No.

The Republic of Indonesia

Ministry of Energy and Mineral Resources
and PT. PLN(PERSERO)

The Study on Optimal Electric Power Development in Sulawesi in the Republic of Indonesia

Final Report
(Summary)

August 2008

JAPAN INTERNATIONAL COOPERATION AGENCY

CHUBU ELECTRIC POWER CO., INC.
NIPPON KOEI CO., LTD.

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Preface

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

JICA selected and dispatched the Study Team, headed by Mr. Yoshitaka SAITO of Chubu Electric Power Co., Inc. and consists of Chubu Electric Power Co., Inc. and Nippon Koei Co., Ltd. from July 2007 to June 2008.

The Study Team held discussions with the officials concerned of the Government of the Republic of Indonesia and the provincial governments in Sulawesi, and conducted field surveys at the study area. Upon returning to Japan, the Study Team headed by Mr. Hirokazu NAKANISHI conducted further studies and prepared this final report.

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

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

August 2008

Seiichi NAGATSUKA
Vice President
Japan International Cooperation Agency

August 2008

Seiichi NAGATSUKA
Vice President
Japan International Cooperation Agency
Tokyo, Japan

Letter of Transmittal

We are pleased to submit to you the report of "the Study on the Optimal Electric Power Development in Sulawesi". This study was implemented by Chubu Electric Power Co., Inc. and Nippon Koei Co., Ltd. from July 2007 to August 2008 based on the contract with your Agency.

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

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

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

Very truly yours,

Hirokazu NAKANISHI
Team Leader
The Study on the Optimal Electric Power
Development in Sulawesi

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Chapter 1 Preface

This Study has been conducted focusing on the area of whole the Sulawesi Island for approximately 13 months from July 2007 to August 2008, in accordance with "Scope of Work (S/W)" agreed upon between the Ministry of Energy and Mineral Resources of the Republic of Indonesia (MEMR), the State Electricity Company (PT. PLN (Persero)) and Japan International Cooperation Agency (JICA).

In Sulawesi, located in the relatively undeveloped, eastern part of the Indonesia, there has been little progress in power development due to PLN's financial constraints in spite of the existence of abundant renewable energy resources as hydropower and geothermal. In the most part of the island, the current situation is that electricity has been supplied by diesel generators and small scale grid systems dispersed mainly in and around local cities. Recent oil price surge has not only caused daily load shedding derived from diesel fuel shortage but made the financial situation of PLN and the lack of development funds even worse.

Given such background, this Study was designed with the following two objectives:

i) Formulation of power development plan and transmission plan with maximum utilization of local primary energy resources, and
ii) Technical transfers for the planning to the Ministry of Energy and Mineral Resources (MEMR) and the state-owned power company (PLN)

This Study has been conducted in the following three stages and works both in Japan and in Indonesia has been made in the respective stages.

- The first stage: Preliminary Study Stage
- The second stage: Optimal Scenario Study Stage
- The third stage: Conclusion and Recommendation Stage

In the first stage, principally existing data and information were collected, organized and analyzed. Especially power sector policies and primary energy resources at the level of the national government and Sulawesi provincial governments were wrapped up. Also, electricity demand forecast was conducted using the necessary social and economic indices collected.

In the second stage, two development scenarios, "Economic Oriented Development Scenario" and "Local Energy Premier Development Scenario" were set. Generation development plans and transmission development plans were investigated and evaluated on each scenario, in terms of not only policy, technical and economic aspects but social and environmental aspects using comparative table.

Below are the definitions of the two scenarios proposed in this Study:

Economic Oriented Development Scenario	Aiming least supply cost without any restriction of power resources. Most of diesel generators will be replaced with coal thermal power plants in this scenario.
Local Energy Premier Development Scenario	Putting higher priority on hydropower and geothermal power that are local energies existing in the Sulawesi Island. This scenario aims to keep CO_2 emission ratio at present level.

As a result of comparison, Local Energy Premier Development Scenario has advantages in most criteria including conformity to energy policies, operation & maintenance cost, global warming protection, despite has some disadvantages in involuntary resettlement, impact on biota and ecosystem. The Study Team judged "Local Energy Premier Development Scenario" as optimal.

In the third stage, measures for funding and private investment promotion were proposed based on the "Local Energy Premier Development Scenario". Power system interconnection including North-South interconnection was studied by means of C/V evaluation and the possibility and timing of introduction were suggested. The Study Team finally proposed specific cooperation measures for some projects presented in the "Local Energy Premier Development Scenario".

This Study forms of a part of "North East Indonesia Regional Development Program" promoted by JICA. Since involvement in the power development planning from the regional levels is expected in such context, the following measures were taken to let all the stakeholders including regional government officers, academic experts, NGOs as well as the official counterparts familiarize and understand the Study contents and results:

i) Participation in total of four workshops, three stakeholders' meeting
ii) Three visits to regional governments
iii) Edit and delivery of brochure (written in both of English and Indonesian language)

This executive summary describes the study results mainly based on the Local Energy Premier Development Scenario.

Chapter 2 Energy Policy and Primary Energy Resources

Provincial policies on energy and power, and primary energy resources in the Sulawesi Island are described in this chapter.

2.1 Energy policies in Sulawesi provinces

(1) Abolition of provincial power development plans (RUKD)

As a result of the ruling by the constitutional court in December 2004, the 2002 Electricity Law was abolished, and this halted the preparation of power development plans (RUKD) by provincial governments that had been required by the law. For this reason, no provincial governments have prepared plans for power development since 2005.

(2) Provincial development plans and energy/power policies

Under the policy of local devolution being deployed by the national government, provincial governments formulate and announce medium- and long-term plans for social and economic development. Nevertheless, while they may present an overall planning framework, these plans do not necessarily extend to detailed measures in each field.

In the field of energy or electric power in particular, the provincial plans merely set forth a basic orientation. The plans in the provinces of North Sulawesi and South Sulawesi, for example, do not present individual policies for energy and power. In the province of West Sulawesi, which was established only recently, provincial development plans per se have not yet been unveiled.

2.2 Primary Energy in Sulawesi

2.2.1 Natural Gas

Central Sulawesi reportedly has 3.92 trillion cubic feet (Tcf) natural gas reserves. This volume is too small to produce liquefied natural gas (LNG), but it is large enough for use as pipeline gas. South Sulawesi has a small gas reserve of 0.79 Tcf.

Although natural gas development in the island is not yet progressing, an independent power producer (IPP)[1] currently owns and operates a 135 MW combined-cycle gas-fired power station in South Sulawesi. It is also constructing an additional 60MW unit, which is expected to start operating in September 2008. In addition, it has proposed construction of a 60 MW open-cycle unit (scheduled to start operation in February 2009) in the second stage and a 60 MW heat-recovery steam-turbine unit (scheduled to start operation in September 2009) in the third stage[2].

In Central Sulawesi, there are several natural gas development plans, but none of them has

[1] PT Energi Sengkan

[2] It is announced that natural gas cost applied to the second and the third stages of the Sengkan project was \$2.30/mmBtu on the year 2007 basis plus 2% p.a. escalation. This price is quite low as compared to the gas price purchased by PLN (i.e., around \$5.5/mmBtu, now), because it uses its own gas field.

actually been initiated yet. MEDCOENERGI, which owns a gas field in Senoro, has launched a marketing effort, and the prospective candidate products are chemicals and/or liquefied natural gas.

2.2.2 Coal

Indonesia is a coal-rich country. In 2006, it extracted 150 million tons of coal and exported 106.38 million tons of this total. The majority of its coal deposits are on the Island of Sumatra and in the province of Kalimantan.

In Sulawesi, there are only small coal deposits amounting to about 60,000 tons on the reserve basis in the Maros Pangkajene, Enrekang, and Mamuju areas in Central Sulawesi and South Sulawesi provinces.

2.2.3 Peat

In South Sulawesi. there are 1.23 million tons of peat resources on the dray basis. Peat has an average calorific value of 4,943 kcal/kg-dry-weight, which is lower than that of coal.

2.2.4 Geothermal

While Sulawesi has widespread geothermal energy resources, the majority are found in the provinces of North and South Sulawesi. North Sulawesi, which in the most geothermal-rich province, reportedly has 540 MWe on the possible reserve basis, 110 MWe on the probable reserve basis, and 65 MWe on the proven reserve basis.

Data for the other provinces are available only on the possible reserve basis. These possible reserves are estimated at 51 MWe in Central Sulawesi, 49 MWe in South Sulawesi, and 15 MWe in Gorontalo. These figures are much lower than those for North Sulawesi.

2.2.5 Hydropower

Together with geothermal power, hydropower is one of the abundant primary energy resources in Sulawesi. PLN has already proven the existence of a total of 10,749 MW in potential hydropower resources, and this figure represents 14% of the hydro potential in all of Indonesia.

This total consists of 4,000 MW in North and Central Sulawesi and 6,749 MW in West, South, and Southeast Sulawesi (Table 2.2.1).

Table 2.2.1 Potential of Ordinary Hydropower Energy in Indonesia

Island	Site	Power (MW)		Energy (GWh)
Sumatra	474	15,585	20.6%	84,110
Java	149	4,531	6.0%	18,042
Kalimantan	177	21,581	28.5%	107,202
Sulawesi	116	10,749	14.2%	52,952
North & Central	-	4,000	-	-
West, South & South East	-	6,749	-	-
Maluku	53	430	0.6%	3,043
Irian Jaya	210	22,371	29.6%	133,759
Bali, NTB, NTT[3]	136	374	0.5%	2,536
Total	1,315	75,624	100.0%	401,644

Source: PLN

In addition to the ordinary scale hydropower mentioned above, the potential of mini-hydropower energy larger than 15 kW is measured at 31,440 kW by PLN. Of which, the largest resources of 12,790kW exist in North Sulawesi, and the next large 11,765kW, South Sulawesi. Resources of 6,885 kW, which is a little larger than one half of those figures, exist in Central Sulawesi.

Meanwhile, a total of 30,474 kW potential energy throughout the island is reported by non-PLN institutions.

Other primary energy resources such as wind power, solar power and biomass/ biogas also found in Sulawesi, their capacity for generation are rather small compared to hydropower and geothermal.

[3] Nusa Tenggara Barat, Nusa Tenggara Timur

Chapter 3 Demand Forecast

This chapter forecasts the future demand based on the past sales and the economic indicators.

3.1 Methodology

The methodology utilized by the study team is straightforward. It follows the following steps

1. The total demand is forecasted using a standard econometric model, using elasticity of demand against the Gross Regional Domestic Product (GRDP).
2. The demand is converted to generation based on the assumed percentage of the station use and the transmission loss.
3. The total demand is separated to each system based on the current percentage of each system.
4. For each system, the peak load is calculated based on the current load factor. The peak load is aggregated into the total peak load forecast.

3.1.1 Elasticity Assumptions

The total demand forecast was made based on the operating division of PLN. Since all grid operations are undertaken by PLN, this was reasonable. Within North Sulawesi and South Sulawesi, the demand pattern is slightly different. In South Sulawesi, 88% of the total demand is dominated by demand around Makassar (Sulsel system). The second largest system, Kendari system, occupies only 6%. While the systems have their distinct characteristics, they do not affect the overall pattern of the power demand. Therefore, it was reasonable to treat the whole demand as a single block.

North Sulawesi, on the other hand, consists of three distinct regions; North, Central, and Gorontalo. While North, with Manado as its center, has the largest share, it does not necessarily dominate the whole PLN operational area. The distribution between North, Central and Gorontalo is about 60%, 28% and 12%. With somewhat different characteristics of these states, the forecast is made separately for the three regions.

Elasticity is simply the ratio between the growth rate of the GRDP and the power demand. Based on the historic figures, the elasticity for each region was set as follows;

	Sulawesi South	North	Central	Gorontalo
Elasticity against GRDP	1.32	1.25	1.3	1.3

3.1.2 GRDP Growth Assumptions

As for the assumption for the GRDP growth, the team has based the forecast on historic figures. It has been established that the growth of Sulawesi as a whole has been higher than the national growth, with an elasticity of about 1.12. This is reasonable, since with a smaller scale of economy compared to the national economy, Sulawesi should show a higher growth. Since the Central Bank has forecasted a future growth of 6% for Indonesia as a whole, this implies that the future growth of Sulawesi is about 6.7%. As the economy grows, however, the growth rate usually tapers down. Therefore, it is assumed that after 2015, the growth will slow down to 6%.

For the northern regions, the team has accepted the GDP growth assumptions made by PLN. It assumes a growth of about 7.4%, gradually declining to about 7.25%. While this seems aggressive, with a smaller sized economy, it is not an unreasonable assumption.

3.1.3 Effects of the pent-up potential demand

Currently, the peak demand is somewhat cut-off by load shedding. Also, due to limitation in supply, there has been a constant waiting list for new customers. If these were properly connected, the demand would increase.

As for load shedding, the actual data has been provided by PLN. In Northern Sulawesi, Minahasa-Kotamobagu System has seen load curtailment since 2008/08 to the present day. Prior to 2006/08, the supply exceeded demand, so load shedding was only done in times of incidental break downs of the facilities. In terms of energy this was negligible. As a result, the un-served energy in 2006 was about 12.8 GWh/year. The critical period was 2006/09-11, with an average of 3.41 GWh/month. Usually, power was cut during 18:00-24:00. Therefore, the un-served capacity amounts to 18.3 MW. The maximum power in 2006 was observed on 12/26. The un-served demand (MW) was about 4.9 MW, so the load factor was not heavily affected

Similarly in Southern Sulawesi, the Sulsel system has seen load curtailment, especially since 2005. In 2005, 43 GWh was not served to the end users, which amounts to 1-2% of the annual generation. The situation improved slightly in 2006, and the un-served energy at the generation end was 18.9 GWh.

Had these demands be met, the total demand would have gone up by about 2%. It is well within the current operational capacity. Therefore, this was included in the demand forecast. Namely, the demand for 2007 was increased by the load-shedded amount.

As for the waiting list, the total amount was significant. In Northern Sulawesi, the capacity on the waiting list was 5.7% of the current generation capacity. In Southern Sulawesi, this was 15.7%. If these demand had the same load factor as the overall area, then the demand would have gone up by this ratio.

However, it is unclear how much of this applied capacity would be actually used. The application would most likely be made at their peak capacity plus some margin, and the load curve for industrial application would be significantly different from those of the overall demand which has a large residential component. Also, to assume that the future system would immediately accommodate this demand would be rather unrealistic. It would also affect the GRDP, which has historically been achieved under the suppressed demand condition. Therefore, although efforts will be made to accommodate the demand from the waiting list, the base case assumed that the tight supply condition will continue somewhat into the future. However, in order to understand the effect of the pent-up demand, a case is assumed where all the demand from the waiting list was somehow completely met, with the same load factor. This will be the high case scenario for the demand.

3.1.4 Other Assumptions

For station use and distribution losses, the current figure is about 15%. The study team has assumed that this will go down to about 10% in the future. While there is no absolute way to forecast this figure, the team feels that this is a realistic figure that is achievable.

As for the distribution of the total to the respective systems, and the load factor of each system, the study team has simply accepted the assumptions of PLN. PLN basically assumes that the current ratio of each system will more or less prevail in the future. It also assumes no significant change in the load factor. The study team finds this to be a reasonable and acceptable assumption.

In any situation, there is a price effect on demand. The change in the power tariff would naturally affect the demand. A higher tariff should lead to a lower demand. This, in theory, should also be observed in Sulawesi.

It has been pointed out, however, that the current power charge is much lower than its actual cost. Since the power tariff is kept artificially low, PLN claims that it has not been a determinant of demand, and the price effects on demand has been negligible.

3.2 Results

Using the above methodology and assumptions, the demand forecast up to 2027. The results show that in 2020, total demand for South Sulawesi will be 7,762GWh, an average growth of 8.5%. For North Sulawesi, the total demand in 2020 will be 3,917GWh, an average growth of 8.97%. The high case would be 15% and 5.7% higher respectively.

This figure is comparable to the historical average growth after the Asian currency crisis in 1997. Prior to the crisis, the economic boom brought a surge in demand, making the annual demand growth in Southern Sulawesi to 20%, but this was not sustainable. We feel that the current figure is a reasonable one that reflects the sustainable realities of the Sulawesi economy.

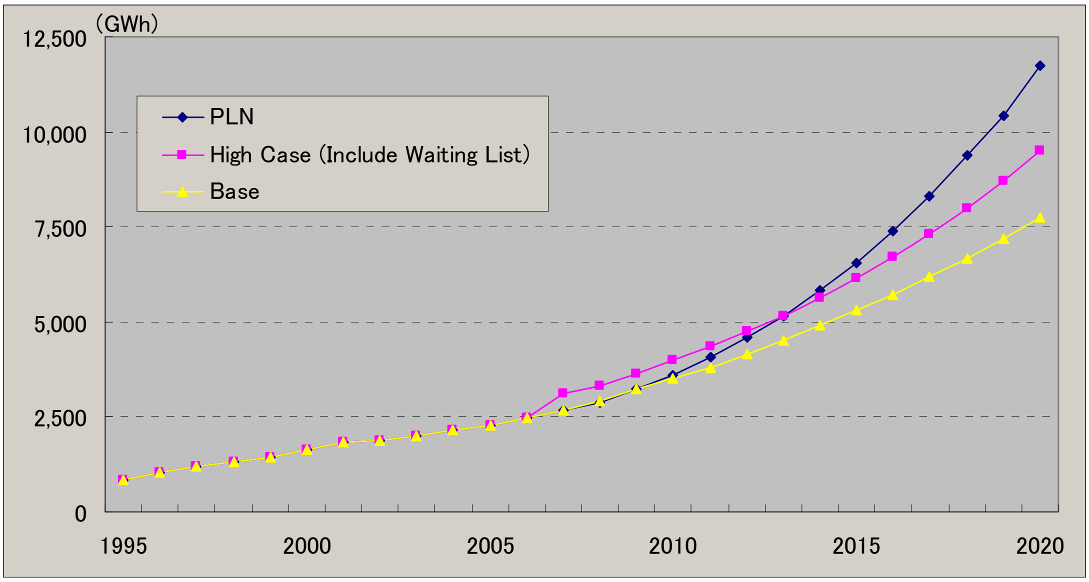


Figure 3.2.1 Demand Forecast results for South Sulawesi

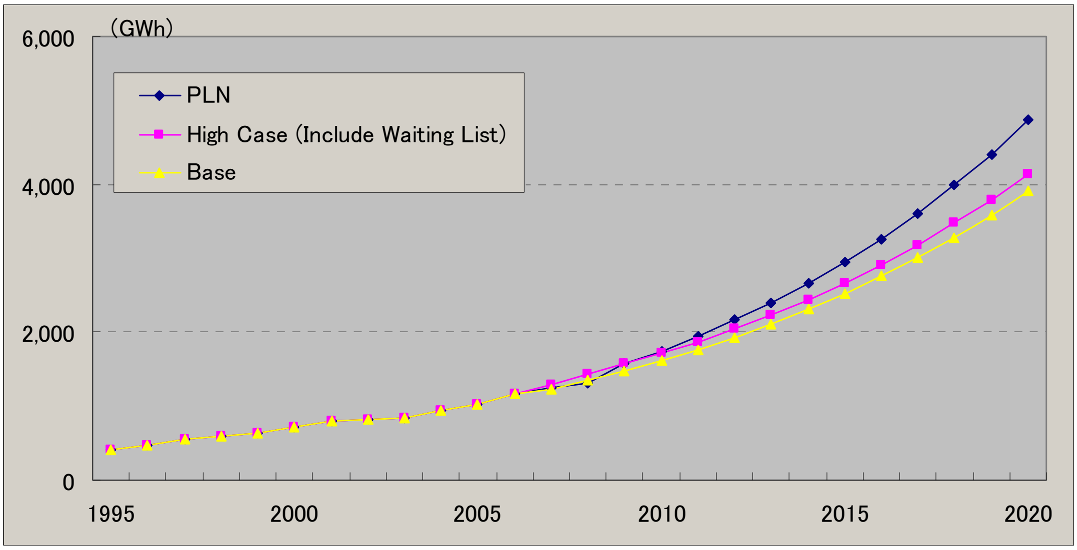


Figure 3.2.2 Demand Forecast results for North Sulawesi

Figure 3.2.1 and Figure 3.2.2 show the results against the forecast of PLN under the current RUPTL. In both regions, the results of the study team are lower than those of PLN. For North Sulawesi, the team's results are about 3/4 of PLN's forecast. In the case of South Sulawesi, it is about 2/3.

The reasons for this difference lie partly in the methodology, but mostly in the assumptions. As for the methodology, PLN forecasts various uses (residential, commercial, industrial, public) separately. The study team has made the forecast in an aggregate form for all uses. While PLN's method is more sophisticated, it will necessarily require the relatively small demand to be further subdivided into use category that may make them susceptible to random noises and fluctuations that does not reflect overall trend. The aggregate forecast used by the study team is rough, but more robust in this sense. Therefore, both approaches have their strengths and weaknesses. PLN also needs to have a consistent methodology with other regions.

The main difference, however, lies in the assumptions, especially the elasticity of demand. PLN chose a more aggressive figure than the study team. The difference was compounded over time, which led to the significant difference.

While the study team believes that the results to be sound, we must also point out that the PLN results are not necessarily out of line. Within the past 20 years, Indonesia has experienced extremely high growth (prior to the Asian Currency Crisis), and extremely low growth (after the Crisis). Therefore, depending on the period that the assumptions are based on, it is possible to make a very optimistic growth scenario, and a very conservative one. The team chose to be rather conservative, basing the assumptions on the periods mostly after 2000 where situation has stabilized. A return to the high growth era, however, may not be out of the question (although it is doubtful whether it can be sustained over an extended period.)

This figure is comparable to the historical average growth after the Asian currency crisis in 1997. Prior to the crisis, the economic boom brought a surge in demand, making the annual demand growth in Southern Sulawesi to 20%, but this was not sustainable. We feel that the current figure is a reasonable one that reflects the sustainable realities of the Sulawesi economy.

3.3 DKL and Simple-E

Initially, there have been significant comments on the use of demand forecast tools, namely DKL and Simple-E. The study team did not rely on either them in making the current forecast, but have looked at these tools.

DKL and Simple-E are demand forecast packages used by the Indonesian authorities. Both are add-on packages for the Microsoft Excel spreadsheet software. Both are based on econometric regression models. In this sense, they are both quite similar. Since the underlying engines that actually does the calculation are the same (namely Excel), there can be no difference in their accuracy or basic calculations.

It should also be pointed out that DKL is an extremely flexible package that allows the user to make many sorts of regression, and to incorporate various additional concerns like captive demand. It is, in fact, possible to create something exactly the same as Simple-E. In this sense, it is rather futile to argue about which program to use.

Chapter 4 Generation Development Planning

JICA Study team proposed an optimal generation development plan considering conditions such as future demand, supply capacity, required supply reliability, costs and environmental aspects. This chapter discusses the generation development plan for power systems in Sulawesi up to 2027.

4.1 Power Supply in Sulawesi

4.1.1 PLN Power Supply

PLN supplies power almost all the area in Sulawesi. Table 4.1.1 shows the PLN's power supply in Sulawesi from 2002 to 2006.

Table 4.1.1 PLN's Power Supply in Sulawesi

	Year				
	2002	2003	2004	2005	2006
Peak Demand (MW)	681	704	722	742	854
Energy Production (GWh)	3,356	3,451	3,764	3,929	4,164

(Source: Statistiks PLN Suluttenggo 2002-2006, Statistiks PLN Sulselrabar 2002-2006)

PLN's power supply systems in Sulawesi divided into three (3) types; (1) Interconnected Systems of the System Minahasa-Kotamobagu in northern Sulawesi and the System Sulsel in southern Sulawesi, (2) Small-scale isolated systems (25 systems), and (3) Scattered stand-alone systems with very small capacity.

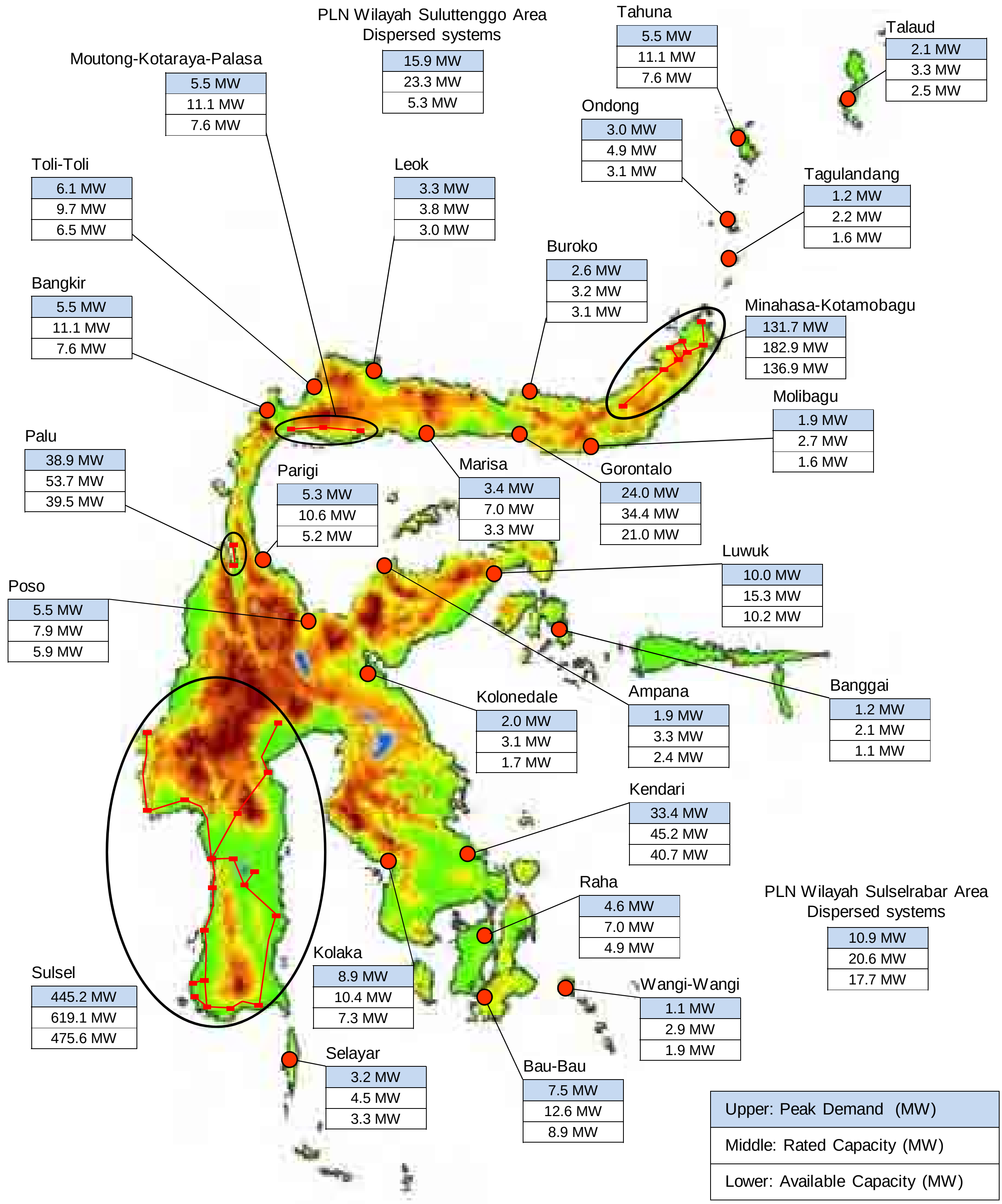
Wilayah Suluttenggo in Manado and Wilayah Sulselrabar in Makassar are PLN regional office which are responsible for power supply in north area and south area, respectively.

Figure 4.1.1 shows outline of PLN's systems in Sulawesi as of the end of 2006.

Table 4.1.2 shows PLN energy production in Sulawesi. The annual energy productions of the System Minahasa-Kotamobagu and System Sulsel are 694 GWh and 2,487 GWh, respectively, which corresponds to 16.7% and 59.7% of PLN energy production in Sulawesi..

Table 4.1.2 PLN Energy Production in 2006

system	Annual Energy Production (GWh)	Component Ratio (%)
Minahasa-Kotamobagu	694	16.7
Sulsel	2,487	59.7
Other systems	983	23.6
Total	4,164	100.0



Source: RUPTL 2008-2017 PLN Wilayah Suluttenggo (Draft)
RUPTL 2008-2017 PLN Wilayah Sulselrabar (Draft)

Figure 4.1.1 Outline of PLN Power Systems in Sulawesi

4.2 Examination of Preconditions

4.2.1 Simulation Software

The Study Team applied WASP-IV as software for formulating generation development plan. WASP-IV is a simulation tool, which PLN uses for generation development plan for the System Java-Bali and the System Sumatra.

WASP-IV can seek a configuration with the minimum object function composed of investment cost, fuel cost, operation cost, etc. from the configurations which meets the electricity demand given in consideration of the cost characteristics in operation such as heat rate of thermal power plant and the probabilistic characteristics such as forced outage rate.

To fulfill the function and merit of WASP-IV, it is preferable that the number of generation units is thirty (30) or more in the system. So JICA Study team use the WASP-V for the 1) System Minahasa-Kotamobagu and 2) the System Sulsel.

The Study Team employs Microsoft Excel in order to make capacity balance and energy balance for the Small-scaled Isolated Systems in the same way that PLN applies it. In case that the number of generation unit in an isolated system increases to 30 units by interconnecting to other systems, the Study team applies WASP-IV for the interconnected system.

4.2.2 Fuel Price

Based on the actual purchase price of PLN and the data in RUPTL Draft, the Study team has set the fuel price and the steam price for geothermal power plant as shown in Table 4.2.1.

Table 4.2.1 Fuel Prices and Steam Price for the Geothermal Power Plant

Items	Units	Coal	HSD	MFO	Natural Gas	Geothermal (Steam)
Price	USD/ton	40				
	USD/liter		0.60	0.60		
	USD/MMBTU				5.0	
	cent/GCal	800	6,652	7,168	1,984	
	cent/kWh					1.9
Heat Content	kCal/kg	5,000	11,000	9,000		
	BTU/scf				1,000	
Specific Gravity	kg/liter		0.82	0.93		

(Source: JICA Study Team)

4.2.3 Fixed Generation Development Project

There are several on-going and committed projects for developing power plants in Sulawesi. These projects are considered as fixed developing projects in the simulation and the commissioned capacity and commissioned year are fixed. Also the procedure of optimization excludes these projects. Table 4.2.2 shows the list of the fixed development projects.

Table 4.2.2 Fixed Generation Development Project in the Study

Responsible Area	System	Owner	Plant Name	Plant Type		Fuel Type	Installed Capacity	Year
Wilayah Suluttenggo	Minahasa-Kotamobagu	PLN	Lahendong II	Geothermal	PLTP	Steam	20.0 MW	2007
		IPP	Mobuya	Mini Hydropower	PLTM		3.0 MW	2008
		PLN	Lahendong III	Geothermal	PLTP	Steam	20.0 MW	2009
		PLN	Lobong	Mini Hydropower	PLTM		1.6 MW	2009
	Gorontalo	PLN	Mongango I	Mini Hydropower	PLTM		1.2 MW	2009
	Ampana	PLN	Sansarino	Mini Hydropower	PLTM		0.8 MW	2009
Wilayah Sulselrabar	Sulsel	PLN	Tengka & Ranteballa	Mini Hydropower	PLTM		11.2 MW	2008
		Rental	Mobile TM 2500	Gas Turbine	PLTG	HSD	20 MW	2008
		Rental	Sewa (Tello)	Diesel Unit	PLTD	MFO	70 MW (10 MW × 7 units)	2008
		PLN	Senkang	Gas Turbine	PLTG	Gas	65 MW	2009
	Kendari	Rental	Sewa (Perusda)	Diesel Unit	PLTD	MFO	5 MW (2.5 MW × 2 units)	2008
	Raha	Rental	Sewa (Raha)	Diesel Unit	PLTD	MFO	3 MW (1 MW × 3 units)	2008

(Source: JICA Study Team)

4.2.4 Characteristics of Candidate Power Plants

Table 4.2.3 shows the characteristics of the candidate power plants for the Study. The necessary capacity to be developed will be discussed in generation development plan. In the isolated systems, the Study team gives a condition that the coal-fired steam turbine unit is allowed to install into the systems when 10% of the peak demand reaches to 5MW, which is the smallest size of coal-fired unit in the Crash Program.

Table 4.2.3 Characteristics of Candidate Power Plant in the Study

		Thermal Power Plant					Hydropower Plant
		Steam Turbine	Gas Turbine	Combined Cycle	Diesel Unit	Geothermal	
Rated Capacity (MW)		5-200	25-50	50-100	10	20	Data for Individual Project
Development cost (USD/kW)		1,150～1,500	430	700	680～730	2,000	
Plant Life (year)		30	20	30	15	30	40
Construction Period (year)		2～3	1.5	2.5～3	1	4	Data for Individual Project
Fuel Type		Coal	HSD	Natural Gas	MFO	Steam	
Fuel Price	(USD/ fuel unit)	40 (USD/ton)	0.6 (USD/Liter)	5.0 (USD/MMBTU)	0.6 (USD/Liter)	19 (USD/kWh)	
	(USD/ Gcal)	800	6,098	1,984	5,974		
Heat Rate* (kCal/kWh)		2,324～3,308	2,529	1,792～2,048	2,529		

*Note: at full load operation

4.3 Power System Interconnection

4.3.1 Interconnection of the power systems in Sulawesi

The power systems in Sulawesi Island include, (a) two major systems: Minahasa system and Sulsel system, (b)small isolated systems (6 systems in Sulselrabar and 19 systems in Suluttenggo as shown in RUPTL) is and (c) other very small isolated systems. In this Study, interconnection of the power systems in Sulawesi is examined with (a) and (b) in consideration. Here the benefit and cost for interconnection is considered as below.

In considering the interconnection of these power systems, benefits and costs of interconnection are examined.

The cost and benefit from interconnection are shown below. By comparing the both factors whether an interconnection is economical or not can be determined. This means that the interconnection is economically viable when the cost exceeds the benefit.

Table 4.3.1 Benefit and cost by interconnection

Benefit of interconnection	Cost of interconnection
· Decrease of power source development due to reliability improvement (Decrease of power plant construction cost) · Decrease of power plant O&M cost · Decrease of fuel cost due to economical operation	· Construction cost of transmission line · Transmission loss · O&M cost of transmission line

In Sulawesi there are a lot of power systems: large and small. Different approach should be adopted depend on the type of interconnection. Here, in considering interconnection, types of interconnection are categorized into the following three types:

I Interconnection between two small isolated systems
II Interconnection between a large system and a small isolated system
III Interconnection between two large systems

4.3.2 Interconnection between two small isolated systems

In case of interconnection between two small isolated systems, reduction of stand-by generator is possible, and it is benefit of interconnection. However, this benefit is smaller than construction cost of interconnection line. Thus interconnection is not economically viable in this case.

4.3.3 Interconnection between a large system and a small isolated system

In case of interconnection between a large system (Minahasa-Kotamobagu or Sulsel system) and a small isolated system, not only reduction of stand-by generator but also decreasing operation cost will be considerable for interconnecting benefit. It is mainly caused by difference of fuel cost between coal power plant in the large power plant and diesel generators in the small power system, and it depends on the demand of small isolated system. Then, the demand will increase yearly, it is possible to decide economical timing for interconnection considering construction cost of interconnection line and annual demand of the small isolated system.

Table 4.3.2 shows the result of interconnection year for small isolated systems. From the result, most of interconnection line will be economically viable in early stage (2008-2014) because of the large difference of fuel cost between coal power plant and diesel generator.

4.3.4 Interconnection between two large systems

Benefit of interconnection between two large systems, Minahasa-Kotamobagu and Sulsel systems is mainly two points as follows;

(1) Installation of large generator unit

Interconnection increase system size and it allows using large generator unit. Thermal efficiency of large generator unit is higher and construction cost is lower than that of small generator unit. Thus the reduction of generating cost is possible by interconnection.

(2) Reduction of reserve margin

Interconnection allows sharing reserve margin between two systems. Thus the reduction of reserve margin is possible.

Calculation of these benefits is not simple, so WASP-IV was used to obtain the benefit. From the results, benefit of North-South interconnection is 101 million USD (NPV 2008). However, there are some problems as construction cost of interconnection line and stability, it is difficult to interconnect North system and South system until 2027.

Table 4.3.2 Interconnection Year of Small Isolated Systems

Isorated System	Nearest point of Large system	Distance (km)	Transmission Cost (US$)	Peak Load (2007)	Interconnection year in terms of economy	Interconnection year
Gorontalo	Buroko	94	15,148,300	25.87	As soon as possible	2010 (in conjunction with coal power plant)
Marisa	Isimu (Between Golontaro and Buroko)	118	17,785,900	6.72	As soon as possible	2011 (after connection of Gorontalo-Minahasa)
Buroko	Bintauna	40	9,213,700	2.05	2009	2010 (in conjunction with Gorontalo coal power plant)
Palu+Parigi	Poso	102	16,027,500	43.06	As soon as possible	2010 (in conjunction with Poso)
Poso	Poso Hydro	37	8,884,000	5.28	As soon as possible	2010 (in conjunction with Poso)
Toli-Toli	Leok	99	15,697,800	6.01	As soon as possible	2014 (after connection of Leok)
Moutong-Kotaraya-Palasa	Marisa	84	14,049,300	5.05	As soon as possible	2012 (after connection of Marisa)
Leok	Gorontalo Coal Power Plant	148	21,082,900	3.84	2013	2013
Kolondale	Poso Hydro	90	14,708,700	1.78	2016	2016
Bangkir	Toli-Toli	98	15,587,900	1.03	2023	2023
Luwuk	Ampana	165	22,951,200	8.7	As soon as possible	2012 (after connection of Ampana)
Ampana	Poso	123	18,335,400	1.84	2018	2011 (after introduction of Poso)
Molibagu	Otam	70	12,510,700	2	2014	2014
Bintauna	Lolak	41	9,323,600	1.6	－*[4]	2010 (in conjunction with Gorontalo coal power plant)
Kendari+Kolaka	Wotu	300	47,969,100	46.1	As soon as possible	2011 (in conjunction with Kendari coal power plant)
Kolaka	Kendari	135	22,101,500	9.7	As soon as possible	2011 (in conjunction with Kendari coal power plant)

[4] Interconnection line with Gorontalo also goes through this area. So, though interconnection of Bintauna itself does not generate merits, it would be beneficial for the northern system as a whole.

4.4 Development Scenarios

A couple of development scenarios will be created from the viewpoint of strategic environmental assessment (SEA). In this study, we created two (2) scenarios of 1) Economic Oriented Development Scenario and 2) Local Energy Premier Development Scenario. They will be assessed from the viewpoints of national energy policy, environmental and social consideration, rural development program, etc. So-called "Zero Option" was not studied since needs for electricity is high as the Government of Indonesia declared its willingness to promote further electrification in RUKN (National Electricity Development Planning).

(1) Economic Oriented Development Scenario

The scenario will be an economic oriented development scenario that aims least supply cost without any restriction of power resources. Most of the diesel generators will be replaced with coal thermal power plants.

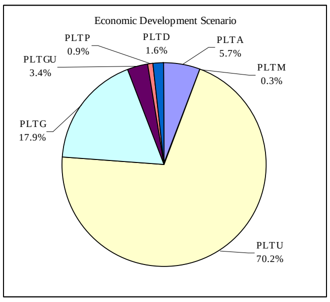
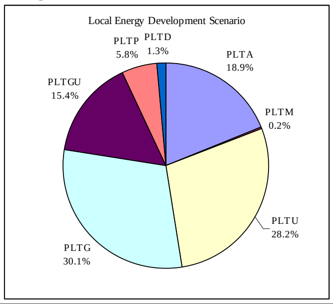
(2) Local Energy Premier Development Scenario

The scenario will be a local energy premier development scenario that put higher priority on hydropower and geothermal power that are local energies existing in Sulawesi Island. This scenario aims to keep CO_2 emission ratio at present revel. Hydropower and geothermal power as well as coal thermal power will be developed in this scenario.

Table 4.4.1 compares the two scenarios. Economic Oriented Development Scenario develops much coal thermal power plants. Investment cost of the scenario is estimated 12% less than Local Energy Premier Development Scenario but the amount of CO_2 emission and unit CO_2 emission are higher than those of Local Energy Premier Development Scenario.

Considering the consistency with national power development policy, such as best mix of the power source, introduction of renewable energy and local energy utilization, and contribution to local economy, Local Energy Premier Development Scenario is given higher priority.

Table 4.4.1 Comparative Table

Criteria		Economic Oriented Development Scenario	Local Energy Premier Development Scenario
Economic and Financial Items	(1) Consistency with the national electricity policy	△ Energy diversity is low. Most of generation depends on coal thermal generation. 	○ Energy diversity is high. Power generation is divided into hydro, coal, gas, and geothermal. 
	(2) Utilization of local energy	△ The percentage of renewable energy is low because of high dependence on coal power plants.	○ The percentage of renewable energy sources such as hydropower and geothermal is relatively high.
	(3) Economic efficiency	△ Economic efficiency is relatively low because of low local procurement.	○ Economic efficiency is relatively high because of high local procurement.
	(4) Total investment cost	○ Investment cost: 5.1 (billion US$)	△ Investment cost: 5.8 (billion US$)
	(5) Uncertainty of operation cost	△ Easily influenced by change in fuel price due to high dependence on thermal power plants	○ Relatively unaffected by change in fuel price due to high percentage of hydropower plants
Social Items	(6) Involuntary resettlement	○ More than 1,652 households	△ More than 1,845 households
	(7) Local economy such as employment and livelihood	△ Contribution to creating jobs in urban area	○ Contribution to creating jobs in poverty areas
	(8) Land use and utilization of local resources	○ Affected farmland: more than 3,129 ha ○ Affected forest area: more than 2,267 ha	△ Affected farmland: more than 3,239 ha △ Affected forest area: more than 3,007 ha
Environmental Items	(9) Air pollution	△ 2.5 MT	○ 1.6 MT
	(10) Waste	△ Fly ash: 13.5 MT △ Bottom ash: 4.1 MT	○ Fly ash: 10.2 MT ○ Bottom ash: 3.1 MT
	(11) Biota and ecosystem	○ Number of affected protected areas: 1 ○ Number of affected rare species: 30	△ Number of affected protected areas: 4 △ Number of affected rare species:31
	(12) Global warming	△ CO_2 emission: 176 MT	○ CO_2 emission: 120 MT
Overall Rating		△	○

4.5 Optimal Generation Development Plan

4.5.1 Generation development plan

It points out that interconnection between main grid and isolated small grid nearby may save the operation cost (fuel cost) and economical feasible. Optimal Generation Development Plan of Minahasa-Kotamobagu system and Sulsel system is shown in Table 4.5.1. Hydropower and

Geothermal power plants are given preference because they are local and renewable.

In the North Sulawesi system, the required generation capacity by 2027 is 1,110MW, of which coal thermal is 26%. Geothermal and hydropower, which are local energy, are introduced relatively much. In the South Sulawesi system, the required capacity is 3,293MW, of which coal thermal is 36%. Hydropower, which are local energy, are introduced to 30% of the capacity. There is no geothermal potential to be developed in the South Sulawesi system area.

Table 4.5.1 Optimal Generation Development Plan

North Sulawesi system								South Sulawesi system							
Year	Peak (MW)	ST (Coal)			GT	Geo	Hydro	Year	Peak (MW)	ST (Coal)			GT	CCG	Hydro
		10	25	50	50	50				10	25	50	50	50	
2006	132							2006	445						
2007	147							2007	488						
2008	161							2008	525						
2009	175							2009	576	10					
2010	223		25		75			2010	687	30		350			180
2011	256	10	50		25			2011	810						
2012	285				25			2012	889						243
2013	314		25				20	2013	962						
2014	355				25	20		2014	1,040			50			
2015	384		25					2015	1,117					200	
2016	415				25	20		2016	1,199			50		50	
2017	449		25					2017	1,291			100			
2018	485				50	20		2018	1,386			50		50	
2019	525				25	20		2019	1,488			100		50	
2020	567		25			20		2020	1,597					50	126
2021	615				25	20		2021	1,724			100	50	50	
2022	667		25		25	20		2022	1,862					50	180
2023	731				75	20		2023	2,009					150	
2024	796		25		25	20		2024	2,168			150		50	
2025	867		25		50	20		2025	2,340			50	100		100
2026	944				50	40		2026	2,525				50	100	174
2027	1,028		25		25	40		2027	2,725			150	50	50	
No. of Units		1	11	0	21	14	1	No. of Units		4	0	23	5	17	6
		48								55					
Capacity (MW)		10	275	0	525	280	20	Capacity (MW)		40	0	1,150	250	850	1,003
		1,110								3,293					

4.5.2 Investment Cost

Table 4.5.2 shows investment cost until 2027 by the Scenarios. Local Energy Premier Development Scenario investment cost is 14 % higher than that of Economic Oriented Development Scenario.

Table 4.5.2 Investment Cost

	2008-2012	2013-2017	2018-2022	2023-2027	Total
North Sulawesi system	260	197	282	464	1,203
South Sulawesi system	1,227	709	1,226	1,430	4,591
All Sulawesi	1,488	906	1,508	1,893	5,795

Table 4.5.3 Generation Development Plan in North Sulawesi System

Items	Unit	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Forecasted Demand																							
Energy Production	GWh	695.4	774.3	849.5	923.4	1,003.7	1,081.9	1,176.8	1,279.9	1,392.1	1,513.8	1,646.1	1,789.9	1,946.0	2,115.5	2,298.7	2,508.6	2,737.6	2,988.4	3,262.3	3,561.2	3,887.4	4,243.6
Peak Load	MW	**131.7**	**146.9**	**161.0**	**174.9**	**229.7**	**256.0**	**285.2**	**314.2**	**354.6**	**383.6**	**415.0**	**448.6**	**485.2**	**524.7**	**567.4**	**615.4**	**667.4**	**730.8**	**795.8**	**866.6**	**943.7**	**1,027.7**
Load Factor	%	60.2	60.2	60.2	60.3	60.3	60.7	61.0	61.4	61.7	62.1	62.4	62.9	63.3	63.7	64.1	64.5	64.9	64.9	64.9	64.9	64.9	64.9
Existing Capacity																							
Installed Capacity	MW	156.2	156.2	156.2	156.2	100.7	100.7	100.7	100.7	100.7	100.7	100.7	100.7	89.7	89.7	89.7	89.7	88.7	75.7	74.7	73.7	73.7	73.7
Derating Capacity	MW	20.0	20.0	20.0	20.0	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	0.8	0.8	0.8	0.8	0.6	0.3	0.2			
Available Capacity	MW	136.2	136.2	136.2	136.2	96.0	96.0	96.0	96.0	96.0	96.0	96.0	96.0	89.0	89.0	89.0	89.0	88.1	75.5	74.6	73.7	73.7	73.7
Existing Plant PLN																							
PLTA/ M	MW	53.7	53.7	53.7	53.7	53.7	53.7	53.7	53.7	53.7	53.7	53.7	53.7	53.7	53.7	53.7	53.7	53.7	53.7	53.7	53.7	53.7	53.7
PLTP	MW	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
PLTD	MW	62.5	62.5	62.5	62.5	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	16.0	16.0	16.0	16.0	15.0	2.0	1.0			
Sewa PLTD HSD	MW	20.0	20.0	20.0	20.0																		
Project PLN																							
Mobuya	PLTM			3.0																			
Lobong	PLTM				1.6																		
Lahendong II	PLTP		20.0							20.0				20.0	20.0							20.0	20.0
Lahendong III	PLTP				20.0							20.0						20.0	20.0			20.0	20.0
Lahendong IV	PLTP																						
Lahendong	PLTP																						
Kotamobagu	PLTP															20.0	20.0			20.0	20.0		
Poigar 2	PLTA							30.0															
Sawangan	PLTA								20.0														
Poigar 3	PLTA																						
New Hydro (ROR)	PLTA																						
New PLTG (Manado)	PLTG					50.0	25.0								25.0				50.0				
New PLTG (Bitung)	PLTG					25.0						25.0											
New PLTG (Kotamobagu)	PLTG							25.0											25.0				
New PLTG (Likupang)	PLTG									25.0				25.0			25.0				25.0	25.0	
Other PLTG	PLTG													25.0				25.0		25.0	25.0	25.0	25.0
Sulut Perpres	PLTU								25.0		25.0												
Amrang	PLTU						110.0																
Other Coal	PLTU															25.0							
Project IPP																							
Koneba	PLTU																				25.0		25.0
TLA/YTL	PLTU																						
Kema	PLTU												25.0					25.0		25.0			
Sulut II (Infra Sammit)	PLTU																						
New Connected Plant																							
Moribagu										5.6													
Goronotaro						66.0																	
Marisa							13.3																
Buroko						4.6																	
Bintauna						4.0																	
Leok									7.0														
MKP								10.7															
Toli Toli										14.5													
Bangir																			5.6				
Total Capacity	**MW**	**136.2**	**156.2**	**159.2**	**180.8**	**290.2**	**438.5**	**504.2**	**556.2**	**621.3**	**646.3**	**691.3**	**716.3**	**779.3**	**824.3**	**869.3**	**914.3**	**983.4**	**1,071.4**	**1,140.5**	**1,234.6**	**1,324.6**	**1,414.6**
Reserve Margin	**%**	**3.4**	**6.3**	**(1.1)**	**3.4**	**26.3**	**71.3**	**76.8**	**77.0**	**75.2**	**68.5**	**66.6**	**59.7**	**60.6**	**57.1**	**53.2**	**48.6**	**47.3**	**46.6**	**43.3**	**42.5**	**40.4**	**37.6**

Table 4.5.4 Generation Development Plan in South Sulawesi System

Items	Unit	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Forecasted Demand																							
Energy Production	GWh	2,526.0	2,772.3	2,991.0	3,293.2	3,569.8	3,869.7	4,194.8	4,547.3	4,929.5	5,298.6	5,695.4	6,122.0	6,580.7	7,073.8	7,600.5	8,202.5	8,852.1	9,553.2	10,309.8	11,126.3	12,007.5	12,958.5
Peak Load	MW	**445.0**	**487.6**	**524.7**	**576.3**	**687.1**	**809.5**	**889.2**	**961.8**	**1,040.3**	**1,116.8**	**1,202.8**	**1,291.2**	**1,386.2**	**1,488.3**	**1,596.8**	**1,724.3**	**1,862.0**	**2,009.3**	**2,168.3**	**2,339.9**	**2,525.0**	**2,724.8**
Load Factor	%	64.8	64.9	65.1	65.2	65.4	65.6	65.7	65.9	66.1	66.3	66.4	66.6	66.8	66.9	67.1	67.1	67.1	67.1	67.1	67.1	67.1	67.1
Existing Capacity																							
Installed Capacity	MW	530.7	530.7	543.3	543.3	415.6	415.6	415.6	415.6	415.6	414.8	348.0	348.0	348.0	347.0	347.0	345.3	345.3	344.5	343.4	342.6	342.6	342.6
Derating Capacity	MW	22.7	25.3	25.3	25.3	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	0.9	0.9	0.5	0.5	0.3	0.1			
Available Capacity	MW	508.1	505.5	518.1	518.1	414.3	414.3	414.3	414.3	414.3	413.7	346.9	346.9	346.9	346.1	346.1	344.8	344.8	344.2	343.2	342.6	342.6	342.6
Existing Plant																							
PLTA/ M	MW	147.6	147.6	147.6	147.6	147.6	147.6	147.6	147.6	147.6	147.6	147.6	147.6	147.6	147.6	147.6	147.6	147.6	147.6	147.6	147.6	147.6	147.6
PLTG	MW	108.3	108.3	108.3	108.3	66.8	66.8	66.8	66.8	66.8	66.8												
PLTD	MW	58.9	58.9	71.5	71.5	6.2	6.2	6.2	6.2	6.2	5.4	5.4	5.4	5.4	4.4	4.4	2.7	2.7	1.9	0.7			
IPP PLTGU PT Sengkang	MW	135.0	135.0	135.0	135.0	135.0	135.0	135.0	135.0	135.0	135.0	135.0	135.0	135.0	135.0	135.0	135.0	135.0	135.0	135.0	135.0	135.0	135.0
IPP PLTD PT MP	MW	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0
Sewa PLTD HSD	MW	21.0	21.0	21.0	21.0																		
Project PLN																							
Tenga&Rantabella	PLTM			11.2																			
PLTG Mobile TM	PLTG			20.0																			
PLTD Sewatama (Tello 2)	PLTD			70.0																			
Poso	PLTA					180.0																	
Poko	PLTA						234.0																
Bakaru 2	PLTA															126.0							
Bonto Batu	PLTA																				100.0		
Malea	PLTA																	180.0					
Mapili	PLTA																					174.0	
Lalindu	PLTA																						
New PLTG (Tello)	PLTG																50.0				100.0	50.0	50.0
New PLTGU	PLTG																						
Barru	PLTU				50.0	50.0																	
Jeneponto (Espanyol)	PLTU					50.0				50.0		50.0								50.0			100.0
Nii Tanasa	PLTU				10.0	30.0																	
NEW PLTU	PLTU												100.0				100.0						
Project IPP																							
PLTG PT Sengkang	PLTG																						
Senkang (New)	PLTGU										200.0												
Takalar	PLTGU															50.0	50.0	50.0		50.0		100.0	50.0
Bosowa	PLTU					100.0	100.0																
Majene	PLTU																			100.0			
Tallo Lama	PLTGU											50.0		50.0	50.0				150.0				
Takalar Baru	PLTU													50.0	100.0						50.0		50.0
New Connected Plant																							
Palu						95.5																	
Poso						11.9																	
Kolendale												5.7											
Ampana							4.4																
Luwuk								22.2															
Kendari							79.3																
Kolaka							19.2																
Total Capacity	**MW**	**508.1**	**505.5**	**619.3**	**679.3**	**1,092.9**	**1,529.8**	**1,552.0**	**1,552.0**	**1,602.0**	**1,801.4**	**1,840.3**	**1,940.3**	**2,040.3**	**2,189.5**	**2,365.5**	**2,564.2**	**2,794.2**	**2,943.6**	**3,142.6**	**3,392.0**	**3,716.0**	**3,966.0**
Reserve Margin	**%**	**14.2**	**3.7**	**18.0**	**17.9**	**59.1**	**89.0**	**74.5**	**61.4**	**54.0**	**61.3**	**53.0**	**50.3**	**47.2**	**47.1**	**48.1**	**48.7**	**50.1**	**46.5**	**44.9**	**45.0**	**47.2**	**45.6**

Chapter 5 Transmission Development Planning

5.1 Preconditions for transmission expansion planning

Transmission development planning has been formulated based on demand forecast and generation development planning. In addition, PSS/E analysis has done to satisfy following criteria for this plan.

Table 5.1.1 Conditions for load flow analysis

	Normal condition	During N-1fault
Power flow limit	80%	100%
Allowable voltage	-10% ～ +5%	

During N-1 fault, the above conditions shall be basically satisfied even if transformer tap or phase-modifying equipment is not switched over.

Table 5.1.2 Preconditions for stability analysis

Type of fault	Transmission Line	3-phase Short Circuit
	Generator	Single unit drop
Fault clearance time	150 kV line	150 ms
	275 kV and 500 kV line	100 ms
Voltage characteristic of Load	Active power	Constant Current
	Reactive power	Constant Impedance
Allowable frequency range	Northern system	49.25 Hz or more
	Southern System	

Table 5.1.3 Analysis conditions for short circuit analysis

Voltage Class	Allowable Short-circuit Current
70 kV	20 kA or less
150 kV	30 kA or less
275 kV, 500 kV	40 kA or less

5.2 Transmission Development Plan

Based on the precondition stated before, the transmission development plan has been formulated. As a result, power system diagram for 2007, 2012, 2017, 2022 and 2027 as the results of the planning are shown in, Figure 5.2.1 to Figure 5.2.5 respectively.

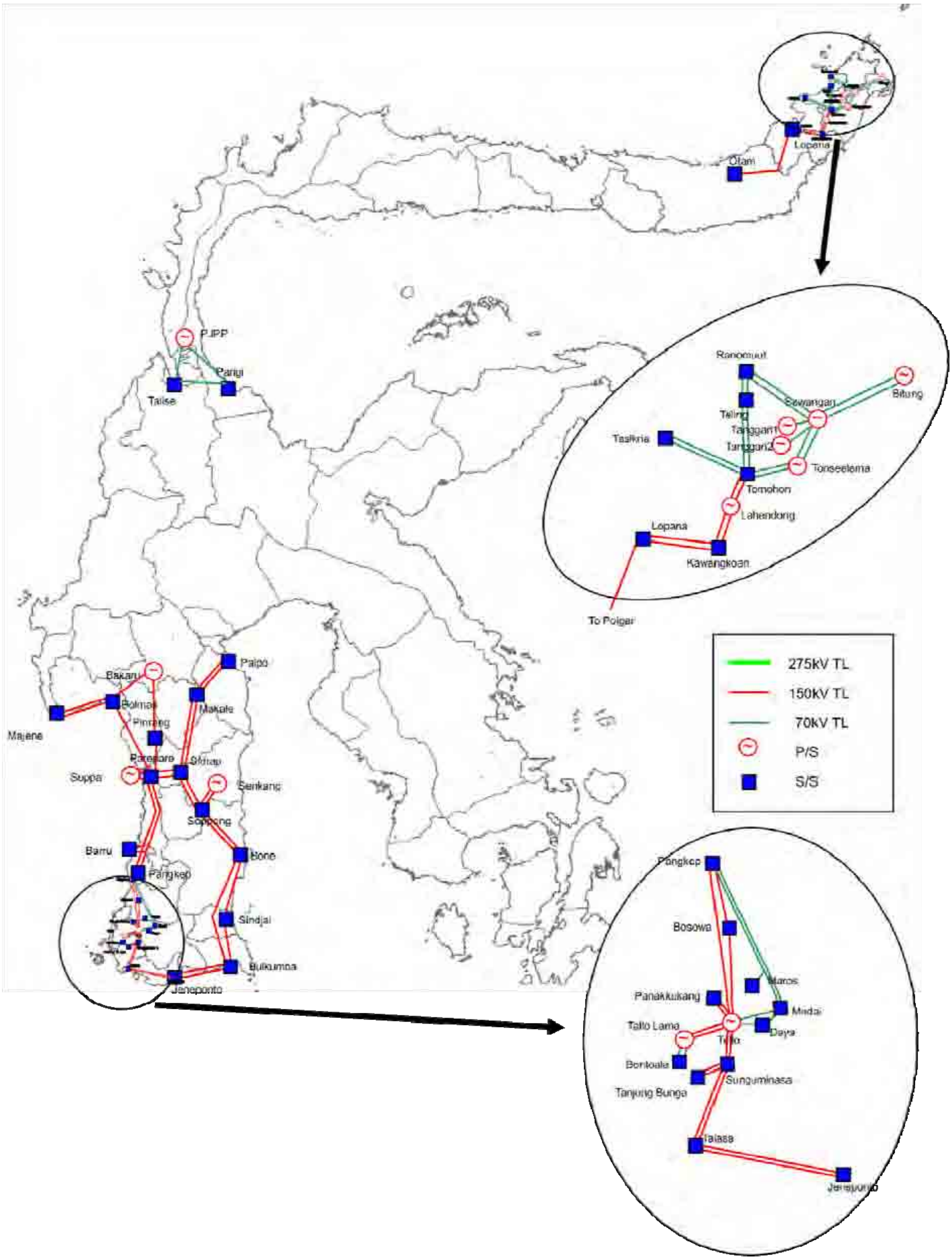


Figure 5.2.1 Sulawesi Power System in 2007

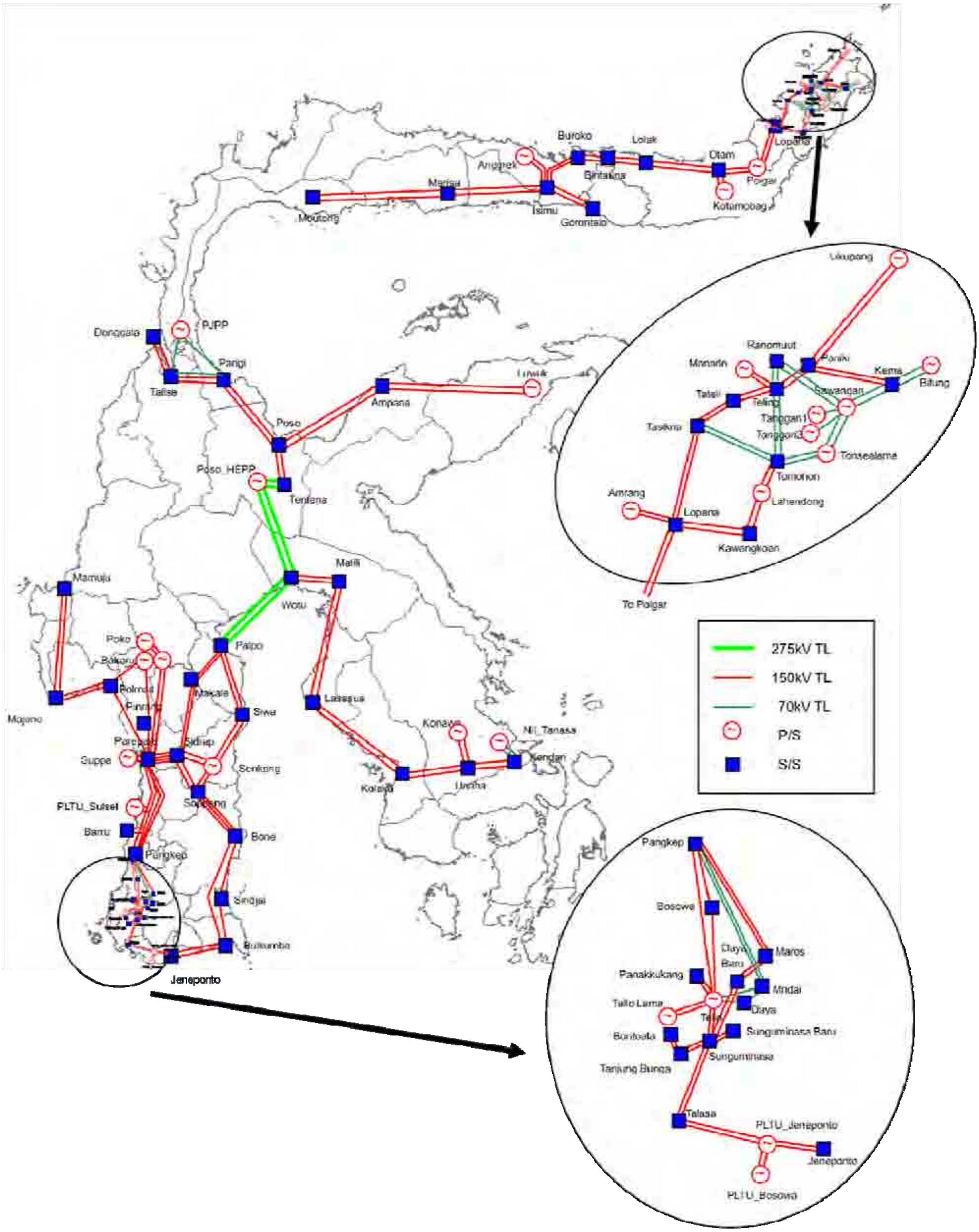


Figure 5.2.2 Sulawesi Power System in 2012
(Local Energy Premier Development Scenario)

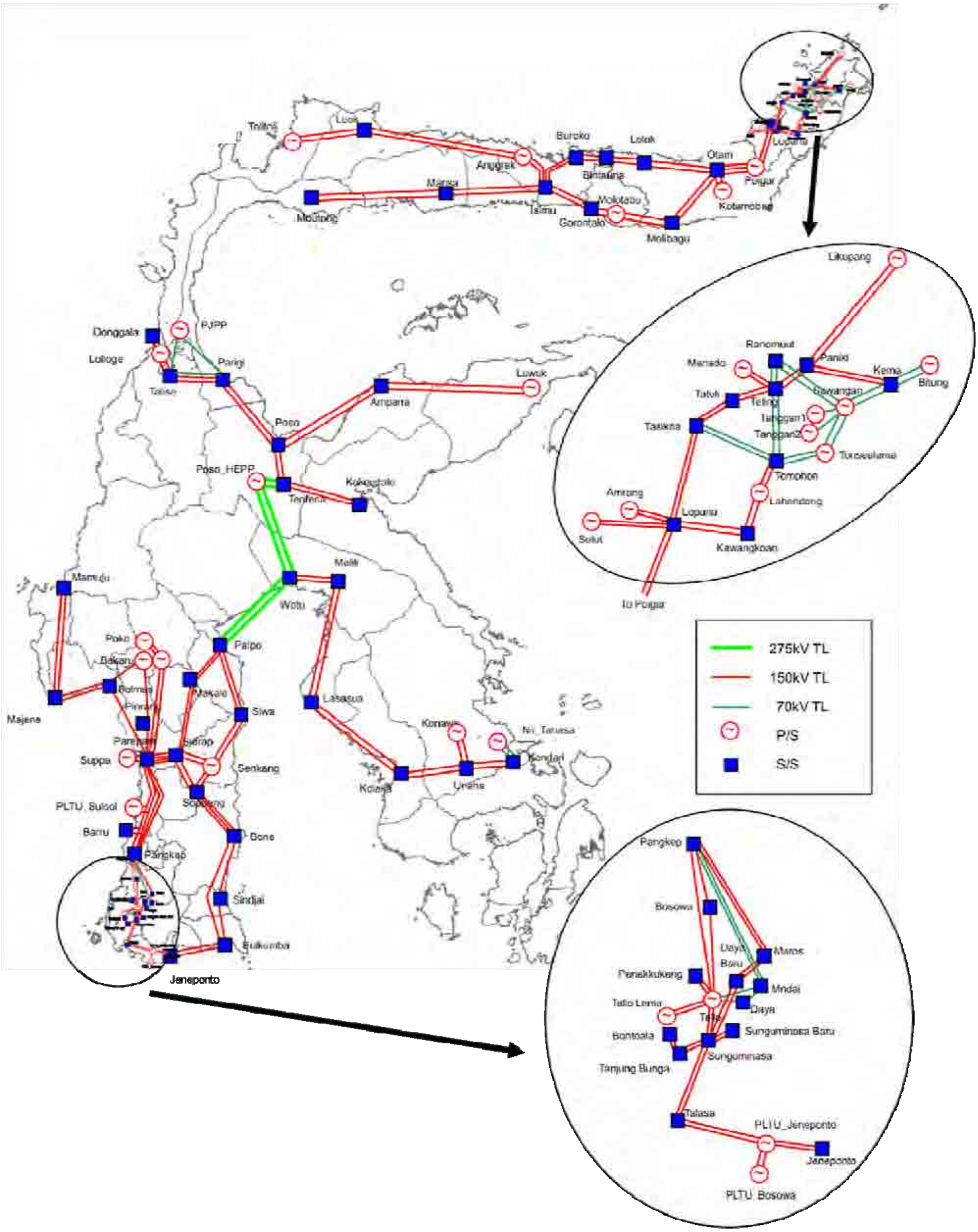


Figure 5.2.3 Sulawesi Power System in 2017
(Local Energy Premier Development Scenario)

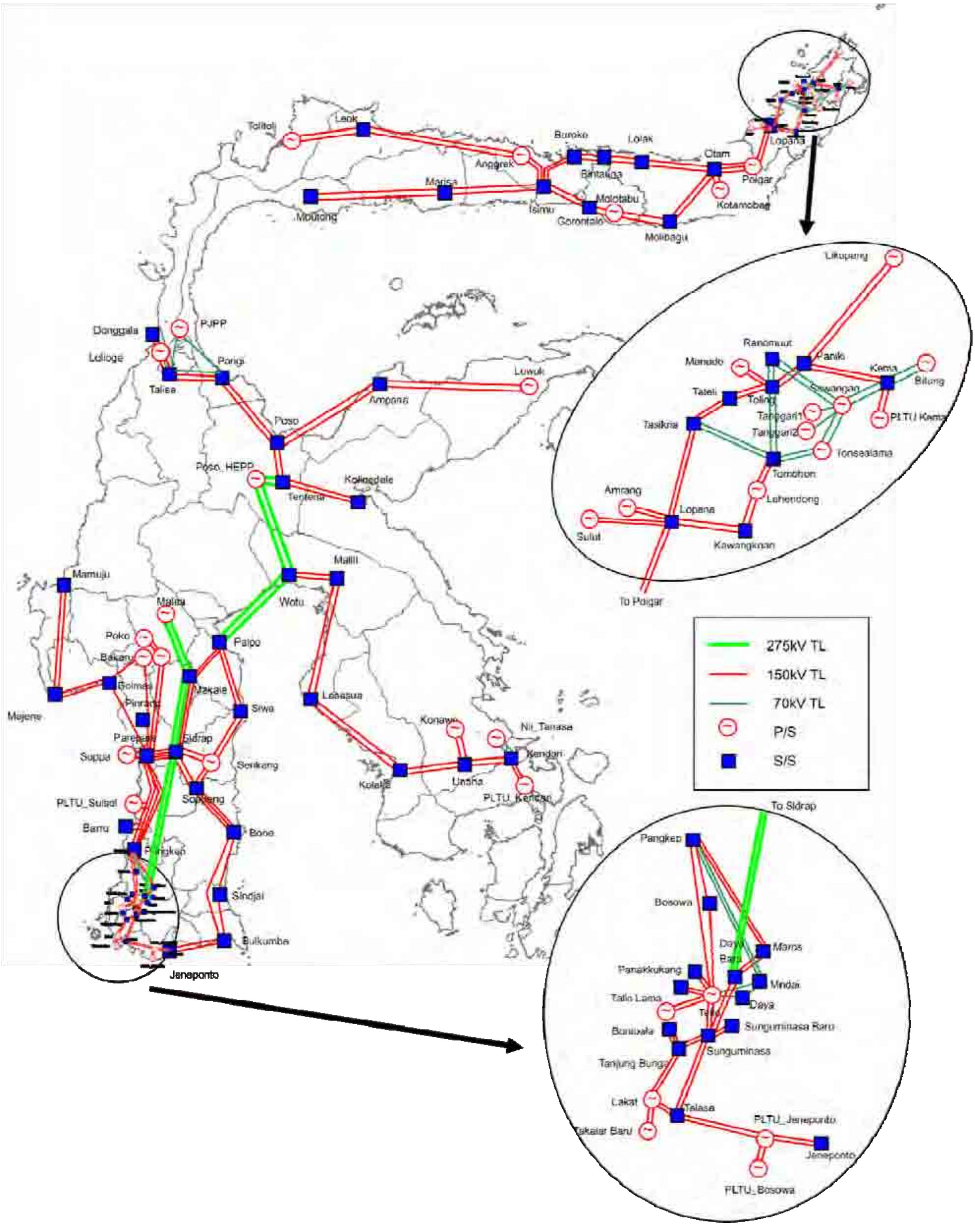


Figure 5.2.4 Sulawesi Power System in 2022
(Local Energy Premier Development Scenario)

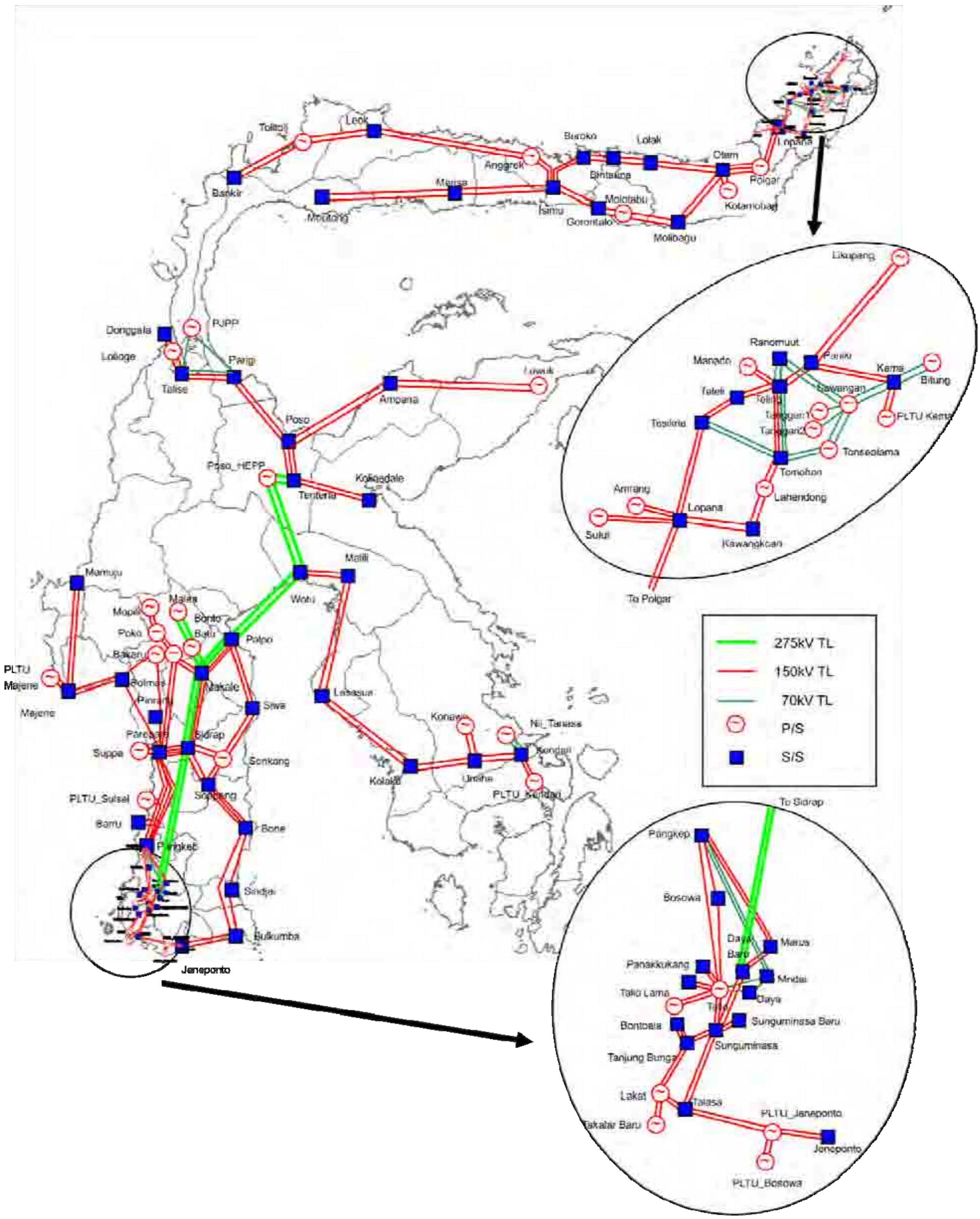


Figure 5.2.5 Sulawesi Power System in 2027
(Local Energy Premier Development Scenario)

From the study so far, the amount of facilities and investment necessary for the transmission development in Sulawesi. Amount of transmission facility development and development cost by 2027 is shown in, Table 5.2.1, Table 5.2.2 and Table 5.2.3. As shown here, the investment is larger in the earlier stage (2008-2012). This is because connecting small isolated systems to the large system as soon as possible will restrict high-cost diesel generation resulting in totally cost effective.

Table 5.2.1 Amount of Development Facilities (Transmission Line)

(kms)

		2008-2012	2013-2017	2018-2022	2023-2027
South	70kV	24	0	0	0
	150kV	3,364	180	191	162
	275kV	400	0	675	75
North	150kV	1,256	910	20	230
Total	70kV	24	0	0	0
	150kV	4,620	1,090	211	392
	275kV	400	0	675	75

Table 5.2.2 Amount of Development Facilities (Transformer)

(MVA)

		2008-2012	2013-2017	2018-2022	2023-2027
South	70/20kV	0	0	30	0
	150/20kV	840	370	800	880
	150/70kV	246	32	0	0
	275/150kV	1,100	0	1,500	150
North	70/20kV	40	10	40	20
	150/20kV	380	190	370	200
	150/70kV	246	0	0	0
Total	70/20kV	40	10	70	20
	150/20kV	1,220	560	1,170	1,080
	150/70kV	492	32	0	0
	275/150kV	1,100	0	1,500	150

Table 5.2.3 Amount of Transmission Investment

(million USD)

		2008-2012		2013-2017		2018-2022		2023-2027	
		FC	LC	FC	LC	FC	LC	FC	LC
South	Transmission	245	102	8	5	134	63	24	15
	Substation	113	26	8	2	83	24	41	14
North	Transmission	52	25	41	24	1	1	13	9
	Substation	48	11	18	5	11	3	12	4
Total	Transmission	296	128	49	28	135	63	36	24
	Substation	161	38	26	7	94	27	53	18

5.3 Study on the North-South interconnection

Regarding the interconnection of small isolated systems to a larger system, voltage stability is a main issue: technical difficulty is limited. By contrast, regarding the interconnection between the northern system and the southern system: the connection is between the two power systems with the capacity of more than 1,000MW for each in 2027 and with 1,800km distance. This will cause not only overloading and voltage instability issues but also, more importantly, dynamic stability problem. The possibility and purpose of the north-south interconnection has been studied for 2027 power system using the following three methods for the North-South interconnection:

i) 150 kV 2cct × 2 routes (total 4cct)
ii) 275 kV 2cct
iii) BTB (Back to Back)

As far as this study in concerned, It would be better not to conduct the north-south interconnection but to develop the northern system and the southern system separately because any alternatives — by 150kV line, by 275kV line or by BTB — proved to be difficult. It would be recommended to construct two separate systems in Sulawesi, and to consider the interconnection in the future after the direct-current technology like DC transmission or BTB is accumulated in Indonesia.

5.4 Issues on the transmission development planning

Among the findings acquired through power system analysis and the transmission development planning, what is especially important are described as below except for North-South interconnection problem.

(1) Power plant's unit capacity issue

Some power plants currently planned in Sulawesi have generators with rather large-size unit capacity like Amurang in the northern system and Jeneponto in the Southern system. It may be reasonable to recommend smaller-sized generator units to be installed because in case such a large-sized unit falls down, the power system may suffer from load shedding or system collapse. However, the introduction of such large units would be actually necessary considering the current situation of serious power deficit in Sulawesi. The countermeasure of this large unit capacity issue would be I) introduction of automatic load shedding scheme on the fault of a large unit, II) full preparation of SCADA system and III) training for dispatchers in order to facilitate restoration after a large scale blackout.

(2) Demand-supply issue during off-peak time

Power plants planned to be installed in Sulawesi, like natural hydro, geothermal and coal power, are mostly the types which output is difficult to change. Because of this, the problem is that when power plans are operated so that the total output matches the peak demand in the evening, power supply may exceed the demand during off-peak time which will cause operational difficulty. To avoid this situation, it would be important to introduce gas turbine plants which is easier to start and stop (though fuel is not cheap), or to develop pondage-type hydro plants by which output can be changed easily.

(3) Transmission line toward Kendari

Kendari system is rather large among isolated systems and far away from the large system (Sulsel system). Because of this, dynamic stability problem may happen just with 150 kV 2 circuits. Therefore, this transmission line needs to be introduced with a view to 4 circuit installation in the future.

Chapter 6 Optimal Power Development Planning

6.1 Optimal power development planning

Local Energy Premier Development Scenario which gives preference to local and renewable energy such as hydropower and geothermal, will be the best scenario for the optimal power development plan. In addition, it points out that interconnection between main grid and isolated small grids nearby may save the operation cost (fuel cost) and be economically feasible. The amount of facilities to be developed and the necessary investment for power development in Minahasa - Kotamobagu system and Sulsel system for 20 years from 2008 to 2027 are shown in Table 6.1.1 and Table 6.1.2 respectively.

Table 6.1.1 Amount of Facilities to be developed

		Amount to be developed				Total
		2008-2012	2013-2017	2018-2022	2023-2027	
North Sulawesi system						
(Power source)	Gas fired (MW)	125	50	125	225	525
	Coal fired (MW)	85	75	50	75	285
	Geothermal (MW)	0	40	100	140	280
	Hydro (MW)	0	20	0	0	20
(Transmission)	Line (kms)	1,256	910	20	230	2,416
	Substation (MVA)	666	200	410	220	1,496
South Sulawesi system						
(Power source)	Gas fired (MW)	0	0	50	200	250
	Gas CC (MW)	0	250	250	350	850
	Coal fired (MW)	390	200	250	350	1,190
	Hydro (MW)	423	0	306	274	1,003
(Transmission)	Line (kms)	3,788	180	866	237	5,071
	Substation (MVA)	2,186	402	2,330	1,030	5,948
All Sulawesi						
(Power source)	Gas fired (MW)	125	50	175	425	775
	Gas CC (MW)	0	250	250	350	850
	Coal fired (MW)	475	275	300	425	1,475
	Geothermal (MW)	0	40	100	140	280
	Hydro (MW)	423	20	306	274	1,023
(Transmission)	Line (kms)	5,044	1,090	886	467	7,487
	Substation (MVA)	2,852	602	2,740	1,250	7,444

Table 6.1.2 Investment for Power Development

(unit: MUS$)

		Amount of investment for Power Development				Total
		2008-2012	2013-2017	2018-2022	2023-2027	
North Sulawesi system						
(Gen)	Gas Thermal	55	43	64	98	260
	Coal Thermal	152	69	79	127	426
	Geothermal	18	86	139	215	458
	Hydro	36	0	0	23	60
(Trans)	Transmission Line	77	65	2	22	166
	Substation	59	23	15	17	113
South Sulawesi system						
(Gen)	Gas Thermal	0	0	21	129	150
	Gas CC	5	235	256	282	779
	Coal Thermal	514	335	272	442	1,563
	Hydro	708	138	677	577	2,100
(Trans)	Transmission Line	347	13	197	39	595
	Substation	140	10	106	55	311
All Sulawesi						
(Gen)	Gas Thermal	55	43	86	227	410
	Gas CC	5	235	256	282	779
	Coal Thermal	666	404	351	569	1,989
	Geothermal	18	86	139	215	458
	Hydro	745	139	676	600	2,159
(Trans)	Transmission Line	424	78	198	61	761
	Substation	199	33	121	72	424

6.2 Financing and private investment promotion

6.2.1 Financial situation of PLN

(1) Electricity tariff and economic & financial analyses

The electricity tariff of PLN is designed based on two major principles of "nationwide uniform rate" and "progressive (large lot is higher than small lot)". As shown in Figure 6.2.1, average electricity rate fell from 7 cent/kWh to 2 cent/kWh in 1998 due to the sudden devaluation of Rupiah against dollar triggered by the Asian currency crisis in 1997. As a result of repeated tariff hikes after the currency crisis, the average electricity rate has almost recovered the level before the crisis since 2003.

(Source: PLN Statistics, 1990-2006.)
Note: Monthly average rates of Bank Indonesia are used as the exchange rates.)

Figure 6.2.1 PLN average selling rate (1990 to 2006)

On the other hand, the recent surge of fuel price shown in Figure 6.2.2 has been worsening the financial situation of PLN negating the continual adjustment of the electricity tariff.

Figure 6.2.2 Energy Price Forecast by the US DOE (2008 Revised Early Release)

Though the sales of electricity and the sold energy have steadily increased at the rate of economic growth or more as shown in Table 6.2.1, sharp rise of fuel cost especially in 2005 and 2006 brought about huge deficit which government subsidy had to compensated for. The amount of government subsidy reached approximately 33 trillion Rupiah corresponding to nearly half of the electricity sales in 2006. In terms of unit value per energy, PLN supplied energy at the cost of Rp. 934/kWh and recovered only Rp. 628/kWh.

The US Department of Energy (USDOE) forecasted as shown in Figure 6.2.2 that the energy price in future will still keep the level in 2005 to 2006 or more after the current upward trend hits the peak in the several years ahead. According to this forecast, drastic measures will be required such as substantial tariff raise or energy shift from fossil fuels in order to outgrow the chronic dependence on the government subsidies.

Table 6.2.1 Business results of PLN (2001 to 2006)

(Unit: million Rupiah)

	2006	2005	2004	2003	2002	2001
REVENUES	104,726,536	76,543,324	62,263,062	54,430,778	44,183,353	35,359,958
Sale of electricity	70,735,151	63,246,221	58,232,002	49,809,637	39,018,462	28,275,983
(annual growth)	11.8%	8.6%	16.9%	27.7%	38.0%	27.7%
Government subsidy	32,909,148	12,510,960	3,469,920	4,096,633	4,739,074	6,735,210
Others	1,082,237	786,143	561,140	524,508	425,817	348,765
OPERATING EXPENSES	105,228,151	76,023,601	59,710,767	58,586,498	52,345,592	31,939,387
Fuel and lubricants	63,401,080	37,355,450	24,491,052	21,477,867	17,957,262	14,007,296
(annual growth)	69.7%	52.5%	14.0%	19.6%	28.2%	35.0%
Purchased electricity	14,845,421	13,598,167	11,970,811	10,837,796	11,168,843	8,717,141
Operation & Maintenance	13,348,811	12,019,070	10,821,530	11,360,788	6,172,117	4,716,689
Depreciation	10,150,985	9,722,315	9,547,555	12,745,047	15,626,763	3,404,114
Others	3,481,853	3,328,598	2,879,819	2,165,000	1,420,607	1,094,147
OPERATIONAL DATA						
Energy sold (GWh)	112,609	107,032	100,097	90,441	87,089	79,165
(annual growth)	5.2%	6.9%	10.7%	3.8%	10.0%	6.8%
Average selling price (Rp./kWh)	628	591	582	551	448	357
Average supply cost (Rp./kWh)	934	710	597	648	601	403

(Source: PLN Financial Statement, 2002 – 2006.)

(2) Business results in Sulawesi

The business scale of PLN in Sulawesi measured by sold energy or electricity sales, falls into approximately 3%[5] (South Sulawesi 2%, North Sulawesi 1%) of that in the whole Indonesia. The recent fuel price hike mentioned above has more significant impact on the outside Java-Madura-Bari region including Sulawesi which power supply heavily depends on small diesel generators, compared to the Java Island which business scale makes up more than 70% of that of whole the Indonesia.

The operational results in South Sulawesi (Wilayah Sulselrabar) and North Sulawesi (Wilayah Suluttenggo) are shown in Table 6.2.2 and Table 6.2.3 respectively.

[5] Values are as of 2005. Those in Java-Madura-Bali occupied 77 % of those in whole the Indonesia.

Table 6.2.2 Business results of PLN Sulselrabar (2002 to 2006)

(Unit: Rupiah)

STATEMENT	2006	2005	2004	2003	2002
OPERATING REVENUES	2,162,539,670,114	1,532,430,486,262	1,368,143,122,113	1,115,183,166,923	857,068,970,472
Sales of electric power	1,463,055,278,407	1,329,045,604,386	1,260,006,937,934	1,103,387,387,082	844,667,642,747
(annual growth)	10.1%	5.5%	14.2%	30.6%	--
Government subsidy	684,556,582,367	189,494,288,414	91,204,869,000	--	--
Others	14,927,809,340	13,890,593,462	16,931,315,179	11,795,779,841	12,401,327,725
OPERATING EXPENSES	2,736,461,929,244	1,912,275,359,941	1,571,646,219,055	1,556,839,271,217	1,719,625,703,626
Fuel and lubricants[6]	1,131,388,033,782	526,110,759,588	289,634,022,749	254,227,775,142	184,482,603,201
(annual growth)	115.0%	81.6%	13.9%	37.8%	--
Purchased electricity	891,315,205,813	732,484,642,343	632,652,643,288	578,939,580,849	578,637,527,685
Operation & Maintenance	377,069,962,843	319,572,509,672	293,856,932,885	271,222,579,753	234,824,544,603
Depreciation	244,915,079,682	244,206,981,716	275,143,734,765	388,496,867,565	669,835,315,685
Others	91,773,647,124	89,900,466,622	80,358,885,368	63,952,467,908	51,845,712,452
OPERATIONAL DATA					
Energy sold in kWh	2,468,100,659	2,293,697,614	2,154,221,384	1,996,936,148	1,882,272,277
(annual growth)	7.6%	6.5%	7.9%	6.1%	--
Average selling price (Rp./kWh)	593	579	585	553	449
Average supply cost (Rp./kWh)	1,109	834	730	780	914

(Source: PLN Wilayah Sulselrabar: RUPTL draft.)

Table 6.2.3 Business results of PLN Suluttenggo (2002 to 2006)

(Unit: Rupiah)

DESCRIPTION	2006	2005	2004	2003	2002
OPERATION INCOME	1,021,723,890,542	708,238,478,775	636,061,618,282	481,013,382,385	353,463,938,995
Energy Sales	671,921,838,218	615,537,600,502	568,860,233,782	475,038,220,257	347,980,706,020
(annual growth)	9.2%	8.2%	19.8%	36.5%	--
Government Subsidy	341,958,976,800	84,687,967,116	54,039,791,000	--	--
Others	7,843,075,524	8,012,911,157	13,161,593,500	5,975,162,128	5,483,232,975
OPERATION EXPENSE	1,978,439,707,961	1,210,333,410,98 3	887,740,491,852	957,276,074,371	1,102,878,447,61 8
Fuel and Lubricant Oil	948,170,265,610	436,798,961,334	257,049,563,301	257,765,260,325	265,617,988,581
(annual growth)	117.1%	69.9%	-0.3%	-3.0%	--
Electricity Purchase	10,305,298,000	4,403,348,500	152,909,985,909	142,591,552,407	47,581,429,087
Operation & Maintenance	314,361,998,904	283,341,999,983	230,524,260,556	244,483,589,593	178,493,025,373
Depreciation	179,179,983,386	170,744,918,043	189,305,517,190	270,868,218,896	579,629,237,092
Other Cost	68,582,564,365	71,083,056,375	57,951,164,896	41,567,453,150	31,556,767,485
OPERATIONAL DATA					
Energy Sold (MWh)	1,098,552	1,019,897	952,297	847,973	828,318
(annual growth)	7.7%	7.1%	12.3%	2.4%	--
Average selling price (Rp./kWh)	612	604	597	560	420
Average supply cost (Rp./kWh)	1,801	1,187	932	1,129	1,331

(Source: PLN Wilayah Suluttenggo: RUPTL draft.)

[6] More than 90 % of fuel and lubricant expense was paid for HSD (High Speed Diesel Oil).

6.2.2 Necessary investment for power development

The necessary investment for power development in Sulawesi for the coming 20 years (2008 to 2027) can be wrapped up as shown in Table 6.2.4.

Table 6.2.4 Necessary investment for power development in Sulawesi
(2008 to 2027)

(unit: million US$)

		2008-2012	2013-2017	2018-2022	2023-2027	Total
South Sulawesi system	Generation	1,227	709	1,226	1,430	4,592
	Transmission	487	23	303	94	906
	Total	1,714	732	1,529	1,524	5,498
North Sulawesi system	Generation	260	197	282	464	1,203
	Transmission	136	88	16	38	278
	Total	396	285	299	501	1,481
Whole Sulawesi	Generation	1,487	906	1,508	1,894	5,795
	Transmission	623	110	319	132	1,184
	Total	2,110	1,017	1,827	2,026	6,980

Note: Price escalations are considered.

Meanwhile, as compared to the present values of the fixed assets in PLN Sulawesi shown in Table 6.2.5, it is easy to understand how large the necessary investment mentioned above, particularly that in the first five years, is. For instance, the necessary investment 1,227 million dollars in South Sulawesi system in the first five years is over five times of the existing assets even evaluated on a basis of acquisition costs neglecting accumulated depreciation. In other words, almost the same amount of the existing assets has to be invested annually in the next five years, which may not be possible by PLN funding only. Moreover, the total investment combined with generation and transmission claims a half of the total existing assets.

Therefore, it is realistic and reasonable that PLN as a public utility, should put priority on the investment in transmission development to generation development in which private investment can be expected. In addition, the promotion of transmission development can create better conditions for private sector to enter generation business.

Table 6.2.5 Fixed assets in PLN Sulawesi (as of Dec. 31, 2006)

(unit: US$)

	Acquisition cost	Accumulated depreciation	Book value
South Sulawesi (Wilayah Sulselrabar)			
Generation	210,413,211	71,747,969	138,665,242
Transmission	124,030,273	24,629,107	99,401,166
Distribution	337,087,440	94,139,930	242,947,510
Others	13,393,744	5,325,609	8,068,135
Total	684,924,668	195,842,615	489,082,053
North Sulawesi (Wilayah Suluttenggo)			
Generation	209,651,975	84,332,246	125,319,729
Transmission	34,393,600	5,980,540	28,413,061
Distribution	186,421,751	57,099,499	129,322,252
Others	8,867,532	4,459,417	4,408,115
Total	439,334,858	151,871,702	287,463,156
Total Sulawesi			
Generation	420,065,186	156,080,215	263,984,971
Transmission	158,423,873	30,609,646	127,814,227
Distribution	523,509,191	151,239,429	372,269,762
Others	22,261,276	9,785,026	12,476,250
Total	1,124,259,526	347,714,316	776,545,210

(Source: JICA Study Team compiled data of PLN Wilayah Sulselrabar and PLN Wilayah Suluttenggo using the exchange rate $1=Rp. 9,000)

6.2.3 Indonesian environment over IPP business

As stated above, private investment in generation sector is indispensable for power development within limited financial resources. In the meantime, it is natural that investment should not be limited to Indonesia and neighboring countries should be comparable in terms of portfolio management, from the viewpoint of private investors, foreign investors in particular.

Table 6.2.6 indicates the situation of IPP investment risk in the comparable countries in South-East Asia selecting Thailand, Philippines and Viet Nam.

Regarding Indonesia, it is obliged to say that the degree of risk cover for IPP investment is low by the following reasons:

i) The legal position of IPPs has become unstable and obscure since the repeal of the electricity law 2002, which granted principally the State (state owned enterprises) only to do electricity business.

ii) The financial viability of PLN is low as the off-taker.

iii) There is no government guarantee for the liabilities of PLN.

Though the environment for IPP investment in Indonesia has little advantage among the neighboring countries in South-east Asia as just describe, the outer region including Sulawesi has less in terms of demand scale and density compared to Java-Madura-Bali, even in Indonesia.

Table 6.2.6 Current conditions of the IPP risk management of Southeast Asian countries

		Indonesia	Viet Nam	Philippines	Thailand
Laws and regulations concerning IPP		• IPP invitation by Presidential Decree No. 37/1992, postponement and review by Presidential Decree No. 39/1997, renegotiation by Presidential Decree No. 15/2002 • Unconstitutional judgment for new Electricity Law 20/2002 while ordinances to treat IPP was drafted	• In 1992, BOT was placed as type of investment in foreign investment act (revised in 2000) • In 1998, an investment rule (Decree No. 62, the following "BOT rules") about the BOT/ BTO/BT contract including the foreign investment	• Establishment of BOT act in 1990. • Revision of BOT act in 1994 • Establishment of EPIRA (Electric Power Industry Reform Act) in 2001, unbundling and privatization of NPC	• Law of private sector utilization for public works in 1992, privatization promotion of national enterprises, entry promotion of private sector in public works • Announcement of IPP Program in 1994 (to IPP introduction)
Off-take risk	Principal off-taker and its status	PLN (State owned company)	EVN (Public corporation)	PSALM (Power Sector Assets Liabilities Management Corporation)→ electricity pool market introduction	EGAT (Public corporation)
	Description on PPA	• Dollar- based "Take or Pay" clause • Fuel price adjustment term in purchase price formula	• Dollar- based "Take or Pay" clause • Fuel price adjustment term in purchase price formula	• Dollar- based "Take or Pay" clause • Fuel price adjustment term in purchase price formula	• Dollar- based "Take or Pay" clause • Fuel price adjustment term in purchase price formula
	Status of PPAliabilities	No description	• Prescription in BOT rules that the state organization entrusted by the government guarantees the commitment on off- take of the Vietnamese enterprise in the BOT/BTO/ BT contract	NPC debt as a part of the sovereign debts in Ministry of Finance statistics	• Government has obligation to perform appropriate fund supply by EGAT act when EGAT fell into finance difficulty • Historic support posture by the government (guarantee for all external liabilities)
	Government Guarantee or Support Letter	Support Letter (Effectiveness ?)	Government Guarantee	Government Guarantee	None
Fuel supply risk	Principal Fuel Supplier	Pertamina, PTBA etc.	Petro Vietnam etc.	PSALM (in case of geothermal, PNC supplies steam for nothing)	PTT etc.
	Contract form	Independent FSA (Parties concerned of FSA is different from PPA)	Independent FSA (Parties concerned of FSA is different from PPA)	ECA (Energy Commerce Agreement)	Independent FSA

		Indonesia	Viet Nam	Philippines	Thailand
	Institutional support	None	Prescription in BOT rules that the state organization entrusted by the government guarantees commitment about the fueling of the Vietnamese enterprise in the BOT/BTO/BT contract	None	None
	Government Guarantee or Support Letter	Support Letter	Government Guarantee	Government Guarantee	None
Policy / Legislation change risk	Description on PPA	Buy out clause by PLN	Buy out clause by the government	Buy out clause by PSALM	Buy out clause by EGAT
	Government guarantee or institutional support	Support Letter	Government Guarantee (In PPA, the Government itself is buyout subject)	Government Guarantee (BOT act prescribes a step by the government at the time of the early end of the contract)	None
Foreign exchange/ Overseas remittance risk	Prescription on PPA	Offshore escrow account	Offshore escrow account	Offshore escrow account	Offshore escrow account
	Government guarantee on freedom of foreign exchange/ overseas remittance	Support Letter	・Government guarantee (stated support of the government clearly in BOT Law) ・Central bank secures foreign exchange and overseas remittance by BOT rules	Government Guarantee	None
Government policy on Government Guarantee or Support Letter		No future issuance of Support Letter	No future issuance of Government Guarantee	No future issuance of Government Guarantee	—
IPP business environment	Preferential Treatment for IPP (Tax etc)	None	Courtesies following for BOT/BTO/BT business (including generation business) ・Import tax exemption for imported raw materials and articles for project implementation ・Exemption of land tax, land use fee	Courtesies following for IPP business ・Exemption of corporate income tax for a certain period assuming registration to the Investment Committee ・Additional subtraction for workers etc.	・Generation business is appointed as special importance type of industry by the Board of Investment (BOI) proclamation, the following courtesies: ・Machine import tax exemption ・Eight years exemption of corporate income tax

		Indonesia	Viet Nam	Philippines	Thailand
	Remarks	• Example that a local court of law does not accept arbitration on the occasion of dispute solution • Generation businesses regulation/ Generation business JV regulation (Local corporate participation duty of 5%)	Complexity of administrative procedures peculiar to socialism countries	• Outlook of review of purchase price by the government (all IPP contracts review specified in EPIRA = electric power industry reform act) • Example of judicial intervention on rate setting	• Two examples that IPP projects changed fuel and geographical convenience, and restarted by the opposition movement of inhabitants for fear of environmental problem • Cover order to EGAT and PTT from the government in the recent example that increase width of fuel adjustment (FT) was kept lower than the actual (The government considers right protection of enterprise side)

6.2.4 Measures for private investment promotion in Sulawesi

As described in section 4.4, Sulawesi has abundant local primary energy resources namely hydropower and geothermal and the conclusion is obtained that the local energy premier development scenario is optimal utilizing them.

It is stated in clause 6.2.2 that private investment should be expected particularly in generation development since the necessary investment to realize the power development plan is too huge for PLN to procure by its own funding.

Meanwhile, the fact is found in clause 6.2.3 that Indonesia has necessarily little advantage compared with the neighboring countries in terms of private investment environment and moreover Sulawesi has further less even in Indonesia. In addition, since big amount of investment is required for the development of hydropower or geothermal, private investors are unwilling to take risks in such areas in general,

Based on such situations, measures for private investment promotion in hydropower and geothermal development are described in the following.

(1) Obligation to buy up renewable energy

In Indonesia, PLN's obligation to buy up renewable energy is prescribed to promote use of renewable energy. In MEMR Ministerial Decree (No. 1122/2002) established in June, 2002, purchase obligation is imposed on PLN about a private (company/ group) dispersed power supply by renewable energy less than 1MW. In addition, the object of purchase obligation was extended to the output of 1-10 MW in the ministerial decree (No. 2/2,006) in January, 2006. Table 6.2.7 shows the summary of the buying up obligation of renewable energy.

Table 6.2.7 Renewable energy buy-up obligation scheme

	MEMR Decree No. 1122/2002	MEMR Decree No. 2/2006
Output	less than 1 MW	1～10 MW
Contract term	One (1) year	Ten (10) years
Purchase price	・LV connection: 60 % of PLN's Production Cost ・MV connection: 80 % of PLN's Production Cost	

However, the following issues can be pointed out for promoting future renewable energy development.

- The existing scheme basically focuses on the small and medium scale generation by domestic capital, and has no scope for large scale development utilizing foreign capital.
- Although basic conditions are prescribed as shown in Table 6.2.7, actually purchase price and contract term in PPA are decided by contract negotiation with PLN, different from the conditions in Table 6.2.7.
- Grounds of purchase price are not clear without Production Cost of PLN being announced.

- There is no courtesy on purchase price for the electricity generating system that it is clear that production cost called small renewable energy is expensive.

For large-scale renewable energy development by the private capital, it is necessary to deal with the above-mentioned issues.

(2) PPP: Public Private Partnership

In general, renewable energy development represented by hydropower and geothermal requires large initial investment. PPP model is nominated as one of the measures on the basis of commerce which can reduce financial burden of the public sector compared with pure public projects and, investment risk of private investors. Three types of PPP, namely, i) hybrid type, ii) OBA and iii) BTO for Value are nominated as PPP models suitable for generation business. The followings are summery of these models.

Additionally PPP on hydropower development is stated in the next clause referring to Malea Hydropower Development for an example.

i) Hybrid type PPP

Hybrid type PPP is a method to share the construction of a power station with public sector and private sector. The private sector also performs all the operation and maintenance work in many cases. Since private sector bears a part of construction costs, public investment can be most surely reduced. Illustratively, there is Philippine San Roque Hydropower Project.

ii) OBA (Output Based Aid)

An IPP business entity (private sector) performs construction of the project in OBA scheme same as in ordinary BOT, but after commissioning, the IPP business entity is supported by public sector in the form of receiving public funds for output, namely, power supply. All the project construction cost is borne by private sector, so that public expenditure can be saved. However, OBA cannot unbundle construction risks and hydrological risks perculiar to hydropower development from private sector compared with Hybrid type PPP.

In addition, OBA may be considered to be a sort of subsidy system for the operation by the private. A negative opinion against Ministry of Finance (MOF) performing borrowed money may be reflected related to the generation business in the case of Indonesia in the privatization way. OBA may be denied by the principle of the self-supporting accounting system even if return can be expected from financial funds of the private sector business concerned.

iii) BTO for value

BTO for Value support is the form to wipe out the side of subsidy of OBA scheme. While in OBA scheme, public service actually provided by private sector is financed, in BTO for value scheme, public fund is utilized to buy some part of assets realized by private investment. But the T = transfer of the ordinary BTO tends to be free, but cannot but think about payment here.

BTO for value scheme as well as OBA scheme cannot unbundle the risks peculiar to hydropower development from private sector.

6.3 Proposed Projects

6.3.1 Execution of Hydro Master Plan

PLN is working out, every year basically, the General Electricity Supply Plan (RUPTL), which stipulates the middle term power develop planning for the country. The planning possibly has included issues of the potential hydropower project listing[7] for recent years. The Indonesian power sector therefore is suffering from the clear picture of the ultimate power development. In Indonesia two large scale hydropower potential studies[8] were conducted. The first one was in 1980s and the other was in 1990s. Such hydropower potential studies can be evaluated significant in the realization of the hydropower development. Bakaru No. 1 (126 MW, South Sulawesi) and Besai (90 MW, South Sumatra) are both examples of the successful outcomes of the studies.

However, the past hydropower potential studies might not stand on the up-to-date concept of the hydropower development, in view of the development type (reservoir or run-of-river). Accordingly, one is not very sure these days about development scales and the development priorities concluded in the studies. In the past studies, it seems that the development efficiency might have been maximized and enough attentions might not be paid to the negative impacts on society nature. Giving the considerations to the fuel price hike these years, the decisions of the project feasibilities should also need up to date. The Asahan No. 3 Hydroelectric Project, which was turned into its development stage with Japanese ODA loan last year, was originally planned as a reservoir type hydro and is going to be a run-of-river hydro. In fact, an efficient-most development with a huge reservoir does not fit the present requirement, but a run-of-river based smaller scale development does.

In 2008, the Government of Indonesia is in a great hurry to finalize the so-called “Second Phase of the Crush Program”, which urges development of renewable energy based power plants with hydropower and geothermal potential in the country. Primarily speaking, the same program should be based on the updated/latest hydropower potential study.

It is highly demanded for the Indonesian electricity sector to have “the Hydro Master Plan” that can be the fundamentals of the middle to long term power development planning, followed by the up-to-date hydropower potential investigations and studies. The Hydro Master Plan is expected to include:

1) Identification of the hydropower development candidates by using the existing data,
2) Preliminary development planning of individual candidates (type, rough electricity generation, rough investment costs including related facilities such as power transmissions),
3) Decision of the development priority, and
4) Execution of the feasibility studies for the high priority candidates.

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7 Ordinary thermal plants have larger freedom for planning and do not highly demand development listing when a power development plan is established. For geothermal plants, there already exists the Geothermal Master Plan, JICA, 2007.

8 The Hydro Potential Study, the World Bank Group, 1978-1982; the Hydro Inventory Study, the World Bank Group, 1997-2000.

6.3.2 Sawangan Hydropower Project

The Sawangan Hydropower Project (run-of-river, 16 MW) can be pointed out as one of the high priority hydropowers in the North Sulawesi region. The Sawangan is located downstream of the Tonsealama Hydro Plant mentioned later in this report. It is the last and downstream most hydro cascade in the Tondano river system. The Hydro Inventory Study conducted its Pre Feasibility Study. To overcome the fuel price hike these years and to reduce the average power generation costs in North Sulawesi, it is strongly desired to conduct the full feasibility study for its realization.

6.3.3 Bakaru 2 Hydropower Project

The Bakaru No. 2 Hydropower Project (run-of-river, 63 MW, South Sulawesi) is extension of the existing Bakaru No. 1 Hydro. PLN's latest power development plan schedules its commissioning in 2015. As the detailed design (with Japanese ODA loan) exists, its promotion stage has reached final. Despite its high profitability computed in the detailed design, there are the sedimentation issues within the existing units of Bakaru No. 1. The sedimentation issues are closely related to other hydropower development in the same river system, such as Poko (reservoir, 234 MW, South Sulawesi). To provide reliable renewable energy to the South Sulawesi System, it is highly desired to promote the Bakaru No. 2, followed by the enhanced studies against the sediment issues including a management program of the upstream land use and operations.

6.3.4 Hybrid Hydro PPP

(1) Issues of Private Hydropower Development

The run-of-river hydropower, of which technology has been matured, is high quality renewable energy. Its aggressive development is desired, if the environmental impacts can be mitigated. There are many stagnated hydropower projects due to the higher natural risks and greater investment costs than typical thermal plants. Particularly in IPPs, these high risk and high cost issues discourage private investors and make the financing more difficult.

(2) Rationale and Effect of Public-Private Partnership

The Public-Private Partnership (PPP) in hydropower development has the great significance in i) reduction of the private sector's risks. Eventually, one can expect ii) reduction of the project implementation cost in comparison with the pure private projects, iii) optimal input of the public money for the hydropower projects, and iv) acceleration of the private investment in the hydropower projects.

There exist a lot of forms of PPP realization, such as from O&M Contract until BOO. Taking all of i) to iv) above into consideration, it is believed that a form of BOT plus the public sector's involvement should be the best and practical choice in the hydropower development. More specifically, (1) Hybrid, (2) Output-based Aid (OBA), and (3) BTO for Value, plus (4) Public-Private Joint Venture scheme, which seems the main formation assumed in the new PPP

Law could be the candidates to choose. Despite less public money input expected, as compared in Table 6.3.1, the Hybrid seems the only scheme that can relieve the private sector from the hydro specific natural condition risk. The Hybrid forces the public sector to take over such natural condition risk. However, this should not be a serious issue, because the same risk needs to be fully bore by the public sector anyway under the conventional public projects.

Table 6.3.1 Comparison of four PPP Schemes

Effect	Hybrid	OBA	BTO for Value	Joint Venture
i) Reduction of Implementation Cost	A certain amount of the cost reduction can be expected from the financing charges and insurance cost.			Depends on depth of thepublic sector's involvement
ii) Relief of Private Sector's Risks	The hydro specific natural condition risk could be unbundled.	The hydro specific natural condition risk remains, because the completion risk needs to be borne 100% by the private sector.		Not sufficient for the private sector.
iii) Optimal Input of Public Money	Because of remarkable private investment, all of 4 schemes must be effective for reducing the public money input, once a project is realized. It is quite possible to optimize the public money input to the hydropower projects.			

Source: Study Team

(3) A Case Study of Hybrid Hydro PPP

The public sector's concerns are i) huge debt in the public projects and ii) enormous governmental guarantee requested in the private (IPP) projects. Either choice would bring about large amount of the national liability. The private sector's concern is the difficulty of gaining reasonable profits from the hydropower projects. The Malea Hybrid Hydro PPP is examined as discussed below. It can overcome both sectors' issues.

(a) Basic Concept

A Hybrid PPP is applicable and effective to infrastructure development projects. The concept of the Hybrid PPP is straightforward; the public and private sectors jointly take respective responsibilities to and profits from a single project. The private sector behaves as a usual private power producer. For example, the public sector develops the non-power station part, and the private sector develops the power station part. Then, the public sector enjoys low tariff electricity purchased from the private sector and the private sector gains reasonable return from less investment.

A case study of the Hybrid PPP for Malea Hydropower Project is compared with the conventional public and conventional BOT schemes in the following table. In the table, values attributed to the conventional BOT scheme are not recommended figures but based on the likely proposal requested by the typical reputable investors. For example, the estimation of the governmental guarantee in the conventional BOT scheme is as much as the total debt of the BOT company, say 70% to the total implementation cost.

Public Sector: Responsible for planning, design, construction, and financing for the upstream facilities from the water intake to the just-upstream of the powerhouse. The relatively high cost overrun risk and/or completion risk such as in the headrace tunnel can be unbundled from the private work. After completion, these facilities are to be leased to the private sector (the project company) and the public sector can enjoy the reasonable return.

Private Sector: Responsible for construction and financing for the powerhouse and its auxiliaries. After completion, the private sector is to borrow the upstream facilities from the public sector, operate the entire facilities and sell economical electricity to PLN.

(b) Assumptions in Hybrid PPP

The responsibility demarcations are assumed as seen in Table 6.3.2. Financing is assumed to be made by the respective sectors.

The demarcations in the table are sort of the study outputs, coming from the physical boundaries of the respective facilities taking the construction time scheduling into consideration. The demarcations should not be decided regardless of such nature of the project.

Apart from the construction cost, the project implementation demands around US$15 million of the design related cost, and US$ 6 million of the environmental mitigation cost. Both costs are assumed to be borne by the public sector in this case study. However, these costs are not necessarily allocated to the public sector.

It is assumed that all of the post construction activities, such as operation, maintenance, and management of the entire project facilities, are the private sector's roles.

Table 6.3.2 Likely Demarcations of Public and Private Sectors in Malea Hydro Hybrid PPP

(A) Construction (unit: US$ million)

Descriptions	Public	Private	Total
Preparatory Work	25.3	–	25.3
Headworks and Headrace	99.3	–	99.3
Penstock and Gates	–	20.3	20.3
Powerhouse	–	12.8	12.8
Generating Equipment	–	42.9	42.9
Transmission and Substation	–	5.9	5.9
Contingency	18.7	5.4	24.1
Total	143.3	87.3	230.6
Public-Private Proportion	62%	38%	100%

(B) Non-construction Cost (unit: US$ million)

Descriptions	Public	Private	Total
EIA and Lands Acquisition	5.7	–	5.7
Design and Management	15.1	–	15.1
Total	20.8	0.0	20.8
Public-Private Proportion	100%	0%	100%

Source: Study Team

(c) Evaluation of Hydro Hybrid PPP

The merits and demerits of the Hybrid Hydropower are summarized as below:

Table 6.3.3 Comparison of Financial Indicators in Hybrid and Conventional Business Schemes

Descriptions		A) Conventional Public Scheme	B) Hybrid PPP Scheme			C) Conventional BOT Scheme
			Public	Private	Hybrid Total	
1. Construction Cost		231	143	87	231	231
2. Design & EIA		21	21	0	21	20
3. Financial Charges		8	5	35	40	60
4. Total Implementation Cost (Unit Implementation Cost)		259 (US$1,356/kW)	169 (US$886/kW)	122 (US$639/kW)	291 (US$1,525/kW)	312 (US$1,631/kW)
5. Public Investment		65	42	0	42	0
6. Public Liabilities	National Debt	194	127	0	127	0
	Governmental Guarantee	0	0	0	0	222
	Total Liabilities	194	127	0	127	222
7. Power Purchase Tariff for PLN		N/A	US¢3.0/kWh			US¢6.5/kWh
8. Unit Power Cost for PLN		US¢3.4/kWh	US¢4.9/kWh			US¢6.5/kWh
9. Net PLN Benefit		227	138	0	138	0
10. Net Private Benefit		0	0	50	50	109
11. Project IRR		16.1%	15.4%	14.1%	13.5%	12.9%
12. Investor's IRR		31.5%	30.3%	18.7%	N/A	17.2%

Sources: Study Team

Table 6.3.4 Merits and Demerits of Hybrid Hydropower

Merits of Hydropower Hybrid	Demerits/Issues of Hydropower Hybrid
i) Risks can be unbundled from the private sector. Investment opportunities for the private investors can be increased.	i) An integrated control or managing system is mandate in order to make two components united. To do this, assignment of the specialists should play an important role.
ii) The hydro hybrid can bring profits to both of the public and private sectors.	ii) The public and private projects are very different each other in their development speed. To have simultaneous completion of the both constructions, careful attention should be paid.
iii) The public sector can procure the electricity with reasonable cost.	iii) There might be a case such that a private company has made his own investigations and/or studies for superior projects. Careful treatment is needed on how such private investigation should be evaluated when selecting the business concessionaire.
iv) Public money to be put in a hydropower project can be reduced.	iv) Hybrid PPP can save the public expenditures. The saved public money should be utilized effectively, such as for the regional development.

Sources: Study Team

6.3.5 Rehabilitation of Tonsealama Hydropower Plant (renewal of the equipment)

There are three runoff type hydropower cascades in Tondano River at the east end of North Sulawesi. Tonsealama Hydropower Station (14.3 MW) is in the upper stream. Tanggari I (2 units × 9 MW) and Tanggari II (2 units × 9.5 MW) are in the just down stream of the Tonsealama. These three power plants are the main electricity source of North Sulawesi region.

The Unit No. 1 of Tonsealama Hydropower Station (4.4 MW) was brought from Yamura Hydropower Station in Yamanashi Prefecture in Japan to Tondano area by former Japanese Army in 1942. The power station has started operation since 1950. It is more than ninety years from the manufacturing. The Unit No. 2 (4.5 MW) was installed in 1970 and the Unit No. 3 (5.4 MW) was installed in 1981 by PLN. Although the original installed capacity is 14.3 MW, the actual capacity has been down to 12.5 MW because of deterioration. It is said that the steel penstock has been decreasing its thickness until 1.0 safety factor.

The Tonsealama Power Station is still an important renewable energy source in North Sulawesi System. PLN has kept considering the total rehabilitation of the station. But PLN has not prepared the specific rehabilitation plan yet because of the limited budget.

Therefore the study team suggests the total rehabilitation of the first hydro turbine of Tonsealama Hydropower Station by a Japan’s grant aid considering the history, the importance and the budget scale.

6.3.6 Power Grid Interconnection Projects

Among the optimal power development plan shown in Section 5.2, the amount of investment for transmission development is shown again in Table 6.3.5.

Table 6.3.5 Amount of Investment for Transmission Development

(Unit: MUSD)

Term	1st	2nd	3rd	4th	Total
	2008-2012	2013-2017	2018-2022	2023-2027	2008-2027
North Sulawesi	136	88	16	38	278
South Sulawesi	487	23	303	94	906
Total	623	110	319	132	1,185

As shown in Table 8.5.8, the half amount of total investment to transmission facilities concentrates on the first 4 years term (2008-2012) in this 20 years plan study. This is because the earlier small isolated systems are interconnected to the large system, the more the fuel cost of diesel generators is decreased. This term includes the following important projects:

I) Grid extension from Manado (Minahasa-Kotamobagu system) to Gorontalo Province
II) Grid extension from Makassar (Sulsel system) to Southeast Sulawesi Province
III) Grid extension in Central Sulawesi Province (from Parigi to Luwuki)

Among the above, the project I) forms backbone of the greater northern Sulawesi system, and II) and III) makes up the basis of greater Northern Sulawesi system. In this way, implementating the first term (2008 -2012) projects will form important backbone of the Sulawesi power system as shown in Figure 6.6.1.

These projects, at the same time, will form the basis of power supply not only city areas but also every area in the Island: as shown in Table 6.3.6, many on-grid substations are constructed also in such areas like Gorontalo, Central Sulawesi and South-east Sulawesi where no or just some substations ever exist.

Table 6.3.6 Number of On-grid Substations to be newly installed

Province	(Existing)	2008-12	2013-17	2018-22	2023-27
North Sulawesi	8	7	0	0	0
Gorontalo	0	4	0	0	0
Central Sulawesi	2	5	3	0	1
South Sulawesi	24	4	0	0	0
South East Sulawesi	0	4	0	0	0
West Sulawesi	2	1	0	0	0

On-grid substations enable 24 hour power supply, which can contribute to the improvement of living standards and the advancement of industry in these areas.

On the other hand, these first-term projects requires a lot of fund as shown in Table 6.3.5, which would be difficult to be all financed by PLN itself. It would be appropriate to apply Yen Loan to the first term transmission project because of its importance for satisfying power in Sulawesi, leading to regional development, and also because of publicity and relatively less burden to environment which is the nature of a transmission project.