REPUBLIC OF INDONESIA

PERUSAHAAN UMUM LISTRIK NEGARA

FEASIBILITY STUDY ON MINE MOUTH STEAM POWER PLANT DEVELOPMENT PROJECT IN SOUTH SUMATRA

FINAL REPORT

EXECUTIVE SUMMARY

SEPTEMBER 1993

JAPAN INTERNATIONAL COOPERATION AGENCY

TOKYO, JAPAN

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P R E F A C E

In response to a request from the Government of the Republic of Indonesia, the Government of Japan decided to conduct a feasibility study on the Mine Mouth Steam Power Plant Development Project in South Sumatra including the Transmission Plan with Submarine Cable for transferring generated power to Java Island and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Indonesia a study team headed by Mr. Katsumi Takasawa, Deputy General Manager of Tokyo Electric Power Services Co., Ltd. from January 1992 to July 1993.

The team held discussions with the officials concerned of the Government of Indonesia, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

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

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Indonesia for their close cooperation extended to the team.

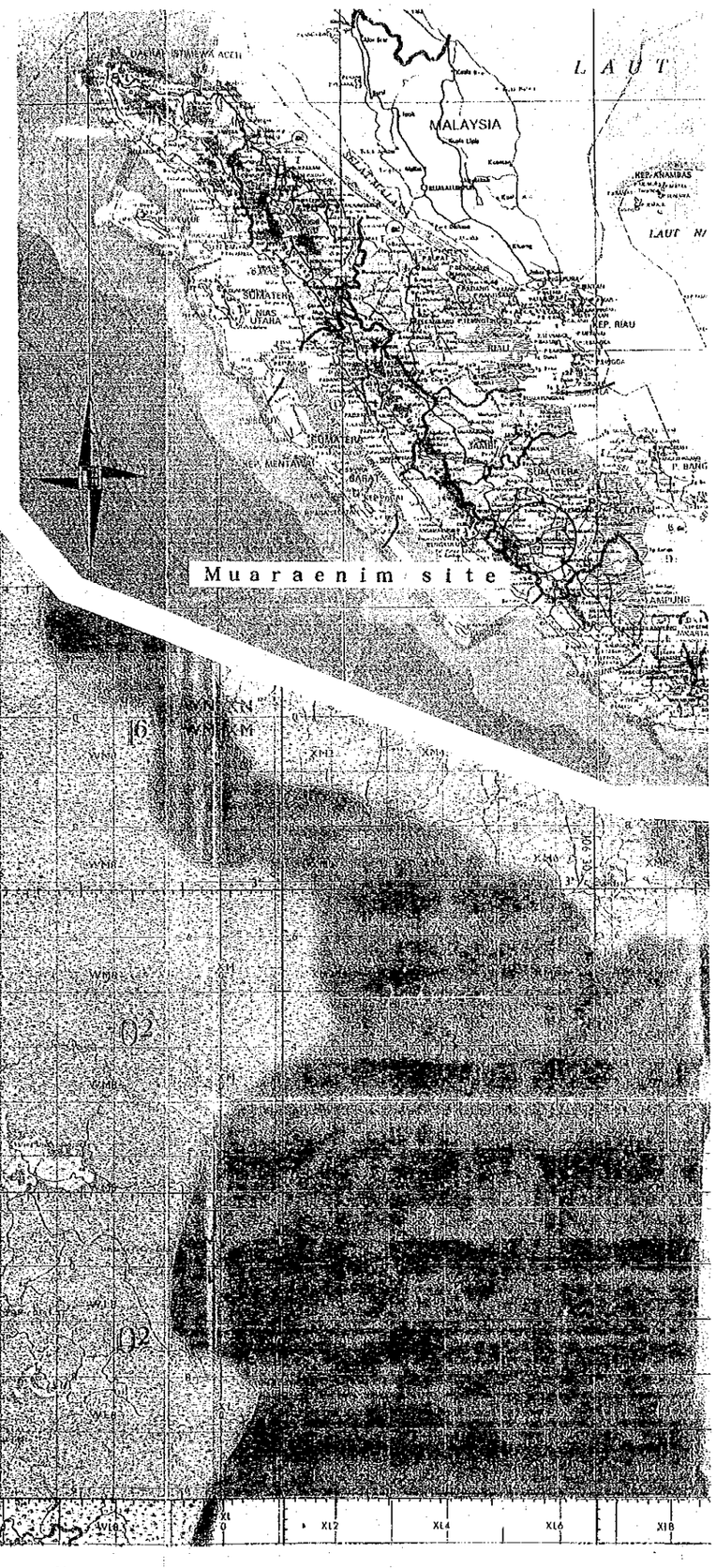
September, 1993

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

Location Map S=1:1,000,000

Mine Mouth Steam Power Plant Development Project in South Sumatra



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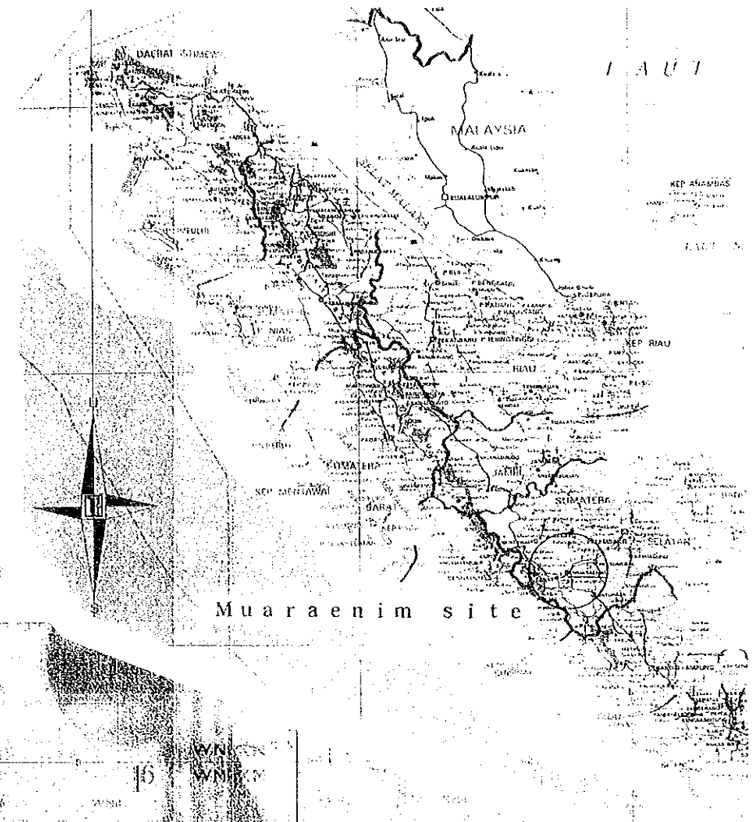

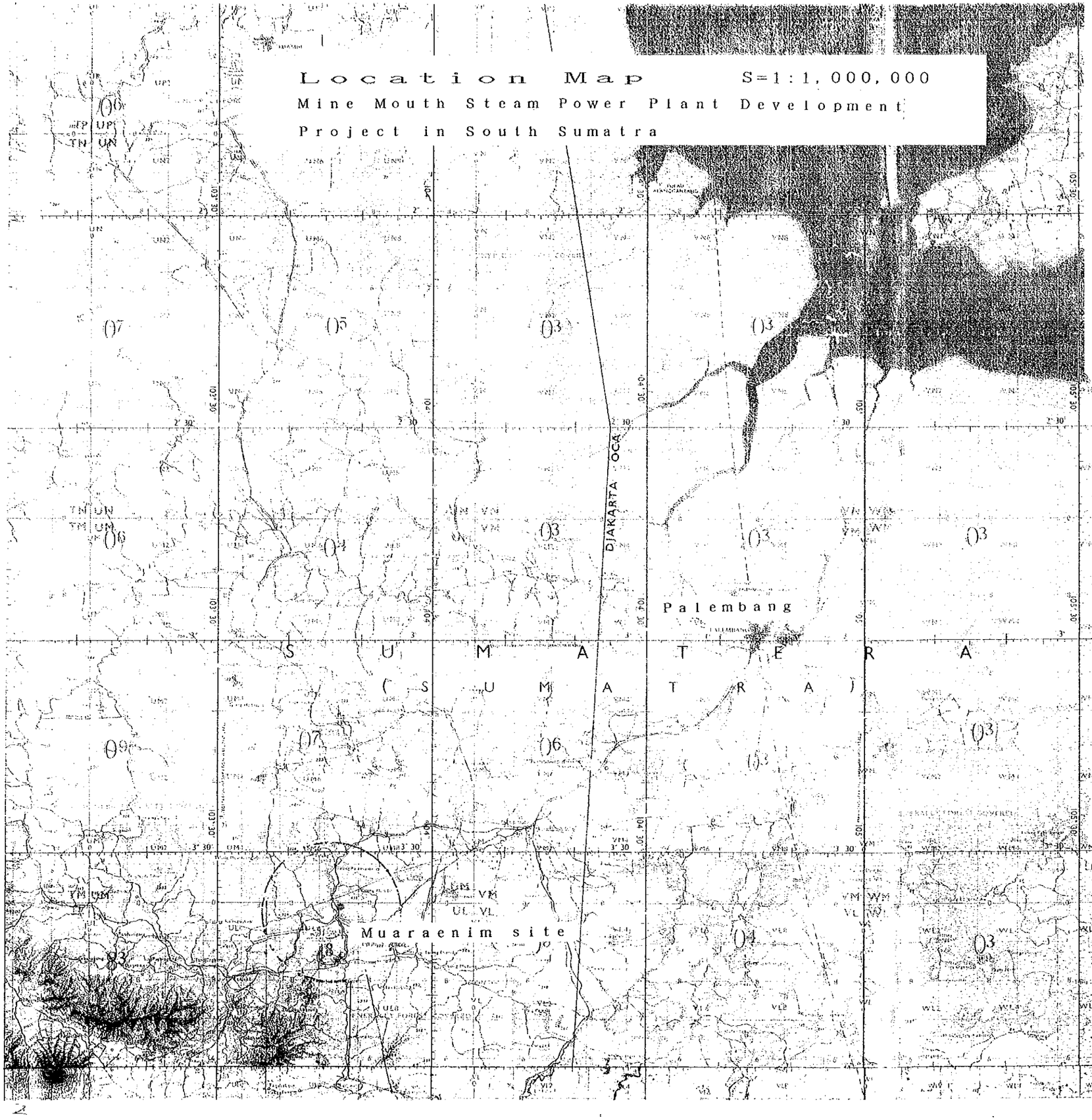

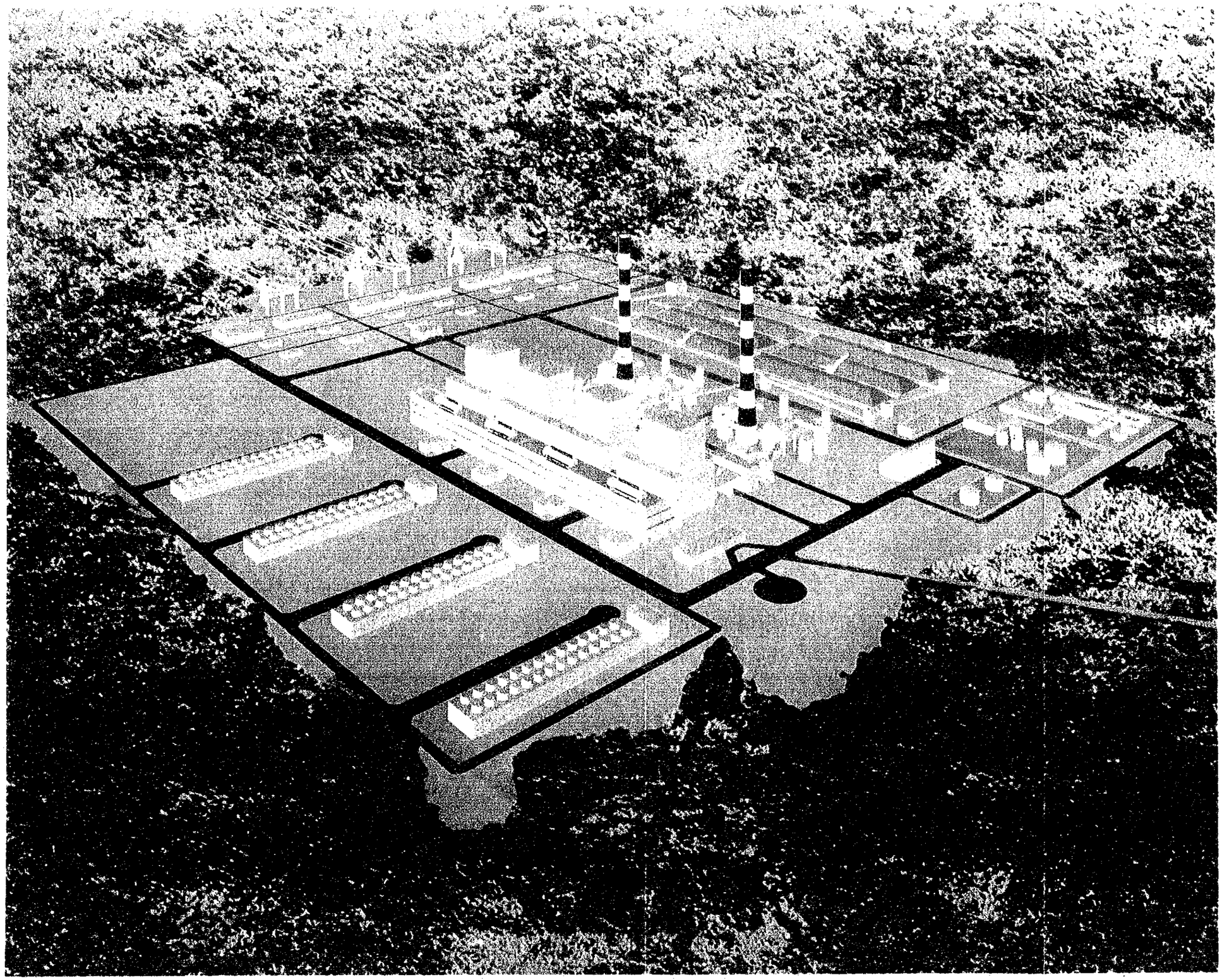

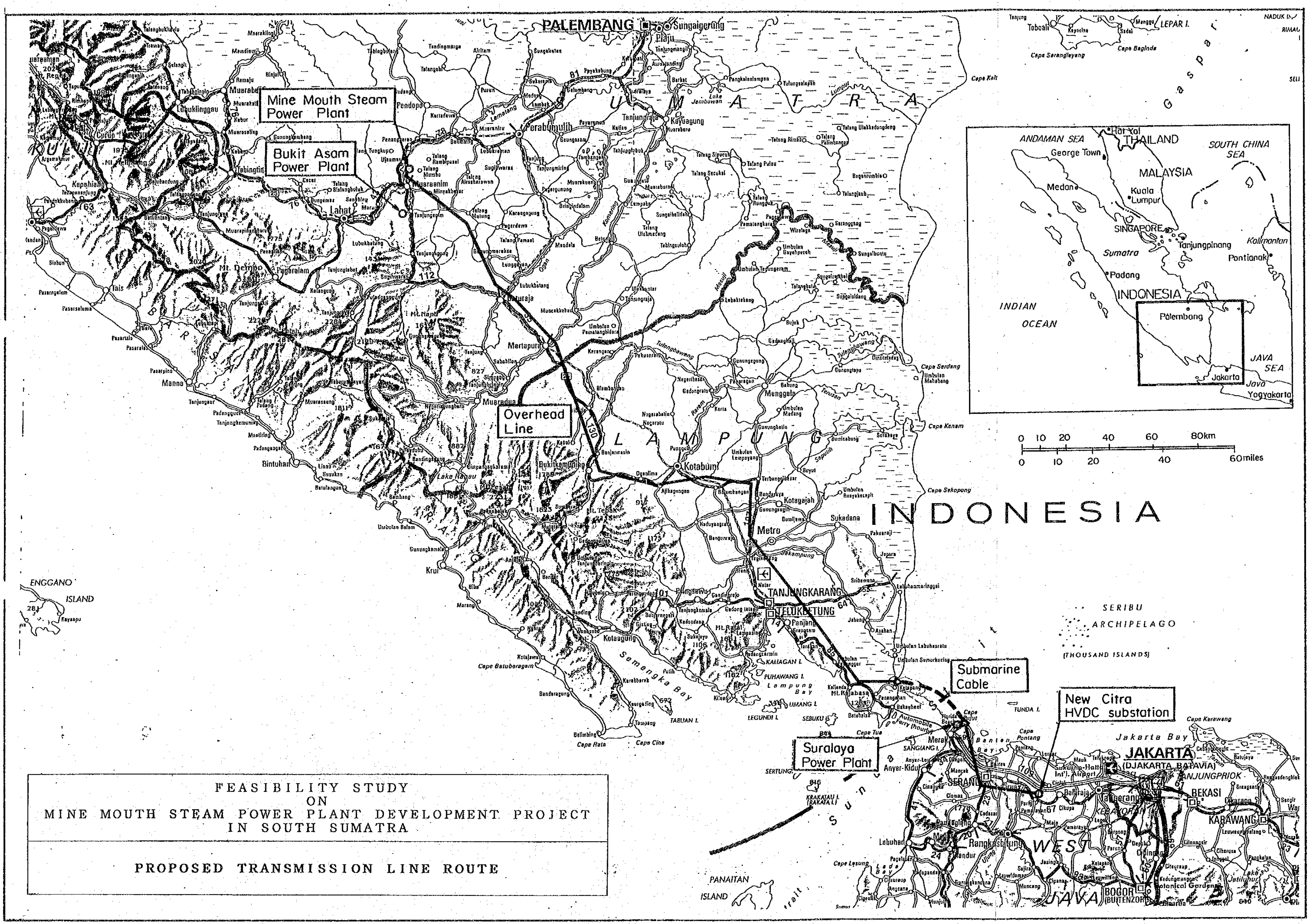

FEASIBILITY STUDY
ON
MINE MOUTH STEAM POWER PLANT DEVELOPMENT PROJECT
IN SOUTH SUMATRA

PROPOSED TRANSMISSION LINE ROUTE

CONCLUSION

According to the latest electric power demand and supply plan (6th and 7th five-year plans) formulated by PLN, the electric power demand on Java Island is forecast to reach 162.1 billion kWh by the fiscal year of 2003, the end of the 7th five-year plan (fiscal 1999 - 2003) from 31.5 billion kWh in fiscal 1991 and expected to grow at an annual average rate of 14% during the period of twelve years in the future.

Moreover, the system peak load is forecast to reach 25,070 MW in fiscal 2003 from 4,728 MW in fiscal 1991.

In order to cope with such a rapid growth of electric power demand and peak load, PLN will be required to develop its electric power sources at an annual average rate of 2000 MW by the end of the 7th five-year plan. Under these situations, this study for the South Sumatra Mine Mouth Steam Power Plant Development Project was carried out by the Japan International Cooperation Agency, JICA [Tokyo Electric Power Services Co., Ltd. (TEPSCO) and the Electric Power Development Co., Ltd.(EPDC)] in 1992 through to 1993.

Regarding the results of this study, it is necessary to evaluate the benefits in view of national economy with technical and financial aspects.

This project is very important to cope with rapid increasing power demand at Java Island, also it is expected to be and economical and benefitable for social in association with development of this project in direct and indirectly.

Thus, completion of this project will be not only resolution of the shortage for power supply at Java system network but also contribute to a secondary integrated effect. It will be possible to reduce the marginal capacity, increase the system reliability between Java and Sumatra interconnection and effective utilization of low grade coal in national use.

Simultaneously, environmental pollution could be reduced by scattered the large capacity of the coal fired thermal power plans from Java Island.

In fact, the total output of coal-fired steam power plants, including those of the private sector on Java Island, will reach 17,400 MW in fiscal year 2003, with about 47,000,000 tons of annual coal consumption. Even for the case in which the sulfur content in 1 kg of consumed coal is assumed to be 0.5%, the amount of SOx gas discharged from the chimneys of the above coal-fired steam power plants will be roughly 480,000 tons per year in the case of conventional type steam power plant. Since this amount by gas emissions would be a source of wide range environmental pollution throughout Java Island, it will be necessary to protect the environment by installing desulfurization and other equipment in the coal-fired steam power plants, particularly, those located near the load centers on Java Island in the future.

These will be effective influence in the national economical benefits and conclusion of this study is as presented below.

1. Technical Conclusion

(1) Based on the results of studies carried out regarding the civil and architectural/structural work, transportation of heavy equipment and materials by barges and so forth centering on the regional characteristics of the South Sumatra Mine Mouth Steam Power Plant construction site, it has been proven to be advantageous economically as well to develop a unit output of 600 MW.

With a development scale of 2,400 MW (600 MW x 4 units), it has been proven technically and economically feasible to implement this power source development project for long distance transmission with 2000 MW of generated power output to Java Island by Fiscal 2001 - 2003.

(2) Based upon the results of reviewing the existing feasibility study reports, it has been proven that 5.40 million ton and 1.8 - 2.0 million ton of coal can be supplied annually to the power plant respectively from the Banko Barat Coal Mine and Muara Tiga Besar Coal Mine.

(3) Two (2) circuits of DC 400 KV bipolar transmission system has been

concluded advantageous both technically and economically for the long distance transmission line to Java Island (430 km of ground section and 45 km of submarine cable section).

(4) The overall development period required for completion of this project is estimated one hundred and sixteen (116) months, after approval of the project (approval of Environment Impact Assessment (EIA) Report) in Indonesia until completion of unit I.

Therefore, it is expected possible to commission Units 1 and 2 in fiscal 2001 - 2002 and Units 3 and 4 in 2002 - 2003.

2. Economic Conclusion

(1) On the basis of the price level in June 1992, the construction cost including the engineering (consulting) fees and contingency is estimated (evaluated) as shown in the followings:

Power plant construction cost: US$2,208,117 x 10^3
(Foreign currency: US$1,575,707 x 10^3)
(Local currency : US$ 632,410 x 10^3)

Transmission line construction cost: US$891,506 x 10^3
(Foreign currency: US$786,427 x 10^3)
(Local currency : US$105,079 x 10^3)

(2) Where the as-received coal price at the power plant is US$20.18/ton (4,800 kcal/kg), the unit power generation cost of the mine mouth power plant is estimated to be 34.36 mills/kWh at the generator end and 36.95 mills/kWh at the sending end.

When the transmission cost to the substation on Java Island is added to the above unit generation cost, the as-received unit power cost on Java Island is estimated at 48.09 mills/kWh.

(3) As a result of economic and financial analysis, the economic internal rate of return (EIRR) and financial internal rate of return (FIRR)

are estimated to be 26.80% and 18.69%, respectively.

On other hand, the plant including desulfurization plant, EIRR has been estimated 24.43% and 16.84% for FIRR.

In conclusion, this project has been proven sufficiently feasible from technical, economic and financial aspects. Therefore, PLN is desired to take urgent measures for concrete implementation of this project in the future.

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CHAPTER 1. INTRODUCTION

CHAPTER 1. INTRODUCTION

1.1 Background of the Project

Recent trends in energy consumption in Indonesian show dramatic changes in the energy consumption structure, that is, from non commercial energy to commercial energy (Oil, Gas, Coal, etc.). Under these circumstances, the Government of Indonesia is strongly promoting a policy of non oil energy.

Commercial energy consumption has brought about the increased use of oil for electrical energy to meet rapid economic growth in Indonesia.

Reflecting this non-oil energy policy which is energetically being promoted by the Government of Indonesia, development of hydroelectric power, coal, gas, geothermal and other sources is being adopted as future electric power energy sources.

While the majority of hydroelectric power sources are located one-sidedly in Irianjaya and Kalimantan, where the electric power demand is rather small, those on Java Island, where the electric power demand is expected to reach a high growth rate in the future, have been developed almost to their full extent.

Concerning gas-fired power units, a combined cycle plant is now under construction at Gresik, East Java, with other plants expected to be constructed at Medan, North Sumatra. Since the amount of natural gas reserves is not sufficient in the Java area as seen from the long term viewpoint, it is unlikely that a substantial increase of gas-fired power units will occur.

Therefore, the main electric power source to be developed by PLN in the future will be coal-fired thermal power units. The construction of a coal-fired thermal power plant will contribute to utilization of domestic coal resources and save oil resources for other effective uses, ultimately resulting in the reduction of electric power cost. In other words, although the initial construction cost is somewhat higher than that of an

oil-fired thermal power unit, the benefit from fuel cost reduction is expected to be much greater.

On the other hand, the demand for electric power in the supply areas of PLN (Perusahaan Umum Listrik Negara) has been increasing at an annual average growth rate of 17% since 1976. Among this demand, the industrial electric power demand has marked an extraordinarily high growth rate of 20%. Regionwise, the demand on Java Island and that on Sumatra Island share 78% and 13%, respectively.

In the future, the electric power demand is forecasted to grow at an annual average rate of a high 14.6% in accordance with the increase in industrial demand during the Fifth Five-Year Plan. On Java Island, the demand, which was 30.0 billion kWh in fiscal year 1990, is predicted to reach 162.0 billion kWh in the fiscal year 2003. Meanwhile, the increase of growth rate in each region is showing the same phenomenon, with three-quarters of the electric power demand expected to be consumed on Java Island in the future.

With regard to coal-fired power units which will cope with the electric power demand, the projects of Suralaya Steam Power Plant Units V, VI and VII, and Paiton Steam Power Plant are already being constructed. Other large capacity coal-fired steam power plans are being formulated to meet the growth in electric power demand in 1995 and thereafter.

On the basis of this background, this feasibility study was commenced in January 1992, and Progress Report was submitted to PLN in August 1992.

At this time, basic development plan in which construction of 2,400 MW (600 MW x 4 units) power plant and transfering 2,000 MW power to Java Island was basically agreed with PLN to proceed future study of this project.

According to this basic development plan, the study team carried out detailed study on possibility of technically and economically in order to aim at effective use of the indigenous coal constituting a major parts of long term energy plan of the Government of Indonesia. It also intends to

clarify construction feasibility of the mine mouth steam power plant, including the long distance transmission line, so as to attain effective utilization of coal and cover the shortage of electric power supply.

As the results of the study, it has been confirmed technically and economically that this project is feasible constructing the steam power plant ajacent to coal mine area, and transfering the power to Java Island by 400 KV direct current with double bipallor system.

1.2 Works Carried Out

In February 1991, the Scope of Work (S/W) and Minutes of Meeting (M/M) pertaining to the feasibility study were agreed upon and signed by the Japan International Cooperation Agency (JICA) and PLN, a Counterpart Agency of the Indonesian Government.

This project will be implemented in compliance with the long-term energy policy of the Government of Indonesia provided that effective utilization of the reserves of more abundant coal resources than other energy resources would play a major role in the energy policy of the country in the future. In other words, comparatively low grade coal reserves abundant in the Bukit Asam Coal Mine and other coal mines in the surrounding areas are not suitable for export. In order to promote effective utilization of the coal of this grade, this study is intended to clarify the feasibility for constructing a large capacity mine mouth steam power plant in the mine area and transmitting the generated power to Java Island through long distance transmission lines (including a submarine cable).

Under the above study purpose, the feasibility study was made in the following three basic stages.

. Preliminnry investigation	January 1992 - March	1992
. Basic planing	June 1992 - August	1992
. Feasibility design	September 1992 - June	1993

In these stages the items shown in the table overleaf, were investigated.

Works Carried out

Preliminary Investigation	Detailed Investigation and Basic Design	Feasibility Design
(1) Review of available investigation reports and collection of other relevant information	(1) Drafting of comparative development schemes	(1) Study for selection of optimum development scale
(2) Field investigation	(2) Comparative study and selection of development schemes	(2) Study on optimum development plan
. Topography and geology of all the area	(3) Geological survey	(3) Design of feasibility study
. Access and transportation routes of construction and heavy equipments	(4) Hydrological investigation	(4) Calculation of construction cost
. Existing irrigation facilities and water use	(5) Electric power demand investigation	(5) Construction schedule
. Hydrology (Data collection and survey of gauging stations)	(6) Investigation on power transmission line routes	(6) Economic and financial analyses
(3) Preparation of implementation plan for detailed investigation, technical specifications and other documentation	(7) Investigation on access roads for construction and route for transportation of materials and equipment	
	(8) Environmental impact assessment	
	(9) Investigation on items for compensation	
	(10) Others (investigation on construction cost, economy and financial assessment indexes)	

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CHAPTER 2. OUTLINE OF THE PROPOSED STUDY SITE AREA

2.1 General Description of Indonesia

The Republic of Indonesia is located between the big two continents of Asia and Australia and on the big two oceans, the Indian Ocean and Pacific Ocean, and blessed with abundant natural resources.

Geographically located from 6 degrees of north latitude through to 11 degrees of south latitude and from 95 degrees of east latitude to 141 degrees of west longitude, Indonesia consists of the largest number of island groups extending over about 5,100 km from Sabangon the Sumatra Island on the west side through to Meraukl in East Irian Jaya. With a total area of about 1.92 million km^2, the Republic of Indonesia is comprised of 13,667 large and small islands altogether, and about 3,500 islands out of them are inhabited.

The population, which was about 147 million according to the census in October 1980 was estimated at 179 million from the census in 1990. The annual average population increase rate was 2.1% in 1961 through 1971, 2.32% in 1971 through 1980 and 1.97% in 1980 through 1990.

60% of the population is distributed on the Java and Madura Islands with only 6.9% of the total area of the country. While the nationwide average population density (per 1 km^2) is 107, that on Java and Madura Islands, one of the densely populated zones in the world, is as large as 814. In contrast, the population density is 17 in Kalimantan, 27 in Sumatra and 4 in Irian Jaya.

Table 2.1 Area and population distribution in major districts

Area/population	Area		Population		Population density
Major districts	(km^2)	Share(%)	(1,000)	Share(%)	per km^2
Sumatra	473,481	24.67	36,455	20.33	77
Java & Madula	132,187	6.39	107,574	59.99	814
Kalimantan	539,450	23.11	9,110	5.08	17
Sulawesi	189,216	9.85	12,522	6.98	66
Irian Jaya	421,981	21.99	1,641	6.92	4
Others	162,993	8.49	12,020	6.70	14
Total	1,919,317	100.00	179,322	100.00	107

Source: "INDONESIA STATISTICS 1991" published by the Central Statistics Bureau

2.2 Outline of the Proposed Development Project Area

This development project area is located at Muara Enim Town of the Muara Enim Prefecture 150 km southwest of Palembang, the capital of the Province of South Sumatra.

The Province of South Sumatra is the largest province on Sumatra Island, and its area extending to 109,254 km^2 occupies 22% of the total area of Sumatra Island and 5.4% of the total land area of Indonesia.

In consideration of these geographical conditions, the Government of Indonesia specified this proposed area as the Development Area B, a preferential development area, in the 4th Five-Year Plan (REPELITA IV) and 5th Five-Year Plan (REPELITA V). Thereby, the government intends to promote economic development of this area as a part of the Java Economic Zone in combination with the regional development of West Java.

Moreover, there are the largest coal reserves among those on Sumatra Island in the coal reserves distributed widely centering on Tanjung Enim. In addition, there are abundant oil, gas and other mineral resources in

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this area.

The proposed power plant construction site is located 3 km southeast of Muara Enim Town developed mainly around the confluence of the Enim and Lematang Rivers, where moderate hills have been developed widely. In the extensively distributed hill zone of this area where palm oil processing is undertaken by PTX, the regional development of this area has been promoted at a rapid tempo along with forestation of palm trees.

Climatically speaking, the yearly (mean) temperature ranges from 26°C to 27°C with the highest and lowest temperatures being roughly 36.5°C and 19°C, respectively. With regard to rainfall, the yearly maximum is 4,176 mm with the yearly being 733 mm. Therefore, this proposed project area is a typical area with the climatic characteristics inherent to Indonesia.

2.3 General Economic Situations

(1) Transition of economic situation

Since 1969, the Republic of Indonesia implemented the First Five-Year Plan mainly for establishment of food self-supply system and modernization of infrastructure. As the domestic and overseas political and economic situations had undergone comparatively stable transition, an annual average growth rate of 7.7 had been achieved in terms of the actual gross domestic products (GDP) during this period.

In 1974 when the Second Five-Year Plan was initiated, the economy underwent smooth transition due to the rise of crude oil export price resulting from the First Oil Crisis. In 1975, however, the growth rate of GDP slowed down to 6.9% from a target rate of 7.5% because of the effects of financial collapse of PERTAMINA and worldwide economic recession.

Since 1979 when the Third Five-Year Plan was started, the taxation systems, tariff (import and export duties), encouragement of

export, promotion of medium and small scale enterprises and many other systems were revised. As a result, the GDP also grew at a rate of as high as 6.3% in 1979, 9.9% in 1980 and 7.9% in 1981, and the per capita GNP exceeded US$500.

Reflecting increasingly deepened worldwide economic recession resulting from slowdown of the oil market since 1982, the economic growth rate dropped sharply to 2.2%. Consequently, the growth rate remained at 6.0% from the planned rate of 6.5% during this plan period. Since 1984, the Fourth Five-Year Plan was initiated with a target for departure from the oil and gas product export-oriented economic structure, and the priority was placed on the development of industrial sector for the purpose of realizing a balanced industrial structure.

Table 2.3.1 Transition of economic growth rate/national productivity (since 1985)

(Constant base in 1983) Unit: %

	1985	1986	1987	1988	1989	Average
Growth rate	2.4	5.9	4.9	5.7	7.3	

Source: Statistic Yearbook of Indonesia 1991

The Fifth Five-Year Plan started was initiated since 1989. In the initial fiscal year of 1989, 7.3% of economic growth rate was recorded. As various kinds of deregulation policies implemented since fiscal year 1988 have come to bring about favorable results and the opening of the financial system has made remarkable progress in particular, it is expected possible to solidify the industrial foundation as targeted in the Fifth Five-Year Plan and it is also predicted possible to attain a target growth rate of 5% during this plan period.

The recent economic trend is characterized by the growth of export-related industries and activation of those related to construction and real estate. Moreover, the amount of non-mineral

product export exceeded that of oil and gas export reflecting the appearance of non-oil and gas products and diversification of export destinations. As the export amount of non-oil and gas products reached US$1 billion level on a monthly basis, it is observed that full scale departure from the structure depending on oil and gas has been started.

(2) Transition of industrial structure

According to the industrial structure (nominal values) in 1987, 25.5% is shared by the agriculture, forestry and fishery industry, 13.1% by the mining industry, 13.9% by the manufacturing industry and 16.8% by the commerce industry. The share of the agriculture, forestry and fishery industry dropped to less than half that in about 1970. From the actual annual average growth rate by the industrial categories during the period of Fourth Five-Year Plan, the manufacturing industry recorded the highest rate of 9.5% followed by 5.2% of transportation and telecommunication industries, 5.0% of construction industry and 3.0% of agricultural industry. Although the industrial structure of Indonesia had been comprised mainly of the land development businesses, the construction, electric power and water service industries indicated high growth rates in 1970's through to 1980's.

As the manufacturing industry has recently been recording the highest growth rate, it can be mentioned that the change in the industrial structure is in progress.

Table 2.3.2 Share and growth rate by industrial sectors during Fourth and Fifth Five-Year Plans (%)

Sector	Fourth Plan			Fifth Plan		
	Fiscal '83	Fiscal '88	Annual growth rate	Fiscal '89	Fiscal '93	Annual growth rate
Agriculture	29.2	26.4	3.0	23.2	21.6	3.8
Mining	7.4	6.6	2.4	15.9	12.6	0.4
Manufacturing	15.8	19.4	9.5	14.4	16.9	8.5
Construction	6.3	6.3	5.0	5.6	5.8	6.0
Commercial	-	-	-	-	-	-
Transportation and Telecommunication	6.0	6.0	5.2	5.7	16.7	6.0
Others	35.3	35.3	5.0	19.3	20.4	6.1
Total	100.0	100.0	100.0	199.9	100.0	100.0

Source: Indonesia Handbook (Association of Jakarta Japan Cooperations)

CHAPTER 3. ELECTRICAL POWER DEMAND AND SUPPLY

3.1 Electrical Power Demand and Supply

According to this load demand forecast, the energy demand throughout Indonesia is forecast to grow at a high annual average rate of 18 to 20% during the period of the Fifth Five-Year Program. It will then gradually slowdown from 20% to 15% during the Sixth Five-Year Program. Finally, it will undergo a downward curve from 14% during the Seventh Five-Year Program to 11% by the end of this program.

The energy load demand on Java Island also indicates a trend similar to the above, and the total energy production in the Java Bali system, according to PLN, is forecast to grow at an annual average rate of 14% in the coming twelve (12) years and reach 162.1 billion kWh in fiscal year 2003 from 31.5 billion kWh in fiscal year 1991.

Although the yearly growth rate fluctuates similarly as in the cast of the overall yearly growth rate in Indonesia, the energy load demand is forecast to grow at an annual average rate of 19 to 22% during the Fifth Five-Year Program, 22 to 15.5% during the Six Five-Year Program, 11 to 9.4% during the Seventh Five-Year Program and then settle at a 9% level at the end of this program.

As the energy load demand in the power system outside Java is also forecast to grow at roughly the same growth rate as that on Java Island, the total energy production of PLN is estimated to reach 35.5 billion kWh in fiscal year 2003 from 7.4 billion kWh in fiscal year 1991 and undergo an annual average growth rate of 14% in a similar manner as in the case of the Java - Bali system.

The system peak load in the Java - Bali system occupying roughly 70% of the total electric power consumption in Indonesia is forecast to increase at an annual average rate of 14% to 25,070 MW (or about five times) in fiscal year 2003 from 4,728 MW in 1991.

Regarding the characteristics of this energy load demand, the industrial

demand supporting the basis of economic and social development of Indonesia occupies more than 60% of the total energy load demand, which is increasing at an annual average growth rate of as high as 12%. In addition, the self-supply ratio of captive power, which will soon reach about 40% of the total energy production of PLN at present, is planned to be reduced to about 3% by the year 2003 (Refer to Table 3.2 and Fig. 3.2).

Although the captive power facilities play a highly important role in view of the energy load demand and supply on Java Island at present, the self-supply ratio of captive power facilities will be decreased gradually and such facilities will be used as standby power sources together with aging of such facilities and improvement of supply reliability through expansion of the power system of PLN. In this way, the industrial demand placed on PLN is expected to undergo gradual increases.

In the case of the power system outside Java, the system peak load of PLN's energy production is also forecast to grow at an annual average rate of 14%, that is, by as much as about 4.4 times in the coming twelve years to 6.642 MW in fiscal 2003 from 1,508 MW in 1991. The share of energy produced by captive power facilities to the total energy production in this area is predicted to be lowered to approximately 40% in fiscal 2003 from the present level of 74%.

Total energy production of Java - Bali system in fiscal 1991 and energy production plan by energy power source categories at the ends of the Sixth and Seventh Five-Year Programs are indicated in Table 3.1.1.

Table 3.1.1 Total Energy Production (GWh) of Java - Bali System

	1991	1998	2003
A. PLN			
Hydro P/S	6,510 (20.5%)	7,232 (13.5%)	8,611 (7.0%)
Diesel P/S	178 (0.5%)	- (-)	- (-)
Steam P/S	22,209 (70.5%)	27,674 (51.5%)	71,134 (57.9%)
Gas Turbine P/S	1,641 (5.5%)	415 (0.8%)	8,837 (7.2%)
Combined Cycle	-	15,902 (29.5%)	31,750 (25.8%)
Geo-Thermal	986 (3.0%)	2,535 (4.7%)	2,535 (2.1%)
PLN TOTAL	31,524 (100.0%)	53,758 (100.0%)	122,868 (100.0%)
		(57.5%)	(75.5%)

Remarks: Total energy production of 35,526 GWh in the outside Java in fiscal 2003

3.2 Electric Power Generation Plan

According to the electric power source development plan of PLN summarized in Fig. 3.2.1, about 26,500 MW of power source has been proposed to be developed in the coming twelve years in the Java - Bali system. Therefore, it is required to develop 2,000 MW of power source on the average per year.

Among 9,500 MW of power source required to be developed under the Sixth Five-Year Program (1994 to 1998) according to the plan, about 70%, or 6,400 MW, is proposed to be developed through construction of coal-fired steam power plants through projects of the private sector, which shares a major portion of electric power source development during this period.

Under the Seventh Five-Year Program (fiscal 1999 to 2003), PLN is required to develop 10,680 MW of power sources, which are consequently composed of large capacity coal-fired steam power and gas turbine power

plant projects.

According to the power source development plan based on this Seventh Five-Year Program, large-scale gas turbine projects having total output of 4,920 MW have been proposed to be implemented in fiscal year 2003 as a measure to meet system peak load. On the other hand, the power sources having a total output of 6,800 MW, or about 65% of the total power sources to be developed, should be developed mainly by construction and extension of large-scale coal-fired steam power plants. Among these coal-fired steam power plant projects, however, two coal-fired steam power plant sites are still under the commencement stage of the feasibility study.

Unlike the large-scale gas turbine projects to be implemented as a measures to meet system peak load, the coal-fired steam power plant projects under the Seventh Five-Year Program should be completed as high reliability coal-fired steam power sources to ver the base load. Otherwise, it would seem impossible to meet the enormously growing electric power demand on Java Island in the future.

Regardless of coal-fired power source development by the private sector, therefore, PLN is required to direct its utmost efforts for construction and extension of coal-fired steam power plants under the Seventh Five-Year Program. Especially, it is essential for PLN to urgently promote concrete implementation program of coal-fired steam power plant projects which have not yet been slated for commencement.

The yearly implementation flow of the electric power source development projects and development sequence of coal-fired steam power sources for the Java - Bali system are presented in Fig. 3.2.1. After completion of coal-fired steam power source development by the private sector by fiscal year 1998 and subsequent to development of Paiton Units 3 and 4 by fiscal year 2000, Central Java Units 5 through to 8 and West Java (I) Unit 3 through to 5 will be completed by fiscal year 2002, completion of West Java (I) Unit 6 and West Java (II) Units 1 and 2 at a new site is planned in fiscal year 2003.

Meanwhile, the above West Java (I) and (II) projects are still at a stage of initiating feasibility study and are not considered to have reached the ultimate construction stage.

The features of the electric power generation plan of PLN are as summarized aforeto. In light of the fact that the new coal-fired steam power plant projects under the Seventh Five-Year Program are still being considered to undergo feasibility study for new sites as mentioned previously, it will be possible to position the South Sumatra Mine Mouth Steam Power Plant Construction Project and associated large-scale transmission line project to the Java - Bali system as a new steam power source to be included in the electric power source development plan.

Based upon the results of study and discussions will PLN, the feasibility study has been determined to be implemented provided that the South Sumatra Mine Mouth Steam Power Plant Project be completed before or after fiscal year 2001, and 600 MW x 2 units be commissioned in the year 2002 under Phase I and 600 MW x 2 units before or after the fiscal year 2003 under Phase II as show in the Fig. 3.3.

Fig. 3.1 GENERATION EXPANSION PROGRAM OF JAVA - BALI SYSTEM BY PLN SCENARIO HIGH (May '92)

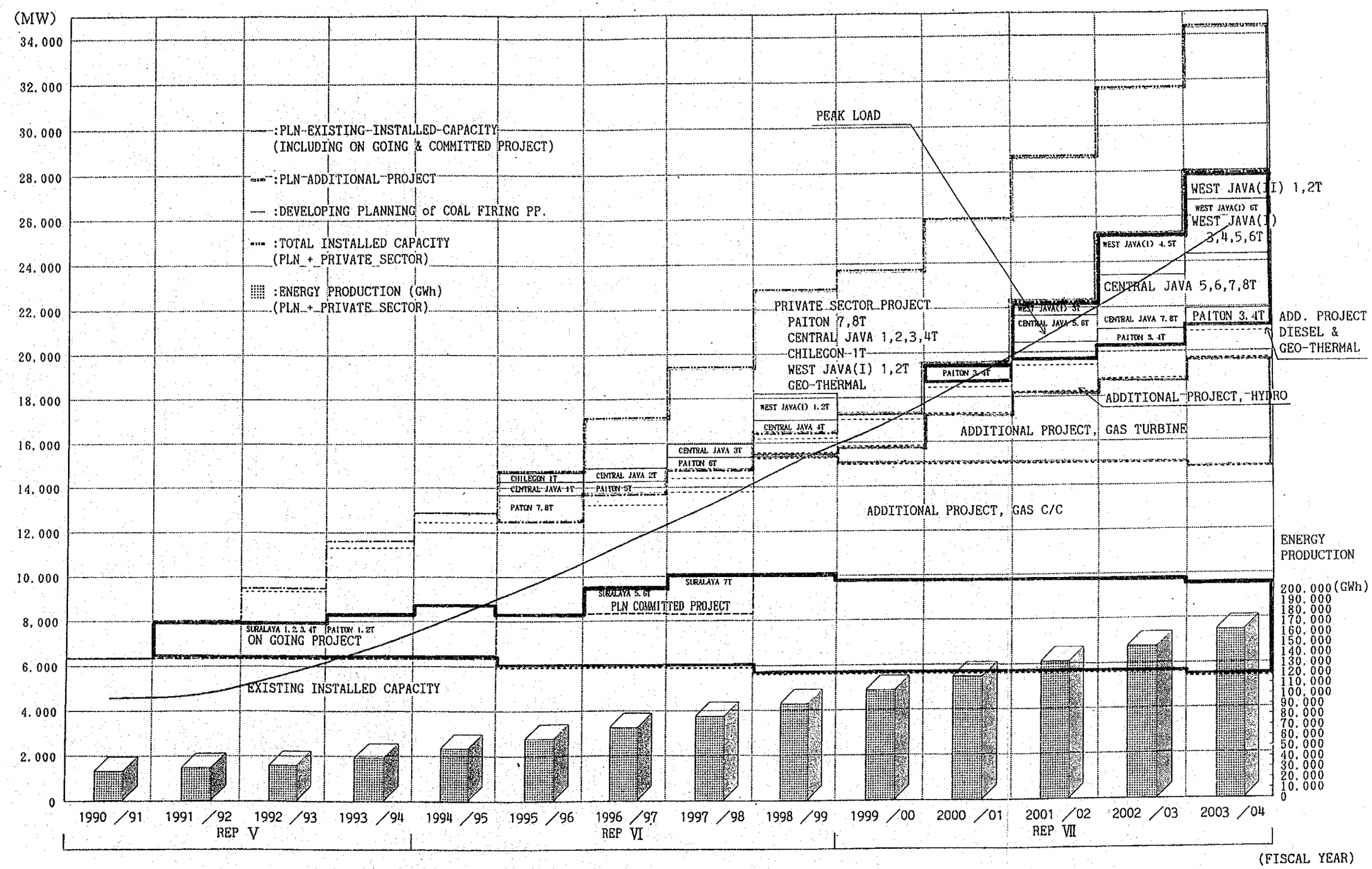

Fig. 3.2 GENERATION EXPANSION PROGRAM OF JAVA - BALI SYSTEM BY PLN SCENARIO HIGH (May '92)

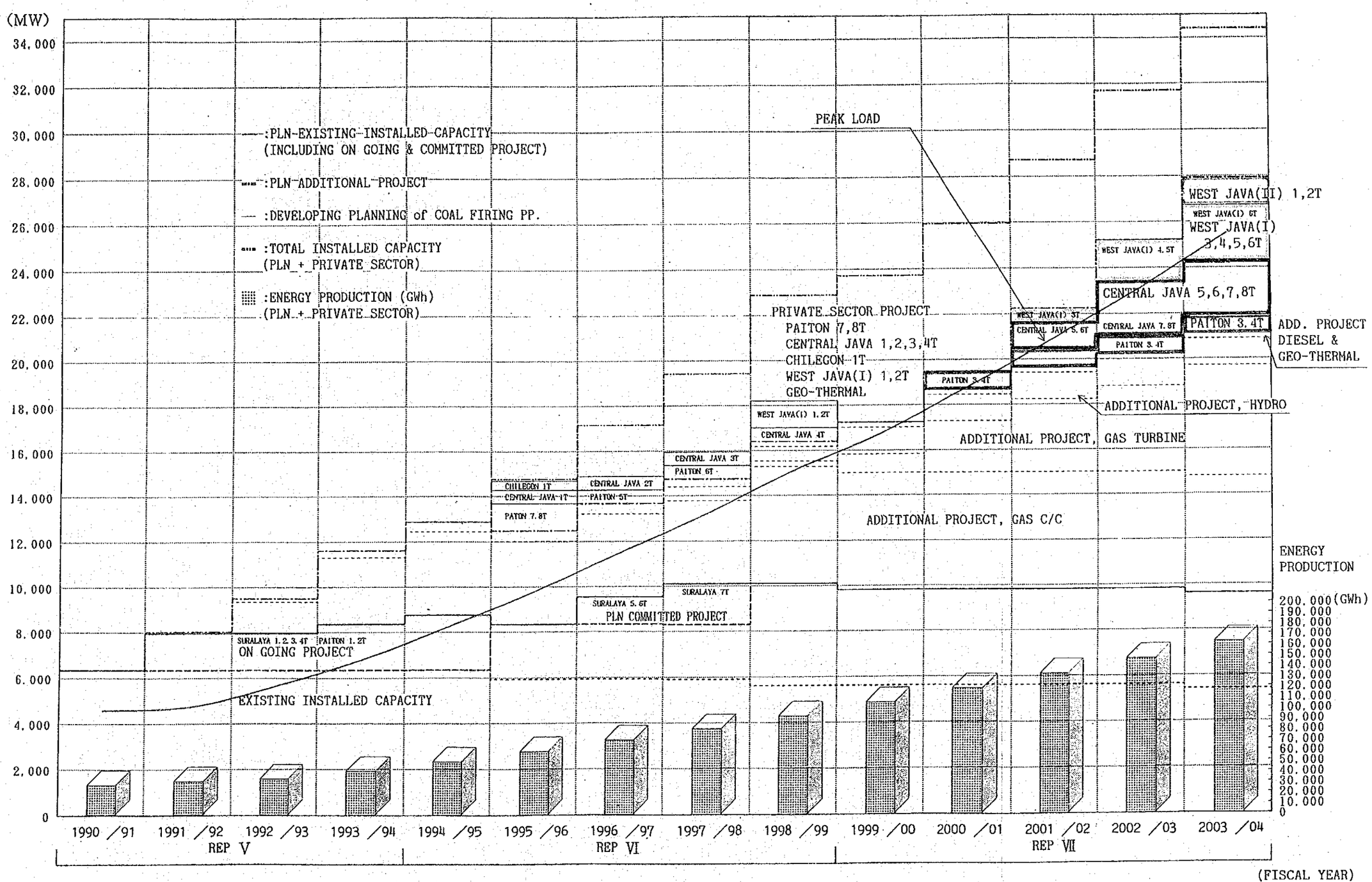

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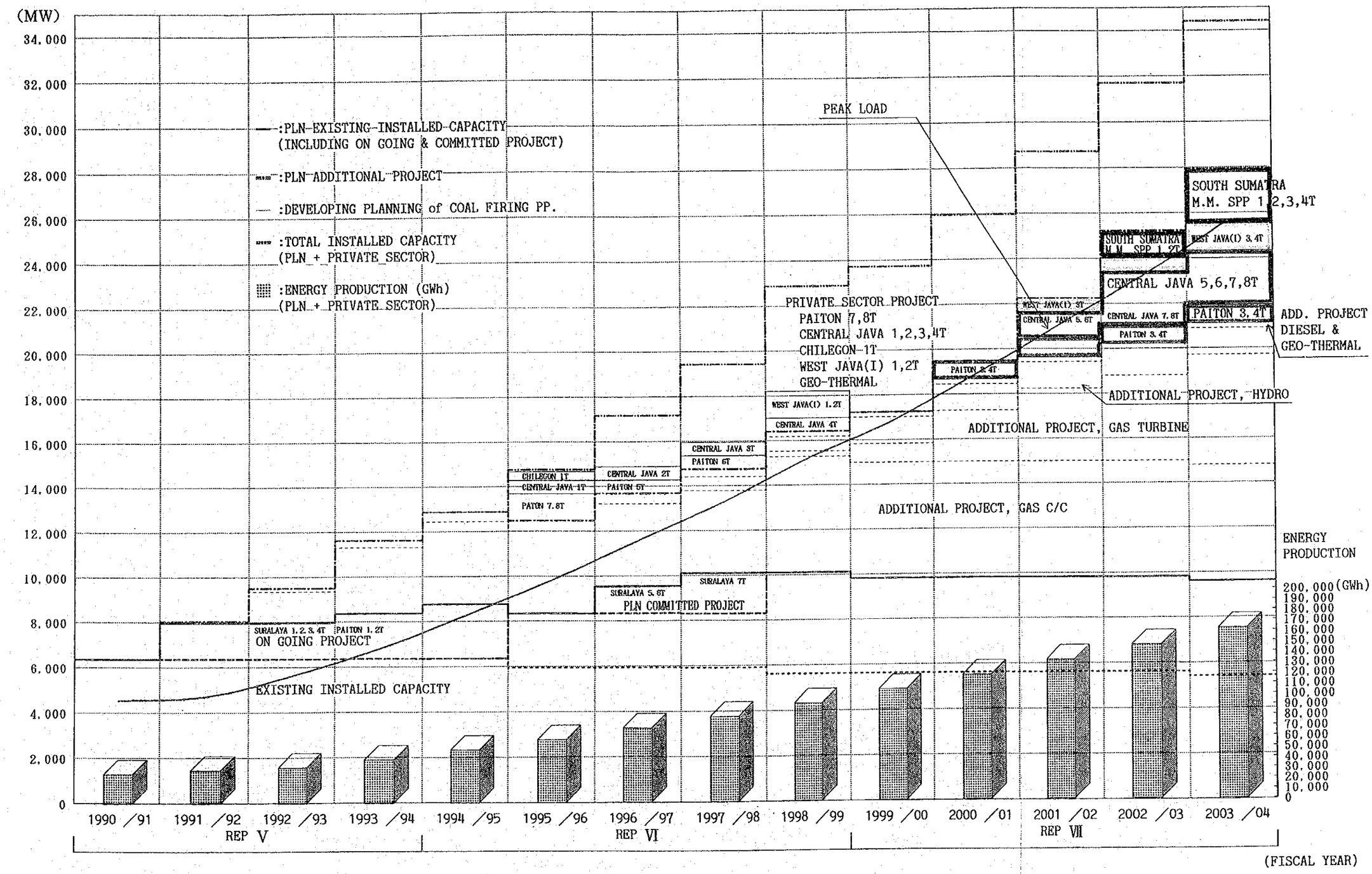
Fig. 3.3 GENERATION EXPANSION PROGRAM OF JAVA - BALI SYSTEM BY PLN SCENARIO HIGH (May '92) ALTERNATIVE PLAN-1



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CHAPTER 4. COAL SUPPLY PLAN

4.1 Outline of Coal Supply Plan

4.1.1 Basic Policy of Study

With regard to supply of coal to the mine mouth steam power plant, this study was carried out based on existing feasibility study data, provided that whole coal from the coal fields in the Banko Barat and a part of coal from Muara Tiga Besar areas, the most feasible coal development areas in South Sumatra in terms of the amount of reserves and coal quality, would be supplied to the power plant. In other words, the following items relevant to development of coal mine have been clarified by reviewing the study data of Shell and JICA, and feasibility study report of K-OG (Kinhill-Otto Gold) Joint Venture.

(1) Optimum long term coal supply plan in accordance with the commissioning period of the mine mouth steam power plant for operating the power plant in the coal reserve areas in South Sumatra

(2) Preliminary estimation of the cost of coal as delivered to the power plant

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4.2 Summary of the Results of Study

The major items of reviewed results are as described below:

(1) It has been confirmed possible to ensure economically optimum coal production of 164.7 million tons and 82 million tons of coal respectively in the Banko Barat and Muara Tiga Besar areas.

(2) It has been clarified that the coal supply amount at an annual production rate of 5.40 million tons and 2.70 million tons respectively, from the Banko Barat and Muara Tiga Besar areas is possible for the over period of thirty years or three decades. In case of full operation at the power plant, the coal supply will be in the proportion of 75% for Banko Barat and 25% for Muara Tiga Besar.

(3) Meanwhile, should deterioration of quality and rise of production cost be allowed, it will be possible to substantially increase the above amount of annual production (by as much as 10% or more at Banko Barat and 20% - 50% at Muara Tiga Besar), and the reserves of coal also be sufficient. In order to attain the above objectives, however, it will be necessary to execute additional feasibility study and clarify the quality and future outlook of cost based upon F/S or implementation plans.

(4) In case of the coal operation cost on the basis of fixed price (without escalation), the cost at Banko Barat is estimated at U$10.18/ton and at Muara Tiga Besar it is U$12.37/ton with the price in June, 1992, and the cost of mixture is U$10.73/ton at the supply ratio of 75% and 25%. Including 16.1% of depreciation cost, the cost is U$12.46/ton. Furthermore, if 62% for profit and taxes are added, the delivered coal price becomes U$20.18/ton.

There are many unknown factors in order to fix the final price of the coal delivered to the power station.

(5) Review coal mining system

According to the feasibility study report of K-OG, the Backet Wheel Escavator (BWE) system was recommended, and its mining methods were described in detail without omission. This system has been adopted also in overseas countries and offers significantly promising possibility. Therefore, the report was reviewed provided that coal production would also be promoted on schedule at Air Laya in the near future. During our study process, the actual operating conditions at Air Laya were also studied, and the results were used as reference data for review of the feasibility study report of K-OG.

As a result, it was determined to estimate the operation cost based on the Shovel and Truck (S/T) system. The reason is that a scheduled annual production of 3 millions ton had not so far been attained at the Air Laya Mine with the BWE system, so that it is difficult to conclude that the cost be made lower in the case of this mining system than the others.

Meanwhile, the Shovel and Truck system has already become very common with enough records of operation in Indonesia. Although the division of mining area direction of face advancement on KOG-F/S should be changed, S/T excavation will be so easy and flexible that there will be not so important items to be added newly for the study. Our study has been carried out provided that a maximum annual production per pit is 3 million tons. According to our experience, it would be difficult to expect a further economic benefit even if the amount of annual production be increased over 3 million tons per pit. Therefore, it is considered justifiable to produce coal from two pits at Banko Barat and one pit at Muara Tiga Besar.

(6) New coal transportation plan

Although the mine mouth steam power plant should preferably be as close as possible to Banko Barat, it is impossible to transport the power plant equipment to the site. Therefore, a place near the

confluence of the Enim River and Lematang River was considered optimum. For this reason, it will be necessary to transport coal from Banko Barat to the proposed power plant construction site. Instead of transporting coal from the coal yard at Banko Barat by trucks or railways, it was concluded to adopt a belt conveyor system. Among various types of belt conveyor systems, the pipe belt conveyor system was recommended on this report. This system requires not any countermeasure against wind and rain and is free from noise as well. With the estimated capital cost, 2 routes of flat type belt conveyer (BC) can be installed, instead of pipe belt conveyer, if necessary.

The coal from Muara Tiga Besar will also be transferred by a flat type belt conveyor. In this case, the conveyor route will be branched simply to an overland conveyor from the area adjacent to the railway wagon loading equipment at Muara Tiga Besar and be joined with the belt conveyor from Banko Barat through a pocket at a place slightly north of Banko Barat.

With the capacity of 1,500 tons/hour, the coal from both of the mines will be transferred with a time lag.

4.3 Coal from other than both of the coal mines

Although the coal mines will be developed at the two areas, Banko Barat and Muara Tiga Besar, there are further abundant coal reserves although any feasibility study has not been executed around Banko Barat. Therefore, our study has been carried out taking into account development and effective utilization of coal from these reserves. For this reason, the allowable lower limit of calorific value for boilers were planned at 4,000 kcal/kg (16.7 MJ/kg).

Please refer to Table 4.1.1 Coal reserves around Banko Barat.

Table 4.1.1 Coal reserves around Banko Barat area

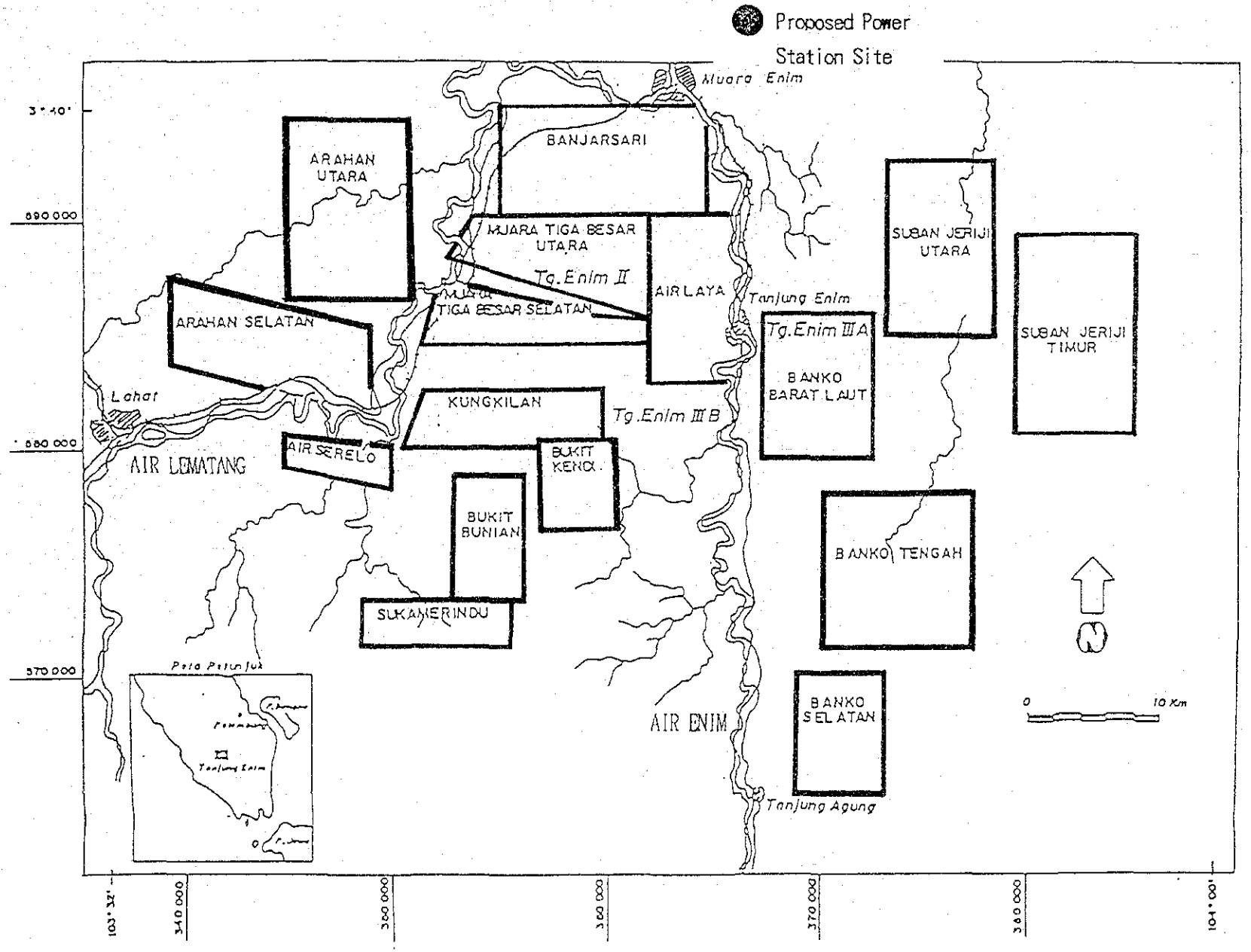
Area	Study phase	Seams present	Accumulated coal thickness(m)	Geological W:C ratio (m^3/t)	Geological reserves, Mt			MINABLE RESERVES PLANNED(Mt)	Calorific value (MJ/kg)	No. of drill holes	Remarks Study by Shell
					Measured	Indicated	Inferred				
Muara Tiga Besar	F/S	A1 A2 B C	47	2.5	371			81.2	18-20	102	
Mura Tiga Selatan	PF/S	A1 A2 B C	45	2.0		86		29.9	18-20	9	
* Kungkilan	PF/S	A2 B C	36	2.8		37		25.6	20-22	6	
Banjarsari	PF/S	Jel Enim	23	3.2		95	800	90.0	13-16	17	
* Arahan Selatan	PF/S	A2 B C	36	2.2	226	73		85.6	16-18	22	
* Arahan Utara	PF/S	A1 A2 B C	45	1.9	180	40	10		15-17		
Banko Barat (NW)	F/S	A1 A2 B1 B2 C1 C2	46	2.3	560			164.7	18-20	142	
Banko Tengah	PF/S	A1 A2 B1 B2 C1 C2	37	2.2	308	370	200		15-17		25-30 MJ/kg = 6100~
Banko Selatan	PF/S	A2 B C	35	2.0		140	440		13-18		7100kcal/kg
Suban Jeriji Utara	PF/S	Jel En.1 En.2	41	2.4		502		99.0	12-15	15	Inferred, 242 Mt, adb
Suban Jeriji Timur	—	Enim	17	2.0			325		8-13		Inferred, 220 Mt, adb
Suban Jeriji Barat	—	A1 A2 B C	53	1.9			95		14-17		

Source : K-OG F/S, SHELL and estimation of JICA Team.

Note : (1) * marks are far away from belt conveyors planned

(2) 4,000kcal/kg=16.7MJ/Kg

Fig. 4.1.1 LOCATION OF CONFIRMED COAL MINES



CHAPTER 5. COAL FIRED THERMAL POWER PLANT DEVELOPMENT PLAN

5.1 Basic Concept

In order to carry out the basic plan for this power plant, the following basic concepts and indicated figures have been applied to determine equipment capacity and type.

(1) Considerations for high reliability

As the power station is positioned as the base load station to cover the tight electric demand in Indonesia, it will require high reliability so as to supply electric power in a suitable and stable manner.

In order to obtain high reliability, the power station should be composed of proven equipment and systems, and should have adequate spare equipment.

In this regard, the basic plan of the power plant has been carried out by taking into account dependable operability and easy maintenance from the standpoint of technical aspects and the power plant scale which will be extended in the future plan.

(2) Operating pattern of the power plant

The developing purpose of this power plant aims to meet the rapid growth in the electric power demand on Java Island.

To cope with electric supply crisis, the power plant will be designed to supply power as the base load.

The control systems and necessary functions have been designed to exhibit high reliability due to the use of proven equipment.

(3) Considerations regarding the environment

To cope with pollutants emitted from this power plant, it is necessary to minimize all detrimental influences to residents and the environment.

For this purpose, basic plan and the designed countermeasure have been devised by taking into account of worldwide trends for environmental protection, as well as incorporating the unique features of the site area.

(4) Considerations regarding station extension

In foreseeing the increase in electric power demand in the future, the layout and equipment of the power station are designed to facilitate easy and simple extension work.

(5) Capability of utilizing a wide range of coals

Coal from the Banko Barat area and partly from the Muara Tiga Besar area are to be supplied to the power station, as these coal resources offer the greatest potential based on the feasibility studies already carried out.

It is supposed that there are high potential coal mines in the vicinity of the power station area. However, feasibility studies for these mines should be carried out. Considering such conditions, the power station will be designed so that it can handle lower quality coals other than those of Banko Barat and Muara Tiga Besar.