Chapter 9 Rehabilitation Plan of Thermal Power Plant

9.1 Summary

In this chapter, rehabilitation of the existing thermal power plants was planned. The following is the flow of the examination and summary of this chapter:

(1) Survey of the current status of the facilities

Operational status (year of commissioning, capacity factor, etc.), derated capacity and its reason, thermal efficiency, fuel cost per kWh, etc. were surveyed.

(2) Selection of focus of rehabilitation

From the survey results, it was decided to focus rehabilitation on thermal efficiency improvement of conventional steam power plants (PLTU).

(3) Selection of measures to improve thermal efficiency

From the result of the data and the interview during the site survey, the following items were selected as the thermal efficiency improvement measures to be examined in detail.

- Cleaning of feed water heater tubes
- Boiler chemical cleaning
- Improving high- and intermediate-pressure turbine blades
- Replacement of air preheater element and seal

(4) Examination of application of the thermal efficiency improvement measures

Efficiency improvement, cost, internal rate of return (IRR), net present value (NPV) and payback period were examined when the selected measures were applied to the target power plants. Table 9.1.1 shows the results.

Table 9.1.1 Application effect of thermal efficiency improvement measures (summary)

Power Station	Unit No.	IC (MW)	Age (year)	LP-HTR cleaning with sponge				HP-HTR cleaning with high pressure jet				Boiler chemical cleaning				Improvement of HP & IP turbine blades				Replacement of AH element & seal			
				Initial cost (x1000US$)	IRR (%)	NPV (x1000US$)	Payback period (year)	Initial cost (x1000US$)	IRR (%)	NPV (x1000US$)	Payback period (year)	Initial cost (x1000US$)	IRR (%)	NPV (x1000US$)	Payback period (year)	Initial cost (x1000US$)	IRR (%)	NPV (x1000US$)	Payback period (year)	Initial cost (x1000US$)	IRR (%)	NPV (x1000US$)	Payback period (year)
Suralaya	1	400	17	0.13	1,415	6	1	15	36	6	2	178	21	34	3	4,450	15	343	5	NA			
	2	400	17	0.13	1,415	6	1	15	36	6	2	178	21	34	3	4,450	14	216	6	NA			
	3	400	13	0.13	1,415	6	1	15	36	6	2	178	21	34	3	NA				NA			
	4	400	12	0.13	1,415	6	1	15	36	6	2	178	21	34	3	NA				NA			
	5	600	5	0.13	2,128	9	1	19	51	13	2	259	23	60	3	NA				NA			
	6	600	4	0.13	2,128	9	1	19	51	13	2	259	23	60	3	NA				NA			
	7	600	4	0.13	2,128	9	1	19	51	13	2	259	23	60	3	NA				NA			
Tambak Lorok	1	50	23	0.13	307	1	1	6	-17	-3	cannot pay back	43	17	5	3	3,910	NA	NA	NA	NA			
	2	50	23	0.13	307	1	1	6	-17	-3	cannot pay back	43	17	5	3	3,910	-1	-1,016	cannot pay back	NA			
	3	200	18	0.13	1,269	5	1	12	46	7	2	100	50	90	2	4,140	19	633	5	NA			
Muara Karang	1	100	22	0.13	628	3	1	7	10	0	3	62	36	33	2	3,990	11	-124	7	260	12	-2	6
	2	100	22	0.13	628	3	1	7	10	0	3	62	36	33	2	3,990	11	-56	7	260	12	-2	6
	3	100	21	0.13	628	3	1	7	10	0	3	62	36	33	2	3,990	11	-111	7	260	12	-2	6
	4	200	20	0.13	1,546	6	1	12	64	11	2	100	66	131	2	4,140	27	1,469	4	531	16	95	5
	5	200	19	0.13	1,546	6	1	12	64	11	2	100	66	131	2	4,140	26	1,406	4	NA			
Gresik	1	100	20	0.13	792	3	1	7	25	1	2	62	52	58	2	3,990	13	97	6	NA			
	2	100	20	0.13	792	3	1	7	25	1	2	62	52	58	2	3,990	13	63	6	260	18	64	5
	3	200	13	0.13	1,598	6	1	12	68	12	1	100	69	139	2	NA				531	17	116	5
	4	200	13	0.13	1,598	6	1	12	68	12	1	100	69	139	2	NA				531	17	116	5
Paiton	1	400	7	0.13	1,424	6	1	15	36	6	2	178	21	35	3	NA				NA			
	2	400	7	0.13	1,424	6	1	15	36	6	2	178	21	35	3	NA				NA			

Precondition: Capacity factor 70% Exchange rate US$1=Rp9,000 Discount rate = 12%
Fuel price Coal 207 Rp/kg (Suralaya), 210 Rp/kg (Paiton)
NG 2.45 US$/MMBTU (Muara Karang), 2.53 US$/MMBTU (Gresik)
MFO 710 Rp/liter

(5) Conclusion

Rehabilitation should be carried out beginning with high IRR items. Therefore, rehabilitation items are prioritized as follows.

1) LP-HTR cleaning with sponge

This work is simple and does not require technical experience and know-how, and the cost is very small. Therefore, this can be carried out immediately by the Indonesian side alone. The targets are the last LP-HTRs of all steam power plants. This should be carried out every 8 years along with periodical inspection of LP-HTR.

2) HP-HTR cleaning with high-pressure jet

One set of high-pressure water jet equipment for common use for all power plants should be purchased first and it costs about US$140,000. And then, when the work is carried out, it costs only about US$2,000-4,000 per one HTR as the costs of transportation of the equipment, consumables such as nozzles, and labor.

Because this work requires technical experience and know-how, guidance from the experts of the water jet cleaning company should be received in the early stages of the introduction (e.g. for several months in total in several power plants).

The targets are the HP-HTRs of Suralaya PLTU 1-7, Tambak Lorok PLTU 3, Muara Karang PLTU 4-5, Gresik PLTU 1-4 and Paiton PLTU 1-2. This should be carried out every 4 years along with periodical inspection of HP-HTR.

3) Boiler chemical cleaning

Boiler chemical cleaning should be carried out at a proper time. Therefore it is necessary to determine whether or when this should be carried out following the detailed examination by the cutout test on the evaporation tube and operational state. The targets are the all steam power plants.

4) Improvement of HP & IP turbine blades and replacement of AH element & seal

IRR is not too high for the high investment cost. Especially for the improvement of HP & IP turbine blades, IRR is evaluated assuming that this improvement is carried out along with the inevitable replacement due to deterioration. Therefore it is necessary to determine whether this should be carried out following the detailed examination of the state of deterioration. In the detailed examination, manufacturers should participate to examine the applicable technology and the amount of efficiency improvement from the viewpoint of design.

The targets of the detailed examination for the improvement of HP & IP turbine blades are Suralaya PLTU 1-2, Tambak Lorok PLTU 3, Muara Karang PLTU 4-5 and Gresik PLTU 1-2.

The targets of the detailed examination for the replacement of AH element & seal are Muara Karang PLTU 4 and Gresik PLTU 2-4.

9.2 Status of Facilities

In the 1970s, small-scale gas turbine plants, diesel plants and oil-fired steam power plants were constructed. Since then, unit capacity of steam power plants has increased and fuel has been converted from oil to natural gas. Recently, low fuel costs, large capacity coal-fired steam power plants, and high efficiency combined cycle power plants have been introduced. Table 9.2.1 shows the operational status of thermal power plants owned by PLN.

(1) Conventional steam power plant (PLTU)

Power Station	Operational status
Suralaya and Paiton	Since they are coal-fired power plants, fuel costs per kWh are low and therefore capacity factors are high.
Tanjung Priok	Long-term outage since 1998 because of frequent boiler WW tube leakage. It is impossible to apply N_2 sealing or hydrazine injection to the boilers because boiler tubes leak. Turbines were rehabilitated in 1994. Turbine rotors are turned periodically (once a week). To prevent rusting on coupling of auxiliaries, inhibitor (grease) is applied.
Tambak Lorok	Capacity factors are high in spite of being an oil-fired steam power plants. In PLTU 1-2, due to the defective design of the boilers, the burner flame reaches the boiler tubes and overheats them at 100% output. So these units cannot generate 100% output and 5 MW/unit is restrained.
Perak	5 MW/unit is restrained due to a boiler problem. In 2000, they were stopped but now they are running.
Muara Karang	In PLTU 1-3, because of leakage of the air preheaters due to their deformation, the forced draft fans cannot supply enough air to the boilers and 5 MW/unit is restrained. In PLTU 4-5, 10MW/unit is restrained due to the HP(E)HTR bypass operation (HP(E)HTRs are now under repair to exchange the HTR tubes and repair work will be completed in Feb. 2002) and leakage of the air preheater. In PLTU 5, thermal efficiency will be improved by replacing the air preheater element and seal, replacing the turbine gland seal, replacing the condenser tubes and installing condenser ball cleaning equipment.
Gresik	Boilers were converted from oil-fired to oil- and gas-fired (for PLTU 1-2: in 1997, for PLTU 3: in 1994, for PLTU 4: in 1993). For PLTU 1-2, the boiler superheater tubes are not suitable for gas firing and therefore 5 MW/unit is restrained.

Table 9. 2. 1 Operational status of thermal power plants owned by PLN

Owner	Power Station	Unit type	Unit No.	Fuel	Commis sioning	IC (MW)	Unit configuration (# x MW)	Manufacturer		AC (MW)	Breakdown of (IC-AC) (MW)						CF (%) in2000	FOF (%) in2000	Thermal efficiency (%) in 2000		Fuel cost (Rp/kWh)
											Derated by				long-term	non-com					
								Boiler	Turbine		fuel	temp.	design	aging	outage	missioned			Gross	Net	
Indonesia Power	Suralaya	PLTU	1	Coal	1984	400		B&W	MHI	400							65.32	0.18	34.36	31.93	108
			2	Coal	1984	400		B&W	MHI	400							65.34	0.64	34.50	31.95	108
			3	Coal	1988	400		B&W	MHI	400							64.06	0.25	35.46	33.13	104
			4	Coal	1989	400		B&W	MHI	400							74.91	0.19	35.70	33.30	104
			5	Coal	1996	600		B&W	MHI	600							71.48	0.23	35.25	33.85	102
			6	Coal	1997	600		B&W	MHI	600							80.14	1.21	36.48	35.07	98
			7	Coal	1997	600		B&W	MHI	600							71.08	0.09	36.79	35.36	98
	Tanjung Priok	PLTU	3	MFO	1972	50		MHI	MHI	0					50		0.00				
			4	MFO	1972	50		MHI	MHI	0					50		0.00				
		PLTGU	Block 1	NG	1993,94	590	3x130GT+1x200ST	ABB	ABB	575			15				70.64	0.89	42.36	41.85	180
			Block 2	NG	1994	590	3x130GT+1x200ST	ABB	ABB	575			15				73.01	0.34	43.36	42.83	176
		PLTG	1,3,4,5	HSD/NG	1976-77	150	2x26, 2x48.8	-	WH, GE	130				20			0.58	24.22	23.36	20.21	383
	Tambak Lorok	PLTU	1	MFO	1978	50		F&W	GE	45			5				78.60	1.00	30.45	28.14	220
			2	MFO	1978	50		F&W	GE	45			5				73.43	1.30	30.04	27.80	222
			3	MFO	1983	200		Mitsui-Riley	MHI	200							70.90	0.06	35.33	33.29	186
		PLTGU	Block 1	HSD	1993,97	517	3x109.7GT+1x188ST	Austrian EE	GE	494	23						34.95	1.44	37.03	36.70	245
			Block 2	HSD	1996,97	517	3x109.7GT+1x188ST	Austrian EE	GE	501	16						28.12	1.45	39.28	38.72	233
	Perak	PLTU	3	MFO	1978	50		MHI	MHI	45			5				0.00				
			4	MFO	1978	50		MHI	MHI	45			5				0.00				
	Grati	PLTGU	Block 1	HSD	1996,97	462	3x100.8GT+159.6ST	CMI	MHI	462							1.66	1.42	25.66	19.74	456
		PLTG	Block 2	HSD		302	3x100.8GT	-	MHI	0						302	0.00				
	Senayan	PLTD	1-6	HSD	1961,90	16	4x2.5, 2x3	-	MAN, Ruston	12				4			1.26	0.00	29.10	26.15	344
	Sunyaragi	PLTG	1-4	NG	1976	80	2x20, 2x20.1	-	Alstom	68				12			1.23	1.76	21.39	17.42	432
	Cilacap	PLTG	1-2	HSD	1976	55	1x29, 1x26	-	WH	41				14			2.59	5.50	18.90	17.87	504
	Pesanggaran	PLTG	1-4	HSD	1985-93	125	1x21.4, 1x20.1, 2x42	-	Alstom,GE,WH	107				18			28.47	0.17	21.59	21.31	423
		PLTD	1-11	HSD	1982	76	4x5.1,1x4.1,2x6.8,2x6.5,2x12.4	-	Mirrlees,SWD	43				33			13.68	2.88	34.79	33.11	272
	Gilimanuk	PLTG	1	HSD	1997	134	1x133.8	-	ABB	134							10.29	0.24	22.42	22.39	402
PJB	Muara Karang	PLTU	1	MFO	1979	100		B&W	MHI	95				5			53.31	2.64	29.52	27.15	228
			2	MFO	1979	100		B&W	MHI	95				5			48.43	3.84	29.26	27.18	228
			3	MFO	1980	100		B&W	MHI	95				5			56.55	3.09	29.44	27.52	225
			4	NG/MFO	1981	200		MHI	MHI	190				10			56.64	4.59	31.75	29.59	254
			5	NG/MFO	1982	200		MHI	MHI	190				10			57.76	2.78	30.48	28.50	264
		PLTGU		NG/HSD	1993,95	509	3x107.9GT+1x185.1ST	Austrian EE	GE	470		39					58.21	4.10	34.95	34.29	219
	Gresik	PLTU	1	NG/MFO	1981	100		IHI	Toshiba	95			5				63.50	0.20	34.33	32.44	240
			2	NG/MFO	1981	100		IHI	Toshiba	95			5				44.23	0.50	32.15	30.15	258
			3	NG/MFO	1988	200		IHI	Toshiba	200							69.84	0.01	33.75	31.75	245
			4	NG/MFO	1988	200		IHI	Toshiba	200							62.47	0.64	34.45	32.40	240
		PLTGU	Block 1	NG/HSD	1992,93	526	3x112.5GT+1x188.9ST	MHI	MHI	526							69.00	0.33	39.69	39.97	194
			Block 2	NG/HSD	1992,93	526	3x112.5GT+1x188.9ST	MHI	MHI	526							66.14	0.41	40.21	39.37	197
			Block 3	NG/HSD	1993	526	3x112.5GT+1x188.9ST	MHI	MHI	526							57.48	0.66	40.58	39.84	195
		PLTG	1-3	NG/HSD	1977,84	61	2x20, 1x21	-		54				7			1.59	14.24	21.70	21.17	367
	Gilitimur	PLTG	1-2	HSD	1994,95	40	2x20	-		36				4			3.31	24.02	20.51	19.85	453
	Paiton	PLTU	1	Coal	1994	400		CE	Toshiba	400							64.61	2.76	36.02	33.26	104
			2	Coal	1994	400		CE	Toshiba	400							77.21	1.66	35.84	33.42	104
	Muara Tawar	PLTGU	Block 1	HSD	1997	640	3x140GT+1x220ST	ABB	ABB	605		35					5.36	21.29	30.74	28.78	313
		PLTG	Block 2	HSD	1997	280	2x140GT	-	ABB	270		10					1.86	68.70	26.64	24.64	365

IC : Installed Capacity AC : Available Capacity (as of Sep. 2001) CF : Capacity Factor FOF : Forced Outage Factor Fuel cost (Rp/kWh) = Net heat rate (kcal/kWh) x Fuel cost (Rp/kcal)

(2) Combined cycle power plant (PLTGU)

Power plant	Operational status
Tanjung Priok	Since they are NG-fired, fuel costs per kWh are comparatively low and therefore capacity factors are high. The output of the steam turbines is restricted by the lack of cooling surface area of the condensers.
Tambak Lorok	Since they are HSD-fired, fuel costs per kWh are high and therefore capacity factors are low. Since installed capacities of these plants are based on NG, available capacities are lower than installed capacities because they are now using HSD as fuel. These are not problems with the facility.
Grati	Since they are HSD-fired, fuel costs per kWh are high and therefore capacity factors are extremely low. Thermal efficiency is also extremely low in spite of being a combined cycle plant.
Muara Karang	Considering that it is a combined cycle plant, thermal efficiency is low and fuel cost is the same level as that of conventional oil-fired steam power plants. Since the installed capacity of this plant is based on the ambient temperature at 15 °C, it is impossible to attain 100% output because the ambient temperature in Jakarta is higher than 15 °C.
Muara Tawar	Since they are HSD-fired, fuel costs per kWh are high and therefore capacity factors are extremely low. Thermal efficiency is also extremely low in spite of being a combined cycle plant. From Oct. to Feb., garbage is drifted to the intake by the west wind and the output of the ST was sometimes constrained. But now there is no problem because garbage collectors have been stationed in the intake on a 24-hour system and garbage has been removed during CWP's operation. The design output of the GT is 133.1 MW when HSD is used as fuel, although installed capacity is 140 MW. The 140 MW installed capacity was determined from the maximum data (based on the lowest ambient temperature)gathered during the first commissioning. Because the output of the GT varies depending on the ambient temperature, available capacity is set at 135MW based on the realistic ambient temperature.

(3) Gas turbine power plant (PLTG)

Because thermal efficiencies are low and fuel price of HSD is high, fuel costs per kWh are very high. Therefore capacity factors are extremely low. There are many plants with constrained output because they are aged.

(4) Diesel power plant (PLTD)

Because fuel costs per kWh are high, capacity factors are low. There are many plants with constrained output because they are aged.

9.3 Focus of Rehabilitation

(1) Reduction of the derated capacity

Reduction of the derated capacity should not be the focus for the following reasons.

- Units of which installed capacity is improper for their current operational status (Tambak Lorok PLTGU, Muara Karang PLTGU, Muara Tawar) only seem to have derated capacity but do not have facility problems
- Units with derated capacities arising from the basis of the design issues (Tanjung Priok PLTGU, Tambak Lorok PLTU 1-2, Perak, Gresik PLTU 1-2) are difficult to solve.
- For the small-scale GT and Diesel plants, their capacity factors are low and therefore their rehabilitation is not cost-effective.
- For the long-term outage units, Tanjung Priok PLTU 3-4, it is impossible to apply N_2 sealing or hydrazine injection to the boilers because boiler tubes leak and the state of the boilers is not good. Therefore, the repair work would cost a great deal and does not seem to be cost-effective.
- For Muara Karang PLTU 1-3, there are derated capacities because of leakage of the air preheaters due to their deformation. However, it is not advisable to invest in the existing boilers because repowering of PLTU1-3 by removing existing boilers and combining existing STs, newly installed GTs and HRSGs is planned.
- In Muara Karang PLTU 4-5, there are derated capacities due to HP-HTRs and AHs. However, HP-HTRs of both units and AHs of PLTU 5 are now under repair. Therefore, we intend to wait and see how the results of the repair go.

(2) Thermal efficiency improvement

Units whose capacity factors are low should not be the target of rehabilitation because it is not cost-effective. Additionally combined cycle plants are new and deterioration of thermal efficiency is small. Therefore, the following steam power plants should be targeted:

- Suralaya PLTU 1-7
- Tambak Lorok PLTU 1-3
- Muara Karang PLTU 1-5
- Gresik PLTU 1-4
- Paiton PLTU 1-2

9.4 Selection of Measures to improve Thermal Efficiency

To select the item for rehabilitation, it is necessary to examine the precise point at which each piece of equipment or plant has had deterioration in performance. Therefore, by collecting and analyzing information such as operating data, overhaul records and repair history about plants and equipment, it is possible to understand the trend of the plants and equipment. Since the survey is of many plants and it is difficult to collect and analyze extensive historical data, we decided to evaluate based on the operational status of the whole plant. We carried out the site surveys to collect data and to interview.

Table 9.4.1 shows thermal efficiency of the target power plants. Factors that may substantially influence turbine efficiency are the internal efficiency of turbine, low vacuum of steam condenser, and heat exchange in feed water heater. Moreover, factors that may influence boiler efficiency are draft loss in the boiler and flue gas system, heat exchange in the AH, and heat exchange in tubes. Table 9.4.2 shows the items selected as the thermal efficiency improvement measures this time.

However, the correlation of the data we collected shows some obvious contradictions. Therefore, when selecting the items for rehabilitation, it is necessary to conduct a final follow-up by checking operation and maintenance data in detail.

Table 9.4.1 Thermal efficiency of the power plants (at maximum output)

Power Station	Unit No.	Commissioning	Age (year)	IC (MW)	Gross plant efficiency (%)		Turbine efficiency (%)		Boiler efficiency (%)	
					Design or commissioning	Current data	Design or commissioning	Current data	Design or commissioning	Current data
Suralaya	1	1984	17	400	39.21	37.57	45.26	43.90	86.63	85.58
	2	1984	17	400	39.21	39.59	45.26	45.68	86.63	86.67
	3	1988	13	400	39.95	39.45	45.74	45.52	87.33	86.67
	4	1989	12	400	39.95	38.04	45.74	43.88	87.33	86.69
	5	1996	5	600	40.43	38.69	45.72	44.70	88.44	86.55
	6	1997	4	600	40.43	38.83	45.72	44.05	88.44	88.14
	7	1997	4	600	40.43	NA	45.72	NA	88.44	NA
Tambak Lorok	1	1978	23	50	33.90	NA	NA	NA	NA	NA
	2	1978	23	50	31.70	30.30	NA	NA	NA	NA
	3	1983	18	200	37.30	37.90	NA	NA	NA	NA
Muara Karang	1	1979	22	100	33.72	29.59	38.08	34.13	88.56	86.71
	2	1979	22	100	32.86	28.56	37.30	32.63	88.09	87.54
	3	1980	21	100	32.95	29.15	37.62	33.81	87.59	86.21
	4	1981	20	200	37.90	35.17	42.80	41.21	88.55	85.34
	5	1982	19	200	37.77	35.90	42.80	41.60	88.25	86.30
Gresik	1	1981	20	100	35.15	33.18	39.31	38.62	89.42	85.92
	2	1981	20	100	35.15	33.64	39.31	39.41	89.42	85.36
	3	1988	13	200	38.35	37.79	44.32	41.98	86.54	90.01
	4	1988	13	200	38.35	34.90	44.32	40.27	86.54	86.66
Paiton	1	1994	7	400	40.64	35.62	45.72	40.47	88.89	88.01
	2	1994	7	400	40.64	36.74	45.72	41.66	88.89	88.20

IC : Installed Capacity

Table 9.4.2 Thermal efficiency improvement measures

Item	Reason of the selection
Cleaning of feed water heater tubes	From the interview, it was learned that they did not clean feed water tubes during the periodic inspections. As can be seen from Table 9.4.3, current terminal temperature differences are larger than design or commissioning values and performance of HTRs are deteriorated.
Boiler chemical cleaning	From the interview, it was learned that they had hardly conducted boiler chemical cleaning.
Improving high- and intermediate-pressure turbine blades	From the interview, it was learned that the turbine blades were original. It is thought that the internal efficiency of the turbine deteriorated due to many years of use.
Replacement of air preheater element and seal	From Table 9.4.4, increase of the air leakage rate and deterioration of the temperature efficiency can be seen in Muara Karang PLTU 1-5 and Gresik PLTU 2-4.

Table 9.4.3 Terminal temperature difference of feed water heater

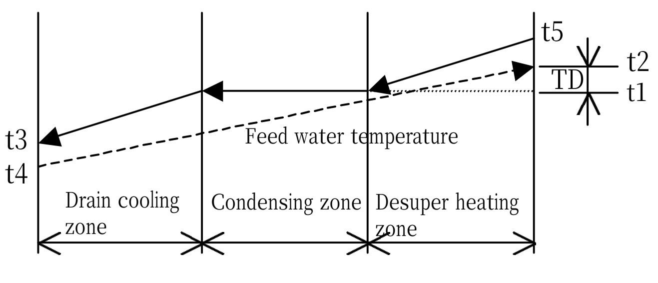
Power Station	Unit No.	HTR	Terminal Temperature Difference (C) Design	Commissioning	Current Data
Suralaya	1	LP 1	3.8	1.6	NA
		LP 2	4.0	2.3	9.0
		LP 3	4.4	3.0	7.6
		HP 5	1.7	0.4	19.9
		HP 6	-0.3	-1.2	5.0
		HP 7	NA	NA	NA
	2	LP 1	3.9	-2.2	NA
		LP 2	4.0	-15.7	6.5
		LP 3	4.4	-1.4	5.3
		HP 5	1.7	2.1	1.3
		HP 6	-0.5	-1.5	11.9
		HP 7	NA	NA	NA
	3	LP 1	3.9	NA	10.7
		LP 2	4.0	NA	5.0
		LP 3	4.4	NA	4.7
		HP 5	1.7	NA	2.1
		HP 6	-0.5	NA	-2.5
		HP 7	NA	NA	NA
	4	LP 1	3.8	-2.3	NA
		LP 2	3.0	5.0	NA
		LP 3	4.4	2.3	NA
		HP 5	1.7	-7.0	12.4
		HP 6	-0.3	-7.2	-4.3
		HP 7	NA	NA	NA
	5	LP 1	3.4	NA	NA
		LP 2	3.5	9.7	4.4
		LP 3	3.6	24.1	7.7
		LP 4	4.0	6.3	12.7
		HP 6	0.1	0.6	-3.4
		HP 7	1.9	4.1	-2.0
		HP 8	1.1	2.2	-2.8
	6	LP 1	3.4	NA	NA
		LP 2	3.5	9.6	6.4
		LP 3	3.6	6.1	6.8
		LP 4	4.0	3.5	2.7
		HP 6	0.1	-2.1	-1.5
		HP 7	1.9	-1.0	-0.3
		HP 8	1.1	-3.0	-3.9
	7	LP 1	NA	NA	NA
		LP 2	NA	NA	NA
		LP 3	NA	NA	NA
		LP 4	NA	NA	NA
		HP 6	NA	NA	NA
		HP 7	NA	NA	NA
		HP 8	NA	NA	NA

Power Station	Unit No.	HTR	Terminal Temperature Difference (C) Design	Commissioning	Current Data
Tambak Lorok	1	LP 2	5.4	5.4	7.7
		HP 1	6.5	6.5	6.5
		HP 2	6.5	6.5	6.5
	2	LP 2	5.4	NA	12.0
		HP 1	6.5	NA	5.4
		HP 2	3.6	NA	-3.8
	3	LP 2	2.0	0.8	4.1
		HP 1	-3.0	-5.5	3.8
		HP 2	-0.5	1.4	11.9
Gresik	1	LP 1	NA	NA	NA
		LP 2	NA	-22.1	17.1
		HP 4	NA	1.6	23.9
		HP 5	NA	7.1	16.1
	2	LP 1	NA	NA	NA
		LP 2	NA	-23.1	4.1
		HP 4	NA	2.0	1.5
		HP 5	NA	2.2	-0.4
	3	LP 1	NA	1.5	2.0
		LP 2	NA	7.4	-1.0
		LP 3	NA	2.9	3.4
		LP 4	NA	2.8	2.6
		HP 6	NA	0.4	0.6
		HP 7	NA	1.9	-0.9
		HP 8	NA	18.6	10.8
	4	LP 1	NA	1.5	0.1
		LP 2	NA	1.0	1.4
		LP 3	NA	3.1	3.8
		LP 4	NA	3.6	3.8
		HP 6	NA	0.4	-0.4
		HP 7	NA	1.9	-0.5
		HP 8	NA	-0.5	7.1
Paiton	1	LP 1	NA	12.5	14.0
		LP 2	NA	18.2	5.4
		LP 3	NA	13.4	7.9
		HP 5	NA	3.7	10.8
		HP 6	NA	-2.0	-10.3
		HP 7	NA	-2.1	0.1
	2	LP 1	NA	-2.6	9.4
		LP 2	NA	-2.6	15.1
		LP 3	NA	-0.2	1.7
		HP 5	NA	3.7	-5.0
		HP 6	NA	-0.7	25.1
		HP 7	NA	0.0	13.4

Note: The terminal temperature difference (TD) is used to judge the performance of a feed water heater. This is expressed by a deviation of a saturated temperature correspondent to the heater inlet steam pressure and the heater outlet feed water temperature.

TD (℃) =t1 (℃) −t2 (℃)

If all heat is transferred without a temperature difference, the performance of the feed water heater is a maximum. It is maximum performance that there is no temperature difference between heater inlet steam and heater outlet feed water.



t1: Saturated temperature correspondent to inlet steam pressure
t2: Outlet feed water temperature
t3: Outlet drain temperature
t4: Inlet feed water temperature
t5: Inlet steam temperature

Table 9.4.4 Air leakage rate and temperature efficiency of air preheater

Power Station	Unit No.	IC (MW)	Air leakage rate (%)		Air-side temperature eff. (%)		Gas-side temperature eff. (%)		Average temperature eff. (%)	
			Design or commissioning	Current data	Design or commissioning	Current data	Design or commissioning	Current data	Design or commissioning	Current data
Suralaya	1	400	NA	NA	NA	NA	NA	NA	NA	NA
	2	400	NA	NA	NA	NA	NA	NA	NA	NA
	3	400	NA	NA	NA	NA	NA	NA	NA	NA
	4	400	NA	NA	NA	NA	NA	NA	NA	NA
	5	600	NA	NA	NA	NA	NA	NA	NA	NA
	6	600	NA	NA	NA	NA	NA	NA	NA	NA
	7	600	NA	NA	NA	NA	NA	NA	NA	NA
Tambak Lorok	1	50	NA	NA	NA	NA	NA	NA	NA	NA
	2	50	NA	NA	NA	NA	NA	NA	NA	NA
	3	200	NA	NA	NA	NA	NA	NA	NA	NA
Muara Karang	1	100	NA	35.5	80.1	75.1	NA	38.4	NA	56.7
	2	100	NA	18.4	79.8	82.9	NA	65.4	NA	74.2
	3	100	NA	28.9	79.0	73.3	NA	65.4	NA	69.4
	4	200	NA	52.2	73.3	72.9	NA	55.7	NA	64.3
			NA	46.1	73.3	70.3	NA	51.8	NA	61.0
	5	200	NA	29.8	78.0	73.9	NA	54.2	NA	64.1
			NA	61.9	71.6	68.6	NA	58.3	NA	63.4
Gresik	1	100	6.8	0.0	NA	71.8	NA	71.2	NA	71.5
	2	100	7.1	25.7	NA	83.8	NA	59.0	NA	71.4
	3	200	8.8	28.3	87.7	46.7	40.0	61.3	63.9	54.0
	4	200	7.4	21.6	87.7	53.8	75.2	71.5	81.5	62.6
Paiton	1	400	2.0	11.6	96.9	90.3	61.8	55.3	79.3	72.8
	2	400	12.8	9.7	96.9	90.7	58.0	55.3	77.4	73.0

IC : Installed Capacity

Note:

(1) Air leakage rate (RA)

$$RA = \frac{Q_A}{Q_G} \times 100$$

$$Q_A = (mout - \min) \times A_0 \times \frac{29}{22.4}$$

$$Q_G = (\min - 0.232) \times A_0 \times \frac{29}{22.4} + K$$

$$\min = \frac{21 - a \times O_2 in}{21 - O_2 in}$$

$$mout = \frac{21 - a \times O_2 out}{21 - O_2 out}$$

$O_2\ in = Eco$ exit O_2 [%]

$O_2\ out = AH$ exit O_2 [%]

α: Air ratio correction coefficient

(for solid & liquid fuel) $$a = \frac{0.21 \times \left\{5.6\left(h - \frac{O}{8}\right) - 0.8n\right\}}{1.867c + 5.6\left(h - \frac{o}{8}\right) + 0.7s}$$

(for gas fuel) $$a = \frac{0.21(1.4Ch_4 + 1.12C_2h_6 + 1.02C_3h_8 + 0.97C_4h_{10} + 0.93C_5h_{12} - n_2)}{2.8Ch_4 + 2.61C_2h_6 + 2.55C_3h_8 + 2.51C_4h_{10} + 2.49C_5h_{12}}$$

A_0: Theoretical amount of air

(for solid & liquid fuel) $$A_0 = \frac{8.89c + 26.7\left(h - \frac{o}{8}\right) + 3.33s}{100} \quad [m^3N/kg]$$

(for gas fuel) $$A_0 = \frac{2.80Ch_4 + 2.61C_2h_6 + 2.55C_3h_8 + 2.51C_4h_{10} + 2.49C_5h_{12}}{0.21 \times 100} \quad [m^3N/kg]$$

K: Correction of wet combustion gas

(for solid & liquid fuel) $$K = \frac{3.667c + 9h + 2s + w + n}{100} \quad [kg/kg]$$

(for gas fuel) $$K = \frac{4.75Ch_4 + 4.73C_2h_6 + 4.64C_3h_8 + 4.53C_4h_{10} + 4.56C_5h_{12}}{100} \quad [kg/kg]$$

(2) Temperature efficiency

Air-side temperature efficiency (ha)

$$ha = \frac{(ta_2 - ta_1)}{(tg_1 - ta_1)} \times 100\ (\%)$$

Gas-side temperature efficiency (hg)

$$hg = \frac{(tg_1 - tg_2')}{(tg_1 - ta_1)} \times 100\ (\%)$$

Average temperature efficiency (hag)

$$hag = \overline{ha + hg}$$

ta_1: AH inlet air temperature (°C)

ta_2: AH outlet air temperature (°C)

tg_1: AH inlet gas temperature (°C)

tg_2: AH outlet gas temperature (°C)

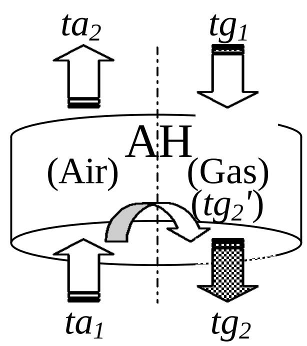
tg_2': AH exit calibration gas temperature (°C)

$$tg_2' = tg_2 + \frac{RA}{100} \times \frac{CP_a}{CP_g} \times (tg_2 - ta_1)$$

CP_a: Air specific heat

CP_g: Gas specific heat

CP_a/CP_g: 0.93



9.5 Examination of Application of Thermal Efficiency Improvement Measures

9.5.1 Cleaning of Feed Water Heater Tubes

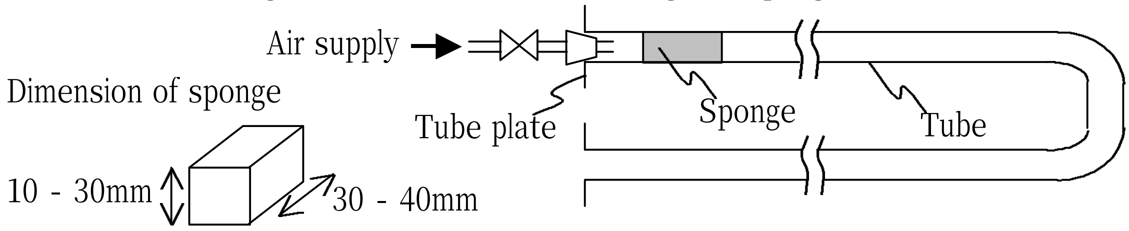
(1) Cleaning method of feed water tubes

Feed water heaters are contaminated with scale which sticks to the tubes, resulting in decreased efficiency or increase in the differential pressure. In order to remove these kinds of loss, cleaning of feed water tubes is conducted in CEPCO every 8 years for LP-HTR with sponge and every 4 years for HP-HTR with high-pressure jet.

1) Cleaning with sponge

A sponge (10-30mm thick, 30-40mm square) is inserted into the tube from the outlet toward the inlet of the feed water, and driven by air to the opposite side. This is designed to drive out the scale from the tube as the sponge moves through. Soft scale can be sufficiently removed with this method. Figure 9.5.1 shows the schematic of cleaning with sponge.

Figure 9.5.1 Schematic of cleaning with sponge



2) Cleaning with high-pressure jet

Water pressure is raised to about 250kg/cm^2 using a plunger, high-pressure water is jetted from a jet nozzle, and using the impact force of this jet water, scale stuck to the inner wall of the tube is removed. Figure 9.5.2 shows the schematic of cleaning with high-pressure jet.

Figure 9.5.2 Schematic of cleaning with high-pressure jet

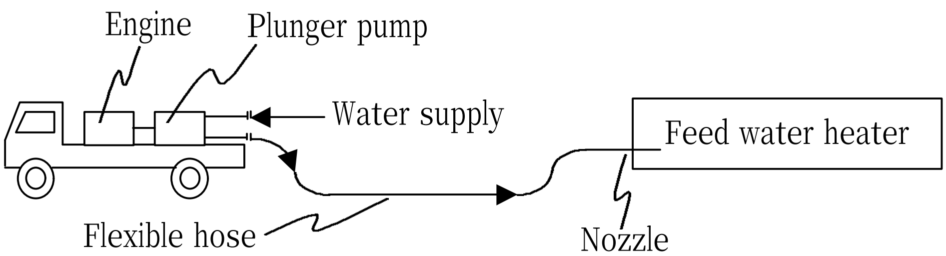


Table 9.5.1 shows efficiency improvement results of cleaning feed water heater tubes in CEPCO.

Table 9.5.1 Efficiency improvement of cleaning feed water heater tubes

Cleaning method	Feed water heater	Improvement of gross heat rate (ΔGHR)
Cleaning with sponge	LP #4 HTR	0.17 kcal/kWh
Cleaning with high-pressure jet	HP #1 HTR	0.14 kcal/kWh
	HP #2 HTR	0.28 kcal/kWh
	HP #3 HTR	0.53 kcal/kWh

(2) Application to the target power plants

Table 9.5.2 shows the efficiency improvement and cost when measures are applied to existing power plants in Indonesia based on the results of cleaning feed water heater tubes in CEPCO.

Table 9.5.2 Efficiency improvement of cleaning feed water heater tubes and its cost

Cleaning method	Unit capacity (MW)	Number of HTRs to be cleaned	Improvement of gross heat rate (ΔGHR)	Cost (US$)
Cleaning with sponge	All units	1 (LP last HTR) [Note]	0.17 kcal/kWh	130
Cleaning with high-pressure jet	50	2 (all HP-HTRs)	0.67 kcal/kWh	6,100
	100	2 (all HP-HTRs)	0.67 kcal/kWh	6,800
	200	3 (all HP-HTRs)	0.95 kcal/kWh	11,700
	400	3 (all HP-HTRs)	0.95 kcal/kWh	14,700
	600	3 (all HP-HTRs)	0.95 kcal/kWh	18,500

Note: In CEPCO, all tubes of all LP-HTRs are cleaned with sponge. However, the scale of low temperature-stage HTRs is limited, so only the last LP-HTR is selected as the focus.

We calculated the efficiency, IRR, NPV and payback period of the target power plants when measures are applied. We assumed that the recovery of the deteriorated efficiency decreases to the pre-improvement state in 8 years for LP-HTR cleaning with sponge and in 4 years for HP-HTR cleaning with high-pressure jet. Figure 9.5.3 and Figure 9.5.4 shows the transition of improved efficiency, that is, transition of profit, which is the reduction of the fuel cost due to the efficiency improvement. Moreover, IRR and NPV were calculated assuming that the cash flow period is 8 years for LP-HTR cleaning with sponge and 4 years for HP-HTR cleaning with high-pressure jet.

Figure 9.5.3 Transition of improved efficiency and profit by LP-HTR cleaning with sponge

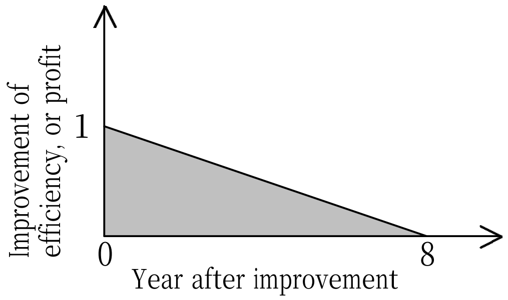


Figure 9.5.4 Transition of improved efficiency and profit by HP-HTR cleaning with high-pressure jet

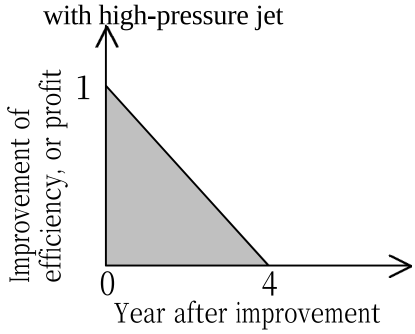


Table 9.5.3 and Table 9.5.4 show the results.

Table 9.5.3 Application effect of LP-HTR cleaning with sponge

Power Station	Unit No.	IC (MW)	Commissioning	Age (year)	Gross plant efficiency (%) design or commissioning	current data	after improvement	Initial investment (x1000US$)	IRR (%)	NPV (x1000US$)	Payback period (year)
Suralaya	1	400	1984	17	39.21	37.570	37.573	0.13	1,415	6	1
	2	400	1984	17	39.21	39.590	39.593	0.13	1,415	6	1
	3	400	1988	13	39.95	39.450	39.453	0.13	1,415	6	1
	4	400	1989	12	39.95	38.040	38.043	0.13	1,415	6	1
	5	600	1996	5	40.43	38.690	38.693	0.13	2,128	9	1
	6	600	1997	4	40.43	38.830	38.833	0.13	2,128	9	1
	7	600	1997	4	40.43	NA	NA	0.13	2,128	9	1
Tambak Lorok	1	50	1978	23	33.90	NA	NA	0.13	307	1	1
	2	50	1978	23	31.70	30.300	30.302	0.13	307	1	1
	3	200	1983	18	37.30	37.900	37.903	0.13	1,269	5	1
Muara Karang	1	100	1979	22	33.72	29.590	29.592	0.13	628	3	1
	2	100	1979	22	32.86	28.560	28.562	0.13	628	3	1
	3	100	1980	21	32.95	29.150	29.152	0.13	628	3	1
	4	200	1981	20	37.90	35.170	35.172	0.13	1,546	6	1
	5	200	1982	19	37.77	35.900	35.903	0.13	1,546	6	1
Gresik	1	100	1981	20	35.15	33.180	33.182	0.13	792	3	1
	2	100	1981	20	35.15	33.640	33.642	0.13	792	3	1
	3	200	1988	13	38.35	37.790	37.793	0.13	1,598	6	1
	4	200	1988	13	38.35	34.900	34.902	0.13	1,598	6	1
Paiton	1	400	1994	7	40.64	35.620	35.623	0.13	1,424	6	1
	2	400	1994	7	40.64	36.740	36.743	0.13	1,424	6	1

Precondition: Capacity factor 70%   Exchange rate US$1=Rp9,000   Discount rate = 12%
Fuel price Coal 207 Rp/kg (Suralaya), 210 Rp/kg (Paiton)
NG 2.45 US$/MMBTU (Muara Karang), 2.53 US$/MMBTU (Gresik)
MFO 710 Rp/liter

Table 9.5.4 Application effect of HP-HTR cleaning with high-pressure jet

Power Station	Unit No.	IC (MW)	Commissioning	Age (year)	Gross plant efficiency (%) design or commissioning	current data	after improvement	Initial investment (x1000US$)	IRR (%)	NPV (x1000US$)	Payback period (year)
Suralaya	1	400	1984	17	39.21	37.57	37.59	15	36	6	2
	2	400	1984	17	39.21	39.59	39.61	15	36	6	2
	3	400	1988	13	39.95	39.45	39.47	15	36	6	2
	4	400	1989	12	39.95	38.04	38.06	15	36	6	2
	5	600	1996	5	40.43	38.69	38.71	19	51	13	2
	6	600	1997	4	40.43	38.83	38.85	19	51	13	2
	7	600	1997	4	40.43	NA	NA	19	51	13	2
Tambak Lorok	1	50	1978	23	33.90	NA	NA	6	-17	-3	cannot pay back
	2	50	1978	23	31.70	30.30	30.31	6	-17	-3	cannot pay back
	3	200	1983	18	37.30	37.90	37.92	12	46	7	2
Muara Karang	1	100	1979	22	33.72	29.59	30.39	7	10	0	3
	2	100	1979	22	32.86	28.56	29.34	7	10	0	3
	3	100	1980	21	32.95	29.15	29.93	7	10	0	3
	4	200	1981	20	37.90	35.17	36.05	12	64	11	2
	5	200	1982	19	37.77	35.90	36.80	12	64	11	2
Gresik	1	100	1981	20	35.15	33.18	33.19	7	25	1	2
	2	100	1981	20	35.15	33.64	33.65	7	25	1	2
	3	200	1988	13	38.35	37.79	37.81	12	68	12	1
	4	200	1988	13	38.35	34.90	34.91	12	68	12	1
Paiton	1	400	1994	7	40.64	35.62	35.63	15	36	6	2
	2	400	1994	7	40.64	36.74	36.75	15	36	6	2

Precondition: Capacity factor 70%   Exchange rate US$1=Rp9,000   Discount rate = 12%
Fuel price Coal 207 Rp/kg (Suralaya), 210 Rp/kg (Paiton)
NG 2.45 US$/MMBTU (Muara Karang), 2.53 US$/MMBTU (Gresik)
MFO 710 Rp/liter

9.5.2 Boiler Chemical Cleaning

(1) Results of application in CEPCO

CEPCO's chemical cleaning criteria stipulate that the amount of scale is 30-40mg/cm^2 or its thickness is 15/100-20/100mm in the evaporation tube. Concretely, the cleaning time will be decided considering scale, metal temperature of the furnace wall, operating hours, and a cutout test on the evaporation tube. The speed at which scale builds up varies depending on type and size of boiler, operating conditions, and tube specifications, which should be managed and controlled individually. Recovery of thermal efficiency by boiler chemical cleaning is an average of 6.4kcal/kWh of heat rate.

(2) Application to the target power plants

Table 9.5.5 shows the efficiency improvement and cost when measures are applied to existing power plants in Indonesia based on the results of boiler chemical cleaning in CEPCO.

Table 9.5.5 Efficiency improvement by boiler chemical cleaning and its cost

Unit capacity (MW)	50	100	200	400	600
Improvement of heat rate (kcal/kWh)	6.4	6.4	6.4	6.4	6.4
Cost (x1000US$)	43	62	100	178	259

We calculated the efficiency, IRR, NPV and payback period of the target power plants when measures are applied. IRR and NPV were calculated assuming that the cash flow period is 4 years. Table 9.5.6 shows the results.

Table 9.5.6 Application effect of boiler chemical cleaning

Power Station	Unit No.	IC (MW)	Commissioning	Age (year)	Gross plant efficiency (%) design or commissioning	current data	after improvement	Initial investment (x1000US$)	IRR (%)	NPV (x1000US$)	Payback period (year)
Suralaya	1	400	1984	17	39.21	37.57	37.68	178	21	34	3
	2	400	1984	17	39.21	39.59	39.71	178	21	34	3
	3	400	1988	13	39.95	39.45	39.57	178	21	34	3
	4	400	1989	12	39.95	38.04	38.15	178	21	34	3
	5	600	1996	5	40.43	38.69	38.80	259	23	60	3
	6	600	1997	4	40.43	38.83	38.94	259	23	60	3
	7	600	1997	4	40.43	NA	NA	259	23	60	3
Tambak Lorok	1	50	1978	23	33.90	NA	NA	43	17	5	3
	2	50	1978	23	31.70	30.30	30.37	43	17	5	3
	3	200	1983	18	37.30	37.90	38.01	100	50	90	2
Muara Karang	1	100	1979	22	33.72	29.59	29.66	62	36	33	2
	2	100	1979	22	32.86	28.56	28.62	62	36	33	2
	3	100	1980	21	32.95	29.15	29.21	62	36	33	2
	4	200	1981	20	37.90	35.17	35.26	100	66	131	2
	5	200	1982	19	37.77	35.90	36.00	100	66	131	2
Gresik	1	100	1981	20	35.15	33.18	33.26	62	52	58	2
	2	100	1981	20	35.15	33.64	33.72	62	52	58	2
	3	200	1988	13	38.35	37.79	37.90	100	69	139	2
	4	200	1988	13	38.35	34.90	34.99	100	69	139	2
Paiton	1	400	1994	7	40.64	35.62	35.71	178	21	35	3
	2	400	1994	7	40.64	36.74	36.84	178	21	35	3

Precondition: Capacity factor 70% Exchange rate US$1=Rp9,000 Discount rate = 12%
Fuel price Coal 207 Rp/kg (Suralaya), 210 Rp/kg (Paiton)
NG 2.45 US$/MMBTU (Muara Karang), 2.53 US$/MMBTU (Gresik)
MFO 710 Rp/liter

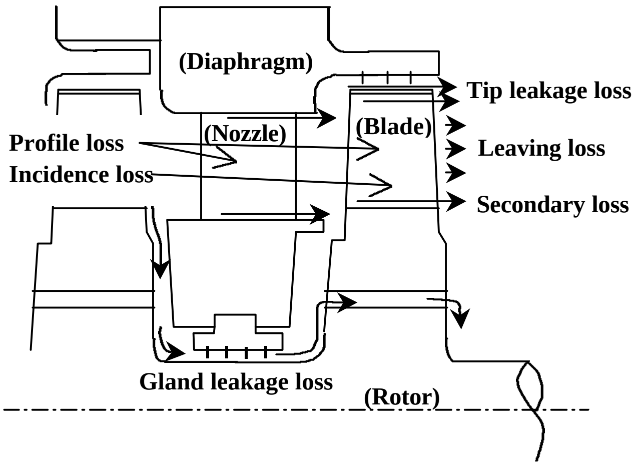
9.5.3 Improving High and Intermediate-Pressure Turbine Blades

(1) Measures for improving turbine efficiency

Steam turbine has deteriorated in efficiency due to erosion and wear of nozzles and blades attributable to long-term use regardless of maintenance, such as periodical inspections.

Figure 9.5.5 shows the internal loss of turbine. It is extremely important to improve internal efficiency of turbine by reducing these losses.

Figure 9.5.5 Cause of internal loss of turbine



Turbine manufacturers are continuously making efforts to improve turbine efficiency and have developed a large number of new technologies. Technologies introduced here have been applied not only to new plants but also to improve existing turbine achieving brilliant success. Chubu Electric Power Co., Ltd. (CEPCO) has many experiences applying these technologies to 220, 375, 500 and 700**MW**steam turbine units, which had been operating for 15-20 years.

The following are aspects of such efficiency improvement measures.

- Improving blade top seal
- Improving axis leakage loss
- Improving blade shape
- Replacement of stop piece to stop blade

The following are specific replacement parts for the above-mentioned improvement measures.

- Moving and stationary blades of HP and IP turbines
- Radial fin (HP and IP)
- Diaphragm packing (HP and IP)
- Fixing part of stop blade (HP and IP)
- Gland packing (HP and IP)

Figure 9.5.6 Improving blade top seal

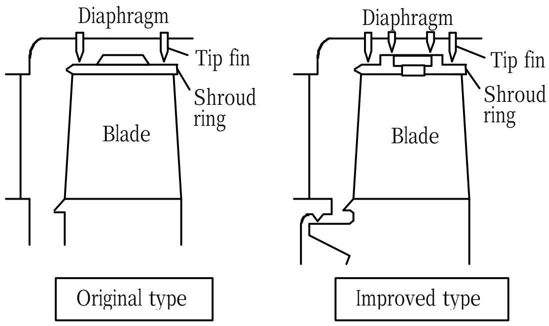
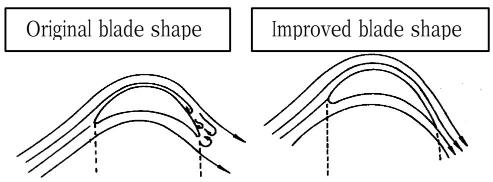


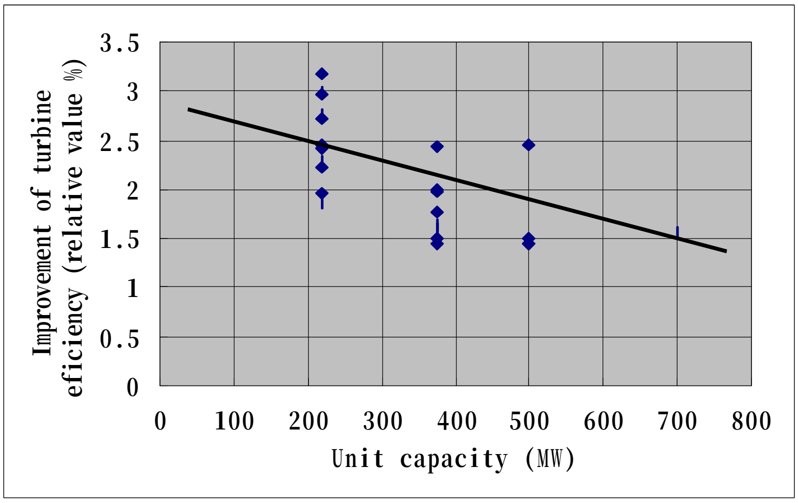
Figure 9.5.7 Improving blade shape



The reason why these improvements were made to these units, which had operated for 15-20 years, was that their high- and intermediate-pressure steam turbine blades had suffered from creep damage through use under high temperature and high-pressure conditions, and had been operating for 100,000-150,000 hours. By implementing the repairs in this proposal a substantial effect can be achieved.

Figure 9.5.8 shows the results of turbine efficiency improvement in CEPCO.

Figure 9.5.8 Turbine efficiency improvement (relative value)



The efficiency improvement values of low-output units are greater than those of high-output ones, showing that the improvement in low output units is greater. The reason is that the output distribution provided to high- and intermediate-pressure casing is greater for low output units.

(2) Application to the target power plants

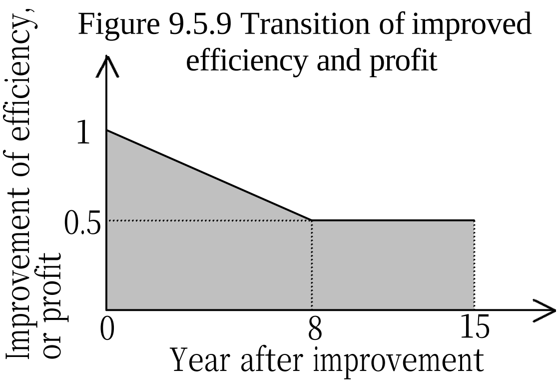
Table 9.5.7 shows the efficiency improvement and cost when measures are applied to existing power plants in Indonesia based on the results of improving HP and IP turbine blades in CEPCO.

Table 9.5.7 Efficiency improvement by improving HP and IP turbine blades and cost

Unit capacity (MW)	50	100	200	400	600
Improvement of efficiency (Relative value) (%)	2.80	2.70	2.50	2.10	1.70
Cost (x1000US$)	3,910	3,990	4,140	4,450	4,750

We calculated the efficiency, IRR, NPV and payback period of the target power plants when measures are applied. Here we assumed that 50% of the efficiency improvement is recovery of the deterioration and the remaining 50% is progress through new technology.

Figure 9.5.9 Transition of improved efficiency and profit



The former decreases to the pre-improvement state within 8 years, the latter continues. Figure 9.5.9 shows the transition of improved efficiency, that is, transition of profit, which is the reduction of the fuel cost because of the efficiency improvement. Moreover, IRR and NPV were calculated assuming that the cash flow period is 15 years. Table 9.5.8 shows the results.

Table 9.5.8 Application effect of improving HP and IP turbine blades

Power Station	Unit No.	IC (MW)	Commissioning	Age (year)	Gross plant efficiency (%) design or commissioning	current data	after improvement	Initial investment (x1000US$)	IRR (%)	NPV (x1000US$)	Payback period (year)
Suralaya	1	400	1984	17	39.21	37.57	38.36	4,450	2	-1,887	13
	2	400	1984	17	39.21	39.59	40.42	4,450	1	-2,017	14
	3	400	1988	13	39.95	39.45	40.28	4,450	1	-2,002	14
	4	400	1989	12	39.95	38.04	38.84	4,450	2	-1,919	14
	5	600	1996	5	40.43	38.69	39.35	4,750	3	-1,724	12
	6	600	1997	4	40.43	38.83	39.49	4,750	3	-1,745	12
	7	600	1997	4	40.43	NA	NA	4,750	NA	NA	NA
Tambak Lorok	1	50	1978	23	33.90	NA	NA	3,910	NA	NA	NA
	2	50	1978	23	31.70	30.30	31.15	3,910	-9	-2,996	cannot pay back
	3	200	1983	18	37.30	37.90	38.85	4,140	4	-1,437	11
Muara Karang	1	100	1979	22	33.72	29.59	30.39	3,990	-1	-2,114	cannot pay back
	2	100	1979	22	32.86	28.56	29.34	3,990	-1	-2,046	cannot pay back
	3	100	1980	21	32.95	29.15	29.93	3,990	-1	-2,101	cannot pay back
	4	200	1981	20	37.90	35.17	36.05	4,140	9	-601	8
	5	200	1982	19	37.77	35.90	36.80	4,140	8	-664	8
Gresik	1	100	1981	20	35.15	33.18	34.08	3,990	0	-1,893	15
	2	100	1981	20	35.15	33.64	34.55	3,990	0	-1,927	15
	3	200	1988	13	38.35	37.79	38.73	4,140	8	-747	8
	4	200	1988	13	38.35	34.90	35.77	4,140	10	-460	7
Paiton	1	400	1994	7	40.64	35.62	36.37	4,450	3	-1,741	12
	2	400	1994	7	40.64	36.74	37.43	4,450	1	-2,072	15

Precondition: Capacity factor 70% Exchange rate US$1=Rp9,000 Discount rate = 12%
Fuel price Coal 207 Rp/kg (Suralaya), 210 Rp/kg (Paiton)
NG 2.45 US$/MMBTU (Muara Karang), 2.53 US$/MMBTU (Gresik)
MFO 710 Rp/liter

Since IRR is extremely low, unless measures are conducted in a timely manner it is not be profitable. In other words, there is an opportunity to profit if measures are conducted when the lifetimes of HP and IP turbine blades are nearly finished. Since 15-20-year-old HP and IP turbine blades have suffered from creep damage and erosion due to the scale carried from the boiler, they should be examined for replacement. Therefore, we assumed that for plants 15 yeas old and over, 50% of HP and IP turbine blades are in a state of inevitable replacement due to deterioration. We also assumed that the investment in efficiency improvement is 50% of the total cost. Table 9.5.9 shows the IRR calculated based on these assumptions.

Table 9.5.9 Application effect of improving HP and IP turbine blades
(Application along with repair when the blades are deteriorated)

Power Station	Unit No.	IC (MW)	Commissioning	Age (year)	Gross plant efficiency (%) design or commissioning	current data	after improvement	Initial investment (x1000US$)	IRR (%)	NPV (x1000US$)	Payback period (year)
Suralaya	1	400	1984	17	39.21	37.57	38.36	2,220	15	343	5
	2	400	1984	17	39.21	39.59	40.42	2,220	14	216	6
Tambak Lorok	1	50	1978	23	33.90	NA	NA	1,960	NA	NA	NA
	2	50	1978	23	31.70	30.30	31.15	1,960	-1	-1,016	cannot pay back
	3	200	1983	18	37.30	37.90	38.85	2,070	19	633	5
Muara Karang	1	100	1979	22	33.72	29.59	30.39	2,000	11	-124	7
	2	100	1979	22	32.86	28.56	29.34	2,000	11	-56	7
	3	100	1980	21	32.95	29.15	29.93	2,000	11	-111	7
	4	200	1981	20	37.90	35.17	36.05	2,070	27	1,469	4
	5	200	1982	19	37.77	35.90	36.80	2,070	26	1,406	4
Gresik	1	100	1981	20	35.15	33.18	34.08	2,000	13	97	6
	2	100	1981	20	35.15	33.64	34.55	2,000	13	63	6

9.5.4 Replacement of Air Preheater Element and Seal

(1) Application results in CEPCO

From the application results in CEPCO, recovery of thermal efficiency through this measure is an average of 9.3kcal/kWh of heat rate.

(2) Application to the target power plants

We examined the application of this measure to the plants (Muara Karang PLTU 1-5 and Gresik PLTU 2-4) because an increase of the air leakage rate and deterioration of the temperature efficiency can be seen from Table 9.4.4. Table 9.5.10 shows the results. IRR and NPV were calculated assuming that cash flow period is 4 years.

Table 9.5.10 Application effect of AH element and seal

Power Station	Unit No.	IC (MW)	Commissioning	Age (year)	Gross plant efficiency (%)			Initial investment (x1000US$)	IRR (%)	NPV (x1000US$)	Payback period (year)
					design or commissioning	current data	after improvement				
Muara Karang	1	100	1979	22	33.72	29.59	29.68	260	12	-2	6
	2	100	1979	22	32.86	28.56	28.65	260	12	-2	6
	3	100	1980	21	32.95	29.15	29.24	260	12	-2	6
	4	200	1981	20	37.90	35.17	35.30	531	16	95	5
	5	200	1982	19	37.77	35.90	36.04	531	16	95	5
Gresik	2	100	1981	20	35.15	33.64	33.76	260	18	64	5
	3	200	1988	13	38.35	37.79	37.95	531	17	116	5
	4	200	1988	13	38.35	34.90	35.03	531	17	116	5

Precondition: Capacity factor 70% Exchange rate US$1=Rp9,000 Discount rate = 12%
Fuel price Coal 207 Rp/kg (Suralaya), 210 Rp/kg (Paiton)
NG 2.45 US$/MMBTU (Muara Karang), 2.53 US$/MMBTU (Gresik)
MFO 710 Rp/liter

For PLTU 1-3, however, repowering by removing existing boilers and combining existing STs, newly installed GTs and HRSGs is planned, so this plan will be monitored. Muara Karang PLTU 5 should not be a target because the air preheaters are now being repaired during a periodic inspection that started in Sep. 2001.

9.6 Conclusion

Table 9.6.1 shows the results of the application of thermal efficiency improvement measures examined in Section 9.5. In this table, items that IRR is above 12% are painted.

Table 9.6.1 Application effect of thermal efficiency improvement measures (summary)

Power Station	Unit No.	IC (MW)	Age (year)	LP-HTR cleaning with sponge				HP-HTR cleaning with high pressure jet				Boiler chemical cleaning				Improvement of HP & IP turbine blades				Replacement of AH element & seal			
				Initial cost (x1000US$)	IRR (%)	NPV (x1000US$)	Payback period (year)	Initial cost (x1000US$)	IRR (%)	NPV (x1000US$)	Payback period (year)	Initial cost (x1000US$)	IRR (%)	NPV (x1000US$)	Payback period (year)	Initial cost (x1000US$)	IRR (%)	NPV (x1000US$)	Payback period (year)	Initial cost (x1000US$)	IRR (%)	NPV (x1000US$)	Payback period (year)
Suralaya	1	400	17	0.13	1,415	6	1	15	36	6	2	178	21	34	3	4,450	15	343	5	NA			
	2	400	17	0.13	1,415	6	1	15	36	6	2	178	21	34	3	4,450	14	216	6	NA			
	3	400	13	0.13	1,415	6	1	15	36	6	2	178	21	34	3	NA				NA			
	4	400	12	0.13	1,415	6	1	15	36	6	2	178	21	34	3	NA				NA			
	5	600	5	0.13	2,128	9	1	19	51	13	2	259	23	60	3	NA				NA			
	6	600	4	0.13	2,128	9	1	19	51	13	2	259	23	60	3	NA				NA			
	7	600	4	0.13	2,128	9	1	19	51	13	2	259	23	60	3	NA				NA			
Tambak Lorok	1	50	23	0.13	307	1	1	6	-17	-3	cannot pay back	43	17	5	3	3,910	NA	NA	NA	NA			
	2	50	23	0.13	307	1	1	6	-17	-3	cannot pay back	43	17	5	3	3,910	-1	-1,016	cannot pay back	NA			
	3	200	18	0.13	1,269	5	1	12	46	7	2	100	50	90	2	4,140	19	633	5	NA			
Muara Karang	1	100	22	0.13	628	3	1	7	10	0	3	62	36	33	2	3,990	11	-124	7	260	12	-2	6
	2	100	22	0.13	628	3	1	7	10	0	3	62	36	33	2	3,990	11	-56	7	260	12	-2	6
	3	100	21	0.13	628	3	1	7	10	0	3	62	36	33	2	3,990	11	-111	7	260	12	-2	6
	4	200	20	0.13	1,546	6	1	12	64	11	2	100	66	131	2	4,140	27	1,469	4	531	16	95	5
	5	200	19	0.13	1,546	6	1	12	64	11	2	100	66	131	2	4,140	26	1,406	4	NA			
Gresik	1	100	20	0.13	792	3	1	7	25	1	2	62	52	58	2	3,990	13	97	6	NA			
	2	100	20	0.13	792	3	1	7	25	1	2	62	52	58	2	3,990	13	63	6	260	18	64	5
	3	200	13	0.13	1,598	6	1	12	68	12	1	100	69	139	2	NA				531	17	116	5
	4	200	13	0.13	1,598	6	1	12	68	12	1	100	69	139	2	NA				531	17	116	5
Paiton	1	400	7	0.13	1,424	6	1	15	36	6	2	178	21	35	3	NA				NA			
	2	400	7	0.13	1,424	6	1	15	36	6	2	178	21	35	3	NA				NA			

Precondition: Capacity factor 70%   Exchange rate US$1=Rp9,000   Discount rate = 12%
Fuel price Coal 207 Rp/kg (Suralaya), 210 Rp/kg (Paiton)
NG 2.45 US$/MMBTU (Muara Karang), 2.53 US$/MMBTU (Gresik)
MFO 710 Rp/liter

(1) Prioritizing of the rehabilitation items

Rehabilitation should be carried out beginning with high IRR items. Therefore, the rehabilitation items are prioritized as follows.

Priority	Item	Reason
1	LP-HTR cleaning with sponge	Very small investment cost but very large IRR
2	HP-HTR cleaning with high-pressure jet	Comparatively small investment but large IRR
3	Boiler chemical cleaning	Large IRR but large investment cost
4	- Improvement of HP & IP turbine blades - Replacement of AH element & seal	Large investment cost but not so large IRR

(2) Rehabilitation plan

1) LP-HTR cleaning with sponge

This work is simple and does not require technical experience and know-how, and the cost is very small. Therefore, this can be carried out immediately by the Indonesian side alone. The targets are the last LP-HTRs of all steam power plants. This should be carried out every 8 years along with periodical inspection of LP-HTR.

2) HP-HTR cleaning with high-pressure jet

One set of high-pressure water jet equipment for common use for all power plants should be purchased first and it costs about US$140,000. And then, when the work is carried out, it costs only about US$2,000-4,000 per one HTR as the costs of transportation of the equipment, consumables such as nozzles, and labor.

Because this work requires technical experience and know-how, guidance from the experts of the water jet cleaning company should be received in the early stages of the introduction (e.g. for several months in total in several power plants).

The targets are the HP-HTRs of Suralaya PLTU 1-7, Tambak Lorok PLTU 3, Muara Karang PLTU 4-5, Gresik PLTU 1-4 and Paiton PLTU 1-2. This should be carried out every 4 years along with periodical inspection of HP-HTR.

3) Boiler chemical cleaning

Boiler chemical cleaning should be carried out at a proper time. Therefore it is necessary to determine whether or when this should be carried out following the detailed examination by the cutout test on the evaporation tube and operational state. The targets are the all steam power plants.

4) Improvement of HP & IP turbine blades and replacement of AH element & seal

IRR is not too high for the high investment cost. Especially for the improvement of HP & IP turbine blades, IRR is evaluated assuming that this improvement is carried out along with the inevitable replacement due to deterioration. Therefore it is necessary to determine whether this should be carried out following the detailed examination of the state of deterioration. In the detailed examination, manufacturers should participate to examine the applicable technology and the amount of efficiency improvement from the viewpoint of design.

The targets of the detailed examination for the improvement of HP & IP turbine blades are Suralaya PLTU 1-2, Tambak Lorok PLTU 3, Muara Karang PLTU 4-5 and Gresik PLTU 1-2.

The targets of the detailed examination for the replacement of AH element & seal are Muara Karang PLTU 4 and Gresik PLTU 2-4.

Chapter 10 Environmental Measures

The following is an overview of the environmental regulations and measures currently utilized in thermal power plants. Proposals for promoting the future use of coal are also included.

10.1 Environmental Regulations and Standards

Indonesia has a "The Basic Environmental Law " which provides fundamental standards to preserve the environment. These pollution standards consist of "Regulations Concerning Establishment of Environmental Standards" formulated and managed by Ministry of Environment. Air emission standard is regulated by the state government based on the "Air and Noise Environment Standard" and guidelines established by Ministry of Energy and Mineral Resources.

(1) Air pollution standards

Table 10.1.1 shows environment standards currently enforced in Indonesia, Thailand, and Japan against SO_2, NO_2, and particulate matters (hereafter abbreviated as PM) contained in the emission gas from thermal power plants. It indicates that environmental standards in Indonesia are almost the same as those in Thailand, which is also part of Asia.

Table 10.1.1 Comparison of air pollution standards in Indonesia, Thailand and Japan

Substance	Indonesia	Thailand	Japan
SO_2	1 hourly values :>900 ìg/Nm3 (0.9 mg/Nm3) 24 hourly values :>365 ìg/Nm3 (0.365 mg/Nm3) 1 year values : > 60 ìg/Nm3 (0.06 mg/Nm3)	1 hourly values :>780 ìg/Nm3 (0.78 mg/Nm3) 24 hourly values :>300 ìg/Nm3 (0.3 mg/Nm3) 1 year values: > 100 ìg/Nm3 (0.1 mg/Nm3)	1 hourly values :>0.1 ppm (0.29 mg/Nm3) 24 hourly values :>0.04 ppm (0.11 mg/Nm3)
NO_2	1 hourly values :>400 ìg/Nm3 24 hourly values :>150 ìg/Nm3 (0.15 mg/Nm3) 1 year values : > 100 ìg/Nm3	1 hourly values :>320 ìg/Nm3	24 hourly values :>0.04-0.06 ppm (0.082 mg/Nm3)
PM10*	24 hourly values :>150 ìg/Nm3 (0.15 mg/m3)	24 hourly values :>330 ìg/Nm3 (0.33 mg/m3) 1 year values : >100 ìg/Nm3	1 hourly values :>0.20 24 hourly values :>0.10mg/m3
PM2.5*	24 hourly values :> 65 ìg/Nm3 (0.065 mg/m3) 1 year values : > 15 ìg/Nm3		

・To facilitate comparison, values are given in the unit of mg/m^3 in parentheses. (Use underlined figures for easy comparison.)

(2) Air emission standards

Indonesia reviewed its emission standards in 2000 and tightened control by reducing the limit to 1/2 of the existing level. Table 10.1.2 shows the emission standards by Indonesia, Japan and the World Bank. While Indonesia's regulations are lax for PM, their levels of SO_2 and NO_2 emissions are nearly equal to that of the World Bank.

In Indonesia, emission standards established by the state government are applied nationwide and separate standards are not set by local governments. However in Japan, each local government establishes its own regulations through mutual agreement based on the standards set by the national government. Thus air pollution standards observed by each thermal power plant differ from region to region.

Table 10.1.2 Comparison of air emission standards in Indonesia, Thailand and Japan

Substance	Indonesia	Japan	World Bank
SO_2	Coal: 750 mg/m^{3}N except Coal: 800 mg/m^{3}N	25-773ppm (71-2209 mg/m^{3}N)	2,000 mg/m^{3}N <500MW: 0.2 tpd/MW >500MW: 0.1 tpd/MW
NO_2	Coal : 850 mg/m^{3}N except Coal:1000 mg/m^{3}N	15-550 ppm (31-1129mg/m^{3}N)	Coal: 750 mg/m^{3}N Lignit: 750 mg/m^{3}N Oil: 460, Gas: 320 mg/m^{3}N Gas Turbin: Gas: 125 mg/m^{3}N Diesel: 165 mg/m^{3}N Oil: 300 mg/m^{3}N
PM	Coal : 150 mg/m^{3}N except Coal: 350 mg/m^{3}N	0.005-0.45g/m^{3}N (5-450 mg/m^{3}N)	50 mg/m^{3}N

(3) Provisions for environmental impact assessment

The Indonesian government formulated provisions for environmental impact assessment (Analisi Menegenai Dampak Lingkungan: AMDAL) in article 29 of the state regulations and enacted them in 1986. These provisions have been revised three times with the latest one having been enacted in 1999.

Currently being applied to newly constructed or expanded thermal power plants, these provisions require an environmental impact assessment and to obtain permission before starting operation. They are designed to ensure minimum impact on the environment with regulations as strict as those in advanced nations.

10.2 Current Environmental Measures taken by Thermal Power Plants

(1) Emission gas in thermal power plants

Table 1–5 attached at the end of this chapter show data on emission gas collected from each power plant. The data was used to analyze the current situation concerning emission gas. The following is a brief summary of the analysis.

- Excessive level of PM emission is observed in some coal-fired plants (Paiton, Sularaya). This is most likely to be attributed to the damage caused by the aging electrostatic precipitator. Plants using such precipitator are required to replace its interior parts. The emission of $SO_{2,}$ while quite high, is within the allowable limits.
- Emission of NO_2 and PM are within the acceptable levels for oil-fired plants; However, SO_2 in such plants exceeds the regulated value since oil contains a high level of Sulfur.
- Natural gas-fired plants maintain allowable limits in emission of all three items: SO_2, NO_2, and PM.

(2) Disposal of coal ash in thermal power plants

In Indonesia, part of the coal ash discharged from the plant is recycled to make items such as cement or building blocks. The unused ash is taken to the ash pond in the power plant.

Suralaya and Paiton power plants promote effective use of the coal ash, with Suralaya recycling 30% of the waste and Paiton 80%, and the rest is disposed after waste water treatment or buried under the ground; maximum care is thus taken to protect the environment.

Furthermore, Suralaya Power Plant utilizes its coal-ash silo for productions to ensure maximum use of the waste.

10.3 Proposals to Improve Environment

10.3.1 Environmental Measures against Problems of Thermal Power Plants

(1) Environmental measures against problems in coal-fired power plants

Excessive level of PM is expected to be reduced successfully by having the interior parts of the electrostatic precipitator replaced. Emission of SO_2 is currently close to the allowable limit. To control levels of emission of SO_2 would require purchasing coal that contains lower levels of Sulfur. However, at this time, identifying such type of coal is considered difficult. Adequate consideration should therefore be given to the level of Sulfur that will be discharged when purchasing coal.

(2) Environmental measures against problems in oil-fired power plants

The following three proposals have been made to reduce the level of sulfur discharged from oil-fired power plants.

a. Conversion of fuel to natural gas
b. Reduction of sulfur in oil
c. Installation of desulfurization facility

Desulfurization of oil is the issue to be discussed from a nationwide perspective of oil consumption. The use of desulfurized oil in only a limited number of power plants may not produce any positive effect upon overall air quality. At the same time, installation of a desulfurization facility in the existing plants may not be cost-effective due to its short economic life. West Java is currently working on construction of new pipelines for natural gas. The conversion to natural gas is considered to be the most environmentally friendly proposal for existing oil-based power generation.

(3) Stricter control over power plants to ensure compliance with the law

As stated above, excessive levels of emissions are observed in some power plants. The following suggestions are to ensure compliance with the emission standards.

a. Introduction of punitive measures such as new penalties and/or cessation of power plant operation;
b. Giving local government authorities broader powers to oversee power plant operation; and,
c. Making monitoring data available to the public.

Taking appropriate measures as listed above will ensure proper compliance with environmental standards.

10.3.2 Environmental Protection Measures for Promoted Use of Coal in Thermal Power Plants

(1) Trend of utilizing various coals

Table 10.3.1 shows the characteristics of coal used in coal-fired power plants in Indonesia. It is categorized as sub-bituminous coal and is excellent in quality with less Sulfur or ash content.

Table 10.3.1 Characteristics of coal used in coal-fired power plants in Indonesia

Items	Suralaya TPP	Paiton TPP
Calorific Value (kcal/kg)	6,944	5,214
Total Moisture (wt%)	23.29	25.42
Ash (wt%)	5.79	0.94
Volatile Matter (wt%)	44.02	35.46
Fixed Carbon (wt%)	50.19	36.18
Total Sulfur (wt%)	0.41	0.06
Nitrogen (wt%)	-	0.74
HGI	58.2	-
recording day	Des.1998	Aug.2001

Data source: PJB, Indonesia Power

However, consumption of lower-grade sub-bituminous coal and brown coal (lignite), which are abundant in coal reserves as shown in Table 10.3.2, are expected to increase in the future because they ensure better cost performance while providing energy security. To ensure ecological use of these types of coal, appropriate measures should be taken. The estimated amount of coal reserves is shown in Table 10.3.2 by coal type.

Japanese power plants are also switching to these types of coal. Table 10.3.3 shows the contract of purchase of sub-bituminous coal by Japanese companies from Indonesia.

Table 10.3.2 Coal reserves by coal type

Type of coal	Amount of deposits (%)
Anthracite	0.36
Bituminous coal	14.38
Sub-bituminous coal	26.63
Brown coal	58.63
Total	100.0

Table 10.3.3 Contract of purchase of sub-bituminous coal by Japanese power companies from Indonesia

Company	Brand	Quantity (1,000 ton)	Note
Touhoku	Adaro	60	Annual contract
	Berau	45	Trial
	Baiduri	60	Annual contract
Tokyo	Adaro	60	
Hokuriku	Adaro	120	Long-term contract(1997-2001)
Zyouban	Berau	240	
	Kideco	60	Bidding
Denpatsu	Adaro	60	Annual contract

(2) Measures to ensure environmental with lower-grade coal

Listed below are suggestions requiring due consideration to ensure ecological power generation with lower-grade coal in new and existing power plants.

a. Use of coal with lower calorific value requires:

- Construction of new coal mills in order to compensate for inadequate capacity of existing mills (for existing plants);
- Reinforced coal handling equipment to accommodate the expected increase in the volume of coal (for existing plants);
- Re-designed combustion equipment and ventilation system that can accommodate additional supply of fuel (for new and existing plants); and,
- Installation of coal mixing equipment to blend high-calorie and low-calorie coals (for new and existing plants).

b. Use of coal with high sulfur/ash content requires:

- Installation/addition of desulfurizers and dust disposal equipment (electrostatic precipitator) (for new and existing plants); and,
- Installation/addition of equipment to treat ash and by-product of desulfurization (for new and existing plant)

(3) Clean Coal Technology (CCT) that can be promoted to Indonesia

The increased use of coal for power generation in many parts of the world has spurred innovation of diverse types of CCT technologies as shown in Table 10.3.4. The three main types of boilers that may apply to Indonesia are: 1) supercritical boiler, 2) brown coal (lignite) -fired boiler, and 3) circulating fluidized bed combustion boiler.

Table 10.3.4 General description of CCT

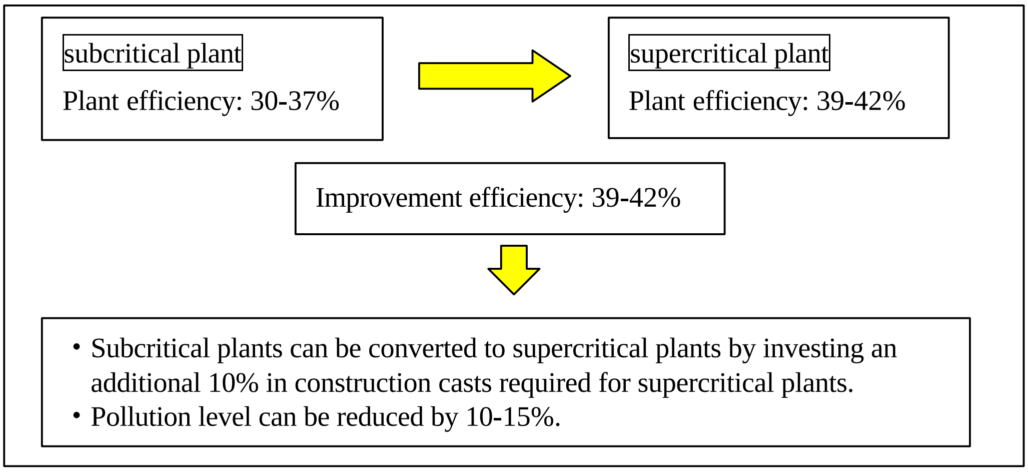
Technology	Name	Outline
1.Coal washing technology	Washing equipment	Usually used in mine-mouth power plant. The cost is included in the selling price in most cases. Effective when content of ash and particles is high.
2.Combution technology	Combustion of pulverized coal Combustion of lignite Fluidized bed combustion boiler Pressurized fluidized bed combustion boiler Coal gasification	Full-fledged technology is available for pulverized coal firings and plants generating 1,000 MW of power are already operating using this technology. High-volume lignite combustion has also been made possible. Pressurized fluidized bed combustion boiler and coal gasification are newly developed technologies that allow highly efficient operation.
3.Desulfulization technology	Limestone-gypsum method Dry-type method Simplified method Sea-water method	The limestone-gypsum method, renowned for its high performance, is most widely used in the world. Dry-type method, which produces no wastewater, is also drawing attention. If priority is not given to high performance, the simplified method or sea-water method may be a cost-efficient alternative.
4.Denitration technology	Low-NOx method Catalytic method	Usually, low NO_x combustion and catalytic method are used in combination.
5.Dudt removal technology	Electrostatic precipitator Bag filter	Though both of them are already established technologies, electrostatic precipitator is usually used for high-volume combustion.
6.Other technology	Waste water treatment Ash treatment By-product treatment	Installation of these treatments is required when desulfurization facility is used.

a. Supercritical boiler

According to the latest data, efficiency of conventional plants in Indonesia is around 29 - 35% (at sending end). It is considered relatively low when compared to the efficiency of 40% or higher with the most recent plants. To compensate for this, these plants tend to use more fuel, which in turn increases generation costs and accelerates environmental pollution by emission of gases such as CO_2.

Use of a supercritical plant, which enjoys popularity throughout the world, is one option to achieve higher plant efficiency. It optimizes the steam condition by converting subcritical pressure to supercritical pressure, thus enhancing plant and cost efficiency. Figure 10.3.1 shows the merits gained by conversion from a conventional subcritical plant to supercritical plant. When considering construction of a new thermal power plant, a comprehensive evaluation of cost performance is required. Introduction of new technology such as a supercritical plant would be one option.

Figure 10.3.1 Merits of conversion from a subcritical to supercritical plant
(Calculation for a Model Plant)



b. Lignite combustion boiler

Approximately 60% of the coal in Indonesian reserves is categorized as low-grade coal called brown coal. Unlike the higher-grade sub-bituminous coal currently used for power generation in the country, brown coal, characterized by low-calorific value and high sulfur/ash content, requires highly technical, unique combustion technology. Lignite is being used for power generation in many countries including those in East Europe.

Lignite combustion technology has made remarkable progress and enhanced performance has been achieved by introduction of large-scale combustion equipment and a supercritical boiler.

Table 10.3.5 shows the performance of the latest large-scale, supercritical lignite plants. These types of plants ensure high performance with a plant efficiency of 40% or more. All of them are designed to minimize environmental pollution and are equipped with a desulfurizer and dust collectors.

Further comprehensive evaluation is required for use of brown coal in the future by conducting fundamental research and other studies.

Table 10.3.5 Latest lignite plants

Plant Name	Schkopan	Schwarze Pump	Lippendorf	Boxberg
Capacity	495MW	800MW	933MW	900MW
Fuel	Lignite	Lignite	Lignite	Lignite
L.H.V.	2746kcal/kg	- kcal/kg	2507kcal/kg	2054kcal/kg
Steam Condition	26.0MPa 545/560 C	25.3MPa 544/562 C	26.75MPa 554/583 C	26.6MPa 545/580 C
Efficiency (Net)	40%	41%	42.3%	41.7%
Commissioning	1996	1997	1999	2000
Country	Germany	Germany	Germany	Germany

c. Circulating fluidized bed combustion boiler (CFBC)

A circulating fluidized bed combustion boiler (CFBC), which allows operation on multiple varieties of fuel and features reduced level of NO_X/SO_X emissions thanks respectively to low-temperature combustion and desulfurization within the bed, is attracting attention as an environmentally friendly boiler and is being used widely for operation on electricity. Circulation type, introduced as an improved version of the conventional babbling type, is designed to enhance fuel efficiency. CFBC allows the fuel to stay longer in the furnace by high-speed fluidization of the fuel and by recycling it with unburned particles trapped and re-supplied into the furnace by cyclone.

Table 10.3.6 shows the specification of the largest CFBC plant in Japan. While it can generate 149 MW of power, the world's largest CFBC features a capacity of 250 MW. Further examination is required to improve the performance of our plant through comparison of the characteristics with those of other plants.

Table 10.3.6 Specifications of CFBC plant in Japan

Item	Specifications
Plant Output	149MW
Efficiency	43%(gross), 39%(net)
Steam Condition	16.6MPa, 566/538
Environmental Facility	PM: Bag Filter SOx: In-furnace SOx reduction (70-80%) NOx: Two-stag combustion (800-900 C)
Emission	PM: Bag under 30mg/Nm3 SOx: under 260mg/Nm3 NOx: under 250mg/Nm3
Starting day	2001 June

Table. 1 Ambient Air condition (SOx) around Sularaya TPP (2000, μg/m3)

No.	Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Gerem			8		8						11	
2	Cipala Dua			10		10						10	
3	Lebak Gede	1		21	4	21	4	9	3	3	8	8	8
4	Brigil	2		7	6	7	7	3	11	2	3	11	17
5	Salira indah	4		8	0	8	5	6	3	2	2		2
6	Pengorengan			10		10							
7	Margasari			3		3							
8	Sumurasari			4		4						7	
9	Gunung Gede			2		2						5	
10	Komp.Suralaya	3		6	6	6	1	7	6	1	5	9	5
11	Halaman Suralaya			3		3						12	
Standard		97											

Table. 2 Ambient Air condition (NOx) around Sularaya TPP (2000, μg/m3)

No.	Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Gerem			19		19							
2	Cipala Dua			16		18						15	
3	Lebak Gede	7		15	7	15	9	13	13	8	6	16	6
4	Brigil	28		17	21	17	2	8	8	6	2	17	1
5	Salira indah	3		1	3	2	2	14	8	9	7	2	8
6	Pengorengan			13		13							
7	Margasari			9		9							
8	Sumurasari			12		10						9	
9	Gunung Gede			5		5						7	
10	Komp.Suralaya	7		15	8	15	1	8	5	4	10	12	10
11	Halaman Suralaya			9		9						11	
Standard		97											

Table. 3 Ambient Air condition (PM) around Sularaya TPP (2000, μg/m3)

No.	Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Gerem			43		74							
2	Cipala Dua			56		51							
3	Lebak Gede	68		43	149	54	129	179	314	298	247	7	267
4	Brigil			57	86	89	50	205	240	274	130	109	248
5	Salira indah	8		76	55	97	102	175	295	248	201	110	238
6	Pengorengan			26		75							
7	Margasari			33		77							
8	Sumurasari			56		86							
9	Gunung Gede			53		58							
10	Komp.Suralaya	14		21	83	46	60	126	125	262	267	62	260
11	Halaman Suralaya			98		99							
Standard		260											

Table.4 Flue Gas Condition (Paiton, Gresik, Muara-Karang)

TTP Name	Unit	Fuel	2000						2001					
			SO_2(mg/m3)		NO_2(mg/m3)		PM(mg/m3)		SO_2(mg/m3)		NO_2(mg/m3)		PM(mg/m3)	
			Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Paiton	PLTU#1	Coal	152.45	223.7	13.5	13.6	31.4	52	66	249.5	4.95	30.8	123.17	166.8
	PLTU#2		44.1	77.6	4.9	5	43.7	55.9	83.16	120.61	11.85	19.76	18.7	20.5
Gresik	PLTU#1	NG	2.5	237	29	284	23.86	48						
	PLTU#2								0.53	11.24	11.46	13.48	6	15.68
	PLTU#3		14.96	137	6.77	766	62.17	73						
	PLTU#4		360.42	360.42	13.1	13.1	24.52	24.52	0.239	0.239	18.12	18.12	18.37	18.37
	PLTGU		30	41.23	43.62	290	20.21	20.21	5.66	5.66	20.34	25.33	18.6	86.5
Muara-Karang	PLTU#1	MFO	27.54	736.01	0.43	294.83	19.5	19.5	297.49	617.01	99.71	291.02	27.9	46.9
	PLTU#2		28.23	1205.2	0.37	282.5	22.1	22.1	1098.6	1732.63	391.83	489.91	62.1	65.7
	PLTU#3		26.54	1093.5	235.77	353.5	10.9	10.9	690.83	1784.98	270.41	302.21	54.41	164
	PLTU#4	NG	4.79	139.21	0.18	97.49	56.43	56.43	69.59	72.14	38.15	65.74	2.6	4.7
	PLTU#5		4.71	562	0.23	133	10.16	10.16	19.16	25.73	14.54	35.28	2.6	16.35
	PLTGU#1		6.28	6.28	2.85	14.93	0.9	0.9	0.071	8.69	8.73	8.73	0.4	20.2
	PLTGU#2		5.99	5.99	2.92	25.25	3.21	3.21	2.19	7.85	0.49	21.79	0.1	23.4
	PLTGU#3		4.58	4.58	6.61	99.63	5.77	5.77	0.24	3.51	0.6	0.6	0.1	13.3
Emission Standard (Coal)			750		850		150		750		850		150	
Emission Standard (Oil, gas)			800		1000		350		800		1000		350	

PLTU: Steam Power Plant, PLTGU: Combined Cycle, MFO: Oil, NG: Natural Gas

Table.5 Flue Gas Condition (Suralaya)

Unit NO.	SO_2 mg/m3			NO_2 mg/m3			PM mg/m3		
	May-Aug 1999	Sep-Nov 1999	Jan-Apr 2000	May-Aug 1999	Sep-Nov 1999	Jan-Apr 2000	May-Aug 1999	Sep-Nov 1999	Jan-Apr 2000
1	103.36	226.72	465.88	78.85	170.36	342.66	85.51	480.29	494.48
2	324.85	323.05	472.36	386.82	294.92	310.34	142.06	922.33	732.35
3	214.54	466.15	546.74	233.37	361.29	421.47	1.59	-	-
4	255.66	399.22	451.12	227.53	373.62	390.63	1.94	-	-
5	383.64	443.03	499.79	254.21	281.84	305.73	87.7	-	38.97
6	148.46	230.76	501.86	201	249.92	293.27	101.72	12.91	11.06
7	161.14	221.87	475.41	171.16	254.97	286.54	36.03	19.86	15.49
Emission Standard		750			850			150	

Chapter 11 Institutional and Organizational Recommendation for the Optimal Electric Power Development Plan and the Stable Power Supply

In this chapter, the following items were studied as the institutional and organizational measures contributing to realize the optimal power development plan and to ensure stable power supply.

(1) Lessons from the California Power Crisis to the power sector liberalization in Indonesia

In this section, the lessons from the California Power Crisis were examined to make use of the power sector liberalization in Indonesia from the viewpoint of stable power supply.

(2) System for power supply bidding with a view to power supply composition

This section will introduce Japan's wholesale electricity bidding system to implement the optimal power development plan by private investment in Single Buyer System.

(3) An approach to power development supporting system in line with energy policy

In this section, measures to support the power development in line with energy policy were examined from the viewpoint of realization of the optimal power development plan.

(4) Utilization of captive power

Captive power in Indonesia can affects stable supply of electric power. Therefore the demand trend of captive and the possibility to utilize as a short-term countermeasure against power deficit were examined.

(5) Utilization of Demand Side Management (DSM)

In this section, DSM was examined as a measure to ensure stable supply of electric power from the demand side.

(6) Financial enhancement of PLN

The financial situation of PLN which affects realization of the optimal power development plan was analyzed. And the required measures for enhancement of PLN financial condition were examined.

(7) Measures to promote private investment

The measures for promoting private investment necessary to realize the optimal electric power development plan were examined.

11.1 Lessons from the California Power Crisis to the Power Sector Liberalization in Indonesia

11.1.1 Present Situation of Power Sector Liberalization in Indonesia

In August 1998 Government of Indonesia issued the Policy Paper as directive to power sector industry to implement Multi-Buyers-Multi-Sellers (MBMS) market structure in commercially viable area, such as Java-Bali System. Accordingly, a new law of power sector is waiting for enactment. The draft new law set the time schedule that the regulatory body should be organized within two years after the enactment of the new law. The Single Buyer (SB) market as a transitional stage should be established after 3 years and the final target of the MBMS should be ready within seven years. This market system would be implemented only in viable area, such as Java-Bali System.

At this stage of early 2002, the market player and the regulator, namely PLN and the government, especially DGEEU are in preparation for SB and for the new regulatory system/body.

(1) PLN and the SB market

In SB, PLN is obliged to separate its functions of generation, transmission and distribution. They will be transformed into, respectively, gencos, transco and distcos. The body of SB will be created within the organization of PLN. The purpose of SB is to purchase all of power produced in the market and selling all power back to Wholesalers or Large Big Customers. SB also is undertaking the whole transmission facilities that require maneuvering power in return to transmission charges following Transmission Service Agreement (TSA) between SB and Transco. Decision to appoint SB as part of Holding organization was very strategic, especially considering outstanding commitments of PLN (such as long-term Power Purchase Agreement) and increasing its financial leverage. The System Operator (SO) and Market Operator (MO) will be the function of Transco as it is.

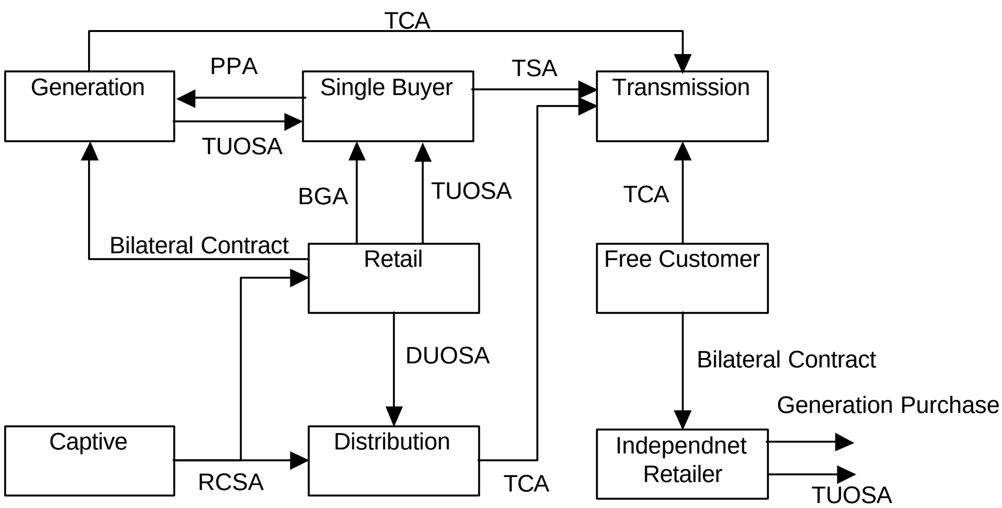
In SB market, dispatch orders are given based on generation cost. SB market in Indonesia has drawbacks because power generation has long-term PPAs with PLN putting more risk to end customers that investors, and also customers cannot participate in market dynamism. The government of Indonesia thinks the drawbacks will be mitigated with the participation of other buyers in MBMS market.

Currently, PLN and consultant Price Waterhouse & Coopers (PWC) with financial support from the World Bank is preparing the transition to SB including the commercial arrangement and the role of PLN. According to their proposal, the commercial agreements in terms of contracts are designed to promote competition among SB, generation, transmission and distribution/retail. For an increased competition the number of gencos for power generation is expected to increase from two (IP and PJB) to four (separate IP and PJB plants in four).

As for PLN, to prepare SB, PLN of Java-Bali has been exercising SB Market internally since June 1, 2000. Currently PLN has functions 1) System Operator, 2) Market Operator and 3) Transmission and 4) System Planner and 5) Single Buyer. In SB market, only the function(s) of Single Buyer (or with System Planner) will be left to PLN.

The design of SB market is not only the restructuring of PLN, but also the re-arrangement of commercial market for power. In their proposal, the commercial agreements as listed below should be arranged to recover all qualified costs incurred. Proposed SB market and the Commercial Arrangement from 2004 by PLN/PWC are following.

1) Power Purchasing Agreement (PPA): contract between generation and SB
2) Bilateral Contract: contract between generation and retail
3) Bulk Generation Agreement (BGA): contract between SB and distribution company/retailer
4) Transmission Service Agreement (TSA): contract between SB and Transco
5) Transmission Usage of Service Agreement (TUOSA): contract between SB and Retailer
6) Transmission Charges Agreement (TCA): contract between Transco and Generation/big customer connected directly to HV grid
7) Distribution Usage Of Service Agreement (DUOSA): contract between distribution and retailer
8) Distribution Charges Agreement (DCA): contract between distribution and customers
9) Retail Charge Service Agreement (RCSA): contract between retailer and captive generation to purchase excessive power from captive



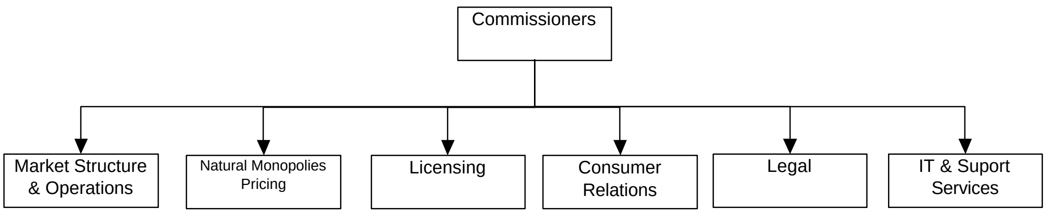
(2) Regulatory body

The regulatory body is responsible for the market rules. In preparing the market rules for SB market that was just accomplished in early of year 2001, Government received assistance from consultant Macro Corporation, KEMA and others with financial support from the Asian Development Bank (ADB).

As important as the market rule is the implementation body or the regulatory body. Although the regulatory body does not necessarily have to be an independent body, the consultant team of KEMA strongly recommended necessity of independence as the regulatory body.

In current institutional structure, the Directorate of Electricity Power Business Supervision of DGEEU is responsible for the implementation of the market rules. According to the study of Hagler Bailey, the current organizational structure in DGEEU focuses on work process structure. Here, the structural divisions are clear, but authorities and responsibilities require clarification. However, the implementation of market rules requires transparency, authority, and accountability because specific organizational units would be responsible for specific decisions, actions, and outputs.

In this regard, it suggests an organizational structure headed by function oriented commissioners with expert staffs, but not by director who tend to be a political appointee. To take account of the current work process oriented structure, it suggested an organizational structure as follows to make it a market rule oriented regulatory body.



11.1.2 Lessons from the California Power Crisis

(1) California power crisis

California's power sector reform started in 1996. Before then, the relatively high price of electricity in California was a burden for the economic activities of California. Then, the objective of the reform was to reduce price of electricity, which is regulated by the California Public Utilities Commission (CPUC) under a traditional cost of service regulatory system.

There were the three privately owned utilities, which supply two-thirds of consumption. The reform required them to sell electricity to the wholesale market operated by the Cal PX and

Cal ISO. Cal PX (California Power Exchange) was a market operator of bid-based, centralized market for forward power sales. Cal ISO (Independent System Operator) was an operator of the transmission facilities owned by private utilities.

Wholesale markets worked reasonably well for the first two years (1996-8) while the initial surplus of generating capacity disappeared. Then by 2000, when the demand surged and supply capacity cannot match the demand, rolling blackouts disrupted the state economy. This shortage of electricity was accompanied by the skyrocketing of the wholesale spot prices.

The immediate cause of the crisis is this mismatch of the demand and supply. The problem is said to be in the design of the wholesale market, which was dominated by spot market in the case of California. Because initially the major private distribution companies were not allowed to buy outside of the spot market, they were exposed to the price volatility of the market. And the price signal of the users was not transmitted to the wholesale market due to the retail price cap system. This price volatility and the lack of interaction between the wholesale market and the retail market made market participants difficult to manage their risks.

(2) Lessons for Indonesia

The purposes of liberalization are clearly different between the cases of California and Indonesia. California wanted to reduce the price by introducing competitive market. Indonesia wants to increase the private participants by liberalizing the market. Also in California crisis, the main concern was the establishment and regulation of a mandatory, wholesale power market based on spot pricing. But Indonesia's case is still far away from such an option.

Although there are such fundamental differences, there are also lessons to be shared.

a. The California case suggests the importance of the system to ensure new supply capacity in the competitive market. In other country, this function can be complemented by various means, namely a capacity obligation on distribution company's purchasing power in market, a parallel capacity market to the energy spot market, or a forward energy trading market whose prices signal expectations about future supply/demand balances. At the same time, the market rule has to be designed so that investors in new supply capacity do not face major barriers to entry to the wholesale power market. These barriers include uncertainty and expense in facing delays to the permitting process, regulatory uncertainties.
b. Indonesia like other developing countries should start with limited forms of competition that can evolve to full wholesale competition. The spot market should not be the priority until the sector can manage full competition.

c. Retail tariffs should be aligned with the costs of wholesale power. A price cap or rate freeze can expose distributors to unsustainable squeeze on their cash flow.
d. Regulators should encourage and even require supplies to take measures for allowing large users to adjust their demand for power in real time, through smart metering and other means, since competition works properly only when both suppliers and users interact in the market.

11.1.3 Institutional Measures in Other Countries

The California crisis mentioned above involves many issues. The section before highlights the issue of (1) incentives of investment into generation and transmission expansion. From the point of power sector liberalization, other important issues to be considered are (2) prevention of the exercise of market power, and (3) supply responsibility.

The liberalization of power sector of Indonesia shares the same issues, which could bring a power sector crisis. For example,

- The result of our study on the optimal power development plan shows that the existing and the planned expansion of the capacity probably cannot catch up the growing demand by the time of MB/MS market;
- In Java-Bali, 80% of market domination by two generators of Indonesia Power and PJB (the dominant buyer PLN has shares) will be a potential threat of market power unless they are restructured;
- Although, Indonesia suffered power shortages in the past, it has not yet established the mechanism and financial means to keep the power supply responsibility or the existing mechanism may not be working.

In this regard, this section briefs the approaches of other countries to these issues focusing on their institutional measures.

(1) Approach of other countries to market mechanism

The market failure of the mandatory wholesale pool model (all or most players are mandated to trade only in the pool market: mandatory pool) experienced in California and in England has caused a shift to give more weight on the model of a combination of wheeling (Third Party Access or TPA in Europe/America) and voluntary pool market (players can trade outside of the pool: voluntary pool).

The mandatory pool was expected to provide the most efficient cost performance of the market with transparent price mechanism through the sustainable and short-term (volatile) spot trade. In reality, however, the structural weakness of the model becomes clear as the market tends to suffer from the exercise of market power by dominant player and as the wholesale price becomes too volatile.

In the combined model of TPA and voluntary pool, most of the power trade is based on bilateral contract through TPA. The primary purpose of pool is limited to send signal of price level of spot market to other power trade contract to align the price with spot market. Because of this limitation, the threat of the dominance of market power and the volatility of wholesale price can be mitigated.

(2) Mechanism for appropriate capacity building

For a power market to be managed stably and efficiently, appropriate mechanism of incentive for capacity building becomes necessary. Namely, the creation of a competitive environment requires the building of enough generation capacity and a fair and an efficient mechanism for the building of transmission capacity, which matches to the power development plan.

- Generation Capacity

Except some country/region, in most of European and American countries, the market participants getting price signals from the generation market are expected to invest into generation market to meet the market demand. Accordingly no special mechanism is employed.

This optimistic view toward the market may be applicable for developed countries where enough generation capacity is available with relatively stabilized increase in demand. However, the application of this view for developing countries would be risky. Namely, without mechanism to secure power supply, incentive to keep the surplus of supply capacity cannot be provided. As a result, as seen California, supply stability deteriorates significantly to cause rolling blackout from supply shortages especially in developing countries where demand growth is high.

In some countries/regions, incentive for generation capacity building mechanism is being employed. For example, PJM in the USA provides incentives for generation market by ruling obligations of reserved capacity for retail supplier and by creating market to trade such supply reserved capacities.

- Transmission Capacity

As for transmission capacity, it has to be considered in line with the generation development planning, fairness of the transmission planning, and congestion of transmission lines.

In most developed countries, independent system operation agency or corporation makes plan and implements the construction as well in discussion with the public authority and interest group in consideration of fairness and mitigation of congestion. In the case of PJM in America, independent system operator (PJM-ISO) is making expansion planning and exercise the right to order the power suppliers who owns the system to construct the transmission lines based on the system operator’s plan.

However, in most developed countries, the mechanism for coordination with generation development planning is not considered because they do not have comprehensive development plan. One exception is the case of France. In France, because the government makes power development plan, the governmental organization “energy commission” is supervising the transmission development planning in line with the power development planning.

(3) Control of market power

The market power in electric power sector has two categories of horizontal market power (ex. The ability of a generating company to manipulate the price through its dominance in the generation market) and vertical market power (ex. The ability of a vertically integrated power company to manipulate the price through its dominance in the transmission market).

For a vertical market power, many countries, which is liberalizing the power sector, is trying to contain the market power through split/privatization or separation of the transmission function from the company.

For a horizontal market power, the measures are different by countries. In UK and USA, the regulatory agency monitors the market to prevent the exercise of market power. If the authority found the exercise, it can order the generating company to pay penalty or to sell power plant. In Germany, large-area connecting lines are installed or connection fees are avoided to keep the appropriate transmission capacity so that the market environment for a new generating company becomes easy to enter to activate the competition in the market and to ease the market power of the existing power company.

(4) Supply responsibility

In general, supply responsibility means the below item 1). However, this section takes from 1) to 3) in wide-sense in consideration of the situation of Indonesian power sector to introduce examples of other countries.

1) Stable Supply (Supply responsibility to existing customers)
2) Rural electrification (Supply responsibility to new customers)
3) Final supply guarantee (Supply responsibility to the customers who cannot contract)

1) Stable Supply

As mentioned before, a mechanism to build generation and transmission capacity is necessary for a liberalized market. For a developing company of weak economic fundamentals, however, even if such a mechanism worked well, it would be very difficult to invite private investment for power generation. Therefore, to secure the supply to meet the high level of growth only by the market mechanism seems very risky. Somebody has to take the final supply responsibility when power shortage becomes serious. For example, in New York States of USA, retail supplier is obliged to have a reserved capacity like PJM and the State itself is authorized to construct generator in case of urgent power shortages.

In the case of France, based on its Power Liberalization Law, the Government makes the multiple-year generating capacity investment plan. It makes plan and if the target becomes difficult to achieve, the Government itself puts the new power development into a tender within the condition of the given place and fuels.

2) Rural electrification and final supply guarantee

Only France has a clear mechanism for the promotion of rural electrification. Its mechanism for rural electrification is aimed not only at the electrification of non-electrified area, but also at a securement of power supply of independent rural system. French National Electric Power Company (EDF) and retail suppliers are responsible for the promotion of rural electrification and final supply guarantee. The cost of the supply is shared by funds from all end users.

As for the final supply guarantee, most countries use the default service. The default service refers to electricity supply provided to those customers that are not receiving service from a competing supplier and the customers who are changing retail supplier. The default service generally charges higher prices. However with this service such customer who cannot get service from the competing supplier is guaranteed to get supply of electricity from retail suppliers.

(5) The Role of a regulatory body

Official supervision and regulations for the proper operations of markets are necessary, and so is the development of general rules in the market. In most countries, official component authorities are responsible for anti-monopoly regulation. On the other hand, organizations responsible for other regulations vary widely between countries. At this point, the roles of UK and US organizations, which are responsible for regulations, excluding anti-monopoly-law, are itemized as follows.

Table 11.1.1 The roles of UK and US regulatory Bodies

	US	UK
Component Authority	Department of Energy ■Initiate Energy Policy ■R & D for Energy	Department of Trade and Industry ■Initiate Energy Policy ■R & D for Energy ■Supervision for Nuclear sector
Independent Regulatory Body	Federal Energy Regulatory Commission ■ Wholesale pricing and willing charge on trans-state power trading ■Wholesale consignation regulation ■Approbation for Independent System Operator ■Approbation of Hydro-power projects	Office of Gas & Electricity Markets ■Approbation of Generation / Transmission / Distribution / Retailing License ■Setting up the license condition ■Regulation on willing charge by price cap
	Public enterprise committee in each state ■Approbation for generation, distribution and retailing ■Approbation for thermal-power plant construction ■Regulation on retail price	

In England and USA, component authorities in the energy sector are responsible for the formation of energy policy and the research and development for energy. The reason is that the formation of energy policy is crucially important for the whole governmental policy and the electric power policy should be consistent with them.

On the other hand, concerning approbation of licenses, independent regulatory bodies are in charge in England and USA. On account of the conditions to obtain the license, independent regulatory bodies have significant influence on each licensed organization. For example, the independent regulatory body can supervise each licensed organization from the viewpoints of unbundling account, prohibition of discrimination on grid access and regulation on generation plant ownership and electricity tariff. If licensed organization would infringe the regulations, the regulatory bodies can penalize them by confiscating their licenses. In USA, transmission grids are operated by Independent System Operator (ISO), not by owners, therefore, ISO, as well as owners, are also required to obtain licenses.

At the same time, independent regulatory bodies are also responsible for issuing licenses for the construction of generation plants. In the USA, FERC, a government level regulatory body, manages the approbation of licenses for hydropower plant constructions, while public enterprise committees in each state are responsible for licensing thermal-power plant constructions. However, ultimate power development planning is led by market mechanisms in almost all the western countries, except France.

On the other hand, concerning the construction of transmission, NGC, a transmission company license by an independent regulatory body, takes the full charges from initial planning to construction in England. In France and Norway, the pre-construction approbation from independent regulatory bodies is required for the construction of the transmission.

Concerning the pricing system, independent regulatory bodies are responsible for regulating the willing charge, which is set by the owners of transmission in England. In the US, FERC is responsible for pricing on trans-state energy trading and public enterprise committee in each state is also responsible for retailing pricing.

11.2 System for Power Supply Bidding with a view to Power Supply Composition

11.2.1 Problems in Past Invitations to IPPs in Indonesia

In 1992 Presidential Decree No.37 was promulgated as a measure to solve the power supply shortage foreseen by the Indonesian government. The decree strongly encouraged private sector participation in power source development projects. By the time of the Asian currency crisis in 1997, purchase contracts had been signed with a total of 27 IPPs. However, the economic depression which began with the Asian currency crisis led to most of the contracts being broken. Under the contracts which were not broken, the currency crisis led to a sharp drop in the value of the Rupiah, causing a severe back spread between the PLN's Rupiah-based electricity sale price and the Dollar-based unit prices for electricity under the contracts with IPPs (approximately 6c/kWh excess). This back spread drastically weakened the PLN's financial position, and it is now reviewing contract unit prices.

The plan to bring in IPPs in Indonesia was intended to use private sector funds to augment power supply development funds, even though they cost rather more, because there was no way to develop sufficient power sources to meet the growth in power demand from public sector funds alone. In order to attract private capital while simultaneously reducing power supply costs, the IPPs were offered attractive terms, but at the same time the IPPs involved had to be chosen with consideration for a balanced power supply composition.

11.2.2 Japan's Wholesale Power Bidding System

The situation described above can hardly be regarded as a success in bringing in IPPs, but the lessons learned from that experience could be employed in a Single Buyer System (SBS), which is being considered for introduction in future. The details of the SBS are now being studied with technical assistance from the WB and ADB. The specifics of the scheme are unclear, but the form of the SBS should be proposed on the basis of past lessons.

This section will introduce Japan's wholesale electricity bidding system as an example for reference in connection with power procurement under the SBS system, which has yet to be clearly defined. The Japanese wholesale bidding power system was introduced with the aim of giving low-cost IPPs the opportunity to enter the wholesale power market as a means of reducing the cost of developing new power sources. Under the wholesale power system, the Japanese power companies play a role relatively similar to that of the single buyer, but the way they obtain new power sources would be of reference in the design of the SBS.

(1) Overview of the system

The Japanese power companies (referred to below as “the power companies”), are permitted to act as regional monopolies, but when they develop thermal power stations, with shorter development periods, they can use bidding to provide cheaper IPPs with opportunities to participate, by using underused private generation equipment. This method is the most notable feature of the system, because it reduces the development cost of new power sources.

The procedure for wholesale power bidding is as follows:

[1] The power companies divide their basic plan for power source development, which is drawn up every year, between sources to develop for themselves and sources to be sought from outside bidders.

[2] The power companies present their bidding terms, including the scope of bidding and the ceiling price.

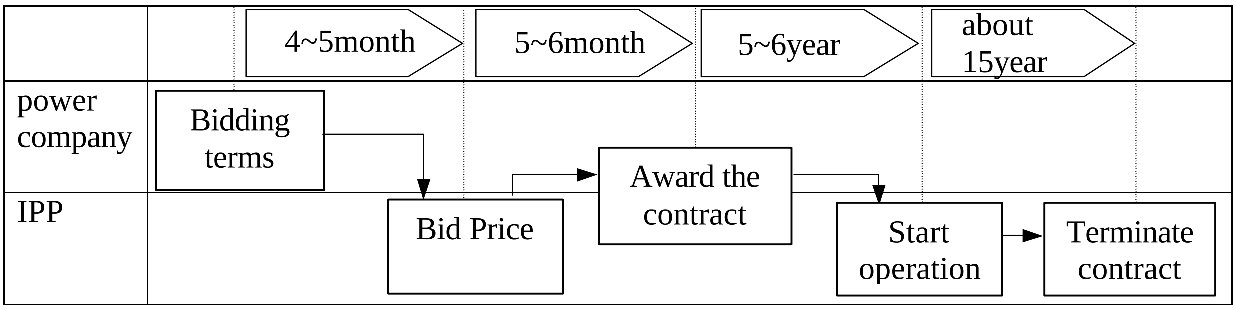
[3] The bids from IPPs are ranked according to generation base cost, proximity to demand centers and other factors.

[4] A long-term sale contract is drawn up with the IPP that made the winning bid.

[5] The IPP starts supplying power to the power company in the financial year of the contract.

Figure 11.2.1 shows an example of a bidding schedule.

Figure11.2.1 Example of a bidding schedule



(2) Bidding terms

There are some differences in bidding terms depending on the power company conducting the bid, but the basic terms are as follows:

[1] Bid prices must be below the ceiling price for each usage rate.

[2] As a rule, supply should be possible over a period of at least 15 years.

[3] Technical conditions for connection to the system must be satisfied.

The main bidding terms are as listed below.

- Usage rate

IPPs must select the usage rates they want, and set bid prices calculated according to the selected usage rate, so that the power companies can accurately evaluate the cost gap arising due to differences in usage rate. The electrical power companies present typical operation patterns in advance for each usage rate.

- Bid ceiling price

For each usage rate, supply is broadly divided into three wholesale supply types, peak, middle and base, and a bid ceiling price is set for each type. The IPPs must bid prices below the ceiling price.

The bid ceiling prices are calculated on the basis of the power supply model envisaged by each power company.

- Solicited bid volume

Based on their basic plans for power source development, the power companies divide the necessary development volume between the portion to be developed by the power companies themselves and the portion to be solicited from bidders. IPP power sources are inflexible power sources within the management of power systems. Therefore the power companies keep their own generation equipment within a range that would be able to secure stable supply in emergency situations and set the volume solicited from bidders accordingly.

- System linkage

The IPPs must meet the technical conditions listed in the "Guidelines to Technical Conditions for System Linkage" in order to ensure the stability of the power companies' systems.

- Miscellaneous

The power companies set conditions such as minimum supply scale, range of variation in power supply, start and stop performance of generation equipment, inspection and repair times for generation equipment, administrative permits and potential for land acquisition.

(3) Criteria for the evaluation of bid prices

There are some differences between the power companies conducting bids, but the basic evaluation criteria include the following:

[1] Bid price

[2] Operating conditions

[3] Proximity to demand centers

[4] Environmental properties

[5] Practicality of the plan

The companies have differing methods for ranking bids according to these criteria. For example, one power company with direct connection to a given company, might assign ranks according to the divergence calculated by the formula below.

Evaluation price (¥/kWh)
= Bid price + system access costs – demand center proximity evaluation.

Divergence
= (Ceiling price – evaluation price) x usage rate (%)/ 100

Chubu Electric Power Company ranks bids according to the price obtained by subtracting the reduction in fuel cost yielded by reducing the company's own generation from the price of electricity purchased from the IPP.

(4) Results

Wholesale power bidding has been conducted under the above system for the last four years. In that period the power companies have solicited a total of approximately 6.6GW of power sources, receiving approximately 200 bids offering approximately 28GW of capacity. As a result, approximately 7GW of power sources have been obtained from IPPs. Individual bid prices are not disclosed, but there is said to have been a considerable divergence between the prices bid by the IPP power sources and the ceiling prices set by the power companies. The scale of the IPP power sources acquired is limited, but the goal of the system, which was to cut the cost of developing new power sources, has been achieved.

11.2.3 Power Source Bidding System taking Power Source Composition into account

As described above, Indonesia's introduction of IPPs was intended to use private sector funds to augment power supply development funds, even though they cost rather more, because there was no way to develop sufficient power sources to meet the growth in power demand from public sector funds alone. In that sense, it differs from the nature of the Japanese IPP bidding system, which was intended to apply market principles to the power sector and reduce electricity charges. Therefore the methods of the Japanese system which appear to be applicable to the future design of the SBS will be summarized below in conclusion.

(1) Expansion of power sources using the power source bidding system

In Indonesia's past introduction of IPPs, the majority of power sources are applied to base load, and the system of soliciting sources from IPPs was certainly advantageous for base load sources. In future, if all power sources are to be developed by the SBS bidding system under the

New Electrical Power Law, a bidding system will have to be introduced with methods that allow peak and middle power sources to compete effectively with base power sources.

Specifically, the power purchase prices will have to be set for the anticipated peak, middle and base power supply types (i.e. equipment usage rates) in order to encourage investment in power stations that will have lower equipment usage rates. Under such a method, there would be progress in expansion of peak and middle power sources.

(2) Power supply bidding system with consideration of power source combination

If peak, middle and base power sources are all targeted for investment under the power source bidding system, the volume solicited and the power purchase prices should be set for each equipment usage rate and fuel type in order to manipulate the power source combination while suppressing electricity charges. Therefore long-term targets for power source combination should be studied with a view to making effective use of primary energy and conserving the environment. It is important to clarify the direction of the nation's power source development in this way in order to provide information on which the private sector can base investment decisions.

11.3 An Approach to Power Development Supporting System in line with Energy Policy

Under the Electric Power Policy, energy development in Indonesia is focused on reduction of use of fossil fuel resources to realize sustainable energy development. New and renewable energy sources are also being introduced as switches in energy use, for the sake of environmental preservation.

The costs of new and renewable energy and environmental friendly gas-fired power are so high that financial and political supports are necessary to be introduced. For example, consideration should be given to the provision of incentives to develop new and renewable energy. Furthermore, there is a limitation for the amount to develop new and renewable energy due to the economical reason. If gas-fired power plants are needed from a viewpoint of environmental preservation, there is also a need for institutional incentives to develop them as well as infrastructure such as gas pipelines. Electric power development supporting systems to introduce new and renewable energy and CDM are studied.

11.3.1 Introduction of New and Renewable Energy Sources

Since usage of each primary energy based on the optimal power development plan has not been fixed yet at this moment, we introduce, in this report, the measures for new and renewable energy promotion, which have introduced in foreign countries.

Under the present situation in Indonesia, the following are the measures to be recommended to introduce new and renewable energy. Systems 1) to 3) are legally regulated, while 4) is self-regulated. These examples are summarized as follows.

1) Obligation to purchase with fixed price

Country	Germany
Energy	Solar power, wind power, geothermal power and hydropower
Background	Based on Electric Power Supply Law revised in 1991, the government ruled that renewable energy was acceptable of connection to the electric power system, and electric power companies ought to buy the electric power from new and renewable energy sources at a fixed price.
Outline	The target is that amount of power from renewable energy should be doubled (to 10% of total energy consumption) by 2010. The expense is passed to consumers' bills without government subsidy.
Evaluation	This system led Indonesia to be No.1 in the world in the amount of introduction of wind power. Since the purchase price is guaranteed, investment increased and generating cost decreased due to mass production. On the other hand, the cost reduction incentive was not promoted.

2) Obligation on the national electric power company to purchase by lump-sum bid

Country	England
Energy	wind power, hydropower, biomass and co-generation
Background	Based on the Electric Power Law enacted in 1990, the government could order local power distributors to secure a fixed quantity of a non-fossil fuel power supply.
Outline	The government contracts the power purchase in bulk of a fixed quantity of non-fossil fuel, and orders to take over it to a local power distributors. The quantity and price are decided at every bid. The government fills up the difference of the purchase price and the wholesale electric power market price. The cost is allocated from the funds for the fossil fuel surcharge.
Evaluation	Although this system produced the expected results in hydropower sector, the disadvantages are that cost reduction incentive was not promoted because construction should be started after the contract, its enforcement efficiency is low (around 50%), and there were some cases that construction could not start. A stabilized price is guaranteed, and the cost to local power distributors is compensated by the fixed price.

3) Quota and RPS (Renewable Portfolio Standard)

Country	California in USA
Energy	Solar power, wind power, geothermal power, hydropower and biomass
Background	Based on the Electric Power Reorganizing law enacted in 1999, the bond system was started in 2001 and a mandatory quota began in 2002.
Outline	2000MW power development is the target for renewable energy by 2009. Retailers set up a quota from the market share of the selling electric power market and it's yearly target. Retailers bear the acquisition of the bond equivalent to its quota and submission of it to the government. Retailers who do not meet their quota are fined. Retailers can add the expenses to electricity bills.
Evaluation	By utilizing the market function which minimizes government intervention, there is the advantage of minimizing expenses. However, only a short time has passed since this system was introduced, so there is no actual result to evaluate.

4) Self-regulated purchase system by the fixed price by Electric Power Companies

Country	Japan
Energy	Solar power, wind power and domestic waste
Background	The fixed price purchase system was launched as an independent effort by electric power companies in 1992.
Outline	This is a self-regulating system which imposes no targets or duties on the electric power companies. A power producer can get a subsidy from the central government or a local government, and electric power companies can pass the difference of the purchase price and a market price onto consumers' electricity bills.
Evaluation	In addition to the self-regulating effort of electric power companies, this system has achieved some success in introducing renewable energy, with assistance of the central government and local government. The purchased power amounted to 70GWh in solar power and 160GWh in wind power. For the further expansion of the amount of installation, a self-regulating effort is inadequate and it is necessary to establish institutional support system, such as introduction of RPS.

Clearly the key point of debate in system evaluations now used by each country is how to reconcile [1] expanded introduction of these energy types with [2] reduction of their costs. The existing systems in Germany and Britain emphasize [1] with legal regulations, and have gained a grasp of the issues involved in evaluation. The US RPS system gave more consideration to [2] through the introduction of market principles, but it is still too soon to produce an evaluation.

In order to identify the optimum system for Indonesia at this stage, it is important for the Indonesian government to clarify its priorities between points [1] and [2]. If it aims to expand the introduction of new and renewable energy sources in the short term, there will be an attendant fiscal burden, but legislative measures could be used to make the use of new and renewable energy sources mandatory. If it aims to reconcile expanded introduction of these energy types with cost reduction in the long term, it will have to await an evaluation of the RPS.

11.3.2 Introduction of Clean Development Mechanism (CDM)

(1) An approach to CDM in Indonesia

The development of large-scale power plants both coal-fired and gas-fired has various problems to be solved. The CDM mechanism will be studied as financial support to promote gas-fired power that discharges lower CO_2 from the viewpoint of environmental conservation and global warming.

CDM is one of the environmental countermeasures of the commercial mechanisms known as "Kyoto mechanisms", which are regarded as a system to promote private investments. In this system, Annex I countries may achieve the allocated targets by the system in economical ways such as by having projects with lower costs to reduce CO_2 emissions in other countries than ones in their own countries, and buying emission credits. Since Indonesia has signed the Kyoto Protocol in 1998, the ratification is necessary to participate the system.

Also in Indonesia, various actions are expected to be taken in regards to environmental preservation and global warming. CDM will play an important role in these efforts. The Ministry of Environment carried out a study in which the marginal abatement costs and the amount of reductions of green house gas emissions were calculated for the proposed power generation projects. Then the priorities were assigned to the various projects. The results are shown in Table 11.3.1. Although large projects are not proposed in the study, the development of gas combined cycle, mini hydropower and cogeneration are given high priorities for CDM and fuel diversification from coal to gas has been recommended.

Table 11.3.1 CDM costs and its priority ranking of project types

	high priority	Medium priority	Low priority
High cost	• Gas turbine • Cogeneration HT Biomass steam		• Geothermal • Solar Termal
Medium cost		• Hydro power	
Low cost	• Gas Combined Cycle • Mini Hydro Power • Low Temperature Cogeneration		

(Source: National Strategy Study on Clean Development in Indonesia,2001)

(2) Possibility of gas-fired power development using the CDM

According to the base case (JICA/LPE Case 2) in the optimal power development study using the least cost method, coal-fired power will have a dominating 57.0% of the installed capacity in 2015. CO_2 emissions are projected to increase to 156.4 million tons in 2015 from 39.6 million tons in 2001.

Although coal-fired power would be given the highest priority due to the lower fuel cost in the least cost method, it would not be reasonable to introduce coal-fired power from the viewpoint of CO_2 emissions. The study on CDM by the Ministry of Environment gives high priority to a gas fired power project as mentioned before. Therefore, the possibility of having the additional cost to replace coal-fired power with gas-fired power plants covered by the third countries or private companies, is going to be considered.

A project that coal fired power with a capacity of 600MW will be replaced with gas-fired power in 2010 is assumed to consist of the following;

Load factor :70%

CO_2 emissions : Coal power 0.982kg-CO_2/kWh, Gas power 0.500kg-CO_2/kWh

Period :5 years from 2008(first commitment period)

Fuel cost : Coal 0.01 US$/kWh、Gas 0.02 US$/kWh

Reduction of CO_2 emissions by replacing facilities:

(0.982-0.500)×600MW×24h×365d×5y×0.7=8.87 Million tons-CO_2

Increase fuel cost:

(0.02-0.01)×600MW×24h×365d×5y×0.7=184 Million US$

CO_2 emissions credit cost:

184 Million US$/8.87 Million tons-$CO_2$＝20.77US$/tons-CO_2

CO_2 emissions cost in Japan, Afforestation & Emission Trading cost overseas are shown in Table 11.3.2.

Table 11.3.2 CO_2 emissions cost in Japan, Afforestation & Emission Trading cost overseas

(Unit：US$/tons-$CO_2$)

Domestic	Fuel conversion(Coal to Gas)	29.5*1
Overseas	Afforestation(Developing Countries)	1.5～14.6*1
	Afforestation (Industrialized Countries)	5.4～29.2*1
	Emission trading	5*2

*1：CRIEPI、1$=130 yen

*2：PCF(Prototype Carbon Fund) average price 5US$/t-$CO_2$

Marginal cost of CO_2 emissions in fuel conversion from coal to gas is 29.5 US$/tons-$CO_2$, considerably high in Japan and the Afforestation Cost and Emission Trading Cost have a wide range as shown in Table 11.3.2. It may provide competitive prices if the high CO_2 emission factor in Indonesia are improved.

Table 11.3.3 Total Generated Power and CO_2 Emission

Item	Indonesia (2001)	Chubu Electric Power Co.,Inc (FY 2000)
Total generated power(million kWh)	81,159	123,000
CO_2 Emission factor(kg-CO2/kWh)	0.658	0.403
Total CO_2 Emission (million tons)	53.40	49.54

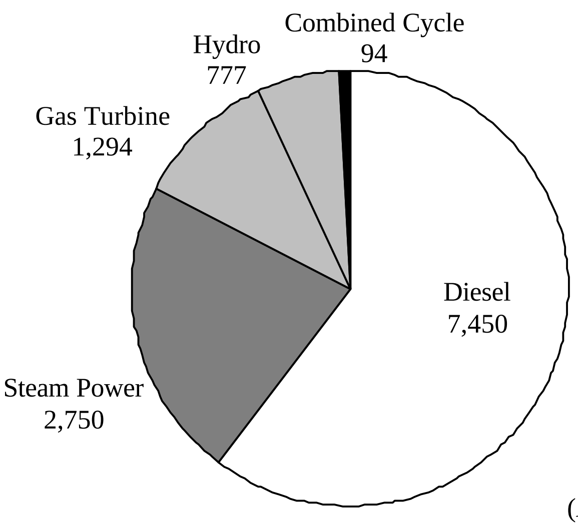
There are a number of fundamental issues to be discussed for the implementation of CDM. For example, effective demand for CDM emissions offset, type of projects, the price of emission credits and credit distribution between the countries are being discussed. Therefore further study on CDM is necessary.

11.4 Utilization of Captive Power

11.4.1 Present Status of Captive Power

Captive power shares about 30% of installed capacity in Java-Bali system, which will make an impact on electric power development plan. In this section, present status and movement of captive power are studied for the power development plan.

Captive power has a long history and the growth of captive capacity is closely related to PLN's capacity growth. From 1982 to 1989, PLN's installed capacity grew sharply, 15.1% per year. This allowed the increasing demand to be met and thus, captive growth was low, only 3.6%. PLN's capacity exceeded the captive capacity in 1986. From 1898 to 1994, PLN and captive capacity grew 9.5% and 9.1% respectively. Captives also grew in areas where transmission capacity was limited. During 1994 to 1997, Captives grew at 4.4%, less than the 9.8% of PLN. The completion of the northern route of a 500-kV transmission line allowed the demand on Java-Bali to be met. Captives were still installed for cogeneration and back-ups. Captive capacity by type of plant and sector is shown in Figure.11.4.1 and 11.4.2.



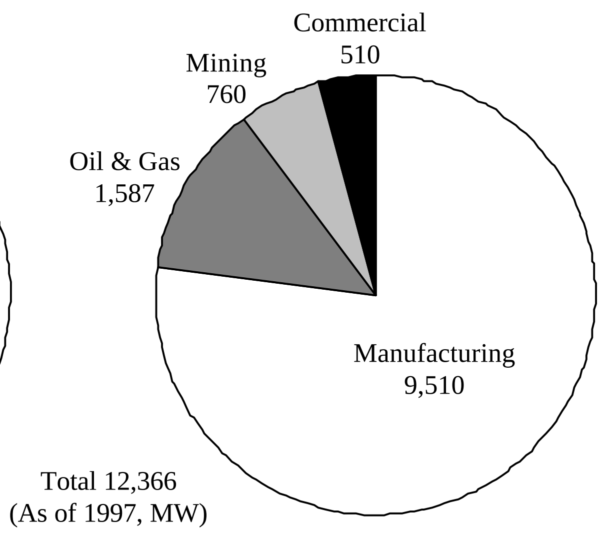


Fig.11.4.1Captive Installed Capacity by Type of Plants

Fig.11.4.2 Captive Installed Capacity by Sector

There are two types of captive power: main power and supplementary power. Main power captive plants are not connected to PLN. The owners have to rely on captive power for economic or reliability reasons. On the other hand, supplementary power is installed for back-up reasons. Captive installed capacity in Java-Bali system is 7,793MW, which is more than 30% of the total capacity of 23,285MW(PLN and captive).

Table 11.4.1 Captive Power Installed Capacity in Java-Bali

	Installed Capacity (MW)
Main Power	1,835
Supplementary Power	5,958
Total	7,793

(Source：PLN Statistic 2000)

Captive generation is estimated although no operation data is available. Accordingly, captive generation was 39.1 TWh in 1997 compared with PLN's generation of 73.1 TWh. Sumatra ranked first with 16.2 TWh and Java-Bali ranked second with 15.5 TWh.

The reasons to introduce captives are as follows.

1) PLN could not supply power
2) Partial back-up for grid supply failures
3) High outage costs and unreliable grid supply
4) Captive costs less than PLN supply

1) will be the main reason but it depends on the consumer's requirement, reliability or electricity price, for example. One of the short-term countermeasures is to purchase power from captives. Among main power captives, those who have surplus power will be the candidates. The availability of facilities to connect to the PLN grid and the conditions (price) will be consideration points. Supplementary power has a large total capacity of 6,000MW, but each power plant is small and with low efficiency. Fuel tanks are small so that fuel supply would be problematic during continuous operation.

PLN conducted a survey regarding purchasing power from captives in 2001. Based on the survey, PLN's target is to buy 250 MW of power from captives in Java-Bali area and it is now in negotiations.

The problem is that the actual condition of captive power plants is not clear. Data is provided by DGEEU, PLN and BPS(Indonesia Bureau of Statistics), but the reliability of these data is not high since numerical data is different among them in the same items. DGEEU and PLN have statistics of installed capacity. BPS has statistics of generated power but it does not cover whole captive power plants. Therefore generated power of captive power plants should be estimated.

DGEEU is the licensing agency of captive power plants with installed capacity of 200kVA or more. However, DGEEU does not have the latest data because the data has not been updated in case of disuse or transfer of the plants and registration service was transferred to regional government because of decentralization from 2001.

11.4.2 Demand of Captive Power with a Fluctuation of Price of Electricity and Fuel

Captive power will be installed as main power when there is a shortage of PLN power, and it will be installed as supplementary power when the power supply is unstable. Consumers who need reliability switch to PLN when the PLN supply becomes stable. Consumers who need low electricity prices switch to PLN when the PLN tariff is still low or fuel prices are high. This can be said generally but there are differences among consumers. The volume of switching can not be estimated because the amount of captive generation is not available.

We will try to calculate the generating cost of captive power and compare it with the tariff of PLN. The calculation is made under the conditions as follows;

- Installed capacity(Diesel) 1,000kVA
- Capital cost US$500,000(US$ 500/kW)
- Lifetime 20years
- Capacity factor 50%
- Discount rate 12%
- Fuel consumption 0.28L/kWh
- Fuel price Rp.1,110/L(present)、Rp.1,830/L(subsidy is removed)
- O&M Rp.118/kWh
- Exchange rate Rp.10,000 to US$

Under the conditions above, generating costs of captive power are shown in Table 11.4.2. In case of new installation, the cost is higher than PLN's present tariff of Rp.371 for Industry (I-4), but it is lower than the tariff which is scheduled to be doubled in 2005. On the other hand, in the case of existing captive which exclude investment costs, the costs are different and depend on the fuel price and tariff schedule.

Table 11.4.2 Comparison the costs between captive power and PLN (Rp./kWh)

Fuel price	Captive power cost		PLN Tariff(I-4)
	Newly installed	Existing	
Rp.1,110/L(with subsidy, present)	Rp.579	Rp.426	Rp.371(Present)
Rp.1,830/L(without subsidy)	Rp.841	Rp.688	Rp.742(Target in 2005)

11.4.3 Recommendations

(1) Data management

The organization should be strengthened to grasp the actual situation of captive power, which affects on the national electric power development plan. MEMR, the responsible agency for licensing of captive power plants, is recommended to manage the data as previous. Although the registration service was transferred from DGEEU to provincial government, these data is recommended to be reported to DGEEU of MEMR and managed by MEMR. MEMR is recommended to give an obligation to captive owners to report fuel consumption and generated power to MEMR periodically, and also disuse or transfer of the plants.

(2) Arrangement of power purchase conditions

Power purchase from captive power has been studied for short-term countermeasures against power deficit. It is needed to arrange technical purchase conditions such as quality and safety, as well as tariff system. In the case of power purchase from existing captive power, selling conditions of captive owners are different so that tariff system should be met in these conditions. The surplus power purchase will offer more reasonable price than newly construction within short time. It will be an idea to give an incentive on the purchase tariff and to give subsidies to connection work. The study to secure the fuel and its transportation is necessary.

(3) Information on captive power demand

It is important for MEMR to collect captive power demand data in private companies as well as to provide accurate supply and demand forecast of power. The private companies may install captives for own defense, depend on the situation, based on the provided information. The stable power will be supplied by reflecting the movement of captive power to the electric power development plan.

11.5 Utilization of Demand Side Management (DSM)

To ensure the stable power supply in Indonesia, it is important to properly control power demand which reflects the power resources as well as to develop power resources.

In this report, DSM implementation issues will be analyzed by examining the power demand and DSM experience in Indonesia, Thailand, Philippine and Japan. Then institutional countermeasures for implementing DSM program in Indonesia will be proposed.

11.5.1 The Outline of DSM

The concept of DSM promotes effective use of energy, environmental preservation and electricity tariff stability through cooperation between the power supplier and the consumer. In other words, DSM not only has direct benefits to both the power supplier and consumer, but also social and economic benefits. Therefore, it is said that DSM is an indispensable system for the power sector.

For example, DSM will be expected to reduce the electricity costs of the consumer by decreasing power consumption and the generation costs of the power supplier by improving load factor and restraining investment in new power development projects.

DSM will also be expected to result in improvements in energy efficiency and environmental preservation as a national and/or regional benefit. In resource producing countries, improved energy efficiency through DSM can result in additional benefits, such as, an increased amount of export bound resources.

Indonesia has been promoting policies to improve efficiency in the energy and power sector, such as the restructuring policy that encourages effective usage of domestic resources and enhanced efficiency of the whole power sector. Implementing DSM in Indonesia is significant, because DSM 's benefits are consistent with the above policy objectives.

11.5.2 Characterization of Power Demand in Indonesia

(1) Daily load curve

Power demand in Indonesia has been increasing constantly, excluding the power crisis in 1991 and economic crisis from 1997 to 1998. As this report discussed in Chapter 7, load factor as of 2000 remained at 69.9% which is comparable with the other ASEAN countries.

Based on Figure 11.5.1, peak demand has increased and sharpened.

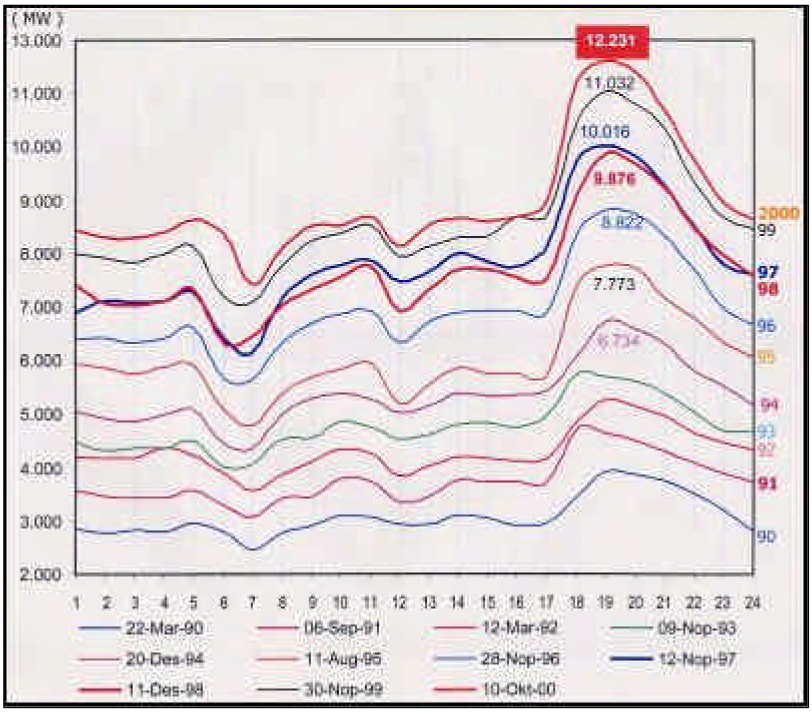


Figure 11.5.1 Trend of daily load curve (Source: PLN)

(2) Evaluation of power demand analysis

Table 11.5.1 shows the result of analysis of peak demand over 1,000 hours.

Table11.5.1 Result of analysis of peak demand over 1,000 hours

Period of year		Time-of-day		Day of the week	
Jan ~ Mar	155	17:00	0	Sun.	47
Apr ~ June	244	18:00	154	Mon.	137
July ~ Sep	316	19:00	333	Tue.	181
Oct ~ Dec	285	20:00	313	Wed.	181
		21:00	200	Thu.	171
		22:00	0	Fri.	149
				Sat.	134
Total	1,000	Total	1,000	Total	1,000

Based on the results for Period of year, peak demand occurs in all months especially between July and December. Based on the results for time-of-day, peak demand occurs only between 18:00-21:00. Based on the results for day of the week, peak demand of weekends is less than of weekdays. The results of time-of-day show a more conspicuous trend than the other results. Therefore the DSM options which decrease demand between 18:00-21:00 mainly caused by the electric lights are reasonable as a "Peak Cut" type of DSM. That is why DGEEU of MEMR is very keen to install the efficient type lamps in household.

11.5.3 Past DSM Program and Current Status

(1) Past DSM program

Indonesia launched the first DSM program that was recognized as a national energy conservation program in early 1980 with a national awareness campaign. In 1987, the Government of Indonesia established PT. Konservasi Energi Abadi (KONEBA) with financial assistance from the World Bank. KONEBA has played a significant role in data base development, human resources development, information dissemination and energy audit services to the industrial facilities. In accordance with the development of the energy conservation program, several government agencies and committee were established in the GOI to prepare energy-related guidelines and regulations.

In 1992, the DSM action plan was reported to the Ministry of Mines and Energy with assistance from USAID. It had the purpose of reducing generation costs and improving power quality. Based on this program, PLN had been implementing a pilot project until the economic crisis of 1997.

The proposed DSM options still seems to be applicable, since the shape of the daily load curve in the Java-Bali area used in this action plan is similar to that of 2000. The proposed options are shown in Table11.5.2.

Table 11.5.2 Proposed DSM options in DSM Action Plan of 1992

Sector	Options
Industrial	Installation of high efficiency lighting, Installation of high efficiency motor, Introduction of Time-of-Use contract, Introduction of Load Adjustment Contract, Consulting Service on energy conservation, Rotating black outs to the captive power users, Purchase of surplus power from captives
Commercial & Public	Installation of a high efficiency air conditioner, Installation of high efficiency lighting, Consulting Service on energy conservation, Installation of heat storage facilities
Residential	Installation of a high efficiency refrigerator, Installation of high efficiency lighting, Installation of high efficiency TV & A/C, Reduction of energy loss in houses

(Source：Indonesia Demand Side Management (USAID, November 1992))

(2) Current status

The DGEEU staff of MEMR, which is in charge of energy conservation, said that the previous DSM program was suspended after the economic crisis of 1997. Until now, although DGEEU appreciates the significance of DSM, it has not been able to implement substantial DSM programs because of financial issues in the GOI.

Given this situation, DGEEU is now planning or implementing following three programs,

- National awareness campaign in Yogyakarta through the mass media and workshops between local governments, universities and NGO's,

- TERANG program which aims to reduce demand by installing compact fluorescent lamps (CFL's) in household, and
- PJU program which aims to reduce demand by installing efficient lamps in public lighting.

Among these programs, TERANG program will be explained in detail at following section, because DGEEU is actively supporting this program proposed by three electric manufacturers.

1) Philips

Target area: Urban area in East Java (Surabaya, Semarang, Denpasar etc)

Target sector: R1 customer

Project summary: To replace 1 million 40W common type lights with Philips's 8W CFL's.

Project structure: Tentative structure is shown in Figure 11.5.2.

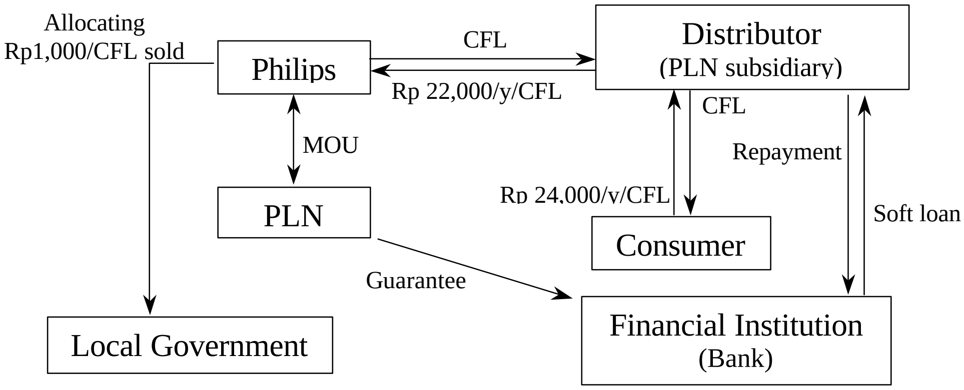


Figure 11.5.2 Tentative project structure (as of February 2002)

Project flow:

a) PLN and Philips sign the MOU on supply of CFLs and support for selling CFLs.

b) Philips supplies CFLs to the distributor established by PLN at a price of Rp 22,000.

c) The distributor purchases CFLs with a bank loan, and supplies the customer through the cooperatives at a price of Rp 24,000. If damaged, CFLs can be replaced repeatedly for up to a year. The distributor's profit of Rp 2,000 is available for operation cost, debt service, etc.

d) PLN guarantees the distributor's repayment to the financial institution.

e) Philips allocates Rp 1,000 per CFL sold to the local government to implement a national awareness campaign.

Although the total project cost is unknown, installation of 1 million CFLs worth US$ 2.2 million (Rp 22 billion) will reduce peak load by 320 MW. In spite of this project being due to start in 2002, it will be delayed because of financial issues.

While DGEEU plans nationwide expansion of the same kind of design, they assume there will be a peak load reduction of 320 MW if 10% of R1 customers, 25 million households, replace four common type lights with four CFLs.

2) General Electric company (GE)

This project design is similar to the Philips project. The project aims to install CFLs in 75,000 households in urban areas such as Bogor, Bandung and Yogyakarta. It is due to start in 2002. This project seems to be going smoothly, because there is no need to find financial support from banks.

3) OSRAM

OSRAM, the electric light manufacturer, will supply CFL's to consumers in Tangerang and Palembang. In December 2001, PLN and OSRAM signed an MOU for this project.

11.5.4 DSM Practices in Other Countries

(1) Thailand

In Thailand, EGAT has been working on the DSM program since 1993. Nineteen programs are under way with a budget of US$ 200 million. The Demand Side Management Office (DSMO) established in EGAT with about 170 employees is the organization in charge of carrying out DSM programs. Table 11.5.3 shows the DSM pilot programs implemented in Thailand until 1996.

Table 11.5.3 DSM pilot programs in Thailand.

Items	Activities
Installation of high efficiency lighting	* Promote high efficiency lighting in cooperation with manufacturer * Bulk purchase of lighting and resell to the market
Installation of high efficiency refrigerator	* Promote high efficiency refrigerators by labeling their efficiency in cooperation with manufacturer
Installation of high efficiency A/C	* Promote high efficiency A/C by labeling its efficiency in cooperation with manufacturer and providing rebates to the retailer
Energy audit service for office buildings	* Energy conservation consulting for office buildings * Provide no interest loan for the building owners

(Source：DSM in Thailand: A Case Study (UNDP/WB ESMAP, October 2000))

In addition, the following projects have been carried out since 1996.

a) Consulting service on energy conservation to hotels, buildings, and factories

b) Introduction of high efficiency motors（HEMs）

c) Educational activities on energy conservation for small and medium sized enterprises

d) Introduction of heat storage system

(2) Philippine

In the Philippines, which lacks sufficient natural resources, the Department of Energy (DOE) mainly has implemented various activities, including DSM for energy conservation. DOE has implemented the preparation of electric appliance efficiency standards and an energy-labeling program in cooperation with the Bureau of Product Standard and the Association of Home Appliance Manufacturers.

Table 11.5.4 On-going DSM program

Item	Contents
Regulation of energy efficiency and energy labeling	*Preparation of energy efficiency standards for window air-conditioners (from 1993), refrigerators (from 1999), fluorescent lamp ballasts (from 1999) and electric motors. *Labeling of electric appliances with their energy efficiency ratio.
Guideline for energy conservation design for buildings	*Publication of guidelines for energy conservation design for buildings and utility systems, a referral code of the National Building Code in 1994. *DOE is currently conducting a study to effectively implement the building standards.

(Source：DOE Homepage)

In addition, the following DSM alternatives have been designed in the Long-term Power Planning Study for the Philippines.

a) Installation of high efficiency fluorescent lamp in all sectors

b) Introduction of Interruptible / Curtailable Agreement (Load Adjustment Contract)

c) Installation of high efficiency and variable speed drives motors

d) Installation of high efficiency electric appliances in residential and commercial sectors (window-type air conditioners, refrigerators, fans and CFL's)

e) Installation of high pressure sodium street lamps

(3) Interruptible / curtailable Agreement (Load adjustment contract) in Japan

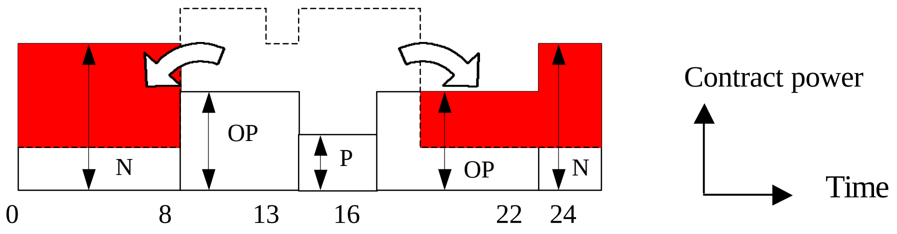
Load Adjustment Contract (LAC) seems to be applicable to Indonesia among other DSM programs in Japan, because the initial cost to implement LAC is relatively low. Therefore, this section will introduce the LAC implemented in Japan. Under LAC, customers have the obligation to reduce their demand during peak load time in exchange for being provided with discounted electricity tariffs. LAC are made with specific customers in order to control their demand. LAC is classified into the following three types of contracts.

- Annual Load Adjustment Contract

The customer must control its demand according to the load curve or the contract power previously defined in the LAC in exchange for special discounted tariffs.

In Japan, contracts are updated annually with customers and the load curve pattern or contract power amount is decided on a monthly basis. Under such contracts, power demand is expected to shift to midnight. Customers who operate their facilities all day are most applicable. Figure 11.5.3 shows an image of an Annual Load Adjustment Contract involving contract power.

Figure 11.5.3 Annual Load Adjustment Contract

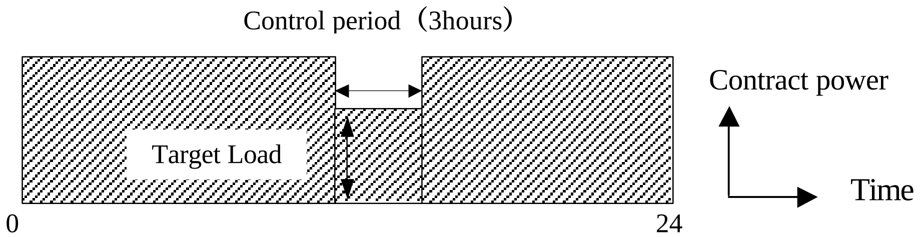


Legend
N : Contract power for nighttime
OP : Contract power for off peak time
P : Contract power for peak time

- Interruptible Load Adjustment Contract

The notice for demand control from the power company to the customer is issued immediately or 3 hours in advance. When customers accept this contract, a discounted electricity tariff can be applied. If customers reduce their demand in response to the notice, they can receive extra discounts.

Figure 11.5.4 Interruptible Load Adjustment Contract



- Load Management Contract

The main differences between this contract and the others are that: 1) the customers can decide the times to adjust their load among the special days contracted with the power company; and 2) the discount can be applied according to the result of their demand control.

In Japan, the special days are set up at weekdays in the summer, because the annual maximum peak often occurs during this period. The special discount can be only applied to the customers who reduce their load by adjusting their production schedule or their holidays.

11.5.5 Analysis of the Issues and Recommendations

The introduction of DSM could provoke several technical, financial and systemic issues. In this section, we are going to analyze these problems, focusing on common points among all DSM programs.

(1) Development of governmental organization and its capacity

In accordance with the restructuring of energy sector, PLN is going to be divided into generation, transmission and distribution sections. At this point, it can be assumed that the responsibility of government will increase as a leading organization in DSM in various ways. For example, concerning the introduction of energy saving oriented DSM programs, parties such as the following are required:

1) Organizations which collect and administrate detailed data, such as load curves and the diffusion rates of electric appliances,
2) Specialists who analyze the data and formulate and evaluate plans for the introduction of DSM,
3) Organizations which support technical roles to formulate standards for electric appliances and examine and evaluate them

are required. In order to keep up with these additional functions, governmental organizations should be developed. In this connection, PLN already set up DSM Implementing Team in every distribution units.

(2) Financial support to implement DSM programs

The introduction of energy saving oriented DSM programs, such as the introduction of highly efficient electric appliances, requires large initial costs for purchasing equipment.

On the other hand, because diffusion rate of highly efficient electric appliances depends on incentives to customers, it could take some time and funds to be widely accepted. Therefore, it is likely to face the same financial difficulties as on-going DSM model project in Indonesia.

At the same time, these energy saving oriented DSM programs are not attractive for energy suppliers because it may result in the decrease of their income. Therefore, governments tend to support the project financially by public funds. However, in the case of Indonesia, both government and PLN could not afford financial support for the project. And there are some objections which even if energy saving oriented DSM is installed, the consumer does not reduce demand because of low electric tariff in comparison with the other countries. So, it is difficult to provide funds for promoting DSM and to invest to DSM projects at present.

Considering these circumstances, it is to be desired that financial assistance such as 'soft loans' are prepared, based on the analysis of installation costs and expected effects, after technical assistance to support organizational development.

(3) Further discussion for DSM under power sector liberalization

In order to introduce a demand-control oriented DSM program such as Load Adjustment contract and Time-Of-Use contract, power suppliers are required to be responsible for the supply of power on the basis of contracts and systems. However, in the case of Indonesian framework of power sector liberalization, there is no power supplier who is capable of meeting that responsibility. Because sales units and generation units governed by PLN Pusat will be split into individual companies, sales units expected to be responsible for promoting demand-control oriented DSM does not have power supply capacity to execute the obligation to meet demand of the customers. As a result, it is feared that these demand-control oriented DSM programs cannot be organized.

In DSM developed countries such as US, investment towards DSM has been decreasing since the implementation of liberalization. Therefore, it may be necessary to discuss methods and actors to promote DSM programs at the formation of liberalization plans in Indonesia.

11.6 Financial Enhancement of PLN

The purpose of this section is to identify the financial problems and to provide suggested remedies for them through the financial analysis of PLN before and after the economic crisis of 1997-98.

11.6.1 Financial Analysis

The following analysis is based on PLN's financial statements from 1996 to 2000 and the Annual Report of year 2000.

(1) Profit (Income) and loss statement: Changes in profit and loss and their causes

Table 11.6.1 shows profit (income) and loss statement for PLN.

Table 11.6.1 Profit (Income) and Loss Statement

Income and Loss (in million IDR)

Description	**Jan 1 '96 up to Dec 31 '96**	**Jan 1 '97 up to Dec 31 '97**	**Jan 1 '98 up to Dec 31 '98**	**Jan 1 '99 up to Dec 31 '99**	**Jan 1 '00 up to Dec 31 '00**
Electricity Energy Sales	9,418,269	10,877,278	13,766,222	15,670,552	22,139,883
Other Operational Revenues	227,724	248,822	269,794	326,566	416,780
Total Operational Revenues	**9,645,993**	**11,126,100**	**14,036,016**	**15,997,118**	**22,556,663**
Electric Energy Purchases	183,236	325,162	1,885,963	5,082,703	9,395,365
Generating Expenses	5,042,177	6,278,167	11,982,274	12,792,910	13,444,380
Use of Maintenance Materials	557,504	595,611	602,894	678,054	1,031,249
Other Operational Expenses	1,930,120	2,250,813	2,337,643	2,949,011	3,344,827
Total Operational Expenses	**7,713,037**	**9,449,753**	**16,808,774**	**21,502,678**	**27,215,821**
Operational Loss/Income	1,932,956	1,676,347	(2,772,758)	(5,505,560)	(4,659,158)
Non Operating Expenses(Net)	(754,541)	(2,255,361)	(6,382,787)	(5,348,228)	(19,331,236)
Loss/Income before Income Tax	1,178,415	(579,014)	(9,155,545)	(10,853,788)	(23,990,394)
Deferred Tax			(390,077)	(514,293)	(620,975)
Net/Loss Income	**1,178,415**	**(579,014)**	**(9,545,622)**	**(11,368,081)**	**(24,611,369)**

PLN's income and net profit (loss) changed drastically after the economic crisis as can be seen from the profit and loss statement. For the last four years PLN's net loss after tax sharply increased each year. This huge loss was mainly due to the significant increase in operating expense and other expense, though its revenue continued to grow in that period. The increased revenue was mainly due to electricity sales through the growth of number in the PLN's customers and the rise in electricity tariffs.

Before the economic crisis, operating expenses increased by 23% in 1997 compared to 1996. At the onset of the crisis in 1998, they increased significantly by 78% from the previous year, followed by an average increase of 27.5% for each subsequent year. A comparison between operating expenses and revenues shows that revenues were higher than operating expenses in 1996 (pre-crisis) but from 1998 until 2000 revenues were lower than operating expenses.

Operating expenses consist of electricity power purchasing, purchasing of fuel & others, fixed asset depreciation, human resources, maintenance, and others. Purchasing of fuel constitutes the biggest part of total operating expenses. Those purchases increased by 29% in 1997, by 116% in 1998, and 3% and 7% in 1999 and 2000. The increase was mainly due to the rupiah depreciation, since most of those purchases were US$ denominated.

Purchase of electricity also significantly increased from 1999. This was a result of the Power Purchase Agreement/PPA and Energy Sales Contract/ESC signed with 27 private electricity developers (Independent Power Producers/IPP) signed in 1997. The main problems in those contracts are: (1) Rupiah depreciation against US$, (2) rupiah risk for PLN but not for IPP under the terms of those contracts.

The net income decrease has another cause, namely the net increase in non-operating expenses especially in year 2000. This was mainly caused by the increase in interest expense and financial charges (including fines due to late of installment and loan maturity) as well as foreign exchange losses. The expense and charges consist of interest expenses and charges in two-step loan, bond, and government and bank loans.

(2) Balance sheet: Changes in assets and liabilities and their causes

Table 11.6.2 shows the balance sheet for PLN

Table 11.6.2 Balance Sheet

Balance Sheet: Assets, Equity and Liabilities					(in million IDR)
Description	**Dec 31, '96**	**Dec 31, '97**	**Dec 31, '98**	**Dec 31, '99**	**Dec 31, '00**
Net Fixed Assets	29,839,075	42,529,494	51,394,967	51,819,420	52,641,089
On Going Construction	18,209,388	13,996,672	14,291,320	13,481,256	14,227,264
Fixed Assets	48,048,463	56,526,166	65,686,287	65,300,676	66,868,353
Share Investment	23,000	42,000	57,080	29,219	26,157
Other Assets	835,002	922,721	1,731,969	1,432,878	2,355,922
Current Assets	3,677,332	3,017,422	6,985,014	6,456,711	8,744,625
Cash & Cash Equivalent Treasury	1,653,057	896,507	4,013,967	2,929,692	4,645,442
Inventories	646,040	5,993,110	770,596	844,021	915,414
Trade Receivables	1,058,162	1,255,832	1,597,750	1,728,766	2,721,180
Other Current Assets	320,073	265,773	602,701	954,232	462,589
Total Assets	**52,583,797**	**60,508,309**	**74,460,350**	**73,219,484**	**77,995,057**
Equity	29,220,018	30,271,943	23,395,070	12,692,692	18,625,103
Deferred Revenues	2,458,208	2,847,458	2,972,169	3,076,638	3,234,451
Long term Liabilities	17,398,537	22,538,980	30,259,397	27,727,899	34,251,746
Short term Liabilities	3,507,034	4,849,928	17,833,714	29,722,255	21,883,757
Total Equity and Liabilities	**52,583,797**	**60,508,309**	**74,460,350**	**73,219,484**	**77,995,057**

As a whole, total assets continued to grow, though the rate of growth has slowed since 1998. This is because PLN has had to expand buildings, power plant installations, transmission equipment, and distribution equipment to maintain the power supply. However, the equity decreased significantly in 1998 complemented by an increase in liabilities.

PLN’s fixed assets constitute around 90% of its total assets. In order to meet the ever-increasing demand for electricity, PLN has continually increased its capacity by the addition of power plants and transmission lines along with expansion of the distribution network. The capacity increase is reflected in the increase of construction in progress. The investment in power plants gradually increased until year 2000, with particularly rapid growth at the end of 1997. Investment in distribution continued. Investment into transmission equipment also increased during the last five (5) years with the exception of 1999.

PLN's fixed assets are stated at cost less accumulated depreciation. Most fixed assets above were provided by foreign currency loans. Based on PLN's accounting policies, foreign currency loans were adjusted to reflect the middle rate of export, which is published by Bank Indonesia, and then the resulting gains or losses were credited or charged to current operation (gain and loss foreign exchange account).

Normally, fixed assets should be recorded at cost (including imported fixed assets) less accumulated depreciation in current value. As compared to the funds of imported fixed assets, the cost of fixed assets in current value must differ from the updated loans in foreign currencies. This difference would be booked as gain/loss on foreign exchange, in 1996 the value of rupiah was four times that of 2000. By the same token, because the value of imported fixed assets dominates the total value of fixed assets, and also to balance imported fixed assets and foreign currency loans, it is recommended that PLN propose to the Government of Indonesia revaluation of its fixed assets.

Next are the current assets. Cash and equivalent have fluctuated every year because of the need to provide funds for interest payment. PLN holds almost 100% of its cash and equivalent in rupiah. If PLN had held cash and equivalent in US$ and other currencies, not rupiah, the company could have avoided the increase of funds needed for interest payment. Holding cash and equivalent in US$ and other currencies would reduce the risk of further rupiah depreciation, given that most of PLN’s expenditure is US$-denominated and that the company is repaying loans.

As regards other assets, non-operating assets took up 49.2%. Non Operating Assets increased significantly by 375% in 1998 and 107% in 2000. This account mentions PLN's fixed assets that temporarily cannot be used/operated due to their physical condition. Thus, they would not be depreciated until the assets are once again operational. In fact, the problem is primarily attributed to incomplete power transmission. This account reflects the inefficiency of PLN’s investment in fixed assets.

Liabilities have been higher than shareholders’ equity since 1997, though they declined slightly in year 2000. In terms of maturity dates, these funds were divided into two categories: short-term liabilities and long-term liabilities. Since 1997, the increase is prominent in short-term liabilities. The short-term liabilities were due to trade payable, notes payable, pension fund liability, tax payable, accrued expenses, current maturity long-term liabilities, and other current liabilities. The increase in short-term liabilities is attributed to trade payables, accrued expenses, two-step loans to mature in the current year and bank loans to mature in the current year. The trade payable occurred because PLN has bought electricity power from third parties and some products and services from related parties such as Pertamina, PT. Tambang Batubara Bukit Asam, PT. Allied Indo Coal, and PT. Telkom. Accrued Expense occurred because of some financial charges arising from two-step loans, government loans, interest expense of bank loans and bonds.

Long-term liabilities dominate total PLN Liabilities. Since the growth in short-term liabilities is higher than that of long-term liabilities, the share was larger before the economic crisis with about 83% in 1996 and 1997, and in the following years by 63%, 48% and 61% respectively. The increase was primarily caused by the growth in two-step loans and the by rupiah depreciation.

Equity is another important factor. Based on an extraordinary shareholders’ meeting in January 1998, PLN issued shares worth Rp 1 million to increase its paid up capital from Rp 13 trillion to Rp 17.3258 trillion. The increase in paid up capital by Rp 4,325.8 billion was generated from the capitalization of additional paid-in capital that came from the net effect of liquidation (the liquidation from PERUM to PT). The changes in the company’s equity over the last five years can be seen in Table 11.6.3.

Table 11.6.3 Total Equity (In billion rupiah)

	1996	1997	1998	1999	2000
Issued & Fully Paid Capital	13,000	13,000	17,325.80	17,325.80	17,325.80
Additional Paid-in Capital	13,862.57	15,528.08	13,480.96	15,446.21	45,960.02
Retained Earnings	2,357.45	1,743.86	(7,411..68)	(20,079.32)	(44,660.71)
Total Equity	29,220.02	30,271.94	23,395.07	12,692.69	18,625.10

In order to meet customer demand for electricity, PLN equity in year 1997 increased by 3.6% to Rp30.271 trillion, generated from the government of Indonesia as well as its retained earnings. In 1998 and 1999, its equity decreased by 22.7% and 45.8%, which was mainly due to the significant net loss experienced. In 2000, the equity then increased again by 46.7%, due to the financial restructuring conducted whereby the interest arrears and the penalty of the two-step loan were converted into government equity.

As a conclusion of profit and loss statement comparison before and after the economic crisis, the most remarkable point is the fact that PLN has suffered from red ink since the crisis. The company began to report losses in 1998 with its retained earnings falling into the negative territory in the year in tandem with loss reporting since 1997, and reported an accumulated loss of Rp 44 trillion in 2000. The huge accumulated loss exceeded shareholders equity as of 1999. PLN would have gone bankrupt without debt-equity swapping by the Indonesian government in 2000.

Table 11.6.4 Changes in Internal Reserves (Retained Earnings) in PLN (in Rp Billion)

Year 1996	Year 1997	Year 1998	Year 1999	Year 2000
2,357	1,744	(7,412)	(20,079)	(44,661)

Source: Audited F/S

The remarkable increase of expenses on the balance sheet was caused by fuel costs, electricity power purchase from IPP and interest payment on increased foreign currency-denominated liabilities, as the following table shows. In accordance with the higher expenses, electricity power supply per cost or cost efficiency in 2000 stood at below one third compared to the level in 1996.

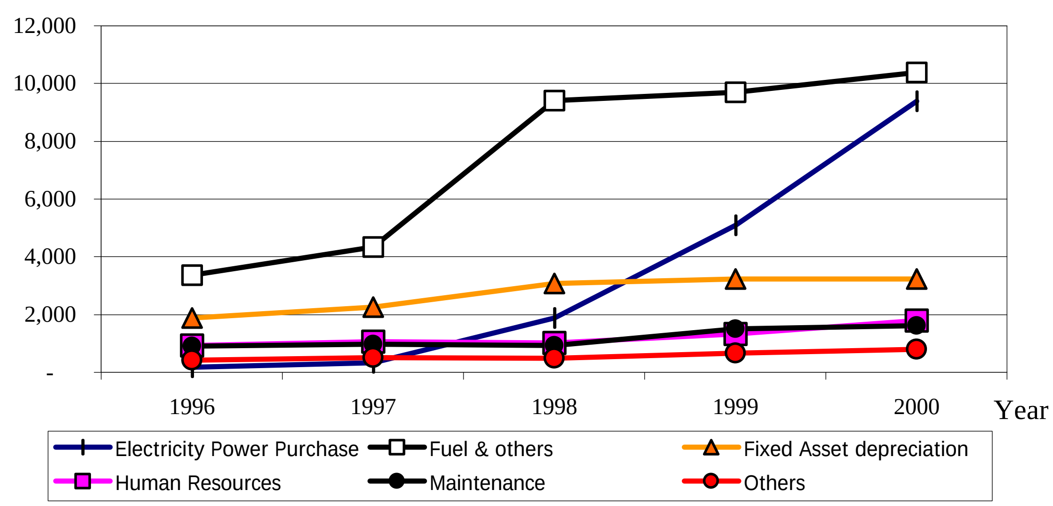
Table 11.6.5 Cost Efficiency (kWh/Rupiah)

Year 1996	Year 1997	Year 1998	Year 1999	Year 2000
0.0067	0.0055	0.0028	0.0023	0.0017

Source: PLN - Company Profile

Operational expenses in PLN mainly consist of a) fuel costs, b) electricity power purchase from IPP, c) expenses for human resources and maintenance, and d) depreciation of fixed assets. In particular, fuel costs and power purchase from IPP get attention because of their sharp increases from 1997, as the following Figure shows.

Figure 11.6.1 Breakdown of Operational Expenses



Source: PLN - Company Profile

As for increases in liabilities and related interest payment, the amount showing large changes is considered here along with the breakdown. The amount of liabilities almost tripled between 1996 and 1999 because of foreign currency-denominated debts, which surged after 1996.

From Consolidated Balance Sheet (Table 11.6.7) which is a further breakdown of Balance Sheet (Table 11.6.2) shown earlier, it can be seen that trade payables in the short-term liability and two-step loans in the long term liabilities are prominent.

Trade payables reached Rp 21 trillion. The amount of power purchase increased based on a contract with IPP, resulting in an expansion of the value to be paid. Meanwhile, balance of long-term, two-step loans stood at as much as Rp 34 trillion in fiscal 2000. On the two-step loan scheme, the Indonesian government borrows money in foreign currency first and then subleases to PLN. Since the borrower PLN takes exchange risks for both trade payables to IPP and two-step loans, its loan balance on a rupiah basis has swollen since rupiah plunged due to the currency crisis.

As previously mentioned, the large increase in debts essentially boosts interest payment. Interest payment on profit and loss statement skyrocketed actually to come to approximately Rp 14 trillion in 2000, up from Rp 1 trillion in 1997. PLN's debt service ratio deteriorated year by year accordingly, as the following table shows.

Table 11.6.6 Debt Service Ratio in PLN (times)

FY 1996	FY 1997	FY 1998	FY 1999	FY 2000
2.39	0.99	0.11	0.48	2.46

Table 11.6.7 Consolidated Balance Sheet

In Rp. Billion

	Before Crisis	Crisis			
	1996	1997	1998	1999	2000
ASSETS					
Current Assets					
Cash & cash equivalents	1,653	897	4,014	2,930	4,645
Short term investments	191	121	191	361	275
Bond Skinking Fund-Current			204	266	
Trade Recivables; net	1,058	1,256	1,598	1,729	2,721
Inventories	646	599	771	844	915
Prepaid Taxes	4	4	5	3	4
Other Receivables	50	54	91	74	73
Prepayments & Advances	75	86	111	250	111
Total Current Assets	**3,677**	**3,017**	**6,985**	**6,457**	8,745
Bond Skinking Funds	**110**	**254**	**266**	-	-
Fixed Assets - Net	**48,048**	**56,526**	**65,686**	**65,301**	**66,868**
Investment	**23**	**42**	**57**	**29**	**26**
Other Assets					
Non Operating Assets	108	194	923	881	1,827
Other Receivables	172	157	147	139	124
Defferred Charges	285	234	347	402	377
Prepayments & Advances	160	83	49	11	27
Total Other Assets	**725**	**669**	**1,466**	**1,433**	**2,356**
Total Assets	**52,584**	**60,508**	**74,460**	**73,219**	77,995

	Before Crisis	Crisis			
	1996	1997	1998	1999	2000
LIABILITIES AND SHAREHOLDERS' EQUITY					
Short Term Liability					
Promissory Notes	210	73	74	-	-
Trade Payables	1,077	2,323	6,046	7,154	16,677
Pension Fund	33	-	-	-	-
Taxes Payable	50	32	33	32	62
Other Payables	156	203	166	170	244
Accrued Expenses	514	613	6,861	15,136	642
Current Mat.of LT Liabilities:					
- Special Relationships					
Subsidiary Loan	752	1,176	3,245	5,253	2,694
Payable due to Government	294	331	311	887	493
Bank Loan	120	100	168	172	73
- Third Parties					
Bank Loan			250		
Bonds	300	-	680	918	1,000
Total Short Term Liabilities	**3,507**	**4,850**	**17,834**	**29,722**	**21,884**
Deferred Revenue	**2,458**	**2,847**	**2,972**	**3,077**	**3,234**
Long Term Liabilities					
Deferred Tax				1,814	2,434
Long-Term Liabilities					
- Special Relationship					
Two-step Loans	9,471	12,444	19,412	18,052	21,310
Payable to Government	2,414	2,075	3,037	1,584	6,393
Bank Loan	780	680	512	340	272
- Third Party					
Bank Loan	250	250			
Bonds	2,598	3,198	2,518	1,600	600
Other Payable	25	32	134	119	104
Customer Deposits	1,231	1,447	1,568	1,762	2,022
Project Cost Payables	629	2,413	3,078	2,457	1,117
Total Long Term Liability	**17,399**	**22,539**	**30,259**	**27,728**	**34,252**
Stockholders' Equity					
Issued & Fully Paid Capital	13,000	13,000	17,326	17,326	17,326
Additional Paid in Capital	13,863	15,528	13,481	15,446	45,960
Retained Earning	2,357	1,744	(7,412)	(20,079)	(44,661)
Stockholders' Equity - Net	**29,220**	**30,272**	**23,395**	**12,693**	**18,625**
Total Liabilities & Shareh's Eq.	**52,584**	**60,508**	**74,460**	**73,219**	**77,995**

11.6.2 Analysis of Financial Structure in PLN

The previous analysis indicates that deterioration of PLN's financial conditions were caused by 1) a sharp increase of operating expenses—higher costs for fuel and electricity power purchase from IPP, and 2) an increase of other expenses—expanding interest payment.

In this section, the reason why these factors had a great impact is considered from the viewpoint of PLN's financial structure.

First, PLN's financial position was extremely vulnerable to rupiah's depreciation against US$ because most of fuel costs, costs for power purchase from IPP, and liabilities are denominated in US$ and other foreign currencies. The currency crisis in Asia in 1997 therefore seriously damaged PLN's financial conditions.

Table 11.6.8 Declines of Rupiah, Results

Unit of Measurement	1996	1997	1998	1999	2000
US$/Rupiah	2,340	4,650	8,026	7,800	9,595

Source : PT. Data Consult Inc. August 2000.

In order to minimize the effect of rupiah's depreciation that stroke a blow at PLN, the Indonesian government and PLN took such measures as 1) revision of power purchase contract with IPP and re-negotiation, 2) debt-equity swaps, and 3) gradual raise of power tariff.

These measures certainly work well in improving PLN's financial figures, whose effects are expected to surface step by step. However, the effects in improving financial figures do not lead to improvement of financial conditions. Even if the price for power purchase from IPP is set at a proper level, borrowings decrease, and even if the tariff were raised, a sharp and large fall of rupiah would cause the same problem in the future.

It looks impossible to depend on these measures – re-negotiate with IPP, carry out debt-equity swaps, and hike tariffs – whenever the rupiah falls in the future. The rupiah depreciation results from failure in economic policies. The government should be blamed for having consumers pay for its failed policies, if it repeats these measures. These methods are to patch over the problems temporarily, not work as drastic solutions. The drastic solution means improvement of PLN's financial structure.

The fundamental problem in PLN's financial structure is revenues from power sales are rupiah-denominated, while most of operational expenses, including fuel costs and power purchase from IPP, and funds raised by borrowing and others are denominated in US$ and foreign currencies.

Generally, companies could report an exchange loss at one point and an exchange profit at other time because the exchange rate fluctuates. However, handling revenues in rupiah and expenses in dollar is a fatal structural defect in Indonesia where the currency rate against US$ has continuously declined. PLN is always exposed to serious exchange risk due to the defect in the financial structures.

The fact to be concerned further is that rupiah has weakened against US$ continuously over the past years. The tendency looks unavoidable given the current problems on Indonesian macroeconomics. Rupiah's depreciation in the supply-demand situation of the currency and US$ are triggered by unbalanced imports and exports, huge interest payment on external debts, and a small amount of foreign capital's inflow into the capital market.

First, a comparison between the figures of exports and imports is shown. Total value of Indonesian exports is higher than the value of imports.

Table 11.6.9 Exports and Imports (Million US$)

	1997	1998	1999	2000 (Jan-Jun)
Export	53,444	48,848	48,665	29,269
Import	41,680	27,337	24,003	13,682

Source : BPS 2000.

The higher exports than imports means that the nation has acquired more foreign currency (US$) than the amount of foreign currency (US$) it has paid for imports. However, demand for US$ is always strong on the Indonesian forex market, thus US$ continuously tends to rise. This is possibly because a great part of foreign currency (US$) paid for exports remained piled up as US$ in Singapore and other foreign countries without returning to Indonesia to be exchanged to rupiah. As a result, there is exclusive demand for US$ to be paid to settle import contracts in Indonesia.

Next is huge interest payment on external debts. Since Indonesia externally owes US$ 140 billion in combining public and private sectors, strong demand for US$ arises every year in line with the interest payment.

Demand for US$ as funds to pay interests on external debts necessarily occurs at the repayment period of every year as long as the balance of foreign debts exists. The Indonesian government currently holds foreign currency reserve of about US$ 28 billion. If the government uses the reserve to repay external debts, demand for US$ linked to interest payment could be weakened to some extent.

As for inflows of foreign capital into the capital market, the condition is unlikely to promote inflow of foreign capital—the capital market is small yet in Indonesia and there are few stocks and bonds to be invested by foreign entities. Demand for rupiah for the purpose of investment will occur in case the capital market is enhanced and inflow of foreign capital is invigorated. The market currently faces demand for rupiah sale and US$ purchase reflecting investment in foreign markets. In conclusion demand for US$ is overwhelmingly stronger than rupiah demand at the key part in deciding supply-demand situation between the two currencies. The Indonesian economy basically keeps a structure of weak rupiah.

A company with heavy burden of external debts could not hold out against a sharp and large rupiah decline if it counts revenue in rupiah and expenditure in US$, given that rupiah is essentially a weak currency due to the structure.

In order to obtain a stable financial base, PLN must drastically renew its financial structure in which revenue is counted in rupiah and expenditure is done in US$. The company should write off substantial losses from the rupiah depreciation at first, while tariff should be hiked in order to prevent occurrence of a deficit in the future. The company currently suffers negative spread caused by lower sales price than production costs.

Nevertheless, raising tariff is not easy in Indonesian economy in which wealth and income are not appropriately re-distributed. People in certain classes could live up with the higher tariff, but many other people could not do so. A uniform tariff raise looks unrealistic in Indonesia that contains a contradiction of the gap between the rich and the poor. Rather than that, a tariff raise based on re-distribution of wealth and income is required.

In conclusion, problems for PLN's financial structure are 1)revenues are rupiah-denominated, while expenditure (fuel costs and electricity power purchase from IPP) and loans are dollar-denominated, leading to a mismatch of currency, 2) there is a negative spread – costs surpassing revenues – caused by an increase of production cost and interest payment.

Production costs and interest payment soared after the plunge of rupiah in the Asian currency crisis. As a result, PLN is suffering from the negative spread between revenue and costs. The currency's plunge was extremely rapid and substantial; PLN suddenly got beleaguered by a huge deficit and accumulated losses. The rupiah's plunge seems to be the main factor for the current predicament of PLN. If so, stabilization of rupiah would be the first priority in stabilizing PLN's financial conditions. The stabilization of rupiah currency, however, is decided by the government's economic policies. PLN could not control the matter.

11.6.3 A Factor Analysis of Revenue

1) Revenue

This section checks the validity to estimate revenue based on the tariff and sales. The revenue is a function of sales or consumption and tariff. It is formulated as follows,

$$Revenue\ (RV) = Tariff\ (T) * Sales\ (S)$$

However, because the tariff is different by sector and category, the differences of tariff categories and their share in total sales can affect the revenue. Considering that tariff is different by sector (i), the formula is:

$$RV = \sum (Ti * Si)$$

The actual data of revenue, sales, and tariff by sector since 1996 is in the next table.

Table 11.6.10 Actual data of revenue, sales, and tariff by sector

Revenue (Rp million)					
Tariff Group	***1996***	***1997***	***1998***	***1999***	***2000***
Residential	3,106,793	3,673,350	4,580,280	5,208,212	6,337,010
Business	1,656,280	1,959,954	2,644,859	2,924,808	4,023,270
Industry	4,085,021	4,606,115	5,634,789	6,536,313	10,289,533
General/Miscelaneous	570,175	637,859	906,286	1,001,218	1,490,071
Total	**9,418,269**	**10,877,278**	**13,766,214**	**15,670,551**	**22,139,884**
Electricity Sales (GWh)					
Residential	19,551	22,739	24,866	26,884	30,564
Business	6,226	7,250	8,667	9,330	10,576
Industry	27,949	30,769	27,985	31,338	34,013
General/Miscelaneous	3,206	3,554	3,743	3,780	4,012
Total	**56,932**	**64,312**	**65,261**	**71,332**	**79,165**
AverageTariff (Rp/kWh)					
Residential	159	162	184	194	207
Business	266	270	305	313	380
Industry	146	150	201	209	303
General/Miscelaneous	178	179	242	265	371
Total	**165**	**169**	**211**	**220**	**280**
Operating Expense (Rp/kWh)	**135**	**147**	**258**	**301**	**344**
Tariff - Expense (Rp/kWh)	**30**	**22**	**(47)**	**(82)**	**(64)**

Source: PLN Annual Report of Year 2000

To see the impact of changes of sales and tariffs on revenue, the above formula is transformed as follows.

$$RV = \sum (Ti * (Si/TS) * TS)$$ [TS: Total Sales, Si/TS: sectoral share of sales]

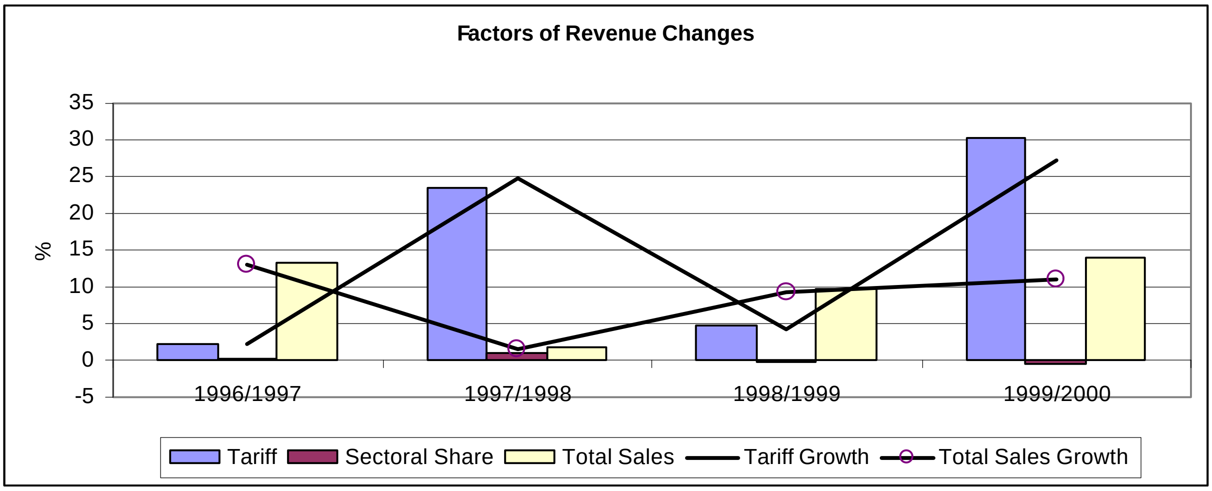
By taking annual difference Δ, the ΔRV can be decomposed to the following components.

$$\Delta RV = \sum(\Delta Ti * (Si/TS) * TS) \quad \text{[Changes in tariff]}$$
$$+ \sum(Ti * \Delta(Si/TS) * TS) \quad \text{[Changes in sectoral share]}$$
$$+ \sum(Ti * (Si/TS) * \Delta TS) \quad \text{[Changes in total sales]}$$
$$+ \text{Residual}$$

The first component with ΔTi represents the impact of the changes in tariff. The second component with Δ(Si/TS) represents the impact of the changes in sectoral share of sales. The third component with ΔTS represents the impact of the changes total sales. The fourth component is the statistical residual.

The factors of change in revenue are therefore, decomposed to 1) tariff, 2) sectoral share, and 3) total sales.

Figure 11.6.2 Analysis result of factors of revenue changes

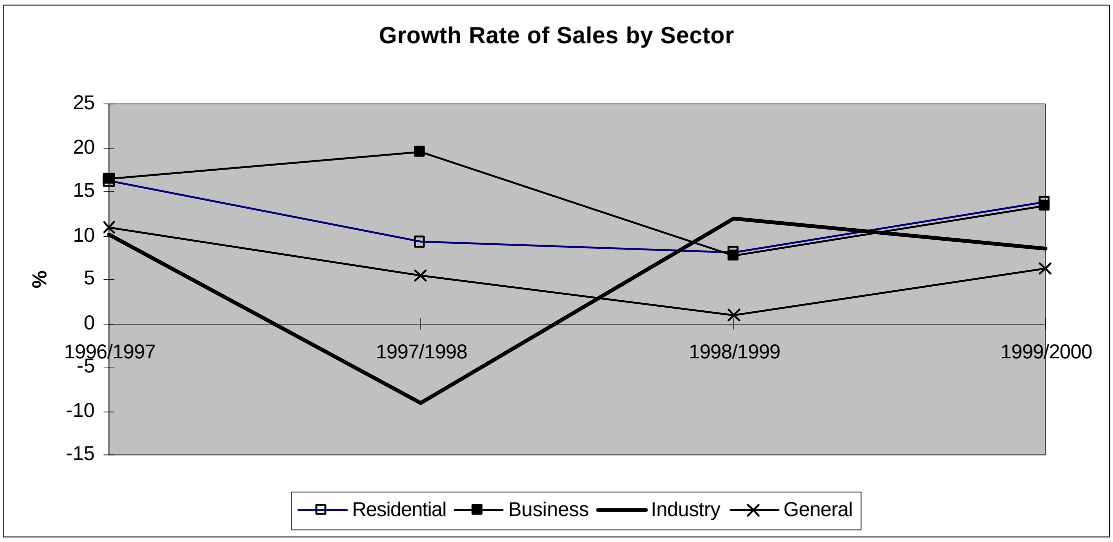


The result of calculation is in above figure. The bar graph shows the above factor components. The two lines show the growth rates of average tariff and total sales.

The above graph shows that the impact of sectoral share is not significant, but the impacts of tariff and total sales growth can roughly match to the growth of tariff and total sales.

The sectoral fluctuation is especially large in industrial sector as shown in below figure. One potential reason is the use of captive power, which might depend on the relative prices of electricity of PLN and captive power. Even though the Figure 11.6.2 shows the negative change in sales in 1998 in industry, the Figure 11.6.3 in sectoral change shows the positive impact. This can be attributed to the increase of business of highest tariff group and increase in tariff in industrial sector in 1998.

Figure 11.6.3 Growth rate of sales by sector

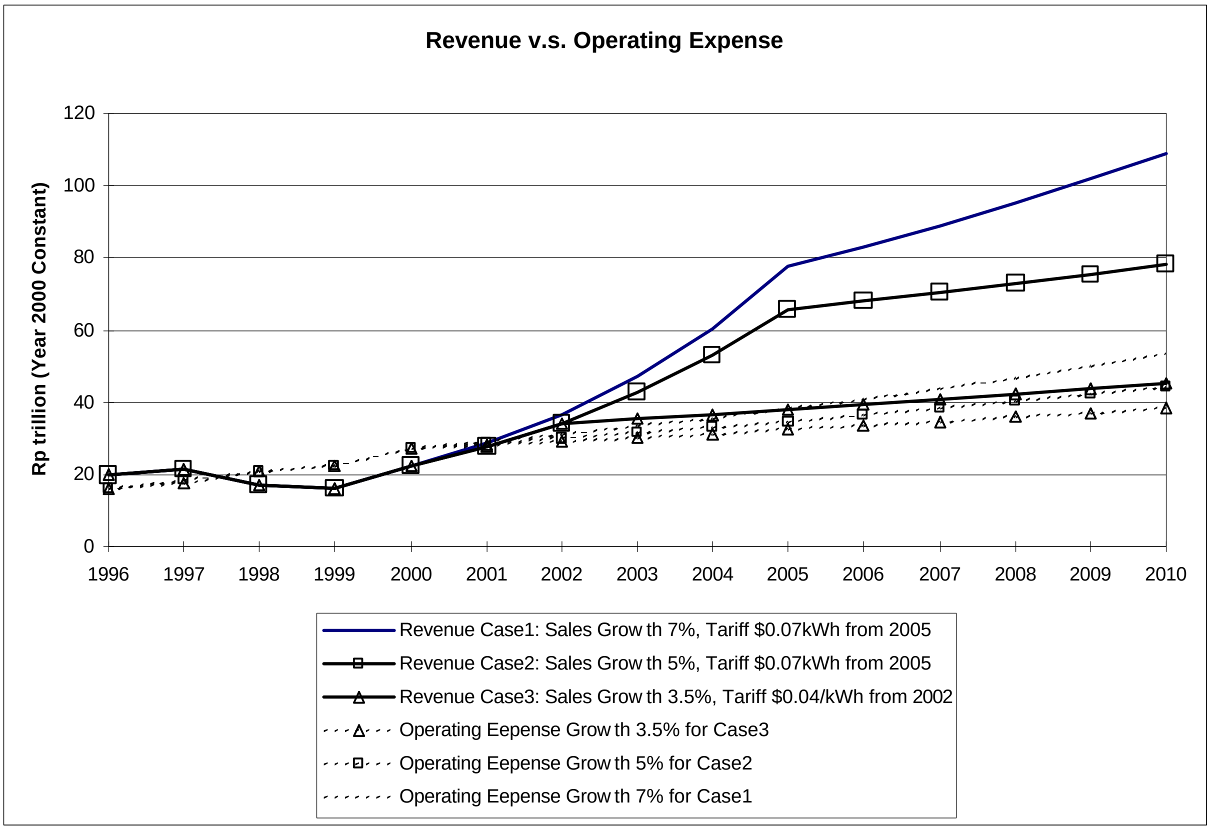


This analysis shows that even though the future revenue will be determined by the rate of sales and tariff, the structural changes in the customers, especially the industrial users can influence the revenue up to several percentages in short term. However, because the manufacturing industry adjust to new environment with considerable time lag of more than one year, the structural change in the share of each sector can be more than several percentages in the long run.

The Figure 11.6.4 shows scenarios of PLN future revenue operating expense. By the year 2005, the tariff is expected to increase from 280 Rp/kWh in 2000 to 700 Rp/kWh or 7 cents/kWh [1$=10,000 Rp]. The high case and the middle case is based on this scenario with the difference that the sales grows 7% for the first and 5% for the second case. The lowest case is a pessimistic case with 3.5% of growth and 4 cents/kWh from 2002. The operating expense is assumed to grow proportionally with the growth of sales with year 2000 as the base year.

The graph shows that the future prospects of income can differ substantially depending on the tariff and sales growth. Especially, the impact of tariff is large. That is, the tariff difference between $0.04 and $0.07 will result in the difference of nearly Rp 40 trillion with operating profit of more than Rp 50 trillion by the year 2010. The pessimistic case 3 is almost at the same level of operating expenses; means that it cannot cover other expenses like interest payment and tax.

Figure 11.6.4 Results of PLN's Income and Operational Expense Predictions
(with no structural change)



2) Factors for expenses

PLN plans additional revenue from electricity power sales at about 16% in 2002 by hiking tariff by four stages as the company did in 2001, according to press release by the PLN headquarters on December 31, 2001. The company expects revenue from power sales of Rp 39.1 trillion at the end of 2002, which is slightly higher than above-mentioned Case 1.

The company also said in the press release that expenses are estimated at Rp 43.9 trillion in total. Since interest payment accounts for 7.3% of the figure, operational expenses other than interest payment will come to Rp 40.7 trillion. The growth in operational expenses is greatly higher than the predictions of operational expenses by Case 1. This is because fuel costs and payment to IPP includes many dollar-denominated items; the rapid increase of IPP-linked payment has an impact in particular (See 11.6.2). Fuel costs and payment to IPP is particularly important among expense factors.

First, the amount of power purchase from IPP and payment is considered. The amount of purchase is expected to continue increasing unless PLN expands its own capacity for electricity power generation. The purchase therefore will become a big factor that squeezes PLN's profit in the future. In fact, the purchase amount was only 3% of the total sales in 1996 (the purchase price was about 4.4 cents/kWh), the purchase amount reached to 11.6% of the total sales in 2000 (purchase price is approximately 10 cents/kWh[1]). In terms of monetary value, it skyrocketed from 2.9% of the total value of power sales in 1996 to as much as 42% by 2000. This rise of purchase expense after Rupia crisis was caused by the "Take or Pay" clause of IPP contract, with which PLN have to pay even if PLN does not accept the power supply from them. Nevertheless, this is the issue of negotiation between IPP and PLN. The purchase amount will swell in the short term, but the purchase price is expected to gradually decline to approach international market prices in the long term as it should reflect the cost. Actually, Electricity Generating Authority of Thailand (EGAT) buys electricity in amount equivalent to 30% of the total production at 4.1 cents/kWh in 2000. The price is less than the half of the current PLN's payment.

In order to see the magnitude of the impacts of increases of power purchase from IPP and decline in purchase prices on PLN's profits, simulation results are presented on Figure 11.6.10 in which proportion of purchase from IPP is assumed to rise to 30% — equal to EGAT's level — by 2010 by scenario for purchase prices in the future. Purchase price remains at current level on IPP Case A, thus IPP electricity unit price at fiscal 2000 level. Electricity unit price declines to 5 cents/kWh from present 10 cents/kWh by 2007 or the target year for liberalization of electricity market on IPP Case B. Demand is assumed to grow by 7% as the above Case 1 takes. Operating Expense Growth 7%, shown on Figure 11.6.4 for the purpose of expense comparison, stands as Base Case here. The case of 7cents/kWh in 2005 is shown as Revenue Case 1 for the purpose of revenue comparison.

On Case A, which assumes current price level, gap between expenditure and operating revenues will fall to 50% of Base Case in 2010. On Case B assuming IPP price decline, the difference from Base Case will reach Rp 15 trillion or so in 2010.

Second, fuel cost is sure to rise further in the future, which currently makes the largest part of operating cost. The outlook contrasts with an expectation that price of electricity from IPP will fall. As the government has controlled fuel prices so far, the fluctuation has been smaller than that of the company's income. Nevertheless, liberalization of the energy sector, scheduled to take effects in the near future, may possibly widen the range of fluctuation of operating expenses. Fuel cost is likely to become a more important factor than it ever was. Fuel cost is predicted to rise by percentage of several decades when subsidies for fuel prices are abolished. Given that fuel accounts for one-third of operating expenses, the entire operating expenses will

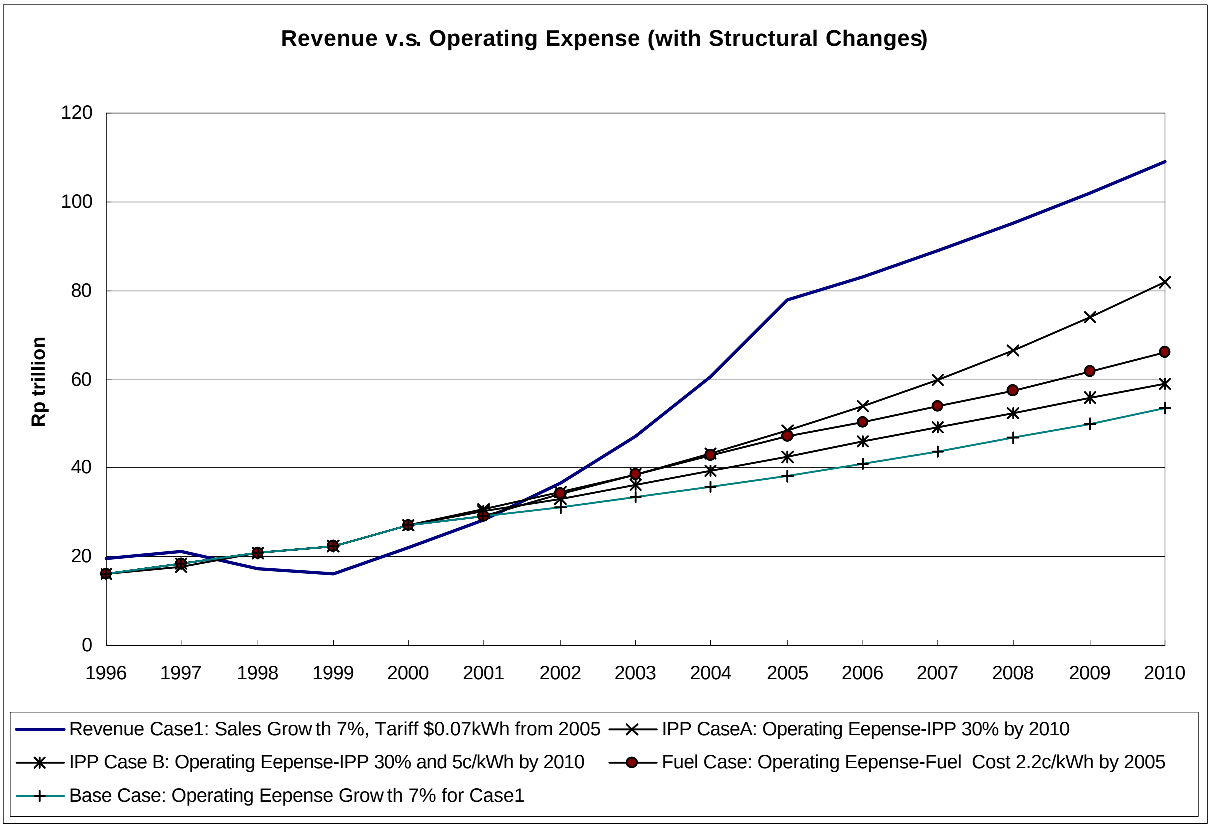
[1] PLN's annual report for year 2000 says that the company spent Rp 9.395 trillion for electricity of 9,135GWh the company bought. 74% of the amount represents the cost of electricity under the "Take or Pay" clause.

be boosted by 10% in case that fuel cost rises by 30%. Since revenues and expenditure are almost balanced these days, the company needs to add 10% to the range of tariff hike.

Moreover, abolishment of subsidies is only one of many factors. The principal factor for fuel cost increase is on-going liberalization of the energy sector. Fuel cost is expected to approach international level in the near future because suppliers will not distinguish between domestic demand and overseas demand once the fuel market is liberalized. This condition parallels a scenario of importing all of needed fuel. The case of EGAT of Thailand should be looked among neighboring countries as it operates under a similar scenario, considering structure of PLN operating expenses in the future.

According to EGAT's annual report for year 2000, EGAT obtained approximately 92% of its total electricity power generation or 62,865GWh from fossil fuel[2]. EGAT bought fuel paying Bt 56 billion. Fuel cost is equivalent to 2.2 cents/kWh ($1=40Bt) on a US$ basis. Meanwhile, PLN said in its annual report for year 2000 that the company made 86% of total production or72,433GWh from fossil fuel, paying Rp 9.59 trillion. The cost is 1.3 cents /kWh ($1=10,000 Rp) on a US$ basis or 59% of EGAT.

Figure 11.6.5 Results of PLN's Income and Operational Expense Predictions
(with structural changes)



[2] EGAT procures part of coal from its own mine but the fact is neglected here for convenience.

PLN's fuel cost may possibly rise to 2.2 cents/kWh and more, considering liberalization of the energy market in the future, although it depends on movement of the international energy market. "Fuel case" on Figure 11.6.10 shows a case that fuel cost climbs to 2.2 cents/kWh by 2005 along with a structural change, that is, one-third of operational expenses comes to 1.7 times. This contrasts with previous Figure of operational expenses without a structural change.

Profits will shrink as a whole to come to Rp10 trillion less than BaseCase after 2005. Nevertheless, the profit squeeze could be tolerated because it is milder than an increase of power purchase from IPP and corresponding squeeze in the profit.

As for expenditure, not an increase in fuel costs but the payment to IPP with "Take or Pay" clause is likely to be the heaviest burden for management of PLN for the future, in accordance with growing demand.

11.6.4 Operational Efficiency Improvements and Efficiency Drive Program (EDP)

Improvements of PLN operational efficiency are an integral part of PLN's financial restructuring objectives. The inefficiency of PLN became problem as the 1997-1998 crisis skyrocketed the cost of operation. Faced to the increase of cost and as the World Bank pointed the inefficiency of PLN operation, PLN proposed the Efficiency Drive Program (EDP). The secretary of EDP was established in PLN headquarter in 1999. The actual implementation of EDP started from the fiscal year 2000 with the initiative by the Ministry of Finance through the Efficiency Audit (Performance Audit).

PLN's Efficiency Drive Program (EDP) can be applied to any activities, which can improve efficiency in monetary term. In EDP, the efficiency improvement activities are categorized by their nature of the expenditures. The categories are Operational Expenditure Efficiency Drive (OPEXD), Capital Expenditure Efficiency Drive (CAPEXD), and Efficiency Drive Integration (EDI) with human resources management, financial management and information system management. For instance, the reduction of duration for maintenance and reduction of construction time are the significant part of OPEXD and CAPEXD. As a conceptual support, the so-called "Value Engineering" was appealed to invite innovation for all activities of efficiency improvements.

The EDP is still in test period as only less than two years has passed since its actual implementation. In this regards, to achieve "Early Wins," PLN has focused so far on the controllable areas including generation, transmission, and distribution.

For generation, operational efficiency activities that are controlled by PLN include heat rate reduction, increase in energy availability factor, maintenance cost reduction and economic amount of inventory. These activities have been implemented for both generation subsidiaries in Indonesia Power and PJB and two generation centers outside of Java-Bali Sumbagut and Sumbagsel.

For transmission, maintenance cost reduction, de-bottlenecking and optimal utilization of its fiber optic assets are efficiency drive assets are efficiency drive activities that have generated a net cumulative gain of around Rp 3 billion. The fiber optic assets have been spun-off into a separate subsidiary that has a huge potential of income generation.

For distribution, technical and non-technical loss efficiency activities have been implemented for all four-distribution centers in Java-Bali and the branches outside of Java-Bali. Account receivable collection speed-up and economic order quantity inventory are efficiency activities that are being tested for full implementation in the third quarter of the year 2000.

In addition to CAPEXD and OPEXD, there is another important category for EDP. It is called Efficiency Drive Integration (EDI). It is the area of support services such as Finance, Human Resources and Information System efficiency activities. For Finance, cost accounting and managerial accounting systems are subjects to improve financial information. For Human Resources, incentive program such as social recognition, cash rewards, promotion and management contracting are the targets. For Information System, beside the managerial reports required by the government, internal managerial reports are under development based on cost accounting data.

As of the end of fiscal 2001, the area of EDI is underway and has not yet realized, since it cannot be implemented independently by regional unit, rather it involves coordination of all management including EDI head office. For instance, the current cost accounting system is based on regional generation section or the bulk generation from one plant or more than one plants. Therefore, the current system cannot identify the efficiency by plants, but only by bulk generation. To compare plants, evaluate efficiency, and identifies the problems, cost accounting system by each plants will greatly improve the prospects of EDP. However, to create such system is a standardization of cost calculation, which involves the difficult task to how to treat the differences of individual plants.

Another challenge of EDI is the financial management system, which integrates EDP into PLN budgeting to maximize the total efficiency in monetary term. This is the issue of an organizational restructuring, which cannot be resolved within the framework of EDP itself.

As for Information System, the present focus is to improve the billing system to reduce the delay of time between meter reading and billing. Currently the lag is about 28 days, means that PLN is losing the opportunity cost of account receivable for 28 days. The system improvement involves standardization of PLN billing system so that it cannot be solved by a regional office through the present EDP implementation system by a Master Action Plan of a regional office as mentioned below.

The significance of EDP is in its approach not to adopt top-down, but to adopt grassroots approach. It tries to lead the value, attitudes and behavior of each employee toward efficiency. Thus, the actual design and implementation of EDP is left to the responsibility of regional office, which directly involves and raises the concern of front line personnel related to upgrade their attitudes and behavior. That is, PLN employees act as owners of EDP processes to drive the efficiency improvement. The actual implementation follows next steps.

1) By the beginning of each fiscal year, the EDP head office in PLN requests all thirty regional operation units to submit Master Action Plan (MAP) with target activities and the potential improvements in monetary term.
2) The EDP head office reviews their MAP from the point of feasibility and set the targets.
3) Each regional office implements its own plan as they designed and make monthly report to the EDP head office.
4) The EDP head office, which has 50 staffs, monitors the implementation directly by dispatching its staffs to the regional units every three months. At the same time the EDP evaluate the improvements and the employees who contribute to the efficiency improvements.
5) The performance audit will be made by independent auditor to evaluate the achievements of MAP of each regional unit.
6) Based on the evaluation by the monitor, the employees who contributed are rewarded directly from the EDP head office. In the case of the year 2000, the rewards were totaled to Rp 10 billion from the gross efficiency gain of about Rp 800 billion.

The achievement of EDP for the fiscal 2000 was targeted about Rp 1,000 billion before start. According to EDP head office, the actual achievement of fiscal year 2000 totaled Rp 804.63 billion of which the breakdown is shown in the Table 11.6.11 below.

Table 11.6.11 Actual achievement of EDP In rupiah

Operating Expenditures Gains in Generation	Rp 387.38 billion
Operating Expenditures Gains in Transmission	Rp 30.71 billion
Operating Expenditures Gains in Distribution and Retail	Rp 297.88 billion
Capital Expenditure Gains	Rp 88.66 billion
Total	Rp 804.63 billion

Considering that the total operational expenditure for 2000 is about 27,215 billion, the EDP has saved about 3.5% of it. For the fiscal 2001, the total gain is expected to be around Rp 600 billion.

11.6.5 Challenges and Proposals

As problems on PLN's financial matters, 1) rupiah's depreciation due to economic crisis, 2) low electricity tariff, and 3) disadvantageous contracts with IPP. PLN reports revenues in rupiah but most of expenditure is US$- and other foreign currency-denominated (fuel cost, parts for maintenance of power generation plants, and other variable cost in PLN's production). Electricity tariff is lower than the average operational expenses currently, with making it impossible to gain profits. PLN is under contracts with 27 IPP firms for long-term electricity purchase, but extremely unstable forex market and interest rates had a negative impact on the price of electricity supplied by IPP.

These problems basically seem to have come from PLN's financial structure in which there are currency mismatches among revenues, expenditure, and fund raising. Although raising tariff on a rupiah basis would clear up the deficit reporting structure temporarily, the method would not settle the currency mismatch. The best solution to the mismatch is denominating part of revenue or tariff in US$. Large-lot electricity users like major companies and part of rich people already holds US$ accounts. Besides, paying power bill in US$ would not have a great impact on their production or everyday life. Setting tariff in US$ is not unfair if the US$-denominated tariff remains at the average level of ASEAN countries.

Private electricity companies in Indonesia already set the tariff in US$, with being accepted by customers. Even IPP suppliers in Indonesia sell power to PLN with denominating in US$ so as to prevent the mismatch. PLN is the only power supplier in Indonesia that is facing the currency mismatch.

In addition to private power bill, some sectors adopt system of denomination and payment by US$, e.g., hotels, condominiums for foreign residents who stay in the country long term, and airfare. Since these companies see another type of currency mismatch –revenues in US$ and expenditure in rupiah, the financial structure enables them to gain profits from both mainline and forex. It would not be unreasonable that PLN sets dollar-denominated tariff to these companies and receive payment in US$.

Also needed is revision of purchase of fuel in US$. The negative spread between revenue and costs will not disappear if the company continues to buy fuel with US$, which accounts for about 60% of power generation cost. Fuel such as gas and oil are rupiah-denominated for consumers, while dollar-denominated for business use in principle. Electricity supply by PLN to households is so-called lifeline for Indonesian people. Even if the electricity is liberalized in the future, no one will start power generation for general households in case PLN makes dollar-denominated purchase for fuel used for service to households. Shifting the exchange risk to consumers, who would be unlikely to hold on to a simple tariff hike, looks unreasonable. PLN will therefore be forced to leave the mismatch on this market. No one would hope to enter there even if the electricity market is liberalized in the near future.

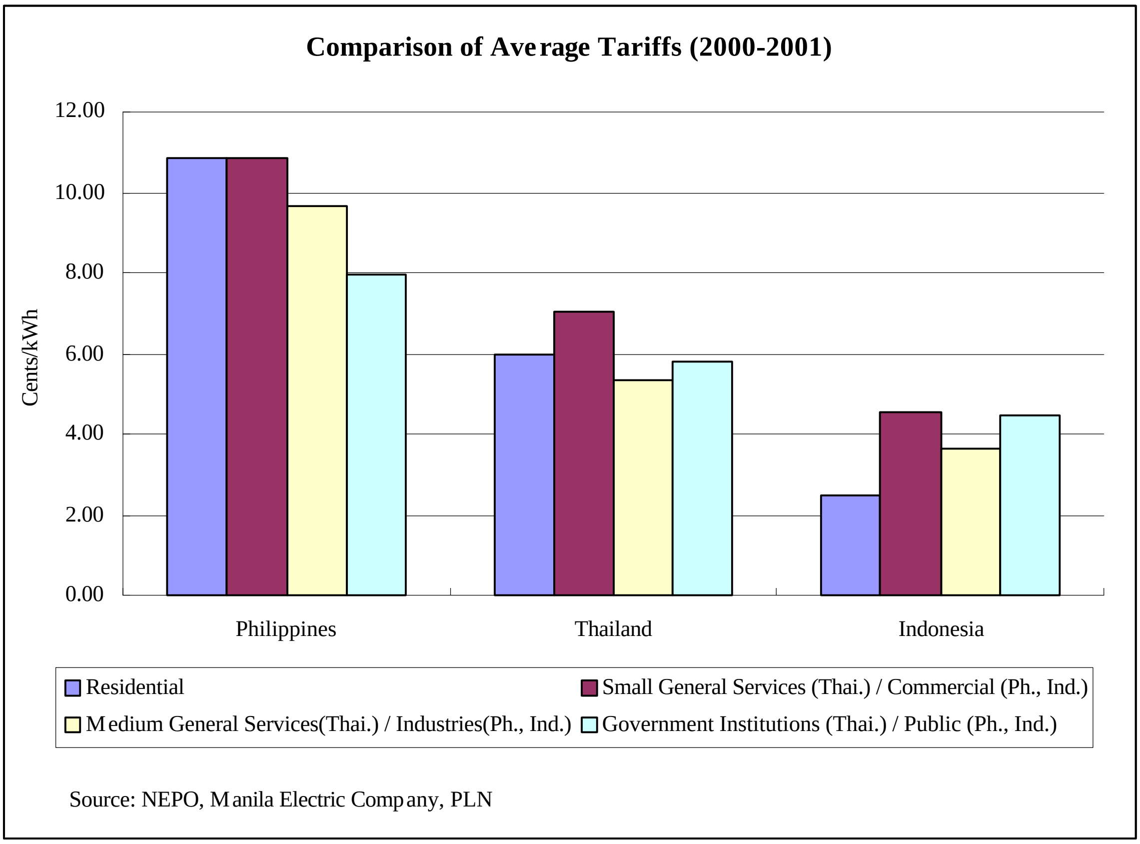
Another proposal is risk curtailment through controlling cash and equivalent. It is desirable that PLN should reduce cash and equivalent holding by rupiah to revise its holding to reflect its currency used in payment and the amount of payment. Furthermore, value of fixed assets is expected to increase after re-evaluation because most of PLN's fixed assets were imported in US$, supported by US$ loans. The re-evaluation of fixed assets is desirable sooner or later in spite of a temporary increase of tax payment, because rupiah is unlikely to recover to the previous level in long run. Meanwhile, large non-operating assets means that there is room to raise efficiency. It is recommended that the company reduce or eliminate real accounts to make them productive assets.

As proved by improvement of management efficiency and efficiency drive program (EDP), PLN has succeeded to identify problems it has since the financial crisis in 1997. The real challenge is the implementation of the solutions. The two approaches for profit increases are 1) cost reduction and 2) revenue increase. Efficiency Drive Program can represent the first one. The second one can be represented by the selective sales promotion for high tariff groups. The audit results show that they are gradually achieving goals or making progress at the moment, as mentioned before.

However, it cannot solve the fundamental problems that PLN have as a public utility. Tackling the fundamental problems is treated as issues of financial restructuring in which the government is involved. They are 1) purchasing price of electricity from IPP and of fuels, 2) electricity tariff, and 3) loan restructuring.

Among these, the foremost important is the electricity tariff. It would be difficult to distinguish users in the way previously mentioned. The present level of around $0.04/kWh (2001-2002) may be able to cover the operating expenses, however, it cannot cover the non-operating expenses such as interest payments, which soared after the currency crisis. In this regard, the survival of PLN is strongly depends on the political will of the government to increase the tariff to the target level of $0.07/kWh (See Figure 11.6.6).

Figure 11.6.6. Comparison of Average Tariffs



The loan restructuring will contribute to reduce the non-operating cost. The asset re-evaluation will make balance sheet attractive for private sector, even though tax payment arises in line with an asset increase. Meanwhile, there are some problems on the reduction of purchasing prices of IPP electricity and fuels. The reduction of fuel price is against the governmental decision to liberalize the energy sector, and may damage PLN’s competitiveness in the long run. In the same context, the reduction of power purchasing price from IPP could harm the future prospect of the IPP market. The Indonesian government has to balance short-term PLN rescue and long-term electricity market.

11.7 Measures to promote Private Investment

11.7.1 Effects of Liberalizing Indonesian Electricity Market

The measures to promote the private investment postulate the ongoing liberalization of Indonesian electricity market. On February 5, 2001 the Indonesian government put the draft of a new electricity law before the Parliament (DPR). Should it win the parliamentary approval, it becomes the law to control the electricity market replacing the current electricity law UU No.15, 1985.

The three visions of the new law are:

1) to create and develop the financially independent and self-contained electricity sector,
2) to supply high-quality and stable electric power meeting the increasing demand and thereby enabling the contribution to the benefit of the consumers and to the international competitiveness of the Indonesian economy, and
3) to electrify all the households and to develop and enhance the electricity market in order to contribute to the development of the domestic industry and commerce.

For this purpose the government has developed the following time-series programs that will be implemented soon after the new electricity law is promulgated.

1) within a year to establish the Social Electricity Development Fund (SEDF),
2) within two years to establish the Independent Regulatory Body for regulating the electricity sector,
3) within three years to establish the single buyer market in the Java-Bali electric power system, and
4) within seven years to realize the fully liberalized electricity market in the Java-Bali electric power system.

In addition, the government has decided to implement before the new law's promulgation, such programs as establishing the Regulatory Council on Electricity as the parent organization for the future Regulatory Body, establishing the Single Buyer Market and liberalizing the electric power rate. The programs have the following objectives.

1) Restructuring of electric power sector

By introducing the market competition principle, the electric power sector will be restructured to become financially independent and self-contained. The market risk will be shared by both of the electric power sector and the consumers, and the electric power charge will be set at least at the level higher than the electricity cost. The role of the government will be significantly reduced by restructuring of the electric power sector.

2) Restructuring of electric power industry

The electric power industry will be divided into three areas of power generation, power transmission and distribution, and retail. The industry will be operated under the principles of transparency, competition, and efficiency.

3) Inviting new investment

The role of the governmental loan to the electric power sector will be reduced, but the new private investment based on the Commercial Arrangement will be aggressively invited.

11.7.2 Measures and Problems of New Private Investment into Indonesia

According to the national electricity plan of Indonesia, the shortage of electric power supply in the Java-Bali system is forecast in 2003 or 2004 at the earliest. In order to avoid the electric power shortage, the system requires the additional generation capacity of about 9,000MW to 12,000MW in total during the period from 2004 to 2010. However, under the situation where the Indonesian economy has not fully recovered from the economic crisis in 1998, the Indonesian state finance cannot afford such a large development cost.

To cope with the situation, the Indonesian government has decoded the strategy to liberalize and restructure the electric power market with the aim to fund the cost for the new power generation development by inviting the private investment on the commercial basis. The Indonesian government considers the following types of new private investment.

1) The new private investment in the future Indonesian electric power market shall be different from the past investment type of IPP.
2) For example, the Indonesian government has proposed the joint investment by the private capital and PLN for the business of power generation. In the case of the joint investment by the private capital and PLN, the private capital may assume up to 95% of the shares in the business of power generation. The share holding by the private capital in power transmission and distribution will also be granted but the right to refuse will be given to PLN. In practice, each of the power plants currently owned by PLN will become a separate company and the private investor may be allowed to hold the stock of the company that seems to be good in profitability and efficiency.
3) In addition a Build Lease and Transfer scheme will become possible. Furthermore, the Indonesian government encourages the proposals from the private sector about the models of possible investment types

The restructuring of the electric power sector: The measures for the restructuring the electric power sector are sound, which aims to restructure the sector into a financially self-contained and independent organization by the introduction the competition principle. No objection will be raised against the sharing the market risk by both of the electric power sector and the consumers and the setting the electric power rate above the power cost. In fact, the financial crisis of PLN was caused by the negative spread between the power rate and the power cost due to the soared fuel price on a foreign currency basis that was triggered by the heavy depreciation of rupiah in reaction to 1997 currency crisis. Based on the fact, it is considered that the consumers should bear in future the market risk of the electric power cost that will be caused by the fluctuation in exchange or by the steep rise in fuel cost.

On the other hand, the Indonesian government has decided the policy to create the Single Buyer Market within three years after the promulgation of the new electric power law and to fully liberalize the electricity market within seven years. In the Single Buyer Market (SB Market), PLN will become a buyer that purchases the cheapest electric power from individual power generation companies. The SB market postulates, as described above, that individual power plants owned by PLN are divided into separate and independent companies. Each power plant will be operated as an independent power generation company and implement the efficiency improvement programs introducing the fund by the private investment. PLN will purchase electric power from these generation companies and sell it to the consumers. PLN will make the agreement covering the price, quantity and purchasing period of electric power with each of the generation companies. Therefore, in the SB market, the principle of the market mechanism will function among the individual generation companies to sell their electric power to PLN. Since each generation company will become independent by the separation, the payroll will be determined by its own profit and loss, so that it will make an every effort to increase the profit by implementing efficiency improvement programs.

However, in order for such an SB market to function under the principle of the market mechanism, the supply and demand of electricity must be balanced at least by expanding the power generation capacity with the private investment. The principle of the market mechanism will never function under the situation where the electric power supply lags the demand as we see it in the current power industry.

If the private investment fund is not infused into the electricity market for the expansion of the power generation facilities, the consequence is nothing but the change in the PLN organization, and there would be essentially no change from the current situation. It is indispensable to introduce the new money for the reform of the Indonesian electric power industry.

The two policies that the Indonesian government considers to be necessary for the introduction of the new money are the price increase of electric power above its power cost and the joint investment with PLN for the power generation companies and transmission/distribution companies. While the idea is based on the assumption that the consideration in the profitability and the provision of the entry opportunity would invite the new private investment, the most important point is lacking for the introduction of the investment. Needless to say, the most important point for the introduction of the private investment is the consideration of the risk management, which is not included in the current plan for inviting the private investment developed by the Indonesian government.

11.7.3 Risk Management for inviting Investment

According to the government plan, the investment in the Indonesian electricity market is the equity participation in power generation companies or transmission/distribution companies. The investment risk rests on the credit of PLN, the buyer of electric power. The risk taken by the investor is if the PLN pays for the purchased electricity or transmission/distribution charge, which is the credit risk of PLN. The investor will make the decision of risk taking based on the credit rating of PLN. The credit rating of PLN, the state-owned company, should be equivalent to that of the state of Indonesia, which is triple C (S&P). Unfortunately the rating suggests that the investment is not the choice of the investment grade.

Furthermore, the recent dispute between the Indonesian government and IPP about the purchase contract suggests that no investor is likely to take the risk of PLN. In order to invite the new private investment into the Indonesian electric power market, the transfer of the investment risk is necessary in the first place from PLN to other low-risk organization.

As stated by the Indonesian government, a new investment model different from the IPP is required for inviting the private investment. The new model must have the organization of the credit rating eligible for the investment replacing PLN or the sate of Indonesia from the standpoint of the investment risk.

The private investment into the Indonesian electricity market is classified in the following three categories by the investment areas.

1) Direct investment in PLN: This is the investment to earn its return from the PLN profit by purchasing the PLN stocks or the bonds issued by PLN. Since PLN has not been privatized

yet, private investors are not allowed to purchase the PLN stock, then they need to buy the stocks of PLN subsidiaries that are divided as separate companies. This type of the direct investment to PLN will infuse the fresh money into PLN, which is the most acceptable investment type to PLN and the Indonesian government that suffer from the chronic financing deficit.

2) Investment in electric power generation market: This is the investment in the Indonesian power generation market and the current IPP falls in this category. The private investors intend to earn the return from the investment in the power generation area of the Indonesian electricity market. If such a type of the investment is activated, PLN can reduce the investment in the new power plants and, as a consequence, it will contribute to avoiding the electricity crisis in the future. This type of the investment will also be acceptable next to the above investment to PLN and the Indonesian government that have the financial problem for building new power plants by their own efforts to meet the future electricity demand.
3) The investment in the transmission/distribution market: This is the investment in the Indonesian market of the electric power transmission/distribution, and the private investors intend to earn the return from the investment in the facilities for power transmission/distribution. Since the considerable part of the transmission/distribution network of the Indonesian electricity market needs to be developed, PLN alone cannot afford the significant amount of the fund required for the transmission/distribution facilities. They are expecting the private investment also in this area.

It must be noted that there exists the investment risk for each type of the above investment categories.

1) Direct investment in PLN: Purchasing the stocks or the bonds of PLN or the PLN subsidiaries is to take the credit risk of PLN or PLN subsidiaries. When the credit rating of PLN or the state of Indonesia is considered, it is not the choice of an investment grade for the private investors. Some measures have to be taken to reduce the risk for inviting the private investment.
2) Investment in market of electric power generation: The investment type in the market of electric power generation is only the IPP model at present. As the problem of the investment by the IPP model has become evident, the investment type depends ultimately on the credit risk of the PLN or Indonesian government i.e. their paying capacity for purchased electricity. If PLN or the Indonesian government falls into the financial crisis by any economic crisis, the plan to recover the investment will be forced to change.

3) Investment in market of power transmission/distribution: The electric power industry will be divided into three areas of power generation, transmission/distribution and retailing. The private investment in the area of power transmission/distribution has been allowed through the joint investment with PLN. No private investment has been made in the area, but the joint investment is expected in the power transmission/distribution companies. Even in this case, the investment will eventually take the PLN risk if the consignment charge payer is PLN or its subsidiary.

As described above, the investment risk is not small in any of the present investment type. Therefore some new business models need to be developed for inviting the private investment in the future.

11.7.4 Measures to invite Private Investment into Indonesian Electricity Market

Various methods of the private investment in Indonesia have been discussed and studied.

1) The typical discussion on the investment would be "the liberalization of the market". This comes from the expectation that introducing the market mechanism into the electricity market, establishing the necessary systems and regulations and opening the market, will invite new participants and new investment funds. The opening of the market is considered as the best for inviting the private investment, because the situation of the Indonesian electricity market where the power supply lags the demand seems to provide a good opportunity for the market entry. However this idea is also lacking in the standpoint of the investment risk.

   Establishing the necessary systems and regulations in itself will not lead to the improvement of the credit rating or credit risk of a state. The most important and necessary element for inviting the private investment is the degree of credit rating or credit risk, and is not the system such as the liberalization or opening of the market. The improvement of the actual economy or the political and social situation of a state will upgrade its credit rating or credit risk. The market opening in itself does not assure the upgrading of credit rating.

2) The partial credit guarantee by the international financial organization (the World Bank) aims to provide the private investors with the ease of entry by assuring a part of loan without specifying the risk items of a project. In fact, EGAT in Thailand had the same financial problem soon after the currency crisis in 1998 as that of PLN, and its credit rating was triple B minus (S&P), which was unacceptable to expect the private investment (loan). The World Bank provided the bond issued by EGAT with the credit guarantee for the original capital

repayment, and its credit rating was upgraded up to A minus (S&P), which encouraged the private investors to buy the EGAT bond.

It is not sure if such a credit guarantee is given to Indonesia, but it is sure that the case of Indonesia is more difficult than that of Thailand. First, the credit rating of the state of Indonesia is triple C minus (S&P), which is lower than that of Thailand at that time. Second, the partial credit guarantee requires the Indonesian government to assure a part of loan as the counter guarantee of the other party government. The key for the success is how the private financial institutions evaluate the arrangement.

3) The next idea for inviting the foreign investment is the selling of the stocks of the PLN subsidiaries of power generation. The purchasing of the stocks of PLN subsidiaries means to take the credit risk of PLN. When the financial standing and the credit rating of PLN are looked at, it is doubtful if any investor makes choice of it.

4) The present IPP investment model is becoming out of the question. The IPP model limits the electricity selling only to PLN. If the PLN financial standing is deteriorated, the renegotiations on the selling price and the selling contact will become unavoidable. Not only the profit earning is hard to secure as planned in a business plan, but also the risk exists such as the extension or the termination of a contract.

As reviewed above, inviting the private investment into PLN and the Indonesian electricity market is not easy because they are lacking in the requirements as the choice of the investment grade from the viewpoint of the investment principle.

Therefore, we need to keep the following two principles in mind, if we develop the practical measures to invite the private investment in the Indonesian electricity market based on the general principle of investment.

1) To minimize the risk of investors:
For this purpose, the essential risk of any choice of the investment needs to be transferred from PLN or the Indonesian government to the other institution of a higher credit rating or a lower credit risk.

2) To narrow down the target from public investors to strategic investors:
The present Indonesian electricity market has no positive incentive to invite public investors. The market has too many unclear and uncertain factors to explain to public investors with confidence that the market is attractive and expected to make sound growth in the future.

11.7.5 New Business Model

We propose the two models for inviting the private investment in the Indonesian electricity market: 1) the investment model to PLN, and 2) the investment model to the electric power generation market. Both of the proposals are practical and highly feasible by having minimized the investor's risk along the investment principle and by having narrowed down the target to the strategic investors.

(1) Investment model to PLN <the use of a special-purpose company (SPC) and the security investment collateralized by the power purchase agreement>

As previously stated, the most important point is that the actual risk is transferred to a more secure institution other than PLN or PLN associates even when the investment is made in PLN, PLN subsidiaries or PLN affiliates.

The proposed security investment model "the use of SPC and the security investment collateralizing the selling contact of electricity" enhances the safety by securing the claim of investors with credit worthiness of electricity purchasers. This model arranges to transfer a part of PLN's power generation facilities to the special-purpose company and to allow the company to sell the generated power at the transferred generation facilities by the sales agreement of electricity (the purchase agreement of electricity). If the buyer is a good-standing company, the special-purpose company is able to raise the fund by issuing its bond collateralizing the purchase agreement of electricity.

1) The procedure of the scheme is as follows:

(i) PLN establishes the special-purpose company (SPC) by its own fund or by a joint venture with other organization. The initial paid-in capital of a SPC will be usually very small. This is because the SPC is a kind of a dummy company that has no actual business activity.

(ii) PLN transfers a specific power plant (or plural) to SPC. In this case, the transfer means to sell the power plant. SPC pays PLN for the power plant by the fund raised by issuing its bond afterwards.

(iii) SPC that owns the transferred generation unit from PLN concludes the long-term purchase agreement of electricity (more than one year) with major electricity customers. SPC issues the bond to raise the fund collateralizing the purchase agreement. The fund is used to pay PLN for the transferred power plant.

If SPC does not repay the interest and the principal of the bond, the purchaser of the bond (the investor) will receive the electricity charge directly from the major customers by exercising the security right (the right of pledge) set in the purchase agreement between SPC and the major customers. The purchaser can appropriate the money for the interest and the principal.

The purchaser of the SPC bond has the right of pledge on the demand right for electricity charge payment set in the purchase agreement of electricity.
If SPC fails to perform its duty of supplying electricity specified by the agreement due to bankruptcy, which forces SPC to discontinue the power generation, the bond purchaser (the investor) is allowed to perform the duty of supplying electricity by exercising the right of pledge on the SPC's power plant.

(iv) After PLN has received the cost of the transferred power plant, PLN is able to implement the building of a new power plant, the renovating, expanding and streamlining of the existing power plants by appropriating the cost received from SPC.

2) In order to make the scheme feasible, the following three conditions must be met.

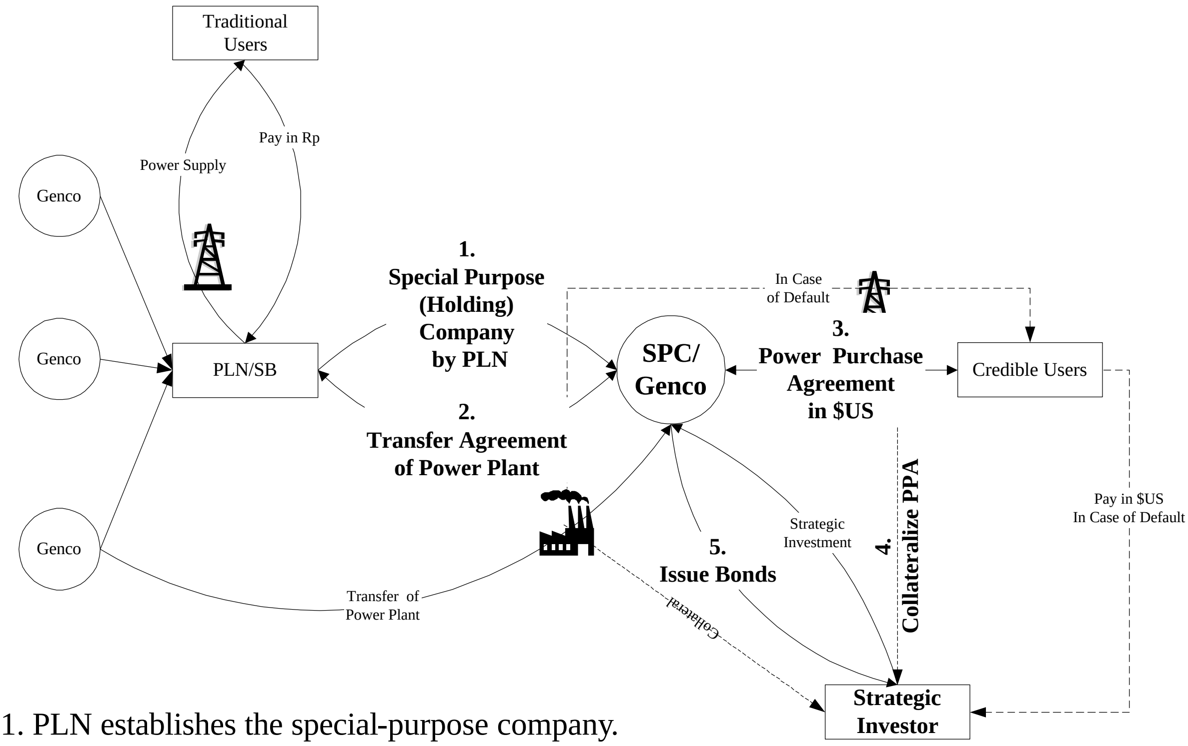
(i) The major electricity customer that concludes the long-term purchase agreement of electricity should be the affiliate of a foreign company that secures the long-term purchase of electricity and the payment for the charge.

(ii) The foreign company should understand the Indonesian electricity market and the current situation of PLN, and recognize that the payment of the electricity rate at the level of 7 cents per kWh is due. The charge level corresponds to that before the economic crisis in 1997 while the current PLN electricity rate of 4-5 cents per kWh is comparatively lower than the level of other Asian countries.

(iii) The SPC bond purchaser should be a strategic investor. The strategic investor means a foreign electric power company that finds interest in having some connections with the power plants, PLN and the Indonesian electricity market by investing in the SPC bond.

3) The above scheme is shown in the following figure.

Figure 11.7.1 Model of Establishing Special-purpose Company



1. PLN establishes the special-purpose company.
2. The transfer agreement of power generation plant
3. The power purchase agreement
4. The collateralizing of the power purchase agreement
5. The issuing of SPC bond

4) Position of Individual Parties

(i) PLN: PLN will assign specific power plants for generating electric power consumed by foreign enterprises and transfer the plants to SPC. The arrangement will enable PLN to raise the new fund by collateralizing the purchase agreement with the foreign enterprises. PLN will continue to operate and maintain the power plants transferred to SPC based on the O&M agreement with SPC, so that there is no essential change in this regard except the ownership of the plants.

(ii) Foreign Enterprises: JJC and foreign enterprises stationed at Jakarta are seriously concerned about the electric power problem. If a power cut occurs due to the shortage of power supply, the foreign enterprises will possibly loose their investment fund and may suffer a significant loss. They are willing to relieve PLN by accepting the electric power rate of 7 cents per kWh in advance. The current rate will be raised to 7 cents per kW sooner or later.

In addition, the power plants of SPC are enabled to supply high-quality electric power through the technical assistance and technology transfer from the foreign electric power companies and they deserve to be paid by the foreign enterprises at the rate of 7 cents per kWh.

(iii) Strategic Investor <the foreign electric power company>: The foreign electric power company invests in the SPC bond, secures the repayment of the interest and the principal of the bond and earns the profit by licensing the technology and know-how for the efficiency improvement of power plants. Here is the room for promoting the technology transfer through the cooperation between PLN and the foreign electric power company.

The purchased bond is secured by the payment of the foreign enterprises for the consumed electric power. Therefore the credit rating of the bond would be objectively higher than that guaranteed by the state of Indonesia.

If SPC goes into bankruptcy, the management authority of the power plants will be transferred to the foreign electric power company that operates the power generation business replacing SPC.

When the above investment model is applied for the actual development, the following points must be reviewed.

(a) The consumption and its distribution of the consumption of PLN electricity by the foreign enterprises

(b) The selection of the power plants (PLN’s plants) to supply electric power to the foreign enterprises (the power consumption and the distribution to be considered)

(c) The necessity of improving the legal system (the law of the special-purpose company, the laws related to electricity business etc.)

(d) The valuation of the assets for specified power plants

(e) The financial analysis of SPC

(f) Sounding the strategic investors about their intention

(g) Sounding the foreign enterprises about their stance for cooperation

(h) The survey the possibility of cooperation by the foreign governments (JBIC etc.)

(i) Sounding the Indonesian government

In this idea, the investor (the bond buyer) will take the credit risk of the foreign enterprises (the electricity purchasers), not that of PLN. If SPC fails to pay the interest and the principal of the bond, the investor will receive the electric power charges directly from the foreign enterprises, which will be appropriated to the interest and the principal of the bond. If SPC or PLN fails to perform the duty of supplying the electric power to the foreign enterprises and cannot pay for the interest and the principal of the bond by the loss of income, the investor is entitled to obtain the power plant by exercising the right of pledge for the plants. The investor, the electric power company at it home country, will start the power generation to supply electric power to the foreign enterprises that are the other parties of the sales agreement, and receive the electric power charge.

The foreign electric power company, which acts as the strategic investor, will also provide the technical assistance for improving the efficiency, productivity and quality of SPC power plants and strive to recover the invested fund. The technical and managerial assistance in this case would be proposed as the condition for the investment, and the assistance from the foreign governments would also be considered in this regard.

This tentative plan will bring PLN a significant benefit. PLN will be enabled to reduce the asset on the balance sheet by selling its power plants to SPC, and to raise the new money. PLN is not required to reduce its workforce because PLN continues to perform the O&M of the power plants sold to SPC. PLN will practically retain the ownership of the power plants.

What would be the position of the foreign enterprises as the customers? Their primary concerns at present are how to prevent the occurrence of planned brown out caused by an electric power crisis in the near future. The stable supply of electric power is given priority over the electricity rate for continuing their operations in Indonesia. Then, they could buy electric power without anxiety, if they conclude the long-term sales agreements with PLN and the foreign electric power company provides the technical assistance for the quality. If they were supplied with stable and high quality electric power for a long period of time, they would accept the electric power charge on US$ basis.

5) Differences from the Case when PLN Power Plants Are Sold Directly to the Strategic Investor

The above business plan may raise such questions. “Why is SPC required to sell PLN power plant?” “Why cannot PLN sell their power plants directly to the investor without such an complex arrangement?” The answers to the questions are shown blow.

i) It is very difficult to find a buyer, if it is planned to sell the PLN power plants. The reason is that the purchaser who has bought the power plant from PLN has no way other than selling the electric power to PLN. In addition, if the electric power rate is set on rupiah basis and paid in rupiah, the purchaser has bought the plant only to take over the loss of PLN in consequence.

ii) According to the model of creating SPC, when the power plant comes finally to the hand of the investor due to the default of PLN, the plant is accompanied by the sales agreement with an excellent customer. The investor will take the power plant together with its customer. The arrangement to protect the bond for the worst should be the point to attract investors.

iii) The route to sell the PLN power plants directly to the investor should not taken, even if the plant is accompanied by the sales agreement with an excellent customer on US$ basis and US$ payment.

The reason is because the difference exists in the basic consideration between the investment model by SPC and the way for PLN to raise fund by selling its power plant directly to the investor. In the case of the SPC model, PLN controls the power plant through SPC. When SPC completes the payment for the interest and the principal of the bond, the power plant will revert to the PLN ownership. The thrust of the SPC model is to assist PLN in financing and technical aspect.

On the other hand, in the case of the sale of PLN power plant, the power plant sold to an investor never reverts to the PLN ownership. The direct selling of the PLN power plant focus on making inroads into the Indonesian electricity market, but it is not appropriate to argue about the selling when the composition of PLN finance is deteriorated.

6) The market size of the SPC model

The size of the possible excellent foreign affiliates (that are expected to conclude the sales agreement on the US$ basis) is estimated based on the survey for the Japanese affiliates.

In 2001, Japan Jakarta Club (JJC) conducted the questionnaire survey for the members of JJC about the contributions to the Indonesian economy by the Japanese affiliates. The respondents to the questionnaire were 116 companies, or about one-third, out of 364 JJC member companies.

The economic contributions in Indonesia by the 116 companies were:

- the investment in Indonesia; 6.6 billion dollars
- the sales in 2000; 3.6 billion dollars (domestic 1.9 billion dollars, export 1.7 billion dollars)
- the number of Indonesian employees; 85,466 (Japanese employees 735)

If it is assumed that the non-respondents had the same level of the contribution as the respondents, the total contributions of the JJC member companies would be three times of the above figures, or the sales of 10.8 billion dollars and the export of 5.1 billion dollars.

The number of the JJC member companies (364) is about one-third of the total Japanese affiliates in Indonesia (approximately 1000 companies). When this is taken in consideration, the contributions by the Japanese affiliates would be again three times of the above figures, or the total sales of 32.4 billion dollars and the export of 15.3 billion dollars. However, not all the companies are engaged in manufacturing business, so that the estimate at a lower side comes to the total sales level of 10 billion dollars, or three times of the total sales by the respondents to the JJC questionnaire survey.

If the GDP of Indonesia keeps the level of about 140 billion dollars, the sales of the Japanese affiliates assumes about 7% of the GDP. If the electric power consumption in Indonesia is estimated at 20 million kW, the Japanese affiliates would consume 7% of the figure, or about 1.4 million kW.

The total investment from Japan during the period from January 1967 to May 2000 amounts to about 36 billion dollars, and it assumes about 15.9% of the total foreign investment, or the largest country in the investment. The second largest is UK with 21 billion dollars, the third Singapore with 19 billion dollars, the fourth Taiwan with 16 billion dollars, the fifth Honking with 15 billion dollars, and the sixth USA with 10 billion dollars.

If Japanese affiliates consume 7% of the total electric power consumption, or 1.4 million kW, and the investment from Japan assumes 15.9% of the total foreign investment, the total power consumption by the foreign affiliates would be about 8.8 million kW, which is simply calculated by proportioning the consumption with the total foreign investment. This is the quite rough estimate of the electric power consumption, but the size for the SPC model would be 8 to 9 million kW.

(2) Investment into market of electric power generation (lifting the ban of the electric power generation in the industrial estate of foreign affiliates)

As stated above, the private investment in the Indonesian market of electric power generation has been only through IPP model. The model has a high possibility of the risk that becomes obvious by the occurrence of the economic change due to a great fall of rupiah. Then a new investment model is required to invite the private investment in the market of electric power generation.

The current IPP model restricts the selling of electric power only to PLN. This means that the financial crisis of PLN makes the return of the IPP investment unrecoverable. If the private investment is to be promoted in electric power generation market, the investor in power generation should be allowed to sell electric power to consumers other than PLN. The most attractive consumer for the investor in power generation would be the industrial estate of foreign affiliates where the investor can supply electric power in the most efficient and safest way. If the Indonesian government decides to allow a partial liberalization of the power supply business to the foreign industrial estate, prior to the full liberalization in future, the investment in the power generation business would increase by the foreign electric power companies.

Followings are the reasons why the foreign industrial estate is focused on for inviting the investment in the market of electric power generation.

1) Few companies in the industrial estate would be forced in a position of nonpayment of electric power charge, because they have enough size to run manufacturing business in the estate. Then there would be no concerns about securing the return on the investment.
2) It is from the viewpoint of profitability. The investment in electric power generation requires selling electricity on the US$ basis and US$ payment in order to avoid the risk of foreign exchange fluctuations in particular by a heavy fall in rupiah. But the companies operating in the industrial estate would have the financial strength enough to pay on US$ basis.
3) It is the efficiency from the technical viewpoint. The transmission and distribution efficiency is higher if the consumers are concentrated in one area.

As for the investment in the power generation business in a leading industrial estate, there is the opinion that the Indonesian government and PLN would not agree with the investment because the investor will take only the excellent consumers. However, the financial problem of PLN and the shortage of electric power are in a serious condition. The introduction of the private investment at the earliest possible point will be the fast road to the sound public finance for PLN and then the state of Indonesia. This model is worthy to be considered as the fundamental plan for inviting the private investment.

11.8 Technical Cooperation Programs

In this section, necessary technical cooperation programs are proposed and summarized from the viewpoint of technical and systematic aspects to make the optimal power development plan and transmission plan smoothly and effectively. The necessary cooperation programs are categorized into the following three items:

1) Promotion of power development
2) Operation and maintenance of existing facilities
3) Demand Side Management (DSM)

11.8.1 Technical Cooperation for the Promotion of Electric Power Development

a) Capacity building

The state owned electric company (PLN) has been in charge of making electric power development, transmission plan, operation plan and maintenance plan. In line with the restricting policy, the function of making electric power development plan will be transferred form PLN to MEMR. As MEMR has no staff members who have enough knowledge and experience for carrying out the electric power development planning so far, external supports to MEMR are necessary, for example, inviting experts from PLN is necessary as well as human development.

P3B, a subsidiary company of PLN, will be in charge of transmission planning according to the unbundling program of PLN. MEMR is expected to have a function to coordinate electric power development planning and transmission planning.

Input:

A long-term Expert assignment to MEMR for 2 years in order to advise a technology of electric power development and transmission plan

b) A feasibility study on power interconnection to Sumatra grid

It is necessary to study of interconnection of the grid from Java-Bali system to the Sumatra system for the suitable allocation of power plants, economical operation and system stability. With the interconnection of these 2 systems, it will be possible to construct coal-fired power plants in Sumatra, and to operate power plants economically by improving stability and essential spinning reserve.

Input:

Development study to MEMR for one year
150 million yen

11.8.2 Operation and Maintenance of Existing Facilities

a) Rehabilitation plan of thermal power plants in operation

In this study, rehabilitation plan of existing thermal power plants was made with a survey of present operational condition, derated capacity, thermal efficiency and fuel cost per kWh. From the survey results, thermal efficiency improvement measures on conventional thermal power plants were focused on and their performance were examined in each power plant. From the higher priority, there are 1) Cleaning of feed water heater tube, 2) Boiler chemical cleaning, and 3) Improving high- and intermediate-pressure turbine blades and replacing air pressure element and seal. 1) Cleaning of feed water heater tube is recommended as a technical and financial assistance.

Input:

1) 2 Short-term Experts to MEMR for 2 months each, for technical advice by OJT basis

2) Provision of equipment of 20 million yen (one set of high pressure jet system and its consumables)

b) Improvement of operational technologies of existing thermal power and hydropower plants

For the sustainable power supply and profitable management, it is necessary to transfer the adequate operational technologies of existing thermal power and hydropower plants, such as reduction of high forced outage rate, Shortening inspection period, and extended operation (extended interval of inspection)

- O&M technology: O&M technology of the aged thermal power plants and hydropower plants
- Repairing technology: Examination and repair of technology of the aged thermal power plants and hydropower plants
- Rehabilitation technology: Rehabilitation skills, repair work planning and operation skill
- Environmental technology: countermeasures against air pollution, water pollution, noise and vibration, and establishment of monitoring system
- Power system operation technology: Economical operation to meet peak load (pumped storage hydropower and DSS system of thermal power)

Input:

Project type cooperation to PLN with 4 Long-term Experts for 5 years each, with an arrangement of counterpart team from PLN training center

c) Introduction of Power System Stabilizer (PSS)

In order to improve the system stability and enlarge the capacity of transmission lines, PSS is recommended to be used on the condition that necessary data of generators is arranged.

Input:

A short-term Expert for 2 months assigned to PLN

Data arrangement of generators by PLN or Local consultant

11.8.3 Demand Side Management (DSM)

a) Supporting of DSM program

The DSM approach such as load management and energy saving will contribute to control the demand and to improve load factor, which may result in the reduction of generation cost and saving of investment cost for power development.

Input:

A short-term expert to PLN for three (3) months for

a) Carrying out CDM potential survey in Indonesia and introduction of DSM in overseas

b) Making proposal of DSM program and implementation scheme

c) Supporting the promotion activities and technical seminar

Financial support of DSM project implementation

b) A study on actual condition of captive powers

Captives share 30% of installed generating capacity in Java-Bali system, which affects on the national electric power development plan so that the actual situation of captive power operation should be studied. Feasibility of power purchase from the captives is also necessary to be studied for short-term countermeasures against to power deficit as well as long-middle term countermeasures to the effective use of the facilities.

Input:

Follow up study

Local consultant will be in charge of the survey of actual captive operational conditions and the study on registration and reporting system on captive power, and Japanese consultant will be in charge of Demand forecast, short-term countermeasures and electric power development plan based on the survey above