No.

Study on the Optimal Electric Power Development in Sumatra

Final Report
(Volume 2)

July 2005

Japan International Cooperation Agency
Economic Develoment Department

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Preface

In response to the request from the Government of the Republic of Indonesia, the Government of Japan decided to conduct the Study on the Optimal Electric Power Development in Sumatra, and entrusted the Study to the Japan International Cooperation Agency (JICA).

JICA sent the Study Team, headed by Mr. Yoshitaka SAITO of Chubu Electric Power Co., Inc. and organized by Chubu Electric Power Co., Inc. and the Institute of Energy Economics, Japan, to Indonesia five times from February 2004 to June 2005.

The Study Team had a series of discussions with the officials concerned of the Government of the Republic of Indonesia and the provincial governments in Sumatra, and conducted related field surveys. After returning to Japan, the Study Team conducted further studies and compiled the final results in this report.

I hope that this report will contribute to the promotion of the plan and to the enhancement of amity between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Republic of the Indonesia, PT. PLN (Persero) and the provincial governments in Sumatra for their close cooperation throughout the Study.

July 2005

Tadashi IZAWA
Vice President
Japan International Cooperation Agency

July 2005

Mr. Tadashi IZAWA
Vice President
Japan International Cooperation Agency
Tokyo, Japan

Letter of Transmittal

We are pleased to submit to you the report of “the Study on the Optimal Electric Power Development in Sumatra”. This study was implemented by Chubu Electric Power Co., Inc. and the Institute of Energy Economics, Japan from February 2004 to July 2005 based on the contract with your Agency.

This report presents the comprehensive proposal, such as the optimal power development plan considering the characteristics of potential primary energy in Sumatra, and the transmission development plan including an interconnection between the North and South Sumatra systems to secure a stable power supply. In addition, macroeconomic & financial and environmental measures, and also investment promotion schemes for the power sector are proposed in order to realize the plans.

We trust that the realization of our proposal will much contribute to sustainable development in the electric power sector, which will contribute to the improvement of the public welfare in Sumatra as well, and recommend that the Government of Republic of the Indonesia priotize the implementation of our proposal by applying results of technology transfer in the Study.

We wish to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Foreign Affairs and the Ministry of Economy, Trade and Industry. We also wish to express our deep gratitude to Ministry of Energy and Mineral Resources (MEMR), PT. PLN (Persero), the provincial governments in Sumatra and other authorities concerned for the close cooperation and assistance extended to us throughout the Study.

Very truly yours,

Yoshitaka SAITO
Team Leader
The Study on the Optimal Electric Power Development in Sumatra

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List of Abbreviations

AC	Alternating Current
ACSR	Aluminum Conductor Steel Reinforced
ADB	Asian Development Bank
AMDAL	Analisis Mengenai Dampak Lingkungan
APS	American Phisical Society
ATA	Automatic Tariff Adjustment
BAPEDAL	Badan Pembangunan Dampak Lingkungan
BAPEDALDA	Badan Pembangunan Dampak Lingkungan Daerah
BAPEPTAL	Badan Pengatur Pasar Tenaga Listrik
BAPPEDA	Badan Perencannan Pembangunan Daerah
Bbl	Barrel
BPS	Badan Pusat Statistic
CC	Combined Cycle
CCT	Clean Coal Technology
CDM	Clean Development Mechanism
CEPCO	Chubu Electric Power Co., Inc.
CER	Certificated Emission Reduction
CFBC	Circulating Fluidized Bed Combustion Boiler
CP	Captive Power
CPI	Consumer Price Index
DF/R	Draft Final Report
DGEEU	Directorate General of Electricity and Energy Utilization
Dinas PE	Dinas Pertambangan dan Energi
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EMF	Electric Magnetic Fields
EMP	Environmental Management and Monitering Plan
EMPT	Environmental Mitigation Plan
ENS	Energy Not Served
EP	Elrctrostatic Precipitator
ESC	Environmental Social Consideration
FGD	Flue Gas Desulfurizer
FIRR	Financial Internal Rate of Return
F/R	Final Report
F/S	Fiesibility Study
FY	Fiscal Year
G&T	Generation and Transmission
GDP	Gross Domestic Product
GHG	Green House Gas
GRDP	Gross Regional Domestic Product

GT	Gas Turbine
GWh	Gigawatt-hour
HPP	Hydropower Plant
HSD	High Speed Diesel Oil
HVDC	High Voltage Direct Current
IC	Interconnection
ICNIRP	International Commission on Non-Ionizing Radiation Protection
Ic/R	Inception Report
IEA	International Energy Agency
IEE	Initial Environmental Examination and Initial Environmental Evaluation
IEEJ	Institute of Energy Economics, Japan
IMF	International Monetary Fund
IPP	Independent Power Producer
IRPA	International Radiation Protection Association
It/R	Interim Report
JAMALI	Jawa-Madura-Bali
JBIC	Japan Bank for International Cooperaqtion
JICA	Japan International Cooperation Agency
kW	kilowatt
kWh	kilowatt-hour
L/G	Letter of Guarantees
LOLP	Loss-of-Load Probability
MEMR	Ministry of Energy and Mineral Resources
METI	Ministry of Economic, Trade and Industry
MFO	Marine Fuel Oil
MIGAS	Directorate General of Oil and Gas
M/M	Minutes of Meeting
MMBTU	Million British Thermal Unit
MOE	Ministry of Environment
MOF	Ministry of Forestry
MP	Master Plan
MW	Mega Watt
NAD	Nanggroe Aceh Darussalam
NAS	National Academy of Science
NGO	Non-Govermental Organization
NEXI	Nippon Expert and Investment Insurance
NIEHS	National Institute of Environmental Health Science
NRPB	National Radiological Protection Board
ODA	Official Development Assistance
OHL	Overhead Line
O&M	Operation and Maintenance
OPGW	Optical Ground Wire

PCM	Pulse Code Modulation
PEMU	Project Environmental Mnagement Unit
PICOM	Power-sector Investment Coordination Meeting
PLC	Power Line Carrier
PLN	PT. PLN (PERSERO)
PLTA	Pusat Listrik Tenaga Air
PLTD	Pusat Listrik Tenaga Diesel
PLTG	Pusat Listrik Tenaga Gas
PLTGU	Pusat Listrik Tenaga Gas & Uap
PLTP	Pusat Listrik Tenaga Panas Bumi
PLTU	Pusat Listrik Tenaga Uap
PPA	Power Purchase Agreement
PPP	Public-Private Partnership
Pr/R	Progress Report
P/S, PS	Power Station
PSS	Power System Stabilizer
PSS/E	Power System Simulator for engineering
PSP	Private Sector Participation
PTI	Power Technologies Inc.
RKL	Rencana Pengelolaan Lingkungan
Rp	Rupiah
RPL	Rencana Pemantauan Lingkungan
RPTL	Rencana Penyediaan Tenaga Listrik
RUKD	Rencana Umum Ketenagalistrikan Daerah
RUKN	Rencana Umum Ketenagalistrikan Nasional
RUNW	Rencana Umum Ketenagalistrikan Wilayah
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SCADA	Supervisory Control And Data Acquisition
SCM	Stakeholder Consultation Meeting
SEA	Strategic Environmental Assessment
SOP	Standard Operating Statement
SPC	Special Purpose Cpmpany
S/S, SS	Substation
ST	Steam Turbine
Sumbagsel	Sumatra Bagian Selatan
Sumbar	Sumatra Barat
Sumsel	Sumatra Selatan
Sumut	Sumatra Utara
SVC	Static Var Compensator
S/W	Scope of Work
T/D	Transmission / Distribution

TNB	Tenaga National Berhad
TOR	Terms of Reference
TSCF	Trillion Standard Cubic Feet
UFR	Underfrequency Relay
UNFCCC	United Nations Framework Convention on Climate Change
UPB	Unit Pengatur Beban
WASP-IV	Wien Automatic System Planning - version IV
WB	World Bank
WHO	World Health Organization
WTI	West Texas Intermediate

Sumatra Region Map

Chapter 6 Transmission Planning and System Analysis

6.1 Current Situation of Sumatra System

6.1.1 Outline of Sumatra System

The Sumatra system is separated into three main systems: North Sumatra (North Sumatra, Aceh), West Sumatra (West Sumatra, Riau, Jambi) and South Sumatra (South Sumatra, Lampung, Bengkulu).

Currently, 150kV has been adopted for trunk lines and 20kV has been adopted for distribution in the Sumatra system. In addition, 70kV has been partially adopted around Palembang and in Bengkulu.

Figure 6.1.1 shows the map of the Sumatra system.

The peak demands and total generation capacities in the North Sumatra system, the West Sumatra system and the South Sumatra system in 2003 are shown in Table 6.1.1. The ratios are shown in Table 6.1.2.

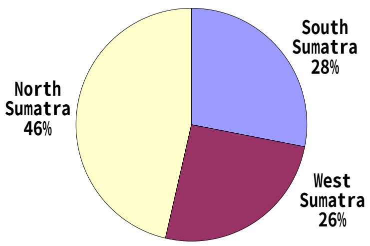
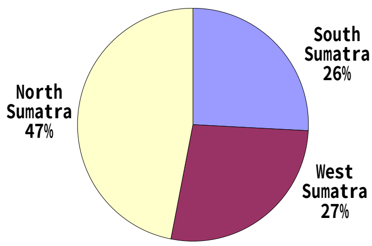
Table 6.1.1 Peak Demand and Total Generation Capacity (2003) (Unit: MW)

	Peak Demand		Installed Capacity	
North Sumatra System	972	(46%)	1,353	(47%)
West Sumatra System	533	(26%)	784	(27%)
South Sumatra System	585	(28%)	741	(26%)
Total	2,090	(100%)	2,878	(100%)

Source :RPTL Sumbagsel 2004-2013 PT PLN, Laporan Pelaksanaan Program Kerja UPB System Sumut-aceh 2003

Note :The peak demand in the West Sumatra system includes the demand of the Jambi system (67MW).

Table 6.1.2 Ratio of Peak Demand and Installed Capacity by System (2003)

Peak Demand	Installed Capacity
	

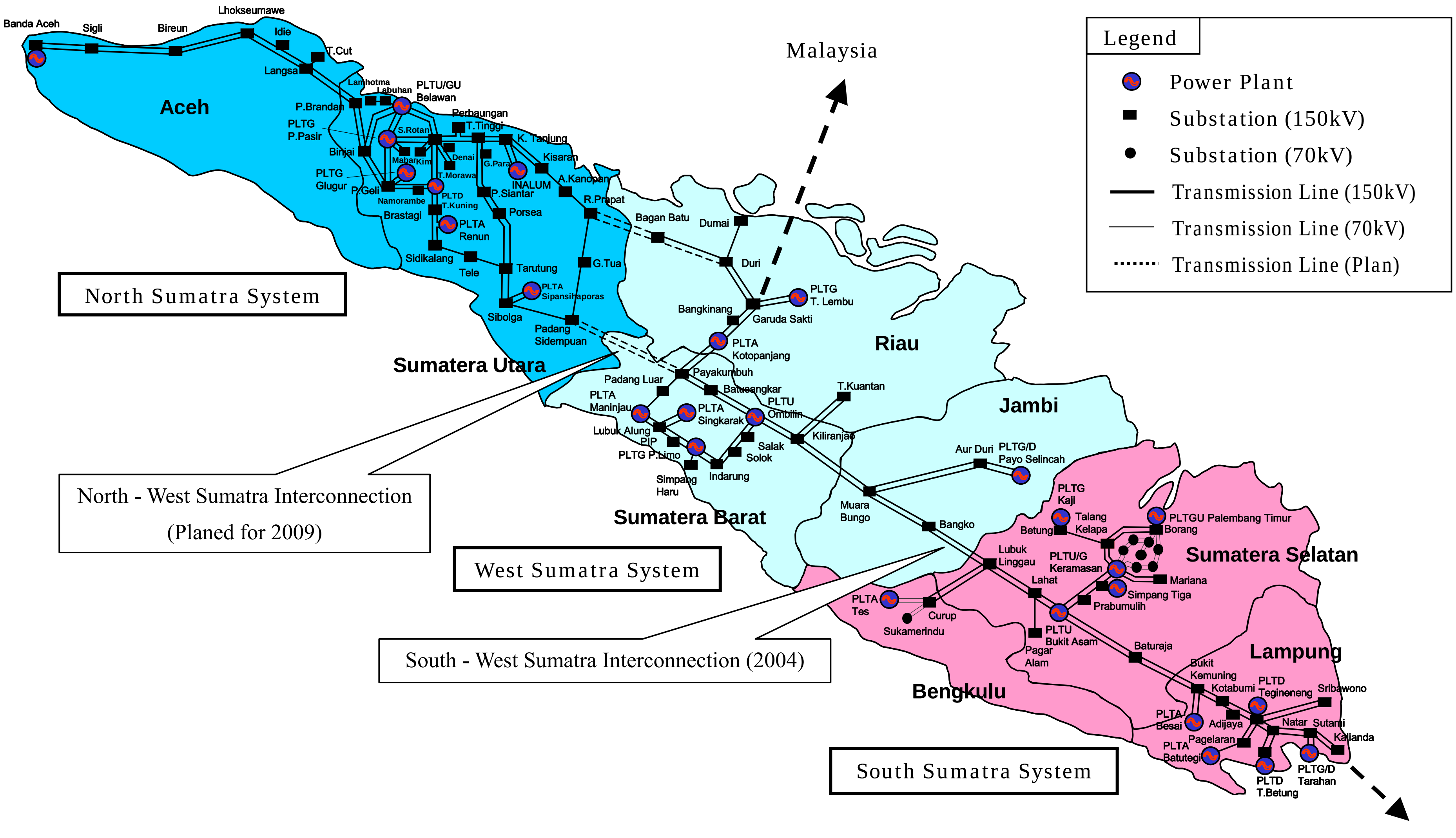


Figure 6.1.1 Map of Sumatra System (2005)

The 150kV transmission lines between the West Sumatra system and the South Sumatra system were completed in July 2004. As a result, the West Sumatra system and the South Sumatra system are interconnected, and rotational blackouts executed in the West and South Sumatra systems can be eliminated, in addition to providing more economical operation of the power plants.

The 150kV South-West Sumatra interconnection is designed for 275kV between Kiliranjao and Lahat in South Sumatra. It will be upgraded to 275kV in line with the demand increase and power development in the future, and will become the backbone of the Sumatra system.

Loop systems have been developed to supply Medan, Padang and Palembang. Meanwhile, the systems are radial in the other areas.

The demand center in the North Sumatra system is Medan. The 150kV transmission lines are configured around Medan. The center of generation is the Belawan thermal power station (1,078MW) located to the North of Medan. Because of the sharp increase in demand in recent years, power shortages are occurring in North Sumatra, although there was a power surplus before. As a result, rotational blackouts are currently being executed.

The demand center in the West Sumatra system is Padang. A 150kV loop system has been developed near Padang and it transfers the power from the hydro-electric power plants, such as Kotopanjang (114MW), Singkarak (175MW) and Maninjau (68MW) as well as the Ombilin coal-fired power plant (200MW). The 150kV transmission lines connect West Sumatra, Riau and Jambi.

The demand center in the South Sumatra system is Palembang. The main power plants are the Bukit Asam coal-fired power plant (260MW), Kramasan thermal power plant (70MW), Tarahan thermal power plant (106MW) and Besai hydro-electric power plant (90MW). The 150kV transmission lines have been constructed to connect South Sumatra, Lampung and Bengkulu. The 150kV and 70kV transmission lines are configured around Palembang to supply power.

Although the Aceh system had been isolated, it was connected to the North Sumatra system in 2004 with the commissioning of the 150kV transmission line from Lhokseumawe to Banda Aceh. However, the 150kV transmission line, which connects the Aceh system and the North Sumatra system, was destroyed between Langsa and Idie by terrorism in June 2004, soon after the commissioning of the interconnection. Although the transmission line was quickly restored, the reliability of the power supply to Aceh has been jeopardized by terrorist activities.

An interconnection between the North Sumatra system and the West Sumatra system is planned for 2009, which is the earliest timing determined by the construction schedule. With the completion of the North-West Sumatra interconnection, all the main systems in Sumatra will be interconnected, except some isolated small systems.

The interconnection between the Sumatra system and the Malaysia system is being planned. In Sumatra the peak time is during the evening because of lighting, and the demand peak in Malaysia is during the daytime. Therefore, reduction of the total peak demand is expected with the interconnection, and the total reserve margin will be reduced.

Table 6.1.3 shows the outline of the Malaysia-Sumatra interconnection. As PLN and TNB of Malaysia are conducting a detailed study, the outline of the interconnection (type, capacity, commissioning year and other details) has not been finalized.

Table 6.1.3 Outline of Malaysia-Sumatra Interconnection

Type	HVDC (Bipolar)
Capacity	600MW (in the future: 1200MW)
Commissioning Year	2008
Converter Station	Telok Gong (Malaysia) Garuda Sakti (Sumatra)

Source: PLN

A Java-Sumatra interconnection is planed for 2009 with AC 150kV (200MW) for the purpose of reducing the total reserve margin and reducing fuel cost by optimizing generation in the Sumatra system and the Java-Bali system. Over the long-term the interconnection will be upgraded to HVDC (2,000MW) for the purpose of transferring the power generated at mine-mouth power plants in South Sumatra. At the Infrastructure Summit 2005, which was held in January 2005 in Jakarta, the Java-Sumatra interconnection was included in the projects that the Indonesian government will promote.

6.1.2 Current Situation of System Operation

The Sumatra system is operated by three dispatching centers (UPB: Unit Pengatur Beban) located at Medan, Padang and Palembang.

N-1 rule is almost satisfied in the Sumatra system at present. There is no specific problem with regard to voltage and short circuit capacity. Currently, there is no stability problem in Sumatra, which is not the case in the Java Bali system. This is because large power is not transferred over long distances in the Sumatra at present.

Table 6.1.4 shows the allowable voltage range and the allowable loadings adopted by PLN.

Table 6.1.4 Allowable Voltage Range and Allowable Loading

Allowable Voltage Range	-10%, +5%
Allowable loading	80% (normal condition) 100% (contingency condition)

The allowable range of the frequency is from 49.5Hz to 50.5 Hz. The frequency is almost constantly kept at 50Hz, and there is no specific problem in regard to frequency. In case of contingency, the frequency will be kept constant by taking the measures shown in Table 6.1.5.

Table 6.1.5 Measures against Frequency Drop

Frequency	Measures
50.00Hz	Normal Operation
49.80Hz	Voltage Reduction (Brown out)
49.50Hz	Manual Load Shedding
49.30Hz	Automatic Load Shedding (UFR-1)
49.10Hz	Automatic Load Shedding (UFR-2)
48.90Hz	Automatic Load Shedding (UFR-3)
48.70Hz	Automatic Load Shedding (UFR-4)
48.50Hz	Islanding Operation (UFR-5)
47.50HZ	House Load Operation

Source: Standing Operation Procedure

6.1.3 Facilities in the Sumatra System

Currently, 150kV, 70kV and 20kV have been adopted in the Sumatra system. According to the PLN's policy, the 70kV systems will be reduced to simplify the voltage classes. Some of the 150kV transmission lines are designed for 275kV. They are planned to be upgraded to 275kV when 275kV is necessary in the future.

Tables 6.1.6, 6.1.7 and 6.1.8 show the outline of the transmission facilities and substation facilities in 2002.

Table 6.1.6 Transmission Facilities in Sumatra System (2002) (Unit: km·cct)

	25-30kV	70kV	150kV	500kV	Total
Northern Part of Sumatra	-	-	3,008.79	-	3,008.79
Southern Part of Sumatra	-	339.70	3,355.85	-	3,695.55
Total	-	339.70	6,364.64	-	6,704.34

Source: PLN Statistics 2002

Table 6.1.7　Number of Transformers in Sumatra System (2002)

	500kV	275kV	150kV	70kV	<30kV	Total
Northern Part of Sumatra	-	2	66	-	-	68
Southern Part of Sumatra	-	-	58	25	2	85
Total	-	2	124	25	2	153

Source: PLN Statistics 2002

Table 6.1.8　Capacity of Transformers in Sumatra System (2002)　(Unit: MVA)

	500kV	275kV	150kV	70kV	<30kV	Total
Northern Part of Sumatra	-	80	2,074	-	-	2,154
Southern Part of Sumatra	-	-	1,776	275	42	2,093
Total	-	80	3,850	275	42	4,247

Source: PLN Statistics 2002

Table 6.1.9 shows the typical transmission lines in Sumatra. Typically, ACSR 240 is adopted for 150kV transmission lines and ACSR 120 is adopted for 70kV transmission lines. With respect to the number of circuits on the transmission lines, double - circuit is usually adopted, although single-circuit is adopted in some cases.

Table 6.1.9　Typical Transmission Line

Voltage	Conductor	Size	Capacity	Remarks
150kV	ACSR	240mm2	645A	
70kV	ACSR	120mm2	300A	

Table 6.1.10 shows the typical capacities of the transformers.

Table 6.1.10　Typical Capacities of Transformers

Voltage	Capacity (MVA)	Remarks
150/70kV	100	
150/20kV	60, 31.5, 30, 20, 10	
70/11.5kV	15, 10, 5	

Table 6.1.11 shows the typical breaking capacities of circuit breakers.

Table 6.1.11　Typical Breaking Capacities of Circuit Breakers

Voltage	Breaking Capacity (kA)	Remarks
150kV	25, 30, 40	
20kV	25	

With respect to transmission line protection relays, distance relays are adopted as the main protection. Over current relays and ground fault relays are adopted as back ups. High reclosing systems are adopted for some of the 150kV transmission lines using power line carrier (PLC).

Table 6.1.12 shows the types of the neutral point connecting methods.

Table 6.1.12 Neutral Point Connecting Methods

Voltage	Neutral Point Connecting Method	Remarks
150kV	Solidly grounding method	
20kV	Resistively grounding method	20Ω or 40Ω

6.1.4 Reliability

Table 6.1.13 shows the System Average Interruption Duration Index (SAIDI) and the System Average Interruption Frequency Index (SAIFI) in Indonesia in 2002.

Table 6.1.13 SAIDI and SAIFI (2002)

		System Average Interruption Duration Index (SAIDI) (hours/customer)	System Average Interruption Frequency Index (SAIFI) (times/customer)
Sumatra	Nangroe Aceh Darussalam	46.66	29.06
	Sumatera Utara	24.01	31.06
	Sumatera Barat	35.97	26.67
	Riau	23.08	13.32
	Sumatera Selatan, Jambi, Bengkulu	4.10	23.41
	Lampung	9.72	6.19
Outside Java (Including Sumatra)		26.17	23.78
Java		8.32	9.26
Indonesia		14.35	14.17

Source: PLN Statistics 2002

This shows the reliability level of the Sumatra system is relatively low, compared with the average for Indonesia.

6.1.5 Transmission Losses

Table 6.1.14 shows the transmission losses in Indonesia in 2002.

Table 6.1.14 Transmission Losses

		Transmission Losses (GWh)	Loss Ratio
Sumatra	Northern Part of Sumatra	195.87	3.1%
	Southern Part of Sumatra	152.49	3.0%
Outside Java (Including Sumatra)		572.91	2.4%
Java		2,133.71	2.5%
Indonesia		2,706.61	2.5%

Source: PLN STATISTICS 2002

The transmission losses in the Sumatra system are approximately 3%. They are relatively high in comparison with the average for Indonesia (2.5%). This is because the Sumatra island is very large and the power is dispatched at 150kV over long distances.

6.2 Transmission Planning of PLN

6.2.1 Methodology of Transmission Planning

Figure 6.2.1 shows the methodology of PLN for transmission planning described in the *Guideline for the Power Development Planning* (Pedoman Penyusunan Rencana Umum Ketenagalistrikan, Nomor: 865K/30/MEM/2003).

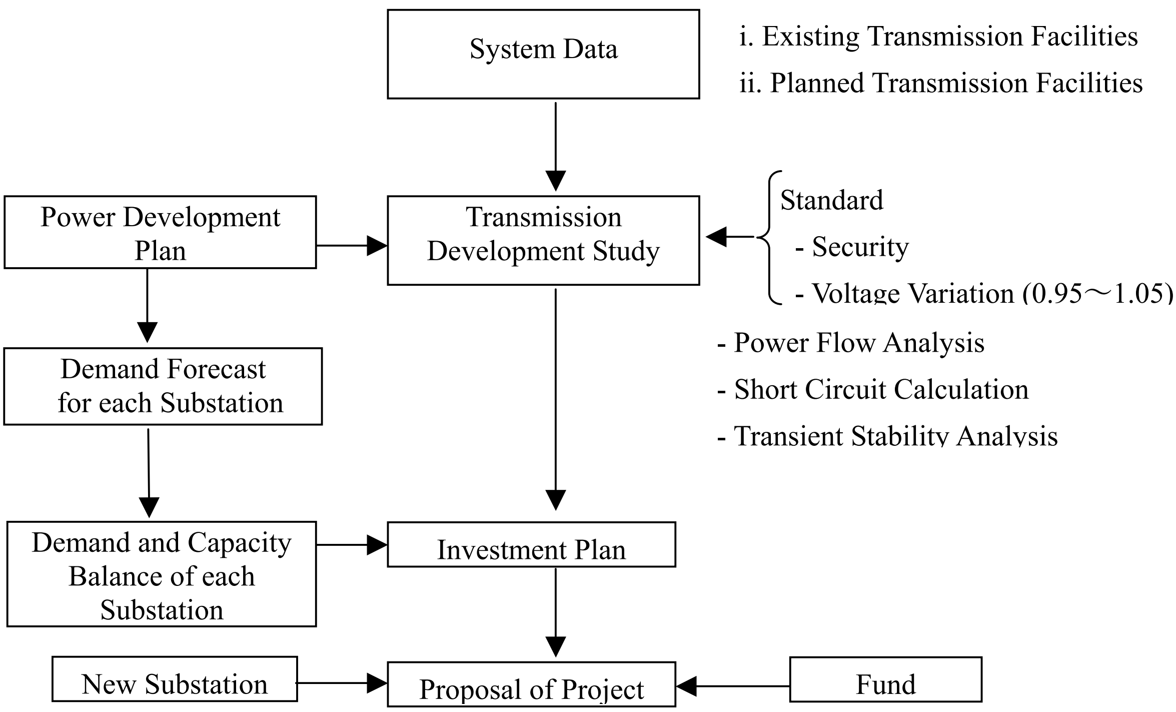


Figure 6.2.1 Methodology for Transmission Planning

Based on the demand forecast for the Sumatra system, demands for each substation are forecasted and the necessity for installing additional transformers and/or constructing new substations is studied. On the other hand, based on the demand forecasts for each substation and the power development plan, a transmission plan is made with system analyses, such as power flow analysis (voltage analysis), short circuit calculation and transient stability analysis, using the system data of the existing and planned facilities. After the study of the investment plan and fund, projects that should be implemented are determined.

6.2.2 Criteria of PLN

PLN adopts the N-1 rule to develop the transmission plan in the Sumatra system. The N-1 rule is internationally adopted for transmission expansion planning. This rule requires that blackouts (except temporary ones) will not occur even when one of the system components is lost (e.g. a one-circuit fault on a transmission line or a fault with one of the transformers).

In regard to stability, PLN requires that the system should be kept stable with a three-phase to ground fault and clearing by a main protective relay (3LGO).

If the unit capacity of the generators is relatively large compared with the system capacity, the frequency of the system drops sharply in the event of a generator drop. Therefore, the unit capacity of the generators is sometimes limited. However, the unit capacity of the generator is not restricted in the Sumatra system.

Table 6.2.1 shows the system capacities and the largest unit capacities of the generators in each system.

Table 6.2.1 System Capacity and Largest Generator Unit (2003)

	System Capacity (MW) (a)	Largest Unit (MW) (b)	Ratio (b) / (a)	Remarks
North Sumatra	972	422.58	43%	Belawan PLTGU 2
West and South Sumatra	1,118	100	9%	Ombilin

6.2.3 Program for System Analysis

PSS/E is adopted at the PLN head office for transmission planning. Meanwhile, DIgSILENT developed by a German company and Power World developed by an American company have been used for system planning and operations at the PLN branch offices in Sumatra. In addition, PSS/E has been introduced recently there based on the policy of the PLN head office. Therefore, three programs are currently used together in Sumatra.

The functions of these programs are almost the same, and the data maintenance would be complicated if plural programs are adopted. Therefore, it is desirable for the PLN branch offices in Sumatra to use PSS/E based on the policy of the PLN head office.

6.2.4 PLN Transmission Plan

PLN has a transmission plan as shown in Tables 6.2.2 and 6.2.3 to accommodate demand increases and power development in the Sumatra system and to keep reliability level.

Table 6.2.2 PLN Transmission Plan (North Sumatra)

Project	Description	Commissioning Year
Bireun – Sigli	150kV, 2cct, 99.2km, ACSR 1x240, OHL	2004
Lhokseumawe – Arun	150kV, 2cct, 2.7km, ACSR 1x240, OHL	2004
Sidikalang – Tarutung	150kV, 2nd cct, 122km, ACSR 1x240, OHL	2004
Titi Kuning GIS Listrik	150kV, 2cct, 12km, Cu 240, UGC	2004
Sigli - Banda Aceh	150kV, 2cct, 102.2km, ACSR 1x240, OHL	2004
PLTU Labuhan Angin Sibolga	150kV, 2cct, 38km, ACSR 1x240, OHL	2006
PLTP Sarulla – Tarutung	150kV, 2cct, 30km, ACSR 1x240, OHL	2006
Rantau Prapat - Padang Sidempuan	150kV, 2nd cct, 127km, ACSR 1x240, OHL	2006
Padang Sidempuan - Panyabungan	150kV, 2cct, 70km, ACSR 1x240, OHL	2005
Rantau Prapat - Kota Pinang	150kV, 2cct, 50km, ACSR 1x240, OHL	2006
Tanjung Morawa - Tebing Tinggi	150kV, 2cct, 50km, ACSR 1x240, OHL	2006
PLTU Sibolga Incomer	150kV, 2cct, 25km, ACSR 1x240, OHL	2007
Payakumbuh - Padang Sidempuan	275kV, 2cct, 200km, ACSR 2x429, OHL	2008
Padang Sidempuan - PLTA Asahan 1	275kV, 2cct, 174km, ACSR 2x429, OHL	2008
PLTA Asahan 1 - Galang	275kV, 2cct, 114km, ACSR 2x429, OHL	2008

Source: Abstraction from RPTL (2004-2013) Luar Jawa, Mandura dan Bali

Table 6.2.3 PLN Transmission Plan (West and South Sumatra)

Project	Description	Commissioning Year
Mariana – Borang	150kV, 2cct, 8.5km, ACSR 1x240, OHL	2004
Duri - Bagan Batu	150kV, 1st cct, 110.2km, ACSR 1x240, OHL	2004
Kiliranjao - Teluk Kuantan	150kV, 2cct, 51.2km, ACSR 1x240, OHL	2004
Singkarak - Padang Panjang	150kV, 2cct, 22.9km, ACSR 1x240, OHL	2004
Padang Panjang - Batu Sangkar	150kV, 2cct, 21.9km, ACSR 1x240, OHL	2004
Aur Duri - Payo Selincah	150kV, 2cct, 27km, ACSR 1x240, OHL	2004
Metro Incomer	150kV, 2cct, 10km, ACSR 1x240, OHL	2004
New Tarahan - Sribawono	150kV, 2cct, 52km, ACSR 2x240, OHL	2005
Menggala – Gumawang	150kV, 2cct, 75km, ACSR 1x240, OHL	2005
Indarung – Bungus	150kV, 2cct, 52km, ACSR 1x240, OHL	2006
Maninjau - Simpang Empat	150kV, 2cct, 75km, ACSR 1x240, OHL	2006
Payakumbuh - Kiliranjao	275kV, 2cct, 130km, ACSR 2x429, OHL	2008
Sribawono - Seputih Surabaya	150kV, 2cct, 52km, ACSR 1x240, OHL	2009
Teluk Kuantan –Rengat	150kV, 2cct, 130km, ACSR 1x240, OHL	2010
Rengat – Tembilahan	150kV, 2cct, 97km, ACSR 1x240, OHL	2010

Source: Abstraction from RPTL (2004-2013) Luar Jawa, Mandura dan Bali

Table 6.2.4 shows the 150kV transmission lines designed for 275kV. The transmission lines from the Kiliranjao substation in West Sumatra to the Lahat substation in South Sumatra are designed for 275kV. Plans are to upgrade these lines to 275kV in the future.

Table 6.2.4 Transmission Lines Designed for 275kV

Section	Length	Number of Circuits	Conductor	Note
Kiliranjao - Muara Bungo	117km	2	ACSR 2x430	
Muara Bungo - Bangko	70km	2	ACSR 2x430	
Bangko - Lubuk Linggau	195km	2	ACSR 2x430	
Lubuk Linggau - Lahat	114km	2	ACSR 2x430	

6.3 Conditions for Transmission Planning

This section presents assumptions for transmission planning, including study cases, demand forecasts and power development plans, as well as conditions for system analysis.

6.3.1 Study Cases

Table 6.3.1 shows the study cases for transmission planning. The study is conducted for three years: 2010, 2015 and 2020.

Table 6.3.1 Study Cases for Transmission Planning

	Demand Forecast	Power Development Plan	Interconnection	
			Malaysia IC	Java IC
Proposed Case 1	High Case	Proposed Case	No	No
Proposed Case 2	High Case	Proposed Case	Considered	Considered
South Case 1	High Case	South Case 1	No	No
South Case 2	High Case	South Case 2	Considered	Considered

(1) Demand Forecast

In regard to demand forecast, the High Case is adopted for the study (Refer to Tables 6.3.2 and 6.3.3).

Table 6.3.2 Demand Forecasts by Province and System (High Case)

(Unit: MW)

	2005	2010	2015	2020
NAD	155	266	336	391
Sumatera Utara	993	1,438	2,035	2,790
Riau	188	321	492	729
Sumatera Barat	318	472	649	849
Jambi	97	182	303	442
Sumatera Selatan	323	442	622	856
Bengkulu	50	72	98	131
Lampung	328	568	838	1,056
North Sumatra System	1,148	1,704	2,371	3,181
West Sumatra System	604	975	1,444	2,021
South Sumatra System	702	1,081	1,558	2,043
Total	2,454	3,760	5,374	7,244

Note: North Sumatra System (NAD, Sumatera Utara)
West Sumatra System (Riau, Sumatera Barat, Jambi)
South Sumatra System (Sumatera Selatan, Bengkulu, Lampung)

Table 6.3.3 Ratios of Demand Forecast by Province and System (High Case)

	2005	2010	2015	2020
NAD	6%	7%	6%	5%
Sumatera Utara	40%	38%	38%	39%
Riau	8%	9%	9%	10%
Sumatera Barat	13%	13%	12%	12%
Jambi	4%	5%	6%	6%
Sumatera Selatan	13%	12%	12%	12%
Bengkulu	2%	2%	2%	2%
Lampung	13%	15%	16%	15%
North Sumatra System	46%	45%	44%	44%
West Sumatra System	25%	26%	27%	28%
South Sumatra System	29%	29%	29%	28%
Total	100%	100%	100%	100%

Note: North Sumatra System (NAD, Sumatera Utara)
West Sumatra System (Riau, Sumatera Barat, Jambi)
South Sumatra System (Sumatera Selatan, Bengkulu, Lampung)

Although the Low Case is not adopted for the study, year 2010 and year 2015 in High Case are equivalent to year 2012 and year 2019 in the Low Case, respectively, judging from the total demand in Sumatra (Refer to Table 6.3.4).

Table 6.3.4 Comparison of High Case and Low Case

High Case		Low Case	
Year	Demand (MW)	Year	Demand (MW)
2010	3,760	2012	3,724
2015	5,374	2019	5,387
2020	7,244	-	-

(2) Power Development Plan

With regard to the power development plans, the Proposed Case and South Case have been adopted. Candidates for the power development plan are determined with consideration of their feasibility and information from PLN. The Proposed Case, where not only the economy but also environmental and social aspects are considered (refer to Table 5.10.2), is adopted as the power development plan in Proposed Case 1 and Proposed Case 2.

In the Proposed Case, sites of power plants are determined to balance the demand and supply in each system: the North Sumatra system, the West Sumatra system and the South Sumatra system, as long as possible. The locations of primary energy, such as coal and natural gas, as well as the potential of hydropower plants and geothermal are considered for this determination.

Meanwhile, as coal resources are mainly located in South Sumatra, it is expected that power development will be regionally unbalanced in the future, as a result of the development of large-scale mine-mouth power plants in South Sumatra. Therefore, South Case 1 and South Case 2, where the power development is mainly implemented in South Sumatra, are also studied.

Table 6.3.5 shows the differences between the Proposed Case and South Case 1. Table 6.3.6 shows the differences between the Proposed Case and South Case 2. In South Case 1 and South Case 2, some candidates in North Sumatra are replaced by power development at Banjar Sari in South Sumatra, as compared with Proposed Case.

Table 6.3.5 South Case 1

		Difference from Proposed Case
2010	North Sumatra	PLTP Sarulla (▲165MW)
	South Sumatra	PLTU Muba (+200MW)
2015	North Sumatra	PLTU Meulaboh (▲400MW)
	South Sumatra	PLTU Banjar Sari (+400MW)
2020	North Sumatra	PLTU Meulaboh (▲400MW) PLTU Medan (▲300MW) PLTA Tampur (▲428MW)
	South Sumatra	PLTU Banjar Sari (+1,100MW)

Table 6.3.6 South Case 2 (with Malaysia Interconnection and Java Interconnection)

			Difference from Proposed Case
2010	North Sumatra		PLTP Sarulla (▲165MW)
	South Sumatra		PLTU Muba (+200MW)
2015	North Sumatra		PLTU Meulaboh (▲400MW)
	South Sumatra	for Sumatra	PLTU Banjar Sari(+400MW)
		for Malaysia	PLTU Banjar Sari (+600MW)
		for Java	PLTU Banjar Sari (+2,400MW)
2020	North Sumatra		PLTU Meulaboh (▲400MW) PLTU Medan (▲300MW) PLTA Tampur (▲428MW)
	South Sumatra	for Sumatra	PLTU Banjar Sari (+1,100MW)
		for Malaysia	PLTU Banjar Sari (+600MW)
		for Java	PLTU Banjar Sari (+2,400MW)

Table 6.3.7 shows the generation capacities by province and by system in Proposed Case 1. Table 6.3.8 shows the ratios of the generation capacity by province and system.

Table 6.3.7 Generation Capacities by Province and System (Proposed Case 1) (Unit: MW)

	2005	2010	2015	2020
NAD	58	210	696	1,324
Sumatera Utara	1,475	1,683	2,017	2,367
Riau	173	307	307	907
Sumatera Barat	518	518	518	518
Jambi	93	112	462	612
Sumatera Selatan	756	893	1,253	1,703
Bengkulu	54	229	313	313
Lampung	224	649	649	649
North Sumatra System	1,533	1,893	2,713	3,691
West Sumatra System	784	936	1,286	2,036
South Sumatra System	1,034	1,771	2,215	2,665
Total	3,351	4,600	6,215	8,393

Note: North Sumatra System (NAD, Sumatera Utara)
West Sumatra System (Riau, Sumatera Barat, Jambi)
South Sumatra System (Sumatera Selatan, Bengkulu, Lampung)

Table 6.3.8 Ratios of Generation Capacity by Province and System (Proposed Case 1)

	2005	2010	2015	2020
NAD	2%	5%	11%	16%
Sumatera Utara	44%	37%	33%	28%
Riau	5%	7%	5%	11%
Sumatera Barat	15%	11%	8%	6%
Jambi	3%	2%	7%	7%
Sumatera Selatan	22%	19%	20%	20%
Bengkulu	2%	5%	5%	4%
Lampung	7%	14%	11%	8%
North Sumatra System	46%	42%	44%	44%
West Sumatra System	23%	20%	20%	24%
South Sumatra System	31%	38%	36%	32%
Total	100%	100%	100%	100%

Table 6.3.9 shows the generation capacity by province and by system in South Case 1. Table 6.3.10 shows the ratio of the generation capacity by province and system.

Table 6.3.9 Generation Capacity by Province and System (South Case 1) (Unit: MW)

	2005	2010	2015	2020
NAD	58	210	296	496
Sumatera Utara	1,475	1,518	2,017	2,067
Riau	173	307	307	907
Sumatera Barat	518	518	518	518
Jambi	93	112	462	612
Sumatera Selatan	756	1,093	1,653	2,803
Bengkulu	54	229	313	313
Lampung	224	649	649	649
North Sumatra System	1,533	1,728	2,313	2,563
West Sumatra System	784	936	1,286	2,036
South Sumatra System	1,034	1,971	2,615	3,765
Total	3,351	4,635	6,215	8,365

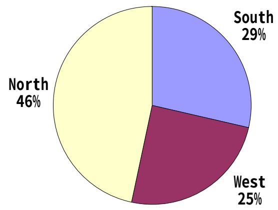
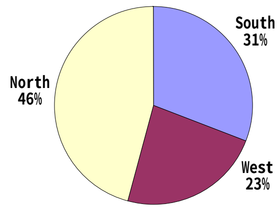
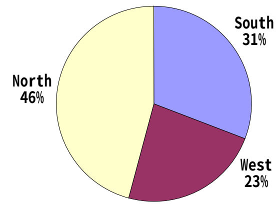
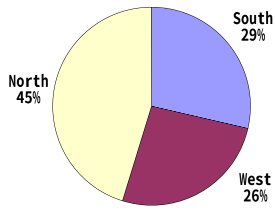
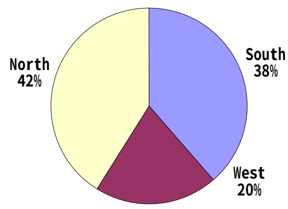
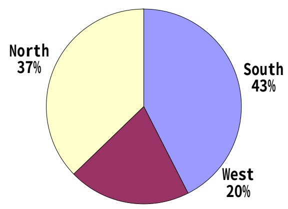
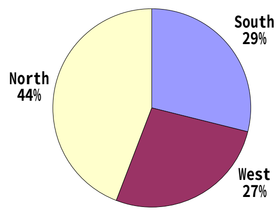
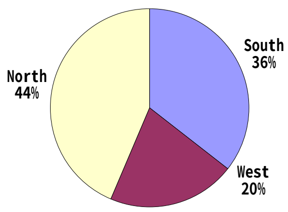
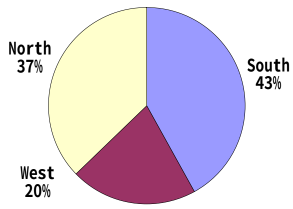
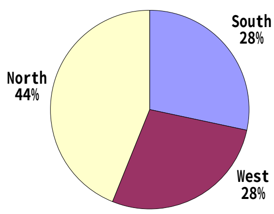
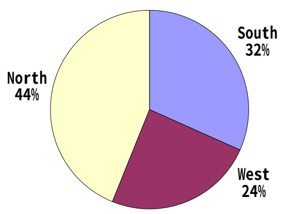
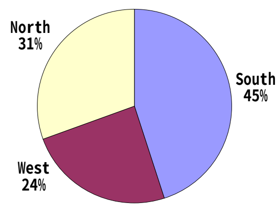
Note: North Sumatra System (NAD, Sumatera Utara)
West Sumatra System (Riau, Sumatera Barat, Jambi)
Sumatra System (Sumatera Selatan, Bengkulu, Lampung)

Table 6.3.10 Ratio of Generation Capacity by Province and System (South Case 1)

	2005	2010	2015	2020
NAD	2%	4%	5%	6%
Sumatera Utara	44%	33%	32%	25%
Riau	5%	7%	5%	11%
Sumatera Barat	15%	11%	8%	6%
Jambi	3%	2%	7%	7%
Sumatera Selatan	22%	24%	27%	33%
Bengkulu	2%	5%	5%	4%
Lampung	7%	14%	11%	8%
North Sumatra System	46%	37%	37%	31%
West Sumatra System	23%	20%	20%	24%
South Sumatra System	31%	43%	43%	45%
Total	100%	100%	100%	100%

Table 6.3.11 shows the ratios of the demand forecasts and the generation capacities for 2010, 2015 and 2020 by system.

Table 6.3.11 Ratios of Demand Forecasts and Generation Capacities by System

	Demand Forecast	Generation Capacity	
		Proposed Case 1	South Case 1
2005			
2010			
2015			
2020			

Note: North (NAD, Sumatera Utara)
West (Riau, Sumatera Barat, Jambi)
South (Sumatera Selatan, Bengkulu, Lampung)

(3) Interconnection Plan

The Malaysia-Sumatra interconnection projects and the Java-Sumatra interconnection projects have not been committed yet. Therefore, two scenarios are studied: one is without interconnections and the other is with interconnections.

Tables 6.3.12 and 6.3.13 show the assumptions for Proposed Case 2 and South Case 2 on the Malaysia-Sumatra interconnection and the Java-Sumatra interconnection.

Table 6.3.12 Assumptions for Malaysia-Sumatra Interconnection

Case	Year	Type and Capacity	Direction of Power Flow
Proposed Case 2	2010 2015 2020	600MW (HVDC)	Malaysia -> Sumatra
South Case 2	2010	600MW (HVDC)	Malaysia -> Sumatra
	2015 2020	600MW (HVDC)	Sumatra -> Malaysia

Table 6.3.13 Assumptions for Java-Sumatra Interconnection

Case	Year	Type and Capacity	Direction of Power Flow
Proposed Case 2	2010 2015 2020	200MW (AC)	Sumatra -> Java
South Case 2	2010	200MW (AC)	Sumatra -> Java
	2015 2020	2,000MW (HVDC)	Sumatra -> Java

The 150kV (designed for 275kV) interconnection between the North Sumatra system and the West Sumatra system is considered in all cases, on the assumption that it will be completed in 2009.

6.3.2 Criteria and Methodology

(1) Criteria

The N-1 rule is applied for the transmission planning. According this rule, no blackouts and no generation restrictions will occur even when one circuit along the transmission lines or one transformer goes out of service.

(2) Methodology

Power flow analysis, stability analysis and short circuit analysis are conduced for transmission planning. Table 6.3.14 shows the permissible range of loading and voltage for power flow analysis.

Table 6.3.14 Permissible Range of Loading and Voltage

Loading	Normal Condition	80%
	N-1 Contingency	100%
Voltage	Normal Condition	0.95 ~ 1.05

In regard to stability, it is required that the system should be kept stable with a three-phase to ground fault and clearing by a main protective relay (3LGO). In the case of a severe instability situation, steady-state stability is also analyzed using eigen value analysis. Table 6.3.15 shows the assumptions for the transient stability analysis.

Table 6.3.15 Assumptions for Transient Stability Analysis

Fault	3LG-O (Three-Phase to Ground Fault)	
Fault Clearing Time	150kV Transmission Lines	150ms
	275kV Transmission Lines	100ms
	500kV Transmission Lines	100ms
Voltage Characteristics of Load	Active Power	Constant Current
	Reactive Power	Constant Impedance

In this study the main focus is on expansion plans for the main system and the system connected to power plants in Sumatra. Meanwhile, detailed study is not conducted for 150kV transmission lines to supply local areas as well as for 150kV and 70kV systems to supply large cities such as Medan, Padang and Palembang. An additional study will be necessary for these distribution systems.

6.3.3 Program and Data for System Analysis

PSS/E, which is developed by PTI, is adopted for the system analysis. The data for system analysis are from PLN. Standard data are adopted for the future system.

6.4 Transmission Plan

6.4.1 Current System (2005)

Figure 6.4.1 shows the current Sumatra system in 2005.

(1) North Sumatra system

There are no specific problems in the North Sumatra system. The Renun hydropower station is planned to start operations in 2005. To transmit its power, a one-circuit cut-in of the existing 150kV Brastagi-Sidikalang line to Renun was implemented.

(2) West Sumatra system

There are no specific problems in the West Sumatra system.

(3) South Sumatra system

In South Sumatra, the steam turbine at Palembang Timur (50MW) is planned to be installed. A gas turbine (100MW) was already installed in 2004, and they are operated as a combined cycle (total capacity: 150MW). The generated power can be transmitted with the existing 150kV and 70kV lines.

The transmission lines, which connect South Sumatra and Lampung (Bukit Asam - Baturaja - B.kemuning - Tegineneng - Natar), are overloaded with a one-circuit fault. This overload will be solved with the completion of the Tarahan coal-fired power plant (3,4G: 100MWx2), which is scheduled to start operations around 2009-2010.

The power flows along the 150kV South-West Sumatra interconnection are less than around 100MW at peak in 2005, and there will be no problem in terms of either thermal capacity or stability.

6.4.2 Proposed Case 1

(1) 2010

Figure 6.4.2 shows the Sumatra system in 2010 in Proposed Case 1.

(i) Aceh system

In Aceh the supply will be short with demand increases, and the existing 150kV transmission lines, which connect Medan and Aceh, will be overloaded with a one-circuit fault. Therefore, installation of generators in Aceh will be necessary to meet this demand increase. Gas turbines are planed to be installed at Arun (60MW), Banda Aceh (100MW) and Aceh (50MW) in 2007.

Meanwhile, stability is very poor in Aceh. Therefore, it is noted that stability problems would occur with the installation of generators and their connections to the existing 150kV transmission lines in Aceh.

At Arun, the gas turbines (20MWx3) have already been installed, and their power will be transferred to the existing Lhoksewmawe substation with the 150kV transmission line, in line with fuel supply from PERTAMINA.

If 100MW gas turbines are installed at Banda Aceh, transient stability and steady-state stability problems will occur. With a fault on the existing 150kV Banda Aceh - Sigli line, the system will be unstable and the generators at Banda Aceh will step out. A drastic measure against this problem is the construction of new 275kV transmission lines from Medan to Banda Aceh and the separation of the generators in Banda Aceh from the 150kV system.

However, early construction of the 275kV transmission lines from Medan to Banda Aceh, of which the length is around 500km, is not realistic from a viewpoint of the construction period and cost. Under the circumstances, a better short-term measure would be to improve the protection and control systems or to install an SVC (Static Var Compensator) to maintain the system stability for the gas turbines at Banda Aceh. As a middle to long-term measure, it is desirable to construct 275kV transmission lines from Medan to Banda Aceh in line with the power development in Aceh to drastically solve the stability problem.

In this study it is confirmed that the system will remain stable by adoption of one of the following measures: (1) shortening the fault clearing time from 150ms to 100ms by replacing the protection relays and circuit breakers; (2) installation of an SVC (200MVA) at Banda Aceh.

If the remaining 50MW for Aceh is installed at Banda Aceh or Arun (Lhoksewmawe), the stability problem would become worse. Therefore, it is desirable to install it at the Langsa substation, although there is no concrete plan.

If these gas turbines are not installed in Aceh, the existing 150kV transmission lines, which connect Medan and Aceh, will be overloaded with a one-circuit fault. To avoid this a new 150kV transmission line needs to be constructed from the Binjai substation near Medan to P.Brandan (or Langsa) substation. In this case the new line should be designed for 275kV to utilize it for future power development in Aceh (e.g. Meulaboh, Tampur, others).

If one 100MW generator is adopted in Banda Aceh, voltage stability problems would occur with a tripping of the generator. To avoid this, it is necessary to adopt two 50MW generators in Banda Aceh.

(ii) North Sumatra system

In 2008 the Labuhan Angin coal-fired power plant (230MW) is scheduled to be in operation. Its power will be transferred with a new 150kV transmission line constructed between Labuhan Angin and the existing P.Sidempuan substation. As a result, the 150kV Sibolga-Tarutung line will be overloaded with a one-circuit fault. As a measure against this problem, it is necessary to construct another transmission line between Sibolga and Tarutung or to reinforce the existing line.

The power of the Sibolga coal-fired power plant (200MW), developed in 2009, will be transferred to the existing P.Sidempuan substation with a new 150kV transmission line.

In 2009 and 2010 the Sarulla geothermal power plant (165MW) will be in operation. If this power plant is connected to the Tarutung substation, several 150kV transmission lines (e.g. Porsea-P.Siantar, others) will be overloaded with a one-circuit fault. To avoid this, it is necessary to construct a new transmission line from Sarulla to the Galang substation, which will be constructed near Medan. This transmission line will be operated at 150kV for some years, and it should be upgraded to a 275kV line in line with the development of the Asahan 1 and 3 hydropower plants. Therefore, the line needs to be designed for 275kV.

(iii) West Sumatra system

In 2006 the Musi hydropower plant (210MW) in Bengkulu is scheduled to be in operation. Its power will be transferred to the existing Curup substation with a new 150kV transmission line.

There is no concrete plan for the 50MW gas turbine in Jambi in 2007. It is assumed that it will be installed at the Payo Selincah substation. As the capacity is relatively small, its power can be transferred with the existing 150kV system.

It is assumed that the combined cycle power plant, developed at Pekanbaru (150MW) in 2008, will be connected to the existing Garuda Sakti substation. Its power can be transferred with the existing 150kV system.

(iv) South Sumatra system

In 2007 the Tarahan coal-fired power plant (3,4G: 100MWx2) is scheduled to be in operation. To transfer the power, a 150kV transmission line from the Tarahan power plant to the existing Sribawono substation is under construction. This new transmission line will accommodate power transfers for Tarahan 1, 2 G (200MW), which is planed for 2009 and 2010.

Installation of combined cycles (82MW) is planed for 2010 at the Kramasan thermal power plant. The generated power can be transferred with the existing 150kV and 70kV system.

The power of the Ulu Belu geothermal power plant (110MW) will be transferred to the Batu Tegi hydropower plant and Pagelaran substation with new 150kV transmission lines.

As a result of system analysis, it was discovered that not stability but thermal capacity of transmission lines is critical in the 150kV system in Lampung.

The power of the Musi Rawas coal-fired power plant developed in 2010 (100MW) will be transferred to the Bangko substation in Jambi with a new 150kV transmission line.

(2) 2015

Figure 6.4.3 shows the Sumatra system in 2015 in Proposed Case 1.

(i) Aceh system

As stability in Aceh is very poor, it is necessary to construct new 275kV transmission lines from Meulaboh to the Binjai substation near Medan to transfer the power from the Meulaboh coal-fired power plant (400MW), which will be developed in 2011, 2014 and 2015.

One 275kV transmission line route would accommodate power transfer of around 300MW in Meulaboh. If the capacity is over 400MW, two 275kV transmission line routes would be necessary because of stability problems. In this case, one 500kV transmission line route could be adopted to avoid construction of multiple transmission line routes, which can also transfer the power from the Tampur hydropower plant (428MW) in the future.

On the other hand, in line with the construction of the 275kV transmission line from Meulaboh to Medan, it is necessary to construct a new 275kV transmission line from Meulaboh to Banda Aceh for the purpose of power transfer from Meulaboh to Banda Aceh and to drastically solve the stability problem in Aceh.

The Peusangan hydropower plant, developed in 2013 (86.4MW), will be connected to the Bireun substation and the Meulaboh power plant with new 150kV transmission lines.

If the Meulaboh plan is delayed and the Peusangan plan is advanced, the power from Peusanga could be transferred with a new 150kV transmission line from Peusangan to Bireun. In that case, however, the stability will be very poor, so measures to improve the stability will be necessary.

(ii) North Sumatra system

In 2012 to transfer the power from the Asahan 3 hydropower plant (154MW) and Asahan 1 hydropower plant (180MW), the 150kV transmission line from the Simangkuk substation near Asahan to the Galang substation near Medan will be upgraded to 275kV.

It should be noted that the timing for introducing 275kV in North Sumatra will be affected not only by the construction of Asahan 1 and 3, but also the construction of the Sarulla geothermal power plant, Sibolga thermal power plant and the power flow from the North-West interconnection.

(iii) West Sumatra system

The Merangin hydropower plant (350MW) will be developed in 2013. As a result of the operations of this power plant, the power flow of the 150kV (designed for 275kV) South-West interconnection exceeds the one-circuit thermal capacity of the transmission line. Additionally, stability problems will also occur. Therefore, the transmission lines from South Sumatra to West Sumatra need to be upgraded to 275kV. The new transmission line from Merangin to Bangko also needs to be operated at 275kV to avoid stability problems.

In 2015 the 150kV transmission line from Payakumbuh to Kotopanjan will be overloaded with a one-circuit fault because of the demand increase in Riau. Therefore, it will be necessary to construct a new 275kV transmission line from Payakumbuh to Garuda Sakti and to introduce 275kV to Riau. This will accommodate the demand increase in Riau, the construction of the interconnection to Malaysia, and large-scale power development at Pekanbaru in the future.

(iv) South Sumatra system

The Kutaun hydropower plant, developed in 2014 (84MW), will be connected to the existing Curup substation with a new 150kV transmission line.

The Ranau hydropower plant, developed in 2014 (60MW), will be connected to the existing Baturaja substation with a new 150kV transmission line.

In 2015 the transmission lines between South Sumatra and Lampung will be overloaded with a one-circuit fault. Therefore, it will be necessary to construct a new 275kV transmission line from Lahat in South Sumatra to Tarahan in Lampung. This will accommodate the demand increase in Lampung, construction of the 150kV interconnection to Java, and large-scale power development in Tarahan in the future.

(3) 2020

Figure 6.4.4 shows the Sumatra system in 2020 in Proposed Case 1.

From 2016 to 2020 the amounts of power development in each system are 978MW in the North Sumatra system, 750MW in the West Sumatra system and 450MW in the South Sumatra system. The total amount is 2,178MW.

In Proposed Case it is assumed that the demand and supply in each system (the North Sumatra system, the West Sumatra system, and the South Sumatra system) are balanced. As a result, power dispatching is possible with one 275kV transmission line route from Aceh to Lampung (except the section from Meulaboh to Binjai, where two routes are necessary).

With regard to the coal-fired power plants in Medan (300MW), there are no specific sites. Therefore, it is assumed that it will be developed at the Belawan power plant as a replacement for the steam turbines.

6.4.3 Proposed Case 2 (with Malaysia-Sumatra Interconnection and Java-Sumatra Interconnection)

(1) 2010

Figure 6.4.5 shows the Sumatra system in 2010 in Proposed Case 2.

If the 600MW HVDC system is connected to the existing 150kV system at Garuda Sakti in Riau, the HVDC system cannot be operated stably because of low short circuit capacity. Furthermore the capacity of the 150kV transmission lines between Riau (Garuda Sakti) and West Sumatra (Payakumbuh) will be short. Therefore, it is necessary to construct a new 275kV transmission line between Garuda Sakti and Payakumbuh.

Additionally, to transfer the power from Malaysia to North Sumatra by way of West Sumatra, it is necessary to upgrade the transmission line between Payakumbuh in West Sumatra and P.Sidempuan in North Sumatra to 275kV and to construct a new 150kV (designed for 275kV) transmission line between P.Sidempuan and Sarulla. This will accommodate power transfer from Malaysia to North Sumatra if generation in North Sumatra is insufficient because of delays in power development, such as Sarulla (165MW) or Sibolga (200MW).

On the other hand, to transfer the power from Malaysia to South Sumatra by way of West Sumatra, it is necessary to construct a new 275kV transmission line between Payakumbuh and Kiliranjao and to upgrade the 150kV transmission line between West Sumatra and South Sumatra to 275kV.

If the Java-Sumatra interconnection is constructed and 200MW power is transferred from the Sumatra system to the Java-Bali system, the existing 150kV transmission lines in Lampung will be overloaded with a one-circuit fault. Therefore, it is necessary to construct a new transmission line from Lahat in South Sumatra to Tarahan in Lampung. The line needs to be designed for 275kV to cope with the demand increase in Lampung in the future.

(2) 2015

Figure 6.4.6 shows the Sumatra system in 2015 in Proposed Case 2.

In this case power dispatching is possible with one 275kV transmission line route from Aceh to Lampung.

(3) 2020

Figure 6.4.7 shows the Sumatra system in 2020 in Proposed Case 2.

In this case power dispatching is also possible with one 275kV transmission line route from Aceh to Lampung.

6.4.4 South Case 1

(1) 2010

Figure 6.4.8 shows the Sumatra system in 2010 in South Case 1 where power development is advanced in South Sumatra.

It is assumed that the Sarulla geothermal power plant (165MW) will be delayed in North Sumatra, and the Muba thermal power plant (200MW) will be advanced in South Sumatra. In this case, the power flow of the 150kV transmission line between South Sumatra and West Sumatra will be heavy and the system will be unstable with a transmission line fault. Therefore, it is necessary to upgrade the 150kV transmission line between Kiliranjao and Lahat to 275kV and to construct a new 275kV transmission line between Kiliranjao and Payakumbuh.

In addition, the power flow of the 150kV transmission line will be heavy between Payakumbuh in West Sumatra and P.Sidempuan in North Sumatra, and the system will be unstable with a transmission line fault. Therefore, it is also necessary to upgrade the transmission line to 275kV. Furthermore, to transfer the power to North Sumatra, it is necessary to construct a 150kV transmission line between P.Sidempuan and Sarulla. As the transmission line will serve as the backbone of the future Sumatra system, it should be designed for 275kV.

On the other hand, a new transmission line will be necessary between the Muba thermal power plant and the Betung substation in this case. A 150kV second circuit will also be necessary between Betung and T.Kelapa. With regard to the transmission line between Bukit Asam and Lahat, its capacity is relatively small (1xA240, 168MVA) and so there would be a bottleneck for the 150kV system. As a result of power development at Muba, the line will be overloaded with a one-circuit fault. Therefore, it is necessary to construct another line between Bukit Asam and Lahat or to reinforce the existing line, in coordination with development of the Muba power plant.

(2) 2015

Figure 6.4.9 shows the Sumatra system in 2050 in South Case 1.

It is assumed that the Meulaboh thermal power plant (400MW) will be delayed in North Sumatra, and the Banjar Sari thermal power plant (400MW) will be advanced in South Sumatra. In this case, the power cannot be transferred from South Sumatra to North Sumatra because of thermal capacity limitations. Therefore, it is necessary to construct a 275kV second route from South Sumatra to North Sumatra. The second route should be designed for 500kV, to cope with further power development in South Sumatra.

(3) 2020

Figure 6.4.10 shows the Sumatra system in 2020 in South Case 1.

It is assumed that the Meulaboh thermal power plant (400MW), Medan thermal power plant (300MW) and Tampur hydropower plant (428MW) will be delayed in North Sumatra, and the Banjar Sari thermal power plant (1,1000MW) will be advanced in South Sumatra. In this case, the power cannot be transferred from South Sumatra to North Sumatra with two 275kV transmission line routes because of thermal capacity limitations and stability problems. Therefore, it is necessary to upgrade the second route to 500kV and to introduce 500kV into the Sumatra system.

6.4.5 South Case 2 (with Malaysia-Sumatra Interconnection and Java-Sumatra Interconnection)

(1) 2010

Figure 6.4.11 shows the Sumatra system in 2010 in South Case 2.

In South Case 1, the 275kV transmission lines from P.Sidempuan in North Sumatra to Lahat in South Sumatra will have been constructed by 2010. These 275kV transmission lines will accommodate power dispatches in Sumatra even if the Malaysia-Sumatra interconnection and the Java-Sumatra interconnection are constructed. In this case, to transfer the power to the Java-Bali system, it will be necessary to construct a new 150kV (designed for 275kV) transmission line from Lahat to Tarahan.

(2) 2015

Figure 6.4.12 shows the Sumatra system in 2015 in South Case 2.

It is assumed that additional 600MW power development will be implemented at the Banjar Sari thermal power plant to export power to Malaysia. In this case, the 600MW power cannot be transferred from Banjar Sari to Malaysia with two 275kV transmission line routes because of the thermal capacity limitations and stability problems. Therefore, it is necessary to upgrade the 275kV transmission lines from Banjar Sari in South Sumatra to Garuda Sakti in Riau to 500kV.

If a 600MW coal-fired power plant is developed at Cirenti in Riau, instead of Banjar Sari, to export power to Malaysia, it will be necessary to construct a new 275kV transmission line between Cirenti and Garuda Sakti.

(3) 2020

Figure 6.4.13 shows the Sumatra system in 2020 in South Case 2.

It is assumed that additional 600MW power development will be implemented at the Banjar Sari thermal power plant to export power to Malaysia.

In South Case 1 the 500kV transmission line from Banjar Sari in South Sumatra to Galang in North Sumatra will have been constructed by 2020. This 500kV transmission line accommodates 600MW power transfers from Banjar Sari to Malaysia.

However, if the power development in South Sumatra is advanced more than South Case 2, or if the Malaysia-Sumatra interconnection is upgraded to 1,200MW and additional amounts of power in South Sumatra are exported to Malaysia, it will be necessary to construct a second 500kV transmission line from South Sumatra (Banjar Sari) to West Sumatra (Garuda Sakti).

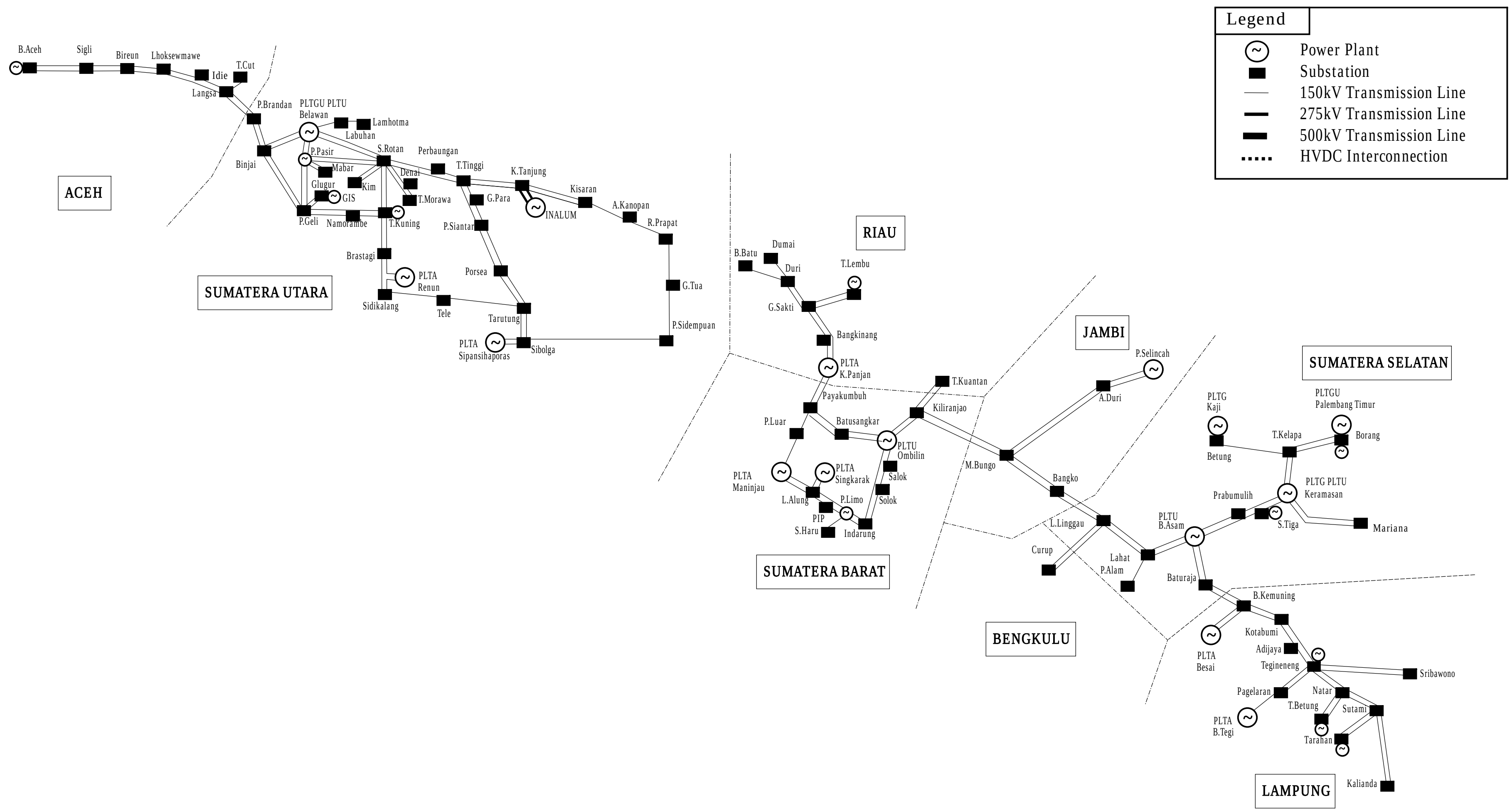


Figure 6.4.1 Current System (2005)

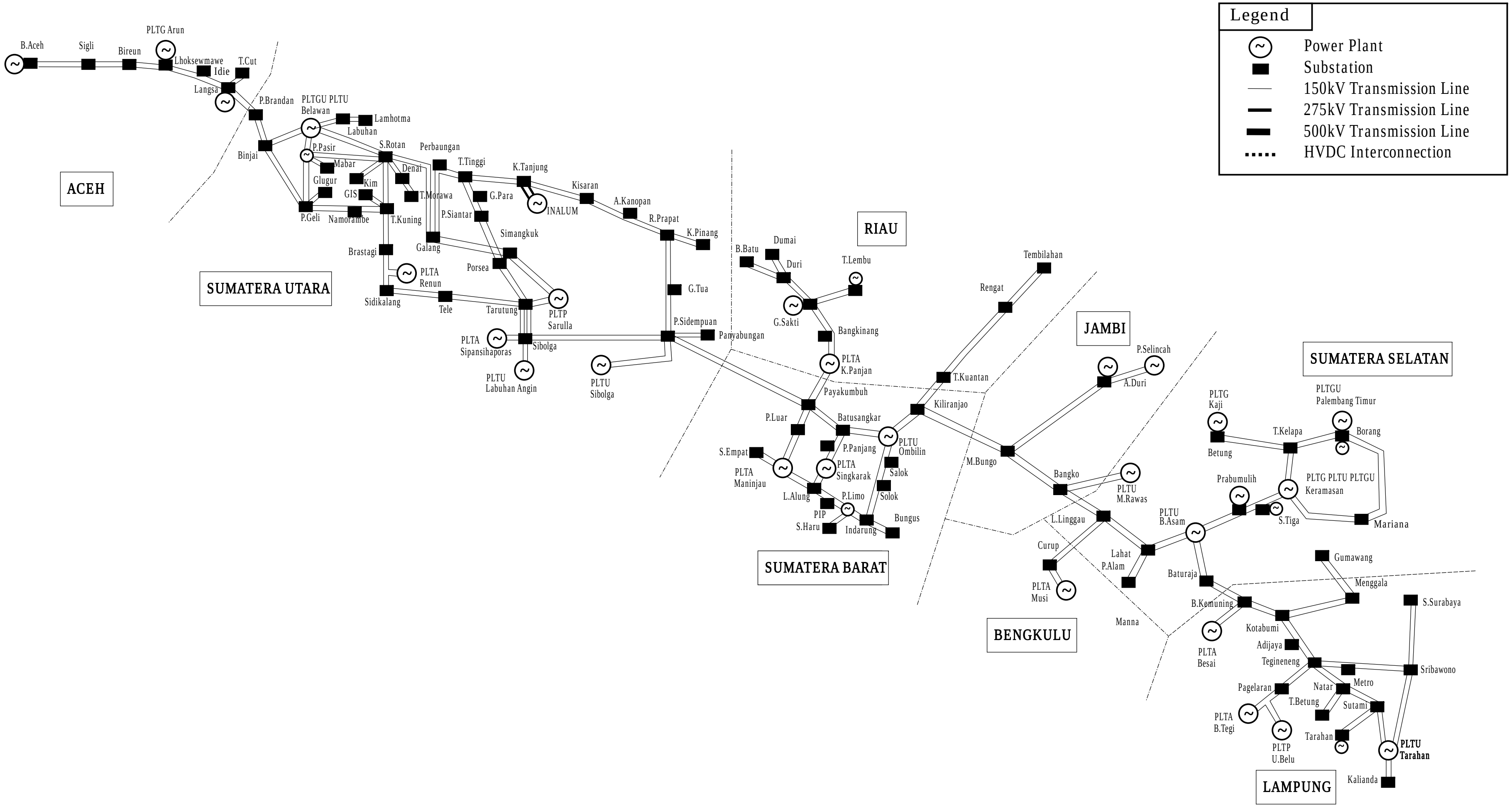


Figure 6.4.2 Proposed Case 1 (2010)

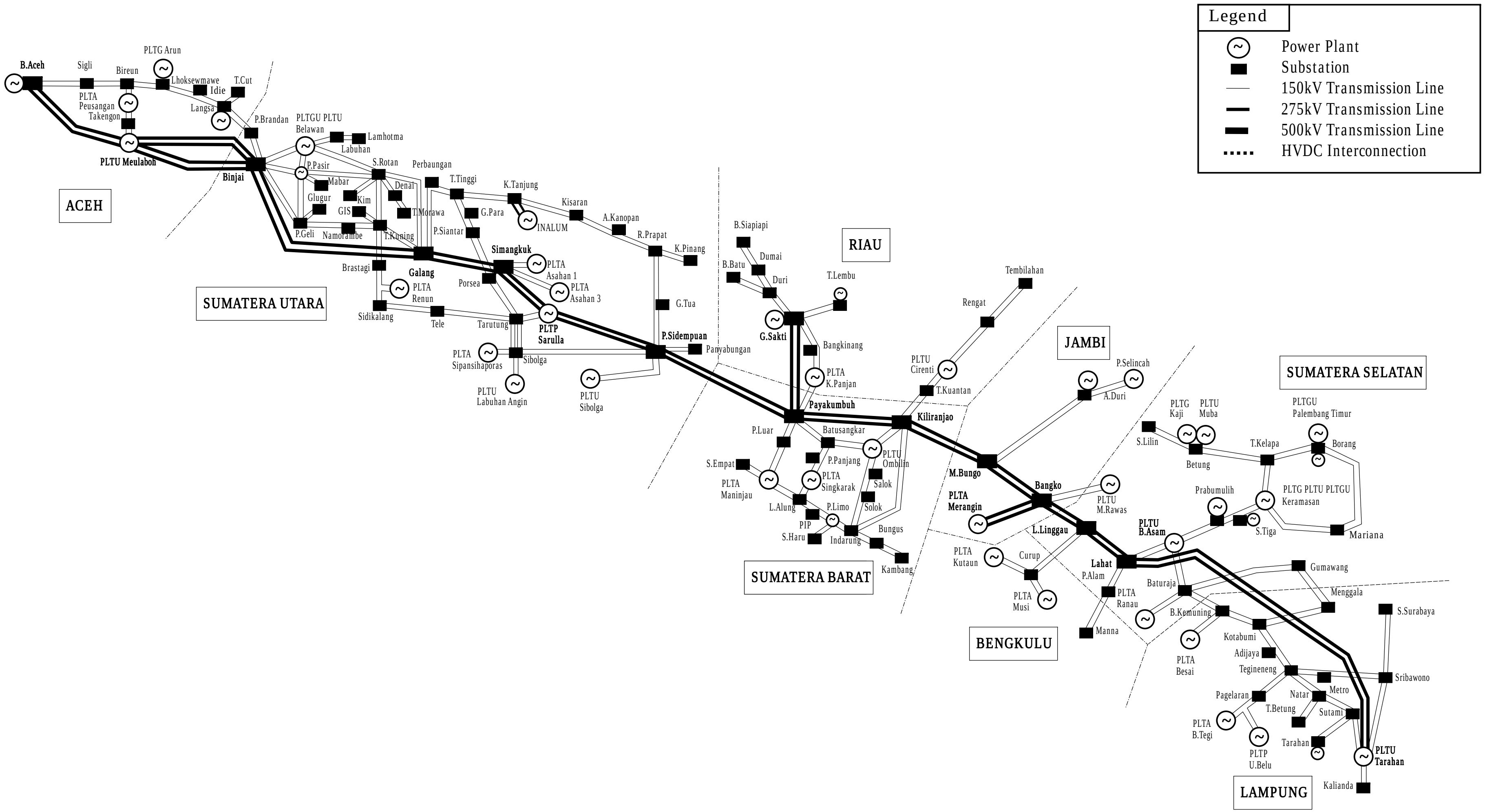


Figure 6.4.3   Proposed Case 1 (2015)

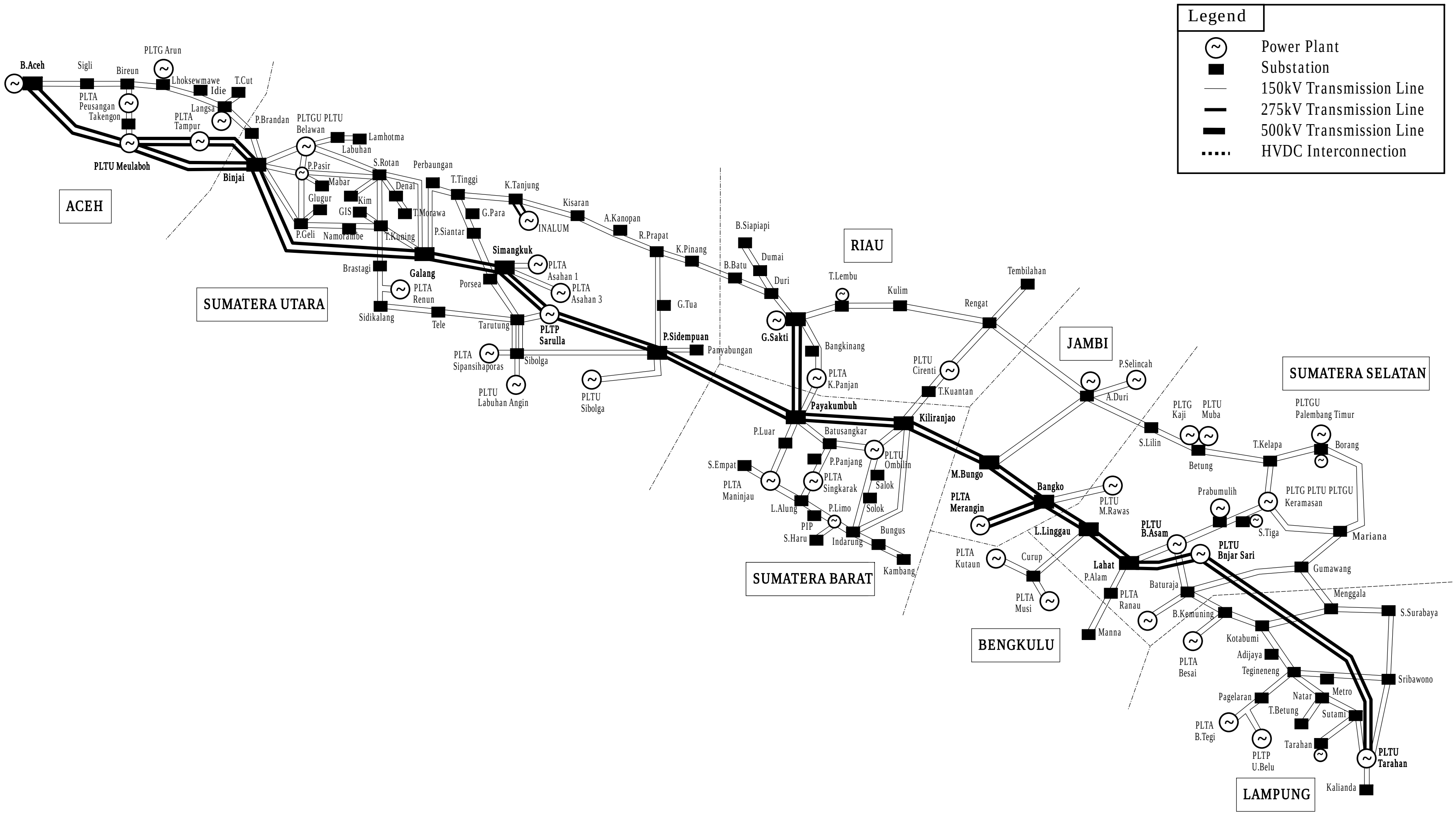


Figure 6.4.4 Proposed Case 1 (2020)

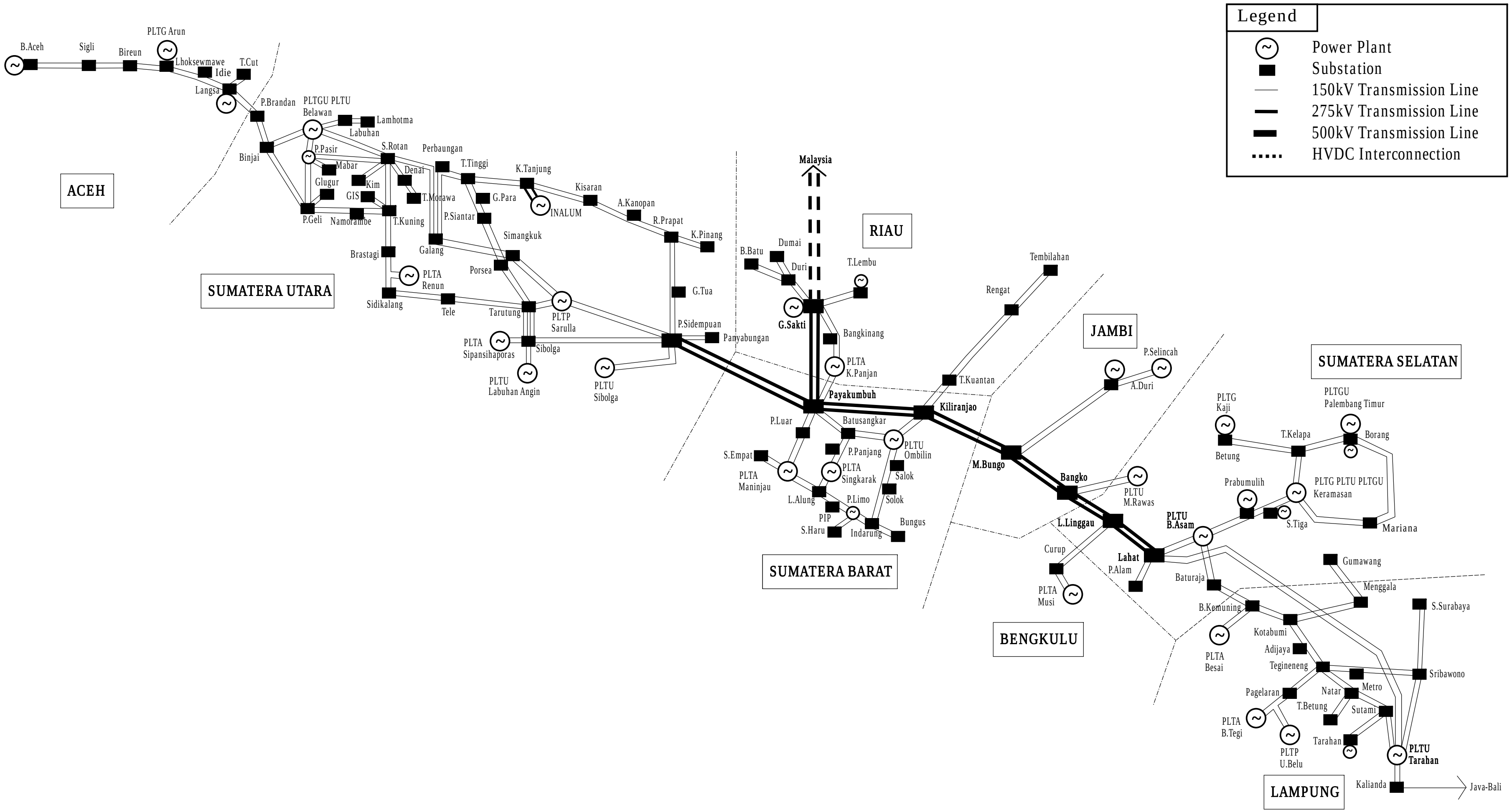


Figure 6.4.5   Proposed Case 2 (2010) [with Malaysia-Sumatra Interconnection and Java-Sumatra Interconnection]

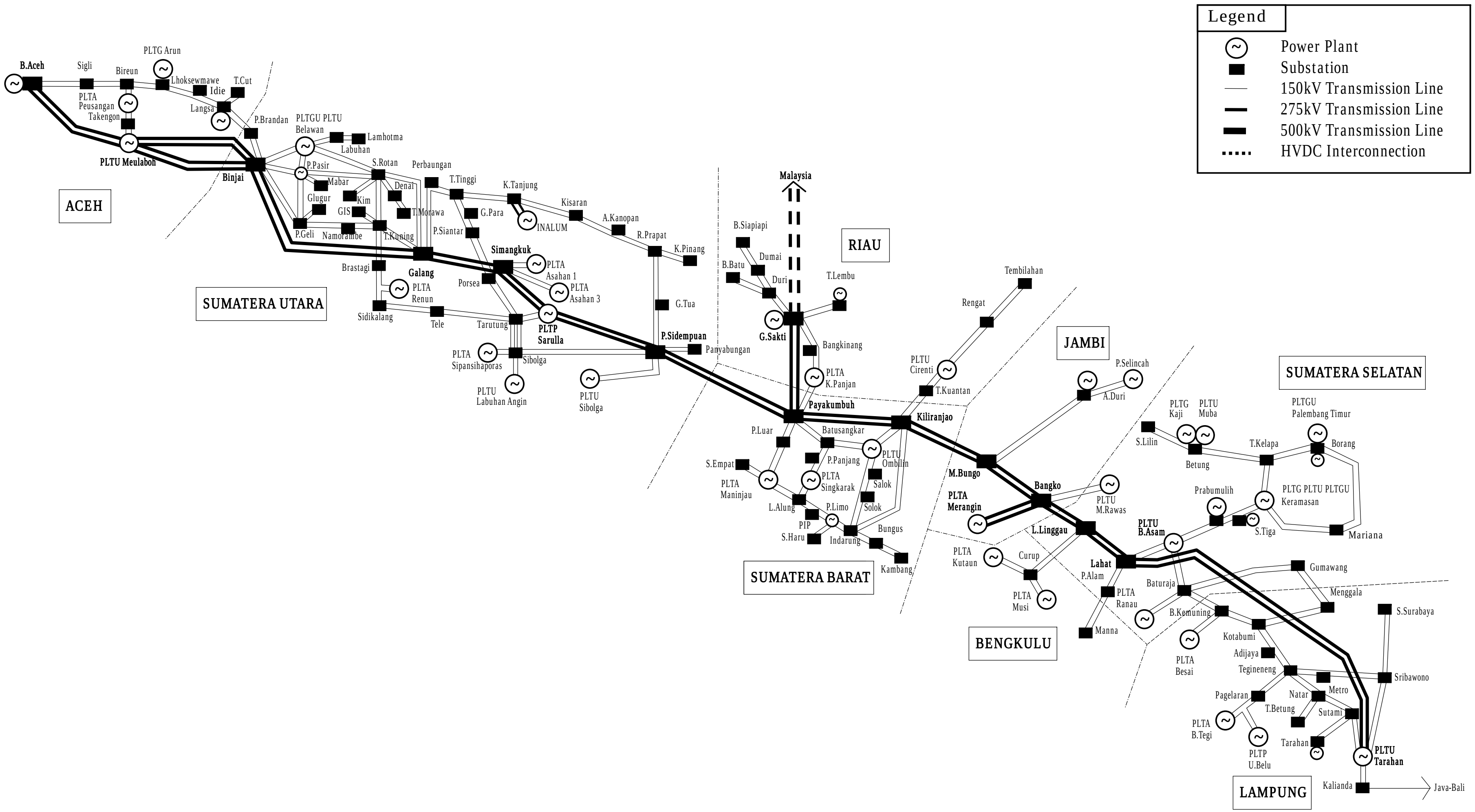


Figure 6.4.6 Proposed Case 2 (2015) [with Malaysia-Sumatra Interconnection and Java-Sumatra Interconnection]

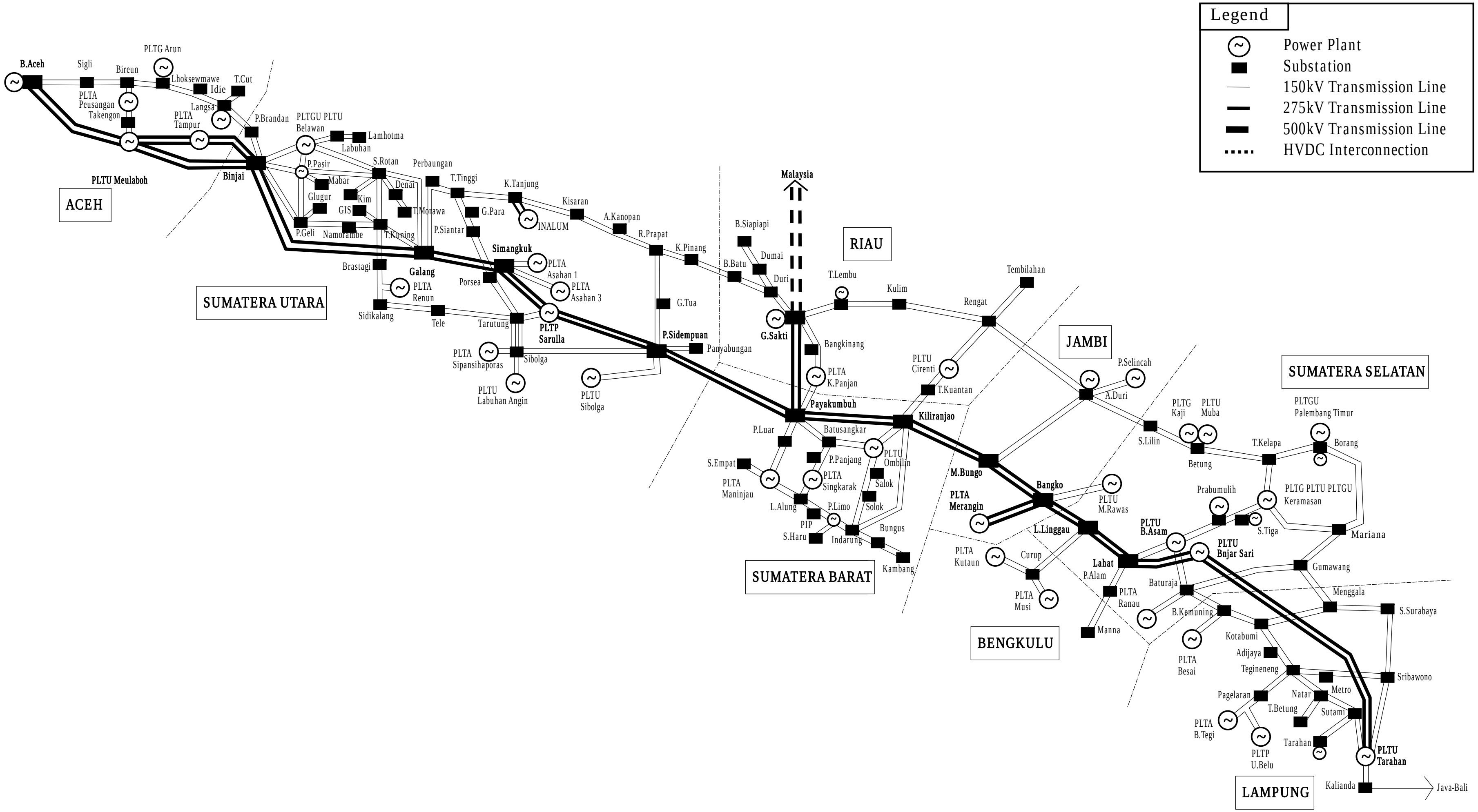


Figure 6.4.7 Proposed Case 2 (2020) [with Malaysia-Sumatra Interconnection and Java-Sumatra Interconnection]

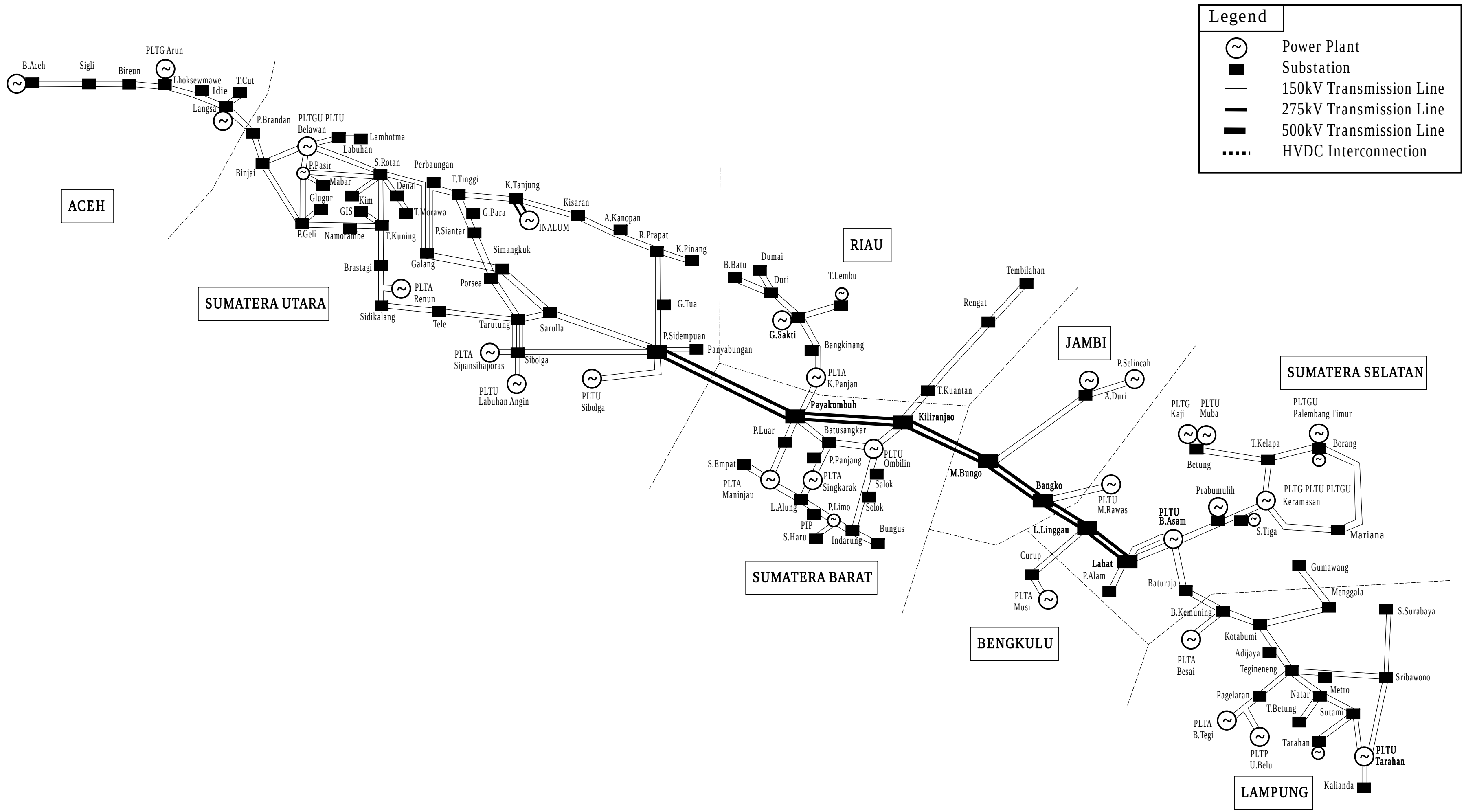


Figure 6.4.8 South Case 1 (2010)

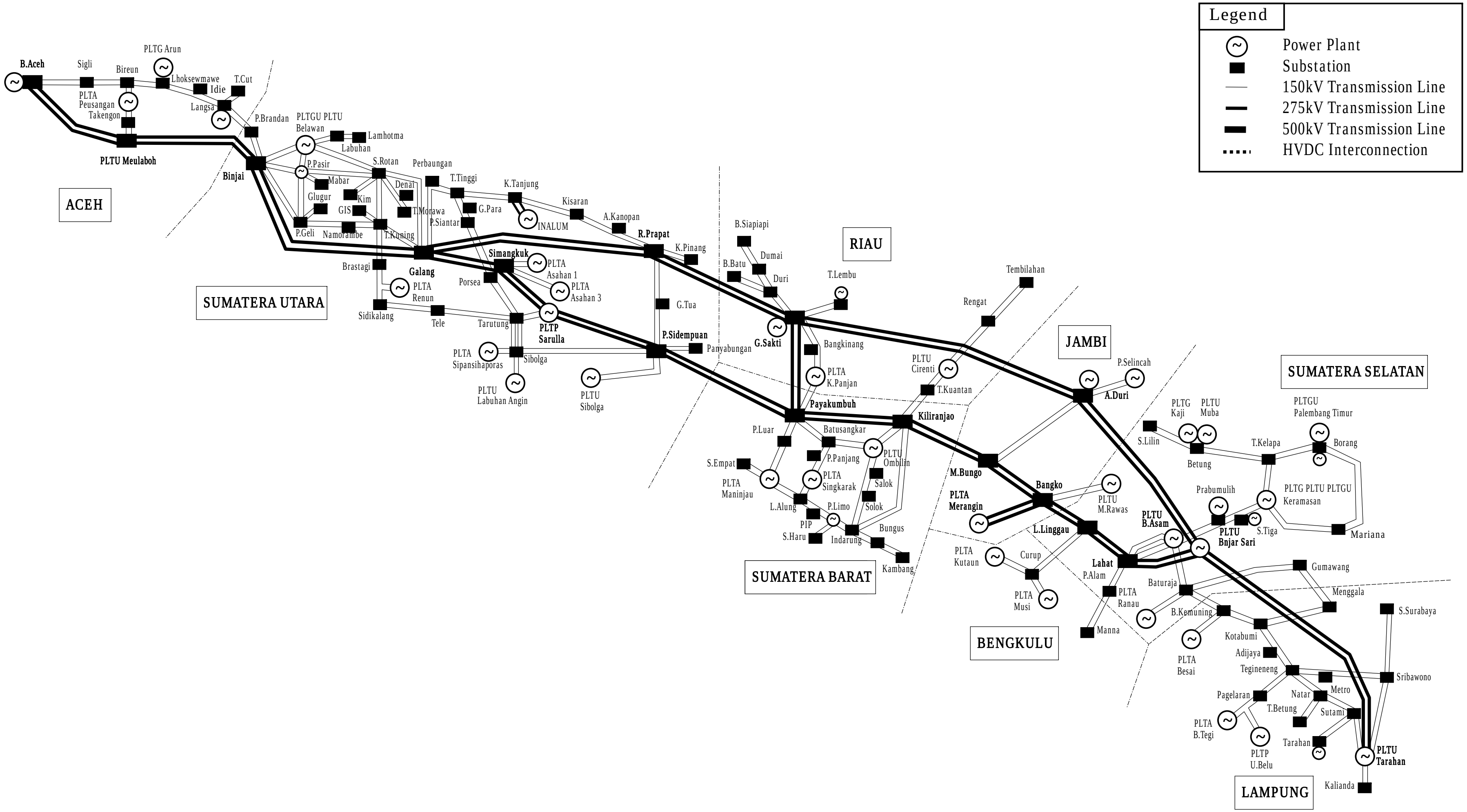


Figure 6.4.9 South Case 1 (2015)

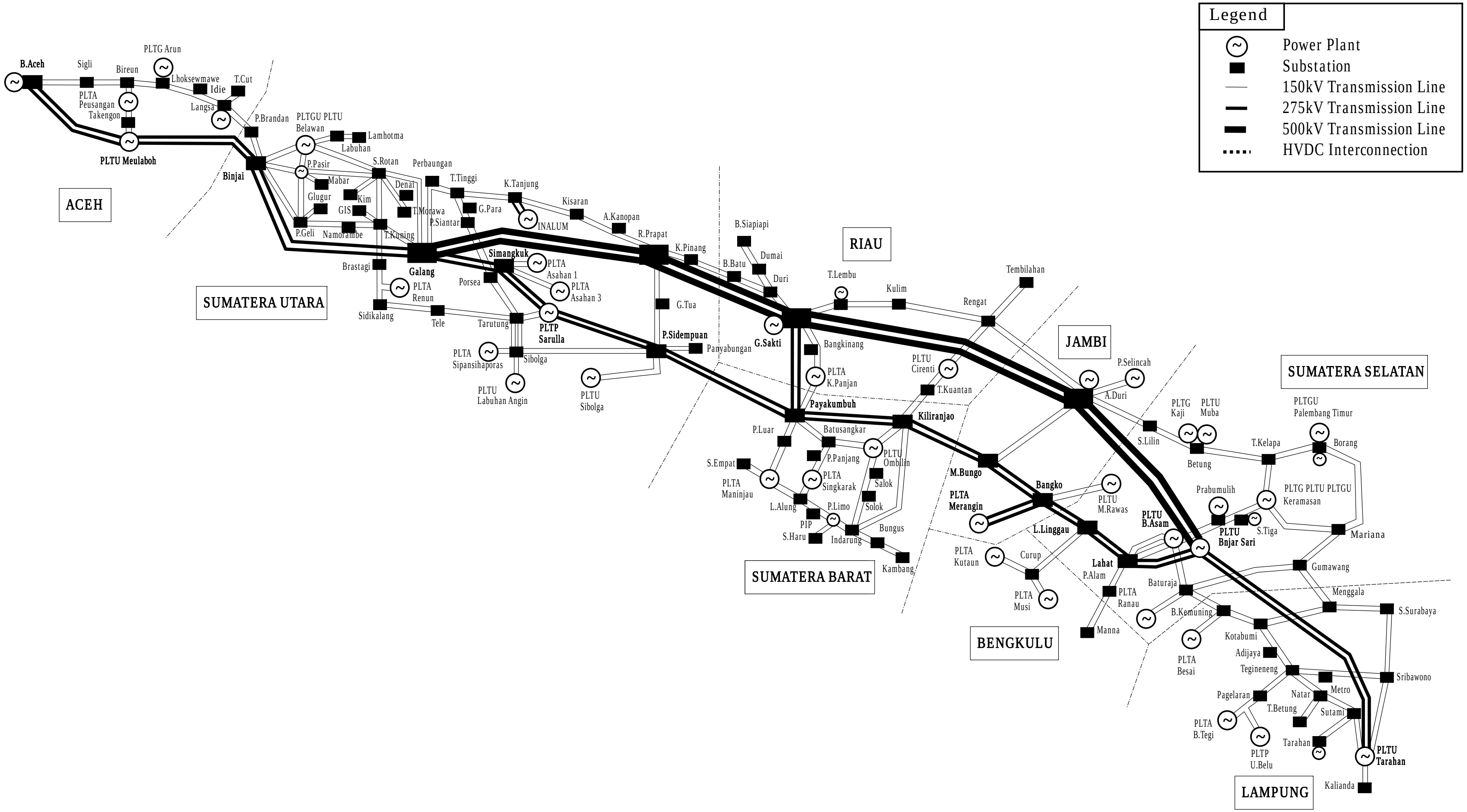


Figure 6.4.10 South Case 1 (2020)

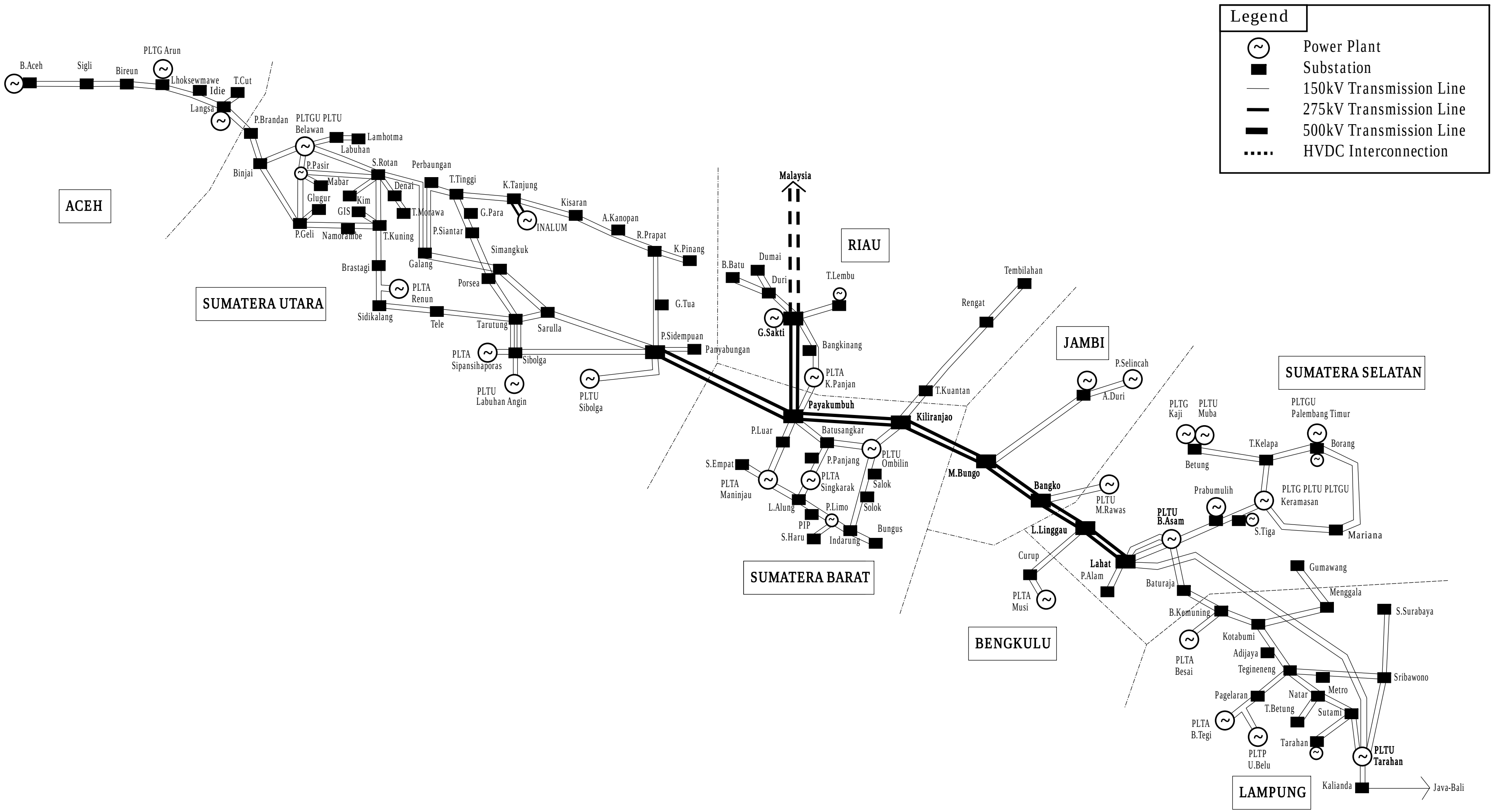


Figure 6.4.11 South Case 2 (2010) [with Malaysia-Sumatra Interconnection and Java-Sumatra Interconnection]

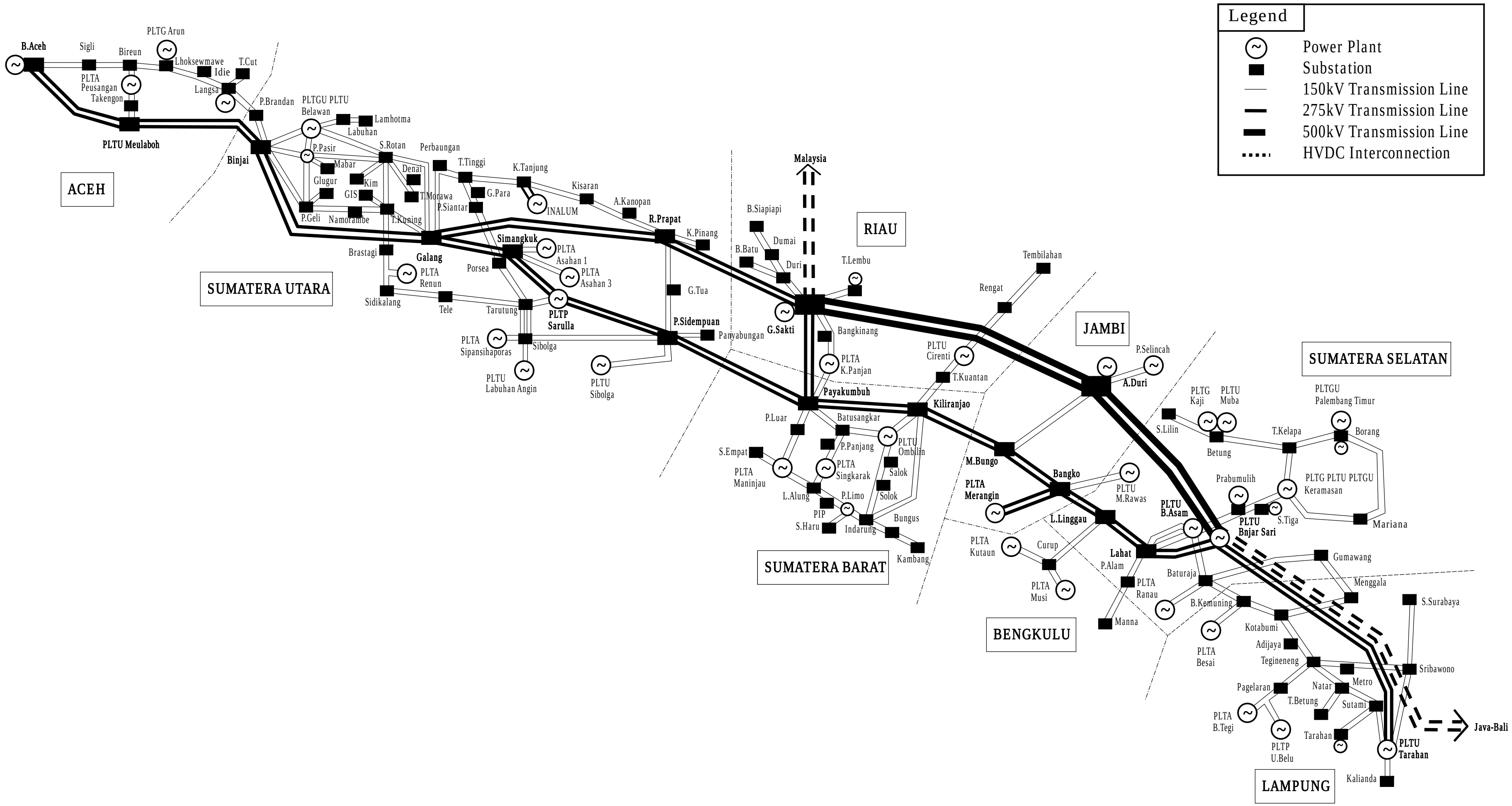


Figure 6.4.12 South Case 2 (2015) [with Malaysia-Sumatra Interconnection and Java-Sumatra Interconnection]

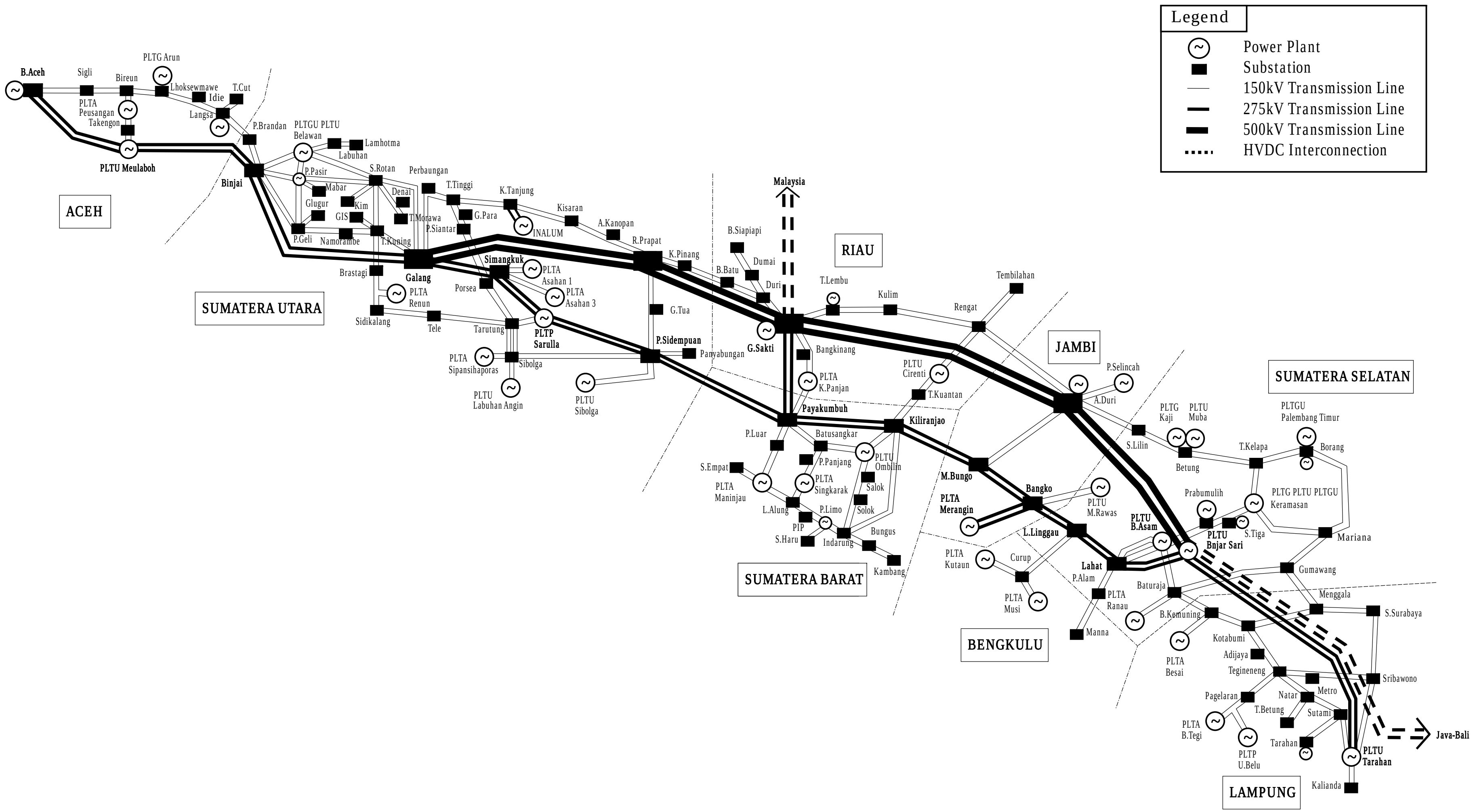


Figure 6.4.13 South Case 2 (2020) [with Malaysia-Sumatra Interconnection and Java-Sumatra Interconnection]

6.4.6 Amount of Planed Facilities

Tables 6.4.1 to 6.4.6 show the lengths of transmission lines and the capacities of transformers in the Sumatra main system (275kV and 500kV) that will be expanded from 2006 to 2020, based on the study.

Table 6.4.1 Length of Transmission Lines (Unit: km)

		Proposed Case 1	Proposed Case 2	South Case 1	South Case 2
2006 - 2010	275kV	539	1,235	725	1,235
	500kV	0	0	0	0
	Subtotal	539	1,235	725	1,235
2011 - 2015	275kV	1,756	1,060	1,240	730
	500kV	0	0	1,140	1,140
	Subtotal	1,756	1,060	2,380	1,870
2016 - 2020	275kV	0	0	0	0
	500kV	0	0	0	0
	Subtotal	0	1,060	0	0
Total	275kV	2,295	2,295	1,965	1,965
	500kV	0	0	1,140	1,140
	Total	2,295	2,295	3,105	3,105

Note: The Malaysia-Sumatra interconnection and the Java-Sumatra interconnection are not included.

Table 6.4.2 Capacities of Transformers (Unit: MVA)

		Proposed Case 1	Proposed Case 2	South Case 1	South Case 2
2006 - 2010	275/150kV	0	4,000	3,500	4,250
	500/275kV	0	0	0	0
	500/150kV	0	0	0	0
	Subtotal	0	4,000	3,500	4,250
2011 - 2015	275/150kV	7,500	3,500	5,000	4,000
	500/275kV	0	0	0	2,500
	500/150kV	0	0	0	500
	Subtotal	7,500	3,500	5,000	7,000
2016 - 2020	275/150kV	500	1,000	0	500
	500/275kV	0	0	3,500	1,500
	500/150kV	0	0	1,000	500
	Subtotal	500	1,000	4,500	2,500
Total	275/150kV	8,000	8,500	8,500	8,500
	500/275kV	0	0	3,500	4,000
	500/150kV	0	0	1,000	1,000
	Total	8,000	8,500	13,000	13,750

Table 6.4.3 List of Transmission Lines (Proposed Case) (Unit: km)

Voltage	Section		Proposed Case 1				Proposed Case 2			
	From	to	2010	2015	2020	Total	2010	2015	2020	Total
275kV	Banda Aceh	Meulaboh		210		210		210		210
	Meulaboh	Tampur		220		220		220		220
	Tampur	Binjai		130		130		130		130
	Meulaboh	Binjai		330		330		330		330
	Binjai	Galang		50		50		50		50
	Galang	Simangkuk	143			143	143			143
	Simangkuk	Sarulla	114			114	114			114
	Sarulla	P.Sidempuan		60		60	60			60
	P.Sidempuan	Payakumbuh	282			282	282			282
	Payakumbuh	G.Sakti		150		150	150			150
	Payakumbuh	Kiliranjao		126		126	126			126
	Merangin	Bangko		120		120		120		120
	Lahat	Banjar Sari		50		50	50			50
	Banjar Sari	Tarahan		310		310	310			310
	Subtotal		539	1,756	0	2,295	1,235	1,060	0	2,295
500kV	Galang	R.Prapat				0				0
	R.Prapat	Garuda Sakti				0				0
	Garuda Sakti	Jambi				0				0
	Jambi	Banjar Sari				0				0
	Subtotal		0	0	0	0	0	0	0	0
Total			539	1,756	0	2,295	1,235	1,060	0	2,295

Table 6.4.4 List of Transmission Lines (South Case) (Unit: km)

Voltage	Section		South Case 1				South Case 2			
	From	to	2010	2015	2020	Total	2010	2015	2020	2020
275kV	Banda Aceh	Meulaboh		210		210		210		210
	Meulaboh	Tampur		220		220		220		220
	Tampur	Binjai		130		130		130		130
	Meulaboh	Binjai				0				0
	Binjai	Galang		50		50		50		50
	Galang	Simangkuk	143			143	143			143
	Simangkuk	Sarulla	114			114	114			114
	Sarulla	P.Sidempuan	60			60	60			60
	P.Sidempuan	Payakumbuh	282			282	282			282
	Payakumbuh	G.Sakti		150		150	150			150
	Payakumbuh	Kiliranjao	126			126	126			126
	Merangin	Bangko		120		120		120		120
	Lahat	Banjar Sari		50		50	50			50
	Banjar Sari	Tarahan		310		310	310			310
	Subtotal		725	1,240	0	1,965	1,235	730	0	1,965
500kV	Galang	R.Prapat		220		220		220		220
	R.Prapat	Garuda Sakti		300		300		300		300
	Garuda Sakti	Jambi		360		360		360		360
	Jambi	Banjar Sari		260		260		260		260
	Subtotal		0	1,140	0	1,140	0	1,140	0	1,140
Total			725	2,380	0	3,105	1,235	1,870	0	3,105

Table 6.4.5 List of Substations (Proposed Case) (Unit: MVA)

Voltage	Substation	Proposed Case 1				Proposed Case 2			
		2010	2015	2020	Total	2010	2015	2020	Total
275/150kV	Banda Aceh		500		500		500		500
	Meulaboh		500		500		500		500
	Binjai		500	250	750		500	500	1,000
	Galang		500	250	750		500	250	750
	Simangkuk		500		500		500		500
	Sarulla		500		500		500		500
	P.Sidempuan		500		500	500			500
	R.Prapat				0				0
	G.Sakti		500		500	500			500
	Payakumbuh		500		500	500			500
	Kiliranjao		500		500	500			500
	M.Bungo		500		500	500			500
	Bangko		500		500	500			500
	Jambi				0				0
	L.Linggau		500		500	500			500
	Lahat		500		500	500			500
	Tarahan		500		500		500	250	750
	Subtotal	0	7,500	500	8,000	4,000	3,500	1,000	8,500
500/275kV	Galang				0				0
	Garuda Sakti				0				0
	Banjar Sari				0				0
	Subtotal	0	0	0	0	0	0	0	0
500/150kV	R.Prapat				0				0
	Jambi				0				0
	Total	0	0	0	0	0	0	0	0
Total		0	7,500	500	8,000	4,000	3,500	1,000	8,500

Table 6.4.6 List of Substations (South Case) (Unit: MVA)

Voltage	Substation	South Case 1				South Case 2			
		2010	2015	2020	Total	2010	2015	2020	Total
275/150kV	Banda Aceh		500		500		500		500
	Meulaboh		500		500		500		500
	Binjai		500	500	1,000		500	500	1,000
	Galang		500	250	750		500	250	750
	Simangkuk		500		500		500		500
	Sarulla		500		500		500		500
	P.Sidempuan	500			500	750			750
	R.Prapat		500	-500	0		500	-500	0
	G.Sakti		500		500	500			500
	Payakumbuh	500			500	500			500
	Kiliranjao	500			500	500			500
	M.Bungo	500			500	500			500
	Bangko	500			500	500			500
	Jambi		500	-500	0				0
	L.Linggau	500			500	500			500
	Lahat	500			500	500			500
	Tarahan		500	250	750		500	250	750
	Subotal	3,500	5,000	0	8,500	4,250	4,000	500	8,750
500/275kV	Galang			1,500	1,500			1,500	1,500
	Garuda Sakti			1,000	1,000		1,500		1,500
	Banjar Sari			1,000	1,000		1,000		1,000
	Subtotal	0	0	3,500	3,500	0	2,500	1,500	4,000
500/150kV	R.Prapat			500	500			500	500
	Jambi			500	500		500		500
	Total	0	0	1,000	1,000	0	500	500	1,000
Total		3,500	5,000	4,500	13,000	4,250	7,000	2,500	13,750

Note: It is assumed that the 275/150kV transformers installed at Jambi and R.Prapat in 2015 will be re-located in 2020.

6.4.7 Construction Cost

Tables 6.4.7 and 6.4.8 show the estimated costs for expansion of the 275kV and 500kV systems in Sumatra from 2006 to 2020, based on the study.

Table 6.4.7 Construction Costs [Main System] (Proposed Case)

(Unit: million US $)

		Proposed Case 1			Proposed Case 2		
		FC	LC	Total	FC	LC	Total
2006 - 2010	Transmission Line	72	36	108	164	83	247
	Substation	0	0	0	148	19	167
	Subtotal	72	36	108	312	102	414
2011 - 2015	Transmission Line	233	118	351	141	71	212
	Substation	279	35	314	160	20	180
	Subtotal	512	153	665	301	91	392
2016 - 2020	Transmission Line	0	0	0	0	0	0
	Substation	23	2	25	33	4	37
	Subtotal	23	2	25	33	4	37
Total	Transmission Line	305	154	459	305	154	459
	Substation	302	37	339	341	43	384
	Subtotal	607	191	798	646	197	843

Note: The costs for the Malaysia-Sumatra interconnection and the Java-Sumatra interconnection are not included.

Table 6.4.8 Construction Costs [Main System] (South Case)

(Unit: million US $)

		South Case 1			South Case 2		
		FC	LC	Total	FC	LC	Total
2006 - 2010	Transmission Line	96	49	145	164	83	247
	Substation	129	16	145	153	20	173
	Subtotal	225	65	290	317	103	420
2011 - 2015	Transmission Line	545	273	818	477	239	716
	Substation	240	31	271	317	41	358
	Subtotal	785	304	1,089	794	280	1,074
2016 - 2020	Transmission Line	0	0	0	0	0	0
	Substation	201	25	226	104	13	117
	Subtotal	201	25	226	104	13	117
Total	Transmission Line	641	322	963	641	322	963
	Substation	570	72	642	574	74	648
	Subtotal	1,211	394	1,605	1,215	396	1,611

Note: The costs for the Malaysia-Sumatra interconnection and the Java-Sumatra interconnection are not included.

6.5 Results of System Analysis

In the previous section system analysis was conduced for system planning. In this section the detailed results of the analysis are explained focusing on the stability, which is a major problem in the Sumatra system.

It should be noted that the results in this section could change depending on the system configuration, power development, operation of the system and the power plants in the future.

6.5.1 Transmission Limit of the 150kV System

(1) South-West Sumatra Interconnection (150kV operation)

The transmission limit of the South-West Sumatra interconnection, which was completed in 2004, is explained here. If the power flow exceeds the limit, 275kV needs to be introduced.

(i) Outline

Table 6.5.1 shows the assumptions for the analysis.

Table 6.5.1 Assumptions for Stability Analysis (150kVSouth-West Interconnection)

Direction of Power Flow		South Sumatra -> West Sumatra	West Sumatra -> South Sumatra
2005	Study Case	Current System	Current System
	Demand	Off-Peak (Demand : 70% of Peak)	Off-Peak (Demand : 70% of Peak)
2010	Study Case	Proposed Case 1 (Without Malaysia IC and Java IC)	
	Demand	Peak	

In 2005 both the West Sumatra system and the South Sumatra system have no surplus power to supply to other system at peak times because of the strict demand and supply balance. Therefore, the study is conducted for off-peak times, of which demand is 70% of the peak demand.

For 2010 the study is conducted for peak time, and the transmission limit from the South Sumatra system to the West Sumatra system is studied. This is because the situation of the demand and supply balance in West Sumatra will be severe at peak times, while there will be enough surplus power in South Sumatra.

The transmission limit of the South-West interconnection will be largely affected by the commissioning of the Musi Rawas power plant (commissioning year: 2009, 100MW), which will be connected to the Bangko substation located along the interconnection. Therefore, the transmission limit in 2010 is calculated in the cases with and without the Musi Rawas power plant.

(ii) Results (off-peak in 2005)

(a) From South Sumatra to West Sumatra

Table 6.5.2 shows the results of the study. This indicates that the system will be unstable with a one-circuit fault if the power flow in the transmission line from Bukit Asam to Lahat is more than around 160MW.

Table 6.5.2 Transmission Limit for Stability (toward West Sumatra System)

Section	Transmission Line with Fault (fault point)	Transmission Limit
Bukit Asam - Lahat	Bukit Asam - Lahat (Bukit Asam)	160MW

As the thermal capacity of the transmission line is 168MVA (1x240mm2), the thermal capacity and the stability limit is almost the same.

As a result, the transmission limit from the South Sumatra system to the West Sumatra system (transmission limit from Lubuk Linggau to Bangko) is around 100MW during the off-peak in 2005.

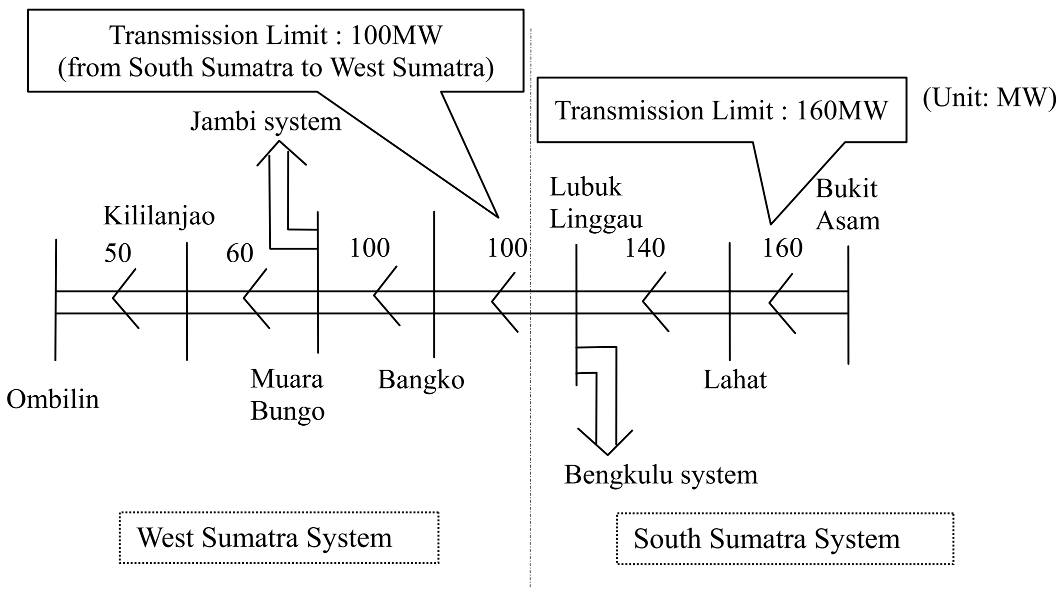


Figure 6.5.1 Transmission Limit from South Sumatra to West Sumatra (off-peak in 2005)

(b)   From West Sumatra to South Sumatra

Table 6.5.3 shows the results of the study.   This indicates that the system will be unstable with a one-circuit fault if the power flow in the transmission line from Ombilin to Kiliranjao is more than around 160MW.

Table 6.5.3   Transmission Limit for Stability (toward South Sumatra System)

Section	Transmission Line with Fault (fault point)	Transmission Limit
Ombilin - Kiliranjao	Ombilin - Kiliranjao (Ombilin)	160MW

As the thermal capacity of the transmission line is 405MVA (2x340mm2), the transmission limit is determined not by its thermal capacity, but by the stability.

As a result, the transmission limit from the West Sumatra system to the South Sumatra system (transmission limit from Bangko to Lubuk Linggau) is around 130MW during the off-peak times in 2005.

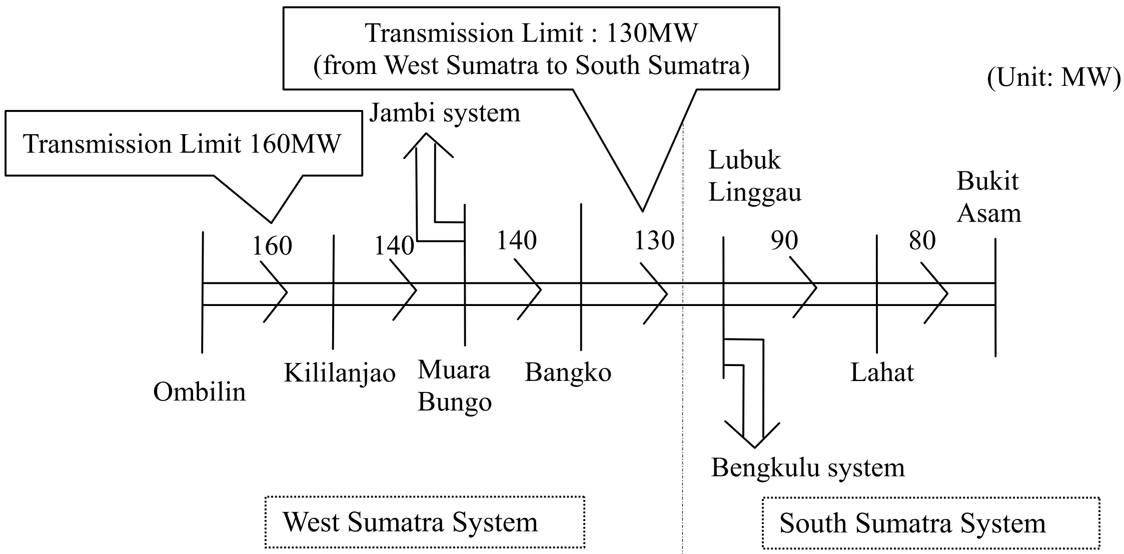


Figure 6.5.2   Transmission Limit from West Sumatra to South Sumatra (off-peak in 2005)

(iii) Result (peak in 2010)

(a) From South Sumatra to West Sumatra [with Musi Rawas P/S]

Table 6.5.4 shows the results of the study. This indicates that the system will be unstable with a one-circuit fault if the power flow in the transmission line from Bangko to Muara Bungo is more than around 290MW.

Table 6.5.4 Transmission Limit for Stability (toward West Sumatra System) [with Musi Rawas P/S]

Section	Transmission Line with Fault (fault point)	Transmission Limit
Muara Bungo - Bangko	Muara Bungo - Bangko (Bangko)	290MW

As the thermal capacity of the transmission line is 338MVA (2x430mm2), the transmission limit is determined not by its thermal capacity, but by the stability.

As a result, the transmission limit from the South Sumatra system to the West Sumatra system (considering Musi Rawas P/S) is around 310MW at the peak demand in 2010, as shown in Table 6.5.5.

Table 6.5.5 Transmission Limit from South Sumatra to West Sumatra

Section	Transmission Limit
Bangko - Lubuk Linggau	210MW
Bangko - Musi Rawas	100MW
Total	310MW

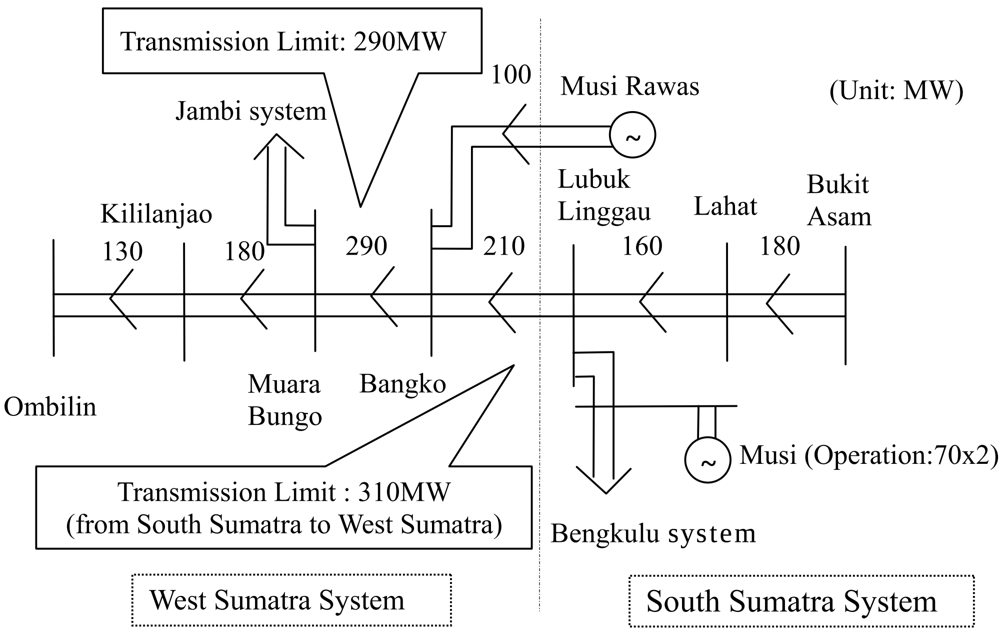


Figure 6.5.3 Transmission Limit from South Sumatra to West Sumatra (peak in 2010) [with Musi Rawas P/S]

In this case, the power flow between Lahat and Bukit Asam exceeds the one-circuit thermal capacity of the transmission line (1xA240: 168MW). Therefore, it is desirable to reinforce this section to relieve the bottleneck.

(b) From South Sumatra to West Sumatra [without Musi Rawas P/S]

Table 6.5.6 shows the results of the study without Musi Rawas P/S. This indicates that the system will be unstable with a one-circuit fault if the power flow in the transmission line from Bangko to Lubuk Linggau is more than around 210MW.

Table 6.5.6 Transmission Limit for Stability (toward West Sumatra System) [without Musi Rawas P/S]

Section	Transmission Line with Fault (fault point)	Transmission Limit
Bangko - Lubuk Linggau	Bangko - Lubuk Linggau (Lubuk Linggau)	210MW

As the thermal capacity of the transmission line is 338MVA (2x430mm2), the transmission limit is determined not by its thermal capacity, but by the stability.

As a result, the transmission limit from the South Sumatra system to the West Sumatra system (transmission limit from Lubuk Linggau to Bangko) is around 210MW at the peak demand in 2010.

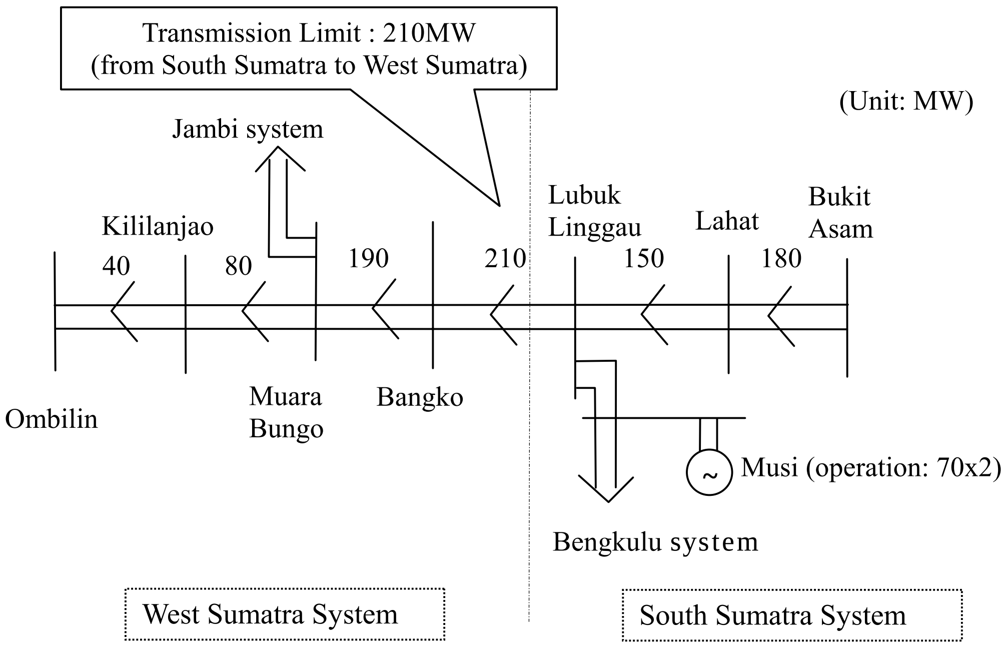


Figure 6.5.4 Transmission Limit from South Sumatra to West Sumatra (peak in 2010) [without Musi Rawas P/S]

In this case, the power flow between Lahat and Bukit Asam exceeds the one-circuit thermal capacity of the transmission line (1xA240: 168MW). Therefore, it is desirable to reinforce the section to relieve the bottleneck.

It should be noted that the transmission limit of the South-West Sumatra interconnection will be affected by the operation of the Musi hydropower plant.

(2) Transmission Limit of the North-West Sumatra Interconnection (150kV)

The transmission limit of the North-West Sumatra interconnection, which is planned for 2009, is explained here. If the power flow exceeds the limit, 275kV needs to be introduced.

(i) Outline

Table 6.5.7 shows the assumptions for the analysis.

Table 6.5.7 Assumptions for Stability Analysis (150kV North-West Interconnection)

Direction of Power Flow		West Sumatra -> North Sumatra
2010	Study Case	South Case 1 (without Malaysia IC and Java IC)
	Demand	Peak

The study is conducted for peak times in South Case 1 (without Malaysia-Sumatra interconnection and Java-Sumatra interconnection). In this case the transmission limit from the West Sumatra system to the North Sumatra system is studied. This is because the situation of the demand and supply balance in North Sumatra will be severe at peak times in 2010, and there will not be enough surplus power there.

(ii) Results (peak in 2010)

Table 6.5.8 shows the results of the study. This indicates that the system will be unstable with a one-circuit fault if the power flow in the transmission line from Payakumbuh to P.Sidempuan is more than around 210MW.

Table 6.5.8 Transmission Limit for Stability (toward North Sumatra System)

Section	Transmission Line with Fault (fault point)	Transmission Limit
P.Sidempuan - Payakumbuh	P.Sidempuan ~ Payakumbuh (Payakumbu)	210MW

As the thermal capacity of the transmission line is 338MVA (2x430mm2), the transmission limit is determined not by its thermal capacity, but by the stability.

As a result, the transmission limit from the West Sumatra system to the North Sumatra system (transmission limit from Payakumbuh to P.Sidempuan) is around 210MW at the peak demand in 2010.

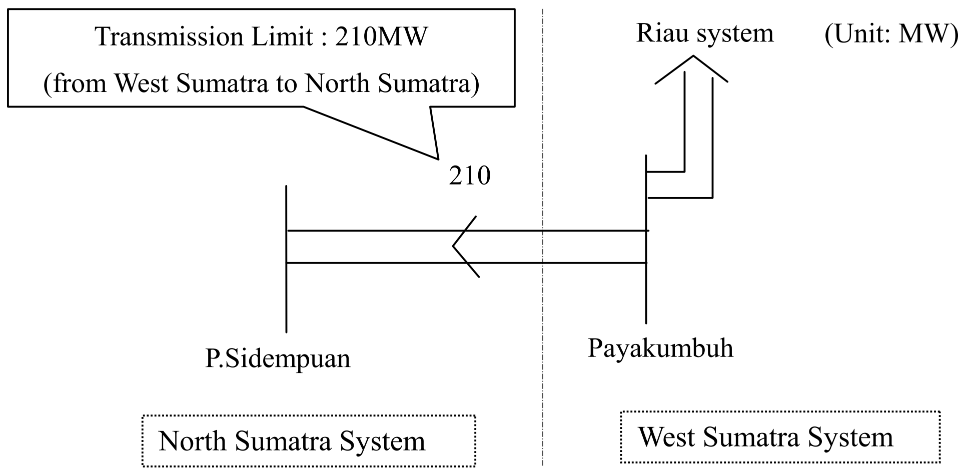


Figure 6.5.5 Transmission Limit from West Sumatra to North Sumatra (peak in 2010)

6.5.2 Transmission Limit of the 275kV System

The transmission limits of the 275kV South-West Sumatra interconnection and the 275kV North-West Sumatra interconnection in 2015 are explained here. If the power flow exceeds the limit, another 275kV route will be necessary. Additionally, the transmission limit in the case of two 275kV routes in 2020 is also explained. If the power flow exceeds the limit, introduction of 500kV will be necessary.

(1) South-West Sumatra Interconnection (275kV operation)

(i) Outline

Table 6.5.9 shows the assumptions for the analysis.

Table 6.5.9 Assumptions for Stability Analysis (275kV South-West Interconnection)

Direction of Power Flow		South Sumatra -> West Sumatra
2015	Study Case	Proposed Case 1 (without Malaysia IC and Java IC)
	Demand	Peak

The study is conducted for peak times in Proposed Case 1 (without Malaysia-Sumatra interconnection and Java-Sumatra interconnection). In this case, the transmission limit from the South Sumatra system to the West Sumatra system is studied. This is because the situation of the demand and supply balance in West Sumatra will be severe at peak times in 2015, and there will not be enough surplus power.

(ii) Result (peak in 2015)

Even if the power flow between Lahat and Lubuk Linggau is over 620MW, the system will remain stable with its one-circuit fault. As the thermal capacity of the transmission line is 338MVA (2x430mm2), the transmission limit is determined not by the stability, but by its thermal capacity. This is because the length of the heavily loaded section is relatively short.

As a result, the transmission limit from the South Sumatra system to the West Sumatra system (considering Musi Rawas P/S) is around 310MW at the peak demand in 2015, as shown in Table 6.5.10.

Table 6.5.10 Transmission Limit from South Sumatra to West Sumatra

Section	Transmission Limit
Bangko - Lubuk Linggau	110MW
Bangko - Musi Rawas	200MW
Total	310MW

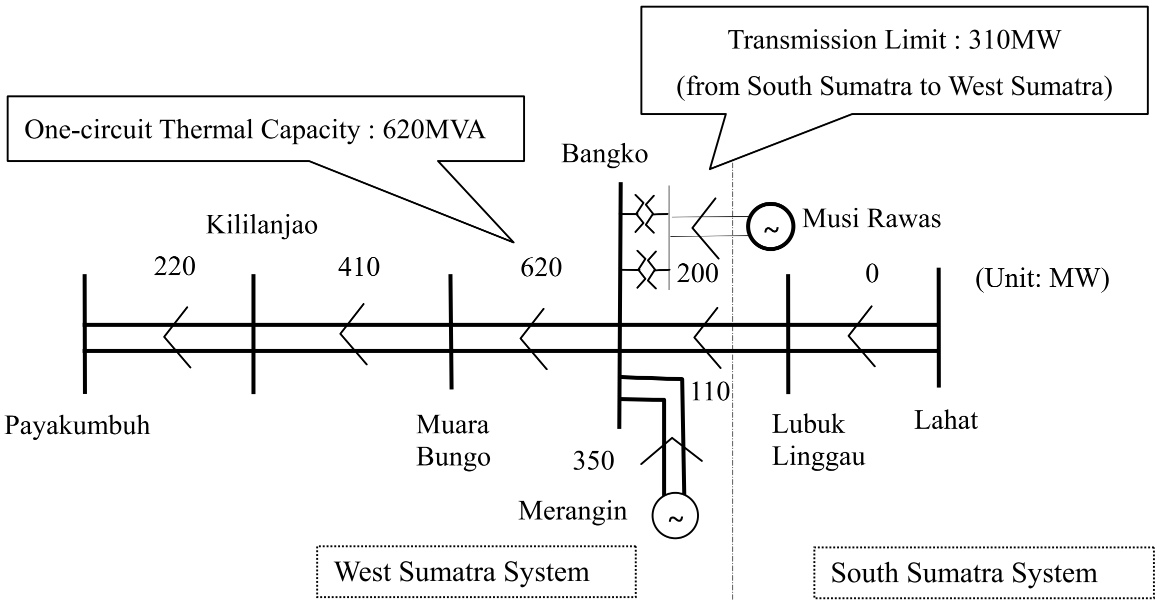


Figure 6.5.6 Transmission Limit from South Sumatra to West Sumatra (peak in 2015)

It should be noted that the transmission limit of the South-West Sumatra interconnection will be affected by the operation of the Merangin hydropower plant.

To mitigate the above-mentioned transmission constraints, it will be necessary to study that Merangin power plant should be connected to Muara Bungo instead of Bangko, although the length of the transmission line will be longer.

(2) North-West Sumatra Interconnection (275kV operation)

(i) Outline

Table 6.5.11 shows the assumptions for the analysis.

Table 6.5.11 Assumptions for Stability Analysis (275kV North-West Interconnection)

Direction of Power Flow		West Sumatra -> North Sumatra
2015	Study Case	South Case 1 (Without Malaysia IC and Java IC)
	Demand	Peak

The study is conducted for South Case 1 (without Malaysia-Sumatra interconnection and Java-Sumatra interconnection) without the 275kV Garuda Sakti-R.Prapat-Galang line. In this case, as the power is mainly developed in South Sumatra, the transmission limit from the West Sumatra system to the North Sumatra system is studied.

(ii) Results (peak in 2015)

Even if the power flow between Galang and Simangkuk is over 620MW, the system will remain stable with its one-circuit fault. As the thermal capacity of the transmission line is 620MVA (in the case of 2x430mm2), the transmission limit is determined not by the stability, but by its thermal capacity. This is because the length of the heavily loaded section is relatively short.

As the North-West Sumatra interconnection has not been constructed yet, consideration should be given to adopting four Zebra conductors (1240MVA), instead of double Zebra conductors (620MVA), which are adopted in the South-West Sumatra interconnection as standard.

As a result, the transmission limit from the West Sumatra system to the North Sumatra system (transmission limit from Payakumbuh to P.Sidempuan) is around 400MW at the peak demand in 2015. It should be noted that the transmission limit of the North-West Sumatra interconnection will be affected by the operations of the Asahan 1 and 3 hydropower plants and the Sarulla geothermal power plant.

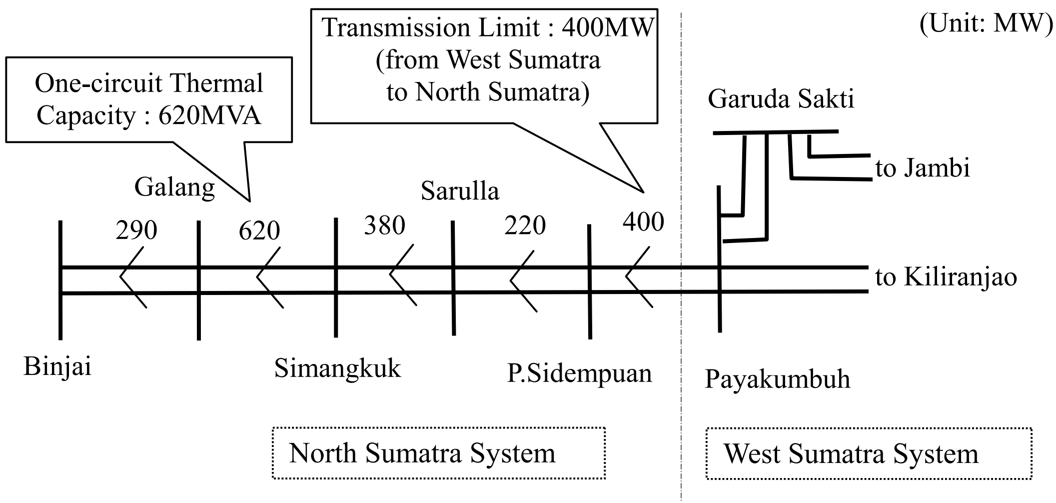


Figure 6.5.7 Transmission Limit from West Sumatra to North Sumatra (peak in 2015)

(3) Two 275kV Routes

(i) Outline

Table 6.5.12 shows the assumptions for the analysis.

Table 6.5.12 Assumptions for Stability Analysis (Two 275kV Routes)

Direction of Power Flow		South Sumatra -> West Sumatra
2020	Study Case	South Case 1 (without Malaysia IC and Java IC)
	Demand	Peak

The study is conducted for South Case 1 (without Malaysia-Sumatra interconnection and Java-Sumatra interconnection) and it is assumed that the 500kV transmission lines are operated at 275kV. In this case, as the power is mainly developed in South Sumatra, the transmission limit from the South Sumatra system to the West Sumatra system is studied.

(ii) Results (peak in 2020)

Table 6.5.13 shows the results of the study. In this case, if the power flow in the transmission line from Banjar Sari to Jambi is more than around 500MW, an oscillation will occur with its one-circuit fault and it will not converge. Therefore, the power flow of the transmission limit needs to be lower than 500MW.

Table 6.5.13 Transmission Limit for Stability (toward West Sumatra System)

Section	Transmission Line with Fault (fault point)	Transmission Limit
Banjar Sari - Jambi	Banjar Sari - Jambi (Banjar Sari)	500MW

As the thermal capacity of the transmission line is 1,092MVA (in the case of 4x282mm2), the transmission limit is determined not by its thermal capacity, but by the stability.

In this case as the oscillation hardly converges, it is possible to improve the transmission limit by adopting PSS (Power System Stabilizer). However, the power flow between Muara Bungo and Bangko is over one-circuit thermal capacity. Therefore, the transmission limit from the South Sumatra system to the West Sumatra system is restricted by the thermal capacity between Muara Bungo and Bangko. (It should be noted that its power flow with a double-circuit could exceed a one-circuit thermal capacity to some extent, because some portion of the power flow would flow into the other 275kV route in the case of a one-circuit fault.) As a result, the transmission limit from the South Sumatra system to the West Sumatra system is around 900MW, as shown in Table 6.5.14.

Table 6.5.14 Transmission Limit from South Sumatra to West Sumatra

Section	Transmission Limit
Bukit Asam – Jambi	500MW
Bangko - Lubuk Linggau	200MW
Bangko - Musi Rawas	200MW
Total	900MW

It should be noted that the transmission limit will be affected by the operations of the Musi Rawas power plant, Merangin power plant and others.

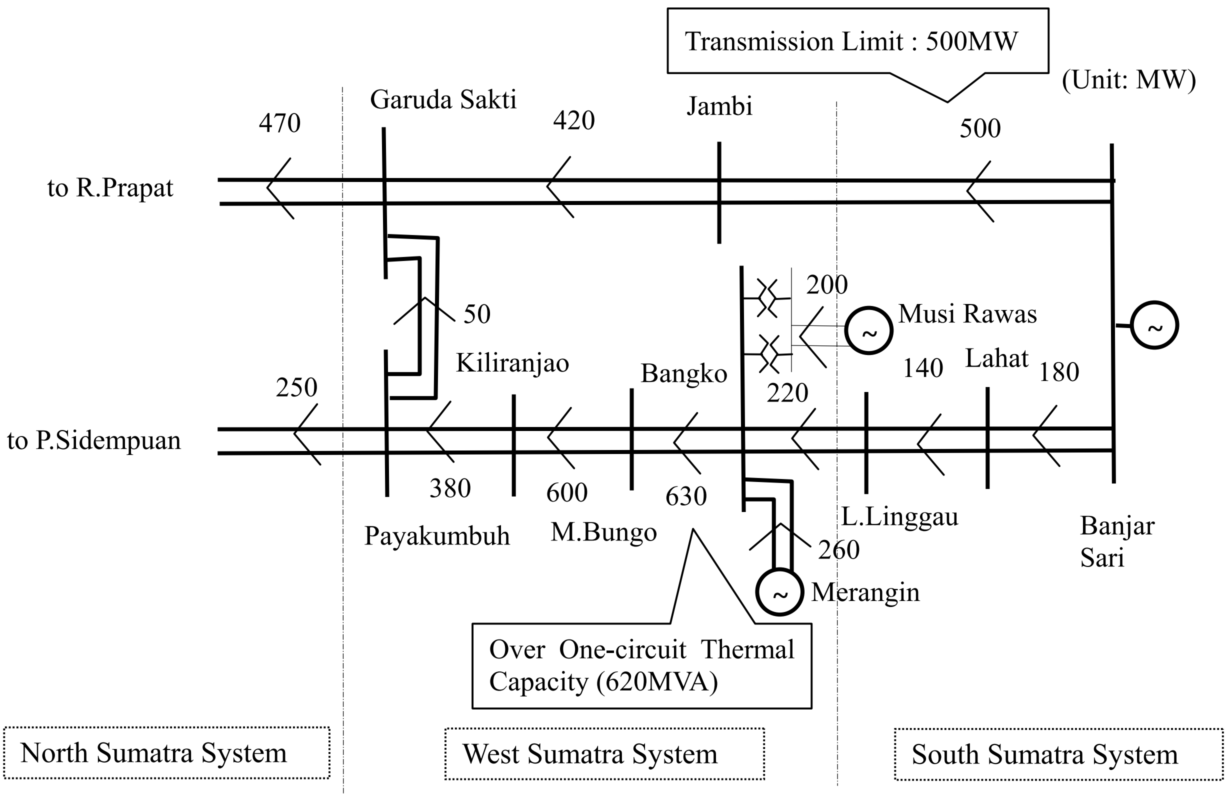


Figure 6.5.8 Transmission Limit in Case of Two 275kV Routes (peak in 2020)

6.5.3 Transmission Limit of 500kV Line

The transmission limit of the 500kV system in 2020 is explained in this section. If the power flow exceeds the limit, two 500kV routes will be necessary.

(1) 500kV Transmission Line

(i) Outline

Table 6.5.15 shows the assumptions for the analysis.

Table 6.5.15 Assumptions for Stability Analysis (500kV Transmission Line)

Direction of Power Flow		South Sumatra -> West Sumatra
2020	Study Case	South Case 2 (with Malaysia IC and Java IC)
	Demand	Peak

The study is conducted for the peak time in the South Case 2 (with Malaysia-Sumatra interconnection and Java-Sumatra interconnection). In this case, as the power is mainly developed in South Sumatra, the transmission limit from the South Sumatra system to the West Sumatra system is studied.

For the study, the power flow of the 500kV transmission lines and the exported power to Malaysia are increased on the assumption that the capacity of the Malaysia-Sumatra interconnection will be increased up to 1200MW.

(ii) Results (peak in 2020)

Table 6.5.16 shows the results of the study. This indicates that the system will be unstable with a one-circuit fault if the power flow in the transmission line from Banjar Sari to Jambi is more than around 1,700MW.

Table 6.5.16 Transmission Limit for Stability (toward West Sumatra System)

Section	Transmission Line with Fault (fault point)	Transmission Limit
Banjar Sari-Jambi	Banjar Sari-Jambi (Bukit Asam)	1,700MW

As the thermal capacity of the transmission line is 1,985MVA in the case of 4xDove (4x4282mm2), the transmission limit is determined not by its thermal capacity, but by the stability.

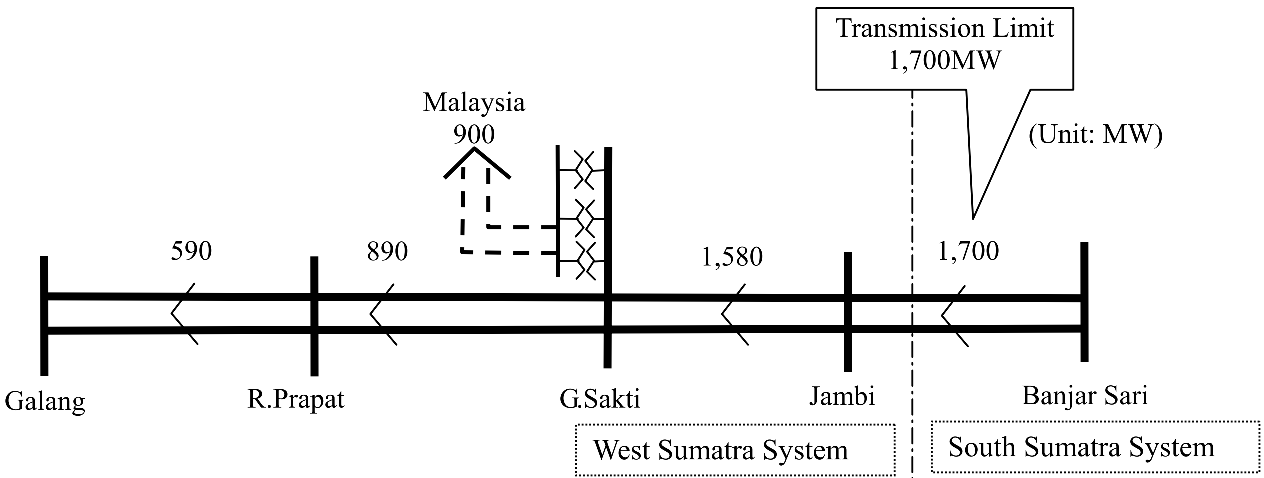


Figure 6.5.9 Transmission Limit of 500kV Line (peak in 2020)

6.6 Issues and Recommendations

6.6.1 Expansion of Main System in Sumatra

To maintain an appropriate level of reliability in Sumatra, it is necessary to expand the transmission system with appropriate scale and to start the construction at the appropriate time in line with demand increases and power development.

If the scale of the transmission line is determined from a short-term viewpoint, the capacity will become insufficient after a while. As a result, a couple of transmission lines will be constructed, or new transmission lines will need to be reinforced. This spoils the economy, and in some cases it would be difficult to construct the second route from environmental and social aspects. Consequently, the generated power would not be transferred and it would lead to black outs. If the scale of the transmission line is unreasonably large without considering any future plans, the capacity would not be utilized in the future and this would not be economical.

Therefore, the expansion of the transmission system in Sumatra should be implemented in accordance with the transmission plan that was developed in this study. The plan needs to be modified appropriately according to the changes in the demand forecast and the situation of each site in the power development plan.

From a viewpoint of transmission planning, it is desirable that new power plants should be located near demand centers and that the amount should be balanced with the demand. If the power plant is far from the demand center, long-distance power transmission will be necessary. In this case, large amounts of construction costs for transmission lines will be necessary and the transmission loss will also be large.

However, the potential of hydropower and geothermal power is high in Sumatra, of which locations are fixed. Additionally, coal resources abound in South Sumatra and natural gas abounds in Riau and South Sumatra. Therefore, the locations of new power plants tend to be fixed in Sumatra, and it is difficult to develop new power plants near demand centers and to balance the demand and the supply in each region.

In conclusion, it is desirable to implement power development to balance the demand and supply in each system (the North Sumatra system, the West Sumatra system and the South Sumatra system) in Sumatra for as long as possible. However, if regionally unbalanced power development is unavoidably advanced, it will be important to expand the transmission system at the proper times.

6.6.2 Measures to Improve Stability

Stability problems can easily occur in the Sumatra system because the Sumatra Island is very large and its length is almost 1,700km. If the system cannot maintain stability, the generators cannot continue stable operation due to transmission line faults and other disturbances. As a result, a black out of the entire system could occur in the worst case. To avoid this problem, the transmission system needs to be expanded properly in Sumatra. Meanwhile, it is also important to install appropriate protection and control equipment and to maintain them to provide system stability.

If the protection system does not work properly when there is a transmission line fault, the fault will continue and the system would collapse. To avoid this it is desirable to double the main protection systems for trunk lines. Step-out relays also need to be installed. They will separate unstable systems and maintain the system stability. In addition, the adoption of the following measures needs to be considered to improve stability: (1) shortening of fault clearing times by replacing protection relays and circuit breakers; (2) adoption of quick response excitation; (3) adoption of power system stabilizer (PSS); (4) installation of SVC (Static Var Compensator) and others.

Although distance relays are presently adopted in the Sumatra system, it is desirable to adopt PCM (Pulse Code Modulation) relays, which have higher reliability and for which operation times are shorter. To accommodate the adoption of PCM relays, it is necessary to develop networks using optical fibers through the adoption of OPGW (Optical Ground Wire) and by stringing optical fibers on transmission towers in line with their construction.

6.6.3 Timing of 275kV introduction

275kV needs to be introduced in the Sumatra system in the following cases:

(1) The case where the demand and the supply are not balanced in each system (North Sumatra system, West Sumatra system and South Sumatra system) because of delays in power development or regionally unbalanced power development
(2) The case where the Merangin hydropower plant (350MW) is developed
(3) The case where the Meulaboh coal-fired power plant (200MW) is developed
(4) The case where the Malaysia-Sumatra interconnection is constructed

If the power development is implemented to balance the demand and the supply in each system, it will be possible to dispatch power with the 150kV system until around 2010. However, the transmission limit between the South Sumatra system and the West Sumatra system will be restricted from around 100 to 200MW because of stability problems. Therefore, if the construction of Pekanbaru power plant (150MW), which is planed in Riau, is delayed, 275kV-upgrading of the South-West Sumatra interconnection will be necessary.

On the other hand, it is desirable to construct the North-West Sumatra interconnection early because better economy is expected by reducing the reserve margin and fuel costs by optimal operation of the generators, as presented in Chapter 4. If the interconnection is operated at 150kV, the transmission capacity will be limited to around 200MW because of stability. Therefore, if either Sibloga (200MW) or Sarulla (165MW) is delayed, which is planed in North Sumatra for around 2010, the North-West Sumatra interconnection will need to be operated at 275kV.

Meanwhile, it is necessary to introduce 275kV in the Sumatra system in the case of developing Merangin (350MW) in Jambi, Meulaboh (200MW) in Aceh, or the Malaysia-Sumatera interconnection (HVDC 600MW).

If it is judged that 275kV is necessary in the Sumatra system based on the situation of power development and demand increase, it will be necessary to start construction of new 275kV transmission lines and/or 275kV-upgrading of the existing 150kV transmission lines at the appropriate times, considering the schedule.

6.6.4 Transmission Plan in Aceh

In Aceh the situation is very complicated because of generation shortage caused by demand increase, overload of the existing 150kV transmission lines with a one-circuit fault, transient and steady-state stability problems and others. As a measure against supply shortage and overload of the transmission lines, it is necessary to install gas turbines in line with demand increases in Aceh. However, the stability is very poor in Aceh, so transient and steady-state stability problems will occur as a result of the installation of the generators.

A drastic measure against this problem is the construction of 275kV transmission lines from Medan to Banda Aceh and the separation of the generators at Banda Aceh from the 150kV system. However, early construction of the 275kV transmission lines from Medan to Banda Aceh, of which the length is around 500km, is not realistic from the viewpoints of construction period and cost. Under these circumstances, as short-term measures it is desirable to improve the protection and control system or to install an SVC (Static Var Compensator) to maintain the system stability for the gas turbines at Banda Aceh. As a middle to long-term measure, it is desirable to construct 275kV transmission lines from Medan to Banda Aceh in line with the power development in Aceh to drastically solve the stability problem.

Concentration of generators should be avoided so as not to worsen the stability problem. Therefore, the gas turbines should be distributed to some substations with large demand such as Banda Aceh, Lhoksewmawe (Arun), and Langsa to mitigate the stability problem. If one 100MW generator is adopted in Banda Aceh, voltage stability problems will occur with the tripping of the generator. To avoid this it will be necessary to adopt two 50MW generators in Banda Aceh.

The diesel generators in Aceh are scheduled to be decommissioned because of aging. The schedule needs to be coordinated with the power development plan and the transmission line, and appropriate timing should be selected.

In conclusion, the power development plan, the transmission plan and the protection and control plan should all be coordinated and appropriate measures should be taken for the Aceh system.

6.6.5 Construction of Second Trunk Lines in Sumatra

From a viewpoint of transmission planning, it is desirable that the amount of demand and supply should be balanced in each region as long as possible to make a power development plan.

In the Proposed Case power development is allocated to each system (North Sumatra system, West Sumatra system and South Sumatra system) to balance demand and supply regionally. In this case one 275kV backbone from Aceh to Tarahan accommodates power dispatch in Sumatra until around 2020. However, the power flow of the 275kV transmission line between Bangko and Muara Bungo will be very heavy in 2015, and it will be close to the one-circuit thermal capacity of the transmission line (620MW). This suggests that the system will hardly be able to accommodate additional power transfers.

Therefore, if one of the power development plans in North Sumatra or West Sumatra is delayed, the 275kV transmission line will be overloaded with a one-circuit fault and power transmission will be restricted. In addition, many of the candidates for power development are located in South Sumatra, so it is highly expected that the imbalance for demand and supply will become large in the long run.

Therefore, it is necessary to start expansion of the transmission system with the proper timing, if second trunk lines are necessary considering the progress of each power development plan and the demand increases. The lengths of the second trunk lines are around 600km from South Sumatra to West Sumatra and around 500km from West Sumatra to North Sumatra. Therefore, the construction period is expected to be long, and so it will be necessary to provide a long enough construction schedule.

If 275kV is adopted for the second trunk lines, the total transmission capacity of the two 275kV routes would be less than around 1,000MW from the South Sumatra system to the West Sumatra system, because of stability and thermal capacity. This means that large-scale transmission will not be possible. Therefore, 500kV should be adopted for the second trunk lines.

6.7 SCADA System

6.7.1 Existing SCADA System

Table 6.7.1 shows the outline of the existing SCADA system in Sumatra. The SCADA system in Medan UPB is going to be replaced. The target year of operation for the new Medan SCADA is the end of 2005. There is a GSW in Lampung under Palembang UPB.

Table 6.7.1 Outline of Existing SCADA System in Sumatra

	Palembang	Padang	Medan
Hardware	Windows based PC	Windows base PC	DEC PDP11/83
OS	Windows	Windows	RSX 11M PLUS
RTU protocol	IEC 870	DNP3	HDLC
Start operation	2003	2002	1986
Next replace (plan)	---	---	2005

Source: JICA study team

Because of the Palembang and Padang SCADA system using Window based PCs, it is expected that the next replacement of the SCADA system will come in several years.

After commissioning the interconnection transmission line between the West Sumatra system and the South Sumatra system in July of 2004, Interconnection Dispatcher (ID) was introduced at Palembang UPB. ID controls major power stations and interconnection transmission lines. Before Commissioning of the interconnection between south and west Sumatra, both Palembang and Padang UPB monitored frequencies and controlled generator output. After commissioning of this interconnection, the interconnection dispatcher has monitored frequencies and made order to control generator output in both south and west Sumatra. Figure 6.7.1 shows regional and work shared with ID and UPBs.

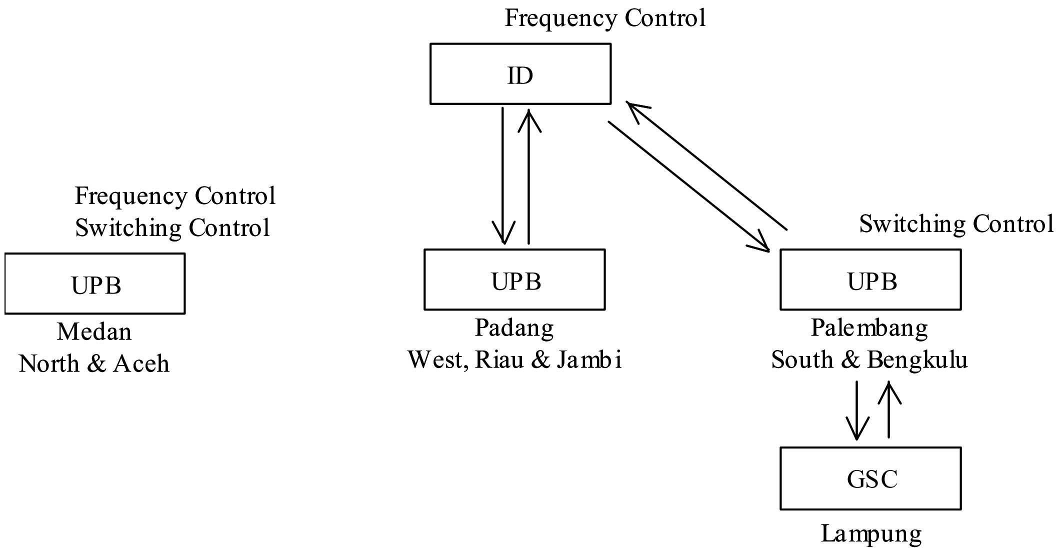


Figure 6.7.1 Interconnection Dispatcher, UPBs and GSC

6.7.2 Issues of SCADA System

There are some issues in the existing SCADA systems, so hopefully improvements will be made for supporting the system operator.

(1) Fixed mimic board

An UPB has a fixed mimic board that only shows the power system diagram, so it can't display the current situation of the power system.

a) It is necessary to select the PS or SS to monitor the current operating status by checking skeleton to the CRT one by one.

b) It might take a longer time to grasp the conditions of the system when a contingency has been occurred. Moreover, it is possible to take time to share the information between system operators under such a situation.

c) At the daily operations, it is requested that the system operator have higher skills of recognizing the power system only from its skeleton.

(2) Poor data collecting function

Collecting the following data every hour is so important because this information allows for the evaluation of operation status;

-Total demand in Sumatra, regional demand

-Generator output one bye one

-Current for each transmission line and transformer

-Bus bar voltage, generator terminal voltage

Those data can be extremely large for one year. However, they are very important for evaluating operations, demand forecasting, power development planning, transmission development planning, and repair planning. Therefore, it should be easy to extract this data from the SCADA system, and it should be easy to evaluate and analyze.

(3) Manual frequency and voltage control

The frequency control procedure is as follows;

a) Prepare a generator operating plan according to the forecasted daily load curve.

b) The system operator watches the frequency and control generator output depending on the prepared generator operating plan.

Bus bar voltages are watched and operated by the system operator. This all depends on the well-trained skills of the systems operators. The SCADA system needs the function of assistance or automation that can watch and control frequency and bus-bar voltage in order to prepare for the increase of power stations / substations.

6.7.3 Discussion on Action Plan for Issues of SCADA System

The issues described in chapter 6.7.2 are mainly applied to following:

- Power system operator
- Demand forecasting,
- Power development planner
- Transmission development planner.

Those issues would be solved, but not immediately. However, it is hoped that power system operators who control the growing Sumatra system will take action for those issues including following:

- Reduction of power system operators for monitoring system
- Quick restoration from contingency and blackout
- Better planning of supply and demand balance, others

(1) Mimic board

The display controller of the mimic board shall be independent from other components of the SCADA system to avoid malfunctions from problem with parts of the SCADA system. In another country, there was a large-scale blackout caused by a system fault during a SCADA system problem that made it impossible to recognize the conditions of the power system by system operators.

(2) Data collecting function

There are some methodologies of the data collecting function to implement. For example, data collection and analysis functions should be implemented into the SCADA system itself. Consideration should also be given to the use of independent systems from the SCADA to collect and analyze data. Another idea is analysis that applies generic data base software, or spreadsheet software, so the data collection can be done by a simple system.

(3) Frequency and voltage control

As for the frequency and demand / supply balance control, it is performed in consideration of so many elements including the economic elements and constraints of generator operations, transmission constraints and others. The development of methodologies is making advancements around the world. It is hard to develop complete automation of frequency and demand / supply balance control. So it is better to start from assisting the decision making of skilled power system operators. Also, it is better to start assisting voltage control of power systems by skilled system operators, because local and global voltage controls are linked each other.

6.8 Sumatra System Operation

6.8.1 Hierarchical System Operation

In 2004 the interconnection between the West Sumatra system and South Sumatra system, and between the Ache system and North Sumatra system were committed. And in 2009 there will be a plan to build interconnections between the West Sumatra system and North Sumatra system. Then the entire Sumatra system except for small island grids will be interconnected. Therefore, the assignment of daily generator operation planning and frequency control should be discussed as it was done individually by Palembang, Padang and Medan UPB. Table 6.8.1 (a) and (b) shows an example of assignments.

Table 6.8.1 (a) Assignment of Generation Planning and Frequency Control (Design 1)

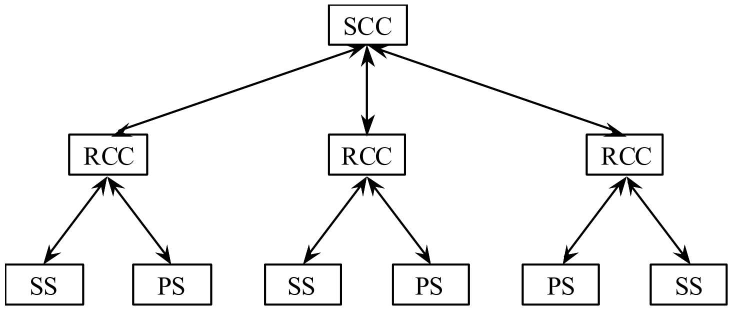
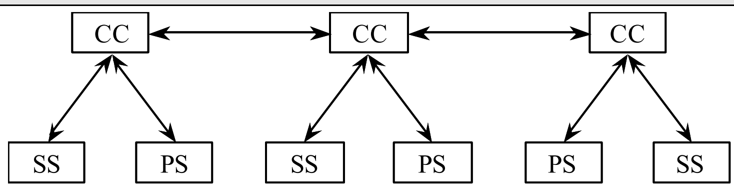
	Design 1
Outline of SCC, RCC, PS and SS	
Generation planning	SCC prepares generating plan for total Sumatra.
Generator Control	SCC have a responsibility of generator control
Frequency Control	SCC has a responsibility of frequency control. SCC watches frequency, and orders to PS to control generator output.
Voltage Control	RCC have a responsibility of voltage control. RCC watches voltage of bus bar, and control.
Switching Control	RCC have a responsibility of switching control Generator start and stop are ordered by SCC.
Merit	Generation planning is prepared for total Sumatra. It enables more effective generating operation than aerial generating operation.
Demerit	New SCADA system for SCC will be introduced. SCC and RCC must share the current operating situation. So, more communication link between PS/SS to RCC and SCC should be needed.
Note: SCC: Sumatra Control Center RCC: Regional Control Center	

Table 6.8.1 (b) Assignment of Generation Planning and Frequency Control (Design 2)

	Design 2
Outline of SCC, RCC, PS and SS	
Generation planning	CC prepares generating plan for each area. CC will coordinate their generation planning each other.
Generator Control	CC has a responsibility of generator control in each area.
Frequency Control	CC has a responsibility of frequency control in each are. So, CC monitors interconnection power flow and demand and supply balance in the area, and frequency to keep frequency.
Voltage Control	CC has a responsibility of voltage control.
Switching Control	CC have a responsibility of switching control
Merit	Same as before the operation of interconnection. SCC is not needed. Less communication link is needed than design 1.
Demerit	Generation planning will be optimized for the area, but whole Sumatra system. Three CC has a responsibility of frequency. So, more complex frequency control procedure will be needed than that one CC has a responsibility of frequency.

Comparing those two designs, it is better to choose design 1, which describes one control center for generation planning and frequency control to be utilize the interconnected Sumatra power system. As a result, UPBs in the north, west, and south will be the regional control centers. It is necessary to define the duties of each RCC, because the Sumatra system will be controlled in cooperation with SCC and RCCs. Table 6.8.2 shows the duties of SCC and RCCs. Figure 6.8.1 shows the relationship between SCC and RCC. Figure 6.8.2 shows an example of control areas for SCC and RCC in a power station.

Table 6.8.2 Example of Duties and Control Areas of SCC and RCC

	SCC	RCC(GSC)
Responsibility	Frequency	Switching Voltage
Control area	Large Power Generating Unit (with CB for generator)	Substation, Large Power Plant (without CB for generator) Small Power Plant

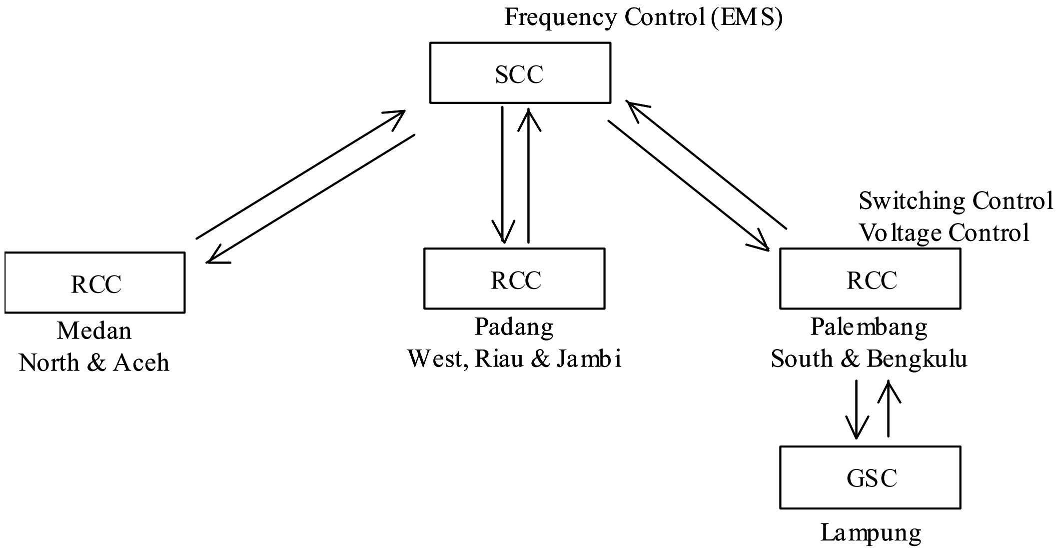


Figure 6.8.1 Example of Relationship between SCC and RCC

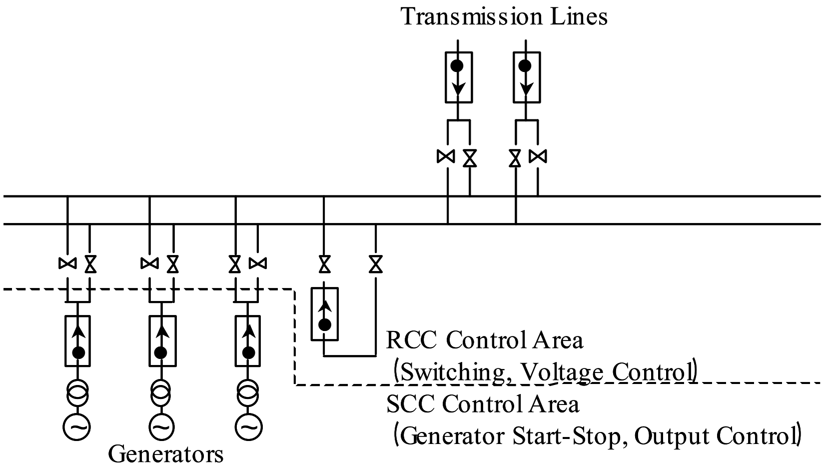


Figure 6.8.2 Example of Control Areas in Power Station

The control area of SCC and RCC that exist in one power station require the sharing of information on such items as generators and bus-operation. Especially, if there is a difficulty in sharing the information between SCC and RCC, it will be hard to recover from a blackout cased by transmission line fault. Therefore, there is an alternative design for the assignment of duties shown in table 6.8.3.

Table 6.8.3 Alternative Design of Affair and Control Area

	SCC	RCC (GSC)
Responsibility	Frequency	Switching
Control area	Substation at the end of interconnection (Bangko, Lubuk Linggau) Large Power Plant (Omblin, Singkarah, Koto panjang, Batanjhar, Bukit Asam, Besai, Borang, Indralanja)	Other substations and power plants

When making duty assignments for SCC and RCC, it will be necessary to consider not only normal operating conditions but also abnormal operating conditions such as during a large-scale black out or disaster. For this, SCC controls power station via RCC, where the power station belongs to the area, to share the operating status of power plant.

If the SCADA system of SCC would be taken off line, a back-up SCADA system of SCC would be needed. However, a SCADA system usually configures to a dual system. And it will be hard to take the SCADA system off line. So, it is better to make RCC to have minimum frequency monitoring and control functions. This assumes that telecommunication between power stations, substations and RCC are easy to contact and control.

6.8.2 Remote Control and Automation of Power Plant and Substation

The system operator monitors the conditions of power plants and substations, such as open/close of circuit breaker, line switch, power flow and bus-bar voltage, which are collected by RTUs and monitored by the SCADA system. Some substations have a capability for controlling their facilities from UPB via RTUs. However, RTUs do not collect information such as on faults and relay-actions. So, system operators have to call the staff at the power station or substation to find out what happened when the RTU shows the opening of a circuit breaker. Therefore, system operators can not start restoring fault without first talking to the staff at power stations or substations.

An increase in the number of power stations and substations is expected by the expansion of the power system caused by growth of demand. There is another way of locating maintenance staff at the power stations and substations. With an evaluation of ranking for power stations and substations, and with upgrades of RTUs, remote control via RTUs and automation of power stations and substations should be examined. As a result, it becomes reasonably possible to utilize skilled technical staff for the maintenance of power stations and substations.

6.9 Communications System

6.9.1 Existing Telecommunications System

On Sumatra island power line carriers (PLC) and wireless (radio) are mainly used for telecommunications. There are plans to introduce optical fibers and grounding wires with optical fibers (OPGW). They were already introduced in the Java-Bali system. However, PLC is used as the main facilities for communications in the Sumatra system at the present time.

6.9.2 Communications System Issues

(1) Congestion of PLC

The carrier frequency of PLC between power stations and substations should set to avoid interference. But there is a limitation to carrier frequency bands, and also the number of transmission channels is reaching its limitation. Moreover, it is found that interference to carrier frequencies is getting worse with the commissioning of new transmission lines and substations. Because of this PLC congestion, it will be harder to add new telecommunication links between power stations and substations, or even adding new substations.

(2) Cooperation of telecommunication system and SCADA, protection relay system

It is expected that constraints of the telecommunication system will affect the design of the SCADA system in the future. These constrains hamper arrangements of SCC or RCC, data collection and remote control systems. Although distance relay are used for protecting transmission lines, it also expected that PCM relays, which enable higher reliability and faster fault clearance times, would be introduced in the future. It will cause congestion for the communications network.

(3) Reliability of telecommunication links

At present, telecommunication links are often composed by point-to-point and single route. In the future, the system operator will collect more information and control power system via RTUs by SCADA. Also, the introduction of transmission line protection relays, such as a PCM relay system that works with the interchange of information on values between transmission line ends, requires higher reliability within the telecommunication system. Important information, such as protection relay information, should be applied to two telecommunication routes. That makes it easier to maintain telecommunications equipment and to arrange new telecommunications links. A bulk and multiplexed telecommunication link is especially effective when two routes are applied. The application of doubling a telecommunication link and route requires larger capacity for telecommunication link.

6.9.3 Discussion on Action Plan for Issues of Communications System

(1) PLC Congestion

A drastic increase in telecommunications will be found in the Sumatra system because of the following reasons:

a) An increase of demand will require more substations and power stations. They require more telecommunication links for RTUs and phones to operate power systems.
b) It is necessary to transfer information for the entire Sumatra power system to SCC after commissioning interconnections between the South, West and North systems in Sumatra.
c) The greater introduction of PCM line protection relays that use telecommunications is expected in order to utilize transmission facilities and to limit the area where fault had been occurring. Especially, the introduction of PCM relays that require telecommunication links would be introduced along with the introduction of generators in Aceh. In Aceh, the limits of transient stability have been extremely severe.
d) A drastic increase in data communications will results from the progress in IT applications in the electric industry sector.
e) The introduction of double-circuit telecommunication links for upgrading reliability will be expected.

A shortage of telecommunications is forecasted only for PLC and radio. So, it is needed to introduce cheap and large telecommunications with enough reliability for the electric power sector in the future. Large multiplexed radio, digital PLC, optical cable and OPGW are likely to be introduced. The introduction of a digital PLC has already been planned. But the capacity is relatively small. Large multiplexed radios need repeater stations with certain intervals. OPGW is an optical fiber within overhead ground-wires, which has huge capacity and enables high speed telecommunications. Moreover, there are advantages to the introduction of OPGW in the Sumatra system, because high-speed telecommunication network as a social infrastructure and higher reliability for the electric power sector will both be needed on Sumatra Island. And the introduction of optical fiber is thought to be worthwhile from viewpoint of utilizing existing transmission lines.

(2) Cooperation of communication system and SCADA system

It can be said that the development of telecommunication systems and SCADA system designs, for example, location and control area, are consistencies. Giving the constrains to design a SCADA system to control the cost of a telecommunication system, or cost analysis including future operation cost of power system, including substation, power station automation, must be discussed. This discussion will include political issues. In addition, discussions should be conducted regarding the cost analysis for not only construction cost, but also operation cost including maintenance and operation.

(3) Cooperation of communication system and protecting relay system

Because Sumatra is a huge island of over 1,500km, the Sumatra power system has stability problems as described in 6.5.2. Therefore, adequate development of transmission facilities is recommended.

The application of PCM relays that enable faster fault clearance periods and discriminative trips are recommended from the application of distance relay for transmission lines. When the PCM relay is applied, enough attention is needed not only for the capacity and doubled link, but also for the reliability of link.

Moreover, the introduction of PCM relays is desired for 500kV and 275kV transmission lines, which are already planned or hoped to be introduced, because a large short circuit or grounding fault current might influence to environment or destruct the transmission facility. Therefore, it is desirable to develop both 500kV and 275kV transmission lines and telecommunication systems simultaneously to coordinate such a situation.

Chapter 7 Investment Promotion in Power Sector

7.1 Electricity Investment with Private Sector Participation

7.1.1 Private Sector Participation in Power Sector since 1990s

Investment with private sector participation (PSP) started to increase in the field of infrastructure development in many countries in the early 1990s. In developing economies, particularly Asian developing economies, PSP-type investment was intensified in order to eliminate bottlenecks to infrastructure that were caused by their rapid economic growth. Actually, demand for electricity, one of the main infrastructure sectors, grew rapidly in these developing economies. Keeping pace with this demand growth required private investment, in addition to traditional public investment, in order to expand the power sector.

Figure 7.1.1 indicates that private investment in electricity in East Asian and Pacific developing economies increased in the first part of the 1990s, peaking at more than $15 billion in 1997. During this period, independent power producers (IPPs) were driving the boom in PSP investment for the region. However, the amount of private investment in the power sector significantly fell off after the 1997 peak, largely due to the 1997-98 Asian economic crisis. After this slump, power demand grew again in East Asia along with the economic recovery, but electricity investment with private participation still stagnated.

Source: World Bank, PPI Project Database

Figure 7.1.1 Annual Investment in Electricity Projects with Private Participation in East Asian and Pacific Regions

7.1.2 IPP Projects in Indonesia

For the purpose of solving budgetary constraints, the Indonesian government attempted to utilize private investment in the power sector. Presidential Decree No. 37, 1992 opened the way for the participation of IPPs in the electricity generation business. Up until the outbreak of the 1997-98 economic crisis, 27 IPP projects were formulated. However, the crisis forced the government and PLN to renegotiate power purchase agreements (PPA) with those IPPs. As shown in Table 7.1.1, with some bumps and detours, the government and PLN completed renegotiations for 26 out of the 27 IPPs by 2003. These renegotiations helped PLN improve financial conditions through the reduction of the power purchase price to the level of less than US$0.05 per kWh, but they have left potential investors with the impression that the Indonesian government failed to enforce contracts and to sustain commitments under long-term contracts. Until now, there has been no formulation of new large-scale IPP projects beyond the above 27.

Table 7.1.1 Results of Renegotiations with 27 IPP Projects

	Project Name	Location	Type	Capacity	Renegotiatio
1	Darajat	West Java	Geothermal	70MW	Agreed
2	Paiton I	East Java	Steam	1,320MW	Agreed
3	Paiton II	East Java	Steam	1,220MW	Agreed
4	Pare-Pare	South Sulawesi	Diesel	60MW	Agreed
5	Asahan	North Sumatra	Hydro	180MW	Agreed
6	Gunung Salak	West Java	Geothermal	165MW	Agreed
7	Sengkang	South Sulawesi	Combined-cycle	200MW	Agreed
8	Sibolga	North Sumatra	Steam	200MW	Agreed
9	East Palembang	South Sumatra	Combined-cycle	150MW	Agreed
10	Tanjung Jati B	Central Java	Steam	1,320MW	Agreed
11	Wayang Windu	West Java	Geothermal	220MW	Pertamina
12	Cikarang	West Java	Combined-cycle	150MW	Agreed
13	Sibayak	North Sumatra	Geothermal	10MW	Agreed
14	Bedugul	Bali	Geothermal	205MW	Agreed
15	Amurang	North Sulawesi	Steam	110MW	Agreed
16	Cibuni	West Java	Geothermal	10MW	PLN
17	Sarulla	North Sumatra	Geothermal	200MW	PLN
18	Dieng	Central Java	Geothermal	180MW	Government
19	Patuha	West Java	Geothermal	180MW	Government
20	Kamojang	West Java	Geothermal		Close out
21	Tanjung Jati A	Central Java	Steam		Close out
22	Tanjung Jati C	Central Java	Steam		Close out
23	Cilacap	Central Java	Steam		Close out
24	Serang	West Java	Steam		Close out
25	Pasuruan	East Java	Combined-cycle		Close out
26	Cilegon	West Java	Steam		Close out
27	Karaha	West Java	Geothermal		Litigation

Source: Office of the Coordinating Minister for the Economy

7.1.3 New Electricity Law and Private Sector Participation

The serious impacts of the 1997-98 economic crisis caused financial difficulties for PLN and forced the Indonesian government to restructure its power sector. The government formulated the Power Sector Restructuring Policy in 1998 and attempted to push forward with sector reform. To this end, the New Electricity Law (Law No. 20 of 2002) was prepared and promulgated.

This new law aims at promoting the restructuring of the power sector through: 1) the introduction of market mechanism principles to the sector in possible regions/fields (Java-Madura-Bali [JAMALI] and Batam as regions; generation as field); 2) the adoption of a decentralization system in formulating power development plans; and 3) the clarification of responsibilities for rural electrification between the central and local governments. Under the law, the government attempted in 2003 to establish the Electricity Market Supervisory Board (BAPEPTAL) responsible for dealing with various issues and monitoring the progress of market liberalization in the power sector. This legal and institutional framework was designed to facilitate structural changes from a monopolistic to a competitive market. A market-oriented stance toward power sector development was one of the main characteristics in this law. Law 20/2002 clearly indicated the necessity of investment with private sector participation for the development of the power sector. It was said that the formulation of more than 10 governmental decrees as well as around 60 presidential/ministerial decrees was required to implement and operate this law. However, detailed laws and regulations that could bring Law 20/2002 into shape and specify the roles, characterization and treatment of IPP investment were not substantially established. The Indonesian government did not express its determination to strongly commit and support IPP investments (e.g. the issuance of government guarantees). Such insufficient commitment and support for IPP business have discouraged potential investors from investing in long-term and large-scale electric power generation projects in Indonesia.

7.1.4 Repeal of New Electricity Law

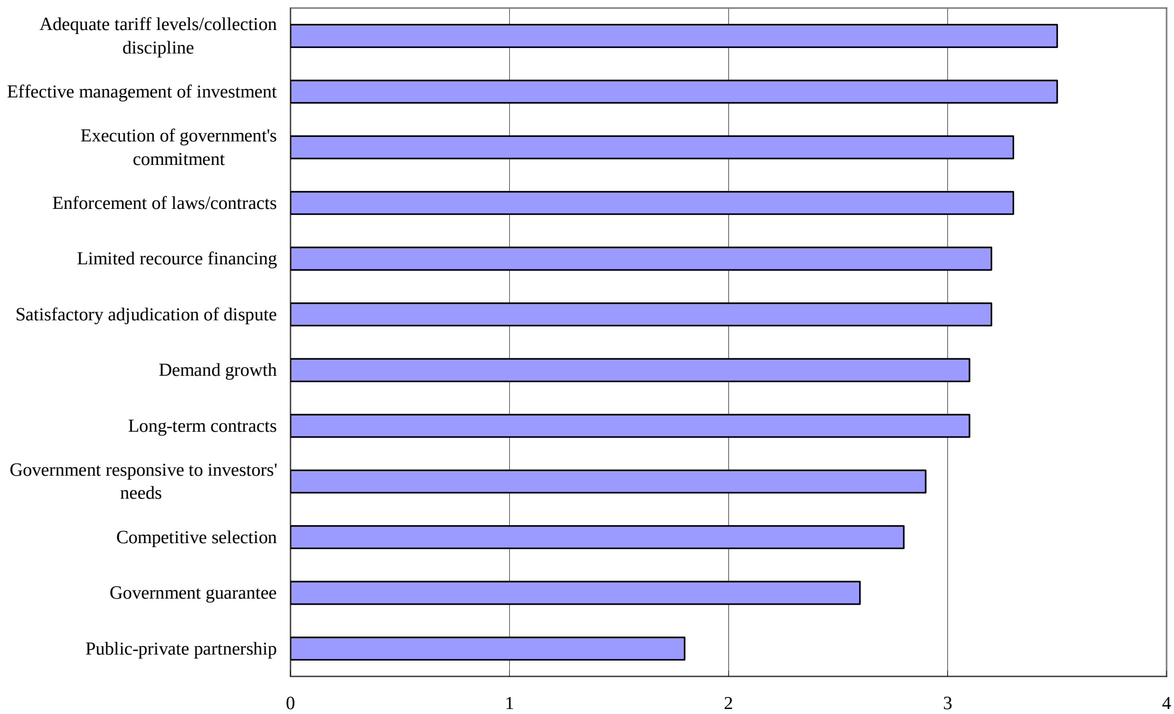
In December 2004, Law 20/2002 was repealed by the Constitutional Court. The 1945 constitution stipulates that important means of production involving natural resources should be controlled by the state. From this point of view, the new law aiming to open the power market to the private sector and promote PSP-type investment was declared as being unconstitutional. Under the Indonesian constitution, PLN is required to be a monopoly in the power sector. The revocation of Law 20/2002 does not seem to have any serious impacts on past IPP projects, those currently underway or those for which preparations are now being made. In the future, however, it will probably require private investment to arrange joint venture projects with the majority stakes held by PLN. A new legal framework for power sector development in place of Law 20/2002 needs to be immediately put together. A lack of funding has hampered plans by the new Yudhoyono administration to improve the investment climate through the development of infrastructure including the power sector. This nullification of Law

No. 20 of 2002 may result in negative impacts for Indonesia at a time when it wishes to attract foreign direct investment through infrastructure building.

7.2 Power Sector Investment Climate

7.2.1 Key Priorities of Power Investors

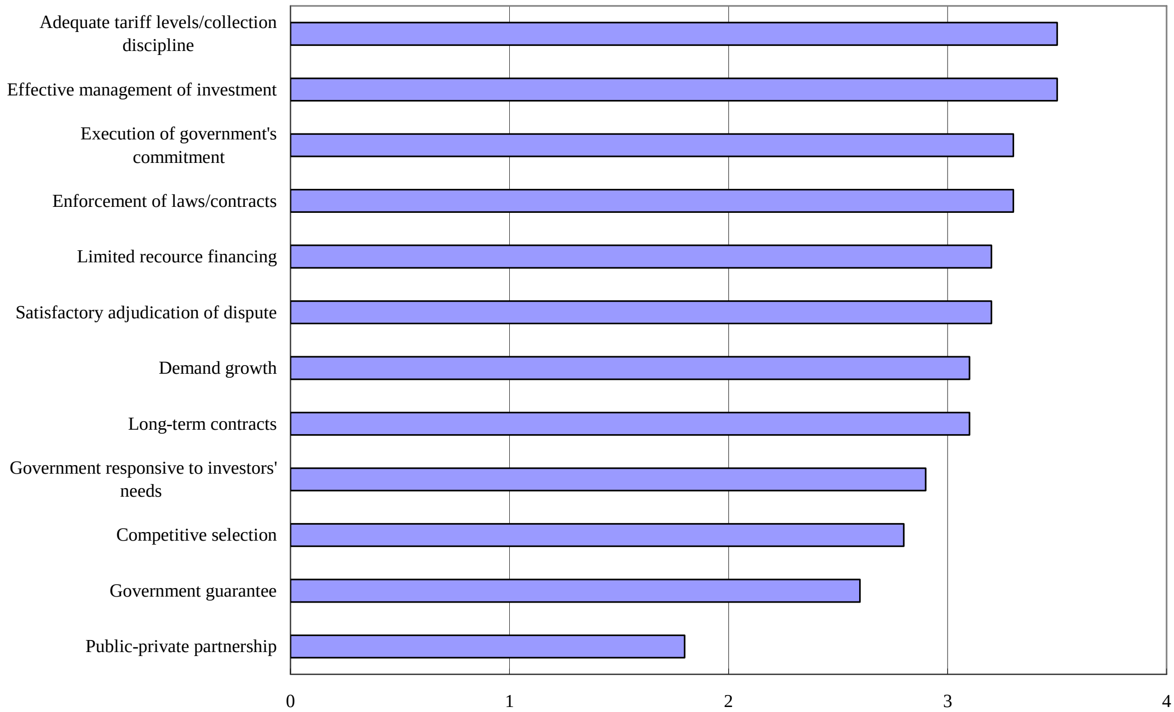
The World Bank conducted a survey of international investors in the power sector in 2002. The survey questions here look at possible factors affecting investment decisions from two dimensions: one focusing on country conditions (Figure 7.2.1); and the other on factors determining the success or failure of specific investment projects (Figures 7.2.2 and 7.2.3).



Note : A scale of 1 to 4 was prepared for factor ratings by evaluating numerals to each possible rating. "Not a factor" was given the value 1, "a minor factor" the value 2, "a major factor" the value 3, and "a critical factor" the value 4. An arithmetic average of all responses was then calculated for each factor.

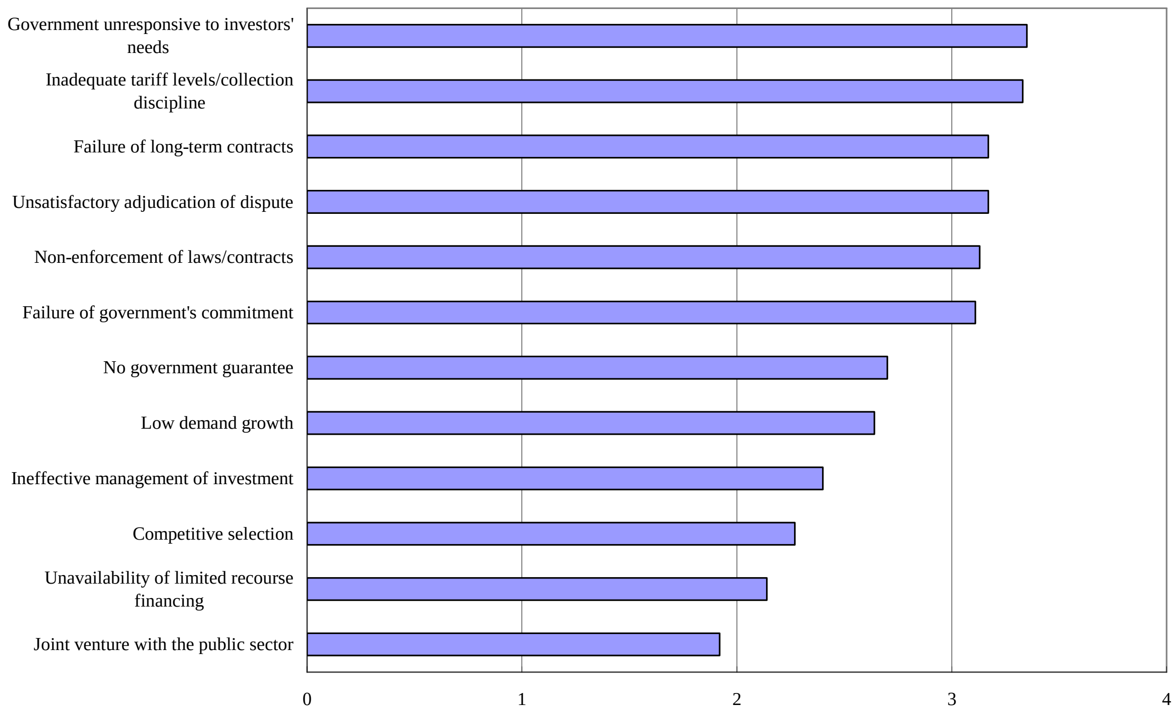
Source : The World Bank, Survey of International Investors in the Power Sector 2002.

Figure 7.2.1 How Investors Rank Priorities when Investing in a Developing Country



Note : See Figure 7.2.1.
Source : See Figure 7.2.1.

Figure 7.2.2 What Makes for the Best Power Project Experiences



Note : See Figure 7.2.1.
Source : See Figure 7.2.1.

Figure 7.2.3 What Makes for the Worst Power Project Experiences

(1) Adequate cash flows

International investors gave the highest priority to adequate cash flows for ensuring reasonable cost recovery and a success in their investments. Figure 7.2.1 shows that, in rating the importance of factors in the country environment, respondents gave the second highest rating to payment discipline by clients or consumers together with a legal and administrative capability useful for enforcing payment. Similarly, Figure 7.2.2 indicates that investors considered retail tariff levels and payment discipline very important in determining the success of investment projects. Figure 7.2.3 confirms from the opposite side that respondents identified inadequate tariff levels and poor collection discipline as the second most crucial contributor to the failure of investments.

(2) Stability and enforcement of laws and contracts

To assure the success of long-term and large-scale investments, private investors want to confirm whether their rights and obligations are clearly defined and whether related laws and contracts are enforced. Respondents rated a legal framework that properly defined the rights and responsibilities of private investors as the most important factor in making decisions to invest in developing economies (Figure 7.2.1). According to Figures 7.2.2 and 7.2.3, investors' responses to the survey also demonstrate that they highly value the enforcement of laws and contracts. This factor ranked high among reasons for the success and failure of investments.

(3) Government responses to the needs and time frames of investors

Delays in government approvals and licensing may cause an opportunity cost for international investors. In fact, investors rated government unresponsiveness to their needs and time frames as the highest factors among those leading to the failure of investment projects (Figure 7.2.3). Respondents ranked administrative efficiency fifth among factors influencing their decisions to invest in a developing country (Figure 7.2.1). The survey responses show that the opportunity cost arising from administrative inefficiency was significant in the power sector of developing economies.

(4) Government interference

International investors gave "opportunity to undertake effective management and operational control" the second highest rating among the contributors to the success of investments (Figure 7.2.2). The degree of independence of regulatory institutions and processes from government interference also influences investors' decision-making. Respondents ranked judicial independence sixth among the factors affecting decisions to invest in a developing country (Figure 7.2.1). The survey results imply that governments can help private investors increase their satisfaction by reducing government interference and allowing them greater management and operational control over their electricity investment projects. This factor may encourage IPPs to invest in a developing economy.

(5) Availability of risk guarantees

As shown in Figure 7.2.1, respondents ranked the availability of risk guarantees second among the factors in determining whether or not to invest in a developing economy. However, Figures 7.2.2 and 7.2.3 indicate that, in the case of individual investment projects, respondents did not necessarily consider the existence of risk guarantees a key factor for success or failure. While international investors do not look at government guarantees as key contributors to the success or failure of investments, they do consider the availability of guarantees an important factor when deciding whether or not to invest in a developing country.

7.2.2 Investment Climates in Indonesia: Comparison with Neighboring East Asian Economies

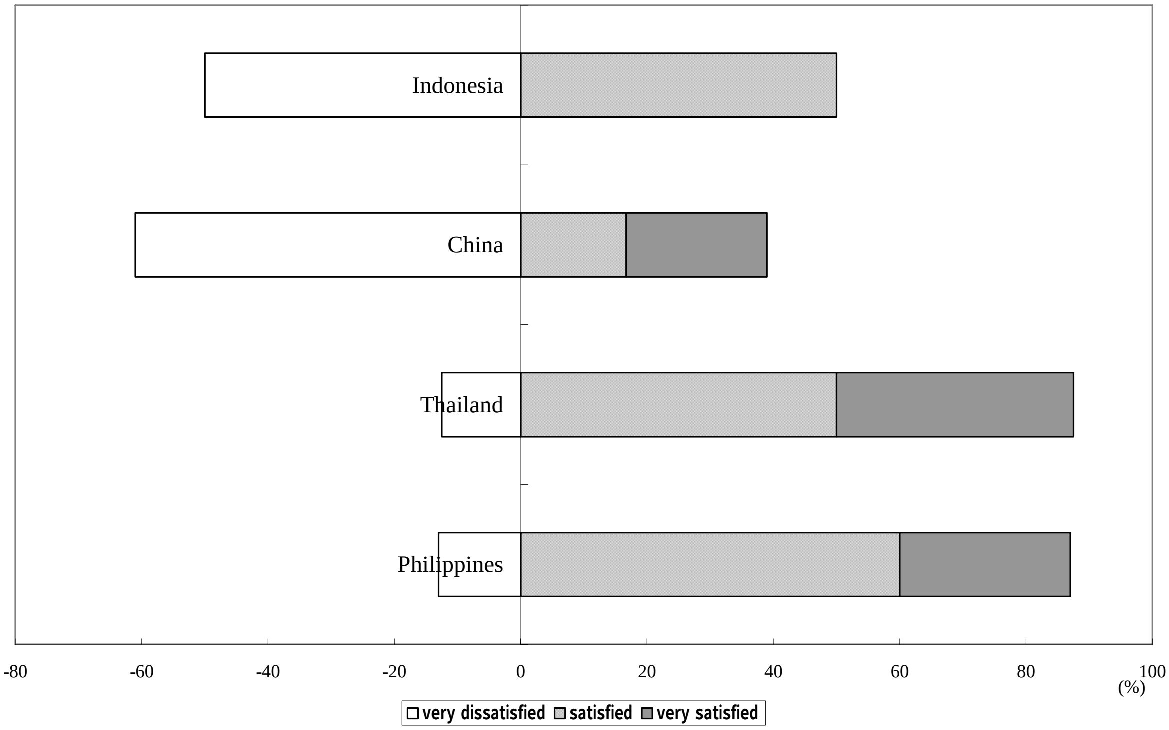
(1) Evaluation of East Asian Economies as Investment Destinations

Figure 7.2.4, which is also based on the World Bank survey results explained above, shows investors' satisfaction levels with specific East Asian countries. The Philippines received favorable ratings. Nearly 90% of the 15 firms with investments in the Philippines reported very high satisfaction or satisfaction with their investment experiences there. Thailand also scored well, with roughly 90% of the 8 respondents with investments there reporting that they were satisfied or very satisfied with their IPP experiences.

Unlike these two countries, Indonesia has not necessarily been appreciated by private investors. Half of the 8 respondents with investments in Indonesia reported that they were very dissatisfied with their IPP projects there. The other half were satisfied with their investments in Indonesia, but no one was very satisfied with their investment experiences. This result implies that the investment climate in the Indonesian electricity sector has not necessarily been attractive to foreign investors. A series of renegotiations concerning PPA between the Indonesian government and 27 IPPs contributed to this relatively low assessment of the investment environment. China shows a similar pattern as Indonesia.

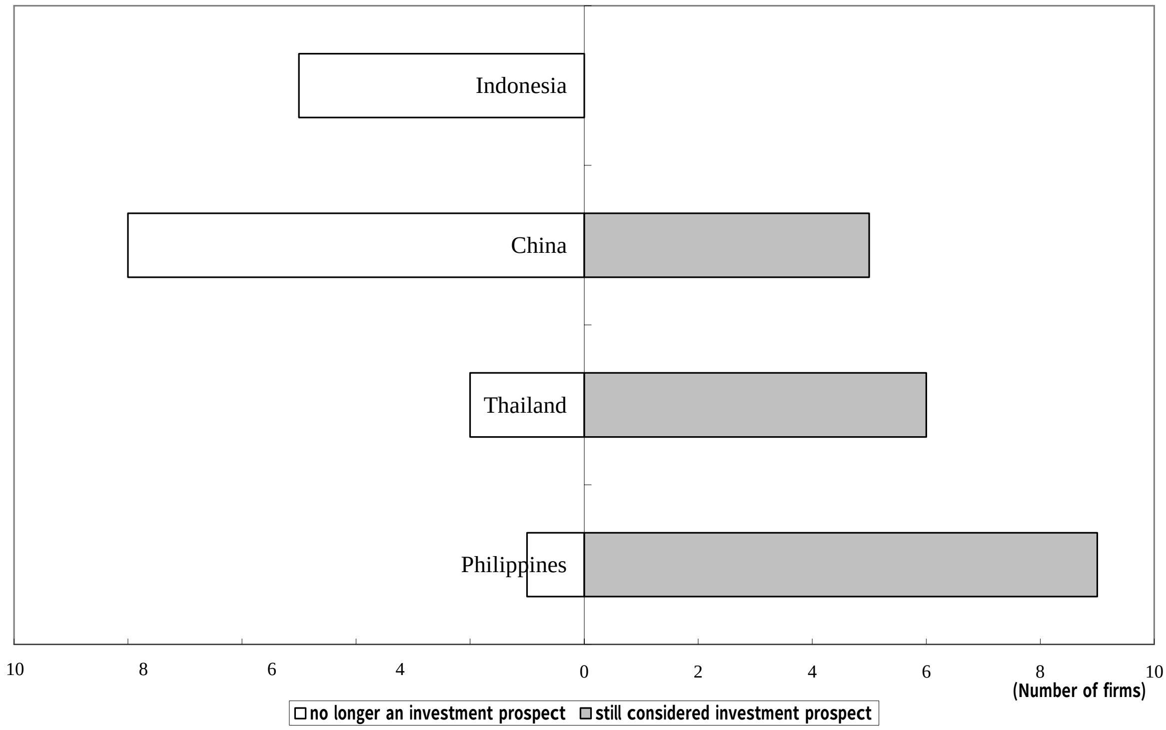
(2) Investment prospects in East Asian economies

The World Bank survey also indicates which countries have investment prospects (Figure 7.2.5). Respondents were asked to identify countries they considered prospects for more electricity investment in the next few years and those they dropped from their electricity investment plans. Figure 7.2.5 shows that international investors still consider the Philippines, Thailand and China to be good investment prospects. In contrast, private investors had an unqualified negative outlook on Indonesia. These results are basically consistent with those demonstrated with investors' priorities (see previous part). Countries that have consistently done well in maintaining the conditions considered key priorities by investors are able to retain their interest. On the other hand, countries with a poor performance in doing so could no longer be considered attractive investment destinations. Indonesia may fit the latter case.



Source: See Figure 7.2.1

Figure 7.2.4 Evaluation of Past Investment Projects



Source: See Figure 7.2.1

Figure 7.2.5 Investment Prospects in the Power Sector

(3) Sovereign ratings for East Asian economies

Table 7.2.1 presents a list of long-term local and foreign currency sovereign credit ratings on Indonesia and its neighboring East Asian economies (as of March 31, 2005) prepared by Standard & Poor's, one of the most influential rating agencies in the world. Basically, a sovereign rating is an independent assessment of a government's creditworthiness, which represents the ability of the government to meet its debt and other obligations. Sovereign ratings are, of course, not designed exclusively for electric power investment, but are generally used by investors, lenders and other counterparties as an estimate of the credit risks (the risk of default) when they deal with the government of a particular country.

The long-term foreign currency sovereign rating for Indonesia is B+. Singapore records the highest sovereign credit rating on the table with AAA for foreign currency, followed by Malaysia with A-. The long-term foreign currency ratings for China, Thailand, the Philippines and Vietnam are BBB+, BBB+, BB-, and BB-, respectively. These ratings seem largely consistent with the findings shown above. To attract investments in the power sector as well as those in other sectors, Indonesia needs to make a greater effort to upgrade its sovereign ratings, which largely reflect the investment climates for potential private investors.

Table 7.2.1 Sovereign Ratings (as of March 31, 2005)

	Long-term Local Currency	Long-term Foreign Currency
Indonesia	BB	B+
China	BBB+	BBB+
Malaysia	A+	A-
Philippines	BB+	BB-
Singapore	AAA	AAA
Thailand	A	BBB+
Vietnam	BB	BB-

Source: Standard & Poor's, Sovereign Ratings.

7.3 Total Investment Necessary for Power Sector Development in Sumatra

Table 7.3.1 shows the estimated investment amount necessary for the development of power generation and transmission facilities in Sumatra from 2006 to 2020. This table excludes the projects that have contracts and/or determined investment. The estimates also exclude investment in power distribution.

Table 7.3.1 Total Investment Necessary for Development of Power Generation and Transmission Facilities in Sumatra during 2006-2020

(Unit: US$ million)

Financing Sources	① 2006-2010			② 2011-2015			③ 2016-2020			①-③ 2006-2020		
	Total	Breakdown		Total	Breakdown		Total	Breakdown		Total	Breakdown	
PLN (including ODA)	221	(1)	0	1,561	(1)	0	585	(1)	0	2,367	(1)	0
		(2)	113		(2)	0		(2)	0		(2)	113
		(3)	0		(3)	0		(3)	0		(3)	0
		(4)	0		(4)	896		(4)	560		(4)	1,456
		(5)	0		(5)	0		(5)	0		(5)	0
		(6)	108		(6)	665		(6)	25		(6)	798
IPP	845	(1)	500	963	(1)	700	400	(1)	400	2,208	(1)	1,600
		(2)	0		(2)	0		(2)	0		(2)	0
		(3)	90		(3)	0		(3)	0		(3)	90
		(4)	0		(4)	263		(4)	0		(4)	263
		(5)	255		(5)	0		(5)	0		(5)	255
		(6)	0		(6)	0		(6)	0		(6)	0
Unknown	0	(1)	0	0	(1)	0	1,060	(1)	700	1,060	(1)	700
		(2)	0		(2)	0		(2)	0		(2)	0
		(3)	0		(3)	0		(3)	360		(3)	360
		(4)	0		(4)	0		(4)	0		(4)	0
		(5)	0		(5)	0		(5)	0		(5)	0
		(6)	0		(6)	0		(6)	0		(6)	0
Total	1,066	(1)	500	2,524	(1)	700	2,045	(1)	1,100	5,635	(1)	2,300
		(2)	113		(2)	0		(2)	0		(2)	113
		(3)	90		(3)	0		(3)	360		(3)	450
		(4)	0		(4)	1,159		(4)	560		(4)	1,719
		(5)	255		(5)	0		(5)	0		(5)	255
		(6)	108		(6)	665		(6)	25		(6)	798

Notes : (1) Coal-fired, (2) Gas turbine, (3) Combined-cycle, (4) Hydropower, (5) Geothermal, and (6) Transmission/substation.

Source : Estimated by JICA Study Team

According to Table 7.3.1, the total investment cost in Sumatra during 2006-2020 is estimated at US$5.635 billion, of which US$2.3 billion (40.8%) is for coal-fired power plants, US$113 million (2.0%) for gas turbine power plants, US$450 million (8.0%) for combined-cycle power plants, US$1.719 billion (30.5 %) for hydraulic power plants, US$255 million (4.5%) for geothermal power plants, and US$798 million (14.2%) for main transmission and substation facilities. In light of the background and characteristics of each investment project, it is expected that, of US$5.6 billion, US$2.36 billion (42.0%) is financed by PLN including its own funds, the Indonesian government budget and ODA (official development assistance) and US$2.21 billion (39.2%) is funded by IPP. The financial sources of the remaining US$1.06 billion (18.8%) are not clarified.

PLN seems to continuously rely on ODA to finance most of the investment projects, in consideration of its financial position. In the second period (2011-2015), the construction of several hydraulic power plants and large-scale expansion of transmission/substation facilities are scheduled to be undertaken. An intensive financing due to this capital demand during 2011-2015 requires Indonesia not only to ensure ODA but also to expand PLN's own financial resources through the improvement of its financial situation.

After 2016, financing sources for many coal-fired power plants and combined-cycle power plants are not decided yet. These power development projects will have to depend on IPP investment to a large extent. This requires the immediate improvement of investment climate. The repeal of Law 20/2002 explained in 7.1.4 may possibly put the brakes on IPP financing that would otherwise cover a large part of the total investment in the Sumatra's power sector up to 2020.

7.4 Recommendations for Investment Promotion in Power Sector

7.4.1 Recommendations: Indonesian Government

To attract electric power investment with private sector participation, the Indonesia government is required to tackle the following challenges that the economy in general and the power sector in particular are facing.

(1) Strong government commitment and support

Without a clear expression of the government's commitment and support to IPP business, private investors will hesitate to invest in long-term and large-scale projects in Indonesia. While the Indonesian government has shown its willingness to attract electric power investors, it has not demonstrated its strong commitment and support to IPP investment. This has discouraged electric power investment with private sector participation. Resumption of the issuance of letter of guarantees (L/G) or support letters, one of the obvious and substantial commitments from the government, may stimulate potential investors to come into the Indonesian electricity market. In addition, the government can indicate its strong commitment and support to IPPs by, for example, accelerating the development of a legal framework, and promoting the institutional and human development necessary for the effective receiving and utilization of IPP investment. Of course, investors do not want government interference but hope for adequate commitment and support from the government.

(2) Availability and enforceability of laws and contracts

A clear and enforceable legal framework favorable to foreign private investment is one of the top priorities for investors. Based on reliable rules, they need to make investment decisions at present and also formulate the business strategy for the future Indonesian market.

(i) Establishment of new investment law

The establishment of the New Investment Law has been far behind the original schedule of December 2003, which was established in the Economic Policy Package Pre and Post-IMF (White Paper) announced in September 2003. The delay has accelerated the exodus of foreign investors from Indonesia. This affects not only the manufacturing sector, but also the power sector. It is necessary to promptly enact the New Investment Law to create a favorable investment environment.

(ii) Development of New Legal Framework after Repeal of New Electricity Law

It is essential to prepare a new legal framework (including decrees and regulations) in place of the New Electricity Law (Law No. 20 of 2002). Under the framework, important issues such as the role of PLN in electricity business, the formulation of joint venture projects between PLN and IPPs, the handling of IPP investment (e.g. tax on IPPs), and the relationships between power development and decentralization should be clarified and stipulated.

(iii) Reconsideration of Sector Reform and Design of Market Liberalization

The New Electricity Law (Law No. 20 of 2002) presented a blueprint for sector reform based on market mechanisms. However, while many foreign investors and parties concerned have understood the basic direction of this vision, they have had anxieties about the reality of such ambitious attempts at sector reform and market liberalization including a multi-seller/multi-buyer system, IPP-oriented power development and unbundling of vertically integrated structures. Along with the cancellation of Law 20/2002, it has become necessary to take into account several factors such as growing power demand, power supply shortages, industrial structures and income levels of consumers and to indicate revised plans for sector reform and market design with adequate speed, reasonable sequence and feasible targets.

(3) Ensuring adequate cash flows

Reasonable tariff levels and collection discipline are of the highest priorities for private investors. IPPs are not willing to consider making investments in Indonesia unless these conditions are satisfied. In connection with these issues, firmly adhering to power purchase agreement (PPA) is important to ensure adequate cash flows. The introduction of an automatic tariff adjustment (ATA) system should also be reconsidered in this context. In addition, the Indonesian government is required to attempt to reduce and eliminate disparities between power sales prices and production costs. However, at the same time, the government has to carefully take into account the income levels of power consumers (particularly low-income earners) in each region, when it sets the prices of electricity.

(4) Improvement of responsiveness to investor needs

International investors tend to consider the administrative efficiency of a host government as one of the key factors in their decisions to invest in a country. It is necessary for the Indonesian government to avoid being unresponsive to the investors' needs and time frames.

7.4.2 Recommendations: External Parties

(1) Promotion of investment coordination

(i) Coordination between ODA and non-ODA projects

ODA (official development assistance) can trigger private investment. Through the utilization of this ODA's pump-priming effect, it is possible to attract IPP projects. For example, if ODA builds public-natured or unprofitable infrastructure such as input fuel facilities, roads and ports for power facilities, IPPs will be more likely to consider electric power investments, because they can avoid such infrastructure development necessary for power generation plants and thus reduce their investment costs. Positive coordination between ODA and non-ODA projects can promote IPP investment.

(ii) Establishment of investment coordination meeting

Currently, JBIC (Japan Bank for International Cooperation), in collaboration with the World Bank and ADB, organizes a stakeholder consultation meeting (SCM), whose participants are from the Indonesian central government, JBIC, the World Bank, ADB, potential IPPs, banks/financial companies, NEXI (Nippon Export and Investment Insurance) and others. It is important to exchange and acquire information on electricity investment in Indonesia among stakeholders. This Study proposes the following institutional arrangements for investment coordination and promotion in the power sector. For this coordination meeting, the Study takes advantage of the existing SCM with some minor adjustments in terms of regional aspects.

Under this structure, the Indonesian central government and PLN in collaboration with local governments and local parties concerned formulate REPISTRAT (Regional Power-sector Investment Strategy) in each region (i.e. Sumatra, Java, Kalimantan and Sulawesi) for the realization of the power development plan based on RUKN (① in Figure 7.4.1). REPISTRAT proposes various kinds of investment projects in the form of PSP (Private Sector Participation)-type projects and traditional GOVEX (Government Expenditure)-type projects, which range from the construction of new power generation facilities to the maintenance, repair and transfer of existing facilities.

The central government, PLN and local governments jointly hold PICOM (Power-sector Investment Coordination Meetings) on a periodic basis and invite IPPs as main players of PSP, domestic and foreign financial institutions, ECA (Export Credit Agencies), potential contractors, international development institutions such as the World Bank and ADB, and bilateral aid organizations such as JICA and JBIC (② in Figure 7.4.1). The establishment of PICOM is aimed at forming a close relationship with those participants and selling them investment projects proposed in REPISTRAT as well as RUKN.

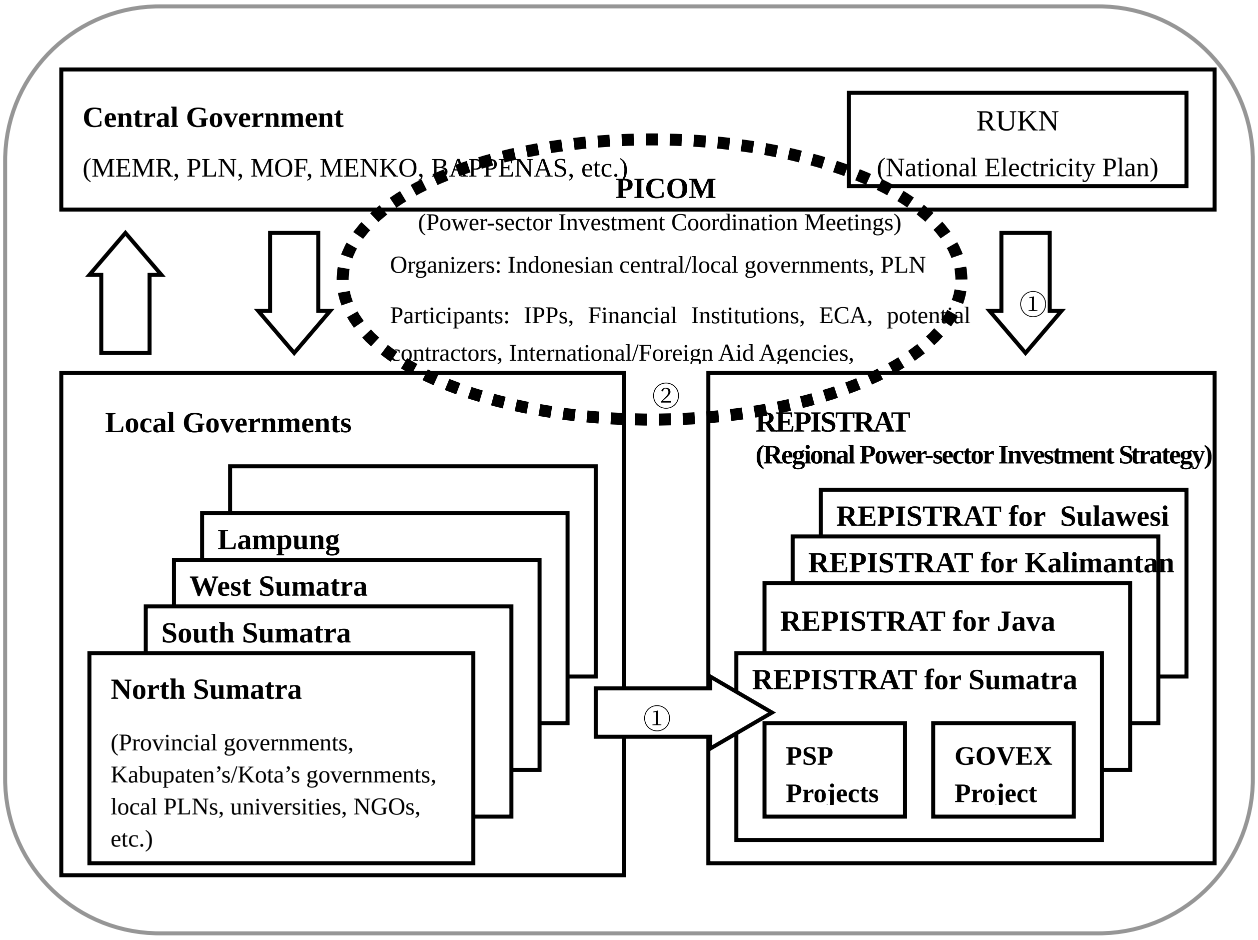


Figure 7.4.1 Institutional Arrangement for Investment Coordination and Promotion in the Indonesian Power Sector (Proposal)

(2) Promotion of flexible donor/financial support activities

On-lending, which transfers from the first and original lending between a donor agency and a central government to the second lending between the central government and a local government, can help a country distribute money for electric power investment at the local level. These kinds of flexible support activities by donor/financial agencies are useful in financing local electric power projects.

(3) Promotion of institutional and human resource development

Through the provision of technical cooperation and/or program loans, donor agencies can assist the development of institutional and financial capabilities of PLN. This support improves the creditworthiness of PLN, which may lead to the facilitation of investment in the Indonesian power sector. Similarly, donor agencies can also help local governments promote human resource development necessary to handle IPP investment at the local level.

7.4.3 Inventive Investment Models

(1) Establishment of risk reduction models for investment in PLN

As an investment model, this study proposes the establishment of a PLN-funded SPC (Special Purpose Company) which has sales contracts with trusted electricity buyers. This formation may reduce the risks of PLN defaulting and improve the credibility of securities investment in it (or other PLN-related firms).

(2) Investment in power generation for non-PLN market

The Study considers a possibility of investment in an electricity generation business for the non-PLN market. In addition to the existing IPP investment exclusive to the PLN market, a new investment model in which a large part of the produced electricity is supplied directly to foreign-affiliated industrial estates and the remaining part to the PLN is also feasible. This approach is a useful way to attract private investment in the power sector. In fact, North Sumatra has adopted and formulated this model for its industrial estate (KIM, Medan Industrial Estate). As of August 2004, four domestic IPPs have expressed their interests in the KIM coal-fired power generation project.

(3) Attraction of investment through CDM

CDM (Clean Development Mechanism) for the reduction of GHG (Green House Gases) under UNFCCC (UN Framework Convention on Climate Change) can be used as one of the effective incentives to attract foreign investment in the power generation business.

(4) Formulation of Public-Private Partnership Projects

In the case where IPP formulates a joint project with a public company (e.g. PLN), the project can avoid the process of bidding. This is the advantage of a Public-Private Partnership (PPP) project.

(5) Establishment of fund by donor agencies

Donor agencies (e.g. JBIC) can promote private investment in the power sector, by establishing a special fund for IPP business. JBIC has such experience in the establishment of the Global Asian Clean Energy Fund.

7.4.4 Special Considerations for Investment Promotion in Sumatra

A major attempt to attract IPPs to Sumatra is beneficial and important. The improvement of fundamental conditions at the national level favorable to private investment as described above is a necessary requirement for the facilitation of IPP projects in Sumatra. Supplementary infrastructure projects in Sumatra through ODA may encourage private investors to make electric power investments in Sumatra. PICOM (Power-sector Investment Coordination Meetings) may be effective in promoting IPP investment in Sumatra. However, in consideration of several factors such as the repeal of the New

Electricity Law (Law No. 20 of 2002), growing power demand, power supply shortages, industrial structure, industrial location and income levels of power consumers, the development of electric power facilities in Sumatra still needs to rely on government budget including ODA financing to a certain extent. Attracting ODA funds in Sumatra and expanding PLN's own investment funds through, for example, a review of the levels of electric power charges and reconsideration of electric rate structure, are required.

Chapter 8 Environmental and Social Consideration (ESC) - Initial Environmental Evaluation (IEE) -

8.1 Legal Framework for ESC

Environmental Impact Assessment (EIA) is a legal institution for environmental and social consideration (ESC) for development projects. EIA is conducted in the planning and implementing process of projects. EIA methods should follow relevant environmental laws and guidelines in Indonesia. However, EIA should also be based on the standard international ESC and EIA guidelines that include the new environmental and social consideration guidelines from JICA, the organization assisting Indonesia in this project study.

8.1.1 Legal Background of EIA/AMDAL in Indonesia

EIA is called AMDAL (Analisis Mengenai Dampak Lingkungan) in Indonesia. The EIA methods should follow all relevant environmental laws and guidelines in Indonesia. The existing Indonesian EIA system is applied to individual projects and implemented on a project-by-project base.

Historically[24], however, as a part of the power shift (during 1993-1997) in the institution of environmental management, the EIMA (the former Environmental Impact Management Agency known as BAPEDAL) started to establish an EIA commission to review complex activities such as 'regional' EIA and 'multi-sector' EIA. The commission has since reviewed 46 EIAs (Directorate AMDAL of BAPEDAL, Annual Report 2000/2001). Furthermore, BAPEDAL functioned as a coordinating agency for the overall EIA implementation at the national and provincial levels. In addition to the EIA process for a single proposed project, the new regulations (1993-1997) introduced three other EIA applications, which are EIA for 'regional', 'multi-sector', and 'multi-project' under one sector's responsibility. The three different EIA approaches were expected to accommodate a broader review and a cumulative impact assessment from multi-activities in a larger area. It was also hoped that these approaches bring about more strategic impacts. Although EIA regulations have been improved by the enactment of Government Regulation No. 51/1993, it was still assumed to be insufficient. Therefore, in May of 1999 Government Regulation No. 27/1999 was put forth.

Still so far SEA (Strategic Environmental Assessment) systems have not been introduced at the master plan stage or the preliminary project formulation stage according to hearings at the AMDAL section of the State Ministry of Environment (MOE).

[24] Dadang Purnama, February 2003, Environmental Impact Assessment Review, 23 (2003) 415–439; Reform of the EIA process in Indonesia: improving the role of public involvement, pp421-424.

(1) Legislation, regulations and guidelines

The major Indonesian regulations and guidelines regarding EIA/ AMDAL that are applicable to project planning and implementing organization are as follows:

<u>Basic Law on Environmental Management</u>

- Law No.23/ 1997; Environmental Management

<u>Basic Legislation on EIA</u>

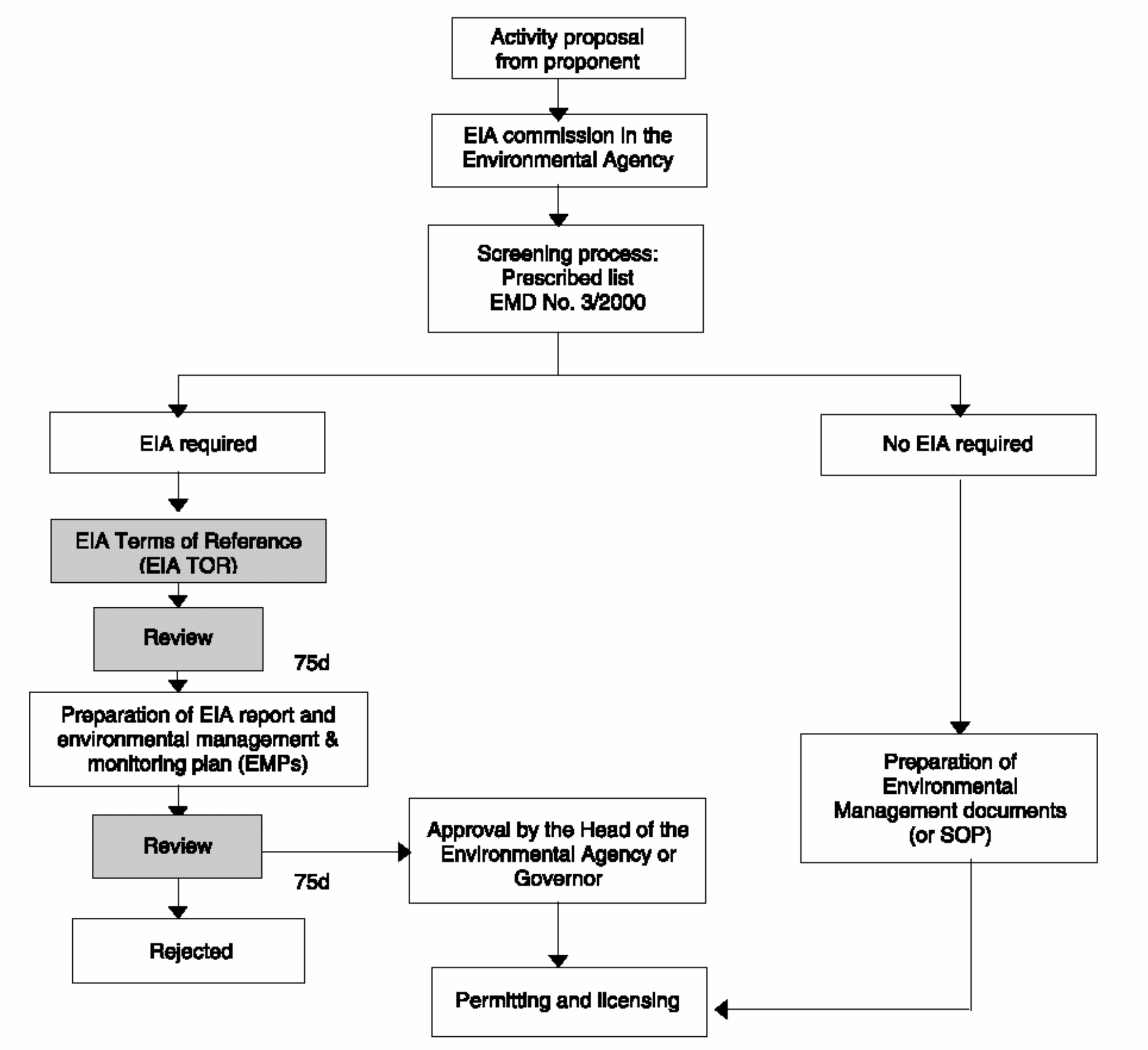
- Government Regulation No.27/ 1999; Environmental Impact Assessment (EIA/ AMDAL)

<u>Implementing Regulations for EIA</u>

- Decree of State Minister of MENLH No.2/ 2000; Guidelines for EIA/AMDAL Document Evaluation: *Reference MENLH; 2000a*
- Decree of State Minister of MENLH No.41/ 2000; Guidelines for Establishment of EIA/ AMDAL Evaluation Committee of Regencies/ Municipalities: *Reference MENLH; 2000b*
- Decree of Head of BAPEDAL No.8/ 2000; Public Involvement and Information Disclosure in the EIA/ AMDAL Process: *Reference BAPEDAL; 2000a*
- Decree of Head of BAPEDAL No.09/ 2000; Guidelines for Preparation of Environmental Impact Assessment Study: *Reference BAPEDAL; 2000b*
- Decree of State Minister of MENLH No.17/ 2001; Types of Business and/or Activity Plans that are Required to be Completed with EIA/ AMDAL: *Reference MENLH; 2001a*

(2) EIA process

The EIA process is carried out according to the scheme shown in Figure 8.1.1. A distinction can be seen from the beginning of the EIA process where a proponent (government or private sector) must contact the EIA commission in the BAPEDAL (the former Environmental Impact Management Agency, now integrated into the Ministry of Environment; MOE). The screening is performed in accordance with a prescribed list, which is established by the Decree of the Environment Minister (EMD) No. 3 of 2000 (further revised by EMD No. 17 of 2001).



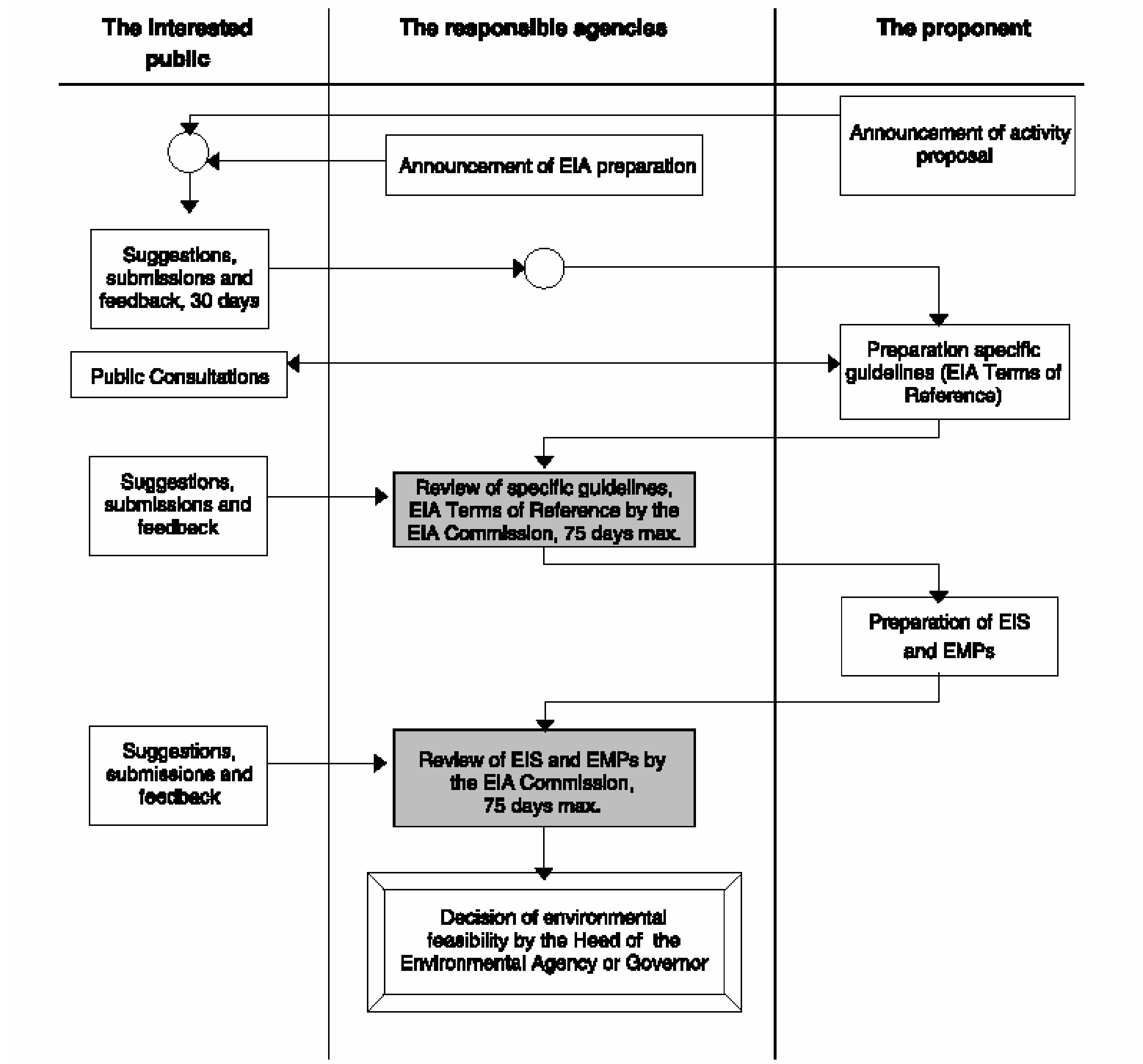
Note: Shaded boxes indicate opportunities for public involvement in the EIA process.
Source: Adapted from Government Regulation No. 27/1999 (The Government of Indonesia, 1999)

Figure 8.1.1 EIA Process in Indonesia under Government Regulation 27/1999

Following screening a proponent is directed to prepare a TOR for the EIA study (scoping process). Some other activities that are not required in order to conduct the EIA study are still needed in order to implement the EIA in a manner that minimizes any negative environmental impacts. A specific Standard Operating Procedure (SOP) established by the sectoral departments or other government agencies must be fulfilled. Environmental Impact Statement (EIS: an EIA study report) and Environmental Management and Monitoring Plans (EMPs called RKL and RPL in Indonesia) are prepared and reviewed at the same time. Both review processes are conducted within a maximum of 75 days. The regulations only specify a rejection procedure without the proponent's right of appeal, and the approval of EIA documents is made by the MOE or Governor. This newest EIA regulation enhances the transparency of the EIA process through EIA publications and the provision of direct public involvement in the process. This is initiated through the implementation of public involvement guidelines as a new approach in the EIA legislation.

(3) Public involvement and the transparency of information in the EIA process

The EIA system in Indonesia is expanding to include an intensive public involvement stage (See Figure 8.1.2). Public involvement is a critical factor that was considered weak in previous EIA implementations. EIA under the previous regulations (Regulation No. 29/1986 and 51/1993) did not have provisions for direct public involvement. Only representation by NGOs was permitted. Regulation No. 27/ 1999 has addressed this matter and now the challenge for all EIA stakeholders is how to consistently implement all these regulations. Public involvement in the EIA process is defined in a decree from the Head of the BAPEDAL. The decree of Head of BAPEDAL No.8/ 2000 (*BAPEDAL; 2000a*) explains the transparency of information in the EIA process. The guidelines allow governors to be more flexible in arranging further implementations at the provincial level since each province has different community characteristics. This applies, for example, in determining the community representative on the EIA commission. The guidelines define terms such as “interested community”, “affected community” and “concerned community”. The term ‘public involvement’ in the EIA process is defined as: the participation of the public in the decision- making process regarding EIA. In this process the communities can convey their aspirations, needs, retained values and suggestions for solving problems facing the interested community with the intention of making the best decisions (*BAPEDAL; 2000a*, p. 2). During the prearrangement stage, which is before EIA documents are prepared, the proponent is required to report its proposal to the BAPEDAL (now a section of MOE) and then, along with the agency, announce the proposed activity. Minimum requirements for the announcement are set by the guidelines as along with mass media specifications and announcement techniques. Furthermore, the public has the right to voice its opinions or responses within 30 days of the announcement date and submit them to the agency with a copy going to the proponent. After obtaining responses from the public, the proponent is required to prepare a Terms of Reference (TOR) for the EIA study. During the TOR preparation, the proponent is also required to conduct public consultations and to document all issues resulting from the consultations and then attach them to the TOR document. The TOR is presented to the EIA commission for review. The public gains another opportunity to provide input through its public representative who sits on the EIA commission or makes written submissions to the commission. The submissions for the TOR have to be made 3 days, at the latest, before the commission proceeds to review the document. Based on the recommendations resulting from the TOR review and input from the public, the proponent then prepares the EIS and EMPs. Again, after all EIA documents have been prepared, the proponent presents those documents to the EIA commission for further review. Ahead of the review process, members of the public have one more opportunity to express their responses and suggestions.



Source: BAPEDAL; 2000a, p8

Figure 8.1.2 Public Involvement Procedures in EIA Process in Indonesia

(4) Features of current EIA system

The following table (Table 8.1.1) describes the features of the current EIA System in Indonesia.

Table 8.1.1 Features of Current EIA System in Indonesia

EIA Framework	Features of Current EIA System
(1) Guidelines	Decrees of the State Minister for Environment No. 30 of 1999, No. 2, 3, 4, 5, 40, 41, 42 of 2000, HEIMAD No. 08, 09 of 2000
(2) Regulatory system	EIA is part of environmental legislation
(3) Triggering mechanism and screening process	Prescribed list from the Environment Minister, Ministerial Decree No. 3 of 2000
(4) Level and type of EIA:	Three types of EIA: (1) Single project EIA; (2) Multi-project EIA; and (3) Multi-sector EIA
(5) Guidelines for EIA report preparation, scoping process	General guidelines are set out by the Decree of the Environment Minister with standardized formats, structures, and content. Specific guidelines (TOR) must be prepared by the proponent with direction from the stakeholders (reviewed)
(6) Times required for EIA process	Time limitation: The EIA evaluation should be undertaken within 150 working days; 75 days for EIS TOR; 75 days for EIA report and RKL, RPL review
(7) EIS assessment authority	Three different EIA Commissions: - Central EIA Commission; - Provincial EIA Commissions; and - District EIA Commissions
(8) Monitoring and management plan Environmental auditing	As a part of EIA process requirement; formal document of Environmental Management and Monitoring plan (RKL, RPL); Mandatory; environmental auditing is separated from the EIA framework
(9) Public involvement methods	(1) Represented by NGOs (2) Involvement of directly affected public in the EIA commission (3) Public consultations (4) Submissions (5) Media publications (6) Public meetings
(10) Time for public participation	Time limitation: 30 days for response after the public announcement of the proposed project. Submissions no later than 3 days before the review of EIA TOR. Submissions no later than 45 days before the review of EIA report and RKL, RPL

8.1.2 International ESC and EIA Guidelines

The methods for ESC/ EIA should also refer to the standards for international ESC/ EIA guidelines that include the new environmental and social consideration guidelines established by JICA, the organization assisting this project study.

Major Reference Guidelines are as follows:

• New **JICA** Guidelines for Environmental and Social Considerations (April 2004)

• **JBIC** Guidelines for Confirmation of Environmental and Social Considerations (April 2002)

• **World Bank** Guidelines for Environmental Assessment:
- OP/BP 4.01 (January 1999)
<http://lnweb18.worldbank.org/ESSD/envext.nsf/47ByDocName/EnvironmentalAssessment>
- Environmental Assessment Sourcebook 1991 and Updates
- Pollution Prevention and Abatement Handbook 1998 (July 1998)

• **ADB** Environmental Assessment Guidelines (2003)
<http://www.adb.org/documents/Guidelines/Environmental_Assessment/default.asp>

8.2 Planning Description (Preparation for Master Plan)

8.2.1 Scope of the Study

(1) Components of the Study

This study has the following three major components:

- Formulation of Optimal Power Development Plan
- Capacity Development of Provincial Human Resources concerning RUKD
- Macroeconomic and Financial Analysis & Investment Promotion Policy for Power Sector in Sumatra

(2) Components in need of ESC

The Formulation of Optimal Power Development Plan consists of the following three components:

- Power Demand Forecasting
- Power Development Planning
- Transmission Planning

(i) Power demand forecasting
- High Case
- Low Case

(ii) Power development planning
- Hydropower (dam/reservoir type, run-of-river type)
- Thermal Power (steam turbine, combined cycle, gas turbine, diesel, with coal fuel, natural gas, Diesel oil, heavy fuel oil)
- Geothermal Power

(iii) Transmission planning
- Transmission Lines
- Substations

8.2.2 Planning Frame

(1) Least Cost Case scenario

The base scenario is based on the Least Cost Scenario. It is called the Least Cost Case.

(2) Alternative scenarios

(i) Zero option scenario: No further development of electric power in Sumatra

This option will clearly lead to frequent blackouts of electricity in Sumatra, resulting in severe economic stagnation since power demand in Sumatra is definitely expanding (refer to Chapter 3).

In addition, the WASP-IV simulation will be applied to the following alternative scenarios as case studies:

(ii) Limiting CO_2 Emission Scenario
(iii) Limiting Gas Supply Scenario
(iv) ESC (Environmental and Social Consideration) Weighted Scenario

(3) Inclusion of environmental cost into project cost

This section's title refers to incorporating environmental costs (lost value from environmental damage or costs for environmental mitigation, protection and conservation measures) into a market economy system, and then including them within the table of a project costs.

It is assumed that environmental costs are categorized into the following two types:

- Costs for environmental mitigation measures; and
- Lost value from environmental damage

The former includes countermeasure costs against environmental risks and for the employment of environmentally-friendly systems and materials, equipment costs for emission/effluent control and industrial waste treatment, costs for environmental management such as monitoring activity and social compensation and others. The latter includes the loss of livelihood, human health and mental damage, forest degradation, air and water quality degradation, lost assets both cultural and natural, negative impacts on communities and global environment and others. As to the former, obtaining reasonable and valid costs can be difficult since standard costs are not readily available. Furthermore, evaluating the latter is an even more difficult task since it is hard to define the extent and the cause-and-effect relation of negative impacts, and then to convert the damage into market economy values (monetary values).

The challenge for the study with respect to ESC is to incorporate these internalized environmental costs into simulation cases with the WASP-IV model. Therefore, the ESC Weighted Case mentioned in the above subsection is applied as the alternative case.

8.3 ESC Scheme for the Study (IEE[25] Method)

Indonesian legislation on EIA requires the completion of the AMDAL process before a project is implemented. However, at the master plan stage just what scheme is required for ESC is not specifically designated even though ESC itself is encouraged at this stage[26]. On the other hand, IEE (Initial Environmental Examination) is required for a master plan study according to the JICA ESC Guidelines. This JICA study on the Optimal Electric Power Development in Sumatra is regarded as a preliminary planning study for formulating master plans for the Sumatra region in RUKN. Therefore, is the correct assumption is that IEE will be applied to this JICA study as an ESC process.

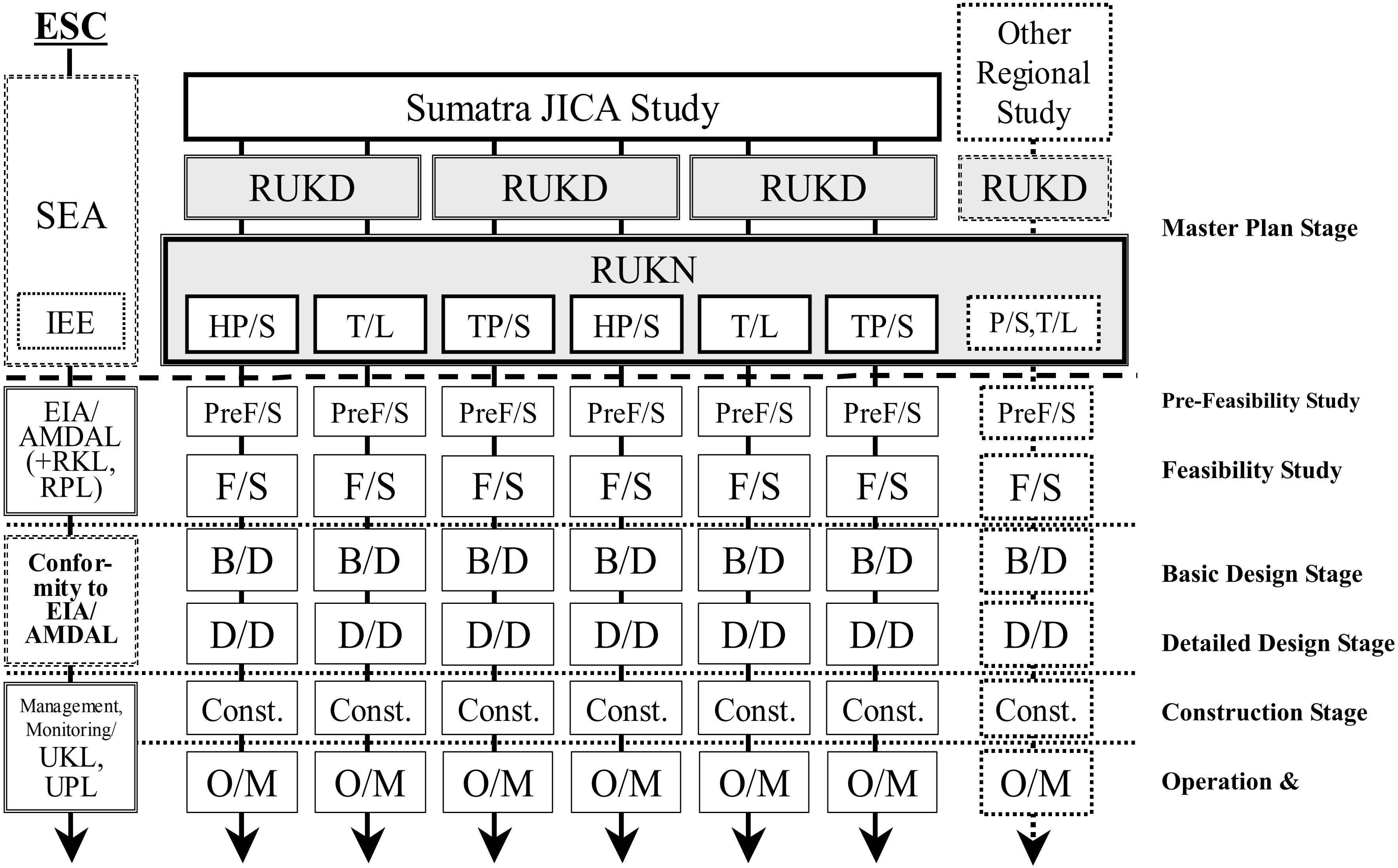
- IEE can be used as a strategic environmental assessment (SEA) for an upstream stage of power development planning.
- IEE will also be conducted as a preliminary assessment for EIA/AMDAL at the feasibility study stage.

8.3.1 Power Sector Project Flow and ESC Flow

The power sector project flow and ESC flow in Indonesia are shown in Figure 8.3.1.

[25] IEE stands for Initial Environmental Examination and Initial Environmental Evaluation. The former applies to the IEE study during this MP study, and the latter to IEE during the Master Plan Stage for Indonesian policy formulation of RUKN (National Electricity General Plan).

[26] Strategic environmental assessment (SEA) guidelines for the MP stage is now under development in MOE of Indonesia, but it has yet to be finalized. The IEE process does not exist in the Indonesian AMDAL scheme.



Note: Shaded boxes refer to the master plan stage.

SEA: Strategic Environmental Assessment, IEE: Initial Environmental Examination/Evaluation, EIA: Environmental Impact Assessment, HP/S: Hydropower Plant, TP/S: Thermal Power Plant, T/L: Transmission Line, P/S: Power Plant

Figure 8.3.1 Power Sector Project Flow in Indonesia and Corresponding ESC Flow

8.3.2 ESC Schedule

(1) During the JICA Study

- **Discussion of TOR** for IEE (ESC at MP) in the first workshop and the meetings with the implementing organizations (MEMR, PT. PLN) and an MOE expert
- **Baseline Study** for IEE on Environmentally/Socially Sensitive Zones and existing data on Environmental Costs regarding a project
- **Scoping for IEE** with implementing organizations and stakeholders (Dinas PE, BAPPEDA and BAPEDALDA)
- **Discussion on IEE (ESC at MP) in** three **Workshops** with stakeholders (MEMR, PT.PLN H.Q. & Sumatra offices and Dinas PEs)
- **Initial Environmental Examination of Alternative Scenarios** with simulation by the WASP-IV model and inclusion of environmental costs
- Initial Consideration on **Mitigation Approaches**
- Optimal Development Plan **with IEE Study**
- **Information Disclosure** of the report

(2) Master Plan stage (Indonesian Policy Formulation)

- Formulation of Power Development Master Plan for Sumatra Region and RUKN **with ESC (Initial Environmental Evaluation) and Stakeholder Meetings**

(3) After the Master Plan

- Feasibility Study with **EIA (AMDAL) and Mitigation Plans/RKL/RPL**
- Designing Study (Basic Design, Detailed Design)
- Implementation with **Mitigation Measures**
- O & M with **Environmental Management and Monitoring**

8.3.3 Organizations in Charge of ESC at MP Study

Indonesian Side

• Responsible Agency: Ministry of Energy & Mineral Resources
• Executing Agency: PT. PLN (PERSERO)

MEMR is the principal organizer of ESC, meaning that MEMR, as the proponent of the M/P Study, is the responsible organization for the ESC Study (IEE). In other words, the ESC Study is organized by MEMR.

Japanese Side

• Assisting Agency: Japan International Cooperation Agency and JICA Study Team

JICA assists MEMR and PT.PLN in the ESC process regarding technical matters.

8.3.4 ESC at MP

(1) ESC Topics

Topics regarding the ESC process are as follows:

- Discussion of TOR for IEE
- Baseline Study for IEE
- Consultations with Local Experts for IEE
- Discussion on IEE (ESC at MP) in three Workshops with stakeholders
- Initial Environmental Examination of Alternative Scenarios
- Information Disclosure of the report

(2) Study contents of respective topics

(i) TOR for IEE

Proposed to MEMR and PLN that discussions about TOR for IEE at the MP Study be held with the following parties. Had discussions with and referred to MOE expert unofficially.

• MEMR
• PLN
• Ministry of Environment
• Other concerned parties
• Provincial Governments
• JICA Study Team

(ii) Baseline study

As baseline information at the MP Study stage, made hearing surveys on the following information with PLN Sumatra branches and the local governments of Sumatra, namely BAPPEDAs and BAPEALDAs in West Sumatra, South Sumatra, North Sumatra, and Riau Provinces.

• Spatial Plans (National & Regional Plans)
  - Refer to Law No.24, 1992 concerning Spatial Use Management

• Protected Zones
  - Social (settlements of minorities: indigenous, ethnic groups, communities with a traditional or unique religious culture, transmigrated or immigrant people, other socially weak groups)
  - Cultural (precious cultural heritage sites, unique settlements strongly related to unique nature, culture)
  - Natural protectorate (national parks, natural parks, wildlife refugees, forest reserves, others)
  - Habitats/ Ecosystems of endangered or rare wildlife species, fauna and flora
• Known Environmental Costs in Existing Cases

(iii) Consultations with Local Experts for IEE, especially on Scoping

Either through direct discussions or in workshops, explained the draft scoping and other considerations by the Study teams to local experts and requested their comments, inputs and advices.

• With PLN specialists in environmental and social considerations
• With MEMR counterparts (the units for electricity development planning and environmental considerations)
• With MOE environmental impact assessment specialists on unofficial basis
• With BAPEDALDA in Sumatra
• With Dinas PE in Sumatra
• With others

(iv) ESC discussions with stakeholders in workshops

Three workshops have been held in this M/P Study.

- Discussion with Concerned Organizations on and prior to the <u>1st Workshop on June 15, 2004</u>
  - Provincial Governments (Dinas PE, BAPPEDA & BAPEDALDA)
  - MOE, unofficially

- <u>The 2nd Workshop in August 23 2004 (at Interim Report)</u>
  - Officials involved with MEMR and PT. PLN
  - Provincial Governments (Dinas PE)

    BAPPEDAs and BAPEDALDAs were not invited under the judgment of MEMR

- <u>The 3rd Workshop around May 25, 2005 (at D/F Report)</u>
  - Officials involved with MEMR and PT. PLN
  - Provincial Governments (Dinas PE)
  - Recommended MEMR should invite the participants of MOE and Provincial Governments (BAPPEDA, BAPEDALDA)

(v) IEE of alternative scenarios

- Application of scoping results to alternative scenarios
- Initial consideration on mitigation approaches
- Optimal development plan with IEE Study

(vi) Information disclosure

Information disclosure is an essential part of ESC based on the following:

- Decree of Head of BAPEDAL No.8/ 2000: Public Involvement and Information Disclosure in the EIA/AMDAL Process
- New JICA Guidelines for Environmental and Social Considerations (April 2004)
- Other guidelines from international cooperation organizations such as WB and ADB

Decree No.8/ 2000 (*BAPEDAL; 2000a,* p.1), the guidelines for public involvement in the EIA process, has the following four <u>objectives</u>:

(1) Protecting the interests of the community
(2) Empowering the community
(3) Ensuring the transparency of the EIA process
(4) Building a partnership among EIA stakeholders

Further, it has the following four basic <u>principles</u>:

(1) Equal positions among EIA stakeholders
(2) Transparency in decision-making
(3) Fair and impartial problem solving
(4) Coordination, communication and cooperation among EIA stakeholders

With reference to the guidelines (*BAPEDAL; 2000a,* p.2), the term ‘public involvement’ in the EIA process means “the participation of the public in the decision-making process regarding EIA”. In this process, communities convey their aspirations, needs and retained values, while also making suggestions for problems solving with the intention of obtaining the best decision.

In order to ensure the realization of the above objectives and principles, information disclosure is indispensable during and the planning, project and ESC processes.

As mentioned above, the reports on the baseline study on the environment and society, the scoping results, the workshops, IEE of the alternative scenarios and the conclusion of the MP study should be discussed by stakeholders and disclosed to them and the public.

8.4 IEE (Examination and Evaluation Draft)

8.4.1 Stakeholders

(1) Stakeholders on MP stage[27]

- Beneficiaries (Sumatra as a Whole):
  - People and communities in Sumatra,
  - Eight (8) provinces (Dinas PE, BAPPEDA, others) and public sectors in Sumatra
  - Industrial, commercial & other private sectors.
- Administration:
  - Responsible Agency: MEMR
  - Executing Agency: PT. PLN
  - Environmental Administration: MOE and BAPEDALDAs in Sumatra provinces
- Other concerned parties, national & international society
- Assisting Agency: JICA

(2) Examples of stakeholders in RUKD

- RUKD Working Group in West Sumatra
  - Dinas Pertambangan Dan Energi
  - BAPPEDA
  - Dinas of Water Resources Development
  - Dinas of Industry
  - BAPEDALDA
  - Statistics Office
  - Universities
  - PLN Regional Offices (Wilayah, Kitlur)
  - Others

(3) Examples of Team Coordination stakeholders for Sumatra power development

This team is working under the meeting of nine governors in Sumatra. In three sectors the coordination effort has developed into consortiums; specifically a shipping and information center from the Sumatra Promotion Center and telecommunication from Sumatra Online. Sumatra Airways also planned to make another consortium. In the power sector a plan for a consortium did not materialize. However, the Team Coordination of the sector supports power sector development in power plants, transmission, substations and interconnection of IPPs.

[27] The guidelines, Decree No.8/ 2000 (*BAPEDAL; 2000a,* distinguish terms such as interested community, affected community and concerned community.

The head of BAPPEDA in West Sumatra province is the chairperson for the Team Coordination of the power sector in Sumatra. The members of the team consist of representatives from BAPPEDA, Dinas PE, BKPPMD (Board of Investment), and the Bureau of Economy in the Offices of Governor for each province.

They have stood by the idea of integrating RUKDs (provincial power plans) into RUKW (Sumatra regional power plan) before incorporating into RUKN (the national power plan). This RUKW idea is characteristic to only the Sumatra region. The idea was first discussed in a 2001 meeting in Bintan Island, and the team has met regularly at least once every two or three months since April 2004.

On December15, 2004, the Indonesian constitutional court ruled that the law on power utility (Law No.20, 2002) was unconstitutional. A new law is now being prepared. Though the revision of this law will not change the fact that Sumatra provincial governments are the stakeholders in the power development master plan for the Sumatra region, it might cancel their administrative role and the authority for RUKN, more specifically the authority to make RUKD and RUKW. Therefore, we will need to carefully monitor the progress of the new law.

8.4.2 Scoping

(1) Protected areas in Sumatra

The Ministry of Forestry (MOF) is responsible for the protected areas in Indonesia. The Law of Living Resources and their Ecosystem (Law No.5, 1990) stipulates the following as natural protected areas:

- Nature Reserves
- Wild Life Reserves
- National Parks
- Nature Recreation Parks
- Grand Forest Parks
- Game Reserves

MOF issued the Map of Natural Protected Areas in Indonesia as of December 2003. Refer to this Map for Sumatra as shown in Figure 8.4.1. Efforts shall be made to avoid locating power facilities such as power plants and transmission lines in these protected areas in accordance with the regulations.

Source: Protected Areas in Indonesia, as of December 2003
Ministry of Forestry, Directorate General of Forest Protection and Nature Conservation

Figure 8.4.1 Map of Natural Protected Areas in Sumatra

Table 8.4.1 Summary of Protected Area in Sumatra

Category	Indonesia Total		Sumatra Total		Sumatra/Indonesia	
	Number of Sites	Area(ha)	Number of Sites	Area(ha)	Number of Sites	Area(ha)
Nature Reserves	223	4,479,954.23	58	522,013.11	26.0%	11.7%
Wildlife Reserves	69	4,946,886.08	23	859,850.95	33.3%	17.4%
National Parks	41	15,049,765.64	9	3,721,482.48	22.0%	24.7%
Nature Recreation Parks	122	1,207,812.25	23	312,999.17	18.9%	25.9%
Grand Forest Parks	17	334,604.80	7	175,075.00	41.2%	52.3%
Game Reserves	14	225,992.70	5	129,650.00	35.7%	57.4%
Total	486	26,245,015.70	125	5,721,070.71	25.7%	21.8%

Table 8.4.2 Nature Reserves in Sumatra

Nature Reserves

No.	Name	Area (ha)	Province
1	Hutan Pinus Janthol	8,000.00	Nanggroe Ache Darussalam
2	Rafflesia I/II Serbojadi	300.00	Nanggroe Ache Darussalam
3	Sibolangit	65.00	Sumatra Utara
4	Martelu Purba	195.00	Sumatra Utara
5	Dolok Tinggi Raja	167.00	Sumatra Utara
6	Batu Gajah	1.00	Sumatra Utara
7	Dolok Saut/ Surungan	39.00	Sumatra Utara
8	Liang Balik	0.50	Sumatra Utara
9	Batu Ginurit	0.50	Sumatra Utara
10	Dolok Sipirok	6,970.00	Sumatra Utara
11	Sibual-buali	5,000.00	Sumatra Utara
12	Beringin Sati	30.30	Sumatra Barat
13	Lembah Anai	221.00	Sumatra Barat
14	Batang Palupuh	3.40	Sumatra Barat
15	Lembah Harau	270.50	Sumatra Barat
16	Pangean II	33,380.10	Sumatra Barat
17	Rimbo Panti	2,830.00	Sumatra Barat
18	Melampah Alahan Panjang	22,364.00	Sumatra Barat
19	Gunung Sago	5,486.00	Sumatra Barat
20	Maninjau Utara Dan Selatan	22,106.00	Sumatra Barat
21	Gunung Singgalang Tandikat	9,658.00	Sumatra Barat
22	Gn. Merapi	9,670.00	Sumatra Barat
23	Air Putih	232,467.00	Sumatra Barat
24	Pangean I	12,200.00	Sumatra Barat
25	Perluasan Lembah Anai	100,000.00	Sumatra Barat
26	Pagai Selatan	4,000.00	Sumatra Barat
27	Aran Hilir	5,377.00	Sumatra Barat
28	Pulau Laut	400.00	Riau
29	Pulau Berkey	500.00	Riau
30	Pulau Burung	200.00	Riau
31	Kel. Ht. Bakau Pantal Timur	6,500.00	Jambi
32	Kel. Ht. Durian Luncuk I	73.74	Jambi
33	Kel. Ht. Durian Luncuk II	41.37	Jambi
34	Gua Ulu Tiangko	1.00	Jambi
35	Buluh Itam	700.00	Jambi
36	Cempaka	1,000.00	Jambi
37	Sungai Batara	1,000.00	Jambi
38	Klowe	7,271.00	Bengkulu
39	Manna	1.50	Bengkulu
40	Pager Gunung I/II/III	0.21	Bengkulu
41	Pager Gunung III/IV/V	0.60	Bengkulu
42	Taba Pananjung	1.24	Bengkulu
43	Cawang I/II	0.22	Bengkulu
44	Despatah I/II	0.26	Bengkulu
45	Dusun Besar	1,777.00	Bengkulu
46	Talang Ulu I/II	0.57	Bengkulu
47	Muko-muko	230.00	Bengkulu
48	Danau Menghijau	139.00	Bengkulu
49	Danau Tes	3,230.00	Bengkulu
50	Pasar Ngalam	265.00	Bengkulu
51	Pasar Seluma	159.00	Bengkulu
52	Pasar Telo	487.00	Bengkulu
53	Pasar Alas	64.00	Bengkulu
54	Tanjung Laksaha	445.00	Bengkulu
55	Kioyo	2,314.00	Bengkulu
56	Sungai Bahelo	674.00	Bengkulu
57	Bunga Maskikim	1.00	Sumatra Selatan
58	Pulau Anak Krakatau	13,735.10	Lampung
		522,013.11	

Table 8.4.3 Wildlife Reserves in Sumatra

Wildlife Reserves

No.	Name	Area(ha)	Province
1	Rawa Singkil	102,500.00	Nanggroe Ache Darussalam
2	Karang Gading Langkat Timur Laut	15,765.00	Sumatra Utara
3	Dolok Surungan	23,800.00	Sumatra Utara
4	Siranggas	5,657.00	Sumatra Utara
5	Barumun	40,330.00	Sumatra Utara
6	Pagai Seletan	4,000.00	Sumatra Barat
7	Bukit Batu	21,500.00	Riau
8	Tasik Tanjung Padang	4,925.00	Riau
9	Glam Siak Kecil	50,000.00	Riau
10	Balai Raja	18,000.00	Riau
11	Danau P.Basar/ Danau Bawah	28,237.95	Riau
12	Tasik Belat	2,529.00	Riau
13	Tasik Besar-Tasik Metas	3,200.00	Riau
14	Tasik Serkap-Tasik Sarang	6,900.00	Riau
15	Kerumutan	120,000.00	Riau
16	Bukit Bungkuk	20,000.00	Riau
17	Bukit Rimbang-Baling	136,000.00	Riau
18	Dangku	31,752.00	Sumatra Selatan
19	Bentayan	23,752.00	Sumatra Selatan
20	Padang Sugihan	86,932.00	Sumatra Selatan
21	Gumai Pasemah	46,123.00	Sumatra Selatan
22	Isau-isau Pasemah	16,998.00	Sumatra Selatan
23	Gunung Raya	50,950.00	Sumatra Selatan
		859,850.95	

Table 8.4.4 National Parks in Sumatra

National Parks

No.	Name	Area(ha)	Province
1	Gunnung Leuser	1,094,692.00	Nanggroe Ache Darussalam
2	Siberut	190,500.00	Sumatra Barat
3	Bukit Tiga Puluh	144,223.00	Riau
4	Kerinci Seblat	1,375,349.87	Jambi
5	Bukit Duabelas	60,500.00	Jambi
6	Berbak	162,700.00	Jambi
7	Sungai Sembilang	202,896.31	Sumatra Selatan
8	Bukit Barisan Selatan	365,000.00	Lampung
9	Way Kambas	125,621.30	Lampung
		3,721,482.48	

Table 8.4.5 Nature Recreation Parks in Sumatra

Nature Recreation Parks

No.	Name	Area(ha)	Province
1	Pulau Weh	3,900.00	Nanggroe Ache Darussalam
2	Kepulaun Banyak	227,500.00	Nanggroe Ache Darussalam
3	Sibolangit	25.00	Sumatra Utara
4	Lau Debuk-debuk	7.00	Sumatra Utara
5	Deleng Lancuk	435.00	Sumatra Utara
6	Sicikeh-cikeh	575.00	Sumatra Utara
7	Sijaba Hutaginjang	500.00	Sumatra Utara
8	Holiday Resort	1,963.75	Sumatra Utara
9	Rimbo Panti	570.00	Sumatra Barat
10	Lembah Harau	27.50	Sumatra Barat
11	Mega Mendung	12.50	Sumatra Barat
12	Kepulauan Pieh	39,000.00	Sumatra Barat
13	Muka Kuning (Batam)	2,065.62	Riau
14	Sungai Dumai	20,000.00	Riau
15	Bukit Sari	300.00	Jambi
16	Sungai Bengkal	1,000.00	Jambi
17	Pulau Panjang	1,265.30	Bengkulu
18	Way Hawang	94.00	Bengkulu
19	Bukit Kaba	13,490.00	Bengkulu
20	Lubuk Tapi-Kayu Ajaran	6.00	Bengkulu
21	Pulau Tikus	2.50	Bengkulu
22	Punti Kayu	50.00	Sumatra Selatan
23	Bukit Serelo	210.00	Sumatra Selatan
		312,999.17	

Table 8.4.6 Grand Forest Parks in Sumatra

Grand Forest Parks

No.	Name	Area(ha)	Province
1	Cut Nyak Dhien	6,300.00	Nanggroe Ache Darussalam
2	Bukit Barisan	51,600.00	Sumatra Utara
3	DR. Mohammad Hatta	71,807.00	Sumatra Barat
4	Sultan Syarif Hasim/Minas	6,172.00	Riau
5	Sultan Thahasaifudin	15,830.00	Jambi
6	Raja Lelo	1,122.00	Bengkulu
7	Wan Abdul Rachman	22,244.00	Lampung
		175,075.00	

Table 8.4.7 Game Reserves in Sumatra

Game Reserves

No.	Name	Area(ha)	Province
1	Lingga Isaq	80,000.00	Nanggroe Ache Darussalam
2	Pulau Pini	8,350.00	Sumatra Utara
3	Pulau Rempang	16,000.00	Riau
4	Semidang Bukit Kabu	15,300.00	Bengkulu
5	Gunung Nanu'ua	10,000.00	Bengkulu
		129,650.00	

(2) Scoping by facility types

At this stage of power development planning, the locations of specific facilities are still not concretely established. However, it is possible and valid to assume environmental and social impacts based on facility type since those impacts reflect the characteristics of the facility types.

Power facility types are categorized in the following manner.

Table 8.4.8 Types of Power Facilities

<table>
<tr><td rowspan="3">Power Plants</td><td>Hydropower</td><td>• Dam, Reservoir Type
• Run of River Type</td></tr>
<tr><td>Thermal Power</td><td>• Steam Turbine, Gas Turbine, Combined Cycle, Diesel
• Fuel: Coal, Natural Gas, Diesel, Heavy-fuel Oil</td></tr>
<tr><td colspan="2">Geothermal Power</td></tr>
<tr><td colspan="3">Transmission Lines and Substation</td></tr>
</table>

Existing and planned power facilities are studied and referred to for scoping by types of facilities (See Table 8.4.9).

Table 8.4.9 Surveyed Facilities by Type

Type of Facility		Surveyed Facility/Project
Hydro Power	Dam / Reservoir	Singkarak PLTA Maninjau PLTA Asahan II PLTA Renun PLTA (under construction)
	Run-of-river	Asahan III PLTA (planning stage)
	Mini/Micro Hydro	village hydropower near Ulubelu site
Thermal Power	Steam Turbine(Coal)	Ombilin PLTU Bukit Asam PLTU Tarahan PLTU (under construction)
	Same (Gas)	Belawan PLTU
	Same (MFO)	Keramasan PLTU Belawan PLTU
	Combined Cycle (Gas)	Belawan PLTGU
	Same (HSD)	Belawan PLTGU
	Gas Turbine (Gas)	Keramasan PLTG Indoralaya PLTG
	Same (HSD)	Tarahan PLTG
	Diesel (HSD)	Tarahan PLTD
	Same (MFO)	-
Geothermal		Ulubelu PLTP (planning)
Transmission Line and Substation		150kV Banko-Lubuk Linggau Transmission Line Lubuk Linggau Substation Lahat Substation

*MFO: Marine Fuel Oil, HSD: High Speed Diesel Oil

(i) Format for scoping potential impacts

Table 8.4.10 Scoping Formats for the Study

Social Environment		Natural Environment		Pollutions & Public Hazards	
Items of Impact	**Degrees of Possible Impacts (A - C)**	**Items of Impact**	**Degrees of Possible Impacts (A - C)**	**Items of Impact**	**Degrees of Possible Impacts (A - C)**
Involuntary Resettlement		Protected Area		Air Pollution	
Minorities or weak people in society		Geographical / Geological Features		Water Pollution	
Inequality and separation in society		Sediment & Hydrology		Soil Contamination	
Cultural heritage / Local landscape		Ecosystems / Wildlife		Wastes	
Economic activities (regional or local)		Global warming		Noise & Vibration	
Water Usage				Others	
Contagious or Infectious disease					
Accidents				Accidents	

(ii) Definitions of categories in the scoping formats

Table 8.4.11 Definitions of Categories (A - C) in Scoping Format

Category	Explanation
Category A	Projects are classified as Category A if they are likely to have significant adverse impacts on the environment and society. Projects with complicated impacts or unprecedented impacts, which are difficult to assess or which have a wide range of impacts or irreversible impacts, are also classified as Category A. Projects are also classified as Category A if they require a detailed environmental impact assessment by environmental laws and the standards of the governments. The impacts may affect an area broader than the sites or facilities subject to physical construction. Category A, in principle, includes projects in sensitive sectors (i.e., characteristics that are liable to cause adverse environmental impact) and projects located in or near sensitive areas. An illustrative list of sensitive sectors, characteristics and areas is given in Appendix-1.
Category B	Projects are classified as Category B if their potential adverse impacts on the environment and society are less adverse than those of Category A projects. Generally they are site-specific; few if any are irreversible; and in most cases normal mitigation measures can be designed more readily.
Category C	Projects are classified as Category C if they are likely to have minimal or little adverse impacts on the environment and society.

Appendix-1 Illustrative list

<u>1. Large-scale projects in sensitive sectors:</u>
(3) Thermal Power (including geothermal power);
(4) Hydropower, dams and reservoirs;
(6) Power transmission and distribution lines;
etc.

<u>2. Sensitive characteristics:</u>
(1) Large-scale involuntary resettlement;
(2) Large-scale groundwater pumping;
(3) Large-scale land reclamation, land development and land-cleaning; and
(4) Large-scale logging.

<u>3. Sensitive areas or their vicinity:</u>
(1) National parks, nationally-designated protected areas (coastal areas, wetlands, areas for ethnic minorities or indigenous peoples and cultural heritage, etc., designated by national governments) and areas being considered for natural parks or protected areas;
(2) Areas the national or local governments believe to require careful considerations.

<u><Natural Environment></u>
- Primary forests or natural forests in tropical areas;
- Habitats with important ecological value (coral reefs, mangrove wetlands and tidal flats, etc.);
- Habitats of rare species requiring protection under domestic legislation, international treaties, etc.;
- Areas in danger of large-scale salt accumulation or soil erosion; and
- Areas with a remarkable tendency towards desertification.

<u><Social Environment></u>
- Areas with unique archeological, historical or cultural value; and
- Areas inhabited by ethnic minorities, indigenous peoples or nomadic peoples with traditional ways of life and other areas with special social value.

(iii) Results of scoping by facility type

Table 8.4.12 Results of Scoping by Power Facility Type

	Item	Hydro Power			Thermal Power																Geo-thermal	Trans-mission & Sub-station
					Steam Turbine						Combined Cycle				Gas Turbine		Diesel					
		Dam/Re-servoir	Run-of-river	Mini/ Micro hydro	Coal*		Gas*		Oil* (MFO)		Gas*		Oil* (HSD)		Gas	Oil (HSD)	Oil (HSD)	Oil (MFO)				
Social Environment	Involuntary Resettlement	A	B	C	B	B	B	B	B	B	B	B	B	B	C	C	C	C	B	B
	Minority or weak people of society	A	C	C	B	B	B	B	B	B	B	B	B	B	C	C	C	C	B	C
	Inequality and separation in society	A	B	C	B	B	B	B	B	B	B	B	B	B	C	C	C	C	B	C
	Cultural heritage	A	B	C	B	B	B	B	B	B	B	B	B	B	C	C	C	C	B	C
	Local landscape	A	B	C	A	A	A	A	A	A	A	A	A	A	C	C	C	C	A	A
	Economic activities (regional or local)	A	B	C	A	A	A	A	A	A	A	A	A	A	B	B	B	B	B	C
	Water Usage	A	A	B	A	C	A	C	A	C	A	C	A	C	C	C	C	C	C	C
	Contagious or Infectious disease	B	B	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
	Accidents	B	B	C	B	B	B	B	B	B	B	B	B	B	C	C	C	C	B	C
Natural Environment	Protected Area	A	A	C	A	A	A	A	A	A	A	A	A	A	B	B	B	B	A	A
	Geographical /Geological Features	B	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
	Sediment & Hydrology	A	B	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	A	C
	Ecosystems/ Wildlife	A	A	C	A	C	A	C	A	C	A	C	A	C	C	C	C	C	B	C
	Global warming	C	C	C	A	A	B	B	B	B	B	B	B	B	B	B	B	B	C	C
Pollutions & Public Hazards	Air Pollution	C	C	C	A	A	B	B	A	A	B	B	A	A	B	A	A	A	B	C
	Water Pollution	A	B	C	A	B	A	B	A	B	A	B	A	B	B	B	B	B	A	C
	Soil Contamination	C	C	C	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	C
	Wastes	A	B	C	A	A	C	C	B	B	C	C	B	B	C	B	B	B	C	C
	Noise & Vibration	B	B	C	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	C
	Others	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	B
	Accidents	A	B	C	B	B	A	A	A	A	A	A	A	A	A	A	A	A	B	A

*: Right side column refers to thermal power plants with cooling tower system for condenser cooling water.

Table 8.4.13 (a) Criteria for Scoping Items (1/6)

Category	Environmental Items	Check Items	Facility: Hydo Power	Facility: Thermal Power	Facility: Geo-thermal Power	Facility: Trans-mission Line
Social Environment	**Involuntary Resettlement**	(1) Do the prospective projects contain any physical transformation, such as facility construction and land reclamation, which is anticipated to cause involuntary resettlement in project implementation ? Does it bring a large scale (more than a few hundred families) resettlement and land expropriation or a limited scale (less than several families) resettlement and land expropriation ?	○	○	○	○
		(2) If resettlement is anticipated, is it possible to change the plan to avoid it ? If it is not avoidable, is it possible to make any alternative plans to minimize the impacts ?	○	○	○	○
		(3) If resettlement is unavoidable, is it likely that the concerned inhabitants will agree to resettle once the situation has been properly explained to them, including the necessary resettlement and compensation plans? Do you anticipate any difficulties in obtaining their agreements?	○	○	○	○
		(4) Is it practically possible to carry out socio-economic surveys for anticipated resettlement inhabitants, to hold public hearings, to make proper resettlement and compensation plans preserving and restoring their living standards, and to prepare and maintain financial measures and implementation structures to realize the plans ? Are these processes guaranteed under the legal system ?	○	○	○	○
		(5) Does the resettlement bring any large disadvantages to the socially vulnerable, such as women, children, the elderly, the poor people, ethnic minorities, and indigenous people ? For instance, hardships related to securing drinking water, educational conditions, medical facilities, job opportunities, and inevitable changes in lifestyles.	○	○	○	○
		(6) Have you observed a political dictatorship in the region that will make it difficult to take the proper measures mentioned above in the event that resettlement is unavoidable?	○	○	○	○
		(7) Is it possible to establish a system to monitor the impacts on the resettled inhabitants and to take sustainable measures for providing them with livelihood support?	○	○	○	○
	Minority or weak people of society	(1) Does the plan (and projects) ignores or has the possibility to ignore lives and benefits of the social minorities and the weak, such as women, children, the elderly, handicapped people, the poor people, ethnic minorities, indigenous people, religious minorities, migrants and veterans, by removing their means of production and living and compelling them to change their basic lifestyles ? Are there any countermeasures for avoiding the above?	○	○	○	○
		(2) Does the plan sufficiently take into account the basic rights and subsistance right of the social minorities and the weak ?	○	○	○	○
		(3) Does the plan damage socio-economic infrastructures of the social minorities and the weak, such as hospitals, schools and roads ?	○	○	○	○
		(4) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous people? Is the project planner (proponent) aware of this need and ready to hold discussions with these groups? Is this guaranteed under the legal system ?	○	○	○	○
		(5) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities or indigenous people when they are living in the right-of-way ? Is the project planner (proponent) aware of this need and ready to hold discussions with these groups? Is this guaranteed under the legal system ?				○

Table 8.4.13 (b) Criteria for Scoping Items (2/6)

Category	Environmental Items	Check Items	Facility: Hydo Power	Facility: Thermal Power	Facility: Geo-thermal Power	Facility: Trans-mission Line
Social Environment	Inequality and separation in society	(1) Are considerations given to distribute project benefits evenly among the concerned society ? Is there a possibility that adverse impacts will converge (or gather) on one particular region or social group ?	○	○	○	○
		(2) Is it possible that the plan may cause friction between different interests in the society?	○	○	○	○
		(3) Is there any possibility that the plan will result in physical separation of traffic, communications, social exchanges, commutes to work and other such items due to the blockage of routes and the disconnection of communication means?	○	○	○	○
	Cultural heritage	Are there any possibilities that the plan damages the local archeological, historical, cultural, and religious heritage sites ?	○	○	○	○
	Local landscape	Are there any adverse impacts on famous aesthetic landscape? Are there any claims from inhabitants hoping to preserve the landscape ? In this case, is it possible to review the plan and take any necessary countermeasures ?	○	○	○	○
	Economic activities (regional/local)	(1) Are there any adverse impacts on agriculture, livestock farming and small fishery, such as loss of farmlands and grassland and blocking of livestock's path, due to construction of large scale facilities, reservoirs, power plants close to river mouths or on coastlines, transmission lines, and access roads ?	○	○	○	○
		(2) Are there any adverse impacts on land use downstream of a dam or an intake ? In particular, does reduction in the supply of fertile soil to downstream areas adversely affect agricultural production?	○			
		(3) Does existence of a dam adversely affect water transport by river vessels or water utilization by local inhabitants	○			
	Water Usage	(1) Does intake of water (both surface and ground) and discharge of used and waste water adversely affect any downstream water supply sources, due to water flow decrease, lowered ground water level, and deterioration of water quality ?	○	○	○	
		(2) Can the minimum water flow needed for water usage be maintained downstream of a dam or intake?	○			
		(3) Does reduction in water flow downstream (of a dam or an intake) or seawater intrusion adversely affect downstream water use and land use ?	○			
		(4) Does intake of water (both surface and ground) and discharge of heated cooling water adversely affect the existing conditions of water and river utilization, especially fishery ?		○		
		(5) Does intake of water (both surface and ground) and discharge of wastewater adversely affect the existing conditions of water and river utilization ?			○	
	Contagious or Infectious disease	(1) Are there any risks that the inflow of workers associated with the project will result in an outbreak of disease, including communicable diseases like HIV? Will it be possible to take proper measures to protect public health, if necessary?	○	○	○	○
		(2) Are there any risks that water-borne or water-related diseases, such as schistosomiasis, malaria and filariasis, will be introduced ?	○	○	○	
	Accidents	Do the prospective projects include large scale civil works which cause a large amount of traffic of heavy vehicles and equipment ?	○	○	○	○

Table 8.4.13 (c) Criteria for Scoping Items (3/6)

Category	Environmental Items	Check Items	Facility			
			Hydo Power	Thermal Power	Geo-thermal Power	Trans-mission Line
Natural Environment	Protected Area	Is it possible to locate the planned facilities so as to avoid protected areas designated by the national legislation or international treaties and conventions ? Will the project activities affect the protected areas?	○	○	○	○
	Geographical /Geological Features	(1) Is it likely that a large-scale alteration of topographic features and geologic structures will be brought about in the surrounding areas of the planned sites, such as land excavation, dredging and reclamation ?	○	○	○	○
		(2) Is it conceivable that the planned facilities will be inevitably situated in areas where topographic features and geologic structures are fragile and may easily result in slope failure, land slides and differential settlement ? In such a case, is there any measure to avoid or mitigate the possible impacts ?	○	○	○	○
		(3) Is it possible to avoid selecting a site where civil works such as land cutting and filling are frequently used on slopes with possible land failures and landslides ? Is it readily possible to take proper measures to prevent slope failures and landslides?	○	○	○	○
		(4) Is there a good risk that soil runoff will occur at land cutting and filling areas, spoil-banks, or borrowing pits ? Is it readily possible to take proper measures to prevent soil runoff ?	○	○	○	○
	Sediment & Hydrology	(1) When a hydropower plant with a dam and reservoir is concerned, do they usually make proper surveys and take sufficient mitigation measures for impacts on upstream and downstream riverbeds, and for erosion and sedimentation of rivers ?	○			
		(2) Is it likely that such structures as dams and weirs will be of the size that may cause changes to a river system or hydrological impacts on the surface or ground water flow ?	○			
		(3) Is there any plan to extract ground water or steam that may affect the ground water system or ground water usage in the surrounding area ?		○	○	
	Ecosystems/ Wildlife	(1) Does the planned project site extend over primeval forests, tropical natural forests, biological corridors or ecologically important habitats such as coral reefs, mangroves and tidal flats ?	○	○	○	○
		(2) Does the planned project site extend over the protected habitats and biological corridors of precious species designated by the country's laws or international treaties and conventions?	○	○	○	○
		(3) Is it likely that the project activities may cause serious impacts on important ecosystems even if the project site is outside of those systems ? For instance, are there any risks of deforestation and poaching under development activities, scattering or falling of atmospheric pollutants and oxides, desertification, or the drying of swamps ? Is there any risks that non-native species, pests and vectors are introduced through tree-planting and imported soil ?	○	○	○	○
		(4) Do they plan to install any blocking structures in the river where important migratory fish species are supposed to live ? If such biological information is insufficient, are there plans to take proper considerations for conducting the necessary surveys and measures ?	○			
		(5) Is there any plan to install such facilities that may possibly affect river systems where rich ecosystems or precious aquatic lives, fauna and flora keep habitats ?	○	○	○	

Table 8.4.13 (d) Criteria for Scoping Items (4/6)

Category	Environmental Items	Check Items	Facility: Hydo Power	Facility: Thermal Power	Facility: Geo-thermal Power	Facility: Trans-mission Line
Natural Environment	**Ecosystems/ Wildlife**	(6) Do they plan to take surface or ground water, and discharge thermal effluent and seepage water, which may affect water volume, temperature and quality of rivers and surrounding aquatic ecosystems ?	○	○	○	
		(7) In cases where the project site is located in an undeveloped area, is there a risk that the natural environment would be severely damaged by the local development and unexpected migration of people from outside? Is it in the scope of plan to take proper countermeasures to manage those issues ?	○	○	○	○
	Global warming	Does the planned power plant emit considerable greenhouse gases?		○		
Pollutions & Public Hazards	**Air Pollution**	(1) In selection of the project, do they employ a design policy to control air pollutants such as sulfur oxides (SOx), nitrogen oxides (NOx), soot and dust emitted from the power plant during operation ?		○		
		(2) In the case of coal-fired power plants, does the project include countermeasures to avoid air pollution due to fugitive coal dust from coal piles, coal handling facilities, and dust from coal ash disposal sites ?		○		
		(3) During planning is proper consideration given to multiple and cumulative impacts on the area that may be adversely affected by fixed and mobile sources of pollutants around the site.		○		
		(4) In the case of geothermal power plants, does the project include countermeasures against air pollution due to hydrogen sulfide emitted from the power plant ?			○	
	Water Pollution	(1) When a dam lake or a reservoir is concerned, is it possible to conduct an assessment study for water quality degradation and to take measures to control water pollution ? is it financially possible to prepare the proper budget for such measures ? For instance, 1) Can they prevent the impacts on aquatic lives and fishes due to the proliferation of water grass and abnormal outbreaks of animal/plant plankton ? 2) Can they supply the project cost for countermeasures against corrosion of trees in the dam lake or reservoir ? 3) Can they take measures for environmental management of waste water and garbage due to the inflow of waste around the watershed, and activities around the dam lake or reservoir such as tourism and fish farming after the development ? 4) Can they take measures for controlling the water quality of discharged water ? 5) Is it possible to follow environmental standards against the decrease of downstream water flow ?	○			
		(2) Do they include in the plan the cost for treating drain water from the power plant including thermal effluent ? Do they cover the cost enough to meet the effluent standards and environmental standards downstream.?		○		
		(3) In the case of coal fired power plants, do they include in the plan countermeasures against leachate from coal piles and coal ash disposal sites ?		○		
		(4) Do they include measures in the plan for treating fuel waste, drain water containing oil and leaked water from the power plant?		○		
		(5) In the case of geothermal power plants, do they include in the plan the cost of countermeasures against water pollution by arsenic and mercury during geothermal utilization ?			○	
		(6) Do they consider the measures against river water pollution due to soil runoff from the bare lands resulting from activities such as land cutting and filling ?	○	○	○	○

Table 8.4.13 (e) Criteria for Scoping Items (5/6)

Category	Environmental Items	Check Items	Facility			
			Hydo Power	Thermal Power	Geo-thermal Power	Trans-mission Line
Pollutions & Public Hazards	**Soil Contamination**	(1) Is there a risk of polluting the bottom sludge in a dam lake due to sedimentation of waste and rotted trees ?	○			
		(2) Is there a risk of concentrated pollutants in the riverbed soil caused by decreased river flow due to water intake and so on ?	○	○		
		(3) In the case of coal thermal power plants, is there a risk of soil contamination due to leachates from coal piles and coal ash disposal sites ?		○		
		(4) In the case of geothermal power plants, is there a risk of soil contamination caused by pollutants such as arsenic and mercury during geothermal utilization ?			○	
		(5) Is there a risk of hazardous earth and sand problems due to imported earth and sand or exposed underground earth and sand in such case as site development, land filling and cutting ?	○	○	○	○
	Waste	(1) Is there a good outlook for the proper treatment and disposal of earth and sand generated by excavation ? For instance, the plans for disposal criteria, disposal site and treatment methods.	○	○	○	○
		(2) Does the plan include a sub-plan for disposal and management of wastes such as debris and driftwood flowing in the reservoir, especially at intakes or dams ?	○			
		(3) Does the plan include a management plan for treatment and disposal of wastes such as waste oils and chemicals, coal ash and by-product gypsum from flue gas desulfurization that come out of the power plant operation ?		○		
	Noise & Vibration	(1) Do noise and vibrations during the operation of the power plant comply with ambient environmental standards, and occupational health and safety standards?	○	○	○	
		(2) Has the boundary of the site been planned so that it will not be near private homes either now or in the future? If such an arrangement is not possible, do they plan to install silencer walls or vibrating protection equipment for meeting the concerned standards?	○	○	○	
		(3) In the case of coal-fired power plants, do they consider the control of noise from the facilities for coal unloading, coal storage areas and facilities for coal handling in the site plan and the facility plan?		○		
	Others (Subsidence)	(1) Does the plan involve extraction of a large volume of groundwater that may cause subsidence ?		○		
		(2) Is there a risk of subsidence caused by steam extraction during geothermal power generation ?			○	
	(Odor)	Is there a risk of offensive odor due to air pollutants, water pollution, soil contamination and wastes ?	○	○	○	○
	(Radio interference)	Is there a risk of radio interference by transmission line towers and so on ? Is it likely that adequate countermeasures will be taken if significant radio interference is expected ?				○

Table 8.4.13 (f) Criteria for Scoping Items (6/6)

Category	Environmental Items	Check Items	Facility: Hydo Power	Facility: Thermal Power	Facility: Geo-thermal Power	Facility: Trans-mission Line
Pollutions & Public	**Accidents**	(1) In the case of dam construction, have they selected a proper location where emergency discharge is less frequently required and downstream danger are reduced ?	○			
		(2) In the case of a gas fired thermal power plant, have considerations at the planning stage been given to securing the safety of the gas pipelines? For example, have the sites and plans been considered so as to decrease the risk of explosions due to natural, human, facility or material factors? Has the site been selected so as to minimize damage in the event that there is an explosion?		○		
		(3) In the case of an oil thermal power plant, have considerations at the planning stage been given to raising the safety of fuel transportation? For example, have they selected sites while taking into consideration sailing route conditions and ship traffic to decrease the risk of oil spills caused by running aground or collisions involving large tankers.		○		
		(4) In the case of a coal fired thermal power plant, have considerations been giving in the planning of facilities and cost to prevent spontaneous combustion at the coal piles?		○		
		(5) In the case of a geothermal power plant, have considerations been giving in the planning phase to securing the safety of steam pipes?			○	
		(6) In the case of transmission lines, have considerations been given in the facility site plan to reduce the risks of local residents having accidents involving high voltage transmission lines?				○

(3) Environmental cost regarding power sector projects

In the contract, some environment-related works (such as slope stabilization) are cost items. Others will be absorbed in the contractor's general estimates.

(i) Case 1: Hydroelectric project (Run-of-River Type, Nepal, 1994-2002, ADB)[28]

The Bill of Quantities in the tender documents includes an item relating to implementation of the agreed EPHSP (Environmental Protection and Health and Safety Plans). Supervision of Environmental Mitigation Plan (EMPT) is a project cost to be borne by the employer. This includes the following:

• Staffing, training, equipping & operating PEMU[29] over the construction period
• Provision of environmental specialist staff for the engineer's team
• Contingencies for specialist consultancies
• Other inputs

This expenditure includes a major benefit for the proponent organization through professional staff training and capacity building. Costs are to be borne by the proponent if donor assistance is not forthcoming.

Table 8.4.14 Examples of Environmental Cost in Hydropower Project

Total cost of EMPT (8-year construction period)		Overall Total	$ 2 mil
	Cost items	Establishment of PEMU, including: ・ Start-up specialist training ・ Annual running costs for salaries and transport Engineer's cost: Environmental Specialist Staff	$ 0.265 mil $ 0.1 mil/yr $ 0.1 mil/yr
Total direct cost of ACRP[30] (for three projects of Stage 1)		Overall Total	$ 1.488 mil
	Cost items	Access Road Hydropower Components Transmission Line System	$ 1.224 mil $ 0.216 mil $ 0.048 mil
RAP[31] (over ten years)			$ 14.6 mil
Overall Total of EMPT, ACRP and RAP		3% of total Stage 1 project costs	

[28] Source: ADB, 1997, Environmental Impact Assessment for Developing Countries in Asia, Vol.2-Selected Case Studies, pp2-1 to 2-57
[29] PEMU stands for Project Environmental Management Unit.
[30] ACRP stands for the land acquisition, compensation and rehabilitation program.
[31] RAP stands for Regional Action Program.

(ii) Case 2 Peusangan Hydroelectric Power Project[32]

(Run-of-River type, Aceh Province, Indonesia, Planned for the period of 1996 –2000)

The concerned project was planned as a sub-project of 'the Power Development and Efficiency Enhancement Project in the Republic of Indonesia, ADB, 1995'[33]. Plans call for the generation of 86.4MW.

The costs for the Peusangan Hydroelectric Power Project were estimated as follows.

Project cost in actual financial terms: about US$ 218.8 million
in economic terms: about US$ 146.9 million
economic internal rate of return (EIRR): 12.8%
Compensation for the houses, land, and crops: about US$ 3 million
(This corresponds to 1.37% of the project cost in actual financial terms.)

(iii) Case3: Coal fired thermal power plant project (the Philippines, 1994-, ADB)[34]

Evaluated financial internal rate of return (FIRR) 18.5%
Evaluated economic internal rate of return (EIRR) 27.9%
Assumption for the evaluation:

(a) A plant service life of 25 years;
(b) Estimated total cost of $1,152 mil (incorporating the cost of environmental protection measures) includes:
    • 2 project phases (600 MW),
    • Transmission lines
    • 33% of the costs of the 500 kV transmission line, and
    • 33% of the costs of 500/230 kV and 230 kV substations
(c) Annual fixed O&M costs are 2.5% of total cost for transmission lines and substations
(d) The variable O&M costs of P0.067 per kWh and the fixed O&M costs of $5.3 mil/year for the plant
(e) The annual sales to be 3,641 GWh based on 3,942 GWh of generation with losses of 7.6% from consumption at the power plant and transmission losses
(f) The average tariff for the executing power corporation of P1.87/ kWh in 1994

[32] Peusangan Hydroelectric Power Project, 'ADB, June 1995, SEIA of the Power Development and Efficiency Enhancement Project in the Republic of Indonesia, p4'
[33] ADB, June 1995, SEIA of the Power Development and Efficiency Enhancement Project in the Republic of Indonesia
[34] Source: ADB, 1997, Environmental Impact Assessment for Developing Countries in Asia, Vol.2-Selected Case Studies, pp 3-1 to 3-27.

Table 8.4.15 Examples of Environmental Cost in Coal Thermal Power Project

Particular Cost Items	Cost (in million US$)
A. Noise and vibration countermeasures	
1. Use of low noise type equipment	Included in item A2
2. Use of silencers and impact absorbers such as rubber, polyethylene, neophrene	1.37
3. Installation of noise shielding walls	Included in item A2
4. Use of vibration dampers and correct installation of equipment	Included in item A2
5. Periodic noise monitoring and reporting	Included in item A2
B. Sox, NOx and dust emission countermeasures	
1. Use of 1% sulfur fuel oil	Operational requirement
2. Use of less than 1% sulfur coal	Operational requirement
3. Two-stage combustion method	Operational requirement
4. Use of efficient electric precipitator with guaranteed dust emission of less than 200 mg/Ncm	9.10
5. Adoption of high stack (150m/min.)	5.30
6. Stack monitoring equipment for SO_2, NO_2, SPM and opacity	3.40[a)]
7. Ambient monitoring instrument for SO_2, NO_2 and SPM	1.25[b)]
C. Countermeasures against coal spillage, flying coal dust, spontaneous combustion, odor and others	
1. Use of imported coal	Operational requirement
2. Use of continuous type unloader	34.90
3. Installation of coal / oil fence	Included in item C2
4. Installation of conveyor enclosure	Included in item C2
5. Installation of water spray system at coal yard & S/R	Included in item C2
6. Use of trees and other greenery as wind shield	
7. Installation of firefighting system	3.64
8. Use of coal compactors such as bulldozers	Included in item C2
9. Installation of coal stockpile temperature monitoring equipment	Included in item C2
10. Sedimentation of pit in coal yard; 1 meter high concrete retaining wall	3.16[c)]
11. Efficient coal inventory control	Operational requirement
12. Provision of public access to Oyon Bay	No cost implication
D. Countermeasures for dust, ground and seawater contamination or damage to marine resources	
1. Employment of dry-type ash disposal system	15.2
2. Installation of ash dehumidifier & efficient bag filters	Included in item D1
3. Use of sedimentation basin and neutralizing pit	Included in item D1
4. Ash compacting and covering with soil	Included in item D1
5.Water pool at the ash disposal area for washing dump tracks	Included in item D1
6. Building of dike before reclamation	7.05[d)]
7. Restoration of affected beach area	Included in item D6
8. Lining of ash pond with clay	Included in item D1
9. Monitoring of ground water quality	
10. No dredging of corals	Saving of 3.59 M
E. Countermeasures for Industrial Wastes	
1. Well designed drainage system	Included in item E2
2. Installation of wastewater treatment plant	4.40
3. Monitoring & reporting effluent quality	
F. Warm Water Discharge Counter Measures	
1. Limitation of discharge water temperature to 3ºC outside mixing zone	Operational requirement
2. Sufficient distance between the intake and discharge	Operational requirement
3. Proper selection of the discharge method	Operational requirement

4. Continuous residual chlorine analyzer	Included in item B7
5. Limit residual chlorine to 0.02 to 0.05 mg/l	Operational requirement
6. Continuous monitoring of pH, temperature and chlorine	Included in item B7
7. Provision of auxiliary pump to cool down effluents	5.58[e)]
F. Coastal Area Management Plan	
1. Fisheries management	0.004
2. Rehabilitation or enhancement of critical habitats	0.033
3. Rehabilitation of linked habitats	0.37
4. Alternative livelihood program	0.37
5. Mariculture development	0.02
6. Assessment and monitoring of marine ecology and water quality	0.70
TOTAL	**95.85**

a) Cost of boiler special instruments
b) Includes water quality monitoring equipment
c) Cost of foundation for coal storage yard
d) Cost of land reclamation
e) Cost of one boiler fee pump

8.4.3 Examination of Alternative Scenarios from ESC Aspect

The examination of alternative scenarios in the Optimal Electric Power Development Plan is based on simulation with the WASP-IV model. Therefore, it is necessary to examine conditions and results of the simulations from the ESC viewpoint. First, in section (1) we screened from the ESC viewpoints the eligibility of facilities that are included in the WASP-IV Least Cost Case simulation. Second, in section (2) we discussed how to apply the scoping results to the WASP-IV simulation in order to include ESC conditions in an alternative case.

(1) Screening of the concerned facilities in the Least Cost Case

In the WASP-IV model, various power facilities are examined as objects of the Least Cost Case for the optimal power development plan. As for the hydroelectric power plants, the facilities listed in Table 5.10.1 are the targets of the Least Cost Case calculation.

Since pre-feasibility, feasibility or EIA studies are proceeding for these facilities, none of them have such a decisively negative reason from the ESC aspect at present stage to be excluded from the objects of the Least Cost Case calculation. The thermal power plants also have no reasons at present to be excluded from examination because they are calculated with the conditions of a model plant and without any fixed locations.

However, the planned site for the Wampu hydropower plant is located near a national park (Gunnung Leuser), and there is the possibility that an access road and transmission lines might pass through a part of the park. Therefore, the Wampu site was put off the list. The planned Merangin hydropower plant is a dam-reservoir type facility utilizing a natural lake, and its power generation facilities and reservoir area might extend into the Kerinci Seblat National Park. A transmission line and access road may also pass through the park or a nature reserve. The plans for these facilities may have to be reviewed from the ESC aspect even if they are favorably evaluated as prospective plans in economic terms. Furthermore, from the standpoint of avoiding facilities standing on or passing through protected areas, we plan to set one of the alternative WASP-IV cases, mentioned in the following subsection as the ESC Weighted Case, where those facilities, such as Merangin, are excluded from simulation.

(2) Application of the Scoping Results

We propose two ways to apply the scoping results to alternative scenarios in this section. One way is to use the results for the WASP-IV calculation scenario itself by weighting the environmental and social impacts by type of power facility. This is an attempt to internalize ESC costs into the plan costs at the strategic level. The other is to analyze and evaluate the placement plans for power facilities in the power development plan[35] presented by the WASP-IV calculation, referring to the scoping results by type of power facility. We will discuss the former in the part (i) and the latter in the section (ii) and 8.4.4.

(i) Application to the calculation of an alternative case
(test case of internalization of environmental costs)

(a) Connecting environmental costs with the scoping results

As described in 8.2.2 -(3), environmental costs consists of so-called internal costs, usually estimated as the internal costs of a project, and so-called external costs, not included in items for the internal costs of a project.

Environmental Costs (T_{EC})

Internal Costs (I_{EC}) : Costs of measures for controlling and alleviating environmental impacts[36] that can be mitigated

External Costs (E_{EC}) : Adverse environmental impacts and damages that cannot be mitigated

$T_{EC} = I_{EC} + E_{EC}$ .... <Equation 1>

[35] Least Cost Case (least cost plan) and alternatives (restricted CO_2 emission scenario, limited gas supply scenario, ESC weighted scenario, others)

[36] Includes negative social impacts.

Internal and external costs can be broken down into the following items.

I_{EC} = (Costs for Environmental Study) + Mitigation Costs
+ Environmental Management Costs

- Costs for Environmental Study include assessment costs and others
- Mitigation Costs include environmental conservation measures, social considerations, compensations for resettlement and land acquisition
- Environmental Management Costs include management, monitoring and periodical environmental reporting

E_{EC} = loss of livelihood basis by resettlement and other reasons
+ human health and mental damage by pollution and public hazards
+ loss of values of ecosystems and landscapes that are both utilized and unutilized
+ increased negative impacts and risks on communities
+ α (such as global environmental impacts)

These are encoded in the following manner:

a. Environmental Study Costs <I_{EC}>
b. Compensations for resettlement and land acquisition <I_{EC}>
c. Mitigation Costs (excluding resettlement and land acquisition costs) <I_{EC}>
d. Environmental Management Costs <I_{EC}>
e. External Costs <E_{EC}>

Then, the next equation is formed with Equation 1, regarding total environmental cost (T_{EC}) as a summation of internal and external costs

$T_{EC} = a + b + c + d + e$ ———————— <Equation 2>

Actually, we showed existing environmental cost cases in the section 8.4.2, (4). Organizing the cases according to the above categories and obtaining ratios (%) to the total are as shown in Table 8.4.16. For reference, in the case of a run-of-river type power facility, T_{EC} can be assumed to be approximately 5% of the total project costs. This is the total for 3% of total project costs (internal costs) plus α (external costs). In the case of a coal thermal power plant, T_{EC} can be assumed to be approximately 10% of total project costs. This is the total of a little more than 8% of total project costs (internal costs) plus α (external costs). Certainly, these ratios cannot be generalized instantly since these existing cases are subject to specific conditions where the projects are located. These numbers are the results of summation of individually estimated items when specific projects have been formed. On the other hand, this study does not target the planning of a specific project, but does the basic program to organize many prospective projects and give a base for the needs of individual projects, examining the composition of projects, placement of facilities and deployment schedule. Therefore, this study does not aim to internalize the environmental costs of a specific project. Rather, that the aim is to have the difference in environmental impacts (costs) by power facility type reflected in the WASP-IV calculation of alternative cases and scenario examinations. Thus, for the purpose of utilizing numbers from existing cases, in examining the target plan of this study it is more useful to put attention on a project cost and its environmental cost ratio by type of facility rather than put attention on the ratios of the above categories, a, b, c and others.

Table 8.4.16 Environmental Cost Ratios for Existing Cases

UNIT: % to total project cost

	a.	b.	c.	d.	e.	Total
Hydropower Plant Case[37]	0.247	0.332		2.42	α	$3 + \alpha$ ($\approx$ 5)
Hydropower Plant Case[38]	1.37	-	-	-	-	-
Thermal power plant Case[39]	-	8.32			β	$8.32 + \beta$ ($\approx$ 10)

Regarding the relation between Environmental Costs (T_{EC}) and total impacts evaluated by scoping[40], '$T_{EC} \approx$ means the total impacts can be assumed to exist conceptually. That is to say, the following approximate equation holds well by type of facility.

a + b + c + d[41] + e ≈ impact level evaluated by the scoping ——— <Equation 3>

[37] ADB, 1997, Environmental Impact Assessment for Developing Countries in Asia, Vol.2-Selected Case Studies, pp2-1 to 2-57; Run of River Type

[38] ADB, June 1995, SEIA of the Power Development and Efficiency Enhancement Project in the Republic of Indonesia, p13; Run of River Type

[39] ADB, 1997, Environmental Impact Assessment for Developing Countries in Asia, Vol.2-Selected Case Studies, pp 3-1 to 3-27; Coal Thermal

[40] See Table8.4.12.

[41] Environmental management costs (EMC) mainly applies to the operational phase of facilities. In principle, scoping will make an initial evaluation for total impacts by a project, including the operational phase. However, indirect impacts also make appearance in the operational phase. It varies by planning, assessment method and type of project just how much the environmental change, the object of environmental management, are covered by impacts level evaluated by scoping. In other words, how much EMC unexpected at a planning phase becomes necessary at the operational phase. In the calculation of WASP-IV on an ESC weighted case, both the capital costs and the operational costs are weighted by the same factor of ESC impacts. If EMC at the operational phase are given separately from the total, it will be possible to examine their contributions to the capital cost factor and operational cost factor (or coefficient) respectively. The operation cost of hydropower is not considered in the WASP-IV simulation because it does not use any fuel and its O&M cost is too little to consider in the simulation.

(b) WASP-IV model calculation and Environmental Costs

1) Application to WASP-IV calculation

WASP-IV is the model where calculation is made on costs of different power facilities and an optimal development plan of power facilities is simulated by a calculation based on the least cost method. The Least Cost Case is calculated with the WASP-IV. In comparison, here we will examine an alternative case that puts more importance on ESC.

To make an ESC weighted alternative plan calculated by WASP-IV, it is necessary to find the ESC factor through the calculation of the alternative scenario. First of all, we convert the scoping results into numerical quantities (scores) to apply these results to the WASP-IV calculation. With numerical scores summed up by type of facility, we have total scores for each type of facility. We assume the score to be the impact level of each type of facility, in other words the environmental costs (T_{EC}) for the corresponding facility (See Equation 2 and 3). Then, the score is applied to scenario calculation by the WASP-IV model (examination of the alternative cases that put importance on risk considerations for negative environmental and social impacts). However, in the Least Cost Case it is assumed that the already internalized part of environmental costs is included in the total cost of the corresponding project. At the present stage, we can only obtain a lump sum of total project cost. Assuming a certain amount[42] of environmental costs is already included in project costs, we multiply it by the load factor that is relative to the impact level of each type of facility. By adding its result to the corresponding project cost in the Least Cost Case, we reach the WASP-IV model for the ESC weighted case.

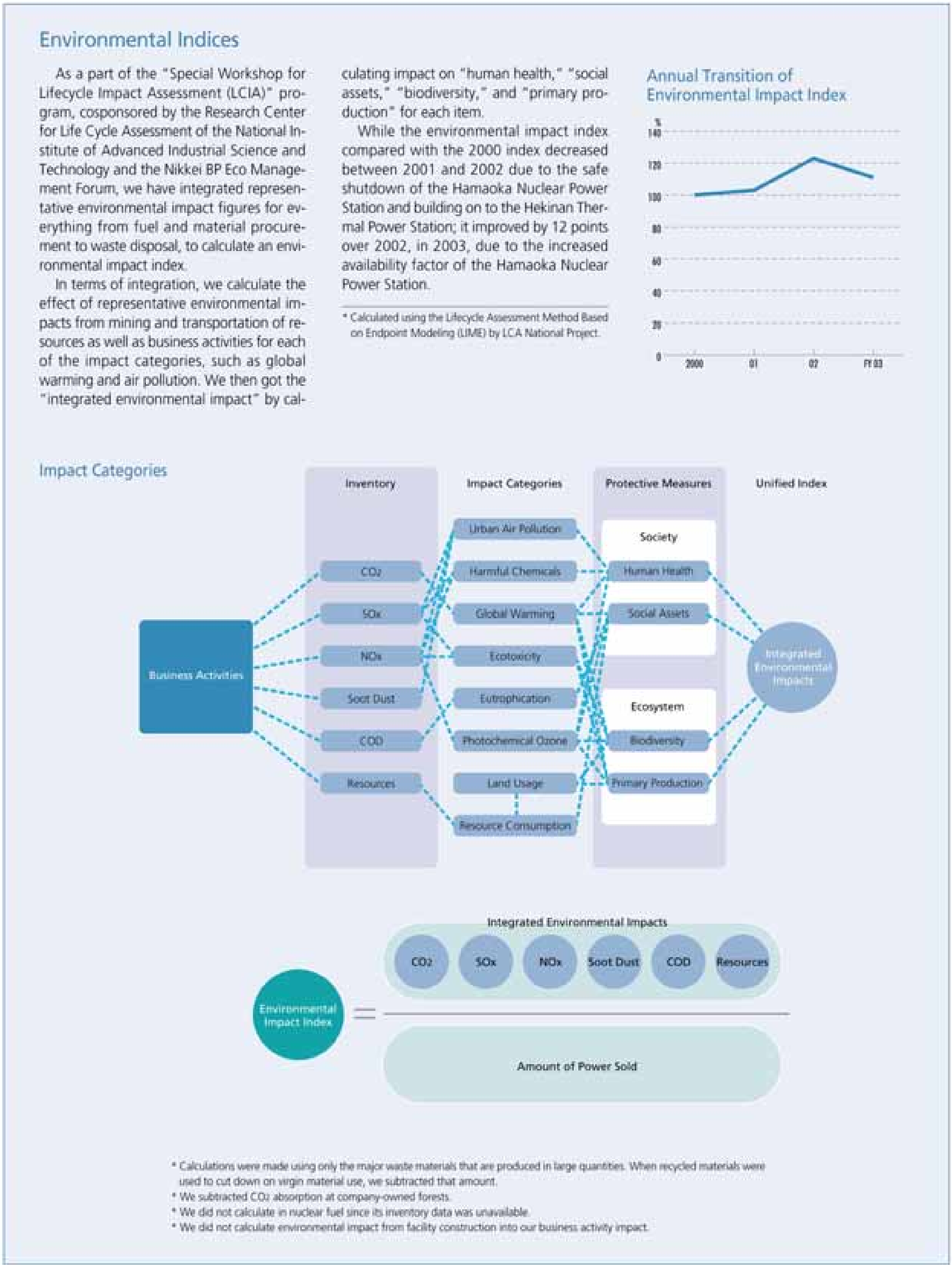
2) Converting the scoping results into numerical quantities[43]

Here we will convert the impact level of each facility type into numerical quantity. For the scoping results on Table 8.4.12, A is given a score of 3, B a score of 2, and C a score of 1. The results of summing up the total score by each type of facility are shown on the first line of Table8.4.17. On the second line, impact levels by type of facility are normalized, assuming “gas turbine with natural gas” as the impact level of 1. On the third line, we find an ESC factor, which means additional (external) costs except the internal costs assumed to be 10% of capital costs and operation costs in the WASP-IV simulation, to add environmental cost in the Least Cost Case in order to calculate an ESC weighted alternative case in WASP-IV[44]

[42] Examining many ratios based on Table 8.4.16 in the last section, we could observe the relative ratios of each facility type in agreement with the common sense of experts in the power sector when we suppose it as 10%. So, here we assume it to be 10%.

[43] Different environmental items must be described by one index if environmental impacts are to be converted into numerical quantities. For an extreme example, level of air pollution impact and that of resettlement have to be compared with the same index. Therefore, it is realistically too difficult to describe environmental impacts by one index because environmental impacts are caused by complicated mechanisms, in addition, the impact differs between affected subjects. Many institutes have been trying to convert environmental impacts into numerical quantities. The next page shows example of the environmental impact index applied by LIME to Chubu Electric Power Co., Inc. It is hoped that environmental indices will become more popular in the future by advancing our studies. This study tries to convert environmental impacts into numerical quantities by applying the scoping results shown in Table 8.4.12.

[44] (Normalized Index Score - 1)＊0.1/ 1.1



Environmental Indices

As a part of the "Special Workshop for Lifecycle Impact Assessment (LCIA)" program, cosponsored by the Research Center for Life Cycle Assessment of the National Institute of Advanced Industrial Science and Technology and the Nikkei BP Eco Management Forum, we have integrated representative environmental impact figures for everything from fuel and material procurement to waste disposal, to calculate an environmental impact index.

In terms of integration, we calculate the effect of representative environmental impacts from mining and transportation of resources as well as business activities for each of the impact categories, such as global warming and air pollution. We then got the "integrated environmental impact" by calculating impact on "human health," "social assets," "biodiversity," and "primary production" for each item.

While the environmental impact index compared with the 2000 index decreased between 2001 and 2002 due to the safe shutdown of the Hamaoka Nuclear Power Station and building on to the Hekinan Thermal Power Station; it improved by 12 points over 2002, in 2003, due to the increased availability factor of the Hamaoka Nuclear Power Station.

* Calculated using the Lifecycle Assessment Method Based on Endpoint Modeling (LIME) by LCA National Project.

* Calculations were made using only the major waste materials that are produced in large quantities. When recycled materials were used to cut down on virgin material use, we subtracted that amount.
* We subtracted CO_2 absorption at company-owned forests.
* We did not calculate in nuclear fuel since its inventory data was unavailable.
* We did not calculate environmental impact from facility construction into our business activity impact.

Figure 8.4.2 Example for Environmental Indices Calculated Using the Lifecycle Assessment Method Based on Endpoint Modeling (LIME) by LCA National Project[45]

[45] Source: 2004 Edition Annual Environmental Report, Chubu Electric Power Co., Inc., June 2004

Table 8.4.17 Environmental Impact Level (ESC Factor) by Type of Facility

Facility Type			Scoping Total	Normalized Index Score (GTG/ DO=1)	ESC Factor
Hydropower	Dam/ Reservoir		51	1.65	5.9%
	Run-of River		39	1.26	2.4%
	Mini Micro		22	0.71	-2.6%
Thermal Power	Steam Turbine	Coal*	48	1.55	5.0%
			43	1.39	3.5%
		Gas*	45	1.45	4.1%
			40	1.29	2.6%
		Oil (M)*	47	1.52	4.7%
			42	1.35	3.2%
	Combined Cycle	Gas*	45	1.45	4.1%
			40	1.29	2.6%
		Oil (H)*	47	1.52	4.7%
			42	1.35	3.2%
	Gas Turbine	Gas*	31	1.00	0.0%
		Oil (H) *	33	1.06	0.5%
	Diesel	Oil (H)	33	1.06	0.5%
		Oil (M)	33	1.06	0.5%
Geo-Thermal			41	1.32	2.9%

Note: For those facility types marked with *, the lower line is applied to thermal power plant with a cooling tower system for condenser cooling water.
ESC Factor = (b-1) * 0.1 / 1.1
$T_{EC} \approx$ ESC Factor + 10% internalized environmental cost (it is assumed that 10% is already included in the Least Cost Case)

(ii) Evaluation from the ESC Aspect on Simulation Results for the Least Cost Power Development Plan and Case Studies

In this sub-section, the simulation results for the Least Cost Power Development Plan will be evaluated from the environmental and social consideration (ESC) aspects. The evaluation does not focus on each individual project, but the power development plans at the master plan stage will comprehensively be evaluated from the ESC aspect. In specific, the major target is to compare simulation results on each case study with that of the Least Cost Power Development Plan (Least Cost Case) which are studied in Chapter 4.

On the other hand, the individual project should be assessed in accordance with the following laws, regulations and standards:

○ Attachment 8.2 Environmental Legislation and Regulations in Relation to Power Sector[46]
○ Attachment 8.3 Environmental Standards Related to Power Sector[47]

[46] (1) General legislations on environmental protection, (2) Environmental Impact Assessment (EIA), (3) Pollution control, (4) Toxic and hazardous substances, (5) Forest and natural resources management, are shown.
[47] (1) Environmental quality standards for water, (2) Standards for effluent water quality, (3) Environmental quality standards for air pollution, (4) Standards for emission gas, (5) Environmental standards for noise, (6) Hazardous waste from specific sources, are shown.

In addition, Attachment 8.1 shows projects and activities subjects that are subject to Environmental Impact Assessment. Specific development plans are required for the securing, maintaining and managing needed to follow the laws, regulations and standards mentioned above in the procedures of the Environmental Impact Assessment (EIA, AMDAL).

(a) Least-cost Case

In the Low Demand Case of the least cost case, the total installed capacity will reach 6,724MW in 2020 and will be 2.3 times as large as 2,878MW in 2004. It consists of: 2,217MW existing power plants, 16 sites and 1,627MW in fixed projects, and 24 units and 2,880MW in candidate projects. In the High Demand Case, the total installed capacity will reach 8,374MW in 2020 and will be 2.9 times as large as that in 2004. In that case, candidate projects are increased by 39 units and 4,580MW compared to the Low Demand Case. Fixed projects consist of 2 sites and 430MW in coal thermal power plants, 5 sites and 146MW in gas turbine thermal power plants, 2 sites and 232MW in combined-cycle thermal power plants, 2 sites and 275MW in geothermal power plants, 4 sites and 479MW in hydropower plants, and 65MW increase in power purchase.

As for candidate projects, in the Low Demand Case coal thermal power plants (unit installed capacity: 100MW) will reach 13 units with 1,300MW in total (45.1% of all candidate projects), combined-cycle power plants with gas fuel (unit installed capacity: 150MW) will reach 1 unit with 150MW (5.2%), hydropower plants will reach 6 sites with 1,230MW (42.7%), and gas turbine thermal power plants (unit installed capacity: 50MW) will be 4 units with 200MW (6.9%). In the High Demand Case, coal thermal power plants will reach 23 units with 2,300MW in total (50.8% of total candidate projects), combined-cycle power plants will reach 5 units with 750MW (16.6%), hydropower plants will reach 6 sites with 1,230MW (27.2%), and gas turbine thermal power plants will reach 5 units with 250MW (5.5%).

In the both cases, coal thermal will rank first in total installed capacity and account for around a half of the total developed installed capacity. This result reflects the economy of coal thermal power plants whose fuel cost is low as a base power source. In the High Demand Case, coal thermal power plant will be developed 1.8 times as large as that in the Low Demand Case. Hydropower plant will rank second in total installed capacity following coal thermal power plant, and will reach 1,230MW in the both High and Low Demand Cases. In the Low Demand Case, gas turbine thermal power plant and combined-cycle thermal power plants will rank third and forth following coal thermal and hydropower while combined-cycle thermal and gas turbine thermal power will rank third and forth in the High Demand Case.

Table 8.4.18 Development Plan of Fixed Projects

(MW)

No.	Power Plant Name	Type	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total
1	Tarahan	PLTU				200						200
2	Labuhan Angin	PLTU					230					230
	PLTU Total					**200**	**230**					**430**
-	(Palembang Timur GT)	(PLTG)	100	-100								0
3	Truck Mounted	PLTG	40									40
4	Indralaya	PLTG	40									40
5	Talang Dukuh 2	PLTG	15									15
6	Apung	PLTG		33								33
7	PuloGadung	PLTG		18								18
	PLTG Total		**195**	**-49**								**146**
8	Palembang Timur CC	PLTGU		150								150
9	Keramasan CC	PLTGU							82			82
	PLTGU Total			**150**					**82**			**232**
10	Sarulla	PLTP						110	55			165
11	Ulu Belu	PLTP							110			110
	PLTP Total							**110**	**165**			**275**
12	Sipansihaporas 1	PLTA	33									33
13	Renun	PLTA		82								82
14	Musi	PLTA			210							210
15	Asahan III	PLTA									154	154
	PLTA Total		**33**	**82**	**210**						**154**	**479**
16	Inalum (additional)	PLTA		65								65
	Special Total			**65**								**65**
	Total		**228**	**248**	**210**	**200**	**230**	**110**	**247**	**0**	**154**	**1,627**

Table 8.4.19 Capacity Transition Plan of Existing Power Plants by Type

(MW)

Type	2004	2005	2006	2007	2008	2009	2010	2011	2012 ~2020
PLTU	746	746	746	746	746	486	486	486	486
PLTD	291	295	295	75	75	0	0	0	0
PLTG	431	442	442	442	442	340	340	340	340
PLTGU	818	818	818	818	818	818	818	818	818
PLTP	0	0	0	0	0	0	0	0	0
PLTA	522	522	522	522	522	522	522	522	522
Mini HP	8	8	8	8	8	8	8	8	8
Special	64	45	45	45	45	45	45	45	45
Total	**2,878**	**2,875**	**2,875**	**2,655**	**2,655**	**2,217**	**2,217**	**2,217**	**2,217**

Table 8.4.20 Least-cost Case (Low Demand Case: 2020)

Least-cost Case (Low Demand Case) (Number)

	PLTU	PLTG	PLTGU	PLTP	PLTA	Special	Total
Fixed Project	2	5	2	2	4	1	16
Candidate Project	13	4	1	0	6	0	24
Total	**15**	**9**	**3**	**2**	**10**	**1**	**40**

(MW)

	PLTU	PLTG	PLTGU	PLTP	PLTA	Special	Total
Existing Plant	486	340	818	0	529	45	2,217
Fixed Project	430	146	232	275	479	65	1,627
Candidate Project	1,300 (45.1%)	200 (6.9%)	150 (5.2%)	0 (0.0%)	1,230 (42.7%)	0 (0.0%)	2,880 (100.0%)
Fixed + Candidate Project	1,730 (38.4%)	346 (7.7%)	382 (8.5%)	275 (6.1%)	1,709 (37.9%)	65 (1.4%)	4,507 (100.0%)
Total	**2,216 (32.9%)**	**686 (10.2%)**	**1,200 (17.8%)**	**275 (4.1%)**	**2,238 (33.3%)**	**110 (1.6%)**	**6,724 (100.0%)**

Table 8.4.21 Least-cost Case (High Demand Case: 2020)

Least-cost Case (High Demand Case) (Number)

	PLTU	PLTG	PLTGU	PLTP	PLTA	Special	Total
Fixed Project	2	5	2	2	4	1	16
Candidate Project	23	5	5	0	6	0	39
Total	**25**	**10**	**7**	**2**	**10**	**1**	**55**

(MW)

	PLTU	PLTG	PLTGU	PLTP	PLTA	Special	Total
Existing Plant	486	340	818	0	529	45	2,217
Fixed Project	430	146	232	275	479	65	1,627
Candidate Project	2,300 (50.8%)	250 (5.5%)	750 (16.6%)	0 (0.0%)	1,230 (27.2%)	0 (0.0%)	4,530 (100.0%)
Fixed + Candidate Project	2,730 (44.3%)	396 (6.4%)	982 (15.9%)	275 (4.5%)	1,709 (27.8%)	65 (1.1%)	6,157 (100.0%)
Total	**3,216** **(38.4%)**	**736** **(8.8%)**	**1,800** **(21.5%)**	**275** **(3.3%)**	**2,238** **(26.7%)**	**110** **(1.3%)**	**8,374** **(100.0%)**

Source: Produced by retouching "Protected Areas in Indonesia", as of December 2003, Ministry of Forestry, Directorate General of Forest Protection and Natural Conservation)

Figure 8.4.3 Protected Areas in Sumatra and Locations of Newly Developing Power Plants

The simulation results are evaluated from the ESC viewpoint as follows:

(Coal Thermal Power Plant)

- Coal thermal will be developed with a total capacity of 2,730MW in the High Demand Case and 1,730MW in the Low Demand Case together with existing plants (430MW) and candidate projects (High Demand Case: 2,300MW, Low Demand Case: 1,300MW).

- Since coal thermal power plants may cause impacts on air pollution such as SOx, NOx, soot and dust, impacts on water pollution such as leach ate from coal piles and ash disposal sites, and problems regarding the disposal and treatment of waste such as coal ash will require careful consideration.

- Other than the impacts mentioned above, careful consideration should also be given to impacts on existing water utilization by intake or discharge of condenser cooling water, impacts on ecosystems and wildlife by thermal water discharge, and problems caused by noise and vibration.

- In addition, careful consideration should also be given to impacts on environmentally protected areas and secondary impacts on them, impacts on local landscape, and any impacts on such economic activities as agriculture and fishery in cases where the power plant is developed at the mouth of river or along the coastal areas.

- Coal thermal power plants will be developed so as many as 23 units/ 2,300MW in the High Demand Case, 13 units/ 1,300MW in the Low Demand Case and so careful consideration should especially be given if some of these plants are located in the same sites. In specific, coal thermal is likely to be intensively developed as mine-mouth thermal power plants in the south region of Sumatra because there are many potential deposits of coal resources. Since coal thermal power plants will predominate over the system (38.4% in the High Demand Case, 32.9% in the Low Demand Case), global warming issues caused by CO_2 emissions may arise.

(Combined-Cycle Thermal Power Plant)

- Combined-cycle thermal will be developed with a total capacity of 982MW in the High Demand Case and 382MW in the Low Demand Case, together with existing plants (232MW) and candidate projects (High Demand Case: 750MW, Low Demand Case: 150MW).

- As for combined cycle thermal power plants, careful consideration should be given to air pollution such as NOx depending on in the project location. However, since the combined cycle thermal power plant is a type of power generation that makes very efficient use of natural gas fuel and since the total installed capacity developed during the period will be less than that of coal thermal, impacts on air pollution caused by combined-cycle thermal will be estimated as being less than that of coal thermal.

- Careful consideration should be given to impacts on water quality by thermal water discharge, impacts on existing water utilization by intake or discharge of condenser cooling water, impacts on ecosystems and wildlife by thermal water discharge, and problems caused by noise and vibration.

- In addition, careful consideration should also be given to impacts on environmentally protected areas and secondary impacts on them, impacts on local landscape, and any impacts on economic activities such as agriculture and fishery when the power plant is developed at the mouth of a river or along the coastal areas.

- Since the total development capacity will reach 5 units, 750MW in the High Demand Case and 982MW together with 2 fixed projects (Palembang Timur and Keramasan), careful consideration will need to be given to the above-mentioned points if these plants are intensively located.

- As for safety aspects, the safety of gas pipelines to power plants should be properly secured.

(Hydropower Plant)

- The candidate projects will reach 5 sites with 830MW in total capacity and 10 sites with 1,709MW together with fixed projects (4sites, 479MW) that are the same in both the High Demand Case and Low Demand Case.

- The candidate projects consist of: 1 site (100MW) with run-of-river type, Asahan I (180MW), Merangin (350MW) with dam/ reservoir type, and 3 dam/ reservoir type hydropower plants (2 sites with 100MW each and 1 site with 400MW).

- As for hydropower plant, careful consideration should be given to impacts on water utilization, ecosystems and wildlife along the areas affected by river diversion. And careful consideration should also be given to making plans to avoid environmentally protected areas and secondary impacts. Merangin hydropower is a reservoir type hydropower plant which utilizes the natural lake Kerinci, but it is not immediately located in the Kerinci Seblat National Park. It is, however, assumed that a development plan will include relevant facilities such as transmission lines and access roads which will pass through the national park or natural preservation areas because the power plant is surrounded with the park. In spite of this, since the detail plan is not decided, it is necessary to reassess whether the project should be implemented after taking into account the environmental impacts at the stage when the plan is materialized.

- As for a dam/ reservoir type hydropower, attention should specifically be paid to the impacts on society such as resettlement due to the existence of a large-scale reservoir, impacts on minorities and weak members of society due to change in life style, impacts on local society due to physical separation by a reservoir, disappearance of a heritage due to submergence, and change in the local landscape. If a run-of-river type hydropower project causes resettlement based on the project plan, careful consideration should also be given. For example, the Asahan III project originally required the resettlement of about 100 households at the early stage of planning because it was planned as a dam/reservoir type hydropower. But it has been changed to a run-of-river type hydropower project that mitigated impacts and resulted in the resettlement of only 10 households.

- As for hydropower in Sumatra, the resettled residents from the Kotopanjang hydropower site in Riau province have recently filed a lawsuit against the Japanese Government because they were not satisfied with the resettlement. This has taught us that careful consideration should be given to any dam/reservoir type hydropower project with resettlement plan by applying the Strategic Environmental Assessment (SEA) including information disclosure to the public and opinion exchanges through stakeholder meetings at the early project stages such as at the formulation stage of a master plan.

- In addition, as for a dam/reservoir type hydropower plant, careful consideration should be given to sedimentation in a reservoir, erosion at downstream riverbanks, water deterioration in a reservoir such as eutrophication and turbidity for long-term issues due to waste flowing into a reservoir and issues on slope collapses and landslides around a reservoir caused by the existence of a reservoir and fluctuation in a water level. Downstream safety involving discharge from a dam and an outlet, and safety against dam collapse should be secured.

- Hydropower plants, for which the careful considerations mentioned above are given, shall have the merit of clean and renewable energy which produces little CO_2.

(Gas Turbine Thermal Power Plant)

- Gas turbine thermal power plants consisting of 4 units/ 200MW in the Low Demand Case and 5 units/ 250MW in the High Demand Case will be developed as candidate projects in 2007. They will reach totals of 346MW and 396MW together with 5 sites / 146MW in fixed projects.

- Candidate gas turbine thermal power plants will be developed to meet the demand as an emergency countermeasure (a short-term countermeasure) as soon as 2007 when the other types of economical power plants cannot be commissioned. This is because these plants can be developed for a short period compared with the other power sources, in spite of being a less economical power source than the others.

- A gas turbine power plant itself causes less impact than the other types of thermal power because its unit capacity (50MW) is smaller than the other power sources and it uses natural gas with better quality. It can avoid impacts on social environment with less difficulty because it can be developed anywhere as it only need a small amount of space.

- From pollution aspects, careful consideration should specifically be given to noise and vibration issues because the plants can be situated close to urban residences in a load center. In addition, the safety of gas pipelines must be secured if fuel for the plant is supplied through gas pipelines.

- The same environmental considerations as with a large-scale thermal power plant, such as combined-cycle thermal power plants with the same fuel, are specifically necessary if a lot of these plants are located in the same places. In this case, careful consideration should be given to air pollution, impacts on environmentally protected areas and impacts on the social environment.

- In order to reduce environmental impact, it is possible to change, in the future, gas turbine thermal power plants developed as short-term countermeasures into combined cycle thermal power plants with higher efficiency by adding steam turbine units. However, this will depend on conditions such as size and location of the site. It is important that deliberate consideration will be given to this when a specific plan is formulated.

(Geothermal Power Plant)

- A geothermal power plant with 2 sites (275MW) will be developed as fixed projects, while there will be no candidate projects by 2020.

- Careful consideration should be given to planning geothermal power plants to avoid environmentally protected areas and secondary impacts on the areas because potential geothermal power plants are likely to be situated in environmentally protected areas and/or near the areas like where hydropower plants are situated. Careful consideration should sometimes be given to impacts on a local landscape. There are no environmentally protected areas near the Sarula site in North Sumatra province and the Ulebelu site in Lampung province.

- Careful consideration should be given to impact on utilization of underground water in surrounding areas due to any impact on underground water structures because geothermal power utilizes underground thermal sources and hot steam. In addition, since extracting underground steam may cause air pollution by hydrogen sulfide and water contamination due to toxic substances such as arsenic and mercury, countermeasures returning the substances to deep underground by return wells should be taken. Depending on the location of the site, for example the plant is located near residential areas, careful consideration should also be given to such issues as noise and vibration. The safety of high-pressure steam pipelines should specifically be secured if the pipelines are situated close to residential areas.

(Diesel Power Plant)

- There will not be any fixed projects nor any candidate projects for diesel power plants. All of the existing diesel power plants with a total capacity of around 300MW will be decommissioned by 2009.

- Almost all existing diesel power plants are so old and less efficient in generation that the impacts on the environment would be higher than those from new power plants. The existing diesel power plants will seemingly be replaced with other new power sources in the future such as thermal power and hydropower. Therefore, the decommissioning of existing diesel power plants is desirable from the environmental aspects.

- However, if planned new power plants are not successfully developed in the future, existing diesel power plants, as emergency countermeasures, will be relocated to Sumatra from other regions. In that case, the relocation should be done while making the proper environmental and social considerations.

- Diesel power plants are likely to be situated in urban areas. Therefore, careful consideration, specifically for noise and vibration issues and impacts on air pollution, should be given for this development. In addition, attention to impacts from air pollution should specifically be given if the diesel power plant uses fuel containing harmful constituents such as heavy fuel oil.

The below tables refer to the comparisons in the total capacity of candidate projects, the total investment cost and the system cost up to 2020, of the CO_2 Emission Prevention Case, the Limited Natural Gas Supply Case, the ESC Weighted Case and the ESC Weighted Case without Merangin Hydropower Plant with those of the Least-cost Case. The following subsections from (b) to (d) describe the comparisons between the cases with the Least-cost Case. The subsection (e) describes the comparison between the ESC Weighted Case and the ESC Weighed Case without Merangin HPP.

Table 8.4.22 Comparison in Total Capacity of Candidate Projects up to 2020 (Low Demand Case)

(Unit: MW)

Case	PLTU		PLTG		PLTGU		PLTA		Total	
	Total Capacity	*deviation*	Total Capacity	*deviation*	Total Capacity	*deviation*	Total Capacity	*deviation*	Total Capacity	*deviation*
Least-cost Case	1,300	*Base*	200	*Base*	150	*Base*	1,230	*Base*	2,880	*Base*
CO_2 Emission Prevention Case	600	*-700*	200	*0*	750	*600*	1,230	*0*	2,780	*-100*
Limited Natural Gas Supply Case	1,400	*100*	200	*0*	150	*0*	1,230	*0*	2,980	*100*
ESC Weighted Case	1,300	*0*	200	*0*	150	*0*	1,230	*0*	2,880	*0*
ESC Weighted Case without Merangin HPP	1,400	*100*	200	*0*	300	*150*	880	*-350*	2,780	*-100*

Table 8.4.23 Comparison in Total Capacity of Candidate Projects up to 2020 (High Demand Case)

(Unit: MW)

Case	PLTU		PLTG		PLTGU		PLTA		Total	
	Total Capacity	deviation	Total Capacity	deviation	Total Capacity	deviation	Total Capacity	deviation	Total Capacity	deviation
Least-cost Case	**2,300**	***Base***	**250**	***Base***	**750**	***Base***	**1,230**	***Base***	**4,530**	***Base***
CO_2 Emission Prevention Case	**1,000**	***-1,300***	**250**	***0***	**2,100**	***1,350***	**1,230**	***0***	**4,580**	***50***
Limited Natural Gas Supply Case	**2,900**	***600***	**250**	***0***	**150**	***-600***	**1,230**	***0***	**4,530**	***0***
ESC Weighted Case	**2,300**	***0***	**250**	***0***	**750**	***0***	**1,230**	***0***	**4,530**	***0***
ESC Weighted Case without Merangin HPP	**2,900**	***600***	**350**	***100***	**450**	***-300***	**880**	***-350***	**4,580**	***50***

Table 8.4.24 Comparison in Investment Cost (total investment cost up to 2020)

(Unit: million US$)

Case	Low Demand Case		High Demand Case	
	Total Investment Cost	*deviation*	Total Investment Cost	*deviation*
Least-cost Case	**3,454**	***Base***	**4,836.5**	***Base***
CO_2 Emission Prevention Case	3,114	*-340*	4,346.5	*-490*
Limited Natural Gas Supply Case	3,554	*100*	5,076.5	*240*
ESC Weighted Case	3,454	*0*	4,836.5	*0*
ESC Weighted Case without Merangin HPP	3,218	*-236*	4,875.5	*39*

Table 8.4.25 Comparison in System Cost (total system cost up to 2020)[48]

(Unit: million US$, NPV in 2003)

Case	Low Demand Case		High Demand Case	
	Sysytem Cost	*deviation*	System Cost	*deviation*
Least-cost Case	**5,248**	***Base***	**6,237**	***Base***
CO_2 Emission Prevention Case	5,228	*-20*	6,220	*-17*
Limited Natural Gas Supply Case	5,263	*15*	6,275	*38*
ESC Weighted Case	5,248	*0*	6,237	*0*
ESC Weighted Case without Merangin HPP	5,252	*4*	6,277	*40*

(b) CO_2 Emission Prevention Case

The differences in the results until 2020 between the Least-cost Case and the CO_2 Emission Prevention Case are as follows:

[48] The Table shows the system cost of the CO_2 Emission Prevention Case is lower than that of the Least-cost Case. But the system cost up to 2025 of the Least-cost Case is the lowest among the cases.

- The total developed capacity of the candidate projects up to 2020 will reach 2,780MW which is 100MW lower than that in the Least-cost Case in the Low Demand Case, while it will reach 4,580MW which is 50MW higher in the High Demand Case,

- From power plant type aspects, coal thermal until 2020 sharply decreases to 6 units which are almost half of 13 units in the Low Demand Case of the Least-cost Case (-700MW). On the other hand, combined-cycle thermal increases by 4 units (+300MW) from 1 unit (150MW) to 5 units (750MW), while hydropower remains the same development but 400MW dam/ reservoir type hydropower is bought forward the commissioning year by 2 years from 2020 to 2018, ,

- In the High Demand Case, coal thermal sharply decreases to 10 units (1,000MW), which is less than half of 23 units (2,300MW) in the Least-cost Case (-1,300MW). On the contrary, combined-cycle thermal increases 9 units (+900MW) from 5 units (750MW) to 14 units (2,100MW). On the other hand, hydropower remains the same development as the Least-cost Case but 400MW dam/ reservoir type hydropower is bought forward the commissioning year by 3 years from 2018 to 2020, and

- Gas turbine power plants do not have changes in developed capacity and commissioning year. Geothermal will not be developed as candidate projects like in the Least-cost Case.

The results of the CO_2 Emission Prevention Case are compared with those of the Least-cost Case from the environmental and social consideration aspects as follows:

Coal thermal, which emits a lot of CO_2, will sharply decrease in capacity less than the half capacity of the Least-cost Case in both the Low and High Demand Cases. Coal thermal is replaced with combined-cycle thermal which emits only half the CO_2 of coal thermal. Combined-cycle thermal increases 4 units (600MW) in the Low Demand Case and 9 units (1,350MW) in the High Demand Case.

Hydropower remains the same development as the Least-cost Case but a 400MW reservoir type hydropower is bought forward from 2020 to 2018 in the Low Demand Case and from 2018 to 2015 in the High Demand Case. This contributes to CO_2 emission reduction.

Since it is assumed that coal thermal may cause more impacts on the air and water according to scoping results (See Table 8.4.12), decreasing the development of coal thermal is equal to decreasing possible impacts on the air and water environments. As a result, coal thermal is replaced with combined-cycle thermal which may cause less impact on air environment.

Fourteen (14) combined-cycle thermal units (2,100MW) will be developed in the High Demand Case (16 units with 2,332MW in total together with fixed projects). If these plants are intensively developed at the same sites, the careful considerations mentioned in the Least-cost Case should be specifically given.

(c) Limited Natural Gas Supply Case

The differences in the results until 2020 between the Least-cost Case and the Limited Natural Gas Supply Case are as follows:

- The total developed capacity of candidate projects up to 2020 will reach 2,980MW which is 100MW higher than that in the Least-cost Case in the Low Demand Case, while it will keep the same total developed capacity as 4,530MWin the High Demand Case,

- From the power plant type aspects, in the Low Demand Case, combined-cycle thermal remains the same 1 unit (150MW) as the Least-cost Case. On the other hand, coal thermal increases 1 unit (+100MW) from 13units (1,300MW) to 14 units (1,400MW). Hydropower remains the same total capacity in candidate projects but a 400MW reservoir type hydropower is brought forward the commissioning year by 1 year from 2020 to 2019,

- In the High Demand Case, combined-cycle thermal sharply decreases by as many as 4 units (600MW) from 5 units (750MW) to 1 unit (150MW). On the contrary, coal thermal increases by 6 units (+600MW) from 23 units (2,300MW) to 29 units (2,900MW). On the other hand, hydropower remains the same total developed capacity as the Least-cost Case but a 400MW reservoir type hydropower is brought forward the commissioning year by 3 years from 2018 to 2015, and

- Gas turbine power plants do not have changes in developed capacity and commissioning year. Geothermal will not be developed as candidate projects like in the Least-cost Case.

The results of the Limited Gas Supply Case are compared with those of the Least Cost Case from the environmental and social consideration aspects as follows:

Due to constraints on gas supply, combined-cycle thermal will decrease in the candidate project in the High Demand Case. Only 1 unit (150MW) of candidate project or 3 units (382MW) together with the fixed projects will be developed in both the High and Low Demand Cases. The combined-cycle thermal is replaced with coal thermal by 1 unit (100MW) in the Low Demand Case or 6 units (600MW) in the High Demand Case. In addition, a 400MW reservoir type hydropower is brought forward the commissioning year from 2020 to 2019 in the Low Demand Case and from 2018 to 2015 in the High Demand Case. The power plant supplements insufficient kWh due to constraints on gas supply. (See Table 5.6.28 and Table 5.8.10)

Natural gas contains less harmful constituents. Since the decrease in combined-cycle thermal is mainly replaced with 1 unit of coal thermal to supplement insufficient kWh due to constraints on gas supply in the Low Demand Case and the increase in coal thermal is limited to 1 unit (100MW). However, an increase in the total impacts on the air environment may be caused because coal thermal increases by as many as 6 units (600MW) in the High Demand Case.

In addition, especially in the High Demand Case, coal thermal will developed for as many as 29 units (2,900MW), and total capacity will reach 3,790MW together with the existing power plants (460MW) and fixed projects (430MW). This accounts for 46% of total capacity in the system. If these plants are intensively developed at the same sites, the careful considerations mentioned in the Least-cost Case should be specifically given.

(d) ESC (Environmental and Social Consideration) Weighted Case

The difference in candidate projects of the Least -cost Case and those of the ESC Weighted Case are as follows:

- Total capacity of the candidate projects up to 2020 is the same between the Least-cost Case and the ESC Weighted Case. Twenty-four units with 2,880MW in the Low Demand Case and 39 units with 4,530MW in the High Demand Case will be developed.

- In the Low Demand Case, 1 hydropower site (100MW) out of 2 hydropower sites (200MW) in 2015 in the Low Demand Case is extended its commissioning year to 2017, while 1 unit (100MW) out of 3 units (300MW) of coal thermal in 2017 is brought forward to 2015. (See Table 5.6.28 and Table 5.8.19)

- On the other hand, in the High Demand Case, there are no difference between the development plan of the Least-cost Case and that of the ESC Weighted Case even in the commissioning year.

- Gas turbine power plants do not change in terms of developed capacity and commissioning year. Geothermal will not be developed as candidate projects like in the Least-cost Case.

The results of the ESC Weighed Case are compared with those of the Least-cost Case from the environmental and social consideration aspects as follows:

Firstly, in the Low Demand Case, no difference in total capacity of candidate projects is found between the Least-cost Case and the ESC Weighted Case by applying the ESC factor to the simulation study. However, the order in development of coal thermal and hydropower after 2015 is changed. A reservoir type hydropower (100MW) is extended from 2015 to 2017, while 1 unit of coal thermal (100MW) is brought forward from 2017 to 2015. These candidate projects switched their commissioning year with each other. We could say that this reflects the ESC factor of a reservoir type hydropower is higher than that of a coal thermal. From the system cost aspects, construction cost becomes lower and operation cost becomes higher because a hydropower with higher in capital cost is extended and, on the other hand, a coal thermal with higher in operation cost (fuel cost) is brought forward. However, total system cost is same between both the Least-cost Case and the ESC Weighted Case. (See Table 5.6.37 and Table 5.8.25)

On the other hand, in the High Demand Case, no difference in total capacity and commissioning year of candidate projects is found, and total investment cost and system cost are the same between both the Least-cost Case and ESC Weighted Case. Therefore, we could say that the Least-cost Case is the same as the ESC Weighted Case in the High Demand Case from ESC aspects because the ESC factor applied in the study makes no difference in total capacity of each type of power plant and commissioning year, namely development plan.

(e) ESC Weighted Case without Merangin Hydropower Plant (No Merangin Case)

In the Least-cost Case, it is concluded that it is necessary to reassess whether the Merangin hydropower plant should be included in a development plan after taking into account environmental impacts at the stage when the project plan will be materialized. In this case, results of the simulation will be assessed from the ESC aspects assuming that the Merangin hydropower plant would not be developed in the process of realizing the development plan in the ESC Weighted Case.

The difference between candidate projects of the ESC Weighted Case and those of the ESC Weighted Case without development of Merangin Hydropower Plant (herein after referred to as the No Merangin Case) are as follows:

- Total capacity of candidate projects until 2020 in the Low Demand Case of No Merangin Case is 100MW lower than that of the ESC Weighted Case, while that in the High Demand Case of No Merangin Case is 50MW higher than that of the ESC Weighted Case.

- As for total development capacity until 2020 by each power plant type, in the Low Demand Case, coal thermal increases by 1 unit (100MW) from 13 to 14 units, combined cycle thermal increases by 1 unit (+150MW) from 1 to 2 units, while a hydropower project of Merangin HPP (-350MW) is cancelled. Totally, 100MW capacity is decreased.

- On the other hand, in the High Demand Case, coal thermal increased by 6 units (+600MW) from 23 to 29 units, combined-cycle thermal decreased from 5 to 3 units (-300MW) and gas turbine thermal increased by 2 units (100mw), while Merangin HPP cancelled (-350MW). Totally, 50MW capacity is increased.

The economics of the development plans in both the Low and High Demand Case get worse because the system cost increases by US$4 million in the Low Demand Case although the total capacity of candidate projects decreases by 100MW, and the total capacity of candidate projects increased by 50MW and the system cost increases by US$40 million in the High Demand Case. The difference in total capacity of candidate projects is made after the year when Merangin Hydropower is cancelled (2014 in the Low Demand Case and 2013 in the High Demand Case, refer to the Table 5.8.19 and Table 5.8.26).

In the Low Demand Case, any new candidate hydropower plants are not developed to make up for the cancellation of Merangin hydropower (350MW). However, a coal thermal (100MW) and a combined-cycle thermal (150MW) are increased and replaced with the Merangin HPP. This means that from the environmental and social aspects, the cancellation of Merangin hydropower, which is a renewable energy, is replaced with a coal thermal and combined-cycle thermal with fossil fuels.

On the other hand, in the High Demand Case, any new candidate hydropower plants are neither developed to make up for the cancellation of Merangin hydropower (350MW). Although combined-cycle thermal decreases by 2 units (-300MW), 6 units of coal thermal (+600MW) and 2 units of gas turbine thermal (+100MW) are increased and substitutes the above candidate projects. This means that from the environmental and social aspects, the cancellation of Merangin hydropower is replaced with no new hydropower of renewable energy and causes cancellation of combined-cycle thermal which is a relatively cleaner thermal power, but coal thermal mainly substitutes the cancellations.

Since many coal thermal sites are developed (33 units with 3,330MW together with fixed projects) in the High Demand Case like in the Limited Natural Gas Supply Case, the careful considerations mentioned in the Least-cost Case should specifically be given if these plants are intensively developed in the same areas.

(f) Evaluation of Transmission Plan from the ESC aspects

The transmission plan that is studied after formulation of the optimal power development plan will be assessed from the ESC aspects.

Transmission lines planned between the power plants and a power system should be surveyed and studied during the planning of an individual power plant. Even when the power plant has no problems from the ESC aspects, the power plant cannot supply electricity to the grid system if construction of the transmission lines is difficult due to problems along the transmission line routes. Therefore, it should be noted that careful consideration should be given to transmission line plans when a power plant is being planned.

As for transmission lines supply power to a load center, if difficulties in the ESC are hard to avoid and mitigate, specifically in the areas where buildings, facilities and residences are crowded, measures such as underground installation to avoid and mitigate these problems can be taken. In this case, it should be noted that the cost for underground installation of transmission lines is higher than that of overhead transmission lines.

Interconnection transmission lines are generally very long (more than a few hundred km) and have high voltage such as 275kV and 500kV to reduce transmission loss and secure stability as it connects different regions. As a result, transmission tower structures are large (around 50-100m high). Therefore, impacts on natural and social environment such as the impacts on the local landscape become large. In addition, careful consideration should be given to environmentally protected areas because transmission lines are often situated in mountainous and depopulated areas and other areas where the natural environment prevails.

Careful consideration should be given to transmission lines at the planning stage. This includes the selection of transmission line routes to avoid being situated in protected areas and to minimize impact on landscape, the painting of transmission towers in scenic areas, and avoiding electrocution by securing enough clearance between the ground and the lines, doubling the protection relays, and warning the public to not climb the transmission lines. In urban areas, underground installation of transmission lines is one countermeasure to avoid or mitigate impacts by transmission line.

In Sumatra the West system often suffered from power outages in 2004 because construction works on the 275kV interconnection transmission line between Bangko and Lubuk Linggau was delayed due to long delays arising from such issues as compensation for landlords and, in addition, power shortage in the West system

From this lesson, careful consideration should be given to the development of transmission lines by applying the Strategic Environmental Assessment (SEA) including information disclosure to the public and opinion exchanges through stakeholder meetings at the early stage of planning such as the formulation stage of a master plan.

As for impact by the electric magnetic fields (EMF), public organizations have expressed their view that EMF does not have harmful impacts on the human body by comprehensively assessing many studies. For reference, Attachment 8.6 refers to public organizations' views and examples of present regulations on EMF in various countries. The countries that have provided regulations are very limited and they adopted the Interim Guidelines of IRPA[49]. The countries whose regulations are below the guideline's regulations provided regulations based on present EMF levels for existing transmission lines, without any scientific impact assessment for human health.

Any plans for major transmission lines with higher voltages in 275kV and 500kV will roughly be assessed from the ESC aspects as follows.

[49] Interim Guidelines on Limits of Exposure to 50/60 Hz Electric and Magnetic Fields, 1990, International Radiation Protection Association, was replaced with the Guidelines of ICNIRP in 1998

(i) Proposed Case 1

Proposed Case 1 until 2020 consists of transmission lines with voltage less than 275kV. Plans for 275kV lines are as follows.

275kV

○ Banda Aceh - PLTU Meulaboh - Binjai (275kV, 2cct)
○ PLTU Meulaboh - PLTA Tampur - Binjai (275kV, 2cct)
○ Binjai - Galang (275kV, 2cct)
○ Galang - Simangkuk (275kV, 2cct)
○ Simangkuk - PLTP Sarulla - P.Sidempuan (275kV, 2cct)
○ P.Sidempuan - Payakumbuh (275kV, 2cct)
○ Payakumbuh - Kiliranjao (275kV, 2cct)
○ Lahat - PLTU Bnjar Sari - PLTU Tarahan (275kV, 2cct)
○ Payakumbuh - G.Sakti (275kV, 2cct)
○ Merangin PLTA- Bangko (275kV, 2cct)

(ii) Proposed Case 2

Proposed Case 2, which includes the interconnections to the Malaysia and Java-Bali systems, consists of transmission lines with voltage less than 275kV as well. Additional transmission lines are as follows:

250kV transmission line

○ G.Sakti - Malaysia system (HVDC)

150kV transmission line

○ Kilianda - Java-Bali system (150kV, 2cct.)

(iii) South Case 1

In the case that power development is facilitated to a greater extent in the South system than in North, 500kV lines will be additionally developed and some 275kV lines will be cancelled.

Additional transmission lines

500kV

○ Galang - R.Prapat (500kV, 2cct.)
○ R.Prapat - G.Sakiti (500kV, 2cct.)
○ G.Sakiti - A.Duri (500kV, 2cct.)
○ A.Duri - PLTU Bnjar Sari (500kV, 2cct.)

Cancelled transmission lines

275kV

○ PLTU Meulaboh - PLTA Tampur - Binjai (275kV, 2cct.)

(iv) South Case 2

South Case 2 includes the interconnections to the Malaysia and Java-Bali systems in addition to South Case 1. The following interconnection lines with HVDC (High Voltage Direct Current) will be added to South Case 1.

Additional transmission lines
- ○ PLTU Bnjar Sari - Java-Bali system (HVDC)
- ○ G.Sakiti - Malaysia system (HVDC)

Power development in the Proposed Case 1 is the greatest among the above four cases. A 500kV transmission line between Galang and PLTU Bnjar Sari will be added if power development is facilitated in the South system (South Case 1), while the interconnection lines to the Malaysia and Java-Bali systems will be added if the cases includes the interconnection plans (Proposed Case 2 and South Case 2).

Therefore, the order of amount of transmission line development is as follows:

South Case 2 > South Case 1 > Proposed Case 2 > Proposed Case 1

From the ESC aspects, the impact to natural and social environments is on the same order as those for transmission line development. On the other hand, from the viewpoint of power development, the following should be considered:

- ○ The amount of power development will be decreased due to the merits of interconnection if the interconnections to the Malaysia and Java-Bali systems are included in the plan.

- ○ The impacts to natural and social environment by total power development will be changed because the power mix in all of Sumatra and each region will be changed if power development in the South system is facilitated. For example, power development in the north and west systems will be decreased if that in the South system is increased, and hydropower development in the North and West system will be decreased if coal thermal power in the South system is increased.

As for the former point, the total impacts on natural and social environment should be considered taking into account both impacts by the interconnection line increase and the power development decrease. On the other hand, as for the latter point, the regional differences in the amount of power development will result in varying degrees of impact on the natural and social environment. Therefore, the impacts on the natural and social environments should be comprehensively assessed by taking account of the above-mentioned items and the impacts by 500kV transmission lines.

Each transmission line plan will be assessed as follows:

Since specific transmission line routes have not been fixed yet, relations between the transmission line plan described above and environmentally protected areas will be roughly identified. Careful consideration should specifically be given to the following from ESC aspects. Specifically, careful consideration should, in the future, be given to the planned transmission lines including the following ones when it is identified that they may cause impacts on environmentally protected areas.

○ Banda Aceh - PLTU Meulaboh - Binjai (275kV, 2cct.)

This transmission line may be situated through the large national park Gunung Leuser, which lies between Nanggroe Aceh Darussalam province and North Sumatra province, if the line is planned on the shortest route between PLTU Meulaboh and Binjai. Therefore, careful consideration should be given to avoid impacts on the national park when the route is selected. For example, it may be possible to make a detour to the north of the national park although the length of this route would be longer than that of the shortest route. In addition, since the line may also be situated through the game reserve Lingga Isaq in the Nanggroe Aceh Darussalam province, careful consideration should also be given to the game reserve.

○ PLTU Meulaboh - PLTA Tampur - Binjai (275kV, 2cct.)

This transmission line may cause impacts on the game reserve Lingga Isaq between PLTU Meulaboh and PLTA Tampur. It may also cause impacts on the national park Gunung Leuser between PLTA Tampur and Binjai. Therefore, careful consideration should be given to these protected areas and national parks when the route is selected. It is assumed that it is relatively easy to make a detour around the areas.

○ Binjai - Galang (275kV, 2cct.)

Since this transmission line may be situated through the grand forest park Bukit Barisan in North Sumatra province, careful consideration should be given to avoiding impacts on the park. One of the countermeasures is to select a detour route around the park. Careful consideration should be given to line route selection because other protected areas such as nature recreation parks and nature reserves, which are respectively small, exist near the route.

○ PLTA Merangin - Bangko (275kV, 2cct.)

As mentioned in the section on optimal power development, the Merangin hydropower plant itself may affect the national park Kerinci Seblat. Since they pointed out that the transmission line between the power plant and Bangko substation may affect the national park, careful consideration should be given to the park. According to the present extent of the park, it may be easy to select a detour route around the park.

○ Kalianda - Java Bali interconnection (150kV, 2cct.)
/ PLTU Bnjar Sari - Java Bali interconnection (HVDC)

○ G.Sakti - Malaysia interconnection (HVDC)

Careful consideration for not only the natural and social environment in Sumatra, but also those in Java island and Malaysia, should be given for these interconnection lines.

Transmission lines connect power plants and substations. The surrounding areas near substations may be crowded with transmission lines where many transmission lines are concentrated. In this case, the transmission lines may cause impacts on the local landscapes and make it harder to reach a consensus on their construction in densely populated urban areas. Effective consideration should be given to substations that may be crowded with many transmission lines like those mentioned above. Such considerations may include selecting a location in advance where the local landscape is hardly affected and few residents are living. If an additional transmission line is planned to connect to an existing substation, one of the countermeasures is to change the location of the substation and build a new substation.

The following substations may be crowded with transmission lines with more than four routes. Therefore, careful consideration should be given to these substations when selecting their locations.

(i) Proposed Case 1

Careful consideration regarding natural and social environments should be given to the following substations during planning since they may be crowded with transmission lines in the Proposed Case 1.

(New substation)

7 routes connected

○ Binjai (3-275kV, 4-150kV)

5 routes connected

○ Galang (2-275kV, 3-150kV)

4 routes connected

○ PLTU Meulaboh (3-275kV, 1-150kV), ○ Simankuk (2-275kV, 2-150kV),
○ Rengat (4-150kV), ○ PLTU Tarahan (1-275kV, 3-150kV)

(Additional transmission line connection to existing substation)

6 routes connected

○ P.Sidempuan (2-275kV, 4-150kV), ○ Payakumbuh (3-275kV, 3-150kV)

5 routes connected

○ P.Pasir (5-150kV), ○ T.Kuning (5-150kV), ○ Tarutung (5-150kV),
○ Sibolga (5-150kV), ○ Kilianjao (2-275kV, 3-150kV)

4 routes connected

○ G.Sakti (1-275kV, 3-150kV), ○ Bangko (3-275kV, 1-150kV),
○ Lahat (2-275kV, 2-150kV), ○ A.Duri (4-150kV), ○ Baturaja (4-150kV)

(ii) Proposed Case 2

Careful consideration regarding natural and social environments should specifically be given to the G.Sakti substation when new transmission lines are connected because 2 transmission line (HVDC) routes will be added compared to Proposed Case 1 and result in 4 routes being connected there in

Proposed Case 2 which includes interconnections to Malaysia and Java-Bali systems.

4 routes to 5 routes

○ G.Sakti (1-275kV, 3-150kV, 1-HVDC)

(iii) South Case 1

Careful consideration regarding natural and social environments should specifically be given to the following substations during the construction of new substations and connection of new transmission lines because new transmission lines will be added in this case as compared to Proposed Case 1.

(New substation)

5 routes to 6 routes

○ Galang (1-500kV, 2-275kV, 3-150kV)

(Additional transmission line connections to existing substation)

3 routes to 5 routes

○ R.Prapat (2-500kV, 3-150kV), ○ G.Sakti (2-500kV, 1-275kV, 2-150kV)

4 routes to 6 routes

○ A.Duri (2-500kV, 4-150kV)

4 routes to 5 routes

○ Lahat (2-275kV, 3-150kV)

3 routes to 4 routes

○ PLTU B.Asam (4: 4-150kV)

(iv) South Case 2

Careful consideration regarding natural and social environments should specifically be given to the following substations during the construction of new substations and connection of new transmission lines because new transmission lines will be added in this case as compared to South Case 1 above.

5 routes to 6 routes

○ G.Sakti (2-500kV, 1-275kV, 2-150kV, 1-HVDC)

3 routes to 4 routes

○ PLTU Banjar Sari (1-500kV, 2-275kV, 1-HVDC)

The following transmission routes, for example, are planned to add one additional transmission line route. In this case, it is important to avoid or mitigate impacts on the environment to avoid building new transmission lines by replacing existing transmission lines with reinforced ones and installing more than one line on the transmission towers.

○ Sibolga - Tarutung (2-150kV), ○ Lahat - PLTU B.Asam (2-150kV)

8.4.4 Initial Study of Mitigation Measures

In this subsection, fundamental mitigation measures will be discussed. Specific mitigation measures for each individual project should be made by studying the optimal measures based on results of sufficient surveys and analysis at the pre-feasibility study and feasibility study stages on every site from now on.

It is important to make mitigation measures for the optimal power development plan based on the fundamental policies as follows:

○ Effective use of energy resources
  - Adopting high efficiency equipment
  - Reducing transmission, substation and distribution losses
  - Facilitation of renewable energy use

○ Improving management of effluvium and waste by applying zero-emission, reduction, recycling and reuse policy

○ Complete environmental management by establishing monitoring systems

○ Building communication with surrounding residents and stakeholders and establishing cooperative relationship

One of the mitigation measures is to facilitate the measures from not only the supply side but also the demand side as follows.

○ Saving electricity consumption by applying DSM
  - Effective use of energy by electricity consumers
  - Facilitating the introduction of energy-saving equipment
  - Raising energy-saving consciousness

Each mitigation measure will be described by environmental items as follows:

(1) Social Environmental Aspects

(i) Consideration of Site Location and Selection of Transmission Line Routes

Careful consideration should be given to involuntary resettlement, minorities and weak people of society, inequalities and separation in society and cultural heritage when selecting a site location for a power plant and a route for the transmission lines. These impacts should be avoided in the development plan as much as possible. If they cannot be avoided, they should be minimized.

For example, in the case of a dam/reservoir type hydropower that involves resettlement, changing the dam location or lowering its height would deteriorate its economic benefits. However, changing the development plan would be worthwhile if resettlement could be remarkably improved. In the case of a thermal power project, the development plan should fundamentally be changed since it is easier to change the site location for thermal power as compared to hydropower. Transmission lines may avoid resettlement problems by making detours around the area. However, in this case its economic benefits are normally deteriorated because detours do not result in the shortest route length.

(ii) Formulation of Proper Resettlement Plan and Compensation Plan, Residents' Consensus and Proper Implementation

If resettlement cannot be avoided, residents' consensus is necessary by formulating resettlement and compensation plans and by properly explaining the plans to the targeted residents. It is necessary to properly prepare and maintain financial measures and implementation structures to realize the plans. In addition, these processes should be guaranteed under the legal system.

In formulating resettlement plans and compensation plans, and in reaching consensus by explaining to residents, information disclosure and holding stakeholder meetings are necessary at an early stage by introducing concepts from the Strategic Environmental Assessment (SEA).

(iii) Careful Consideration of Layout, Shape, and Color of Power Plants

Reviewing the layout of a power plant may avoid and mitigate impacts on local landscape. For example, placing tall buildings, such as a boiler building, turbine, generator building and a stack on the inside of a site to avoid being in plain site may mitigate impacts on local landscape, and having the coloring of a building match the local landscape may also mitigate impacts. Careful consideration to the shapes and colors of transmission lines may mitigate impacts on the local landscape. In the case of hydropower plants, adopting tunnel or shaft type waterways and using underground powerhouses may mitigate impacts on local landscapes and environments.

In the case of substations where many transmission lines may concentrate and be crowed, careful considerations in advance, such as locating them on the sites where they may not affect local landscape and where there are few residents, are effective. Building a new additional substation by changing its location from the existing one is a countermeasure that can be adopted for a plan connecting new transmission lines to an existing substation.

(iv) Maintaining Proper Water Utilization

In the planning of a hydropower plant, careful consideration should be given to formulating a generation plan that includes discharging the proper water flow to downstream of the dam and outlet by deliberately examining the situation for downstream water utilization.

In planning the taking and discharging of condenser cooling water at a thermal power plant, the location of the plant and layouts for intake and an outlet should be properly planned taking into account impacts on fishery activities around the plant. Adopting a cooling tower system for condenser cooling is one countermeasure against impacts on water utilization. However, this system requires additional cost, decreases generation efficiency and results in deteriorating economic benefits.

(2) Natural Environmental Aspects

(i) Consideration of Site Location and Selection of Transmission Line Routes

In selecting the power plant location and transmission line route, every effort should be made to avoid impacts on environmentally protected areas, ecosystems/ wildlife and secondary impacts to them, similar to the previous subsection regarding social environmental aspects.

Changing the location of the dam site and lowering the dam height may generally deteriorate the economic benefits of a dam/ reservoir type hydropower plant. However, it is worthwhile to revise the plan if impacts on environmentally protected areas and ecosystems/ wildlife can be avoided or mitigated. In the case of thermal power, the development plan should fundamentally be changed in order to avoid impacts on environmentally protected areas and ecosystems/ wildlife, since it is easier to change the site location for thermal power than hydropower. Transmission lines may also avoid environmentally protected areas and ecosystems/ wildlife by making detours around the area. In this case, however, its economic benefits will usually be deteriorated because a detour does not result in the shortest route length. In addition, for transmission line expansion plans it is important as a countermeasure to avoid expansion of transmission lines as much as possible by reinforcing the transmission lines on the existing transmission tower and by mounting more than one transmission line on the transmission towers while keeping the same single route.

Secondary impacts such as impacts by many immigrants due to the creation of a reservoir after building the facilities should also be deliberately considered.

(ii) Minimizing Land Alteration

In the panning stage of a specific power plant, alteration of land should be minimized even if the land has to be altered. Excavation, dredging, reclamation and landfills should be minimized, taking into account the balance of earth and sand. Furthermore, earth and sand by excavation and dredging should be effectively used for reclamation and landfill. In this case, studying not only the project itself but also regional development plans could minimize impacts. Soil runoff should be avoided by installing walls if such runoff is anticipated.

(iii) Adopting Generation Equipment with High Efficiency

Coal thermal emits about twice the CO_2 as combined cycle thermal power. This is caused by the features of the fuel itself and the efficiency difference in the generation types. High efficiency generation equipment results in not only increased specific generation costs, but also increased impacts such as air pollution and CO_2 emission because it requires more fuel than thermal power to generate the same energy. Therefore, adopting highly efficient equipment can reduce impacts on the air environment and CO_2 emission per kWh due to higher generation efficiency. Generally, highly efficient equipment is expensive but it is often possible to reduce total generation cost due to improved efficiency.

Upgrading unit capacity, for example installed capacity from 100MW to 300MW a unit, can generally improve its generation efficiency because the larger the unit capacity is the easier the technology for improving generation efficiency can be applied. In addition, the larger a power plant is, the lower the cost per kW tends to be. Therefore, unit capacity should be upgraded if many units are planned to be built at the same site in order to reduce CO_2 emission.

(iv) Applying Kyoto Mechanisms

The government of Indonesia formally registered its ratification of the Kyoto Protocol[50] for UNFCCC on December 3, 2004. The Kyoto Protocol became officially effective after February 16, 2005 because it met necessary conditions to be effective through ratification by Russia on November 18, 2004.

After the enactment of the Kyoto Protocol, Indonesia can utilize the Clean Development Mechanism (CDM)[51], one of three Kyoto Mechanisms[52], as a host county. Specifically, if Annex I counties (developed countries) implement projects that reduce emissions of greenhouse gases or enlarge absorption sources, the Certificated Emission Reduction (CER) will be issued based on the amount of emission reduction or absorption increase caused by the projects and the credit can then be transferred to project participants of Annex I countries. CDM can contribute to countermeasures against global warming issues and reduce project cost.

CDM can facilitate the reduction of CO_2 emission and cost reduction at the same time if the power sector aggressively utilizes CDM. For example, CDM should be utilized to develop renewable energies such as hydropower, geothermal, photovoltaic cell and biomass generation, and to apply highly efficient equipment to thermal power.

(v) Countermeasures against Slope Collapse and Landslide around a Reservoir

The existence of a reservoir and the fluctuation in water level may cause slope collapses and landslides around a reservoir in a dam/reservoir type hydropower. This can generally apply to large-scale reservoirs not only for hydropower but also for irrigation. However, in a hydropower project achieving peak load supply, fluctuation in the reservoir water level and ground water level around the reservoir may especially cause severe conditions for slope stability and landslide because the water level fluctuates between high and low water levels in one day.

It is necessary as a countermeasure to avoid site locations where land collapses and landslides are anticipated by carrying out sufficient geological surveys at the planning stages. Some of the countermeasures are to make a hydropower plant with conditions for limiting the high water level, regulating the fluctuation speed for a reservoir water level, and applying countermeasure works to the dangerous slopes. In all cases, sufficient geological and other surveys are important.

[50] Kyoto Protocol was adopted in December 1997 at the 3rd Meeting of the Conference of the Parties (COP3), United Nations Framework Convention on Climate Change (UNFCCC). It was decided that greenhouse gasses should be reduced by 5% during 2008 to 2012 compared to the level in the standard year (CO_2, CH_4, N_2O in 1990, HFC, PFC, SF_6 in 1995) such as Japan etc.: -6%, EU etc.: -8%, USA: -7%. However, USA and Australia have policies against ratifying the Kyoto Protocol.

[51] The UNFCCC homepage describes CDM in detail. http://unfccc.int/kyoto_mechanisms/cdm/items/2718.php

[52] Kyoto Mechanisms consist of Emission Trading (Article 17), Joint Implementation (JI, Article 6) and Clean Development Mechanism (CDM, Article 12).

(3) Pollution and Public Hazards

(i) Countermeasures against Air Pollution

(a) Utilizing Proper Quality Fuels

Coal thermal and oil thermal power use fuels containing sulfur and ash, which may have large impacts on the environment. Utilization of proper quality fuel, which contains these matters as little as possible, can reduce impacts on environment. However, it is necessary to deliberately evaluate economic benefits and whether fuel should be changed to ones with better quality or whether countermeasure equipment should be installed with low quality fuel.

Environmental countermeasures for existing thermal power are environmental mitigation by proper quality measures such as conversion from oil into natural gas and conversion into low sulfur oil. However, its economic benefits should be evaluated as mentioned above. In addition, conversion into low sulfur oil should comprehensively be studied, taking into account the entire country's oil consumption because applying a conversion to low sulfur oil to specific power plants is not always a wise policy. In the study, countermeasures should assume that low quality fuel will be intensively used at new power plants with installation of environmental equipment and converted into proper quality fuel at existing power plants without this equipment.

(b) Adopting a Taller Stack

Raising the height of a stack at a thermal power plant could reduce impacts to the surrounding environment by decreasing ground level concentration due to improved diffusion effect for exhaust gas. Specifically, the proper stack height should be adopted by evaluating the anticipated impacts on the surrounding environment if many units are concentrated at the same site.

(c) Adopting Electrostatic Precipitators

As for coal thermal among thermal power, the Electrostatic Precipitator (EP) should be installed to prevent diffusion of soot and dust into the surrounding environment as coal fuel contains a lot of ash constituents. Large-scale oil thermal, except for gas thermal, should also be studied as to whether EP should be installed by evaluating anticipated impacts on the surrounding environment.

(d) Adopting Flue Gas Desulfurizer

As for coal thermal and oil thermal among thermal power, impacts on the surrounding environment such as acid rain may be anticipated. Therefore, installation of the Flue Gas Desulfurizer (FGD) should be studied if this is anticipated. Careful consideration should specifically be given to the environment if many units are planned to be concentrated at the same site.

For reference, it has been said that the installation of FGD to existing thermal power may not be effective because of the small effect compared to its cost, taking into account its remaining service life.

(e) Adopting Exhaust Gas Denitrizer

Nitrogen Oxide (NOx) emitted from thermal power plants consists of Fuel-NOx caused by nitrogen constituents in the fuel and Thermal-NOx caused by oxidization reaction of nitrogen constituents in the atmosphere. These may cause impacts on the surrounding environment such as photochemical smog. Specifically, installation of FGD at coal thermal power plants should be studied according to the amount of development and geographical features as coal contains a lot of nitrogen.

(f) Adopting Highly Efficient Equipment

As described in the previous subsection on natural environmental aspects, adopting highly efficient equipment can reduce impacts on the air environment per kWh due to higher generation efficiency. Generally, highly efficient equipment is expensive, but it is often possible to reduce total generation cost due to the improvement in efficiency.

Upgrading unit capacity, for example installed capacity from 100MW to 300MW per unit, can generally improve generation efficiency because the larger a unit capacity is, the easier the technology for improving generation efficiency can be applied. In addition, the larger a power plant is, the lower the cost per kW tends to be. Therefore, upgrading unit capacity is recommended for reducing air pollution when many units are planned to be built at the same site.

(ii) Countermeasures against Deterioration in Water Quality

(a) Countermeasures against Thermal Effluent

Impacts on the surrounding environment due to thermal effluent from thermal power plants should be evaluated with the anticipated temperature rise. To reduce the affected area, adopting the following system is recommended; a cooling system taking water from low temperature layers (deep layers); a quick diffusion system for thermal effluent; studying the layout of intakes and outlets to prevent recirculation of thermal effluent.

Proper planning for the location of power plants, intakes and outlets of cooling water for condensers should be studied taking into account the surrounding ecosystems / wildlife. Adopting a cooling tower system to cool water for condensers is one countermeasure against impacts on ecosystems / wildlife though it deteriorates the economic benefits of the plant because of the additional investment and decreased generation efficiency.

(b) Countermeasures against Deterioration in Water Discharged from Dam and Power Plant

Selective water withdrawal equipment, which takes the top clear layer of reservoir water in order to prevent taking deteriorated sediment water, should be installed if reservoir water may deteriorate for a long period at a reservoir-type hydropower plant.

(c) Measures for Preventing Eutrophication in a Reservoir

There may be eutrophication of the hydropower plant reservoir depending on upstream water use, draining of living water in the surrounding area and the quality of the water source. Reservoir water quality should be evaluated at the planning stage by making assumptions based on water quality investigations and environmental surveys in the surrounding area. Increasing the number of exchange times for the reservoir water may be one countermeasure resulting from reviews of generation and operation plans.

(iii) Recycle Use and Management of Waste such as Coal Ash

The treatment situation for coal ash produced by coal thermal power plants, such as at Bukit Asam in South Sumatra province, is as follows:

- Refilling coal mining tunnels
- Use for road construction as additive to cement mixed with sand
- Use for ceramic tiles
- Use for soil improvement mixture in sugar cane fields

Refilling coal-mining tunnels is the most frequently used option. Although some coal ash is effectively utilized as cement mixture and in construction bricks, most coal ash is disposed to landfills in ash disposal areas.

At the Ombilin coal thermal power plant, the ash disposal area near the power plant seemed not to be managed well because the drainage water was not treated and disposed coal ash was not covered with soil or sand and the coal ash could be scattered about by strong wind. Therefore, even existing facilities also need to facilitate more effective use of coal ash and manage ash disposal areas.

As for a new coal thermal power plant, the study of the effective use of coal ash, securing an ash disposal area, and establishing the proper management of ash disposal areas are necessary in planning the plant.

(iv) Countermeasures against Noise and Vibration

Thermal power and geothermal power may cause noise and vibrations for residences near the power plant. Therefore, a layout that keeps enough distance between the main equipment and the border of the plant site and the installation of soundproof walls and equipment will be necessary.

(v) Announcement of Water Discharge to Downstream of Dam and Outlet

Rapid increase in the water level downstream of the dam and outlet due to discharge by flooding and by generation, may cause damage for river users. Therefore, to prevent damage to downstream river users, it is necessary to establish restrictions on power plant operation to regulate the speed in which the water level rises downstream and install an announcement system to inform downstream river users in advance of the water discharge.

(4) Environmental Protection Measures for Promoting Use of Coal in Thermal Power Plants

According to the results of the optimal power development plan, it is necessary to promote the use of coal in thermal power plants in Sumatra. Therefore, in this subsection environmental measures to promote the use of coal in thermal power plants will be described from technical aspects.

(i) Trend of Utilizing Various Coals

Table 8.4.26 shows the estimated amount of coal reserves and their proportion by coal type in Sumatra. Consumption of lower-grade sub-bituminous coal and brown coal (lignite) are expected to increase in the future because they ensure better-cost performance while providing energy security. To ensure ecological use of these types of coal, appropriate measures should be taken.

Table 8.4.28 Coal Reserves and their Proportion by Coal Type in Sumatra[53]

Area	Coal Total	Anthracite	Bituminous	Sub-Bituminous	Lignite
North Sumatra	**1.7** (4.6%)	-	-	-	**1.7** *100.0%*
Central Sumatra	**4.2** (11.5%)	**0.1** *0.2%*	**0.5** *11.3%*	**0.4** *9.1%*	**3.2** *79.4%*
South Sumatra	**18.8** (51.4%)	**0.2** *0.9%*	**0.2** *1.1%*	**0.4** *2.3%*	**18.0** *95.7%*
Indonesia Total	**36.6** (100.0%)	**0.1** (0.3%)	**5.2** (14.3%)	**9.7** (26.7%)	**21.6** (58.7%)

Unit: billion ton, Italic figure: % of coal total by area, (%): % of total Indonesia
The Study Team partially calculated quantity of coal reserves by coal type.

(ii) Measures to Protect Environment with Lower-Grade Coal

Listed below are suggestions requiring due consideration to ensure ecological power generation with lower-grade coal at new and existing power plants.

(a) Use of Coal with Lower Calorific Value Requires:

- Construction of new coal mills in order to compensate for inadequate capacity of existing mills (for existing plants)
- Reinforced coal handling equipment to accommodate the expected increase in the volume of coal (for existing plants)
- Redesigned combustion equipment and ventilation systems that can accommodate additional supply of fuel (for new and existing plants)
- Installation of coal mixing equipment to blend high-calorie and low-calorie coals (for new and existing plants)

(b) Use of Coal with High Sulfur/Ash Content Requires:

- Installation/addition of desulfurizers and dust disposal equipment (electrostatic precipitator) (for new and existing plants)
- Installation/addition of equipment to treat ash and by-product of desulfurization (for new and existing plant)

[53] Source: Directorate of Mineral and Coal Enterprises, "Indonesian Coal Mining Development & Company Profiles 1997"

(iii) Clean Coal Technology (CCT) that can be promoted for Sumatra

The increased use of coal for power generation in many parts of the world has spurred innovation for diverse types of CCT technologies as shown in Table 8.4.27. The two main types of boilers that may be applied to Sumatra are: (a) brown coal (lignite) -fired boiler, and (b) circulating fluidized bed combustion boiler[54].

Table 8.4.27 General Description of CCT

Technology	Name	Outline
1.Coal washing technology	Washing equipment	Usually used in mine-mouth power plants. The cost is included in the selling price in most cases. Effective when content of ash and particles is high.
2.Combution technology	Combustion of pulverized coal	Full-fledged technology is available for pulverized coal firings and plants generating 1,000 MW of power are already operating using this technology. High-volume lignite combustion has also been made possible. Pressurized fluidized bed combustion boilers and coal gasification are newly developed technologies that allow for highly efficient operation.
	Combustion of lignite	
	Fluidized bed combustion boiler	
	Pressurized fluidized bed combustion boiler	
	Coal gasification	
3.Desulfulization technology	Limestone-gypsum method	The limestone-gypsum method, renowned for its high performance, is most widely used in the world. the dry-type method, which produces no wastewater, is also drawing attention. If priority is not given to high performance, the simplified method or seawater method may be a cost-efficient alternative.
	Dry-type method	
	Simplified method	
	Sea-water method	
4.Denitration technology	Low-NOx method	Usually, low NO_x combustion and catalytic method are used in combination.
	Catalytic method	
5.Dudt removal technology	Electrostatic precipitator	Though both of them are already established technologies, electrostatic precipitator is usually used for high-volume combustion.
	Bag filter	
6.Other technology	Waste water treatment	Installation of these treatments is required when a desulfurization facility is used.
	Ash treatment	
	By-product treatment	

(a) Lignite Combustion Boiler

Approximately 60% of the coal in Indonesian reserves is categorized as low-grade coal called brown coal. Unlike the higher-grade sub-bituminous coal currently used for power generation in the country, brown coal, characterized by low-calorific value and high sulfur/ash content, requires highly technical and unique combustion technology. Lignite is being used for power generation in many countries including those in East Europe.

Lignite combustion technology has made remarkable progress and enhanced performance has been achieved by introduction of large-scale combustion equipment and supercritical boilers.

[54] Adopting supercritical boilers is one of the other technologies widely applied in the world. But this type of boiler is generally applied to a power plant with unit capacity over 500MW. Therefore, application of this technology to the Sumatra system is not realistic because power plants with unit capacity of only 100MW class are planned in the optimal power development plan and the system is too small to apply a power plant with unit capacity over 500MW. However, it is worthwhile to study again the application of this type of power plant when a power plant with unit capacity over 500MW is planned for the Sumatra system in the future.

Table 8.4.28 shows the performance of the latest large-scale, supercritical lignite plants. These types of plants ensure high performance with a plant efficiency of 40% or more. All of them are designed to minimize environmental pollution and are equipped with a desulfurizer and dust collectors.

Further comprehensive evaluation is required for use of brown coal in the future by conducting fundamental research and other studies.

Table 8.4.28 Latest Lignite Plants

Plant Name	Schkopan	Schwarze Pump	Lippendorf	Boxberg
Capacity	495MW	800MW	933MW	900MW
Fuel	Lignite	Lignite	Lignite	Lignite
L.H.V.	2746kcal/kg	- kcal/kg	2507kcal/kg	2054kcal/kg
Steam Condition	26.0MPa 545/560˚C	25.3MPa 544/562˚C	26.75MPa 554/583˚C	26.6MPa 545/580˚C
Efficiency (Net)	40%	41%	42.3%	41.7%
Commissioning	1996	1997	1999	2000
Country	Germany	Germany	Germany	Germany

(b) Circulating Fluidized Bed Combustion Boiler (CFBC)

A circulating fluidized bed combustion boiler (CFBC), which allows operation on multiple varieties of fuel and features reduced level of NO_X/SO_X emissions thanks respectively to low-temperature combustion and desulfurization within the bed, is attracting attention as an environmentally-friendly boiler and is being used widely for electricity operations. Circulation type, introduced as an improved version of the conventional babbling type, is designed to enhance fuel efficiency. CFBC allows the fuel to stay longer in the furnace by high-speed fluidization of the fuel and by recycling it with unburned particles trapped and re-supplied into the furnace by cyclone.

Table 8.4.29 shows the specifications of the largest CFBC plant in Japan. While it can generate 149 MW of power, the world's largest CFBC features a capacity of 250 MW. Further examination is required to improve the performance of our plant through comparison of the characteristics with those of other plants.

Table 8.4.29 Specifications of CFBC Plant in Japan

Item	Specifications
Plant Output	149MW
Efficiency	43%(gross), 39%(net)
Steam Condition	16.6MPa, 566/538
Environmental Facility	PM: Bag Filter SOx: In-furnace SOx reduction (70-80%) NOx: Two-stag combustion (800-900˚C)
Emission	PM: Bag under 30mg/Nm^3 SOx: under 260mg/Nm^3 NOx: under 250mg/Nm^3
Starting date	2001 June

8.4.5 Recommendations for ESCs in the Next Steps of Planning Process

(1) ESC needed for the next step in the planning process

This study puts forward the basic concepts of the Sumatra electric power development master plan. A local (regional) electric power development master plan has to match the regional development plan, the spatial plan, and designation of protected areas. The basic concepts of this study also include basic measures such as avoiding protected areas.

However, this study does not settle the location of each project included in the draft master plan. In other words, no specific location is to be set in the study of hydroelectric power plants and thermal electric power plants other than the designated hydroelectric power plant locations in the existing plan. From now on, in formulating the Sumatra part of the National Electric Power Development Plan (RUKN), locations of individual projects are to be further scrutinized. At the same time, these locations need to match the regional development plan of each province in Sumatra, the spacial plan, and designation of protected areas. Accordingly, the proponent organization needs to keep good communications with the mining and energy department (Dinas PE), planning department (BAPPEDA), environment department (BAPEDALDA), and forestry department (Dinas Forestry) of each province (prefecture if necessary).

The next planning stage of this study is the feasibility study on each electric power development project whose necessity is recognized in the master plan. The following are recommendations for ESCs needed for the feasibility study in individual projects such as hydroelectric power plant development, thermal electric power plant development, and transmission grid projects.

a) Implementation of the EIA study in the feasibility study

In the feasibility study for each project, the project proponent (PLN) needs to proceed with the EIA process (AMDAL in Indonesian) in accordance with the government decree on environmental impact assessment (government decree No. 27 of 1999) (See Figure 8.1.1). EIA would be required in all plans, except for small ones, for electric power plant development through screening by Ministry of Environment. The feasibility study will clarify such factors as location of the project and detailed dimensions of buildings, facilities and equipment. It may thus repeat checks on the scoping items shown in this comprehensive study, however, it will need to look into environmental and social impacts and their mitigation in a more thorough fashion than at the master plan stage (ESCs at the EIA level). For instance, development of a thermal electric power plant often needs a field study on pollutants in the ambient air around the prospective location and a simulation of the spread of pollutants. On the other hand, development of a hydroelectric power plant needs a study of the current state of river water quality and the ecosystem, a more thorough understanding of the impacts of resident resettlement, and plans for specific mitigation (minimizing the scale of resettlement and compensation for resettlement). In addition, EIA needs to produce the EIA report and formulate an environmental management plan as well as an environmental monitoring plan (government decree No. 27 of 1999). Each project needs to have a vision on how to implement the necessary mitigation measures as well as sustained management and monitoring of the surrounding environment.

Prior to implementing EIA, it is important to set in a clear and fair manner the objective, method, and scope of the ESC study (hereinafter referred to as TOR of EIA). Government ministries in charge of environmental management need to approve the contents of this TOR. The government decree No. 27 of 1999 specifies the procedures for such approval. The procedures in which an oversight organization other than the implementing agency approves the TOR of EIA are also an important step prior to the implementation of EIA in the ESC guidelines of JICA and international organizations. The implementing agency (the project proponent) must confer and be in close touch with the relevant government agencies for environment on how to proceed with ESC on the stage where the necessity and contents of EIA is decided depending on the dimensions of the project. If the project affects more than one province or is particularly large, the proponent must confer with the national Environment Ministry. If the project is within the boundaries of a province or prefecture, the proponent is to engage in a dialogue with the environment department (BAPEDALDA) of the province or prefecture.

Communication with government agencies responsible for environmental administration makes it easier to carry out information disclosure to project stakeholders and participation of stakeholders in the project planning and implementing process. Participation of stakeholders is what about all recent international guidelines have tried to strengthen and emphasize. Indonesian legal framework on ESCs also focuses and gives high priority on the participation of stakeholders, as seen in the executive order No. 8 of 2000 by the BAPEDAL Secretary. The JICA environmental and social guideline in effect since April 2004 emphasizes the importance of stakeholder participation and stakeholder meetings as a specific means of achieving that purpose.

In formulating a project plan, the priorities in terms of measures to alleviate impacts (mitigation measures) should be in the following order[55]: (1) Avoid; (2) Minimize; (3) Rectify; (4) Reduce; and (5) Compensate. In other words, the most important concept in mitigation of impacts is to avoid them in the first place if at all possible. If they cannot be avoided, then one may choose to minimize them. Compensation in (5) is the last resort.

The project implementing agency (PLN) needs to examine itself from the EIA stage on how it is involved in the ESC study and planning. In ESCs, the contents of EIA are obviously important. However, EIA works only when the mitigation measures in it are put into practice. During the feasibility study and project implementation, most of the time a donor agency supports EIA and a private EIA specialized organization will conduct the study for it on a contractual basis. However, if the project implementing agency does not get fully involved in the process of ESC TOR and study, the implementing agency's capacity for ESC will be challenged and questioned after the project when the

[55] From the "Definition of Mitigation" of the Council on Environmental Quality (CEQ) of the United States, and the Natural Environment Assessment Technical Manual (1995) of the Environment Agency of Japan.

contents planned in EIA are to be put into practice in a sustainable manner. At the stage of EIA implementation, the project implementing agency needs to do the following in order to make possible its ownership of the project and sustainable environmental management after implementation and on operational phase: to firmly establish a system (or an organization structure) in itself to implement ESC in the project at hand. For the sake of efficiency, it may well outsource the EIA study to an outside organization. However, by taking the lead in ESC at the project office, the system mentioned above can prepare for implementation of measures for ESC and sustainable environmental management after the project. It is thus very important to establish an ESC team with substance at this stage.

- Communication and discussions with the Environment Administrations on contents of environmental study (such as TOR of EIA)
- Information disclosure to stakeholders and participation of stakeholders
- Study of environmental and social impacts and their mitigation at the EIA level
- Priorities in concepts of 'mitigation'
- To make possible its ownership of the project and sustainable environmental management after implementation and on operational phase, the implementing agency needs to be actively involved in the study and planning of ESC from the EIA stage.
  - The implementing agency needs to firmly establish a system in itself to implement ESC in the project at hand. Such a system is to take the lead in ESC at the project office (the implementing agency is to establish in the project unit an ESC team with substance).
  - The implementing agency is not to carry out a fully delegated study, totally dependent study on outer source, regarding ESC.

b) Hydroelectric power development

In hydroelectric power development particular attention needs to be given to the following aspects at the EIA stage in the feasibility study (F/S).

■ Relations with protected areas

The outline of the project is to become clear at the F/S stage. Accordingly, it is necessary to set details of the project plan with particular attention to relations with the locations of natural protected areas. The project team needs to pay attention to the impacts of related surrounding facilities such as access roads in addition to dams, water reservoirs, power plants, and conduits.

Indonesia has nature reserves, wildlife reserves, national parks, tourist recreational parks and forest parks. Sometimes the project team may need to give due consideration to protected cultural heritage sites, enclaves of minority people and scenic areas. In recent years, particular attention has been paid to biological corridors that connect protected areas and parks from the perspective of protecting wildlife and ecosystems.

- Electric power transmission routes

With regard to electric power transmission lines, there have been cases of taking a detouring route in an area with small impacts and sometimes through a protected area with an approval by an assessment. However, these methods are expensive and go against the principle of giving the highest priority to "avoiding" impacts. A project plan should avoid such methods if at all possible. A hydroelectric power plant may be constructed in a reservoir or somewhere upstream of a river basin. Accordingly, it is necessary to formulate a plan for an electric power plant in such a way that it enables the selection of power transmission routes with due consideration to preservation of forests and landscape and reduction of disaster risks.

- Consideration of environmental impacts including secondary ones such as increase in migrating population through a newly built access road

In the existing hydroelectric power development projects, there have been numerous problems including the following: deterioration of vegetation in river basins due to disorderly cultivation by residents who moved to the vicinity of the project and illegal logging by various companies; dumping of garbage; and pollution of lakes and rivers due to such garbage and an increase in the inflow of discharged water from fish culture. These problems have been caused by access roads that let people go to remote areas and make access by car easier, invigorating and diversifying commercial activities. Developers of hydroelectric power plants are not directly responsible for these problems, and local governments have not begun implementing any regulations for environmental management. If no action is taken for these problems, then similar problems may occur in every instance of hydroelectric power plant development from now on. The project team needs to discuss with local governments the implementing plans for restriction on entry into the area, notification systems for commercial activities, and environmental education on such subjects as proper management of garbage. Then the team needs to incorporate such implementation plans as a management plan for the regional environment in the environmental management plan that goes with EIA.

- Minimizing the scale of resident resettlement
- Formulating a resettlement method with the least impact

It may be necessary to relocate residents for the construction of a hydroelectric power plant. Compared to the construction of a thermal electric power plant, the scale of resettlement may be larger if hydroelectric power is to be generated at a dam or reservoir. The highest priority is to minimize the scale of resident resettlement even if resettlement is unavoidable.

Moreover, if compensation through resettlement is the only remaining option, the project team must formulate a reasonable and workable resettlement plan that makes the living conditions of relocated families as similar to the conditions prior to the resettlement as possible. For that purpose, dialogues with residents are essential. Worldwide lessons so far point to the need to avoid easy resort to monetary compensation if possible.

The following are indicators for selecting a resettlement destination.

Minimizing the moving distance in involuntary resettlement	Securing drinking water and domestic water
Selecting a resettlement destination with as similar living conditions as possible	Securing a safe and sanitary living environment
Similarities in working and educational conditions	Access to places for religious and recreational activities
Maintaining unity with neighboring communities	

- Coordination of interests and joint water resource management with other sectors using water

River water used for hydroelectric power generation is sometimes also used for agriculture, irrigation, industry and daily life. Rivers also serve the following purposes: places for bathing and laundry; where fish for food and game inhabit; providing water for wild animals; and creating landscapes such as waterfalls. Development of hydroelectric power inevitably affects water usage in certain portions of rivers. Many users share the same water resources. Accordingly, it is very important to confer with stakeholders on rules to obey in the use of water. Rights to the usage of water must be coordinated in advance as there are regions that set the priorities to the rights in a traditional way.

c) Construction of a thermal electric power plant

In planning the construction of a thermal electric power plant, particular attention needs to be paid to the following aspects at the EIA stage in the feasibility study (F/S).

- Prediction on the impact of air pollution

At the F/S stage of individual projects, details including the following become clear: location of the construction, type of fuel, scale of the facilities, and composition of the facilities. Accordingly, at the EIA level, an environmental prediction (such as measurement of current concentration and simulation of diffusion) will be needed on the concentration of pollutants in the ambient atmosphere. Predictive assessment will also be needed on such matters as smoke dust, SOX, NOx, photochemical smog and acid deposition.

- Checking the regulations on the air quality and study of design of facilities and pollution prevention measures (mitigation)

The project team needs to check national and regional regulations on the concentrations of air pollutants. It also needs to study the following aspects for mitigation in the basic design: fuel to use, composition of facilities for preventing pollution (e.g. height of chimneys, dust collector, desulphurization equipment, de-nitration equipment) and operation methods.

■ Consideration for compound impacts to such matters as the air quality of the area

A thermal electric power plant is likely to be set up near a city with high traffic density, or a waterfront or estuary near an industrial zone. In constructing a power plant in such a location, the project team needs to put forward forecasts with due consideration to the following: NOx emission from cars, diesel gas emissions from large vehicles, acidic substances from nearby factories (SOx, NOx), heavy-metal pollutants and ozone, and compound impacts of these substances. To take effective measures on compound impacts, the project team needs to exchange information with local governments and work proactively with them on comprehensive regional development plans and environmental management plans.

■ Study of disposal and control methods of coal ashes and other by-products in coal-burning thermal power plants

A coal-burning thermal electric power plant produces a large quantity of coal ashes and needs to manage and dispose of them properly. Ways of disposing of coal ashes include the following: putting them in a landfill, using them for construction materials, ceramics and soil conditioners. From the stage of design outline, the project team needs to formulate a concrete plan for disposal of coal ashes including the quantities of disposal by method, securing the needed land, and ways to prevent the scattering of ashes. Existing projects have not taken adequate measures in transporting routes and disposal sites for preventing the scattering of ashes by watering, covering with soil, and proper disposal of waste water.

■ Forecasting and study of countermeasures for problems in fuel shipping, noise and vibration

Since a thermal electric power plant uses petroleum and natural gas as fuel, there are risks of fire and explosion in the ships, vehicles and pipelines that carry this fuel. There will be problems in terms of noise and vibration if a thermal power plant is set up in an urban area. There have been problems caused by changes in the outside environment after the planning stage, e.g. an increase in residential houses near the plant boundaries. It is hard to predict changes in the outside environment. Accordingly, the project team should study countermeasures by creating with the relevant government agencies rules and regulations on safety measures in fuel shipping routes and use of land in the vicinity.

d) Transmission grids

In planning transmission grids, particular attention must be paid to the following aspects at the EIA stage in the feasibility study (F/S).

■ Study of land usage on the grid route

A study of stakeholders and land usage on the grid route is needed to clarify the following items that the construction of the planned transmission grid may influence.

・Existence of protected areas
・Lifestyles, characteristics, and number of stakeholders
・Basic conditions of their awareness on and cooperation with electric power projects

・Number of households to be relocated

・Types and values of agricultural products in forests and farms

■ Study of ways to avoid protected areas

Transmission grids routes are to be set on the principle of avoiding protected areas. An alternative location for grids is to be considered if there is no way of going around protected areas.

■ Study of safety measures

Safety measures under overhead electric wires are to be studied.

(2) Consideration for cumulative and compound impacts

From the perspective of strategic environmental assessment that has recently been a topic of discussion worldwide, project formulation needs to be done very carefully with attention to compound impacts. Strategic environmental assessment needs to pay attention not only to environmental and social impacts from a single project that appear immediately, but also cumulative impacts as a result of long-term and underlying causes and compound impacts of multiple projects, sectors and human activities in the same areas and locations over a long time. As a result of human activities that have become more advanced and complex, it is no longer possible to prevent deterioration of the human environment by assessment of a single project. The JICA Guidelines for ESCs since April 2004 also request due consideration of such cumulative and compound impacts[56].

a) Cumulative impacts over years

The following are cumulative impacts from long-term repeated factors in development of an electric power plant.

- Accumulation of chemical impacts (media)

・Deposition of oxidized substances ・Rare metallic substances

・Photochemical smog on trees and inhabitants

- Accumulation of impacts on the air quality

・Heat-trapping gases such as CO_2

- Accumulation of hydrological impacts

・Change in the quantity of flow ・Collection of ground water and steam

・Change in water temperature and quality

- Cumulative impacts on geological shape, conditions, and ground

・Change in landscape ・Continuous slope failure

[56] JICA Guidelines for ESCs, 2.3, p.7, April 2004

- Accumulation of biological and ecological impacts
・Change in river basin ・Fishes that swim upstream ・Amount of forests and ratio of vegetation cover

- Cumulative impacts on the global environment
・Global warming ・Amount of natural resources

- Cumulative impacts on the socio-economy and the regional economy
・Triggering human activities in undeveloped places

Even a single project may cause problems including the following: change in river basin and quantity of flow due to hydroelectric power generation; and acid precipitation due to a large coal-burning device. Accordingly, the project team needs to plan a study to assess long-term impacts in a thorough manner, not a shortsighted assessment. Most of the problems, however, are ones that a single project may not be able to address on its own. It is thus necessary to thoroughly consult the local environmental management and protection plans at the time of ESCs (assessment) and examine the role of the electric power project at hand. On global environmental issues, the project team needs to refer to national policies and international treaties. If there is no basic environmental management and protection plan in the area although problems are expected to worsen, then it may make sense for the project team to approach local government actively and help formulate a local environmental basic plan. The party that requests the project also needs to consider giving job instructions (TOR) to make possible such study and evaluation activities.

b) Compound impacts by multiple projects and sectors

The following are examples of compound impacts by human activities and economic/industrial sectors in the same area or phenomenon, as well as by the electric power sector.

- Development of remote areas, undeveloped areas around new access roads
・Partnership with local governments (local environmental management)

- Concentration of factories in areas such as river estuaries
・Waste water ・Gas emissions ・Impacts on vulnerable ecosystems such as mangrove wetlands

- Control of the total amount of pollutants
・Regional restriction on the total emission ・Compound impacts of and exposure to pollutants

- Destruction of landscape

- Global warming

- Depletion of natural resources
・Water resources・Underground mineral resources

Like problems of cumulative impacts, these problems cannot be addressed by a single electric power development project or the electric power sector alone. Recommended measures include the following: approach to local governments and environmental administration; formulation of self-imposed regulations and standards by industries; and joint research on environmental improvement by industries. As a leading industrial sector, the electric power sector would set a good example by taking up such measures in ESCs.

(3) Recommendations on environmental management and monitoring

Indonesia's decrees[57] require submission of the environmental management plan (RKL) and monitoring plan (RPL) attached to the EIA report. To comply with the requirement, the existing electric power projects implement monitoring and submit reports on a regular basis. ESCs in the project include the following: environmental management throughout the project life cycle, i.e. at the stages of construction, operation and proper closure of the facilities; and environmental monitoring to realize such environmental management. Since the 1990s, international aid and financing organizations have greatly increased requirements on environmental management and monitoring plans in their guidelines. This chapter examines and proposes measures for improvement in the conduct of environmental management and monitoring in electric power projects in Indonesia, and appropriate countermeasures to be taken if problems are discovered.

(a) Environmental management and monitoring on air and water pollution and improper waste disposal

Throughout the project cycle, environmental management to prevent and control harmful effects must be carried out on the following: direct impacts on the surrounding environment from the construction and operation on electric power facilities (e.g. pollutants from the facilities and their actions, changes and deterioration in the surrounding environment due to the construction of an electric power facility, and environmental risks that occur). This has to be done even after the end of the development project as long as the impacts are continuing.

[57] Government decree on environmental impact assessment (Government decree No. 27, 1999), decree of the Environmental Management Director on the guideline on environmental management and monitoring plans (Environmental Management Director decree No. 105, 1997), etc.

◆ Indicators of pollutants and changes in the surrounding environment

The following is a table on indicators of pollutants and changes in the surrounding environment.

Air pollution	Water pollution
■ Sulfur oxides (SOx) ■ Nitrogen oxides (NOx) ■ Smoke dust ■ Carbon dioxide (CO_2) , carbon monoxide (CO) ■ Ozone (O_3) ■ Control of coal ash (fly ash, etc.) ■ Hydrogen sulfide (geothermal power generation) ■ Hydrocarbon ■ Trace metal	■ Pollution indicators of dams and lakes: COD; water plants; zooplanktons; amount of floating garbage; change in surrounding environment (e.g. tourism, fish culture) ■ Indicators of water quality of rivers and downstream of discharged water: Organic pollution; BOD; COD; thermal discharged water (water temperature), etc. ■ Leaching water from coal storage and coal ash disposal facilities ■ Waste water treatment and leakage of waste fuel, oil content, etc. ■ Pollution by soil runoff ■ Arsenic and mercury (geothermal power generation)
Soil pollution	**Others**
■ Bottom deposit in dam reservoirs (waste and rotten trees) ■ Bottom deposit soil in rivers (zones where flow has decreased) ■ Pollution by leaching water ■ Exposure of harmful earth and sand at cut earth and filling ■ Arsenic and mercury (geothermal power generation)	■ Waste materials such as waste oil, chemicals, coal ash, and by-product plaster ■ Noise, vibration ■ Decrease in ground water level, subsidence of ground ■ Offensive foul odor ■ Radio disturbance
Safety measures	
■ Communication and warning system for water discharge ■ Safety of gas pipelines ■ Transportation safety on fuel shipping route	■ Control of flammable and combustible fuel and materials ■ Maintenance and checking of high-voltage electric power lines, and observation on situation beneath the lines ■ Safety of steam pipes (geothermal power generation)

◆ Process and standards of environmental management

Implementation of environmental management measures begins with (1) monitoring of the quantities of pollutants and the indicators above. Then the environmental management unit is to do the following: (2) evaluate the monitoring results; (3) implement appropriate measures if there are problems; and (4) take preventive measures to make sure the same problems do not occur. The unit is to (5) confirm improvements and try to identify new problems when the monitoring cycle begins again. Thus the environmental management cycle is complete.

[(1) Monitoring; (2) Evaluation of results; (3) Identification of problems and implementation of measures; (4) Preventive measures for similar problems; (5) Confirmation of improvement (monitoring)]

Management standards are needed to evaluate monitoring results. Depending on the seriousness of problems and the purpose of environmental management, strict standards or moderate management (monitoring) may be required. The management unit is to comply with the existing standards - by law, ministerial decrees, or internal regulations - in the concentration of pollutants and environmental indicators (See Attachment 8.3: Environmental Standards Related to Power Sector), and set standards of its own (internal standards) in areas with no existing standards.

The environmental management unit should note that the purpose of setting environmental standards is to take concrete measures for problems. It makes no sense to just identify problems and then do nothing: that means that the process of monitoring leading to the implementation of counter measures is not functioning. Accordingly, the unit needs two types of management standards, both those on the normal range of indicators to identify problems and the formulation of a manual (standard operation procedure) to implement counter measures. The unit is to begin with setting internal standards in accordance with the table above. The unit should know that it has a serious problem if a number of monitoring reports pile up without any concrete actions being taken. Such a situation may occur when there is no standard manual that indicates measures to take, or the existing standards defining normal range are so strict that they can not apply to the real situation and no appropriate measures are found. In such cases, the management unit will need to go back to the original management standards and revise them to be able to take practical and workable measures. The bottom line, of course, is to solve the problems.

The following knowledge, experience and judgment are at work in the formulation of environmental management standards (defined normal ranges of indicators and a manual to implement measures).

(i) Knowledge and insights of experts
(ii) Experience of engineers and expert staff on the project sites
(iii) Knowledge, insights, and techniques of consultants
(iv) Government deliberations and decisions
(v) Opinions and judgments of stakeholders

It may be seen that 1 and 3 are given excessive importance in the cases, such as adapting generic international standards the way they are, and totally delegating to a consultant regular environmental monitoring and reporting. As a result, the purpose of environmental management and monitoring activities becomes just to satisfy the legal requirements. To avoid such a situation, the environmental management unit must utilize the experience of engineers and expert staff on the project sites as stated in 2. Again, the purpose of setting environmental standards is to take concrete measures for problems. The unit cannot implement concrete measures if it has unrealistic standards and monitoring results. The best thing to do is to collect the views of stakeholders and make sure that the management standards meet their needs once the outline of the standards are made with the experience of staff members on the sites taken into account. If the sector or an organization as a whole sets practical standards, then it will be possible to examine such matters as environmental management policies for ESCs, in line with the standards, at the project level in a stakeholder meeting.

◆ Human resources development and the implementation structure

To proceed with the process of the formulation and implementation of environmental management standards, human resources and an organizational structure with the following capacities and authorities are needed.

On formulation of environmental management standards:

1. Engage in detailed and technical discussions with experts and consultants on ESCs and environmental management.
2. Summarize the experiences of on-site engineers and staff members on environmental management issues and measures, and reflect them in the formulation of standards.
3. Explain the management standards to the administrative agencies and coordinate with their requirements.
4. Run meetings such as stakeholder meetings.

As coordinator of the environmental management process:

1. With the support of professional experts, control monitoring, evaluation and study of measures in light of environmental management standards and policies.
2. Make sure that measures are taken for identified problems and check if they are proper.
3. Investigate how to improve the system to prevent similar problems in the future.
4. Confirm that matters at hand have improved as a result of the action or preventive measure.

With regard to ESCs as a whole, the human resources and systems (the environmental management unit) are also to consider in each PLN project the necessity and contents of ESCs - whether they are SEA, EIA, or simplified assessment - and control the study in each project.

◆ Recommendations

The following is a summary of recommendations on environmental management and monitoring on pollution and changes in the surrounding environment by electric power facilities.

① The management unit is to set environmental management standards on pollutants and changes in the surrounding environment.
② Environmental management standards include both defined normal ranges of indicators and the standard operation manual to implement counter measures.
③ The management unit is not to create unrealistic standards that impede the implementation of measures. Accordingly, the formulation of standards is not to be completely delegated to a consultant; it is rather to integrate the experience and insights of on-site staff members and professional experts.
④ The organization concerned is to establish a unit that can proceed with the comprehensive study plan on ESCs and the tasks ① to ③, coordinate all the work, and assign several expert staff to it. They are to be capable of explaining the standards to the government and stakeholders and coordinate their views and support.

(b) Environmental issues due to development-induced human migration and regional environmental management

As seen at sites of hydroelectric power development, new access roads have brought people to previously remote areas and caused problems. Incoming population includes construction workers, migrants from other regions, vendors who enter protected areas for poaching and logging, fish culture managers along dams and rivers, and restaurants and tourist agents. Their activities may invigorate the local economy, but also cause the following problems.

- Disorderly cultivation of undeveloped areas
- Unlawful logging of reserved forests and water source forests that protect areas around rivers
- Illegal entry into and residence in protected areas
- Pollution of lakes and rivers
- Dumping of garbage (domestic waste)

These problems are not direct results of hydroelectric power development but are caused indirectly by changes in the surrounding environment, i.e. increase of incoming population. Since they are secondary problems, developers of a hydroelectric power plant resist regarding them as objects of ESCs. On the other hand, local governments are not ready to implement environmental management and regulations for these problems, and have a hard time recognizing the very existence of the problems. In many cases, the environment deteriorates while there is no organization to take responsibility for the problems.

Although these are secondary problems as a result of hydroelectric power development, the project would do well to consult with local government and support the formulation of a local environmental management plan. The formulation of a local environmental management plan in itself can be part of strategic environmental assessment (SEA). Another option is to include in the environmental management plan attached to EIA the implementation plan for entry restrictions, a notification system for commercial activities, and environmental education on waste management

(c) Putting together a database on environmental costs

Environmental costs in each project in the electric power sector are to be recorded and organized. It would make sense to create classification and formats for common expenditures in all electric power projects and put together a database. The database is to enable the following: comparison of environmental expenditures in different types of electric power facilities; distinction between environmental equipment costs included in initial investment and environmental management costs needed for operation; and more precise estimates of internal and external costs.

Attachment 8.1 Projects and Activities Subject to EIA

When project proponents plan to establish business operations in Indonesia, almost all of them are subjected to the EIA system, and must prepare an EIA report. Government Regulation No.51 of 1993, which provides the basic rules for EIA, states nine criteria to judge whether a certain business and/or activity has the possibility of having a serious impact on the environment. They include: (1) alterations to topography or the natural environment, (2) processes and activities which have a probability of causing destruction or deterioration by the generation of waste or by the use of natural resources.

Specifically, the attachment table to the Decree of State Minister for the Environment No.17, 2001 announced the types of business and/or activity plans that are required to be completed with the EIA indicates a detailed list of the types and scales of business operations subjected to EIA. They are divided into 14 sectors and 81 activities, such as mining and energy, public works, industry, transport, and hazardous and toxic waste management.

The specific types and scales of operations subject to EIA related to power facilities are shown in Table 8.A.1

Table 8.A.1 Business and/or Activities Subject to EIA[58]

No.	Activity Type	Scale	Special Scientific Reason
B.1.	Construction of **Network**	**150kV**	- Community unrest due to health disturbance as a result of transmission - Social, economic and cultural aspects especially in land acquisition and community unrest
B.2.	Construction of **PLTD/ PLTG/ PLTU/ PLTGU**	**≥100MW**	Potentially causes impacts on: - Physical-chemical aspects, especially in air quality (emission, ambient and noise) and quality of water (lubricant spillage, heat waste etc.) and ground water - Social, economic and cultural aspects, especially at the time of land acquisition and population resettlement
B.3.	Exploitation and development of **geothermal** steam and/or development of geothermal	**≥55MW**	Potentially causes impacts on: - Physical-chemical aspects, especially in air quality (odor and noise) and water quality - Flora-fauna aspects - Social, economic and cultural aspects, especially in land acquisition
B.4.	Construction of **PLTA** with: -Height of dam -Or extent area of stagnant water -Or direct flow (power capacity)	 **≥15m** **≥200ha** **≥50MW**	Potentially causes impacts on: - Physical-chemical aspects, especially in air quality (odor and noise) and water quality - Flora-fauna aspects - Social, economic and cultural aspects, especially in land acquisition - Category of "large dam"

[58] Source: Kepmen LH Nomor 17 Tahun 2001 tentang Jenis Usaha dan/atau Kegiatan yang Wajib Dilengkapi Dengan Anallisis Mengenai Dampak Linkungan Hidup.

No.	Activity Type	Scale	Special Scientific Reason
			- Dam failure (dam break) will cause flood surge with high potential to cause damages to the downstream environment - At this scale, special specifications are required both for materials and constructional design - At this scale, a large quarry/burrow area is required, therefore potentially causing impacts - Impact on hydrology
B.5.	Construction of electric center of other types (**Solar, Wind, Biomass and Turf**)	**≥10MW**	- Requires very spacious areas - Visual (sight) impact - Noise impact - Especially turf usage, potentially causes disturbance to the turf ecosystem
L.1.	Construction and operation of nuclear reactor: Power reactor (**PLTN**)	All installations	- Construction safety - High risk - Radiation impact at decommissioning stage (post-operation) - Transportation, storage and disposal of raw materials and residual radioactive materials

Attachment 8.2 Environmental Legislation and Regulations in Relation to Power Sector

(1) General legislation on environmental protection

General legislation on environmental protection related to power and transmission facilities are as follows:

Table 8.A.2 General Legislation on Environmental Protection

Law No.5, 1990	Law of the Republic of Indonesia concerning Conservation of Living Resources and their Ecosystems
P.D. No.32, 1990	President Decision of the Republic of Indonesia concerning Protected Areas
Law No.5, 1992	Law of the Republic of Indonesia concerning Cultural Heritage Objects
P.D. No.55, 1993	President Decision of the Republic of Indonesia concerning Acquisition of Land for Carrying out Developments in the Public Interest
Law No.23 1997	Law of the Republic of Indonesia concerning Environmental Management

Law of Living Resources and their Ecosystem (Law No.5, 1990) stipulates the following protected areas:

- Nature Reserve
- Wild Life Reserve
- National Park
- Nature Recreation Park
- Grand Forest Park
- Game Reserve

The Ministry of Forestry is responsible for the protected areas in Indonesia. The ministry issued the Map of Protected Areas in Indonesia as of December 2003. Refer to the map regarding Sumatra as shown in Figure 8.4.1. Power facilities such as power plants and transmission lines shall avoid being located in these protected areas in accordance with the regulations.

(2) Environmental Impact Assessment (EIA)

The following are examples of typical legislation related to power and transmission projects in Indonesia.

Table 8.A.3 EIA Regulations

G, R. No.27, 1999	Government Regulation of the Republic of Indonesia concerning EIA
D. BAPEDAL No.08, 2000	Decree of Head of Environmental Impact Management Agency on Community Involvement and Information Openness in the Process of Environmental Impacts Assessment
D. BAPEDAL No.09, 2000	Decree of Head of Environmental Impact Management Agency on Guidelines for Preparation of Environmental Impacts Assessment Study - Attachment I: Guidelines for Preparation of Reference Team for Environmental Impact Analysis (KA-ANDAL) - Attachment II: Guidelines for Preparation of Environmental Impact Analysis (ANDAL) - Attachment III: Guidelines for Preparation of Environmental Management Plan (RKL) - Attachment IV: Guidelines for Preparation of Environmental Monitoring Plan (RPL) - Attachment V: Guidelines for Preparation of Executive Summary Document
D. MOE No.02, 2000	Decree of State Minister for the Environment of the Republic of Indonesia on Guidelines for AMDAL Document Evaluation
D. MOE No.41, 2000	Decree of State Minister for the Environment of the Republic of Indonesia on Guidelines for Establishment of Regencial /Municipal Evaluator Committee for EIA
D. MEMR No.1457 K/28/MEM/2000	Decree of Ministry of Energy and Mineral Resources concerning the Technical Guidelines of the Environmental Management in Mining and Energy
D. MOE No.17, 2001	Decree of State Ministry for the Environment on Types of Business and/or Activity Plans that are Required to be Completed with the EIA

(3) Pollution control

Regulations on pollution control related to power and transmission projects are as follows:

Table 8.A.4 Pollution Control Regulations

D. MOE No.KEP-13, 1995	Decree of the State Minister of Environment of the Republic of Indonesia concerning Emission Standards for Stationary Sources
D. MOE No.KEP-35A, 1995	Decree of the State Minister of Environment of the Republic of Indonesia concerning the Assessment Programme of Business/Industrial Activities in Pollution Management
D. MOE No.KEP-51, 1995	Decree of the State Minister of Environment of the Republic of Indonesia concerning Liquid Waste Quality Standards for Industrial Activities
D. MOE No.KEP-42, 1996	Decree of the State Minister of Environment of the Republic of Indonesia concerning Liquid Waste Quality Standards for Oil, Gas, and Hot Earth Activities
D. MOE No.KEP-48, 1996	Decree of the State Minister of Environment of the Republic of Indonesia concerning Noise Level Standards
D. MOE No.KEP-49, 1996	Decree of the State Minister of Environment of the Republic of Indonesia concerning Vibration Level Standards
D. MOE No.KEP-50, 1996	Decree of the State Minister of Environment of the Republic of Indonesia concerning Odor/Smell Level Standards
G.R. No.82, 2001	Government Regulation of the Republic of Indonesia concerning Water Pollution Control

(4) Toxic and hazardous substances

Regulations on toxic and hazardous substances related to power and transmission projects are as follows:

Table 8.A.5 Toxic and Hazardous Substances Regulations

G.R. No.18, 2001 jo G.R. No.85, 2001	Government Regulation of the Republic of Indonesia concerning Hazardous Waste Management
G.R. No.74, 2001	Government Regulation of the Republic of Indonesia concerning Toxic Waste Management

(5) Forest and Natural Resources Management

Legislations concerning forest and natural resources management are shown as follows:

Table 8.A.5 Forest & Natural Resources Management Regulations

G. R. No.28, 1985	Government Regulation of the Republic of Indonesia concerning Protection of Forests
P. D. No.43, 1990	President Decree of the Republic of Indonesia concerning Management of Protected Areas
G. R. No.27, 1991	Government Regulation of the Republic of Indonesia concerning Wetlands
Law No.41, 1999	Law of the Republic of Indonesia concerning Forest

Attachment 8.3 Environmental Standards Related to Power Sector

There are a lot of standards regarding the environment. Shown here are some of the basic environmental standards in Indonesia with respect to power and transmission projects.

(1) Environmental quality standards for water

The law that forms the basis of water pollution control measures was firstly the Government Regulation Concerning the Control of Water Pollution (Government Regulation No.20 of 1990). Then, the regulation was amended on Dec.14, 2001 as Government Regulation No.82, 2001 of Water Quality and Water Pollution Control (See Table 8.A.6). This regulation stipulates water quality environmental standards for land water. The standards separate water into four classifications according to water use.

These are:

I : Water used as direct drinking water without treatment or water of the equivalent quality
II : Water used for facilities or equipment for water recreation, freshwater fish farming, livestock farming or plant watering, or water of the equivalent quality
III : Water used for fisheries, livestock farming or plant watering, or water of the equivalent quality
IV : Water used for plant watering, or water of the equivalent quality

Necessary parameters relative to respective water use are then selected from 46 parameters classified into (1) physical parameters, (2) inorganic chemical parameters, (3) organic chemical parameters, (3) microbiology parameters, and (4) radioactive substances, and the maximum value for each parameter is indicated by classification.

Table 8.A.6 Environmental Quality Standards for Water[59]

Parameter	Unit	Classification				Remarks
		I	II	III	IV	
Physics						
Temperature	℃	Deviation 3	Deviation 3	Deviation 3	Deviation 5	Temperature deviation from natural condition
Soluble Residue	mg/l	1,000	1,000	1,000	2,000	
Suspended Residue	mg/l	50	50	400	400	For controlling water drinking conventionally, suspended residue ≤5,000mg/l

[59] Source: Peraturan Pemerintah Nomor 82 Tahun 2001 tentang Pengelolaan Kualitas Air dan Pengendalian Pencemaran Air

Chemical (Inorganic)						
pH		6~9	6~9	6~9	5~9	If pH is beyond this scope, it is decided based on its natural condition.
BOD	mg/l	2	3	6	12	
COD	mg/l	10	25	50	100	
DO	mg/l	6	4	3	0	Minimum figure
Total Phosphate as P	mg/l	0.2	0.2	1	5	
NO_3 as N	mg/l	10	10	20	20	
NH_3-N	mg/l	0.5	(-)	(-)	(-)	For fishery, the contents of free ammoniac for fish≤0.02mg/l NH_3
Arsenic	mg/l	0.05	1	1	1	
Cobalt	mg/l	0.2	0.2	0.2	0.2	
Barium	mg/l	1	(-)	(-)	(-)	
Boron	mg/l	1	1	1	1	
Selenium	mg/l	0.01	0.05	0.05	0.05	
Cadmium	mg/l	0.01	0.01	0.01	0.01	
Chrome (VI)	mg/l	0.05	0.05	0.05	1	
Copper	mg/l	0.02	0.02	0.02	0.2	For controlling drinking water conventionally, Cu≤1mg/l
Iron	mg/l	0.3	(-)	(-)	(-)	For controlling drinking water conventionally, Fe≤5mg/l
Timval	mg/l	0.03	0.03	0.03	1	For controlling drinking water conventionally, Pb≤0.1mg/l
Manganese	mg/l	0.1	(-)	(-)	(-)	
Quicksilver	mg/l	0.001	0.002	0.002	0.005	
Zinc	mg/l	0.05	0.05	0.05	2	For controlling drinking water conventionally, Zn≤5mg/l
Chloride	mg/l	600	(-)	(-)	(-)	
Cyanide	mg/l	0.02	0.02	0.02	(-)	
Fluoride	mg/l	0.5	1.5	1.5	(-)	
Nitrate as N	mg/l	0.06	0.06	0.06	(-)	For controlling drinking water conventionally, NO_2-N≤1mg/l
Sulphate	mg/l	400	(-)	(-)	(-)	
Free Chloride	mg/l	0.03	0.03	0.03	(-)	For ABAM is not required
Sulfur as H_2S	mg/l	0.002	0.002	0.002	(-)	For controlling drinking water conventionally, S as H_2S≤0.1mg/l

Detergent as MBAS	μg/l	200	200	200	(-)	
Phenol	μg/l	1	1	1	(-)	
Chemical (Organic)						
Oil and Fat	μg/l	1,000	1,000	1,000	(-)	
BHC	μg/l	210	210	210	(-)	
Aldrin/Dieldrin	μg/l	17	(-)	(-)	(-)	
Chlordane	μg/l	3	(-)	(-)	(-)	
DDT	μg/l	2	2	2	2	
Heptachlor and Heptachlor Epoxide	μg/l	18	(-)	(-)	(-)	
Lindane	μg/l	56	(-)	(-)	(-)	
Methoxychlor	μg/l	35	(-)	(-)	(-)	
Endrin	μg/l	1	4	4	(-)	
Toxaphan	μg/l	5	(-)	(-)	(-)	
Microbiology						
- Fecal coliform	Contain /100ml	100	1,000	2,000	2,000	For controlling drinking water conventionally, fecal coliform≤2,000 cnt/100ml and total coliform≤10,000 cnt/100ml
- Total coliform	Contain /100ml	1,000	5,000	10,000	10,000	
Radioactivity						
- Gross –A	Bq/l	0.1	0.1	0.1	0.1	
- Gross –B	Bq/l	1	1	1	1	

(2) Standards for effluent water quality

With regard to effluent water standards directly related to project activities, the Decree of the State Minister of Environment Concerning Quality Standards of Liquid Waste for Industry Activity (No. 51, 1995) stipulates 21 types of factory effluent water standards at a national level. Indonesia's traditional major industries are selected as specified sectors, which include soda, metal processing, tanning, textile, palm oil, pulp and paper, soft drinks, and paint.

The Decree of KEP-09/MENLH/4/1997 stipulates the effluent water standards for geothermal power plants, which are shown in Table 8.A.7

Table 8.A.7 Effluent Water Standards for Geothermal Power Plants[60]

Item	Unit	Maximum concentration
BOD_5	mg/l	100
COD	mg/l	200
Oil content	mg/l	25
Sulfur as H_2S	mg/l	1.0
Ammonia as NH_3-H	mg/l	10
Total phenol	mg/l	0.1
Temperature	ºC	45
pH		6.0-9.0
Max. effluent volume		$1{,}200m^3/1{,}000m^3$ production

(3) Environmental quality standards for air pollution

Standards targeting the prevention of air pollution are Government Regulation No.41, 1999. The environmental standards indicate measurement conditions and standard values for 11 parameters including sulfur dioxide, nitrogen oxides and dust. The environmental quality standards for air pollution related power facilities are shown in Table 8.A.8.

Table 8.A.8 Environmental Quality Standards for Air Pollution[61]

No.	Parameter	Measurement Period	Emission	Analysis Method	Tools
1	SO_2 (Sulfur Dioxide)	1 hour 24 hours 1 year	900 μg/Nm^3 365 μg/Nm^3 60 μg/Nm^3	Pararosanilin	Spectro-photometer
2	CO (Carbon Monoxide)	1 hour 24 hours 1 year	30,000 μg/Nm^3 10,000 μg/Nm^3	NDIR	NDIR Analyzer
3	NO_2 (Nitrogen Dioxide)	1 hour 24 hours 1 year	400 μg/Nm^3 150 μg/Nm^3 100 μg/Nm^3	Saltzman	Spectro-photometer
4	O_2 (Oxide)	1 hour 1 year	235 μg/Nm^3 50 μg/Nm^3	Chemi-luminescent	Spectro-photometer
5	HC (Hydro Carbon)	3 hours	160 μg/Nm^3	Flame Ionization	Gas Chromatography
6	PM_{10} (Particle<10μm)	24 hours	150 μg/Nm^3	Gravimetric	Hi-Vol
	$PM_{2.5}$ (Particle<2.5μm)	24 hours 1 year	65 μg/Nm^3 15 μg/Nm^3	Gravimetric Gravimetric	Hi-Vol Hi-Vol
7	TSP (Dust)	24 hours 1 year	230 μg/Nm^3 90 μg/Nm^3	Gravimetric	Hi-Vol
8	Pb (Tin Lead)	24 hours 1 year	2 μg/Nm^3 1 μg/Nm^3	Gravimetric Ash Extractive	Hi-Vol AAS

[60] Source: Kepmen LH Nomor 09/MENLH/4/1997 tentang Perubahan Kepmen LH Nomor 42/MENLH/10/1996 tentang Baku Mutu Limbah Cair Bagi Kegiatan Minyak dan Serta Panas Bumi.

[61] Source: Peraturan Pemerintah Nomor 42 Tahun 1999 tentang Pengendalian Pencemaran Udara

9	Dustfall	30 days	10 ton/km^2/month (Housing complex) 20 ton/km^2/month (Industry)	Gravimetric	Cannister
10	Total Fluorides (as F)	24 hours 90 days	3 µg/Nm^3 0.5 µg/Nm^3	Specific Ion Electrode	Impinger or Continuous Analyzer
11	Fluor Index	30 days	40 µg/100cm^2 made by limited filter paper	Colourimetric	Limed Filter Paper
12	Chlorine & Chlorine Dioxide	24 hours	150 µg/Nm^3	Specific Ion Electrode	Impinger or Continuous Analyzer
13	Sulphate Index	30 days	1 mg SO_3/100cm^2 from Lead Peroxide	Colourimetric	Lead Peroxide Candle

(4) Standards for emission gas

Five types of standards with regard to emission gas were established for stationary sources by the Decree of the State Minister of Environment No.13 of 1995. These were for the 4 sectors of iron and steel, pulp and paper, cement, and coal-fired power generation, with all other industries lumped together as other industries. These standards have been applied since 1995. The stricter emission gas standards in the Decree have been applied since the year 2000.

Standards for emission gas related to power and transmission projects are shown in Table 8.A.9 to Table 8.A.10. Table 8.A.11 covers power boilers based on the same decree as mentioned above.

Table 8.A.9 Emission Gas Standards for Coal Fired Steam Power Plants[62]

Parameters	Maximum Threshold (mg/m^3)
1. Total Particulates	150
2. Sulfur Dioxide (SO_2)	750
3. Nitrogen Oxide (NO_2)	850
4. Opacity	20%

Notes:

- Nitrogen Dioxide is specified as NO_2
- Particle concentration is corrected around 3% O_2
- Gas volume in standard condition (25˚C and pressure of 1 atm)
- Opacity is used as a practical indicator for monitoring and developed to obtain correlation with total particle observation
- Enforcement of Emission Quality Standard for 95% of normal operation time for three months

[62] Source: Appendix III B, Decree of the State Minister for Environment, KEP-13/MENLH/3/1995 concerning Emission Standards for Stationary Sources

Table 8.A.10 Emission Gas Standards for Power Boilers[63]

Parameters	Maximum Threshold (mg/m^3)
1. Total Particulates	230
2. Sulfur Dioxide (SO_2)	800
3. Nitrogen Oxide (NO_2)	1,000
4. Opacity	20%

Notes:

- Nitrogen Dioxide is specified as NO_2
- 7 % oxygen correction for boilers
- Gas volume on dry basis in standard condition (25˚C and pressure of 1 atm)
- Opacity is used as a practical indicator for monitoring and developed to obtain correlation with total particle observation
- Enforcement of Emission Quality Standard for 95% of normal operation time for three months

Table 8.A.11 Emission Gas Standard for All Other Industries[64]

Parameters	Maximum Threshold (mg/m^3)
Non-Metals	
1. Ammonia (NH_3)	0.5
2. Chlorine Gas (Cl_2)	10
3. Hydrogen Chloride (HCl)	5
4. Hydrogen Fluoride (HF)	10
5. Nitrogen Oxides (NO_2)	1,000
6. Opacity	35%
7. Total Particulates	350
8. Sulfur Dioxide (SO_2)	800
9. Total Reduced Sulfur (TRS)	35
Metals	
10. Mercury (Hg)	5
12. Arsenic (As)	8
13. Antimony (Sb)	8
14. Zinc (Zn)	50
15. Lead (Pb)	12

Notes: Gas volume on dry basis in standard condition (25˚C and pressure of 1 atm)

[63] Source: Appendix I B, II B, IV B, Decree of the State Minister for Environment, KEP-13/MENLH/3/1995 concerning Emission Standards for Stationary Sources

[64] Source: Appendix V B, Decree of the State Minister for Environment, KEP-13/MENLH/3/1995 concerning Emission Standards for Stationary Sources

(5) Environmental standards for noise

Decree of State Minister for Environment concerning Noise Level Standards (KEP-48/ MENLH/11/1996) stipulates standards for noise according to the type of land use and activity area. Noise level standards are shown in Table 8.A.12.

Table 8.A.12 Standards for Noise Level by Type of Land Use & Activity Area[65]

Item	dB(A)
a. Area Usage	
1. Residential	55
2. Commercial	70
3. Office and Trade	65
4. Open Green Area	50
5. Industry	70
6. Government and Public Industry	60
7. Recreation	70
8. Special	
- Airport	
- Train Station	
- Shipyard	70
- National Port	60
b. Activity Area	
1. Hospital	55
2. School	55
3. Place of worship: Church/ Temple/ Mosque	55

(6) Hazardous waste from specific sources

Waste to which laws and regulations apply in Indonesia is the hazardous and toxic waste usually referred to as B3, a name taken from the first letters of dangerous, hazardous, and toxic in Indonesian.

With regard to hazardous and toxic waste control measures, in response to Indonesia's ratification of the Basel Convention (Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal) in 1993, the Government Regulation Concerning Hazardous and Toxic Waste Management (No.19, 1994) was enacted. This marked the first implementation of regulations on hazardous and toxic waste in Indonesia. Together with this, five Decrees of Head of BAPEDAL (Decree of Head of Environmental Management Impact Agency, No.1 to 5, 1995) were prepared showing the details for the storage, collection, treatment and disposal procedures. The Government Regulation Concerning Hazardous and Toxic Waste Management was amended as Peraturan Pemerintah Nomor 85 Tahun 1999 tentang Perubahan Atas Peraturan Pemerintah Nomor 18 Tahun 1999 tentang Pengelolaan Limbah Bahan Berbahaya dan Beracun. This regulation stipulates the duty of management of companies that discharge hazardous and toxic waste, the procedures for collection, storage, transport and treatment of hazardous and toxic waste, and the disciplinary measures for violators. Its appendix provides details of specific substances that come under the term of hazardous and toxic substances. Hazardous waste from specific sources related to power and transmission projects are shown in Table 8.A.13.

[65] Source: Kepmen LH Nomor 48/MENLH/11/1996 tentang Baku Mutu Tingkat Kebisingan.

Table 8.A.13 Hazardous Waste from Specific Sources[66]

Waste Code	Type of Industry/ Activity	Explanation of Waste
D220	Oil and natural gas exploration - Exploration and production - Maintenance of production facilities	- Residues of oil emulsions - Drilling mud - Sludge
D222	Mining	- Heavy metal sludge - Solvents
D223	Steam electric power generation, fly ash, bottom ash	

Attachment 8.4 Background of EIA System in Indonesia[67]

Indonesia's environmental impact assessment system was first introduced in 1986 in accordance with the provisions of Article 16 of the former Environmental Management Act (No.4, 1982). The article stipulates that business operations, which have the possibility of generating a serious impacts on the environment, must implement an environmental impact assessment. Later, the Government Regulation No. 51 of 1993 Concerning Environmental Impact Assessment implemented significant revisions to the assessment system. Major points of the revision were that the initial screening process was simplified and the authority of the Environmental Impact Management Agency (BAPEDAL: Badan Pengendalian Dampak Lingkungan) was strengthened concerning examination of business operations that involve multiple ministries and agencies. Based on this revision, Indonesia's current environmental impact assessment system known as AMDAL (Analisis Mengenai Dampak Lingkungan) was established.

The revision of EIA regulations was compelled by the promulgation of Act No. 23 in 1997. The revision process of EIA regulations was carried out before a critical social movement in Indonesia called 'reformasi' (political reform) in 1998, but Regulation No. 27/1999 had been established during this political transition period. Therefore, new legislation brought different characteristics, new ideas and new spirits to environment management. The new regulation is expected to improve and provide more democratic circumstances. Additionally, 10 guidelines established by the State Minister for the Environment and the Head of the Environmental Impact Management Agency (BAPEDAL) were decreed on 8 November 2000. This period is marked by the cancellation of EIA commissions in sectoral departments at the central government level, while all tasks for EIA review were put on the EIA commission at the BEPEDAL.

[66] Source: Peraturan Pemerintah Nomor 85 Tahun 1999 tentang Perubahan Atas Peraturan Pemerintah Nomor 18 Tahun 1999 tentang Pengelolaan Limbah Bahan Berbahaya dan Beracun.

[67] Dadang Purnama, February 2003, Environmental Impact Assessment Review, 23 (2003) 415–439; Reform of the EIA process in Indonesia: Improving the role of public involvement, pp417-427

EIA administrations were also established at the provincial and district government levels of the BAPEDAL, that is BAPEDALDA. Responsibilities to implement and supervise EIA are distributed to all provinces and districts and are performed by the Ministry of Environment[68] at the national level, and BAPEDALDA at the provincial and district levels. This arrangement is expected to promote a clearer and more integrated coordination under one competent leading agency.

[68] BAPEDAL were integrated into the Ministry of Environment (MOE) in 2003. Therefore, at present, MOE is responsible for EIA at the national level.

Attachment 8.5 JICA Guidelines for Environmental and Social Considerations, April 2004[69]

JAPAN INTERNATIONAL COOPERATION AGENCY
GUIDELINES FOR ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

April 2004

Japan International Cooperation Agency

[69] English version: http://www.jica.go.jp/environment/guideline/pdf/guideline_eng.pdf, Japanese version: http://www.jica.go.jp/environment/guideline/pdf/guideline_jap.pdf, versions in Spanish, French and Chinese are also available on the JICA Homepage.

CONTENTS

List of Acronyms

B/D	Basic Design
D/D	Detailed Design
EIA	Environmental Impact Assessment
IEE	Initial Environmental Examination
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
MOFA	Ministry of Foreign Affairs
OECD	Organization for Economic Cooperation and Development
R/D	Record of Discussions
S/W	Scope of Work
TOR	Terms of Reference

Preface

Principle 17 of the Rio Declaration on Environment and Development proclaims that an Environmental Impact Assessment, as a national instrument, shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent national authority. Agenda 21 proposes that the governments should, at the national level, promote the development of appropriate methodologies for integrating energy, environmental and economic policy decisions for sustainable development, inter alia, through environmental impact assessment (9.12(b)). The Universal Declaration of Human Rights makes clear a common standard of achievement for all peoples and all nations to promote respect for human rights and freedoms, and to secure their universal and effective recognition and observance. In 1985, the OECD Council Recommendation on Environmental Assessment of Development Assistance Projects and Programs was endorsed, and since then multilateral donors including the World Bank and main bilateral donors have prepared guidelines for environmental considerations and applied them.

JICA, which is responsible for the implementation of technical cooperation and the preliminary study of grant aid projects in Japan's bilateral grants, prepared environmental guidelines for infrastructure projects in 1990, in response to a proposal made by the first JICA Working Task on Environmental Cooperation in 1988, which introduced a screening and a scoping process to the preparatory study of Development Study. After more than ten years since the former guidelines were prepared, JICA decided to revise them, in response to the need for preparing basic principles of environmental and social considerations for all of JICA's activities. The revisions extended the range to be covered by the guidelines, promoted information disclosure, and strengthened the internal organization to ensure compliance with the guidelines and to enhance environmental and social considerations for the Official Development Assistance according to the governmental policy.

In December 2002, JICA established a committee for revising JICA guidelines for environmental and social considerations. The members of this committee were from universities, NGOs, private sector and related ministries. The committee held nineteen meetings which were open to the public and submitted its proposal of new guidelines to JICA in September 2003. JICA then established a follow-up committee for the guidelines in November 2003 and a draft of guidelines prepared by JICA was reviewed by the follow-up committee. JICA requested public comments from December 2003 to February 2004 for two months and incorporated submitted comments into the guidelines. JICA completed the new guidelines for environmental and social considerations in March 2004.

These guidelines cover development studies, preliminary studies of grant aid projects and technical cooperation projects. The Business Protocol and Mid-term Plan of JICA state clearly that JICA implements cooperation activities in accordance with the guidelines. JICA encourages the recipient governments by conducting cooperation activities to implement the appropriate measures for environmental and social considerations, and at the same time JICA gives support for and examination of environmental and social considerations according to the guidelines. JICA will make a comprehensive review of the guidelines within five years of their enforcement and revise them if necessary.

I. BASIC MATTERS

1.1 Policy

Japan's Official Development Assistance (ODA) Charter states that, in formulating and implementing assistance policies, Japan will take steps to assure fairness. This should be achieved by giving considerations to the conditions of the socially vulnerable and the gap between the rich and the poor as well as the gap among various regions in developing countries. Furthermore, great attention will be paid with respect to factors such as environmental and social impacts on developing countries when implementing ODA.

JICA, which is responsible for technical cooperation in ODA, plays a key role in contributing to sustainable development in developing countries. The inclusion of environmental and social costs in development costs, and the social and institutional framework to make it possible to internalize environmental and social costs in development costs, are crucial for sustainable development. The internalization and the institutional framework are requirements for measures of environmental and social considerations, and JICA has been requested to take suitable considerations of environmental and social factors.

Democratic decision-making is indispensable for environmental and social considerations, and, in order to achieve an appropriate decision-making process, it is important to ensure stakeholder participation, information transparency, accountability and efficiency in addition to respect for human rights.

In this context, with respect to human rights and in view of the principles of democratic governance, the measures for environmental and social considerations are implemented by ensuring a wide range of meaningful stakeholder participation and transparency of decision-making as well as by working for information disclosure and by ensuring efficiency. The governments bear responsibility for accountability and at the same time stakeholders are also responsible for their comments.

Under the above views, JICA considers the environmental and social impacts when implementing cooperation projects.

1.2 Objectives

The objectives of the guidelines are to encourage the recipient governments to take appropriate considerations of environmental and social factors as well as to ensure that JICA's support for and examination of environmental and social considerations are conducted accordingly. The guidelines outline JICA's responsibility and procedures, and requirements for the recipient governments to facilitate achievement of the objectives.

1.3 Definitions

1. "environmental and social considerations" means considering environmental impacts on air, water, soil, ecosystem, fauna and flora as well as social impacts including involuntary resettlement and respect for human rights of indigenous people and so on.
2. "cooperation projects" means development studies, preliminary studies of grant aid project or technical cooperation projects that JICA undertakes.

3. “projects” means undertakings or projects that the recipient governments conduct and JICA supports.
4. “environmental and social considerations studies” means studies including baseline surveys, predicting and evaluating adverse impacts and likely impacts that projects are to have on the environment and local society, and mitigation measures to avoid and minimize them.
5. “environmental impact assessment” means evaluating environmental and social impacts that projects are likely to have, analyzing alternative plans and preparing adequate mitigation measures and monitoring plans in accordance with laws or guidelines of the recipient governments.
6. “strategic environmental assessment” means an assessment being implemented at the policy, planning and program level rather than a project-level EIA.
7. “support for environmental and social considerations” means offering the recipient governments assistance by conducting environmental and social considerations studies, analyzing countermeasures, accumulating knowledge and experience, and developing human resources and so on.
8. “examination of environmental and social considerations” means judging whether adequate considerations for the projects are ensured. Judgement is performed by discussing the considerations with the recipient governments and doing field surveys; by confirming project description, site description, likely impacts on the environment and society, and legal frameworks concerning EIA; and by confirming the implementing of capacity, including the budget, organization, personnel and their experience, and the frameworks and operating procedures regarding information disclosure and public participation.
9. “screening” means deciding whether proposed projects are likely to have impacts that should be assessed by conducting environmental and social considerations studies according to project description and site description. JICA conducts screening by classifying proposed projects into three categories: A, B and C. Proposed projects classified as Category A are likely to have significant adverse impacts, and proposed projects classified as Category B are likely to have less adverse impacts than those of Category A projects. Category C projects are likely to have minimal or no adverse impacts.
10. “scoping” means deciding alternatives to be analyzed, a range of significant and likely significant impacts, and study methods.
11. “local stakeholders” means affected individuals or groups including squatters and local Non-governmental Organizations (NGOs), and “stakeholders” means individuals or groups who have views about cooperation projects, including local stakeholders.
12. “advisory council of environmental and social considerations review” means a council which advises on the support for and examination of environmental and social considerations about cooperation projects.
13. “international agreements” means agreements between the government of Japan and the recipient governments after the Ministry of Foreign Affairs selects cooperation projects.
14. “follow-up activities” means confirming that the recipient governments incorporate the conclusions of environmental and social considerations studies in the decision-making process to implement projects.
15. “Terms of Reference (TOR)” means a set of administrative, procedural and technical

requirements.

16. "Scope of Work (S/W)" means agreement documents between JICA and counterpart institutions in recipient countries that include the scope of the studies, the contents to be addressed, a schedule of studies, and mutual undertakings.
17. "Record of Discussions (R/D)" means agreement documents between JICA and counterpart institutions in recipient countries that include the objectives of technical cooperation projects, the activities, a schedule of the activities, and mutual undertakings.
18. "Environmental Impact Assessment (EIA) level study" means a study including analysis of alternative plans, prediction and assessment of environmental impacts, and preparation of mitigation measures and monitoring plans on the basis of detailed field surveys.
19. "Initial Environmental Examination (IEE) level study" means a study including analysis of alternative plans, prediction and assessment of environmental impacts, and preparation of mitigation measures and monitoring plans on the basis of secondary data and simple field surveys.
20. "coordinated detailed design (D/D) study with JBIC" means a detailed design study for a yen loans project where JICA works in closer cooperation with Japan Bank for International Cooperation (JBIC).
21. "basic design study" means a study to prepare basic plans, basic designs, cost estimation and operational organization plans about grant aid projects.

1.4 Basic Principles regarding Environmental and Social Considerations

JICA supports the recipient governments by offering cooperation projects into which JICA incorporates appropriate environmental and social considerations so as to avoid or minimize development projects' adverse impacts on the environment and local communities. JICA thus promotes sustainable development in developing countries.

JICA makes clear requirements that the recipient governments must meet and that are mindful of environmental and social considerations in the guidelines, and JICA provides the recipient governments with support to facilitate the achievement of these requirements by implementing cooperation projects. JICA examines undertakings by the recipient governments in accordance with the requirements and makes adequate decisions regarding environmental and social considerations on the basis of the results of the examination.

JICA submits proposals to MOFA regarding selection of cooperation projects from a viewpoint of environmental and social considerations, so that the Government of Japan can make an appropriate decision regarding project selection. JICA recognizes the following seven principles to be very important.

1. A wide range of impacts to be addressed is covered.

   The types of impacts addressed by JICA cover a wide range of the environmental and social impacts.

2. Measures for environmental and social considerations are implemented at an early stage.

   JICA introduces the concept of Strategic Environmental Assessment (SEA) when conducting Master Plan studies, etc., and works with the recipient governments to address a wide range of environmental and social factors from an early stage. JICA makes an effort to include an analysis of alternatives on such occasions.

3. Follow-up activities are carried out after cooperation projects are terminated.

JICA asks the recipient governments to incorporate the outcome of environmental and social considerations in the implementation of projects after cooperation is terminated. JICA offers cooperation projects in accordance with other requests, when necessary.

4. JICA is responsible for accountability when implementing cooperation projects.

JICA pays attention to accountability and transparency when implementing cooperation projects.

5. JICA asks stakeholders for their participation.

JICA incorporates stakeholder opinions into decision-making processes regarding environmental and social considerations, and JICA ensures the meaningful participation of stakeholders in order to take consideration of environmental and social factors and to reach a consensus accordingly. Stakeholders participating in meetings are responsible for what they say.

6. JICA discloses information.

JICA itself discloses information on environmental and social considerations in collaboration with the recipient governments, in order to ensure accountability and to promote participation of various stakeholders.

7. JICA enhances organizational capacity.

JICA makes an effort to enhance the comprehensive capacity of organizations and operations to consider environmental and social factors appropriately and effectively at all times.

1.5 Responsibility of JICA

1. The recipient governments take the initiative in dealing with environmental and social considerations of their projects. However JICA supports and examines measures for environmental and social considerations that the recipient governments implement in the following ways which are responsive to the nature of such cooperation projects and are in accordance with the guidelines.
2. When requests for cooperation projects are made, JICA examines the contents with regard to environmental and social considerations and categorizes the proposed projects.
3. When JICA makes plans of projects, JICA prepares reports on environmental and social considerations studies in collaboration with host countries. JICA reviews the categorization if necessary and conducts scoping with information disclosure and stakeholder consultation.
4. JICA conducts monitoring during the implementation stage of technical cooperation projects. During this stage, it is necessary to consider environmental and social factors.
5. JICA conducts follow-up activities after cooperation projects are terminated.
6. JICA provides technical assistance to host countries through mutual collaborative work for environmental and social considerations studies.
7. JICA provides technical assistance regarding the enforcement of environmental impact assessment in host countries, in response to other requests.
8. JICA makes an effort to incorporate the concept of SEA into cooperation projects when taking part in the planning or program level rather than in the project level, or comprehensive studies like master plan studies. At the same time, JICA works with the recipient governments to take

measures to address a wide range of measures for environmental and social considerations from an early stage.

9. JICA keeps in mind accountability and transparency when supporting and examining environmental and social considerations.
10. Experts dispatched by JICA give the recipient governments advice or support, with respect to the relevant clauses of the guidelines within the experts' mandates.

1.6 Requirements of the Recipient Governments

1. The recipient governments are required to incorporate the outcome of environmental and social considerations studies into their planning and decision-making process once they receive authorization for a project's implementation.
2. When JICA considers either the selection of proposed projects or the support for and examination of environmental and social considerations, JICA examines how the recipient governments meet the requirements that JICA requires as mentioned in Appendix 1.
3. Various documents prepared through the EIA process and reports (EIA documents) must be written in official languages or in languages familiar to people within the host countries. Documents written in understandable languages and forms for local people must be prepared and explained to them.
4. It is requested that EIA documents be made open to local stakeholders including local people. In addition, EIA documents should be available for public reading at all times, and the making of copies of these for the local stakeholders should be permitted.

1.7 Covered Schemes

The guidelines cover three schemes which JICA implements: Development Studies, Preliminary Studies of Grant Aid Projects, and Technical Cooperation Projects. In the case when JICA conducts studies besides the above three schemes, JICA respects related clauses of the guidelines according to project objectives.

1.8 Measures Taken in an Emergency

An emergency is defined as a case that must be dealt with immediately – such as restoration after natural disasters or post-conflict restoration – when it is clear that there is no time to follow procedures of environmental and social considerations mentioned in the guidelines. In such an emergency, JICA consults the advisory council of environmental and social considerations' review on categorization, judgement of emergency, and procedures to follow at an early stage, and discloses results of review by the advisory council and results of cooperation projects after their completion.

1.9 Dissemination

JICA makes the guidelines available through its home page. JICA explains the guidelines to the recipient governments, ministries and related institutions, and requests that they take the guidelines into consideration.

II. Process of Environmental and Social Considerations

2.1 Information Disclosure

1. In principle, the recipient governments disclose information about environmental and social considerations of projects. JICA assists the recipient governments by implementing cooperation projects.
2. JICA itself discloses important information about environmental and social considerations at the main stages of cooperation projects in an appropriate manner in accordance with the guidelines.
3. JICA discusses frameworks to ensure information disclosure with the recipient governments and comes to an agreement with them at an early stage of cooperation projects.
4. The information to be disclosed includes that of the project itself.
5. Besides the information to be disclosed on JICA's own judgment, JICA provides information about environmental and social considerations to third parties within the extent possible in response to requests.
6. JICA encourages the recipient governments to disclose and present information about environmental and social considerations to local stakeholders.
7. JICA discloses information well in advance when JICA has meetings with local stakeholders in cooperation with the recipient governments, so that they have time to review the information.
8. JICA discloses information through its website in Japanese and English, and provides related reports for public reading at its library and at a concerned overseas office.
9. JICA prepares documents in cooperation with the recipient governments in an official or familiar language and an understandable form for local people, and is willing to provide them with documents at the same time of information disclosure on its website.

2.2 Consultation with Local Stakeholders

1. In principle, the recipient governments consult with local stakeholders through means that induce reasonably broad public participation, in order to consider environmental and social factors in the way most suitable to local situations and to reach an appropriate consensus. JICA assists the recipient governments by implementing cooperation projects.
2. With the recipient governments, JICA discusses and reaches a consensus on the frameworks for consulting with local stakeholders at an early stage of cooperation projects.
3. In order to have meaningful meetings, JICA, in collaboration with the recipient governments, publicizes in advance that JICA consults with local stakeholders, particularly the people directly affected.
4. In the case of Category A projects, JICA consults with local stakeholders in collaboration with the recipient governments about the understanding of development needs, the likely adverse impacts on the environment and society of such needs, and an analysis of alternatives at an early stage. JICA will hold at least a series of discussions at each stage of scoping, preparing an outline of measures for environmental and social considerations, and the completion of a draft of the final report.
5. In the case of Category B projects as well, JICA consults with local stakeholders in collaboration with the recipient governments when necessary.

6. JICA prepares minutes of the meeting in collaboration with the recipient governments when consulting with local stakeholders.

2.3 Impacts to be Assessed

1. The impacts to be assessed with regard to environmental and social considerations include impacts on human health and safety as well as the natural environment. Impacts on the natural environment include trans-boundary or global-scale impacts through air, water, soil, waste, accidents, water usage, climate change, ecosystems and biodiversity. The impacts to be assessed also include social impacts, which include the migration of populations and involuntary resettlement; local economy such as employment and livelihood; utilization of land and local resources; social institutions such as social infrastructure and local decision-making institutions; existing social infrastructures and services; vulnerable social groups such as the poverty level and indigenous peoples; equality of benefits and losses and equality in development process; gender; children's rights; cultural heritage; local conflict of interests and infectious diseases such as HIV/AIDS.
2. In addition to the direct and immediate impacts of projects, derivative, secondary and cumulative impacts are also to be assessed in regard to environmental and social considerations within the extent possible. The life cycle impact during a project period is considered also.
3. Various kinds of relevant information are needed to assess impacts on the environment and local communities. There are, however, uncertainties in predicting impact due to incomplete understanding of an impact mechanism and limited information available. Therefore, if the scale of uncertainty is considered to be large, JICA provides environmental and social considerations which include preventive measures as much as possible.

2.4 Inquiry to Advisory Council of Environmental and Social Considerations Review

1. In order to seek advice regarding support for and examination of environmental and social considerations about cooperation projects, JICA establishes a standing advisory council as a third party, composed of external experts with the necessary knowledge.
2. The advisory council takes part in Category A and B projects from a request review stage until a final stage and gives advice about the propriety of support in response to inquiries by JICA. The council also gives advice on each cooperation project. Ad-hoc members are requested to participate in the council when necessary, taking into account the nature of each project.
3. Discussions by the advisory council are open to the public. Minutes are prepared with the names of speakers in the order of speaking and are made available to the public.
4. A committee to be established for the purpose of giving technical advice to cooperation projects must obtain advice from the advisory council in regard to environmental and social considerations.

2.5 Categorization

1. JICA classifies projects under three categories according to the extent of environmental and social impacts. To make this classification, JICA takes into account an outline of the project, the scale, the site condition, and the environmental impact assessment scheme in host countries.

2. Category A: Projects are classified as Category A if they are likely to have significant adverse impacts on the environment and society. Projects with complicated impacts or unprecedented impacts, which are difficult to assess or which have a wide range of impacts or irreversible impacts, are also classified as Category A. Projects are also classified as Category A if they require a detailed environment impact assessment by environmental laws and the standards of the recipient governments. The impacts may affect an area broader than the sites or facilities subject to physical construction. Category A, in principle, includes projects in sensitive sectors (i.e., characteristics that are liable to cause adverse environmental impact) and projects located in or near sensitive areas. An illustrative list of sensitive sectors, characteristics and areas is given in Appendix 2.
3. Category B: Projects are classified as Category B if their potential adverse impacts on the environment and society are less adverse than those of Category A projects. Generally they are site-specific; few if any are irreversible; and in most cases normal mitigation measures can be designed more readily.
4. Category C: Projects are classified as Category C if they are likely to have minimal or little adverse impacts on the environment and society.
5. JICA flexibly reviews a categorization even after screening, to determine whether a new significant impact has come to light as a result of the cooperation project process.
6. Projects may not be clearly specified at an early stage like the Master Plan Study. In such cases, however, projects are categorized based on their likely significant impacts. At that time, derivative, secondary and cumulative impacts are also to be considered. When considering plural alternatives, projects are classified as the category of that alternative which has the most significant impact among them. JICA reviews the categorization accordingly after projects have been identified by means of a progress of studies.
7. JICA requests that the recipient governments fill in the screening form of Appendix 3 and the information in this form will be a reference for the categorization of proposed projects.

2.6 Laws and Standards of Reference

1. JICA in principle confirms whether projects meet the requirements for environmental and social considerations in the following ways.
2. JICA confirms whether projects comply with laws or standards relating to the environment and local communities within both central and local governments in host countries as well as whether projects conform to their own policies and plans.
3. JICA refers to international standards, treaties and declarations and good practices which Japan, international and regional organizations and developed countries have. When JICA recognizes that laws and regulations regarding environmental and social considerations of host countries are substantially inferior to these standards and good practices, JICA encourages the recipient governments – including local governments – to take more appropriate considerations through a series of dialogues, and confirms background and justification for that.
4. JICA takes into account the importance of good governance surrounding projects so that measures for appropriate environmental and social considerations are implemented.
5. JICA discloses information with reference to relevant laws of the recipient governments and the

government of Japan.

2.7 Concern about Social Environment and Human Rights

1. Environmental and social factors are affected by the social and institutional conditions of host countries and the actual conditions of the project location. Therefore, JICA fully takes these conditions into account when supporting and examining environmental and social conditions. In particular, special measures must be taken for cooperation projects when disclosing information and holding consultation with local stakeholders after obtaining understanding from the recipient governments, in countries and areas affected by conflict or where basic freedoms – including freedom of expression and the right to receive legal relief – are restricted.
2. JICA respects the principles of internationally established human rights standards like the International Convention on Human Rights, and gives special attention to the human rights of vulnerable social groups – including women, indigenous peoples, persons with disabilities, and minorities – when implementing cooperation projects. JICA obtains country reports and information issued by related institutions about human rights, and JICA understands local human rights situations by disclosing information about cooperation projects. Thus, JICA integrates local human rights situations into the decision-making process regarding environmental and social considerations.

2.8 Decision-making by JICA

1. JICA makes recommendations to the Ministry of Foreign Affairs of Japan (MOFA) from the viewpoint of environmental and social considerations at the review stage of requests. In addition to the categorization by screening, JICA makes these recommendations after confirming the nature of proposed projects, site description, scope of impacts on the environment and local communities, operational capacities of the recipient governments and project executing bodies, and prospect of information disclosure and public participation in addition to categorization by screening. The recommendations include changing studies to an upper level or changing preliminary studies of grant aid projects to feasibility studies when necessary.
2. JICA takes necessary measures to ensure suitable environmental and social considerations of cooperation projects, if unexpected inadequate matters come to light after MOFA concludes international agreements.
3. JICA makes a decision to stop cooperation projects and recommends MOFA to do the same when JICA concludes that it is impossible to ensure environmental and social considerations even if the above measures are taken. Cases where it is impossible to ensure environmental and social considerations are, for example, where development needs are inappropriately understood, where projects are expected to have significant impacts even if mitigation measures are taken into consideration during implementation stage, where the affected residents or social organizations concerned hardly participate in projects and are not expected to do so in the future though serious impacts are to be predicted, or where it is expected to be difficult to implement mitigation measures to avoid or minimize impacts in consideration of social and institutional conditions to the project's site, etc.

2.9 Ensuring Appropriate Implementation of and Compliance with the Guidelines

JICA appropriately implements principles and procedures mentioned in the guidelines and ensures compliance with them. JICA responds to objections regarding non-compliance with them by establishing a body for prescribing regulations separately from the guidelines. The body is independent from the project executing departments.

2.10 Implementation and Review of the Guidelines

1. The guidelines come into force on April 1, 2004 and projects proposed in and beyond FY 2004 are subject to the guidelines. Ongoing cooperation projects requested before April 1, 2004 are subject to possible items mentioned in the procedures. JICA proceeds with a system to respond to objections regarding non-compliance with the guidelines.
2. JICA verifies the status of implementation of the guidelines, and based on its findings makes a comprehensive review of them within five years of their enforcement. A revision is made as needed. When JICA revises the guidelines, JICA seeks opinions from the government of Japan and developing countries, NGOs in developing countries, as well as NGOs in Japan, the private sector and experts, etc., in a process which ensures transparency and accountability.
3. JICA studies problems to be solved and methods in applying the guidelines, and incorporates the results of studies in a review process of the guidelines.