.3.1 Policy

In the south of Vietnam, at which this project site is located, coal is not produced, so coal produced in the north needs to be transported or imported coal needs to be used. As described above, domestic coal will become insufficient to meet the increasing coal demand in 2015 or later.
In response to this, coal used in this project has been planed to be imported from Indonesia or Australia according to the Song Hau power complex plan (No. 6722/QD-BCT dated December 23, 2008).

5.3.2 Coal characteristics

The ranges of the characteristics of the coal used in this project are planned as follows.

- ✓ Coal calorific value 5,500 – 6,500 kcal/kg (HHV, air dry basis)
- ✓ Total moisture Max 28 % (as received)
- ✓ Ash in coal Max 15 % (air dry basis)
- ✓ Sulfur in coal 0.53 – 0.86 %

Details of the coal characteristics are as follows.

Table 5.3.2.1 Coal characteristics

Item		Range	Design Value (Performance Coal)
Proximate Analysis			
Total Moisture	a.r. %	Max 28	
Inherent Moisture	a.d. %	1 - 18	9.5
Volatile matter	a.d. %	26 - 45	36.2
Fixed Carbon	a.d. %	35 - 60	42.8
Ash Content	a.d. %	Max. 15	11.5
Total Sulphur	a.d. %	Max. 1	0.8
Calorific Value			
Gross CV (ADB)	kcal/kg	5,500 - 6,500	5,725
Physical Characteristic			
Grindability HGI	―	35 - 60	45
Ultimate Analysis			
Carbon	%	51 - 75	60.1
Hydrogen	%	4.0 – 7.5	4.1
Nitrogen	%	1.1 – 1.8	1.4
Oxygen	%	By difference	12.7
Chlorine	%	< 0.05	< 0.05
Sulfur	%	0.53 – 0.86	0.7
Ash	%	Max. 15	11.5
Inherent Moisture	%	1 - 18	9.5
Ash Fusion Temp. (RA)			
Initial Deformation	℃	Min. 1,050	1,050
Hemispherical	℃	Min. 1,100	1,100
Ash oxides composition			
SiO_2	d.b.%	24 – 62	46.5
Al_2O_3	d.b.%	12 – 35	22.3
Fe_2O_3	d.b.%	5 – 22	11.3
CaO	d.b.%	Max. 18	5.9
MgO	d.b.%	0.5 – 8.6	3.9
Na_2O	d.b.%	0.1 – 7.2	2.6
K_2O	d.b.%	0.2 – 1.76	1.13
TiO_2	d.b.%	0.5 – 3	1.19
Mn_3O_4	d.b.%	0.04 – 0.2	0.1
SO_3	d.b.%	0.3 – 20.34	4.1
P_2O_5	d.b.%	0.1 – 1.1	0.5
Others	d.b.%		0.48

Source: PVC/PECC2

Table 5.3.2.2 shows the characteristics of some candidate coals which meet the above coal ranges and are applicable for this project. Moreover, the locations of these coal mines are shown in Figure 5.3.2.1 and Figure 5.3.2.2.

Table 5.3.2.2 Characteristics of candidate coals

No		Source 1	Source 2	Source 3	Source 4
Country		Australia	Australia	Indonesia	Indonesia
Location		Queensland	Queensland	Central Kalimantan	South Kalimantan
		Surat Basin	Bowen Basin	Barito River Basin	South Coast
Coal Supplier		Xstrata Coal	Xstrata Coal	PT. Tuah Turangga Agung	PT.Bayan Resources
Coal Brand		Wandoan	Rolleston	TOP Coal	Wahana Coal
Proximate Analysis					
Total Moisture	a.r. %	14-15	18.0	13.69	12
Inherent Moisture	a.d. %	10	9.5	7.39	7
Volatile matter	a.d. %	42-43	31	38.81	40
Fixed Carbon	a.d. %	36-37	51.5	43.32	38
Ash Content	a.d. %	10-12	8	10.48	15
Total Sulphur	a.d. %	0.25-0.35	0.65	0.47	1
Calorific Value					
Gross CV (ARB)	kcal/kg	5,800-5,900	5,850	5,890	6,000
Gross CV (ADB)	kcal/kg	-	6,456	6,320	6,350
Physical Characteristic					
Grindability HGI	―	35	53	48	42
Ash Fusion Temp. (RA)					
Initial Deformation	℃	1,340	1,210	1,460	1,400
Spherical	℃	1,400	1,320	-	1,450
Hemispherical	℃	1,410	-	1,530	1,500
Flow/Melting	℃	1,440	1,350	1,590	1,550
Ash oxides composition					
SiO_2	d.b.%	51	55	66.1	50
Al_2O_3	d.b.%	29	22	25.4	33.4
Fe_2O_3	d.b.%	3.1	13	4.0	5.9
CaO	d.b.%	6.7	3.8	1.2	3.8
MgO	d.b.%	1.8	1.8	0.5	0.9
Na_2O	d.b.%	-	0.8	0.1	1.2
K_2O	d.b.%	0.6	0.7	0.3	0.9
TiO_2	d.b.%	1.6	0.9	1.3	1.5
Mn_3O_4	d.b.%	0.03	0.05	0.1	0.01
SO_3	d.b.%	3.2	0.9	0.9	1.5
P_2O_5	d.b.%	0.1	1.1	0.2	0.2
Others	d.b.%	-	-	-	0.69

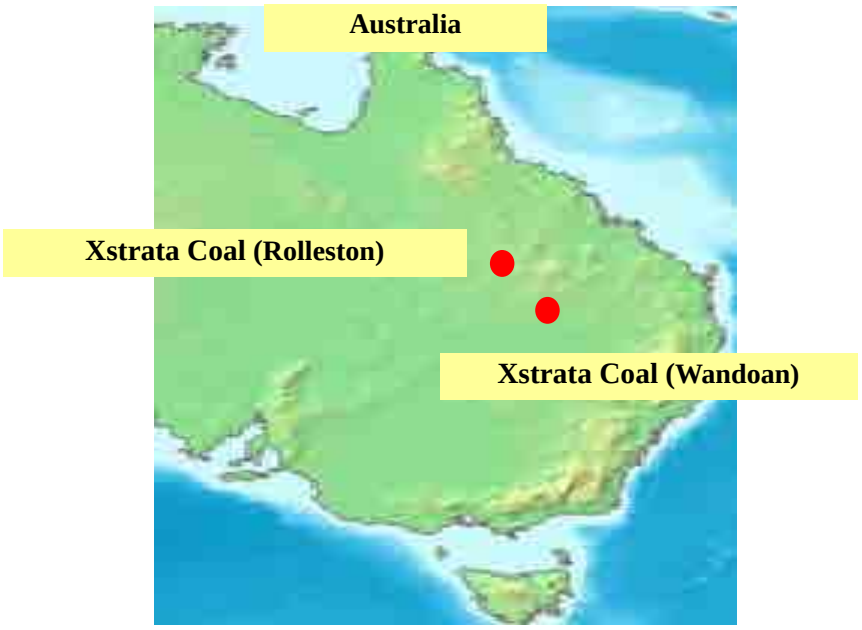


Figure 5.3.2.1 Location of candidate coal mine (Australia)

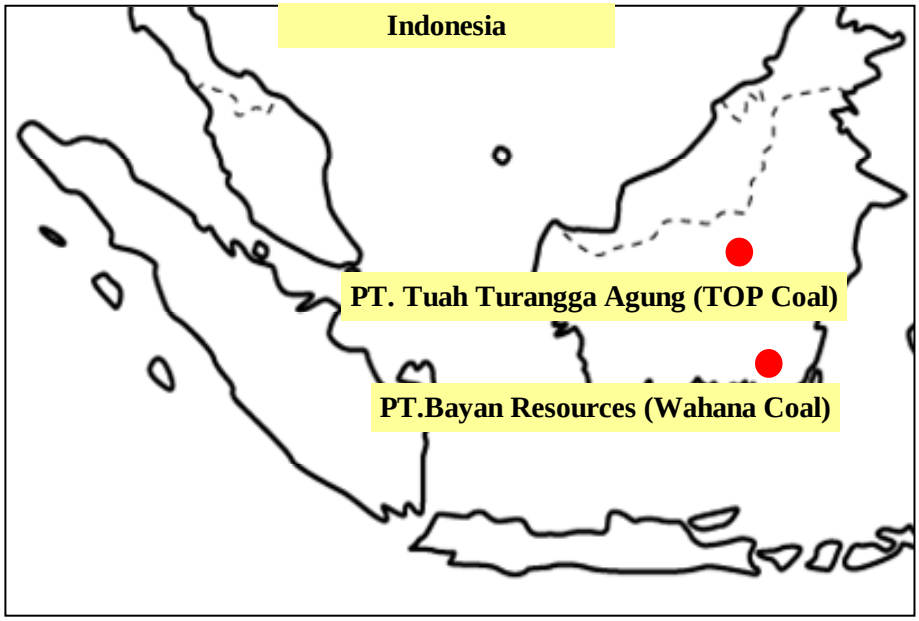


Figure 5.3.2.2 Location of candidate coal mine (Indonesia)

5.3.3 Investigation of coal suppliers

5.3.3.1 Overview of candidate coal suppliers

- Xstrata Coal

Xstrata Coal is the world's largest exporter of thermal coal and a significant producer of hard coking coal. Headquartered in Sydney, Xstrata Coal has interests in over 30 operating coal mines in Australia, South Africa, and North and South America, and it is a subsidiary of Xstata plc who is world's leading company of mine business. This company has enough credibility and results as a candidate for the coal supply company of this project.

- PT. Tuah Turangga Agung

Coal miner PT. Tuah Turangga Agung (hereinafter referred to as “TTA”) is a subsidiary of PT. United Tractors Tbk (hereinafter referred to as “UNTR”) that is the maximum heavy equipment company listed on Indonesian stock market. UNTR bought-out TTA in 2007 and plan to expand the coal mine property further through TTA. TTA has 100million tones of coal reserves including TOP Coal. Moreover, TTA is positively working on the improvement of the production ability. Therefore, this company has enough capacity and results as a candidate for the coal supply company of this project.

- PT.Bayan Resources

PT. Bayan Resources is a major coal production company listed on an Indonesian stock market. This company produced high calorific coal, sub-bituminous coal of low sulfur, non caking coal. Therefore it is thought that this company has enough production ability for this project.

5.3.3.2 Coal reserves

The amounts of resources and reserves of the four (4) candidate coals are shown in Table 5.3.3.2.1. The amount of coal required by this project is 3.5 million tons per year based on design coal. All of the coal mines have enough resources and reserves to satisfy this requirement.

Table 5.3.3.2.1 Amount of Coal Resources and Reserves

(Unit: Million tons)

No	Source 1	Source 2	Source 3	Source 4
Country	Australia	Australia	Indonesia	Indonesia
Coal Supplier	Xstrata Coal	Xstrata Coal	PT. Tuah Turangga Agung	PT.Bayan Resources
Coal Brand	Wandoan	Rolleston	TOP Coal	Wahana Coal
Reserves	1,040	180	42	75.8
Resources	3,367	751	Not confirmed	250

5.3.3.3 Coal production results

The production results and the production plans in the future for each candidate coal are shown in Table 5.3.3.3.1. The amount of coal required by this project is 3.5 million tons per year based on design coal. It is thought that the risks in coal supply can be reduced by receiving the well-balanced coal supply from each supplier.

Table 5.3.3.3.1 Coal Production Result and Expected Coal Production Plan

(Unit: Million tons)

No		Source 1	Source 2	Source 3	Source 4
Country		Australia	Australia	Indonesia	Indonesia
Coal Supplier		Xstrata Coal	Xstrata Coal	PT. Tuah Turangga Agung	PT.Bayan Resources
Coal Brand		Wandoan	Rolleston	TOP Coal	Wahana Coal
Production Result	2008	-	7.3	-	0.8
	2009	-	6.7	-	2.9
	2010	-	5.2	0.75	4.0

No		Source 1	Source 2	Source 3	Source 4
Expected Production Plan	2015	30.0	8.0	3.0	5.0
	2020	30.0	8.0	3.0	5.0
	2025	30.0	8.0	3.0	5.0

5.3.4 Coal transportation plan

The transportation ways for each candidate coal are shown in followings,

5.3.4.1 Loading port and transportation way upto the loading port

(1) Xstrate/Wandoan & Rolleston :
Both brands of coals are transported by railway from the mining site to the port and gathered into stock pile of coal terminal at the port. Both brands use R.G. Tanna Coal Terminal at Gladstone port for their stock piling before shipment and loading onto coal vessel.

(2) PT Tuah Turangga Agung/Top Coal :
From the mining located at Central Kalimantan to first transit port on riverside, the coal are transported by dump truck, and loaded onto the river barge at the transit port. After being transported upto second transit port, the coal are re-loaded onto bigger size of barges which access to the coal loading (ocean-going) vessel waiting at anchorage.
Due to conditions of depth and others of the river to be used, generally the coal are forced to be transported via two transit ports /stock places and by different size of barges upto alongside the vessel. Taboneo port (anchorage) is used for loading this brand of coal onto the vessel.

(3) PT Bayan Resources/Wahana Coal :
The mining of this brand are located at South Kalimantan, and the way of transportation is nearly same as Top Coal by dump truck and river barge. Satui port (anchorage) is used for loading this brand of coal onto the vessel.

5.3.4.2 Information for each loading ports

Table 5.3.4.2.1 & 2 show the information for each loading ports.

Table 5.3.4.2.1 Australia Gradstone Port Coal Terminal Information

Name of Coal Terminal	RG Tanna Coal Terminal	Barney Point Coal Terminal
User	Multi User	Multi User
Nos. of Berth	4 berths	1 berth
Max.Vessel Size LOA	315m	242m
Same as above BEAM	55m	45m
Same as above DWT	220,000DWT	105,000DWT
Same as above Draft	17-18m	15m

Name of Coal Terminal	RG Tanna Coal Terminal	Barney Point Coal Terminal
Nos.& Capacity of Loader	3x6,000mt/hr	1x2,000mt/hr
Contractual Loading Rate	25,000-30,000LT/day	25,000-30,000LT/day
Working Hours	24hrs	24hrs
Annual Throughput Capa.	70Mt/year	8Mt/year
Congestion	0-14days	0-14days

Table 5.3.4.2.2 Indonesia Coal Loading Ports Information

Name of Port	Taboneo	Satui
Location	South Kalimantan	South Kalimantan
Type	Anchorage (Open Sea)	Anchorage (Open Sea)
Max.Draft for Handy Size	13m	10m
Max.Draft for Panamax	15m	12m
Max.Draft for Cape Size	19m	16m
Contractual Loading Rate	10,000-15,000mt/day	8,000-10,000mt/day
Loading Facility	Ship's Crane/Floating Crane	Ship's Crane/Floatging Crane

5.3.4.3 Special remarks for each loading ports

(1) Gladstone port, Australia

In almost all coal terminals in Australia, the congestion of the vessel become chronic due to the lack of capacities against increasing demand in export. Gladstone port is not exceptional and 0-14days of congestion (waiting for berthing) are found generally.

For solving this issue, each coal terminal has expansion plan for coal handling area and improvement plan for coal handling equipments.

RG Tanna coal terminal has the plan to increase its annual throughput capacity upto 73 millions tons by 2016 (current capacity is 70 millions tons). On the other hand, Barney Point coal terminal are planned to close by 2014 due to the limitation of its expansion, and as alternative for Barney Point, Gladstone port are planning to construct new coal terminal, Wiggins Coal Terminal which are aimed to open by 2014 and to handle 30 millions tons as Phase 1.

(2) Taboneo port and Satui port, Indonesia

Both ports are anchorage. Compared with fixed berth of coal terminal, Loading works at anchorage are unstable subject to weather and sea condition. In addition to this loading conditions, the restrictions in transportation from the mining to the anchorage gives the coal loading vessel with some range of congestion (waiting for start loading) easily.

The main reasons for congestion are considered as follows,

- Waiting for the barges due to lack in numbers of barges to be arranged
- Delay in arrangement of floating crane
- Delay in supplying the coal due to mining/production trouble
- Due to trouble in transportation (by weather and river conditions)

5.3.4.4 Consideration into ocean transportation

5.3.4.4.1 The vessel for coal transportation to be used

The types of vessel to be used for coal transportation from each loading port to the coal terminal planned in Vietnam are to be fixed carefully considering not only specification of loading port and discharging port, demand of coal of final user, but also economical analysis and vessel availability.
Considering annual demand of coal by Song Hau CPPP would be 3.5million tons, around 20 numbers of 180,000DWT of the vessel (Cape Size) shall be required annually. To minimize the risks in ocean transportation, the maximam size of vessel allowable is to be used for this transportation.
For accepting for big size of vessel, the loading & discharging ports have enough capacity and appropriate specification (acces route, depth of berth, strength of berth etc.) and have equipped efficient loading and discharging facilities to meet with the vessel.
Generally, Cape Size and Panamax of vessel don't have own crane facility (except some of Panamax), so in case of using these type of vessel, loading & discharging facility are to be prepared properly in the ports. Supramax and Handy Size of vessel have own crane facility, but to increase loading & discharging rate, the port facility are to be used frequently.
Table 5.3.4.4.1 shows general and averaged particulars of the vessel for coal transportation (dry bulker).

Table 5.3.4.4.1.1 General Information for Coal Vessel (Dry Bulker)

Type of Vessel	DWT(MT)	LOA(M)	BEAM（M）	Full DRAFT(M)
Cape Size (Large)	220,000	325	54	18.13
Cape Size(Standard)	180,000	292	45	18.25
Post Panamax	110,000	255	43	14.5
Panamax	72,000	225	32.2	13.5
SupraMax	55,000	190	32.2	12.5
Handy Max	48,000	190	32.2	12.0

(Remarks）DWT： Dead Weight Ton、LOA：Length Over All、 BEAM：Breadth Over All、Full, DRAFT：Draft at full loading

5.3.4.4.2 Rough calculation of ocean freight

Rough calculation of ocean freight are made based on following conditions.

(Given Conditions)

- Charterage, fuel charges, and port charges are on current base.
- Based on spot chartering, getting the vessel at Shanghai free.
- Loading/discharging conditions : FIOT (not including loading/discharging expenses)
- Loading Rate
  - Gladstone : 30,000mt/WWDSHINC
  - Taboneo : 15,000mt/WWDSHINC
  - Satui : 9,000mt/WWDSHINC
- Discharging Rate : 20,000mt/WWDSHINC
  WWDSHINC = weather working day sunday holiday including
- Discharging port : Vung Tau is supposed to be as location of coal terminal
- Distance of ocean transportation :

- Gladstone > Vung Tau : 3,669 Nautical Mile (Nm)
-Taboneo>Vung Tau : 1,175 Nm
-Satui>Vung Tau : 1,245Nm

- Loading quantity : DWT x 95% but Satui is subject to draft restriction
- Speed : 14Knot/hr for exceeding 100,000DWT
  13Knot/hr for 100,000 & under 100,000DWT
- Spare time for transportation and port stay : each one day

Table 5.3.4.4.2.1 Indicative Current Ocean Freight（Unit：US$/MT）

Type of Vessel (DWT)	Gladstone Loading	Taboneo Loading	SatuiLoading
220,000	12.33	N/A	N/A
180,000	12.57	9.37	N/A
110,000	—	9.85	N/A
72,000	18.76	11.35	14.44
55,000	21.73	12.85	17.29
48,000	—	12.46	15.48

(Remarks)

- Satui port has the restriction in draft, so even though using same type of vessel, its loadable quantity are varied (less than others). Satui is open sea port and has no restriction in the type of vessel, but due to the type of floating cranes there, actually Panamax is largest size of vessel to enter.
- The above freight is calculated on spot chartering base, and not on COA (Contract of Afreightment = contract by quantity in certain period) and Time Charter Contract (contract for certain period under fixing the vessel) in which case ocean freight shall be cheaper and stable.
- Demmurage and dispatch money are not considered in the above even though congestions are generally occurred. These kinds of charges are to be settled between seller & buyers.

5.3.4.4.3 Special remarks for ocean transportation

(1) Booking right for the vessel

According to the standard trading terms for Australian coal and Indonesian coal, their delivery terms are FOB Loading Port, so generally the vessel shall be arranged by buyer, not by supplier. In this case, the buyer has to make chartering contract with shipping company.

As stated before, continuous SPOT contract is not recommendable since the buyer cannot secure stable vessel arrangement and cannot enjoy stable ocean freight in SPOT contract. So COA and/or Time Charter Contract are recommended to secure more stable ocean freight and vessel arrangement.

(2) Plan for vessel arrangement

In case of Time Charter, cycle time (period of one round) is to be considered to make the plan for vessel arrangement. Cycle time is consisting of not only transit time and stay time at loading and discharging ports, but also waiting time for berthing by congestion in each port.

After fixing supplier of the coal, the buyer will make the procurement plan of the coal, and based on this plan, fix the type of vessel to be used and make the plan for vessel arrangement after checking several related conditions. Based on this plan, the contract terms with shipping company are to be negotiated and finalized.

(3) Plan for coal terminals in Vietnam

As stated before, The type of vessel to be used shall be fixed by specification of loading and discharging ports (Coal Terminal in Vietnam). In case the capacity for receiving the vessel is not sufficient, and The congestion becomes chronic, efficient coal supply by smooth implementation cannot be managed. The coal terminal's specification including safety stock are to be planned and fixed carefully.

In this report, consideration about the cost occurred in coal terminal is not taken up since details about coal terminal is not yet finalized.

5.3.4.5 2nd transportation from the coal terminal to Song Hau CPPP

5.3.4.5.1 Route for 2nd transportation

1) 2nd transportation from the coal terminal to Song Hau CPPP is to be made via Hau river estuaries (Dinh An or Tran De) or via Bassac channel (Quan Chanh Bo channel) which is planned to construct in future, since Song Hau CPPP is located on left bank of Hau river.

2) The depth around both Hau river estuaries is very shallow (around -4m) due to heavy sedimentation by earth and sand carried down from the upper stream. In this situation, around 3,000DWT of coaster vessel can pass through these estuaries. The dredging works to remove
sedimentation and maintain depth of river are made periodically, but in every rainy season heavy sedimentation is repeated. The route via Hau river estuary seems not suitable for the coaster more than 5,000DWT's passing through.

3) Bassac Channel (Quan Chanh Bo channel) is planned to construct as follows,
   - 10,000DWT of coaster can be passed through.
   - Maximam LOA 142m of coaster can be passed through.
   - Maximam BEAM 20m of coaster can be passed through.
   - Maximam DRAFT 8.2m of coaster can be passed through.
   - Under keel clearance : 1.4m to 1.7m
   - The navigation channel to be dredged to -6.5m (transportation on high tide)

Considering the demand of coal in Song Hau CPPP, 2nd transportation should be made by the maximum size of coaster allowable. The present plan for coal receiving terminal at Song Hau CPPP are made under the condition that 10,000DWT of coasters are to be used for transportation from coal terminal. The dredging works for maintenance for Bassac Channel seems easier than Hau river estuary, so early opening of Bassac channel is expected for smooth 2nd transportation.

5.3.4.5.2 Type of vessel for 2nd transportation

1) As stated before, The coal receiving berth at Song Hau CPPP is planned to receive 10,000DWT of coaster in full load condition which draft is -7.7m.

2) According to 4.4.5.1, To satisfy coal demand in the peak of Song Hau CPPP, 389 numbers of 10,000DWT of coaster are to be required. Considering unworkable days by weather or other uncertain reason, The maximum size of coaster allowable are to be arranged.
3) On the other hand, to solve the bottleneck of 2nd transportation such as shallow depth of Hau river, Big size of barges & tug boat are to be considered to use. Table 5.3.4.5.2.1 shows

information (Theoritical Particulars) about these big barges.
These kind of barges seem not available in Vietnam now, so if required, are to be newly constructed as dedicated barges. But the beam of these barges are more than 30m and not satisfy
planned design of Bassac Channel (Max 20m). The point is whether these barges can pass through Hau river estuary or not. Investigation for candidate transportation route should be done
in Phase 2 of Coal Transit Terminal.

Table 5.3.4.5.2.1 Information for Big Size of Barges

DWT	10,000DWT	15,000DWT	20,000DWT
LOA	93.4m	123.4m	140.0m
BREADTH/BEAM	34.6m	38.0m	42.0m
DEPTH	5.5m	8.0m	8.0m
FULL DRAFT (MID)	4.0m	5.0m	5.5m
DISPLACEMENT	12,500MT	20,235MT	27,500MT

Main particular for tug boat towing these big size of barge is shown as follows,

- Engine Horse Power : 2,400BHP
- LOA : 28m
- BEAM : 8m
- DRAFT : 3.5m
- SPEED : 11Knot in full
-

Coaster and Barge are different in their particulars, so which type of transport facility is to be used is decided according to the condition of transport route and conditions, and which affects design of loading and discharging facilities

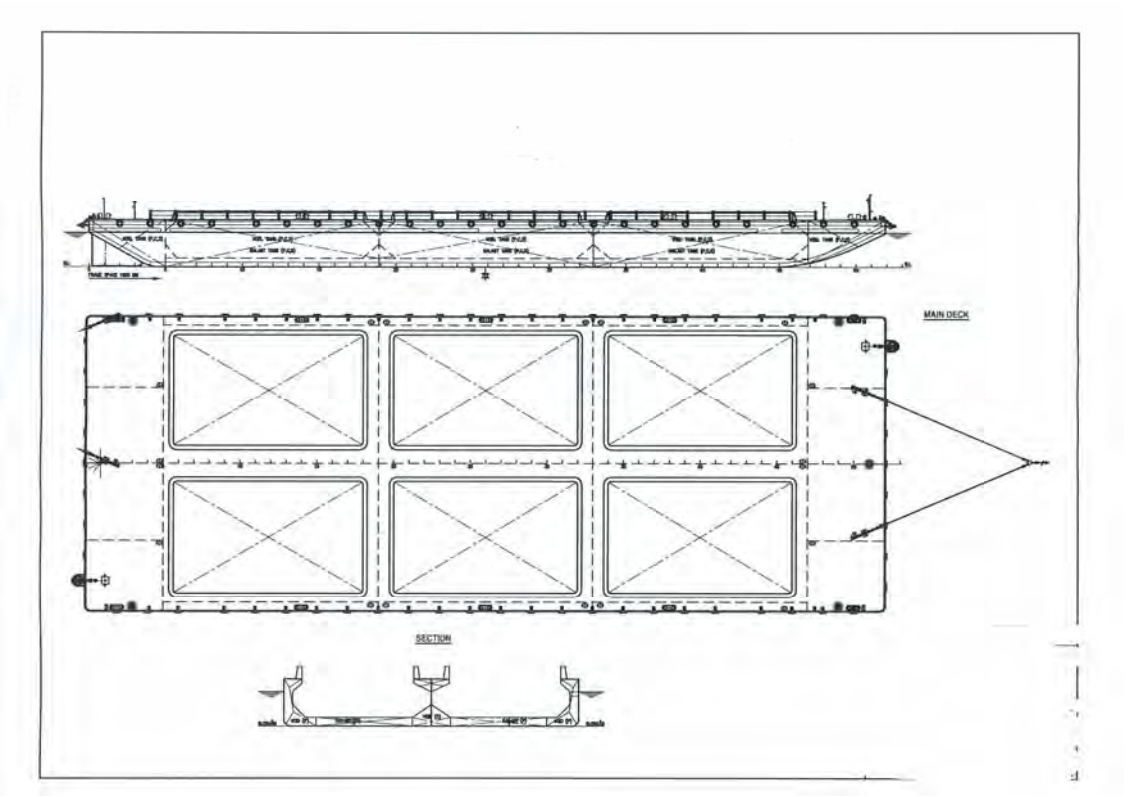


Figure 5.3.4.5.2.1 Images for Big Size of Barge

5.3.4.5.3 Rough indication for freight of 2nd transportation

Based on current charterage of coaster and following given conditions, Rough indication for freight of 2nd transportation are shown below,

(Given Conditions)

- Candidate location of coal terminal : Vung Tau or Tra Vinh offing
- Distance from coal terminal to Song Hay CPPP :
  - Vung Tau to Song Hau : approx 110 Nm
  - Tra Vinh offing to Song Hau : approx 56Nm
- Speed of coaster : 5.5Knot/hr in average
- Loading rate at coal terminal : 1,700mt/hr
- Discharging rate at Song Hau CPPP berth : 1,700mt/hr
- Current charterage in VN market :
  - 3,000DWT coaster : USD800.00/day
  - 5,000DWT coaster : USD1,300.00/day
  - 10,000DWT coaster : USD3,500.00/day

  These charterages are not including fuel charges and port charges etc., these kind of charges are calculated as 50% of charterage.
- Loadable quantity : DWT x 90%
- Berth occupancy : 0.5
- Loading & discharging efficiency : 75%
- Preparation at ports : each 2 hours

Table 5.3.4.5.3.1

Location of Coal Terminal	Vung Tau	Tra Vinh Offing
Transit Time (one way)	21hrs	11.2hrs
Port Stay 10,000DWT	16.4hrs	16.4hrs
same 5,000DWT	9.2hrs	9.2hrs
same 3,000DWT	6.2hrs	6.2hrs
Cycle time 10,000DWT	74.8hrs (3.2d)	55.2hrs (2.3d)
same 5,000DWT	60.4hrs (2.6d)	40.8hrs (1.7d)
same 3,000DWT	54.4hrs (2.3d)	34.8hrs (1.5d)
Charterage 10,000DWT	US$16,800	US$12,075
same 5,000DWT	US$5,070	US$3,315
same 3,000DWT	US$2,760	US$1,800
Freight Rate 10,000DWT	US$1.90/MT	US$1.40/MT
same 5,000DWT	US$1.20/MT	US$0.80/MT
same 3,000DWT	US$1.10/MT	US$0.70/MT

(Remarks)

- Due to shortage of big size of coaster in Vietnam, Charterage for 10,000DWT coaster is rather expensive currently.
- The above freight is based on T/C base, and same coasters are used continuously.
- Time for congestion and waiting for high tide are not counted.
- The above freight is covering only freight and not cover loading & discharging expenses.

5.4 Limestone supply plan

5.4.1 Policy

According to Petro Vietnam Long Phu - Song Hau Power Project Management Board (hereinafter referred to as “LP-SH PMB”), which is an organization that carries out this project, limestone used for desulfurization is planed to be provided from Prumbo mine of Southern Construction and Mineral Exploitation JSC-KG Branch (hereinafter referred to as “SCME”). SCME is a proven firm with a sound track record of supplying limestone for Omon thermal power plant at present.
The Prumbo mine is located in the Kien Luong district of the Kien Giang province, about 200 km apart from Can Tho City in the west-northwest direction.

Figure 5.4.1.1 Location of the limestone mine

5.4.2 Investigation of limestone suppliers

5.4.2.1 Limestone characteristics

Table 5.4.2.1.1 shows the characteristics of limestone produced in Pnumpo mine.

Table 5.4.2.1.1 Limestone characteristics

$CaCO_3$	96.0 %
MgO	1.2 %
Al_2O_3	0.1 %
SiO_2	0.2 %

Result of analysis (2008.8)
Source: SCME

5.4.2.2 Limestone Reserves

The present reserves of limestone in Pnumpo mine are 2,104,295 tons. These are enough reserves to satisfy the amount of limestone, 50,000 tons per year required for this project based on design coal. Moreover, SCME also has Xa ngach mine near Pnumpo mine, where limestone of 3,178,571 tons are reserved. SCME says that it can also supply limestone from Xa ngach mine.

5.4.2.3 Limestone Production Results

The limestone production results for the past five years are shown in Table 5.4.2.3.1 SCME explains that, since SCME is planning to increase the limestone production in the future, it will be capable of supplying 84,000 tons annually for this project. This is an enough supply capacity of limestone comparing with the 50,000 tons per year consumption in this project.

Table 5.4.2.3.1 Limestone Production Result

Year	Production Result (ton/year)
2006	4,845.400
2007	27,232.520
2008	27,465.228
2009	22,423.593
2010	17,846.918

Source: SCME

Photographs of 5.4.2.3.1 through 5.4.2.3.2 below show the landscapes of the limestone quarry and equipment in Pnumpo mine. The equipments such as crushers in the limestone quarry are of threadbare structure. Therefore, it is necessary to confirm the reinforcement plan how to increase the capacity of the equipments in the future.
The capacity of the limestone loading equipment is 600 tons per day in working for 7 hours a day. SCME is planning to increase the limestone production further by extending the working hours.
At present, SCME is under consideration of supplying the limestone for Long Phu 1 coal fired power plant. It is expected that the limestone demand will increase in line with the increasing constructions of coal fired power plants in South Vietnam. Therefore, in the future it is preferable for the power station to secure two or more limestone supply companies.

Photo 5.4.2.3.1 Limestone quarry

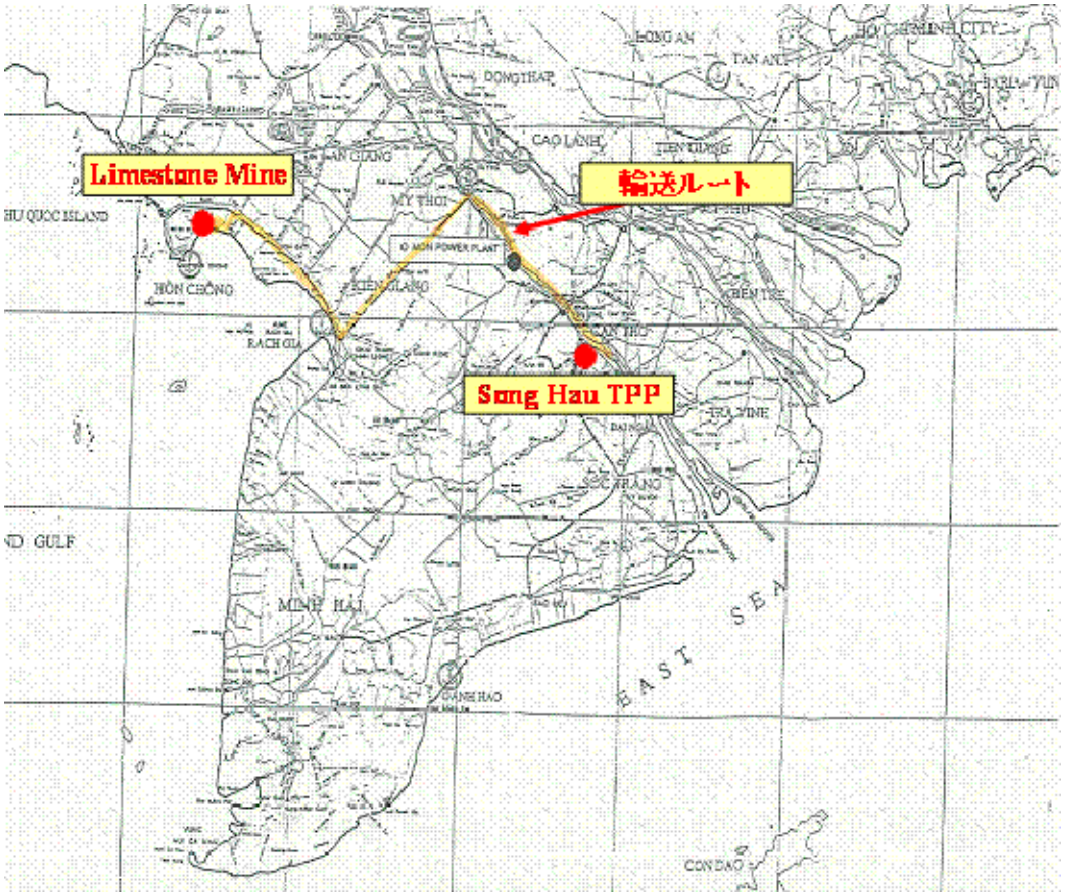
Photo 5.4.2.3.2 Limestone crusher

Photo 5.4.2.3.3 Limestone loading equipment

5.4.3 Limestone transportation plan

5.4.3.1 Transportation route and way :

For transporting limestones from Pnumpo mining owned by SCME to Song Hau CPPP, Barges are used through inland waterway (rivers and channels), and its distance is around 95Nm (175km). According to SCME, 800DWT of barges are to be used as maximam size due to the restrictions in transportation route (water depth and navigation width etc.). SCME's recommended route is shown in Figure/Map 5.4.3.1.1
Transit time is to be around 2-2.5days in rainy season, and 3days in dry season.
As alternative, transporting from the Pnumpo mining to sea coast, loading onto bigger vessel, and transporting through Hau river upto Song Hau CPPP are to be considerable. But as of now no port for loading onto big vessel is available in Kien Giang area. This alternative is to be discussed with supplier and others about its possibility, if required to study.



Map 5.4.3.1.1 Route from Pnumpo Mine to Song Hau CPPP

5.4.3.2 Receiving limestone at Song Hau CPPP :

Limestone receiving berth at Song Hau CPPP is designed for receiving 3,000DWT of coaster, and discharging equipment there is designed with 250mt/hr of capacity. In case only 800DWT barges can be used for limestone's transportation, approx 70 numbers of barges are required for supplying 50,000 mt of limestons which is annual consumption of Song Hau CPPP. Shipment

from Pnumpo mining shall be made twice a week and its transit time is around 7-8 days per round. In this case, minimum 2 barges are to be fixed in this transportation.

5.4.3.3 Transportation cost

According to SCME, Transportation charges (not only freight) from Pnumpo mining upto Omon CPPP located at upstream of Hau river is around VND45,800/mt, so transporting charges from Pnumpo mining to Song Hau CPPP is supposed to be around VND50,000/mt.
Details of transportation charges are to be re-studied after fixing more details.

Chapter 6 Rational Assessment of PPP Project

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Chapter 6 Rational Assessment of PPP Project

6.1 Scope of Rational Assessment in this Survey

The objective of this survey is to examine a project plan for the PPP project which comprises of the three components of construction of the Song Hau 1 Coal Fired Power Plant, construction of imported coal terminal and construction of transmission line and substation. The power plant will be constructed by joint investment of Vietnam Oil and Gas Corporation (PVN) and a private investor. The state-owned power transmission company, National Power Company (NPT), which is a subsidiary of Vietnam Electricity Corporation (EVN) will be responsible for construction of transmission line and substation. For the construction of coal terminal, an authorized company by the government of Vietnam will be an implementing agency.

In order to ensure feasibility of the power plant project, it is inevitable to assess financial and economic feasibility of the entire PPP project covering the three components based on well-coordinated and well-arranged project plan. However, under the current situation, it is difficult to develop a project plan including all the three components because of undetermined project formulation for the other components besides the power plant.

Therefore, this survey will analyze rationality of PPP project considering risk factors related to all the three components, but analyze financial feasibility on only the component of power plant. In terms of the component of transmission line and substation, it is difficult to conduct economic analysis since the project cost cannot be estimated due to the delay of project planning. Also, the economic analysis for the entire PPP project cannot be done because of the same reason.

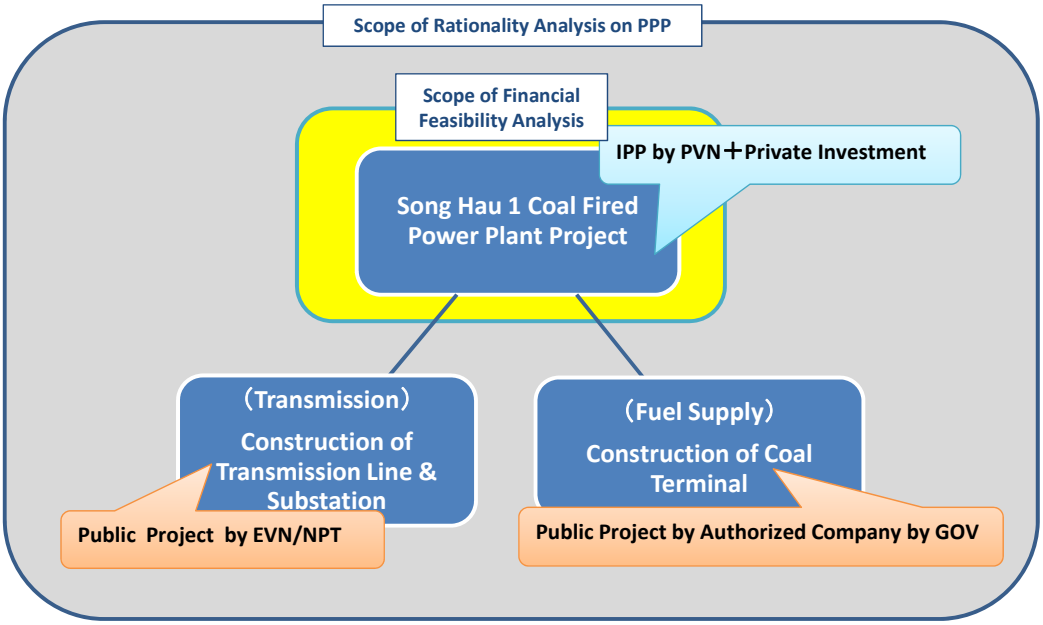


Figure 6.1.1: Scope of Rational Analysis

6.2 Project Purpose

Construction of Song Hau 1 Coal Fired Power Plant will have the following four meanings.

- Supplying power to Hau Giang Province and the South of Vietnam, which center is Hochiminhcity, ensuring power security of the national grid, reducing losses in transmission lines and improving the power quality.
- Conformable with Master Power Plan 7 announced by the Vietnamese Government and socio-economic plans of the Region.
- Making contribution on inviting new industries to the Region, increasing the demand of works.
- Generating stable profit as a long term business for PVN and other expected investors.

6.3 Sharing of Roles between Private and Public

6.3.1 National Structure of Vietnam and Major Industries

Vietnam is a country of Socialism, and the major industries are directly controlled and operated by the Government. Therefore, the employees of the major industries are considered as the public officers.
PVN – major owner of Song Hau 1 Power Project, NPT – to construct and operate the related transmission lines of Song Hau 1 Power Plant, Vinacomin – responsible for the feasibility study of the Imported Coal Transshipment Terminal, all of them are typical public organizations under Vietnamese Government. In this sense, all of three projects (Power Plant, Transmission Lines, and Imported Coal Transshipment Terminal) can be considered as “Public” Projects.

6.3.2 Sharing of Roles as a PPP Project among Song Hau 1 Power Plant and the Related Projects

Song Hau 1 Power Plant will be constructed as an independent project for generating long term profit for the project owners. On the other hand, the related Transmission Lines will be constructed as a necessary infrastructure to assist the Power Plant. The Coal Terminal will be constructed for the purpose of supporting the plural number of Power Plants those will use imported coals, and are planned to be constructed along the basin of the Mekong River and Southern Vietnam.
Furthermore, while it is expected to invite foreign investors for the Song Hau 1 Power Plant Project, it is not expected for foreign investors to make investment on the NPT’s transmission lines. Regarding the Imported Coal Transshipment Terminal, even no domestic investor and/or the Project owner have been appointed as of today.
Because of the above status, Song Hau 1 Power Plant can be considered as a “Private” project owned by a Special Purpose Company (SPC) which is aiming at the profit, while the related Transmission Lines and the Imported Coal Transshipment Terminal shall be considered as “Public” projects those will have clear role of public and support for others

6.4 Investment Outline of the Public Project

We hereby study the Investment Outline of the Song Hau 1 Power Project which is considered as a Private Project.

6.4.1 Justification of the EPC Cost and other Project Costs

Generally speaking, even though there will be gap of the project costs based on the difference of the scale of projects and the conditions of location, we can estimate that the equipment and construction cost (EPC cost) will reach to around 80% in the total Project Cost (capital investment cost) of large size coal fired power projects in Asia.
Based on the F/S report written by PECC3, we added estimated Interest during Construction (US$274mil) on the Project Cost, reach to US$1,761mil as the Capital Investment Cost. The ratio of EPC cost (US$1,188mil) against the capital investment cost will be about 67.5% only. It means that ratio of non EPC cost which was estimated in the F/S by PECC3 was rather high compare to other projects.
These non EPC cost are administration cost and contingency etc those will be able to reduce by the effort. Therefore, these costs must be reconsidered in detail before the time of project implementation.
On the other hand, EPC cost, which is a very important factor together with the above cost factors and estimated as US$1,188mil by PECC3, will give big influence on the profitability of the Project. Considering the generating capacity of 1,200MW, the unit price of EPC cost is US$990/kW in this project. Though this price level will fluctuate in different countries, this Unit price level is very low. Generally speaking, this unit price level will reach to around 1.5times in G7 countries. Also, it will not be easy to achieve this price level even in the developing countries. However, PVN always aim at achieving such a price level for all their other on-going similar projects, so this EPC price level will be considered as achievable.

6.4.2 Debt/Equity

In the F/S report by PECC3, the ratio of foreign currency debt is 70% of the Project Cost, which means Debt/Equity ratio is 70:30. For example, the Debt/Equity ratio for Mong Duong 2 CFPP (620MW x 2 units), which major developer is AES Corporation, and the Financial Close was done on July 2011, is 75:25. The Debt/Equity ratio of similar projects in other countries will be also around 70:30 or 80:20, so PECC3's assumption on this project can be considered as reasonable range. PVN is a superior government own company who represents Vietnam, so the Debt Ratio on this project will be achievable up to 75% – 80% level subject to the negotiation with banks.

6.4.3 Shareholders/Ratio of Investment

In this Project, it is expected to invite the investors including the foreign companies. The shareholders should provide the equity pro-rate to their shareholding levels and in line with the Project Schedule without any delay. PVN does not insist on maintaining the major share of this Project, plans to invite foreign investors from all over the world. However, it will be considered that forming up BOT scheme must be the key point in order to obtain foreign investors on the size of Power Projects such as Song Hau 1 Coal Fired Power Project.

6.5 Estimation of Project Cost

The project cost for the power plant construction project is estimated in the Chapter 4. Please refer to the section 4.8 for the details of the cost estimation.

6.6 Financing Plan

6.6.1 Financing

Regarding the case of Song Hau 1 CFPP, the huge project cost will be budgeted at around US$ 2 billion in total, the long term project plan will continue 25 – 30 years. For such a project it will not be realistic to cover all the necessary project cost by the investors' own investment, which may give huge impact on the investors' balance sheet, may cause serious risk, and will be exceed the capable range for a private enterprise to bear. Therefore, it is usually applied for many independent power projects that plural enterprises (sponsors or investors) will jointly found a Special Purpose Company (SPC) for the project. It will be recommended that the SPC shall seek for the possibility of introducing project finance scheme by which the SPC will arrange finance by its own company name and responsibility

This scheme is also called "Non Limited Recourse Finance," since the source of reimbursement is limited to the invested project, is not rely on the creditability or mortgage of the sponsors/investors. Therefore, it is our precondition for this feasibility study that the financing will be arranged by project finance scheme.

6.6.2 Surroundings of the Financing

To arrange project finance on this project, we would like to investigate the present surroundings to be considered and list up the following factors.

- Because of BIS restrictions, the project finance scheme itself has been an undesirable scheme for the banking world.
- Generally speaking, most of banks in USA are not positive to support project finance scheme.
- By the influences of the recent economical situation in Europe (including the financial crisis in Greek etc.), the French banks who had positively supported project finance scheme gradually change to be in the negative position on the scheme.
- Japanese banks are keeping healthy operation, they remain the sufficient capability to support project finance scheme.
- Financial Base of Vietnam is considered as not very stable, and the country risk of Vietnam must be judged as rather high.

Considering the above factors, we need to consider the following restrictions of project finance.

- ✓ The numbers of commercial banks, who are willing to provide project finance, has been decreased comparing to before. Though Japanese banks keep healthy operation, it is too big to prepare necessary debt amount by Japanese banks only. Furthermore, since the country risks of Vietnam becomes higher, it is difficult to obtain long term loan, or the loan amount will be restricted. Considering such surroundings, securing the necessary amount of loan to found a project finance scheme only by commercial banks on this project must be very difficult.
- ✓ Judging from the country risks of Vietnam (for example CDS of Vietnam is about 300bp), the debt margin will be possibly exceed the so to speak category of financing. Normally, such kind of debt will be treated as a high risk loan similar with Mezzanine loan etc. which belong to a category of subordinated loans. In other words, it is not considered as bankable project even offered with very high margin, but it will be categorized as "non-bankable project."

6.6.3 Applying Export Credit Agency (ECA)

Referring to the above 6.6.2, we would like to conclude that financing for this project only by commercial banks is difficult at present. Therefore, it will be mandatory factor to jointly apply ECA finance. In case some Japanese company will participate or develop a power project in Vietnam, the following types of ECA finance such as JBIC or NEXI etc. will be considered as realistic and competitive option.

- Overseas Investment Loan (OIL) by JBIC
- Overseas Project Equity Fund Insurance by NEXI
- Export Credit (Buyer's Credit) from each country's ECA

Since Export Credit shall be basically determined in line with OECD guideline, we would like to perform the feasibility study subject to OIL for which some Japanese company will make investment, as well as Buyer's Credit for which some Japanese company will export equipment etc. General conditions of OIL will be shown in the Table 6.6.3.1.

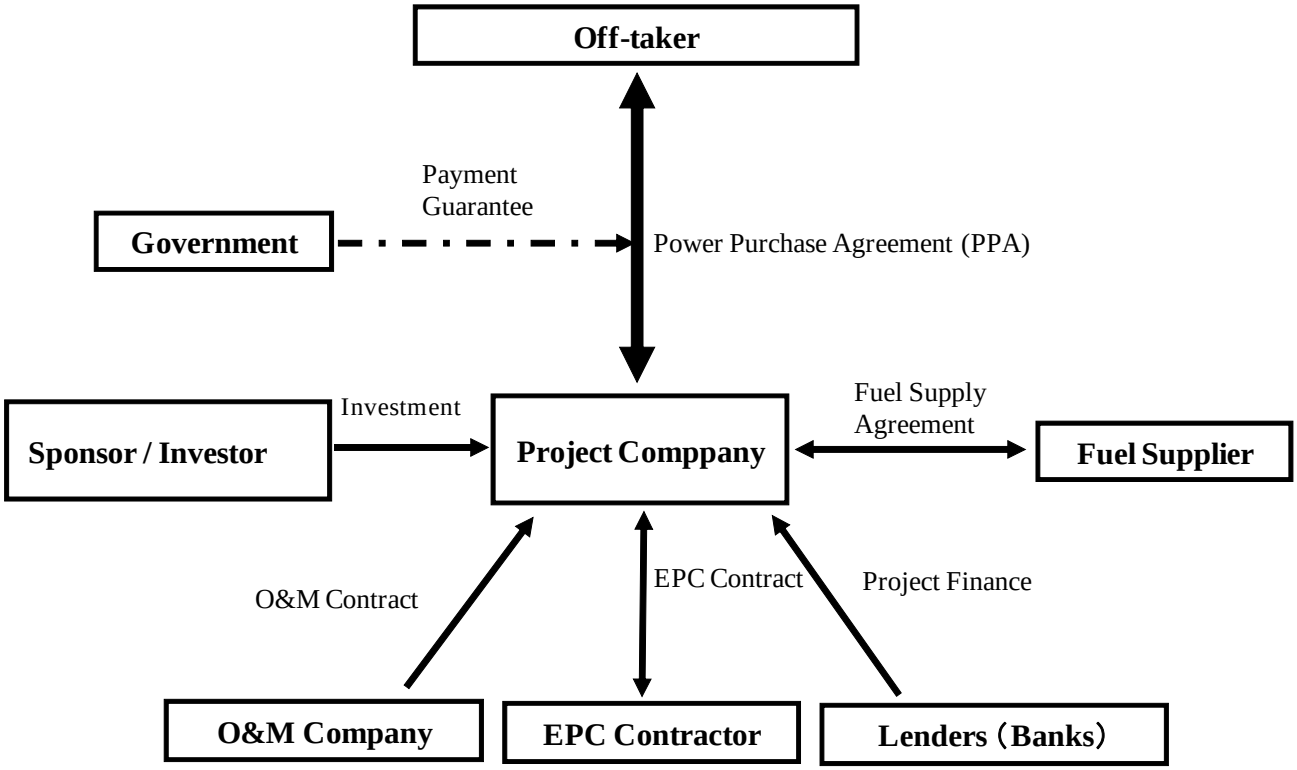
Table 6.6.3.1 Comparison of the Conditions of OIL and Buyer's Credit

	JBIC Overseas Investment Loans	JBIC Buyer's Credit
Application	International business development by Japanese firms	Exports to developing countries of machinery and equipment produced in Japan, and Japanese technical services
Applicable Conditions	・More than 20% of investing ratio by a Japanese firm to the Project company for the whole investing period ・Actual participation (O&M etc.) by the Japanese firms	Actual participation of Japanese products and/or technical service through EPC contract
Lenders	Direct loan from JBIC	60% : Direct loan from JBIC 40% : Loan from comercial banks with the coverage of NEXI's insurance
Loan Amount	Max. 60% of Debt	・Max. 85% of contract for equipment export and/or technical service excluding down payment ・JBIC cover Max. 60% of the above loan amount
Repayment Period	Determined by taking account of the period required for recouping investment. No limit on the repayment period, so repayment schedule can be set flexibly depending on the expected rate of return on individual projects. (1 to 10 years in general)	Determined based on OECD Guidelines （at most 12 years in general）
Interest Rates	Japanese Yen : fixed interest rates at providing loan in general Other Currencies : floating interest rates based on LIBOR	Commercial Interest Reference Rates (CIRRs) at the time of commitment is applied
Merit	Long repayment period with low interest rates	Long repayment period with low interest rates

In case we apply OIL, the sealing amount to be directly invested by JBIC will be 50% to 60 % of the total debt amount, so the remaining amount must be covered by commercial banks loan. As it is explained 6.6.2, project finance by commercial banks for the remaining 40% to 50% amount must be very difficult, and the country risk of Vietnam should be covered or supported by some other effective method.
For this Song Hau 1 CFPP project, it is recommended to cover at least the political risks by applying Extended Political Risk Guarantee by JBIC or Overseas Project Equity Fund Insurance by NEXI for urging commercial banks to participate in.

6.6.4 Image of Financing Structure

In the Drawing 6.6.4.1, it is shown a general structure of an IPP investor and the related contracts including project finance.



Drawing 6.6.4.1 Sample structure of IPP project based on project finance

The procedure of documentation and the time frame from the signing of a loan agreement until the commencement of the loan will be investigated in the Clause 6.12.

6.6.5 Importance of the Support by Vietnamese Government

In order to complete the financial closing, Due Diligence of the documents related with the project by the lenders such as confirmation of the project structure, Power Purchase Agreement (PPA) will be performed. During the process of Due Diligence, the confirmation of Security Packages is important, and it must be quite important to secure the participation of the Vietnamese Government on them.

As it was shown in the Drawing 6.6.4.1, and 6.14.1 of Clause 6.14, the Low of Vietnam specified that “In the BOT Contract, if the Vietnamese entity including Off-taker cannot fulfill the obligations of the Contracts, The Project Company have the right to petition Government Guarantees and Undertakings Agreement, and the Vietnamese Government should guarantee the obligations and commitment on BOT Contract, PPA, Fuel Supply Agreement (FSA), Water Supply Agreement (WSA), and Land Loan Agreement (LLA) so on.”

Since the Project Period is quite long, such kind of guarantees by the Vietnamese Government is very important. In other words, the project risks of this Project must be basically concentrated into the country risk of the Vietnamese Government, so only through the coverage of the country risks by ECA will be able to realize the project finance. We expect the Vietnamese Government will positively participate in the project in order to obtain full support by ECA on the project finance.

6.7 Proposal of Procurement Package

This Study does not propose a procurement package for the transmission line and substation project.

6.8 Financial Analysis on the Power Plant Construction Project

This Study examines the rationality of the PPP project by assessing financial feasibility of the Song Hau 1 Coal-Fired Power Plant Project.

6.8.1 Basic Conditions for Financial Analysis

In this study, financial analysis on the Song Hau 1 Coal-Fired Power Plant Project is based on the feasibility study report prepared by PECC3 in March 2011. However, variables such as construction cost and fuel costs are revised by this study. The basic conditions for financial analysis are as follows:

Table 6.8.1.1: Basic Conditions for Financial Analysis

Item	Condition
a. Power Generation	Plant Capacity: 1,200MW Plant Factor: 74.2% （6,500 hours） Annual Output: 7,800GWh Auxiliary Consumption: 6.4% Net Power Production: 7,301GWh
b. Construction Period	54 months(starting from 2013)（Completion for Unit No.1 at the end of December, 2017, for Unit No.2 at the end of June, 2018）
c. Project Life	30 years
d. Funding	Equity：30% Loan in foreign currency：70%
e. Terms and Conditions on Loan	Repayment period：10 years Interest rate： 8% p.a.
f. Depreciation	12 years
g. Revenue	Electricity Tariff: 0.0658 USD/kWh
h. Fuel Cost	(Coal) Annual Consumption：3.326 million tons, Unit Price：90 USD/ton (Limestone) Annual Consumption:76,000 tons, Unit Price：11 USD/ton (Oil) Annual Consumption：6,000 tons, Unit Price 929 USD/ton

Item	Condition
i. Physical Contingency	10%
j. Exchange Rate	1 USD = VND 20,658
h. Tax and Duty	Foreign Portion: 3% Domestic Portion: 10%

6.8.2 Financial Costs and Benefits

(1) Financial Costs

The financial costs for the Project include the capital investment cost which covers the construction cost and the recurrent cost which covers operation and maintenance of the newly installed power plant.

[Capital Investment Cost]

The total capital investment cost amounts to 1,761million USD. It includes engineering, procumbent and construction (EPC), physical contingency, consulting service, land expropritation and compensation, interest during construction (IDC), and tax & duty. For the breakdown of EPC, please refer to the section 4.8.

Table 6.8.2.1 Capital Investment Cost

Item	Amount (million USD)
■ EPC	1,188
■ Consulting Service	25
■ Land Reclamation and Compensation	64
■ Administration and others	44
■ Physical Contingency	112
■ Tax and duty	54
■ Interest during Construction (IDC)	274
Total	**1,761**

In the F/S report by PECC3, IDC was included in the administration and other cost despite that it should not be included and should be separately itemized. In addition, the amount of IDC calculated in the F/S report by PECC3 is 118.6 million USD. However, it is underestimated since the amount of interest on loan outstanding disbursed in the previous year is only semiannual instead of annual.

[Recurrent Cost]

The recurrent cost covers O&M cost and fuel cost. The annual O&M cost is estimated as 3.5% of EPC cost. The total recurrent cost will be 347 million USD. The cost driver is the fuel cost.

[Unit Cost for Power Generation]

The estimated unit cost for power generation is 0.0564 USD/kWh which covers the both capital investment cost and recurrent cost. It is higher than the current average electricity tariff for end users charged by EVN of 1,242 VND/kWh (about 0.06 USD/kWh).

(2) Financial Benefits

The financial benefit for the Project is revenue by electricity sales of the Song Hau 1 Power

Plant. In the case that the annual net sales production is 7,301 GWh at the unit sales price of 0.0658 USD/kWh which is an assumption by PECC3, the expected annual electricity revenue is 480 million USD.

6.8.3 Financial Analysis

The results of financial analysis are shown as Table 6.8.3.1.

Table 6.8.3.1 Results of Financial Analysis

Financial Internal Rate of Return (FIRR)

(USD Million)

Fiscal Year	Financial Cost (A)			Financial Benefit (B)	(B) - (A)	Net Profit After Tax
	Capital	O&M	Total Cost			
2012	66	0	66	0	-66	
2013	64	0	64	0	-64	
2014	245	0	245	0	-245	
2015	484	0	484	0	-484	
2016	582	0	582	0	-582	
2017	319	0	319	0	-319	
2018	0	260	260	360	100	-35
2019	0	347	347	480	133	9
2020	0	347	347	480	133	9
2021	0	347	347	480	133	9
2022	0	347	347	480	133	9
2023	0	347	347	480	133	9
2024	0	347	347	480	133	9
2025	0	347	347	480	133	9
2026	0	347	347	480	133	9
2027	0	347	347	480	133	9
2028	0	347	347	480	133	9
2029	0	347	347	480	133	9
2030	0	347	347	480	133	9
2031	0	347	347	480	133	120
2032	0	347	347	480	133	120
2033	0	347	347	480	133	100
2034	0	347	347	480	133	100
2035	0	347	347	480	133	100
2036	0	347	347	480	133	100
2037	0	347	347	480	133	100
2038	0	347	347	480	133	100
2039	0	347	347	480	133	100
2040	0	347	347	480	133	100
2041	0	347	347	480	133	100
2042	0	347	347	480	133	100
2043	0	347	347	480	133	100
2044	0	347	347	480	133	100
2045	0	347	347	480	133	100
2046	0	347	347	480	133	100
Total	1,761	9,985	11,746	13,811	2,065	1,708
FIRR	**5.29%**					
NPV	**-483**					
ROI	**217%**					
ROE	**379%**					

(1) Financial Internal Rate of Return (FIRR)

FIRR is an indicator to measure the financial return on investment of project and is used to make the investment decision. FIRR is obtained by equating the present value of investment costs (as cash-outflows) and the present value of net incomes (as cash in-flows). In general, in the case that FIRR is higher than the funding cost for the investment, it can be judged that the

investment can be financially effective.

Based on the financial model shown in the Table 6.8.1.1, the FIRR of the Project is estimated as 5.29%. It is below of the funding cost of 7.8%, which is obtained by the weighted average capital cost (WACC). The formula of WACC is as follows:

WACC (%) = D/(E+D) x rD x (1-T) + E/(E+D) x rE
D: The total amount of debt
E: The total amount of equity
rD: The interest rate of debt (8%)
rE: The cost of equity (12%)
T: Business tax rate of Vietnam (25%)

In order to obtain investment effect which is higher than the funding cost of 7.8%, it is necessary to reduce the financial costs or to increase the financial benefit. For example, in the case that the selling price of electricity increased to 0.0723 USD/kWh, the FIRR of the Project can reach 7.83% which is higher than the funding cost.

(2) Net Present Value (NPV)
NPV is the difference between the present value of cash inflows and the present value of cash outflows. It is used in capital budgeting to analyze the profitability of an investment or project.

Based on the preconditions shown in the Table 6.8.1.1 NPV for the Project is negative 483. It means that the profitability of investment for the Song Hau 1 Power Plant Project is negative.

(3) ROI (Return on Investment)
ROI is a performance measure used to evaluate the efficiency of an investment. The larger ROI indicates a better investment opportunity with higher profitability. ROI is obtained by the following formula:

ROI (%) = Net gain of investment/ Cost of investment x 100

ROI of the Project is 217%. It indicates that the benefit of the Project will be around 2 times the capital investment.

(4) ROE (Return on Equity)
ROE measures profitability of project by revealing how much profit the project generates with the money shareholders have invested. For investors, ROE indicates profitability of project as well as efficiency of investment. ROE is obtained by the following formula:

ROE (%) = Net income returned/ Amount of equity x 100%

In the case of the expected equity of 451 million USD[1], ROE for the Project is 379% which will ensure certain level of profitability of the Project for the equity.

[1] The expected amount of equity is according to the F/S report by PECC 3. It is equivalent to 28% of the capital investment cost of 1,617 million USD excluding IDC.

6.8.4 Sensitivity Analysis

Due to the recent growing prices of construction materials and fuels, this Study examines effects of those price increases on the financial feasibility of the Project.

(1) The Increase in EPC costs
The increase in EPC cost will affect the financial feasibility of the Project as below, in the case of no change in other variables of the financial model for the base case.

Table 6.8.4.1 : Impacts of the Increase in EPC Cost on FIRR

Change in EPC Cost	Capital Investment Cost	FIRR
5%	1,844 million USD	4.93%
10%	1,928 million USD	4.60%
15%	2,012million USD	4.28%
20%	2,096 million USD	3.98%

In the case of the increase in EPC cost by 5%, the capital investment cost will expand to 1,844 million USD, which results FIRR of 4.93%. When the EPC cost increases by 20%, the capital investment cost will increase to 2,096 million USD. In that case, FIRR will decrease to 3.98%, which is 1.3 point below the FIRR of the base case.

(2) The Increase in Imported Coal Price
Considering the recent increase in international coal prices and the transportation cost, it is anticipated that the actual fuel cost will exceed over the estimated fuel cost of 90 USD/ton in the Feasibility Study Report prepared by PECC 3. The simulated FIRRs by the increase in the fuel cost are shown in the Table 6.5.

Table 6.8.4.2: Impacts of the Increase in Imported Coal Price on FIRR

Change in Coal Price	Imported Coal Price	FIRR
10%	99 USD/ton	3.39%
20%	108 USD/ton	1.09%
30%	117 USD/ton	-1.97%
40%	126 USD/ton	-7.60%

In the case that the coal price increases to 99 USD/ton by 10%, the FIRR will go down to 3.39%. However, the current level of international coal prices[2] and the transportation cost indicates that the fuel cost can be over 120 USD/ton. The 20% increase in the fuel cost, which amounts 108 USD/ton, will bring about the FIRR of 1.09%. The 30% increase in the fuel cost will result the negative FIRR of 1.97%. Therefore, it is a key for the Project to find alternatives with lower fuel cost since the fuel cost has significant impact on the profitability of the Project.

6.9 Economic Analysis of the PPP Project

It is difficult to implement economic analysis on the entire PPP project including all the three components since the project formulation for the components of the transmission line / substation and the coal terminal has been behind in comparison with the Power Plant

[2] As of January 2012, the FOB spot prices are 95 USD/ton for the Indonesian coal and 116 USD/ton for the Australian coal.

Construction Project. Thus, this Study conducts economic analysis on the Power Plant Construction Project in order to assess its economic effect.

(1) Economic Cost
The economic analysis is based on the capital investment cost and the recurrent cost for the financial analysis, but excluding tax and duty.

(2) Economic Benefit
The economic benefit can be derived by positive difference of "with-project" situation from "without-project" situation. The Least Cost Alternative method is conventionally used for the economic analysis of power projects. For the Least Cost Alternative method, "the avoid cost" can be considered as the economic benefit of project. The avoid cost can be estimated by difference between the capital and O&M costs of the Project and the ones of alternative power plant, such as small off-grid diesel power plants. In the case that the unit generation cost for the off-grid diesel power plants is assumed as 0.1 USD/kWh, the expected annual economic benefit is 730 million USD

(3) EIRR (Economic Internal Rate of Return)
Based on the assumption mentioned above, EIRR for the Project is 16.0 % as shown in the Table 6.9.1. Since the electricity supply in the Southern region of Vietnam has been tight for the rapidly growing demand, it is expected that the Project can induce a certain economic effect through the enhancement of power generation capacity by the construction of large scale power plant.

Table 6.9.1: Results of Economic Analysis

Economic Internal Rate of Return (EIRR)

(USD Million)

Fiscal Year	Economic Cost (A)			Financial Benefit (B)	(B) - (A)
	Capital	O&M	Total Cost		
2012	66	0	66	0	-66
2013	64	0	64	0	-64
2014	245	0	245	0	-245
2015	484	0	484	0	-484
2016	582	0	582	0	-582
2017	319	0	319	0	-319
2018	0	260	260	548	287
2019	0	347	347	730	383
2020	0	347	347	730	383
2021	0	347	347	730	383
2022	0	347	347	730	383
2023	0	347	347	730	383
2024	0	347	347	730	383
2025	0	347	347	730	383
2026	0	347	347	730	383
2027	0	347	347	730	383
2028	0	347	347	730	383
2029	0	347	347	730	383
2030	0	347	347	730	383
2031	0	347	347	730	383
2032	0	347	347	730	383
2033	0	347	347	730	383
2034	0	347	347	730	383
2035	0	347	347	730	383
2036	0	347	347	730	383
2037	0	347	347	730	383
2038	0	347	347	730	383
2039	0	347	347	730	383
2040	0	347	347	730	383
2041	0	347	347	730	383
2042	0	347	347	730	383
2043	0	347	347	730	383
2044	0	347	347	730	383
2045	0	347	347	730	383
2046	0	347	347	730	383
Total	1,761	9,985	11,746	20,990	9,244
EIRR	**16.0%**				

6.10 Operation and Effect Indicators

This Study proposes the following operation and effect indicators for the Power Plant Construction Project in order to monitor and verify the operation and maintenance situation of the power plant to be installed as well as the project effect by utilizing it. The target value for each indicator should be determined according to the O&M plan and the discussions among the stakeholders.

6.10.1 Operation Indicators

The operation indicators are measures to assess operation and maintenance situation of facilities and equipment to be installed. For coal-fired power plant project, the following indicators are applicable in general.

Table 6.10.1.1: Operation Indicators

Operation Indicator	Definition	Object to Measure
Maximum Output (MW)	—	Assessing the planned capacity
Plant Factor)(%)	= Annual power generation/ (Rate capacity x Annual operation hours) x 100	Assessing rationality of the operational plan (in the case of the base load operation)
Auxiliary Rate (%)	= Annual auxiliary consumption / Gross power generation x 100	Assessing the planned capacity
Gross Thermal Efficiency（%）	= (Gross power generation x 860) / (Annual fuel consumption x caloric value) x 100	Assessing the planned capacity and energy saving （1kWh=860kcal）
Outage Hours by Cause (hours)	・Human errors ・Mechanic failure ・Planned outage	Assessing adequacy of operation and maintenance of power plant
Outage times by Cause	Same as above	Assessing adequacy of operation and maintenance of power plant

6.10.2 Effect Indicator

The effect indicator measures the project effect by the operation of the Song Hau 1 power plant. The propose effect indicator is as shown in the Table 6.10.2.1.

Table 6.10.2.1: Effect Indicator

Effect Indicator	Definition	Object to be Measured
Annual Net Power Generation	-	Assessing the production volume of the power plant

6.11 Analysis on Project Revenue by the Power Plant Construction Project

This Study assesses the expected project revenue on the condition that EVN and the government of Vietnam guarantee for purchasing the total volume of electricity produced by the Song Hau 1 Power Plant as well as that the purchasing price by EVN is linked to the fuel cost (imported coal price).

6.11.1 Expected Revenue of the Base Case

The Feasibility Study Report by PECC 3 assumes the annual operating hours of 6,500 hours (plant factor of 74.2%), the auxiliary rate of 6.4% and the annual sales volume of 7,301 GWh. In that case, the expected annual electricity sales revenue will be 480 million USD by the sales price to EVN of 0.0658 USD/kWh. The expected total electricity revenue generated by 30 years operation will amount to 13,811 million USD[3].

[3] Since it is expected that the Unit 2 will operate for a half year for the 1st year operation, the revenue for the 1st year operation will amount 360 million USD which account for 75% of the annual revenue by the full operation of the

6.11.2 Sensitivity Analysis

Changes in sales price will significantly affect the project revenue. The impacts of changes in sales price on the annual revenue and the profitability (FIRR) of the Power Plant Construction Project are analyzed as below.

The base case of the financial analysis above applies the sales price set in the Feasibility Study Report by PECC 3. Table 6.11.2.1 shows impacts of change in the sale price on the revenue and the financial feasibility of the Project.

Table 6.11.2.1: Impact of Unit Price on Revenue

Change in Price	Unit Price	Annual Electricity Sales Revenue	FIRR
5%	0.0691USD/kWh	504 million USD	6.64%
10%	0.0724USD/kWh	528 million USD	7.88%
15%	0.0757USD/kWh	552 million USD	9.03%

The sale price of 0.0757 USD/kWh, which is 15% higher than the base case, can increase to the FIRR of 9.03% by more than 3 point from the FIRR of the base case. It means that the FIRR can be higher than the funding cost.

While the higher sales price can considerably improve the profitability of the Project, the current electricity tariff of EVN, which is below the level of cost recovery, may hamper to set the sales price ensuring higher profitability. Therefore, it is necessary to adjust both of sales volume and sales price in order to ensure a certain level of profitability.

6.11.3 Financial Performance of Off-Taker (EVN)

EVN is a state-owned power company group which plays a key role in the power sector of Vietnam. The business areas of EVN cover not only power generation, transmission, and distribution but also communication and machinery.

The total gross sales of EVN, including electricity sales, amounted to 96,944 billion VND (approximately 5.1 billion USD) in 2010. Out of it, the electricity sales were 90,910 billion VND (4.8 billion USD) which accounted more than 90% of the total gross sales. The electricity sales have grown due to the increasing power demand. Along with the raise in electricity tariff in 2010, the electricity sales in 2010 expanded by 25% from the previous year. Approximately 30% of the electricity supplied by EVN was purchased from IPPs/BOTs.

The cost of sales in 2010 sharply increased by 39% from the previous year because of the increasing power generation cost caused by the sharp increase in fuel prices, including coal. As a result, the gross revenue reduced over 60% from 12,482 billion VND (696 million USD) in 2009 to 4,657 billion VND (246 million USD).

The electricity tariff which has not been sufficient to cover the costs including administrative and financial costs has made EVN run losses before tax. Particularly, in 2010, the losses considerably expanded to 14,292 billion VND (755 million USD) which is 13.5 times of the

Unit 1 and Unit 2.

previous year.

Table 6.11.3.1: Financial Performance of EVN

	2008		2009		2010	
	VND billion	USD million	VND billion	USD million	VND billion	USD million
Sales	63,732	3,754.02	78,975	4,401.93	96,944	5,120.64
Electricity Sales	57,469	3,385.11	72,726	4,053.62	90,910	4,801.92
Cost of Sales	-54,592	-3,215.64	-66,493	-3,706.20	-92,287	-4,874.66
Gross Revenue	9,139	538.32	12,481	695.67	4,657	245.99
Selling and General Expense	-5,283	-311.19	-6,607	-368.26	-7,320	-386.65
Other Operating Income	1,277	75.22	1,342	74.80	762	40.25
Other Operating Expense	-10,592	-623.90	-6,173	-344.07	-8,101	-427.90
Investment Income	1,569	92.42	1,356	75.58	1,776	93.81
Financial Expense	-3,047	-179.48	-3,457	-192.69	-6,065	-320.36
Loss before Tax	-6,937	-408.61	-1,057	-58.92	-14,292	-754.91

Source: EVN, "Audited Consolidated Financial Statements: For the year ended 31 December 2009"
Note: The exchange rates (annual average) are as follows:
For 2008: 1 USD = 16,977VND
For 2009: 1 USD = 17,941 VND
For 2010: 1 USD = 18,932 VND.
(IMF, "International Financial Statistics Yearbook 2011")

Currently, the government of Vietnam has been promoting the power sector reform, including the liberalization of electricity tariff which can improve the profitability of the electricity business. However, the insufficient raise in the electricity tariff could not absorb the increasing fuel cost due to the sharp increase in the international coal price. As a result, EVN has been facing financial difficulty. According to the public release, EVN reduced the purchasing volume of electricity from the IPPs, which are more expensive than the power plants owned by EVN. On the other hand, EVN keeps purchasing electricity from the thermal power plants constructed by the BOT scheme funded by China due to the power purchase agreement including the clause of penalty charges. In order to reduce the costs, EVN indicated their intention to increase the portion of electricity supply from their own power plants.

6.12 Conditions and Process of Permits and Approvals required for the Project

In this section, we list up the permits and approvals those will be necessary to develop the Project, from obtain the Investment Certificate, obtain financing and construct the Project. We also show the process and time schedule for the development and implementation of the Project.

6.12.1 Definitions

In this section, the following terms shall be interpreted as indicated in the Table 6.12.1.1.

Table 6.12.1.1 Definition of Terms

Project Company	=	The Project company which implements the Project
BOT Contract	=	The BOT contract relating to the Project
EVN	=	Vietnam Electricity
EIA	=	Environmental Impact Assessment
Investment Certificate	=	The Investment Certificate for the Project

Investment Report	=	The Investment Report relating to the Project
IPR	=	Investment Project Report
GGU	=	Government Guarantees and Undertakings Agreement
MOC	=	Ministry of Construction
MOF	=	Ministry of Finance
MOIT	=	Ministry of Industry and Trade
MONRE	=	Ministry of Natural Resources and Environment
MPI	=	Ministry of Planning and Investment
PM	=	The Prime Minister
PPA	=	Power Purchase Agreement
SBV	=	State Bank of Vietnam

6.12.2 Permits and Approvals required for the Project

Permits and Approvals required in line with each project implementation stage shall be indicated in the Table 6.12.2.1

Table 6.12.2.1 List of Permits and Approvals required for the Project

	Issues	**Applicable Law/Decree/Decision and/or Authority**
I.	**IPR Preparation**	
1.	Approval of the IPR by the MOIT	
II.	**From IPR approval to issuance of the Investment Certificate**	
2.	PM's approval on issuance of a GGU for the Project	Decree 78 [4]
3.	PM's approval of the BOT Contract and other Project documents	Decree 62 [5]
4.	Approval of the EIA of the Project by the MONRE	Decree 80 [6]
5.	Application and receipt of the Investment Certificate by the MPI	Decree 78 & Decree 108 [7]
III.	**Permits and approvals to be obtained as soon possible as after issuance of Investment Certificate**	
6.	Approval of the MOF on adopting amendments and supplements to	Circular 122 [8]

[4] Decree 78 of the Government dated May 11, 2007 on investment projects in the forms of BOT, BTO or BT contracts
[5] Decree 62 of the Government dated August 15, 1998
[6] Decree 80 of the Government dated August 9, 2006 implementing the Law on Environmental Protection
[7] Decree 108 of the Government dated September 22, 2006 implementing the Investment Law
[8] Circular 122 of the MOF dated December 22, 2004 providing the implementation of accounting and auditing regimes by

	Issues	Applicable Law/Decree/Decision and/or Authority
	Vietnam accounting standards if the Project Company intends to use different accounting standards	
7.	Work permits for expatriates	Decree 34 [9]
IV.	**Permits and approvals to be obtained before construction of the Project**	
8.	Land acquisition	Decree 181 [10]
9.	Approval of the MOIT for any change in the technical design of the Project which is not consistent with the basic design of the Project	Decree 78
10.	Certificate of appraisal of the fire prevention and extinguishment design of the Project from provincial police	Decree 35 [11]
11.	Contractor permits from the MOC for the foreign contractors employed by the Project Company or notification of selection of foreign contractors to the MPI and the MOC	Decision 87 [12] and Decree 58 [13]
12.	Construction permit	Decree 12 [14]
V.	**Permits and approvals to be obtained before commercial operation of the Project**	
13.	Water permits from MONRE or provincial people's committee	Law on Water Resources of the National Assembly dated May 20, 1998 and Decree 149 [15]
14.	Certificate of ownership of construction works	Decree 95 [16]
15.	Power generation license	Decision 32 [17]
VI.	**Permits and approvals to be obtained before financial close of the Project**	
16.	Approval of the MOIT for any security interests created over the Project's assets, if the same are not contemplated and specifically approved in the BOT Contract (as is usually the case).	Decree 78

Vietnam-based enterprises and organizations with foreign capital

9 Decree 34 of the Government dated March 25, 2008 on employment and management of foreigners working in Vietnam.

10 Decree 181 of the Government dated October 29, 2004 implementing the Land Law

11 Decree 35 of the Government dated April 4, 2003 on fire prevention and extinguishment

12 Decision 87 of the Prime Minister dated May 19, 2004 issuing the regulations on management of activities of foreign contractors in the construction sector in Vietnam

13 Decree 58 of the Government dated May 5, 2008 on tendering

14 Decree 12 of the Government dated February 12, 2009 on management of construction investment projects

15 Decree 149 of the Government dated July 27, 2004 implementing the Law on Water Resources

16 Decree 95 of the Government dated July 15, 2005 on issuance of house ownership certificate and construction work ownership certificate

17 Decision 32 of the MOIT dated September 6, 2006 on electricity licenses

	Issues	Applicable Law/Decree/Decision and/or Authority
17.	Certificate of registration issued by the SBV in respect of all foreign loans relating to the Project.	Decree 134 [18]
18.	Registration or certification of the security interests relating to the Project and registration of security interests over the property, land, revenues, rights or other assets that are the subject of these security agreements.	Decree 163 [19]

6.12.3 Process for Development and Implementation of the Project

Regarding Song Hau 1 CFPP, Vietnamese Government had provided the Investment Certificate to PVN. PVN have been implementing the project based on Local IPP scheme, and the process for the approval on IPR was completed already. As we explained in the Clause 6.6 of this report, it is realistic to apply BOT Scheme for which Sovereign Guarantee by Vietnamese Government legally secured, in order to invite some foreign companies to co-invest on this Project. We listed the necessary permits and approvals in the Clause 6.12.2 provided to apply BOT scheme on this project, and investigated the necessary time frame for each item, and show the expected schedule in the table 6.12.3.1.
For comparison purpose, we introduce time schedule for another on-going power project under BOT scheme, which was designated by MOIT.

[18] Decree 134 dated November 1, 2005 on management of foreign loans
[19] Decree 163 of the Government dated December 29, 2006 on secured transactions

Table 6.12.3.1 Expected time schedule for Song Hau1 CFPP under BOT scheme

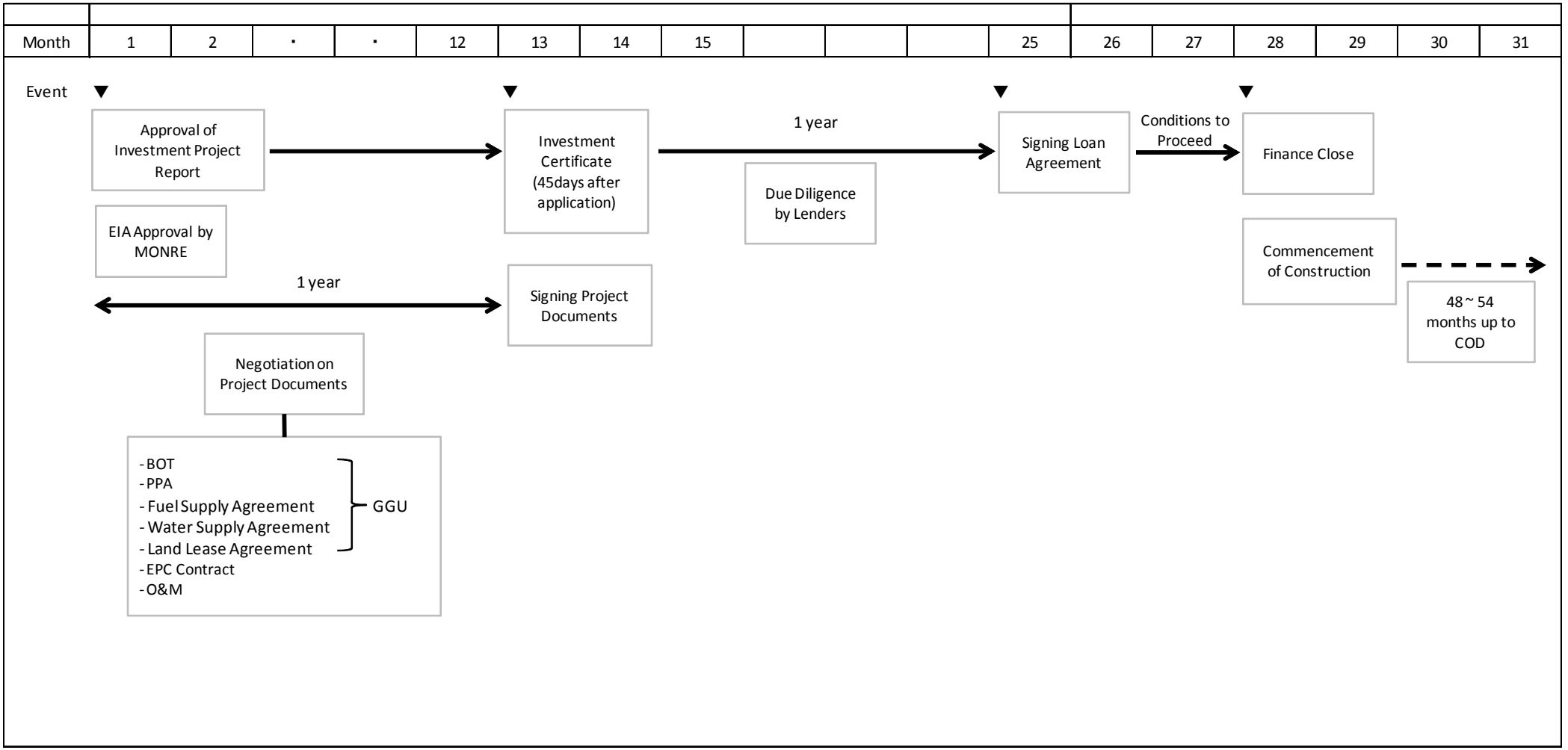
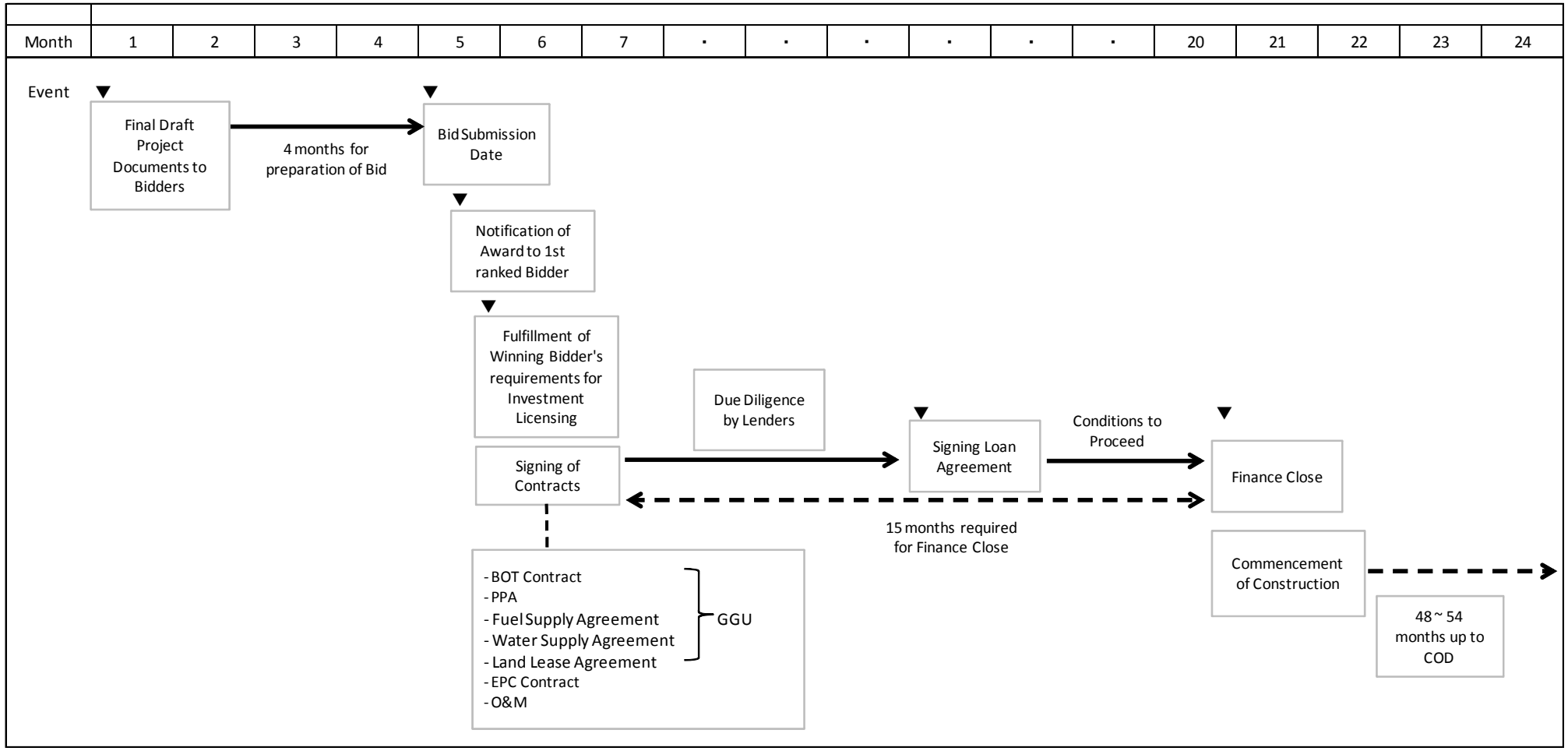


Table 6.12.3.2 Time schedule for another on-going Power Project under BOT scheme in Vietnam



Judging from the above comparison, it will take very long time for the negotiation of the PPA etc. We investigate that it will take at least one year to conclude necessary contracts including BOT contract. There is also a project which has taken several years time until the commencement of the construction of the power plant, and normally the period from approval of IPR to commencement of construction after signing loan agreement will take more than 2 years, since concluding PPA negotiation and financial close took very long time. Therefore, if the BOT scheme will be applied to Song Hau 1 CFPP, it must be rather difficult to meet with the period of COD scheduled by PVN.

On the other hand, if the Local IPP scheme were applied, it will not be required to take very long period compare with BOT scheme. However, some items of Sovereign guarantee by Vietnamese Government will not be secured in Local IPP scheme. Foreign investors must have a difficulty to make investment including the arrangement of financing.
Anyway, Local IPP scheme must be effective and will make contribution on power development in Vietnam.

6.13 Study of Project Implementation Schedule

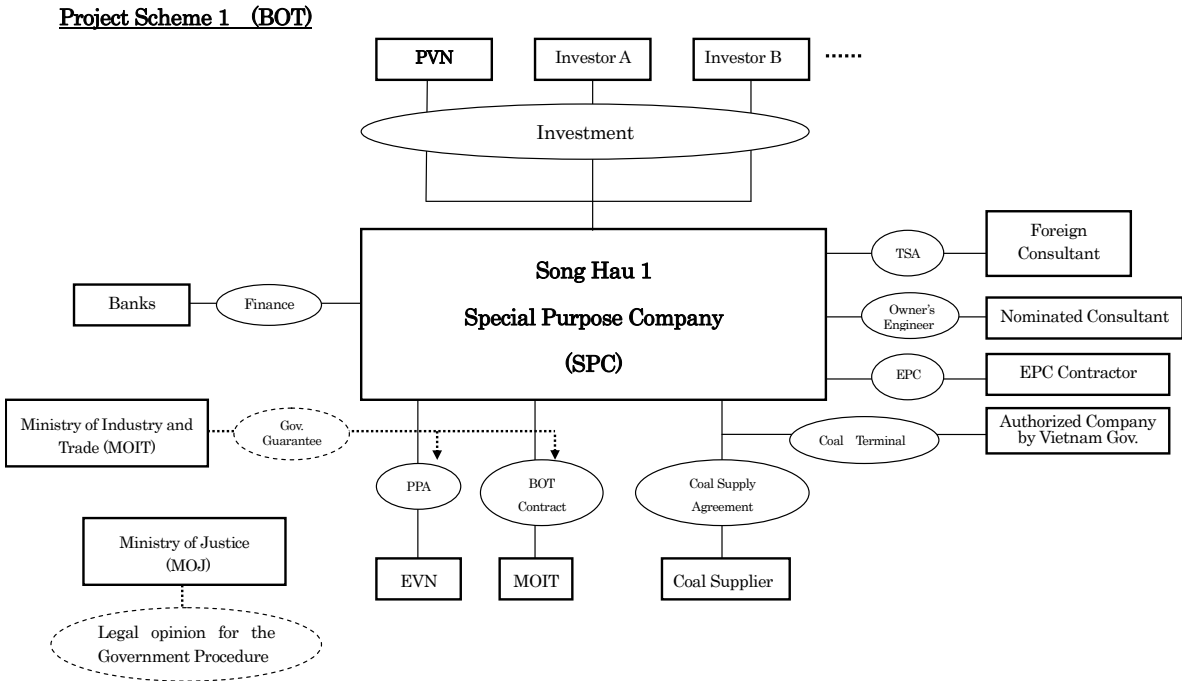
Regarding the Project implementation schedule of the Power Plant, please refer to the secton 4.7 of Chapter 4.

6.14 Study of Organization of Project Scheme, Operation & Maintenance

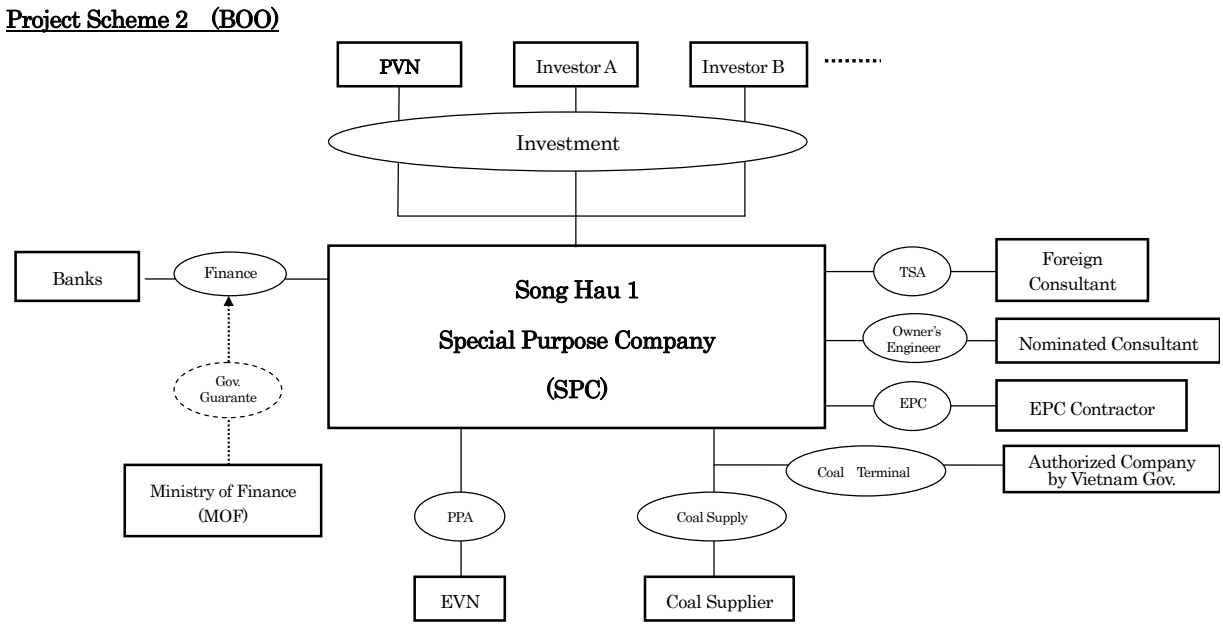
6.14.1 Project Scheme

In order to effectively construct, operate, and maintain the Song Hau 1 Coal Fired Power Plant under the conditions of obtaining the investment by foreign shareholders and/or finance by foreign banks, BOT and BOO project schemes shown in the Drawings 6.14.1.1 and 6.14.1.2 shall be considered.

Drawing 6.14.1.1BOT Scheme



Drawing 6.14.1.2 BOO Scheme



It is on the premise that the project operation and maintenance of the Power Plant will be generally performed by a Special Purpose Company (SPC) which will be founded by PVN and other shareholders. It is necessary to obtain Project Finance by Banks for 70% to 80% of the total Project Cost. In order to obtain such finance from foreign banks, it is on the premise that Vietnamese Government shall provide the necessary guarantee and support.

Expected supports on the Project by the Vietnamese Government are as follows;

- BOT Scheme
  - Payment guarantee based on the PPA (by MOIT)
  - Support guarantee on procedures of approvals by Vietnamese Government during the Project implementation stage (by MOIT)
  - Guarantee on exchange the project net profit from the local currency to foreign currencies, as well as transferring to abroad (by MOIT)
  - Providing the Legal Opinion to justify the rules, regulations and procedures by Vietnamese Government related with the BOT Scheme (by MOJ)

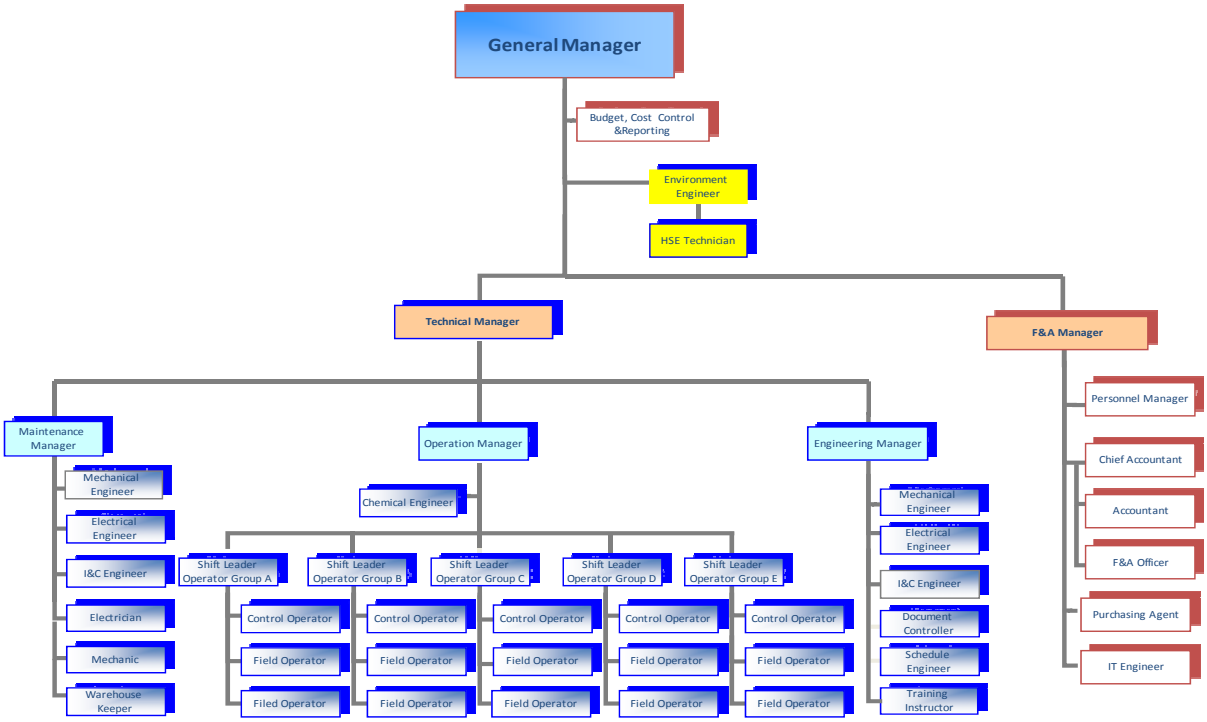
- BOO Scheme
  - Payment guarantee against the loan amount by foreign banks (by MOF)

EVN have not selected the EPC contractor for this project, and they have a strong intention to select top quality manufactures' equipment (so to speak G7 products) with enough export track records for the main equipment such as Boiler, Steam Turbine, Generator etc., or request to provide the quality guarantee by G7 manufacturers.
During the construction period, it is recommended to adopt an experienced foreign consultant as Technical Advisor (TA), and let them make quality control of the generating equipment and schedule control, in order to construct a reliable power plant timely.

6.14.2 Project Operation and Organization of O&M

Regarding the Operation and maintenance (O&M) of the Power Plants, two options will be considered. The first option will be direct operation by the SPC, and the other will be consignment on experienced O&M Company. If an experienced foreign Utility will be one of the Shareholders, it is expected to ask them to participate in the O&M directly or ask them to be the Technical Advisor.
Song Hau Power Plant is a Super Critical Coal Fired Power Plant, which system has not been under operation in Vietnam as of today. This type of Power Plant has some particular maintenance item etc., so the following O&M Organization on this type of power plants will be useful.

Drawing 6.14.2.1 Organization of O&M



Regarding the utilized coal, it is necessary to make a long term coal purchase contract which will cover the whole project period. The Supplier and/or the Agent of the coal have not been designated on this Project. However, PVN have founded a subsidiary company namely PVCoal who is specialized to handle coals, and this company is mostly expected to be a trader of importing coals and supply to this Project.

At the time of transportation of the coals, the shallow depth of Hau River is a bottle neck to make the constant transportation by over 3,000DWT barges. Therefore, the coals to be imported from Australia and Indonesia should be transshipped into barges at the newly constructed "Imported Coal Transshipment Terminal," and to be made 2nd transportation to the power plant site. Because of this condition, to secure the long term contract for using the imported Coal Transshipment Terminal is mandatory required.

6.15 Analysis on Financial Situation of the Implementing Agency (PVN)

6.15.1 Power Development Plan, Power Demand and the IPP/BOT Projects

The Government of Vietnam formulates a Power Development Master Plan (PDP) and announces it every five year. The PDP 6 for the period from 2006 to 2015 was approved by the Prime Minister in July 2007. The PDP 7 was approved by the Prime Minister in July 2011.

Under the PDP 6, it was expected to newly install 4,960 MW of power generating capacity in total by 2010. However, the actual installed capacity by 2009 was only 1,879MW, and the expected achievement in 2010 was 2,272 MW which account for 46% of the planned capacity.

The lower execution rate of the PDP6 can be attributed to the following factors:

- Suspensions of construction due to the financial shortage of project owners for IPP/BOT project triggered by the Leman shock,
- Prolonged construction period caused by lack of experiences of contractors in tender process and time management for construction,
- Delays of port development for imports of coal,
- Delays of land expropriation for the project sites for the extended process of compensation for the resettlements.

Those troubles increased with the increasing number of IPP/BOT projects and expanding diversification of electric sources besides hydro power.

Table 6.15.1.1 Implementation of PDP 6

	2006	2007	2008	2009	2010*
Approved Capacity (MW)	861	2,096	3,271	3,393	4,960
Installed Capacity (MW)	756	1,279	2,251	1,879	2,272
Execution Rate (%)	87.8%	61.9%	68.8%	55.4%	45.8%

Source: JETRO, "Vietnam Power Sector Study 2010", Dec. 2010, p.4, Table.1
Note: * The data for 2010 are estimated ones.

The available capacity at the end of 2009 was 17,652 MW. Although the existing power plants in the country kept the normal load factor, the blackouts occurred frequently in the southern regions. It means that the current installed capacity may not enough to meet the electricity demand in the country. It is because of the slow progress in the implementation of the PDP 6.

The electricity consumption in Vietnam has shown the rapid growth of 14% per annum. 50% of the consumption is composed of the industry and construction sector. Since the new projects including steel and cement plants are planned to implement for next few years, it is forecasted that the electricity consumption is going to steadily increase in the industry and construction sector. Also, the power demand of the household sector, which consumes 40% of electricity, may also grow when home electric appliances including air conditioners are widely used in the country.

By region, the electricity consumption in the southern regions is larger by 10-13% than the ones in the northern regions. It is expected that the trend will continue for future. However, the size of planned installed capacity of power plant in both southern and northern regions is almost same in the draft PDP 7 which forecasts that the power demand will increase by 13% by 2030.

Therefore, there is a concern that the power supply will be tighter in the southern region for next few years.

6.15.2 The Planned Power Plant Project

According to the JETRO's report, there are at least 75 projects of power plant development on the list. Total generation capacity installed by those projects could reach 58,652 MW. Out of them, 16 projects and 12 projects are expected to start commissioning in 2011 and 2012, respectively. The large scale coal-fired power plants with capacity over 1,000MW are expected to start of commercial operation in 2015.

The major electricity sources for the planned project are hydropower and coal-fired thermal power: 31 projects for hydropower and 36 projects for coal-fired. Others are gas-fired and nuclear power plants. As mentioned above, there are concerns about implementation of those planned projects since numbers of IPP/BOT projects have been implemented behind their initial schedule because of vulnerable financial and management capacity. Also, the projects by EVN are also fragile due to the financial difficulty of EVN.

6.15.3 Financial Performance of PVN

PVN is a state-owned company group composed of oil and gas business and related business which contribute to the energy security for Vietnam. As a part of contribution to the energy security, PVN also has the electricity division which makes investment on power plants and supplies the electricity as IPPs. PVN owns three power plants: Ca Mau 1, Ca Mau 2 and Nhon Trach 1. Those three power plants started their operation by 2010. The total generation capacity is 1,950 MW.

The Table 6.12 shows the recent financial performance of PVN. The total sales of the PVN group in 2009 were 136,511 billion VND (7.6 billion USD). 6% of the total sales came from the electricity sales of 8,408 billion VND (470 million USD). The PVN group keeps net profit: the profit before tax in 2009 was 480 billion VND (27 million USD). According to the public release, the gross profit of the PVN group for January to August 2011 will amount 10.85 billion USD which will be the largest profit for them.

Table 6.15.3.1: Financial Performance of PVN

	2008		2009	
	VND billion	**USD million**	**VND billion**	**USD million**
Sales	126,592	7,456.68	136,511	7,608.88
Electricity Sales	2,923	172.17	8,408	468.65
Cost of Sales	-91,210	-5,372.56	-101,406	-5,652.19
Gross Revenue	35,381	2,084.05	35,104	1,956.64
Selling and General Expense	-4,974	-292.98	-6,874	-383.14
Other Operating Income	593	34.93	810	45.15
Other Operating Expense	-236	-13.90	-331	-18.45
Investment Income	7,156	421.51	8,136	453.49
Financial Expense	-5,310	-312.78	-3,277	-182.65
Loss before Tax	357	21.03	480	26.75

Source: PVN, "Annual Report 2009"
Note: The exchange rates (annual average) are as follows:
For 2008: 1 USD = 16,977VND
For 2009: 1 USD = 17,941 VND
For 2010: 1 USD = 18,932 VND.
(IMF, "International Financial Statistics Yearbook 2011")

Since EVN reduces the electricity purchase from the IPPs as mentioned above, there is a concern that the profitability of the IPPs operated by the PVN group will decline. However, it is considered that the PVN group has the steady financial performance and the sufficient profitability to make new investment in IPPs.

6.15.4. Investment Plan of PVN

As mentioned above, PVN has been investing in the power generation business as a part of the energy security for Vietnam. PVN aims at expanding their power generation to 20-25% of the total power generation of the country.

PVN plans to make investment in 19 new power plants including the Song Hau 1, which have the power generation capacity of 9,899.6 MW in total. The total investment will be 12,620 million USD. PVN will invest in not only thermal power plants but also power plants using renewable energies such as hydropower and wind power.

It is scheduled that the Vung Ang 1 Coal-Fired Power Plant (600MW x 2 units) in northern part of Vietnam will start to operate in 2012. Through the operation of this power plant, it is expected that PVN will ensure the management capacity for the large scale thermal power plant.

Table 6.15.4.1: Investment Plan of PVN for IPPs (as of the end of 2010)

No.	Project's name	Owner	Location	TIC/Charter Unit: Million $US
I	**Power**			**12,620.68**
1	Ca Mau 1 750MW	PVPower	Camau Province	436.45
2	Ca Mau 2 750MW	PVPower	Camau Province	429.14
3	Nhon Trach 1 450MW	PVPower	Dong Nai Province	338.15
4	Nhon Trach 2 750MW	PVN/PVPower	Dong Nai Province	602.00
5	Long Phu 1 Coal-Fired Power Plant 1200MW	PVN	Soc Trang Province	1,432.80
6	Thai Binh 2 Coal-Fired Power Plant 1200MW	PVN/PV Power	Thai Binh Province	1,605.60
7	Vung Ang 1 Coal-Fired Power Plant 1200MW	PVN	Ha Tinh Province	1,595.10
8	Song Hau 1 Coal-Fired Power Plant 1200MW	PVN	Hau Giang Province	1,611.00
9	LuangPraBang Hydro Power Plant 1100MW	PVN/PV Power	Luang-Prabang Province, Laos	2,764.90
10	Hua Na Hydro Power Project 180MW	PVPower 55.4%	Nghe An Province	256.00
11	Xekaman 1 Hydro Power Project 290MW	PVN/PVPower	Atapu Province, Laos	411.00
12	Xekaman 3 Hydro Power Project 250MW	PVN/PVPower	Sekong Province, Laos	311.00
13	Dakdrinh Hydro Power Project 125MW	PVPower 75.6%	Quang Ngai Province	180.15
14	Nam Chien Hydroelectric JSC 200MW	PVN 32% share	Son La Province	219.70
15	Song Tranh 3 Hydro Power Project 64MW	PVN/PVPower	Quang Nam Province	76.58
16	Son Tra 2 Hydro Power Project 14MW	PVN/PVPower	Quang Ngai Province	13.47
17	Nam Cat Hydro Power Project 3.2MW	PVN/PVPower	Bac Can Province	4.63
18	Binh Thuan Wind Turbine Power Plant 165MW	PVN/PVPower	Binh Thuan Province	310.80
19	Phu Quy Island Wind Turbine Power Plant 8.4MW	PVN/PVPower	Binh Thuan Province	22.21
TOTAL: 9899.6 MW				

6.16 Risks on PPP Project and Expected Countermeasures

This Study analyzes risks on the Project, mainly for the power plant construction project, and considers possible countermeasures to mitigate risks identified.

6.16.1 Risks on Power Generation Activities

(1) Electricity Tariff

The most critical issue is electricity tariff for the electric power business in Vietnam. The current tariff system is complicated because different prices apply for different categories of customers and different with variable rate by electricity consumption and time (peak, normal and off). While the price at peak time for the commercial and service sector is more than VND 3,000/kWh (0.145 USD), the average price for the industry and construction sector which consume more than 50% of the power supply by EVN, is below VND 2,000/kWh (0.097 USD). Also the average electricity price for household is less than VND 2,000/kWh (0.097USD). For irrigation, the electricity price is extremely low though their consumption is limited to less than 1% of the total power supply by EVN: VND 1,300/kWh (0.063 USD) for peak time, VND 700/kWh (0.034 USD) for normal time, and VND 300/kWh (0.015 USD) for off time.

In 2009, the Decision 21 of the Prime Minister ordered the introduction of a 3-year plan to increase the average retail electricity price until a “market mechanism” sets prices from 2012. The Prime Minister’s approval is required for more than 5% increase from previous year. In

March 2010, The Government of Vietnam raised the retail electricity price by 6.8% compared with 2009 to reflect the increasing price of coal. In March 2011, the Prime Minister approved a 15.3% increase in electricity price and applied the new tariff in April.

In addition, in April 2011, the Prime Minister issued "Decision on the Adjustment of Electricity Selling Price According to Market Mechanism". The Decision applies the principle to make adjustment of electricity selling price in accordance with cost of power generation, transmission and distribution, cost of management and administration, and cost of electricity system supporting services. On the other hand, the Decision suggests establishment of the fund of electricity price stability to stabilize electricity selling price in order to avoid adverse impacts on macroeconomic stability as well as social security. Under the Decision, EVN is entitled to adjustment to raise electricity selling price at the correlative rate within 5% after registering with and been approved by MOIT.

Table 6.16.1.1 Electricity Tariff Household (as of July 2011)

Category of Consumption	Electricity Price (per kWh)	
	VND	USD*
First 50kWh (only for poor or low-income household)	993	0.048
0～100kWh (for others)	1,242	0.060
101～150kWh	1,304	0.063
151～200kWh	1,651	0.080
201 ～300kWh	1,788	0.087
301 ～400kWh	1,912	0.093
More than 401kWh	1,962	0.095

Source: Vietnam Electricity (EVN) website (http://www.evn.com.vn/, as of July 2011)
Note: The exchange rate is 1 USD = 20,658 VND.

The EVN groups proposed further increase in electricity tariff due to the deterioration of their financial position, but the Ministry of Industry and Trade (MOIT) rejected it. There are still strong oppositions against increases in electricity price because it can hit households which consume around 40% of electricity while there are concerns about power shortage.

On the other hand, MOIT started a test operation of "the Vietnam Competitive Generation Market (VCGM)" which is a competitive electricity market. VCGM enables negotiations between a power company and power producers. A power company can contract with a power producer offering lower wholesale electricity price. The payment to the power producer from the power company is composed of two tranches: 95% of the payment is based on a fixed price and the rest 5% is based on hourly market price

Thus, execution of the reasonable electricity pricing policy or the establishment of market mechanism for electricity trading is necessary for promotion of IPP and BOT business in electric power development in Vietnam.

(2) Coal Price

Vietnam has abundant coal resource of 49.8 billion tons as of January 2010. The main player of the coal sector in the country is Vinacomin (the Vietnam National Coal, Mineral Industries Holding Corp.). Their business covers exploitation, production, distribution, export of coal as well as operation of coal-fired thermal power plants.

In 2010, the total coal supply was 45 million tons while the total coal domestic demand was 26 million tons. Of those demand 11 million tons were consumed for power generation. The

rapid growth of power generation has been led the sharp increase in coal demand. Although Vietnam has been traditionally a coal exporter, it started to import coal for thermal power plants in July 2011. It is forecasted that the annual import volume will grow to around 10 million tons in 2012. Furthermore, imports of coal could surge to 100 million tons/year by 2020 due to the expected expansion of power grid and power plant development.

The fact indicates that coal-fired thermal plants to be constructed require more imports of coal, in particular the power plants to be located in the southern regions in the country. Also, accommodation capacity to receive imported coals should be expanded to cope with the growing demand.

Table 6.16.1.2 Coal Supply/Demand Balance in Base Scenario

(Unit: million tons)

	2010	2015	2020	2025	2030
Total Coal Supply	**45**	**58**	**70-80**	**85-100**	**90-110**
Total Coal Demand	**26**	**58-68**	**93-114**	**135-162**	**204-241**
Other demand	**16**	**27**	**32-34**	**36-42**	**42-51**
Coal for Power	**11**	**32-42**	**61-80**	**99-120**	**162-190**
Domestic	**10**	**27**	**40**	**60**	**90**
Imported (min/max)		**5-15**	**21-40**	**39-60**	**72-100**

(Source) Vinacomin

Similarly to the electricity price, the domestic coal price has been suppressed at low level. Although the Government of Vietnam decided that the domestic coal price should be more than 90% of the export price, it can only cover 50% of the production cost (70 USD/ton). The second proposal for increase in domestic coal price by Vinacomin was rejected by the Government in 2010.

In the draft Power Development Plan 7, it is forecasted that the domestic coal price in 2030 would be doubled from the price in 2010. For achieving the target price in 2030, the price requires to increase by 8% annually, which is unrealistic under the current conditions.

On the other hand, the price gap between domestic and international market is necessary to be adjusted to the fair level for both the supply side and the demand side including power plants. Since the coal-fired power plants in the southern regions need to depend on import coal, a stable procurement of import coal at fair value is also a key factor for private investors who interests in PPP or BOT business in power generation.

(3) Fuel Transportation Cost

In the Southern region of Vietnam, most of coal-fired power plants to be installed plans to use imported coal for their fuel. On the other hand, some of them, including Song Hau 1, will be located in inland areas where are inconvenient for procurement of imported coal because of geographic factors. Therefore, it is necessary for those power plants to construct an imported coal terminal and to transport coals to them through the rivers. However, an obstacle for the project plan is identified: Insufficient depth of the river constrains coal transportation to the planned power plant by large size vessels.

In order to enable transportation of large size vessels, it is necessary to implement large scale dredging of the river which requires more capital investment. In addition, maintenance cost of the channel will be also needed for regular maintenance dredging. Those capital and recurrent costs will be added to transportation cost for fuel which may affect on profitability of the

planned power plant. Therefore, it is inevitable to incorporate economically efficient fuel transportation in the project plan in order to ensure financial feasibility of the planned power plant.

6.16.2 Risks on Project Implementation

There can be risks on project management in addition to commercial risks on power generation. The project plan should be considered the following risks as well.

(1) Feasibility of Public Infrastructure Development for the Planned Power Plant
As mentioned above, the PPP project comprises the three components of construction of power plant, transmission line and substation, and imported coal terminal. However, these three components are independent projects owned by different project owners. Also they require substantial capital investment, respectively. Therefore, the stage of project planning varies by component. While the project plan for construction of power plant has been progressed, it is unlikely to prepare project plans for the two other components because of uncertain institutional arrangement and site selection.

The planned power plant will not be able to start commercial operation unless the necessary public infrastructure, including a coal terminal for fuel supply and transmission line and substation for connecting with power grid, are completed on time. In order to ensure feasibility of the planned power plant, it is inevitable to prepare project plans for the two other components and to assess their feasibility.

For development of transmission line and substation, the investment plan by EVN/NPT will affect on power plant development because power transmission is monopolized by EVN/NPT. Considering the current financial difficulty of EVN, implementation of the transmission line project linked the planned power plant is still unclear.

Also, the project plan for coal terminal, including its capacity, is still under consideration and not determined yet though it is planned to supply coal for coal-fired power plants to be installed in Southern region, including Song Hau 1. Construction of dedicated coal terminal for Song Hau could be an alternative.

(2) Project Management
In general, EPC contractor and/or consultant are in charge of total project management, including the whole constructions and procurements, in order to ensure the planned schedule and quality of outputs. Fragmented construction lots contracted by different contractors can bring about difficulty to control the whole construction process and to make adjustments among the lots although delay in minor lots can disturb major portion in large-scale construction project. As a result, completion of the whole construction can be delayed. Also, there is a similar issue in quality management. Fragmented procurements can make difficult adjustment if any problems occur among facilities and equipment procured from different suppliers.

6.16.3 Expected Countermeasures

For the implementation of the Song Hau 1 Power Plant Project, it is necessary and effective to consider the following possible countermeasures.

【Thorough implementation of the power sector reform by the Government of Vietnam to mitigate risks on the power generation business】

It is essential to firmly implement the on-going power sector reform in order to reduce risks on the power generation business. In particular, the electricity tariff reform which ensures a certain level of profitability for the power generation business is inevitable to cope with the sharp increase in fuel prices. In addition, for the implementation of PPP project, it is needed that the government appropriately coordinates among responsible ministries and government bodies in order to reduce the risks on the business risks from the institutional aspect.

【Utilization of Expertise in Management of the Private Sector】

In Vietnam, there are number of IPP and BOT projects under the PDP 6. However, most projects are behind schedule as mentioned above. It is pointed out that the one of critical reasons for those delays in implementation of IPP and BOT projects is prolonged construction period due to inexperienced project management including procurement and process control.

Since PVN, the implementing agency for the power plant construction project, has experiences of IPP projects, they have sufficient project management capacity. On the other hand, for the large-scale international plant construction projects, it is preferable that well-experienced international EPC contractors and consultants are engaged in the project management for implementation and supervision of the entire schedule and the procurement for the project in order to ensure delivery time and quality of the outputs.

Also, it is expected that their expertise in project management will be transferred to local contractors through the project implementation, which can increase reliability and credibility of those local contractors. In addition, the on time delivery of power plant project is essential for Vietnam, in particular in the southern regions under the current situation. Thus, the reliable project management for the proposed PPP project is enough rational to contribute to acceleration of power development in the country.

Chapter 7 Environmental and Social Considerations

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Chapter 7 Environmental and Social Considerations

7.1 Background and Existing Conditions

The JICA established the scheme of Private Partnership Project (PPP), and Song Hau power plant project phase1 was planned as a part of PPP project. Conditions of the proposed PPP project consists of the following three sub-projects which are equally indispensable to ensure smooth operations and availability of power supply:

- Construction of Song Hau power plant project phase1
- Construction of coal transship terminal project
- Construction of transmission line project

Each sub-project is essential for the smooth operation of the 1,200MW power plant and the completion date of construction work shall be planned in the same period. As for the Song Hau power plant project, the financial source for the construction project will be arranged by Vietnamese side (PVN). However, three projects were categorized as PPP project and thus a study of environmental and social considerations is required according to the Vietnamese Government laws and new JICA guideline.

Recent international guidelines on infrastructure development suggest that the environmental and social considerations have become a critical factor that affects the feasibility of the projects. Environmental and social consideration is mandatory, especially in cases when the financial resources are mobilised or sourced from the International Financial Institutions (IFI). In the case of JICA, they have established the new JICA Guideline on Environmental and Social Considerations on April 2010. The JICA guideline is compulsory applied for all of their lending operations.

The proposed projects would surely require a clearance for environmental and social safeguard based on the policies of IFIs like WB, IFC and JICA, which mandates adequate environmental and social considerations for development projects. The objective of this study aims to review EIA report for the Song Hau power plant project phase1 (Version 2007) and assist the project owner PVN to carry out and clarify environmental and social considerations prior to proceeding with the implementation of the proposed project.

According to the information of PECC3 who prepared EIA, the EIA report for power plant project was divided into two (2) categories i.e. for the infrastructures and, for the power plant facilities. The category for the infrastructures was approved by Peoples Committee of Hau Giang Province on February 9, 2009 (No. 190QD UBND), As for the EIA report for the power plant facilities, it was submitted to MONRE on July 2010 and approved on July 25, 2011 (No.1455/QD-BTNMT) by MONRE. Current field work by contractor has been conducted based on approved EIA report for infrastructures.

As for the Feasibility Study (FS) Report for Song Hau power plant phase 1 was already approved by the prime minister’s office on April 5, 2011 (No.2824/QD-DKVN).

7.2 Terms of Reference of Environmental Study

The environmental study would carry out the evaluation of Environmental conditions for Song Hau power plant project phase1 in accordance with the approach described in Table 7.2.1.

Table 7.2.1 Terms of Reference for Review of EIA report

No.	TOR	Approach
1	Review of EIA report for Song Hau power plant project phase1.	The environmental experts carry out the review of EIA report and prepare the check lists based on new JICA guideline and the Vietnamese Government laws, codes, and standards.
2	Study of environmental social conditions for power plant project phase1.	The environmental experts carry out the study of environmental conditions for power plant project phase 1 according to the EIA Report.
3	Study on Environmental Legislation in Vietnam	Following laws and regulations are studied: (a) Environmental Protection Laws (b) Regulations on water contamination, air pollution, noise and vibration (c) Regulations on the process of EIA approval (d) Regulation of involuntary resettlement
4	Environmental Issues Identification	The environmental expert proposed recommendations of the environmental elements to be considered during construction and operation phase in accordance with new JICA guideline on Environment and Social Considerations.

7.3 Project Description

7.3.1 Brief Description of the Project

Construction of Song Hau power plant project phase1 will be conducted with the following conditions:

Output capacity	1,200MW (600MW x 2)
Employer	Vietnam Oil and Gas Corporation (PVN)
Project owner	Longphu-Song Hau Power Project Management Board

7.3.2 Scope of the Project

Construction of Song Hau power plant project phase1 include as follows:

- Compensation of resettlement and site clearance
- The main work of Song Hau power plant phase1: two (2) generating unit 600 MW x 2 with traditional steam condensation thermal technology, once-through, pulverized coal-fired boiler and reheat, supercritical steam parameter, applied advanced technology (low NOx burning) and install exhaust gas treatment equipment to ensure compliance with the environmental requirements.
- The auxiliary system of Song Hau power plant project phase1: the supply and storage system of coal, oil, limestone, gypsum and ash, removing system, cooling water system with the water taken from Hau River, fresh water supply system, exhaust gas treatment system.
- The transformer station, electrical system of the plant.
- The specialized port to receive the fuel, materials and output the by-products of the plant.
- Ash dump.

Layout of power plant and building structures are shown in attached drawings in Annex E-3.

7.3.3 Land Use Plan

Conditions of required land use plan for Song Hau power plant is shown in Table 7.3.1.

Table 7.3.3.1 Land Use Plan for Song Hau Power Plant Phase 1

Items	Area (ha)	Notes
Song Hau power plant phase 1, main plant	42	
220kV switchyard	2.5	
Cooling water discharge canal/box culvert	20.7	
Construction ground No.1 & No2 for temporary work	12.5	
Ash dump site	33	Phase 1
Traffic corridor and other auxiliary areas	4.5	
Song Hau power center (all project area)	139.5	Phase1 &Phase 2
Other facilities	24.3	

Source: PECC3 FS Final (received in June 2011) Part 2 Vol.1 Construction Report

7.3.4 Operation Schedule of the Project

The operation schedule of Song Hau power plant is planned in the EIA report as following:

- Generating Unit No.1 Y2017
- Generating Unit No2 Y2018

7.3.5 Main Facilities Related to Environment

(1) Coal storage area

The coal storage area of power plant is arranged on the land lot located in the Northeast of the power plant. Phase 1 power plant shall be furnished with a coal storage sheds which are designed to store 30 days of full load operation.

(2) Ash dump

The ash dump area is located in the southwest of the power plant, isolated with the traffic road and the residential areas surrounded by the green belt. Ash dump of phase 1 has an area of 33 ha, with ash storage capacity of about 10 years in case of failure to consume the ash.

(3) Fuel and equipment loading and unloading port

Required coal, oil, limestone and gypsum for the power plant operation shall be loaded and unloaded by the specialized port which is designed only for Song Hau power plant. The port has inclined quay to load and unload the super-dimensional and super-weight equipment.

(4) Cooling water system

The cooling water is taken from Hau River. The cooling water system includes: cooling water intake, cooling water pumping station, chlorination system, buried cooling water supply pipeline and cooling water discharge system.

(5) Fresh water supply system

The fresh water source is Hau River. River water is used by residents of Phu Huu Commune.

Utilization of river water source requires the treatment of the sedimentation and filtration in order to meet the water quality and technical requirement.

(6) Waste water treatment system

The waste water which comes from the power plant is designed to treat with the waste water treatment system set up in the plant in order to ensure reaching under permissible standard (QCVN 08-2008-BTNMT) and discharge into Hau River.

(7) Exhaust gas treatment system

To meet the environmental standards and regulations, the power plant installs the following dust, SO_2, and NOx treatment system in order to ensure reaching permissible standard (QCVN 05-2009-BTNMT, QCVN22-2009-BTNMT).

-Electrostatic precipitator (ESP)

-Flue gas desulphurization (FGD)

-NOx reduction system uses catalyst (SCR)

The boiler chimney is designed for two generating units with separate flue pipeline for each unit. Height of the chimney is 200m, which includes the reinforced concrete casing with covering, bearing functions for the two flue exhaust steel pipes with inside diameter 6.2m.

(8) Ash discharge system

The ash is discharged from the boiler in two forms: bottom ash (clinker) is collected from the boiler bottom and fry ash is collected from the exhaust fume of the boiler through the ESP, water heater and at the boiler wind dryer. It is planned that the dry fry ash be utilized to make concrete additive and raw materials of cement. The planning of ash yard has the provision of standby nature during the initial period when it is unable to consume ash or when there is the failure of ash treatment system.

(9) Gypsum transportation system

The gypsum generated after the exhaust gas treatment process shall be dried and transported by two conveyors to the storage depot. From the storage depot, the gypsum is transported by conveyers to the pouring quay. The quay is installed with gypsum pouring set for the barges. Daily produced gypsum volume is estimated about 243tons.

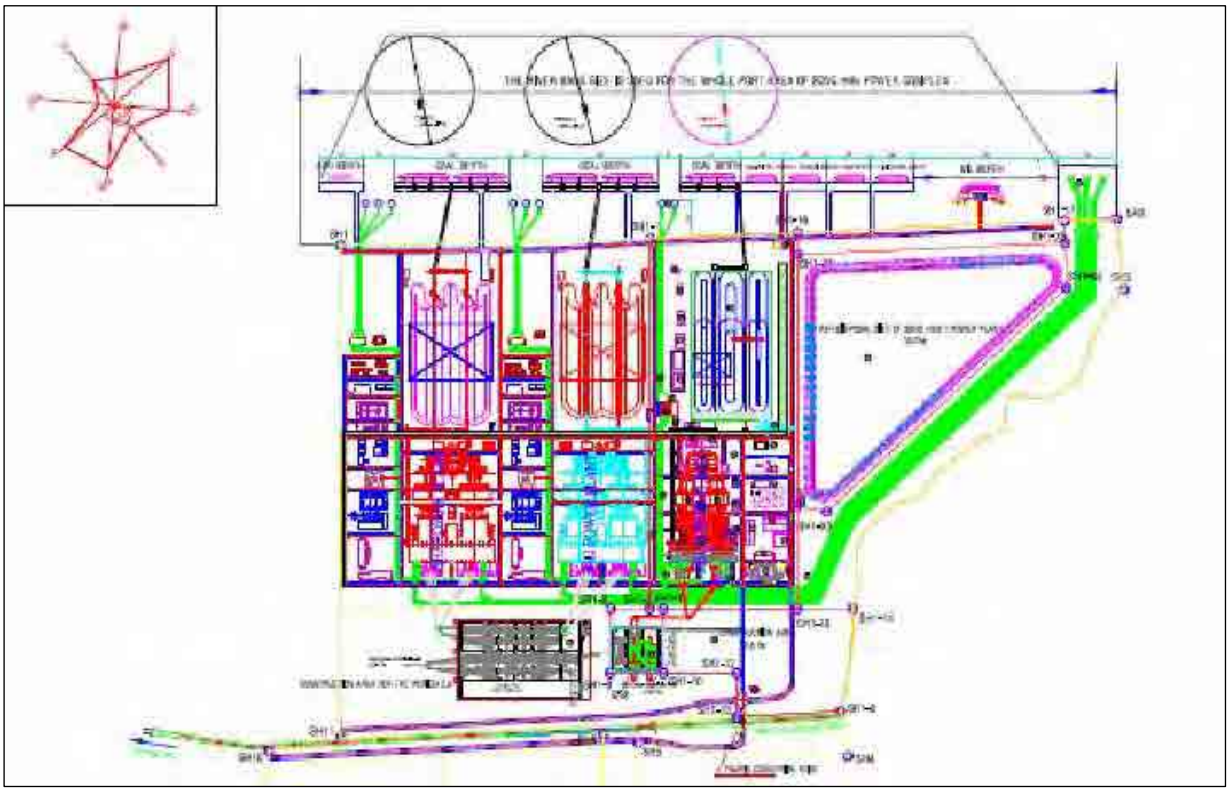
(10) Landscape and greenery planting

The flower garden, green trees, grass carpet, lake are designed in harmony with the natural landscape and overall architecture of the plant. The density of green trees must ensure that a minimum of 15% of the whole land area is seeded.

7.3.6 Geographical Position of the Project

Song Hau power plant is located within the planning area of Song Hau-Hau Giang Power Center in Phu Huu commune, Chau Thanh district, Hau Giang province. The project is located on the right bank of Hau River, 12km far from Can Tho City on the downstream and 180 km far from Ho Chi Minh City to Southwest. The location has an elevation of +0.4m to 1.9m. Main business of local residents who live in the proposed project areas is farming and agriculture. Vegetation of this area is mainly growing rice and some kind of fruit trees. There is an industrial zone beside the access road to the power plant named Song Hau Industrial Area. Center of Can Tho City to the proposed site is connected with paved 7m wide road and this road will be

utilized as the main access road to the power plant. There are shops and local restaurants along the access road to the project site. Project site is located in the delta area of Mekong River, and many local residents utilize small type of boats for their daily life at the present. (Existing views of the project site, access road and Can Tho City is shown in the attached photos Annex E-1).



Source: FS report

Figure 7.3.6.1 Layout of Power Plant

7.4 Existing Site Conditions of Project Area

In order to confirm the current situations of the site, the field reconnaissance survey of the site intended for the power plant facilities including access road was carried out on May 10, 2011, and the site for the proposed route of access channel of vessels on June 28, 2011 respectively. The following descriptions are mainly based on findings during the field reconnaissance survey.
According to the basic plan of FS report, an area of 42ha was reserved for this project and the plant area of phase1 site has almost completed construction works of land reclamation and grading, cutting of tree, removing of the existing housing facilities. This site preparation work started from last year 2010 according to the information of PVN site office. According to the EIA report, a total of 185 families with 2570 residents have been requested for resettlement for the construction of Son Hau Power Plant phase 1 project. As of October 25, 2011, almost all of the resettlement has been completed except for a couple of families All of the obstructions in the project area have been cleared and the site was already prepared and leveled as flat conditions through land reclamation (See Annex E-1 photo for the existing site of power plant). The existing housing areas of local residents are located in the riverbank of Hau River which will be utilized as buffer zone of power plant and area of port facilities.

7.5 Implementing Organization of Song Hau Power Plant Project

Long Phu-Song Hau Power Project Management Board was established as the responsible organization for the construction works. This organization was established for management of both construction project of Long Phu coal power plant and Song Hau coal power plant project. As for the Long Phu power plant project, land acquisition, resettlement and land preparation were already completed and the construction work for soil improvement has already started in May 2011 (See photo Photo7.5.1through Photo7.5.4).

Photo7.5.1 View of construction site

Photo7.5.2 View of power plant area

Photo7.5.3 View of management office

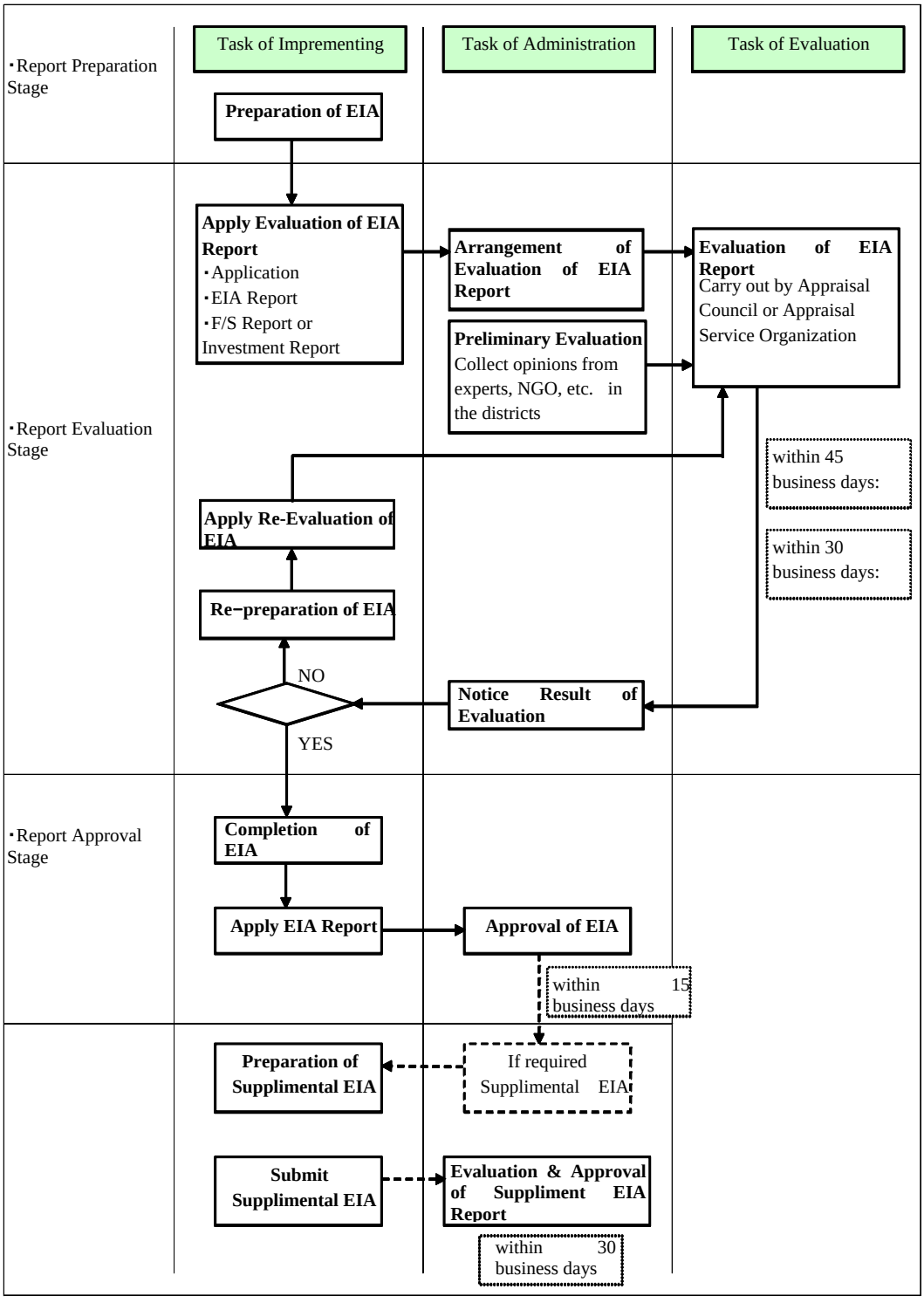
Photo7.5.4 Birdview of Power Plant

7.6 EIA Approval Process

The Decision No. 80/2006/ND-CP on EIA process, defines the types of projects that required an EIA, together with EIA approval process. According to the guideline for preparation of EIA report for thermal power project issued by MONRE in 2009, representative organization of investment owner who plan the development project of power plant have to prepare an EIA report and submit to the MONRE. Also according to the decree, the implementing organization shall prepare an application for evaluation of EIA report such as EIA report, F/S report, etc. then MONRE will establish an assessment council or select an assessment service organization for approving the EIA report.
In the case of the large scale project such as power plant constructions, appraisal council or appraisal service organization will be evaluated within 45 business days. After evaluation, a "notice of result" will be issued to the implementing organization. In case of acceptance, a final EIA report shall be prepared and then the authorization authority will have to approve the EIA report within 15 business days. If EIA report is not approved, the applicant (investor) have to revise or complete it according to the request of the council and send the EIA report back to the council to obtain agreement. Then EIA report will be accepted and eventually approved by the MONRE. The following cases shall require a supplemental EIA report:

- Changed location, size/scale, design capacity or technology of the project
- Project started after 24 months of the EIA report approval

Evaluation and approval of this report will be done by the above organization within 30 days after submission of the supplemental EIA report. Figure 7.6.1 shows the flow of approval for EIA report.



Source: JICA study Team

Figure 7.6.1 Flow of Approval for EIA Report

7.7 Public Consultation Meeting at EIA Approval Process

The environment involves not only the biophysical aspects but also the socioeconomic dimension of a proposed development. People are part of the environment and are often the subject of directly affected by projects or undertakings. Public participation therefore becomes crucial in making decisions that affect their lives and their environment.
Public consultation is a form or stage of public participation that involves information dissemination and gathering of public opinion. It is a form of participation where citizens can directly be involved in planning or decision making. It aims to produce the widest and most diversified public consultation possible involving people directly affected by a project. Proponents of projects shall initiate the conduct of public consultation to ensure that the concerns of the public are fully integrated into the project. In this project, public consultation for the project was held several times by the regional people's committee who is responsible organization for resettlement.
EIA approval process in Vietnam required that opinions of the public who live in targeted areas be heard. In the EIA for power plant project, regional people's committee in the district already collected the opinion from local residents. JICA guideline on environmental and social considerations requires the project owner to explain the project outline and their consequences from the environmental and social impact, and to respond adequately to the comments raised by the stakeholders. The comments received in the stakeholder consultation meeting were reflected into the final EIA report.
Public consultations were held before the preparation of EIA and RAP, and the comments received from the local residents were summarized by the People's Committee in the district and submitted to the project owner (PVN) as requirement. The following three items were requested to PVN:

- Reducing environmental impact by construction works in the site
- Provide mitigation measures which could reduce environmental impact for the project
- Discharge drainage to the river shall comply with environment regulations

The above requirements were studied and reflected in to the mitigation plan, environmental management plan in the EIA and basic design of FS for the proposed power plant project.

7.8 Environmental Monitoring

It is anticipated that various unexpected environmental problems will be occurred during the construction and operation of the project. Monitoring plan aimed to provide smooth actions of countermeasure for the environmental issues generated from the project with corresponding detailed monitoring programs will be covered entirely. Monitoring is necessary because the proposed power plant is a large scale development project and it has potential to cause unexpected impact to the environment. In addition, for understanding the change of environmental conditions, continuous monitoring is required. Table 7.8.1 and 7.8.2 shows environment monitoring plan described in the EIA.

Table 7.8.1 Monitoring Plan 1

No.	Observation Index	Observation Position	Sample Collection Equipment	No. of Samples	Frequency
A	**CONSTRUCTION PERIOD**				
B	**OPERATING PERIOD**				
B.1	**Exhaust gas of the plant**				
	-CO -SO2 -NOx -TSP -Temperature	-Community system	Exhaust gas measurement and monitoring system	-	Continuous (cycle 1-24 hours)
B.2	**Waste water from the centralized water treatment system**				
	-pH -Turbidity -BODs -COD -Grease -Temperature -Coliforms	-In front of and behind the centralized waste water treatment system	-Glass electrode pH meter -Turbidity meter -Consumed oxygen after 5 days at 20ºC -Oxygenated by $K_2Cr_2O_7$ -Gas chromatograph (TCVN 5070:1995) -Temperature meter -Filter through membrane and culture at 43 ºC	2	3 months/once
B.3	**Cooling waste water**				
	-pH -Temperature	-Cooling drainage channel	-Glass electrode pH meter -Temperature meter	1	1 day/once in the first month

Table 7.8.2 Monitoring Plan 2

No	Observation Index	Observation Position	Sample Collection Equipment	No. of Samples	Frequency
A	**CONSTRUCTION PERIOD**				
A.1	**Surrounding air**				
	-Total suspended dust (TSP) -SO_2 -NO_x -CO -Hydrocarbon -Noise	-Construction site (concrete mixing plant) (2 points) -Equipment and materials transportation road -Surrounding residential area (2 points)	-Sampling by the sample receiver DESAGE GS 312 (1 hr), analyze according to the method of Griss-Saltman under ISO 6768/1995 -Volume measurement method under TCVN 5067:1995 -Noise level meter equivalent to integration	5	6 months/once during the construction period
A.2	**Underground water environment**				
	-pH -SS -Fe -As -NH_3 -NO_3 -NO_2 -Coliforms	The underground water of the private house surrounding the plant area (2 samples)	-Glass electrode pH meter -Volume measurement method under TCVN 5067:1995 -Atom absorption spectrum -Visible light spectrum color -Filter through membrane and culture at 43 ºC	2	6 months/once during the construction period
A.3	**Surface water environment**				
	-pH -Turbidity -BOD5 -COD -Grease -Coliform	River water surrounding the project area (2 samples)	-Glass electrode pH meter -Turbidity meter -Consumed oxygen after 5 days at 20ºC -Oxygenated by $K_2Cr_2O_7$ -Gas chromatograph (TCVN 5070:1995) -Filter through membrane and culture at 43 ºC	2	6 months/once during the construction period
B	**OPERATING PERIOD**				

No	Observation Index	Observation Position	Sample Collection Equipment	No. of Samples	Frequency
B.1	**Surrounding air environment**				
	-CO -SO_2 -NO_X -TSP -VOC -Temperature -Moisture -Noise	-DO storage shed -Boiler area -Chimney base area -In the plant campus according to the wind direction -Port area (2 points) -Coal storage shed -Surrounding residential area according to the wind direction (5 points)	-Sampling by the sample receiver DESAGE GS 312 (1hr), analyze according to the method of Griss-Saltman under ISO 6768/1995 -Volume measurement method under TCVN 5067:1995 -Temperature meter -Moisture meter -Noise level meter equivalent to integration	12	3 months/once
B.2	**Underground water environment**				
	-pH -SS -Fe -As -NH_3 -NO_3 -NO_2 -Coliforms	The underground water of the private house surrounding the plant area (3 points)	-Glass electrode pH meter -Volume measurement method under TCVN 5067:1995 -Atom absorption spectrum -Visible light spectrum color -Filter through membrane and culture at 43 ºC	3	6 months/once
B.3	**Surface water environment**				
	-pH -Turbidity -BOD_5 -COD -Grease -Temperature -Coliform	-Cooling water channel -Cooling drainage channel -Point far from the cooling water outlet 100m -Hau River surface water (2 points)	-Glass electrode pH meter -Turbidity meter -Consumed oxygen after 5 days at 20ºC -Oxygenated by $K_2Cr_2O_7$ -Gas chromatograph (TCVN 5070:1995) -Temperature meter -Filter through membrane and culture at 43 ºC	5	3 months/once
B.4	**Aquatic organism**				
	Phytoplankton Zooplankton Zoobenthos	Hau River (upstream and downstream of the project area)	-Phytoplankton: qualitative samples are collected by plankton net; 60 liter of water was filter for quantity samples. -Zooplankton: qualitative samples are collected by Petersen grab in area with 0.025m^2. The samples after collecting are purified through a sieve 1mm.	2	6 months/time

Source: EIA report for Song Hau power plant project phase 1

7.9 Environmental Conditions of Power Plant: Construction Phase

(1) Result of EIA in construction phase

Summary of project activities impacting on the environmental and socio-economic in construction phase is shown in Table 7.9.1.

Table 7.9.1 Summary of Environmental Impact during Construction Stage

No.	Activities of Project / Items of Environment	Compensation, site clearance and resettlement	Open the road for construction	Clear, leveling, bulldozing, prepare site plan, work area, auxiliary area, hot area	Traffic, transport of building materials, equipment	Dredging at the port area and building the port	Building the work items of the project	Gather labor forces for construction	Incidents: fire, explosion, industrial accidents, traffic accidents	Total
1	Air	0	-1	-2	-2	-1	-1	0	-1	-8
2	Noise	0	-1	-1	-1	-1	-1	-1	0	-6
3	Erosion	0	0	-1	-1	0	-2	0	0	-4
4	Soil Quality	0	-1	-1	0	0	-1	0	-1	-4
5	Hydrography	0	0	0	0	-1	0	0	0	-1
6	Surface water	0	0	0	-1	-1	-1	-1	-1	-5
7	Underground water	0	0	0	0	0	0	-1	0	-1
8	Terrestrial plants	0	-1	-2	0	0	-1	0	0	-4
9	Aquatic organisms	0	0	0	0	-2	0	0	0	-2
10	Animal	0	0	0	0	0	-1	-1	0	-2
11	Treatened organism	0	0	0	0	0	0	0	0	0
12	Conservation areas	0	0	0	0	0	0	0	0	0
13	Population community	-2	0	0	0	0	0	-1	0	-3
14	Technical infrastructure	-1	0	0	0	0	0	0	-1	-2
15	Industrial activities	0	0	0	0	0	0	0	0	0
16	Agricultural activities	-1	0	0	0	0	0	0	0	-1
17	Small scale industries	0	0	0	0	0	0	0	0	0
18	Aquatic products	0	0	0	0	-1	0	0	0	-1
19	Transport	0	0	0	-2	0	0	0	0	-2
20	Land use planning	-2	-1	0	0	0	-1	0	0	-4
21	Economic activities	0	0	0	0	0	0	+1	0	+1
22	Community health	0	0	0	-1	0	-1	-1	-2	-5
23	Culture and society	-1	0	0	0	0	0	-1	0	-2
24	Historical relics	0	0	0	0	0	0	0	0	0
25	Natural landscape	-1	-1	-1	0	0	-1	0	0	-4
	Total	-8	-6	-8	-8	-7	-11	-7,+1	-6	

Source: EIA report for Song Hau power plant project phase 1
Note: the scoping system from 0 to 3
0: No impact inconsiderable impact
1: Small impact
2: Medium impact
3: Strong impact
Sign ”-“: express negative impact
Sign “+”: express positive impact

7.10 Environmental Conditions of Power Plant: Operation Phase

(1) Cooling waste water

Song Hau power plant shall use and discharge cooling water of about 56m^3/s and the temperature difference of the cooling waste water compared to the input water will be about 7 ℃. The average water temperature of Hau River is 27℃ to 30.1℃, therefore with the temperature difference of cooling waste water and input water of 7℃, the average discharge water temperature will increase 34℃ to 37.1℃. Under the standard QCVN24-2009-BTNMT on industrial waste water – discharge standard, the permissible discharge water temperature is 40℃ (source type A), so that the waste water temperature at the discharge gate mouth is well within the standard.

(2) Result of EIA in operation phase

Summary of project activities impacting on the environmental and socio-economic in operation phase is shown in Table 7.10.1.

Table 7.10.1 Summary of Environmental Impact during Operating Stage

No.	Activities of Project / Items of Environment	Cooling water intake	Cooling water outlet	Discharge water to Hau River	Exhaust gas emission	Receiving transport and storage of coal	Collection and removal of ash	Activities of operators	Discharge of product solid wastes	Excess heat	Oil spill, explosion and breaking of pipelines	Fire, explosion, industrial Accidents and other	Activities of receiving port	Total
1	Air	0	0	0	-1	-1	-1	0	0	-1	-1	-1	-1	-7
2	Noise	0	0	0	0	0	0	0	0	0	0	0	-1	-1
3	Erosion	-1	-1	-1	0	0	0	0	0	0	0	0	0	-3
4	Soil Quality	0	0	0	0	-1	-1	-1	-1	0	-1	-1	-1	-7
5	Hydrography	-1	-1	-1	0	0	0	0	0	0	0	0	0	-3
6	Surface water	0	0	-1	0	-1	-1	-1	-1	0	-1	-1	-1	-8
7	Underground water	0	0	0	0	0	0	0	0	0	-1	0	0	-1
8	Terrestrial plants	0	0	0	0	0	0	0	0	0	-1	0	0	-1
9	Aquatic organisms	-2	-1	-1	0	0	0	0	0	0	-1	0	-1	-6
10	Animal	0	0	0	0	0	0	0	0	0	0	0	0	0
11	Treatened organism	0	0	0	0	0	0	0	0	0	0	0	0	0
12	Conservation areas	0	0	0	0	0	0	0	0	0	0	0	0	0
13	Population community	0	0	0	0	0	0	0	0	0	0	0	0	0
14	Technical infrastructure	0	0	0	0	0	0	0	0	0	0	-1	0	-1
15	Industrial activities	0	0	0	0	0	0	0	0	0	0	0	0	0
16	Agricultural activities	0	0	0	0	0	0	0	0	0	0	0	0	0
17	Small scale industries	0	0	0	0	0	0	0	0	0	0	0	0	0
18	Aquatic products	-1	-1	-1	0	0	0	0	0	0	-1	0	0	-4
19	Transport	-1	0	0	0	0	0	0	0	0	0	0	0	-1
20	Land use planning	0	0	0	0	0	0	0	0	0	0	0	0	0
21	Economic activities	0	0	0	0	0	0	0	0	0	0	0	0	0
22	Community health	0	0	0	0	0	0	0	0	0	0	-2	0	-2
23	Culture and society	0	0	0	0	0	0	0	0	0	0	0	0	0
24	Historical relics	0	0	0	0	0	0	0	0	0	0	0	0	0
25	Natural landscape	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	-6	-4	-5	-1	-3	-3	-2	-2	-1	-7	-6	-5	

7.11 Evaluation of EIA

Evaluation of EIA report prepared by the Vietnamese side (PECC3) was carried out according to JICA's Check List form for the power plant, and the result of evaluation is shown in attached Annex E-2.

7.12 Recommendations

In order to ensure the adequacy of environmental and social considerations for the project implementation, issues were identified by using an environmental check list according to the new JICA guideline on Environmental and Social Considerations. The results of the study were shown in Annex E-2 for the Song Hau power plant project phase 1. As for the phase 2 project of power plant, EIA report is not prepared yet as of November, 2011. Therefore, the recommendation prepared is applied only for the proposed power plant project phase1.
The items of our recommendation for Song Hau power plant project phase1 are:

(a) Survey of riverbed soils in the proposed dredging area.
(b) Monitoring of involuntary resettlement people.
(c) Survey of the existing disposal area for dredged materials
(d) Utilization of ash generated from power plant
(e) Countermeasures of fine particles of coal

7.12.1 Survey of Riverbed Soils in the Proposed Dredging Area

Dredged materials will be utilized for the reclamation of the proposed project site according to the basic design. However, there are no data of riverbed soil quality for the proposed dredging area in the EIA report. In the case that polluted dredging materials are disposed at river or river side, it will cause serious impact to the existing ecology in the project area. Therefore, survey of riverbed soil quality including analysis of heavy metals and oil is recommended. Dredging work for the port shall be conducted after clarification of riverbed soils. In addition to the above, these data will be used as baseline data of riverbed and these data will be compared with monitoring data of riverbed taken in the operation of the power plant. Because of the discharge water to the river after treatment, the possibility of pollution of river water is still possible including sedimentation in the river at the vicinity of power plant. The items which required survey for the riverbed soils is shown in Table 7.12.1.1

Table 7.12.1.1 Data of Riverbed Soil Analysis (for reference)

No	Name of Chemical Substance	Symbol of Elements
1	Particle size	-
2	pH	-
3	Chemical Oxygen Demand	COD
4	Normal Hexane extractive Chemicals	-
5	Total Sulphur	T-S
6	Total Nitrogen	T-N
7	Total Phosphorus	T-P
8	Total Mercury	T-Hg
9	Alkyl Mercury	R-Hg
10	Cadmium	Cd
11	Total Cyanides	CN
12	Organic Phosporus	Or-P
13	Lead	Pb
14	Chromium	Cr
15	Arsenic	As
16	Polychloro biphenyl	PCB
17	Copper	Cu
18	Zink	Zn

7.12.2 Monitoring of Involuntary Resettlement People

The power plant facilities will be constructed in the existing farming and agricultural land where local residents live as such involuntary resettlement is anticipated by the project implementation. The following numbers of households and individuals may require involuntary resettlement according to the EIA report.

Table 7.12.2.1 Expected Numbers of Involuntary Resettlement

Districts	Affected Households	Required Resettlem-ent	Number of Inhabitants	Notes
Phu Huu commune, Chau Thanh district, Hau giang province	258	185	2570	Phase 1

Source: EIA report book2

In the resettlement action plan, a total of 25 necessary items from the requirements of Vietnamese Government laws, codes, decrees and regulation of people's committee for resettlement are described. In addition, sufficient amount of budget for compensation of resettlement was already reserved by PVN. Conditions of resettlement were confirmed through interview of PVN staff, the local consultant. Therefore, it is judged that a thorough study as far as proper compensation, restoration of livelihoods and living standards developed based on socioeconomic and responsible organization etc. is concerned have been carried out in this report.

Resettlement Plan was already prepared as a part of EIA. Study of proper compensation, restoration of livelihoods and living standards developed based on socioeconomic and responsible organization etc. are carried out in this report. In the resettlement plan, the framework of resettlement including the concept of proper compensation, restoration of livelihoods and living standard are already completed. The resettlement plan shall encompass measures for vulnerable group and persons based on the result of public consultation meetings.
The organizational framework for resettlement is described in the EIA. The required budget for resettlement was also studied in this report and partial relocation was already completed by the regional people's committee. Total estimated cost for compensation for Song Hau power plant phase 1 is 547,166,823,840 VND (US$ 26.7 million).

Table 7.12.2.2 Estimated Cost for Compensation

Items	Amounts (VND)	Notes
Compensation for land	117,924,290,000	Approved by people's committee
Compensation for removing	80,367,085,800	
Supporting cost	313,079,885,000	
Provision	25,568,563,040	5%
Cost for the compensation council	10,227,000,000	2%
Total	547,166,823,840	

Source: EIA report book2

According to new JICA guideline, resettlement action plan was required according to the description of World Bank's safeguard policy (operation manual: OP4.12). Proposed resettlement for the project has almost been done and completed according to the Vietnamese Government laws, standards, degrees and regulations of the people's committee. The items of estrangement between WBK guideline and the framework of resettlement issued by the Vietnamese Government are the following two items:

- Monitoring after completion of the resettlement
- Hollow up system after completion of the resettlement

After completion of the agreement with the local residents and clarification of the required resettlement, land acquisition and resettlement will follow based on the above regulations by responsible organization of regional people's committee with assistance of PVN. The methodology of involuntary resettlement and payment system for the targeted local residents who live in the proposed project site is all of made and settled in cash based on the conditions of lands, building type and area, assets, supporting of moving, graves, compensation of job change etc. The list of unit prices for the compensation was prepared and based on this list, the calculated amount of each household was drawn. Finally, all of the required budget for resettlement will be covered by PVN according to their unit cost approved by the regional peoples committee. As for this project, all of compensation for resettlement was made by Cash and the local residents are solely responsible for finding of new farming and agricultural land, as well as finding new housing facilities. Therefore, for the confirmation of final conditions of all the targeted resettlement peoples, we recommended the monitoring of households who made resettlement in this project by third party. Recommended monitoring items are shown in Table 7.12.2.3.

Table 7.12.2.3 List of Recommended Monitoring Items

No.	Monitoring Items	Notes
1	Received amounts for compensation	Confirmation
2	Conditions of new housing facilities	
3	Conditions of new farming/agricultural land	
4	Conditions of new job	
5	Conditions of infrastructure in new resettlement areas	Electricity, water supply etc.
6	Necessity of life support by project owner	
7	Availability of claim windows	
8	Conditions of training	

7.12.3 Survey of the Existing Disposal Area of Dredged Materials

In this project, approximately 250,000m^3 of dredging work for the construction of berth, turning basin and navigation channel are expected. The overall impact estimated during the construction work is not small. However, the EIA report did not described any information regarding the disposal site such as boundary line and the receiving capacity of the site for dredged soil. It is expected that a routine maintenance dredging will be required in the operation phase in the future and in the case of maintenance dredging, the dredged materials will be disposed into a new dumping area. Therefore, it is recommended to study and clarify the designated sites for disposing the disposal of the dredged materials. A site survey of the existing disposal site shall be additionally carried out.

For reducing and avoiding maintenance dredging, study and simulation for minimizing the sedimentation is required based on the depth of Hau River, flow (velocity) and conditions of river bed in the design stage of port facilities. Also, monitoring of sedimentation in the port and access channel is required during the operation phase according to the details of monitoring plan which will be prepared during the design stage.

7.12.4 Utilization of Ash Generated from Power Plant

Huge quantities of coal will be used in the operation of power plant, because power plant system is coal fired thermal power plant. According to EIA report, ash (234,650 ton/year) was planned to be moved by vessels to somewhere, however details of destination, name of cement factory and location are not mentioned. The ash storage yard will be utilized with provision for standby nature during the initial period and when it is unable to consume ash or when there is failure in the ash treatment system. An area of 33 ha of storage yard for phase 1 project is already reserved, and this power plant will be operated continuously as a major source of electricity to families and industries in the South of Vietnam. In the case of keeping ash in the stock yard, it is assumed to cause secondary environment troubles, because size of fly ash is small and can be easily diffused by windows therefore countermeasures for safety storage is necessary to avoid troubles. In addition, huge storage areas for safety storage of accumulated ash from the power plant is further required.
Japanese coal fired power plant has been transported generated ash to cement factories and utilizing ash for raw materials of cement, concrete additives, and construction materials for the civil work. Almost all ashes are utilized for civil work which consequently reduces environmental impact by ash. It is recommended as a long term plan of the operation of coal power plant, that utilization or disposal system of generated ash is indispensable for

environmentally friendly power plant. It is important that construction of fry ash cement factory shall be carried out based on the market research of cement and demand of local use for civil construction works.

7.12.5 Countermeasures of Fine Particles of Coal

Huge quantities of coal will be imported and used in the operation of power plant, because power plant system is a coal fired thermal power plant. Details of environmental impact of coal are not described in the EIA report. Air pollution caused by coal handling work shall be minimized and comply with QCVN05-2009-BTNMT shown in Table 7.12.5.1 In general, the following coal handling work has high potentiality of impact as air pollution.

- Receiving coal from vessels to stock yard
- Storage coal in stock yard
- Moving coal from stock yard to boiler by belt conveyer

Approximately 3.32 million tons of coal will be imported yearly through the domestic coal terminals from Indonesia/Australia. There are two coal stock yards in the power plant area, and after unloading all of the coal, it is stored into the coal stock yards located at the river side of plant. Finally, all of the coals are transported to the boiler facility by belt conveyer. In dry season, the handling of coal is expected to have significant impact bearing on surrounding areas including the residential facility approximately 350m far from the coal stock yard.
Therefore, for reducing environmental impact generated by coal handling and stock yard, the following facilities and construction works are recommended during the design stage for prevention of pollution of coal dust generation:

- Installation of dust prevention type belt conveyers
- Water spray system including pumps
- Construction of concrete/asphalt paving (operation yard)
- Run-off collection system with settling basin
- Construction of dust prevention roof and fence

In addition, collection system of run-off was necessary at operation yard and polluted run-off which were washed coal by rain water and directly discharged into the river. The run-off discharged to river from coal stock yard required adequate environment preservation measures to prevent water pollution and ecology in the river.

Table 7.12.5.1 Environmental Standard of Air (QCVN 05-2009-BTNMT)

Unit: $\mu g/m^3$

Items	Average per Hour	Average per 8 hours	Average per 24 Hours	Average per Year
SO2	350	—	125	50
CO	30,000	10,000	5,000	—
NOx	200	—	100	40
O3	180	120	80	—
TSP	300	—	200	140
PM10	—	—	150	50
Pb	—	—	1.5	0.5

Note : — No description

Annex -E1

Photos of Current Conditions

	
A View of Hau River	A View of Hau River
	
A Hau River & Can Tho Bridge	B Access Road to Site
	
B House of Local Resident	B House of Local Resident

Location : Refer to Site Plan

A: Can Tho City (River Side)
B: Can Tho City (Outskirts)
C: Proposed Construction Site
D: Household of Local Residents
E: New Resettlement Areas

B View of Small River

C ① Access Road to Power plant

C ② View of Construction Site

C ③ View of Construction Site

C ④ View of Construction Site
Site Preparation Work

C ⑤ Soil Discharge Pipe for Land Reclamation

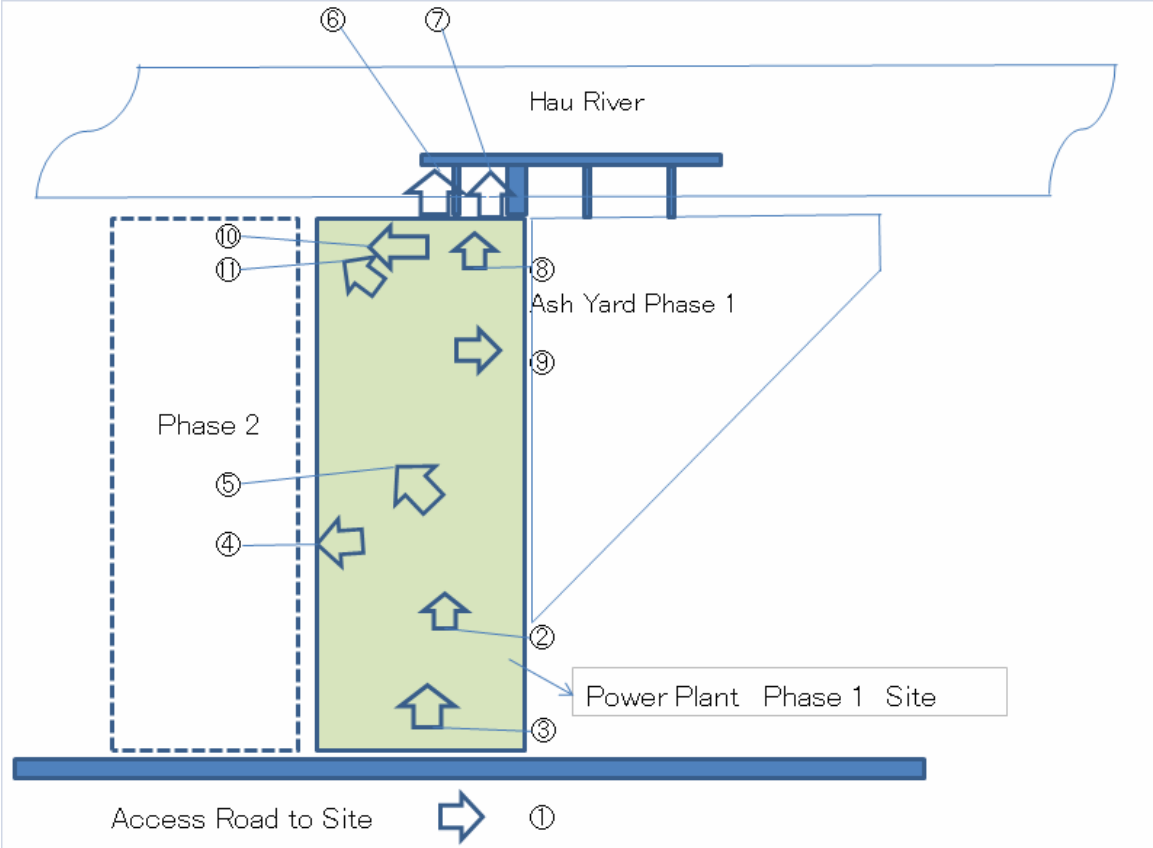
Location : Refer to Site Plan

	
C ⑥ Riverbank View of Power plant	C ⑦ Riverbank View of Power plant
	
D ⑧ Remained House of Local Residents (River Side)	D ⑨Remained House of Local Residents (Proposed Ash Storage Yard)
	
D ⑩Remained House of Local Residents (River Side)	D ⑪Remained House of Local Residents (River Side)

Location : Refer to Site Plan

	
E View of Proposed Resettlement Area	E Access Road to New Resettlement Area
	
E Access Road to New Resettlement Area	E View of Proposed Resettlement Area
	
E View of Proposed Resettlement Area	E New House of Local Resident (adjacent to Resettlement Area)

Location : Refer to Site Plan



Site Plan of Song Hau Power Plant

Annex -E2

Power Plant Check List of JICA

- Power plant
- Port Facilities

Appendix E-2 Evaluation based on the Environmental Check List of the JICA

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process?	(a)Y	(a) EIA report was prepared and submitted to MONRE , -EIA for Infrastructure : February 2008 -EIA for power plant : July 2010
		(b) Have EIA reports been approved by authorities of the host country's government?	(b)N	(b) EIA for infrastructure was approved by people's committee of Hau Giang Province on February 9, 2010, (No.190QD UBND), and power plant was approved on July 25, 2011 (No.1455-QD-BTNMT) by MONRE.
		(c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied?	(c)-	(c) Original EIA report for power plant was revised according to comments received from MONRE. Approved EIA is not including supplementary items.
		(d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(d)Y	(d) The Feasibility Study (FS) Report for Song Hau power plant phase 1 was submitted and was already approved by the prime minister's office on April 5, 2011 (No.2824/QD-DKVN). As for approval except EIA, the report will be submitted at detailed design stage and at construction stage.
	(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders?	(a)Y	(a)People's committee held a public consultation and several opinions are reflected to the EIA report. It is necessary to carry out the project according to the approved EIA report. The opinions and comments gathered on the meetings are described in the EIA report. However, there are no detailed information of each meeting, such as date, number of attendants, stakeholders, explanation data, pamphlets, way of announcement, etc.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		(b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(b) Y	(b)Comments received from the people's committee during the public consultation meeting are reflected in the EIA report; In addition, further clarifications and confirmation during the construction and operation stage by the responsible project execution organization is still necessary.
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a)Y	(a) EIA report did not include the study of alternative plan. The project is one of several power plants which was planned for corresponding of deteriorated power supply in south of Vietnam. EIA was prepared based on power plant's guideline by MONRE. This project is planned with the same design as Longphu power plant, so the alternative plan at FS stage is conducted based on general consideration including site location.
2 Pollution Control	(1) Air Quality	(a) Do air pollutants, such as sulfur oxides (SOx), nitrogen oxides (NOx), and soot and dust emitted by the power plant operations comply with the country's emission standards? Is there a possibility that air pollutants emitted from the project will cause areas that do not comply with the country's ambient air quality standards? Are any mitigating measures taken?	(a)Y	(a) The emission gas and maximum concentration of effluent was analyzed in EIA. Effluent concentration of dust and hydrocarbon were estimated quantitatively in EIA. With respect to the ambient air quality concentration, spatial distribution of the concentration was estimated so as to satisfy the QCVN requirements. <Vietnamese Standard: QCVN05-2009-BTNMT> TSP: 300 μ g/Nm3 , SO2: 350 μ g/Nm3, NOx:200 μ g/Nm3 (average of one hour) The load of gas from power plant and reduction efficiency by environmental mitigation facilities is shown in the following table.

<table>
<tr><th>Category</th><th>Environmental Item</th><th>Main Check Items</th><th>Yes: Y
No: N</th><th>Confirmation of Environmental Considerations
(Reasons, Mitigation Measures)</th></tr>
<tr><td></td><td></td><td>(b) In the case of coal-fired power plants, is there a possibility that fugitive dust from the coal piles, coal handling facilities, and dust from the coal ash disposal sites will cause air pollution? Are adequate measures taken to prevent the air pollution?</td><td>(b)N</td><td>
<table>
<tr><th>Parameter</th><th>Emission load after treatment (mg/Nm^3)</th><th>Reduction efficiency (%)</th></tr>
<tr><td>TSP</td><td>79.44</td><td>99</td></tr>
<tr><td>SO2</td><td>287.44</td><td>80</td></tr>
<tr><td>NOx</td><td>155.79</td><td>65</td></tr>
</table>
A 200m chimney height for plant was selected to ensure compliance with the technical conditions as well as economic point of view. Power plant was also installed with dust precipitator, SO2 desulfurizer and NOx eliminator as added environmental impact measures. Therefore, the impact of exhaust gas of the plant is considered as insignificant on the inhabitants living in the adjacent area.

(b)The calculation result shows that the dust concentration in the coal storage shed exceeds the standard (QCVN22-2009-BTNMT) on the surrounding air quality.
No special countermeasures are described in the EIA report. Therefore, for reducing the environmental impact generated by coal handling and stock yard, the following facilities and construction works are recommended in the design stage:
-Installation wind and dust protection net wall,
-Installation of dust prevention type belt conveyer
-Water spray system including pumps
-Construction of concrete/asphalt paving (operation yard)
-Run-off collection system with settling basin
- Construction of dust prevention roof and fence</td></tr>
</table>

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(2) Water Quality	(a) Do effluents including thermal effluents from the power plant comply with the country's effluent standards? Is there a possibility that the effluents from the project will cause areas that do not comply with the country's ambient water quality standards or cause any significant temperature rise in the receiving waters?	(a)Y	(a)All of the construction work and power plant operation comply with the effluent standards and ambient water quality standards of Vietnam as designated by Vietnam's environment standard (QCVN 08-2008, QCVN 09-2008, QCVN 10-2008, QCVN 14-2008 -BTNMT). Power plant shall use and discharge a cooling water volume of 56m3/s. The temperature difference of the cooling waste water compared to the input water is 7℃. The average water temperature of Hau River is 27℃ to 30.1℃. With the temperature difference of cooling waste water and the input water of 7℃, the average discharge water temperature becomes 34℃to 37.1℃. Under the standard QCVN 24-2009-BTNMT on Industrial waste water – discharge standard, the permissible discharge water temperature is 40℃ (source typeA) .
		(b) In the case of coal-fired power plants, do leachates from the coal piles and coal ash disposal sites comply with the country's effluent standards?	(b)N	(b) No special countermeasures are described in the EIA report. leachate quality comply with the effluent standards of Vietnam as QCVN 24-2009-BTNMT. Design is not completed and detail is not known.
		(c) Are adequate measures taken to prevent contamination of surface water, soil, groundwater, and seawater by the effluents?	(c)Y	(c) Floor of storage yard constructed with several layers of water proof structure. The source of generating waste water during the construction of the project is mainly domestic waste water of construction workers. It is observed that the contamination of domestic water were exceeds permissible standard (QCVN14-2008-BTNMT) . With respect to the water quality standard, discharge of domestic water are to be treated, so as to satisfy the QCVN 14 requirements.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(3) Wastes	(a) Are wastes, (such as waste oils, and waste chemical agents), coal ash, and by-product gypsum from flue gas desulfurization generated by the power plant operations properly treated and disposed of in accordance with the country's regulations?	(a)Y	(a) The hazardous waste of the plant is mainly oil residues. The plant shall contract with a company specializing in hazardous waste treatment to transport and treat all arising waste. Impact of hazardous waste on the environment and health, especially the risk of fire and explosion is low and controllable. Ash generated from power plant is transported to cement factory by ship. In addition, ash dump area which has a capacity of 10 years and 33ha has reserved for standby. To ensure safety conditions for the surrounding environment in the dump area, the water removed from the ashes is prevented from penetrating into the land as well as underground water sources by designing and providing the ash dump base with 4 beddings. Gypsum is transported to the storage yard by conveyer, and from the port is transported to the user by ship. The amount of vaporized leaking in petrol oil during output, input and storage of petrol and oil has the pollution composition mainly as VOC (Volatile Organic Substance). However the amount is considered small, but somehow during operation, the plant shall take specific measures to minimize the effect, so this impact is assessed as inconsiderable.
	(4) Noise and Vibration	(a) Do noise and vibrations comply with the country's standards?	(a)Y	(a) The noise levels are lower than the permissible standard at the residential area (from6-18pm) under QCVN 26-2010-BTNMT (75dBA), except for the activities of diesel hammer(82.6dBA) The project site located beside of Hau River, is surrounded mainly of agricultural land with many green trees which have the capacity of preventing and reducing noise. The private houses are located far from the construction site at more than 350m. Therefore, the impact caused by noise and vibration

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
				from construction equipment is small. The proposed project contains the following sources of noise. -Pile driver :110dB at 15 meter from source -Bulldozer : 90dB at 15 meter from source.
	(5) Subsidence	(a) In the case of extraction of a large volume of groundwater, is there a possibility that the extraction of groundwater will cause subsidence?	(a)N	(a)Extraction of groundwater is not anticipated at the proposed project and not included for evaluation.
	(6) Odor	(a) Are there any odor sources? Are adequate odor control measures taken?	(a)Y	(a)Control measures have not yet been planned; however sufficient areas have been reserved as buffer zone. As for the VOC, refer to Item 2 pollution control (3) waste.
3 Natural Environment	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a)N	(a) The proposed project site is not located in the protected area.
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)?	(a)N	(a) The proposed site is not located in the area of primeval forests, tropical rain forests, or ecologically valuable habitats. No issues have been found at this moment.
		(b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions?	(b)N	(b) The site is not located within the area of protected habitats of endangered species designated by the country's law or international treaties and conventions. No issues have been found at this moment.
		(c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem?	(c)N	(c) The significant ecological impacts are not anticipated, since the area is not located within the habitats that can be disturbed by the human activities. No issues have been found at this moment.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		(d) Is there a possibility that the amount of water (e.g., surface water, groundwater) used by the project will adversely affect aquatic environments, such as rivers? Are adequate measures taken to reduce the impacts on aquatic environments, such as aquatic organisms?	(d)Y	(d) The surface water and groundwater being discharged into Hau River was examined, and the impact on the aquatic resources was considered small. However, the impact should be examined quantitatively by the monitoring in operation phase.
		(e) Is there a possibility that discharge of thermal effluents, intake of a large volume of cooling water or discharge of leachates will adversely affect the ecosystem of surrounding water areas?	(e)Y	(e) The water used for cooling of the equipment is derived mainly from the Hau River. The cooling system of the power plant was analyzed. Discharge of thermal effluents, intake of cooling water and discharge of leachates were expected to have insignificant impact to the ecosystem in the Hau River. However, in the operation phase, monitoring of temperature should be carried out for confirmation.
4 Social Environment	(1)Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement?	(a)Y	(a) 185 families are required for involuntary resettlement, all resettlement are carried out according to Vietnamese government regulations. Number of resettlement family was minimized by the basic planning of FS.
		(b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement?	(b)Y	(b) Regional People's Committee (RPC) made public meeting with targeted residents. Compensation was carried out according to the Government regulations. All of the compensations made were settled in cash based on the conditions of lands, building type and area, assets, supporting of moving, graves, etc.
		(c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement?	(c)Y	(c)Resettlement plan was prepared according to the Vietnamese government regulations, and the baseline survey was conducted by RPC then the unit prices for compensations was established according to the grade of housing facilities and type of land. Also new resettlement area was reserved for

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
				resettlement families.
		(d) Are the compensations going to be paid prior to the resettlement?	(d)Y	(d) After signing of the agreement, compensation was done by RPC.
		(e) Are the compensation policies prepared in document?	(e)Y	(e) Compensation policy was described in the government laws.
		(f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples?	(f)Y	(f) Schemes of 6 month training program for both resettlement people and affected people was established by PVN. Ethnic groups in the project area are mainly Kinh, Khmer and some Chinese-native people. They have a good and established relationship with the local community. No issues have been found.
		(g) Are agreements with the affected people obtained prior to resettlement?	(g)Y	(g) Before starting resettlement, each targeted household have made agreement which described the basic conditions with RPC. Upon completion of this agreement each household can receive compensation according to regulations.
		(h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan?	(h)Y	(h) Organizational framework was established, and RPC was assigned as the responsible organizations for resettlement. The required budget for resettlement was prepared based on the baseline survey results. Budget reserved by PVN was US$ 26.7 million.
		(i) Are any plans developed to monitor the impacts of resettlement?	(i)N	(i) There are no descriptions in the EIA report submitted to MONRE. It is recommended to monitor the progress of compensation and evaluation of living conditions of the inhabitants after completion of resettlement.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		(j) Is the grievance redress mechanism established?	(j)N	(j) There are no descriptions in the EIA report submitted to MONRE. It is necessary to provide assistance to ensure the smooth implementation of resettlement by local residents.
	(2) Living and Livelihood	(a) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary?	(a)Y	(a) The project site is located approximately 12kms away from the central Can Tho City. The site is surrounded by agricultural land with inhabitants. Considering these facts, it is necessary to consider removing environmental impact. The transportation of main construction materials will be done by ships; therefore no significant impact on the living conditions of inhabitants is anticipated. Environmental mitigation measures are shown in annex E-4.
		(b) Is sufficient infrastructure (e.g., hospitals, schools, and roads) available for the project implementation? If the existing infrastructure is insufficient, are any plans developed to construct new infrastructure or improve the existing infrastructure?	(b)Y	(b) There is an industrial zone beside the access road to the proposed construction site, and a good access road to the site is available. There are no public facilities in the proposed project site. No significant issue is anticipated.
		(c) Is there a possibility that large vehicles traffic for transportation of materials, such as raw materials and products will have impacts on traffic in the surrounding areas, impede the movement of inhabitants, and any cause risks to pedestrians?	(c)N	(c) The transportation of main construction materials will be done by ships; therefore no significant impact on the living conditions of inhabitants is anticipated.
		(d) Is there a possibility that diseases, including infectious diseases, such as HIV, will be brought due to the immigration of workers associated with the project? Are adequate considerations	(d)Y	(d) About 1000 construction workers will be employed in this project. It is necessary to implement a public health program for the influx of workers. These programs shall be included in the contract with construction workers.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		given to public health, if necessary? (e) Is there a possibility that the amount of water used (e.g., surface water, groundwater) and discharge of thermal effluents by the project will adversely affect existing water uses and uses of water areas (especially fishery)?	(e)N	(e)In EIA, a simulation for hot discharged water is conducted. As a result, the impact of discharged water is observed under 3 ℃ as temperature within 100 km from discharged point since the amount of water is huge and the impact on ecosystem is not serious. The amount of intake water is 56m^3/sec and it is designed to lower 0.2m/sec of velocity of flow in order to reduce the impact. Required water for power plant intake from Hau River will be of large capacity. Confirmation for any environmental impact by regular monitoring during operation phase is necessary.
	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a)N	(a)There is no local archaeological, historical, cultural and religious heritage site in the project site.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a)N	(a) Song Hau power plant facilities will be constructed at the river side of Hau River upon completion of land reclamation. No significant impact on the landscape is anticipated. The flower garden, green trees, grass carpet, lake are designed in harmony with the natural landscape and overall architecture of the plant. The density of green trees must ensure minimum 15% of the area of whole land area.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples?	(a)Y	(a) Ethnic groups in the project area are mainly Kinh, Khmer and some Chinese-native people. They have good and established relationship with the local community, therefore no issues is expected. However, there are no detailed information in the EIA report.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		(b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources respected?	(b)Y	(b) No issues have been found. However, there are no detailed information in the EIA report. .
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project?	(a)Y	(a)Basically all of the workers involved for the project shall comply with the Vietnamese laws.
		(b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials?	(b)Y	(b) As for the generated hazardous materials in power plant, such will be requested for final treatment from a waste disposal company via contract. However, details of this condition are not described in the current EIA report. It is recommended that an operation manual for hazardous materials as environment management plan be prepared.
		(c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.?	(c)-	(c) It is recommended to include the contents of the health and safety education program for workers during construction. Identified necessary measures should be implemented as an obligation of contractors in the form of special clause of the contract.
		(d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?	(d)-	(d) In order to remove infringe on safety of local residents and project staff, It is recommended to include the contents of health and safety education program for security guards during construction.
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)?	(a)Y	(a) Environmental mitigation measures and environmental monitoring plan are examined in the EIA report. Mitigation measures studied in EIA are shown in Annex E-4.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		(b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce the impacts?	(b)Y	(b) Environmental mitigation measures and environmental monitoring plan are examined in the EIA report. In the construction stage, an environment management plan shall be prepared as an obligation of contractors for more study.
		(c) If construction activities adversely affect the social environment, are adequate measures considered to reduce the impacts?	(c)Y	(c) Environmental mitigation measures and environmental monitoring plan are examined in the EIA report. In the construction stage, an Environment Management Plan shall be prepared as an obligation of contractors for more study.
	(2) Accident Prevention Measures	(a) In the case of coal-fired power plants, are adequate measures planned to prevent spontaneous combustion at the coal piles (e.g., sprinkler systems)?	(a)-	(a) There are no description in the EIA report. However, to prevent spontaneous combustion, adequate countermeasures shall be considered during the design stage of the power plant facilities according to authorized and recognized international standards.
	(3) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts?	(a)Y	(a)Environment monitoring plan was examined in the EIA report, and a detailed monitoring plan will be prepared at the construction stage based on approved EIA report. The mitigation measure which is described in EIA report is shown in Attachment 4.
		(b) What are the items, methods and frequencies of the monitoring program?	(b)Y	(b) These information are described in monitoring program in the EIA report, and a detailed monitoring program will be prepared at the construction stage based on the approved EIA report.
		(c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)?	(c)Y	(c) These information are described in monitoring program in the EIA report.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		(d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(d)Y	(d) There is a monitoring report system identified in the EIA report, therefore a monitoring plan will be prepared based on the approved EIA report. Detailed method of monitoring and frequencies should be described at the Environmental Monitoring Plan for construction and operation phase respectively.
6 Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Power Transmission and Distribution Lines checklist should also be checked (e.g., projects including installation of electric transmission lines and/or electric distribution facilities). (b) Where necessary, pertinent items described in the Ports and Harbors checklist should also be checked (e.g., projects including construction of port and harbor facilities).	(a)N (b)Y	(a) The evaluation of the Power Transmission Line will be done at the environmental checklist of the Power Transmission Line by others. (b) See check list for evaluation of the Port facilities.
	Note on Using Environmental Checklist	(a) If necessary, the impacts to transboundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, and global warming).	(a)N	(a)There are no description in EIA report, but since this item is essential for evaluation of the project, it is recommended to study the impacts to transboundary or global issues after completion of the detailed design work and after selection of main facilities of power plant.

Appendix E-2 Evaluation based on the Environmental Check List of the JICA(Port Facility)

Category	Environmental item	Main Check items	Yes: Y No: N	Confirmation of Environmental Considerations and Recommendations
1. Pollution control	(1) Water Quality	(a) Do effluent from ships and ancillary facilities (e.g., dock) comply with the country's effluent standards and ambient water quality standard?	(a) Y	(a) There are no oil treatment and oil disposal facilities provided in the power plant, and all of the effluent (bilge) from ships will be treated at the maintenance docks. As for the generated sewage of personnel living in the power plant which are treated by the sewage treatment plant prior to being discharged to the Song Hau River, such disposal comply with the effluent standards and ambient water quality standards of Vietnam as designated by Vietnam's environment standard.
		(b) Are adequate measures taken to prevent spills and discharges of materials, such as oil and hazardous materials to the surrounded water areas?	(b)Y	(b) Hazardous materials are treated according to the regulations set forth by the government. As countermeasures to accidental oil spill, oil fences, adsorptive mats etc. shall be purchased according to the basic plan. As a part of risk analysis, appropriate countermeasure plan shall also be established at the operation stage.
		(c) Is there a possibility that oceanographic change, such as alteration of ocean current, and reduction in seawater exchange rates (deterioration of seawater circulation) due to modification of water areas, such as shoreline modifications, reduction in water areas, and creation of new water areas will cause changes in water temperature and water quality?	(c)Y	(c) The following large scale construction work and land reclamation work will be conducted in the river side: ● Construction of Jetty ● Land reclamation ● Dredging of river ● Construction of coal stock yard To avoid sand accumulation in the access channel, simulation for minimizing sedimentation shall be conducted in the design stage.
		(d) In the case of projects including land reclamation, are adequate measures taken to prevent contamination of surface water, seawater and groundwater by leachates from reclamation areas?	(d) N	(d) All of the soils required for landfill will be brought in from the Hau River. The water discharged from spillway in

Category	Environmental item	Main Check items	Yes: Y No: N	Confirmation of Environmental Considerations and Recommendations
				the reclamation area shall be provided with environment preservation measures to prevent diffusion of pollutant. However, the EIA does not mention any preservation measures, therefore the following studies shall be additionally completed at the construction stage: ● Analysis of soil quality ● Reclamation method ● Construction method of soil improvement Mitigation of water pollution
	(2) Wastes	(a) Are waste from ships and the related facilities properly treated and disposed of in accordance with the country's standard?	(a)Y	(a) Waste generated from ship is treated according to the regulations of power plant and Vietnamese laws. There are no oil treatment and oil disposal facilities provided in the power plant, and all of the effluent (bilge) from ships will be treated at the maintenance docks. Therefore, no serious impact of bilge and used oil from the ships is anticipated.
		(b) Is offshore dumping of dredged materials and soils properly performed in accordance with the country's standard to prevent impacts on the surrounding waters?	(b)Y	(b) Monitoring of the river water shall be conducted during the dredging and disposal work period according to the environmental monitoring plan. Dredged materials will be utilized as land reclamation for the project site according to the basic design. However, there are no data of riverbed soil quality for proposed dredging area in the EIA report. Therefore, it is recommended to carry out a survey of riverbed soil quality including analysis of heavy metals and oil.
		(c) Are adequate measures taken to prevent discharge or dumping of hazardous materials to the surrounding water areas?	(c)Y	(c) The hazardous waste expected at the plant will be mainly coming from oil residues. The plant shall contract with a company specializing in hazardous waste treatment and treat arising from such waste.

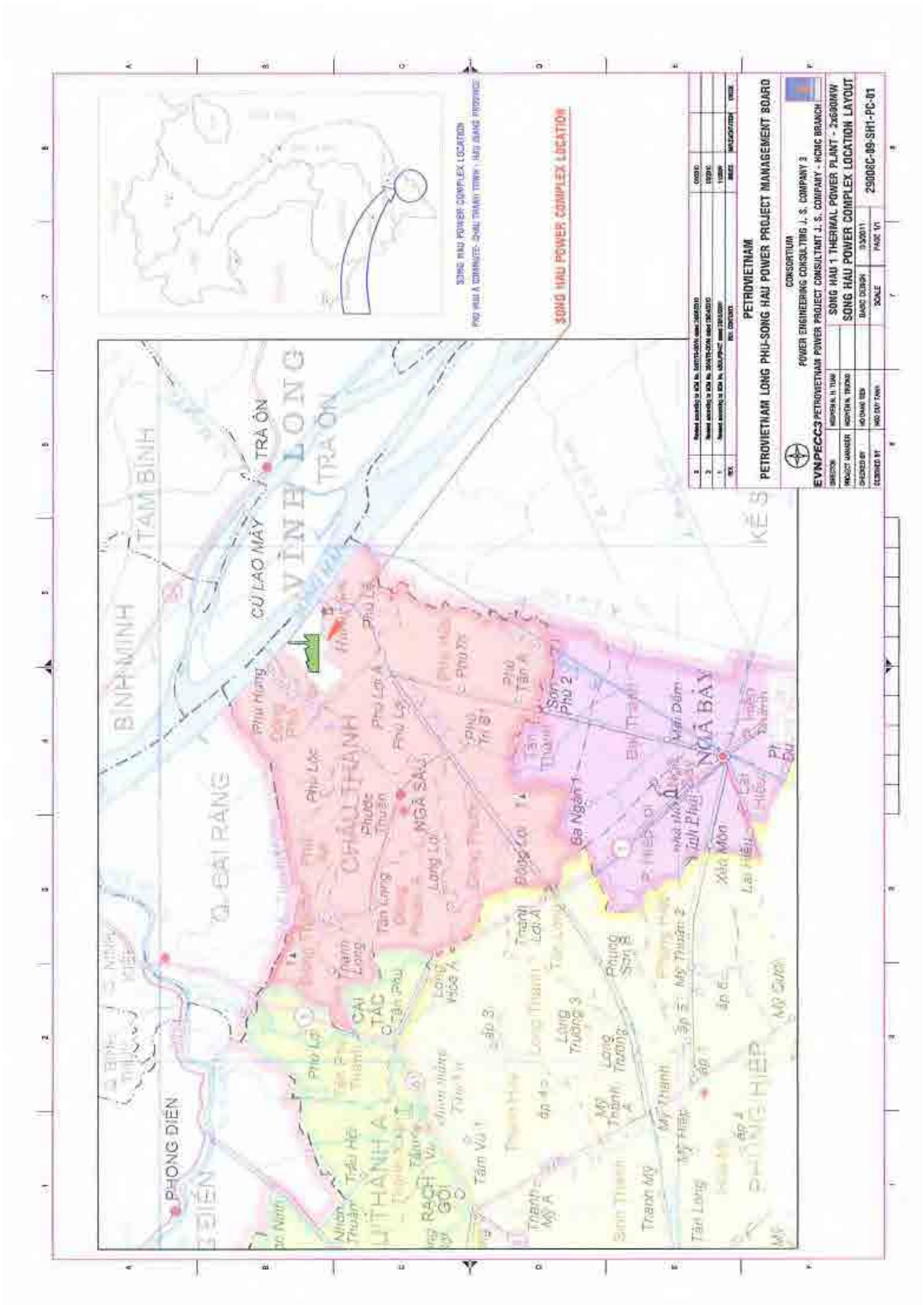
Category	Environmental item	Main Check items	Yes: Y No: N	Confirmation of Environmental Considerations and Recommendations
	(3) Noise and Vibration	(a) Do noise and vibrations comply with the country's standards?	(a) Y	(a) Port operation shall comply with the noise and vibrations control standards of Vietnam as designated by Vietnam's environment standard (QCVN 26-2010-BTNMT (75dBA). The expected noise sources during the construction are the earth works equipment and transportation vehicles and ships. The noise levels are lower than the permissible standard at the residential area under QCVN 26.
	(4) Sediment	(a) Are adequate measures taken to prevent contamination of sediments by discharge or dumping of materials, such as hazardous materials from ships and the related facilities?	(a) Y	(a) Hazardous waste generated in the ship will be treated in the maintenance docks according to the government regulations.
3. Natural environment	(1) Hydrology	(a) Is there a possibility that installation of port and harbor facilities will cause oceanographic changes? Is there a possibility that installation of the facilities will adversely affect oceanographic conditions, such as induced currents, waves, and tidal currents?	(a) N	(a) For reducing and avoiding maintenance dredging, study and simulation for minimizing the sedimentation is required based on the depth of Hau River, flow (velocity) and conditions of the river bed in the design stage of port facilities.
	(2)Topography and Geology	(a) Is there a possibility that installation of port and harbor facilities will cause a large-scale alteration of topographic and geologic features in the surrounding areas or elimination of natural beaches?	(a) Y	(a) This project includes land reclamation; however, it is not anticipated to cause a large-scale alteration of topographic and geologic features in the surrounding areas.
	(3) livelihood	(a) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, If necessary?	(a)Y	(a) The transportation of main construction materials will be done by ships; therefore no significant impact on the living conditions of the inhabitants is anticipated.

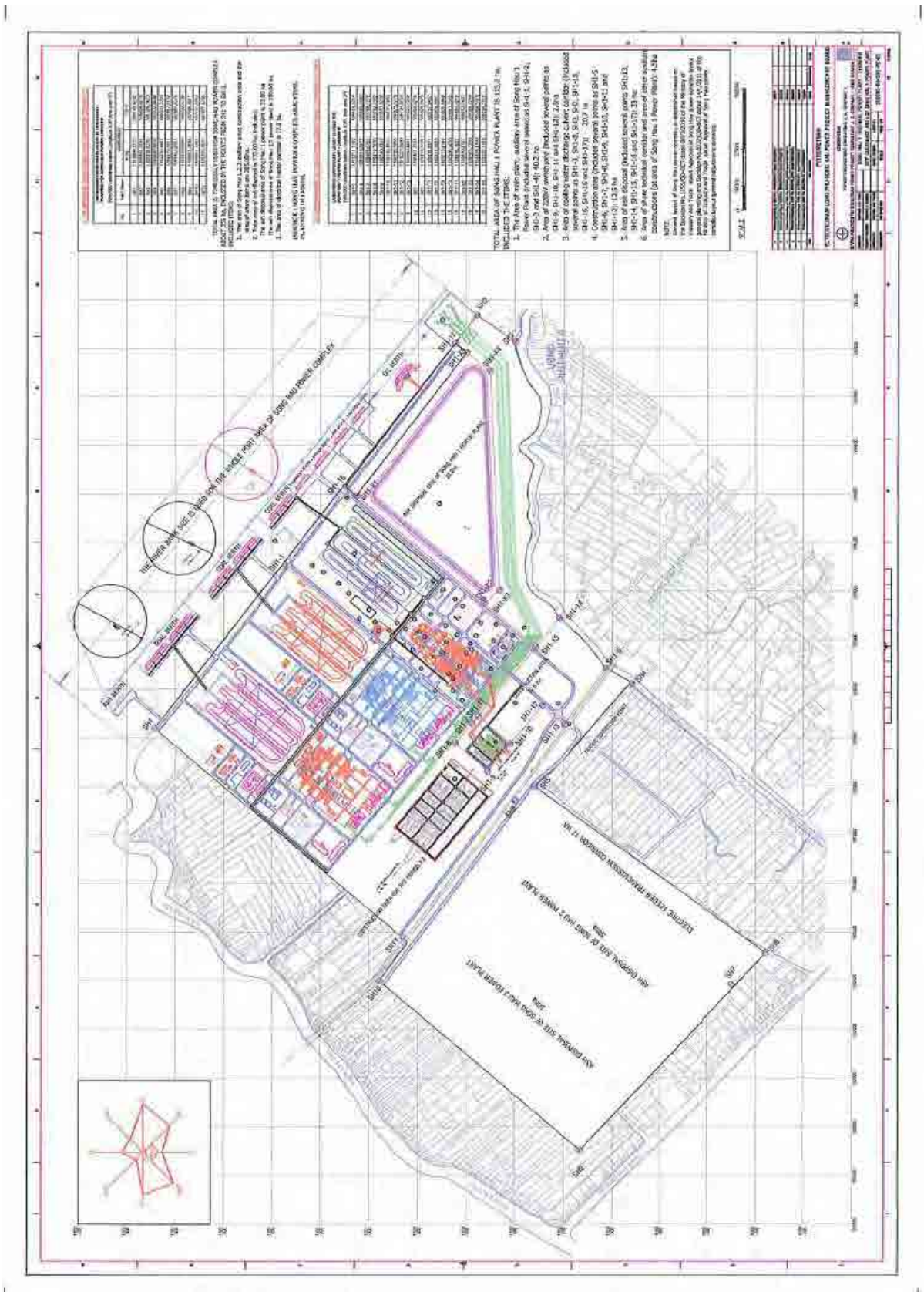
Category	Environmental item	Main Check items	Yes: Y No: N	Confirmation of Environmental Considerations and Recommendations
		(b) Is there a possibility that changes in water uses (including fishery and recreational uses) in the surrounding areas due to project will adversely affect the livelihood of inhabitants?	(b)Y	(b) There are no resort and recreational facility in the surrounding areas. Fishermen living adjacent to the project conducts fishing operation in the Hau River. There are concerns that the construction of the port facilities could lead to or worsen their income levels. However, there are no information of their activities mentioned in the EIA report.
		(c)Is there a possibility that the port and harbor facilities will adversely affect the existing water traffic and road traffics in the surrounding areas?	(c) Y	(c) The increase in the number of ships may occur in the future, as such, there might be some possibility that the impact to traffic condition would increase.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) Y	(a) Port facilities will be constructed at the river side of Hau River, however no significant impact on the landscape is anticipated.

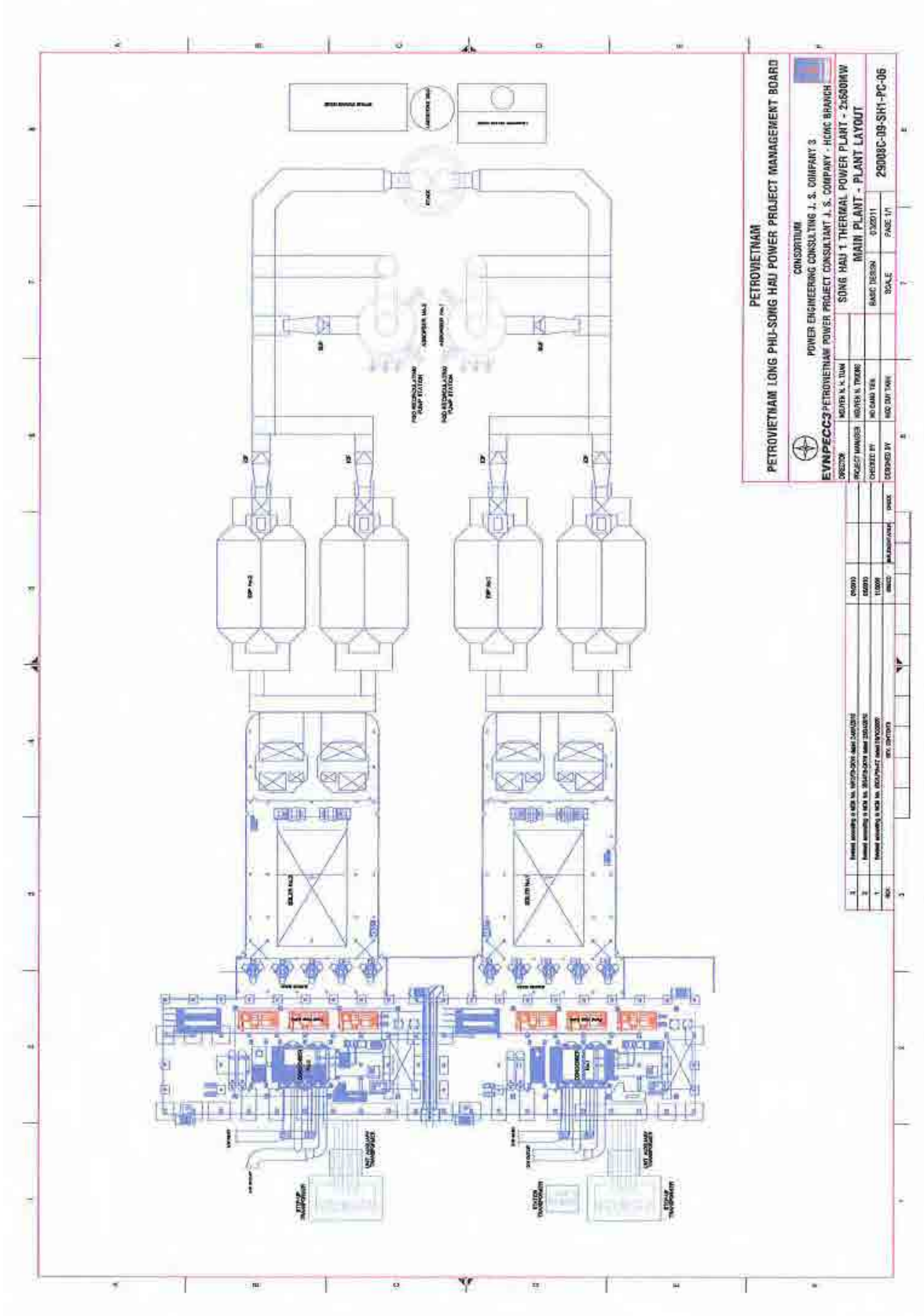
Annex -E3

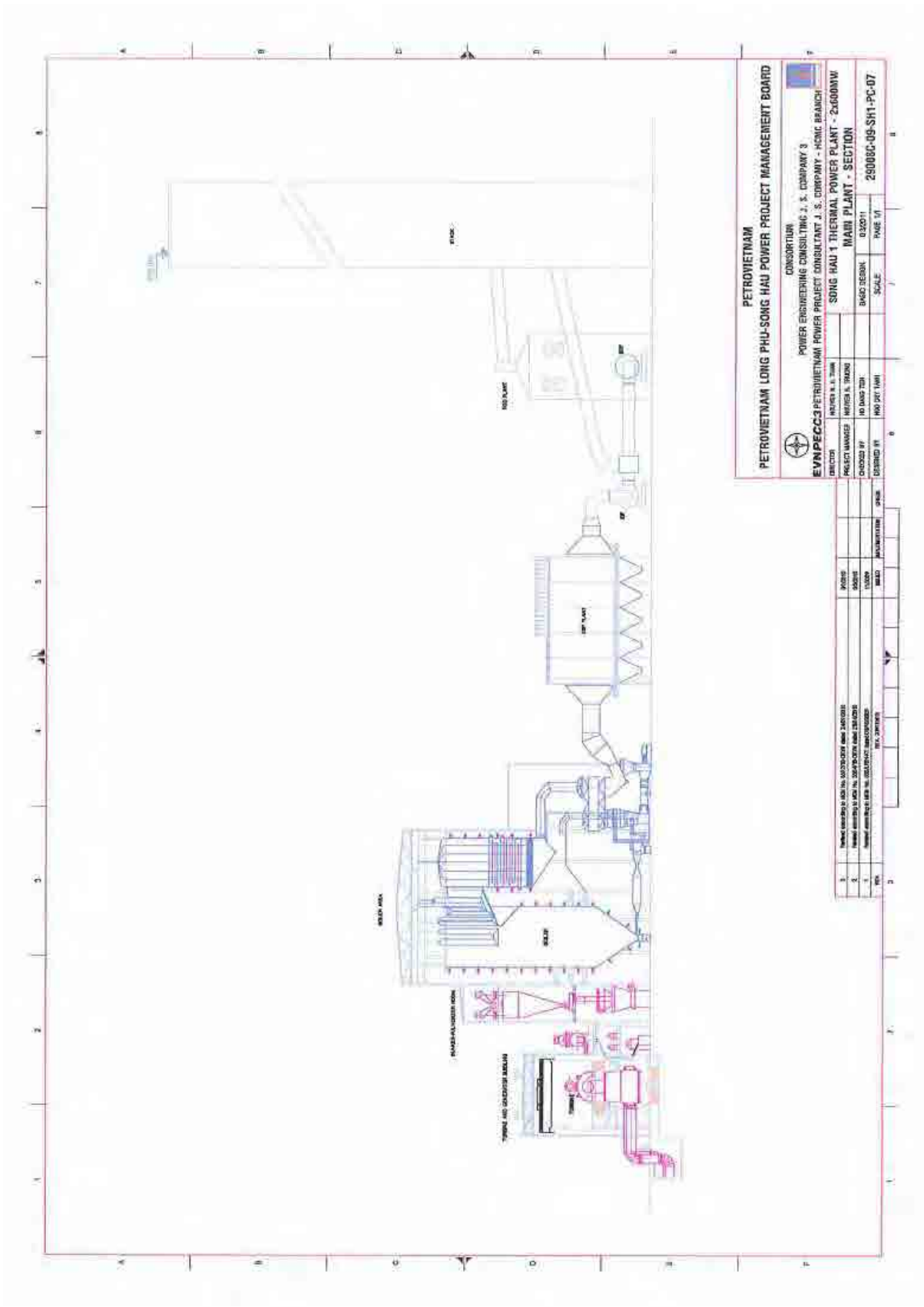
Power Plant Layout and Building Plan

Source:FS Report


SONG HAU POWER COMPLEX LOCATION
PETROVIETNAM
PETROVIETNAM LONG PHU-SONG HAU POWER PROJECT MANAGEMENT BOARD
CONSORTIUM
POWER ENGINEERING CONSULTING J. S. COMPANY 3
EVNPECC3 PETROVIETNAM POWER PROJECT CONSULTANT J. S. COMPANY - HCMC BRANCH
SONG HAU 1 THERMAL POWER PLANT - 2x600MW
SONG HAU POWER COMPLEX LOCATION LAYOUT
29008C-00-SH1-PC-01
PHONG DIEN
TRA ON
CU LAO MAY
VINH LONG
BINH MINH
TAM BINH
CHAU THANH
NGA BAY
LONG MY
VI THANH
RACH GOI
CAI TAC
PHUNG HIEP




PETROVIETNAM
PETROVIETNAM LONG PHU-SONG HAU POWER PROJECT MANAGEMENT BOARD
CONSORTIUM
POWER ENGINEERING CONSULTING J. S. COMPANY 3
EVNPECC3 PETROVIETNAM POWER PROJECT CONSULTANT J. S. COMPANY - HOANG BRANCH
SONG HAU 1 THERMAL POWER PLANT - 2x600MW
MAIN PLANT - PLANT LAYOUT
29008C-09-SH1-PC-06


PETROVIETNAM
PETROVIETNAM LONG PHU-SONG HAU POWER PROJECT MANAGEMENT BOARD
CONSORTIUM
POWER ENGINEERING CONSULTING J. S. COMPANY 3
EVNPECC3 PETROVIETNAM POWER PROJECT CONSULTANT J. S. COMPANY - HCMC BRANCH
SONG HAU 1 THERMAL POWER PLANT - 2x600MW
MAIN PLANT - SECTION
290080-09-SH1-PC-07

Annex –E4

Environmental Mitigation

Source: EIA Report

NO	Impacted Source	Impacted Objects	Mitigation Measures	Implementing Agency
1	Compensation, site clearance and resettlement	Inhabitants	✓Make compensation, support, evacuation and resettlement for the affected households in accordance with the current regulations. ✓The compensation, evacuation and resettlement of the project are completed before any reclaiming land including leveling and bulldozing the plane for carrying out the construction began. ✓The compensation, evacuation and resettlement are implemented in accordance with the current regulations at the time of implementation.	Project management unit
		Locality	✓Use and train the local labors for the suitable works ✓Establish the regulations, rules, and discipline management for all employees working on the construction site	Project management unit
2	Open the road to serve the construction service road	Vegetation and natural landscape	✓Collect rubbish and materials in the construction site ✓Avoid the chopping of trees within the necessary scope as much as possible when opening the road for construction ✓Ensure to restore the landscape in the temporary occupied area after the period of construction	Contractor/ Project management unit
		The land use of the locality	✓Avoid the land occupation within the necessary scope when opening the road for construction ✓Ensure to restore the land and the landscape in the temporary occupied area after the period of construction	Contractor/ Project management unit
3	Clear, level, bulldoze, prepare the place work area, auxiliary area and hut area	Vegetation	✓Strictly forbid the workers from chopping the trees within the necessary scope, the construction unit has the responsibility for management and bear responsibility for the workers in its unit. ✓Regulations and measures are set in place for dealing with penalty ✓Appoint the staff to be in charge of supervision	Project management unit
		Air environment	✓Build the fence in the construction site to limit noise and dust from the project to the surrounding area ✓Use suitable equipment generating low noise and vibration ✓Do not discharge the solid waste (building waste, sand, stones) and the used oil from the mechanical equipment into the water source	

NO	Impacted Source	Impacted Objects	Mitigation Measures	Implementing Agency
		Water environment	✓Do not create ponds, plashes in the construction site to prevent water pollution ✓Arrange the material storage depot in a safe position, and avoid any oil from overflowing and falling ✓Collect and remove oil residue in accordance with the regulation	Contractor/ Project management unit
		Natural Environment	✓Collect rubbish and materials in the construction site ✓Construct isolating fences in the construction site ✓Ensure to restore the landscape in the temporary occupied area after the period of construction	Contractor/ Project management unit
4	Activities of motorized means for construction, transportation of building materials , equipment of large weight and size	Air environment	✓Use specialized means of transport, and carefully check the load string before any transport taking place ✓Take advantage of the existing water truffle ✓Build the fence in the construction site to limit the noise, dust from the project to surrounding area ✓Monitor the exhaust gas at the construction site	Contractor/ Project management unit
		Water environment	✓Collect and remove oil residue in accordance with the regulation	Contractor
5	Develop the ship turning and port construction site	Air environment	✓The dredging is conducted in the shortest time ✓The pile pressing for port construction is conducted on the day time and before 10pm	Contractor
		Soil environment	✓The volume of waste mud is used according to the proper requirement of the locality ✓Collect and remove oil residue in accordance with the regulation	Contractor/ Project management unit
		Water environment	✓Control closely the dredging for the ship turning area, avoid dredging exceeding the necessary demand	Contractor
6	Build work items of the project	Air environment	✓Build the fence in the construction site to limit the noise, dust from the project to surrounding area ✓The workers are equipped with proper protective equipment when working in the area with high noise ✓Use of suitable equipment generating low noise and vibration	Contractor
		Water, soil, aquatic organism environment	✓Do not discharge the solid wastes (building wastes, sand, stone, etc) and the used oil from the mechanical equipment into the water source ✓Do not create ponds, plashes in the construction site to prevent water	Contractor

NO	Impacted Source	Impacted Objects	Mitigation Measures	Implementing Agency
			pollution ✓Arrange the material storage depot in a safe position, and avoid any oil from overflowing and falling ✓Collect and remove oil residue in accordance with the regulation	
		Natural landscape	✓Collect rubbish and materials in the construction site ✓Construct isolating fences in the construction site ✓Ensure to restore the landscape in the temporary occupied area after the period of construction	Contractor
7	Gather many labor fences for construction	Water environment, soil environment, natural landscape and community health	✓The domestic solid waste shall be collected daily, gathered in the waste gathering area. The project owner/constructer shall contract with urban environment company of the locality to treat this volume of domestic waste ✓At the construction site, arrange WC with septic tank (fixed and mobile) for the workers and construction site steering board	Contractor/ Project management unit
		Culture, socio economic of the locality, community health	✓Use and train the local labors for the suitable jobs ✓Set up regulations and discipline management for all workers working on the construction site ✓Notify, coordinate with the local authority for the administrative management of the laborers working in the project in order to avoid creating social evils, minimize the dispute between the local workers and inhabitants in the area.	Contractor/ Project management unit
8	Fire, explosion, labor accident, traffic accident	Construction workers, inhabitants in the project area	✓Planning fuel storage area, with protection, shield, spraying water and wetting in the hot condition ✓Regularly check, maintain, ensure that the leak does not occur ✓Take options, prepare readily the means, materials for fire prevention and firefighting and rescue in case of fire and explosion ✓Build, disseminate and request the workers to absolutely conform to the regulations on labor safety and labor regulation in order to limit maximally the labor accidents	Contractor/ Project management unit

Chapter 8 Conclusion

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Chapter 8 Conclusion

8.1 Importance of Constructing Song Hau 1 Coal Fired Power Plant by PVN

Recently Vietnam is making rapid economical development, and among the basic infrastructure, securing necessary power supply is one of the most important factors. In Vietnam, their power supply has been secured based on the own natural source of energy such as hydro, coal and natural gas. However, in order to fulfill the necessary power demand in future, it is surely necessary to construct many numbers of large size coal fired power plants. In the latest Vietnamese 7th National Power Development Master Plan (hereinafter referred to as "PDP7"), announced in July 2010, many imported coal fired power plants including Son Hau 1 are under planning.

Especially in Southern Vietnam with the main city of Ho Chi Minh City, power consumption has been increasing by more than 15% every year, the increasing rate during 2011 to 2015 is expected more than 18% per year. It is expected for Song Hau 1 Power Plant to compromise very important role to Southern Vietnam aria by (1) Stable power supply, (2) Improving the power quality, (3) Developing the regional economy, (4) Increasing the demand of works. In accordance with the PDP7, Unit 1 of Song Hau 1 Power Plant will be started commercial operation in the year 2017, and Unit 2 will be started in the year 2018. This schedule is around 3 years behind compare to the original schedule in PDP6, and the expectation to the related people of this Project not to make any further delay is very big, in order to secure the economical development in Southern Vietnam area.

PVN who is promoting the Song Hau 1 Coal Fired Power Plant Project, is considered as a representing enterprise in Vietnam with stable management base, and is operating many power projects at present. Therefore, PVN will be the most suitable Vietnamese enterprise to promote large scale Power Projects. Viewing to the Song Hau Power Plant, securing the land for the Project site and its leveling work have been completing very smoothly by PVN, and their excellent capability on the preparation work on the Power Project can be seen.

8.2 Investment on the Song Hau 1 Coal Fired Power Plant Project

In the F/S report studied by PECC3, the total Project Cost for Song Hau 1 was estimated in rather competitive level. Regarding the coal price, it is estimated as US$90/MT for whole the Project implementation period, while the present market price will be reach to US$120/MT level. On the other hand, the imported coal should be transshipped at the Imported Coal Transshipment Terminal, and the cost for 2nd transportation from the Coal Terminal to the Power Plant. If we compare the Song Hau 1 Power Plant with other Power Plants those have a condition of direct approach by the large size coal transship vessels, Song Hau 1 Power Plant must have clear disadvantage economically. On the other hand, electricity tariff has been kept in very low level in Vietnam, and EVN who sells the electricity is under very critical economic conditions. To set up the electricity tariff on which the fuel costs are reasonably referred to, and to be guaranteed the adjustment to the fluctuation of coal price sufficiently, must be the most important key points of success not only for this Project but also other IPP projects those will use imported coals.

For Song Hau Power Plant, it is important to adopt 10,000DWT class large size coaster vessels for improving the effectiveness of the 2nd transportation from the Imported Coal Transshipment Terminal to the Power Plant. Also it is desirable that the Bassac Channel (Quan Chanh Bo

Channel) would be enlarged for the usage of transportation for large size coaster vessels. But, both construction of the Imported Coal Transshipment Terminal and the Bassac Channel must be allocated huge amount of National budget, new types of challenging construction for Vietnam, and nobody can guarantee on their timely completion at the time of Commercial Operation Date (COD) of the Song Hau 1 Power Plant. In case the Imported Coal Transshipment Terminal were not constructed timely, a temporally coal terminal only for the Song Hau 1 Power Plant will be additionally required. On the other hand, very frequent transportation by 3,000DWT class coaster vessels will be the only way for the 2nd transportation of the coals until the completion of the Bassac Channel for the large size coaster vessels' operation.

As we state in the Chapter 6, it will be required to form up BOT Scheme, which is secured various guarantee by the Vietnamese Government, in order for the foreign investors to make due diligence of investment on Song Hau 1 Power Project. Even though the BOT Scheme will be approved, it will not be easily estimated that the achievement of the designated COD in PDP7, considering the former result of the other BOT projects of Coal Fired Power Projects in Vietnam. However, any investment method of BOT or BOO will be adopted, the importance of this Project cannot be changed. We sincerely hope that Song Hau 1 Power Plant will be constructed in line with the latest schedule to make very big contribution on the development of the Southern Vietnam based on the good coordination by the Vietnamese Government Organization and PVN.