

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.

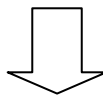
Accordingly, the Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of the technical cooperation programs of the Government of Japan, will undertake the Study in close cooperation with the authorities concerned with the Government of Indonesia.

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			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

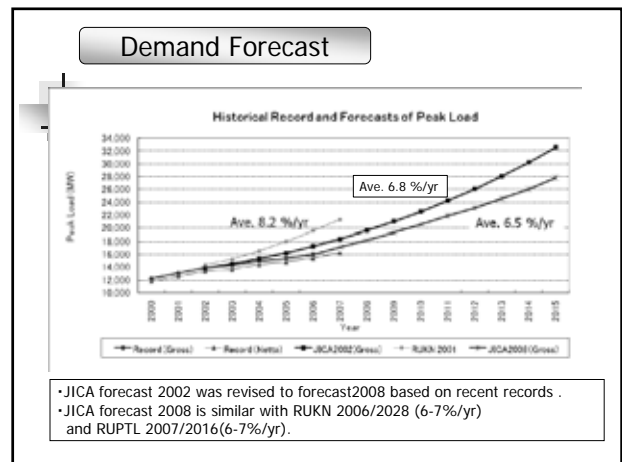
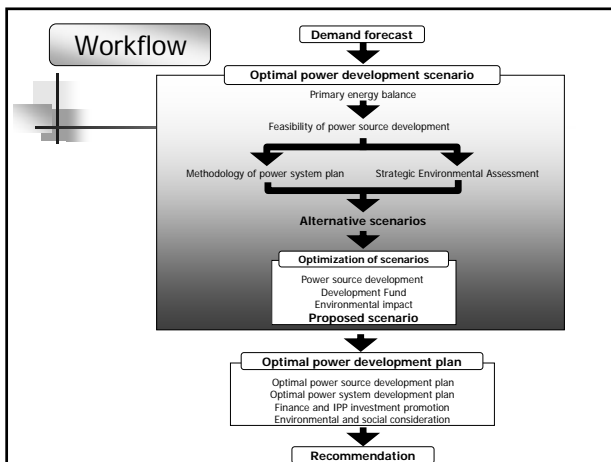
SPEAKER: MR. YAMAOKA SATOSHI,
NEWJEC INC.

1. Optimal Power Development Scenario

Optimal Power Development Scenario

Contents

- Workflow
- Demand Forecast
- Alternative Scenarios
- Proposed Scenario



Alternative scenarios

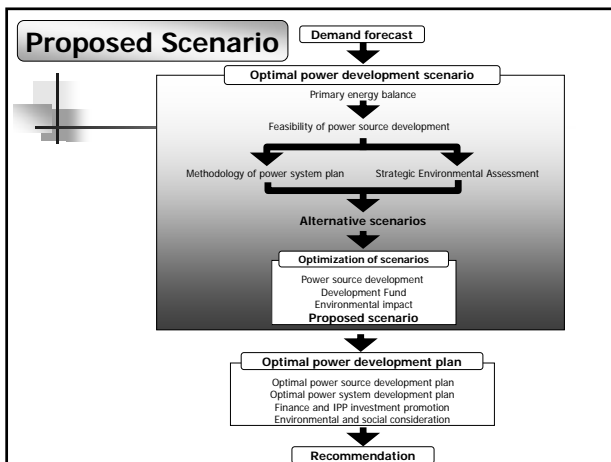
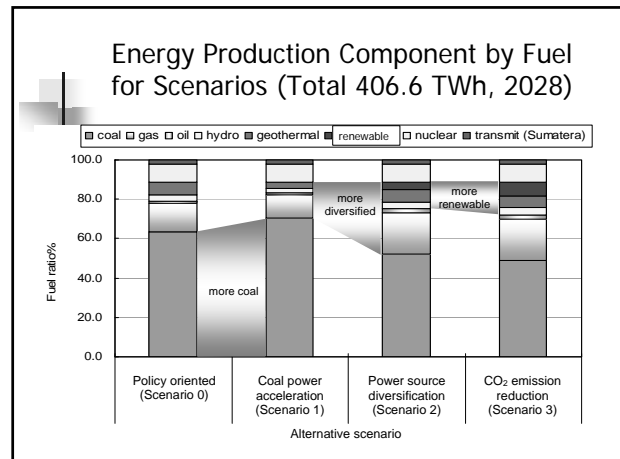
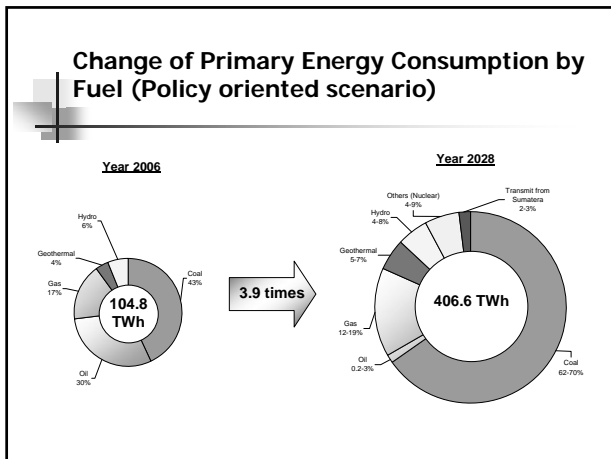
- Priority -

- 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 : CO₂ emission reduction

1. Optimal Power Development 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 %.	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/kWh (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/kWh (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.

1. Optimal Power Development Scenario

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.

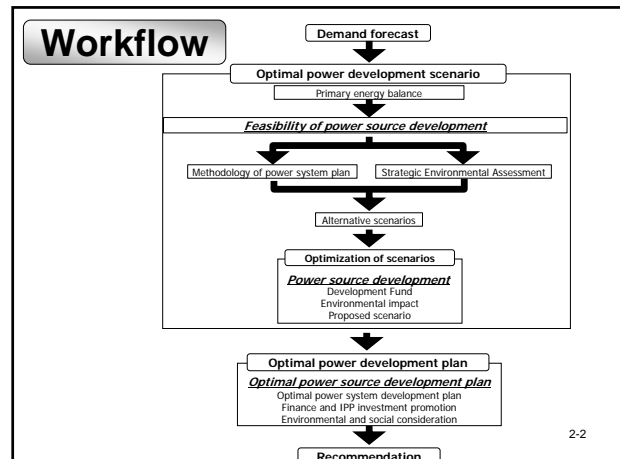
2. Optimal Power Source Development Plan

SPEAKER: MR. MATSUDA YASUHARU,
NEWJEC Inc.

2. Optimal Power Source Development Plan

2. Optimal Power Source Development Plan

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2.1 Study on Alternative Scenarios

- 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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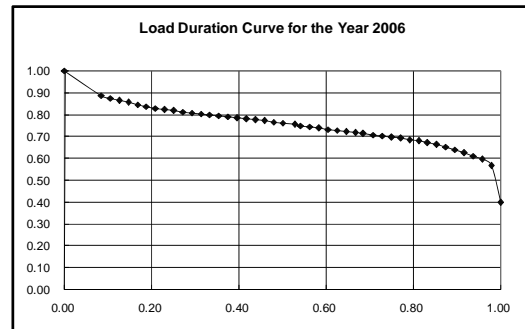
2. Optimal Power Source Development Plan

(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 \geq 30 %
Loss of Load Probability	\leq 0.274 %	Less or equal to one (1) day / year
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

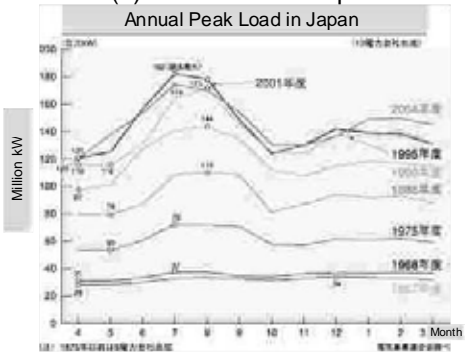
Uncertainties

- 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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2. Optimal Power Source Development Plan

(1) Common Assumption
Annual Peak Load in Japan



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(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)

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

No.	Name	Type	Explanation	No. of Sets	Min. Load		Capacity	Heat Rates	
					MW	MW		Base Load	Average Incremental
1	SRL1	PLTU	Bunaway #1-44 400 MW	4	240	381	2,822	2,452	
2	SRL2	PLTU	Bunaway #5-47 600 MW	3	340	579	2,560	2,309	
3	MKR1	PLTU	M. Karang #1-3 100 MW	3	44	84	3,273	3,184	
4	MKR2	PLTU	M. Karang #4-5 200 MW	2	50	155	2,548	2,884	
5	MKR3	PLTGU	M. Karang	1	300	465	2,433	2,018	
6	MKR4	PLTGU	M. Karang Repowering 2011	1	500	750	2,433	2,018	
7	PRK1	PLTU	P. Prak #3 & #4 80 MW	2	25	45	3,229	2,957	
8	PRK2	PLTGU	P. Prak Block 1 & 2	2	315	560	2,319	1,924	
9	PRK3	PLTGU	P. Prak #1 & #2 26 MW	2	10	20	4,711	3,830	
10	PRK4	PLTGU	P. Prak Extension 2012	1	500	750	2,433	2,018	
11	MT R1	PLTGU	M. Tawar Block 1	1	315	565	2,555	2,245	
12	MT R2	PLTGU	M. Tawar #2 - #2.2 145 MW	2	72	138	3,376	3,204	
13	MT R3	PLTGU	M. Tawar #3.1-#3.3 15 MW	6	72	143	3,376	3,204	
14	MT R4	PLTGU	M. Tawar Repowering 2011	1	150	225	2,433	2,018	
15	SUK1	PLTP	Suka #1 - #3 80 MW	3	52	52	1,000	1,000	
16	SLK2	PLTP	PP. Suka #4 - #6 80 MW	3	52	52	1,000	1,000	
17	CLND	PLTGU	PP. Cikarang Lirisindo 150 MW	1	50	150	4,465	3,200	
18	CLNG	PLTGU	PP. Cikarang 740 MW	1	240	740	2,175	1,800	
19	SBL3	PLTU	C.P. Palembang Sulaiba 600 MW	1	340	500	2,560	2,309	
20	LBNH	PLTU	C.P. Luban 300 MW x 2	1	150	300	2,622	2,452	

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

No.	Name	Type	Explanation	No. of Sets	Min. Load		Capacity	Heat Rates	
					MW	MW		Base Load	Average Incremental
21	TUNG	PLTU	C.P. Tungk Naga 300 MW x 3	3	150	300	2,622	2,452	
22	KMJ1	PLTP	Kamjang #1 30 MW	1	26	26	1,000	1,000	
23	KMJ2	PLTP	Kamjang #2 & #3 55 MW	2	47	47	1,000	1,000	
24	KMJ3	PLTP	PP. Kamjang #4 40 MW x 1	1	60	60	1,000	1,000	
25	DR J1	PLTP	IPP. Dajur #1 95 MW	1	44	44	1,000	1,000	
26	DR J2	PLTP	IPP. Dajur #2 95 MW	1	70	70	1,000	1,000	
27	DR J3	PLTP	IPP. Dajur #3 110 MW x 1	1	110	110	1,000	1,000	
28	WW1	PLTP	PP. Wiyudu #1 110 MW	1	110	110	1,000	1,000	
29	SRG1	PLTGU	Sunparig #1 & #2 20.03 MW	2	8	18	4,700	4,084	
30	SRG2	PLTGU	Sunparig #3 & #4 20.10 MW	2	8	20	4,700	4,084	
31	PTH1	PLTP	IPP. Patih #1-#3 80 MW x 3	3	60	60	1,000	1,000	
32	BSL	PLTU	C.P. Palembang Bess 300 MW x 3	3	150	300	2,560	2,315	
33	IBUT	PLTU	C.P. Indramayu 300 MW x 3	3	150	300	2,560	2,315	
34	CRBN	PLTU	IPP. Cirebon 600 MW x 1	1	360	600	2,560	2,160	
35	TBK1	PLTGU	Tembak Lorok Block 1 & 2	2	297	496	2,632	2,015	
36	TBK2	PLTU	Tembak Lorok #1 & #2 50 MW	2	25	41	3,229	3,127	
37	TBK3	PLTU	Tembak Lorok #3 200 MW	1	125	192	3,229	3,127	
38	CLC1	PLTU	Cikarang #1 & #2 29 & 26 MW	2	10	22	4,700	4,079	
39	CLC2	PLTU	IPP. Cikarang #1 & #2 300 MW	2	150	300	2,772	2,285	
40	TJB1	PLTU	Tanjung Jati B #1 & #2 60 MW	2	330	660	2,772	2,285	

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

No.	Name	Type	Explanation	No. of Sets	Min. Load		Capacity	Heat Rates	
					MW	MW		Base Load	Average Incremental
41	JBR	PLTU	C.P. Jati Baru/Cikarang 600 MW x 1	1	360	600	2,560	2,160	
42	DJEN	PLTP	PP. Djeng #1 60 MW	1	60	60	1,000	1,000	
43	RMB6	PLTP	C.P. Rembang 300 MW x 2	2	150	300	2,590	2,115	
44	PJN1	PLTU	Pakso #1 & #2 400 MW	2	225	370	2,678	2,432	
45	PTN2	PLTU	C.P. Pakso 600 MW x 1	1	340	600	2,560	2,309	
46	PEC	PLTU	PP. Pakso #7 & #8 84.5 MW	2	368	615	2,772	2,285	
47	JPOW	PLTU	PP. Jawa Power #5 & #6 610 MW	2	355	610	2,700	2,310	
48	GSK1	PLTGU	Disek Block 1-3	3	250	480	2,318	1,980	
49	GSK2	PLTGU	Disek #1 & #2 20.1 MW	2	8	18	4,456	4,284	
50	GSK3	PLTGU	Disek #1 & #2 100 MW	2	43	85	2,882	2,709	
51	GSK4	PLTU	Disek #3 & #4 200 MW	2	90	175	2,826	2,601	
52	PAK4	PLTU	Pakso #1 & #2 20.1 MW	2	25	48	4,323	3,517	
53	GRT1	PLTGU	Gresi Block 1	1	270	462	2,632	2,083	
54	GRT2	PLTGU	Gresi #2.1-#2.3 100.75 MW	3	40	100	3,376	3,210	
55	PMRN	PLTGU	Pemaron #1 & #2 48 & 8 MW	2	12	48	4,438	4,035	
56	GLMR	PLTU	Gilimanuk #1 & #2 20.1 MW	2	5	16	4,456	4,284	
57	GLMK	PLTGU	Gilimanuk #1 133 & 8 MW	1	56	133	4,439	4,035	
58	BLJ1	PLTGU	Pasanggahan #1 - #4 20 & 42 MW	4	6	20	4,700	4,131	
59	BLJ2	PLTGU	Pasanggahan #2 - #41 5-12 MW	10	2	5	3,880	3,476	
60	BLU1	PLTU	PP. Batu Luhu 300 MW x 3	3	65	150	2,590	2,115	

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

No.	Name	Type	Explanation	No. of Sets	Min. Load		Capacity	Heat Rates	
					MW	MW		Base Load	Average Incremental
61	SDCL	PLTP	PP. Seledang 10 MW x 1	1	10	10	1,000	1,000	
62	TJAW	PLTU	C.P. Tawang 300 MW x 2	2	150	300	2,590	2,115	
63	UTSL	PLTU	C.P. Sebatan/Pactan 300 MW x 2	2	150	300	2,590	2,115	
64	CSLC	PLTP	PP. Caidok - Caidok 45 MW x 1	1	45	45	1,000	1,000	
65	TGBP	PLTP	PP. Tangkuban Perahu 10 MW x 2	2	220	220	1,000	1,000	
66	TMPM	PLTP	PP. Tampomas 50 MW x 1	1	50	50	1,000	1,000	
24'	KM14	PLTP	PP. Kambojang #5 60 MW x 1	1	60	60	1,000	1,000	
42'	DIEN2	PLTP	PP. Djeng #2 & #3	2	60	60	1,000	1,000	
28'	WW2	PLTP	PP. Wiyudu #2 110 MW	1	110	110	1,000	1,000	
A1	IRJMD	PLTA	PP. Rajam and an data 47 MW x 1	1	0	0	47		
A2	JTGD	PLTA	PU. Jangede 85 MW x 2	2	0	0	110		

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2. Optimal Power Source Development Plan

(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		Heat Content	
	USD	Cents/mKcal		
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		

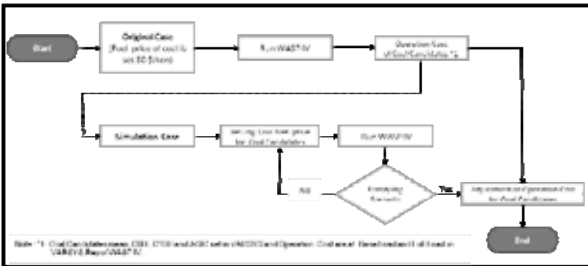
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2.1.2 Simulation Method by WASP IV

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)				TOTAL	OBJ.FUN. (CUMM.)
	CONCST	SALVAL	OPCOST	OP-Coal		
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	4,456,551	-	5,737,522	21,836,740
2013	-	-	4,267,108	(1,138)	4,285,970	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	780,850	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)	3,426,883	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	Y-0.5	NPV Conv	Fuel Price 3.019	UsrM.kcc		Original F.P. 1.509	UsrM.kcc	Additional Cost	FD \$/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	0.12298	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)

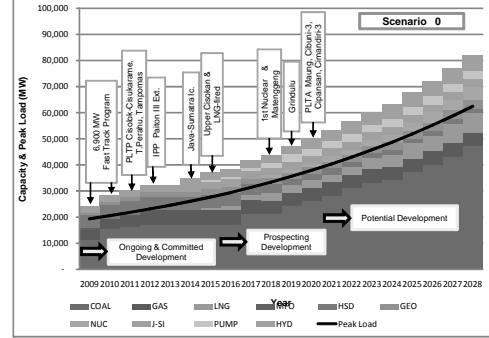
MEMRSIM1.REP

YEAR	C10H Generation (1000 GWh)			S1 Generation (1000 GWh)			T. Generation (1000 GWh)			OP Cost	OP Cost	
	P-1 Base	P-2 Peak	P-2 Base	P-1 Base	P-2 Peak	P-2 Base	BASE	PEAK	KS			
2021	13.60	0.15	11.12	0.04	2.84	0.00	2.84	0.00	30.38	0.19	-1,159,433	230,585
2022	15.44	0.14	13.75	0.38	3.03	0.00	3.30	0.00	35.52	0.50	-1,354,708	225,528
2023	20.70	0.36	19.08	0.99	3.46	0.00	3.41	0.00	46.54	1.36	-1,814,816	250,710
2024	21.00	0.28	19.27	0.87	3.40	0.00	3.59	0.00	47.28	1.13	-1,834,101	216,521
2025	26.88	0.94	24.56	1.80	3.51	0.00	3.89	0.00	58.84	2.74	-2,331,416	359,384
2026	28.58	0.97	26.63	1.91	3.74	0.00	3.87	0.00	62.79	2.88	-2,486,301	342,165
2027	34.01	1.78	32.58	3.19	3.93	0.00	4.10	0.00	74.61	4.97	-3,011,690	370,927
2028	41.61	2.59	38.60	3.63	3.80	0.00	4.15	0.00	88.16	6.21	-3,571,034	391,779

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	
CSH 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	
RES PLTP	50									1,000	
G150 PLTG	150			330	330	330	550	660	770	880	
PS Pumped S.	500						500	1,000	1,000	2,000	
CIB PLTA	172										
CPS PLTA	400										
CMD3 PLTA	238										
MAN3 PLTA	360										
PLTA PLTA	300										
Jawa-Sumatera I C	600			330	1,330	1,330	2,400	3,000	3,000	3,000	
Total Supply Capacity at year end	24,389	28,305	30,318	32,285	32,285	34,905	36,975	38,330	41,842	43,801	
Reserve Margin %		26.2%	37.8%	39.0%	38.4%	31.4%	33.9%	33.7%	30.4%	32.9%	
		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
CSH 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	2,000	2,000	2,000	2,000	3,000	3,000	4,000	4,000	5,000
RES PLTP	50	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
CIB PLTA	172			172	172	172	172	172	172	172	172
CPS PLTA	400			400	400	400	400	400	400	400	400
CMD3 PLTA	238			238	238	238	238	238	238	238	238
MAN3 PLTA	360			360	360	360	360	360	360	360	360
PLTA PLTA	300			900	900	1,800	1,800	1,800	2,100	2,100	2,100
Jawa-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 Supply Capacity at year end	19,100	22,880	25,450	29,500	33,110	36,120	40,730	44,840	49,750	54,860	60,000
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

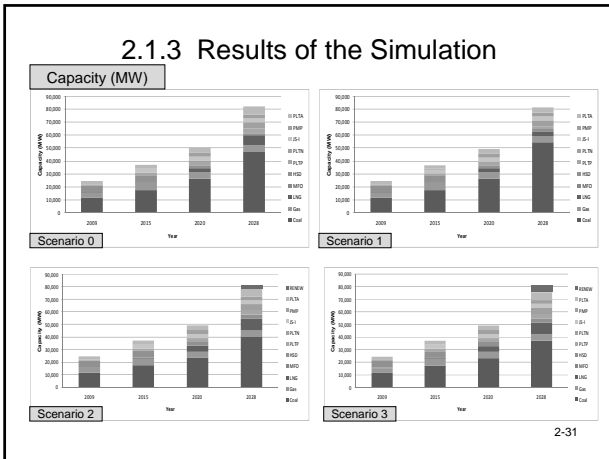
Scenario	Oil	Coal	Gas	Geothermal	Hydro	Pumped Storage	Nuclear	Other Renewable	
Scenario 0	Target in 2028	Energy rate 0.2%	Energy rate 56 - 66%	Energy rate 12%	Energy rate 5%	Energy rate 4 - 8%	Up to WASP IV economic development	Capacity rate 5 - 7.5%, 4 - 5 GW	Negligible
	Simulation Results in 2028	Energy 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 1,686 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 3.6 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 16% capacity after PLTP	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

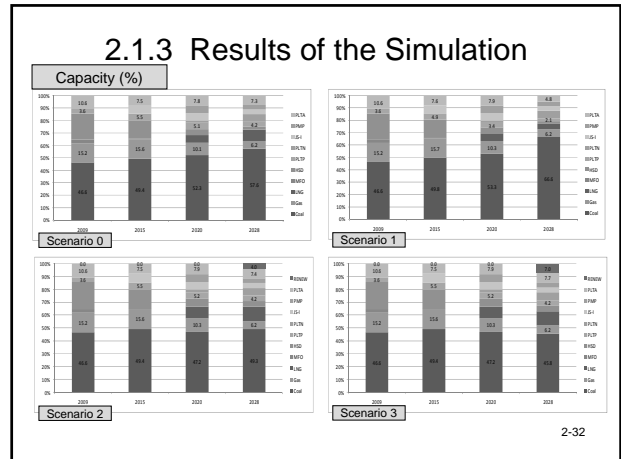
2-30

2. Optimal Power Source Development Plan

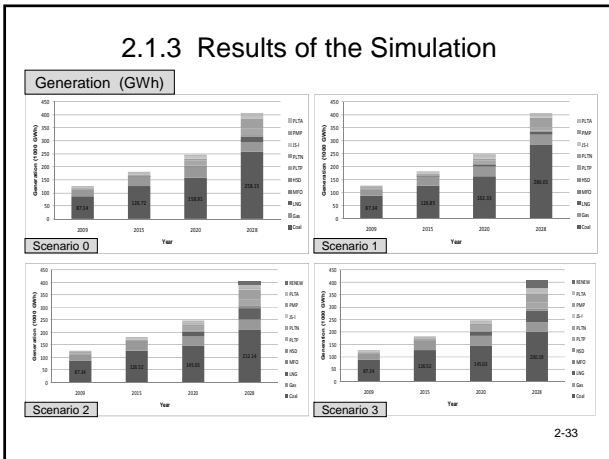
2.1.3 Results of the Simulation



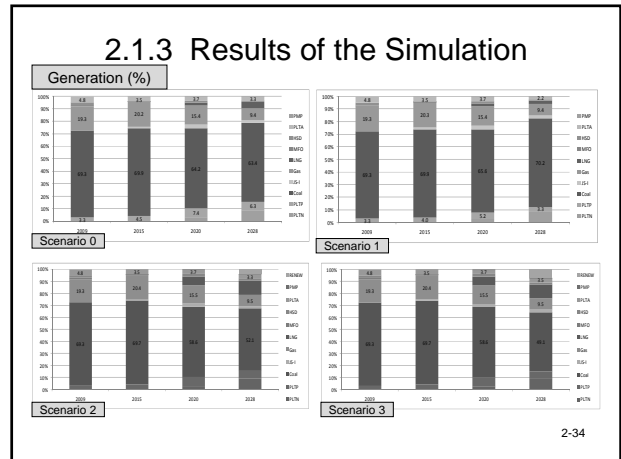
2.1.3 Results of the Simulation



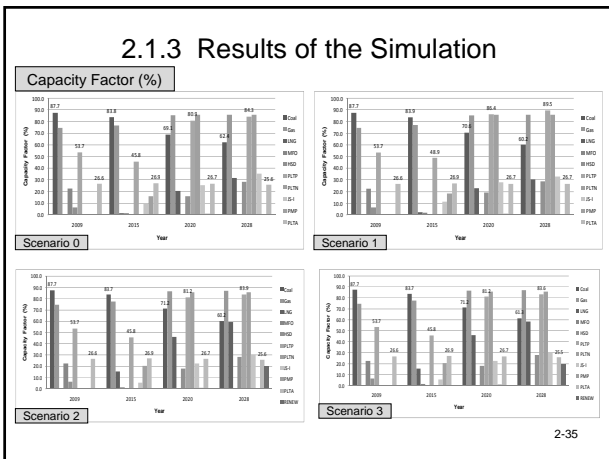
2.1.3 Results of the Simulation



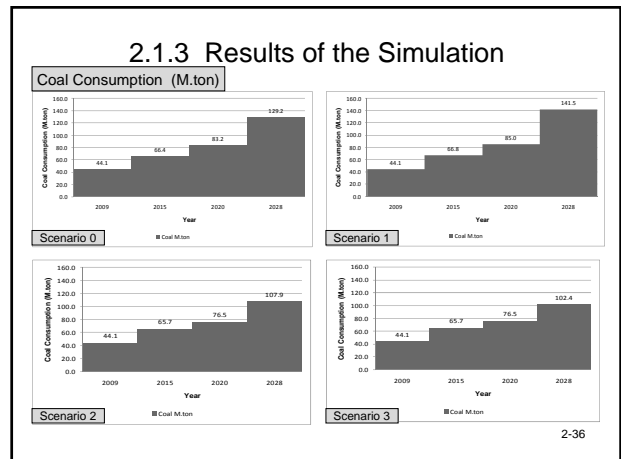
2.1.3 Results of the Simulation



2.1.3 Results of the Simulation



2.1.3 Results of the Simulation



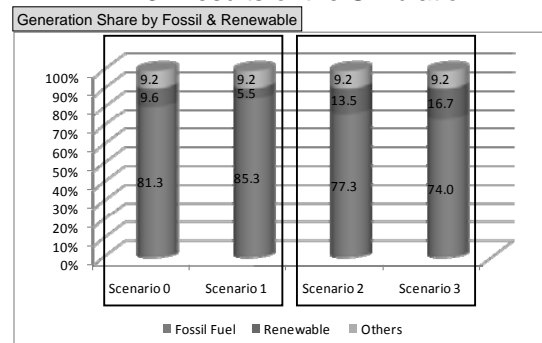
2. Optimal Power Source Development Plan

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



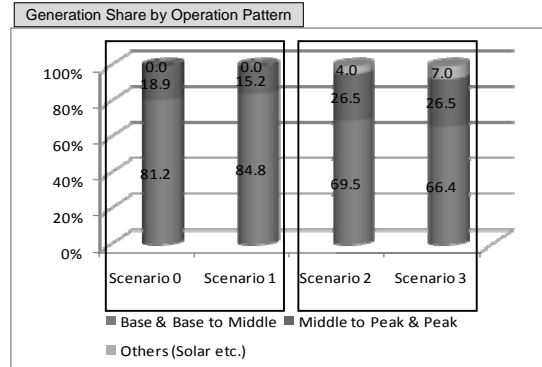
2-38

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



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. Optimal Power Source Development Plan

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

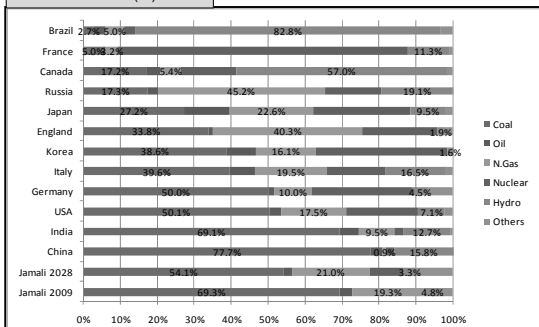
2.2.2 Towards Implementation of the Optimal Power Source Development

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

2. Optimal Power Source Development Plan

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 Paton 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 allocated 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. Optimal Power Source Development Plan

(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 mine-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



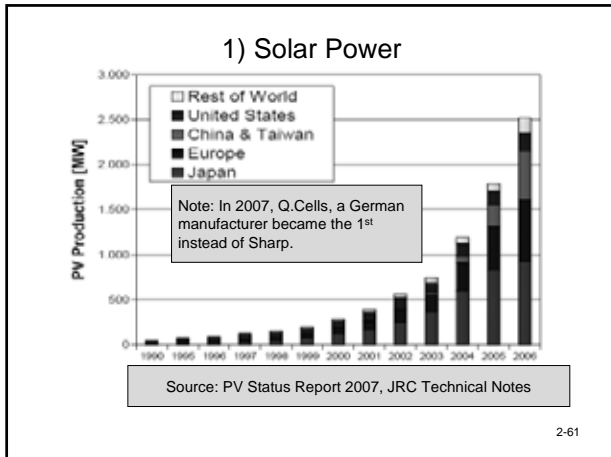
2-59

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

2. Optimal Power Source Development Plan



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

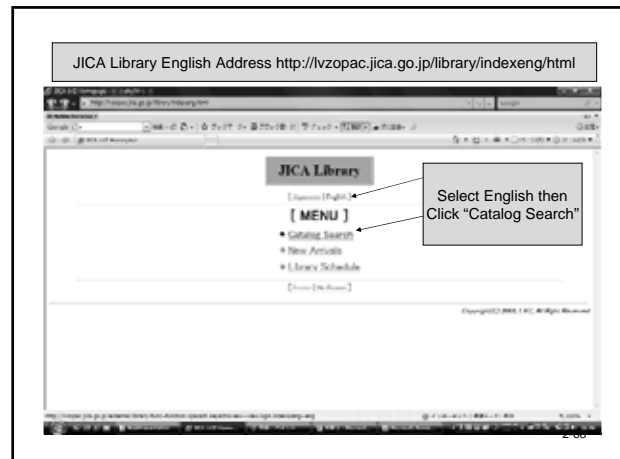
2-66

2. Optimal Power Source Development Plan

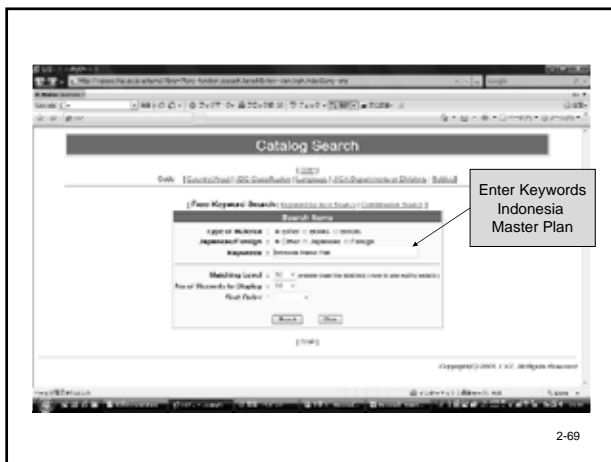
(5) Utilization of JICA Reports

- 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



2-68



2-69



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

2. Optimal Power Source Development Plan

(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, NO_x and SO_x Emission in 2028 (Million ton)

Case	CO ₂	NO _x	SO _x
With Nuclear	239.4	1.4	0.5
W/O Nuclear	269.6	1.5	0.5

CO₂ 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

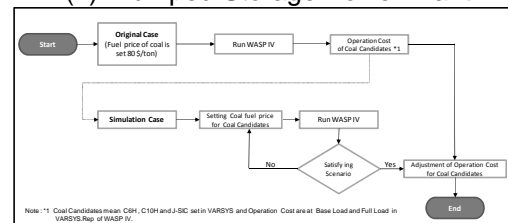
(1) Nuclear Power Plant

Conclusion

Increase of objective function (total cost), fuel consumption and CO₂ emission are confirmed by WASP simulation in case of "Without Nuclear Plants".

2-77

(2) Pumped Storage Power Plant



Note: *1: Coal Candidates mean CBH, C10H and J-SIC set in VARSYS and Operation Cost are at Base Load and Full Load in VARSYS file of WASSP-IV.

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. Optimal Power Source Development Plan

(2) Pumped Storage Power Plant

Conclusion

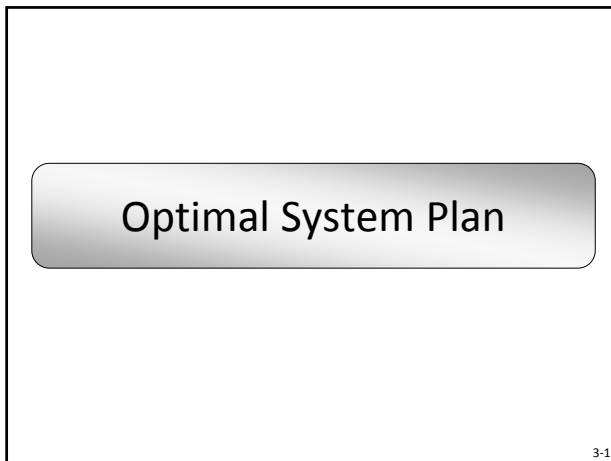
Since the available generation energy at the installed capacity of 3,000 MW is 4,200 GWh, pumped storage power plants will be operated at full load after 2020 by introduction of coal-fired thermal plants and nuclear power plants which will provide pumping energy with low cost. Therefore, the development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

2-79

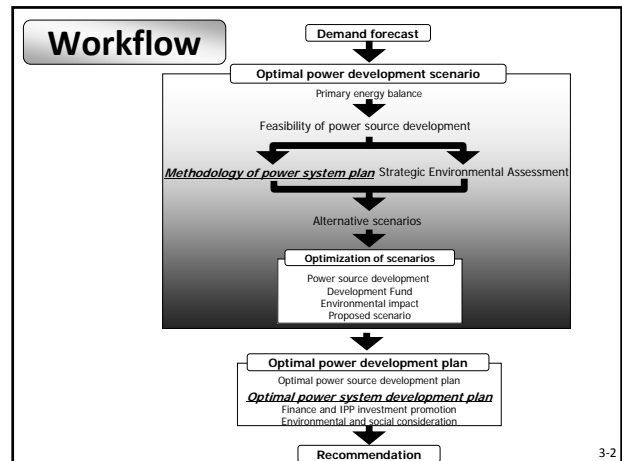
3. OPTIMAL SYSTEM PLAN

SPEAKER: MR. TANAKA YUKAO,
NEWJEC INC.

3. Optimal System Plan



3-1



3-2

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

3-4

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

Stations

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

3-5

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**

Region	Substation	Year	Load (MW)
Region 1	Caran	2005	100
	Caran	2006	105
	Caran	2007	110
	Caran	2008	115
	Caran	2009	120
	Caran	2010	125
	Caran	2011	130
	Caran	2012	135
	Caran	2013	140
	Caran	2014	145
	Caran	2015	150
	Caran	2016	155
Region 2	Caran	2005	100
	Caran	2006	105
	Caran	2007	110
	Caran	2008	115
	Caran	2009	120
	Caran	2010	125
	Caran	2011	130
	Caran	2012	135
	Caran	2013	140
	Caran	2014	145
	Caran	2015	150
	Caran	2016	155
Region 3	Caran	2005	100
	Caran	2006	105
	Caran	2007	110
	Caran	2008	115
	Caran	2009	120
	Caran	2010	125
	Caran	2011	130
	Caran	2012	135
	Caran	2013	140
	Caran	2014	145
	Caran	2015	150
	Caran	2016	155
Region 4	Caran	2005	100
	Caran	2006	105
	Caran	2007	110
	Caran	2008	115
	Caran	2009	120
	Caran	2010	125
	Caran	2011	130
	Caran	2012	135
	Caran	2013	140
	Caran	2014	145
	Caran	2015	150
	Caran	2016	155

3-6

3. Optimal System Plan

Assumption of Each substation Load(2)

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

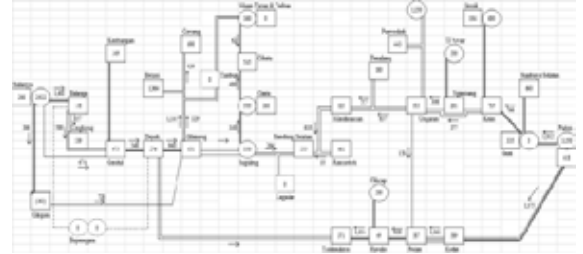
	PLM001	PLM002	PLM003	PLM004	PLM005	PLM006	PLM007	PLM008	PLM009	PLM010
Region 1	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
Region 2	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
Region 3	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
Region 4	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
Total of substation load	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
Total of substation PLM	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000

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.

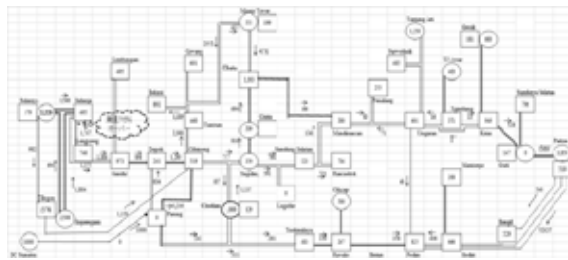


3-8

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.

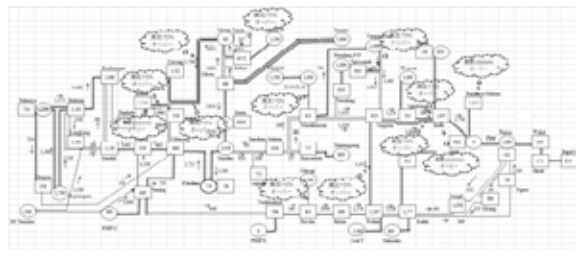


3-9

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

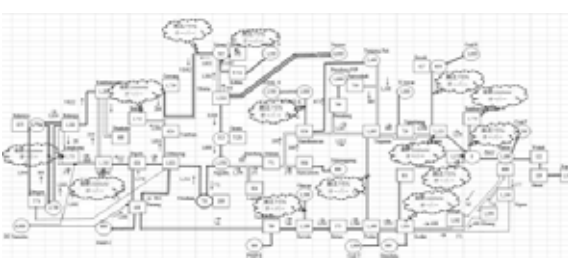


3-10

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 Durikabi/S as well.
- Ungaran-Pedan is recommended to reinforcement of another one circuit
- Bali Conecton 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)

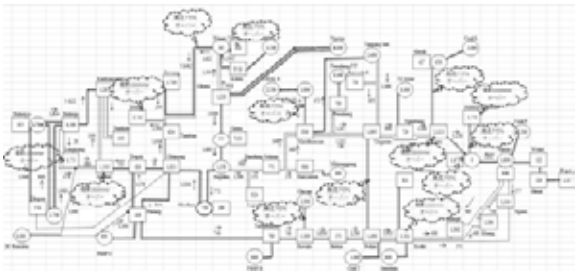


3-11

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

3. Optimal System Plan

Capacity of Trunk Substation

- Precondition
 - > Short period overload Capacity 150%, Continuous 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

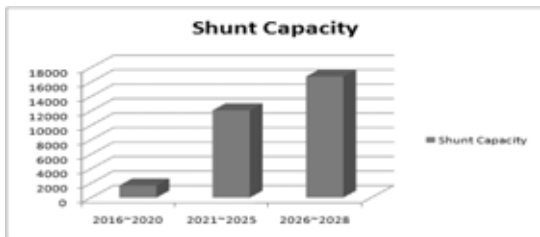
Summary of power flow analysis result(1)

- 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.
- Regarding 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 larger 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 much 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

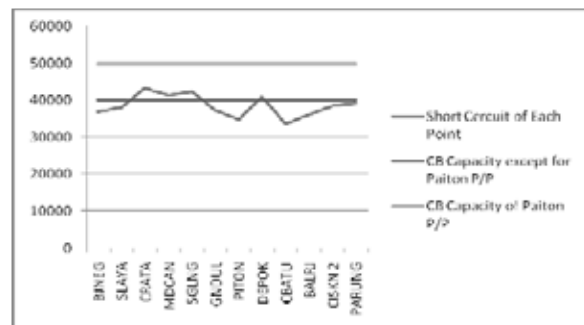
Summary of power flow analysis result(4)

- (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

3. Optimal System Plan

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 Paton 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 Breaker 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



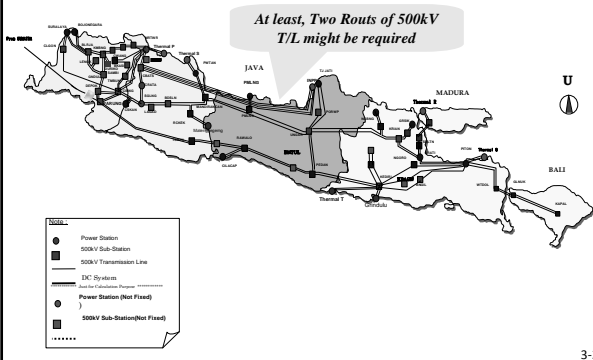
- Swing of Bus voltage in case of Nuclear power plant Accident



3-20

JAVA BALI 500kV SYSTEM year 2028

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



3-21

Power System development

(Main Concept)

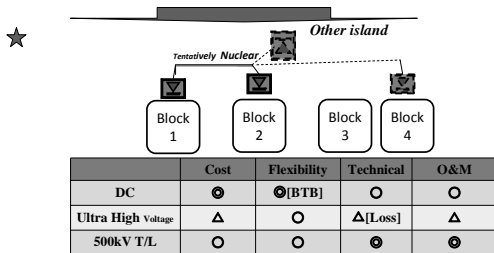
- Optimization of System Reinforcement with Flexibility coincide to Power Plants Development
- ★ Keep Feasibility of Java-Bali Trunk Power system for meeting situation change in the future
- ★ Composed by common equipments widely used in the world for smooth O & M
- ★ Utilizing FACTS Equipments efficiently 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

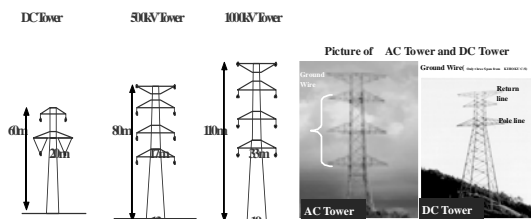


- ★ Introduction of Method for enhancing Local Demand for achieving Block Balance

5-23

Rough Comparison of AC/DC(1)

- Illustration of each transmission configuration

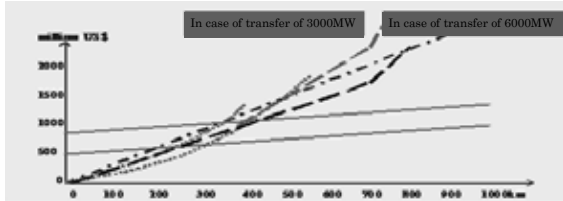


3-24

3. Optimal System Plan

Rough Comparison of AC/DC(2)

- ◆ The cost of DC transmission line is lower than that of AC, however DC system requires AC/DC converter 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

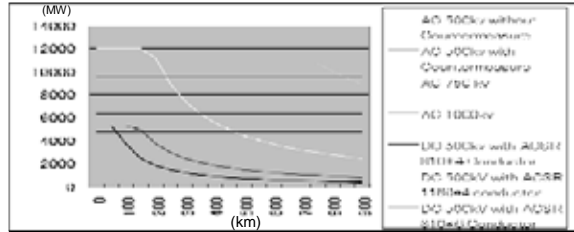


	500kV DC	500kV AC *	750-1000kV AC	Others
Transmission Cost	0.46*10 ⁶ \$/US\$km	1.125*10 ⁶ \$/US\$km	About 2.0-3.0 times	Sending Distance Around 250-300km
Converter Equipment	INV/CNV (MUS\$) 450(225*2)	-----	-----	Sending Capacity of 3000MW

3-25

Rough Comparison of AC/DC(3)

◆ Illustration of each transmission Sending Capacity



Specification of UHV Transmission Line (Base 1000MVA %/sec-km - 50Hz)

Voltage (kV)	Conductor Size	Impedance		
		Resistance	Reactance	Admittance
750	AS10* (1200*6)	0.001624	0.04771	0.2375
1000	AS10*10	0.000626	0.02362	0.4788
1400	AS10*14	0.000301	0.01267	0.8916

3-26

Application of Direct Current Power Transmission

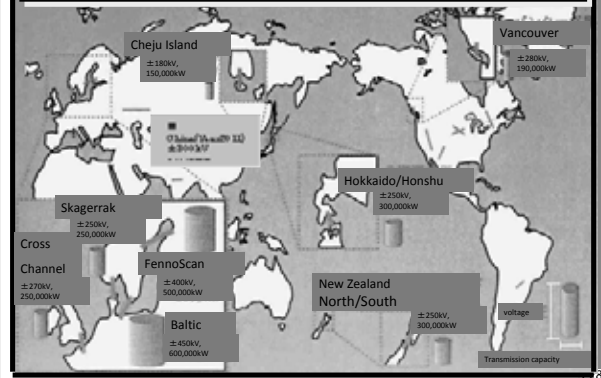
- ◆ The direct current power transmission has many advantages which cannot be realized by AC transmission as follows

*** 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.

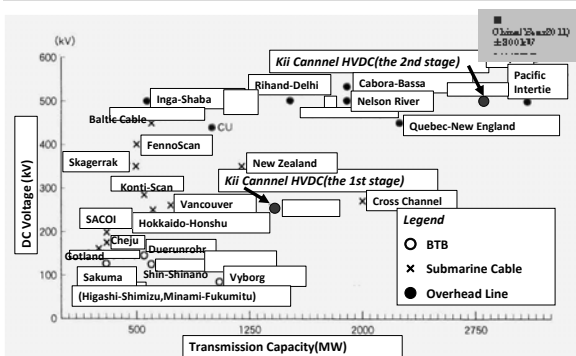
3-27

World's Main DC Facilities



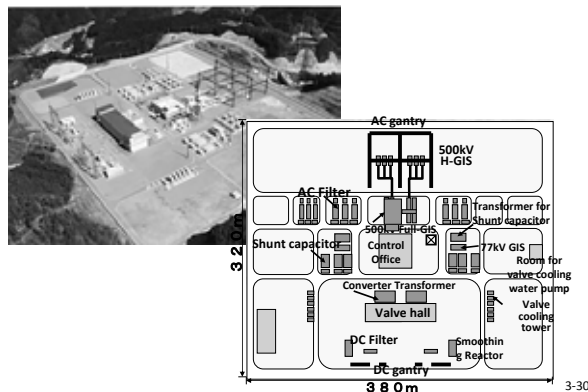
3-28

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



3-29

Layout of Kihoku Converter Station



3-30

3. Optimal System Plan

Latest DC System operation method

- Conventional DC system must be stopped and restarted in case of system voltage drop for avoiding continuous commutation 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 voltage drop, Dc system enables to be operated continuously. So, reliability is the same as AC system

3-31

Just Image of DC Composition

Short Circuit Capacity of Vicinity Area

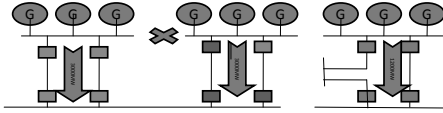
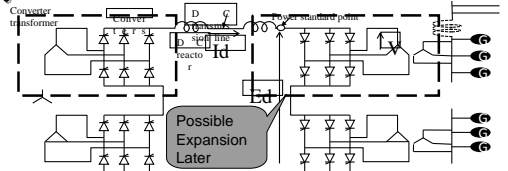


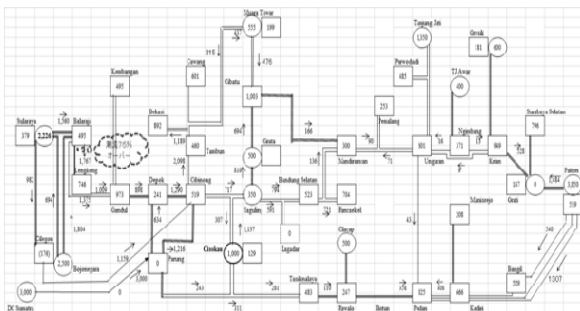
Image of DC Composition



Possible Expansion Later

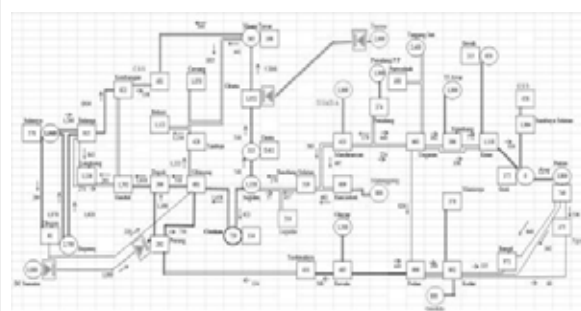
3-32

Optimal System Reinforcement (Year 2015)



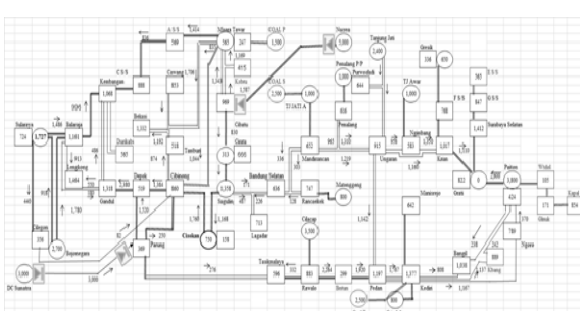
3-33

Optimal System Reinforcement (Year 2020)



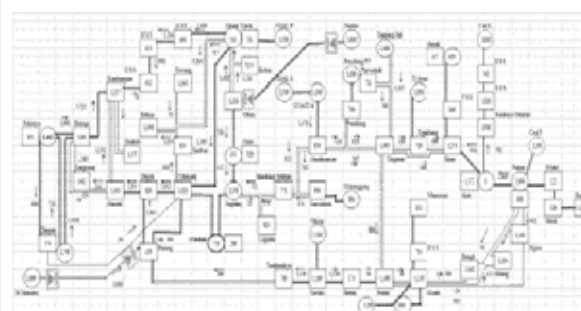
3-34

Optimal System Reinforcement (Year 2025)



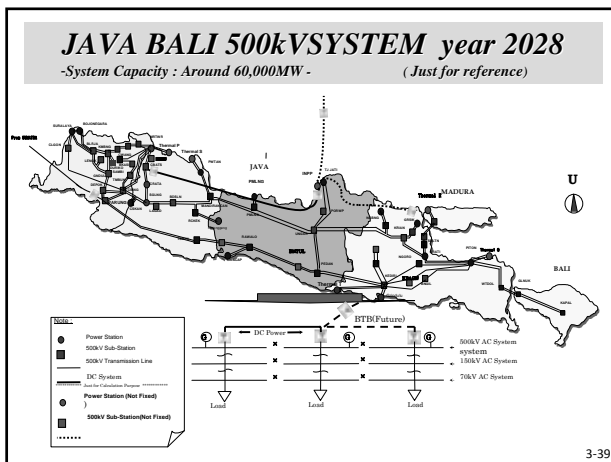
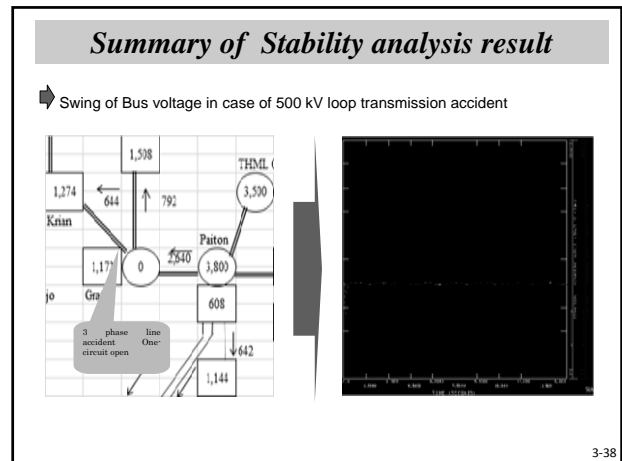
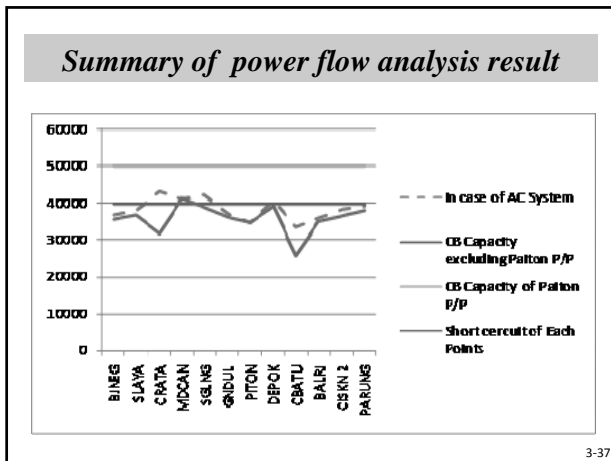
3-35

Optimal System Reinforcement (Year 2028)



3-36

3. Optimal System Plan



JAVA BALI 500kV SYSTEM year 2028

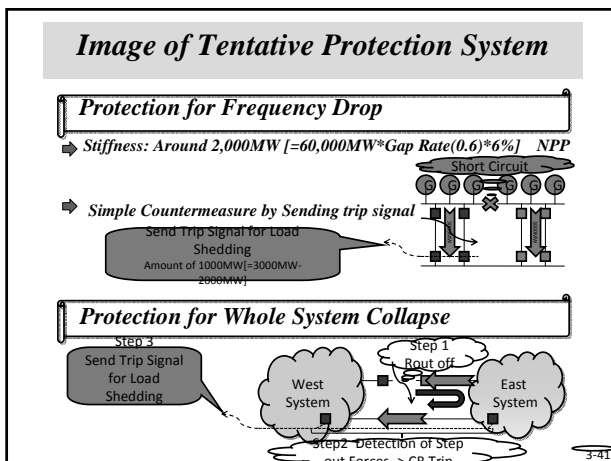
-System Capacity : Around 60,000MW - (Just for reference)

	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

	2010	2015	2020	2025	2028
Construction Cost	3276	1238	2357	2838	932

From RUPTU up to year:2015

3-40



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.

Provinsi	Residence	Industry	Commercial	Social	Gov't Offices	Public	Total	Area	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
Jawa 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 & Inderagiri	8655.1	8029.36	7480.28	735.6	730.85	279.71	25880.91	740.29	5321
JawaMali 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]

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

3-42

3. Optimal System Plan

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 /Zcct.410mm ² [Impedance Base1000MVA]	Max Length (Km)	Bank Combination of Trunk Substation	Number of Dispatching Substation for Trunk Substation	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)	Sm

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
 $(275/150)^{**2} ; (500/275)^{**2} = 3.36 : 3.31$

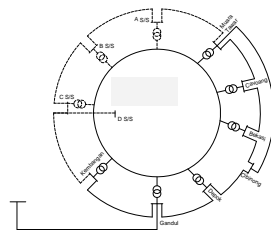
- Therefore, from the sending capacity ratio of existing voltage level, 275kV system would be suitable for next higher middle voltage as well.
- As summary, 275kV should be recommended to introduce as higher middle system voltage in the future from the above consideration, simplification of system voltage level, install cost reduction and reduction of system losses as well.
- In addition, 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.

4. Improvement of Power System Operation

Improvement of Power System Operation

4-0

Topics

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

4-1

Voltage

4-2

- 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.

4-3

- 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

4-4

- 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)

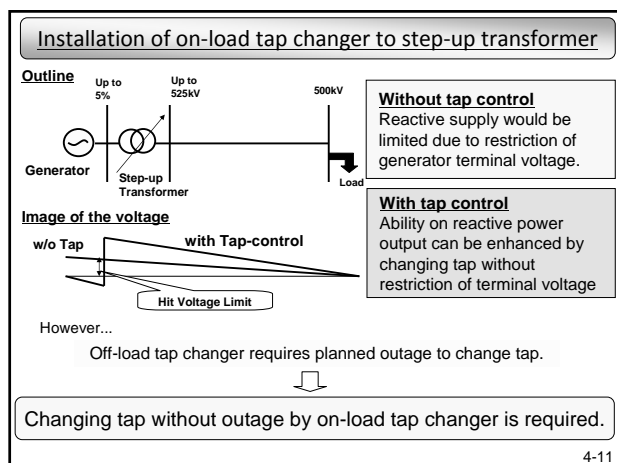
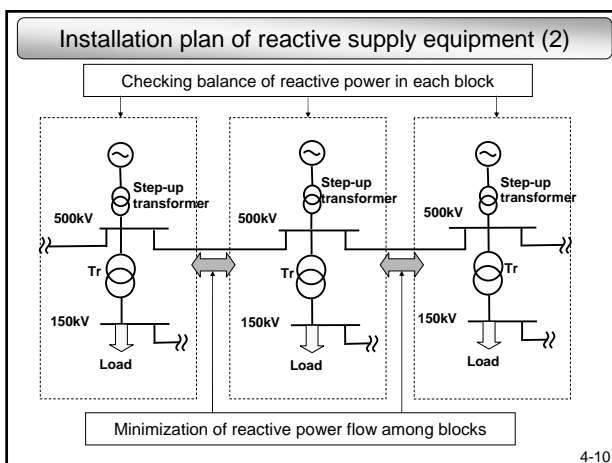
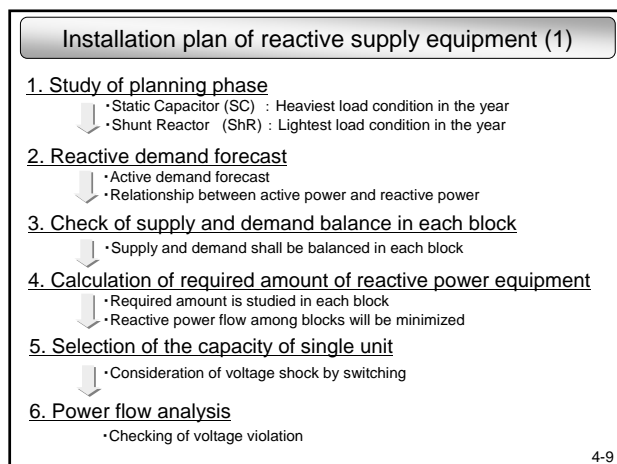
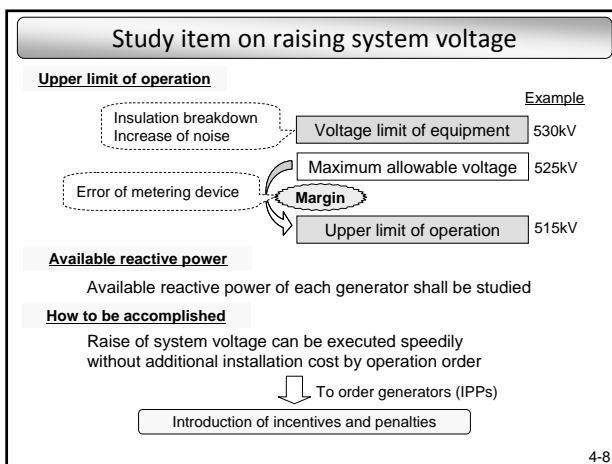
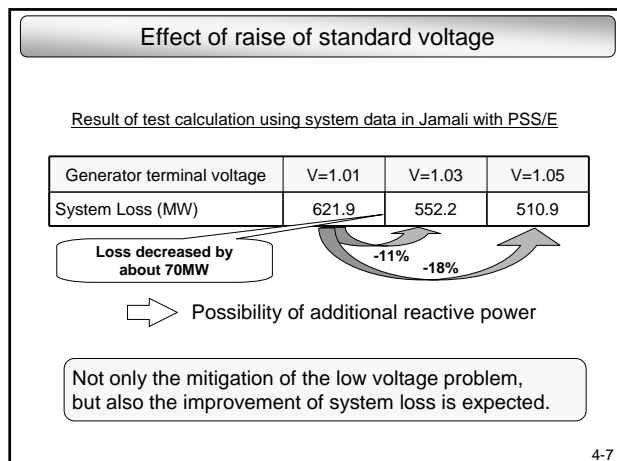
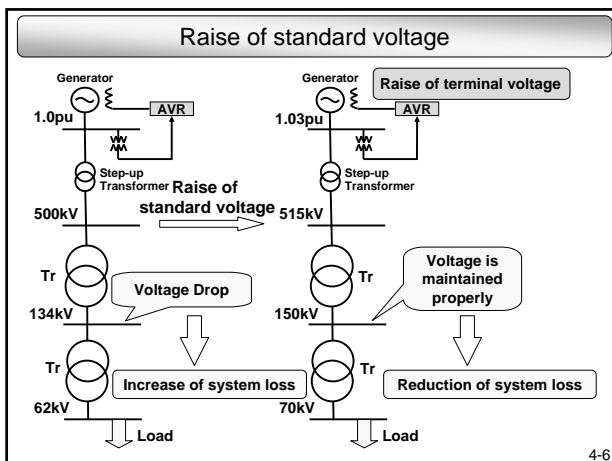
- On-load tap changer contributes to utilize reactive output from generator

Installation of Power System Voltage Regulator (PSVR) (4-13)

- PSVR tries to keep system voltage constant against fast change of load

4-5

4. Improvement of Power System Operation



4. Improvement of Power System Operation

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

4. Improvement of Power System Operation

- 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)

4-18

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

4-19

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.

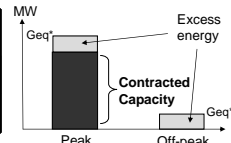
4-20

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

Capacity Fee



*Geq = Equivalent Generated Capacity

(Payment)

Primary energy x Primary tariff
+ Secondary energy x Secondary tariff

(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.

4-21

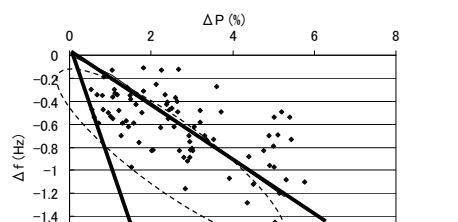
Proper Calculation of System Frequency Characteristics

System capacity shall be considered

MW/Hz \Rightarrow %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



Worst Case
K = 1.1 (%MW/Hz)

Some cases exist
worse than RMS

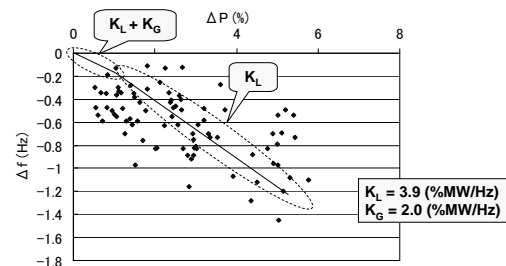
RMS
K = 4.3 (%MW/Hz)

4-22

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.

4-23

4. Improvement of Power System Operation

Outage

4-24

- Outage - Current Condition

Main reason for outages

	2002	2003	2004	2005	2006	2007	2008*
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

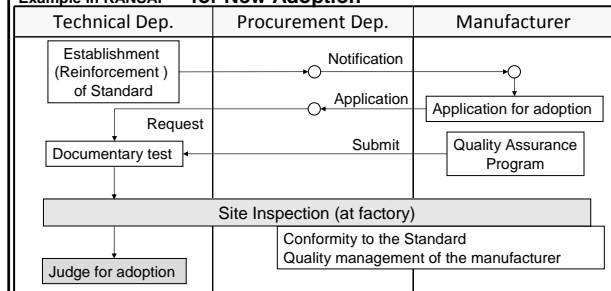
- Important equipment (Type of equipment, Voltage class)
- Recurrence is probable

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)

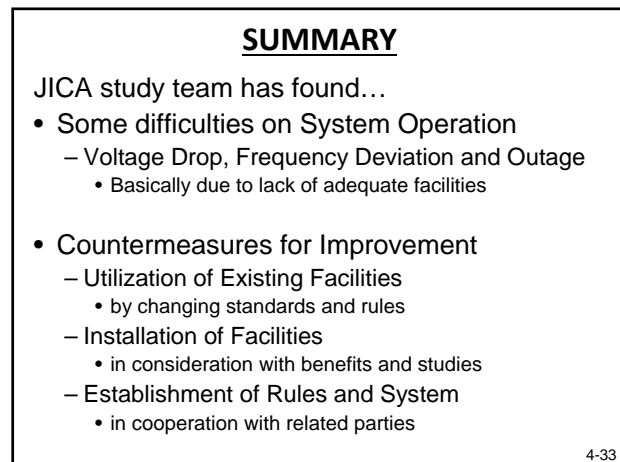
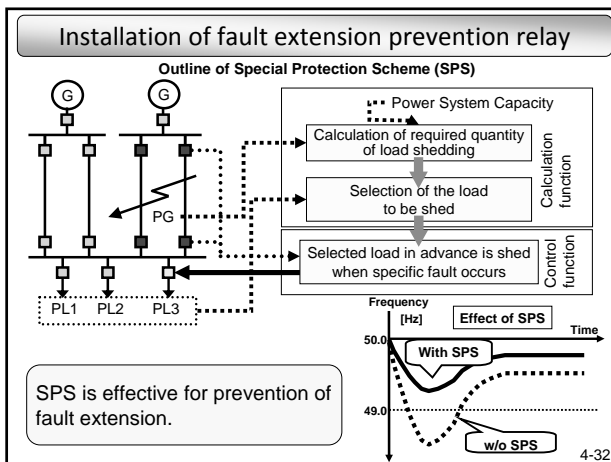
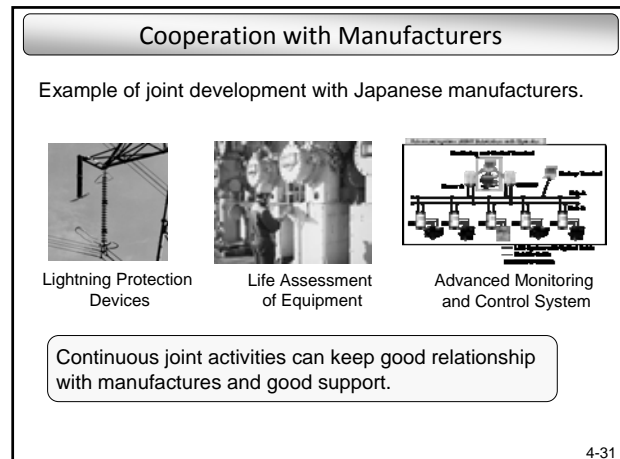
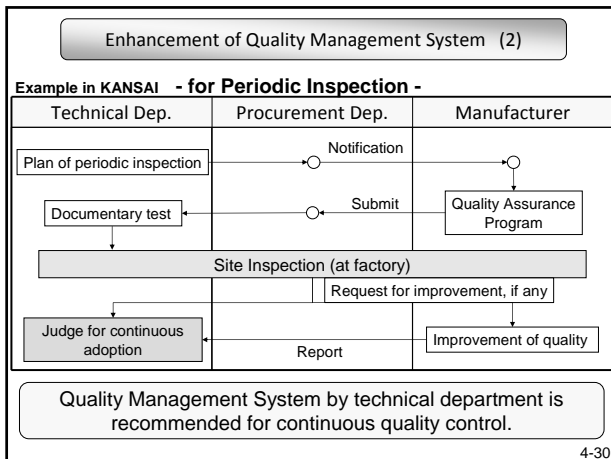
Example in KANSAI - for New Adoption -



Adoption of equipment is judged by technical department

4-29

4. Improvement of Power System Operation



5. INVESTMENT SCHEDULE, IPP PROMOTION PLAN

SPEAKER: MR. NISHIDA MASARU,
NEWJEC INC.

5. Investment Schedule & IPP Promotion Strategy

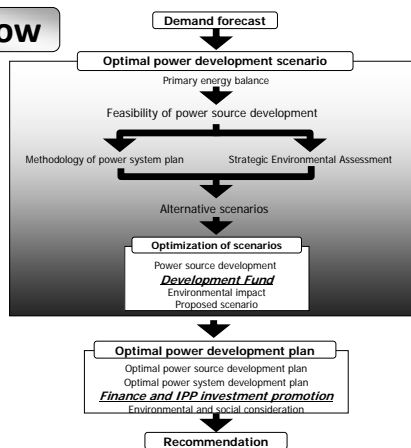
Investment Schedule & IPP Promotion Strategy

Table of Contents

1. Capital Requirement of Four Scenarios
2. Unit Generation Cost of Four Scenarios
3. Investment Schedule for Optimal Power Development Plan
4. Strategy for Promotion of Private Sector Participation (IPP)

5-1

Workflow



1. Capital Requirement of Four Scenarios

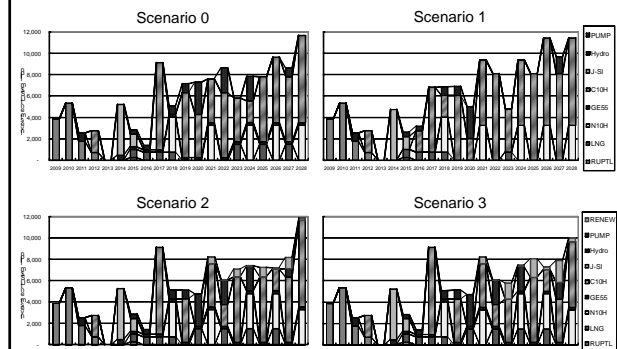
5-3

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.

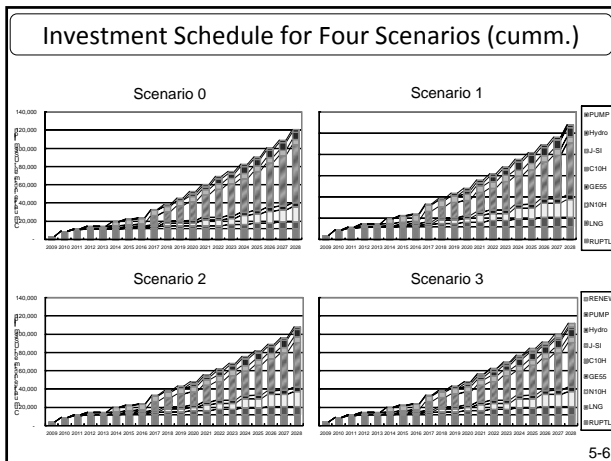
5-4

Investment Schedule for Four Scenarios



5-5

5. Investment Schedule & IPP Promotion Strategy



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

	Capital cost (US\$/kW)	cost	Life time	Unit Costs of Renewable Energy
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	

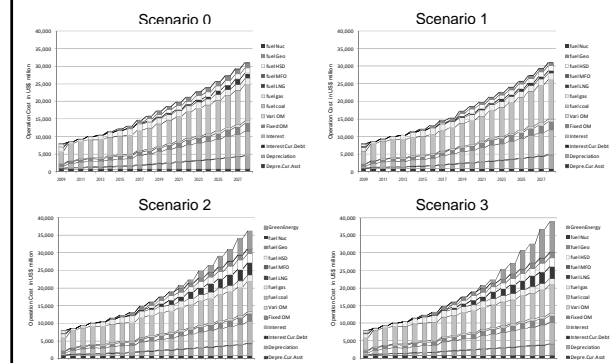
Calculation of Unit Cost of Solar (Green Energy Payment)

	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	

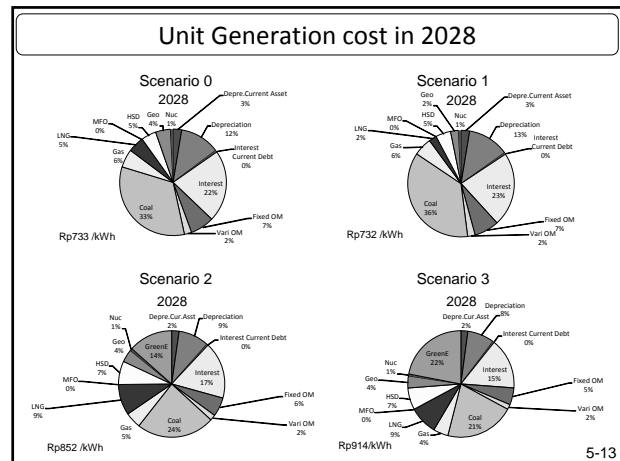
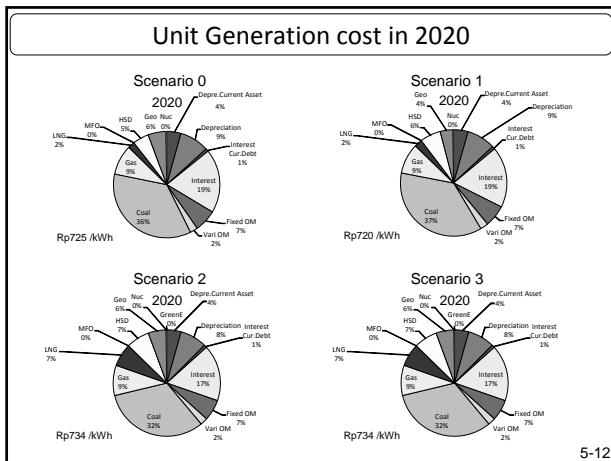
Source: "A REVIEW OF PV SYSTEM PERFORMANCE AND LIFE-CYCLE COSTS FOR THE SUNSMART SCHOOLS PROGRAM, Proceedings of ISEC2006/ASME International Solar Energy Conference 2006, modified by JICA team"

5-10

Generation cost



5. Investment Schedule & IPP Promotion Strategy



Summary of Four Scenario Comparison

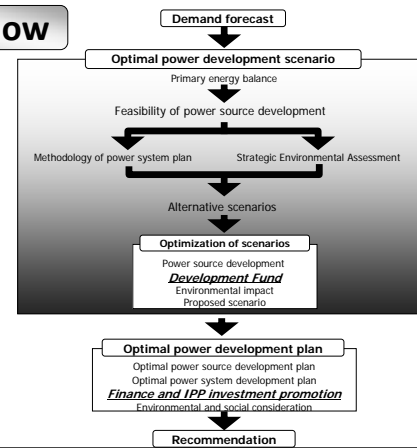
- Capital requirement is largest in Scenario 1 with more coal thermal plants, but only about 2%
- Capital requirement smaller in S2 and S3, because no solar investment included
- Unit Generation Cost Estimated (Rp/kWh)

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

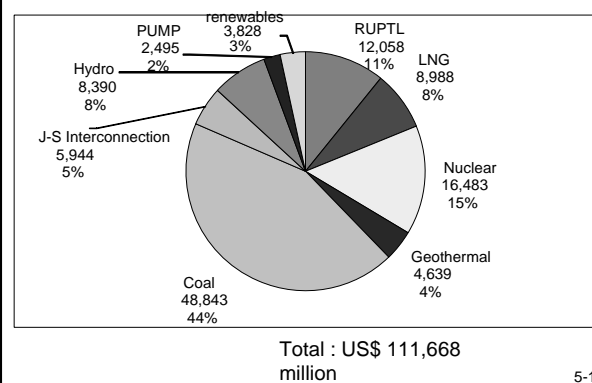
Workflow



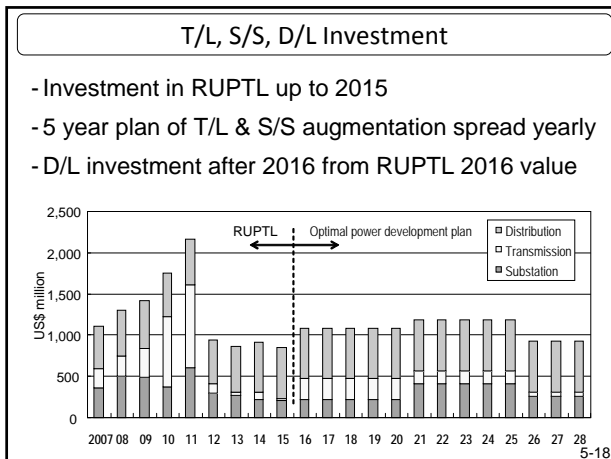
3. Investment Schedule for Optimal Power Dev. Plan

5-16

Component of Power Plant Investment 'til 2008



5. Investment Schedule & IPP Promotion Strategy



		Investment Schedule for Optimal Power Development Plan																					
		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total	
Power Plant	FC	3,115	4,284	1,455	583	0	0	220	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3,547
	LIC	779	1,071	361	146	0	0	55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,412
RUPTL	FC	3,893	5,355	1,817	729	0	0	275	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6,020
	LIC	0	0	0	0	0	0	637	637	637	637	1,273	0	1,273	0	1,273	0	1,273	0	1,273	0	0	7,640
LNG	FC	0	0	0	0	0	0	112	112	112	112	0	225	0	225	0	225	0	225	0	225	0	1,348
	LIC	0	0	0	0	0	0	740	740	740	740	0	1,480	0	1,480	0	1,480	0	1,480	0	1,480	0	8,936
Nuclear	FC	0	0	0	0	0	0	0	0	0	0	0	2,967	0	2,967	0	2,967	0	2,967	0	2,967	0	14,835
	LIC	0	0	0	0	0	0	0	0	0	0	0	330	0	330	0	330	0	330	0	330	0	1,648
1004	FC	0	0	0	0	0	0	0	0	0	0	3,297	0	3,297	0	3,297	0	3,297	0	3,297	0	3,297	16,463
	LIC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Geo	FC	0	0	540	0	0	366	183	183	183	183	183	183	183	183	183	183	183	183	183	183	183	1,480
	LIC	0	0	160	0	0	122	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	1,188
1004	FC	0	0	733	0	0	488	244	244	244	244	244	244	244	244	244	244	244	244	244	244	244	1,639
	LIC	0	0	1,730	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coal	FC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	LIC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S-I Interconnection	FC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	LIC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydro	FC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	LIC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pump	FC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	LIC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Renewable	FC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	LIC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Substation	FC	413	319	919	294	225	186	171	186	186	186	186	186	186	186	186	186	186	186	186	186	186	1,828
	LIC	73	56	92	45	40	33	30	33	33	33	33	33	33	33	33	33	33	33	33	33	33	955
Transmission Line	FC	486	375	611	301	266	219	202	219	219	219	219	219	219	219	219	219	219	219	219	219	219	1,864
	LIC	259	219	851	30	39	81	22	215	215	215	215	133	133	133	133	133	133	133	133	133	133	49
Distribution Line	FC	301	846	1,001	106	40	36	26	253	253	253	253	157	157	157	157	157	157	157	157	157	157	1,387
	LIC	579	529	553	539	559	556	517	517	517	517	517	517	517	517	517	517	517	517	517	517	517	5,389
Total	FC	3,826	5,322	3,365	2,659	264	4313	2,532	1,449	1,449	1,449	1,449	1,449	1,449	1,449	1,449	1,449	1,449	1,449	1,449	1,449	1,449	16,723
	LIC	1,483	1,783	1,340	1,051	650	1,240	1,188	1,048	2,082	1,566	1,733	2,324	1,861	2,341	1,867	2,378	1,901	1,821	2,261	2,331	1,389	13,389
Total		5,309	7,105	4,705	3,710	910	6,153	3,719	2,497	3,022	3,209	3,209	3,209	3,209	3,209	3,209	3,209	3,209	3,209	3,209	3,209	3,209	30,112

5-19

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

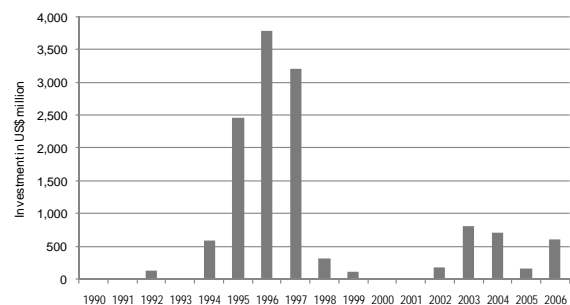
- Market Confidence in PLN is the key

Lease

- A Limited case for Tanjung Jati-B

5-22

IPP in Power Sector of Indonesia



5. Investment Schedule & IPP Promotion Strategy

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)

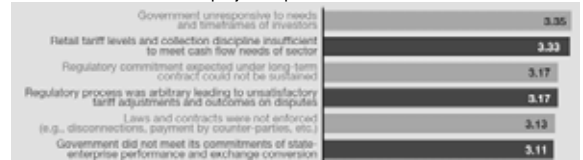
5-24

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 “Crash 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

5-39

6. STRATEGIC ENVIRONMENTAL ASSESSMENT

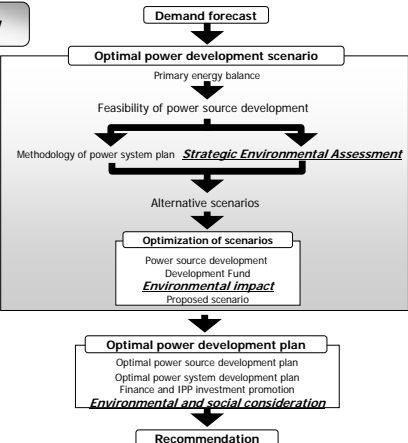
SPEAKER: MR. OHWADA TAKASHI,
NEWJEC INC.

6. Environmental & Social Considerations

Environmental & Social Considerations

6-1

Workflow



6-2

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)

6-3

◆ 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

6-4

◆ What to do in SEA of Power Sector?

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

ex. SO₂, NO_x, PM, CO₂ from Coal-Fired,
Loss of Habitats/Involuntary Resettlement for Hydro,
Radiation from Nuclear,
H₂S from Geothermal

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

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

6-5

◆ Comparison of Environmental Performance

	Coal	Oil	Gas	Geo	Hydro	Nuclear
Air Pollution	SO ₂ , NO _x , PM	SO ₂ , NO _x , PM	NO _x	H ₂ S	-	-
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	-	-	-	-	-	+

6-6

6. Environmental & Social Considerations

◆ 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 , NO _x , PM	SO ₂ , NO _x , PM	NO _x	H ₂ S	-	-
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".

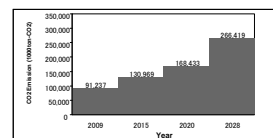
6-10

◆ Alternative Power Development Scenarios

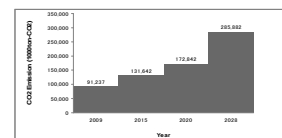
- Scenario 0 – Original Scenario (following the present Indonesian Policy)
 - Scenario 1 – Coal Power Acceleration Scenario
 - Scenario 2 – Power Source Diversification Scenario
 - Scenario 3 – CO₂ Emission Reduction Scenario
- All scenarios are the mixture of several power generation options.
- None of them relies solely on a particular type of power generation.

6-11

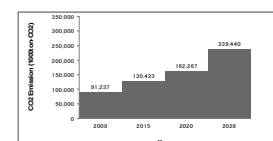
◆ Comparison of Alternative Scenarios (CO₂)



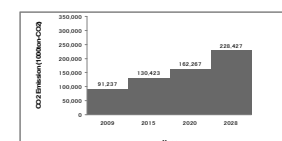
Scenario 0



Scenario 1



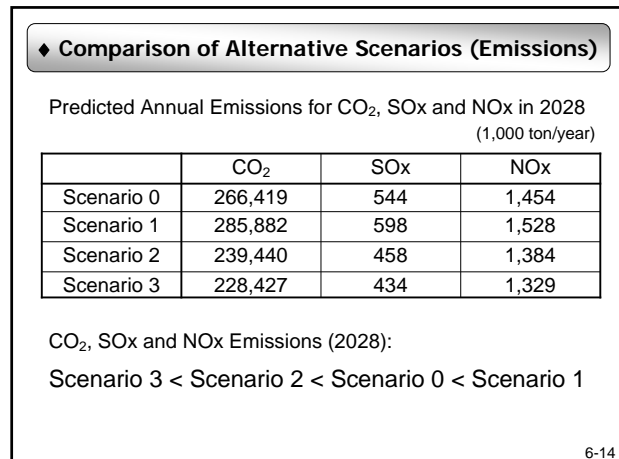
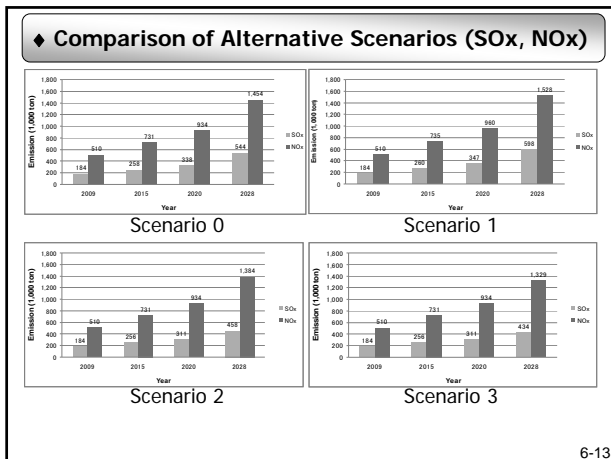
Scenario 2



Scenario 3

6-12

6. Environmental & Social Considerations



◆ 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

6. Environmental & Social Considerations

◆ Coral Reefs around Jamali



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 CO₂.
- ↓
- It is desirable to take measures to reduce CO₂ emissions.
(ex., improvement of generation efficiencies, afforestation to offset CO₂ 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

6. Environmental & Social Considerations

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

[Unfounded Upper Limits in Several Reports]

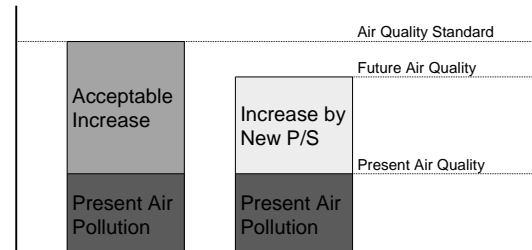
- How can we assess impacts of coal-fired P/Ss when we do not know the present level of air pollution?

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?

$$\text{Acceptable Increase} = \text{Air Quality Standard} - \text{Present Air Quality}$$



6-26

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

[Unfounded Upper Limits in Several Reports]

- 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]

- How can we set a limit on CO₂ emission from P/Ss when Indonesia does not have a legally-binding target for its CO₂ emission reduction under Kyoto Protocol?

Indonesia reserves a right to emit CO₂ for its industrial development. We can not limit its maximum CO₂ 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;

- Locations of individual P/Ss, and
- Present level of air pollution, and
- Efficiency of ESP, FGD and Low-NOx Burner, or
- CO₂ 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]

- All reservoirs of HEPPs release CH₄ into the atmosphere.

Influx of excessive nutrients to a reservoir → Proliferations of phytoplankton/floating plants → Anaerobic decomposition → CH₄ emission

6-30

6. Environmental & Social Considerations

◆ Does hydroelectric power generation suppress global warming?

[HEPPs are not always friendly to the earth]

2. CH₄ has GWC (Global Warming Coefficient) of 21.

(1 ton of CH₄ = 21 tons of CO₂)

Too much CH₄ emission from a reservoir →

Offset CO₂ 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 CO₂ 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 SO₂, NO_x, PM and CO₂ from geothermal power generation]

But,

- H₂S emission → Offensive odor, corrosion of metal, negative impacts on local vegetation.

(Emission Standard for H₂S 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.

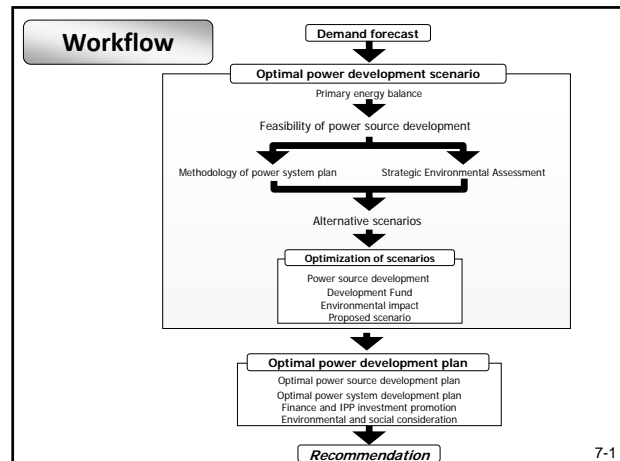
6-34

7. RECOMMENDATION

SPEAKER: MR. YAMAOKA SATOSHI,
NEWJEC INC.

7. Recommendation

7. Recommendation



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

1. Power Source Development
2. Environment
3. Promotion of Private Investment
4. Power System Expansion Plan
5. Improvement of System Operation

7-3

1. Power Source Development

- 1.1 Coal-fired Thermal Power Plant
- 1.2 Java-Sumatra Interconnection
- 1.3 Geothermal Power Plant
- 1.4 Nuclear Power Plant
- 1.5 Gas-fired Thermal Power Plant
- 1.6 Hydropower
- 1.7 Solar and Wind Power
- 1.8 General

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

7. Recommendation

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 CO₂ 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 CO₂ Emissions

- If a legally binding emission reduction target is established in future for greenhouse gas emissions from Indonesia, it will be required to reduce CO₂ production through improvements of generation efficiencies in thermal power generation, or to sequester CO₂ 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

7. Recommendation

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

7. Recommendation

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!

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