1.3 3rd Workshop (November 5, 2008)

3RD WORKSHOP
OF
THE STUDY ON
OPTIMAL ELECTRIC POWER DEVELOPMENT
IN JAVA-MADURA-BALI
IN THE REPUBLIC OF INDONESIA

NOVEMBER 5, 2008

AT

MINISTRY AND MINERAL RESOURCES OFFICE

PRESENTED BY

JICA STUDY TEAM

THE STUDY ON OPTIMAL ELECTRIC POWER DEVELOPMENT IN JAVA-MADURA-BALI IN THE REPUBLIC OF INDONESIA

Introduction

In response to the request of the Government of the Republic of Indonesia, the Government of Japan decided to conduct THE STUDY ON OPTIMAL ELECTRIC POWER DEVELOPMENT IN JAVA-MADURA-BALI IN THE REPUBLIC OF INDONESIA.

Accordingly, the Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of the technical cooperation programs of the Government of Japan, will undertake the Study in close cooperation with the authorities concerned with the Government of Indonesia.

NEWJEC Inc. and the KANSAI Electric Power Co., Inc. have been selected as the JICA Study Team to conduct the captioned Study.

The Study will begin in January 2008 and finish in December 2008.

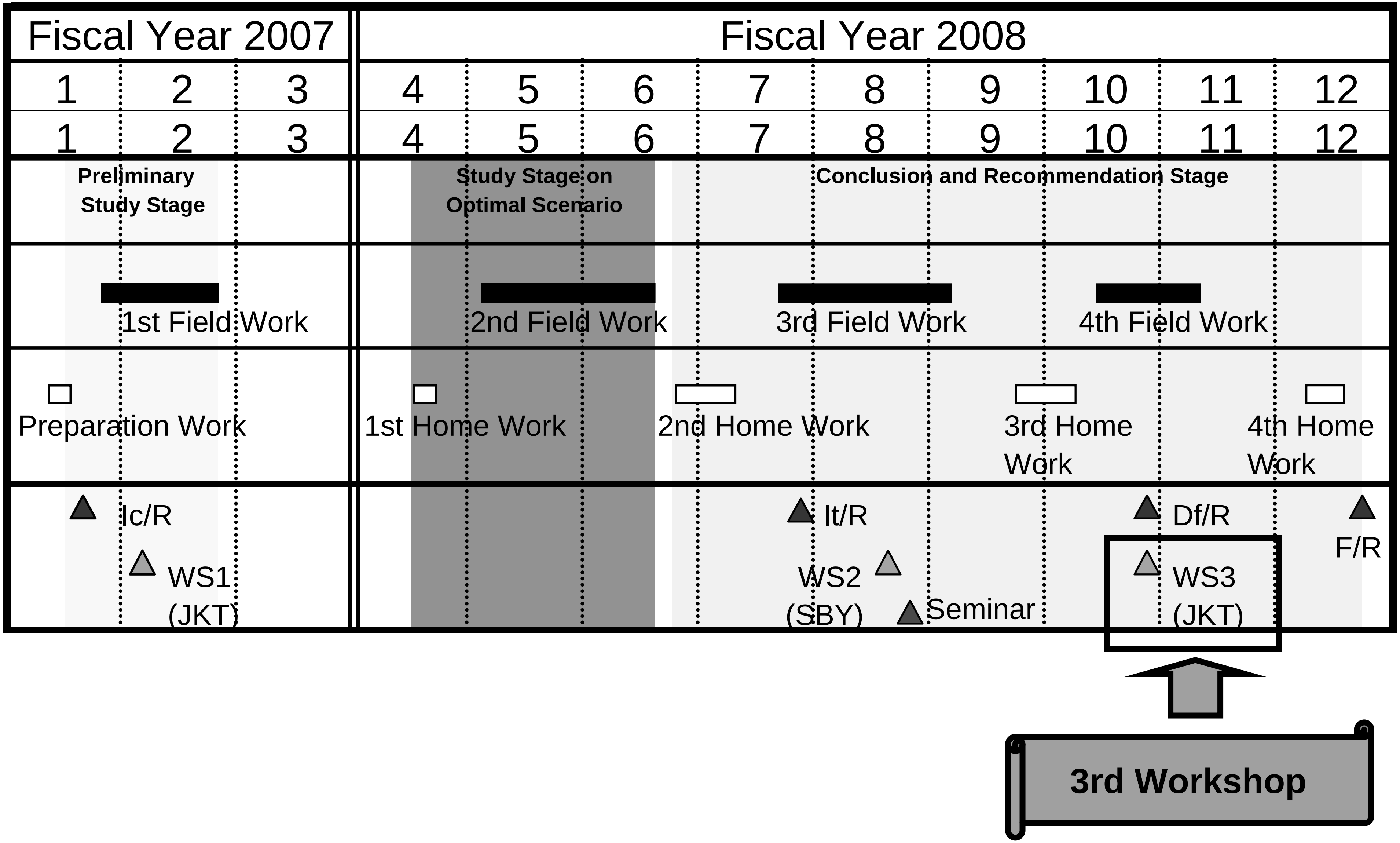
Study Items

1. Power Demand Forecast
2. Primary Energy Supply
3. Generation Expansion Plan
4. Power System Plan
5. Study on Recommendation for Improvement of Power System Operation
6. Economic and Financial Study
7. Environmental and Social Consideration
8. Power Development Plan

Conclusion

1. Accomplish the optimal power development plan, from 2009 to 2028, with the least cost under the conditions of probable power sources, probable site locations and environmental impact.
2. Accomplish Jamali transmission system development plan corresponding to the optimal power development plan in terms of economy and reliability.
3. Suggest the improvement methods of system operation through seminar based on the experience of the KANSAI and current conditions in Indonesia.
4. Support to produce environmental friendly optimal power development plan.

Work Plan



Fiscal Year 2007
Fiscal Year 2008
1 2 3 4 5 6 7 8 9 10 11 12
1 2 3 4 5 6 7 8 9 10 11 12
Preliminary Study Stage
Study Stage on Optimal Scenario
Conclusion and Recommendation Stage
1st Field Work
2nd Field Work
3rd Field Work
4th Field Work
Preparation Work
1st Home Work
2nd Home Work
3rd Home Work
4th Home Work
Ic/R
WS1 (JKT)
It/R
WS2 (SBY)
Seminar
Df/R
WS3 (JKT)
F/R
3rd Workshop

The Study on Optimal Electric Power Development in Java-Madura-Bali in the Republic of Indonesia

The 3rd Workshop Program (Draft)

Date :	5 November 2008 at 09:00 AM.
Place:	MEMR DGEEU
Subject:	Draft Final Report

Time	Content	Presenter
09:00 - 09:10	Opening Speech by MEMR	Mr. Ir. J. Purwono
09:10 - 09:15	Opening Speech by Embassy of Japan	Mr. Tsuchiya
09:15 - 09:20	Opening Speech by JICA	Mr. Kawanishi
09:20 - 09:35	Optimal Power Development Scenario	Mr. Yamaoka
09:35 - 10:35	Optimal Power Source Development Plan	Mr.Matsuda
10:35 - 11:35	Optimal System Plan	Mr.Tanaka
11:35 - 12:00	Question and Answer	
12:00 - 13:00	Lunch	
13:00 - 13:30	Improvement of Power System Operation	Mr.Koyama
13:30 - 14:10	Investment Schedule, IPP Promotion Plan	Mr.Nishida
14:10 - 14:50	Strategic Environmental Assessment	Mr.Ohwada
14:50 - 15:00	Recommendation	Mr. Yamaoka
14:50 - 15:30	Question and Answer	
15:30 - 15:35	Closing Speech by PLN	

1. OPTIMAL POWER DEVELOPMENT SCENARIO

SPEAKER: MR. YAMAOKA SATOSHI,

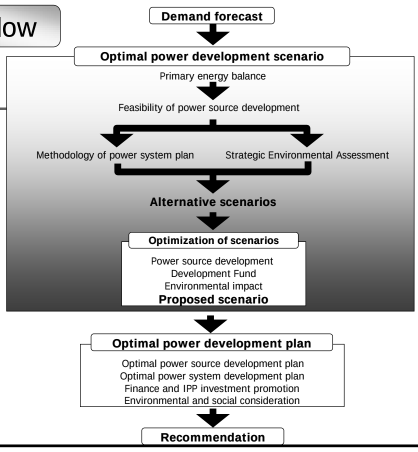
NEWJEC INC.

Optimal Power Development Scenario

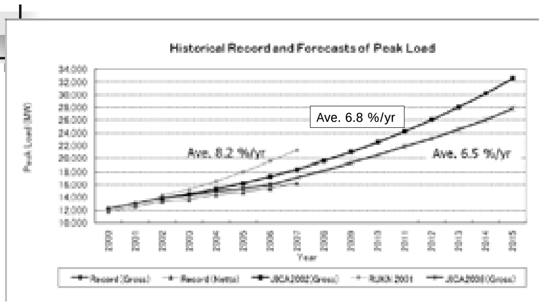
Contents

- Workflow
- Demand Forecast
- Alternative Scenarios
- Proposed Scenario

Workflow



Demand Forecast



- JICA forecast 2002 was revised to forecast2008 based on recent records .
- JICA forecast 2008 is similar with RUKN 2006/2028 (6-7%/yr) and RUPTL 2007/2016(6-7%/yr).

Alternative scenarios

- Priority -

1) Policy and plan in Indonesia,
2) Lower generation cost (priority to coal),
3) Reliable and stable power supply system,
4) Less global environmental impact

- Alternative Scenarios -

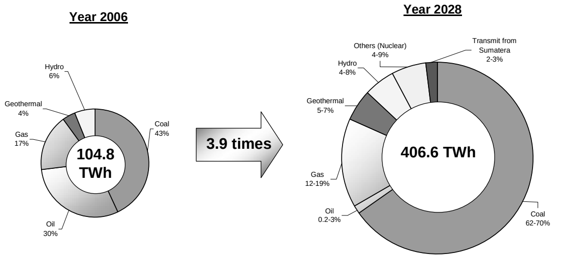
Scenario 0 : Policy oriented

Scenario 1 : Coal power acceleration

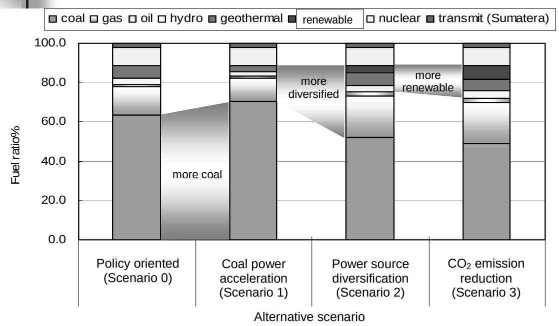
Scenario 2 : Power source diversification

Scenario 3 : CO_2 emission reduction

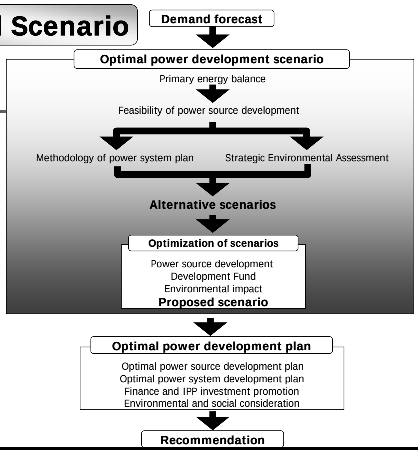
Change of Primary Energy Consumption by Fuel (Policy oriented scenario)



Energy Production Component by Fuel for Scenarios (Total 406.6 TWh, 2028)



Proposed Scenario



Comparison (as of 2028)

Description	Reliability		Generation Cost	Environmental impact
	Power sources	System		
Scenario 0	Fossil fuel 81 % inc. coal 66%. No renewable (solar, wind, and biomass)	Middle to peak, (oil, gas, large hydro and pumped storage) 19 %.	Generation cost 733Rp/kWh (100%)	Second largest emission of CO_2, NOx and SOx
Scenario 1	fossil fuel 85% inc. coal 72%. No renewable	Middle to peak 15 %.	732Rp/kWh (100%)	Largest emission of CO_2, NOx and SOx
Scenario 2	fossil fuel 77% inc. coal 54%. Renewable 4%, 3.3 GW	Middle to peak 26%	852Rp/kW (116%)	Second least emission of CO_2, NOx and Sox
Scenario 3	fossil fuel 74% inc. coal 51%. Renewable 7%, 5.7 GW.	Middle to peak 26 %	914Rp/kW (125%)	Least emission of CO_2, NOx and SOx

Note: Values in “reliability” show energy production ratio.

Discussion

1) Excessive dependence on coal should be avoided to diversify energy resources.
2) Gas will be developed and used in the form of LNG to efficiently meet middle to peak load.
3) Government has interest in new energy and renewable energy development.
4) In Scenarios 2 and 3, more than 20% of energy comes from non-fossil fuel (nuclear, geothermal, other renewable).
5) Cost difference is not significant among scenarios.

Screening

1) Scenarios 2 and 3, reducing fossil fuel burning ratio, look well-balanced in terms of power supply reliability, environmental impact and cost.

2) Renewable capacity must be developed as of 2028 by 3.3 GW (4%) in Scenario 2 and 5.7 GW (7%) in Scenario 3.

3) The target of 7% for renewable capacity is evaluated to be too risky to be accomplished.

Conclusion

1) Scenario 2, power source diversification scenario, was selected as optimal (proposed) scenario.

2) Scenario 2 is studied in detail to identify the issues and measures in terms of power source development, power system development, finance and IPP investment promotion, and environmental and social consideration.

2. Optimal Power Source Development Plan

SPEAKER: MR. MATSUDA YASUHARU,

NEWJEC Inc.

2. Optimal Power Source Development Plan

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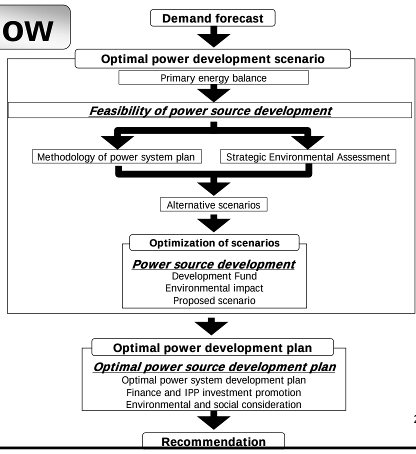
Workflow



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2.1.1 Common Assumption

2.1.2 Simulation Method by WASP IV

2.1.3 Results of the Study

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2.1.1 Common Assumption

(1) Common Assumption

(2) Existing Power Plants, On-going and Committed Projects

(3) Candidates for Future Power Source Development Plan

(4) Construction Costs of Candidates

(5) Fuel Prices

(6) Salient Features of Candidates (Skip)

(7) Screening Curve (Skip)

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(1) Common Assumption

Items	Conditions	Remarks
Study Period	20 years	20 years from 2009 to 2028
Demand Forecast	Base Case	6.5 % of average power growth rate
Load Duration Curve	Typical Duration Curve as shown in Fig.4.6-1	Developed by annual operation data for the year 2006 provided by P3B (Constant for 20 years)
Minimum Reserve Margin	30 %	Minimum Reserve Margin = Supply Capacity / Peak Load ≧ 30 %
Loss of Load Probability	≦ 0.274 %	Less or equal to one (1) day / pear
Hydro Condition	1 condition	
Periods per year	2 periods	Wet season (6 months) and Dry season (6 months)
Peak Load ratio		Rainy season : Dry Season = 1: 0.971 Based on 2006 operation data
Cost of the energy not served	None	Due to the uncertainty of kWh cost of the energy not served

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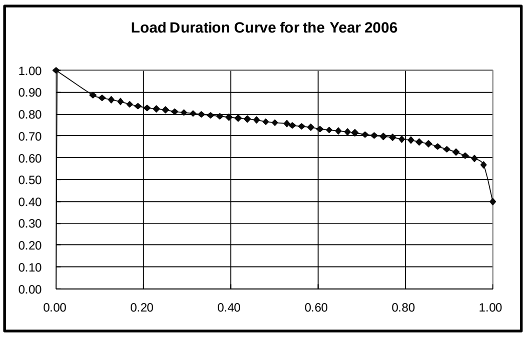
(1) Common Assumption



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(1) Common Assumption

Reserve Margin

- The average reserve margin of ten (10) power utility companies in Japan from 1995 to 2005 has been fluctuated between 9.3 % (min. 2001) and 16.6 %(max.1999).
- The target reserve margin of 30 % in Jmali seems to include the following uncertainties.

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(1) Common Assumption

Uncertainties

1) Once malfunction and/or breakage occurs, duration for restoration cannot be estimated and/or requires long term sometimes, because main parts and/or spare parts for power generation facilities have to be procured from overseas.

Sularaya unit No.5 stopped operation for 241 days in 2007 and still stopped when JICA team visited Sularaya thermal power station on June 3, 2008.

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(1) Common Assumption

Uncertainties

2) Negotiations on conditionality between PLN/MEMR and international financial institutes sometimes cause the delay of project implementation due to the lack of guarantee against the conditionality.

Commencements of Engineering Service for T.Priok, M.Tawar and M.Karang projects were delayed for more than one year due to delay of issuance of gas supply agreement which consist a part of conditionality.

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(1) Common Assumption

Uncertainties

3) Since peak load always occurs in summer season (July or August) in Japan, periodical maintenance for generation facilities is planned to conduct in other seasons. On the other hand, timing (month/dates) of peak load cannot be forecasted in advance like Japan due to wet and dry seasons in Indonesia. Therefore, there is possibility that some power stations are under periodical maintenance and stop the operation at the occurrence of peak load.

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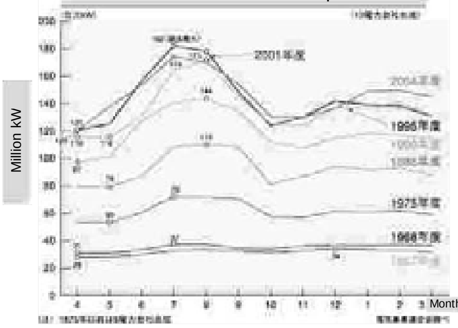
(1) Common Assumption

Annual Peak Load in Japan



(1) Common Assumption

Uncertainties

4) Generation energy by hydropower fluctuates remarkably between dry season and wet season.

Monthly average generation energies from 2003 to 2006 in wet season and in dry season are 166.5 GWh and 66.8 GWh respectively for Saguling Hydropower Station (Source: data provided by Indonesia Power)

(2) Existing Power Plants, On-going and Committed Projects

No.	Name	Type	Explanation	No. of Sets	Min. Load MW	Capacity MW	Heat Rates Kcal/kWh Base Load	Heat Rates Kcal/kWh Average Incremental
1	SRL1	PLTU	Suralaya #1-#4 400 MW	4	240	381	2,622	2,452
2	SRL2	PLTU	Suralaya #5-#7 600 MW	3	340	579	2,560	2,309
3	MKR1	PLTU	M. Karang #1~#3 100 MW	3	44	84	3,273	3,194
4	MKR2	PLTG	M. Karang #4~#5 200 MW	2	90	165	2,948	2,884
5	MKR3	PLTGU	M.Karang	1	300	465	2,433	2,018
6	MKRR	PLTGU	M.Karang Repowering 2011	-	500	750	2,433	2,018
7	PRK1	PLTU	T.Priok #3 & #4 50 MW	2	25	48	3,229	2,957
8	PRK2	PLTGU	T.Priok Block I & II	2	315	560	2,319	1,994
9	PRK3	PLTG	T.Priok #1 & #3 26 MW	2	10	20	4,711	3,930
10	PRKE	PLTGU	T.Priok Extension 2012	-	500	750	2,433	2,018
11	MTR1	PLTGU	M.Tawar Block I	1	315	605	2,555	2,246
12	MTR2	PLTG	M.Tawar #2.1 ~ #2.2 145 MW	2	72	138	3,376	3,204
13	MTR3	PLTG	M.Tawar #3.1~#4.3 153 MW	6	72	143	3,376	3,204
14	MTRR	PLTGU	M.Tawar Repowering 2011	-	150	225	2,433	2,018
15	SLK1	PLTP	Salak #1 ~ #3 60 MW	3	52	52	1,000	1,000
16	SLK2	PLTP	IPP Salak #4 ~ #6 60 MW	3	52	52	1,000	1,000
17	CLND	PLTG	IPP Cikarang Listrindo 150 MW	1	50	150	4,465	3,200
18	CLGN	PLTGU	Cilegon 740 MW	1	240	740	2,175	1,800
19	SRL3	PLTU	Crash Program Suralaya 600 MW	-	340	600	2,560	2,309
20	LBHN	PLTU	C.P. Labuhan 300 MW x 2	-	150	300	2,622	2,452

(2) Existing Power Plants, On-going and Committed Projects

No.	Name	Type	Explanation	No. of Sets	Min. Load MW	Capacity MW	Heat Rates Kcal/kWh Base Load	Heat Rates Kcal/kWh Average Incremental
21	TLNG	PLTU	C.P. Teluk Naga 300 MW x 3	-	150	300	2,622	2,452
22	KMJ1	PLTP	Kamojang #1 30MW	1	26	26	1,000	1,000
23	KMJ2	PLTP	Kamojang #2 & #3 55MW	2	47	47	1,000	1,000
24	KMJ3	PLTP	IPP Kamojang #4 60 MW x 1	1	60	60	1,000	1,000
25	DRJ1	PLTP	Darajat #1 55 MW	1	44	44	1,000	1,000
26	DRJ2	PLTP	IPP Darajat #2 95 MW	1	70	70	1,000	1,000
27	DRJ3	PLTP	IPP Darajat #3 110 MW x 1	1	110	110	1,000	1,000
28	WW1	PLTP	IPP Wyndu #1 110MW	1	110	110	1,000	1,000
29	SRG1	PLTG	Sunyaragi #1 & #2 20.03 MW	2	8	18	4,700	4,084
30	SRG2	PLTG	Sunyaragi #3 & #4 20.10 MW	2	8	20	4,700	4,084
31	PTH1	PLTP	IPP Patuha #1~#3 60 MW x 3	-	60	60	1,000	1,000
32	JBSL	PLTU	C.P Pelabuhan Baru 300MW x 3	-	150	300	2,590	2,115
33	JBUT	PLTU	C.P. Indramayu 300 MW x 3	-	150	300	2,590	2,115
34	CRBN	PLTU	IPP Cirebon 600MW x 1	-	360	600	2,560	2,160
35	TBK1	PLTGU	Tambak Lorok Block I & II	2	297	496	2,632	2,015
36	TBK2	PLTU	Tambak Lorok #1 & #2 50 MW	2	25	41	3,229	3,127
37	TBK3	PLTU	Tambak Lorok #3 200 MW	1	125	192	3,229	3,127
38	CLC1	PLTG	Cilacap #1 & #2 29 & 26 MW	2	10	22	4,700	4,079
39	CLC2	PLTU	IPP Cilacap #1 & #2 300 MW	2	150	300	2,772	2,285
40	TJB1	PLTU	Tanjung Jati-B #1 & #2 660 MW	2	330	660	2,772	2,285

(2) Existing Power Plants, On-going and Committed Projects

No.	Name	Type	Explanation	No. of Sets	Min. Load MW	Capacity MW	Heat Rates Kcal/kWh Base Load	Heat Rates Kcal/kWh Average Incremental
41	TJB2	PLTU	C.P T.Jati Baru/Cilacap 600 MW x 1	-	360	600	2,560	2,160
42	DIEN	PLTP	IPP Dieng #1 60MW	1	60	60	1,000	1,000
43	RMBG	PLTU	C.P Rembang 300 MW x 2	-	150	300	2,590	2,115
44	PTN1	PLTU	Paiton #1 & #2 400 MW	2	225	370	2,579	2,412
45	PTN2	PLTU	C.P Paiton 600 MW x 1	-	340	600	2,560	2,309
46	PEC	PLTU	IPP Paiton #7 & #8 645 MW	2	368	615	2,772	2,285
47	JPOW	PLTU	IPP Jawa Power #5 & #6 610 MW	2	355	610	2,700	2,310
48	GSK1	PLGU	Gresik Block I ~ III	3	250	480	2,318	1,990
49	GSK2	PLTG	Gresik #1 & #2 20.1 MW	2	5	16	4,456	4,284
50	GSK3	PLTU	Gresik #1 & #2 100 MW	2	43	85	2,882	2,709
51	GSK4	PLTU	Gresik #3 & #4 200 MW	2	90	175	2,826	2,601
52	PRAK	PLTU	Perak #1 & #2 50 MW	2	25	48	4,323	3,517
53	GRT1	PLTGU	Grati Block I	1	270	462	2,632	2,083
54	GRT2	PLTG	Grati #2.1~#2.3 100.75 MW	3	40	100	3,376	3,310
55	PMRN	PLTG	Pemaron #1 & #2 48.8 MW	2	12	48	4,439	4,035
56	GLMR	PLTG	Giltimur #1 & #2 20.1 MW	2	5	16	4,456	4,284
57	GLMK	PLTG	Gilimanuk #1 133.8 MW	1	56	133	4,439	4,035
58	BLI1	PLTG	Pesanggaran #1 ~ #4 20/42 MW	4	6	20	4,700	4,131
59	BLI2	PLTD	Pesanggaran #2 ~ #11 5~12MW	10	2	5	3,880	3,576
60	BLUT	PLTU	IPP Bali Utara 130 MW x 3	-	65	130	2,590	2,115

(2) Existing Power Plants, On-going and Committed Projects

No.	Name	Type	Explanation	No. of Sets	Min. Load MW	Capacity MW	Heat Rates Kcal/kWh Base Load	Heat Rates Kcal/kWh Average Incremental
61	BDGL	PLTP	IPP Bedugul 10 MW x 1	-	10	10	1,000	1,000
62	TJAW	PLTU	C.P T Awar-awar 300 MW x 2	-	150	300	2,590	2,115
63	JTSL	PLTU	C.P J.Selatan/Pacitan 300 MW x 2	-	150	300	2,590	2,115
	CSLC	PLTP	IPP Cisolok - Cisukarame 45 MW x 1	-	45	45	1,000	1,000
	TGBP	PLTP	IPP Tangkuban Perahu 110 MW x 2	-	220	220	1,000	1,000
	TMPM	PLTP	IPP Tampomas 50 MW x 1	-	50	50	1,000	1,000
24*	KMJ4	PLTP	IPP Kamojang #5 60 MW x 1	-	60	60	1,000	1,000
42*	DIEN2	PLTP	IPP Dieng #2 & #3	-	60	60	1,000	1,000
28*	WW2	PLTP	IPP Wyndu #2 110 MW	-	110	110	1,000	1,000
A1	RJMD	PLTA	IPP Rajamandandala 47 MW x 1	-	0	47		
A2	JTGD	PLTA	PU Jatigede 55 MW x 2	-	0	110		

(2) Existing Power Plants, On-going and Committed Projects

PUMP STORAGE (Upper Cisokan)

PS1

Installed Capacity	500	MW
Efficiency	76	%
O&M (Fix)	0.55	$/kW-month
Available Year	2015	

Period	Pump Cap. MW	Gen. Cap. MW	Max. Energy GWh
1	530	500	600
2	530	500	600

PS2

Installed Capacity	500	MW
Efficiency	76	%
O&M (Fix)	0.55	$/kW-month
Available Year	2016	

Period	Pump Cap. MW	Gen. Cap. MW	Max. Energy GWh
1	530	500	600
2	530	500	600

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(3) Candidates for Future Power Source Development Plan

Thermal Power

Power Resource	Abbreviation	Unit Capacity
PLTU-Coal	C6H	600 MW / unit
PLTU-Coal	C10H	1,000 MW/unit
LNG-fired PLTG/TGU	LNG	750 MW / unit
PLTP	GE55	55 MW / unit
PLTN	N10H	1,000 MW / unit
PLTG	G150	150 MW / unit
Java-Sumatra Interconnection	JS-IC	600 MW / unit, Max 5 units

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(3) Candidates for Future Power Source Development Plan

Hydropower & Pump

Name	Location	Type	Total Cost (M.US$)	Installed Capacity (MW)	Unit Cost ($/kW)	Annual Energy (GWh)
Cibuni-3	W.J	RES	363.3	172.0	2112.2	568.0
Cipasang	W.J	RES	482.4	400.0	1205.0	751.1
Cimandiri-3	W.J	RES	350.6	238.0	1473.1	600.0
Maung	C.J	RES	511.6	360.0	1421.1	534.9

Name	Location	Type	Total Cost (M.US$)	Installed Capacity (MW)	Unit Cost ($/kW)	Annual Energy (GWh)
Matenggeng	W.J	PST	585	1,000	585	905.2
Gurindulu	E.J	PST	624	1,000	624	905.2

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(4) Construction Cost

Plant Type	Overnights Cost Updated Cost ($/kW)
C6H	1,250
C10H	1,718
LNG	875
N10H	2,604
G150	500
PS 1&2	697
PS 3	647
PS 4	691
GE55	1,945
J-SIC	1,736

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(5) Fuel Cost

Kind of Fuel	Price USD		Price Cents/mKcal	Heat Content	
Coal	80.0	per Ton	1,509	5,300	Kcal/kg
LNG	10.0	per MMBTU	3,968	252,000	Kcal/mmbtu
Gas	5.0	per MMBTU	1,984	252,000	Kcal/mmbtu
HSD	133.0	per Barrel	9,222	9,070	Kcal/l
MFO	81.0	per Barrel	5,437	9,370	Kcal/l
Geothermal	0.0553	per kWh	6,430		
Nuclear			250		

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2.1.2 Simulation Method by WASP IV

Target for Each Scenario

Scenario		Oil	Coal	Gas	Geothermal	Hydro	Pumped Storage	Nuclear	Other Renewable
Scenario 0	Target in 2028	Energy rate 0.2 %	Energy rate 56 ~ 66 %	Energy rate 12 %	Energy rate 5 %	Energy rate 4 ~ 8 %	Up to WASP IV economic development	Capacity rate 5 ~ 7 %, 4 ~ 5 GW	Negligible
Scenario 1	Target in 2028	Energy rate 0.2 %	Energy rate 70 %	Capacity rate 10 %	Capacity 1,620 MW	Energy rate 2 %	Up to WASP IV economic development	Capacity rate 7 %, 5 GW	Negligible
Scenario 2	Target in 2028	Energy rate 2 ~ 3 %	Cover power shortage	Energy rate 19 %	Available capacity 3.6 GW, 5 %	Energy rate 4 ~ 8 %	Up to WASP IV economic development	Capacity rate 7 %, 5 GW	Energy rate 4 % by solar, wind and biomass
Scenario 3	Target in 2028	Energy rate 2 ~ 3 %	Cover power shortage, at least 18 % capacity after FTP	Energy rate 19 %	Available capacity 3.6 GW, 5 %	Energy rate 4 ~ 8 %	Up to WASP IV economic development	Capacity rate 7 %, 5 GW	Energy rate 5% by solar, wind and 2 % by biomass

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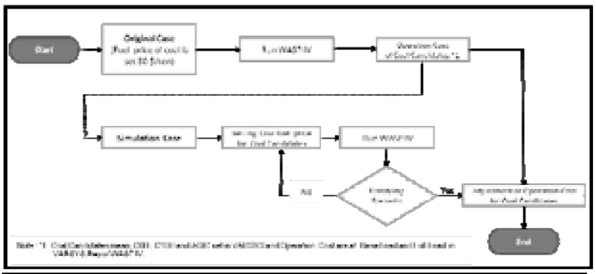
2.1.2 Simulation Method by WASP IV



Since WASP IV is a generation expansion planning tool based on the least cost and if coal fuel price of 80 $/ton is used, four (4) scenarios cannot be reproduced due to its lower fuel price in comparison with those prices of PLTP and LNG.

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2.1.2 Simulation Method by WASP IV

Scenario 2 (Power Source Diversification)

Operation Cost Adjustment

YEAR	PRESENT WORTH COST OF THE YEAR (K$)					OBJ.FUN.
	CONCST	SALVAL	OPCOST	OP-Coal	TOTAL	(CUMM.)
2009	-	-	6,019,205	-	6,019,205	6,019,205
2010	-	-	4,899,357	-	4,899,357	10,918,562
2011	584,024	58,402	4,655,034	-	5,180,656	16,099,218
2012	1,449,185	168,313	4,456,651	-	5,737,522	21,836,740
2013	-	-	4,267,108	(1,138)	4,265,970	26,102,710
2014	3,489,675	539,064	4,155,456	(23,572)	7,082,494	33,185,204
2015	1,436,983	251,475	4,030,534	(46,810)	5,169,232	38,354,436
2016	642,766	127,521	3,964,651	(87,316)	4,392,580	42,747,016
2017	3,690,462	846,234	3,937,643	(182,096)	6,599,776	49,346,792
2018	1,832,782	502,776	3,860,806	(183,764)	5,007,048	54,353,840
2019	1,741,811	521,413	3,854,422	(260,781)	4,814,039	59,167,879
2020	1,201,499	411,259	3,782,688	(259,923)	4,313,005	63,480,884
2021	1,953,862	760,850	3,517,136	(280,966)	4,429,182	67,910,066
2022	1,385,679	601,874	3,434,939	(295,528)	3,923,216	71,833,282
2023	1,299,786	636,367	3,323,517	(350,701)	3,636,235	75,469,517
2024	1,334,852	744,452	3,152,904	(316,621)	3,426,683	78,896,200
2025	1,036,181	645,474	3,043,621	(359,364)	3,074,964	81,971,164
2026	1,054,334	740,919	2,911,153	(342,165)	2,882,403	84,853,567
2027	938,587	741,885	2,814,338	(370,067)	2,640,973	87,494,540
2028	1,356,615	1,207,212	2,673,134	(391,778)	2,430,758	89,925,298

2-26

2.1.2 Simulation Method by WASP IV

Scenario 2 (Power Source Diversification)

VARSYS.REP

Operation Cost of Coal-fired in VarSys Adjustment (Net Present Value)

YEAR	t'-0.5	NPV Conv.	Fuel Price 3,019 Usc/M.kcal		Original F.P. 1,509 Usc/M.kcal		Additional Cost	
		12.0%	BASE $/MWh	FLD $/MWh	BASE $/MWh	FLD $/MWh	BASE $/MWh	FLD $/MWh
2021	-12.5	0.24254	77.8	76.0	39.9	39.0	-37.9	-37.0
2022	-13.5	0.21655	77.8	76.0	39.9	39.0	-37.9	-37.0
2023	-14.5	0.19335	77.8	76.0	39.9	39.0	-37.9	-37.0
2024	-15.5	0.17263	77.8	76.0	39.9	39.0	-37.9	-37.0
2025	-16.5	0.15414	77.8	76.0	39.9	39.0	-37.9	-37.0
2026	-17.5	0.13762	77.8	76.0	39.9	39.0	-37.9	-37.0
2027	-18.5	0.12288	77.8	76.0	39.9	39.0	-37.9	-37.0
2028	-19.5	0.10971	77.8	76.0	39.9	39.0	-37.9	-37.0

Scenario 2 (Power Source Diversification)

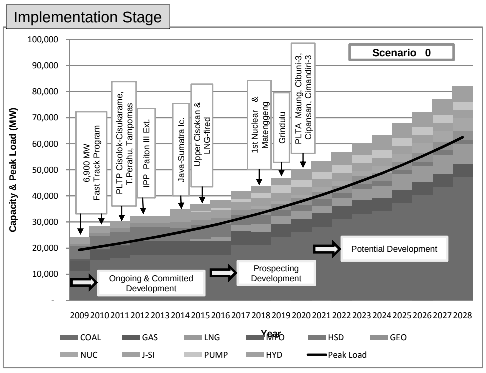
MEMRSIM1.REP

YEAR	C10H Generation (1000 GWh)				JS-I Generation (1000 GWh)				T. Generation (1000 GWh)		OP Cost	OP Cost
	P-1 Base	P1-Peak	P-2 Base	P-2 Peak	P-1 Base	P1-Peak	P-2 Base	P-2 Peak	BASE	PEAK	K$	(NPV) K$
2021	13.60	0.15	11.12	0.04	2.84	0.00	2.82	0.00	30.38	0.19	-1,158,432	-280,966
2022	15.44	0.14	13.75	0.36	3.03	0.00	3.30	0.00	35.52	0.50	-1,364,708	-295,528
2023	20.79	0.36	19.08	0.99	3.26	0.00	3.41	0.00	46.54	1.35	-1,813,816	-350,701
2024	21.03	0.26	19.27	0.87	3.40	0.00	3.59	0.00	47.29	1.13	-1,834,101	-316,621
2025	26.88	0.94	24.56	1.80	3.51	0.00	3.89	0.00	58.84	2.74	-2,331,416	-359,364
2026	28.58	0.97	26.60	1.91	3.74	0.00	3.87	0.00	62.79	2.88	-2,486,301	-342,165
2027	34.01	1.79	32.58	3.18	3.92	0.00	4.10	0.00	74.61	4.97	-3,011,609	-370,067
2028	41.61	2.58	38.60	3.63	3.80	0.00	4.15	0.00	88.16	6.21	-3,571,034	-391,778

2-27

2.1.2 Simulation Method by WASP IV

Implementation Stage



2-28

2.1.2 Simulation Method by WASP IV

Scenario 0

			2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
C6H	PLTU	600										
C10H	PLTU	1000				1,000	1,000	1,000	1,000	1,000	5,000	5,000
LNG	PLTG	750							750	1,500	2,250	3,000
N10H	PLTN	1000										1,000
GE55	PLTP	55			330	330	330	550	660	770	880	990
G150	PLTG	150										
PS	Pumped S.	500							500	1,000	1,000	2,000
CIB3	PLTA	172										
CPSG	PLTA	400										
CMD3	PLTA	238										
MANG	PLTA	360										
PLTA	PLTA	300										
Java-Sumatera I.C.		600						2,400	3,000	3,000	3,000	3,000
Total Additional Capacity			-	-	330	1,330	1,330	3,950	5,910	7,270	12,130	14,990
Total Supply Capacity at year end			24,389	28,305	30,318	32,285	32,285	34,905	36,975	38,335	41,642	43,801
Reserve Margin	%		26.2%	37.8%	39.0%	39.4%	31.4%	33.9%	33.7%	30.4%	32.9%	31.2%

			2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
C6H	PLTU	600										
C10H	PLTU	1000	8,000	10,000	12,000	15,000	17,000	18,000	21,000	24,000	27,000	31,000
LNG	PLTG	750	3,000	3,000	3,000	3,000	4,500	4,500	6,000	6,000	7,500	7,500
N10H	PLTN	1000	1,000	1,000	2,000	2,000	2,000	3,000	3,000	4,000	4,000	5,000
GE55	PLTP	55	1,100	1,210	1,320	1,430	1,540	1,650	1,760	1,870	1,980	2,090
G150	PLTG	150										
PS	Pumped S.	500	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000
CIB3	PLTA	172		172	172	172	172	172	172	172	172	172
CPSG	PLTA	400		400	400	400	400	400	400	400	400	400
CMD3	PLTA	238		238	238	238	238	238	238	238	238	238
MANG	PLTA	360		360	360	360	360	360	360	360	360	360
PLTA	PLTA	300				900	900	1,800	1,800	1,800	2,100	2,100
Java-Sumatera I.C.		600	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000
Total Additional Capacity			19,100	22,380	25,490	29,500	33,110	36,120	40,730	44,840	49,750	54,860
Total Supply Capacity at year end			46,913	50,193	53,303	56,708	60,318	63,328	67,938	72,048	76,958	82,068
Reserve Margin	%		31.9%	32.5%	32.1%	32.0%	31.8%	30.0%	31.1%	30.6%	31.1%	31.4%

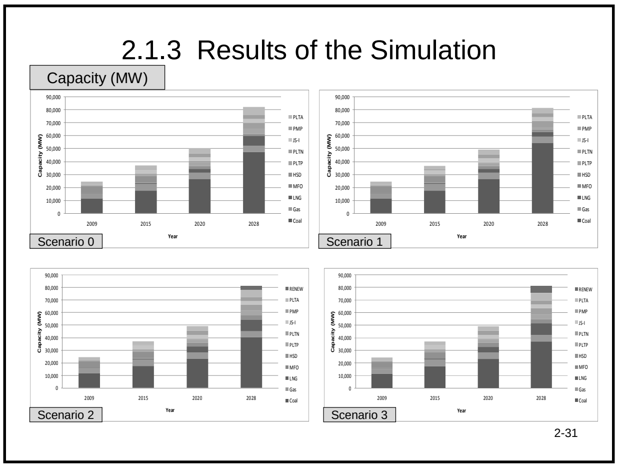
2-29

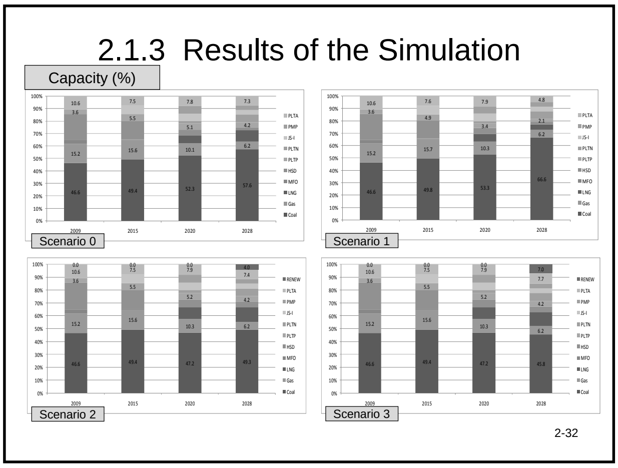
2.1.3 Results of the Simulation

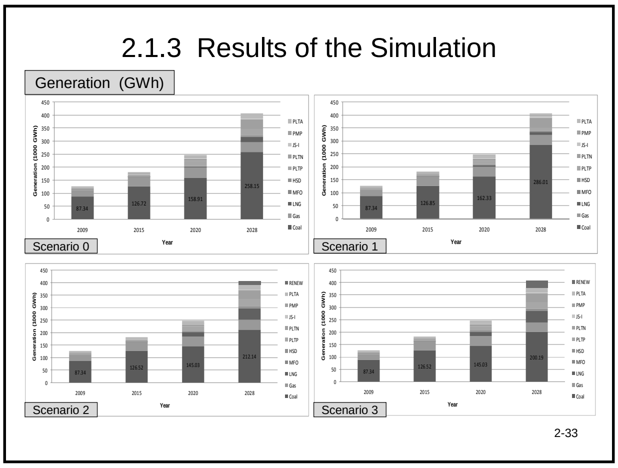
Scenario		Oil	Coal	Gas	Geothermal	Hydro	Pumped Storage	Nuclear	Other Renewable
Scenario 0	Target in 2028	Energy rate 0.2 %	Energy rate 56 ~ 66 %	Energy rate 12 %	Energy rate 5 %	Energy rate 4 ~ 8 %	Up to WASP IV economic development	Capacity rate 5 ~ 7 %, 4 ~ 5 GW	Negligible
	Simulation Results in 2028	Energy rate 1.1 %	Energy rate 65.7 %	Energy rate 14.5 %	Energy rate 9 %	Energy rate 3.3 %	Negligible	Capacity rate 6.1 %, 5 GW	None
Scenario 1	Target in 2028	Energy rate 0.2 %	Energy rate 70 %	Capacity rate 10 %	Capacity 1,620 MW	Energy rate 2 %	Up to WASP IV economic development	Capacity rate 7 %, 5 GW	Negligible
	Simulation Results in 2028	Energy rate 1.1 %	Energy rate 72.3 %	Capacity rate 10.8 %	Capacity 1,696 MW	Energy rate 2.2 %	Negligible	Capacity rate 6.1 %, 5 GW	None
Scenario 2	Target in 2028	Energy rate 2 ~ 3 %	Cover power shortage	Energy rate 19 %	Available capacity 3.6 GW, 5 %	Energy rate 4 ~ 8 %	Up to WASP IV economic development	Capacity rate 7 %, 5 GW	Energy rate 4 % by solar, wind and biomass
	Simulation Results in 2028	Energy rate 2.2 %	Energy rate 54.1 %	Energy rate 21.0 %	Available capacity 3.5 GW, 4.2 %	Energy rate 3.3 %	Negligible	Capacity rate 6.1 %, 5 GW	Energy rate 4 %
Scenario 3	Target in 2028	Energy rate 2 ~ 3 %	Cover power shortage, at least 18 % capacity after FTP	Energy rate 19 %	Available capacity 3.6 GW, 5 %	Energy rate 4 ~ 8 %	Up to WASP IV economic development	Capacity rate 7 %, 5 GW	Energy rate 5% by solar, wind and 2 % by biomass
	Simulation Results in 2028	Energy rate 2.2 %	Energy rate 51.0 %	Energy rate 20.8 %	Available capacity 3.5 GW, 4.2 %	Energy rate 3.5 %	Negligible	Capacity rate 6.1 %, 5 GW	Energy rate 7 %

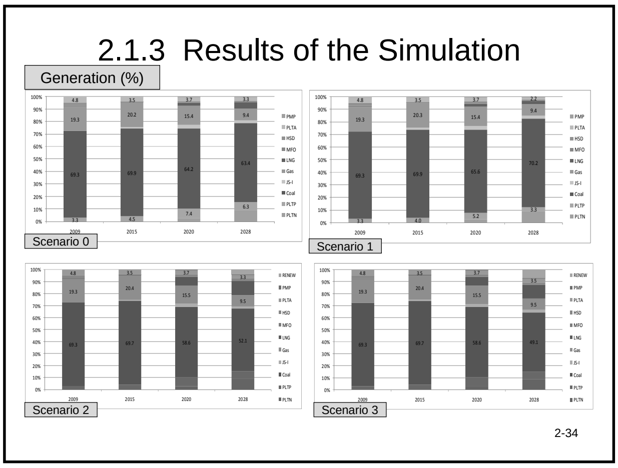
Comparison with Target

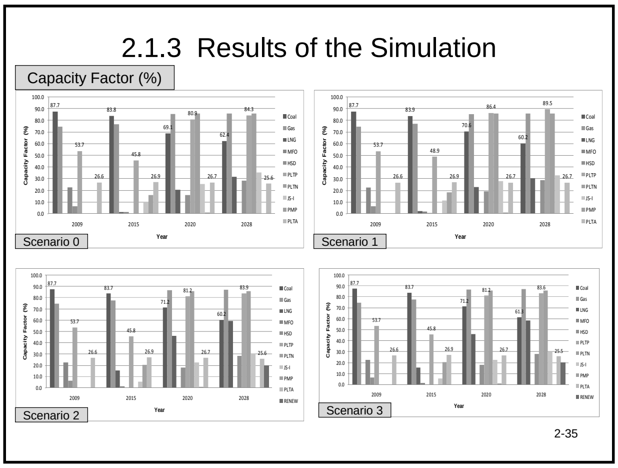
2-30

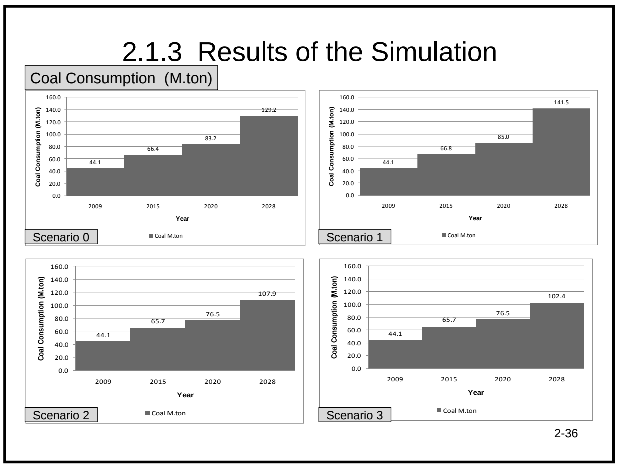

2.1.3 Results of the Simulation
Capacity (MW)
Scenario 0
Scenario 1
Scenario 2
Scenario 3
2-31


2.1.3 Results of the Simulation
Capacity (%)
Scenario 0
Scenario 1
Scenario 2
Scenario 3
2-32


2.1.3 Results of the Simulation
Generation (GWh)
Scenario 0
Scenario 1
Scenario 2
Scenario 3
2-33


2.1.3 Results of the Simulation
Generation (%)
Scenario 0
Scenario 1
Scenario 2
Scenario 3
2-34


2.1.3 Results of the Simulation
Capacity Factor (%)
Scenario 0
Scenario 1
Scenario 2
Scenario 3
2-35


2.1.3 Results of the Simulation
Coal Consumption (M.ton)
Scenario 0
Scenario 1
Scenario 2
Scenario 3
2-36

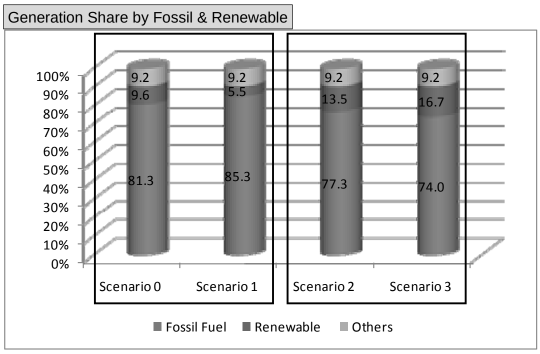
2.1.3 Results of the Simulation

Operation Pattern	Power Sources	Generation Share (%) in 2028			
		Scenario 0	Scenario 1	Scenario 2	Scenario 3
	Generation	407 Th.GWh	407 Th.GWh	407 Th.GWh	407 Th.GWh
Fossil Fuel (Coal)	Coal-fired Java-Sumatra In.	65.7	72.3	54.1	51.0
Fossil Fuel (Gas + LNG + MFO +HSD)	Gas, LNG, MFO, HSD	15.6	13.0	23.2	23.0
Renewable	Geothermal Hydropower	9.6	5.5	9.5	9.7
Other Renewable	Solar, Wind, Biomass	0.0	0.0	4.0	7.0
Others	Nuclear	9.2	9.2	9.2	9.2
Total		100.1	100.0	100.0	99.9

2-37

2.1.3 Results of the Simulation

Generation Share by Fossil & Renewable



2-38

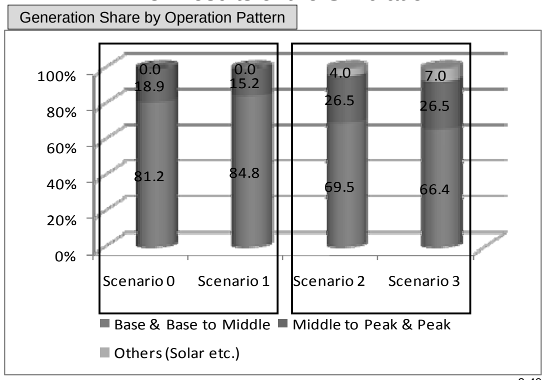
2.1.3 Results of the Simulation

Operation Pattern	Power Sources	Generation Share (%) in 2028			
		Scenario 0	Scenario 1	Scenario 2	Scenario 3
	Generation	407 Th.GWh	407 Th.GWh	407 Th.GWh	407 Th.GWh
Base	Nuclear Geothermal	15.5	12.5	15.4	15.4
Base to Middle	Coal-fired Java-Sumatra In.	65.7	72.3	54.1	51.0
Middle to Peak	Gas-fired LNG-fired Hydropower	17.8	14.1	24.3	24.3
Peak	MFO & HSD-fired Pumped Storage	1.1	1.1	2.2	2.2
Others	Solar, Wind & Biomass	0.0	0.0	4.0	7.0
Total		100.1	100.0	100.0	99.9

2-39

2.1.3 Results of the Simulation

Generation Share by Operation Pattern



2-40

2.1.3 Results of the Simulation

Conclusions

(1) All scenarios indicate more than 50 % of generation energy will be provided by coal-fired thermal plants including Java-Sumatra Interconnection up to the year 2028. And coal-fired thermal plants will play an important role in the future power source development plan.

2-41

2.1.3 Results of the Simulation

Conclusions

(2) Maximum coal consumption in 2028 will be 75 % of production of 190 Million ton in 2006. Export amount will be remarkably decreased unless acceleration of coal production will be achieved.

(3) Operation pattern of coal-fired thermal plants will be changed from a base load plant to a base & middle load plant.

2-42

2.1.3 Results of the Simulation

Conclusions

(4) Despite its costly initial investment cost, a nuclear power plant will be full operation for all scenarios due to its lowest operation cost.

(5) Oil-fired power plants will still account for 1% ~ 2 % share of generation energy in 2028 as a peak load plant.

(6) Gas and LNG-fired plants will account for 15 % ~ 21 % share of generation energy in 2028 as a peak load & middle load plant

2-43

2.2 Optimal Power Source Development Plan

2.2.1 Optimal Power Source Development Plan (OPSDP) and its Salient Feature

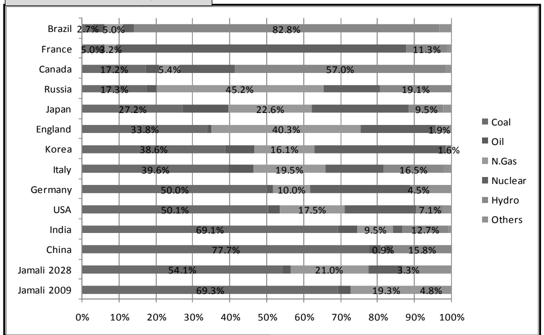
2.2.2 Towards Implementation of the Optimal Power Source Development

2.2.3 Study on the First Power Sources in Indonesia

2-44

2.2.1 OPSDP and its Salient Feature

Generation Share (%) in 2004



Source: IEA Electricity Information 2006 Edition

2-45

2.2.1 OPSDP and its Salient Feature

As shown in Figure,

(1) Coal of 54.1 % corresponds to USA (50.1%) and Germany(50.0%) and less than China (77.7 %) and India (69.1 %)

(2) Gas of 21.0 % corresponds to Japan (22.6 %)

(3) And renewable energy of 10.2 % corresponds to Germany (6.8 %) approximately.

Scenario 2 will be attainable.

2-46

2.2.2 Towards Implementation of the Optimal Power Source Development

(1) Coal-fired Thermal Plants
(2) Geothermal Plants
(3) Java-Sumatra Interconnection
(4) Other Renewable Energy
(5) Utilization of JICA Reports

2-47

(1) Coal-fired Thermal Plants

1) Preparation of candidate sites
2) Introduction of Supercritical coal-fired thermal plant
3) IGCC (Integrated Gasification Combined Cycle)
4) Utilization of Low Rank Coal (LRC)

2-48

1) Preparation of candidate sites Inventory

- The required additional capacity except the fast track program of 6,900 MW will be 29,000 MW.
- Inventory of candidate sites including the possibility of land acquisition should be commenced as soon as possible.

2-49

2) Introduction of Supercritical coal-fired thermal plant

Advantages of Supercritical

- Existing coal-fired thermal plants are operated at base load pattern.
- Supercritical thermal plants offer with stable operation within the range of 35% ~ 100% MCMR approximately and high thermal efficiency of more than 40 % in comparison of 30 % ~ 37 % of the current PJB Paiton and IP Suralaya thermal plants.
- Higher thermal efficiency means less fuel consumption and less air pollution emission.

2-50

3) IGCC (Integrated Gasification Combined Cycle)

- IGCC is one of the latest clean coal technologies.
- High thermal efficiency with 40 % more is expected and fuel flexibility is also expected because IGCC fires gas converted from coal to gas.
- In Japan, ten (10) power utility companies jointly established “Clean Coal Power R&D Co., LTD. (CCP)” in 2001. Operation tests (250 MW Class) will be continued until the end of 2009 to verify reliabilities of the plant.

Note: CNG (Compressed Natural Gas) System is more practical technology at the moment.

2-51

3) IGCC (Integrated Gasification Combined Cycle)

- If PLN has a strong interest in development of IGCC, dispatch of PLN staffs to CCP as a long term overseas training is recommended.

Demonstration Plant (250 MW) in Japan

2-52

4) Utilization of Low Rank Coal (LRC)

Benefit of Utilization of LRC

- High and very high coals can be allocate to export to a certain extent as heretofore and earn the foreign currencies under the soaring coal prices in the world market.
- Utilization of LRC will contribute not only to the security of stable energy supply but also greatly air pollution problem in Jamali because of its less content of sulfur.
- Restriction in terms of coal consumption will be mitigated and more flexible expansion planning of coal-fired thermal plants will be available, if necessary.

2-53

4) Utilization of Low Rank Coal (LRC)

Measures for Utilization of LRC

- Developing coal-fired thermal plants at mine-mouth in Kalimantan and Sumatra, and using LRC as fuel because LRC is not suitable for storage/transport for long time due to its more water content and more active oxidizing substances
- Using LRC by mixture with fuel coal, as being mixed in Sularaya thermal plant and/or using LRC in the form of gasification like IGCC.
- Dismantling HSD and MFO-fired thermal plants in outer islands, and constructing LRC-fired coal thermal plants

2-54

(2) Geothermal Plants

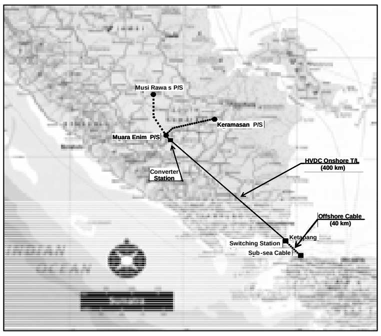
Reinforcement of PLN Role

- About 2,600 MW of geothermal plants are to be developed from 2010 to 2028 and all of them are to be developed by IPP scheme.
- In terms of proper development of geothermal plants, the Government should prepare the evaluation criteria for local governments, if not for and PLN should participate in planning and evaluation stages in some forms as one the stakeholders.

2-55

(3) Java-Sumatra Interconnection

- Basic concept of Java-Sumatra Interconnection is to develop IPP coal-fired thermal plants at mine-mouth in South Sumatra and to deliver surplus power of 3,000 MW by HVDC to the Jamali system in tight power balance condition.



2-56

(3) Java-Sumatra Interconnection

Expected Benefits

- No transportation of coal, which means stable power supply are available because coal transportation by ships is affected by weather condition sometimes.
- No plant sites in Jamali, which means less acceleration of air pollution in Jamali with high population density.
- Development at mime-mouth coal-fired thermal plants, which will contribute to revitalization of local communities through improvement of infrastructures.

2-57

(3) Java-Sumatra Interconnection

Implementation on Schedule

(1) PPA between PLN and IPP developers are still under negotiation at the moment.

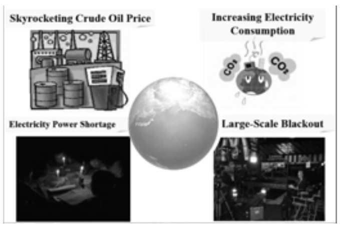
(2) PLN is expected to keep the implementation schedule of IPP coal-fired thermal plants as much as possible so that Java-Sumatra Interconnection can be put into the Jamali system (in 2014) on schedule.

2-58

(4) Other Renewable Energy

1) Solar power

2) Wind Power



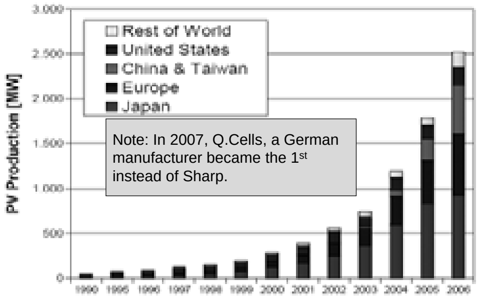
2-59

1) Solar Power

- Germany has managed to become the world' leading solar power generator even though it rains year round and clouds cover the skies for about two-thirds of all daylight hour
- Solar power seems to be the most appropriate generation system among renewable energy (solar power, wind power and biomass) considering sunny weather of Indonesia.

2-60

1) Solar Power



Note: In 2007, Q.Cells, a German manufacturer became the 1st instead of Sharp.

Source: PV Status Report 2007, JRC Technical Notes

2-61

1) Solar Power

German Case

- Renewable Energy Law in 2000, which offers cash incentives to peoples introducing renewable energy sources.
- “Feed-in Tariff” system, which gives anyone who generates power from solar power, wind or hydro a guaranteed payment from the local power company. The power companies are obliged to buy 20 years at more than triple market prices (49 cents per kWh for solar electricity).

2-62

1) Solar Power

Benefit of Solar Power Expansion

- Expanding use of solar power system contributes to not only climate change and fossil fuels saving but also creating new industries and job opportunities. It is expected in Germany that the number of jobs in solar power alone to double to 90,000 over the next five years and hit 200,000 in 2020.

2-63

1) Solar Power

Role of MEMR

- MEMR is expected to establish concrete encourage measures to expanding use of and investment for solar power system.

2-64

2) Wind Power

Installation of wind power is accompanied by environmental issues as listed below;

- Whether permit to install in national parks and conservation forest areas in terms of landscape
- Radio disturbance to be caused by wind power made of metal
- Damage to birds and migratory birds by bird strike

2-65

2) Wind Power

MEMR is recommended to develop the Environmental Impact Assessment guidelines or criteria in cooperation with MOE, if not for guidelines/criteria.

Wind Power Farm in Hokkaido, Japan

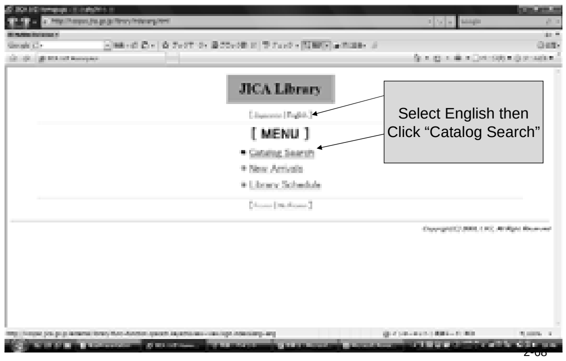
2-66

(5) Utilization of JICA Reports

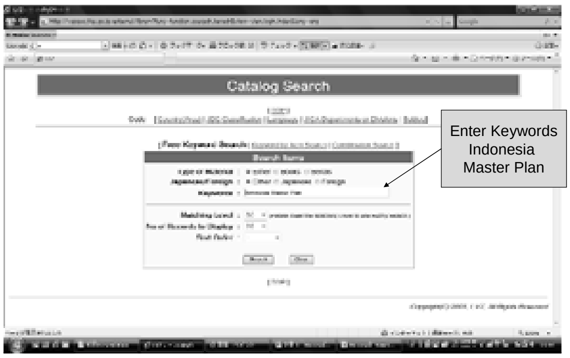
- JICA has a library and almost JICA reports can be read on or downloaded from the JICA Library Website.
- Utilization of the JICA Library is strongly recommended especially for PLN and MEMR local offices which might have seldom chances to read the relevant JICA reports, in terms of not only as references but also capacity building.

2-67

JICA Library English Address http://lvzopac.jica.go.jp/library/indexeng/html



2-68



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2-70

2-71

2.2.3 Study on the First Power Sources in Indonesia

The validity of the implementation of a nuclear power plant and a pumped storage power plant, which are the first power generation facilities in Indonesia, is studied in this section.

(1) Nuclear Power Plant

(2) Pumped Storage Power Plant

2-72

(1) Nuclear Power Plant

Additional coal-fired thermal plants with unit capacity of 1,000 MW will substitute for nuclear power plants with unit capacity of 1,000 MW. Reserve margin with 30 % will be still kept after 2018.

Table 5.1-1 Cumulative Objective Function for With and Without Nuclear

Case	Investment Cost (Million US$)	Salvage Value (Million US$)	Operation Cost (Million US$)	Objective Function (Million US$)	Ratio
With Nuclear	26,429	-9,505	73,001	89,925	1.000
W/O Nuclear	25,091	-8,834	74,857	91,114	1.013

Cumulative objective function in 2028 converted to 2009 price with discount rate of 12 % will be increased by 1.3 % for W/O Nuclear.

2-73

(1) Nuclear Power Plant

Table 5.1-2 Generation Energy Component in 2028 (%)

Case	Coal	Gas	Oil	Geo	Nuclear	Others	Total
With Nuclear	54.1	21.0	2.2	6.2	9.2	7.3	100.0
W/O Nuclear	61.3	22.3	2.6	6.4	0.0	7.3	99.9

Note: Others include Hydro (3.3 %) and renewable energy (4.0%).

9.2 % of nuclear power plants are compensated by not only coal but also gas, oil and geo.

2-74

(1) Nuclear Power Plant

Table 5.1-4 Coal, Gas/LNG and Oil Consumption in 2028

Case	Coal	Gas/LNG	Oil
Unit	M. ton	M. mmbtu	M. KL
With Nuclear	107.9	692.1	3.1
W/O Nuclear	121.4	732.8	3.7

Coal consumption in 2028 will be increased by 13.5 Million ton or 12.5 % for W/O Nuclear.

2-75

(1) Nuclear Power Plant

Table 5.1-5 CO2, NOx and SOx Emission in 2028 (Million ton)

Case	CO2	NOx	SOx
With Nuclear	239.4	1.4	0.5
W/O Nuclear	269.6	1.5	0.5

CO_2 emission will be increased by 30.2 Million ton or by 12.6 % for W/O Nuclear due to increase of generation energy by coal-fired thermal plants mainly.

2-76

(1) Nuclear Power Plant

Conclusion

Increase of objective function (total cost), fuel consumption and CO_2 emission are confirmed by WASP simulation in case of "Without Nuclear Plants".

2-77

(2) Pumped Storage Power Plant

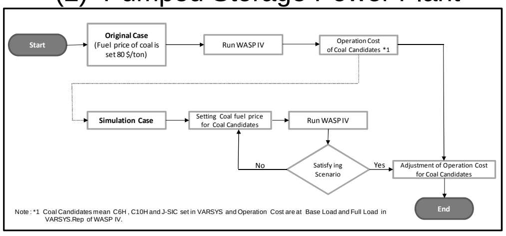


Table 5.1-6 Generation Energy and Capacity Factor of Pumped Storage Power Plants

Year	2015	2018	2020	2022	2024	2026	2028
Capacity (MW)	500	2,000	3,000	3,000	3,000	3,000	3,000
G.Energy (GWh)	751	2,853	4,200	4,200	4,200	4,200	4,200
C.Factor (%)	17.12	16.27	15.98	15.98	15.98	15.98	15.98

2-78

(2) Pumped Storage Power Plant

Conclusion

Since the available generation energy at the installed capacity of 3,000 MW is 4,200 GWh, pumped storage power plants will be operated at full load after 2020 by introduction of coal-fired thermal plants and nuclear power plants which will provide pumping energy with low cost. Therefore, the development of pumped storage power plants should be promoted.

2-79

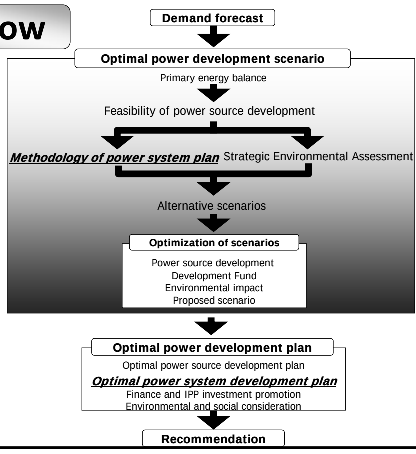
3. OPTIMAL SYSTEM PLAN

SPEAKER: MR. TANAKA YUKAO,

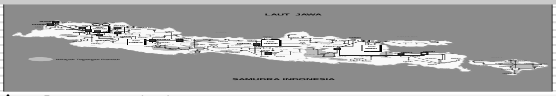
NEWJEC INC.

Optimal System Plan

Workflow



Java-Bali Power System



Characteristics

- *Long distance of about 1,000 km to west –east direction.*
- *Large Power flow toward west direction*
- *Mainly Depending on long-distance Northern AC 500 kV transmission Line*
- *System has stability Problem*

Change of Situation

- *Coal fire plants under Crash program*
- *Upper Ciscocan Pumped Storage power Station*
- *Interconnection with Java- Sumatra*
- *Introduction of new type Large Power Plant(Nuclear)*

Review of System Study

- *Study based on reviewed data using PSS/E*
  - *Reliability of the hole power system with respect to stability of frequency and voltage*

Power System development

(System Analysis)

Development of the integrated optimal system Reinforcement plan with Criteria Reliability

- *Optimal Plan should be developed up to 2028*
  - *Key Year of 2010,2015 ,2020 and 2028 should be analyzed*
- *"PSS/E" soft wear should be used for Analysis*
- *Reliability Criteria*
  - *Total power system should be stable in case of any Equipment or Route Down Accident*

Power System development(Step)

Step 1:Prediction of Trunk substation load & **Available power plant**

Step 2:**Estimation of location & out put of available Power Stations**

Step 3:**The expansion plans of transmission lines and substations**

Step 4 : **Assumption of tentative configuration and power flow of Java-Bali power system in the future**

Step 5: **Evaluation of power system reliability at each key years (Power supply quality and Power flow & Short circuit condition etc,.)**

Step 6 : Power system reinforcement points based on system analysis evaluation

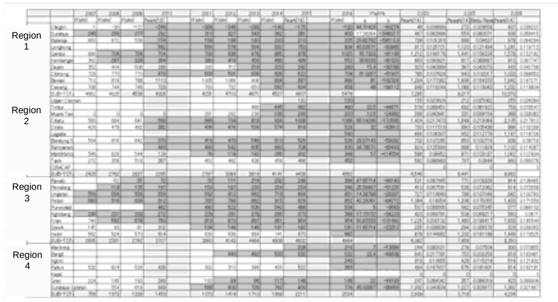
Step 7 : **Introduction of DC system for sending long distance large power**

Step 8 : **Development of Optimum power system reinforcement plan**

Step 9: Evaluation of system reliability for optimal system development plan

Assumption of Each substation Load(1)

Assumption of the demand of each trunk substation using reguretion method based on the PLN forecast trend up to year2016



Assumption of Each substation Load(2)

Assumption of Reactive power based on actual record of each substation taking situation change into consideration

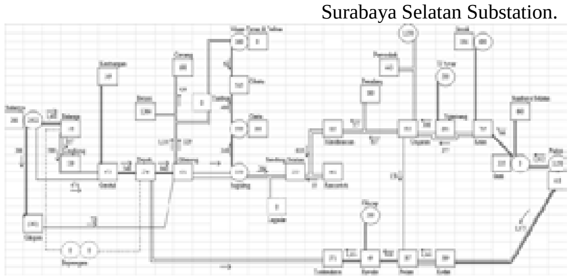
		2028								
		Peak(14)	P(MW)	P(MW)	P(MW)		Q(Mvar)	Off Peak		Q(Mvar)
Region 1	Cilegon			0.039207	574	0.93	227	232	0.93	92
	Suralaya			0.058415	855	0.95	281	345	−0.98	−70
	Balaraja			0.094284	1,380	0.94	501	557	1	0
	Lengkong			0.119713	1,753	0.94	636	708	1	0
	Gandul			0.152182	2,228	0.95	732	900	−0.98	−183
	Kembangan			0.087747	1,285	0.94	466	519	0.96	151
	Parung	Cibinon +0.3			438	0.94	159			
	Depok			0.042739	626	0.94	227	253	0.99	36
	Cibinong			0.069653	1,021	0.94	371	589	1	0
	Bekasi			0.187271	2,742	0.94	995	1,107	−0.97	−278
	Cawang			0.118804	1,739	0.95	572	702	−0.98	−143
	SUB-TOT	0	22,629	7,988	14,641			5,913		
Region 2	Upper Cisokan			0.026384	209	0.94	76	148	1	0
	Tmbur			0.078547	624	0.94	226	441	1	0
	Muara Tawar			0.038083	302	0.94	110	214	1	0
	Cibatu			0.217812	1,729	0.94	628	1,222	1	0
	Cirata			0.102039	810	0.94	294	573	−0.98	−116
	Lagadar			0.118726	942	0.95	310	666	1	0
	Bandung Selatan			0.09716	771	0.85	478	545	0.89	279
	Rancaekek			0.114087	906	0.95	298	640	−0.98	−130
	Mandirancan			0.107834	856	0.95	281	605	−0.97	−152
	Tasik			0.099378	789	0.94	286	558	1	0
	CIRACAP			0	0		0	0		0
	SUB-TOT	0	10,742	2,804	7,938	0.93	3,137	5,611		
Region 3	Rawalo			0.109495	1,189	0.93	470	868	−0.98	−176
	Pemalang			0.073558	789	0.93	316	583	−0.98	−118
	Ungaran			0.100793	1,095	0.93	433	799	0.96	233
	Pedan			0.171559	1,863	0.93	736	1,359	0.96	397
	Purwodadi			0.069102	750	0.93	297	548	0.98	111
	Ngimbang			0.0671	729	0.92	310	532	0.98	108
	Krian			0.195544	2,123	0.93	839	1,549	0.95	509
	Gresik			0.039363	427	0.91	195	312	−0.97	−78
	Kedri			0.173525	1,884	0.91	859	1,375	1	0
	SUB-TOT	0	11,649	789	10,859			7,924		
Region 4	Mandirejo			0.070855	831	0.95	273	888	1	0
	Bangil			0.193481	2,270	0.95	746	2,424	1	0
	Ngoro			0.121932	1,430	0.95	470	1,528	1	0
	Paiton			0.192181	487	0.95	160	2,408	−0.97	−604
	Kapal			Max(2800	1,317	0.95	433	1,505	−0.97	−377
	Gilnuk	Bali Demand +0.2			329	0.95	108			
	Wtdol	Piton Demand +0.2			122	0.95	40			
	Grati			0.099906	1,172	0.92	499	1,252	0.96	365
	Surabaya Selatan			0.321667	3,773	0.94	1,370	4,030	0.97	1,010
	SUB-TOT	0	17,454	5724	11,731			12,530		
Total of Substation Lo		0		17305.71	45,168					0
Total Demand(PLN)							0			0

3-7

Load Flow Diagram for 500kV System

(Year 2010)

● There is no big problem in particular.
It is need to watching the load condition of Surabaya Selatan Substation.

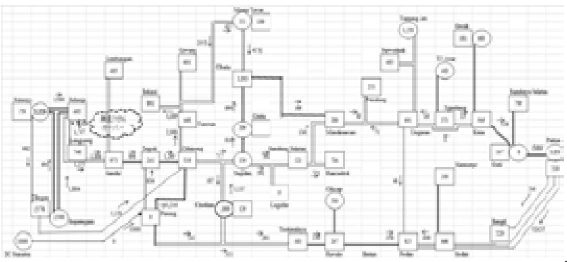


3-8

Load Flow Diagram for 500kV System

(Year 2015)

● There is no big problem in Jamali system in particular.
It seems to become heavy power flow in Surabaya Selatan substation.
Regarding to the new transmission line of Cibatu-Mandirancan, it is better to consider relation to the Introduction of DC transmission mentioned later.

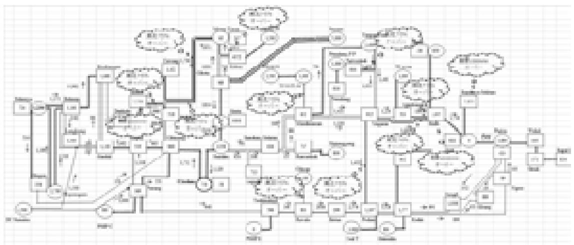


3-9

Load Flow Diagram for 500kV System

(Year 2020)

● Some substations vicinity of Jakarta area seem to become heavy load.
→ to develop of optimal power supply method to Jakarta Metropolitan area.
● It is recommended to introduce DC system for sending power of Nuclear plant
● It is recommended to reevaluate the necessity of Tanjung Jati-Mandirancan

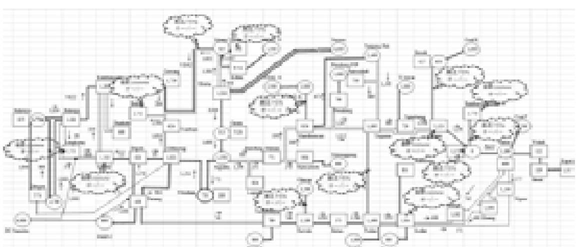


3-10

Load Flow Diagram for 500kV System

(Year 2025)

● It is recommended to develop related transmission lines of Muara Tawar- Cibinong and Muara Tawar – Durikosambi)
- It is recommended to built New substation of DurikabiS/S as well.
● Ungaran-Pedan is recommended to reinforcement of another one circuit
● Bali Conection is recommended to reinforce the interconnection line with AC 500kV overhead transmission line
● It is expected to reinforce southern area in Java island(Especially southern east area)

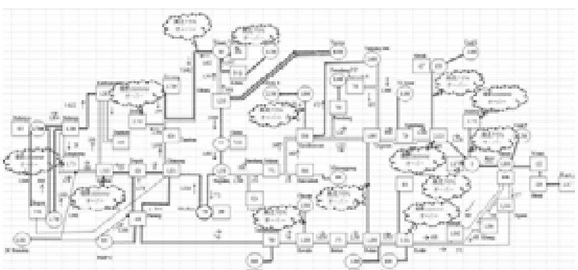


3-11

Load Flow Diagram for 500kV System

(Year 2028)

● It is recommended to develop new 500kV substation between Muara Tawar-Durikosambi
● It is recommended to develop additional 500kV trunk substation in the vicinity of Kediri
● It is recommended to reduce east direction power flow in loop system
● It is recommended to reduce heavy power flow between Krian-Grati



3-12

Capacity of Trunk Substation

● **P**recondition
->Short period overload Capacity 150%,Contnuous overload capacity 110%

In case of one Transformer → to add another transformer when reached 60% .
In case of two Transformers → to add another transformer when reached 75% .
In case of over 3 Transformers → to add another transformer when reached 100%

●Following concerns in case of installation of over 3 units transformer in trunk S/S
- There might be case which could not operate in parallel due to short circuit problem.
- Load amount of one trunk substation becomes too large to restore in case of upper side accident
- Preferable supply area from one trunk substation seems to be within 100-50km. So, around 3 units seems to be maximum capacity in one trunk substation.
- It should be considered to introduce larger transformer units
  Example : Demand concentrated area →Max around 3 units with 750MVA (500/150kV Tr) or 1,000 MVA (500/275 kV)
  Other area →Around 2 units(Max 3 units) with 500MVA (500/150kV Tr)

Therefore, target maximum capacity of one trunk substation seems to be around 1,500 MVA (500 MVA * 3 Unit) or 1,000 MVA

3-13

Summary of power flow analysis result(1)

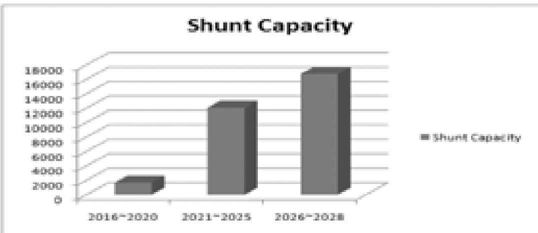
Regarding to transmission lines
●to develop the power supply method of metropolitan high demand density area.
●to reinforce Ungaran-Pedan transmission line (Current 1 circuit -> 2 circuit)
●to reinforce the 500 kV total trunk loop system
●to adapt larger size conductor for meeting final capacity of new power plant.

Rgarding to Substation &Transformers
●to construct new substation in vicinity at the time main substation load is over certain capacity
●to develop "Metropolitan Power supply method " by total consideration from every view point.
- to evaluate introduction of 500kV voltage into load center directly as well
●to develop new substation and additional transformer in southern area of east Java
●to introduce lager size unit of transformer taking final capacity into consideration from long term view point.

3-14

Summary of power flow analysis result(2)

Regarding to Reactive power compensation
●to install Reactive power compensation Equipment for keeping system voltage within suitable rang.
●to be made effort to generate lagging reactive power as mach as possible



3-15

Summary of power flow analysis result(3)

In relation to develop the actual reactive power plan

●**to keep a balance of not only the total system, but also of the partial area system.**

●to **be installed at sending end sub-stations for the sake of increasing voltage regulation capacity and reducing System losses.**

●to **be selected as large shunt unit as possible within the limit of tolerable voltage Fricker (2 or 3%)**

●to install **on-load tap changer to transformers especially for a higher voltage system.**

3-16

Summary of power flow analysis result(4)

(Rough Evaluation)
In case of around 5% Up of system voltage partially by shunt equipment

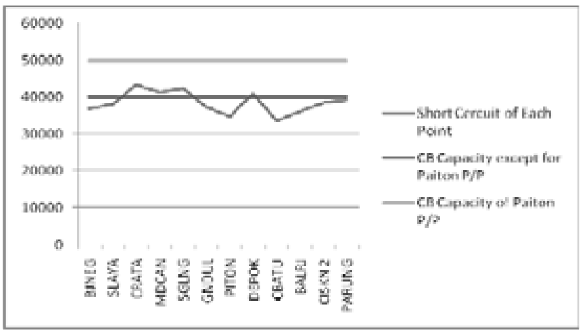
*Amount of Shunt equipment of :5719MVar
*Amount of system loss reduction : 49MW
*Economic Evaluation of system loss :About 180 Billion Rp
［Precondition: ***Load factor -> 0.61875 , Generation cost -> 705.96Rp/kWh]***

*Equivalent Economic effect of shunt equipment : about 6500 Million Rp /MVar
［Commercial Install cost :about 240 Million Rp /MVA］

It seems to be economical to raise system voltage up by installation of shunt equipment at effective point

3-17

Summary of power flow analysis result(5)



3-18

Summary of power flow analysis result(6)

Almost existing equipment in the 500kV substation in Indonesia is designed to against maximum short current 40kA in Java-Bali power system, except Paiton 50kA.

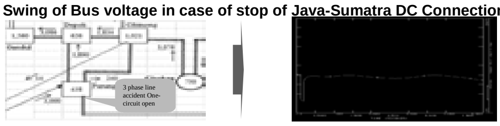
- *Cirata and Saguling have relatively high short circuit capacity due to connection of large power plants.*
- *In case of concentration of power units including expansion in the future, it should be evaluated from the short circuit capacity view point.*
- *It is respectable to locate power plants in central & east Java area uniformly instead of concentration in west Java area which is heavy load center.*

It seems to be easy for handling this issue by changing 50 or 63KA Circuit Bleaker if there is no severe problem such as no severe magnetic field effect etc.

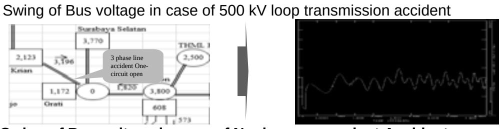
3-19

Summary of Stability analysis result

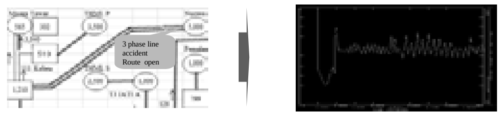
Swing of Bus voltage in case of stop of Java-Sumatra DC Connection



Swing of Bus voltage in case of 500 kV loop transmission accident



Swing of Bus voltage in case of Nuclear power plant Accident

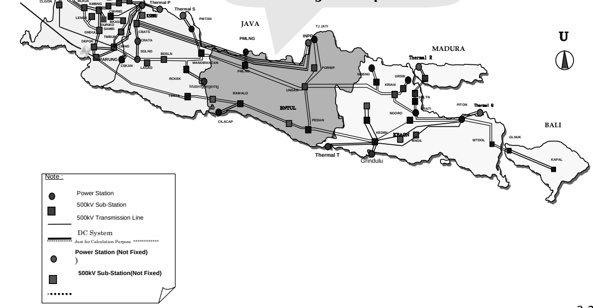


3-20

JAVA BALI 500kVSYSTEM year 2028

-System Capacity : Around 60,000MW - *(Just for reference)*

At least, Two Routs of 500kV T/L might be required



3-21

Power System development

(Main Concept)

- *Optimization of System Reinforcement with Flexibility coincide to Power Plants Development*

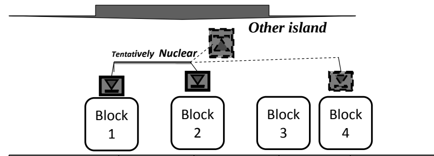
- *Keep Feasibility of Java-Bali Trunk Power system for meeting situation change in the future*
- *Composed by common equipments widely used in the world for smooth O & M*
- *Utilizing FACTS Equipments efficiently for Cost Reduction*
- *Simplify the power system as possible*
- *Utilizing the Existing Power Equipments at maximum*
  - *- Adaption of the least Protection system for Avoiding Expansion Development of System Accident*
- *Enhancing the Supply-Demand Balance of Block areas*

3-22

Power System development

(Main Concept)

- ***Comparison of several reinforcements measure***
  mainly from the View point of Installation Cost, Flexibility and Realization



	Cost	Flexibility	Technical	O&M
DC	◎	◎[BTB]	○	○
Ultra High Voltage	△	○	△[Loss]	△
500kV T/L	○	○	◎	◎

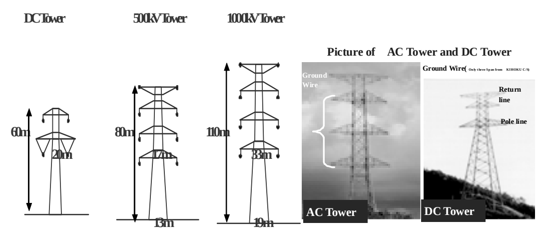
◎: Excellent ○ :Good △ :Bad

★ *Introduction of Method for enhancing Local Demand for achieving Block Balance*

3-23

Rough Comparison of AC/DC(1)

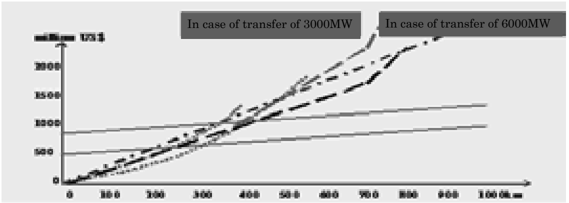
- *Illustration of each transmission configuration*



3-24

Rough Comparison of AC/DC(2)

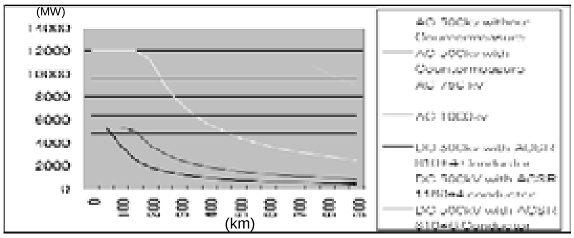
- ***The cost of DC transmission line is lower than that of AC, however Dc system requires AC/DC convector station at both ends additionally.***
- ***So, Generally speaking, in case of sending large power with long distance of around 300km , DC might be suitable for reducing Install cost of transmission line***



	500KV DC	500kV AC *	750-1000kV AC	Others
Transmission Cost	0.46*10**6US$/km	1.125*10**6US$/km	About 2.0-3.0 times	Sending Distance Around250-300km
Convertor Equipment	INV/CNV (MUS$) 450(225*2)	--------	----------	Sending Capacity of 3000MW

Rough Comparison of AC/DC(3)

- ***Illustration of each transmission Sending Capacity***



Specification of UHV Transmission Line (Base1000MVA %/cct･km - 50Hz)

Voltage (KV)	Condocter Size	Impedance		
		Resistance	Reactance	Admitance
750	A810*6 (1200A*6)	0.001624	0.04771	0.2375
1000	A810*10	0.000626	0.02362	0.4788
1400	A810*14	0.000301	0.01267	0.8916

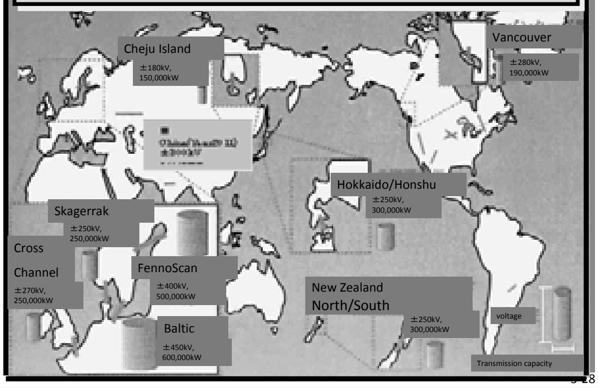
Application of Direct Current Power Transmission

- ***The direct current power transmission has many advantages which cannot be realized by AC transmission as follows***

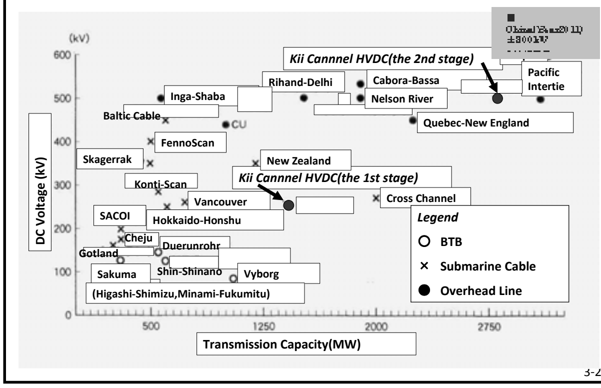
****** The profitable characteristics of DC system******

- *Less Install cot compared to another alternatives*
- *Suitable system for meeting situation changes and developing power system in flexible*
- *Easiness of introducing electric power from KALIMANTAN island.*
- *Easy Possibility for transferring to AC separate operation when required*
- *Capability of sending large electric power with long distance without Stability issues.*

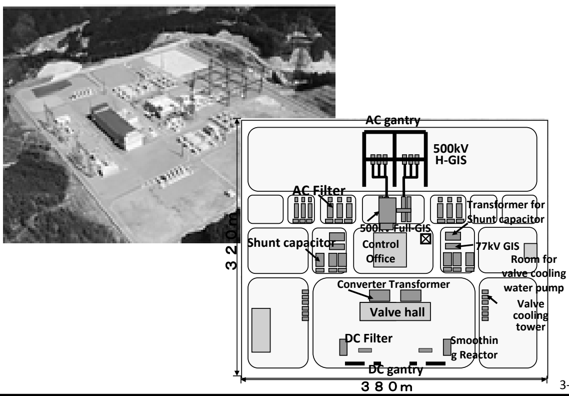
World's Main DC Facilities



Relation between Transmission Capacity and DC Voltage in the World HVDC Project



Layout of Kihoku Converter Station



Latest DC System operation method

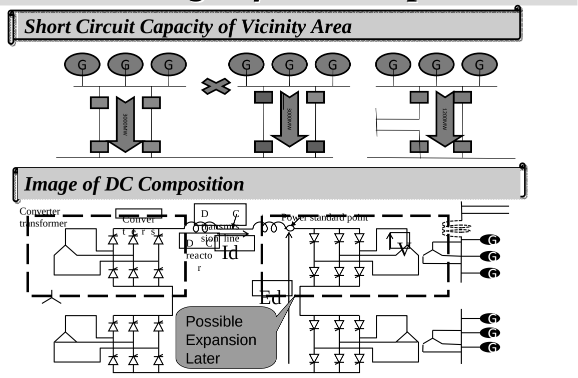
- ***Conventional DC system must be stopped and restarted in case of system voltage drop for avoiding continuous commuting failure. In this case, it requires around 200ms for restarting***
- ***Latest DC control method is enable to operate continuously during system voltage drop period. Latest DC system has the same reliability as AC system***

(a) Control Method of Conventional DC system
In case of AC voltage drop、DC system needs to stop and restart and it takes over 200ms until restore power.

(b) Control Method of Latest DC system
In case of AC stseem drop, Dc system enables to be operated continuously. So,reliability is the same asAC system

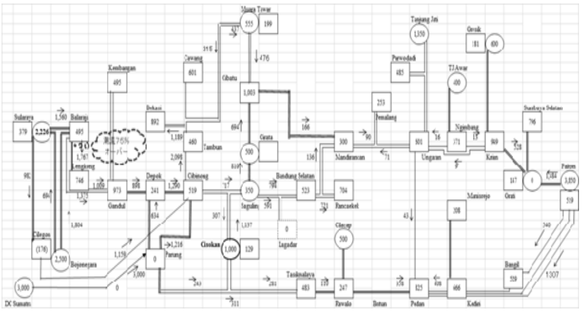
3-31

Just Image of DC Composition



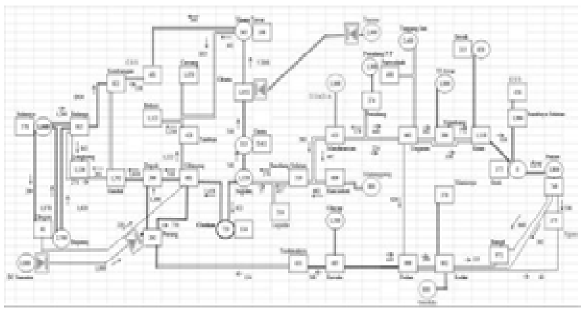
3-32

Optimal System Reinforcement (Year 2015)



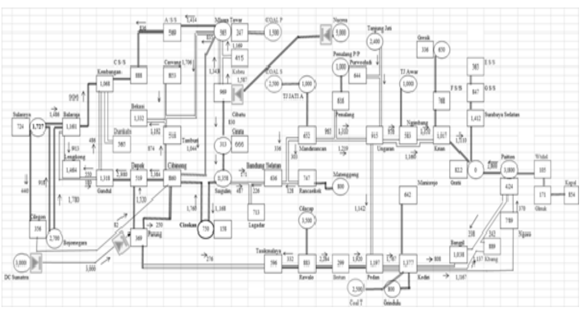
3-33

Optimal System Reinforcement (Year 2020)



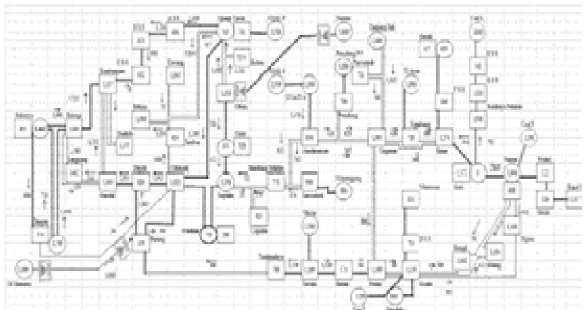
3-34

Optimal System Reinforcement (Year 2025)



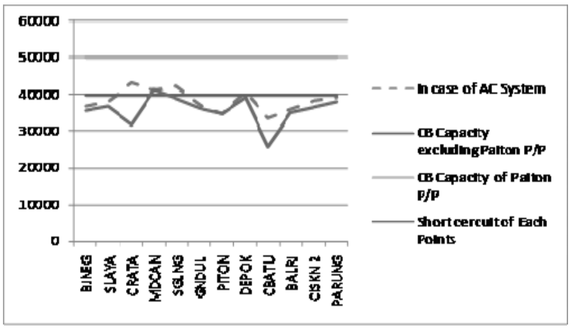
3-35

Optimal System Reinforcement (Year 2028)



3-36

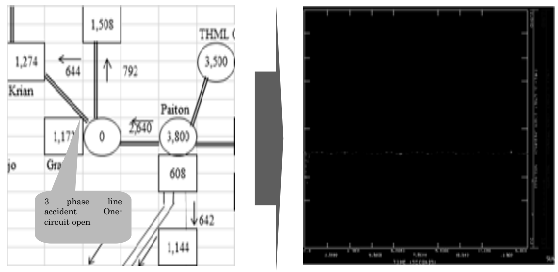
Summary of power flow analysis result



3-37

Summary of Stability analysis result

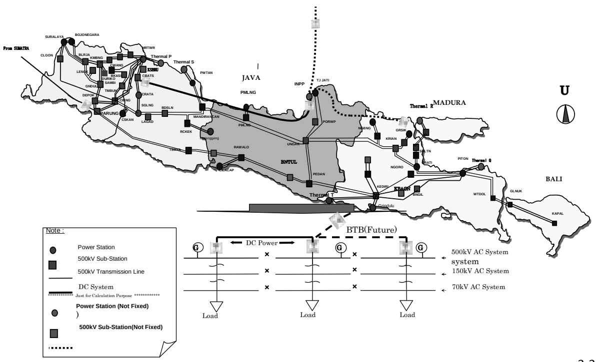
Swing of Bus voltage in case of 500 kV loop transmission accident



3-38

JAVA BALI 500kVSYSTEM year 2028

-System Capacity : Around 60,000MW - *(Just for reference)*



3-39

JAVA BALI 500kVSYSTEM year 2028

-System Capacity : Around 60,000MW - *(Just for reference)*

	2010	2015	2020	2025	2028
Peak Demand (JICA)[MW]	20535	27657	37895	51840	58712
New 500kV transmission(Km)	------	-------	890	570	110
New 500kV Substation(S/S)	------	--------	4	10	2

Million US$

Construction Cost	3276	1238	2357	2838	932

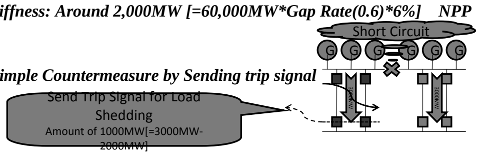
From RUPTU up to year:2015

3-40

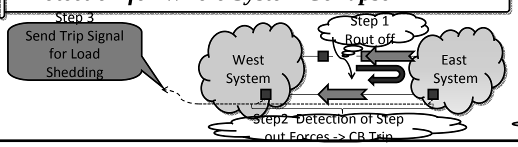
Image of Tentative Protection System

Protection for Frequency Drop

- *Stiffness: Around 2,000MW [=60,000MW*Gap Rate(0.6)*6%]*
- *Simple Countermeasure by Sending trip signal*



Protection for Whole System Collapse



3-41

Middle Power System for Dispatching

- Sample Concept for reference-

◆*Base on the preposition, rough study was carried out for the possibility for introduction of higher middle system voltage compared to current 150kV voltage.*

ovinsi	Residence	Industry	Commercial	Social	Gov't Offices	Public	Total (GWh)	Area (km^2)	kW/km^2
Bali	951.93	87.38	938.67	38.83	60.42	47.80	2125.03	5449.37	59
Jawa Timur	6574.85	8737.33	2016.17	408.41	169.62	416.72	18323.11	46689.64	60
wa Tengah dan Yogyakarta	6121.55	4040.69	1274.14	384.02	118.4	475.01	12415.81	35932.86	53
Jawa Barat dan Banten	9343.1	17761.26	2363.94	398.34	186.15	246.01	30298.80	45943.69	100
Jaya Raya & nggerang	8655.1	8029.36	7450.28	735.6	730.85	279.71	25880.91	740.29	5321
JaMali Total	31646.53	38656.02	14043.2	1965.2	1265.44	1465.25	89043.66	134755.85	101

The Current Demand Density by Area

◆*Rough Assumption of heavy load demand area in Indonesia Demand Density and possible length of dispatching line*

[Tolerable Current of Dispatching line - > 300A]

	Current	Future
Density(Length)	5MVA/km*2 (6km)	20MVA/km*2(3km)

3-42

Introduction of Higher Middle system Voltage(1)

◆*Maximum length of middle dispatching system between trunk substation and dispatching substation.*
-> Considering protection relay, tolerable voltage drop etc, maximum voltage drop of 5％ was assumed with the capacity of 100MVA,3Bank,LF:90% for dispatching substation and Maximum dispatching length was calculated roughly.

Base on these assumption ,the result of rough comparison of each medium system voltage is shown in Table 4.3.4-2,

Middle System Voltage (Kv)	Sending Capacity /2cct.410mm**2 [Impedance Base1000MVA]	Max Length (Km)	Bank Combination of Trunk Substation	Number of Dispatching Substation for Trunk Substat5ion	Rough Line Length [Km]	Required Trunk Substation	Syst Loss
150	760MVA[0.08+j0.9]	50	500MVA*３ Unit	5	6-9	Many (Around25)	Lar
230	MVA[0.05+j0.6]	70	750MVA*３ Unit	8	9-12	Middle (Over 10)	Mid
275	1360MVA [0.04+j0.5]	90	1000MVA*３ Unit	10	9-15	Little (Under10)	Sma

3-43

Introduction of Higher Middle system Voltage(2)

◆ *In addition, sending capacity rate of each voltage is as follows*
-Sending Capacity rate of 220kV system voltage :
Twice of the capacity of 150kV、one fifth of capacity of 500kV
*(230/150)**2: (500/230)**2= 2.15:5.17*
-Sending Capacity rate of 275kV system voltage :
Three times of the capacity of 150kV、one thirds of capacity of 500kV
*(275/150)**2 ; (500/275)**2 = 3.36 : 3.31*

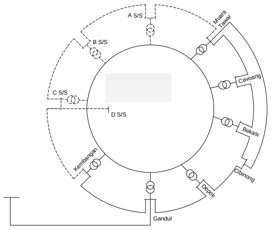
- *Therefore, from the sending capacity ratio of existing voltage level, 275kV system would be suitable for next higher middle voltage as well.*
- *As summary, 275kV should be recommended to introduce as higher middle system voltage in the future from the above consideration, simplification of system voltage level, install cost reduction and reduction of system losses as well.*
- *In add ion, regarding to extreme heavy demand density Ares, more higher voltage such as 500kv should be considered to introduce directory from the view point of economic and technical based on more realistic demand density condition for further study.*

3-44

Power supply method to Metropolitan area

● It is recommended to study the economic power supply method taking every concerns into consideration
-> Introduction of middle high system voltage
-> or 500kV voltage directly in this area

Image of power supply method.



3-45

Other Interest Issues

- ***Connection point of additional Java-Sumatra connection.***
  - *- Judging from the space, Lengkong or Balaraja should be possible site.*
  - *- Lengkong seems to be less system losses*
  - *- It should be determined from total consideration of cost & Less Environment etc,*
- ***Frequency raising up in the Sumatra when Trip of connection.***
  - *- In case of Stop of Java-Sumatra connection with 3000MW, frequency of Sumatra system would be raised up*
  - *- It should be kept within around 1 Hz by power shedding etc, if required*
- ***Frequency drop problem when pumping operation in mid night***
  - *- The unit capacity of motor is 275MW, the biggest motor*
  - *- The maximum frequency drop shall be calculated as about 0.2Hz which seems to be allowable level*

3-46

Other Main Issues for further study

- ***Develop the power supply method of metropolitan area***
- ***Utilization of DC System as BTB Operation***
- ***F/S for DC connection with Kalimantan***
- ***Consideration of applicable stability criteria***
- ***Enhancing the Supply-Demand Balance of Block areas***
- ***Elaboration of previous recommended issues***
  - Introduction of DC &
  new Medium system Voltage in Metro area -

3-47

4. IMPROVEMENT OF POWER SYSTEM OPERATION

SPEAKER: MR. KOYAMA YASUSHI,

KANSAI ELECTRIC POWER CO., Inc.

Improvement of Power System Operation

Topics

- Voltage, Frequency, and Outage
  - Current Condition (Problems) :Briefly
  - Probable Reasons :Briefly
  - Possible Countermeasures
    (Required study to be implemented)

Voltage

- Voltage - Current Condition

The number of substation with voltage drop

Voltage	2002	2003	2004	2005	2006	2007	2008*
500kV (S/S)	103	158	149	145	75	60	23
150kV (S/S)	566	551	407	479	288	153	106
70kV (S/S)	319	248	198	207	169	252	34

*As of March, 2008

Assumed voltage drop at the peak time (night time) in 2008

Voltage	RCC1	RCC2	RCC3	RCC4	Total
500kV (S/S)	0	0	0	0	0
150kV (S/S)	1	11	0	0	12
70kV (S/S)	4	0	0	6	10

Although there is a tendency to decline in recent years, the number of voltage drop is still quite large.

- Voltage - Probable Reasons

Voltage problem is fundamentally due to the lack of reactive power supply

Static Capacitors and Shunt Reactors

- Lack of long-term reactive balance study and installation plan

Reactive output from generators

- Shortage of functional requirement in the grid code
- Generators not able to follow operational orders

- Voltage - Possible Countermeasures

Short-term Countermeasure

Raise of standard voltage (4-6)
Raise of standard voltage at extra high voltage system
Ex. 500kV -> 515kV

Incentives and penalties on reactive power supply
Rules and structures so that IPPs follow operation order from P3B

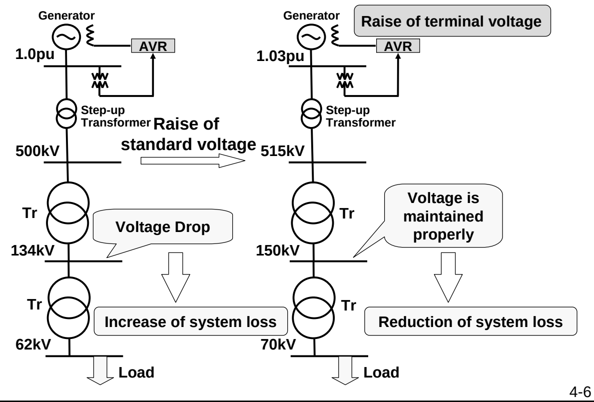
Long-term Countermeasures

Installation plan of reactive supply equipment (4-9)
Installation based on long term reactive demand and supply balance

Installation of on-load tap changer to step-up transformer (4-11)
On-load tap changer contributes to utilize reactive output from generator

Installation of Power System Voltage Regulator (PSVR) (4-13)
PSVR tries to keep system voltage constant against fast change of load

Raise of standard voltage



4-6

Effect of raise of standard voltage

Result of test calculation using system data in Jamali with PSS/E

Generator terminal voltage	V=1.01	V=1.03	V=1.05
System Loss (MW)	621.9	552.2	510.9

Loss decreased by about 70MW (-11%, -18%)

⇨ Possibility of additional reactive power

Not only the mitigation of the low voltage problem, but also the improvement of system loss is expected.

4-7

Study item on raising system voltage

Upper limit of operation

Example

Insulation breakdown / Increase of noise	Voltage limit of equipment	530kV
	Maximum allowable voltage	525kV
Error of metering device	Margin	
	Upper limit of operation	515kV

Available reactive power

Available reactive power of each generator shall be studied

How to be accomplished

Raise of system voltage can be executed speedily without additional installation cost by operation order

⇩ To order generators (IPPs)

Introduction of incentives and penalties

4-8

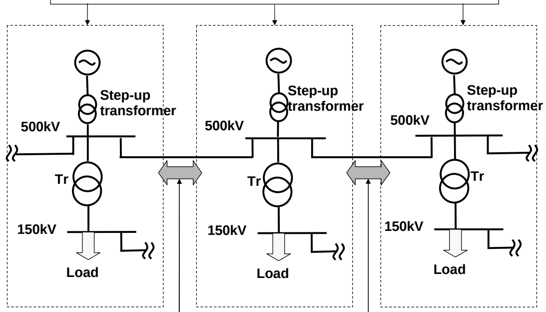
Installation plan of reactive supply equipment (1)

1. Study of planning phase
   - ・Static Capacitor (SC) : Heaviest load condition in the year
   - ・Shunt Reactor (ShR) : Lightest load condition in the year
2. Reactive demand forecast
   - ・Active demand forecast
   - ・Relationship between active power and reactive power
3. Check of supply and demand balance in each block
   - ・Supply and demand shall be balanced in each block
4. Calculation of required amount of reactive power equipment
   - ・Required amount is studied in each block
   - ・Reactive power flow among blocks will be minimized
5. Selection of the capacity of single unit
   - ・Consideration of voltage shock by switching
6. Power flow analysis
   - ・Checking of voltage violation

4-9

Installation plan of reactive supply equipment (2)

Checking balance of reactive power in each block

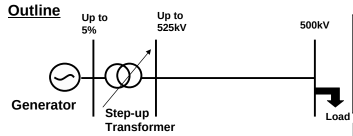


Minimization of reactive power flow among blocks

4-10

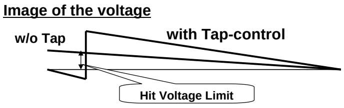
Installation of on-load tap changer to step-up transformer

Outline



Without tap control
Reactive supply would be limited due to restriction of generator terminal voltage.

Image of the voltage



With tap control
Ability on reactive power output can be enhanced by changing tap without restriction of terminal voltage

However...

Off-load tap changer requires planned outage to change tap.

⇩

Changing tap without outage by on-load tap changer is required.

4-11

Study item on installation of on-load tap changer

Place to be installed

It is better to install for ;
- Generator with large capacity (Ex. more than 300MW)
- Generator with large reactive margin

To force generators to install, it shall be described in rules

Range and number of tap

[Maximum /Minimum tap]
1) Reactive power of generator is limit
2) Terminal voltage of generator is within the limit
3) Bus Voltage at higher side of step-up transformer within the limit

[Number of tap]

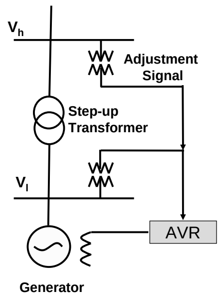
$(V_{max} - V_{min})/V_A + 1$

- V_{max} :Highest voltage of the tap
- V_{min} :Lowest voltage of the tap
- V_A :Allowable voltage change by tap operation

To fully utilize reactive power output, the study on the range and the number of tap is important.

4-12

Installation of Power System Voltage Regulator (PSVR)



AVR

Refer to the terminal voltage (low side of the step-up transformer) and regulates reactive power to maintain terminal voltage

PSVR

Refer to the transmission voltage (high side of the step-up transformer) and regulates reactive power so as to maintain transmission voltage

PSVR reacts speedily against fast change of voltage and contributes to maintain the grid voltage.

For installation, the following items should be studied
- Place to be installed (Ex. generators more than 300MW)
- Description in rules such as the grid code

4-13

Study item on installation of PSVR - Comparison of PSVR and On-load tap changer -

Item	PSVR	On-load tap changer
Limit of Utilization	Limit by Generator terminal voltage	Tap range can be selected properly.
Speed of change	Fast (Electric control)	Slow (Mechanical operation)
Installation Cost	Almost same as AVR	A little expensive than PSVR
Installation for existing facilities	Relatively easy (Aux. to AVR)	Relatively difficult (Replacement of TR)
Possibility of failure	Low (Electric control device)	Higher than PSVR (Mechanical structure)

PSVR and/or on-load tap changer shall be applied properly considering characteristics of each measure.

4-14

Frequency

4-15

- Frequency - Current Condition

Deviation of Standard Frequency

Year	2002	2003	2004	2005	2006	2007	2008*
The number of deviation	108	361	338	239	741	510	296

*As of March, 2008

[Record of 2007]

F > 50.5 Hz (189 times)

179 times of them were caused by load fluctuation

F < 49.5 Hz (321 times)

252 times of them were caused by load fluctuation

69 times of them were caused by generator outage

about 83%

Lack of generation capability to respond to load fluctuation

4-16

- Frequency - Probable Reasons

[Frequency control under normal condition]

Lack of Governor Free (GF) Capacity

GF Capacity seems to be insufficient.

Lack of LFC Capacity

LFC Capacity seems to be insufficient.

Lack of generators of middle and peak type

Proper amount of middle and peak type generators isn't secured.

Difficulty of operation order to IPP generators

Difficult for JCC to order IPPs to change output.

Output change of natural gas generators with pipeline

Natural gas generator with pipeline is difficult to change output.

Low ramp rate

Actual ramp rate is lower than designed value in some cases.

[Frequency control under emergency condition]

Inadequate calculation of System Frequency Characteristics

System Frequency Characteristics may not be appropriate.

4-17

- Frequency - Possible Countermeasures

[Frequency control under normal condition]

Application of penalty for generators (4-19)
- Penalty for generators not complied with requirements and/or violation of operation orders

Bidding classified by operation type (4-20)
- Bidding considering peak and middle type generators

Introduction of specific price schedule for IPPs (4-21)
- Capacity fee based on contracted and available capacity
- Specific tariff considering peak and middle type operation

[Frequency control under emergency condition]

Proper calculation of system frequency characteristics (4-22)

Detailed analysis of system frequency characteristics (4-23)

Application of penalty for generators

<Example of the application of penalties>

Item	Example
Criteria	should be the same as operation order for every 30 minutes.
Penalty unit price	[Standard range (Ex: within 3% of order value)] = [Imbalance adjustment cost] / [the amount of imbalance] = Variable cost + [Fixed cost for Spinning reserve *1] / [Energy Fluctuation*2] [Excess over standard range] = 3 times*3 of Imbalance Fee
Description	Description in documents such as Grid Code and PPA
Settlement	Deduction from payment of income

*1: Corresponds to spinning reserve 4%
*2: (Demand fluctuation 1% + Generation fluctuation 2.7%) of generated energy
*3: Considering level of trading spot price, and moral hazard and entry barriers for IPP

Bidding for generator classified by operation type

In bidding for IPPs, generators are classified by operation type.

Bid Price = Capacity Fee + O&M Fee + Fuel Fee

Type of Generator	Base	Middle	Peak
Capacity factor	70%	50%	30%
Limit of fuel fee	3 cent/kWh	5 cent/kWh	7 cent/kWh

Middle and peak generators are allowed to set high fuel fee.

Bid price of middle/peak type of generators are converted to Equivalent Evaluation Price considering capacity factor

Ex. Equivalent Evaluation Price (Peak) = Bid Price x [30% / 70%]

The bidding system can make middle/peak generators feasible and enhance construction of middle/peak type generators.

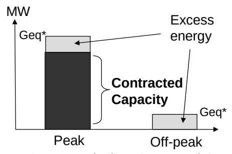
Introduction of specific price schedule for IPPs

Classified Tariff

Item	Ex:Tariff (cent/kWh)	Operation Hours	
		Weekday	Holiday
Primary Energy	7.0	16 hours (6-22)	N/A
Secondary Energy	4.2 (60% of PE)	8 hours (22-6)	24 hours

(Payment)
Primary energy x Primary tariff
+ Secondary energy x Secondary tariff

Capacity Fee



*Geq = Equivalent Generated Capacity

(Payment)
Capacity tariff x Contracted capacity
+ Energy tariff x Excess energy
+ Operation fee

(Benefits)
Makes it easier to recover capital investment
Enhance feasibility of generators for middle and peak load

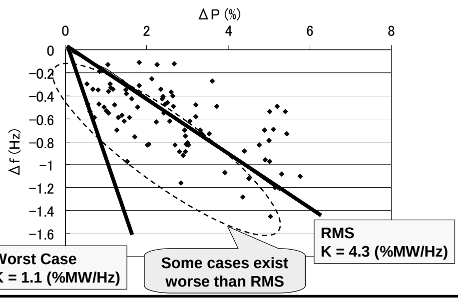
The price schedules would help to make IPP project feasible and enhance investment.

Proper Calculation of System Frequency Characteristics

System capacity shall be considered

~~MW/Hz~~ ⇨ %MW/Hz — The amount of tripped generator shall be represented as a ratio to system capacity

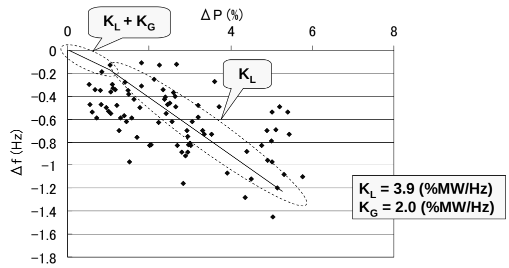
Calculation based on RMS is not in safety side



Detailed Analysis of System Frequency Characteristics (Consideration with K_L and K_G)

System Frequency Characteristics is represented by two parts

K_L : Load Frequency Characteristic, K_G : Generator Frequency Characteristic



Appropriate amount of shed load shall be studied with appropriate system frequency characteristics.

Outage

4-24

- Outage - Current Condition

Main reason for outages

		2002	2003	2004	2005	2006	2007	2008*
Outage	Nature	68	48	51	54	42	28	44
	Defect of Facilities	130	136	114	113	108	95	55
	Animals	16	19	7	9	9	9	3
	Human Factor	3	4	11	3	10	3	1
	Kite	21	18	13	7	10	9	4
	Overloading	9	13	6	16	3	0	0
	Trees	3	2	3	1	1	3	1
	Relay malfunction	1	16	11	9	8	9	0
	Others	50	29	31	24	11	3	1
	Total	301	285	247	236	202	159	109
Control	Load Curtailment	18	9	9	26	29	9	0
	Manual Load Shedding	19	10	10	34	19	61	17
	*OLS	0	13	6	16	3	9	2
	Automatic load shedding	42	6	15	25	21	15	7
	Total	79	38	40	101	72	94	26

OLS : Load shedding system against over load *As of March, 2008

Many outages are caused by the problem of facilities

4-25

- Outage - Probable Reasons

Aged deterioration
- Aged deterioration
- Lack of spare parts

Poor performance of equipment
- Suppliers with bad quality

Lack of support from manufacturers
- Insufficient support from manufacturers after installation
- Diversification of manufactures

Violation of N-1 criteria
- Some outages are caused by OLS because of violation of N-1 Criteria

Power supply shortage
- Load curtailment cannot be avoided because of shortage of power supply

Calculation of required amount of load shedding
- System frequency characteristics shall be calculated in proper manner

4-26

- Outage - Possible Countermeasures

Measure for same type of equipment (4-28)

Will be effective to avoid recurrence of same kind of failure

Enhancement of Quality Management System (4-29,30)

Reinforcement of technical standard (SPLN)
Quality Management System involving technical department

Cooperation with Manufacturers (4-31)

Priority of procurement from local manufacturers
Joint technical development and research with manufacturers

Planned installation of facilities based on N-1 Criteria

Appropriate calculation of system frequency characteristics

Installation of fault extension prevention relay (4-32)

4-27

Measure for same type of equipment

Necessity of the measure for same type of equipment can be judged by;

Level of the outage
- Supply outage

Condition of the failure
- Failure of major function
- Caused not by nature but by malfunction
- Difficult to be detected by alarm or maintenance

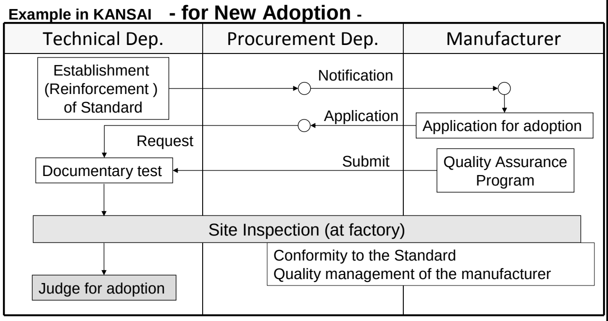
Influence and Probability of recurrence
- Important equipment (Type of equipment, Voltage class)
- Recurrence is probable

When all condition is satisfied, measure for same type of equipment will be conducted.
Information on all equipment shall be managed properly.

4-28

Enhancement of Quality Management System (1)

Example in KANSAI - for New Adoption -

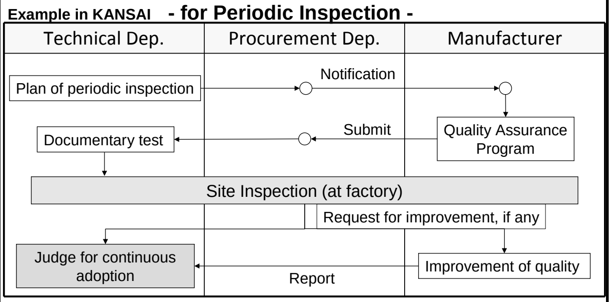


Adoption of equipment is judged by technical department

4-29

Enhancement of Quality Management System (2)

Example in KANSAI **- for Periodic Inspection -**



Quality Management System by technical department is recommended for continuous quality control.

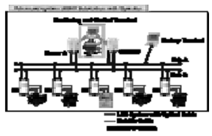
4-30

Cooperation with Manufacturers

Example of joint development with Japanese manufacturers.


Lightning Protection Devices


Life Assessment of Equipment

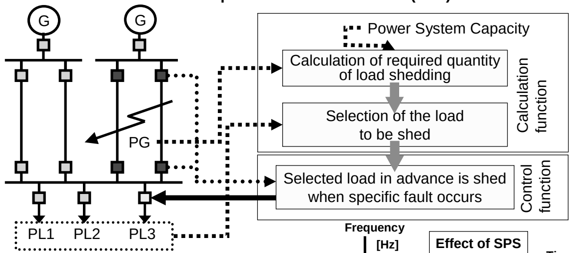

Advanced Monitoring and Control System

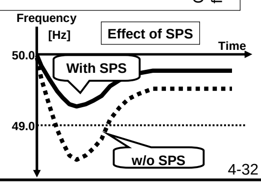
Continuous joint activities can keep good relationship with manufactures and good support.

4-31

Installation of fault extension prevention relay

Outline of Special Protection Scheme (SPS)





SPS is effective for prevention of fault extension.

4-32

SUMMARY

JICA study team has found…

- Some difficulties on System Operation
  - Voltage Drop, Frequency Deviation and Outage
    - Basically due to lack of adequate facilities
- Countermeasures for Improvement
  - Utilization of Existing Facilities
    - by changing standards and rules
  - Installation of Facilities
    - in consideration with benefits and studies
  - Establishment of Rules and System
    - in cooperation with related parties

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5. Investment Schedule, IPP Promotion Plan

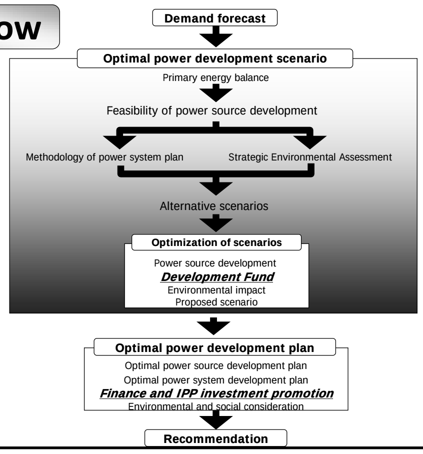
Speaker: Mr. NISHIDA Masaru,

NEWJEC Inc.

Investment Schedule & IPP Promotion Strategy

Table of Contents

Workflow

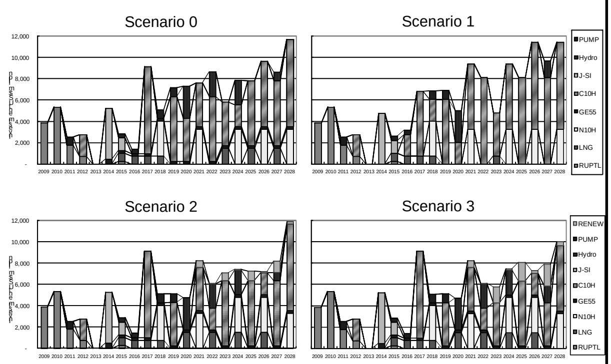


1. Capital Requirement of Four Scenarios

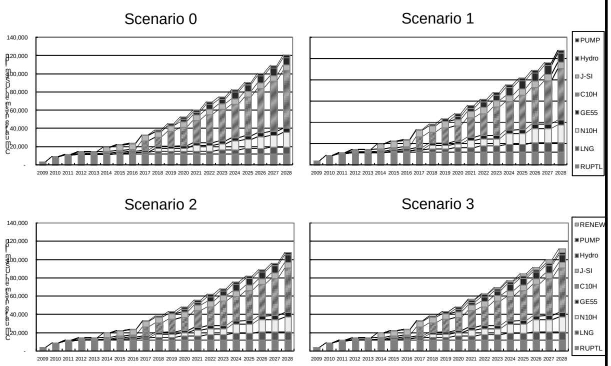
Assumptions for Estimation

- Investment costs after Generation Expansion Planning, 2008 price, no escalation
- Investment cost with IDC is shown on the year in which the plant (unit) is put in operation
- IPPs (existing & planned) are included
- Projects in RUPTL2007-16 handled in a group, except Pumped Storage, J-S InterC.
- PV (solar) assumed to be invested by many individuals, not by PLN. PLN purchases power generated by PVs.

Investment Schedule for Four Scenarios



Investment Schedule for Four Scenarios (cumm.)



5-6

Capital Requirement for Power Plant Development

YEAR	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Scenario 0	3,893	5,355	2,539	2,764	-	5,243	2,873	1,409	9,134	5,121	7,181
Scenario 1	3,893	5,355	2,539	2,764	-	4,755	2,629	3,200	6,854	6,912	6,937
Scenario 2	3,893	5,355	2,539	2,764	-	5,243	2,873	1,409	9,134	5,121	5,146
Scenario 3	3,893	5,355	2,539	2,764	-	5,243	2,873	1,409	9,134	5,121	5,146

YEAR	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total	PV
Scenario 0	7,316	7,611	8,659	5,812	7,885	7,848	9,646	8,617	11,681	120,589	-
Scenario 1	5,037	9,402	8,141	4,819	9,402	8,141	11,437	9,680	11,437	123,334	-
Scenario 2	4,744	8,241	6,124	7,103	7,435	7,241	7,222	8,178	11,902	111,668	30,180
Scenario 3	4,744	8,241	6,124	5,776	7,480	8,090	7,319	7,917	10,033	109,202	52,795

Unit: US$ million

5-7

2. Unit Generation Cost of Four Scenarios

5-8

Assumptions for Estimation

- Fuel & OM costs after Gen. Expansion Planning, 2008 price, no escalation
- Depreciation and interest of current assets and debts taken from PLN Annual Rep 2007 , 75% of PLN total, assumed constant for the period
- Investment assumed by loans -> interest payment
- Constant depreciation with no residual values.
- Costs related to transmission/distribution system not included
- Head office markup of PLN not included.

5-9

Assumptions for Estimation

Unit Costs of Renewable Energy

	Capital cost (US$/kW)	cost	Life time
Solar	5,000	US¢3/kWh	24.4
Wind	1,100	0.6% of capital cost	25
Biomass	1,700	3% of capital, US¢0.44/kWh	15

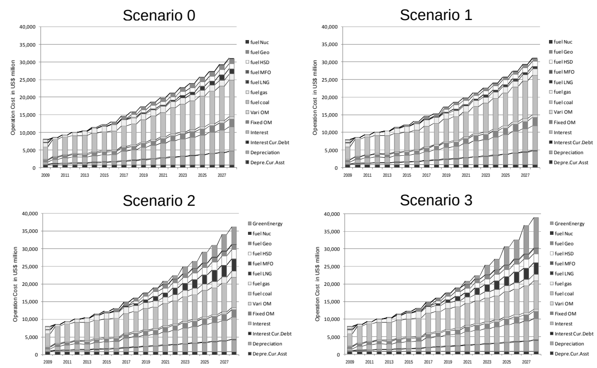
Calculation of Unit Cost of Solar（Green Energy Payment）

	Cost per kW	Cost per kWh	Remark	
System Life (years)	24.4			
Total kWh (capacity factor)	30,535.66		14%	
Installed cost	$5,000.00	$0.16		
Reliability/Maintenance costs	$575.58	$0.02		
Maintenance contract				
Insurance	$226.47	$0.01		
Decommissioning	$46.95	$0.00		
Permitting	$30.95	$0.00		
Financial cost (Interest R, Yr)	$3,137.27	$0.10	10%	10
TOTAL Costs	$9,017.22	$0.30		

Source: "A REVIEW OF PV SYSTEM PERFORMANCE AND LIFE-CYCLE COSTS FOR THE SUNSMART SCHOOLS PROGRAM, "Proceedings of ISEC2006:ASME International Solar Energy Conference 2006, modified by JICA team

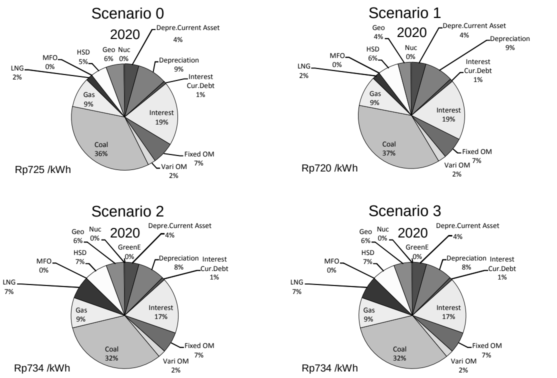
5-10

Generation cost



5-11

Unit Generation cost in 2020



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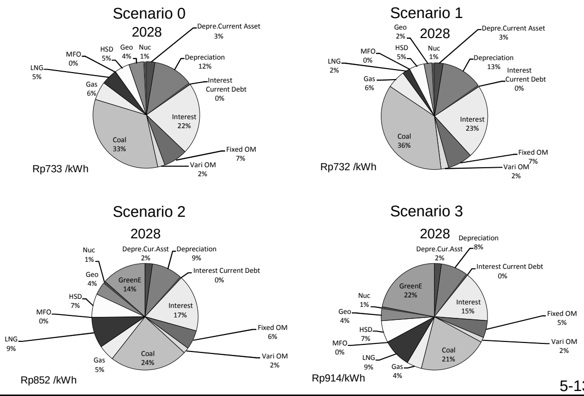
Unit Generation cost in 2028



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Summary of Four Scenario Comparison

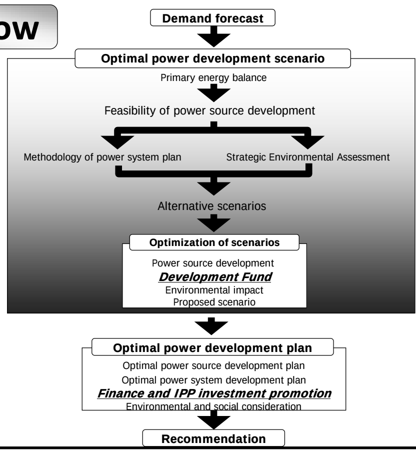
- Capital requirement is largest in Scenario 1 with more coal thermal plants, but only about 2%
- Capital requirement smaller in S2 and S3, because no solar investment included
- Unit Generation Cost Estimated (Rp/kWh)

YEAR	Scenario 0	Scenario 1	Scenario 2	Scenario 3
2009	614	614	614	614
2015	649	643	650	650
2020	725	720	734	734
2028	733	732	852	914

- S1 marginally lower than S0
- S2 and S3 higher due to more LNG burnt & "Green Energy Payment" (Purchase of Solar Energy)

5-14

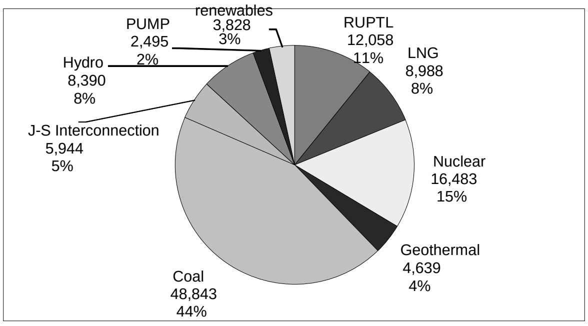
Workflow



3. Investment Schedule for Optimal Power Dev. Plan

5-16

Component of Power Plant Investment 'til 2008

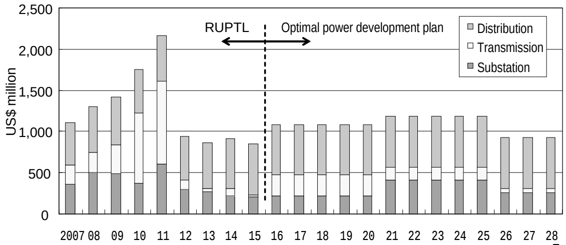


Total : US$ 111,668 million

5-17

T/L, S/S, D/L Investment

- Investment in RUPTL up to 2015
- 5 year plan of T/L & S/S augmentation spread yearly
- D/L investment after 2016 from RUPTL 2016 value



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Investment Schedule for Optimal Power Development Plan

Descripton		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total
Power Plant																						
RUPTL	F/C	3,115	4,284	1,445	583	0	0	220	0	0	0	0	0	0	0	0	0	0	0	0	0	9,647
	L/C	779	1,071	361	146	0	0	55	0	0	0	0	0	0	0	0	0	0	0	0	0	2,412
	total	3,893	5,355	1,807	729	0	0	275	0	0	0	0	0	0	0	0	0	0	0	0	0	12,058
LNG	F/C	0	0	0	0	0	0	637	637	637	637	0	1,273	0	1,273	0	1,273	0	1,273	0	0	7,640
	L/C	0	0	0	0	0	0	112	112	112	112	0	225	0	225	0	225	0	225	0	0	1,348
	total	0	0	0	0	0	0	749	749	749	749	0	1,498	0	1,498	0	1,498	0	1,498	0	0	8,988
Nuclear	F/C	0	0	0	0	0	0	0	0	0	2,967	0	0	2,967	0	0	2,967	0	2,967	0	2,967	14,835
	L/C	0	0	0	0	0	0	0	0	0	330	0	0	330	0	0	330	0	330	0	330	1,648
	total	0	0	0	0	0	0	0	0	0	3,297	0	0	3,297	0	0	3,297	0	3,297	0	3,297	16,483
Geo	F/C	0	0	549	0	0	366	183	183	183	183	183	183	183	183	183	183	183	183	183	183	3,480
	L/C	0	0	183	0	0	122	61	61	61	61	61	61	61	61	61	61	61	61	61	61	1,160
	total	0	0	733	0	0	488	244	244	244	244	244	244	244	244	244	244	244	244	244	244	4,639
Coal	F/C	0	0	0	1,730	0	0	0	0	6,919	0	3,460	0	3,460	1,730	5,190	0	5,190	1,730	5,190	6,919	41,517
	L/C	0	0	0	305	0	0	0	0	1,221	0	611	0	611	305	916	0	916	305	916	1,221	7,327
	total	0	0	0	2,035	0	0	0	0	8,141	0	4,070	0	4,070	2,035	6,105	0	6,105	2,035	6,105	8,141	48,843
S-J Interconnection	F/C	0	0	0	0	0	4,280	1,070	0	0	0	0	0	0	0	0	0	0	0	0	0	5,350
	L/C	0	0	0	0	0	476	119	0	0	0	0	0	0	0	0	0	0	0	0	0	594
	total	0	0	0	0	0	4,755	1,189	0	0	0	0	0	0	0	0	0	0	0	0	0	5,944
Hydro	F/C	0	0	0	0	0	0	0	0	0	0	0	1,651	0	1,270	0	1,270	0	0	423	0	4,614
	L/C	0	0	0	0	0	0	0	0	0	0	0	1,351	0	1,039	0	1,039	0	0	346	0	3,775
	total	0	0	0	0	0	0	0	0	0	0	0	3,002	0	2,309	0	2,309	0	0	770	0	8,390
Pump	F/C	0	0	0	0	0	0	229	229	0	457	457	0	0	0	0	0	0	0	0	0	1,372
	L/C	0	0	0	0	0	0	187	187	0	374	374	0	0	0	0	0	0	0	0	0	1,123
	total	0	0	0	0	0	0	416	416	0	832	832	0	0	0	0	0	0	0	0	0	2,495
Renewable	F/C	0	0	0	0	0	0	0	0	0	0	0	0	473	28	565	65	669	111	794	165	2,871
	L/C	0	0	0	0	0	0	0	0	0	0	0	0	158	9	188	22	223	37	265	55	957
	total	0	0	0	0	0	0	0	0	0	0	0	0	630	38	754	87	892	148	1,059	220	3,828
Substation	F/C	413	319	519	256	225	186	171	186	186	186	186	186	349	349	349	349	349	215	215	215	5,409
	L/C	73	56	92	45	40	33	30	33	33	33	33	33	62	62	62	62	62	38	38	38	955
	total	486	375	611	301	265	219	202	219	219	219	219	219	411	411	411	411	411	253	253	253	6,364
Transmission Line	F/C	299	719	851	90	39	81	22	215	215	215	215	215	133	133	133	133	133	49	49	49	3,989
	L/C	53	127	150	16	7	14	4	38	38	38	38	38	24	24	24	24	24	9	9	9	704
	total	351	846	1,001	106	45	96	26	253	253	253	253	253	157	157	157	157	157	58	58	58	4,693
Distribution Line	F/C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	L/C	579	529	553	539	559	595	617	617	617	617	617	617	617	617	617	617	617	617	617	617	11,987
	total	579	529	553	539	559	595	617	617	617	617	617	617	617	617	617	617	617	617	617	617	11,987
Total	F/C	3,826	5,322	3,365	2,659	264	4,913	2,532	1,449	8,140	4,645	4,501	3,508	7,565	4,967	6,420	6,241	6,524	6,529	6,854	10,499	100,723
	L/C	1,483	1,783	1,340	1,051	605	1,240	1,186	1,048	2,082	1,565	1,733	2,324	1,861	2,341	1,867	2,378	1,901	1,621	2,251	2,330	33,989
	total	5,309	7,105	4,705	3,710	869	6,153	3,718	2,497	10,222	6,209	6,234	5,832	9,425	7,308	8,287	8,619	8,425	8,150	9,105	12,829	134,712

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4. Strategy for Promotion of Private Sector Participation (IPP)

5-20

PLN's Financing for Power Development

- Own resources (working capital)
- Loan (Two-step(Multi-/Bi-Dev.Banks), Commercial)
- Bonds and Guaranteed Notes
- Lease (a limited case)
- IPP (PPA)

5-21

PLN's Financing for Power Development

Own resources
- Limited by [BPP – Tariff = Subsidy]
- Mostly for T/L and local currency portion

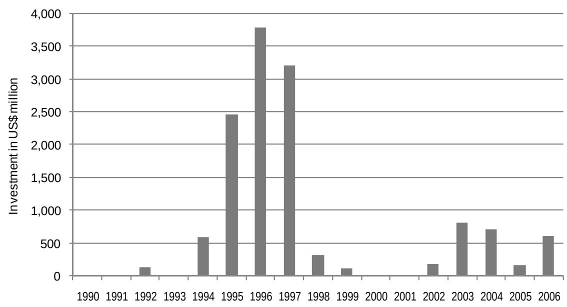
Loan (Two-step, Gov't, Commercial)
- Chiefly for Priority Projects : Nuclear, Hydro, LNG…
- Huge capital requirement may exhaust ODA resources

Bonds and Guaranteed Notes
- Market Confidence in PLN is the key

Lease
- A Limited case for Tanjung Jati-B

5-22

IPP in Power Sector of Indonesia



5-23

Financing PDP by IPP #1 – Current Framework

Legislations introduced in the last 5 years

Setting up of KKPPI

Infrastructure Summit/Forum 2005/2006

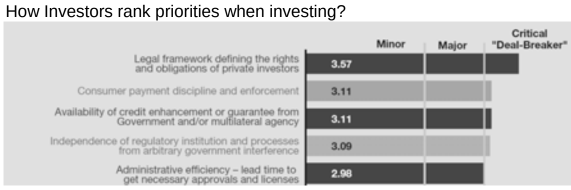
- "Risk Guarantee Fund"
- "Infrastructure Investment Fund"
- A revolving fund "Land Acquisition Fund"
- Public Service Obligation (PSO) policy

Supports from WB, ADB, JBIC(umbrella agreement)

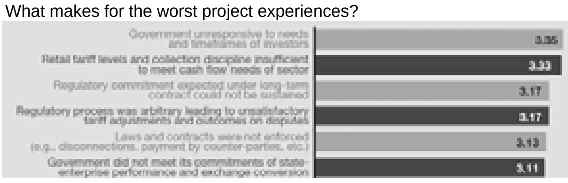
5-24

Financing PDP by IPP #2 – Private Investors View

How Investors rank priorities when investing?



What makes for the worst project experiences?



The Energy and Mining Sector Board Discussion Paper, The World Bank, May 2003

5-25

Financing PDP by IPP #3 – Common Issues 1

Tariff and PLN Revenue

- Subsidy Too Large in Size and Proportion
- Regressive Structure, Inefficient Use of Resources
- Volatility due to Input Cost (Fuel Cost)
- Limited Adjustment within Framework of TDL2004
- BPP allow for only Depreciation Cost (= existing facilities), not Future Investment Needs
- Undermining Market/Investors Confidence in PLN Financial Ability

5-26

Financing PDP by IPP #3 – Common Issues 2

Openness and Competitiveness of Bidding

- Bidding is the only chance of competition
- Monitoring by KKPPI, only for PPP projects
- Limited Number of Participants
- Administrative Capacity of Local Government

5-27

Financing PDP by IPP #3 – Common Issues 3

Loose Project Schedule Management

- Delay in Any Project
- "Fast Track" not Fast Enough
- Additional Cost (bridge finance, etc) Borne by Users
- Problems under Inflation
- Disrupt Financiers Schedule, Future Projects
- Undermines Confidences in Financial/Private Sectors

5-28

Financing PDP by IPP #3 – Common Issues 4

Land Acquisition by Private Companies

- Risk Allocated to IPP
- Familiarity/Closeness of Local Gov't & PLN to Local Communities/Authorities Unexploited
- Too Much Burden/Risks for Foreign Investors
- Construction of T/L better managed by PLN

5-29

Financing PDP by IPP #3 – Common Issues 5

Securing Flexibility

- IPP has been for Base-Load Plant
- Future IPP for Middle-/Peak-Load Plant
- Unit Price in PPA will be Higher - Standardized "Price Cap" becomes Irrelevant
- Understanding of Peaker Cost is not Sufficient
- Bidding for
  Designated operation pattern,
  Capacity fee,
  Technical specification for Higher Ramp Rate, etc

5-30

Financing PDP by IPP #3 – Common Issues 6

Foreign Exchange Risks

- Larger F/C Liabilities increase PLN's risks

Restriction on Foreign Capital Ownership

- "95% Ownership" restriction in Negative List, despite "Equal Treatment" Principle in New Investment Law
- Efficacy & Contribution of "5% Participation by National Capital" Unverified
- Restriction may discourage Foreign Capital

5-31

Financing PDP by IPP #4 – Specific Issues, COAL

Procurement of Low Rank Coal (LRC)

- LRC has not been distributed in the market
- Production may need government support

Tech Spec for Environmental Protection

- Tech Spec: Existing IPP >> Crash Program
- Increase of "Clash Program Spec" Plants may be Socially Unacceptable = Unsustainable

5-32

Financing PDP by IPP #4 – Specific Issues, GEO

Bidding for License by Local Government

- After Geothermal Law 2003, relevant Regulations/ Standards not yet provided
- Insufficient data provision: Too Large Risks

Project in Protected Forest

- Kamojang Extension rejected by Minister of Forestry

PPA Price Cap

- PPA price is capped by Permen 2008/14
- Geothermal cost highly dependent on site condition

5-33

Financing PDP by IPP #4 – Specific Issues, RENEW

Decentralized Development

- Capital cost is expensive, will be so for foreseeable future
- No guarantee for Power Purchase
- No economic advantage in investing in renewables

5-34

Financing PDP by IPP #5 – Recommendations

1. Tariff Reform and Increase of PLN Revenue

- Subsidy should be restricted to R-1 450VA to reduce total subsidy amount
- Change in BPP Calculation formula to increase PLN revenue
- Introduction of Fuel Cost Pass-Through System

2. Bidding – Selection of IPP Operator

- Supervision by Independent Body necessary
- Continuing Evaluation & Improvement of Process

5-35

Financing PDP by IPP #5 – Recommendations

3. Management of Project Schedule
- Examination on Delayed Cases
- Countermeasures : Streamlining Processes

4. Risk Allocation of Land Acquisition
- Better Managed by PLN/Local Government
- Main role of LA desirable from PLN/Local Government, not from IPPs and Private Companies

5-36

Financing PDP by IPP #5 – Recommendations

5. Bidding for Future Technical Requirement
- Bidding for
  Designated operation pattern,
  Capacity fee,
  Technical specification for Higher Ramp Rate, etc
- Revision to Standardized (upper limit) PPA Prices

6. Increase of L/C Portion
- Devising Evaluation Method for L/C portion in bid

7. Foreign Capital Ownership
- Examination of efficacy of restriction

5-37

Financing PDP by IPP #5 – Recommendations

8. Coal Thermal
- Government Support for LRC Exploitation/Infra.
- Provision of Submarine Cables for Mine-mouth PSs

9. Geothermal
- Provision of regulation/standards for Bidding Process
- Financial Support to Local Gov't for Site Survey e.g., Provision of Revolving Fund for Pilot Boring
- Site Selection by Bidders
- Pre-bid confirmation of MoForestry approval
- Monitoring and Revision to PPA Cap
- Provision of Tec/Institutional Support for Cap.Build'g

5-38

Financing PDP by IPP #5 – Recommendations

10. Renewables
- Establishment of Fund e.g. from Export Tax on Carbon Hydrate Resources, to provide financial support for investment on renewables
- Guarantee to private investors of power purchase (even at higher than retail prices) by PLN
- Provision of interest-free loans, Tax exemption

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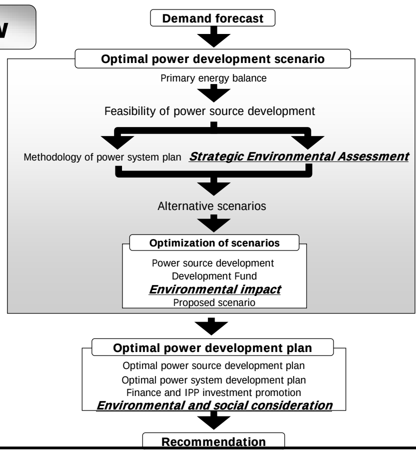
6. Strategic Environmental Assessment

Speaker: Mr. OHWADA Takashi,

NEWJEC Inc.

Environmental & Social Considerations

Workflow



Environmental & Social Considerations

Objective

Incorporate Environmental & Social Considerations into the Study on the Optimal Electric Power Development in Java-Madura-Bali Area through Strategic Environmental Assessment (SEA)

(= Optimal Electric Power Development Scenario should not be identified solely for economic or engineering reasons)

♦ What is Strategic Environmental Assessment (SEA)?

Strategic Environmental Assessment (SEA)	Environmental Impact Assessment (EIA)
Applied to Policy, Plans & Programs (Upstream of Decision-Making)	Applied to Individual Projects (Downstream of Decision-Making)
General Assessment	Specific Assessment
Area Basis and/or Long-Term	Site and Project Specific
Can Consider Synergistic Impacts	Difficult to Consider Synergistic Impacts
Can Consider Cumulative Impacts	Difficult to Consider Cumulative Impacts
Greater Flexibility for Alternatives	Constrained to Specific Projects

♦ What to do in SEA of Power Sector?

- Identify Potential Environmental Impacts associated with each Type of Power Generation

  ex. SO_2, NOx, PM, CO_2 from Coal-Fired,
  Loss of Habitats/Involuntary Resettlement for Hydro,
  Radiation from Nuclear,
  H_2S from Geothermal

- Recommend Measures to Prevent/Reduce/Mitigate Potential Environmental Impacts

  ex. FGD, Low-NOx Burner, ESP for Coal-Fired,
  Cooling Towers to reduce Thermal Effluents from Thermal,
  Information Disclosure to obtain Consent for Resettlement for Hydro

♦ Comparison of Environmental Performance

	Coal	Oil	Gas	Geo	Hydro	Nuclear
Air Pollution	SO_2, NOx, PM	SO_2, NOx, PM	NOx	H_2S	-	-
Water Pollution	From Ash Pond?	-	-	As, Hg	From Reservoir?	-
GHG Emission	CO_2	CO_2	CO_2	-	CH_4 from Reservoir	-
Thermal Effluent	++	++	++	+	-	++
Resettlement	?	?	?	-	Large Scale?	Large Scale?
River Water Use	-	-	-	-	+	-
Radiation Risk	-	-	-	-	-	+

♦ What is Outcome of SEA?

- Provide Environmental Inputs to Production of Alternative Electricity Development Scenarios.
  (Scenarios with potential extreme environmental impacts are excluded to obtain environmentally reasonable scenarios for further consideration)
- Contribute Environmentally to Identification of the Optimal Electricity Development Scenario.
  (Alternative scenarios are assessed for their potential impacts on global warming and air quality to identify the environmentally most favorable scenario)
- Recommend Measures to make the Optimal Electric Power Development Scenario more Friendly to the Environment.
  (Environmental protection measures for the optimal scenario are recommended on the basis of potential environmental concerns associated with each generation option and how to address them)

6-7

♦ How to make Environmental Inputs to Alternative Scenarios

- Only Environmentally Reasonable Scenarios can be Alternative Scenarios.

What is "Environmentally Reasonable"?

⬇

Alternative scenarios shall not have too much risk for a particular environmental impact.

6-8

♦ Comparison of Environmental Performance

	Coal	Oil	Gas	Geo	Hydro	Nuclear
Air Pollution	SO_2, NOx, PM	SO_2, NOx, PM	NOx	H_2S	-	-
Water Pollution	From Ash Pond?	-	-	As, Hg	From Reservoir?	-
GHG Emission	CO_2	CO_2	CO_2	-	CH_4 from Reservoir	-
Thermal Effluent	++	++	++	+	-	++
Resettlement	?	?	?	-	Large Scale?	Large Scale?
River Water Use	-	-	-	-	+	-
Radiation Risk	-	-	-	-	-	+

6-9

♦ How to make Environmental Inputs to Alternative Scenarios

- Only Environmentally Reasonable Scenarios can be Alternative Scenarios.

What is "Environmentally Reasonable"?

⬇

Alternative scenarios shall not have too much risk of a particular environmental impact.

⬇

Every alternative scenario shall be a well-balanced mixture of various power generation options, to accomplish "Diversification of Risk".

6-10

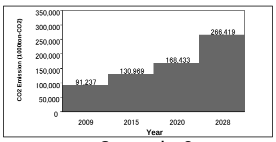
♦ Alternative Power Development Scenarios

- Scenario 0 – Original Scenario (following the present Indonesian Policy)
- Scenario 1 – Coal Power Acceleration Scenario
- Scenario 2 – Power Source Diversification Scenario
- Scenario 3 – CO_2 Emission Reduction Scenario

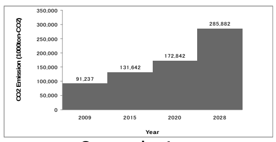
- All scenarios are the mixture of several power generation options.
- None of them relies solely on a particular type of power generation.

6-11

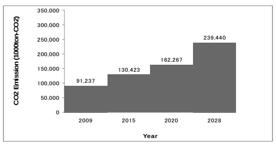
♦ Comparison of Alternative Scenarios (CO_2)



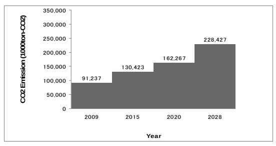
Scenario 0



Scenario 1



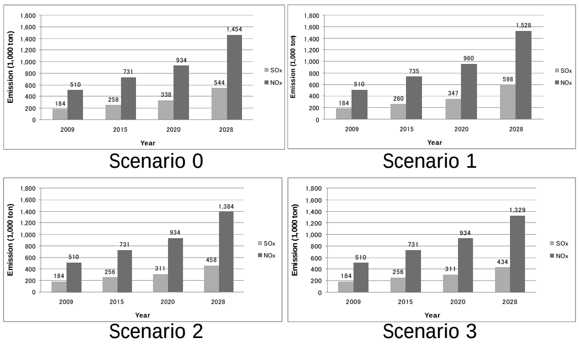
Scenario 2



Scenario 3

6-12

♦ Comparison of Alternative Scenarios (SOx, NOx)



6-13

♦ Comparison of Alternative Scenarios (Emissions)

Predicted Annual Emissions for CO_2, SOx and NOx in 2028

(1,000 ton/year)

	CO_2	SOx	NOx
Scenario 0	266,419	544	1,454
Scenario 1	285,882	598	1,528
Scenario 2	239,440	458	1,384
Scenario 3	228,427	434	1,329

CO_2, SOx and NOx Emissions (2028):

Scenario 3 < Scenario 2 < Scenario 0 < Scenario 1

6-14

♦ Recommendations to the Optimal Scenario (1)

- ■ Power Source Diversification Scenario (Scenario 2) was identified as the Optimal Power Development Scenario for Jamali.
- ● Coal-fired power generation is still a major power source in Power Source Diversification Scenario.
- ● Regulations to protect air quality shall be respected. (ex., emission standards, air quality standards)
- ● Siting of coal-fired power stations shall be determined after proper prediction of future air quality. (Understanding of the present air pollution levels at and around the proposed site is very much required to avoid heavy air pollution)

6-15

♦ Recommendations to the Optimal Scenario (2)

- ■ Power Source Diversification Scenario (Scenario 2) was identified as the Optimal Power Development Scenario for Jamali.
- ● Coal-fired power generation is still a major power source in Power Source Diversification Scenario.
- ● If required, equipments to reduce emissions of air pollutants shall be introduced;

  (ex., FGD=Flue Gas Desulfurization, deNOx=Denitrification/Low-NOx Burner, Efficient ESP=Electrostatic Precipitator/Additional Bag Filter)

6-16

♦ Recommendations to the Optimal Scenario (3)

- ■ Power Source Diversification Scenario (Scenario 2) was identified as the Optimal Power Development Scenario for Jamali.
- ● Hydroelectric power generation plays an important role in Power Source Diversification Scenario.
- ● Degradation of water quality in the reservoir may lead to water pollution in the downstream. (ex., Saguling HEPP)
- ● Management of water quality in the reservoir is required.

6-17

♦ Recommendations to the Optimal Scenario (4)

- ■ Power Source Diversification Scenario (Scenario 2) was identified as the Optimal Power Development Scenario for Jamali.
- ● Thermal and nuclear power generations discharge substantial amounts of thermal effluents.
- ● Potential impacts on marine organisms (ex., corals) and local fishery shall be predicted and evaluated.
- ● If required to lower the temperature of thermal effluents, cooling towers need to be introduced.

6-18

♦ Coral Reefs around Jamali

Coral Reefs

Distribution of Coral Reefs in Indonesia

Source: GCRMN Report on East Asian Water 2005

6-19

♦ Recommendations to the Optimal Scenario (5)

■ Power Source Diversification Scenario (Scenario 2) was identified as the Optimal Power Development Scenario for Jamali.

● Reservoir-type hydroelectric power generation and nuclear power generation need a vast land for power stations.

● Large-scale involuntary resettlement may be required to construct these power stations.

● Consultations shall be made with local residents to ensure that there will be no significant impact on them.

6-20

♦ Recommendations to the Optimal Scenario (6)

■ Power Source Diversification Scenario (Scenario 2) was identified as the Optimal Power Development Scenario for Jamali.

● Thermal power generation emits substantial amounts of CO_2.

● It is desirable to take measures to reduce CO_2 emissions.

(ex., improvement of generation efficiencies,
afforestation to offset CO_2 emissions,
CCS=Carbon Capture & Storage)

6-21

♦ Recommendations to the Optimal Scenario (7)

■ Power Source Diversification Scenario (Scenario 2) was identified as the Optimal Power Development Scenario for Jamali.

● Hydroelectric power generation releases methane from reservoirs.

● Methane is strong greenhouse gas.

● Management of water quality in the reservoir is required to suppress emissions of methane.

6-22

♦ Frequently Asked Questions and Answers

6-23

♦ Can SEA suggest the maximum capacity of coal-fired power generation to be allowed in Jamali ?

[Unfounded Upper Limits in Several Reports]

1. How can we assess impacts on air quality when we do not know locations of individual P/Ss?

   Extension of existing P/Ss may deteriorate local air quality down to unacceptable levels, while construction of the same capacity at new locations as new P/Ss may not pose threats to the health.

6-24

♦ Can SEA suggest the maximum capacity of coal-fired power generation to be allowed in Jamali ?

[Unfounded Upper Limits in Several Reports]

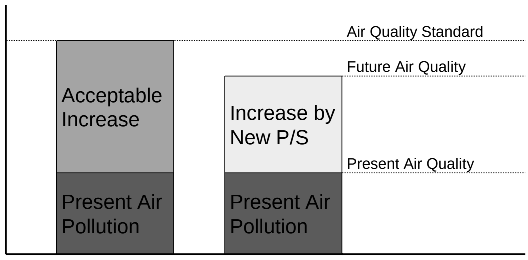
2. How can we assess impacts of coal-fired P/Ss when we do not know the present level of air pollution?

   We can not accommodate a coal-fired P/S at a location already with serious air pollution.

6-25

♦ How to predict local air quality under operation of new P/S?

Acceptable Increase =
Air Quality Standard – Present Air Quality



6-26

♦ Can SEA suggest the maximum capacity of coal-fired power generation to be allowed in Jamali ?

[Unfounded Upper Limits in Several Reports]

3. How can we assess impacts on air quality when we do not know efficiency of ESP at each P/S?

   We can construct more P/Ss in Jamali, if more efficient ESPs are introduced to them.

☆This is also the case for FGD and Low-NOx burner.

6-27

♦ Can SEA suggest the maximum capacity of coal-fired power generation to be allowed in Jamali ?

[Unfounded Upper Limits in Several Reports]

4. How can we set a limit on CO_2 emission from P/Ss when Indonesia does not have a legally-binding target for its CO_2 emission reduction under Kyoto Protocol?

   Indonesia reserves a right to emit CO_2 for its industrial development. We can not limit its maximum CO_2 emission from power generation.

6-28

♦ Can SEA suggest the maximum capacity of coal-fired power generation to be allowed in Jamali ?

[To Justify the Maximum Acceptable Capacity]

We need to know;

1) Locations of individual P/Ss, and

2) Present level of air pollution, and

3) Efficiency of ESP, FGD and Low-NOx Burner, or

4) CO_2 emission reduction target for the power sector.

6-29

♦ Does hydroelectric power generation suppress global warming?

[HEPPs may not be "green" as we used to think]

1. All reservoirs of HEPPs release CH_4 into the atmosphere.

   Influx of excessive nutrients to a reservoir → Proliferations of phytoplankton/floating plants → Anaerobic decomposition → CH_4 emission

6-30

♦ Does hydroelectric power generation suppress global warming?

[HEPPs are not always friendly to the earth]

2. CH_4 has GWC (Global Warming Coefficient) of 21.

(1 ton of CH_4 = 21 tons of CO_2)

Too much CH_4 emission from a reservoir →
Offset CO_2 emission reduction by a HEPP →
This HEPP will be an emission source of GHG

6-31

♦ Does hydroelectric power generation suppress global warming?

[Some HEPPs may be emission source of GHG]

As results,

- We can not rely CO_2 emission reduction solely on HEPPs.
- HEPP with a large reservoir can not be registered as a CDM project.

6-32

♦ Is geothermal power generation really environment-friendly?

[No noticeable emission of SO_2, NO_x, PM and CO_2 from geothermal power generation]

But,

- H_2S emission → Offensive odor, corrosion of metal, negative impacts on local vegetation.
  (Emission Standard for H_2S from GEO: 35 mg/m³)
- As and Hg effluent → Toxic to aquatic organisms.
  (Effluent Standards for As & Hg from GEO: 0.5 mg/ℓ & 0.005 mg/ℓ)

6-33

♦ Why is geothermal power generation promoted?

[Geothermal power generation is not necessarily environment-friendly]

- **Geothermal power generation has its specific environmental problems, and it is promoted because geothermal energy is domestic energy.**

6-34

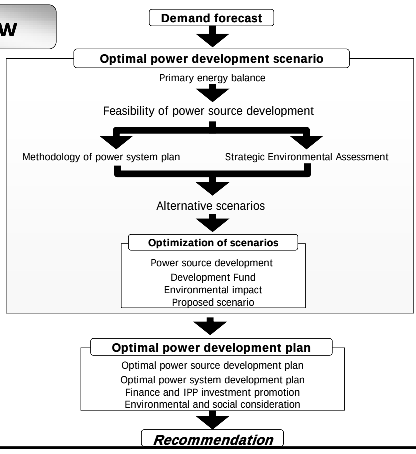
7. RECOMMENDATION

SPEAKER: MR. YAMAOKA SATOSHI,

NEWJEC INC.

7. Recommendation

Workflow



7-1

Remaining Issues and Actions To Be Taken

Issues to be recognized and actions to be taken in order for the Government of Indonesia and national power utility, PLN, to proceed to the realization of the optimal power development plan.

7-2

Contents

7-3

1. Power Source Development

7-4

1.1 Coal-fired Thermal Power Plant

- New 29 locations are required for the future development except the ongoing fast track program projects.
- Inventory study on new candidate sites including possibility of land acquisition shall be commenced as soon as possible.
- Study on introduction of a supercritical plant is recommended because of its capacity for flexible operation (base to middle).

7-5

1.2 Java-Sumatra Interconnection

- PLN is expected to keep the implementation schedule of IPP coal-fired thermal plants so that the Java-Sumatra Interconnection will be put into the Jamali system in 2014.

7-6

1.3 Geothermal Power Plant

- To attract private investment therein, regulations and standards regarding geothermal development, particularly the process of bidding for license, shall be provided as soon as possible.
- The preliminary FS level study for prospecting potential sites is desirable to lessen a risk burden of developers.
- A provision for confirming the possibility of geothermal development prior to license bidding must be established; for example an establishment of inter-ministry coordination board.

7-7

1.3 Geothermal Power Plant

- To fully exploit the experiences and knowledge of bid participants on feasibility of potential sites, a method of bidding with which several potential sites are offered and to be chosen by bidders can be effective.
- For a local government to better carry out preliminary site exploration, establishing a financial support system such as a revolving fund should be considered.

7-8

1.4 Nuclear Power Plant

- As nuclear power development plan may well face a delay, a study on additional coal-fired thermal plants to substitute for nuclear power shall be prepared.

7-9

1.5 Gas-fired Thermal Power Plant

- For the purpose of improving operational flexibility of gas-fired thermal power plants being provided by gas pipelines, CNG (Compressed Natural Gas) Storage System, which allows the same plant to operate for middle and peak load, is recommended.
- Middle- to small-sized gas fields, which are not suitable for LNG export, may be suitable for supplying fuel to thermal power plants by CNG vessel. Study on such development is recommended. This will also enables conversion of HSD-fired PLTG to CNG-fired PLTGU.

7-10

1.6 Hydropower

- Re-evaluation of hydropower potential, as a domestic resource of energy, in Jamali is required.
- Pumped storage power plants will be able to fully exploit the advantage of low cost power supply from coal-fired thermal and nuclear power plants for its pumping energy after 2020.
- As a pumped storage project requires a long lead time, earlier preparation of implementation is recommended.

7-11

1.7 Solar and Wind Power

- Specific measures to encourage use of and investment for solar power and wind power should be considered and implemented.
- It is recommended to establish Environmental Impact Assessment guidelines and/or criteria, in cooperation with Ministry of Environment.

7-12

1.8 General

- To respond to the climate change, measures to promote energy conservation and use of renewable energy shall be taken.
- To expedite the finding of power plant site, economic measures, such as a support for regional development and/or a subsidy scheme, shall be studied and introduced.
- Initiative in land acquisition for power plants and transmission lines should be taken by local government or PLN.

7-13

1.8 General

- Supervision of bidding process by an independent body
- Continuous efforts to evaluate and improve bidding process, particularly concerning the details of tendering information and participation of wide range of bidders should be made.
- Cases of significant delays in project schedule should be studied and their solutions to their causes be found.
- Technical requirements of bidders for IPP projects should be revised on the basis of the results of the study on improvement of power system operation.

7-14

2. Environment

2.1 Air Pollution

2.2 Thermal Effluents

2.3 CO_2 Emissions

2.4 Water Quality Management in Reservoir type Hydro

2.5 Industrial Wastes from Nuclear Power Generation

7-15

2.1 Air Pollution

- Siting of a coal-fired power station shall be conducted upon due consideration on whether additional air pollution load is acceptable or not.
- Construction of a power station in an area already with noticeable air pollution requires installation of a desulfurization/denitrification facility or electrostatic precipitator.
- Continuous monitoring of emission and ambient air quality shall be conducted.

7-16

2.2 Thermal Effluents

- Thermal power generation and nuclear power generation discharge substantial amounts of thermal effluents. Special attentions shall be paid to potential impacts of thermal effluents on corals.
- In Indonesia, it is required to reduce the temperature of thermal effluents down to less than 2 degree Celosias above that of receiving water, while thermal effluents are required to be less than about 6 degree Celosias in Japan. It is desirable to conduct rather an impact assessment through the simulation on diffusions of thermal effluents.

7-17

2.3 CO_2 Emissions

- If a legally binding emission reduction target is established in future for greenhouse gas emissions from Indonesia, it will be required to reduce CO_2 production through improvements of generation efficiencies in thermal power generation, or to sequester CO_2 in the atmosphere through afforestation.

7-18

2.4 Water Quality Management in Reservoir type hydro

- Reservoir-type hydroelectric power generation will emit methane of significant greenhouse effects when water quality in a reservoir goes down. It is required to prevent eutrophication through uncontrolled discharges of domestic sewage into reservoirs for prevention of water quality degradation there.

7-19

2.5 Industrial Wastes from Nuclear

Appropriate treatment of spent fuel from nuclear power generation is required.

7-20

3. Promotion of Private Investment

3.1 Retail Tariff

3.2 Project Schedule

3.3 Standardization of IPP wholesale price

3.4 Use of domestic inputs and increase of local currency portion

3.5 Limitation of Foreign Capital Ownership

7-21

3.1 Retail Tariff

- PLN's profit margin should be increased to allow for future investment. Such measures as a revision to the calculation method of BPP shall be considered.
- Limiting electricity subsidy to customer category R-1, 450VA is recommended, in order to reduce the government subsidy payment.
- Further, a possibility of introducing cost-pass-through system to the electricity tariff should be studied.

7-22

3.2 Project Schedule

- The causes of project delay should be studied. Particularly, financial closing process for foreign lending needs to be streamlined.

7-23

3.3 Standardization of IPP wholesale price

- Regulation on PPA price capping needs to be revised taking into consideration of the difference of plant operation and resulting cost difference.
- As geothermal development cost varies in one project to another, setting PPA price capping on geothermal IPP may preclude investors/developers from participating in bidding. The regulation and its effect should be monitored and, if necessary, revised.

7-24

3.4 Use of domestic inputs and increase of local currency portion

- A method of valuing higher a bid with larger L/C portion should be considered.

7-25

3.5 Limitation of Foreign Capital Ownership

- The current regulation on the limitation of foreign capital ownership of power plant, 95% maximum, can be one of factors that impede foreign investment. The efficacy of the regulation in the promotion of domestic industries and private investment in the power sector should be studied and verified..

7-26

4. Power System Expansion Plan

4.1 Land Acquisition

4.2 Countermeasures to Avoid Large Power Failure

4.3 Power Supply Method to High Load Density Areas (Jakarta)

4.4 Java-Sumatra Interconnection

7-27

4.1 Land Acquisition

- Right-Of-Way for planned transmission lines and substation facilities should be acquired prior to their construction so that the land acquisition would not cause any delay in their realization.

7-28

4.2 Countermeasures to Avoid Large Power Failure

- Countermeasures against frequency drop, such as an installation of simple load-breaking system by sending trip signal, should be studied.
- Introduction of system disconnection devices as a countermeasure against the whole system collapse should be studied.

7-29

4.3 Power Supply Method to High Load Density Areas (Jakarta)

- Economic power supply method to high load density areas, such as Jakarta, should be studied comprehensively, which may include raising voltage of middle-voltage system and direct connection of 500kV system.

7-30

4.4 Java-Sumatra Interconnection

- Countermeasures against upward frequency deviation, which may occur in the Sumatra system in the case of an interruption of Java-Sumatra Interconnection, should be studied.

7-31

5. Improvement of System Operation

5.1 Result of analysis of current conditions on the system operation

5.2 Voltage

5.3 Frequency

5.4 Outages

7-32

5.1 Result of analysis of current conditions on the system operation

- The important issues to be considered on the system operation are related to voltage, frequency and outages. The suggestions on measures for the improvement of the system operation in terms of these issues are described as follows:

7-33

5.2 Voltage

- The reasons for system voltage drop in Jamali are that reactive power source to maintain proper voltage is fundamentally lacked and existing reactive source is not fully utilized.
- As short term measures, in order to make best use of the reactive supply capability of the existing generators, a) Raise of system standard voltage and b) Introduction of incentives and penalties for reactive power supply are suggested.

7-34

5.2 Voltage

- As long term measures, planning of reactive supply equipment is required. In addition, in order to follow deviations of voltage, a) Installation of on-load tap changer to step-up transformer and b) Installation of PSVR (Power System Voltage Regulator) are to be considered.

7-35

5.3 Frequency

- Countermeasures against frequency fluctuation can be classified into normal and emergency frequency control.
- As measures for normal frequency control, a) Application of penalty, b) Bidding classified by operation type, c) Application of tariff for middle and peak type generators, and d) Application of Capacity Fee are effective.
- As measures for emergency frequency control, a) Proper calculation of system frequency characteristics and b) Detailed system frequency characteristics considering K_G and K_L are effective.

7-36

5.3 Outages

- Major reason for frequent outage in Jamali is the problem of facilities.
- For improvement on the problem of outage,
  a) Measures for same type of equipment,
  b) Establishment of quality management system,
  c) Cooperation with manufacturer,
  d) Planned installation of facilities based on N-1 criteria,
  e) Appropriate calculation of system frequency characteristic and
  f) Installation of fault extension prevention relay are effective.

7-37

Thank you for your attention!

Japan International Cooperation Agency (JICA)

NEWJEC Inc. & KANSAI

7-38