The Republic of Indonesia
PT PLN (Persero)

Preparatory Survey on Central and West Java 500kV Transmission Line Project

Final Report

March 2012

Japan International Cooperation Agency

Tokyo Electric Power Services Co., Ltd.

ILD
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Abbreviations

Abbreviations	Words (Original)
AC	Alternative Current
ACSR	Aluminum Cables Steel Reinforced
ADB	Asian Development Bank
AIDS	Acquired Immune Deficiency Syndrome
AMDAL	Environmental Impact Assessment (*Analisis Mengenai Dampak Lingkungan*)
ANDAL	Environmental Assessment Statement (*Analisis Dampak Lingkungan*)
BAPPEDA	Regional body for planning and development (*Badan Perencanaan Pembangunan Daerah*)
BAPPENAS	National Development Planning Agency
BLH	Department of Environment of Central Java Province (*Badan Lingkungan Hidup*)
BPLH	Department of Environment of West Java Province (*Badan Pengelolaan Lingkungan Hidup*)
BPS	Central Statistics Department (*Badan Pusat Statistik*)
CB	Circuit Breaker
CBF	Circuit Breaker Failure protection
CCP	Constant Current Protection
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CO2	Carbon Dioxide
COD	Commercial Operation Date
DC	Direct Current
DCPT	Dutch Cone Penetration Test
DKI	Special Capital City District (*Daerah Khusus Ibukota*)
DI	Special Region (*Daerah Istimewa*)
EDS	Every Day Stress
EIA	Environmental Impact Assessment
EMS	Environmental Management Section
EPC	Engineering, Procurement and Construction
FACTS	Flexible Alternative Current Transmission System
FC	Foreign Currency
FR	Friction Ratio
GDP	Gross Domestic Product
GW	Ground Wire
HIV	Human Immunodeficiency Virus
HSD	High Speed Diesel
HVDC	high-voltage direct current
IBT	Inter Bus Transformer
ICB	International Competitive Bidding
IDC	Interest during Construction
IEC	International Electro technical Commission
IKL	Isokeraunic Level
IPP	Independent Power Producer
IUCN	International Union for Conservation of Nature and Natural Resources
IUPTL	Electricity Supply Business License
JICA	Japan International Cooperation Agency
KA-ANDAL	Term of Reference on Environmental Assessment Statement (*Kerangka Acuan – Analisis Dampak Lingkungan*)
KEP	Decision (*Keputusan*)
KLT	
KLH	Ministry of Environment (*Kementerian Lingkungan Hidup*)
LAC	Land Acquisition Committee

LC	Local Currency
LTE	Labour, inland transportation and expenses
MEMR	Ministry of Energy and Mineral Resources
MD	Minutes of Discussion
MFO	Marine Fuel Oil
MOF	Ministry of Finance
MPE	Ministry of Mines and Energy (*Menteri Pertambangan dan Energi*)
MSOE	Ministry of State Owned Enterprises
NJOP	Tax Object Selling Price (*Nilai Jual Objek Pajak*)
NOx	Nitrogen Oxide
OCR	Over Current Relay
ODA	Official Development Assistance
ONAN	Oil Natural Air Natural
ONAF	Oil Natural Air Fan
OPGW	Optical Ground Wire
PAP	Project Affected Person
PLN	PT. Perusahaan Listrik Negara (Persero)
PQ	Pre-Qualification
P/S	Power Station
PSO	Public Service Obligation
qc	Cone Friction Resistance
RKL	Environmental Management Plan (*Rencana Pengalolaan Lingkungan*)
RAP	Resettlement Action Plan
RJBR	Branch of West Java
RJTD	Branch of Central Java
ROW	Right of Way
RPL	Environmental Monitoring Plan (*Rencana Pemantauan Lingkungan*)
RTRW	Regional Spatial Plan (*Rencana Tata Ruang Wilayah*)
RUKN	National Electricity Plan (*Rencana Umum Ketenaga Nasional*)
RUPTL	Electricity Supply Business Plan (*Rencana Usaha Penyediaan Tenaga Listrik*)
RUS	Rated Ultimate Strength
SF_6	Sulfur Hexafluoride
SOx	Sulfur Oxide
S/S	Sub Station
TDL	Basic Electricity Tariffs (*Tarif Dasar Listrik*)
TOC	Taking Over Certificate
TTL	Electricity Tariff (*Tarif Tenaga Listrik*)
T/L	Transmission Line
TR, Tr	Transformer
UIP	Project Implementation Unit (*Unit Induk Pembangunan*)
UPK	*Unit Pelaksana Konstruksi*
UPP	Maintenance Service Units
UPT	Transmission Service Units (*Unit Pelayanan Transmisi*)
US	United States of America
UTS	Ultimate Tensile Strength
W/O	Without
ZnO	Zinc Oxide

Chapter 1 Introduction

1.1 Background of the Study

Since the 1997 Asian financial crisis, the Indonesian economy has achieved a significant recovery and has enjoyed an average annual high growth rate of more than 5 percent over the past 10 years, though its growth slowed down slightly (still at 4.6%) during the recent global recession. The country's demand for electricity has been increasing at an annual rate of 5 percent. The Java Bali system, especially, provides electricity for the nation's political and economic center, which comprises 80 percent of power demand.

The government has developed electrical power sources to supply the tremendous demand through the Indonesia Crash Program. In addition, improving the transmission line in order to deliver power from remote locations is an urgent matter. Especially, the Central and West Java 500 kV Transmission Line Project of the plan for the development of the transmission line of the Long Term Electricity Development Plan 2010-2019 (hereafter RUPTL2010-2019) will enable the 500 kV transmission line the capability of supplying power efficiently from a total 6,640 MW of three massive power plants in North Java, is absolutely imperative.

1.2 Purpose and Activities

1.2.1 Purpose of the Study

The Central and West Java 500 kV Transmission Line Project (hereafter the Project) aims at constructing a 500 kV transmission line in Central and West Java in order to improve the tight electricity situation and power supply reliability, which results in regional socio-economic improvements and an enhanced quality of life.

The purpose of the Study is to investigate the information required for the Yen-Loan Project such as the cost estimate, schedule, implementation, organizational structure, management, and socio-environment.

1.2.2 Area in Which to Conduct the Study

Central and West part of Java Island

1.2.3 Scope of the Study Works

The following are the targeted study items. This Study will be conducted in accordance with the Minutes of Discussion (MD) signed between the organization of the partner country and the Japan International Cooperation Agency on May 24, 2011.

(1) Confirmation of the necessity of the Project
- 1-1. Confirmation of the power development plan
- 1-2. Confirmation of the network development plan and power flow forecast
- 1-3. Confirmation of the regional demand and supply balance forecast
- 1-4. Availability and cost of construction materials, machinery, equipment and construction workers
- 1-5. Confirmation of a serious past network accident
- 1-6. Review and confirmation of the necessity and appropriateness of the Project

(2) Review and confirmation of the components of the Project

2-1. To review the Feasibility Study undertaken in 2010 and update the Project scope and preliminary design
2-2. Proposal of consulting service and technical assistance under the Project
2-3. To review the Project cost
2-4. Study of cost reduction measures
2-5. Proposal of the Project implementation schedule
2-6. Proposal of the project's procurement package

(3) Confirmation of operation, maintenance and management

3-1. Confirmation of PLN's technical and financial capacity
3-2. Proposal of appropriate operations and the maintenance and management system to enhance project output

(4) Project evaluation

4-1. Proposal of the operation and evaluation indicators of the Project
4-2. Indication of project beneficiaries
4-3. Calculation of EIRR
4-4. Evaluation of the qualitative effect from the Project
4-5. To calculate the amount of CO_2 emissions reduction by the Project

(5) Environmental and social considerations

5-1. To confirm the legislation and institutional framework for the environmental and social safeguards in Indonesia
5-2. To implement scoping
5-3. To confirm the volume of the forest area and the classification to be leased for the Project
5-4. To monitor the progress of EIA implementation and to provide technical supports
5-5. To monitor the progress of RAP development and follow up
5-6. To confirm if there are any rare species and to examine mitigation measures
5-7. To measure the environmental and social impact
5-8. To assess the environmental and social impact and to examine alternatives
5-9. To examine mitigation measures (avoid, minimize or compensate)
5-10. To examine environmental management plan and environmental monitoring plan
5-11. To provide supports to stakeholder meetings

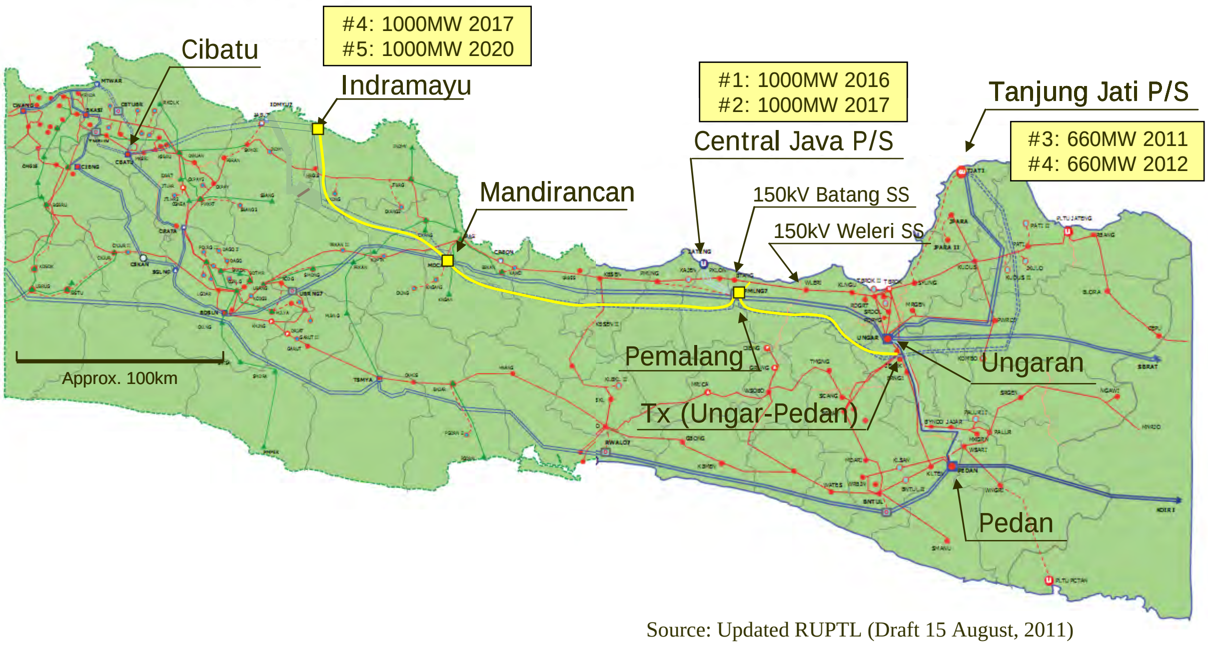
(6) To hold a workshop during the preparatory survey and feedback for the report drafts

1.3 Scope of the Project

The target facilities of the Project is shown in Table 1. 1.

Table 1. 1 Target Facilities

Transmission line	Section	Distance
	500kV Tx (Ungar-Pedan) – Pemalang	86.1 km
	150kV Pemalang – Inc 2 Pi (Batang-Weleri)	2 km
	500kV Pemalang – Mandirancan	166.9 km
	500kV Mandirancan - Indramayu	89.6 km
Substation	Location	New/Ext.
	Pemalang (500kV, 150kV)	New
	Mandirancan	Extension
	Indramayu	Extension



Source: Updated RUPTL (Draft 15 August, 2011)

Figure 1. 1 Scope of the Project

1.4 Organization and the Results

1.4.1 Conducting Organizations of the Partner Country

PLN organized the following team for the Project.

Table 1. 2 Member List of the Project Team of PLN

Name	Company	Assignment
Andi Darmawati	PLN Pusat	Project Leader / Power System Planning
Suroso Isnandar	PLN Pusat	Project Sub-Leader / Power System Planning
Indira Almatsier	PLN Pusat	Environment and Social Consideration
Marina Kurniati	PLN Pusat	Environment and Social Consideration
Ratnasari Sjamsuddin	PLN Pusat	Transmission Line & Substation Designing
Andrey Kennedy	PLN Pusat	Administrative Loan
Novi Tria Susanti	PLN Pusat	Administrative Loan
Mujilin	PLN UIP Jaringan Jawa Bali	Environment and Social Consideration
Retno	PLN UIP Jaringan Jawa Bali	Environment and Social Consideration
Warsono	PLN P3B Jawa-Bali	Operation
Ahmad Yusuf Salile	PLN P3B Jawa-Bali	Operation
Muhammad Nuh	PLN-E	Transmission Line & Substation Designing

1.4.2 Member List of the Study Team

The Study Team is composed of the following experts.

Table 1. 3 Member List of the Study Team

Expert’s Name	Assignment
Noboru SEKI	Project Leader / Power System Planning A
Masaharu YOGO	Power System Planning B
Yasushi SHINOGI	Power Demand Forecast
Atsumasa SAKAI	Power System Analysis
Manabu ONODA	Economic and Financial Analysis
Masahiro OGAWA	Transmission Line Designing
Keiichi FUJITANI	Substation Designing A
Takayuki KIKUCHI	Substation Designing B
Kiminori NAKAMATA	Geological Survey
Satoshi KOBAYASHI	Route Survey & Route Selection
Shigeki WADA	Environment and Social Consideration A (Environment Consideration)
Junko FUJIWARA	Environment and Social Consideration B (Social Consideration)

1.4.3 Results

(1) Period of the Study

From July 2011 to February 2012.

(2) Study in Indonesia

Table 1. 4 Study Results

Stage	Implementing Items
1st Study in Indonesia (Aug. 10 – Aug.24, 2011)	- 1st workshop to discuss the Inception Report - 1st site survey for Tx – Mandirancan (Transmission Line and Substations)
2nd Study in Indonesia (Sep. 13 – Oct. 8, 2011)	- 2nd site survey for Tx – Mandirancan (Transmission Line, Substations, Soil Investigation, Environment and Social Survey)
Meeting about Pemalang SS in Indonesia (Nov.16 – Nov. 19, 2011)	- Meeting about the location of the Pemalang Substation - Site survey for the Pemalang Substation (Transmission Line, Substations, Soil Investigation, Environment and Social Survey)
3rd Study in Indonesia (Dec. 15 – Dec. 25, 2011) (Jan. 8 – Jan. 25, 2012)	- 3rd site survey for Tx – Mandirancan (Transmission Line) - Site survey for Mandirancan – Indramayu (Transmission Line, Soil Investigation, Environment and Social Survey)
4th Study in Indonesia (Feb. 12 – Feb. 25)	- 2nd workshop to discuss the Draft Final Report

(3) Reporting

Table 1. 5 Reporting Schedule

Report	Duration
Inception Report	August 8, 2011
Interim Report	October 31, 2011
Draft Implementation Program	November 30, 2011
Draft Final Report	January 31, 2012
Final Report (Tentative)	March 6, 2012

Chapter 2 The Power Sector in Indonesia

2.1 Economic Condition in Indonesia

2.1.1 General Outline

Indonesia consists of over 13,000 islands and 33 provinces and also is the fourth most populated country in the world with around 237.6 million people after China, India and the US. The economic conditions in Indonesia are as follows, focusing especially on the Java-Madura-Bali region[1] which plays an important role in the Indonesian economy.

2.1.2 Transition of Population

One of the reasons for the steady economic growth in Indonesia seems linked to the large population which was 237.6 million as of 2010.

As shown in Table 2. 1, the population distribution ratio in the Java-Madura-Bali region which serves as the center of politics and economics amounts to 59.1% of the total population in the whole area as of 2010. Though the ratio has decreased slightly compared with 65.6% in 1971, the Java-Madura-Bali region is still maintaining a high ratio as the main region in Indonesia.

The population in the Java-Madura-Bali region has increased 13% in this decade from 124.5 million in 2000 to 140.5 million in 2010.

Table 2. 1 Transition of the Population in each Area

Province	Population					
	1971	1980	1990	1995	2000	2010
DKI Jakarta	4,579,303	6,503,449	8,259,266	9,112,652	8,389,443	9,607,787
Jawa Barat	21,623,529	27453525	35,384,352	39,206,787	35,729,537	43,053,732
Jawa Tengah	21,877,136	25372889	28,520,643	29,653,266	31,228,940	32,382,657
DI Yogyakarta	2,489,360	2,750,813	2,913,054	2,916,779	3,122,268	3,457,491
Jawa Timur	25,516,999	29188852	32,503,991	33,844,002	34,783,640	37,476,757
Banten	-	-	-	-	8,098,780	10,632,166
B a l i	2,120,322	2,469,930	2,777,811	2,895,649	3,151,162	3,890,757
Others	41,001,580	53,750,840	69,019,829	77,125,673	81,760,825	97,139,979
INDONESIA	119,208,229	147,490,298	179,378,946	194,754,808	206,264,595	237,641,326
java-Bali (%)	65.6%	63.6%	61.5%	60.4%	60.4%	59.1%

Source: BPS (Badan Pusat Statistik) Central Statistics Department data

2.1.3 Gross Domestic Product (GDP)

The real economic growth rate in Indonesia was 6.3% per annum in 2007, 6.0% in 2008, 4.6% in 2009 affected by the global recession and 6.1% in 2010 as shown below in Table 2. 2. Furthermore, the Asian Development Outlook 2011 (ADB) estimates that Indonesia will continue to grow maintaining a high

[1] Java-Madura-Bali region consists of seven provinces, DKI Jakarta, Banten, West Java, Central Java, DI Yogyakarta, East Java and Bali.

growth rate in the future, 6.4% in 2011 and 6.7% in 2012.

Table 2. 2 Transition of GDP Growth by Expenditure over the past 4 Years

Persent

Component	2007	2008	2009	2010
Consumption	4.9	5.9	6.2	4.0
Household Consumption	5.0	5.3	4.9	4.6
Government Consumption	3.9	10.4	15.7	0.3
Gross Fixed Capital Investiment	9.3	11.9	3.3	8.5
Non-construction Investment	11.9	25.4	-6.7	13.1
Construction Investment	8.5	7.5	7.1	7.0
Net Export	6.5	7.6	12.5	7.5
Export of Goods and Services	8.5	9.5	-9.7	14.9
Import of Goods and Services	9.1	10.0	-15.0	17.3
Gross Domestic Product	**6.3**	**6.0**	**4.6**	**6.1**

Source: BPS Statistics data

In 2010, household consumption supported by a strengthening labor market and rising prices for agricultural commodities increased by 4.6%. The Gross Fixed Capital Investment grew by 8.5%. Investment in machinery and equipment rebounded by 13.1% from a contraction in 2009, while that of buildings, including infrastructure grew by 7.0% in 2010. Net exports also contributed to GDP growth.

Furthermore, in consideration of the GDP components from each industry, it is said that manufacturing, commercial, agriculture, forestry and fishery industries comprise the main industries in Indonesia and they seem to be the driving force behind economic growth in Indonesia. In recent years, the growth of the transportation and telecommunication industries has been expanding drastically and it is assumed that they will continue to grow for the next few years. The GDP ratio in each industry is as follows.

Table 2. 3 GDP Structure Divided into each Field of Industry

(Persent)

Component	2007	2008	2009	2010
1. agriculture, forestry and fisheries industry	13.82	13.67	13.59	13.17
(growth rate)	3.47%	4.83%	3.97%	2.87%
2. mining industry	8.72	8.28	8.27	8.07
(growth rate)	1.96%	0.70%	4.46%	3.44%
3. manufacturing industry	27.39	26.79	26.17	25.76
(growth rate)	4.67%	3.66%	2.15%	4.48%
4. electricity, water, gas	0.69	0.72	0.79	0.78
(growth rate)	9.76%	11.11%	14.00%	5.85%
5. construction	6.20	6.29	6.44	6.50
(growth rate)	8.56%	7.55%	7.10%	6.99%
6. commerce, hotel, restaurant	17.33	17.47	16.93	17.34
(growth rate)	8.93%	6.87%	1.32%	8.68%
7. transportation, telecommunication	7.24	7.97	8.80	9.41
(growth rate)	13.84%	16.58%	15.49%	13.47%
8. finance, real estate, corporate service	9.35	9.55	9.59	9.55
(growth rate)	8.00%	8.22%	5.03%	5.65%
9. service	9.25	9.27	9.43	9.43
(growth rate)	6.44%	6.27%	6.37%	6.04%
total	**100**	**100**	**100**	**100**
(growth rate)	**6.3%**	**6.0%**	**4.6%**	**6.1%**

(Source) BPS statistics data

The following regional GDP Table 2. 4 shows that the ratio of Java Island makes up 57.7% in the second Quarter forecast 2011, signifying that the Java region is an important area and is upholding the Indonesian economy as mentioned in part 2.1.2 Transition of Population.

Table 2. 4 Contribution Ratio of GDP by Islands

Persent

Island / Districts	2009	2010	2011 (Second Quarter)
Sumatera	22.6	23.1	23.5
Java	58.6	58.0	57.7
Bali and Nusa Tenggara	2.7	2.7	2.5
Kalimantan	9.2	9.2	9.5
Sulawesi	4.6	4.6	4.7
Maluku and Papua	2.3	2.4	2.1
Total	**100.0**	**100.0**	**100.0**

(Source) BPS Berita Sesmi Statistik, 5 August, 2011

2.2 Basic Policy and Background in the Power Sector

2.2.1 Related Laws in the Power Sector

The Government of Indonesia is conducting their Electricity Policy aiming for low and stable supply of electricity in order to maintain the country's high economic growth and fair societal development.

Under the Law No. 15 ("Old Electricity Law") which was established in 1985, the electricity business enterprise or related organizations were stipulated. Furthermore, PLN as a holder of the electricity business authority has become the only one enterprise who has a monopolistic control over generation, transmission and distribution.

As time goes by, Indonesia's circumstances changed and electricity demand began expanding gradually. To cover and fulfill the growing demand, the utilization of IPPs has been expected. In 1992, Presidential Degree No.37 was issued allowing IPPs to join the field of generation. However, because of the Asian Financial Crisis in 1997, many IPP projects except a few were shut down by the Government.

In September 2002, Law No.20 was affected and it aimed to abolish the monopoly of electricity supply only by PLN and it also intended IPPs to be able to join the field of generation and retail business under the principle of free market mechanism. However, the Constitutional court judged that Law No.20 was unconstitutional and was thus voided on 15 December, 2004. The reasoning behind this judgment was that in article 33 in the Constitution of Indonesia, "Public services seriously affecting people's lifestyles are maintained and controlled by the Government". After the unconstitutional judgment, Law No. 15 ("Old Electricity Law") again became effective.

In March 2006, a new bill was submitted to the congress, and after repeatedly being discussed, the Law No. 30 year 2009 ("New Electricity Law") was approved and enacted.

The framework of the New Electricity Law is as follows;

The main supplier composed of the Power Sector is still the Government and the Government is responsible for electricity supply. (under the influence of the unconstitutional judgment in 2004.)

Private business enterprises, cooperatives and non-governmental enterprises are allowed to participate in the electricity supply under this New Electricity Law. However, PLN still has first priority to be the electricity supplier for the public needs.

Electricity supply businesses are required to acquire the Electricity Supply Business License (IUPTL) for the purpose of supplying electricity for public use. PLN is deemed as having already obtained the IUPTL.

The across-the-board electricity tariff was revised and the differentiation of tariffs across regions is allowed. The approval of the Government is required for the tariff setting.

2.2.2 RUKN and RUPTL

The overall national electricity plan (RUKN, Rencana Umum Ketenaga Nasional) is a general electricity plan of Indonesia, following Law No. 30 year 2009 ("New Electricity Law"), Article 7. In this Law, the necessity and importance of this plan is mentioned. The Ministry of Energy and Mineral Resources (MEMR) is responsible for the issuance of RUKN in order to formulate a stable energy supply system and secure energy sources. The RUKN 2008-2027 is the latest one already issued.

For the supplement of the RUKN, the Directorate General of Electricity in the Ministry is preparing a Master Plan for electricity development. The Master Plan covers the short-term electricity plan for 5 years and is a part of a combination of the two national plans, the national electricity plan (RUKN) and the electricity supply business plan (RUPTL) so as to provide information in the development of electricity. The Master Plan (Pembangunan Ketenagalistrikan 2010 s.d. 2014) is the latest one that was already issued on December 2009.

Under the national electricity plan, PLN creates an electricity supply business plan titled RUPTL (Rencana Usaha Penyediaan Tenaga Listrik). The RUPTL is made by PLN and after the approval of the Ministry of Energy and Mineral Resources (MEMR), it is issued and publicly released.

2.3 Related Organizations and their Role in the Power Sector

2.3.1 Related Organizations in the Government

The following are the main Governmental organizations in the Power Sector.

- Ministry of Finance (MOF)
  Controlling and supervising PLN from the view of finance.
- Ministry of Energy and Mineral Resources (MEMR)
  Responsible for the development policy and the energy plan in Indonesia, and The Directorate General of Electricity and Energy Utilization in the Ministry is in charge of the electricity development plan.
- Ministry of State Owned Enterprises (MSOE)
  Having the power to supervise all state owned enterprises including PLN in terms of the owner, and checking all activities done by PLN.
- National Development Planning Agency (BAPPENAS)
  Designing the whole development plans in Indonesia. If a project is funded by Japanese Official Development Assistance (ODA), BAPPENAS will liaison with the Japanese Government.

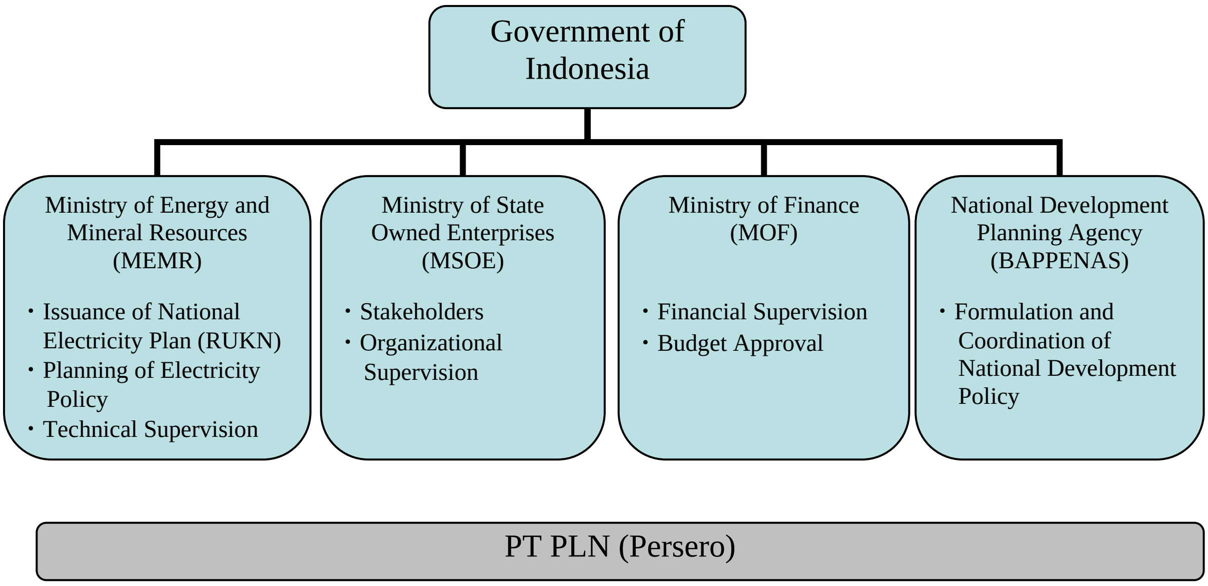
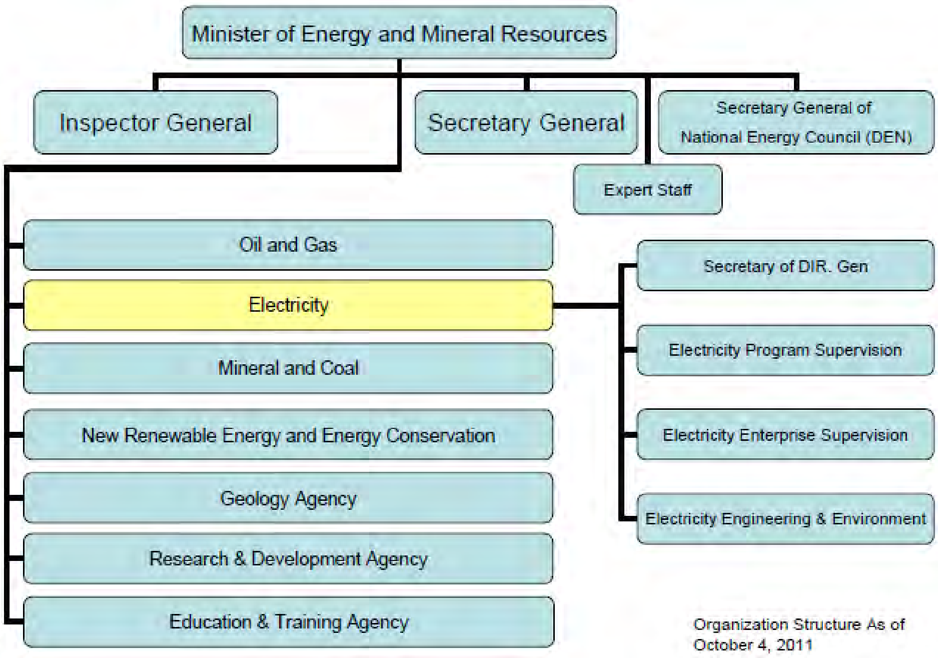


Figure 2. 1 Framework of the Power Sector in Indonesia

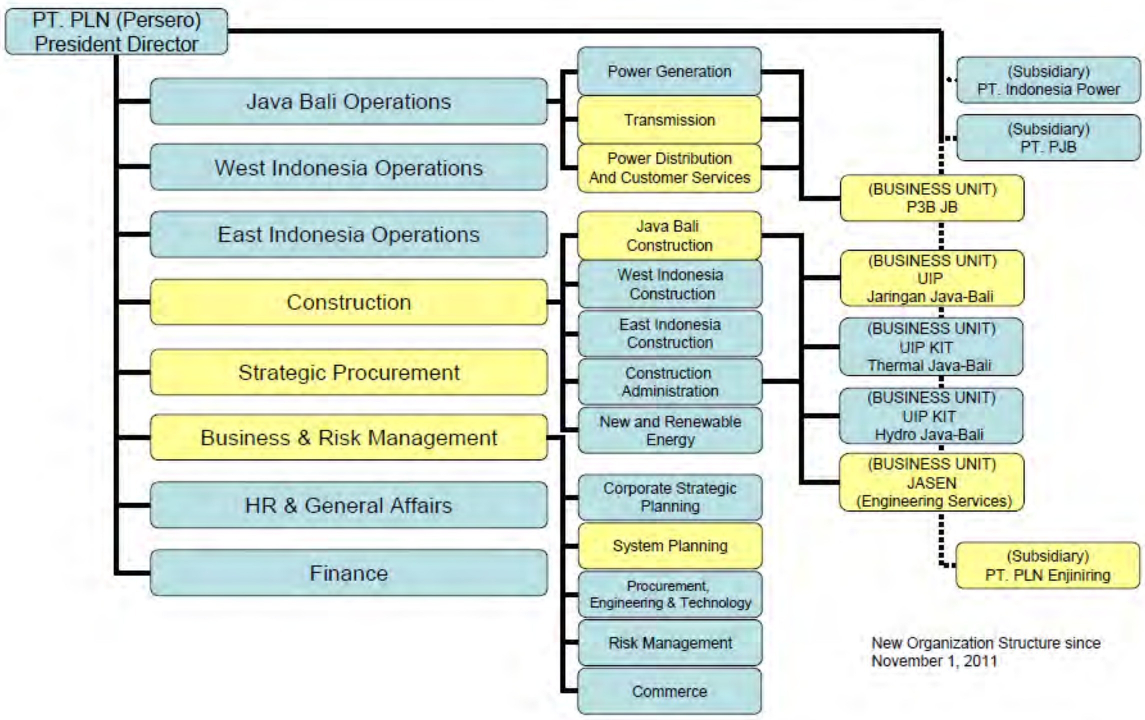


Source: received data from MEMR

Figure 2. 2 Organizational Structure of MEMR

2.3.2 PT PLN (Persero)

PLN is a 100% state-owned electricity company covering the whole area in Indonesia. PLN changed their organization from the time that the new president director was appointed in November 2011. The organizational structure is shown as follows and the yellow-marked items are the related sections for this survey and the future prospective project.

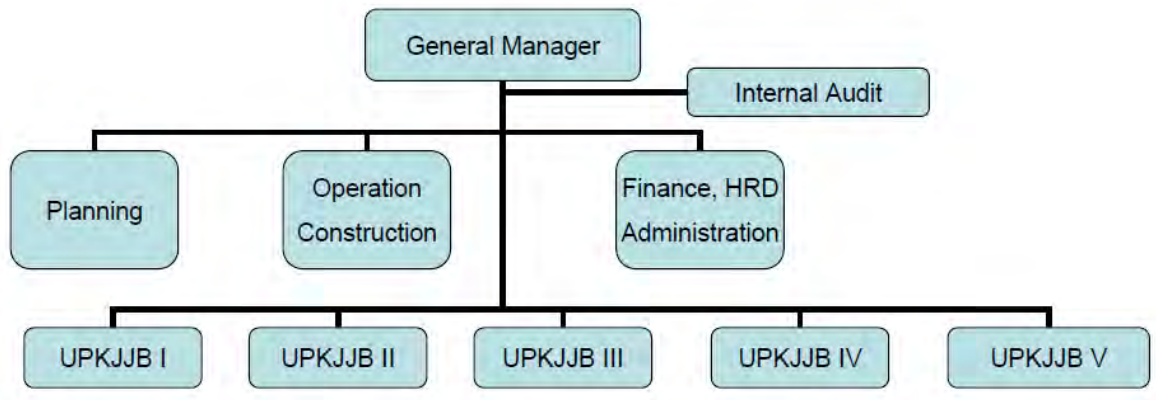


Source: PLN Announcement No.010. Pm/SETPER/2011

Figure 2. 3 PLN Organization Chart

PLN consists of 8 departments. Once this project commences with its construction works, the Java Bali Construction division in the Construction department will be responsible for its overall supervision.
In the Java Bali Construction division, there are 3 general construction supervision business units, *UIP Jaringan Jawa-Bali* for transmission and substations, *UIP KIT Thermal Java-Bali* for thermal power plants and *UIP KIT Hydro Java-Bali* for hydro power plants.

In March 2011, the Java-Bali-Nusa Tenggara construction center known as "*JBN*" which played a former role was abolished and divided into these three construction supervision business units via PLN organizational reforms.
The organizational structure of the transmission and substation construction supervising business unit (*UIP Jaringan Java-Bali*) at the time of August 2011 was as follows.



(Source) Data from UIP Jaringan Java-Bali

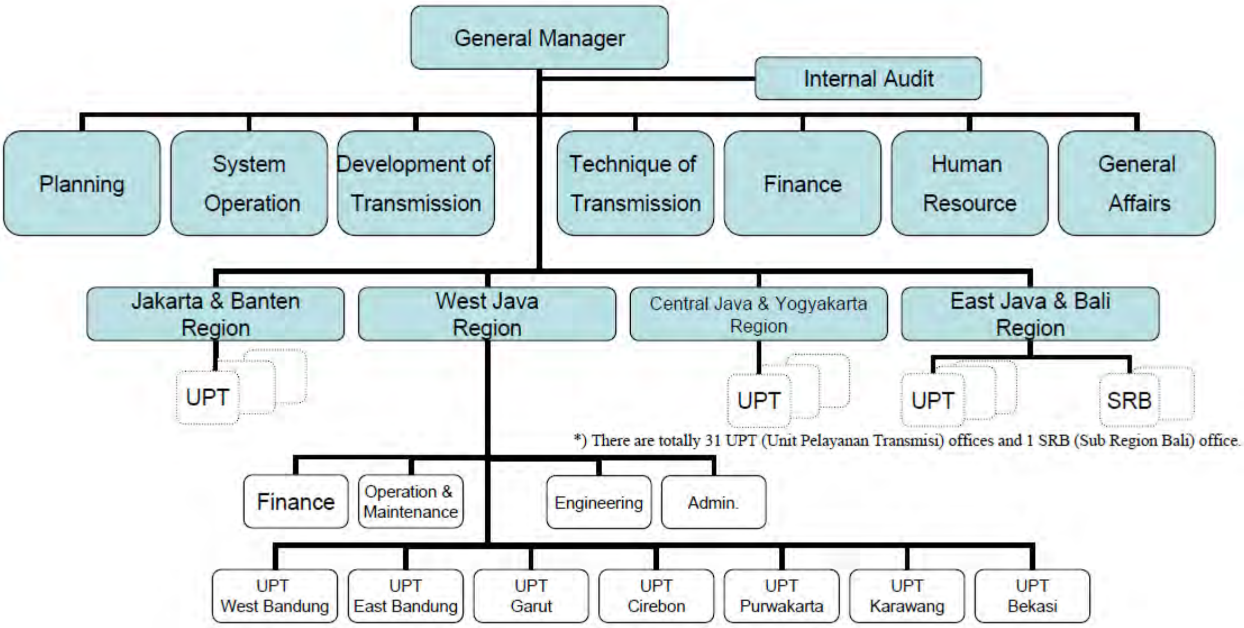
Figure 2. 4 Organizational Chart of UIP Jaringan Java-Bali

The Strategic Procurement department at PLN headquarters is in charge of bidding and the selection of a contractor. After the signing of the contract with a selected bidder, the procurement stage concludes and then goes on to the next construction stage. The role in the Strategic Procurement department is transferred to the Java Bali Construction division in the Construction department.

After the appointment of a project manager, the supervision of construction is conducted by the *UIP Jaringan Java-Bali* under the Java Bali Construction division. *UIP Jaringan Java-Bali* not only implements the construction supervision but also is responsible for the EIA permission procedures, land acquisition and payment of social compensation.
From the point of supervising the designing of the construction drawings, the Engineering Services Business Unit (*JASEN)* is responsible for the inspection and approval of the drawings as a position of the supervisor on behalf of the owner, PLN.

At the time of the completion of the construction, the property right of the outcome is transferred from the contractor to PLN by a Taking Over Certificate (TOC) and the role of *UIP Jaringan Java-Bali* is also finished. This signifies that the construction stage is finished.

Then, the Transmission and Center for Load Dispatching of the Java-Bali Business Unit (P3B JB) takes over the facility and operates and maintains it.
The organizational chart of the Transmission and Center for Load Dispatching of the Java-Bali Business Unit (P3B JB) on August 2011 is as follows.

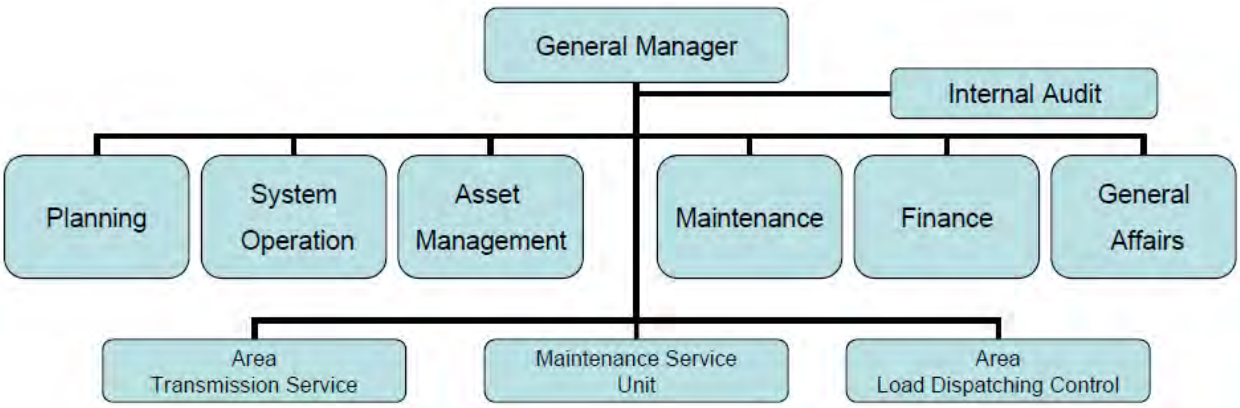


(Source): Data from P3B JB office

Figure 2. 5 Organization of P3B JB

There are seven sections under the General Manager that covers the job of planning, operations, development and maintenance. Control is achieved via the business unit method for distribution which is divided into the four areas Jakarta & Banten, West Java (*Jawa Barat*), Central Java (*Jawa Tengah*) and East Java & Bali (*Jawa Timur &Bali*).

The Transmission and Center for Load Dispatching of Java-Bali Business Unit (P3B JB) has a plan to change its organization from year 2012. The planned organizational chart is as follows.



(Source): Data from P3B JB office

Figure 2. 6 Planed Organizational Chart of P3B JB

The main point is that those four regional branch offices in old organization are abolished and the role of the four offices are conducted and controlled directly by P3B JB.

In the summarizing the aforementioned, the flow chart of the planning, construction and operations for this project has been plotted as follows.

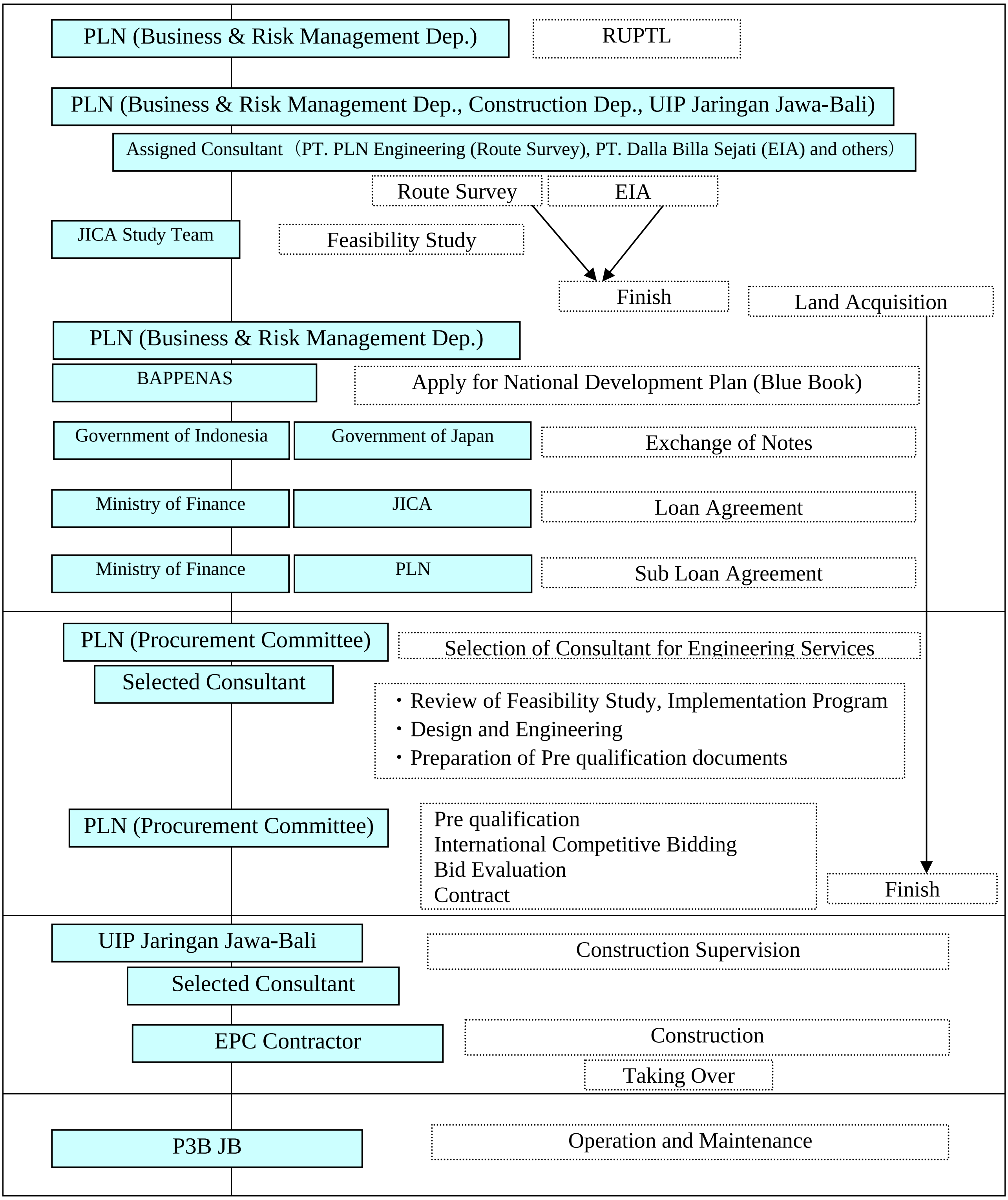


Figure 2. 7　Flow Chart of Planning, Construction and Operation for the Central and West Java 500kV Transmission Line Project

2.3.3 The Electricity Supply Framework

The present structure of the electric power industry consists of the following. The electric power generation part is owned by PLN, a 100% state owned company, and their subsidiary companies and IPPs. In the Java Bali region, which is a huge business area, the PLN has two subsidiary generating companies such as PT. Indonesia Power and PT. PJB. The transmission and load dispatching and distribution parts are fully owned and maintained by PLN. The Transmission and load dispatching part is controlled by P3B JB. Furthermore, the distribution part is divided into 5 areas and operated by each business unit in PLN.

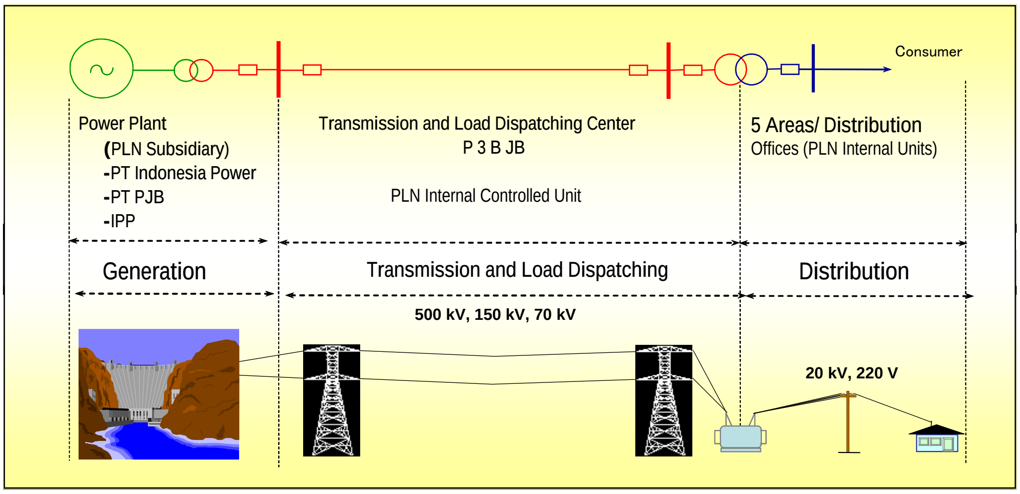


Figure 2. 8 Framework of Electricity Supply in Java-Bali Area

2.4 Electricity Tariff System

2.4.1 Electricity Sales Revenue

The transition of electricity sales revenue in PLN is as shown in Table 2. 5. In 2010, the largest source of the electricity power sales revenue is coming from the group of industrial and residential tariffs. The electricity sales revenue was increased by 14.20% to 102,974 million Rupiah from 2009, due to the revised 2010 electricity tariff.

Table 2. 5 Transition of Electricity Sales Revenue in PLN

(Unit: Million Rp

Component	2006	2007	2008	2009	2010
Residential	24,988	27,058	32,815	32,380	36,875
Business	14,074	15,920	14,991	22,116	25,408
Industry	27,226	28,458	31,364	29,771	33,621
Public	4,446	4,844	5,188	5,903	7,070
Total	**70,735**	**76,280**	**84,358**	**90,172**	**102,974**

(Source): PLN Annual Report 2010

In considering the average selling price of electricity, the price of the residential type is being kept lower than the other type. This is because the electricity price is decided by the Government aiming for a low and stable supply of electricity in order to maintain the high economic growth of the country and fair development of society. The figures are as follows.

Table 2. 6 Average Selling Price of Electricity by Type of Customer

(Unit: Rp./kWh)

Type	2006	2007	2008	2009	2010
Residential	571.12	571.76	588.01	589.33	615.92
Industrial	624.23	621.32	622.04	644.34	660.99
Business	764.25	772.51	850.56	890.90	934.32
Social	585.30	574.08	580.89	577.77	623.76
Gov. Office	755.53	743.40	847.15	870.38	953.03
Public Service	644.87	647.73	665.11	663.33	745.77
Total (Average)	**628.14**	**629.18**	**653.00**	**670.02**	**699.09**

(Source): Statistic 2006-2010

2.4.2 Electricity Tariffs System

In Indonesia, the basic electricity tariffs (TDL, Tarif Dasar Listrik) are decided by the Government and the House of Representatives per Law No. 30 year 2009 ("New Electricity Law"), Article 33 to 41. Following the decision by the Government, PLN applies the electricity tariff (TTL, Tarif Tenaga Listrik) which is stipulated per the Ministerial decree in MEMR.

The newest TDL and TTL were decided by the Presidential decree No. 8 / 2011 and the Ministerial decree No. 9 / 2011. The details of TDL are shown below in Table 2. 7.

Table 2. 7　Electricity Tariff in 2011

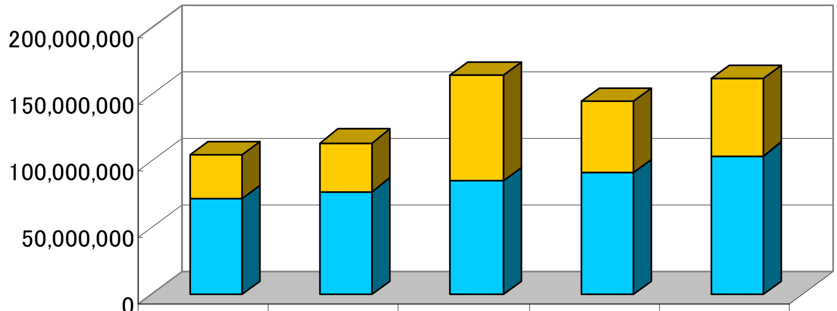
Class	Category	Regular Price	
		Basic Price (Rp. kVA/month)	Rates (Rp./kWh)
(Social Services)			
S-1/TR	220 VA	-	Fixed 14,800
S-2/TR	450 VA	10,000	0-30 kWh: 123, 30-60 kWh: 265, over 60 kWh: 360
S-2/TR	900 VA	15,000	0-20 kWh: 200, 20-60 kWh: 295, over 60 kWh: 360
S-2/TR	1,300 VA	40 hours x consumed kVA x used time	605
S-2/TR	2,200 VA	40 hours x consumed kVA x used time	650
S-2/TR	3,500 VA to 200 kVA	40 hours x consumed kVA x used time	755
S-3/TM	over 200 kVA	40 hours x consumed kVA x off-peak used	different price depending on peak or off-peak time
(Household)			
R-1/TR	450 VA	11,000	0-30 kWh: 169, 30-60 kWh: 360, over 60 kWh: 495
R-1/TR	900 VA	20,000	0-20 kWh: 275, 20-60 kWh: 445, over 60 kWh: 495
R-1/TR	1,300 VA	40 hours x consumed kVA x used time	790
R-1/TR	2,200 VA	40 hours x consumed kVA x used time	795
R-2/TR	3,500 VA to 5,500 VA	40 hours x consumed kVA x used time	890
R-3/TR	over 6,600 VA	40 hours x consumed kVA x (Block 1) used	different price Block 1, Block 2
(Business)			
B-1/TR	450 VA	23,500	0-30 kWh: 254, over 30 kWh: 420
B-1/TR	900 VA	26,500	0-108 kWh: 420, over 108 kWh: 465
B-1/TR	1,300 VA	40 hours x consumed kVA x used time	795
B-1/TR	2,200 VA to 5,500 VA	40 hours x consumed kVA x used time	905
B-2/TR	6,600 VA to 200 kVA	40 hours x consumed kVA x (Block 1) used	different price Block 1, Block 2
B-3/TM	over 200 kVA		different price depending on peak or off-peak time
(Industry)			
I-1/TR	450 VA	26,000	0-30 kWh: 160, over 30 kWh: 395
I-1/TR	900 VA	31,500	0-72 kWh: 315, over 72 kWh: 405
I-1/TR	1,300 VA	40 hours x consumed kVA x used time	765
I-1/TR	2,200 VA	40 hours x consumed kVA x used time	790
I-1/TR	3,500 VA to 14 kVA	40 hours x consumed kVA x used time	915
I-2/TR	14 kVA to 200 kVA	40 hours x consumed kVA x off-peak used	different price depending on peak or off-peak time
I-3/TM	over 200 kVA	40 hours x consumed kVA x off-peak used	different price depending on peak or off-peak time
I-4/TT	over 30,000 kVA		different price depending on peak or off-peak time
(Public Use)			
P-1/TR	450 VA	20,000	575
P-1/TR	900 VA	24,600	600
P-1/TR	1,300 VA	40 hours x consumed kVA x used time	880
P-1/TR	2,200 VA to 5,500 VA	40 hours x consumed kVA x used time	885
P-1/TR	6,600 VA to 200 kVA	40 hours x consumed kVA x (Block 1) used	different price Block 1, Block 2
P-2/TM	over 200 kVA		different price Block 1, Block 2
P-3/TR	-	40 hours x consumed kVA x used time	820
(Others)			
T/TM	over 200 kVA	25,000	different price depending on peak or off-peak time
C/TM	over 200 kVA	30,000	different price depending on peak or off-peak time
L/TR,TM,TT	-		1,450

Source: Selected data from Presidential Decree No.8, 2011

2.4.3 Government Subsidies

In the Law No. 19/2003 on State Owned Enterprises, it has been stipulated that the Government is obliged to provide its Public Service Obligation (PSO) subsidy for PLN.
Since the current electricity tariff which is decided in consideration of people's lifestyles, social welfare, economic development and so on is not at a sufficient level to cover capital and production costs, the Government of Indonesia provides PLN with a subsidy to compensate a part of the production cost of electricity, which is called a "Public Service Obligation (PSO) margin". The subsidy amount for 2010 was Rp. 58,108,418 million, an 8% increase from Rp. 53,719,818 million in 2009. The figures are as follows.

(Unit: million Rp.)



	2006	2007	2008	2009	2010
Government's Subsidy	32,909,148	36,604,751	78,577,390	53,719,818	58,108,418
Electricity sales & Connection Fee & Others	71,817,388	77,437,936	85,631,120	91,502,326	104,266,676

Source: PLN Financial Statements 2006-2010

Figure 2. 9 Transition of Subsidies in Total Revenue

Chapter 3 The Necessity and Validity of the Project

3.1 Power Demand

3.1.1 Power Demand Forecast

(1) Power Demand Result

The power demand results from 2005 to 2010 are shown in following table.[2]

Table 3. 1 Demand Results

	2005	2006	2007	2008	2009	2010
Maximum Demand (MW)	14,821	15,396	16,251	16,301	17,211	18,100
Annual growth rate (%)	2.9%	3.9%	5.6%	0.3%	5.6%	5.2%
Annual Demand (GWh)	98,038	101,611	107,975	112,312	117,103	125,909
Annual growth rate (%)	5.8%	3.6%	6.3%	4.0%	4.3%	7.5%
Loss rate (%)	11.54%	11.45%	11.08%	10.67%	9.93%	9.70%

Source: PLN annual report, P3B statistics

The demand for electricity in the Java-Bali System has been increasing at an annual rate of 5%. On the other hand, the country's system loss rate has decreased gradually.

(2) Power Demand Forecast of the Java-Bali System

According to the updated RUPTL (Rencana Usaha Penyediaan Tenaga Listrik) (Draft 15 August, 2011), the future demand of the Java-Bali System has been estimated as follows.

Table 3. 2 Demand Forecast

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Energy sales (TWh)	113.4	125.2	135.8	146.8	158.5	171.1	184.6	197.4	211.1	225.8	241.2
Growth rate (%)	8.9	10.4	8.4	8.1	8.0	7.9	7.9	7.0	7.0	7.0	6.8
Load factor (%)	79.5	78.5	78.8	79.1	79.6	79.7	79.7	79.7	79.8	79.8	79.9
Maximum demand (MW)	18,694	20,672	22,283	23,928	25,635	27,625	29,763	31,801	33,974	36,305	38,742

Source: RUPTL (Draft 15 August, 2011)

The energy sales are estimated to be an average of 7.8% annual growth over the next 10 years. Furthermore, the maximum demand of the Java-Bali area will similarly increase, and the figures in 2010 are expected to double by 2020.

(3) Java-Bali System in position

Indonesia is divided largely into three districts, and the energy sales forecasts for each area are shown in Figure 3. 1.

[2] Maximum demand (MW) and Annual demand (GWh) are the data of Java-Bali system at substation end. (Source: P3B Statistics) Loss rate is the data of whole Indonesia. (Source: PLN Annual report)

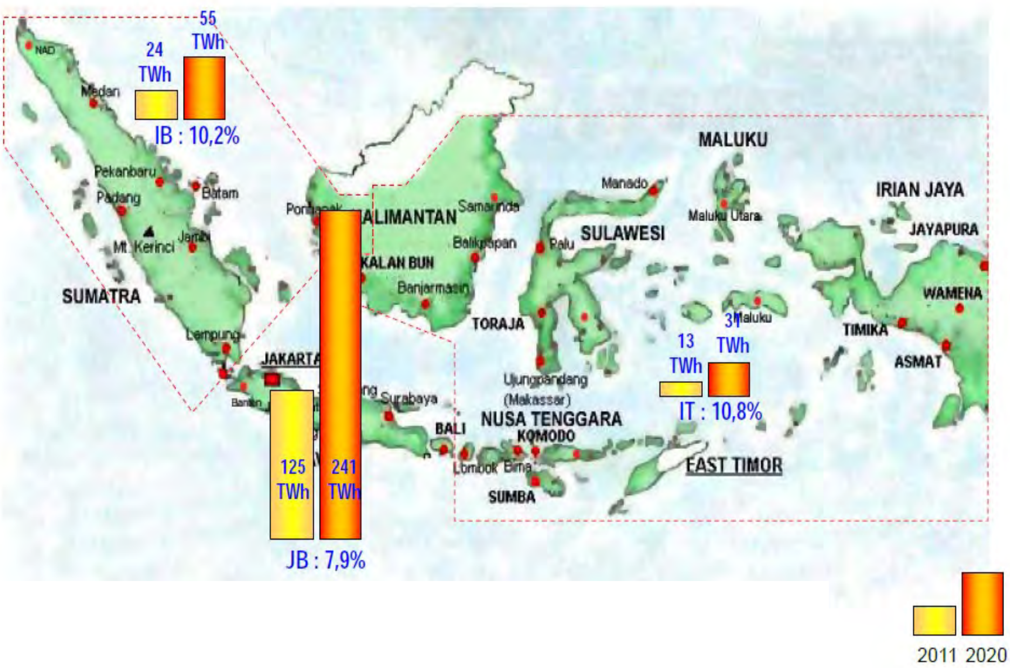


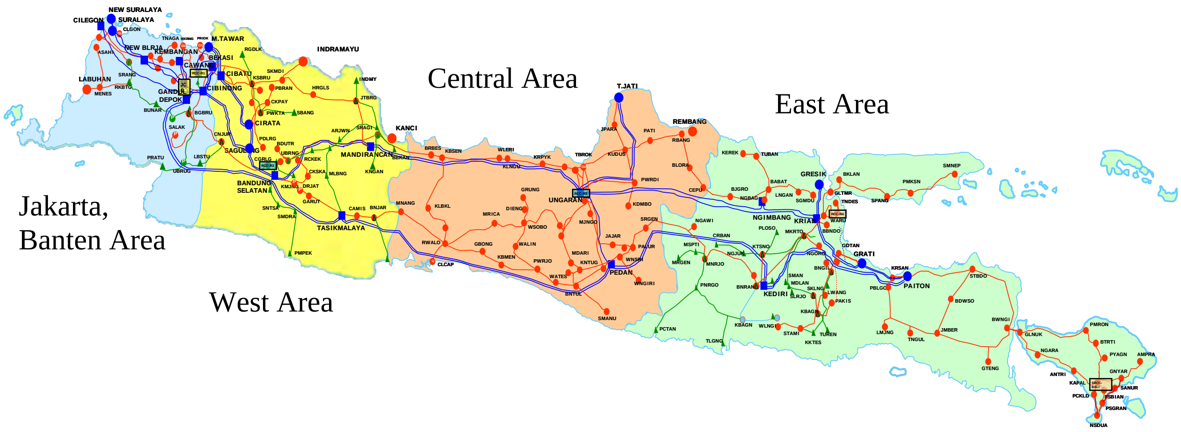
Figure 3. 1 Energy Sales Forecasts of each Area

The percentage of the total demand in the Java-Bali System is very large, 77% in 2011. Given that the assumed growth rate of the other areas is over 10%, the percentage in Java-Bali will decrease gradually, but it will still comprise 74% in 2020

3.1.2 Power Demand in each Area

(1) Regional partition

P3B has the Java-Bali System, divided the System into four regional areas (Jakarta, Banten Area, West Area, Central Area, East Area), these areas have their respective load dispatching centers as follows.

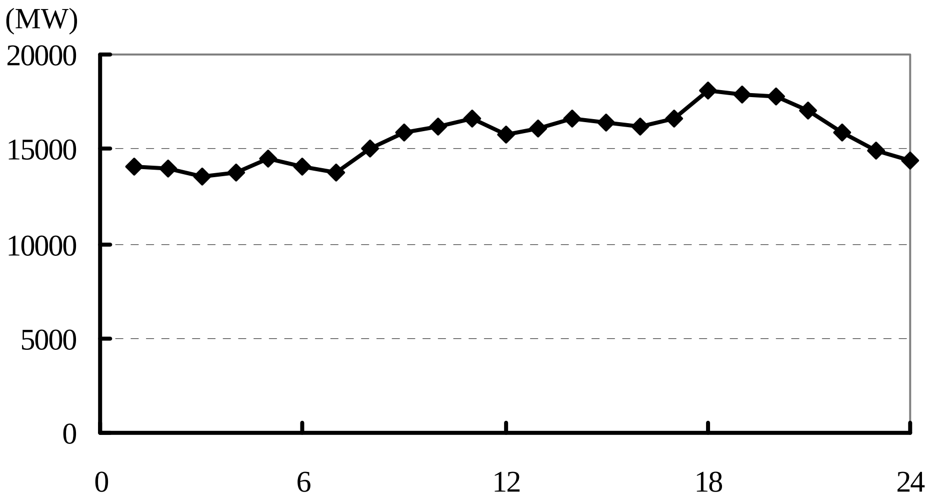


Source: P3B Annual Report (2010)

Figure 3. 2 Map of 4 Regional Area

(2) Demand Shape

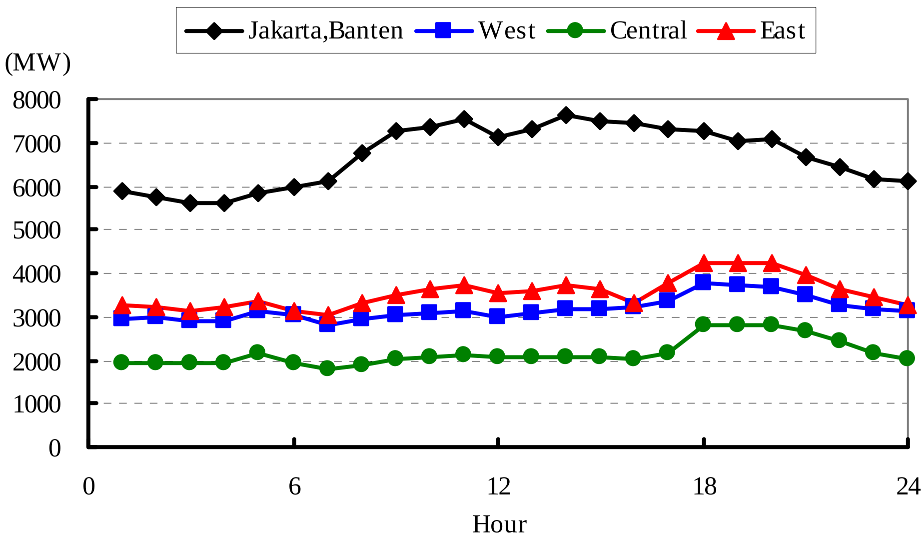
The demand shape in Oct. 20, 2010 is shown in Figure 3. 3, which recorded the largest peak demand in the year, which was recorded at 6p.m. The minimum power was recorded at 3a.m., three quarters of the day's peak demand. The difference between the two extreme values is 4,500MW, and the demand is at little risk of experiencing a sharp rise or decline.



Source: P3B's data

Figure 3. 3 Demand Shape

According to the demand shape of each area, a similar tendency was seen among the three, West Area, Central Area and the East Area. The Jakarta, Banten Area, on the other hand, is extremely-different from the other three.

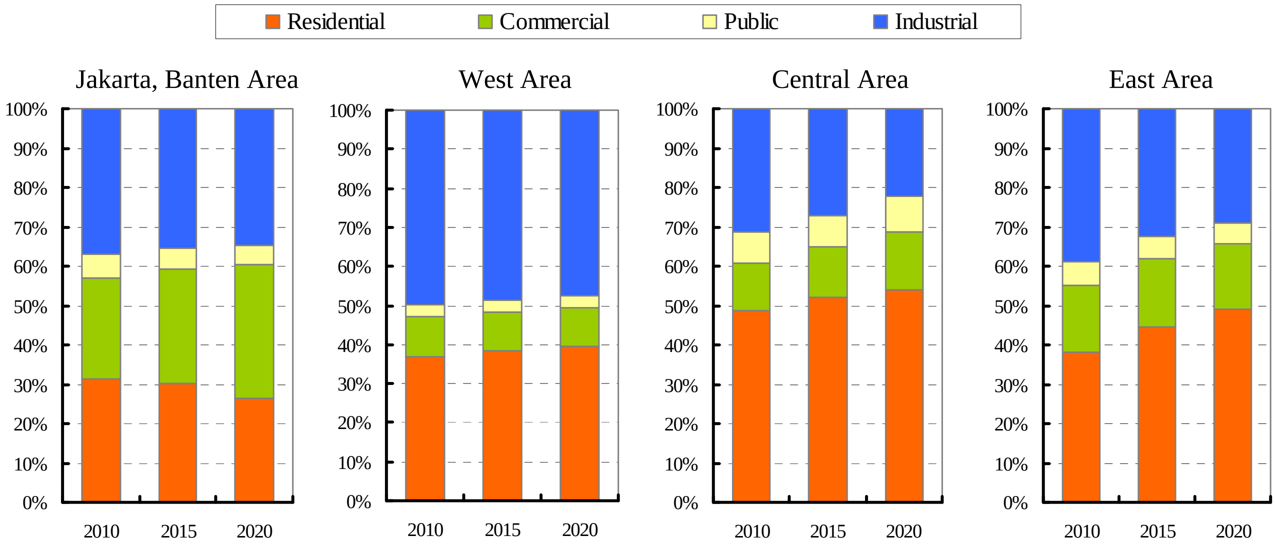


Source: P3B's data

Figure 3. 4 Demand Shape of each Area

The three areas excluding the Jakarta and the Banten Area have such traits as the peak demand being recorded at 6p.m. to 8p.m., when the lights are on. The Jakarta and the Banten Area demand is the largest in these areas, on the other hand, its demand peaks at 2p.m., when commercial demand maximizes.

This depends greatly on the structure of the electrical demand in each area. Generally, the ratio of commercial and industrial demand will increase due to urbanization, and the demand will peak during the day time. On the other hand, residential demand tends to peak in the evening when the lights are working.
The composition of the demand category in each area is shown as follows.

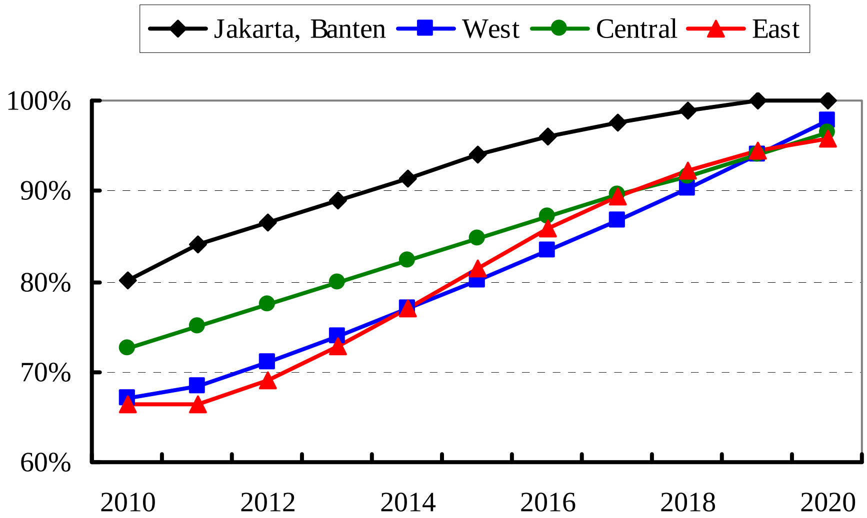


Source: PLN's data

Figure 3. 5 Composition of Demand Category

The Jakarta and the Banten Area, which is a step ahead of urbanization, has high percentages in the Industrial and Commercial areas, and these percentages will increase in the future. On the other hand, the other three areas have a high percentage of residential areas, which are expected to increase in the future. Therefore, the difference of the demand between Jakarta and Banten Area's and the other areas will continue.

In addition, the electrification rates in each area are shown in following table.



Source: PLN data

Figure 3. 6 Electrification Rate

While the electrification rate in the Jakarta, Banten Area already reached 80%, in the other three areas it reached 70%. The government plans to execute an approximate 100% electrification rate in each area by 2020. Thus, it seems that this plan will contribute to increasing residential shares in the near future.

(3) Demand Share

The demand share, which recorded peak demand from 2008 to 2010, is shown as follows. In addition, the regional demand share is populated here, which is used in the future demand forecast by P3B.

Table 3. 3 Regional Demand Share

	2010.10.20 18:00		2009.11.11 18:00		2008.08.12 18:00		Reference
	MW	%	MW	%	MW	%	
Jakarta, Banten Area	7,253	40.2	6,874	40.4	6,601	40.9	41%
West Area	3,765	20.8	3,543	20.9	3,285	20.4	20%
Central Area	2,801	15.5	2,756	16.2	2,549	15.8	16%
East Area	4,245	23.5	3,822	22.5	3,696	22.9	23%
Total	18,064	100	16,995	100	16,131	100	100%

Source: P3B's data

During the peak demand in the Java-Bali System, the power demand in the Jakarta, Banten Area comprises 41% of the total.

Here, the regional demand share as of July 1, 2010 is shown as follows, the date the largest peak demand of the Jakarta, Banten Area for the year was recorded.

Table 3. 4 Regional Demand Share at Peak in Jakarta, Banten Area

	2010.06.01 14hr	
	MW	%
Jakarta, Banten Area	7,846	47.9
West Area	3,086	18.8
Central Area	2,012	12.3
East Area	3,441	21.0
Total	16,385	100

Source: P3B's data

At the largest power demand in the Jakarta, Banten Area, the demand share of that area will increase and comprises approximately 48%.

3.2 Power Development Plan

3.2.1 Present Situation of Generation Capacity

The installed capacity in 2010 is shown as follows.

Table 3. 5 Installed Capacity (2010)

(Unit: MW)

	2010								
	Jakarta, Banten		West Java		Central Java		East Java, Bali		Total
Coal		3812		0		1884		3190	8885
	Suralaya	3212			Cilacap	562	Paiton	3190	
	Labuhan	600			Tanjung Jati E	1322			
Gas Oil		3140		1962		1157		3183	9442
	Cilegon	739	Muara Tawar	1740	Cilacap	40	Gresik	1941	
	Muara Karang	1224	Cikarang Listr	150	Tambak Lorol	1117	Perak	80	
	Priok	1177	Sunyaragi	72			Grati	750	
							Gilitimur	33	
							Gilimanuk	130	
							Pemaron	80	
							Pesanggaran	169	
Geothermal		0		1030		45		0	1075
			Kamojang	192	Dieng	45			
			Gunung Salak	367					
			Darajat	248					
			Wayang Wind	223					
Hydro		37		1885		287		269	2477
	Small hydro	37	Saguling	698	Mrica	179	Karang Kates	103	
			Cirata	948	Small hydro	107	Small hydro	166	
			Jatiluhur	180					
			Small hydro	58					
Total		6989		4877		3372		6642	21880

Source: PLN's data

Out of the total, the coal generation capacity comprises 41% and the gas and oil generation capacity comprises 43%.

The regional demand and capacity balance is shown as follows, which shows that the Jakarta, Banten Area and East Area have a higher capacity than other areas.

Table 3. 6 Regional Demand and Capacity Balance (2010)

	Capacity (MW)	Demand (MW)	Capacity/Demand
Jakarta, Banten	6,989	7,253	0.96
West	4,877	3,765	1.30
Central	3,372	2,801	1.20
East	6,642	4,245	1.56
Total	21,880	18,064	1.21

Source: PLN's data and P3B's data

Also the above table indicates that the Jakarta, Banten Area has a shortage capacity, while the East Area has enough capacity to transfer power to other areas.

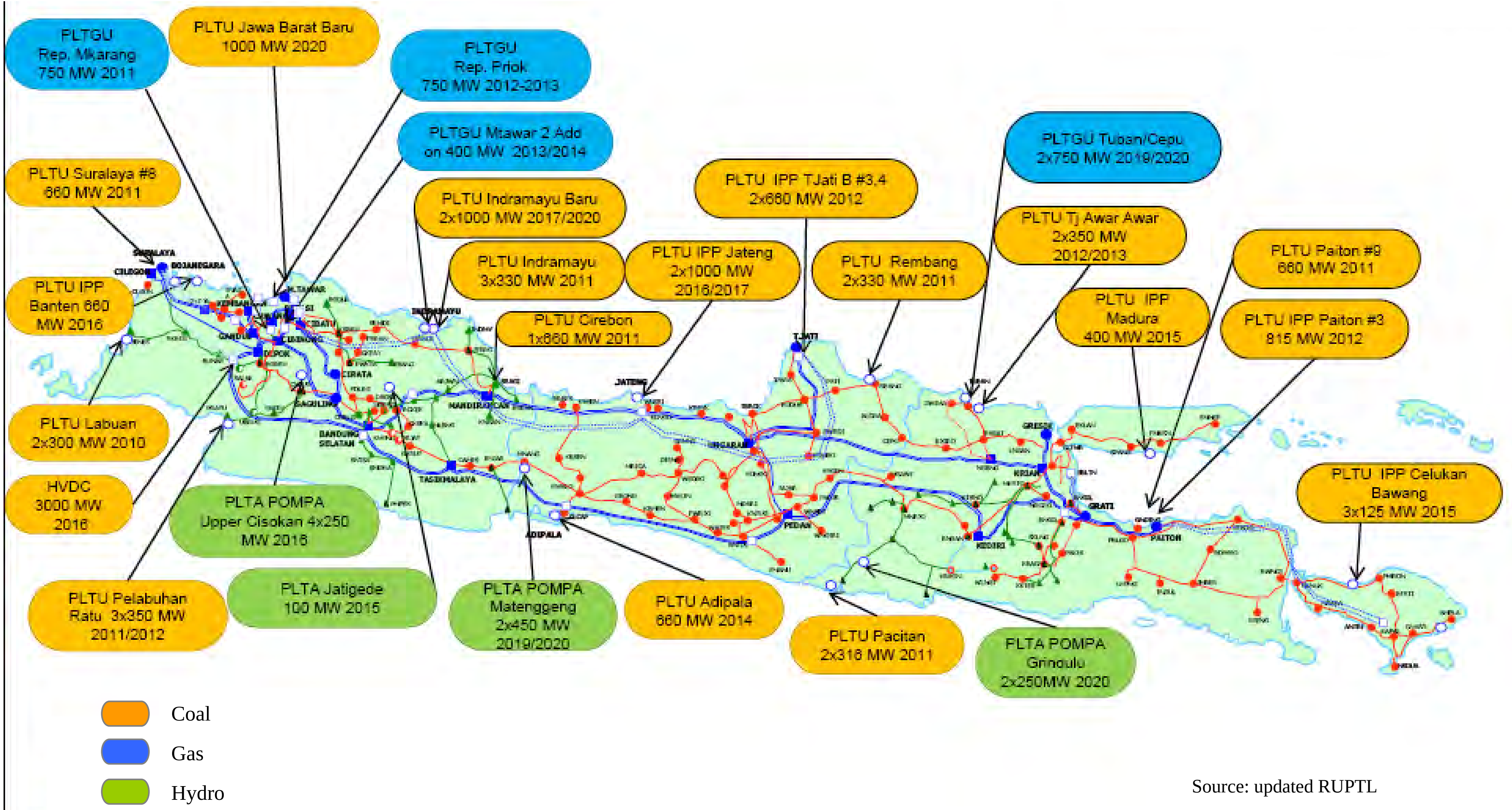
3.2.2 Power Development Plan (updated RUPTL)

The latest power development plan is shown as follows, which is in the updated RUPTL (Draft 15 August, 2011).

Table 3. 7 Power Development Plan (2011 – 2020)

(Unit: MW)

			2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
Jakarta, Banten			1360	1758	26	0	660	1860	1200	1110	55	400	8429
	Coal	Suralaya	625										
		Teluk Naga/Lontar	630	315									
		Pelabuhan Ratu		700	350								
		Lontar					660						
		Banten						660					
		South Sumatra						1200	1200	600			
	Gas, oil	Muara Karang	220										
		Priok		743									
		LNG								400		400	
		Retirement	(115)		(324)								
	Geothermal									110	55		
West Java			1962	0	210	0	1147	1250	1170	810	710	1055	8314
	Coal	Indramayu	990						1000			1000	
		Cirebon	660				660						
		Bekasi								600	600		
	Gas, oil	Muara Tawar	234		150								
		Cikarang Listrindo	150										
		Retirement	(72)										
	Geothermal				60		330	210	170	210	110	55	
	Hydro	Upper Cisokan						1040					
		Hydro					157						
Central Java			1163	530	0	810	655	1060	1000	275	865	560	6918
	Coal	Rembang	630										
		Tanjung Jati B	660	660									
		Cilacap New/Adipala				660							
		Cilacap					600						
		Jawa Tengah						1000	1000				
	Gas, oil	Peaker Semarang				150							
		Retirement	(127)	(130)									
	Geothermal						55	60		275	415	110	
	Hydro	Matenggeng									450	450	
East Java, Bali			1129	1005	301	380	510	117	147	220	970	1305	6084
	Coal	Pacitan	630										
		Paiton Baru	660										
		Paiton		815									
		Tj Awar-awar		350	350								
		Celukan Bawang				380							
		Madura					400						
	Gas, oil	Tuban/Cepu									750	750	
		Retirement	(161)	(160)	(49)								
	Geothermal						10	55	110	220	220	55	
	Hydro	Grindulu										500	
		Hydro					100	62	37				
Total			5614	3293	537	1190	2972	4287	3517	2415	2600	3320	29745



Source: updated RUPTL

Figure 3. 7 Site Map of Power Development Plan

While the power demand will be associated with 20,678MW in the next 10 years, a total 29,745MW of the installed capacity will be developed, which is 1.44 times the expected demand. According to the plan, the total 21,245MW of coal generation will be constructed, which is composed of 71% of the planned installed capacity. Concerning regional development, the increasing capacities of the Jakarta, Banten Area and the West Area will be approximately 28%, which is slightly higher and the increased capacity of the East Area is slightly less, 21%. It seems that the differences of the developing capacities between the four areas are not great.
As a result, the installed capacity in 2020 will be as follows.

Table 3. 8 Installed Capacity (2020)

(Unit: MW)

	2020								
	Jakarta, Banten		West Java		Central Java		East Java, Bali		Total
Coal		10752		5510		7094		6775	30130
	Suralaya	3837	Cirebon	1320	Cilacap	1162	Paiton	4005	
	Labuhan	600	Indramayu	2990	Tanjung Jati E	2642	Paiton Baru	660	
	Teluk Naga/L	1605	Bekasi	1200	Cilacap Baru/	660	Pacitan	630	
	Pelabuhan Ra	1050			Rembang	630	Tj Awar-awar	700	
	Sumsel	3000			Jawa Tengah	2000	Celukan Bawa	380	
	Banten	660					Madura	400	
Gas Oil		4464		2424		1050		4313	12252
	Cilegon	739	Muara Tawar	2124	Peaker Semara	150	Gresik	1733	
	Muara Karang	1120	Cikarang Listr	300	Tambak Lorol	900	Grati	750	
	Priok	1805					Gilimanuk	130	
	LNG	800					Pemaron	80	
							Pesanggaran	120	
							Tuban/Cepu	1500	
Geothermal		165		2175		960		670	3970
	Rawa Dano	110	Kamojang	282	Dieng	270	Bedugul	10	
	Endut	55	Gunung Salak	367	Ungaran	195	Iyang Argopu	275	
			Darajat	248	Baturaden	220	Willis/Ngebel	165	
			Wayang Wind	463	Guci	110	Ijen	110	
			Patuha	180	Candi Umbul	55	Arjuno Welira	110	
			Tangkuban Pe	170	Gn. Lawu	110			
			Karaha Bodas	140					
			Cibuni	10					
			Cisolok-Cisuk	160					
			Tampomas	45					
			Gn. Ceremei	110					
Hydro		37		3081		1186		968	5273
	Small hydro	37	Saguling	698	Mrica	179	Karang Kates	203	
			Cirata	948	Matenggeng	900	Kalikonto-2	62	
			Jatiluhur	180	Small hydro	107	Kesamben	37	
			Jatigede	110			Grindulu	500	
			Rajamandala	47			Small hydro	166	
			Upper Cisoka	1040					
			Small Hydro	58					
Total		15418		13190		10290		12726	51625

Source: PLN's data

The ratio of coal generation will increase to 58%, but at the same time the ratio of gas and oil generation will decrease to 24% in 2020.

Concerning the regional demand and capacity balance which is shown as follows, the capacity ratio of the

Jakarta, Banten Area is approximately 30% which is slightly higher than other areas, while the capacity ratio of the Central area is slightly less at 20%.

Table 3. 9 Regional Demand and Capacity Balance (2020)

	Capacity (MW)	Demand (MW)	Capacity/Demand
Jakarta, Banten	15,418	15,884	0.97
West	13,190	7,748	1.70
Central	10,290	6,199	1.66
East	12,726	8,911	1.43
Total	51,625	38,742	1.33

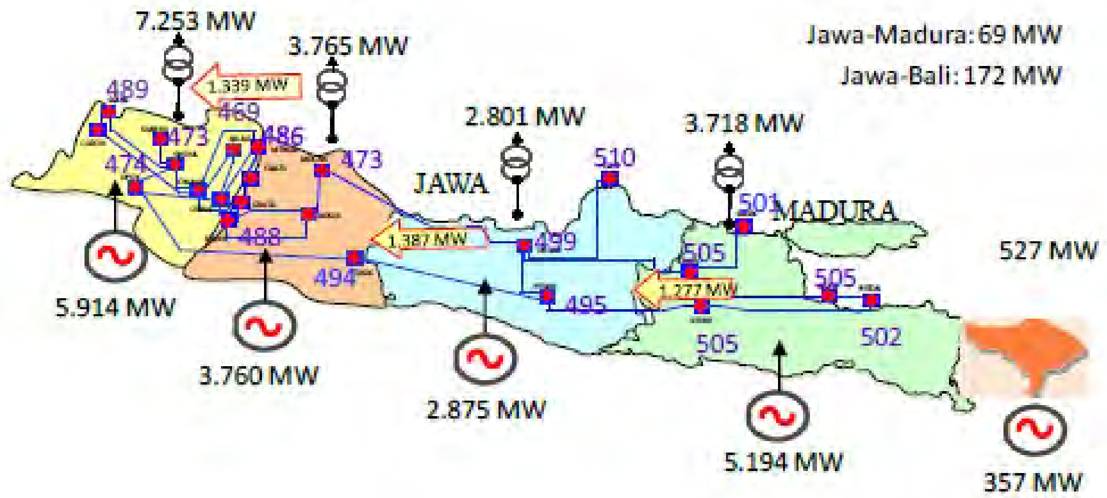
Source: PLN's data and P3B's data

While the Jakarta, Banten Area has a shortage of power generation, other areas have enough capacity to transfer electric power to the others. Especially, the West Area and Central Area have a slightly larger capacity than the others.

3.2.3 Supply Demand and Transferring the Power Forecast in each Area

(1) Present situation

The regional supply and demand balance at 6p.m. on Oct. 18, 2010 was shown in the following, which recorded the largest peak demand in the Java-Bali System.



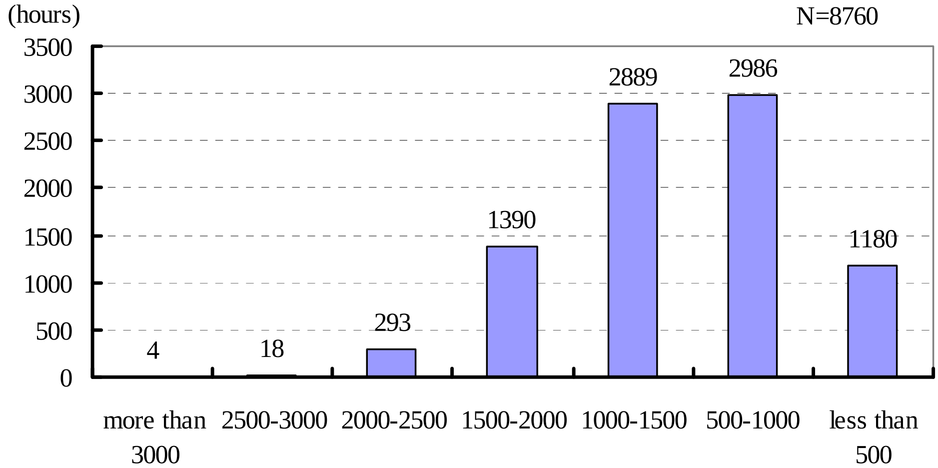
Source: P3B Annual Report (2010)

Figure 3. 8 Regional Demand and Supply Balance

The power supply and the power demand in each West Area and Central Area are close to being in balance. While the power supply in the East Area exceeded its power demand as approximately 1,300MW, the power supply in the Jakarta, Banten Area was below its power demand as the same, approximately 1,300MW. Therefore, approximately 1,300MW of electric power generated in the East Area was transferred to Jakarta, Banten Area.

In the case of the Jakarta, Banten Area, the power demand increased by approximately 600MW during the day time, and reached 7,846MW at 2p.m. The power supply, on the other hand, increased to only approximately 300MW, so a total of approximately 1,600MW of electric power was transferred from the East Area to the Jakarta, Banten Area. Thus, the transferred power from the East Area to the Jakarta, Banten Area will peak outside of the peak demand time of the Java-Bali System.

The frequency distribution of the difference between the demand and the power generation in the 8760 hours per year in the Jakarta, Banten Area in 2010 is shown in the following. These differences reveal a power shortage in the Jakarta, Banten Area, and are nearly equal to the transferred power from the West Area to the Jakarta, Banten Area.



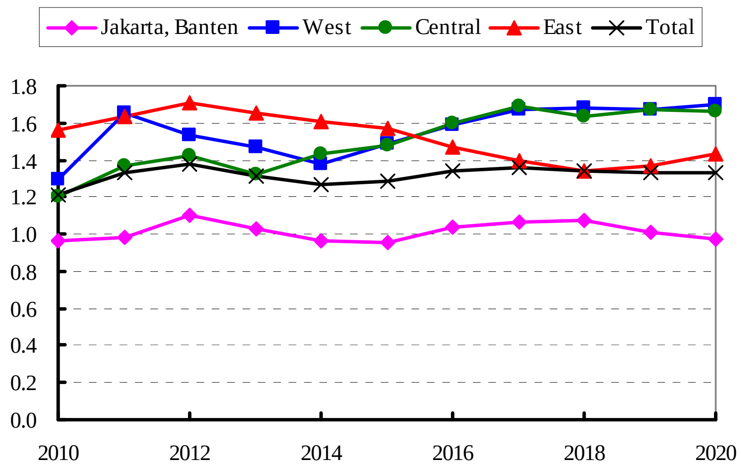
Source: P3B's data

Figure 3. 9 Frequency Distribution of Difference between Demand and Generation in Jakarta, Banten Area

The Jakarta, Banten Area is experiencing a chronic power shortage, but the range of the power shortage between 500 MW and 1500 MW is composed of approximately 67% of the total. There are, however, approximately 300 hours where the power shortage exceeds 2,000 MW, it also seldom happened to exceed 3,000 MW. The heavy transmission amount of electricity described above is attributed to decreased power generation which occurs when the Suralaya Power Station, which is important as a regional power generator, is not expected to shutdown.

(2) Supply demand forecast in the future

When the power development shown in the updated RUPTL (Draft 15 August, 2011) is conducted, the process of the ratio of regional capacity to the regional power demand will be as follows.



Source: PLN's data and P3B's data

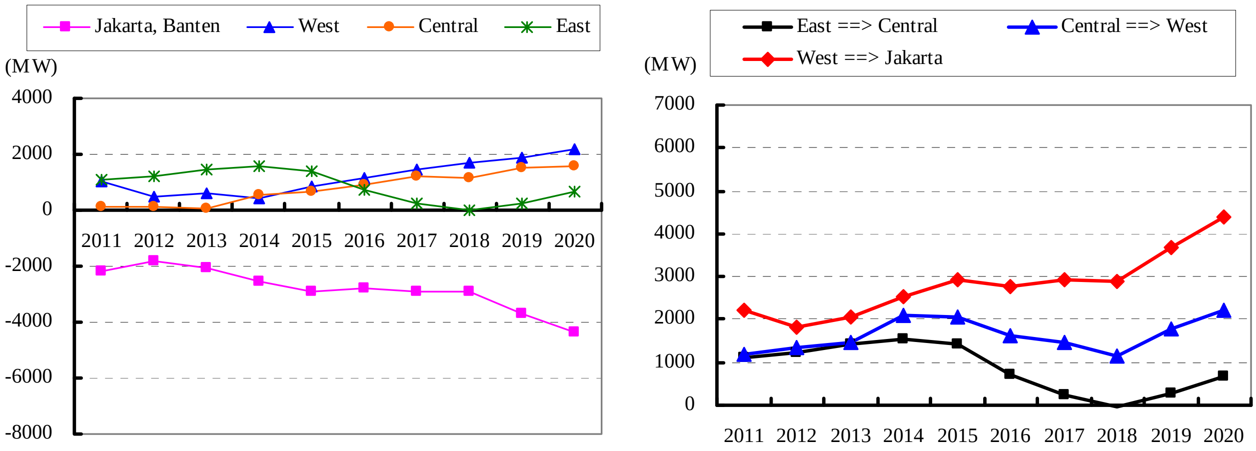
Figure 3. 10 Trend of Regional Demand and Capacity Balance

The Java-Bali System has power facilities that amount to approximately 1.3 times its maximum power demand, to secure its regulated power supply reliability (LOLP=1 day per year). The amount of the power facilities, however, in the Jakarta, Banten Area is almost the same capacity as the maximum power demand. Especially, the capacity of its power facilities in 2015 will be only 95% of its power demand. As a result, the situation will aggravate power shortage conditions.
The East Area transfers electric power to other areas, and will have enough power facilities to respond to its power demand and transfer electric power until 2015. However, the surplus power in the East Area will be reduced gradually, and its ratio will be the same as that of the Java-Bali System since 2017. The West Area and the Central Area will have power facilities with a capacity that exceed their maximum power demand substantially since 2014, and will become power supply areas.

The power flow of the regional interconnection will vary according to the operations and management in the power station and it will usually be larger during the period of maximum power demand.

(a) Proportionally reduced all the generators

The difference between the demand and generation, and the power flow of the regional interconnection is shown in the following, which in that case all the generators will be reduced proportionally to adjust varying power demand. In addition, the power demands shown in the following figure in each area show the maximum power demand in the Java-Bali System at 6p.m.

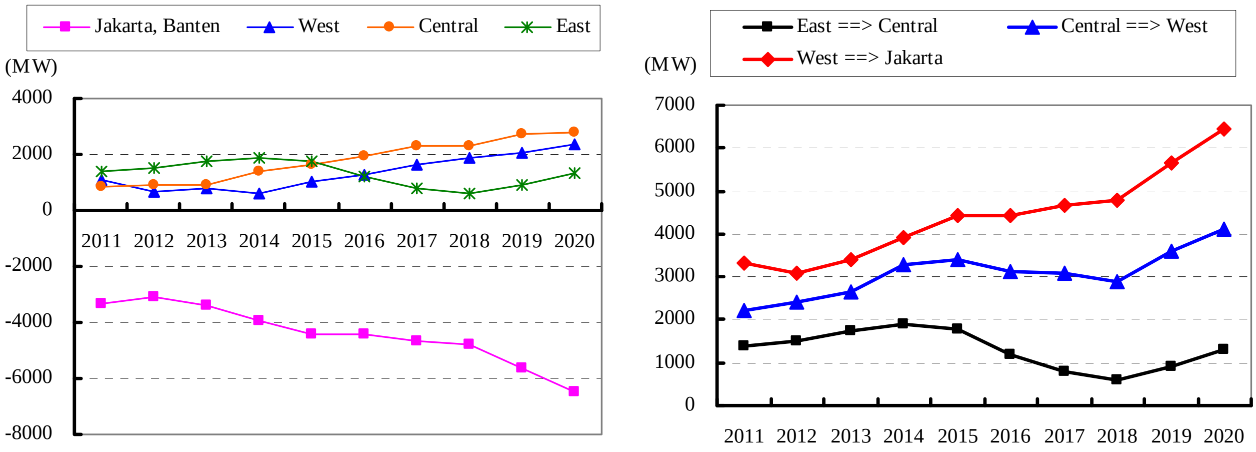


Source: PLN's data and P3B's data

Figure 3. 11 Difference between Demand and Generation (Left), Power Flow of Regional Interconnection (Right) - 1

The differences between the supply and demand in the Jakarta, Banten Area are the largest in the Java-Bali System, and it will reach approximately 4,000 MW in 2020. The transferred power from the Central Area to the West Area, the zone the project scope, will increase in 2014, 2015 and 2020, but reach approximately only 2,000 MW.

In the same situation, the power demands in each area shown in the following figure show the power demand at 2p.m.



Source: PLN's data and P3B's data

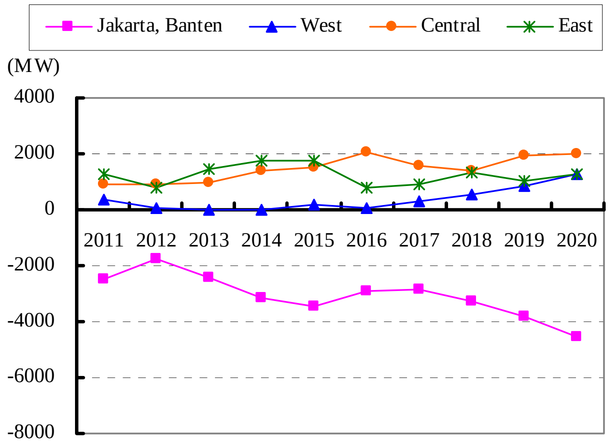
Figure 3. 12 Difference between Demand and Generation (Left), Power Flow of Regional Interconnection (Right) - 2

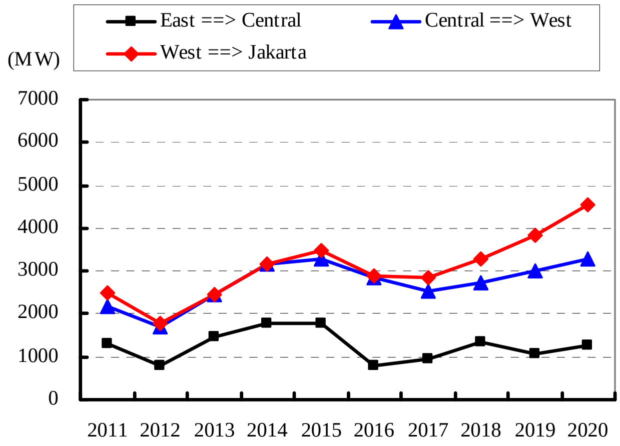
The difference between the power demand and generation at 2p.m. in the Jakarta, Banten Area will be larger than the difference at 6p.m., and reach approximately 6,500 MW. The transferred power from the Central Area to the West Area, the zone the project scope, will reach approximately 3,000 MW in 2014 or 2015, and reach approximately 4,000 MW in 2020.

(b) Economic operation

The generators will be run in ascending order according to the generation cost of the economic operation. Therefore, electricity from coal generators, which can run at low cost, will increase.

The high speed diesel (hereafter HSD) power plants, on the other hand will be controlled. The gas combined cycle power plants will be positioned between coal and HSD.
The difference between demand and generation is shown in following figure, which shows the maximum power demand at 2p.m. in the economic operation.





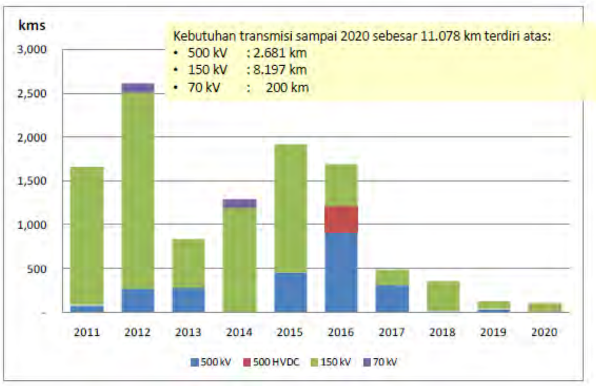
Source: PLN's data and P3B's data

Figure 3. 13 Difference between Demand and Generation (Left), Power Flow of Regional Interconnection (Right) - 3

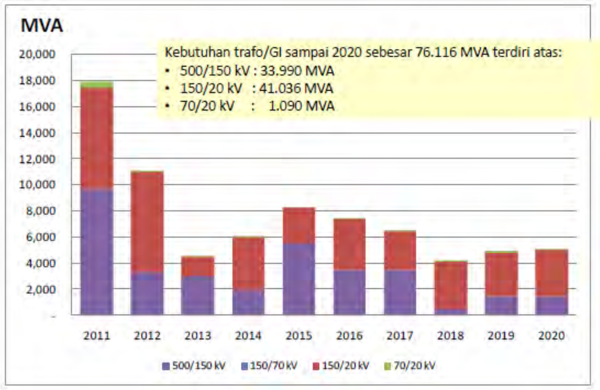
There are a few differences from the case of "(a)", because each area has large coal power plants, and power plants consist of the same portion in each area.
The Jakarta, Banten Area has larger coal plants including Suralaya and Lontar, and its proportion of coal power plants is slightly higher than other areas. Therefore, in the case of economic operations, there is less of a difference between the demand and generation than in the case of the proportionate reduction. In addition, the transferred power from the Central Area to the West Area is up to approximately 3,000 MW.

3.3 Power Network Planning

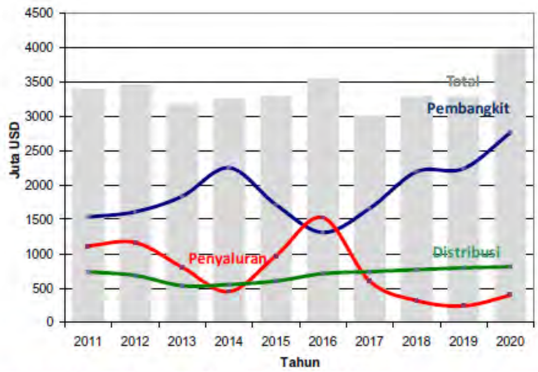
PLN develops a long-term power development plan up to year 2020, know as RUPTL (Rencana Usaha Penyediaan Tenaga Listrik). The summary of the 500-kV transmission system development plan of the Java-Bali system deployed in the RUPTL is shown in Figure 3. 14. Table 3. 10 shows the major events of the system plan during the development period.



The Transmission development plan of Java-Bali System



The Substation development plan of Java-Bali System



Projected investment requirement (disbursement) PLN alone until 2020 was USD 33.7 billion or USD 3.37 billion per year. These numbers only EPC cost, not including IDC, financing costs, tax.

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Pembangkit	1,539	1,616	1,842	2,257	1,717	1,315	1,666	2,200	2,247	2,772	19,171
Transmisi	1,119	1,166	808	456	977	1,527	605	324	248	401	7,630
Distribusi	738	683	532	550	601	711	740	769	797	812	6,932
Total Investasi	3,396	3,465	3,182	3,262	3,295	3,553	3,011	3,293	3,291	3,985	33,734

(SOURCE: draft RUPTL 2011-2020)

Figure 3. 14 Power System Plan in the Draft RUPTL 2011-2020.

Table 3. 10 Major Transmission System Development Plan

COD	System
2015	500 kV AC Transmission Line of Tj Jati-Ungaran -Pemalang-Mandirancan -Indramayu -Cibatu
2016	Sumatera –Jawa 500 kV HVDC

(SOURCE: draft RUPTL 2011-2020)

The project's 500-kV transmission line from Tx-Ungaran to Pemalang Substation, Mandirancan Substation, and Indramayu Power station is described as the transmission line which transfers electricity from the Tj Jati Power station, Jawa-Tanah Power station, and the other power station in the Eastern region of Java island to the island's Western region including Jakarta.

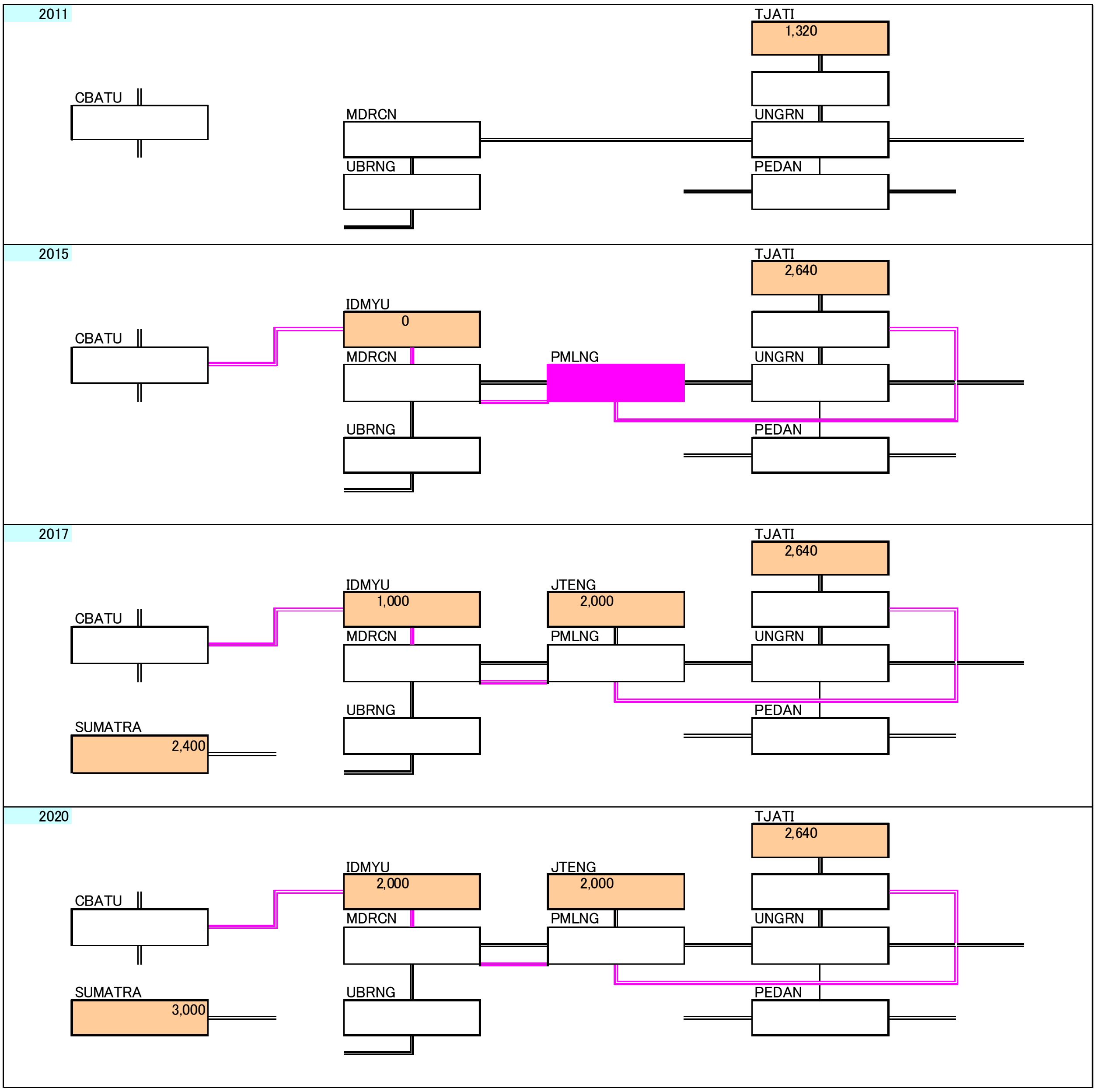


Figure 3. 15 The Image of Power System Expansion

3.4 Learn from Serious Past Network Accidents

During the past decade, the Jakarta Metropolitan area has suffered from several large-scale blackouts. The blackouts occurred intensively on the demand peak months, i.e. August and September. The expansion of the Java-Bali power system by the Project is expected to bring about advantages such as the expansion of the power accommodation amount, the secured reserve margin, the improvement of reliability, and economical benefits. At the same time, however, the coverage of areas which would suffer from power failures is anticipated to expand due to the system expansion. This section analyzes the causes of past large-scale blackouts and proposes their preventive measures. Based on a discussion with P3B, the following three large-scale blackouts have been reviewed as a sample, in order to shed light on these blackout' processes and issues.

- Blackouts triggered by unscheduled shutdowns at the Sulayara Power Station shutdown in 2005
- Blackouts caused by fire at the Cawang 500kV Substation in 2009
- Blackout triggered by a line fault at the line between Cilegon Substation and Cibinong Substation.

Figure 3. 16 depicts the power failure.

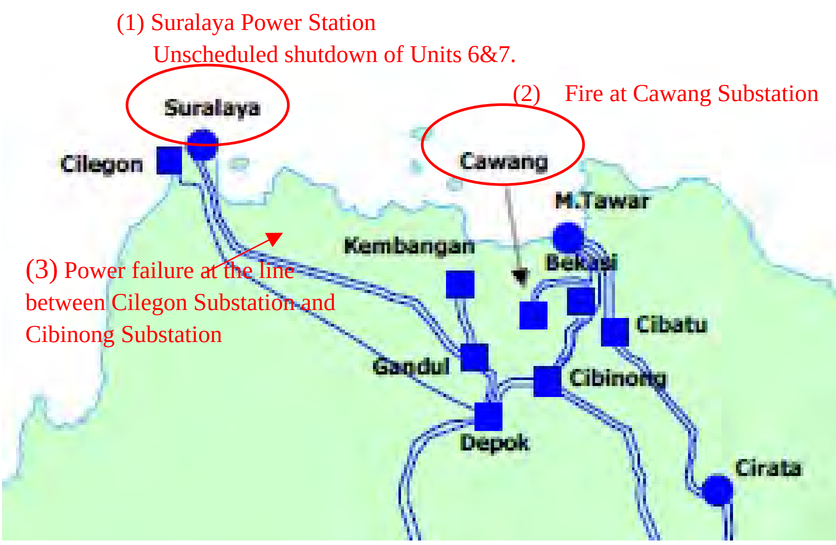


Figure 3. 16 The Map of Locations Triggering the Large-scale Blackouts in the 500kV System surrounding the Jakarta Metropolitan Area.

3.4.1 Review of Past Blackouts (Case – 1)

CASE-1: Blackout triggered by the unscheduled Sulayara Power Station shutdown in 2005

Table 3. 11 Summary (Case - 1)

Date	August, 2005
Place	Suralaya Power Station, which is the coal-fired thermal power plant located at the western side of Java Island. The installed capacity is 400 MW/ unit for Units 1 to 4, and 600 MW/ unit for Units 5 to 7, amounting to 3,400MW in total. The power station is the principal power station to supply electricity to the Jakarta Metropolitan area.
Event	Due to the unplanned shutdown of Units 6 and 7 at Suralaya Power station on August 2005, the reserve capacity of the whole Java-Bali System turned out to be short, power stations located in the east to Jakarta immediately started their operations. As a result, the power flow to the west increased, reaching the level to trip the east-west interconnection, leading to the large-scale blackout in the disconnected western area encompassing the Jakarta district.

(1) Major Causes

The following are the suspected causes:

- Malfunction of protection relays due to the inappropriate setting of the relay's setting values.
- Inappropriate choice of the protection relay type (ground directional protection relay), which may have resulted from the change of the surrounding environment.
- The dispatching center operators' insufficient recognition of the possibility of malfunction of the designated ground directional protection relay, including a knowledge of the relay's triggering condition and the limitation of the transmission line's operation.

(2) Implemented Prevention Measures

The following measures have been implemented after the blackout:

1) The protection relay's detection level has been raised: 0.06 => 0.1[pu].

2) The route between Sulayara Power Station and Cibinong Substation was upgraded from the single circuit to double circuits. In addition, a 500/150 kV substation, Bekasi Substation, has been placed between the route to improve system reliability.

(3) Possible other countermeasures in the long term

1) To replace ground-fault directional relays with current-differential protection relays. (According to PLN's facility design philosophy, the current differential type of the protection relay would be installed for new system instead of existing directional relays.

2) Apply a transposition to certain sections of the route to reduce the unbalanced current.

3.4.2 Review of Past Blackouts (Case – 2)

CASE-2: Blackout caused by fire at the 500kV Cawang Substation in September 2009

Table 3. 12 Summary (Case - 2)

Date	At approximately 1:00 pm on September 29, 2009	
Place	Cawang Substation, which is located in the east-south of Jakarta and is a component forming the 500 kV ring surrounding the Jakarta Metropolitan area. Muara Tawar Thermal Power Station (1785MW) supplies part of its generated power to this substation directly.	
Event	Due to the fire at its two main transformers out of the six, the substation stopped the power supply to its service area, leading to a large-scale blackout affecting the eastern and the southern part of the Jakarta Metropolitan Area. The disturbance resulted in the interruption of power supply to consumers of 701.8 MW of energy that was channeled by 2560.53 MWh.	

SOURCE: LAPORAN GANGGUAN (INTERFERENCE REPORT) IBT-2 500/150 kV 500 MVA FASA R GITET CAWANG BARU, Tuesday, 29 SEPTEMBER 2009 PT PLN (Persero), Oktober 2009.

(1) Major Causes

According to the accident evaluation report, the “Disorder thought to have come from the seal damage phase 150 kV neutral bushing R resulting in the oil main tank and caused the transformer to burn out. Seal damage allegedly caused by more related to the pattern of the accumulation of the heat load served by the transformer which can lead to a fast-growing hotspot when the load transformer is high.”

(2) Implemented Prevention Measures

The proposed order is to install the transformers of the Air-Insulated type.

3.4.3 Review of Past Blackouts (Case – 3)

CASE-3: Blackout triggered by power failure at the line between Cilegon Substation and Cibinong Substation in September 2002

Table 3. 13 Summary (Case - 3)

<table>
<tr><th>Date</th><td colspan="2">September, 2002</td></tr>
<tr><th>Place</th><td colspan="2">Transmission line between Cilegon Substation and Cibinong Substation</td></tr>
<tr><th>Event</th><td colspan="2">At the fault at the transmission line between Cilegon Substation and Cibinong Substation, the circuit breaker at Cibinong Substation did not trip, extending the fault situation. The circuit breaker at Gandul Substation, which is connected with Cibinong Substation, detects the fault and tripped line, resulting in the disconnection of Cibinong Substation from the grid. This has resulted in the separation of the Jakarta Metropolitan area into the eastern and western parts. Finally, due to the tight demand-supply gap, the whole of the western area suffered from a blackout.</td></tr>
<tr><th>Cause</th><td colspan="2">Two causes are suspected: 1) the cause of CB – inappropriate maintenance and/or aged deterioration of CBs, 2) protection relay's malfunctioning which might have been caused by flaws of the protection relay setting.</td></tr>
<tr><th>Note</th><td colspan="2">As of now, because another 500-kV backbone transmission route has been completed, the possibility of a similar failure happening again is minute.</td></tr>
<tr><th colspan="2">Events leading to the blackouts</th><th>Possible cause and factors</th></tr>
<tr><th>Primary events</th><td>The malfunction of circuit breakers at Cibinong Substation against the fault at the line between Cilegon Substation and Cibinong Substation.</td><td>◆ Malfunction of the transmission-line protection relay.
◆ Inappropriate setting of protection relay's setting values.
◆ Aged deterioration of CBs.
◆ Inappropriate maintenance/ inspection of CBs.</td></tr>
<tr><th>Secondary events</th><td>No backup/ malfunction against the malfunction of the CB at Cibinong Substation (If the designated relay had worked appropriately, the operation of the backup relay at Gandul could have been avoided, preventing the separation of the Jakarta Grid).</td><td>◆ In the case of No backup: The inappropriate designing of the protection relay system.
◆ In the case of malfunctioning: Inappropriate maintenance/ inspection of CBs/ protection relays.</td></tr>
</table>

3.4.4 Lessons Learnt and Preventing Measures for the Project

(1) Major causes and factors

To summarize, the following are the suspected causes/ factors of the above accidents:

- Alleged Flaws of the protection relay setting
- Inappropriate maintenance/ inspection of facilities
- Overload operations of the transmission/ substation facilities.

The possible factors to expand the coverage of damage caused by blackouts are as follows:

- Lack of operators (power station, load dispatch center, substation)' capability to handle the events.
- Chronic short of supply capacity for the transmission/ substation facilities.
- Lack of a backup protection system (e.g. power system stabilizer).

Among the above, the first two major causes of the accident are closely related to the case of the Sulayara power station in 2005. There are cases in the malfunction of protection relays. That is, despite that there is nothing wrong with the facilities, a protection relay might recognize that there is a fault at the facilities, leading to tripping lines. Several reasons can be raised for this event. Sometimes, the fault detection type of a protection relay has become inappropriate in terms of the electrical characteristics (e.g. large amount of unbalanced elements). The other time, the setting values have become inappropriate due to the change of the grid system configuration after the expansion project.

(2) Recommended Prevention Measures for the Project

This Project is expected to expand the capacity of transferred electricity between the east and west of the Java-Bali system, improving the supply reliability to the Jakarta Metropolitan area, while it is also anticipated that large-scale blackout risks may occur. Based on these aspects, the following prevention measures are recommended.

(a) Inspection of setting values of protection relays around the Project's transmission line

Because the Project adds 500-kV backbone transmission lines to the Java-Bali system, the power flow on the grid would not be the same as before the addition. Therefore, it is recommended to review the setting values of the protection relays around the Project's line. If necessary, the values need to be modified reflecting the new power flow pattern. The placement of the Pemalang Substation in the middle of the existing 500-kV transmission lines might affect the existing setting values.

(b) Identification of protection relays to be replaced (or those which would malfunction)

Like the case of setting values, the fault-detection type of protection relays also needs to be reviewed because the addition of the Project's transmission line would change the electrical characteristics of the Java-Bali Grid as a whole, which would result in the change of the condition to select the fault-detection type. Depending on the degree of the condition change, the protection relays would need to be replaced with appropriate ones.

3.5 Necessity and Validity of the Project

3.5.1 Objective

As the purpose of the Project is to transmit electricity produced at power stations in Central Java to the Jakarta load center located in the west of Java Island, the necessity of the Project would be demonstrated if any inconvenience, which might be caused without the Project, would be addressed by the implementation of the Project.

3.5.2 Approach and Methodology

This study takes the ratio of the actual transmission capacity against the thermal capacity of the transmission line as the index to prove the necessity. In this section, power flow, voltage, the fault current, and stability analyses were conducted in order to confirm the necessity of the PJ line. These analyses would also determine the technical adequacy of the project and determine main specifications. Because the project will be operating at high voltages over a large distance, it may have a significant impact on the existing system and generators. In order to identify the required specifications of the project to ensure stable and continuous power-transmission, an extensive power system analysis was undertaken. A power system analysis is carried out from the technical system criteria and preliminary network plans are evaluated. Finally, a technically acceptable and fully representative plan is established.

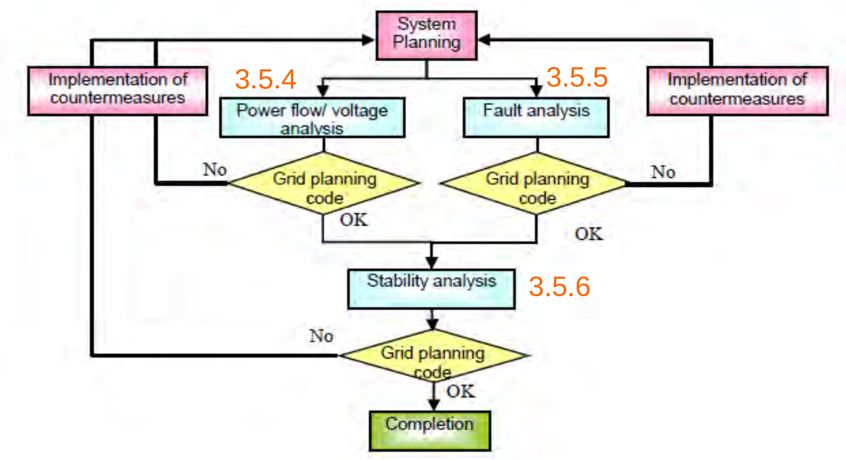


Figure 3. 17 Image of System Analysis

For the analysis, the year 2017 has been chosen as the base year, because most of the power stations (Tanjung Jati B - #3, 4; Jawa Tengah -#1,2; and Indramayu -#1) whose generated electricity would be transmitted over the Project's 500 kV transmission line would be transmitted would commence their operation, and the interconnection between Sumatra Island and Java Island would start operations in the year. The same analysis is also conducted for the year 2015 and the year 2020.
According to recent P3B's operation statistics, it was found that at approximately 1:00 pm, peak power flow was observed from Central Java to West Java. Therefore, the Team has modified the data to duplicate the same situation as the one at approximately 1:00 pm.

For the data, the JICA Study Team (the Team) used the PSS/E data obtained from P3B during its 1st mission in August 2011 (Demand pattern at the peak time of Java Island (around 6:00 pm); the Generation pattern as a uniform output rate for all the power stations).

(1) Criterion/ Indices

Firstly, for the power flow analysis, the following indices are used. Those are supplied by PLN/ P3B.

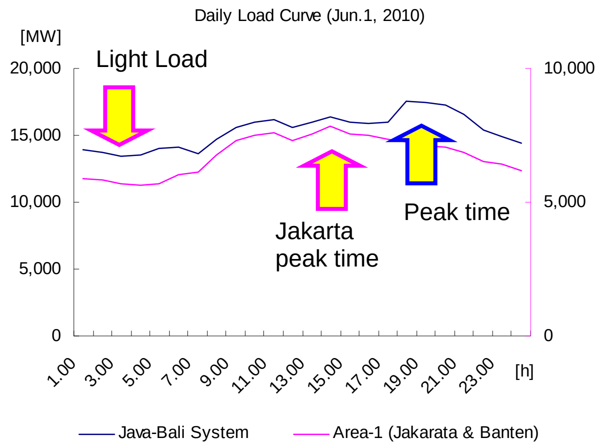
Table 3. 14 Indices and Criterion for the System Analysis

Index	Criteria
a. Loading	Normal and contingency acceptable loading for facilities (Transformers and lines): 100%.
b. Reliability Criteria	N-1

3.5.3 Calculation Premise

For the evaluation, the year 2017 has been selected as base year because most power stations connected to this Project's transmission line – Tanjung Jati B #3,4, Jawa Tengah #1,2, Indramayu #1 - would be in operation in the year and because the interconnection between Sumatra Island and Java Island would start its operations also in the year. The data to be adopted for this system analysis has been provided as PSS/E Data by P3B during the study's first mission. Originally, the data set assumes the peak time of the Java-Bali system, at approximately 7 pm, allowing all generators to operate at around 65% output of installed capacity.

For the power flow analysis, the time around 1pm has been selected as the most severe condition since the amount of power flow from the Central to West Region would peak around the time, according to the P3B's past operations record. The time is the peak time for the Jakarta Metropolitan area (Figure 3. 18).



(Source: data provided byP3B)

Figure 3. 18 Jakarta-Peak Time shown in Daily Load Curve

The demand data set to be analyzed has been developed utilizing P3B's original data set (assuming Normal Peak time) and the demand pattern by region for the Jakarta Peak shown in Table 3. 15.

Table 3. 15 Regional Pattern of Demand (Left) and Generation (Right) used for the Simulation

Region	Normal Peak 19:00	Jakarta Peak 13:00	Light Load 3:00
1: JKRT	40%	46%	42%
2: WEST	21%	19%	21%
3: CTR	16%	13%	14%
4: EAST	23%	21%	23%
All	100%	100%	100%
Peak Load	100%	92%	73%
	Original data obtained from P3B.	Data actually used for the analysis.	

(Source: P3B)

The generation data set to be analyzed has been developed also utilizing P3B's original data set (assuming Normal Peak time). Further, following the PLN's advice, the original data set has been modified based on the actual generation pattern by region on September 2011. For this purpose, the study Team set up all of the IPP's coal-fired power stations connected to a 500 kV system – most of them locating in the eastern area of Java Island and operating at low generation cost - to operate at maximum capacity (Table 3. 16). The power factor of generators are set between 0.9 (leading) and 0.85 (lagging).

Table 3. 16 The List of Power Stations operated at Full Output (YR2015 – YR2020)

System Voltage	IPP/PLN	Name	Output/ Installed capacity [MW]	Area	COD
500	IPP	BNTEN71	660	Jakarta & Banten	2016
500	IPP	CLCAP#1,2	300x2	Central	2015
500	IPP	CLCAP72	660	Central	2014
500	IPP	JTENG#1,2	1,000x2	Central	#1: 2016, #2: 2017
500	IPP	PITON734	814	Eastern	Existing
500	IPP	PITON75	610	Eastern	Existing
500	IPP	PITON76	610	Eastern	Existing
500	IPP	PITON77	615	Eastern	Existing
500	IPP	PITON78	615	Eastern	Existing
500	IPP	PITON79	650	Eastern	Existing
500	PLN	IDMYU#1,2	1,000x5	Western	#1: 2017 #2: 2020
500	PLN	TJATI-B#1-4	660x4	Eastern	#1,2: Existing, #3:2011,#4:2012
Total)			11,474		
150	IPP	CRBON21	660	Western	2011
150	IPP	CRBON22	660	Western	2015
150	IPP	MDURA#1,2	200x2	Eastern	2015
Total)			1,720		

(Source: developed based on "Draft RUPTL 2011-2020", PLN; PSS/E data, P3B) ;
"Existing Power Plants in Java-Bali System", PLN; "PSS/E data",P3B)

For the line constants of the Project's transmission line, such as the length and reactance, the JICA Study Team adopted the values provided by PLN-E.

(1) Transmission Lines, Transformers, and Generators

The rated thermal capacities of the typical conductors that are used for PLN's 500kV transmission lines are shown in Table 3. 17.

Table 3. 17 Rated Capacities of Conductors for 500kV Transmission Lines

Conductors per Phase	Type	Code Name	Allowable Current (A)	MVA	MW*
4 x 282mm2	ACSR	DOVE	2,292	1,985	1,786
4 x 337.8mm2	ACSR	GANNET	2,551	2,209	1,988
4 x 428.9mm2	ACSR	ZEBRA	3,200	2,611	2,493

* Power factor is assumed to be 0.90.

The line constants for the aforementioned conductors are shown in Table 3. 18.

Table 3. 18 Line Constants

Type of Conductor	Code	Positive-phase-sequence Impedance (pu/km)		
		R	X	B
500kV 4 x 282mm2 ACSR	DOVE	0.000011	0.00011	0.01011
500kV 4 x 337.8mm2 ACSR	GANNET	0.000010	0.00011	0.01011
500kV 4 x 428.9mm2 ACSR	ZEBRA	0.000008	0.00011	0.01095

(Source: PSSE data obtained from P3B; and "Technical Parameters of Conductor", obtained from P3B's system operation dept. For ZEBRA, calculated by JICA Team)

The length of the Project's 500 kV transmission line has been updated referring to the recent PLN-E's feasibility study, as shown in Table 3. 19.

Table 3. 19 Length of each Section of the Project's Transmission Line

Indramayu PS – Cibatu SS	Mandirancan SS – Indramayu PS	Pemalang SS - Mandirancan SS	Existing Ungaran SS - Pemalang SS	Tanjung Jati B PS – Pemalang SS
110 km	90 km	167 km	63 km	246 km

(Source: FS by PLN-E)

Key development plan like the commission of power plants is in line with the draft RUPTL 2011-2020, provided by PLN also during the Team's 1st mission in August 2011.

3.5.4 Power Flow Analysis Result.

Figure 3. 19 shows the result of the case without the Project lines. The figures in the drawing show only the power flow over the 500 kV transmission lines.

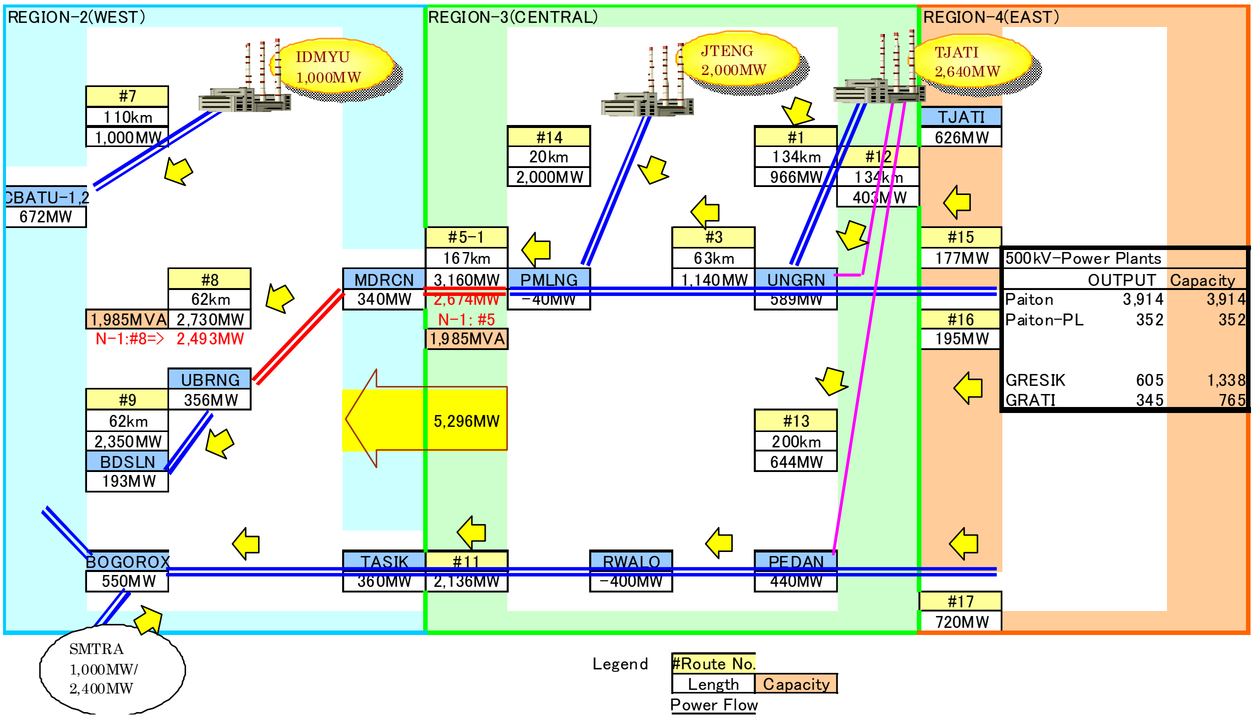


Figure 3. 19 The Power Flow Analysis Result of the Case without the Project's Line (YR2017)

As obvious from the above figure, per the N-1 accident at the line between Pemalang Substation and Mandirancan Substation and at the line between Mandirancan Substation and Ujung Berung Substation, the power flow amount exceeds the rated thermal capacity. For the countermeasure, it is advised to increase the capacity of the corresponding sections, or to divert the power flow to the other sections. Figure 3. 20 shows the result of the power flow analysis of the case with the Project's line.

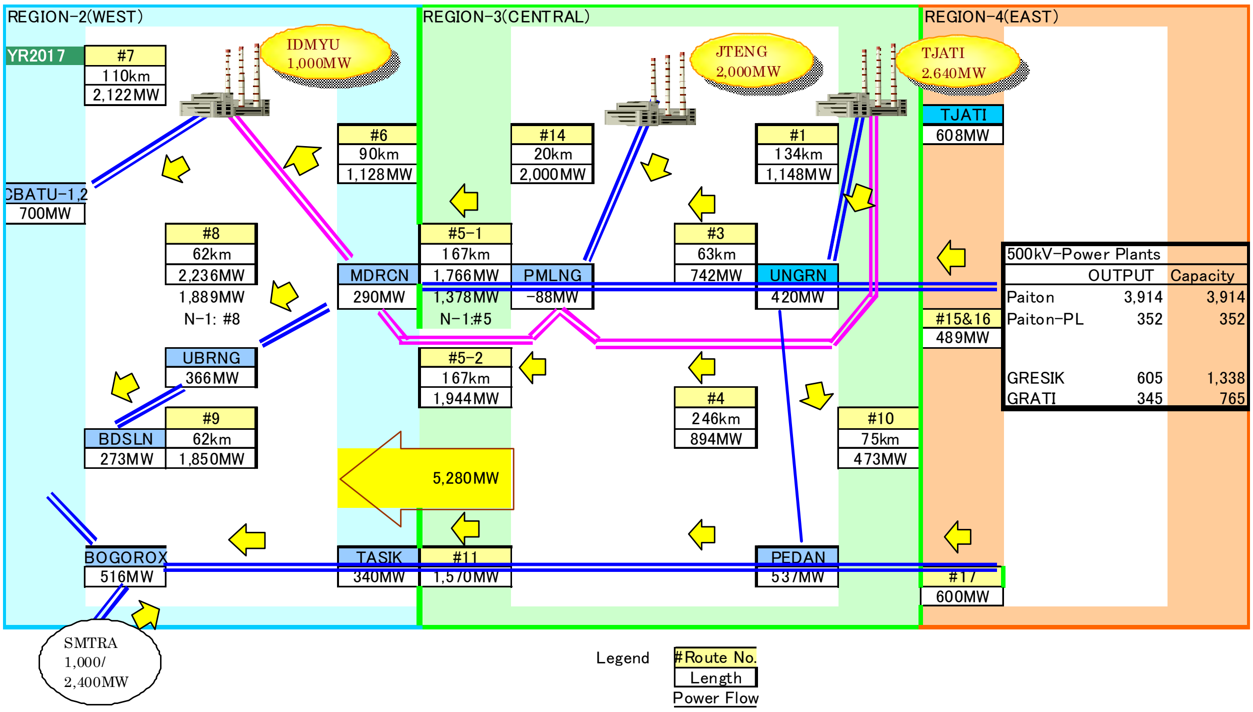


Figure 3. 20 The Power Flow Analysis Result of the Case with the Project's Line (YR2017)

As shown in Figure 3. 20, the installation of the Project has solved the concern about the over-capacity at the designated sections, confirming the necessity of the Project's transmission line. Similar flow analyses have been conducted for the other years, Year 2015 and Year 2020, arriving at the same conclusion. Based on those analysis results, it has been confirmed that the Project's transmission line is necessary.

The following table shows the thermal capacity of the main existing / planned transmission lines used for the decision of a permissible current value.

Table 3. 20 Rated Thermal Capacity of the Major existing/ planned Sections

Section	Rated Thermal capacity/ cct
Ungaran - Pemalang	1,984 MVA/cct (approx. 1,900 MW/cct)
Pemalang - Mandarincan	1,984 MVA/cct (approx. 1,900 MW/cct)
Mandarincan - Ujun Berung	1,984 MVA/cct (approx. 1,900 MW/cct)
Pedan-BNTUL-RWALO-Western area	2,209 MVA/cct (approx.2,100 MW/cct)

3.5.5 Fault Current Analysis

(1) Approach and Methodology

Maximum three-phase short circuit fault currents were calculated for the 500kV power system before and after the development of the Project's transmission line. The same analysis models for the power flow and voltage analysis were used.

The criteria used for the analysis is shown in Table 3. 21 obtained from P3B.

The year 2017 has been chosen as the target year to be evaluated.

- Assuming the three-phase short circuit fault.
- The evaluation has been conducted both for cases without the Project's 500kV line (from Tx-Ungarn to Pemalang Substation, Mandirancan Substation, and Indramayu Power station and for cases with the Project's line.

- For the generation pattern, the one for the normal peak has been selected, which is also the data set originally provided by P3B.
- Circuit breaker's operation time and the breaking capacity have been cited from P3B's standard values as shown in Table 3. 21.

Table 3. 21 Maximum Allowable Fault Currents

Nominal Voltage	Total Clearance time (Primary protection)	Maximum Allowable Fault Current
500kV	Max 90 ms	50kA
150kV	Max 120 ms	50kA

(Source: P3B)

(2) Results and Recommendation

The result for the case of the three-phase short circuit fault on 500 kV bus is shown in Table 3. 22.

Table 3. 22 Result of Fault Current Analysis of 500 kV Bus after three-Phase Short Circuit Fault.

Substation	Without Project	With Project
Cibatu	48.66	51.17
Indramayu	18.27	28.57
Mandirancan	25.38	36.7
Pemalang	33.67	39.84
Ungaran	32.06	37.36
TanJati	32.94	30.6
Rwal	23.79	25.18

After the commission of the Project's transmission line, the fault current due to the three-phase short circuit fault at Cibatu 500 kV Substation's bus exceeds 50 kA, the maximum allowable amount. The fault current, however, already reaches around 49 kA even without the Project. With the operation of the adjacent power station which is currently out of service, the fault current exceeds 50kA without the Project. For these reasons, regardless of the development of the Project's line, any countermeasures against the fault current at Cibatu 500 kV Substation's bus needs to be implemented. Such countermeasures would include separation of the grid, limitation of the number of generators as a measure from a system operations perspective.

The fault current analysis result of the three-phase short circuit fault at 150 kV bus 150 kV is shown in Table 3. 23.

Table 3. 23 Result of Fault Current Analysis of 150 kV Bus after three-Phase Short Circuit Fault.

Substation	Without Project	With Project
Cibatu	50.62	53.27
Mandirancan	47.53	54.22
Pemalang	45.33	49.06
TanJati	52.65	53.31
Rwal	46.51	47.39
Ungaran	51.15	52.92

The fault current of some of the buses shown above already exceeds 50 kA. Therefore, regardless of the development of the Project's transmission line, measures to suppress the fault current are to be implemented. Such measures would include a review of whole 150 kV systems.

Another particular point is that the amount of the single-phase ground fault current becomes larger than the three-phase short circuit fault current near power stations in some cases. Therefore, it is recommended to assess the single-phase ground fault current at locations around the power stations such as Tanjung Jati power station and Jawa Tengah power station, once the database regarding the zero-phase-sequence impedance has been setup.

3.5.6 Stability Analysis

(1) Approach and Methodology

Stability analyses were conducted. When all of the synchronous generators in the system are able to maintain synchronized operations even in the event of an equipment fault occurring, which constitutes the system, the system can be considered stable. The calculations were executed under the criteria that “when the oscillations of the phase angles among the rotors of synchronous generators which constitute the system tends to converge even in the case of the severest single contingency, the system is stable.”

The fault locations were set to the 500kV sections as follows:

- TJATI – PMLNG
- PMLNG – MDRCN
- MDRCN – IDMYU

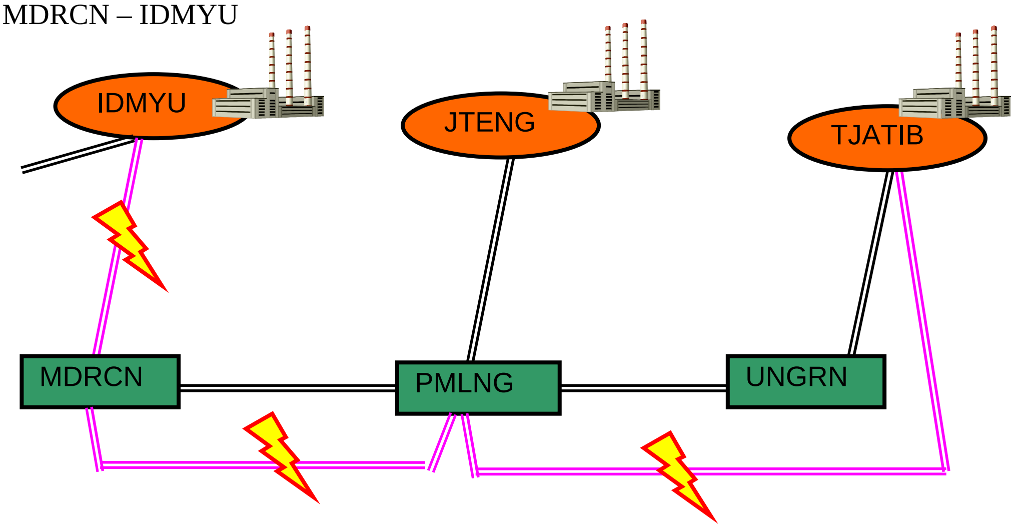


Figure 3. 21 The Image of Fault Locations analyzed in the Stability Analysis

The fault sequence is described as follows:

- 0ms: Single circuit three-phase short-circuit fault at the selected section.
- 90ms: Fault clearance and 1cct open.
- 10s: End of calculation

The data used is as follows**:**

- Data used is mostly those obtained from P3B and the others modified from those data (Source: Mainly “ModelingList.xls,” supplemented by “2019.dyr.” Both provided by P3B).
- Table 3. 24 to Table 3. 26 show the models of the representative power stations.

Table 3. 24 Generator Model for Major three Power Stations and Slack: GENROU

Slack: SLAYA77-COA (GENROU)

T’do	T”do	T’qo	T”qo	H	D	Xd	Xq	X’d	X’q	X”d=X”q	Xl	S(1.0)	S(1.2)
5.69	0.05	1.5	0.144	2.64	2	2.11	2.02	0.28	0.49	0.245	0.155	0.079	0.349

(Source: “2. Generator Modeling.xls,” P3B)

Tanjung Jati B #1-4 Power Station (SOURCE: ModelingList.xls)

T'do	T"do	T'qo	T"qo	H	D	Xd	Xq	X'd	X'q	X"d=X"q	Xl	S(1.0)	S(1.2)
4.57	0.04	0.5	0.1	2.71	0	1.64	1.38	0.26	0.60	0.245	0.216	0.118	0.46

(Source: "2. Generator Modeling.xls," P3B)

Jawa Tengah Power Station (SOURCE: ModelingList.xls)

T'do	T"do	T'qo	T"qo	H	D	Xd	Xq	X'd	X'q	X"d=X"q	Xl	S(1.0)	S(1.2)
5.11	0.04	0.42	0.059	2.71	0	1.44	1.36	0.18	0.32	0.17	0.102	0.11	0.377

(Source: "2019.dyr," P3B)

Indramayu Power Station (source: Jawa Tengah)

T'do	T"do	T'qo	T"qo	H	D	Xd	Xq	X'd	X'q	X"d=X"q	Xl	S(1.0)	S(1.2)
5.11	0.04	0.42	0.059	2.71	0	1.44	1.36	0.18	0.32	0.17	0.102	0.11	0.377

(Source: applied the data set of Jawa Tengah.)

Table 3. 25 Exciter Model

Slack: SLAYA77-COA. IEEX1

TR	KA	TA	TB	TC	VRMAX	VRMIN	KE	TE	KF	TF1	0.Switch	E1	SE(E1)	E2	SE(E2)
0.02	100	0.05	0	0	7.6	-7.6	1	0.98	0.04	0.5	0	2.9	0.22	3.84	0.5

Tanjung Jati B #1-4 Power Station: IEEET1

TR	KA	TA	VRMAX	VRMIN	KE	TE	KF	TF	Switch	E1	SE(E1)	E2	SE(E2)
0.06	40	0.1	1	-1	-0.06	0.67	0.12	1	0	2.44	0.09	3.3	0.368

Jawa Tengah Power Station: IEEET1

TR	KA	TA	VRMAX	VRMIN	KE	TE	KF	TF	Switch	E1	SE(E1)	E2	SE(E2)
0.06	40	0.1	1	-1	-0.06	0.67	0.12	1	0	2.44	0.09	3.3	0.368

Indramayu Power Station: IEEET1

TR	KA	TA	VRMAX	VRMIN	KE	TE	KF	TF	Switch	E1	SE(E1)	E2	SE(E2)
0.06	40	0.1	1	-1	-0.06	0.67	0.12	1	0	2.44	0.09	3.3	0.368

Table 3. 26 Governor Model

Slack: SLAYA77-COA. IEEEG1

K	T1	T2	T3	Uo	Uc	PMAX	PMIN	T4	K1	K2	T5	K3	K4	T6	K5	K6	T7	K7	K8
20	0	0	0.1	0.1	-0.1	0.903	0	0.4	0	0	9	0.4	0	0.5	0.3	0	0	0	0

Tanjung Jati B #1-4 Power Station: IEEEG1

K	T1	T2	T3	Uo	Uc	PMAX	PMIN	T4	K1	K2	T5	K3	K4	T6	K5	K6	T7	K7	K8
20	0	0	0.1	0.1	-0.1	0.903	0	0.4	0	0	9	0.4	0	0.5	0.3	0	0	0	0

Jawa Tengah Power Station: IEEEG1

K	T1	T2	T3	Uo	Uc	PMAX	PMIN	T4	K1	K2	T5	K3	K4	T6	K5	K6	T7	K7	K8
20	0	0	0.1	0.1	-0.1	0.903	0	0.4	0	0	9	0.4	0	0.5	0.3	0	0	0	0

Indramayu Power Station: IEEEG1

K	T1	T2	T3	Uo	Uc	PMAX	PMIN	T4	K1	K2	T5	K3	K4	T6	K5	K6	T7	K7	K8
20	0	0	0.1	0.1	-0.1	0.99	0	0.4	0	0	9	0.4	0	0.5	0.3	0	0	0	0

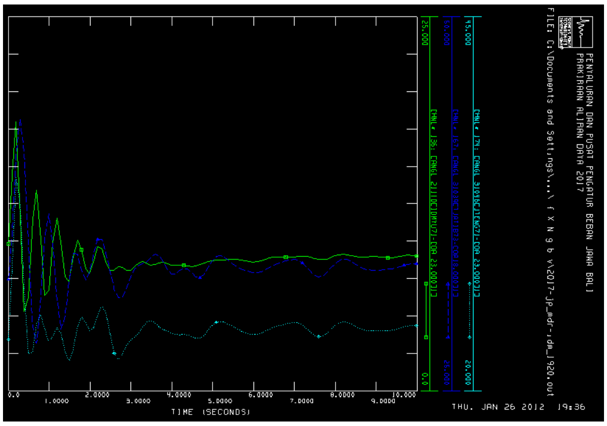
(2) Stability Analysis Results

Rotor angle oscillations of major generators, including Tanjung Jati B #3, Jawa Tengah #1, and Indramayu #1, measured from the slack generator – Suralaya PS#7 - are shown in Figure 3. 22 to Figure 3. 24. The vertical axis in each figure indicates the phase angle difference between the aforementioned generators and the range covers from -180 degrees to 180 degrees.

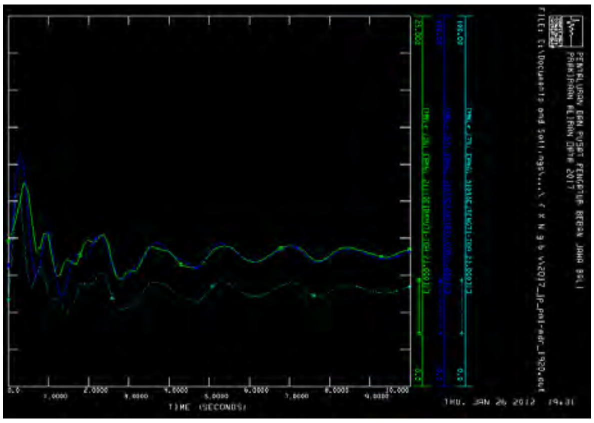
(a) Heavy Load Conditions

As shown in Figure 3. 22, the oscillation of the phase angle difference is likely to converge, thus the power system is considered stable.

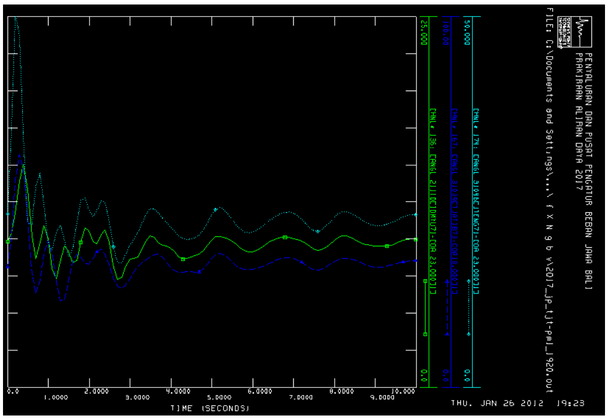
YR2017



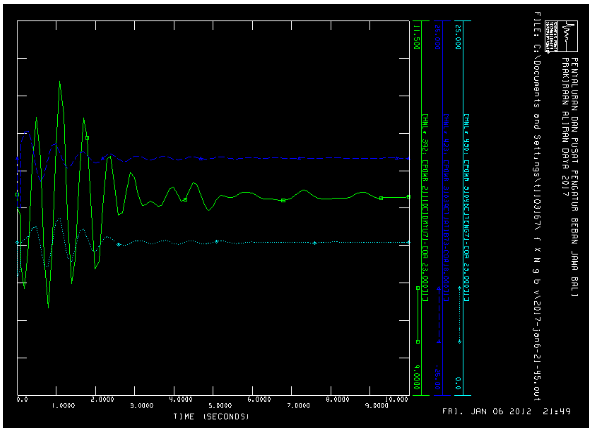
3ph-fault at MDRCN - IDMYU



3ph-fault at PMLNG - MDRCN



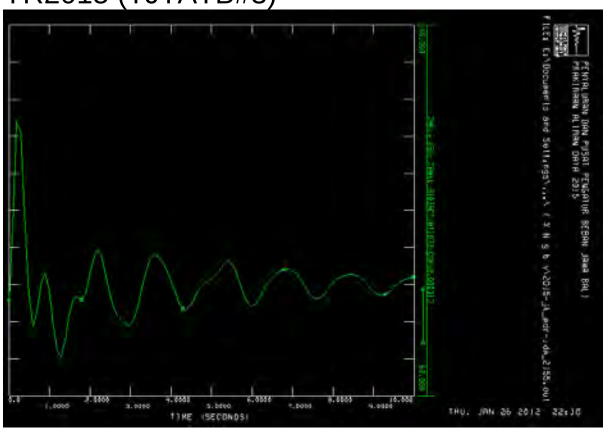
3ph-fault at TJATI – PMLNG



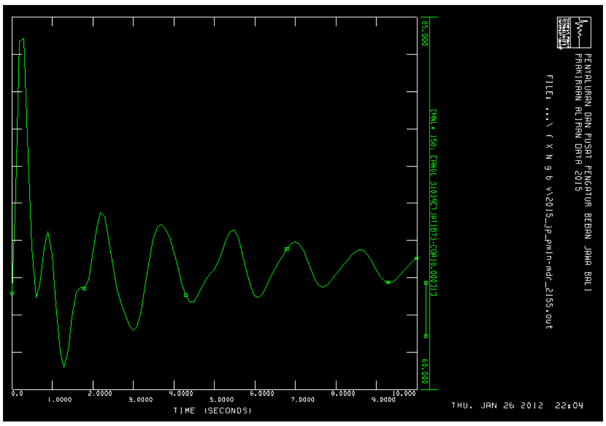
Power (t at TJATI – PMLNG)

Figure 3. 22 Result (YR2017)

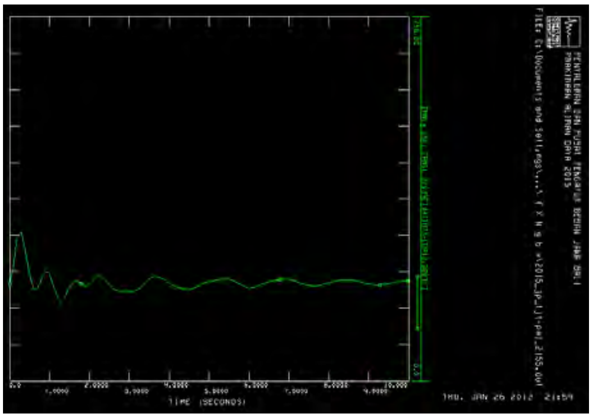
YR2015 (TJTATB#3)



3ph-fault at MDRCN - IDMYU



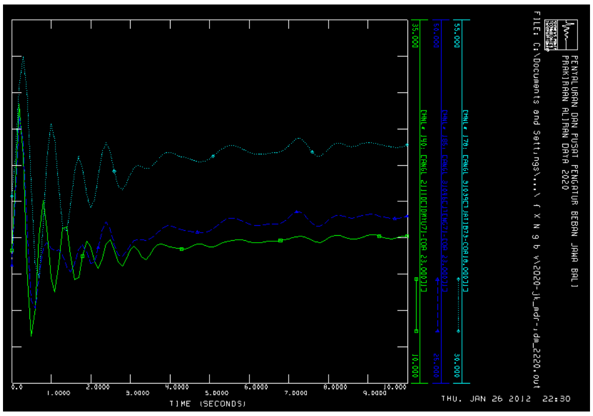
3ph-fault at PMLNG - MDRCN



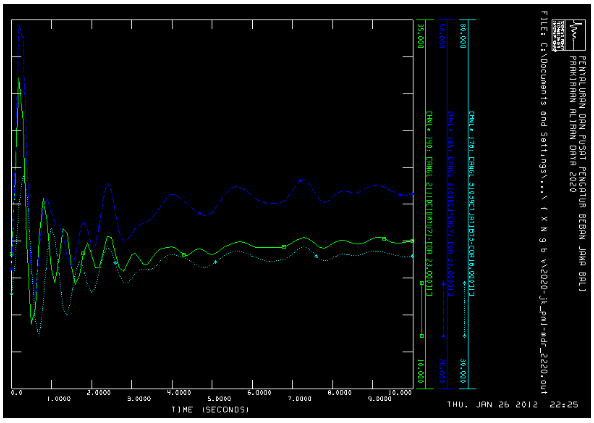
3ph-fault at TJATI – PMLNG

Figure 3. 23 Result (YR2015)

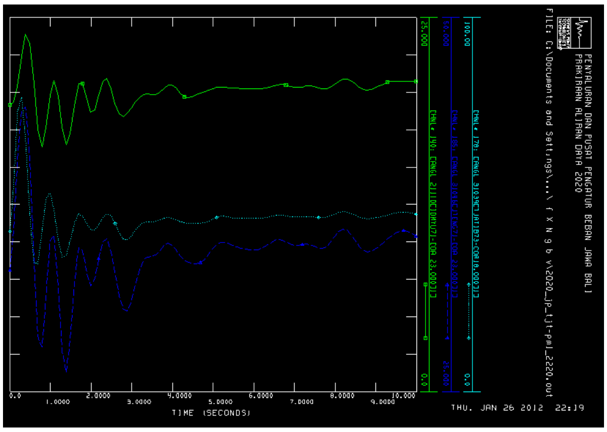
YR2020



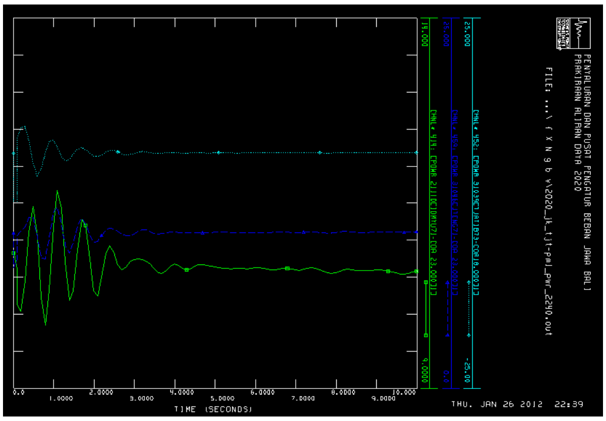
3ph-fault at MDRCN - IDMYU



3ph-fault at PMLNG - MDRCN



3ph-fault at TJATI – PMLNG



3ph-fault at TJATI – PMLNG(power)

Figure 3. 24 Result (YR2020)

(b) Light Load Condition

As is the case of a heavy load condition, the oscillation of the phase angle difference is likely to converge, thus the power system is considered stable.

(c) Case of N-2

The following shows the stability analysis result for the case of N-2 at the transmission section between Pemalang Substation and Mandirancan Substation during the Jakarta Peak Time (the case with the Project).

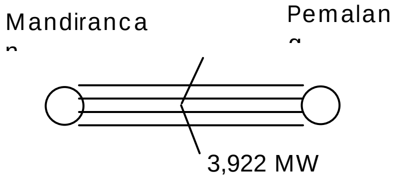
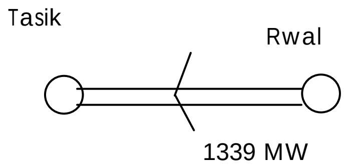
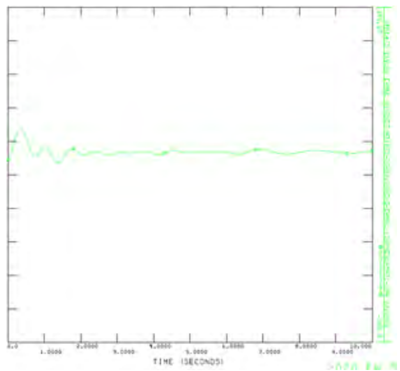
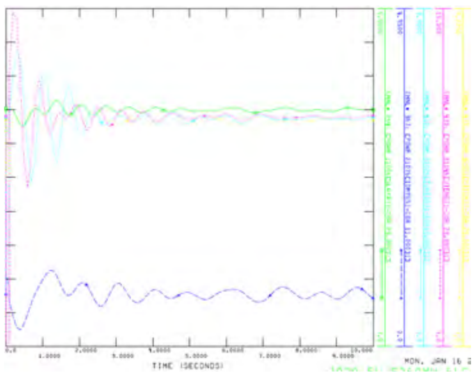
	With Project
Current before the fault	 
Pemalang-Mandirancan Two-circuit fault (6LGO)	Angle between Slaya and Piton  

Figure 3. 25 Result (N-2, YR2017)

3.5.7 Alternative Projects

This Project is considered as one of the radical measures, however, because of its high-cost and long amount of time necessary for its completion, the alternatives were examined in terms of power transmission methodology.

For the studies shown in the following (1)-(3) in this Section discussing the alternatives, Indramayu, Tanjung Jati, and Central Java power stations are operating at their full outputs, however, other power plants operate in proportion to their capacities. The operation pattern of those studies is as shown in Table 3. 27.

(1) Replacement of the existing conductors to the large capacity ones

Replacing the existing 500 kV transmission lines (Pemalang – Mandirancan – Bandung) to the low sag conductors or the low loss and low sag conductors with large capacity can increase the thermal capacity of the transmission lines by around a 1.5 factor.

Those conductors have low sags even with their high temperature when a large amount of the current is flowing.

(2) Doubling circuits of the existing 500 kV transmission line from Ungaran to Pedan

This option is to add a circuit to the existing transmission line from Ungaran Tx to Pedan (70km) that is a part of a single circuit line from Ungaran to Pedan to make a double circuit line aimed at guiding the portion of power flow to the south route of the existing 500kV transmission lines whose power flow is of a relatively lesser degree.

Since the south route of the existing lines has a power flow of less than 1,000 MW as shown in Figure 3. 26, it can afford to have more power in comparison with its capacity.

This option is to replace the existing single circuit towers to the double circuit towers between Ungaran and Pedan to guide the power flow to the south route and to reduce the power flow in the northern route.

The overloaded situation that occurs when the N-1 fault happened at the interval between Pemalang and Mandirancan and the interval between Mandirancan and Ujung Berung can be avoided, however, its effects in reducing the power flow in the northern route of the transmission lines would be around 100 MW and not so much.

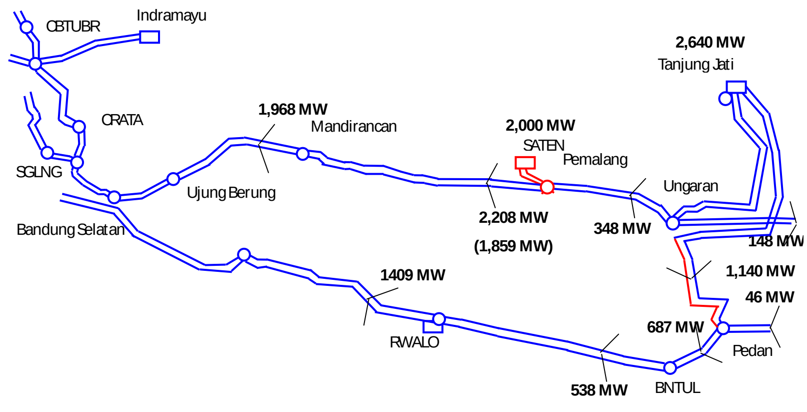


Figure 3. 26 Power Flow between Ungaran and Pedan when Doubling Circuits (in case of Power Flow of 3,600 MW between Region 2 and 3 in 2017)

(a) Option of replacement of the existing transmission lines to the double circuit towers

Since the impact on the land acquisition procedures and the environment would be relatively limited, it can be realized within a short period of time. On the other hand, as the overall interval of the transmission lines cannot be operated during the construction periods, power evacuation from Tanjung

Jati B may be interrupted. Not operating the transmission may not have a significant effect on the system because at present, its power flow is not so large (400 MW at maximum).

(b) Option of adding a route

This option will require the route surveys and the environmental impact studies from their beginning stage and its preparatory works are considered to take much time. Furthermore, the category of the environmental impact study may become A.

(3) The option of the guiding power flow to the south route of the transmission lines by applying series capacitors

This option is to apply the series capacitors or FACTS devices to guide the power flow to the south route of the transmission line. Since the series capacitors or FACTS devices are installed at the substations, this option can be realized if the substations have room for their installation.

Figure 3. 27 shows the power flow when the series capacitors compensate 60% of the reactance of the transmission lines. Its effect on the reduction of the power flow of the north route of the transmission line is around 300 MW. However, the sub-synchronous oscillation of the shaft of the thermal power generators is feared when the series capacitors are installed. The effect of the reduction of the power flow becomes weakened if smaller sized capacitors have to be applied to suppress the sub-synchronous oscillation.

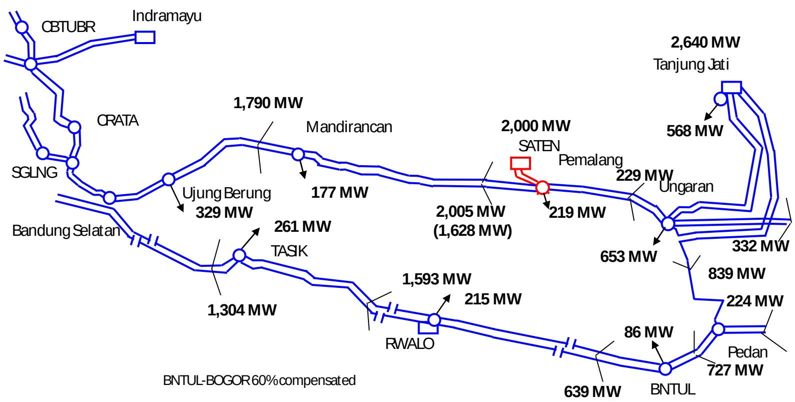


Figure 3. 27 Power Flow when Series Capacitors are installed in the South Route (in case of Power Flow of 3,600 MW between Region 2 and 3 in 2017)

3.5.8 Comparison of Options

The abovementioned studies assumed the case of the full outputs of Tanjung Jati and Central Java coal thermal power stations in the central area with the balancing of the power supply and demand by reducing the outputs of the remaining power stations. As shown in Figure 3. 27, in this pattern of the power outputs of generators, the power flow between Region 2 and Region 3 was 3,600 MW in 2017.

Table 3. 27 show the power outputs of the coal thermal power plant in this pattern.

Table 3. 27 Generation Pattern of Coal Thermal Plant IPPs when the Power Flow between Region2 and 3 is 3,600 MW

(Peak Power Demand in Jakarta)

	Power Generation Pattern of this study	
	2015	2017
IDMYU	0 MW	1,000 MW
CLCAP	1,512 MW	707 MW
TJATI	2,640 MW	2,640 MW
CENTRAL JAVA	0 MW	2,000 MW
PITON	3,072 MW	2,645 MW
MDURA	261 MW	225 MW

* Excluding power generators at Indramayu 990 MW units connected at 150 kV system

On the other hand, the case of the full outputs of all the coal thermal power IPPs is considered to be a condition where more power flow is flowing from east to west than the abovementioned case. The power flow from east to west is increased per the increase in the power outputs of the coal thermal power IPPs because they are relatively concentrated in the east side of Java. In this case, the power flow reaches around 5,000 MW between Region 2 and Region 3 from the results of the power flow calculation mentioned below. Table 3. 28 shows the power generation pattern in this case.

Table 3. 28 Generation Pattern when all the Coal Thermal Power Plant IPPs are at Maximum Power Output Operation

	Power Generation Pattern of this study	
	2015	2017
IDMYU	0 MW	1,000 MW
CLCAP	1,920 MW	1,920 MW
TJATI	2,640 MW	2,640 MW
CENTRAL JAVA	0 MW	2,000 MW
PITON	4,324 MW	4,714 MW
MDURA	400 MW	400 MW

Figure 3. 28 show the results of the power flow calculation in 2015 in the case of maximizing the power outputs of all the coal thermal power plant IPPs when the transmission lines of the Project are not constructed. The power flow between Region2 and 3 reaches around 5,000 MW. The power flow of the remaining circuit far exceeds 1,900 MW that is its thermal capacity when a single circuit of the transmission line is dropped. Furthermore, the south route cannot afford to have enough thermal capacity to cover its power flow.

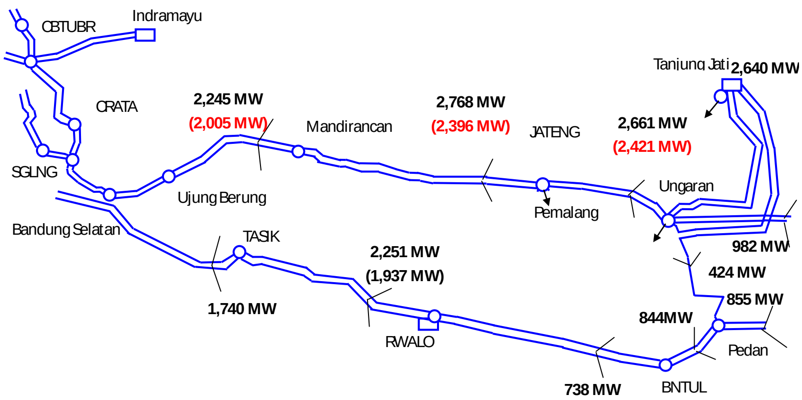


Figure 3. 28 Result of Power Flow Calculation in 2015 without the Project (in case of Maximizing the Power Outputs of all the Coal Thermal Power Plant IPPs)

Figure 3. 29 shows the results of the power flow calculation in 2017. The power flow between Region2 and 3 reaches around 5,000 MW. The power flow of the remaining circuit far exceeds their thermal capacity when a single circuit of the transmission lines at the interval between Pemalang and Mandirancan or at the interval between Mandirancan and Ujung Berung is dropped. Furthermore, the southern route cannot afford to have enough thermal capacity to cover its power flow.

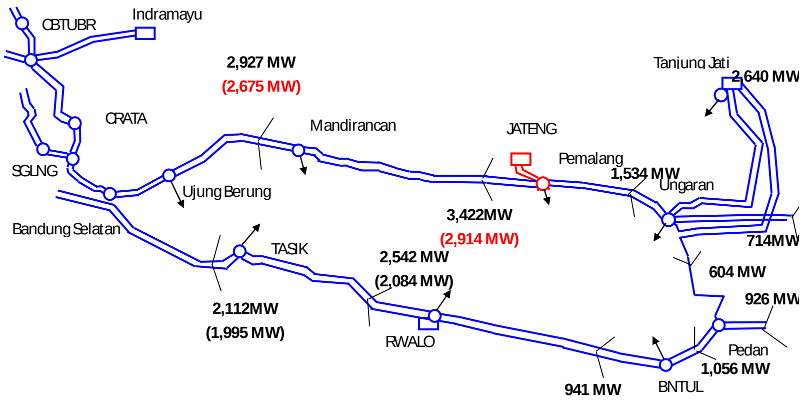


Figure 3. 29 Result of Power Flow Calculation in 2017 without the Project (in case of Maximizing the Power Outputs of all the Coal Thermal Power Plant IPPs)

From the abovementioned results, in the case of full power generation of all the coal thermal power IPP plants, the power flow of the northern route with double circuits exceeds the thermal capacity of a remaining single circuit when a single circuit fault occurs and the power flow of the southern route approaches its thermal capacity if the project is not realized. Furthermore, in this power flow situation, Tanjung Jati and power stations located in the east area would be dropped without their synchronism when a single circuit fault occurs at the interval between Pemalang and Mandirancan. Thus, the existing four circuits of 500 kV transmission lines from east to west are considered insufficient to be able to transmit power in correspondence with the maximum power generation pattern of all the coal thermal IPP power plants from the power flow and system stability aspects. The new transmission lines from east to west would be required.

Figure 3. 30 shows the power flow in 2017 after the Transmission Line Project is constructed in case of the full power generation of all the coal thermal IPP power plants.

All the power flow at the eastern side from Mandirancan can be sufficiently lower than the thermal capacity of the transmission lines even though a single circuit fault is considered. However, the power flow between Mandirancan and Ujung Berung exceeds the thermal capacity of the remaining circuit when a single circuit fault occurs. It is because the four circuits transmission line with their normal capacity does not enough capacity at the western side from Mandirancan due to the combined power flow of the four circuits lines at the interval between Indramayu and CBTU and at the interval between Mandirancan and Ujung Berung that is a power flow from the eastern side of Mandirancan plus the power output from Indramayu.

Thus, it is necessary to examine the methodology of reinforcement of the transmission lines at the western side of Mandirancan apart from the installation of this Project in order to treat the situations of full power output of all the coal thermal IPP power stations.

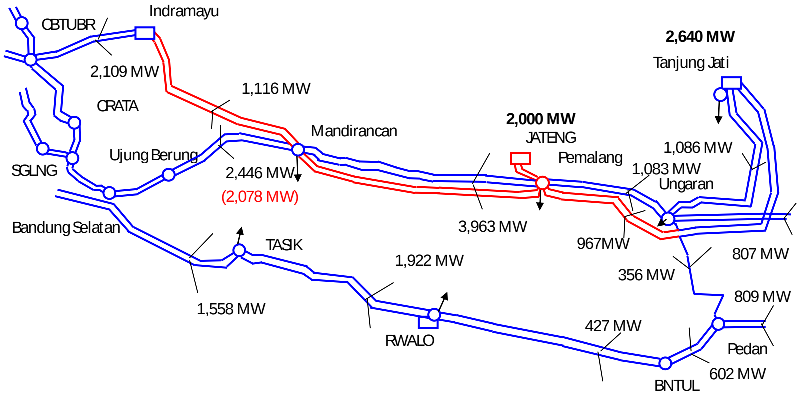


Figure 3. 30 Result of the Power Flow Calculation (2017) after Completion of the Project (All the Coal Thermal IPP Power Stations at Full Output)

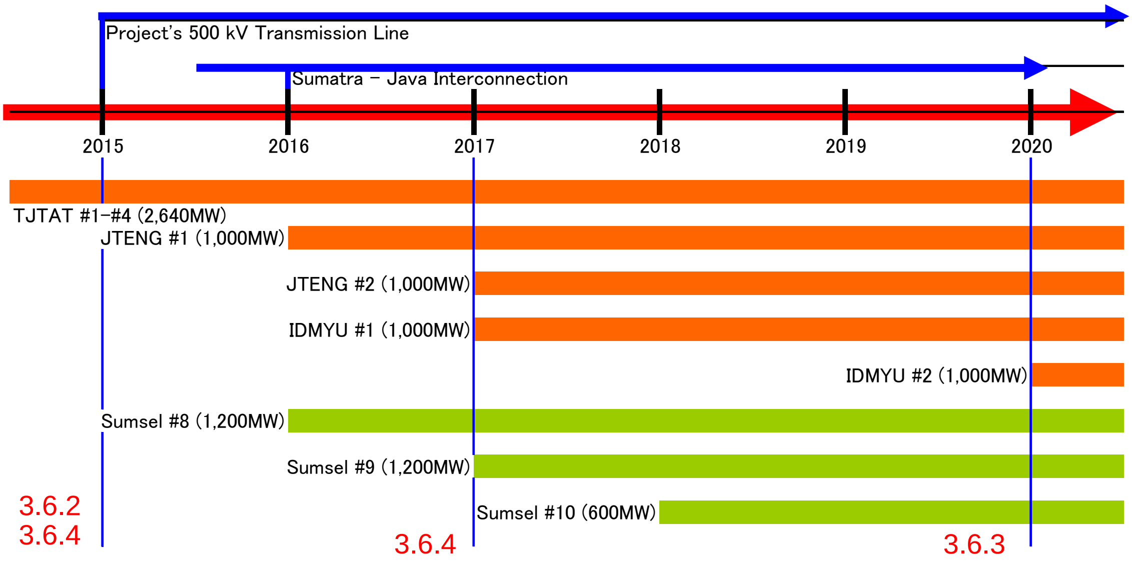
3.6 Issues Related to the Development of the Project's Line

3.6.1 Objective

To identify issues related to the development of the Central and West Java 500kV Transmission Line (hereafter, the PJ line) and to address the issues.

- Topics to be analyzed

1) Evaluation of the impact when the other planned transmission line between Indramayu power plant and Cibatu substation is not yet in operation even after 2015, which is the COD of the PJ line.
2) Overload test over the existing 500 kV north route, specifically its sections west to Mandirancan substation after the commission of all units (2 units) of Indramayu thermal power plant (in and after 2020).
3) Overload test during the capacity-increase construction at the section between Mandirancan substation and Ujung Berung substation, as its one circuit will be on a scheduled outage during the construction period.



Note: It has been agreed between the Indonesian counterpart and JICA that the COD of the Project's transmission line will be year 2017. This study is based upon the JICA Study Team's assumption mainly referring to the draft RUPTL 2011-2020.

Figure 3. 31 Key Events

3.6.2 Coordination of the Indramayu and Cibatu Line

(1) Objective

This part aims to identify any issues resulting from those cases where the commission of the transmission section between Indramayu power plant (hereafter IDMYU) and Cibatu substation (hereafter CBATU) would be later than the commission of the PJ line, i.e. 2015. It is anticipated that there would be an overloaded section at sections starting from the Mandirancan substation (hereafter MDRCN) through Ujung Berung (hereafter UBRNG) to Bandung Selatan (hereafter BDSLN). Therefore, the necessary power output reduction from coal-fired IPP power plants is also calculated for reference.

(2) Approach

The N-1 test has been conducted for the two sections (1: the section between MDRCN and UBRNG; 2: the section between UBRNG and BDSLN).

(3) Analysis Premise

For the analysis, the year 2015 has been chosen because the PJ line would start its operations in the year. In terms of the demand, as requested by PLN, the demand peak at Jakarta and Banten area (hereafter Jakarta peak time), around 2:00 pm, has been selected when the maximum power flow would appear on the PJ line. For the generation pattern of the Java-Bali system, as requested by PLN, the generation pattern close to current one during Jakarta peak time has been chosen. That is, the output of the 3 power plants to be connected with the PJ line (namely, Tanjung Jati B, Jawa Tengah, and Indramayu) and of all the coal-fired IPP power plants has been set at the maximum output, while the rest of the power plants of the system generate power evenly (*). Calculation conditions are summarized below.

*: The generation pattern of the original calculation data provided by P3B at the JICA Study Team's 1st mission last August was to generate electricity evenly among all power plants with approximately 65 % of installed capacities.

Table 3. 29 summarizes the premise.

Table 3. 29 Analysis Premise

YEAR:	2015 (COD of the PJ line)
DEMAND:	The demand peak time of the Jakarta & Banten Area (around 1:00 pm)
GENERATION:	Maximum output from the relevant 3 power plants and all coal-fired IPP power plants. The remaining power plants generate power evenly.

(4) Finding

According to the results of the N-1 test, it turned out that the transmission section between MDRCN and UBRNG and the section between UBRNG and BDSLN would be overloaded. Therefore, it would be necessary to increase the transmission capacity for the two sections (Table 3. 30 and Figure 3. 32). In the table, the figures in the red reveal that the section is overloaded.

Table 3. 30 Power Flow at the Evaluation Sections [Unit: MW]

N-1 Section	#8)MDRCN-UBRNG	#9)UBRNG-BDSLN	#6)MDRCN-IDMYU	#7)IDMYU-CBATU
1. MDRCN-UBRNG	2,228x1	1,012x2	0	
2. UBRNG-BDSLN	1,174x2	1,946x1	0	
(Normal time)	1,255x2	1,109x2	0	
Ref.: After the commission of IDMYU-CBATU section	797x2	671x2	622x2	618x2
Thermal rate [MVA]	1,984/cct	1,984/cct	2,612/cct	

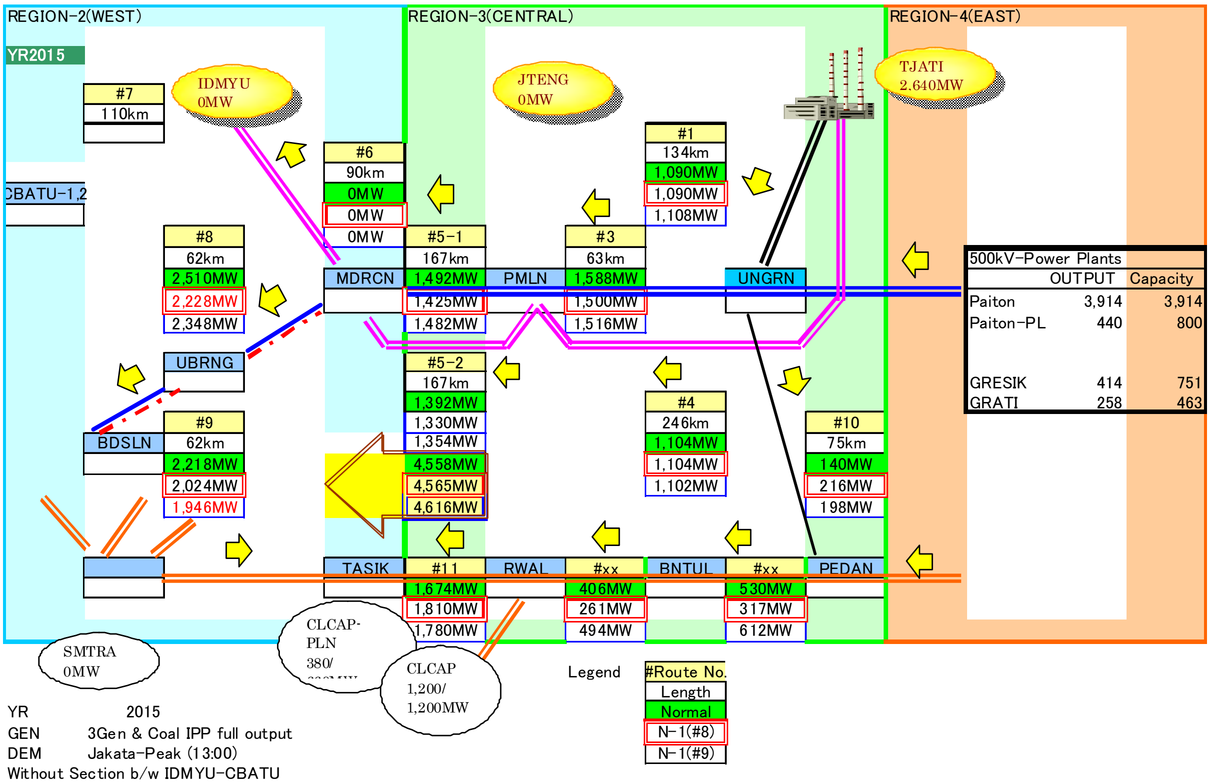


Figure 3. 32 Power Flow Analysis (2015)

(5) Countermeasures

Besides the countermeasures such as increasing the transmission capacity for the two sections, reducing the amount of power flow transmitted over the two sections would prevent this from being an issue. This would be achieved by reducing the output of the power generators located at the east of the sections, e.g. Paiton power plant, and by increasing the output of power generators located at the west of the sections, e.g. Sulaya power plant. The necessary output of coal-fired IPP power plants is to be reduced in order to avoid such an overloaded situation is estimated in the following manner:

(2,228 MW(*)－1985 MVA (thermal rate) x 0.85 (power factor) x 2)

= 1,080 MW ≅ 1,200 MW

*: Power flow on the section between MDRCN and UBRNG during N-1 accident

As an example, Table 3. 31 shows the necessary power output to be adjusted for this purpose. That is, the Paiton coal-fired power plant in the Eastern Area decreases its output, while the Sulaya coal-fired power plant in the Jakarta and Banten Area increases its output.

Table 3. 31 Adjusted Generation Pattern

Power plant in Jakarta and Banten Area	Adjusted output	Power plant in Eastern Area	Adjusted output
Sulaya #6	20MW => 600 MW	Paiton #5	610 MW => 0MW
Sulaya #8	340 MW => 500MW	Paiton #6	610 MW => 0MW

As a result, the amount of power flow in the circuit of the section between MDRCN and UBRNG has been reduced from 2,228MW (overloaded) to 1,630MW (within thermal capacity).

(6) Conclusion

The power flow analysis has revealed that there would be an overloaded section from MDRCN to UBRNG and BDSLN in the case of an N-1 accident, if the commission of the transmission line from the Indramayu power plant to the Cibatu substation, whose construction is a component of another project, would be later than 2015 when the PJ line is planning to start operations.

In order to address this issue, although the best way is to let the section between IDMYU and CBATU start its operation or before 2015, it is recommended to reduce the output of coal-fired IPP power plants located in Central and Eastern Java Island by more than 1,200 MW.

3.6.3 Impact on the Other Sections of the Grid

(1) Objective

This PART conducts an overload test for the Java-Bali system after the commission of the 2 units of the Indramayu power plant (1,000MW×2) in 2020. While the section between IDMYU and CBATU might not be overloaded thanks to its original large-capacity design (ZEBRA), the existing section between MDRCN and BDSLN is estimated to be overloaded in the case of an N-1 accident. This part aims to identify the exact section which needs to have its capacity increased as well as to specify the appropriate transmission capacity necessary for the suspected section.

(2) Approach

The N-1 test has been conducted for the three sections (1: the section between MDRCN and UBRNG; 2: the section between UBRNG and BDSLN; 3: the section between IDMYU and CBATU)

(3) Analysis Premise

YEAR:	2020
DEMAND:	Jakarta Peak Time (around 1;00 pm)
GENERATION:	Maximum output from the relevant 3 power plants and all coal-fired IPP power plants. The remaining power plants generate power evenly.

(4) Finding

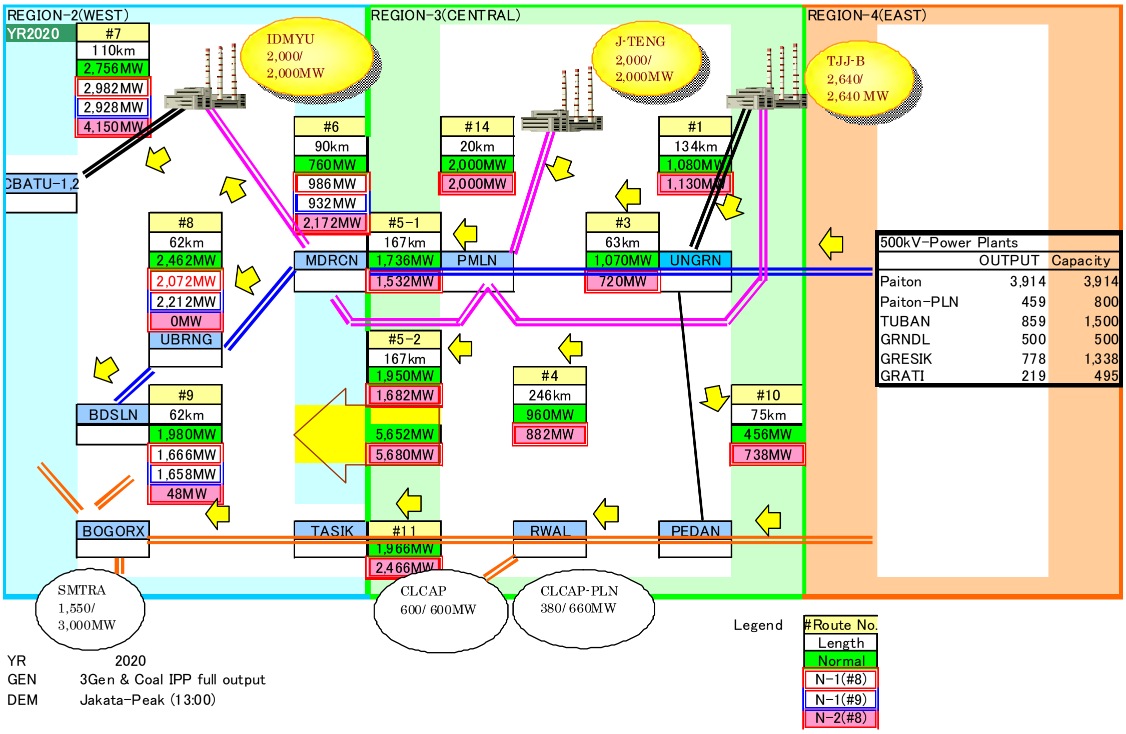
Table 3. 32 summarizes the results of the N-1 test for the evaluation sections. In the table, the figure in red means that the section is overloaded.

Table 3. 32 Power Flow at the Evaluation Sections [Unit: MW]

N-1 Section	#8)MDRCN-UBRNG	#9)UBRNG-BDSLN	#6)MDRCN-IDMYU	#7)IDMYU-CBATU
1. MDRCN-UBRNG	2,072x1	1,106x2	493x2	1,491x2
2. UBRNG-BDSLN	1,106x2	1,658x1	466x2	1,464x2
3. IDMYU-CBATU	1,407x2	1,174x2	-49x2	2,017x1
4. MDRCN-UBRNG(N-2)	0	24x2	1,086x2	2,075x2
Ref.: Normal time	1,173x2	954x2	250x2	1,249x2
Thermal capacity [MVA]	1,984/cct	1,984/cct	2,612/cct	2,612/cct

Note: To let the simulation result converged, a reactor is placed at the bust of BLRJA Substation.

Figure 3. 33 summarizes the results of the power flow analysis in the drawing.

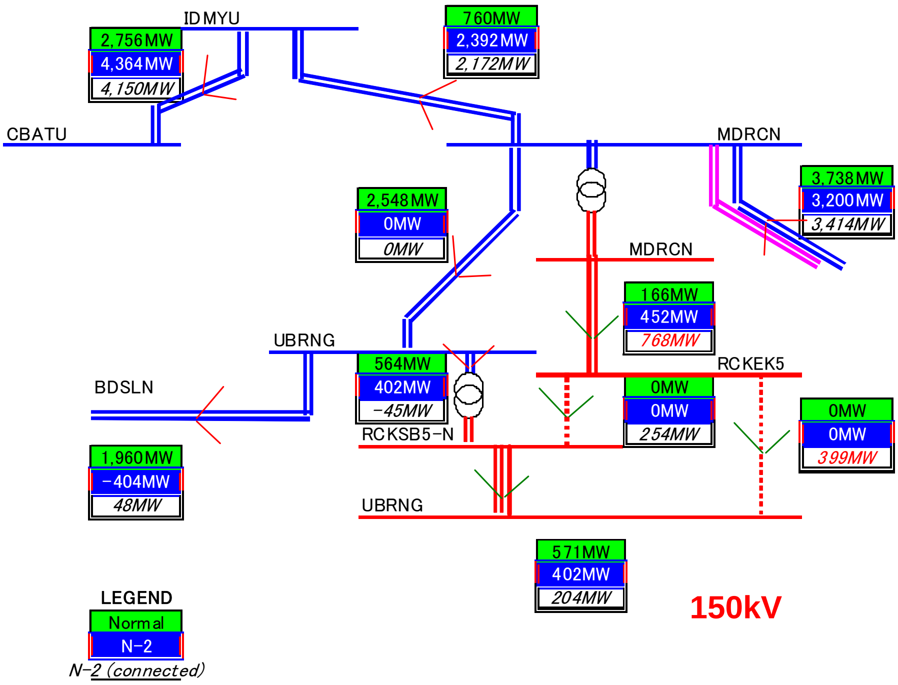


Note: To let the simulation result converged, a reactor is placed at the bust of BLRJA Substation.

Figure 3. 33 Power Flow Analysis (2020)

(5) Conclusion

In terms of thermal capacity, the analysis found that there would be no significant problems. After the commission of all units (2 units) of the Indramayu power plant in 2020, the section between MDRCN and UBRNG would be overloaded in the case of an N-1 accident even after the commission of the section between IDMYU and CBATU, though there would turn out to be no overloaded section in the Java-Bali system because the other circuit of the MDRCN-UBRNG section would trip thanks to its over load relay (OLR). Furthermore, it would be necessary to keep open 150 kV circuits near the Ujung Berung substation as the same section of the 150 kV network would be overloaded during the event (N-2).



Note1: The sections in the dashed line are usually open. The figure in red stands for the overloaded section.
Note2: To let the simulation result converged, a reactor is placed at the bust of BLRJA Substation.

Figure 3. 34 Power Flow Analysis (2020, 150 kV System)

To summarize, although it is necessary to adjust the setting of the OLR and to keep open the side of the UBRNG for 150 kV system, it would not be necessary to implement any construction to increase the capacity of the sections over the 500 kV north route via UBRNG west to Mandirancan substation, as there would be no overloaded section in case of an N-1 accident.

3.6.4 Assessment during Transmission Replacement Construction

The objective is as follows: Although the analysis at the previous part tells us that it is not necessary to conduct replacement construction for the section between MDRCN and UBRNG in order to increase its capacity, this section analyzes the cases to replace the section with larger line capacity. After the commission of the 2 units of Indramayu thermal power plant in 2020, the transmission section between MDRCN and UBRNG is estimated to be overloaded with the N-1 accident. The construction to increase the section's capacity would address the issue. The point, however, is whether supply reliability could be maintained during the construction period because one circuit of the section between MDRCN and UBRNG would be on the scheduled outage due to the construction work for the long term. Here we assumed that the transmission section between IDMYU and CBATU started its operations in 2015.
Specifically, we evaluated whether there would be no overloaded section with one circuit of the section from MDRCN to UBRNG disconnected before year 2020 (0 or 1 unit of the Indramayu power plant is in operation). Likewise, under the same conditions for the section, we conducted an N-1 analysis to identify any potential problems.

(1) CASE 1: 0 Unit of the Indramayu Power Plant is in operation

(a) Approach

An N-1 test has been conducted for one circuit of the section between MDRCN and UBRNG, and for both circuits of the section at a time.

(b) Analysis Premise

YEAR: 2015

DEMAND: Jakarta Peak Time (around 1:00 pm)

GENERATION: Maximum output from the relevant 3 power plants and all coal-fired IPP power plants. The remaining power plants generate power evenly.

(c) Finding

There is no overloaded section during the one circuit of the scheduled outage as well as a simultaneous two-circuit disconnection (Figure 3. 35 and Table 3. 33).

Table 3. 33 Power Flow at the evaluated Sections [Unit: MW]

N-1 Section	#8)MDRCN-UBRNG	#9)UBRNG-BDSLN	#6)MDRCN-IDMYU	#7)IDMYU-CBATU
1. MDRCN-UBRNG#1	1,306x1	557x2	705x2	568x2
2. MDRCN-UBRNG#1,2	0	25x2	1,082x2	1,070x2
Thermal Capacity [MVA]	1,984/cct	1,984/cct	2,612/cct	2,612/cct

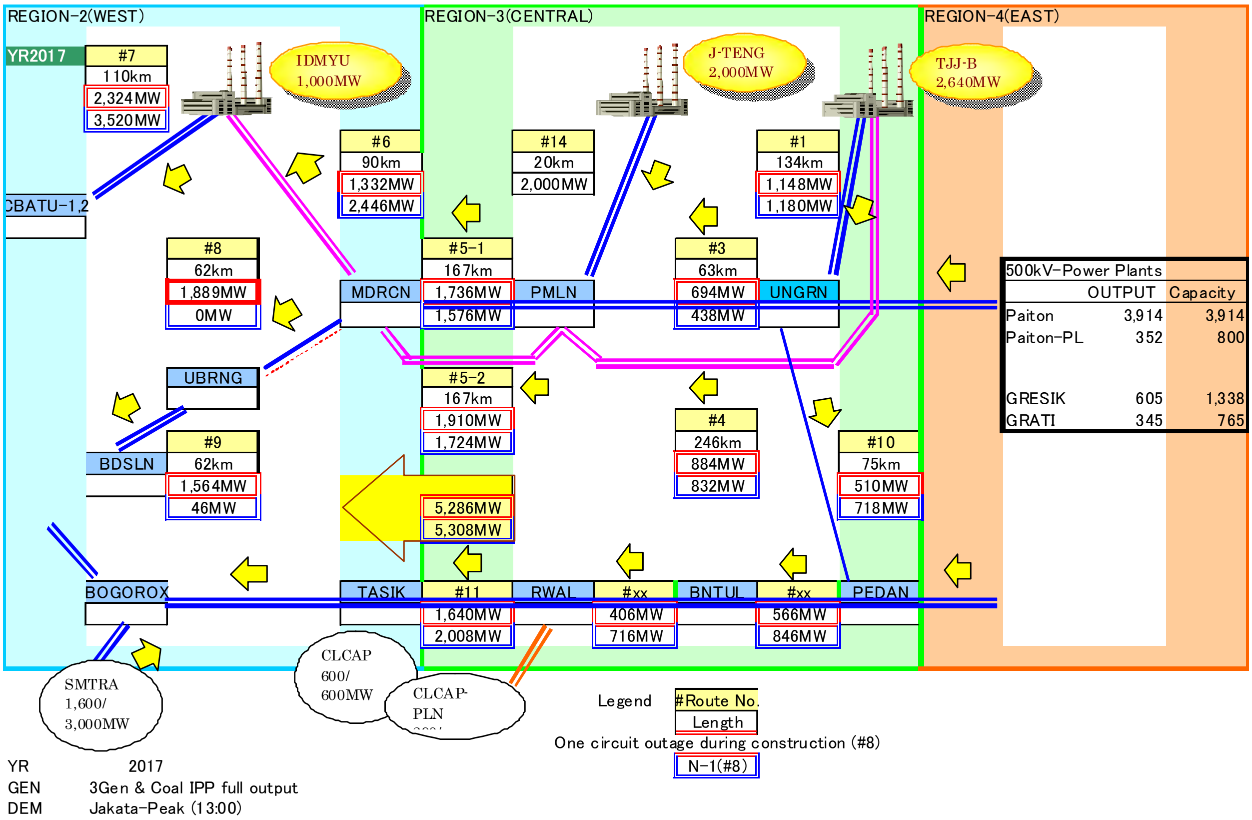


Figure 3. 35 Power Flow Analysis (0 Unit under Operation at Indramayu Power Plant. YR 2015)

(2) CASE 2: 1 Unit of Indramayu power plant is in operation

(a) Approach

An N-1 test has been conducted for one circuit of the section between MDRCN and UBRNG, and for both circuits of the section at a time.

(b) Analysis Premise

YEAR: 2017

DEMAND: Jakarta Peak Time (around 1:00 pm)

GENERATION: Maximum output from the relevant 3 power plants and all coal-fired IPP power plants. The remaining power plants generate power evenly.

(c) Finding

Different from CASE 1 (the case without any operated unit at Indramayu power plant), the remaining one circuit of the section between MDRCN and UBRNG is estimated to be almost overloaded (1,889MW) constantly during the replacement construction (the other circuit of the section is on scheduled outage due to construction) (Table 3. 34 and Figure 3. 36).

Table 3. 34 Power Flow at the evaluation Sections [Unit: MW]

N-1 Section	#8)MDRCN-UBRNG	#9)UBRNG-BDSLN	#6)MDRCN-IDMYU	#7)IDMYU-CBATU
1. MDRCN-UBRNG#1	1,889x1	804x2	604x2	1,105x2
2. MDRCN-UBRNG#1,2	0	30x2	1,162x2	1,648x2
Thermal Capacity [MVA]	1,984/cct	1,984/cct	2,612/cct	2,612/cct

In the case of an N-1 accident (both circuits are down) during construction, however, there would be no overloaded section in the Java-Bali 500 kV System. Figure 3. 36 shows that the figures in the cell surrounded by blue-colored double lines show the power flow amount during a complete route outage (N-1) of the section between MDRCN and UBRNG.

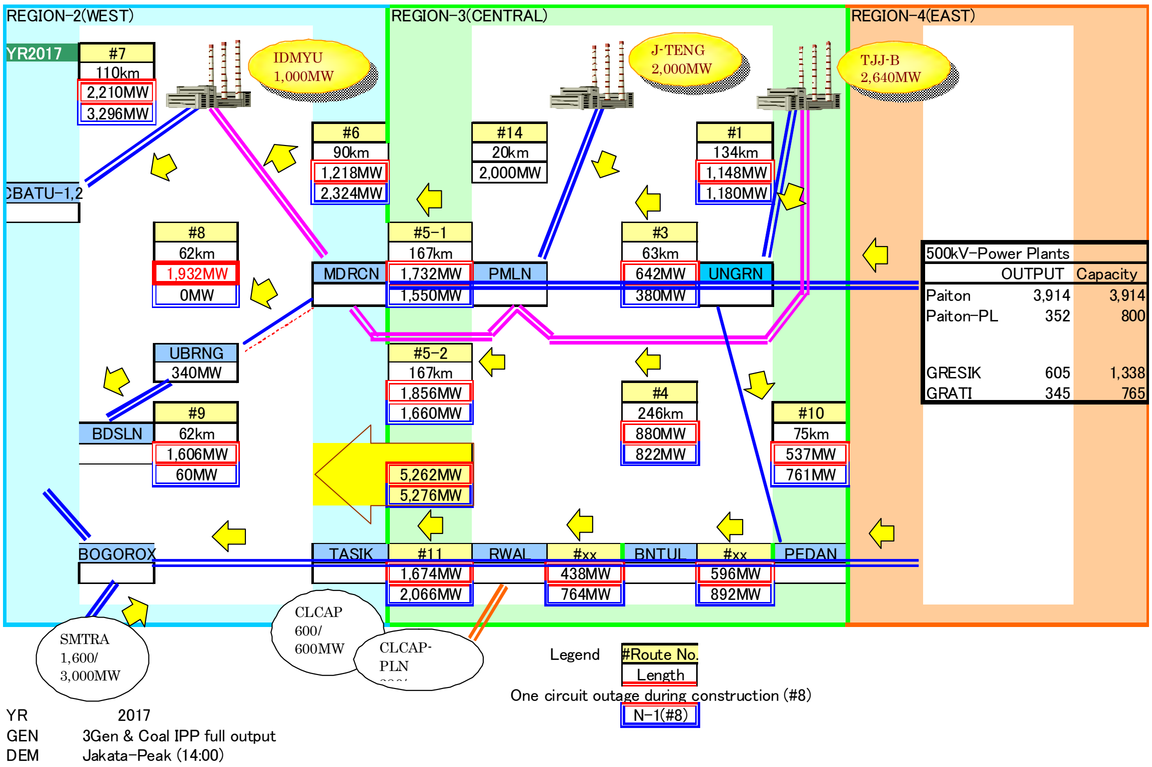


Figure 3. 36 Power Flow Analysis (1 Unit under Operation at Indramayu Power Plant. YR 2017

(3) Conclusion

This section analyzed those cases to replace existing lines with the larger-capacity line for the section between MDRCN and UBRNG in order to solve the problem raised in the aforementioned section, assuming that the transmission section between IDMYU and CBATU is commissioned in 2015. The main objective is to secure the supply reliability during the construction because one circuit of the targeted transmission section is open during the construction period. The analysis found that the reliability can be secured when there are no units operating at Indramayu power plant (Year 2015), though the reliability might not be secured when 1 unit of the plant is operated (year 2017). Based on those findings, it is recommended to finish the replacement construction for one circuit of the section before the commissioning of the first unit of the Indramayu power plant. This would enable the replacement construction for the other circuit even after the commissioning of the first unit of the plant, because the new conductor's thermal capacity can afford the power flow in the case of an N-1 accident. For these reasons, the overload issue of the section between MDRCN and UBRNG is expected to be solved by replacing one circuit of the section with a larger-capacity conductor before the commissioning of the first unit of the Indramayu power plant in 2017.

3.6.5 Transmission Loss

For the cost-benefit analysis shown later in this report, the transmission loss of the total Java-Bali system has been calculated for those cases with the Project's line and for those cases without the Project's line. Table 3. 35 summarizes the results.

Table 3. 35 Transmission Loss [MW]

	Jakarta Peak		Off-peak	
	W/ PJ	W/O PJ	W/ PJ	W/O PJ
YR2015				
PG:	23,538.4	23,389.6	14,724.9	14,701.4
PL:	23,047.5	22,795.4	14,554.4	14,510.3
Loss:	490.9	594.2	170.5	191.1
(Loss rate)	2.09%	2.54%	1.2%	1.3%
YR 2017				
PG:	27,088.7	26,938.1	17,010.7	17,004.8
PL:	26,495.7	26,253.4	16,782.9	16,754.6
Loss:	593.0	684.7	227.8	250.2
(Loss rate)	2.18%	2.53%	1.3%	1.5%
YR 2020				
PG:	32,664.1	32,293.7	23,776.2	23,752.2
PL:	31,487.2	31,197.4	23,298.7	23,257.0
Loss:	921.9	1,011.5	477.5	495.3
(Loss rate)	2.82%	3.13%	2.0%	2.1%

3.6.6 Low Voltage Issue

(1) System Voltage

According to P3B's design criteria, the system voltage should be maintained within the following limits:

Table 3. 36 Allowable Range of Voltage

Nominal Voltage	Allowable Range (Normal Operation Condition)	Allowable Range (Emergency Operation Condition)
500kV	95% ≦ V ≦ 105%	90% ≦ V ≦ 110%
150kV	90% ≦ V ≦ 105%	90% ≦ V ≦ 110%
70kV	90% ≦ V ≦ 105%	90% ≦ V ≦ 110%

(Source: "PLN Planning and Operation Criteria", P3B)

The Power flow analysis results tells us that the calculated voltage at most 500kV Substations are under the upper limit of the allowable range, while the voltage at some 500 kV Substations are below the lower limit of the allowable range. Given that this tendency does not change between the case with the Project line and the one without the Project line, this issue should be addressed besides the development of the Project's transmission line.

3.6.7 Findings and Conclusions

- Without the transmission line from the Indramayu power plant to Cibatu substation in and after 2015, the two sections from Mandirancan substation to Bandung Selatan substation via Ujung Berung substation would be overloaded in the case of an N-1 accident. In order to avoid such a situation, the total output of the coal-fired thermal power plants in the Central and East Area needs to be reduced by more than 1,200 MW.
- After the year 2020, the COD of the Indramayu thermal power plant (2 units), the section between Mandirancan substation and Ujung Berung substation would be overloaded in the case of an N-1 accident. It would, however, not be necessary to increase the transmission capacity of the section, as there would turn out to be no overloaded section in the Java-Bali System due to the other circuit trips by means of the OCR (Over Current Relay)'s operation. The only thing to be taken care of is to confirm the setting of the relay. Furthermore, it would be necessary to keep open the 150 kV circuits near Ujung Berung substation as the same section of the 150 kV network would be overloaded during the event (N-2).
    - For reference, in case of the increasing the capacity of the section, one circuit of the section in a scheduled outage during the construction period. The section would be stable in year 2015 when no units of Indramayu power plant are in operation, but would be overloaded during and after year 2017 when one unit of the plant is in operation. Therefore, in order to secure the supply reliability, it is recommended to complete the replacement of one circuit before the commission of the plant's one unit (before year 2017).

3.7 Design of Shunt Reactor at Pemalang Substation

This section analyzes the necessity of the Shunt reactors at Pemalang Substation. As shown in Figure 3. 37, there seems to be no significant problem during the heavy load in year 2017, while the generators at Tanjung Jati B Power station absorbs reactive power from the transmission line in connection to the PMLNG Substation during the light load time (approximately 110 MVar/ unit). This might be partly because the length of the line stretches for a long distance, thus increasing the charge amount. In a worst case scenario– three units out of four would be out of service at Tanjung Jati B Power station – the total reactive power could flow into the remaining unit, causing severe damage to it, if the transmission line trips due to any faults while a small number of units are operated. Therefore, it is essential to place the shunt reactors at Pemalang Substation to prevent such a consequence.

(1) Before Shunt Reactor installation

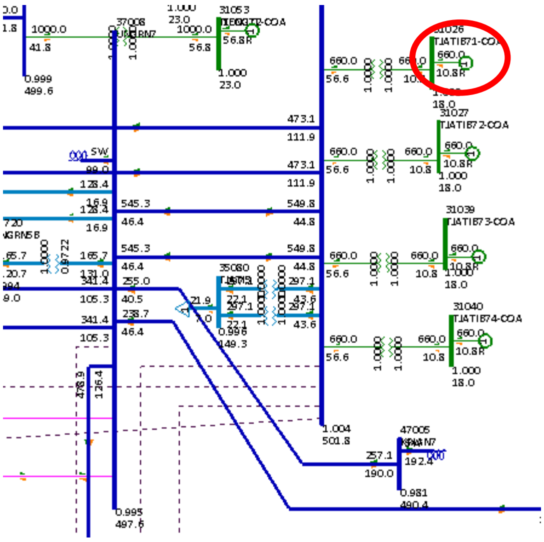


Figure 3. 37 During Jakarta Peak Time (Heavy Load) in YR 2017

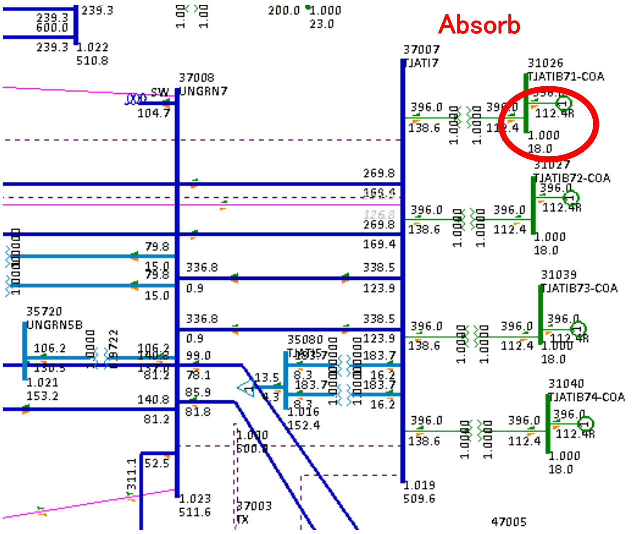


Figure 3. 38 During Light Load in YR 2017

According to Indonesia's grid code, the shunt reactors are to be placed directly at one end of the transmission line. The appropriate capacity of the shunt reactors would be calculated in the following manner. Firstly, the value of "b" or the charge amount for the ZEBRA line is 0.01095 [pu/km]. The necessary capacity for the transmission line between the Tanjung Jati B power station and Pemelang Substation is

0.01095 [pu/km] x 246 [km] = 2.694 p.u. (equivalent to 269.4 MVar)

269.4 MVar x 60% = 161.6 MVar

Therefore, the standard capacity of P3B, 200 MVar, would be appropriate for this purpose. For the line between Pemalang Substation and Mandirancan Substation, the capacity is calculated as follows:

0.01095 [pu/km] x 167 [km] = 1.83 p.u. (equivalent to 182.9 MVar)

182.9 MVar x 60% = 109.7 MVar

Therefore, the standard capacity of P3B, 100 MVar, would be appropriate for this purpose.

(2) After the installation of the Shunt Reactors at Pemelang Substation

Figure 3. 39 shows the power flow analysis results after placing the shunt reactors at Pemalang Substation. As seen, the amount of reactive power absorbed by the generators at Tanjung Jati B power station has been reduced.

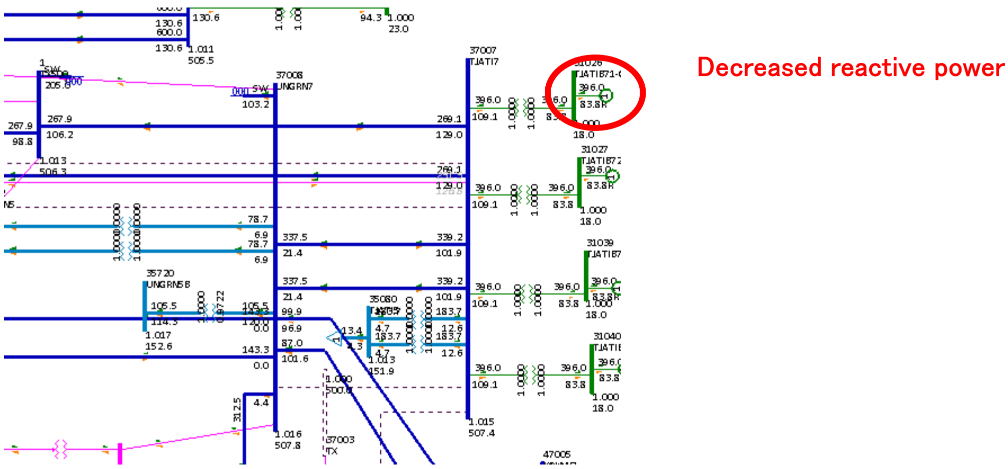


Figure 3. 39 During Light Load (YR 2017) after Installation of Shunt Reactors at Pemalang Substation

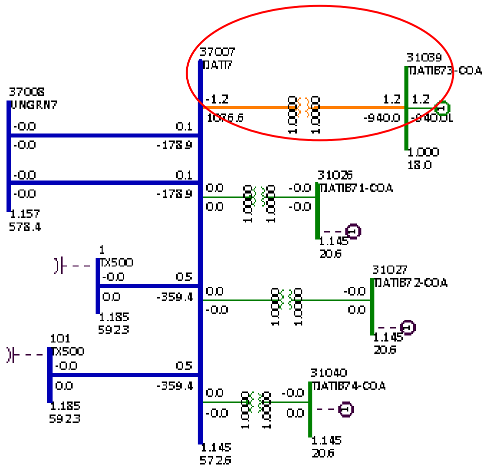
For reference, it would also be possible to address this reactive power issue from an operational perspective. Increasing the voltage at the power station would be effective to reduce the amount of reactive power absorbed by generators. In this case, the voltage can be increased to up to 5 % of its base value in general.

(3) For the design of the Project

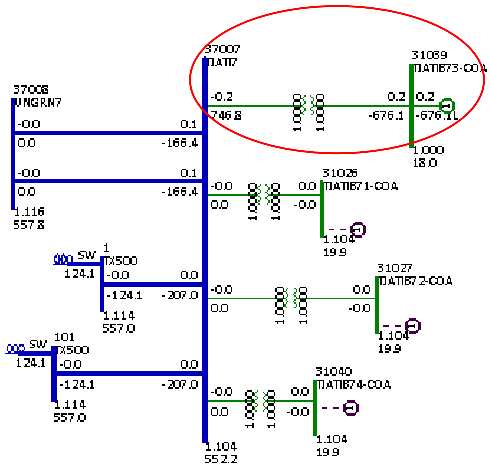
For the Project, however, the design of reactors at Pemalang Substation is set in the following manner, reflecting the comment from the counterpart:

- A reactor with the capacity of 100 MVar/ cct will be placed to the transmission line connecting Pemalang Substation and Tanjung Jati B Power Station.
- No reactor will be placed to the line connecting Pemalang Substation and Mandirancan Substation.

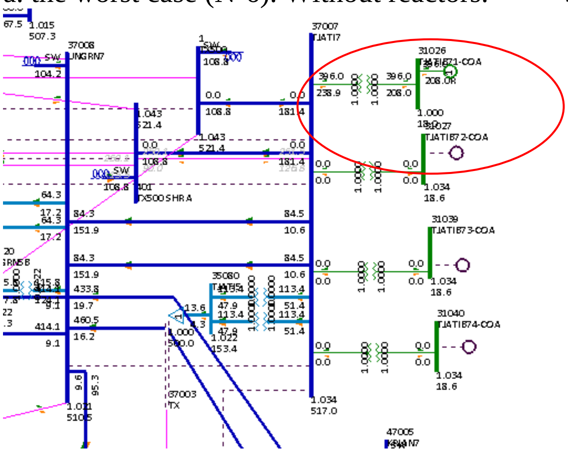
According to the counterpart, the design is in accordance with PLN’s design policy including the country’s grid code. According to their policy, the transmission lines longer than 200 km are to be eqquipped with line reactors with the capacity of 200 MVar/cct. Further, the grid code defines the extreme case as N-2 accident. To confirm that there would be no significant influence to the facilities if the above design is adopted, the Study Team conducted simulation for two cases under the designed condition: 1) N-2 accident, 2) the worst case (N-6). Figure 3. 40 shows the result.



a. the worst case (N-6). Without reactors.



b. the worst case (N-6). With reactors of 100MVar/cct.



c. N-2. With reactors of 100MVar/cct (Light load)

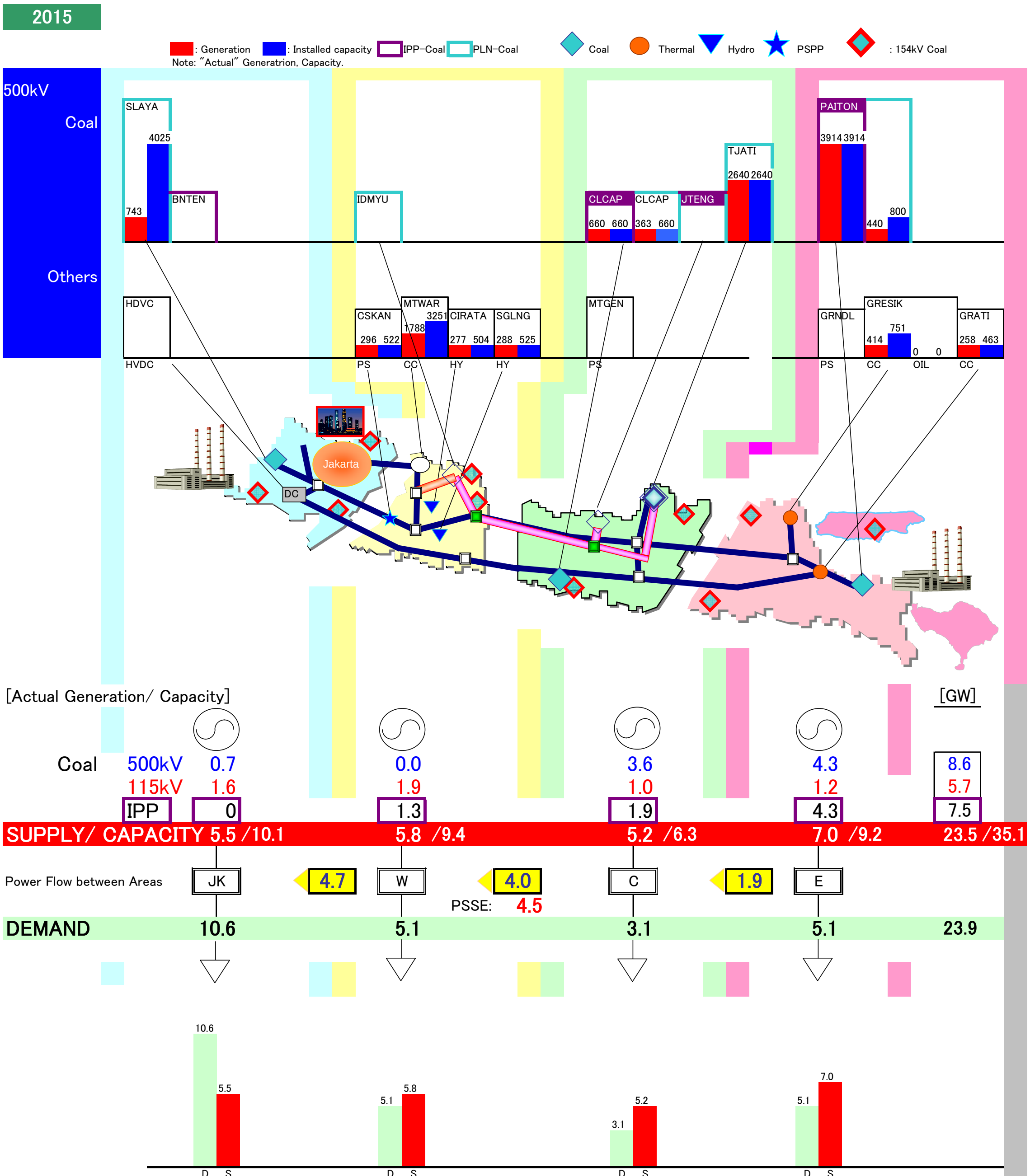
Note.
The definition of 'N-2' is the status which disconnects the 500 kV transmission lines with the section between Pemalang Substation and Tanjung Jati B Power Station, while the definition of 'N-6' is the status which disconnects the 500 kV transmission lines with the section between Pemalang Substation and Tanjung Jati B Power Station and with the section between Ungaran Substation and Tanjung Jati B Power Station, and the secondary lines of transformers at Tanjung Jati B Power Station. For both definition, three units of Tanjung Jati B Power Station (Unit 2 to 4) are out of service.

Figure 3. 40 Simulation Result on Reactors

As seen in the above, different from the worst case seen in a. (reactive power absorbed by the generator #1 is estimated as 940 MVar, exceeding the upper limit of the generator facility), N-2 case seen in c. would not be likely to make damage to the generators at Tanjung Jati B Power Station (reactive power absorbed by the generator #1 is estimated less than 208 MVar). Therefore, it is concluded that the design of reactors at Pemalang Substation which is set as shown above (100 MVar/cct x 2 to the transmission line connecting Pemalang Substation and Tanjung Jati B Power Station) would be appropriate for the Project.

Map of Power Plants in Java Bali System

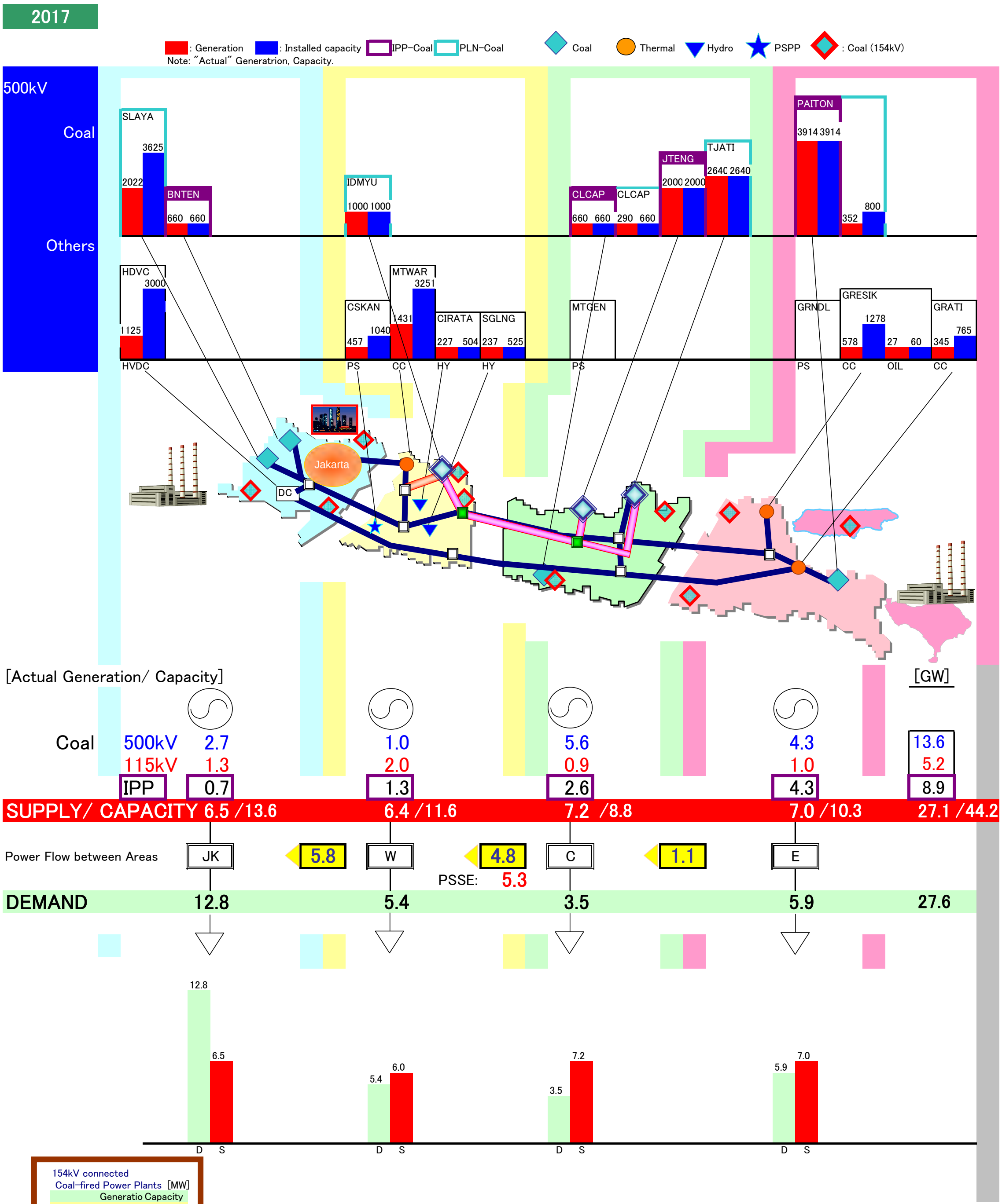
Below are rough images of the power output of the major power plants during Jakarta Peak time.



154kV connected
Coal-fired Power Plants [MW]

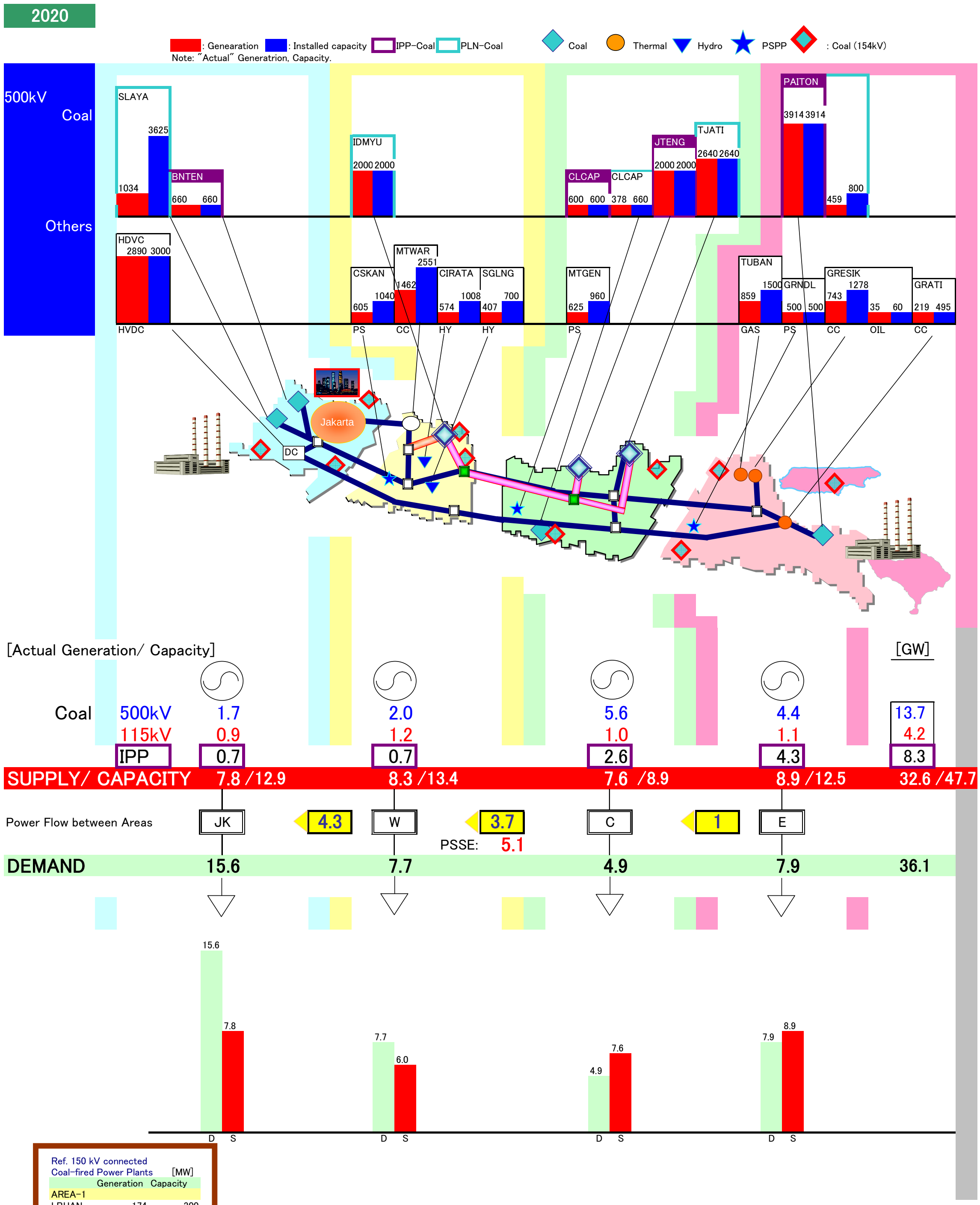
	Generatio	Capacity
AREA-1		
LBUAN	331	600
TNAGA	888	1605
PRATU	385	700
AREA-2		
IDMYU	544	990
CRBON	1320	1320
AREA-3		
CLCAP	660	660
RMBNG	354	630
AREA-4		
PTCAN	346	630
TJWAR	385	700
MDURA	400	400

2017



154kV connected
Coal-fired Power Plants [MW]

	Generatio	Capacity
AREA-1		
LBUAN	264	600
TNAGA	707	1605
PRATU	308	700
AREA-2		
IDMYU	726	990
CRBON	1320	1320
AREA-3		
CLCAP	600	600
RMBNG	285	630
AREA-4		
PTCAN	277	630
TJWAR	308	700
MDURA	400	400



Ref. 150 kV connected Coal-fired Power Plants [MW]	Generation	Capacity
AREA-1		
LBUAN	174	300
TNAGA	366	630
PRATU	407	700
AREA-2		
IDMYU	568	990
CRBON	1,320	1,320
AREA-3		
CLCAP	660	660
RMBNG	366	630
AREA-4		
PTCAN	361	630
TJWAR	400	700
MDURA	400	400

Chapter 4 Selection of the Optimal Transmission Line Route and Geological Survey

4.1 Scope of the Project

4.1.1 Transmission Line

The scope of works for the Project is shown in Table 4. 1.

Table 4. 1 Target Transmission Lines of the Project

Items	Sections	Length
500 kV Transmission Line 2 circuits, 4*Zebra	Tx (Ungaran – Pedan) – Pemalang SS	86.1 km
	Pemalang SS – Mandirancan SS	166.9 km
	Mandirancan SS – Indramayu P/S	89.6 km
150 kV Transmission Line 2 circuits, 2*TACSR 410	Pemalang SS – Inc 2 Pi (Batang – Weleri)	2.0 km

4.1.2 Substation Facilities

The scope of work for the Project is described below.

(1) Construction of new Pemalang S/S

(a) Cleaning of trees and other vegetation from the complete substation area and cutting, filling, leveling and compacting of the 150kV substation area (500kV substation area and common area lies outside of the scope)

(b) Installation of two 500/150 kV 500 MVA main transformers and two 150/20 kV 60 MVA transformers

(c) Installation of two 500 kV 100 MVA reactors

(d) Construction of a 500 kV outdoor switchyard (Extension)

- Installation of four 500 kV transmission line bays (A TL bay consists of a 1.5 set of circuit breakers, 3 sets of disconnecting switches, 1 set of a disconnecting switch with an earthing switch, 2 sets of current transformers, 2 sets of capacitor voltage transformers and 1 set of surge arresters.)
- Installation of two 500 kV main transformer bays (A TL bay consists of a 1.5 set of circuit breakers, 3 sets of disconnecting switches, 1 set of a disconnecting switch with an earthing switch, 2 sets of current transformers and 1 set of surge arresters.)
- 500kV busbars including supporting structures, tubular busbars, two sets of earthing switches and two sets of capacitor voltage transformers, etc.

(e) Construction of a 150 kV outdoor switchyard

- Installation of four 150 kV transmission line bays (A TL bay consists of 1 set of circuit breakers, 4 sets of disconnecting switches, 1 set of a disconnecting switch with an earthing switch, 1 set of current transformers, 1 set of capacitor voltage transformers and 1 set of surge arresters.)
- Installation of two 150 kV transformer bays (A TL bay consists of 1 set of circuit breakers, 2 sets of disconnecting switches, 1 set of disconnecting switch with earthing switch, 1 set of current transformers, 1 set of capacitor voltage transformers and 1 set of surge arresters.)
- Installation of one 115 kV bus-tie bay (A bus-tie bay consists of 1 set of circuit breakers and 2 sets of disconnecting switches.)
- Installation of four 150 kV buses (A bus consists of 1 bus bar, 1 set of earthing switches and 1 set of capacitor voltage transformers.)
- 150kV busbars including supporting structures, tubular busbars, two sets of earthing switches and two sets of capacitor voltage transformers, etc.

(2) Expansion of Mandirancan S/S

(a) Expansion of 500 kV outdoor switchyard

- Installation of two 500 kV transmission line bays (A TL bay consists of a 1.5 set of circuit breakers, 3 sets of disconnecting switches, 1 set of disconnecting switches with earthing switch, 2 sets of current transformers, 2 sets of capacitor voltage transformers and 1 set of surge arresters.)

(b) Reinforce of busbars and expansion of gantries of 500 kV outdoor switchyard

(3) Expansion of Indramayu S/S

(a) Expansion of 500 kV outdoor switchyard

- Installation of four 500 kV transmission line bays (A TL bay consists of a 1.5 set of circuit breakers, 3 sets of disconnecting switches, 1 set of disconnecting switch with earthing switch, 2 sets of current transformers, 2 sets of capacitor voltage transformers and 1 set of surge arresters.)

Table 4. 2 Target Substations and Main Facilities of the Project

Location	New/Ext.	Outline of the Facilities
Pemalang	New	500 kV, 4 circuits, CB: 10 sets Tr.500/150kV: 2 units (2*500 MVA)
		150 kV, 4 circuits, Tr.150kV/20kV: 2 units (2*60 MVA)
Mandirancan	Extension	500 kV, 4 circuits, CB: 6 sets, Reinforce of busbars
Indramayu	Extension	500 kV, 2 circuits, CB: 2 sets

4.1.3 Items to be considered for the Transmission Line Route Selection

As of September 2011 when the study team conducted the 2nd site survey, regarding the target section of the Project, route survey/selection between Tx (Ungaran – Pedan) and Mandirancan SS has already been conducted but the route survey between Mandirancan SS and Indramayu P/S has not. The study team confirmed that the candidate site for Pemalang SS would be switched from PLN's originally selected location to the IPP proposed location through discussion with PLN after the 2nd site survey. Therefore, the survey results on the originally selected route by PLN are described in this report.

Furthermore, because the additional survey regarding the alternative route between Tx and Mandirancan SS associated with the switch of the Pemalang SS candidate site as well as the route between the Mandirancan SS and Indramayu P/S will be implemented by PLN by December 2011, the study team will conclusively review and evaluate the route selected by PLN and consider alternatives if necessary based on the survey report of PLN in this study.

The following items will be considered for the transmission line route review and evaluation especially:

- Land usage of tower sites
- Geography and geological condition of the expected route
- Considerable crossing points such as national roads, existing transmission lines and large rivers
- Land compensation for crossing and access to buildings and other structures
- Native environment and social surroundings
- Conditions of construction (such as the difficulty level of transportation and construction)
- Economic efficiency

In addition, preparation of draft transmission line route regarding the section between Mandirancan S/S and Indramayu P/S, will provided to PLN by the Study Team to help their route selection.

4.2 Site Survey

4.2.1 Outline of the Transmission Line Route

The study team conducted a site survey between Tx (Ungaran-Pedan) and Indramayu P/S in August and September 2011. The transmission line route between Tx and Mandirancan SS selected by PLN runs parallel to the existing 500 kV transmission line through the southern flat terrain of the existing transmission line. Furthermore, the expected route between Mandirancan SS and Indramayu P/S will run through plain land such as paddy fields and general farm land.

- Tx (Ungaran-Pedan) – Mandirancan SS: 242.5 km
- Mandirancan SS – Indramayu P/S: Approx. 91.0 km
- Total Length: Approx. 333.5 km

The surveyed points in 1st and 2nd survey are shown in Table 4. 3.

Table 4. 3 Surveyed Points of the T/L Route

Suveyed Points (Tower Number)	Remarks
[1st Survey in August 2011]	
Tx & T.001	Nearby Tower No. 12 of existing 500kV T/L
T.004	Heavy angle tower
Pemalang SS candidate site	Candidate site suggested by IPP
T.172	Forest
Pemalang SS candidate site (T.148 & T.149)	Candidate site planned by PLN
T.233	River crossing
Mandirancan SS	
Indramayu P/S candidate site	
[2nd Survey in September 2011]	
Tx & T.001	Nearby No.12 tower of existing 500kV T/L
T.004, T.015, T.026, T.039, T.052, T.061, T.141	Angle tower, geological survey point
T.008, T.044, T.300	Residential area
T.080	Angle tower, river side, geological survey point
T.125	The longest span, geological survey point
Pemalang SS candidate site	Candidate site suggested by IPP
Pemalang SS candidate site (T.148 & T.149)	Candidate site planned by PLN
T.204	River crossing
T.391	Existing 150kV T/L crossing
Crossing point of existing 500kV & 150kV T/L	
[3rd Survey in December 2011]	
Pemalang SS candidate site	Candidate site suggested by IPP
T.193q - T.193t	Existing 500kV T/L & national road crossing
T.038 - T.039	Prefectural road crossing
T.089 - T.090	River crossing
T.197 - T.198	National road crossing
T.205	Paddy field
Indramayu P/S candidate site	

(1) Tx (Ungaran-Pedan) – Mandirancan SS

The planned transmission line will be connected to the transmission line between Tanjung Jati B and Tx which is under construction. Gantries for crossing the existing 1 circuit 500 kV transmission line between Ungaran and Pedan will be installed by PLN nearby the No. 12 tower of the existing transmission line and the gantries will become the demarcation point.

Furthermore, because Tanjung Jati B P/S and Tanjung Jati B – Tx line will be operated ahead of the planned transmission line, Tanjung Jati B – Tx line is planned to be connected to the existing transmission line with a π connection before the completion of the planned transmission line.

The outline of the planned transmission line route is as follows.

(a) The route runs toward the west from Tx and then runs toward the north in parallel with the existing transmission line from the T004 tower. The route then runs toward the northwest as per the existing transmission line after passing through the nearby Ungaran S/S. After that the route departs from the existing transmission line gradually and runs toward the west in parallel with the existing transmission line at approximately 7.5 km south.

(b) The route runs towards the northwest getting closer to the existing transmission line from the T113 tower gradually, and then is drawn into the south side of the new Pemalang SS from the T148 tower.

(c) The route comes out from the south side of the Pemalang S/S and runs toward the west in parallel with the existing transmission line at around several km south. After that, the route is drawn into the south side of the existing Mandirancan SS from the T564 tower.

(d) The geographical features of the proposed area are comprised of paddy fields, cultivated fields, forests and shrub lands in general, and sporadic residential areas. The south side of the proposed route is a mountainous/hilly area and would run through a hilly area from T190 to the east, however the route generally runs through flat land such as paddy fields and cultivated fields from the T190 tower and to the west.

(e) The route was selected to avoid residential areas as much as possible but the proximity of several tower sites such as T027, T049, T089, T116, T220 and T252 to nearby residences was unavoidable.

(f) The route crosses over a relatively large river at the spans such as T078 – T079, T232 – T233, T272 – T273, T275 – T276, T377 – T378 and T426 – T427.

(g) The route crosses over the existing 150 kV transmission line between T391 and T392.

(h) There is no crossing over the national roads and express ways.

(2) Mandirancan S/S – Indramayu P/S

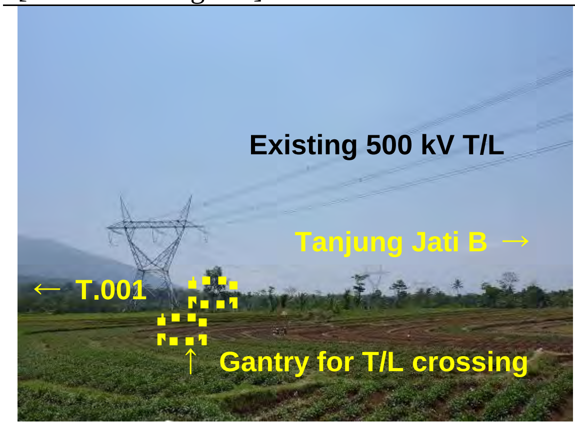
Regarding the outline of the route between Mandirancan S/S and Indramayu P/S, the brief overview of the area is as follows;

(a) The geographical features of the proposed route are mainly paddy fields and cultivated fields dotted with residential areas.

(b) There is no crossing over the national roads and express ways.

The circumstances of the surveyed points are as follows.

[Tx – Pemalang S/S]

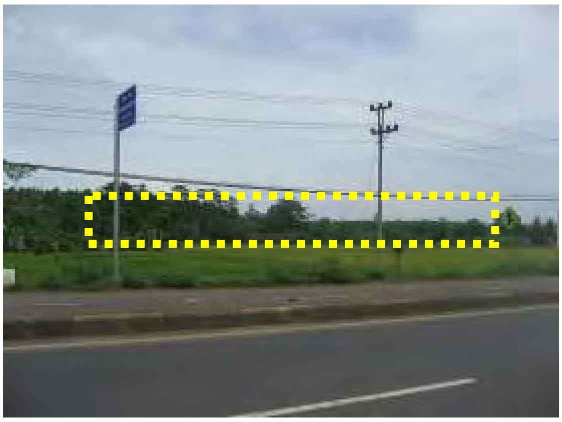


Tx (Ungaran – Pedan)

T.004 tower site (heavy angle)

T.008 tower site

T.080 tower site (river location)



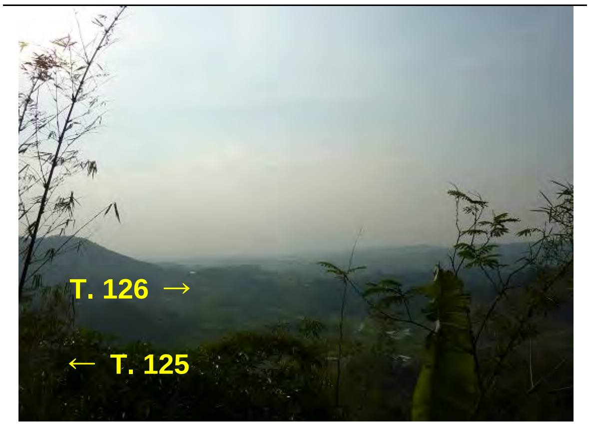
North side of national road for Pemalang S/S candidate site

South side of national road for alternative site for Pemalang S/S

Tower sites for national road crossing near Pemalang S/S candidate site

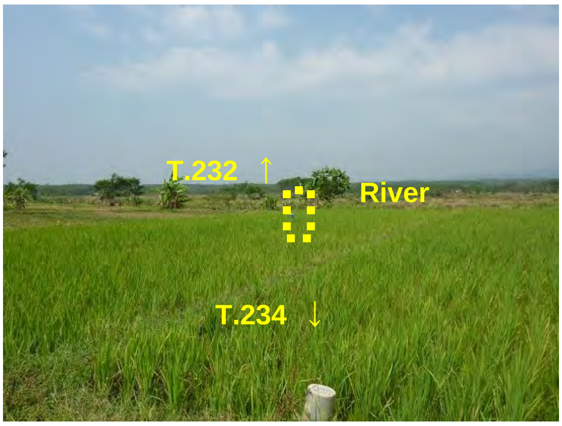
[Pemalang S/S – Mandirancan S/S]

Existing 115kV T/L nearby Pemalang S/S candidata site



The longest span between T.125 and T.126

River crossing between T.203 and T.204

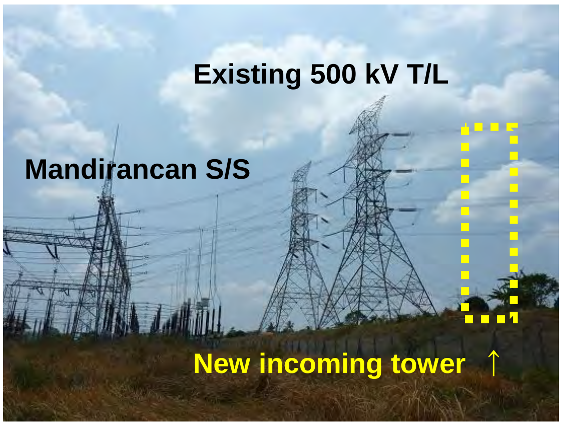


River crossing between T.232 and T.233

Residences around T.300 Tower site

Crossing of existing 150 kV & 500 kV T/L

Existing 150 kV T/L crossing between T.391 and T.392



Incoming tower to Mandirancan SS

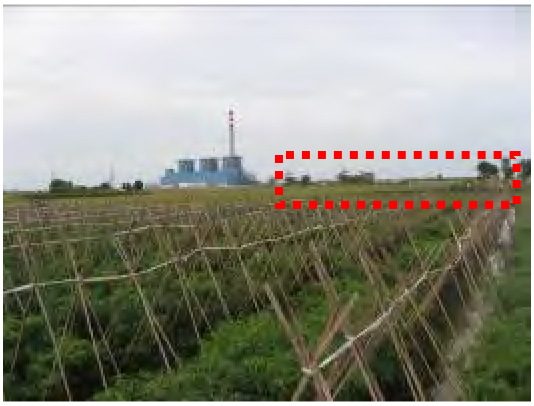
[Mandirancan S/S – Indramayu P/S]

Prefectural road crossing between T.038 and T.039 (crossing parallel with the existing 150 kV T/L)

River crossing between T.089 and T.090


National road crossing between T.197 and T.198


T.205 tower site


Indramayu P/S site

4.2.2 Outline of the Substation Facilities

(1) New Pemalang S/S

As shown in Figure 4. 1, the planned site for the new 500 kV Pemalang S/S is located north of the National Route (Jakarta-Surabaya) (lat.06°56′50″S long.109°48′05″E 107 meters above sea-level) and near the existing 500kV transmission line.

The planned site is a coconut plantation zone with about 1% of the vertical interval. The scope of this study is only a 150kV area. The 500kV area is built by another project (IPP project). The IPP project also including land acquisition, development, and common equipment (control rooms, batteries, etc.) is due to build 500 kV equipment. PLN has not acquired the land yet, but land acquisition has been confirmed orally.

Figure 4. 1 Location of New Pemalang S/S

(2) Mandirancan S/S

The existing Mandirancan S/S commenced operations in 1997. As shown in Figure 4. 2, Mandirancan S/S is located on a hillside approximately 15 km south-west of Cirebon City (lat. 06°49′09″S long. 109°56′41″E 338 meters above sea-level).

The main existing facilities are four diameters for the 500kV transmission line, two main transformers (500kV/150kV 500MVA) and four 150kV transmission bays.

The Project plans to install two diameters for the 500kV transmission line to Pemalang S/S and Indramayu S/S. The present land space for the substation is sufficient to fulfill such plans with the space for the control room also being sufficient to install the necessary control panels. Therefore, extension of the land space is not necessary under the Project.

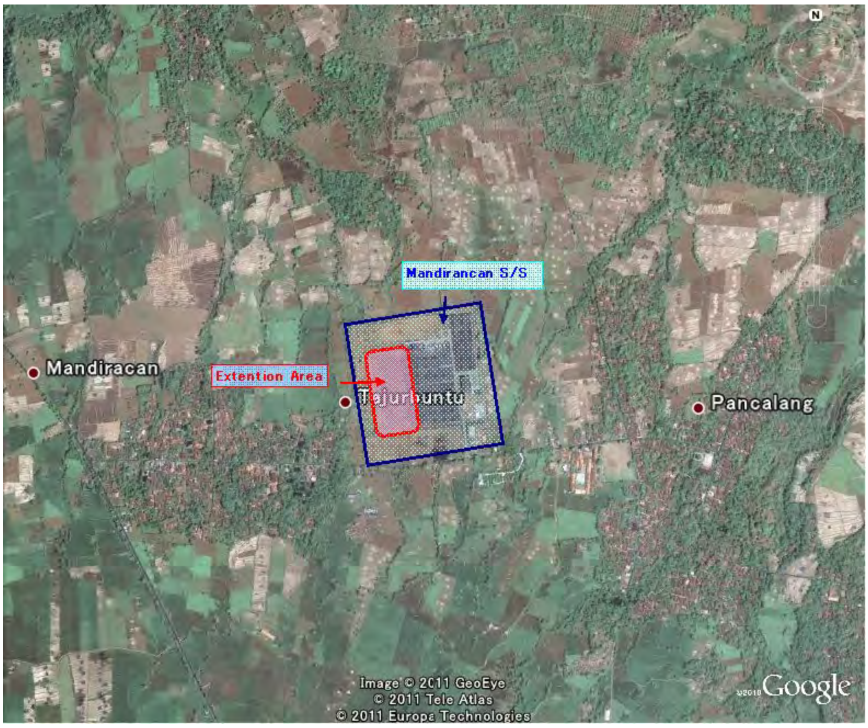


Figure 4. 2 Location of Mandirancan S/S

(3) Indramayu S/S

The planned site for new 500 kV Indramayu S/S is located 1 km north of the National Route (Jakarta-Surabaya) inside of Indramayu P/S consisting of a paddy field and flat land.

The Project plans to install two diameters for the 500kV transmission line to Mandirancan S/S. The planned land space for Indramayu P/S is wide enough to secure two additional diameters for Indramayu S/S. Therefore, the extension of land space to install them is not necessary under the Project.

4.3 Optimal Transmission Line Route

The overall transmission line route between Tx and Mandirancan S/S selected by PLN is shown in Figure 4. 3 and the more detailed route maps prepared by PLN are attached as Appendix I.

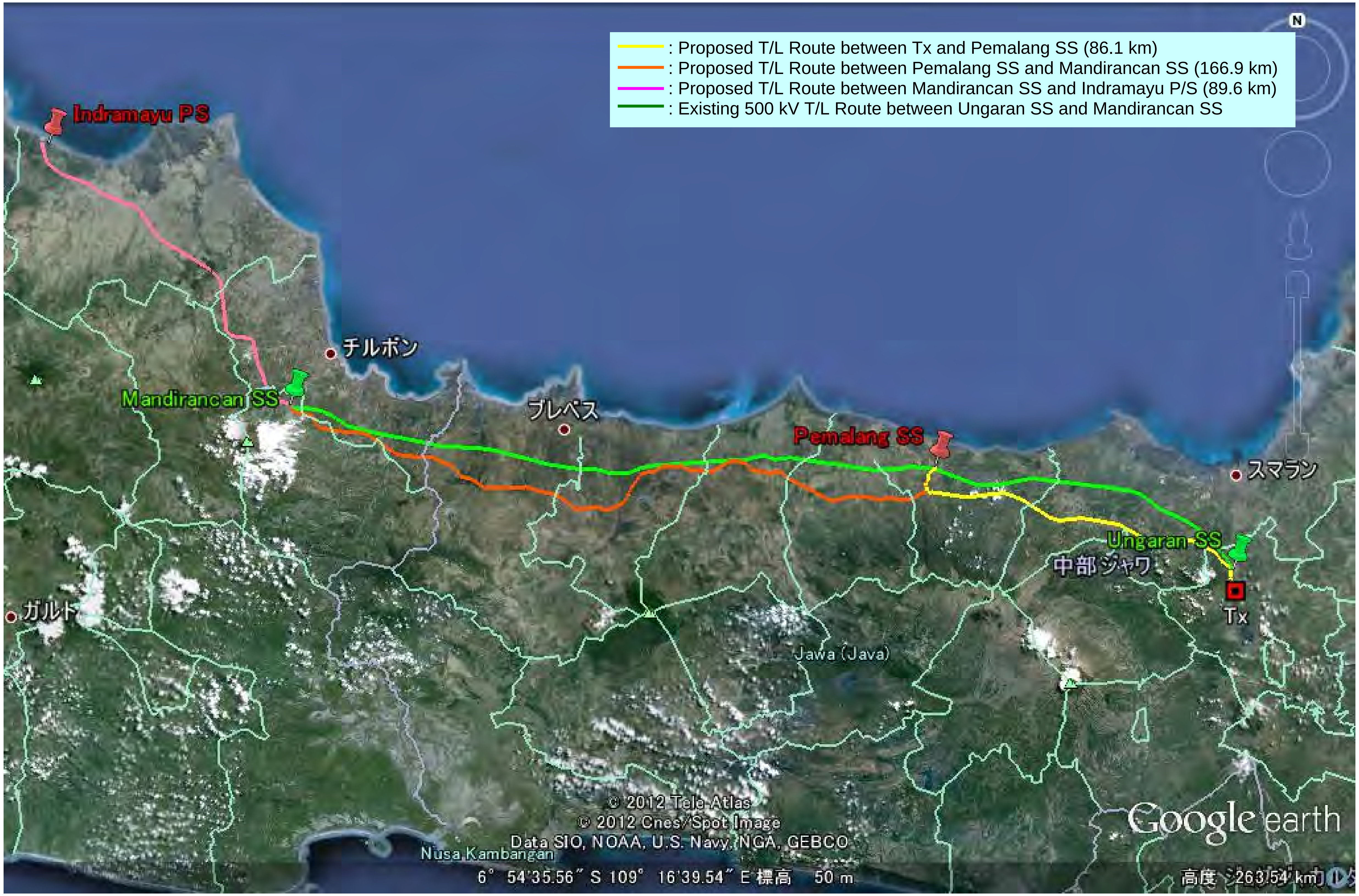


Figure 4. 3 T/L Route between Tx (Ungaran-Pedan) and Mandirancan S/S

4.4 Geological Survey

4.4.1 Location of Soil Investigation

25 points of soil investigation works such as Dutch Cone Penetration Test (DCPT) and Seismic Refraction survey were conducted (Picture 4.1)throughout the transmission line route shown on Figure 4. 3, from Ungaran to Mandirancan and from Mandirancan to Indramayu in various regions throughout Central and West Java.

Site conditions of all the surveyed locations are shown on Table 4. 4

Photo 4.1 Site Survey Scene of DCPT(Left) and Seismic Refraction Survey(Right)

Table 4. 4 Soil Investigation Locations for Dutch Cone Penetration Test (DCPT) and Seismic Refraction Survey

	No	Tower No	Geographic Coordinates		Elevation (m)[3]	Land use	Remarks (tower condition and reason of selection)
			Latitude (S)	Longitude (E)			
Ungaran – Mandirancan	1	T.004	7˚ 11’ 44.0”	110˚ 24’ 20.7”	590	Plantation	angled, representative of the mountainous area
	2	T.015	7˚ 09’ 10.3”	110˚ 24’ 08.3”	370	Paddy Field	bend, representative of the rice field area
	3	T.026	7˚ 07’ 22.6”	110˚ 22” 23.8”	530	Plantation	bend, representative of the mountainous area
	4	T.039	7˚ 05’ 58.9”	110˚ 19’ 33.8”	325	Paddy Field	bend, representative of the rice field area
	5	T.044	7˚ 05’ 59.2”	110˚ 18’ 20.3”	300	Paddy Field	representative of the rice field area
	6	T.052	7˚ 05’ 38.3”	110˚ 16’ 27.0”	250	Paddy Field	bend, representative of the rice field area
	7	T.080	7˚ 03’ 58.6”	110˚ 10’ 30.3”	65	Paddy Field	bend, rice field on the river bank
	8	T.125	7˚ 02’ 25.3”	110˚ 00’ 53.5”	320	“Melinjo”(*Gnetu mgnemon*) Field	longest span, representative of the rice field area, Edge of a hill
	9	T.141	7˚ 00’ 31.3”	109˚ 57’ 32.2”	245	Paddy Field	bend, representative of the rice field area

[3] read roughly from Google Earth

	10	T.149	6° 59 21.1	109° 56 17.20”	200	Corn Field	near Pemalang switch Yard site
	11	T.172	7° 00 38.3	109° 51 46.00”	370	Rubber Plantation	bend, representative of the gentle hilly area
	12	T.196	7° 00 05.2	109° 46 15.20”	240	Cassava Plantation	bend, representative of the hilly so-called "sawah" area
	13	T.236	7° 00’ 30.3”	109° 37’ 46.00”	40	Paddy Field	bend, representative of the semi-lowland rice field area
	14	T.257	6° 59’ 59.0”	109° 33’ 13.00”	80	Pine Forest	representative of the independent hill
	15	T.278	6° 57” 24.9”	109° 28’ 54.70”	20	Crops	bend, representative of the lowland rice field area
	16	T.429	6° 59' 16.06"	108° 57' 58.97"	15	Crops	bend, representative of the lowland rice field area
	17	T.451	6° 59' 21.79"	108° 52' 42.21"	25	Cornfield	bend, representative of the rice field area
	18	T.471	6° 56' 45.13"	108° 49' 0.52"	15	Crops	bend, representative of the lowland rice field area
	19	T.564	6° 49' 26.27"	108° 29' 02.10"	350	Cassava Plantation	representative of the rice field area
	20	S/S	6° 56’ 46.00”	109° 48’06.00”	270	Palm Plantation	Pemalang Sub-station
Mandirancan - Indramayu	1	T.043	6° 41” 16.5”	108° 24’ 29.20”	16	Paddy Field	angled, representative of rice field area
	2	T.058	6° 40” 24.2”	108° 21’ 23.30”	26	Paddy Field	angled, representative of rice field area
	3	T.085	6° 33” 55.0”	108° 20’ 26.20”	14	Paddy Field	angled, representative of rice field area
	4	T.141	6° 25” 07.3”	108° 10’ 19.60”	3	Paddy Field	angled, representative of rice field area
	5	T.194	6° 19” 30.3”	107° 59’ 01. 01”	10	Paddy Field	angled, representative of rice field area

4.4.2 Topographic, Geologic Condition through the Transmission Route and Investigation Points

Topography and geology along the Transmission Line route between Mandirancan Sub-station to Indramayu is shown in Table 4. 5. The team selected 25 points which might be representative of topographic and geologic features during the reconnaissance term. The areas of analysis to be carried out through the reconnaissance were topographic condition, surface geology expected depth of bearing layer and present land use. Furthermore, topographic profile along the T/L route between Tx and Mandirancan S/S is shown in Figure 4. 4. It is categorized by two main characteristics, namely mountainous regions and the flat plain areas. Most parts of the route lie on the northern foothill of volcanoes except Pekalongan and Cirebon area.

Table 4. 5 Topographic, Geologic Condition through the T/L Route and Investigation Points

Area	Chosen No.	TTNo.	Topographic Condition	Geology Quoted from the Quadrangle	Surface Geology	Present Land-Use
Ungaran to Mandirancan	1	4	foothills	(Qug) volcanic products Bedrock; Andesite	reddish cultivated soil	banana farm and orchard
	2	15	foothills	(Qhg) Andesite	gravel layer covered by thin silty sand	paddy on the terrace
	3	26	foothills	(Qhg) Andesite	reddish cultivated soil	rambutan orchard
	4	39	foothills	(Qhg) Andesite	cultivated soil	paddy and farm on the hilltop terrace
	5	44	foothills	(Qhg) Andesite	cultivated soil	paddy and farm on the hilltop terrace
	6	52	large valley spreading hillside	(Qhg) Andesite	boulder gravel layer covered by silty sand	water-filled paddy
	7	80	riverbank Plain	Qa; alluvium clay, silt, sand, gravel. Mainly deposits of Holocene streams. (Tmk) Tuffaceous clay	terrace deposited gravel layer covered by thin cultivated soil	paddy partially farm
	8	125	foothills	(Qpkg) Sand-clay (Qb) conglomerate put thin sandstone	conglomerate covered by thin cultivated soil	farm changed from paddy
	9	141	large valley between low hills	(Qf) Volcanics debris	cultivated soil	water-filled paddy
	10	149	foothills	(Qf) Volcanics debris	cultivated soil	
	11	172	foothills	(QTd) Tuffaceous clay-sand	reddish cultivated soil	cassava farm and orchard
	12	196	foothills	(Qj) Lava Andesite	reddish cultivated soil including huge Basalt boulders in a surface	cassava farm changed from paddy on the hilltop terrace
	13	236	plain	(Qf) Volcanics debris	boulder gravel layer covered by silty sand (2.5m thick)	dry paddy
	14	257	independent hilltop	(QTd) Tuffaceous clay-sand		details are unclear
	15	278	plain	(Qa) alluvium pebble, sand, silt and clay; as river and coastal deposits	silty sediments which estimated thicker than 5 m	dry paddy
	16	429	Plain	(Qa) alluvium pebble, sand, silt and clay; as river and coastal deposits	silty sediments	onion farm using paddy area
	17	451	plain	(Qa) alluvium pebble, sand, silt and clay; as river and coastal deposits	silty sediments	corn farm using paddy area
	18	471	plain	(Qa) alluvium pebble, sand, silt and clay; as river and coastal deposits	silty sediments	corn farm using paddy area
	19	564	foothills	(Qyu)undifferentiated young volcanic products	huge boulder gravel layer covered by silty sand	sweet potato farm using paddy area

Area	Chosen No.	TTNo.	Topographic Condition	Geology Quoted from the Quadrangle	Surface Geology	Present Land-Use
	20	S/S	foothills	(Qyu) Volcanics products	reddish cultivated soil including round pebbles in a surface	Palm garden
Mandirancan to Indramayu	21	043	foothills	(Pk) Claystone	silty sediments	Paddy Fields
	22	058	plain	(Qyu) breccia, andesitic, and basaltic lava, tuffaceous sand, lapilli	silty sediments	Paddy Fields
	23	085	plain	(Qa) clay, silt, sand, gravel. Mainly deposits of Holocene streams.	silty sediments	Paddy Fields
	24	141	plain	(Qaf) sandy-humic clay, clayey sand, partly tuffaceous.	silty sediments	Paddy Fields
	25	194	plain	(Qaf)tuffaceous clay, silts, and fine sand	silty sediments	Paddy Fields

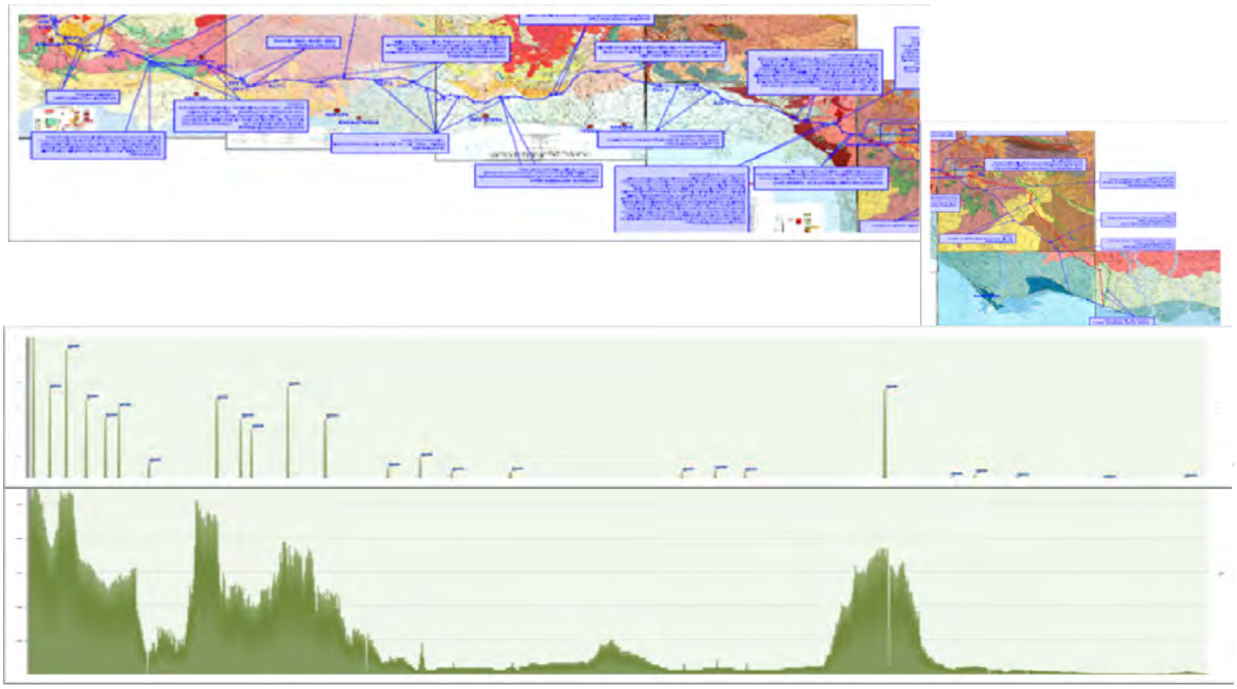


Figure 4. 4 Topographic Feature from East to West between Tx (Ungaran-Pedan) via Mandirancan S/S to Indramayu and surveyed Points with Geological Map along the T/L Route

4.4.3 Soil Investigation Result

To get the bearing capacity of the transmission tower, the Dutch Cone Penetration Test (DCPT) and seismic refraction survey were conducted on selected tower site of the Transmission line route from Ungaran to Mandirancan S/S. Figure 4. 5 shows some actual results of DCPT. The blue colored graph shows “qc (Cone Friction Resistance)”, and the red line at right side shows “FR (Friction Ratio)” on the figure.
The results such as qc, FR value description, maximum depth, soil type, and classification as per DCPT are arranged on Table 4. 6.

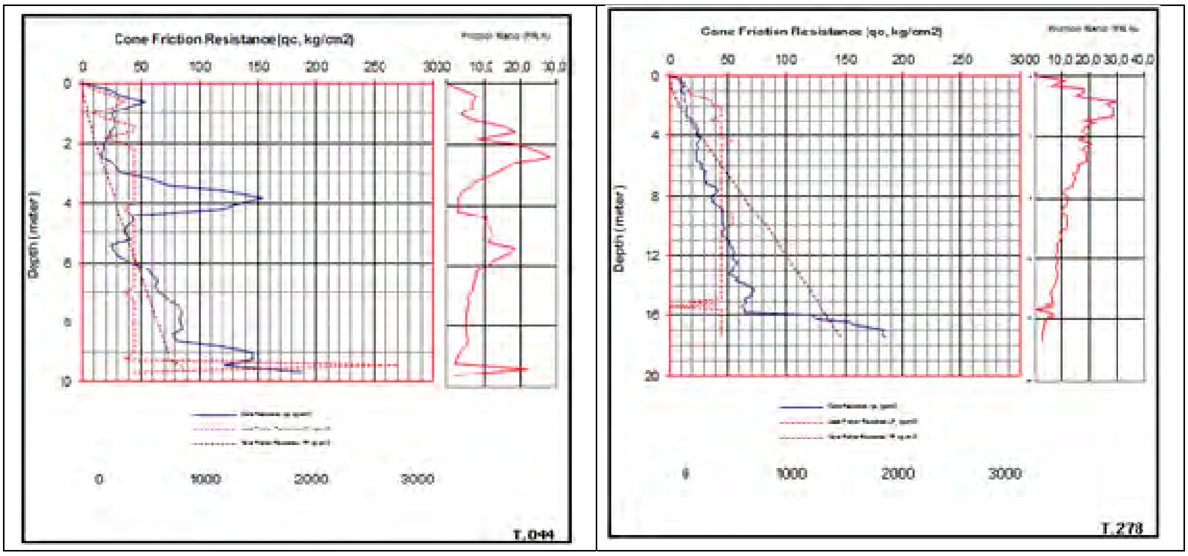


Figure 4. 5 Actual Result of DCPT at T.004 and T.278

Table 4. 6 Summary of the Dutch Cone Penetration Test (DCPT) Result

Area	No. of Towers	Depth (m)			Geological description by DCPT	qc (kgf/cm²)	FR (%)	Maximum Depth(m)
Ungaran to Mandirancan	T.004	0.0	-	2.0	Clayey-sands and silts	16	2.66	6.60
		2.0	-	5.2	Sand (medium-dense)	64	1.55	
		5.2	-	6.8	Sand (dense-very dense)	130	0.58	
	T.015	0.0	-	1.0	Clayey-sands and silts	25	2.76	6.20
		1.0	-	3.2	Sand and silty clays	20	4.18	
		3.2	-	4.6	Clayey-sands and silts (soft-firm)	58	2.34	
		4.6	-	6.2	Sandy (dense-very dense)	172	0.58	
	T.026	0.0	-	4.6	Sandy and silty clays	22	3.36	7.80
		4.6	-	6.4	Sand (medium-dense)	51	1.89	
		6.4	-	7.8	Sand (dense-very dense)	122	0.87	
	T.039	0.0	-	2.0	Clayey-sands and silts	14	2.52	9.20
		2.0	-	5.4	Sand and silty clays	21	4.07	
		5.4	-	7.8	Sand (medium-dense)	47	2.25	
		7.8	-	9.2	Sand (dense-very dense)	136	1.03	
	T.044	0.0	-	2.0	Sand (loose-medium)	29	1.99	9.60
		2.0	-	5.4	Clayey-sands and silty	57	2.48	
		5.4	-	7.8	Sand (medium-dense)	58	1.81	
		7.8	-	9.6	Sand (medium-dense)	114	1.22	
	T.052	0.0	-	2.0	Clayey-sands and silts	23	2.59	7.20
		2.0	-	3.6	Clayey-sands and silts	32	2.96	
		3.6	-	5.8	Sand (medium-dense)	57	1.70	
		5.8	-	7.2	Sand (dense-very dense)	132	0.84	
	T.080	0.0	-	1.0	Clays	5	6.96	5.40
		1.0	-	2.6	Clayey-sands and silts	19	2.45	
		2.6	-	4.4	Sand (medium-dense)	98	1.12	
		4.4	-	5.4	Sand (dense-very dense)	122	0.83	
	T.125	0.0	-	1.2	Sandy and silty clays	21	3.93	2.80
		1.2	-	2.0	Sand (medium-dense)	64	1.94	
		2.0	-	2.8	Sand (dense-very dense)	138	0.58	
	T.141	0.0	-	1.2	Clay (very soft-soft)	6	3.55	7.00
		1.2	-	3.4	Clayey-sands and silts	14	2.72	
		3.4	-	5.8	Sandy and silty clays	16	3.88	
		5.8	-	7.0	Sand (medium-dense)	80	1.47	
	T.149	0.0	-	2.0	Sandy and silty clays	16	3.71	9.60
		2.0	-	5.4	Clayey-sands and silty	34	3.05	
		5.4	-	8.2	Sand (medium-dense)	64	1.15	
		8.2	-	9.6	Sand (dense-very dense)	130	0.75	
	T.172	0.0	-	3.0	Sandy and silty clays	18	3.97	12.40
		3.0	-	6.0	Sandy and silty clays	24	3.74	
		6.0	-	8.6	Sandy and silty clays	25	3.82	

		8.6	-	10.8	Sand (medium-dense)	71	1.26	
		10.8	-	12.4	Sand (dense-very dense)	141	0.67	
	T.196	0.0	-	3.0	Sandy and silty clays	21	3.56	14.60
		3.0	-	6.0	Sandy and silty clays	23	4.02	
		6.0	-	8.6	Sandy and silty clays	30	3.04	
		8.6	-	11.0	Sand (medium-dense)	44	2.10	
		11.0	-	13.0	Sand (medium-dense)	106	0.94	
		13.0	-	14.6	Sand (dense-very dense)	169	0.54	
	T.236	0.0	-	1.8	Clay (very soft-soft)	13	4.32	3.80
		1.8	-	2.6	Clayey sands and silts	45	2.77	
		2.6	-	3.8	Sand (medium-dense)	117	1.15	
	T.257	0.0	-	2.0	Sandy and silty clays	12	3.23	4.60
		2.0	-	3.8	Clayey sands and silts	50	2.27	
		3.8	-	4.6	Sand (dense-very dense)	135	0.71	
	T.278	0.0	-	3.0	Clay (very soft-soft)	14	4.08	17.40
		3.0	-	6.0	Sandy and silty clays	25	3.71	
		6.0	-	11.0	Clayey sands and silts	40	2.38	
		11.0	-	13.6	Sand (medium-dense)	55	1.65	
		13.6	-	15.8	Sand (medium-dense)	65	1.32	
		15.8	-	17.4	Sand (dense-very dense)	150	0.67	
	T.429	0.0	-	2.2	Clayey sands and silts	11	2.26	15.80
		2.2	-	5.0	Sandy and silty clays	20	4.13	
		5.0	-	8.6	Clayey sands and silts	37	2.48	
		8.6	-	13.0	Sand (medium-dense)	60	1.5	
		13.0	-	15.8	Sand (dense-very dense)	149	0.63	
	T.451	0.0	-	3.0	Sandy and silty clays	15	3.41	7.80
		3.0	-	5.0	Sand (medium-dense)	53	3.16	
		5.0	-	6.4	Sand (medium-dense)	99	1.32	
		6.4	-	7.8	Sand (dense-very dense)	180	0.64	
	T.471	0.0	-	3.0	Sandy and silty clays	18	3.35	9.20
		3.0	-	6.0	Clayey sands and silts	30	2.88	
		6.0	-	8.2	Sand (medium-dense)	59	1.63	
		8.2	-	9.2	Sand (dense-very dense)	134	0.74	
	T.564	0.0	-	2.8	Sandy and silty clays	15	3.62	5.60
		2.8	-	4.0	Sand (medium-dense)	58	1.77	
		4.0	-	5.6	Sand (dense-very dense)	131	0.79	
	S/S Pemalang	0.0	-	2.0	Sandy and silty clays	13	3.19	14.20
		2.0	-	4.2	Sandy and silty clays	22	4.08	
		4.2	-	8.2	Clayey sands and silts	37	2.66	
		8.2	-	11.8	Sand (medium-dense)	70	1.33	
		11.8	-	14.2	Sand (dense-very dense)	141	0.68	
Mandirancan to Indramayu	**T.043**	0.0	-	2.0	Clay (medium-stiff)	11	4.71	15.40
		2.0		5.0	Sandy and silty clays	16	2.73	
		5.0	-	10	Clayey-sands and silts	24	2.19	
		10	-	12	Clayey-sands and silts	38	2.10	
		12	-	14	Sand (medium-dense)	60	1.28	

		14	-	15.4	Sand (dense-very dense)	120	0.64	
	T.058	0	-	2.0	Sandy and silty clays	14	3.41	10.60
		2.0	-	5.0	Sand (medium-dense)	69	1.38	
		5.0	-	7.4	Sand (medium-dense)	86	1.16	
		7.4	-	9.0	Sand (medium-dense)	93	1.38	
		9.0	-	10.6	Sand (dense-very dense)	165	0.5	
	T.085	0	-	1.0	Clay (medium-stiff)	8	5.73	11.20
		1.0	-	3.0	Sand (loose-medium)	23	1.78	
		3.0	-	5.2	Clayey-sand and silty	29	2.36	
		5.2	-	7.4	Sand (medium-dense)	91	0.79	
		7.4	-	9.0	Sand (medium-dense)	79	1.09	
		9.0	-	10.2	Sand (medium-dense)	80	1.22	
		10.2	-	11.2	Sand (dense-very dense)	155	0.6	
	T.141	0	-	3.0	Clay (medium-stiff)	8	5.26	15.00
		3.0	-	6.0	Sandy and silty clays	13	3.6	
		6.0	-	8.6	Sand (very loose-loose)	26	1.93	
		8.6	-	10.0	Sand (very loose-loose)	34	1.32	
		10.0	-	12.0	Sand (loose-medium)	85	1.13	
		12.0	-	13.4	Sand (dense-very dense)	142	0.72	
		13.4	-	15	Sand (dense-very dense)	182	0.55	
	T.194	0	-	3.0	Clay (medium-stiff)	8	6.03	11.40
		3.0	-	5.4	Sandy and silty clays	38	3.07	
		5.4	-	8.0	Sand (medium-dense)	86	1.10	
		8.0	-	10.4	Sand (medium-dense)	100	1.06	
		10.4	-	11.4	Sand (dense-very dense)	135	0.83	

4.4.4 Summary of Bearing Capacity and Velocity of P-wave(Vp) of each Tower's Points

Based on the results of the soil investigation, bearing capacity and Vp are summarized in Table 4. 7. The followings are the generally used formulas for conversion to the bearing strength (qa) from qcd (Cone Friction Resistance by actual DCPT)[4].

1. qcd≒5qu*0.741 (kN/m^2) for cohesive soil
2. qu=25~50N (kN/m^2) for cohesive soil[5]
3. qa≒15~30N (kN/m^2) (safety ~applicable) **then, qu=3.333~1.667qa**
4. qac≒2.5N (cohesive soil), qas≒1N (kN/m^2) (sand) **then, qac/qas=2.5**

The required qcd for the spread foundation for sandy soil is more than 57.5 (kg/cm^2), and for cohesive soil is more than22.9 (kg/cm^2) .In some places especially in the coastal plain near Indramayu, the pile foundation should be used because the stable bearing layer is too deep for the spread foundation.

[4] Recommended Procedures for Planning Soil Investigations for Design of Building Foundations (Architectural Institute of Japan 2000)

[5] Japanese Standards for Geotechnical and Geoenvironmental Investigation Methods –Standards and Explanations- (The Japanese Geotechnical Society 2004)

Detail location of each survey site, pictures and compiled section of both DCPT and seismic prospecting are attached in Appendix III.

Table 4. 7 Summary of the Survey Results

Area	No. of Towers	Depth (m)	Geological description as per DCPT	Bearing strength (average) qa (kN/m²)	Vp (km/sec) As per seismic refraction	Bearing strength at depth of 6 m (kN/m²)	Depth cover the required strength (m)
Ungaran to Mandirancan	1) T.004	0.0 - 2.0	Clayey-sands and silts	139	0.46	586	4.6
		2.0 - 5.2	Sand (medium-dense)	223			
		5.2 - 6.8	Sand (dense-very dense)	453			
	2)T.015	0.0 - 1.0	Clayey-sands and silts	218	1.70	642	4.2
		1.0 - 3.2	Sand and silty clays	174			
		3.2 - 4.6	Clayey-sands and silts (soft-firm)	506			
		4.6 - 6.2	Sandy (dense-very dense)	600			
	3)T.026	0.0 - 4.6	Sandy and silty clays	192	0.43	230	6.0
		4.6 - 6.4	Sand (medium-dense)	178			
		6.4 - 7.8	Sand (dense-very dense)	425			
	4)T.039	0.0 - 2.0	Clayey-sands and silts	122	0.43	112	8.4
		2.0 - 5.4	Sand and silty clays	183			
		5.4 - 7.8	Sand (medium-dense)	164			
		7.8 - 9.2	Sand (dense-very dense)	474			
	5)T.044	0.0 - 2.0	Sand (loose-medium)	101	0.39	146	8.8
		2.0 - 5.4	Clayey-sands and silty	497			
		5.4 - 7.8	Sand (medium-dense)	202			
		7.8 - 9.6	Sand	398			

					(medium-dense)				
	6)T.052	0.0	-	2.0	Clayey-sands and silts	201	0.60	251	5.4
		2.0	-	3.6	Clayey-sands and silts	279			
		3.6	-	5.8	Sand (medium-dense)	199			
		5.8	-	7.2	Sand (dense-very dense)	460			
	7)T.080	0.0	-	1.0	Clays	44	0.36	＞697	4.6
		1.0	-	2.6	Clayey-sands and silts	166			
		2.6	-	4.4	Sand (medium-dense)	342			
		4.4	-	5.4	Sand (dense-very dense)	425			
	8)T.125	0.0	-	1.2	Sandy and silty clays	183	0.50	＞697	1.7
		1.2	-	2.0	Sand (medium-dense)	223			
		2.0	-	2.8	Sand (dense-very dense)	481			
	9)T.141	0.0	-	1.2	Clay (very soft-soft)	52	0.43	115	6.8
		1.2	-	3.4	Clayey-sands and silts	122			
		3.4	-	5.8	Sandy and silty clays	139			
		5.8	-	7.0	Sand (medium-dense)	279			
	10)T.149	0.0	-	2.0	Sandy and silty clays	139	0.60	195	8.6
		2.0	-	5.4	Clayey-sands and silty	296			
		5.4	-	8.2	Sand (medium-dense)	223			
		8.2	-	9.6	Sand (dense-very dense)	453			
	11)T.172	0.0	-	3.0	Sandy and silty clays	157	0.37	209	6.0
		3.0	-	6.0	Sandy and silty clays	209			
		6.0	-	8.6	Sandy and silty clays	218			
		8.6	-	10.8	Sand (medium-dense)	248			

		10.8	-	12.4	Sand (dense-very dense)	492			
	12)T.196	0.0	-	3.0	Sandy and silty clays	183	0.44	209	5.4
		3.0	-	6.0	Sandy and silty clays	201			
		6.0	-	8.6	Sandy and silty clays	262			
		8.6	-	11.0	Sand (medium-dense)	153			
		11.0	-	13.0	Sand (medium-dense)	370	2.30		
		13.0	-	14.6	Sand (dense-very dense)	589			
	13)T.236	0.0	-	1.8	Clay (very soft-soft)	113	0.76	＞697	2.9
		1.8	-	2.6	Clayey sands and silts	392			
		2.6	-	3.8	Sand (medium-dense)	408			
	14)T.257	0.0	-	2.0	Sandy and silty clays	105	0.40	＞697	3.5
		2.0	-	3.8	Clayey sands and silts	436			
		3.8	-	4.6	Sand (dense-very dense)	471			
	15)T.278	0.0	-	3.0	Clay (very soft-soft)	122	0.40	244	3.4
		3.0	-	6.0	Sandy and silty clays	218	0.66		
		6.0	-	11.0	Clayey sands and silts	139			
		11.0	-	13.6	Sand (medium-dense)	192			
		13.6	-	15.8	Sand (medium-dense)	227	1.90		
		15.8	-	17.4	Sand (dense-very dense)	523			
	16)T.429	0.0	-	2.2	Clayey sands and silts	96	0.41	279	4.8
		2.2	-	5.0	Sandy and silty clays	174	0.65		
		5.0	-	8.6	Clayey sands and silts	323			
		8.6	-	13.0	Sand (medium-dense)	209	1.50		

		13.0	-	15.8	Sand (dense-very dense)	520			
	17)T.451	0.0	-	3.0	Sandy and silty clays	131	0.38	439	4.2
		3.0	-	5.0	Sand (medium-dense)	185			
		5.0	-	6.4	Sand (medium-dense)	345	1.70		
		6.4	-	7.8	Sand (dense-very dense)	628			
	18)T.471	0.0	-	3.0	Sandy and silty clays	157	0.52	314	2.8
		3.0	-	6.0	Clayey sands and silts	262			
		6.0	-	8.2	Sand (medium-dense)	206	1.80		
		8.2	-	9.2	Sand (dense-very dense)	467			
	19)T.564	0.0	-	2.8	Sandy and silty clays	131	0.39	>697	3.3
		2.8	-	4.0	Sand (medium-dense)	202			
		4.0	-	5.6	Sand (dense-very dense)	457	2.10		
	20) Pemalang Sub-station	0.0	-	2.0	Sandy and silty clays	113	0.41	296	5.2
		2.0	-	4.2	Sandy and silty clays	192			
		4.2	-	8.2	Clayey sands and silts	323			
		8.2	-	11.8	Sand (medium-dense)	244			
		11.8	-	14.2	Sand (dense-very dense)	492	1.90		
Mandirancan to Indramayu	**21)T.043**	0.0	-	2.0	Clay (medium-stiff)	96	0.59	244	5.6
		2.0		5.0	Sandy and silty clays	139			
		5.0	-	10.0	Clayey-sands and silts	209	1.70		
		10.0	-	12.0	Clayey-sands and silts	331	>1.70		
		12.0	-	14.0	Sand (medium-dense)	209			
		14.0	-	15.4	Sand	418			

					(dense-very dense)				
	22)T.058	0	-	2.0	Sandy and silty clays	122	0.46	244	4.3
		2.0	-	5.0	Sand (medium-dense)	241			
		5.0	-	7.4	Sand (medium-dense)	300	1.60		
		7.4	-	9.0	Sand (medium-dense)	324	>1.60		
		9.0	-	10.6	Sand (dense-very dense)	575			
	23)T.085	0	-	1.0	Clay (medium-stiff)	70	0.47	314	5.3
		1.0	-	3.0	Sand (loose-medium)	80			
		3.0	-	5.2	Clayey-sand and silty	253			
		5.2	-	7.4	Sand (medium-dense)	317	1.50		
		7.4	-	9.0	Sand (medium-dense)	275			
		9.0	-	10.2	Sand (medium-dense)	279			
		10.2	-	11.2	Sand (dense-very dense)	541			
	24)T.141	0	-	3.0	Clay (medium-stiff)	70	0.48	166	12.0
		3.0	-	6.0	Sandy and silty clays	113			
		6.0	-	8.6	Sand (very loose-loose)	91	1.70		
		8.6	-	10.0	Sand (very loose-loose)	119	>1.70		
		10.0	-	12.0	Sand (loose-medium)	296			
		12.0	-	13.4	Sand (dense-very dense)	495			
		13.4	-	15	Sand (dense-very dense)	635			
	25)T.194	0	-	3.0	Clay (medium-stiff)	70	0.65	338	5.2
		3.0	-	5.4	Sandy and silty clays	331	1.50		
		5.4	-	8.0	Sand (medium-dense)	300			

		8.0	-	10.4	Sand (medium-dense)	349	＞1.50		
		10.4	-	11.4	Sand (dense-very dense)	471			

4.4.5 Relation between Bearing Strength and their Topographic Environment

The transmission line route between Ungaran and Mandirancan Sub-station runs through various topographic areas. Most parts of the transmission line from Ungaran up to Mandirancan are in mountainous and hilly areas. Fourteen (14) locations of twenty (20) surveyed sites are in the foothills and mountainous regions. On the other hand, the transmission line between Mandirancan Sub-station and Indramayu, the total of five (5) investigation points are in the paddy area of the lowland plain. These 25 points of the transmission tower are grouped into two (2) major topographic characteristics which are foothills, mountainous regions and lowlands. They are summarized in Table 4. 8 and detailed in Figure 4. 6.

Table 4. 8 Topographic Condition of each Transmission Tower

Topographic group	Topographically grouped Tower No.	
	Ungaran – Mandirancan route	Mandirancan – Indramayu route
Foothills and Mountainous region	4, 15, 26, 39, 44, 52, 80, 125, 141, 149, 172, 196, 257, 564	
Lowland plain	Pemalang Sub-station, 236, 278, 429, 451, 471	43, 58, 85, 141, 194

Figure 4. 6 Topographic Characteristics of each Transmission Tower Site
(Blue; Foothills and Mountainous region, Green; Lowland Plain area)

The qc profiles of each topographic group are arranged in Figure 4. 7 (No. 4, 15, 26, 39, 44, 52, 80, 125, 141, 149, 172, 196, 257, and 564 in Ungaran – Mandirancan route) and Figure 4. 8 (No. 236, 278, 429, 451, 471 in Ungaran – Mandirancan route and No.43, 58, 85, 141, and 194 in Mandirancan – Indramayu route).

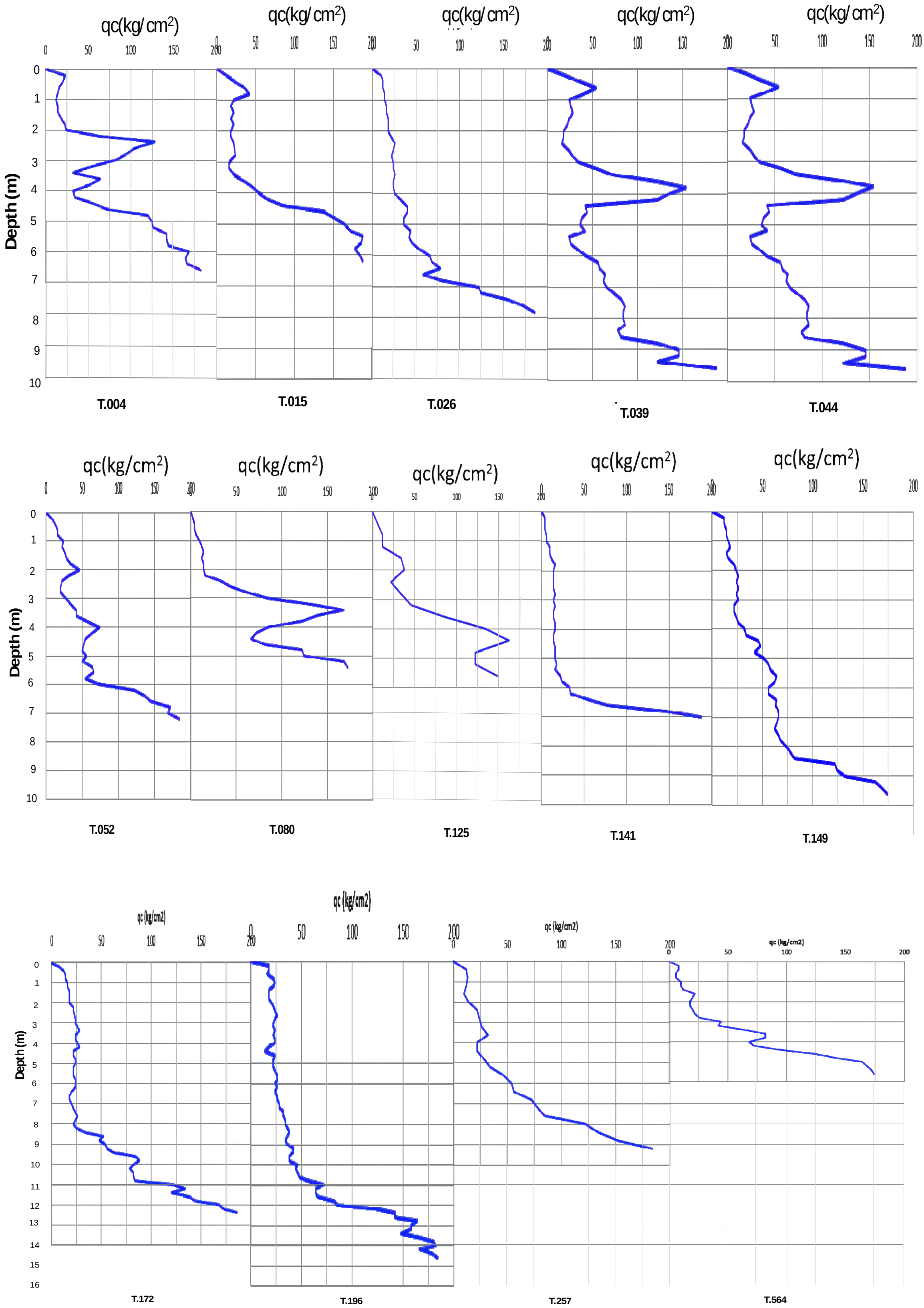


Figure 4. 7 qc Graphs of Foothills and Mountainous Regions

(Tower No. 4, 15, 26, 39, 44, 52, 80, 125, 141, 149, 172, 196, 257, and 564)

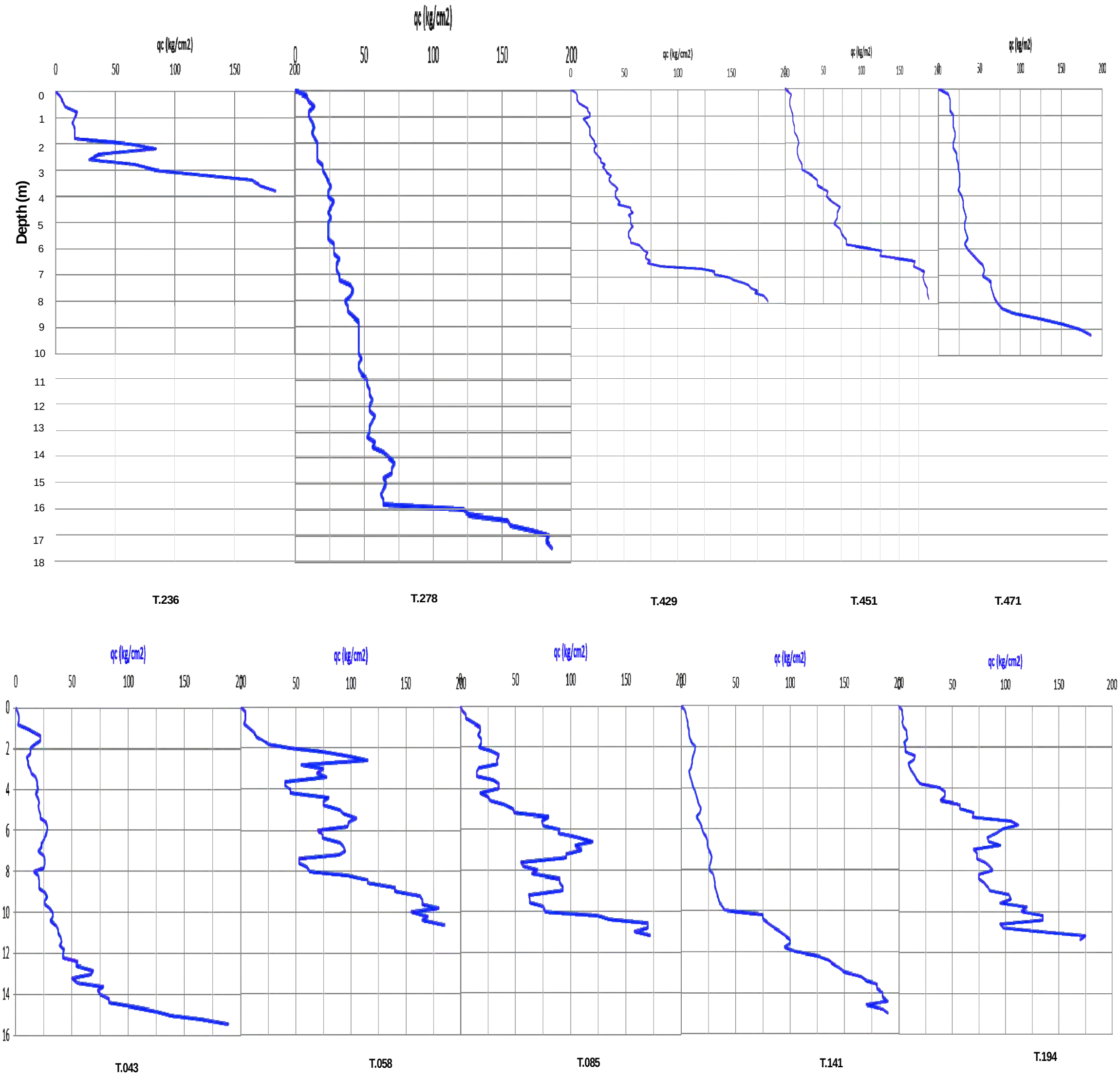


Figure 4. 8 qc Graphs of Lowland Plain Area
(Tower No. 236, 278, 429, 451, and 471 in Ungaran – Mandirancan route
and No.43, 58, 85, 141, and 194 in Mandirancan – Indramayu route)

4.4.6 Relation between Bearing Strength and their Topographic Environment

The bearing strength and recommendable foundation are summarized in Table 4. 9. The pile foundation should be arranged at Five (5) of the surveyed 25 points, which could not cover the strength of the 200kN/m^2 at 6m below ground level. This result suggests that Piling is not always required in the Lowland Plain area, but instead, deep soft sediments are scattered throughout the bottom of some of the mountainous region’s valley. Accordingly, a more detailed geological survey will be required at the next design stage.

Table 4. 9 Bearing Strength and Recommendable Foundation for each Tower

Survey No.	TTNo.	Ground Level (m)	Qa (kN/m2) at 6m depth	recommendable foundation type	recommendable depth for piling (m)	present Land-Use
1	4	590	586	spread		banana farm and orchard
2	15	370	642	spread		paddy on the terrace
3	26	530	230	spread		rambutan orchard
4	39	325	112	pile	8.4	paddy and farm on the hilltop terrace
5	44	300	146	pile	8.8	paddy and farm on the hilltop terrace
6	52	250	251	spread		water-filled paddy
7	80	65	＞697	spread		paddy partially farm
8	125	320	＞697	spread		farm changed from paddy
9	141	245	115	pile	6.8	water-filled paddy
10	149	200	195	pile	8.6	Corn Field
11	172	370	209	spread		cassava farm and orchard
20	SS_Pemalang	70	296	spread		coconut plantation
12	196	240	209	spread		cassava farm changed from paddy
13	236	45	＞697	spread		dry paddy
14	257	20	＞697	spread		details are unclear
15	278	20	244	spread		dry paddy
16	429	15	279	spread		onion farm using paddy area
17	451	20	439	spread		corn farm using paddy area
18	471	15	314	spread		corn farm using paddy area
19	564	352	＞697	spread		sweet potato farm using paddy area
21	43	16	244	spread		Paddy Fields
22	58	26	244	spread		Paddy Fields
23	85	14	314	spread		Paddy Fields
24	141	3	166	pile	12	Paddy Fields
25	194	10	338	spread		Paddy Fields

Chapter 5 Environmental and Social Considerations for the Project

5.1 JICA Guidelines for Environmental and Social Considerations

JICA applies the Japan International Cooperation Agency Guidelines for Environmental and Social Considerations issued in April 2010 (hereinafter "the Guidelines") to the preparatory surveys for yen loan projects to which the Government of Indonesia and the Government of Japan agree to implement.
Along with the Guidelines, JICA is mandated to confirm that PLN is undertaking appropriate environmental and social considerations so as to avoid, mitigate or minimize adverse impacts on the environment and local communities which may be caused by the Project for which JICA provides funding, and not to bring about unacceptable effects for sustainable development in the project area.

5.1.1 Summary of Underlying Principles

JICA puts emphasis on transparent and accountable processes, as well as the stakeholders' participation in the processes. There are underlying principles described in the Guidelines:

a) Environmental impacts that may be caused by projects must be assessed and examined in the earliest possible planning stage. Alternatives or mitigation measures to avoid or minimize adverse impacts must be examined and incorporated into the project plan.

b) Such examinations must endeavour to include an analysis of environmental and social costs and benefits in the most quantitative terms possible, as well as a qualitative analysis. They must be conducted in close harmony with economic, financial, institutional, social and technical analyses of projects.

c) The findings of the examination of environmental and social considerations must include alternatives and mitigation measures, and must be recorded as separate documents or as a part of other documents. EIA reports must be produced for projects in which there is a reasonable expectation of particularly large adverse environmental impacts.

d) For projects that have a particularly high potential for adverse impacts or that are highly contentious, a committee of experts may be formed so that JICA may seek their opinions, to increase accountability.

5.1.2 Screening and Environmental Review

JICA classifies projects into one of the categories A, B or C. Category A project is the one which is likely to have significant adverse impacts on the environment. A project with complicated impacts or unprecedented impacts difficult to assess is also classified as Category A. The scope of environmental reviews for Category B projects may vary from project to project, but it is narrower than that for Category A projects.
JICA confirms in its environmental reviews: i) whether appropriate and sufficient consideration is given to environmental and social issues before the implementation of the project; ii) whether appropriate environmental and social considerations can be expected after JICA makes decisions on the funding of the project in light of such factors as the state of preparation by the project proponent and the recipient government, their experience, operational capacity, and the state of securing funds, as well as external factors of instability.

5.1.3 Scoping

Environmental impact to be investigated and examined includes factors that affect natural environment as well as human health and safety, such as: air, water, soil, waste, noise and vibrations, ground subsidence, offensive odors, geographical features, bottom sediment, biota and ecosystems, water usage, accidents and global warming. Whereas social concerns include: involuntary resettlement, local economies, land use and utilization of local resources, social institutions, existing social infrastructures and services, poor, indigenous or ethnic people, misdistribution of benefits and damages, local conflicts of interest, limitation of accessibility to information, meetings etc. on a specific person or group, gender, children's rights, cultural heritage, infectious diseases such as HIV/AIDS.

The Study Team conducted a scoping, prior to field surveys in Indonesia, as shown in Table 5. 1 for pre-construction and construction stage, and operation stage in order to find and further assess critical impacts possibly caused by the implementation of the Project, based on which the Team developed an implementation plan of desk survey and field survey in Indonesia, and TOR for detailed local surveys in the project site. As possible impacts can be not only negative ones but also positive, positive impacts are described in the table as "+1" or "+2", and negative impacts are described as "-1" or "-2" according to their degrees. If no impact is so far identified, "0" is applied, and "unknown" is applied when magnitude of the impact is not known yet.

Table 5. 1 Scoping Prior to Study Implementation

		Pre-construction and Construction Stage		Operation Stage	
	Item	Degree of Impact	Impact	Degree of Impact	Impact
1	Air pollution	-1	Transportation vehicles may cause exhaust gas and dust while carrying facilities and equipment into the project site.	+1	SOx, NOx, CO, O_3, soot, dust, SPM will not be discharged by the operation.
2	Water pollution	-1	Water can be contaminated by the construction of roads and towers facilities which require a lot of civil engineering.	0	Not Applicable
3	Soil pollution	0	Not particularly anticipated.	0	Not Applicable
4	Waste	-1	Spoil materials such as soil, sand, and rock can be generated by excavation.	0	Solid waste such as metal scraps, wooden packing material will not be generated by the operation.
5	Noise and vibration	-1	Transportation vehicles may cause noise and vibration while carrying equipment to the site.	-1	There may be coronanoise from the conductors.
	Ground subsidence	0	Activities such as the intake of groundwater are not planned in the Project, and there is no ground subsidence therefore anticipated.	0	Not Applicable
7	Offensive odors	0	Not particularly anticipated.	0	Not Applicable
8	Geographical features	0	Not particularly anticipated.	0	Not Applicable
9	Bottom sediment	0	Not particularly anticipated.	0	Not Applicable
10	Biota and ecosystems	-1	Construction of towers or sub-stations may cause negative impacts on rare species and their living environment.	-1	The removal of herbaceous vegetation from the soil and loosening of the top soil generally causes soil erosion.
11	Water usage	0	Not particularly anticipated.	0	Not Applicable

12	Accidents	-1	Inappropriate safety management can lead to accidents at any time.	0	Not Applicable
13	Global warming	0	Not Applicable	0	Not Applicable
14	Involuntary resettlement	-2	Can happen when the tower sites are located in settlements. It will take a lot of time for local consultations and negotiations when acquiring their lands.	0	Not Applicable
15	Local economies, such as employment, livelihood etc	-2	Local livelihoods can be lost when acquiring lands for tower sites. They can also be temporarily lost when PLN extends transmission lines over ROW.	-2	Land price may fall and local people may thus lose their property value to certain extent.
		+1	Employment opportunities for laborers may benefit local community and to some extent contribute to improvement of local livelihoods.	+1	The Project will improve the reliability of power supply, which will help reduce the number of defective products caused by the power outage. It also will indirectly help increase local employment opportunities and improve local livelihoods.
16	Land use and utilization of local resources	-2	Lands for tower locations will be acquired, which may lower yield amount (paddy, fruits, vegetables etc.). Lands for ROW may also be affected temporarily during construction period.	0	Not Applicable
17	Social institutions such as social infrastructure and local decision-making institutions	0	Not Applicable	0	Not Applicable
18	Existing social infrastructure and services	0	Not Applicable	+1	The Project will improve the reliability of power supply, which will help reduce the number of defective products caused by the power outage. It also will indirectly help increase local employment opportunities and improve local livelihoods.
19	Poor, indigenous, or ethnic people	-2	Poor people can lose job opportunities as daily laborers when their employers lose their lands, or temporarily suspend their works during construction period.	0	Not Applicable
		+1	Employment opportunities for laborers may benefit poor people and to some extent contribute to improvement of their livelihoods.		
		0	There are no indigenous or ethnic people existing in the project sites.		
20	Misdistribution of benefits and damages	-1	Not only land owners but farmers employed by them to cultivate paddy will be affected.	-1	Local communities may state their dissatisfaction in case power supply is not stable in their villages.

21	Local conflicts of interests	-1	There can be disputes over compensation amount among land owners and other related parties.	-1	Local communities may state their dissatisfaction in case power supply is not stable in their villages.
22	Gender	0	Not Applicable	0	Not Applicable
23	Children's rights	0	Not Applicable	0	Not Applicable
24	Cultural heritage	0	There is no cultural heritage existing in the project sites.	0	Not Applicable
25	Infectious diseases such as HIV/AIDS	-1	There may be a risk of infection when collecting laborers from / out of local communities.	0	Not Applicable
26	Others	unknown	Unknown	unknown	Unknown

(Remarks) Possible impacts are described either of "+2": highly positive impact is expected; "+1": positive impact is expected; "0": no impact is so far expected; "-1": negative impact is expected to some extent; "-2": severe negative impact is expected, and; "unknown" magnitude of the impact is unknown.
(Source) Developed by JICA Study Team

The scoping outcome implied that biota and ecosystems would be the most critical issues among all to assess as the project site lies in the Java Island where exceptional topographic features are found with affluent diversity in flora and fauna. And that land acquisition and compensation for the right of way (ROW) would be the primary social issues to be assessed in this study.

The Study Team identified legislative documents, analyzed secondary data (forest management map, designated area map, flora and fauna, demographic data, administrative data etc.), and collected rare and protected species of fauna and flora and mapping, vegetation and mapping, and conducted interviews with households and local authorities through site surveys. Along with the Team's field survey in Indonesia, the Team commissioned two local surveys to an Indonesian consulting firm in order to figure out in detail the degree and volume of environmental and social impacts which are likely to occur.

5.2 Study Outcome

5.2.1 Policy and Legal Framework Relevant to the Project

(1) Decentralization

Upon the issuance of the Law No.22/1999 (dated May 7, 1999) regarding regional governance, most governmental functions were transferred from the central to local governments at province (*propinsi*), regencies (*kabupaten*) and cities (*kota*). It now is each region which has an authority to manage their own natural resources and is responsible for environmental preservation in accordance with national laws and regulations. And the environment management is among those which must be carried out at regency and city level.

This decentralization policy has given mandate to the Provincial Governments to: i) manage the environment across regencies and cities; ii) control the security and conservation of water resources across regencies and cities; iii) conduct evaluations of AMDAL studies for activities that have potential negative impacts on the public whose location cover more than one regency or city; iv) supervise environmental conservation across regencies and cities, and; v) determine environmental standards based on the national environmental standards. And the Local Governments of Central Java Province and West Java Province are responsible for land use planning and authorization of all the procedures relevant to the environmental clearance.

Table 5. 2 Autonomy and Decentralization

No	Name	contents
1	Government Regulation No.38/2007 dated July 9, 2007	Governmental Demarcation between Province and Regency/Town
2	Law No.33/2004 dated October 15, 2004	Financial Sharing Between the Central Government and Regional Administration
3	Law No.32/2004 dated October 15, 2004	Regional Administrations
4	Government Regulation No.25/2000 dated May 6, 2000	The Authority of the Government and the Authority of a Province as an Autonomous Region
5	Law No.22/1999 dated May 7, 1999	Regional Administrations

(Source) Developed by JICA Study Team

(2) Environmental Impact Assessment

Regulations on the Environmental Impact Assessment (*Analisis Mengenai Dampak Lingkugan, AMDAL*) in Indonesia are systematically organized. "The Law No. 23/1997 dated September 19, 1997 on Environmental Management" obligates that EIA be conducted for all projects with possible significant impacts anticipated on natural and social environment. Projects of fourteen sectors and 84 activities are identified as those which may cause significant impacts on environment by the "Decree of the State Minister of Environmental Affairs No. 17/2001 dated May 22, 2001 on the Types of Business and/or Action Plans Which Must be Completed with EIA", and the "Decree of the State Minister of Environmental Affairs No. 11/2006 dated October 2, 2006".

Transmission line projects with voltage bigger than 150 kV, no matter how long it is extended, are subject to EIA as they are categorized as having significant impacts on environment and required to follow the procedure of the decree. The following 4 documents (*KA-ANDAL,ANDAL, RKL, RPL*) are under preparation by PLN for this Project, which is subject to be evaluated by the AMDAL Commission.

(i) Term of Reference on Environmental Assessment Statement (*Kerangka Acuan - Analisis Dampak Lingkungan, KA-ANDAL*)

The scope of EIA is built up first as the framework of reference for the AMDAL Commission to review and approve prior to the commencement of EIA. Public consultation is legitimately required to determine the terms of reference on environmental assessment statement (KA-ANDAL) in which experts and others including representatives of the communities in the project areas are invited. PLN then provides details on the proposed project and encourages discussion, and the meetings results should be recorded and reflected into KA-ANDAL.

(ii) Environmental Assessment Statement (*Analisis Dampak Lingkungan, ANDAL*)

Provides baseline environmental information and draw potential major and significant impacts which result from the project implementation.

(iii) Environmental Management Plan (*Rencana Pengalolaan Lingkungan, RKL*)

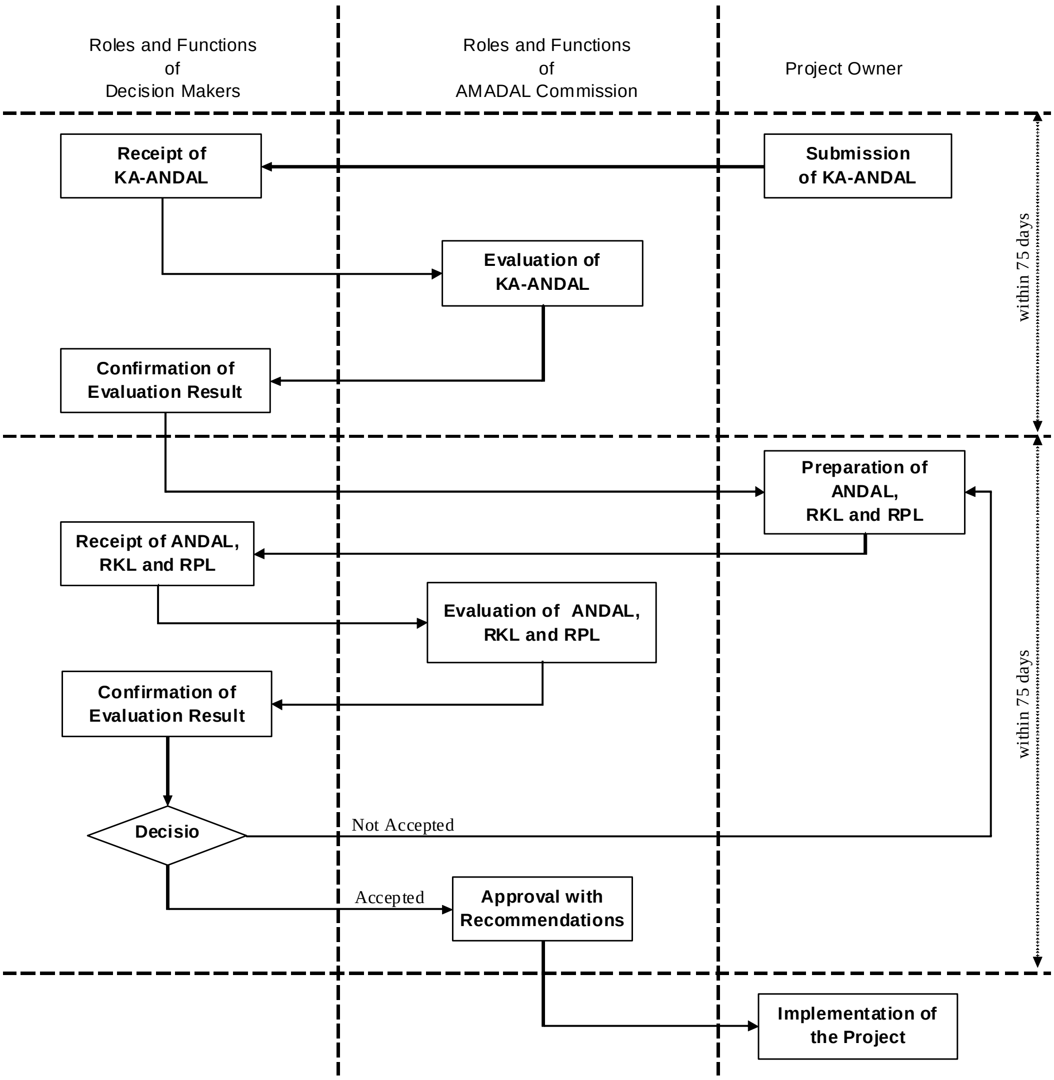
Explains the plans and procedures to be followed during the project to prevent or mitigate the anticipated impacts which are brought about as consequences of the project implementation.

(iv) Environmental Monitoring Plan (*Rencana Pemantauan Lingkungan, RPL*)

Identifies the reports and procedures for informing concerned agencies of progress and problems in implementing the RKL.

All these four documents must be approved by the AMDAL Commission prior to the project implementation. The Commission should appraise KA-ANDAL within 75 days upon receipt, and ANDAL, RKL and RPL[6] within the next 75 days.

Among those studied in EIA, population, social, economic and cultural aspects have technical guidelines to follow in terms of study items, methods, and concerned issues on which stage of construction. They are described in the Decision of the Head of the Agency for Social Study Analysis No. KEP-299/11 dated November 4, 1996. Community involvement is also secured by the Decision of the Head of the Agency for Control over Environmental Impacts No. 8/2000 dated February 17, 2000. Local community has legitimacy to be involved in the approval process of EIA, and have the right of access to all kinds of information.



(Source) Developed by JICA Study Team

Figure 5. 1 EIA Procedure

[6] Article 16 and 20 of the Government Regulation No.27/1999 dated May 7, 1999

Table 5. 3 Environmental Issues

No	Name	contents
1	Decree of the State Minister of Environmental Affairs No.11/2006 dated October 2006	Business and/or Action Plans Which Must be Completed with Environmental Impact Analysis
2	Decree of the State Minister of Environmental Affairs No. 45/2005 dated April 5, 2005	Guidelines on Formulation of Reports on the Realization of Environmental management Plan (RKL) and Environmental Monitoring Plan (RPL)
3	Decree of the State Minister of the Environment No.8/2002	Public Participation and Access to EIA Information
4	Decree of the State Minister of Environmental Affairs No.17/2001 dated May 22, 2001	Business and/or Action Plans Which Must be Completed with Environmental Impact Analysis
5	Decree of the State Minister of Environmental Affairs No.40/2000 dated November 6, 2000	Working Procedures for the Commission for Appraisal of EIA
6	Government Regulation No.54/2000 dated July 17, 2000	Institution for Providing Service in Settling Environmental Disputes Out of Court
7	Decree of the State Minister of Environmental Affairs No.2/2000 dated February 21, 2000	The Guidance for Evaluation Documents of Environmental Impact Analysis
8	Decision of the Head of the Agency for Control over Environmental Impacts No.08/2000 dated February 17, 2000	Community Involvement and Access to Information in the Process of Analysis on Environmental Impacts
9	Government Regulation No.27/1999 dated May 7, 1999	Analysis of Environmental Impacts
10	Law of the Republic of Indonesia No. 23/1997 dated September 19, 1997	Environmental Management
11	Decision of the Head of the Agency for Social Study Analysis No. KEP-299/11 dated November 4, 1996	Technical Guidelines for Social Studies in EIA
12	Decision of the Minister of Mining and Energy No.103.K/008/M.PE dated January 19, 1994	Supervision on Environmental Management Plan and Environmental Monitoring in Mining and Energy Field
13	Decision of the Head of Environmental Impact Management Board No.Kep-056/1994 dated March 18, 1994	The Guidance on the Extent of Significant Impact

(Source) Developed by JICA Study Team

(3) Land Use

The Government of Indonesia attempted to adapt its land law to modern needs through adopting the Basic Agrarian Law No.5 of 1960. It is the National Land Agency (*Badan Pertanahan Nasional*, *BPN*) that administers all land matters, except mining and forestry, related to the above law such as registration of land rights, granting and relinquishment of rights and other various permits to use the land. The Agrarian Law introduces a new classification of land rights and extends to all lands a system of land registration and certificate issuance. Land rights have become increasingly individualized even in regions where the Agrarian Law still has not been fully applied. However, a prospective purchaser is always encouraged to obtain the endorsement of the heads of village (*lurah*) and sub-district (*camat*) as well as the government officials when acquiring land titles as the customary (*adapt*) law principle is still continued that the community has the ultimate right to approve of the party to whom the land is transferred.

Major land rights introduced in the Agrarian Law are the following:

- Right of Ownership: *Hak Milik*
  Hak Milik is an inheritable, the strongest and fullest right on land which one can hold. This right is available only to Indonesian citizens, and can be transferred to other parties (only those with

Indonesian citizenship). This right is conveyed by executing a deed before a Land Deed Office/Notary reflecting the desired transaction.

- Right of Use of Structures: *Hak Guna Bangunan*
  This title is granted for 30 years authorizing the holder to utilize the land and anything previously or thereafter built upon the land on an exclusive basis for that period. It in principle can be extended for another 20 years after the expiration of the first 30 years. This right can be held by Indonesian citizens and Indonesian enterprises including foreign investment companies with legal domiciles in Indonesia. This title can be transferred and such transfers must be registered at the National Land Office.

- Right of Cultivation: *Hak Guna Usaha*
  It is a right to work on government-owned land for Indonesian individuals or legal entities including foreign, for agriculture purposes. It is granted on land whose area is at least five ha, and its term is 35 years for companies and 25 years for the others with a possible extension of another 25 years. It is transferrable to other parties.

- Right of Use: *Hak Pakai*
  This is a subsidiary right in land which may be granted by the holder of any of the land rights mentioned above. It is a right to use and/or to collect products from the land, and is ordinarily subject to specific restrictions on the intended use of the land. It lasts for a definite term or for as long as the land is used for a specific purpose. Indonesian citizens, foreign citizens residing in Indonesia, corporate bodies domiciled in Indonesia, and representative offices of foreign entities, international institutions, social and religious institutions, and government (both central and local) offices, may possess this right over land they occupy.

All transactions of land rights must be via deeds executed before a Land Deed Office/Notary where the land is located and must be registered in the regional office of BPN. Whereas land acquisition by the government for public interest purposes is defined in the Presidential Regulation No.65/2006 (dated June 6, 2006) on the Procurement of Land for Development for Public Interest Purposes, which secures transparency of the procurement process and respects to the rights of land title holders.

Table 5. 4 Land Use

No	Name	contents
1	Regulation of Head of National Agrarian No. 03/2007 dated May 21, 2007	Provision for Implementation of Presidential Regulation No.36/2005
2	Law No.26/2007 dated April 26, 2007	Land Use Plan
3	Presidential Regulation No.65/2006 dated June 6, 2006	The Amendment to Presidential Regulation No.36/2005 on Procurement of Land for Realizing Development for Public Interest
4	Presidential Regulation No.36/2005 dated May 3, 2005	Provision of Land for Realizing the Development for Public Interests
5	Government Regulation No.16/2004 dated May 10, 2004	Land Use Management
6	Presidential Decree No.34/2003 dated May 31, 2003	The National Land Affairs Policy
7	MEMR Decision No.975.K/47/MPE/1999	Right of way of high voltage transmission line and ultra high voltage transmission line for electric power supply

8	Government Regulation No.40/1996 dated June 17, 1996	Land Title for Business Operations, Land Title for Building Construction and the Right of Utilization over Land
9	Regulation of the Minister of Internal Affairs No. 15/1975 dated December 3, 2007	Conditions for Customs on Free Land
10	Act No.5/1960	Basic Agrarian Law regarding the Basic Provisions concerning the Fundamentals of Agrarian Affairs

(Source) Developed by JICA Study Team

(4) Forest Use

Act No.41/1999 (dated September 30, 1999), or the Forestry Law, stipulates that forests are designated into three types: conservation forest, protected forest, and production forest[7]. See their functions described in the Table 5. 5.

Table 5. 5 Forest Type and Function

Type	Main Function
Conservation Forest	Conserve biodiversity and Ecosystem
Protected Forest	Arrange water management Prevent flood, erosion, brine water intrusion Maintain land fertility
Production Forest	Yield forest produces

(Source) Developed by JICA Study Team

The use of forest besides forestry activities is in principle prohibited by the Ministry of Forestry Decree No.P.43/MENHUT-II/2008 which stipulates that forest area is only leased when it is a public development such as a) Religious purposes b) Defense and security c) Mining d) Development of electricity and technology installation of renewable energy d) Telecommunication distribution development e) Public road h) Clean water channel and/or wastes water i) Irrigation j) Water pond k) Public facilities l) Telecommunication repeater m) Radio transceiver station n) Television relay station o) Sea and air traffic safety utilities. The application should contain: a) work plan of the concerned forest area with a location map of scale 1:50,000 or bigger b) recommendation from the Governor and/or *Bupati/Walikota* for permission pertaining to leasing the concerned forest area, and c) A full set of approved AMDAL.

Table 5. 6 Forestry Use

No	Name	contents
1	Regulation of the Minister of Forestry No.P.43/Menhut-II/2008 dated July 10, 2008	Guidelines on the Lease of Forest Area
2	Regulation of the Minister of Forestry No.P.64/Menhut-II/2006 dated October 17, 2006	Amendments in the Ministry of Forestry Regulation No.P.14/Menhut-II/2006
3	Government Regulation No.45/2004 October 18, 2004	Forest Protection
4	Act No.41/1999 dated September 30, 1999	Forestry Law

[7] Described in (a),(b),(c) of paragraph (2) of Article 6 of the Act.

5	Minister of Mining and Energy and Minister of Forestry No.969.K/05/M.PE/1989, and No.429/KPTS-II/1989	Guidelines of Mining and Energy Business in Forest Area
6	Government Regulation No.28/1985	Forest Environment

(Source) Developed by JICA Study Team

(5) Conservation of Biodiversity
For the conservation of biodiversity and ecosystem, Act No.5/1990 on Conservation of Biological Natural Resources and Their Ecosystems is the key document to refer.
This law stipulates that all elements of living resources and their ecosystem are interdependent, and deterioration or extinction of one element leads to damaging the ecosystem as a whole. The Act also prohibits any activities detrimental to the survival of protected species.

Table 5. 7 Biodiversity Conservation

No	Name	contents
1	Act No.5/1990	Conservation of Biological Natural Resources and Their Ecosystems

(Source) Developed by JICA Study Team

5.2.2 Impact on Natural Environment

(1) Kinds of Forest to be acquired in the Project
Findings in the local survey on natural environment have suggested that there are no such protected areas designated in the Project site from Ungaran to Indramayu as national parks or strict nature reserve areas as stipulated by the Indonesian laws or international treaties and conventions. Most of the land use in the project site is paddy field. Low-altitude areas connected to foot areas of central mountainous zones are occupied by typical vegetation of Central Java such as the Deciduous Forest or the Dry Evergreen Forest.
The section of forest which passes through the proposed transmission line route has species generally associated with secondary and pioneer communities, poor vegetation cover, and non-timber forest products (see Photo 5-1 and 5-2).

Photo 5-1 Forest composition near Tower No. 69
Occupied mainly by "teak." All of the forests are production forests owned by the Indonesian National Forest Public Corporation (*PT.Perhutani*) and called as "community forest" jointly managed with local residents who conducts the mixed plantation of trees and fruit trees in the forest.
(Source) Taken by JICA Study Team

Photo 5-2 Forest adjusting village near Tower No. 69
The forest consists of man-made forest with planted trees such as "Teak" and "Paraserianthes Falcataria." They grow to maturity in as few as 10 to 15 years, much quicker than other kinds of trees, and can be cut down for sale. There are cultivations of pulses, corn, casaba and banana between trees.
(Source) Taken by JICA Study Team

All these forests are managed as man-made forests, which do not require vegetation conservation. They are designated as “production forest” mainly to promote sustainable forest production as in the Article 6 (2) of the Forestry Law, which is different from “conservation forest” or “protection forest” designated not only to protect its conservation of animal and plant species and its ecosystem, but also to prevent from flood, erosion and to maintain soil fertility.

The production forest, of which 2.9 ha is earmarked for construction sites of 38 towers and 53.7 ha, is restricted for the ROW for transmission line with 34 m width. The total length of T/L which will pass through / over forest is approximately 15,794 m constituting 4.6% of the total T/L of approximately 340km.

When looking at a result of numerical value from the ratio of total production forest of target regencies, the degree of area-wise impact is small. For instance, Kendal Regency has the largest forest area to be used for tower sites (1.9ha) and ROW (33.7ha) under the Project (see the table below). Out of a total production forest area of 1,327ha[8] in the regency though, tower sites and ROW occupy only 0.14% and 2.6% respectively.

Therefore, not only is adverse damage to the production forest caused by construction of towers envisaged to be minimal, but also restriction to the owners of these forest by designated as ROW should also be minimal.

Table 5. 8 Forest Area Acquired for Tower Site and Designated for ROW

Regency	Tower Code No.	Number of Tower	Forest areas for Tower site/ROW		
			Area for Tower	Area for ROW	
			(m^2)	Length of T/L (m)	(m^2)
Kendal	60-64,67-69,81-83,86,87,91-100	24	18,816	9,920	337,280
Batang	169-171,175,177-180,188,189	10	7,840	4,123	140,182
Pekalongan	257, 258	2	1,568	910	30,940
Tegal	340, 341	2	1,568	841	28,594
TOTAL		38	29,792	15,794	536,996

(Remarks) Consultant’s calculation based on data provided by PLN: Area of Tower: 28*28=784m2, Area for ROW is calculated by multiplying total length and 34 m (17m from line center to each side).
(Source) Developed by JICA Study Team

(2) Rare Species[9] of Fauna and Flora

Prior to JICA’s study, no biological study had been done in and around project site. Information of fauna, flora and its ecosystem in site is limited and information on these issues is inadequate.

The Study Team conducted a sampling survey of rare, endangered and protected species of fauna and flora in and along transmission line route as part of this project preparatory technical assistance was given in October 2011 and January in 2012 at six sampling sites in Cirebon, Kuningan, Tegal, Pemalang, Batang and Kendal Regencies (of which only Cirebon Regency was covered by site survey of January in 2012).

These six sampling sites were chosen from the forest which seems to not only abound rare, endangered and protected species but also seems to represent a true reflection of the ecosystem of each region

Survey methods are i) direct sampling at six stations along the T/L with ten quadrats of 10 m x 10 m in or outside of ROW areas of forest respectively; ii) observations; iii) photo albums for confirmation of species identities, and; iv) interviews with local people.

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[8] Data of Forest Ministry
[9] which has been designated species by IUCN and/or CITES and/or Indonesian Law

The results are as below:

(i) Flora

The Flora survey of this study identified 23 higher vascular plant species of 21general and 16 families (see the Table 5. 9) and of which three species (*Swietenia macrophylla*-Mahogany, *Gnetum gnemon*-Joint Fir, *Mangifera indica*-Mango) are listed in IUCN Red Data Book as Rare Evaluated species. 1 species (*Swietenia macrophylla*-Mahogany) has also been listed on "CITES as appendix II". Out of these 3 species, 1 species (*Swietenia macrophylla*-Mahogany) is classified as Vulnerable (VU), another (*Gnetum gnemon*-Joint Fir) is as Least Concern (LC) and the last 1 (*Mangifera indica*-Mango) is as Data Deficient (DD).

All of the rare species which have been identified by site survey were discovered outside of tower construction sites and ROW area of forest.

Table 5. 9 List of Rare and Protected Species of Flora

	English Name	Scientific Name	Local Name	Treaty or Local Law			Location of observation
				IUCN*1	CITES*2	Law	
1	Mahogany	*Swietenia macrophylla*	Mahoni	VU	II	-	Identified at 2 sites 1) Tegal Regency Near the tower No.341 90m away from T/L and no adverse impacts to this species. 2) Kuningan Regency Near the tower No.562 60m away from T/L and no adverse impacts to this species.
2	Joint Fir	*Gnetum gnemon*	Melinjo	LC	-	-	Kuningan Regency Near the tower No.562 90m away from T/L and no adverse impacts to this species.
3	Mango	*Mangifera indica*	Mangga	DD	-	-	Pemalang Regency Near the tower No.274 90m away from T/L and no adverse impacts to this species.
Total 3	-	-	-	3	1	0	

(Remarks) 1. IUCN: International Union for Conservation of Nature and Natural Resources, 2. CITES: The Convention on International Trade in Endangered Species of Wild Fauna and Flora

(Source) Developed by JICA Study Team

- Anticipated adverse impacts to Flora

The number of species recorded was 23 and was considered to be low perhaps due to the generally poor habitats, as a result of human influence on much of the land area in or along the project area, particularly by shifting cultivation over several generations and by illegal logging[10] that has gone on for some time.

These species have wide distributions and are common in the region especially in Kuningan Regency (near Tower No.562) and Pemalang Regency (near Tower No.274). The risk of loss of species can be

[10] Results of the interviews with local people who manage forests in or adjacent project site

minimized by careful removal of trees with as little site disturbance by construction of access roads as possible.

Although the three species (*Swietenia macrophylla-Mahogany, Gnetum gnemon-Joint Fir,Mangifera indica-Mango*) listed in IUCN Red Data Book are widely distributed and are common in Central and West Java, there will not be any reduction of these species and their habitats caused by construction activities, as a result of precautions taken to reduce indirect impacts to these species during construction and vegetation clearing.

(ii) Fauna

The Fauna survey of this study identified 43 species including 2 species of mammals, 18 species of birds, 6 species of reptiles, 2 species of amphibians, and 15 species of insects.

Among these, 18 species of birds are listed in IUCN Red Data Book, of which 1 species (*Anhinga melanogaster*-Oriental Darter) is Near Threatened (NT) and 17 species listed as Least Concern (LC), 4 species (*Ictinaetus malayensis*-Black Eagle, *Falco moluccensis*-Spotted Kestrel, *Naja sputatrix*-Cobra, *Apis Spp*-Bee) are listed in CITES as appendix II, and 6 species of birds (*Alcedo atthis*-Common Kingfisher, *Halcyon pileata*-Black capped Kingfisher, *Halcyon cyanoventris*-Java Kingfisher, *Ictinaetus malayensis*-Black Eagle, *Falco moluccensis*-Spotted Kestrel, *Anhinga melanogaster*-Oriental Darter) are being designated by the Indonesian Law.

All of the rare species which have been identified by site survey were founded at outside of tower construction sites and ROW area of forest.

Table 5. 10 List of Rare and Protected Species of Fauna

		English Name	Scientific Name	Local Name	Treaty or Local Law			Location of observation
					IUCN	CITES	Law	
bird	1	Common Kingfisher,	*Alcedo atthis*	Raja udang Erasia	LC	-	○	1) Kendal Regency Near the tower No.94 100m away from T/L
	2	Black-capped Kingfisher	*Halcyon pileata*	Cekakak cina	-LC	-	○	1) Tegal Regency Near the tower No.341 100m away from T/L
	3	Java Kingfisher	*Halcyon cyanoventris*	Cekakak Jawa	-LC	-	○	1) Batang Regency Near the tower No.179 120m away from T/L 2) Pemalang Regency Near the tower No.274 60m away from T/L
	4	Black Eagle	*Ictinaetus malayensis*	Elang hitam	LC	II	○	1) Tegal Regency Near the tower No.341 200m away from T/L
	5	Spotted Kestrel	*Falco moluccensis*	Alap-alap sapi	-LC	II	○	1) Tegal Regency Near the tower No.341, 90m away from T/L
	6	Oriental Darter	*Anhinga melanogaster*	Pecuk-ular Asia	NT	-	○	1) Kuningan Regency Near the tower No562 120m away from T/L
	7	Bar-winged Prinia	*Prinia familiaris*	Perenjak Jawa	LC	-	–	Pemalang Regency Near the tower No.274 100m away from T/L
	8	Olive-backed Tailorbird	*Orthotomus sepium*	Cinenen Jawa	LC	-	-	Tegal Regency Near the tower No.341 60m away from T/L
	9	Red Junglefowl	*Gallus gallus*	Ayam hutan	LC	-	-	Batang Regency Near the tower No.179 150m away from T/L
	10	Sooty-headed Bulbul	*Pycnonotus surigaster*	Cucak kutilang	LC	-	-	Batang Regency Near the tower No.179 200m away from T/L

	11	Spotted Dove	*Streptopelia chinensis*	Tekukur	LC	-	-	Batang Regency Near the tower No.179 50m away from T/L
	12	Common Goldenback	*Dinopium javanense*	Burung Pelatuk besi	LC	-	-	Tegal Regency Near the tower No.341 50m away from T/L
	13	Javan Munia	*Lonchura leucogastroides*	Bondol Jawa	LC	-	-	1)Pemalang Regency Near the tower No.274 2) Kendal Regency Near the tower No.94 80m away from T/L
	14	Scaly-breasted Munia	*Lonchura punctulata*	Bondol peking	LC	-	-	Kendal Regency Near the tower No.94 150m away from T/L
	15	Small Buttonquail	*Turnix sylvatica*	Gemak tegalan	LC	-	-	Kendal Regency Near the tower No.94 60m away from T/L
	16	Cave Swiftlet	*Collocalia linchi*	Walet linci	LC	-	-	Kuningan Regency Near the tower No.562. 100m away from T/L
	17	Chesnut-bellied Partridge	*Arborophila javanica*	Puyuh Gonggong Jawa	LC	-	-	Tegal Regency Near the tower No.341. 60m away from T/L
	18	Scarlet-headed Flowerpecker	*Dichaeum trochileum*	Cabai Jawa	LC	-	-	Cirebon Regency Near the tower No.29 60m away from T/L
am-phibia	1	African Clawed Frog	*Xenopus sp*	Katak Sawah	LC	-	-	Cirebon Regency Near the tower No.29 70m away from T/L
reptile	1	Cobra	*Naja sputatrix*	Kobra	LC-	II	-	Tegal Regency Near the tower No.341 40m away from T/L
insect	1	Bee	*Apis Spp*	Lebah kayu	-	II	-	Tegal Regency Near the tower No.341 30m away from T/L
Total	21	-	-	-	(NT-1) (LC-19)	4 (All-II)	6	Some species plurly designated

(Source) Developed by JICA Study Team

- Anticipated adverse impacts to Fauna

  One rare and endangered species (Anhinga melanogaster) which is classified as Near Threated (NT) by IUCN Red Data Book was recorded in the forest about 120m from the planned transmission line near Tower No.562.

  There are no predicted adverse impacts envisaged on this species by construction works of towers and transmission line because the Tower (No.562) site of this area is being built in rice field (not in forest). It will pass about 120m away from the habitat with the transmission line passing through the fringes of the forest.

  But, during their reproduction phase, this species is more sensitive to disturbances such as appearances of human beings or infrastructures, noise and vibrations, so that it is important to take precautions to minimize activities that may compromise the survival of their populations during construction and vegetation clearing phase[11].

[11] Guideline for protection of Raptores (Japan, Ministry of Environment 1997)

The other 17 birds which are being listed as Least Concern (LC) are being considered as low risk of extinction in IUCN Red Data Book. These birds have high adaptability to habitat change by flying away to find another suitable habitat available, so that the risk of loss of species is minimal.
The direct impacts to the other 4 species listed on “CITES as appendix II”, and 6 species protected by Indonesian Law are considered as low level. They are widely distributed and common in Central and West Java, hence the risk of loss of species is minimal.

5.2.3 Impact on Social Environment

The Study Team along with a local consulting firm conducted a socio-economic survey from August 2011 to February 2012. Information on provincial and regency levels was obtained through publications issued by the Provincial Government: BAPPEDA; Provincial Statistics Office (*Badan Pusat Statistik, BPS*); Dept of Health, and Dept of Education and Culture. Interviews were conducted using two methods, namely open interviews with key informants (such as village heads and village government staff) and structured interviews using a set of questionnaires with local households. During field observations, ad-hoc questions were raised for local residents in order to further understand the local contexts of socio-economy and culture in each study site.
Apart from secondary data collection which covered all regencies of two provinces under the Project, interviews and field observations were conducted only in selected locations where the transmission line might likely pass above or close to residents or settlements. To identify such sites, the Study Team and surveyors carefully studied the project map and the tower schedule provided by PLN. The project map shows the planned transmission line route, and the tower schedule shows tower locations by both geographical location (latitude/longitude) and administrative location (regency, sub-district and village), and describes their conditions (paddy field, groves and forests) and what the lines would cross (paddy field, groves, forests, streets, rivers, settlements and houses).
The Team and surveyors visited the sites and conducted interviews and field observations to clarify the degree of social impact caused by the construction of transmission lines. Due to the time constraints, the Team and surveyors did not visit all sites which were likely to be affected by the Project. The Team selected the 22 locations below as samples for making analyses to assess what kind of adverse impact and to what extent might likely be caused. Although it was intended to select only one or two survey sites from each regency, that of Batang and Cirebong contain more than the rest. The Central Java Coal-fired Steam Power Plant (2*1,000MW) is under construction in Ujung Negoro Village, Tulis Sub-district of Batang Regency facing the coast of the Java Sea, and a 150kV substation and associated transmission line route will be extended in the Project to connect to the power station. Three tower locations in Batang (T193f, T193g, and T193h) were additionally chosen to study the substation surroundings. Additionally, two transmission line routes have been designed to pass Cirebon Regency so that two from Ungaran-Mandirancan route and one from Mandirancan-Indramayu route were also selected.

Table 5. 11 List of Surveyed Sites

No	Survey date	Survey locations				
		Tower No.	Village	Sub-district	Regency	Province
1	23 Sep 2011	T030	Branjang	Ungaran Barat	Semarang	Central Java
2	24 Sep 2011	T050	Boja	Boja	Kendal	Central Java
3	24 Sep 2011	T069	Ngareanak	Singorojo	Kendal	Central Java
4	25 Sep 2011	T149b*[1]	Rowosari	Limpung	Batang	Central Java
-	19 Jan 2012	Pemalang S/S	Beji	Wonotunggal	Batang	Central Java
5	19 Jan 2012	T193f	Batiombo	Wonotunggal	Batang	Central Java
6	19 Jan 2012	T193g	Batiombo	Wonotunggal	Batang	Central Java

7	19 Jan 2012	T193h	Batiombo	Wonotunggal	Batang	Central Java
8	25 Sep 2011	T200	Wonotunggal	Wonotunggal	Batang	Central Java
9	26 Sep 2011	T236	Jetak Kidul	Wonopringgo	Pekalongan	Central Java
10	26 Sep 2011	T249	Sambiroto	Kajen	Pekalongan	Central Java
11	27 Sep 2011	T296	Penggarit	Taman	Pemalang	Central Java
12	27 Sep 2011	T300	Sungapan	Pemalang	Pemalang	Central Java
13	28 Sep 2011	T347	Karangmalang	Kedungbanteng	Tegal	Central Java
14	28 Sep 2011	T398	Sidomulyo	Pagerbarang	Tegal	Central Java
15	29 Sep 2011	T425	Cenang	Songgom	Brebes	Central Java
16	29 Sep 2011	T449	Kubangsari	Ketanggungan	Brebes	Central Java
17	30 Sep 2011	T531	Sedong Kidul	Sedong	Cirebon	West Java
18	30 Sep 2011	T543	Kertawangun	Sedong	Cirebon	West Java
19	18 Jan 2012	T039*[2]	Gempol	Gempol	Cirebon	West Java
20	18 Jan 2012	T006*[2]	Mandirancan	Mandirancan	Kuningan	West Java
21	17 Jan 2012	T160*[2]	Wirakanan	Kandanghaur	Indramayu	West Java
22	17 Jan 2012	T198*[2]	Sumuradem Timur	Sukra	Indramayu	West Java

(Remarks) 1. There was a design change in the study stage to reroute transmission lines and substation. And T149b is not among new route. 2. Serial numbers of towers from Mandirancan and Indramayu starts from one (T001), and they are thus duplicated.
(Source) Developed by JICA Study Team

(1) Land Use

General condition of corridor area of northern coast of Java Island is characterized by lowland areas of 0 to 200m above sea level and slopes of 0 to 10 percent. Most areas on the transmission line route are rice fields or groves. Rice fields occupy 60 to 70 percent of line route followed by various kinds of fields such as coffee or rubber plantation, corn field, orchard etc. (approximately 20 percent). Forests are mainly found in Kendal and Batang, and constitute around five percent of the route.

Photo 5-3 Paddy Field near Tower No. 249
Sambiroto Village, Kajen Sub-district, Pekalongan Regency. The owner of paddy field where a tower will be located is now out of town for working opportunity in Jakarta. Other farmers are employed for cultivation.
(Source) Taken by JICA Study Team, September 2011

Photo 5-4 A Town near Tower No. 52
Boja Village, Boja Sub-district, Kendal Regency. The town has been electrified since 1980s. Well water is still widely used, and over 80% of populations are farmers. The transmission line may cross over the town.
(Source) Taken by JICA Study Team, September 2011

(2) Population

Majority of population are Sundanese and Javanese with the majority being pious Islam.

(3) Livelihoods

The majority of existing land use in study area is agricultural land. More people work as farmers and farm laborers in agricultural sector than in other sectors. Other sectors also absorb a significant workforce such as construction workers, traders and domestic servants. In recent years economic factors have increased people's mobility and emigration to urban areas for employment opportunities. Children often drop out of junior high school and consequently do not enroll for higher education which is not regarded as being overly important for them as it does not necessarily guarantee better living standards in economic terms. More important for them is the focus on meeting the daily needs of their families.

Photo 5-5 In a settlement nearby Tower No. 236
Jetak Kidul Village, Wonopringgo Sub-district, Pekalongan Regency. Laborers work in a house to sew jeans. They export jeans to urban areas such as Bandung, Surabaya and Jakarta.
(Source) Taken by JICA Study Team, September 2011

Photo 5-6 A village nearby Tower No. 39
Gempol Village, Gempol Sub-district, Cirebon Regency. A female villager holds a very small shop in front of her house to sell snacks.
(Source) Taken by JICA Study Team, January 2012

(4) Hygiene and Sanitation

Local population in the route area has access to water. The majority of them still use water wells for all kinds of purposes such as cooking, drinking, washing and bathing. Tap water (PDAM) is becoming available but has not fully changed people's habits. People in some areas of Central Java (such as Kendal Regency) often suffer from water shortage as their villages are located at rather a high altitude, and suffer from an unhygienic environment. They dispose of waste water through septic tank channels and burn refuse after collecting certain amount in their yards. They often suffer from influenza, dengue fever and diarrhea, requiring medical assistance from health centers nearby. Despite heavy rains in rainy season, villages along transmission line route rarely suffer from floods, which helps them stay in better hygiene condition throughout the year.

5.3 Anticipated Impacts caused by Project Implementation

Based on the outcome from studying legislative documents, conducting secondary data collection and analyses, and field survey for primary data collection, the Study Team developed a list of anticipated impacts caused by the Project, and possible mitigation measures to cope with such impacts. See Table 5. 12 for pre-construction and construction stage and Table 5. 13 for operation stage.

Table 5. 12 Anticipated Impact on Environment (Construction Stage)

	Item	Impact	Pre-construction and Construction stage	Mitigation Measures
1	Air pollution	-1	Transportation vehicles may cause exhaust gas and dust while carrying facilities and equipment into the project site.	・Periodic inspection and maintenance work for transportation vehicles should be properly conducted. ・Efficient schedule management of the whole construction works and proper time management of the equipment use should be secured. ・Watering on the streets should be done periodically.
2	Water pollution	-1	Water can be contaminated by the construction of roads and towers facilities which require a lot of civil engineering.	To treat by sedimentation and carrying contaminated water to the water treatment plant by sealed tank.
3	Soil pollution	0	Not particularly anticipated.	-
4	Waste	-1	Spoil materials such as soil, sand, and rock can be generated by excavation.	Industrial waste disposal will be selected for proper waste treatment by contractor. Almost all soil materials shall be used wherever possible for site leveling, back-filling etc.
5	Noise and vibration	-1	Transportation vehicles may cause noise and vibration while carrying equipment to the site.	・Periodic inspection and maintenance of transportation vehicles should be properly conducted. ・Efficient schedule management of the whole construction works and proper time management of the use of equipment should be secured especially including prohibiting of construction works at night time. .
6	Ground subsidence	0	Activities such as the intake of groundwater are not planned in the Project, and there is no ground subsidence therefore anticipated.	-
7	Offensive odors	0	Not particularly anticipated.	-
8	Geographical features	0	Not particularly anticipated.	-
9	Bottom sediment	0	Not particularly anticipated.	-

10	Biota and ecosystems	-1	Construction of towers or sub-stations may cause negative impacts on rare species and their living environment.	・Confirmed areas of rare species of flora/fauna will be avoided in advance. ・Optimization of the location- size of towers and sub-stations to minimize loss of vegetation. ・Planning of construction activities so as not to disturb habitat of endangered species by approaching its nest or feeding areas.to conserve ecosystem.
11	Water usage	0	Not particularly anticipated.	-
12	Accidents	-1	Inappropriate safety management can lead to accidents at any time.	Safety manual should be developed and applied.
13	Global warming	0	Not Applicable	-
14	Involuntary resettlement	0	Land acquisition for tower sites will be legislatively required, whereas there will be no involuntary resettlement inccurred as no tower is presently planned to be constructed in any settlement. Although right of way (ROW) will cross some settlements, such area will remain minimum (less than one percent of total ROW) and there will be no requirement for them to be resettled.	It is strongly recommended to clearly state that there will be no involuntary resettlement required in public consultations and stakeholder meetings, to prevent any misunderstanding by local people.
15	Local economies, such as employment, livelihood etc	-2	Local livelihoods can be lost when acquiring lands for tower sites. They can also be temporarily lost when PLN extends transmission lines over ROW.	・In order to collect and reflect local views, obtain their consensus and cooperation for the Project, a series of public consultations and socializations should be properly conducted in accordance with the Indonesian regulations and the JICA Guidelines. ・Inventory list should be properly developed to identify who will be affected to which extent. ・Land owners of tower locations and ROW of T/L lines should be properly compensated in accordance with the Indonesian regulations and the JICA Guidelines.
		+1	Employment opportunities for laborers may benefit local community and to some extent contribute to improvement of local livelihoods.	Labor Law should be strictly followed and payment should be properly done to the laborers.

16	Land use and utilization of local resources	-2	Lands for tower locations will be acquired, which may lower yield amount (paddy, fruits, vegetables etc.). Lands for ROW may also be affected temporarily during construction period.	・In order to collect and reflect local views, obtain their consensus and cooperation for the Project, a series of public consultations and socializations should be properly conducted in accordance with the Indonesian regulations and the JICA Guidelines. ・Inventory list should be properly developed to identify who will be affected to which extent. ・Land owners of tower locations and ROW of T/L lines should be properly compensated in accordance with the Indonesian regulations and the JICA Guidelines.
17	Social institutions such as social infrastructure and local decision-making institutions	0	Not Applicable	-
18	Existing social infrastructure and services	0	Not Applicable	-
19	Poor, indigenous, or ethnic people	-2	Poor people can lose job opportunities as daily laborers when their employers lose their lands, or temporarily suspend their works during construction period.	・In order to collect and reflect views of poor people, obtain their consensus and cooperation for the Project, they also should be invited to attend public consultations and socializations. ・Inventory list should be properly developed to identify to what extent poor people will be affected. ・Actions should be examined to help improve poor people's livelihoods.
		+1	Employment opportunities for laborers may benefit poor people and to some extent contribute to improvement of their livelihoods.	Affirmative actions are recommended to allocate certain seats for poor people to get jobs.
		0	There are no indigenous or ethnic people existing in the project sites.	-
20	Misdistribution of benefits and damages	-1	Not only land owners but farmers employed by them to cultivate paddy will be affected.	・In order to collect and reflect local views, obtain their consensus and cooperation for the Project, a series of public consultations and socializations should be properly conducted in accordance with the Indonesian regulations and the JICA Guidelines. ・Inventory list should be properly developed to identify who will be affected to which extent. ・Not only land owners of tower locations and ROW of T/L lines but also farmers employed for rice cultivation should be properly compensated or given other job opportunities.

21	Local conflicts of interests	-1	There can be disputes over compensation amount among land owners and other related parties.	・In order to collect and reflect local views, obtain their consensus and cooperation for the Project, a series of public consultations and socializations should be properly conducted in accordance with the Indonesian regulations and the JICA Guidelines. ・Inventory list should be properly developed to identify who will be affected to which extent. ・Process monitoring should be properly conducted by the third party for transparency and accountability.
22	Gender	0	Not Applicable	-
23	Children's rights	0	Not Applicable	-
24	Cultural heritage	0	There is no cultural heritage existing in the project sites.	-
25	Infectious diseases such as HIV/AIDS	-1	There may be a risk of infection when collecting laborers from / out of local communities.	Contraceptive devices can be distributed for immediate solution, and awareness raising program should be organized for long-term impact.
26	Others	unknown	Unknown	-

(Remarks) Possible impacts are described either as "+2": highly positive impact is expected; "+1": positive impact is expected; "0": no impact is so far expected; "-1": negative impact is expected to some extent; "-2": severe negative impact is expected, and; "unknown" magnitude of the impact is unknown.
(Source) Developed by JICA Study Team

Table 5. 13 Anticipated Impact on Environment (Operation Stage)

	Item	Impact	Operation stage	Mitigation Measures
1	Air pollution	+1	SOx, NOx, CO, O_3, soot, dust, SPM will not be discharged by the operation.	-
2	Water pollution	0	Not Applicable	-
3	Soil Pollution	0	Not Applicable	-
4	Waste	0	Solid waste such as metal scraps, wooden packing material will not be generated by the operation.	-.
5	Noise and vibration	-1	There may be corona noise and/or electromagnetic disturbance (EMD) to home electric appliances from the conductors.	The level of corona and EMD will be controlled by national or local standards according to the technical manual.
6	Ground subsidence	0	Not Applicable	-
7	Offensive odors	0	Not Applicable	-
8	Geographical features	0	Not Applicable	-
9	Bottom sediment	0	Not Applicable	-

10	Biota and ecosystems	-1	The removal of herbaceous vegetation from the soil and loosening of the top soil generally causes soil erosion.	Mitigation measure of surface treatment will be planned
11	Water usage	0	Not Applicable	-
12	Accidents	0	Not Applicable	-
13	Global warming	0	Not Applicable	-
14	Involuntary resettlement	0	Not Applicable	-
15	Local economies, such as employment, livelihood etc.	-2	Land price may fall and local people may thus lose their property value to certain extent.	・It is strongly recommended that local people should be well informed of the possibility of losing their land values through public consultations and stakeholder meetings during construction stage, and the amount for compensation should be taken into account this issue. ・Monitoring should be continued.
		+1	The Project will improve the reliability of power supply, which will help reduce the number of defective products caused by the power outage. It also will indirectly help increase local employment opportunities and improve local livelihoods.	・Periodic interview with customers can also be conducted. ・Transition of electricity consumption over years can be observed. ・Transition of the number of defective products over years can be observed ・The degree of local industry promotion can be observed over years. ・Distribution system should also be secured for stable power supply and equally provided to individual customers.
16	Land use and utilization of local resources	0	Not Applicable	-
17	Social institutions such as social infrastructure and local decision-making institutions	0	Not Applicable	-
18	Existing social infrastructure and services	+1	The Project will improve the reliability of power supply, which will help reduce the number of defective products caused by the power outage. It also will indirectly help increase local employment opportunities and improve local livelihoods.	・Periodic interview with customers can also be conducted. ・Transition of electricity consumption over years can be observed. ・Transition of the number of defective products over years can be observed ・The degree of local industry promotion can be observed over years. ・Distribution system should also be secured for stable power supply to individual customers.
19	Poor, indigenous, or ethnic people	-1	Poor people may permanently lose jobs which they used to have before the construction.	・It is strongly recommended that poor people should be well informed of the possibility of permanently losing their jobs during construction stage. ・Inventory list should be properly developed and actions to improve

				their livelihoods should be examined. ・Monitoring should be continued.
20	Misdistribution of benefits and damages	-1	Local communities may state their dissatisfaction in case power supply is not stable in their villages.	・Distribution system should be secured for stable power supply and equally provided to individual customers in local communities.
21	Local conflicts of interests	-1	Local communities may state their dissatisfaction in case power supply is not stable in their villages.	・Distribution system should be secured for stable power supply and equally provided to individual customers in local communities.
22	Gender	0	Not Applicable	-
23	Children's rights	0	Not Applicable	-
24	Cultural heritage	0	Not Applicable	-
25	Infectious diseases such as HIV/AIDS	0	Not Applicable	-
26	Others	unknown	Not Applicable	-

(Remarks) Possible impacts are described either as "+2": highly positive impact is expected; "+1": positive impact is expected; "0": no impact is so far expected; "-1": negative impact is expected to some extent; "-2": severe negative impact is expected, and; "unknown" magnitude of the impact is unknown.
(Source) Developed by JICA Study Team

5.4 EIA Progress

Along with the field survey, the Study Team also identified the progress of EIA implementation by PLN, and consulted with relevant authorities in Central Java Province and West Java Province.

BLH of Central Java confirmed that official approval of implementation of PLN's transmission line project as described in the 6th Regional Spatial Plan of Central Java Province 2009-2029 (*Rencana Tata Ruang Wilayah, RTRW*). BPLH of West Java also confirmed official approval of implementation of the project as described in the 22nd RTRW 2009-2029.

PLN concluded a contract with a local consulting firm PT. Dalla Billa Sejati as of 6 June 2011 until the end of March 2012 for implementing AMDAL from Ungaran to Mandirancan. The Study Team confirmed, as of the end of January 2012, that the local consultant had completed a preliminary survey on AMDAL and helped PLN hold public consultations between November and December 2011 as given in the table below, using handouts (see Appendix IV Distributed materials at Public Consultation) with the Department of Environment of Central Java Province (*Badan Lingkungan Hidup, BLH, Provinsi Jawa Tengah*) and the Department of Environment of West Java Province (*Badan Pengelolaan Lingkungan Hidup, BPLH*) (see Appendix V Announcement on EIA Procedure). They took minutes of the discussion and participants' comments are to be reflected into KA-ANDAL. But there were no comments from participant without requests of appropriate compensation on their assets (see Appendix VI Minuttes of Public Consultation).

Table 5. 14 Facts on Public Consultations on EIA Study from Ungaran to Mandirancan

Date	Venue		Remarks
	Regency	Province	
-	Semerang	Central Java	Omitted (Using results of EIA on Pedan to Ungaran)*
30/11/2011	Kendal		-
29/11/2011	Batang		-
24/11/2011	Pekalongan		-
24/11/2011	Pemalang		-
23/11/2011	Tegal		-
28/11/2011	Brebes		-
-	Cirebon	West Java	Joint meeting with Kuningan on 18 November 2011.
18/11/2011	Kuningan		-

(Source) PT. Dalla Billa Sejati

*As this 500Kv project had been explained to Semerang regency at Public Consultation of EIA on Pedan to Ungaran

Photo 5-7 Public Consultation in Kuningan

PLN explained project outline. Project details and potential impacts will be given during EIA implementation.

(Source) PT. Dalla Billa Sejati

Photo 5-8 Public Consultation in Kendal

Comments from participants obtained in the meeting are to be reflected into KA-ANDAL (TOR).

(Source) PT. Dalla Billa Sejati

Although PLN intended to get EIA approval at the end of April 2012, the whole progress is behind schedule as of the end of January 2012. Setting of public consultation meeting with concerned regencies, sub-districts and other stakeholders required PLN to spend more time on administrative procedures than PLN had envisioned. Furthermore PLN is mandated to conduct another two rounds of public consultations (one for explanation of KA-ANDAL, the other is for explanation of ANDAL) for the project-affected regencies of two provinces. The public consultation for explanation of KA-ANDAL is scheduled to be held on February 10th to 12th at the Central Government of Environment, following which PLN will compile KA-ANDAL in which stakeholders' opinions will be reflected.
As the locations of this Project are extended in two provinces, EIA approval will ultimately be made by the Minister of Environment as the authorizing agency based on the Government Regulation No.05 of 2008. The Provincial Governors are advised to provide opinions to the Technical Board of the Environment of each province, which should be reflected into.
Judging from overall reviews of original schedule and present conditions, PLN has envisaged the timing of final approval of EIA is to be middle of June 2012 at earliest and draws up the revised up-to-date schedule as shown in the next page.

As per another EIA from Mandirancan to Indramayu, PLN intends to obtain EIA approval on this route construction apart from the Ungaran to Mandirancan project by the end of September 2012, but PLN has not commenced the whole process as of January in 2012. The Study Team strongly recommends that PLN start the procedure at its earliest.

As per ANDAL, the Environmental Management Plan (RKL) and the Environmental Monitoring Plan (RPL), PLN has not yet developed them as of February 2012. The Study Team recommends that PLN take into consideration when completing ANDAL, RKL and RPL, the mitigation measures raised in Table 5.12 and Table 5.13, and the environmental management plan and monitoring plan introduced in Chapter 7.

Table 5. 15 Revised Schedule for EIA Implementation on EIA Study from Ungaran to Mandirancan

Activities	2011							2012						
	6	7	8	9	10	11	12	1	2	3	4	5	6	7
Acquisition of Budget for EIA (PLN)														
Execution of EIA														
1. Selection & Hiring Local Consultant by PLN	6 Jun 2011													
2. Participation of community in EIA preparation														
a. Announcement in daily Newspaper	OMITTED													
b. Announcement in board in project area														
c. Socialization (Public Meeting)							18 to 24 Dec							
d. Public response														
3. Determination of Assessment Method (Scoping) as TOR														
a. Drafting Assessment Method (Scoping)														
b. Submitted of TOR of EIA(Draft) to KLH									25 Jan 2012					
c. 1st Stakeholder and Technical Meeting (jointmeeting)														
i) Announcement of SHM														
ii) Holding a SHM									10-12 Feb					
d. Finalization of Assessment Method (Scoping)														
e. Approval of TOR of EIA by KLH														
5. Execution of EIA by Local Consultant														
a. Environmental Survey (sampling and analysis of data)														
- Site survey														
- Data analysis														
d. Examination of Mitigation Measures														
e. Evaluation														
f. Drafting EIA report														
6. Preparation of Related Action Plans by Local Consultant														
b. Environmental Management Plan (EMP)														
c. Environmental Monitoring Plan (EMP)														
7. Authorization of EIA														
a. Submission of EIA (DRAFT) Report to KLH											1 April			
b. 2nd Stakeholder and Technical meeting KLH (jointmeeting)														
i) Announcement of SHM														
ii) Holding a SHM														
c. Submission of Final EIA Report														
d. Approval of EIA														

(Source) Developed by JICA Study Team (As of January 19, 2012)

5.5 Social Impact

5.5.1 Land Acquisition and Compensation for Right of Way

PLN will be responsible for payment of land acquisition of tower locations and compensation for the Right of Way (ROW) in this project as stipulated in the Presidential Regulation No.36/2005 (dated May 3, 2005) and No.65/2006 (dated June 6, 2006). The amount of indemnity depends on the agreement amongst the related institutions with the affected people, among whom PLN and the affected people are two important parties who determine it.

Upon receiving yen-loan from the Government of Japan, PLN will be responsible for carefully following the JICA Guidelines. People whose means of livelihood are hindered or lost must be sufficiently compensated and supported by PLN in a timely manner. PLN and relevant government authorities must make efforts to enable people affected by the Project to improve their standard of living, income opportunities, and production levels, or at least to restore these to pre-project levels.

(1) Land Acquisition

Tower locations have been carefully chosen, so as not to conflict with any existing settlements. There will therefore not likely be any involuntary resettlement undertaken. However, PLN will pay for the owners of land acquired for tower sites comprised of mostly rice field, groves, and forests.

(2) Compensation for Right of Way

According to the tower schedule given by PLN, the transmission line route presently selected will cross over settlements, houses and other buildings, streets and rivers. Compensation for the ROW from Ungaran to Indramayu, which amounts approximately 1,100 ha for 343 km (17m each from center line (= 34m) except 71 ha acquired for tower locations).

5.5.2 Eligibility and Entitlement

A new Land Acquisition Law was endorsed by the House of Representatives in December 2011, which is expected to become effective within 2012. The Law sets the timeframe of every acquisition process, and the public (except those without any of land rights) can have more than one form of settlement, and are entitled to file a legal complaint and seek court rulings up to the Supreme Court if they disagree with the compensation settlement or the proposed land prices. It will accelerate each process and minimize the time to complete payment for land acquisition.

Apart from the new law, the present mechanism for defining eligibility and entitlement is as follows:

(1) Eligibility

Eligibility of communities and assets for obtaining redress and compensation are as following:

- Right holders to any lands acquired for the Project, with or without certificates;
- Tenants cultivating the land under share-cropping, rent or other arrangements;
- Nadzir or waqaf landholder (owner of religiously donated land);
- Owners of buildings and other structures, plants or other objects attached to the lands, and;
- Those individuals or groups who have any interest over land and buildings, plants and other objects attached to the land.

(2) Entitlement

According to the Presidential Regulation No. 36/2005 and No. 65/2006, redress and compensation will be given for land which is to be acquired and for buildings and other structures, crops, and other objects related to the land.

The forms of compensation can be:

- Cash;
- Land for land;
- Resettlement/relocation;

- Any combination of these types of compensation, and;
- Any form of compensation which is agreed by the parties concerned.
- The following table indicates entitlement matrix for Project Affected People (PAPs).

Table 5. 16 Entitlement Matrix for Eligible Project Affected People

Types of Loss	Object	Eligible PAPs	Compensation policy
Tower locations			
Loss of land	Project affected persons (PAPs) with land located in tower sites	Owners with land certificate or those who can prove land occupancy prior to cut-off date	• Cash • Substitute land • Other forms stipulates in the Presidential Decree No.36/2005 and No.65/2006
Loss of structure	Structures including houses and other types of buildings located in tower sites or part of them within buffer zone	Owners of the structure	• Cash • Construction of equivalent structure
Loss of crops such as rice/paddy, maize, soy bean, etc.	Crops cultivated in tower sites	Farmers who cultivated the land (landowner, tenant, etc)	• Cash compensation for affected crops based on local regulations for crops
Loss of trees	Trees located in tower sites or part of trees within buffer zone	PAP who utilize lands where trees are located	• Cash with equivalent value based on type, age and size of trees
Right of Way			
Compensation of land	PAP with land in the ROW other than tower sites	Owners with land certificate or those who can prove land occupancy prior to cut-off date	• Cash as stipulated in the MEMR Decision No.975.K/47/MPE/1999
Compensation of structure	Structures including houses and other types of buildings located in the ROW other than tower sites and buffer zones	Owners of the structure	• Cash as stipulated in the MEMR Decision No.975.K/47/MPE/1999

(Source) Presidential Regulation No. 36/2005, Presidential Regulation No. 65/2006, and MEMR Decision No.975.K/47/MPE/1999

(3) Cut-off Date

A cut-of date determines eligibility for entitlement. Anyone who enters project area after the cut-off date, whether they have lands certificate of ownership or not, will be identified as non-eligible. Cut-off date will also be applied as a consideration in taking any action due to eligible PAPs identification, and anticipation of unexpected increase of PAPs numbers. Any people moving inside the project area boundary or on to the ROW after cut-off date will not be considered as PAPs.

As those who live and/or work inside the project area boundary will be treated as PAPs whether they have legal titles or not when PLN applies yen loan assistance for the project, discretion in assessing the eligibility and preventive actions against further population influx without legitimacy are required.

Cut-off date should be declared before the census begins (or in the census) to nominate / determine PAPs. Census of PAPs and inventory of losses will be conducted for data collection of completing enumeration of all PAPs and their assets. Along with the census, stakeholder meetings should be implemented which target any person or organization involved in the project including PAPs, relevant local government authorities, community figures, etc. At such meetings, there is expected to be effective public disseminations of information on project area boundary, details of cut-off date declaration for entitlements, study progress and overall Project status. In order to prepare profile of PAPs, a socio-economic survey should be conducted for qualitative interview with sufficient number of samples of PAPs. The survey results should be used to (i) assess income, identify productive activities, and plan for income restoration; (ii) develop relocation options, and; (iii) develop social preparation phase for vulnerable groups. As EIA also requires socio-economic survey, the raw data and data analysis can be shared.

(4) Compensation Rates

According to the Presidential Regulations No. 36/2005 and No. 65/2006 is the basis for calculation of payment for land to be acquired and compensation for property acquired in the public interest. It discusses Tax Object Selling Price (NJOP) of land or market price with reference to NJOP; market value of building assessed by the relevant local government authority, and: market value of crops and trees assessed by the relevant local government authority. While NJOP may be the basis of calculation, in many cases this is far below current market prices.

According to the MEMR Decision No.975.K/47/MPE/1999, amount of compensation is calculated with the following formula:

Optimization of Land x Utilization Index of Function of Land and Building x Land Status x NJOP

Constants:

- Optimization of land: 0.1
- Utilization Index of Function of Land and Building
  - Building: 1
  - Land for building construction: 1
  - Garden: 0.5
  - Field and grove: 0.3
  - Rice field: 0.1
- Land Status
  - Land with right of ownership (*tanah hak milik*): 100%
  - Land with traditional right of ownership (*tanah hak milik adat*): 90%
  - Land with right of using structure (*tanah hak guna bangunan*): 80%
  - Land for lease (*tanah hak guna usaha*): 80%
  - Land with right of use (*tanah hak pakai*): 70%
  - Land for benefaction (*tanah wakaf*): 100%

While NJOP is the basis of calculation of cost for land acquisition of tower sites and compensation for ROW (See Chapter 6), it is below current market price as is often the case and thorough negotiations with PAPs will finally determine the price. The JICA Guidelines also stipulate that cash compensation levels for land acquisition should be sufficient to replace the lost land and other assets at full replacement cost in local markets, and that PAPs without land rights be fully paid attention to. Appropriate participation by PAPs and their communities must be promoted in the planning, implementation, and monitoring of measures to prevent the loss of their means of livelihood. Also appropriate and accessible grievance mechanisms must be established for them.

(5) Implementation Arrangements

PLN is the executing agency of this Project and will be responsible for planning, coordinating, implementing, monitoring and evaluating land acquisition and compensation activities. A Land Acquisition Committee (LAC) will be formed in each regency with representatives from local governments, the National Land Agency and other government representatives. Regional body for planning and development (*Badan Perencanaan Pembangunan Daerah, BAPPEDA*) of the Central Java and West Java will play the key role in coordinating and implementing the income restoration activities.

(6) Budget and Financing

Financial arrangements required for this Project will be spent for land acquisition of tower sites and compensation for ROW. Details of compensation cost is described in the next chapter.

(7) Implementation Schedule

Implementation schedule of land acquisition, compensation and income restoration activities are incorporated into the project implementation schedule.

(8) Grievance Procedure

There are grievances for lands to be acquired, compensation and procedures.

- Grievances for lands to be acquired

  This grievance should initially be addressed to the Project Engineers involved in construction works who will provide an alternative technical solution by redesigning the section concerned.

  Where a technical solution to the problem is not able to be obtained, the complaint should be referred to the LAC with a copy to the Regent (*Bupati*). The LAC should attempt to resolve the issue but if this is not possible, the matter should be referred to Regent to make a decision.
- Grievances for compensation

  According to the Presidential Decree No.36/2005 and Presidential Decree No 65/2006, PAPs are legitimately allowed to express their complaints regarding the accuracy of measurements and calculations including the amount of compensation offered to them as stated in the List of Measurements and Compensation in writing to the LAC within one month. They may request the assistance of village leaders to assist them in this matter. Whenever the dispute cannot be resolved between the PAPs and the LAC, the grievance will be addressed initially to the Regent for consideration, then the Governor and finally the Minister of Home Affairs.
- Grievance Regarding Procedures

  This will be addressed in writing to the LAC. The village head can be requested to provide assistance when required. Discussion between PAPs and the other party will be mediated by the LAC until the matter is resolved. When the matter cannot be resolved, the Regent should be requested to make decision.

Chapter 6 Transmission Line Facilities

6.1 Design of Transmission Lines

Design of transmission lines for the Project is carried out via the following flow.

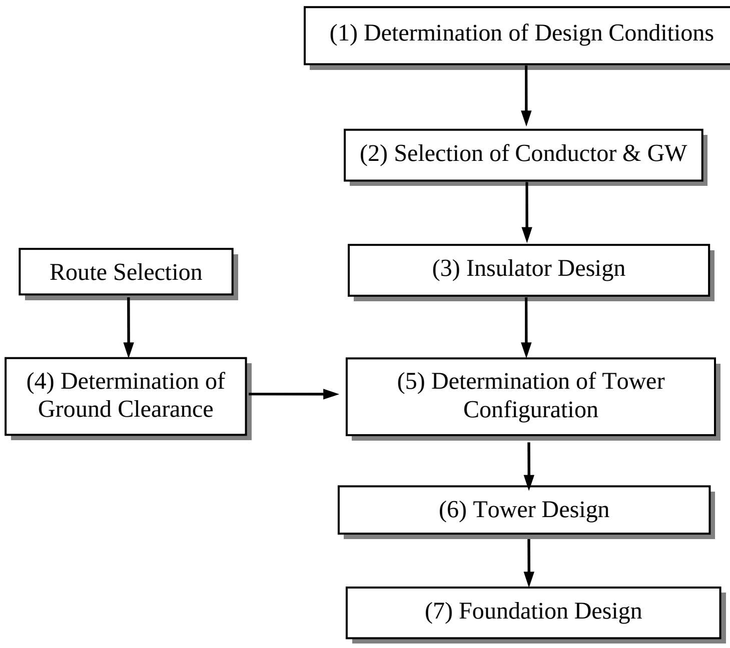

Figure 6. 1 Flow of Design for the Project

6.1.1 Determination of Design Conditions

Since the Project connects to 500 kV transmission line between Tanjung Jati B and Tx that is currently under construction and to be completed as a continuous transmission line facility in the future, the design conditions are unified as per Tanjung Jati B - Tx line.

Basic design conditions are as mentioned below

(1) Atmospheric Temperature

Maximum air temperature: 40 ºC
Minimum air temperature: 10 ºC
Annual mean air temperature: 27 ºC

(2) Wind Velocity

10 minutes mean wind velocity is 25 m/s at 10 m height

(3) Wind Pressure

Conductor:	400 N/m2
Insulator string:	600 N/m2
Tower:	1,200 N/m2

(4) Stringent (the most severe design) Condition and EDS (Every Day Stress) Condition
The conditions were determined as follows.

Condition	Temperature	Wind
Stringent	10 ºC	25 m/s
EDS	27 ºC	Still air

(5) Maximum Annual Rainfall
2,300 mm

(6) Isokeraunic Level (IKL)
100 days

(7) Other conditions assumed
Maximum humidity: 100 %

(8) Safety Factors
Required minimum safety factors for facilities of transmission lines were determined as follows.
(a) Conductor/Ground-wire
- 2.5 to UTS (Ultimate Tensile Strength) for stringent condition

(b) Insulator string
- 2.5 to RUS (Rated Ultimate Strength) for maximum working tension at supporting point

(c) Tower
- 1.5 to yield strength of material under Normal Condition (= stringent condition)
- 1.1 to yield strength of material under Broken-wire Condition (= normal condition + one ground-wire or one phase conductor breakage)

(d) Foundation
- 2.0 under Normal Condition
- 1.5 under Broken-wire Condition

6.1.2 Conductor and Ground Wire Design

(1) Conductor and ground-wire
The system analysis up to 2020 proved that ACSR 429 mm2 (Zebra), 4 bundles for the conductor are appropriate for this Project. Therefore, ACSR/AS 429 mm^2, AS 95 mm^2 and OPGW 100 mm^2 for conductors and ground-wires are applied as the same as the facilities of Tanjung Jati B – Tx line. The technical characteristics of the conductor and ground-wire are shown in Table 6. 1 and Table 6. 2.

Table 6. 1 Technical Characteristics of Conductor

Type	ACSR/AS 429 mm^2 (EN (BS): Zebra)
Component of stranded wires	Al: 54/3.18 mm St: 7/3.18 mm
Total area of aluminum wires	428.9 mm^2
Overall diameter	28.62 mm
Weight	1,524 kg/km
Ultimate tensile strength	131.9 kN
Modulus of elasticity	73,300 N/ mm^2
Coefficient of linear expansion	17.5 x 10^{-6}/ ºC
DC resistance at 20 ºC	0.0674 Ω/km

Table 6. 2 Technical Characteristics of Ground-wire

Type	AS 95 mm^2	OPGW 100 mm^2
Component of stranded wires	St: 19/2.5 mm	23AC: 8/3.8 mm OP unit: 1/6.0
Total area of solid wires	93.27 mm^2	105.4 mm^2
Overall diameter	12.5 mm	13.4 mm
Weight	626 kg/km	613.0 kg/km
Ultimate tensile strength	121.4 kN	98.3 kN
Modulus of elasticity	147,000 N/ mm^2	149,000 N/ mm^2
Coefficient of linear expansion	15.0×10^{-6}/ ºC	12.9×10^{-6}/ ºC
DC resistance at 20 ºC	0.925 Ω/km	0.411 Ω/km
Number of optical fiber	-	12

(2) Maximum Working Tension and Every Day Stress (EDS)

As the maximum span length is measured to be 666 m at the span between T.125 and T.126, the maximum design span length is assumed to be 700 m including the difference of the towers elevation. The values of the maximum working tensions and the EDS of both the conductor and ground-wire satisfy the determined safety factors as shown in Table 6. 3.

Table 6. 3 Maximum Working Tension and Every Day Stress (Span length =700 m)

Type	UTS	Tension		Safety Factors
ACSR/AS 429 mm^2	131.9 kN	Maximum Tension	39.2 kN	3.36 > 2.5
		Every Day Stress	26.3 kN	5.02 > 5.0
AS 95 mm^2	121.4 kN	Maximum Tension	20.1 kN	6.04 > 2.5
		Every Day Stress	14.2 kN	8.55 > 5.0
OPGW 100 mm^2	98.3 kN	Maximum Tension	20.7 kN	4.75 > 2.5
		Every Day Stress	14.1 kN	6.97 > 5.0

(3) Sags and tensions of the ground-wires

The sags of the ground-wires under EDS condition must be below 80% of the conductors' sag at the standard span length for avoiding a reverse flashover from the ground-wire to the conductors and direct lightning stroke to the conductors. The tensions of the ground wires are determined to satisfy the safe separation of conductors and ground-wires in the mid-span

(4) Standard span length

Standard span length between towers: 450 m.

6.1.3 Insulator Design

(1) Insulator type and size

(a) Type:

Insulator unit applied to the transmission lines is a standard disc type porcelain insulator with ball and socket, complying with IEC 60305.

(b) Size:

Table 6. 4 Insulator Size

Type	Height	Diameter	R.U.S. (*)	Applied Area
U210 BP	170 mm	330 mm	210 kN	More than 5 km from sea

(*: RUS: Rated Ultimate Strength)

(2) Number of insulator units per String

For the 500 kV transmission line, the number of insulator unit per string of the standard set applied 26 units as same as the design conditions of Tanjung Jati B- Tx line.

(3) Mechanical strength of insulator

- Safety factors of insulator:
  Mechanical strengths of insulator sets were determined so as to satisfy following minimum safety factors.

Table 6. 5 Minimum Safety Factors of Insulator Sets

Loading condition	Safety factors
Stringent condition	2.5 (40%RUS)

- Number of insulator strings per set:
  Number of insulator strings per set is either single or double, which was determined in accordance with the line crossing places and based on the safety factors shown in Table 6. 5.

(4) Tension insulator assembly

Double string of the 210 kN insulator is applied to all tension insulator assemblies for the Project. Insulator fittings also have to keep the same strength as the insulators.

Table 6. 6 Tension Insulator Assemblies

Conductor	Maximum Tension (Span length: 700 m)	Suspension and tension insulator assemblies	Safety factor
ACSR/AS 429 mm^2	160 (40kN x 4) kN	Double strings of 420 kN (210kN x 2)	2.62 > 2.5

6.1.4 Ground Clearance

The most severe state for the ground clearance of the conductors will occur when the conductor's temperature rises to 80 ºC under still air condition. The minimum height of the conductor above ground at 500 kV level is determined as below.

Table 6. 7 Minimum Height of Conductor above Ground

Classification	Applied areas for the Project	Height
Open field area	Bush lands, grass lands, paddy fields	18.0 m
Crossing point of roads and railways	National and district roads	18.0 m
General field area	Residential areas, areas where houses will be built in the future	8.5 m

6.1.5 Determination of Tower Configuration

(1) Clearance Design

The clearance design was applied using the same values of Tanjung Jati B- Tx line.

Table 6. 8 Swinging Angle (Only Tension Tower)

Wind Velocity	15 m/sec
Swinging angle of conductor	15 deg

Table 6. 9 Values of Clearance Diagram for Tower

Tower type	Item	Values
Suspension and tension tower	Clearance of Switching Impulse (Swinging angle 15 deg)	4,400 mm

(2) Insulation design of the ground-wires

Number and shielding angle of the ground-wires were determined as below:

- Number: 2
- Maximum shielding angle: 0 deg

(3) Tower Configurations

The towers shall normally be of the following 6 standards types.

Table 6. 10 Tower Types and the Applied Conditions

Type (Double Circuit)	Position of Use	Angle of Deviation or Entry	Type of Insulator
AA (Figure 6.2)	Straight Line	0 – 5	V-Suspension
BB (Figure 6.3)	Angle	0 – 10	Tension
CC (Figure 6.3)	Angle	10 – 30	Tension
DD (Figure 6.4)	Angle	30 – 60	Tension
EE (Figure 6.4)	Angle	60 – 90	Tension
FF (Figure 6.4)	Terminal	0 – 45	Tension

Table 6. 11 Unit Weight of the Towers

Tower extension [m]	AA [ton]	BB [ton]	CC [ton]	DD [ton]	EE [ton]	FF [ton]
-3	36	55	58	90	-	-
0	38	56	61	96	-	87
+3	40	61	65	99	-	97
+6	42	62	68	103	102	-
+9	44	66	73	109	-	-
+12	46	67	-	-	-	-
+15	48	-	-	-	-	-

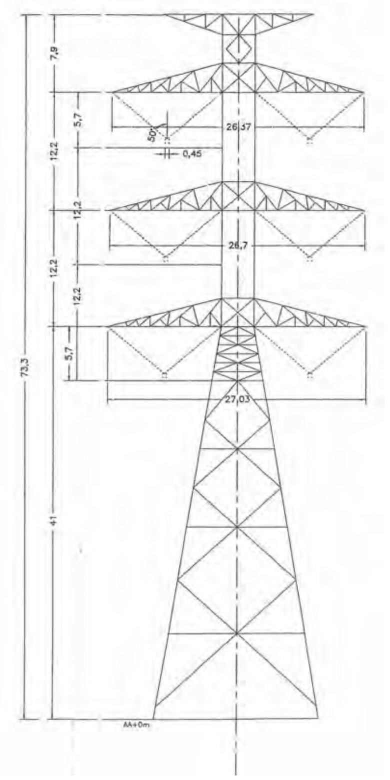

Figure 6. 2 Type "AA" Tower

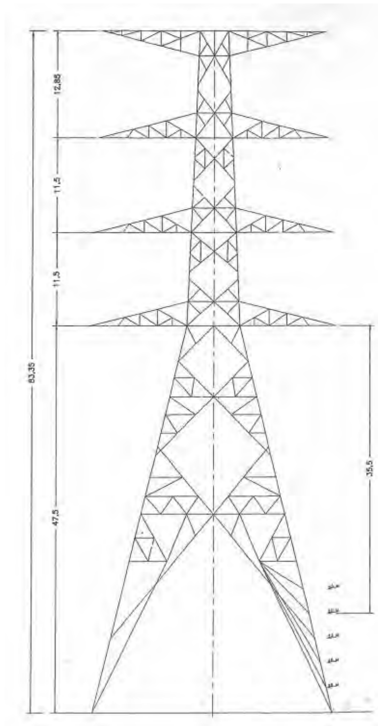

Figure 6. 3 Type "BB-CC" Tower

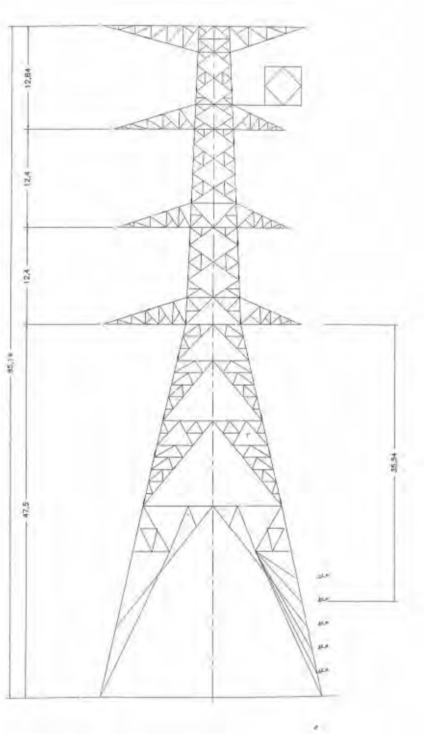

Figure 6. 4 Type "DD-EE-FF" Tower

6.1.6 Foundation Configuration

According to the result of simple boring by sounding which was conducted totally 25 points along the line route, the team confirmed the sufficient bearing capacities of bearing layer that “more than 200 kN/m2 at 6 meters depth” at most points except some of valleys where covered by deep hidden soft sediments.

Therefore, it can be assumed that the normal pad and chimney type foundations (Figure 6. 5) are applicable to all towers in the Project. Additionally, the assumed foundation loads that are transmitted from each tower are shown in Table 6. 12.

Final foundation type at each tower including possibility of appearance of pile foundation shall be examined by results of real boring at detail design stage.

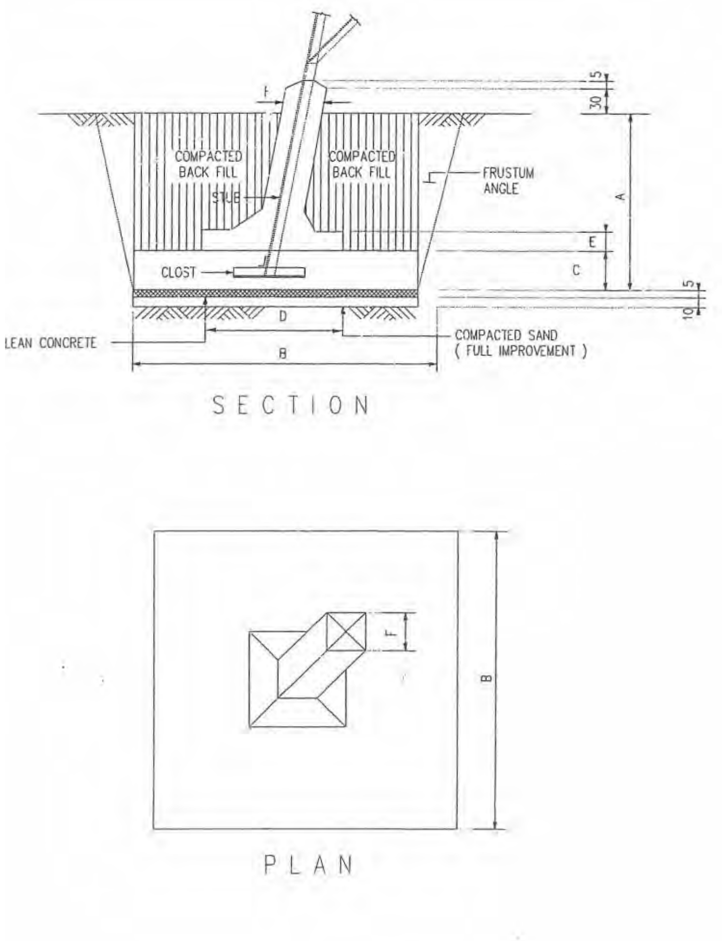

Figure 6. 5 500 kV T/L Foundation Type Pad and Chimney

Table 6. 12 Assumed Foundation Loads (Reference)

Tower type	Compressive load [kN]	Tensile load [kN]
AA	580	320
BB	820	470
CC	890	510
DD	1,400	800
EE	1,500	810
FF	1,270	730

6.2 Design of Substation Facilities

6.2.1 Design Concept

(1) Design Particulars for Substation Facilities

IEC standards are applied to the design of new substation facilities and their extensions thereof. IEC-600711[12] and IEC-606942[13] are applied to the insulation design of the substation facilities with the following latest and relevant IEC standards/recommendations having been applied to the design of the substation facilities.

Table 6. 13 Standards Applied to the Design

Equipment	Standard Applied	
Transformers	IEC-60076	Power transformers
Circuit breakers	IEC-60056	High voltage alternating-current circuit breakers
Disconnectors	IEC-60129	lternating current disconnectors and earthing switch
Current Transformers	IEC-60185	Current transformers
Voltage Transformers	IEC-60186	Voltage transformers
Lightning Arresters	IEC-60099	Surge arresters

(2) Coordination with the Existing Substation Facilities

The specifications and the layout of the existing substation facilities in Indonesia are not standardized, rather they are different from one to the next depending on the time of construction or the facility designers. Accordingly, the specifications and layout of the facilities for the Project should be determined by coordinating with the existing facilities in each substation.

(3) Busbar System

The 500kV busbar system of Mandirancan S/S is one-and-a-half CB system. While the 500kV busbar system of Indramayu S/S is planned one-and-a-half CB system.[14] Therefore the 500kV busbar system of new Pemalang S/S is also planned one-and-a-half CB system to assure the ease of switching operations and system reliability. Meanwhile the 150kV busbar system of Mandirancan S/S and Indramayu S/S is planned double busbar system. Therefore the 150kV busbar system of Pemalang S/S is also planned double busbar system to assure the ease of switching operations and the system.

(4) Main Transformer

The required capacity of 500kV transformers at Pemalang S/S is planned to be up to 190.9MVA in 2014 according to "RUPTL 2011-2020". This number and the capacity of the 500kV transformer is designed based on the reliability criteria of "N-1", therefore two new 500kV transformers shall be installed in this study according to the coordination with the existing facilities in each substation. The total capacity of Pemalang S/S is 1000MVA.

(5) Protection of transmission line

According to the Indonesia Grid code, transmission line is classified by SIR (source to line impedance ratio).

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[12] IEC-60071: Insulation co-ordination
[13] IEC-60694: Common Specification for high-voltage switchgear and control gear standards
[14] Preparatory Survey for Indramayu Coal-fired Power Plant Project in Indonesia Final Report (2009.12) JICA

Based on Grid code, transmission line with SIR bigger than 4.0 is classified short line, SIR between 0.5 and 4.0 is classified medium Line and SIR smaller than 0.5 is classified long Line.
But PLN simply classify the transmission line based on following criteria.
But for simplification in 500 kV System:

- ✓ Short line: length is shorter than 12 km
- ✓ Medium line: length is between 12 km and 90 km
- ✓ Long line: length is longer than 90 km

In both medium and short line 500 kV System, PLN use redundancy (Main A and Main B) for each protected line using fiber optic as the teleportation medium. Type of relay explained as follows;

- ✓ Main A: Line Current Differential with Distance+DEF internally or externally
- ✓ Main B: Line Current Differential with Distance+DEF internally or externally

For long line in 500 kV System we also use redundancy for each protected line. Fiber Optic is used as the teleportation medium for main A and PLC as the teleportation medium for main B. Type of relay explained as follows;

- ✓ Main A: Distance + DEF with teleportation
- ✓ Main B: Distance + DEF with teleportation

In 150 kV systems for medium line and short line, type of relay explained as follows;

- ✓ Main: Line Current Differential with Distance+DEF internally or externally
- ✓ Backup: Over current relay

An in 150 kV systems for Long line, type of relay explained as follows;

- ✓ Main: Distance with teleportation
- ✓ Backup: Over current relay

Therefore the following protective relay system will be applied to this project for main relay.

- ✓ 500 kV: Distance + DEF with teleportation
- ✓ 150kV: Distance with teleportation

6.2.2 Design for Pemalang Substation

(1) Facilities layout

Equipment layout is studied in this study according to the scope of work for the 4.1 project and design concept of 6.2.1. Four diameters of 500kV, two transformer bays, two 500kV main transformers, four bays of 150kV and two 150kV transformers shall be designed in this study. However, it is necessary to design the layout of all transmission lines and transformers installed by other projects and future projects in order to create an efficient design. A single line diagram of the substation, including future facilities, is shown in Appendix II.

(2) Specification of main facilities

(a) 500kV main transformer

Two new 500kV transformers (IBT #1,2) shall be added. The new transformers bank shall have three single-phase tanks and shall be a three-winding type as per other existing substation.
The transformers shall be oil-immersed with an ONAN/ONAF cooling type. The single-phase capacity rating shall be 166.7 MVA each ONAN and ONAF. The total capacity rating of the transformer, each consisting of three single-phase units, shall be 500 MVA according to the coordination with the existing facilities in each substation.
A separated tank shall be provided for the on-load tap changer. The neutral of the primary and secondary of the transformer shall be solidly ground. The transformer shall be designed according to the IEC 60076 standard.
Other main specifications are shown below:

Type	core type
Mounting	outdoor
Rated voltage ratio	500/168/71.5 kV
Rated frequency	50 Hz
Vector group	YNyn0d1
Rated lightning impulse withstand voltage (phase to earth)	
HV terminal	1550 kV
MV terminal	750 kV
LV terminal	350 kV

Main facilities for two bays are described as shown in Appendix II. They shall be designed according to the IEC standard.

(b) 150kV transformer

Two new 150kV transformers (IBT #1,2) shall be added. The new transformers bank shall have a three-phase tank and shall be a three-winding type like other existing substation.
The transformers shall be oil-immersed with an ONAF cooling type. The total capacity rating of the transformer shall be 60 MVA according to the coordination with the existing facilities in each substation.
A separated tank shall be provided for the on-load tap changer. The neutral of the primary and secondary of transformer shall be solidly ground. The transformer shall be designed according to the IEC 60076 standard.
Other main specifications are shown below.

Type	core type
Mounting	outdoor
Rated voltage ratio	150/20 kV
Rated frequency	50 Hz
Vector group	YNyn0(d)
Rated lightning impulse withstand voltage (phase to earth)	

HV terminal	750 kV
MV terminal	150 kV

Main facilities for the two bays are described as shown in Appendix II. They shall be designed according to the IEC standard.

(c) 500kV switchgear

Six new bays for two feeders from Tanjung Jati, two feeders to the Mandirancan and two transformer banks shall be added in this study.
The main facilities for ten bays are described as shown Appendix II. They shall be designed according to the IEC standard.

1) Circuit breaker

The 500kV circuit breaker shall be the SF6 gas Type, single-pole operated with two interrupters per phase. The circuit breaker shall be designed according to the IEC 60056 standard. In addition, operating time for the breaker to be opened is 90 ms including the operating time and the relay must operate within 20 ms in 500kV system.
Other main specifications are shown below.

Type	live tank type
Rated voltage	550 kV
Rated frequency	50 Hz
Rated short-circuit breaking current	50 kA
Rated current	4000 A
Rated lightning impulse withstand voltage	1800 kV

2) Disconnector

The 500kV disconnection switch shall be a single pole operated with a horizontal break motor operated type.
The main specifications are shown below.

Type	live tank type
Rated voltage	550 kV
Rated frequency	50 Hz
Rated current	4000 A
Rated lightning impulse withstand voltage	1800 kV

3) Lightning arrester

500kV lightning arresters shall be designed according to the IEC 60099 standard.
The main specifications are shown below.

Type	ZnO type
Rated voltage (r.m.s.)	420 kV
Continuous operating voltage	$550/\sqrt{3}$ kV
Rated discharge current	20 kA
Rated frequency	50 Hz

4) Current transformer

500kV current transformer shall be the oil-filled type.
The main specifications are shown below:

Type	live tank type
Rated voltage	550 kV

Rated frequency	50 Hz

5) Voltage transformer

500kV voltage transformer shall be of the oil filled type.
Main specifications are shown below.

Type	live tank type
Rated voltage	500 kV
Rated frequency	50 Hz
Rated lightning impulse withstand voltage	1800 kV

6) Line trap

Rated continuous current	4000 A
Coil inductance	1.0 mH

7) Protective relay system

The following protective relay system will be applied to this project.

500kV Transformer protection

- ✓ Circulating current differential protection
- ✓ High impedance restricted earth fault
- ✓ Over-current protection
- ✓ Neutral earth fault relay
- ✓ Transformer differential protection
- ✓ Over load protection

500kV Transmission Line Protection

- ✓ High speed multi-zone phase and earth fault distance impedance protection
- ✓ Instantaneous directional earth fault protection
- ✓ Over-current protection
- ✓ Fault locator phase and earth fault
- ✓ Auto-reclosing relay
- ✓ Breaker failure relay.
- ✓ Synchro check relay

500kV Bus bar Protection

- ✓ CCP
- ✓ CBF

(d) 150kV switchgear

Six new bays for four 150kV line feeders and two transformer banks shall be added in this study. And one coupler bay also shall be added in this study.
Facilities shall be designed according to the IEC standard.

1) Circuit breaker

The 150kV circuit breaker shall be a SF6 gas Type, single-pole/three-poles operated with two interrupters per phase. The circuit breaker shall be designed according to the IEC 60056 standard.
Other main specifications are shown below.

Type	live tank type
Rated voltage	150kV
Rated frequency	50 Hz
Rated short-circuit breaking current	50 kA
Rated current	3150 A

Rated lightning impulse withstand voltage	750kV

2) Disconnector

The 150kV disconnector switch shall be a single pole operated with a vertical break type motor operated.

Main specifications are shown below.

Type	live tank type
Rated voltage	150 kV
Rated frequency	50 Hz
Rated current	3150A
Rated lightning impulse withstand voltage	750kV

3) Lightning arrester

150kV lightning arresters shall be designed according to the IEC 60099 standard.

Main specifications are shown below.

Type	ZnO type
Rated voltage	150kV
Rated voltage (r.m.s.)	$150/\sqrt{3}$ kV
Rated discharge current	20kA
Rated frequency	50 Hz

4) Current transformer

150kV current transformer shall be oil filled type.

Main specifications are shown below.

Type	live tank type
Rated voltage	150kV
Rated frequency	50 Hz

5) Voltage transformer

150kV voltage transformer shall be of oil filled type.

Main specifications are shown below.

Type	live tank type
Rated voltage	150kV
Rated frequency	50 Hz
Rated lightning impulse withstand voltage	750kV

6) Protection relay

150kV Transformer protection

- ✓ Circulating current differential protection
- ✓ High impedance restricted earth fault
- ✓ Over-current protection
- ✓ Neutral earth fault relay
- ✓ Transformer differential protection
- ✓ Over load protection

150kV Transmission Line Protection

- ✓ High speed multi-zone phase and earth fault distance impedance protection
- ✓ Instantaneous directional earth fault protection
- ✓ Over-current protection

- ✓ Fault locator phase and earth fault
- ✓ Auto-reclosing relay
- ✓ Breaker failure relay
- ✓ Synchro check relay

150kV Bus bar Protection

- ✓ Circulating current differential protection
- ✓ Under voltage protection

6.2.3 Design for Mandirancan Substation

(1) Facilities layout

The equipment layout is looked at in this study according to the scope of the works for the project of 4.1 and the design concept of 6.2.1. The two diameters of 500kV shall be designed in this study. The specifications and layout of the facilities for the Project should be determined by coordinating with the existing facilities in the Mandirancan substation. A single line diagram of the substation, including future facilities, is shown in Appendix II.

(2) Capacity of Busbar

The Busbar capacity of the existing Mandirancan substation is 4000A. If new transmission lines are installed between Mandirancan substation from Pemalang substation, the designed total capacity of four transmission lines from Pemalang substation (2291A (Ganet)*2+ 3016A (Zebra400mm2)*2) is 10,614A. Therefore busbars reinforcement is needed, because the necessary busbar capacity is 5,307A. And with reinforcing of busbars, upgrading of current transformers is required.

(3) Specification of the main facilities

(a) 500kV switchgear

Four new bays for two feeders from Pemalang and two feeders to Indramayu shall be added in this study.

Main facilities for four bays are described as shown in Appendix II. They shall be designed according to the IEC standard.

1) Circuit breaker

A 500kV circuit breaker shall be of the SF6 gas Type, single-pole operated with two interrupters per phase. The circuit breaker shall be designed according to the IEC 60056 standard.

Other main specifications are shown below.

Type	live tank type
Rated voltage	550 kV
Rated frequency	50 Hz
Rated short-circuit breaking current	50 kA
Rated current	3150 A
Rated lightning impulse withstand voltage	1800 kV

2) Disconnector

The 500kV disconnection switch shall be a single pole operated with a horizontal break type motor operated.

Type	live tank type
Rated voltage	550 kV
Rated frequency	50 Hz
Rated current	3150 A
Rated lightning impulse withstand voltage	1800 kV

3) Lightning arrester

The 500kV lightning arresters shall be designed according to the IEC 60099 standard. Main specifications are shown below.

Type	ZnO type
Rated voltage (r.m.s.)	420 kV
Continuous operating voltage	$550/\sqrt{3}$ kV
Rated discharge current	20 kA
Rated frequency	50 Hz

4) Current transformer

500kV current transformer shall be oil filled type.
Main specifications are shown below.

Type	live tank type
Rated voltage	550 kV
Rated frequency	50 Hz

5) Voltage transformer

500kV voltage transformer shall be of oil filled type.
Main specifications are shown below.

Type	live tank type
Rated voltage	500 kV
Rated frequency	50 Hz
Rated lightning impulse withstand voltage	1800 kV

6) Line trap

Rated continuous current	4000 A
Coil inductance	1.0 mH

7) Protection relay system

The following protection relay system will be applied to this project.

500kV Transmission Line Protection

- ✓ High speed multi-zone phase and earth fault distance impedance protection
- ✓ Instantaneous directional earth fault protection
- ✓ Over-current protection
- ✓ Fault locator phase and earth fault
- ✓ Auto-reclosing relay
- ✓ Breaker failure relay
- ✓ Synchro check relay

6.2.4 Design for Indramayu Substation

(1) Facilities layout

The equipment layout is specified in this study according to the scope of work for the project of 4.1 and the design concept of 6.2.1. The two diameters of 500kV shall be designed in this study. The specifications and layout of the facilities for the Project should be determined by coordinating with the planned facilities in the Indramayu substation. A single line diagram of the substation, including future facilities, is shown in Appendix II.

(2) Specification of main facilities

(a) 500kV switchgear

Two new bays for two feeders from Mandirancan shall be added in this study.
The main facilities for the two bays are described as shown in Appendix II. They shall be designed according to the IEC standard.

1) Circuit breaker

The 500kV circuit breaker shall be of the SF6 gas Type, single-pole operated with two interrupters per phase. The circuit breaker shall be designed according to the IEC 60056 standard.
Other main specifications are shown below.

Type	live tank type
Rated voltage	550 kV
Rated frequency	50 Hz
Rated short-circuit breaking current	50 kA
Rated current	3150 A
Rated lightning impulse withstand voltage	1800 kV

2) Disconnector

The 500kV disconnection switch shall be a single pole operated with a horizontal break type motor.
Main specifications are shown below.

Type	live tank type
Rated voltage	550 kV
Rated frequency	50 Hz
Rated current	3150 A (4000A for Bus Pantograph)
Rated lightning impulse withstand voltage	1800 kV

3) Lightning arrester

500kV lightning arresters shall be designed according to the IEC 60099 standard.
Main specifications are shown below.

Type	ZnO type
Rated voltage (r.m.s.)	420 kV
Continuous operating voltage	$550/\sqrt{3}$ kV
Rated discharge current	20 kA
Rated frequency	50 Hz

4) Current transformer

500kV current transformer shall be an oil-filled type.
Main specifications are shown below.

Type	live tank type
Rated voltage	550 kV
Rated frequency	50 Hz

5) Voltage transformer

500kV voltage transformer shall be an oil-filled type.
Main specifications are shown below.

Type	live tank type
Rated voltage	500 kV
Rated frequency	50 Hz
Rated lightning impulse withstand voltage	1800 kV

6) Line trap

Rated continuous current	4000 A
Coil inductance	1.0 mH

7) Protection relay system

The following protection relay system will be applied to this project.

500kV Transmission Line Protection

- ✓ High speed multi-zone phase and earth fault distance impedance protection
- ✓ Instantaneous directional earth fault protection
- ✓ Over-current protection
- ✓ Fault locator phase and earth fault
- ✓ Auto-reclosing relay
- ✓ Breaker failure relay
- ✓ Synchro check relay

6.3 Quantities of Transmission Line Materials

6.3.1 Number of Towers and Total Weight of Towers

Based on the tower schedule prepared by PLN, the tower types, the number of towers and their total weight necessary for the Project are summarized in Table 6. 14. Type-AA is suspension tower and others are tension towers.

Table 6. 14 Number of Towers and Total Weight of Towers

Tower type	Extension	Unit weight [ton]	Tx - Pemalang		Pemalang - Mandirancan		Mandirancan - Indramayu		Total	
			Tower [unit]	Subtotal [ton]	Tower [unit]	Subtotal [ton]	Tower [unit]	Subtotal [ton]	Tower [unit]	Total weight [ton]
AA	-3	36	2	72	41	1,476	0	0	43	1,548
	0	38	35	1,330	98	3,724	69	2,622	202	7,676
	+3	40	41	1,640	113	4,520	75	3,000	229	9,160
	+6	42	33	1,386	43	1,806	20	840	96	4,032
	+9	44	28	1,232	24	1,056	5	220	57	2,508
	+12	46	3	138	0	0	5	230	8	368
	+15	48	1	48	0	0	2	96	3	144
BB	-3	55	1	55	4	220	0	0	5	275
	0	56	8	448	4	224	6	336	18	1,008
	+3	61	12	732	8	488	3	183	23	1,403
	+6	62	7	434	3	186	2	124	12	744
	+9	66	6	396	1	66	0	0	7	462
	+12	67	3	201	0	0	2	134	5	335
CC	-3	58	0	0	4	232	0	0	4	232
	0	61	2	122	6	366	4	244	12	732
	+3	65	5	325	12	780	4	260	21	1,365
	+6	68	4	272	3	204	1	68	8	544
	+9	73	3	219	0	0	1	73	4	292
DD	-3	90	0	0	5	450	0	0	5	450
	0	96	2	192	8	768	2	192	12	1,152
	+3	99	4	396	7	693	4	396	15	1,485
	+6	103	1	103	4	412	1	103	6	618
	+9	109	2	218	0	0	0	0	2	218
EE	+6	102	1	102	0	0	1	102	2	204
FF	0	87	1	87	1	87	1	87	3	261
	+3	97	1	97	1	97	0	0	2	194
Total			206	10,245	390	17,855	208	9,310	804	37,410

*1: GG type tower is calculated as BB type tower.

*2: Drd type tower is calculated as DD type tower.

6.3.2 Quantities of Conductor and Ground Wire

Quantities of conductor and ground wires for the Project were computed by multiplying the number of conductor or ground wire by the route length [km], and multiplying that number by 1.05 for the sag allowance and margin for stringing works.

Table 6. 15 Quantities of Conductor and Ground Wire

Conductor/ Ground wire type	No. of bundles	No. of Phases	No. of Circuits	Tx - Pemalang		Pemalang - Mandirancan		Mandirancan - Indramayu		Total
				Route length [km]	Line length [km]	Route length [km]	Line length [km]	Route length [km]	Line length [km]	Line length [km]
ZEBRA 429/56 mm^2	4	3	2	86.10	2169.7	166.90	4205.9	89.60	2257.9	8633.5
OPGW 100 mm^2	1	-	1	86.10	90.4	166.90	175.2	89.60	94.1	359.7
AS 95 mm^2	1	-	1	86.10	90.4	166.90	175.2	89.60	94.1	359.7

6.3.3 Quantities of Insulator and Insulator Assemblies

Quantities of insulator and insulator assemblies for the Project were computed from number of suspension and tension towers, including number of double string assemblies that are applied to important crossing sections. These are shown in Table 6. 16.

Table 6. 16 Quantities of Insulator and Insulator Assemblies

Foundation type	Tower type	Unit concrete volume [m^3]	Tx - Pemalang		Pemalang - Mandirancan		Mandirancan - Indramayu		Total	
			Tower [unit]	Subtotal [m^3]	Tower [unit]	Subtotal [m^3]	Tower [unit]	Subtotal [m^3]	Tower [unit]	Total concrete volume [m^3]
Pad and Chimney	AA	69	143	9,867	319	22,011	176	12,144	638	44,022
	BB	119	37	4,403	20	2,380	13	1,547	70	8,330
	CC	140	14	1,960	25	3,500	10	1,400	49	6,860
	DD	200	9	1,800	24	4,800	7	1,400	40	8,000
	EE	278	1	278	0	0	1	278	2	556
	FF	286	2	572	2	572	1	286	5	1,430
Total			206	18,880	390	33,263	208	17,055	804	69,198

*1: GG type tower is calculated as BB type tower.
*2: Drd type tower is calculated as DD type tower.

6.3.4 Quantities of Tower Foundations

Quantity of reinforced concrete of the foundations for 6 types of towers is summarized in Table 6. 17.

Table 6. 17 Quantities of Tower Foundations

Foundation type	Tower type	Unit concrete volume [m^3]	Tx - Pemalang		Pemalang - Mandirancan		Mandirancan - Indramayu		Total	
			Tower [unit]	Subtotal [m^3]	Tower [unit]	Subtotal [m^3]	Tower [unit]	Subtotal [m^3]	Tower [unit]	Total concrete volume [m^3]
Pad and Chimney	AA	69	143	9,867	319	22,011	176	12,144	638	44,022
	BB	119	37	4,403	20	2,380	13	1,547	70	8,330
	CC	140	14	1,960	25	3,500	10	1,400	49	6,860
	DD	200	9	1,800	24	4,800	7	1,400	40	8,000
	EE	278	1	278	0	0	1	278	2	556
	FF	286	2	572	2	572	1	286	5	1,430
Total			206	18,880	390	33,263	208	17,055	804	69,198

*1: GG type tower is calculated as BB type tower.
*2: Drd type tower is calculated as DD type tower.

6.3.5 Spare Parts, Tools and Measuring Devices

Design specifications of the transmission line for the Project are common to the whole line. Since maintenance work of the transmission line after completion of the Project will be carried out by PLN branch offices, it is necessary to provide spare parts, tools and measuring devices considering common stock among branch offices. Although items and quantities thereof will be determined in the detail design stage of the Project, it is assumed that the principal items are as follows;

(a) Transmission line materials for maintenance:
Complete set of standard towers, galvanized steel materials and bolts for replacement of damaged members, spares of conductor, ground wires and their fittings, insulators and their fittings, etc.

(b) Tools and measuring devices:
Insulator replacing devices, tools for repair works, insulated earthing rods, insulation resistance testers, equipment for maintenance staffs, vehicles for facilities' inspection, etc.

Estimate cost of spare parts, tools and measuring devices for the Project is assumed to be approximately 5% of the total costs of the transmission line materials.

6.4 Quantities of Substation Facilities

6.4.1 Quantities of Pemalang Substation Materials

With reference to the single line diagram and layout drawing, the quantity of the main facilities is shown in the following table.

Table 6. 18 Quantity of Main Facilities for Pemalang S/S

No.	Items	Number of unit
1	500MVA 500/168/71.5kV Transformer (3-phase)	2 set
2	500kV Circuit Breaker (3-phase)	10 set
3	500kV Disconnecting Switch with Ground (3-phase)	6 set
4	500kV Disconnecting Switch (3-phase)	26 set
5	500kV Current transformer for Diameter (3-phase)	10 set
6	500kV Current transformer for Line Protection (3-phase	4 set
7	500kV Voltage transformer for Instrument (3-phase)	8 set
8	500kV Voltage transformer for Line Protection (3-phase	4 set
9	500kV Lightning arrester (3-phase)	12 set
10	500kV Line trap (3-phase)	4 set
11	100MVAR 500kV Reactor (3-phase)	2set
12	60MVA 150/20kV Transformer (3-phase)	2set
13	150kV Circuit breaker (3-phase)	9 set
14	150kV Disconnecting Switch with Ground (3-phase)	8 set
15	150kV Disconnector Switch (3-phase)	18 set
16	150kV Current transformer (3-phase)	10 set
17	150kV Voltage transformer (3-phase)	10 set
18	150kV Lightning arrester (3-phase)	8 set
19	150kV Earthing Switch Bus	2 set

6.4.2 Quantities of Mandirancan Substation Materials

With reference to the single line diagram and layout drawing, the quantity of the main facilities is shown in the following table.

Table 6. 19 Quantity of Main Facilities for Mandirancan S/S

No.	Items	Number of unit
1	500kV Circuit Breaker (3-phase)	6 set
2	500kV Disconnecting Switch Ground (3-phase)	4 set
3	500kV Disconnecting Switch (3-phase)	12 set
4	500kV Current transformer Line (3-phase)	18 set
7	500kV Voltage transformer for Instrument (3-phase)	8 set
5	500kV Voltage transformer for Line Protection (3-phase)	4 set
6	500kV Lightning arrester (3-phase)	4 set
7	500kV Line trap (3-phase)	4 set

6.4.3 Quantities of Indramayu Substation Materials

With reference to the single line diagram and layout drawing, the quantity of the main facilities is shown in the following table.

Table 6. 20 Quantity of main facilities for Indramayu S/S

No.	Items	Number of unit
1	500kV Circuit Breaker (3-phase)	2 set
2	500kV Disconnecting Switch Ground (3-phase)	2 set
3	500kV Disconnecting Switch (3-phase)	6 set
4	500kV Current transformer Line (3-phase)	4 set
5	500kV Voltage transformer for Line Protection (3-phase)	4 set
6	500kV Lightning arrester (3-phase)	2 set
7	500kV Line trap (3-phase)	2 set

Chapter 7 Proposal of Appropriate Operation, Management and Maintenance System for PLN

7.1 Financial Analysis of PLN

PT. Perusahaan Umum Listrik Negara Persero (PLN), registered as a state-owned enterprise, runs an electricity business that integrates generation, transmission, and distribution to supply electricity to the whole nation, and owns power generation facilities minus those owned by independent power producers (IPPs). This section analyzes its financial conditions by reviewing its financial statements.

7.1.1 Present Situation of PLN

The economic growth of Indonesia exceeded 6.1% in 2010, and is expected to sustain the same rates. The power supply demand forecast in Indonesia is expected to increase as the same ratio of the Java-Bali System, which is the largest network system in Indonesia. In 2020, it will more than double compared with 2010. To meet the demand, PLN needs access to financing in order to invest in its power supply facilities. Therefore, it is essential for PLN to maintain a healthy balance sheet. The following table has been taken from a PLN brochure.

Table 7. 1 Company Profile of PT PLN (Persero)

Foundation and history	Established in 1961, Nationalized in 1994
Number of Employees	40,108 (2010)
Total Assets	369,560 Billion Rupiah (2010)
Generation Capacity	26,895 MW (2010)
Number of Customers	42,435 Thousand (2010)
Electricity Generated and Purchased	169,786 GWh (2010)
Electricity Sales	147,297 GWh (2010)
Revenue	162,375 Billion Rupiah (2010)
- from Electricity Sales	102,974 Billion Rupiah (2010)
- Government Subsidy	58,108 Billion Rupiah (2010)
Net Income	10,087 Billion Rupiah (2010)
Fiscal Term	December
President Commissioner	YOGO PRATOMO

(Refer: PLN “Annual Report 2010”)

(1) Insufficient Domestic Sale as Revenue Source

The following tables show PLN’s historical turnover and profit over the past 9 years. PLN has increased revenues and remained in surplus since 2009. The breakdown of operating revenue, however, shows the key issue which is the fact that operating income does not fully cover the supply cost and therefore PLN does not make sufficient profit from its core business of electricity supply. The Indonesian government is planning to increase the electricity tariffs by 10 percent on average annually starting in April 2012. In addition, PLN is continuing efforts to reduce its supply cost. Regarding fuel costs, which consume a larger share of PLN's spending, the Crush Program conducted by the government will reduce the percentage of oil generation, and fuel expenses are expected to diminish the effect of fluctuation in oil prices near the future.

Table 7. 2 Revenues and Profit of PLN

(Unit: Billion Rupiah)

	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total Revenues	44,183	54,431	62,273	76,543	104,727	114,043	164,209	145,222	162,375
Total Operating Expenses	52,346	55,877	59,711	76,024	105,228	111,506	160,598	135,276	149,108
Income from Operations	(8,162)	(1,446)	2,562	519	(502)	2,537	3,611	9,946	13,267
Other Income	1,584	(1,306)	(1,118)	(2,694)	(584)	(5,635)	(15,802)	2,257	1,867
Income Before Tax	(6,578)	(2,752)	1,445	(2,175)	(1,085)	(3,098)	(12,191)	12,203	11,400
Tax Expense	1,815	1,819	3,185	2,746	2,973	2,547	113	1,848	1,313
Extraordinary Item	2,333	1,013	(282)	—	2,139	—	—	—	—
Net Income	(6,060)	(3,558)	(2,021)	(4,921)	(1,928)	(5,645)	(12,304)	10,356	10,087

Loss: ( )

Source: PLN "Laporan Keuangan (Tahunan)" (2002-2010)

Table 7. 3 The Breakdown of Operating Revenue of PLN

(Unit: Billion Rupiah)

	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total Revenues	44,183	54,431	62,273	76,543	104,727	114,043	164,209	145,222	162,375
Sale of Electricity	39,018	49,810	58,232	63,246	70,735	76,286	84,250	90,172	102,974
Government's Electricity Subsidy	4,739	4,097	3,470	12,511	32,909	36,605	78,577	53,720	58,108
Customer Connection Fee	302	342	387	439	480	535	590	652	761
Others	124	182	184	346	602	616	792	679	533

Source: PLN "Laporan Keuangan (Tahunan)" (2002-2010)

Table 7. 4 Major Cost Factors of PLN

(Unit: Billion Rupiah)

	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total Operating Expenses	52,346	55,877	59,711	76,024	105,228	111,506	160,598	135,276	149,108
Fuel and Lubricants	17,957	21,478	24,491	37,355	63,401	65,560	107,783	76,235	84,191
Purchased Electricity	11,169	10,834	11,971	13,598	14,845	16,947	20,743	25,448	25,218
Maintenance	3,589	4,828	5,202	6,511	6,629	7,269	7,620	7,965	9,901
Personnel	2,583	3,828	5,619	5,508	6,720	7,064	8,344	9,758	12,954
Depreciation	15,627	12,745	9,548	9,722	10,151	10,716	11,373	11,835	12,559
Others	1,421	2,165	2,880	3,329	3,482	3,950	4,735	4,036	4,286

Source: PLN "Laporan Keuangan (Tahunan)" (2002-2010), "Annual Report" (2002-2010)

(2) Financial Capital Investment

Generally, Utility Bonds of which the sourcing cost can be calculated on the publication, will be used because utility enterprises including the electric power company can create their operating plan with stable revenue. PLN also has some recent financing options including Utility Bonds in domestic and foreign currency.

Table 7. 5 Balance Sheet of PLN

(Unit: Billion Rupiah)

	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total Noncurrent Assets	200,995	195,318	199,114	203,348	219,097	230,227	259,643	296,714	324,417
Total Current Assets	12,893	12,298	12,679	17,494	28,821	43,213	31,076	36,999	45,143
Total Assets	213,888	207,616	211,794	220,843	247,918	273,480	290,719	333,713	369,560
Total Noncurrent Liabilities	42,958	37,189	47,109	49,274	80,381	96,791	123,079	144,783	164,655
Total current liabilities	14,847	16,163	17,192	25,956	27,698	40,276	40,654	47,734	55,320
Total Liabilities	57,805	53,352	64,300	75,230	108,079	116,108	163,733	192,517	219,975
Total Equity	156,083	154,264	147,493	145,612	139,838	136,413	126,987	141,196	149,586
Total Equity and Liabilities	213,888	207,616	211,794	220,842	247,918	273,480	290,719	333,713	369,560

Source: PLN "Laporan Keuangan (Tahunan)" (2002-2010)

Table 7. 6 The Breakdown of Liabilities for PLN

(Unit: Billion Rupiah)

	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total Noncurrent Liabilities	42,958	37,189	47,109	49,274	80,381	96,791	123,079	144,783	164,655
Two-step loans	16,764	15,018	14,025	14,237	12,419	13,776	18,929	19,112	22,804
Government loans	5,326	4,781	4,464	4,148	3,831	3,526	3,232	2,938	2,017
Lease liability	—	—	—	—	13,230	13,642	18,564	14,364	14,167
Bank loans and medium term notes	140	90	—	—	21	23,426	10,192	23,705	36,400
Bond Payable	600	600	2,090	2,091	12,755	25,454	28,508	46,246	46,656
Project cost payable	20,128	16,700	26,530	28,798	38,125	16,967	43,654	38,418	42,661
Total current liabilities	14,847	16,163	17,192	25,956	27,698	40,276	40,654	47,734	55,320
Total Liabilities	57,805	53,352	64,300	75,230	108,079	116,108	163,733	192,517	219,975

Source: PLN "Laporan Keuangan (Tahunan)" (2002-2010)

Table 7. 7 Historical Rating for PLN

Moody's		Standard & Poor's	
Jan. 17, 2011	Ba1	Mar. 15, 2010	BB
Dec. 1, 2010	Ba2+	Oct. 11, 2006	BB-
Nov. 16, 2009	Ba2		
Oct. 18, 2007	Ba3		
Aug. 1, 2007	B1+		
Oct. 3, 2006	B1		

Source: Bloomberg

7.1.2 Present Situation for the Republic of Indonesia

The financial statement of the Indonesian government is important because PLN runs with the Governmental Electricity Subsidy composed of over 30% of total revenue. The government has acquired sovereign ratings because of its political stability and the annual GDP growth is approximately 6%.

Table 7. 8 Historical Sovereign Rating for Indonesia

Moody's		Standard & Poor's	
Jan. 18, 2012	Baa3	Apr. 8, 2011	BB+
Jan. 17, 2011	Ba1	Mar. 12, 2010	BB
Dec. 1, 2010	Ba2+	Jul. 26, 2006	BB-
Nov. 16, 2009	Ba2		
Oct. 18, 2007	Ba3		

Source: Bloomberg

7.2 Operation and Maintenance Management System

The PLN UIP Jaringan JB, one of Business Units of PLN, will manage the supervision of construction work for the Project. The organization is under the command of the Director in charge of construction, and a Division Head in charge of the Java-Bali Transmission Line construction project.

After completion of the Project, the Transmission Line and the Substation will be transferred to P3B, one of the Business Units of PLN, and P3B will conduct operation and maintenance. (The organizational structure of P3B is shown in Figure 2.5).

Regarding the operation of 500 kV transmission lines and substations including plans of outage for maintenance and decision of operations, the central dispatch center JCC, under the System Operation Division gives directions to their branches, and each branch operate their equipment of which they are in charge. Regarding the Transmission Line and the Substations constructed in the Project, the branch of west Java (RJBR) and the branch of central Java (RJTD) conduct common operations and maintenance such as inspection and patrol etc.

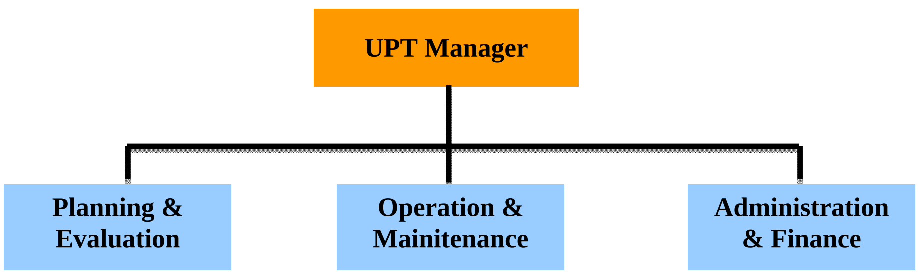
The features of the RJBR and the RJTD is as follows.

Table 7. 9 Features of Region Offices

		West (RJBR)	Central (RJTD)
Employees		885	809
Number of UPT office		7	7
Location of head office		Bandung	Ungaran
Transmission lines	500kV	1,054 km	1,617 km
	Below 150kV	3,327 km	3,819 km
Transformers	500/150kV	(9 units) 4,500MVA	(4 units) 2,000MVA
	Below 150kV	(156 units) 7,020MVA	(133 units) 5,170MVA

(Source: P3B Statistics, 2009)

Common operation and maintenance in each branch is divided into several regions, and Transmission Service Units (Unit Pelayanan Transmisi:UPT) organized in each region conducts common operation and maintenance. The structure of UPT is shown in following table.



(Source: Data from P3B JB office)

Figure 7. 1 Organization Chart of UPT

Each UPT conduct maintenance of equipment constructed in the Project. The three UPTs shown in following table will be responsibility for maintenance of equipment as usual, but this matter should be discussed with each related party.

Table 7. 10 Prospect of Responsibilities to Maintenance of Equipment in the Project

	500kV Transmission line	500kV Substation
Cirebon UPT /West (RJBR)	Indramayu SS – Mandirancan SS (89.6 km) Mandirancan – #487 Tower (34.3 km)	Mandirancan SS Indramayu SS
Tegal UPT /Central (RJTD)	Pemalang SS – #487 Tower (132.6 km) #131 Tower – Pemalang SS (30.5 km)	Pemalang SS
Semarang UPT /Central (RJTD)	Tx – #131 Tower (55.6 km)	

The three UPTs will need workers, however only a few skilled workers because of the fact that there seemed to be an ever increasing number of simple tasks with fewer difficult tasks when the 500kV Transmission Line is constructed, because the three UPTs have the maintenance responsibilities of part of an existing 500 kV transmission line, which they are conducting currently as of January 2012.

The Cirebon UPT and the Semarang UPT are now conducting maintenance of 500kV substations, however the Tegal UPT is limited to, rather only 150kV substations. The skills required to maintain 500kV substations are higher than 150kV substations, so the Tegal UPT needs to accept not only non-skilled workers but also skilled workers who have experiences of 500kV substations maintenance. Otherwise, there is a problem whereby younger, less experienced substation engineers of Tegal UPT get transferred to a branch having responsibilities for maintenance of 500kV substations.

In addition, P3B is now under re-organization (refer Figure 2.6).
According to the plan, there is a suggestion that four branches be abolished and UPT undergo a name change to Maintenance Service Unit (UPP) which is under the president. That being the case, there would only be a name change from UPT to UPP keeping its business contents unchanged.

7.3 Environmental Management Plan

According to the regulation regarding environmental impact assessment of No.51, 1993, it is mandatory to submit an “Environmental Management Plan (RKL)” which can be used to reduce impacts and it corresponds with the mitigation measures described in EIA report and an “Environmental Monitoring Plan (RPL)” which can be used to monitor timely implementation of proposed mitigation measures and warn management of any unforeseen impacts requiring attention described in RKL.

But the EIA report on “Central and West Java 500kv Transmission Line Project” has not been compiled and so then neither impacts to the environment in the course of Project implementation nor appropriate mitigation measures to minimize the risk of adverse impacts caused by the Project are being revealed to concerned stakeholders as the middle of January in 2012.

These reasons as mentioned above have being refrained The Team from giving PLN a specific technical support on compiling not only “Environmental Management Plan (RKL)” but also “Environmental Monitoring Plan (RPL)” concerning this 500kv T/L Project.

Therefore, the Study Team shows matters that should be taken care of by PLN as a project proponent when compiling above “RKL” and “RPL” report, based on the site surveys and hearings from some residents living in or along Project site which were done two times in September 2011, and January 2012 and also referring to the “Guidelines of Environmental Management and Environmental Monitoring Plan” (Decree No.86/2002) and “Compilation Environmental Impact Assessment Guidance” (Regulation No.08/2006).

7.3.1 Environmental Management Plan (RKL)

(1) Main objectives

The purpose of Environmental Management Plan (RKL) should ensure that the proposed environmental mitigation and protection measures which should be incorporated into the final project design and contract specifications and then implemented during pre-construction, construction and operation stages.

The contents of RKL concerning 500kv T/L Project should include the following items;

1) Encourage positive impacts and depress negative impacts in consequence of 500kv T/L Project to natural and social environment
2) Striving to find a way of overcoming or lessening the negative impacts and encouraging arising out positive impacts
3) Identifying relevant institution in charge of management plan affect

And the environment management interventions should be carried out in three stages,

4) Pre-construction
5) Construction
6) Operation

(2) Anticipated Environmental Management Interventions

The EIA which is being envisioned to submit to Ministry of Environment (KLH) around middle of April in 2012 should identify a number of potential negative environmental and social impacts and propose various actions to prevent these impacts.

It is imperative to incorporate a number of mitigation procedures where environmental management can minimize the negative impacts of a particular activity of the project and compensation which provides an acceptable alternative resource for the lost resources into project design.

While most of these impacts will occur during the construction phase, others are related to the operation phase.

It is not easy to lump together accurately adverse impacts before compiling in EIA report on this 500kv T/L Project which will identify them in imminent future. Therefore, the team intends to only describe to a dispensable items which must be discussed in RKL report as follows;

1) Impact Source
2) Impacted Environmental Component
3) Measuring Rod of Impact
4) Aim of Environmental Management Plan
5) Environmental Management efforts
6) Environmental Management Institution
   - Implementer
   - Supervisor
   - Reporting

The environment management interventions which will arise from 500kv T/L Project should be described for each phase in the following.

- Pre-construction phase

  Social denunciation of the project plan or community/individual complaints should be described.

- Construction phase

  Environmental protection measures such as protection works for landslides, turbid water treatment at excavation site of towers, dust and vibration/noise control, disturbance or damage to adjacent habitat of species should be described.

  As for social management interventions, the clear countermeasures to cope with disquieting on construction works from residents or land owners of paddy field of which will be used for tower construction site or site for access roads should be described.

- Operation phase

  Maintenance way of Transmission Line to minimize elector magnetic disturbance should be described as key mitigation measures.

  As for social issues, support measures on socio-economic change should also be described.

The Study Team shows here an illustration of Environmental Management Plan (RKL) concerning Air/Noise Component which is expected to be discussed during compiling RKL at Table 7. 11.

Table 7. 11 Illustration of Expected Environmental Management Plan (Description only on Impacted Component of Air/Noise Quality)

No	Impact Source	Impacted Component	Measuring Rod of Impact	Aim of EMP	Environmental Management Effort	Environmental Management Institute		
						Implementer	Supervisor	Reporting
Pre-Construction Stage								
1	Field Survey	Community's Attitude/ Perception	-Community's Conduct and perception before field survey -Number of Community's Complaint to plan	Press Social Vulnerability	-Perform Socialization -Involve local in Field survey	PT. PLN (UIP)	Apparatus Village/ Regency	To each Regency
Construction Stage								
2	Civil Works	-Air Quality and Noise	- Kep-48/MENLH/11/1996 for Noise Standard Level -PP RI No.41/1999 for Air Pollution Control	-Press noise around community settlement and project sites	-Activities in the night is forbidden -Set up fence around activity site with the height 2-3 m.	Initiator coordinates with environmental sections of each Regency, district and Villages	Environmental Control Institution of Central Java/West Java Province	Environmental Control Institution of Central Java/West Java Province
Operation Stage								
		-Air Quality and Noise	- Kep-48 /MENLH/11/1996 for Noise Standard Level -PP RI No.41/1999 for Air Pollution Control -Kep-13/MENLH/3/1995 for Emission Quality Standard Unmovable Source	-Press decrease of ambient Air quality and noise increase		Initiator coordinates with environmental sections of each Regency, Sub-district and Villages	Environmental Control Institution of Central Java/West Java Province	Environmental Control Institution of Central Java/West Java Province

In addition, the Environmental Management Plan (RKL) should have the flexibility to deal with unforeseen impacts during implementation of the 500kv T/L Project and to provide additional social and environmental mitigation and compensation as required.

(3) The Environmental Management Section (EMS)

The PLN as a project proponent should establish an Environmental Management Section (EMS) under existing Project Implementation unit (*UNIT INDUK PEMBANGUNAN JARINGAN JAWA BALI* -UIP) to carry out and supervise interventions which will be caused during project some years after the completion of 500kv T/L Project.

This EMS also should implement the “Environmental Monitoring Plan (RPL)” to support activities which will be described in “Environmental Management Plan (RKL)”.

The Study Team recommends that the EMS should have environmental section with some staff assigned to supervise interventions, land acquisition frameworks and to implement the monitoring program both directly and through the construction contractors and relevant agencies such as two province of Central Java and West Java, and nine regencies of
“Semerang”, ”Kendal”, ”Batang”, ”Pekalongan”, ”Tegal”, ”Brebes”, ”Cirebon”, and ”Kuningan.

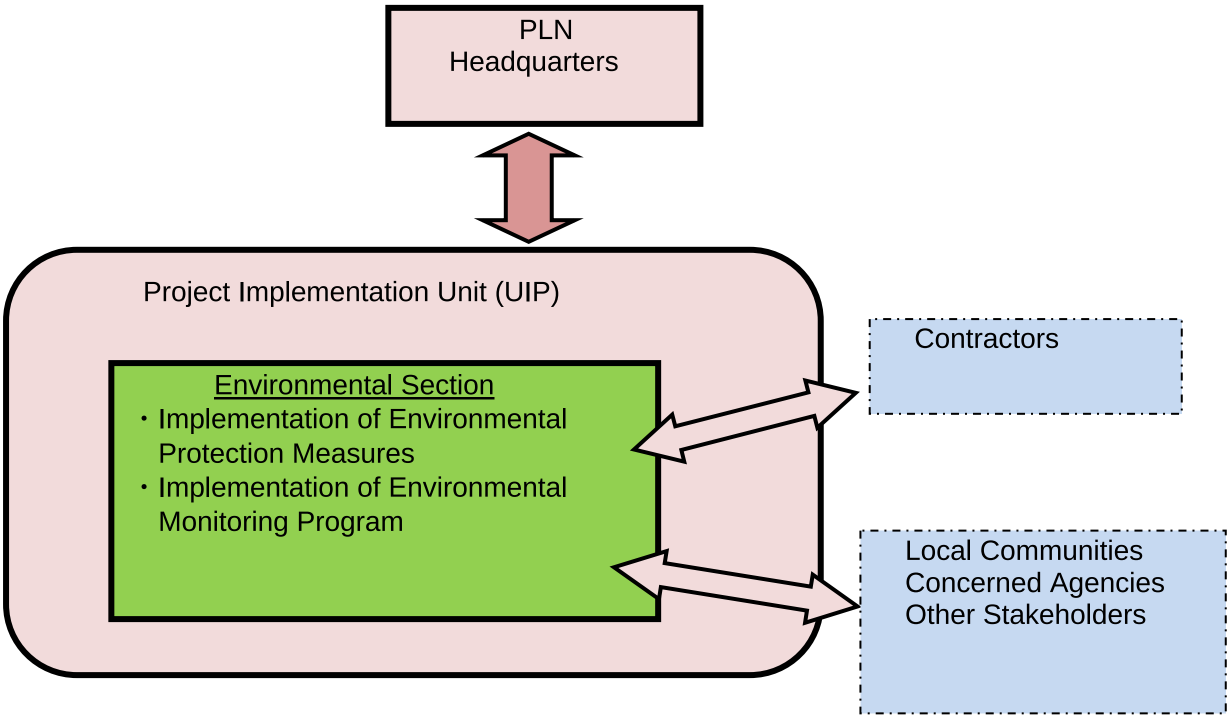


Figure 7. 2 The Proposed Environmental Management Section

7.3.2 Environmental Monitoring Plan (RPL)

(1) Main objectives

The main purpose of the monitoring program is to contribute to the management of social and environmental interventions, and to have the PLN respond to changing circumstances as they occur. Therefore, information should be provided in a clear format at regular intervals as below;

1) **At Pre-construction monitoring,** social matters concerning grievance from community should be monitored as baseline conditions of local communities.
2) **At Construction monitoring,** physical issues such as air quality, water quality, waste, noise and vibration should be monitored. And for biological and social issues such as rare species and grievance from community should be monitored.
3) **At Operation monitoring,** physical issues such as air quality, water quality, waste, noise, vibration and electromagnetic disturbance should be monitored. And for biological and social issues such as rare species and grievance from community should be monitored.

(2) Proposed items of monitoring concerning 500kv T/L project

It is not easy to lump all monitoring issues into an environmental impacts identification matrix before compiling Environmental Management Plan (RKL) report which generally contains several important points for the evaluators to understand the project and to learn the anticipated social and environmental impacts and their corresponding mitigation based on EIA report.

Therefore the Study Team shows here the essential elements which should be included in RKL and also shows a general sample description citing for example of Air Quality and Noise, Vibration concerning 500kv T/L project.

(a) Essential elements which should be included

1) Environment Aspect Affected by Impact

Environment aspect affected by impact of development of tower structure, access roads and transportation of materials is due to Air Quality, noise and vibration.

2) Source of Impact

The source of impact to aspect of air quality, noise and vibration is development of tower structure, access roads and transportation of materials

3) Monitoring Parameter Measured

Monitoring of air quality conducted by related particular CO, NO2, SO2 and noise level.

4) Monitoring Objectives

Monitoring of aspect of air quality and noise aims to ascertain decrease of ambient air quality and excessive noise standard level

5) Monitoring Method and Data analysis

Monitoring of air quality conducted by air sampling at 24 locations and analysis at laboratory and results compared with standard of Government RI No. 41/1999

Monitoring of noise quality conducted by noise measurement instrument at 24 locations and results compared with standard of Government KEP-48/MENLH/11/1996

Monitoring of vibration level from the Contractors Activities at 24 construction sites of all construction sites and its result compared with standard of Government No.49/1996

6) Monitoring Location

Monitoring of air quality, noise and vibration is to be checked every 10 Km of T/L, which means 24 locations (From Ungran to Mandirancan with 240km T/L length)

7) Monitoring Frequencies and Period

Monitoring of air quality and noise is to be checked four times per year during construction and operation period.

Operation period is to be continued for 4 years for Natural Environment and 10 years for Social Environment respectively after completion of construction

8) Monitoring Cost Source

It is to be provided by project proponent

JICA Team estimates total cost concerning Ungran to Mandirancan T/L Project as 4,340.000.000Rp (see Table 7. 12)

9) Monitoring Institutional

Executor : PLN (UNIT INDUK PEMBANGUNAN JARINGAN JAWA BALI -UIP)

Supervisor : Environmental section of each Province and regency

Reporting : Environmental section of each Province and regency

(b) Model of Monitoring Format on RPL for 500kV T/L project.

Team shows here just an illustration of Environmental Monitoring Plan (RPL) which should be drawn up after compiling EIA and RKL.

Table 7. 12 Model of Monitoring Format on MPL for 500kV T/L Project

Items	Frequency			Methodology and Locations	Cost
	Pre Construction	Construction	Operation		
Ambient Air Quality	N/A	4 times per year at 24 locations *4 x 24 = 96 times/year* *96 x 1MRp** =96 MRp	N/A	Air quality sampling and Lab analysis of samples to monitor ambient dirt rate and air quality. Monitor at 24 locations of S/S site, along T/L, roads side which cause traffic-related air quality impacts and material yards	96 x 2 years = 192 MRp
Electro magnetic Disturbance	N/A	N/A	4 times per year at 24 locations *4 x 24 x = 96 times/year* *96 x 1MRp** =96 MRp	Measuring at sites and hearing from residents on impact generated by magnet to radio waves and microwaves.	96 x 4 yeas =384MRp
Water Quality (Waste)	N/A	4 times per year at 24 locations *4 x 24 = 96 times/year* *96 x 1MRp** =96 MRp	N/A	Water quality sampling, direct visual inspection and Lab analysis of samples to control management of site drainage. Waste-water discharging sites to river	96 x 2 years = 192 MRp
Waste	N/A	4 times per year at 24 locations *4 x 24 = 96 times/year* *96 x 1MRp** =96 MRp	N/A	Observation of dumpsites which are close to human settlements and hearing from residents	96 x 2 years = 192 MRp
Noise/ Vibration	N/A	4 times per year at 24 locations *4 x 24 = 96 times/year* *96 x 1MRp** =96 MRp	N/A	Monitor noise level ,vibration level at S/S site and material yards	96 x 2 years = 192 MRp
Natural Environment					
Rare species (Vicinity of Project site)	N/A	2 times per year at 24 locations *2 x 24 = 48 times/year* *48 x 1MRp** =48 MRp	2 times per year at 24 locations *2 x 24 = 48 times/year48 x 1MRp** =48 MR	Site direct survey, hearing from residents to monitor disturbance or damage to adjacent habitat of species. Two times a year (dry and rainy season)	1)48 x 2 years =96 MRp 2)48 x 4 years =192 MRp 1)+2)=288 MRp
Sub-Total		432 x 2 years= 864.MRp	144 x 4 years= 576.MRp		1.440.MRp
Social Environment					
Grievance from community, Human health and safety	3 times per year at 10 locations *3 x 10 = 30 times/year* 30 x 10MRp** =300MRp	3 times per year at 10 locations *3 x 10 = 30 times/year* 30 x 10MRp** =300MRp	2 times per year at 10 locations *2 x 10 = 20 times/year* 20 x 10MRp** =200MRp	Hearing at residential areas	
Sub-Total	300MRp x 1 year = 300.MRp	300MRp x 2 years = 600.MRp	200MRp x 10 years = 2.000.MRp		2.900.MRp
Total	300.MRp	1.464.MRp	2.576.MRp		4.340MRp

Remarks) : Average cost of implementation per one location is 1.000.000Rp, excepting Social Environment issues which cost 10.000.000Rp** per one location. (these cost are estimated referring to the existing similar Transmission Line project in Indonesia by Team with supporting of local consultant hired by PLN)

Chapter 8 Project Evaluation

8.1 Effect of Project

The following figure shows the 500kV transmission line network related to the Project.

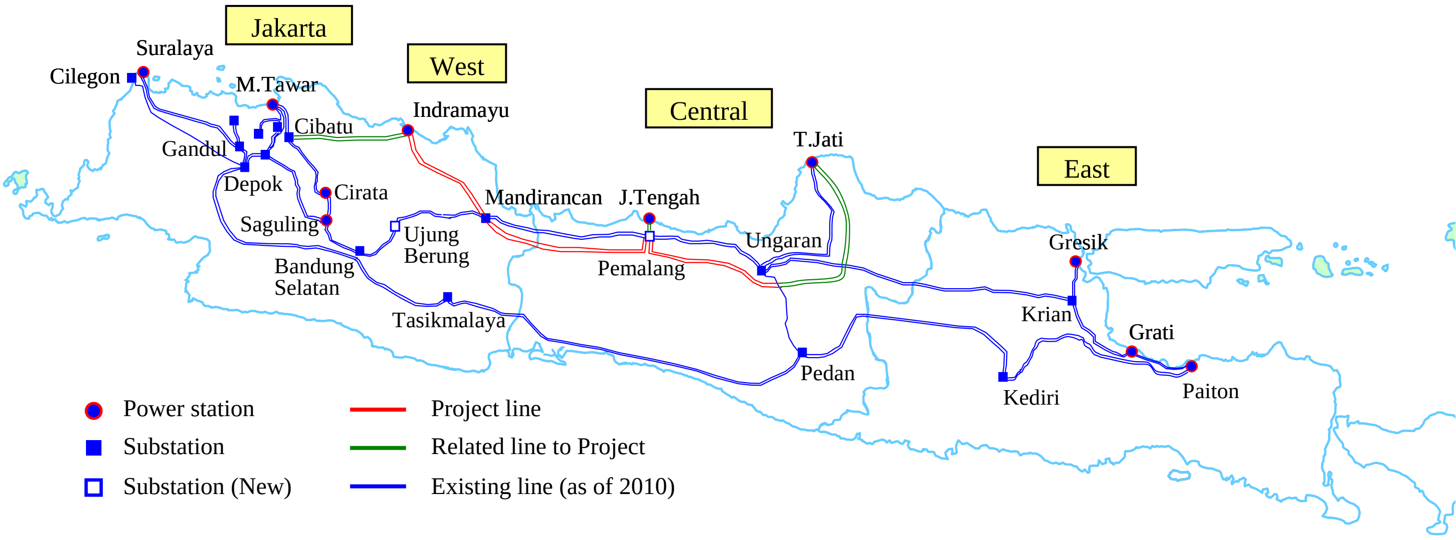


Figure 8. 1 500kV Transmission Line Network Related to the Project

The purpose of the Project is to ensure the stable transfer of power generated in East and Central Java to the West especially Jakarta.

As of 2011, there is an existing north transmission line and an existing south transmission line, and the two double-circuit lines are transferring power generated in East Java to around Jakarta. After the construction of the Project, it is expected that the transfer capacity will increase enough to transfer power including under the constructing/planning generation capacities to around Jakarta.

8.1.1 Indication of Project Beneficiaries

To identify the beneficiary of the Project, situational changes depending on the presence (with) or absence (without) of the Project should be considered exactly.

It seems that the transmission line will be connected directly to the Tanjung Jati power plant and the Central Java power plant, and the transfer of power generated in both power plants. In the case of the absence of the Project, it is possible to transfer all of the power generated in both Tanjung Jati and Central Java through the existing transmission lines if the amount of the power flow from the east part to the west part can be controlled by increasing the output of thermal power that uses expensive fuels such as natural gases and HSD located in the Jakarta neighborhood. Therefore, the Tanjung Jati and Central Java power plants will not be beneficiaries, they will not be affected in the Project. It has enough surplus supply capacity when the Project's transmission line starts its operation if present plan (RUPTL) advances according to schedule. Therefore the outputs of almost all thermal power that uses a expensive fuel are not full, and it is possible to carry out the above-mentioned operation.

It is thought that the benefit from the Project is the reduction of transmission loss. The conductor introduced in the Project will reduce the resistance value of the unit length to 65% less than existing conductors. In addition, system loss reductions are expected after the construction work, because the power transferred through each transmission line adding a new transmission route will be reduced, and the system loss is proportional to the square of the transferring power. It is estimated that the amount of the system losses, affected by the amount of power transferred from East to West is approximately 100MW during the peak demand period, and approximately 400-500GWh annually. As a result, PLN will be able to save generation using fuels where the price is highest in affected areas, and reduce the unit price of power supply.

In consideration of the above point of view, though it is difficult to identify exact beneficiaries, the Indonesian people will benefit indirectly. In addition, stable power supply will be ensured around the Pemalang Substation because there power will be supplied via the substation. Therefore, the people living around the Pemalang Substation will benefit directly.

8.1.2 Evaluation of the Qualitative Effect of the Project

As described in the previous subchapter, there appeared to be the system loss reduction as a quantitative benefit after the construction work. There are also the following qualitative effects:

(1) Improving the flexible operation of the power plants

There are large thermal power plants such as the Paiton, the Gresik and the Tanjung Jati etc, in the Central and the East area. Given that the amount of power demands in the Central and East area is not so big, power generated in the East area is being transferred to the West. The transfer capacity is approximately 3000MW.

The transfer capacity after the operation of the Project will increase to approximately 6,000MW. Although the generation capacity in the East part of Java will increase since Paiton will operate additional power plants and Central Java will start their generation, increasing transferring power dramatically is not expected as power demand in the East will also increase. However, the total 3,000MW of transfer capacity might limit the generating power of the East generators depending on the power supply and demand situation. Increasing the transfer capacity through the Project will allow these large power plants to operate economically without limitations, and improve the flexible operations of the power plants.

(2) To improve power supply reliabilities during the double-circuit failure

To construct equipment for stable power supply, the transmission lines or substations associated with higher frequencies of failures to be a single-circuit failure will be evaluated (N-1 Standards) by conducting a power system analysis, and also consider its countermeasures based on the results.

That is, it is possible to supply power stably in a single-circuit failure. However, in the cases of double-circuit failures, which is extremely low frequency, it may cause a supply power shortage.

The existing 500kV transmission line consists of single-line towers, and it is extremely low frequency to be double-circuit failures. However, these towers are built in parallel, so it is not infallible.

In the case that there is not the transmission line of the Project, out of one of the two existing 500kV transmission lines, there occurs a double-circuit failure under the situation where 3,000MW of power is transferred from East to West, and the generators in the East area increase rotation speed transiently, reach a dangerous area and be paralleled off automatically. In this case, the power system undergoes a power shortage and drops frequency. If the load match of the frequency drop could not be shutdown, the generators in West area detect the frequency drop and these generators are paralleled off, finally a black-out could affect the whole Java Island.

In other cases, there is a new transmission line of the Project, there appeared three transmission lines between the East and West area. If a double-circuit failure occurs with one of the three 500kV transmission lines, the other two transmission lines will be able to transfer power stably because the increasing rotation speed will be within the allowable range.

(3) Improving power supply qualities around Pemalang Substation Pemalang

In the Project, the 500/150kV transformer will be installed in the 500kV Pemalang Substation and be connected to 150kV transmission lines which are for regional supply. Before the Pemalang Substation begins operation, the area will be supplied through the Mandirancan Substation and the Ungaran Substation via the 150kV transmission lines. The distance in the section is approximately 250km, and the area farthermost from the two substations will be in voltage reduction depending on its power demand situation. It seems that the area also will be affected by failures because there is a long distance from the substations.

After the Pemalang Substation is operated, the surrounding areas will be supplied from the Substation directly, and it will decrease the voltage reduction, the frequency and time-length of the failure caused by transmission accidents, and the power supply qualities will be improved.

(4) Improving the voltage problems at 500kV substations

It is expected to reduce the electric current through each 500kV transmission line between the East and West, and the voltage reduction in the same section. Therefore, the Project will contribute to improving the voltage reduction of the 500kV substations around Jakarta, but the improvement is only about 1kV.

8.2 Proposal of the Operation and Evaluation Indicators of the Project

The purpose of the Project is to ensure the stable transfer of power generated in the Central and East area to the West area. The Study Team suggests that the following four indicators should be considered to understand the effectiveness. The targets are set under the situation of 2020 based on RUPTL (2011). The 2020 will be 2-3 years after the transmission line is operated. These targets should be reconsidered when there is a big issue such as the rescheduling of the start of the large coal power plants, since the transmission line operations will be affected by the operations of the generators.

(1) The situation of transferring power through the new 500kV Pemalang – Mandirancan transmission line (the annual amount of power transferrence)

(a) Meaning of the index

It is an index that shows the utilization of the transmission line constructed by the Project. It is possible to calculate a loss reduction (presumption value) from the resistance of the transmission line by using this index.

(b) Target value : 5,200 GWh/annually

(c) Foundations and conditions

The Study Team analyzed and considered the power flow under the stringent conditions that all of the coal power plants of IPPs in the Central and the East area are under their full-load operations at around 2p.m. when maximum power demand comes in the Jakarta power system. At the same time, the transfer of power from the Central and the East area to the West area is approximately 4,500MW. The transfer of power is divided into the three lines, the two existing both north and south lines and the new transmission line and the new line has approximately 1,700MW under the condition. However, it seems like the average of the transferred power during the daily maximum power demand is approximately 1,200MW because there appeared to be not so many times under the stringent conditions. There will be more reductions during the off-peak hours, so the load factor for the peak hours is assumed to be 50%, and the annual transferring power is estimated as follows.

1,200MW x 8,760 hrs x 50% = 5,200 GWh

(d) Data correction

The Java Control Center of the P3B corrects the transferring power flow data of all of the 500kV transmission lines per 30 minutes through their SCADA system. It is possible to correct the historic data concerning the indicator.

(e) Others

The maximum transferring power under the static state will also be considered as the second indicator. The value occurs at around 2p.m. and is assumed to be 1,700MW.

(2) The situation of transferring power through the new Mandirancan – Indoramayu transmission line (the annual amount of transferring power)

(a) Meaning of the index

It is an index that shows the utilization of the transmission line constructed by the Project. It is possible to calculate a loss reduction (presumption value) from the resistance of the transmission line by using this index.

(b) Target: 1,300 GWh/annually

(c) Foundation and condition

As for evaluating the effectiveness of the Project, the Indramayu power plant will start generation and the transmission line between Indramyu and Cibatu will be constructed. In case the two generators of the Indramayu power plant operate, the maximum transferred power is estimated to be approximately 500MW. The average transferring power during peak hours is assumed to be 300MW, and the load factor is 50%, the annual transferring power is estimated as follows.

300MW x 8,760 hrs x 50% = 1,300 GWh

(d) Data correction

As described in (1), the data can be corrected through the JCC.

(e) Others

The situation of transferred power of the transmission line will be tremendously affected by the operation of the Indramayu power plant. In case the generator of the Indramayu power plant operates 1 unit, the amount of transferred power will increase slightly.

(3) The number of times to limit generation in the Central and the East depending on the power system limitations

(a) Meaning of the index

It is an index that shows the flexible operation of the power plants.

(b) Target: 0

(c) Foundations and conditions

After the operation of the transmission line of the Project, the capacity of the stable transferring power will increase from approximately 3,000MW to approximately 6,000MW. The transferring capacity will be able to transfer power in the case of large-scale accidents such as a double-circuit failure. Therefore, there will not be limitations depending on the power system limitations.

(d) Data correction

The JCC corrects the data of the equipment accidents, and it is possible to correct the data of generation limitations.

(4) Maximum load factors of 500/150kV transformers in the Mandirancan substation and the Ungaran substation

(a) Meaning of the index

It is an index that shows the effectiveness of transformer set up in Pemalang substation.

(b) Target: 10% reduction compared with before operation of the Pemalang substation

(c) Foundations and conditions

Two 500/150kV transformers will be installed in the Pemalang substation, and supply power to the surrounding areas. The areas are supplied with power via the 150kV transmission lines through the Mandirancan and the Ungaran substations before operating the Pemalang substation. After operating the Pemalang substation, the power supply from the Pemalang substation will be possible, and the load of the Mandirancan and the Ungaran substations will decrease.

(d) Data correction

Each substation records its load situation of 500/150kV transformers every hour. The corrected data based on these records can be achieved from the P3B, P3B central java branch (RJTD) or P3B west java branch (RJBR).