JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
DIRECTORATE OF COAL
REPUBLIC OF INDONESIA

MASTER PLAN STUDY ON HUMAN RESOURCES DEVELOPMENT PLAN FOR COAL MINING IN THE REPUBLIC OF INDONESIA

FINAL REPORT

MAIN REPORT

MARCH 1997

Japan Technical Cooperation Center for Coal Resources Development
Mitsui Mining Engineering CO., LTD

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PREFACE

In response to a request from the Government of the Republic of Indonesia, the Government of Japan decided to conduct the Master Plan Study on Human Resources Development Plan for Coal Mining in Indonesia in the Republic of Indonesia and entrusted the study to Japan International Cooperation Agency (JICA).

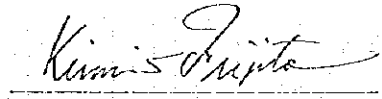
JICA sent a study team, led by Mr. Takao Okazaki of the Japan Technical Cooperation Center for Coal Resources Development (JATEC) and organized by JATEC and Mitsui Mining Engineering CO., LTD., to the Republic of Indonesia three times from January 1996 to February 1997.

The team held discussions with the officials concerned of the Government of the Republic of Indonesia, and conducted related field surveys. After returning to Japan, the team conducted further studies and compiled the final results in this report.

I hope this report will contribute to the promotion of the plan 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 throughout the study.

March 1997



Kimio Fujita
President
Japan International Cooperation Agency

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Abbreviations

AFC : Armored Face Conveyor
BOE : Billion Oil Equivalent
BOO : Build Own Operate
Bldg : Building
CCC : Coal Cooperation Contract
CCOW : Coal Contract of Work
CCT : Clean Coal Technology
COM : Coal Oil Mixture
CWM : Coal Water Mixture
Dep't : Department
DERDS : Double Ended Ranging Drum Shearer
DGM : Directorate General of Mines
Div. : Division
DME : Directorate of Mining Engineering
DMP : Directorate of Mining Industry Promotion and Supervision
DOC : Directorate of Coal
F/S : Feasibility Study
FBS : Fajar Bumi Sakti
GDP : Gross Domestic Product
GWh : Giga-watt-hour(s)
ha : Hectare(s)
HP : Horsepower
IPP : Independent Private Producer
IRR : Internal Rate of Return
ITB : Institute of Technology Bandung
JATEC : Japan Technical Cooperation Center for Coal Resources Development
JBT : John Batman Institute of TAFE
JICA : Japan International Cooperation Agency
KP : Eewasa Pertambangan
KPC : Kaltim Prima Coal
KUD : Koperasi Unit Desa
kV : Kilo-volt
kW : Kilo-watt(s)

LHD : Load Haul Dump

LPPT : Lembaga Pendidikan Dan Pelatihan Tambang

MDCM : Manpower Development Center for Mines

MME : Ministry of Mines and Energy

MOT : Management of Training

Mpa : Mega-Pascal

MTRDC : Mineral Technology Research and Development Centre

MTDC : Mineral Technology Development Center

MW : Mega-watt(s)

NEDO : New Energy and Industrial Technology Development Organization

NPV : Net Present Value

O/C : Open Cut

P/S : Production Sharing

PLN : Perusahaan Listrik Negara (State Enterprise for Electricity)

PTBA : PT. Tambang Batubara Bukit Asam: State-owned coal company

SPM : Suspended Particulate Matter

TOT : Training of Trainer

TWh : Trillion-watt-hour(s)

TWI : Training Within Industry

U/G : Underground

1. General

1-1 Background

The Japanese government responded a request from the government of the Indonesia by agreeing to carry out a " Master Plan Study on Human Resources Development Plan for Coal Mining " (hereinafter called the Study). The Study is to be conducted by Japan International Cooperation Agency (hereinafter called JICA) and the Directorate General of Mines in the Indonesia (hereinafter called DGM) pursuant to the delegation of tasks for both parties as stated in the S/W (Scope of Work) signed on October 31, 1995.

1-2 Outline of the Study

The Republic of Indonesia has potential coal reserves estimated at approximately 36 billion tons. The demand for coal in the country and Asia-Pacific region is expected to increase rapidly in the future. The Indonesian government therefore plans to enlarge its coal production from the present 40 million tons to 200 million tons per annum by the year 2020.

In order to attain this target production level, it is essential not only improve the productivity of the existing coal mines but also to speed up the development of new coal mines, including underground mines. It is also essential to educate / train specialists on coal mining technology and related fields. The government of Indonesia already has a program for advancing training programs system in coal mining technology through both the existing training institutions and new training center to be established in future.

However, no comprehensive studies for formulating such future programs and proposals have yet been conducted. It is thus essential to establish a master plan by studying the present condition of the coal mining industry in Indonesia and the actual state of its long-term production plans, estimating the demand for coal in relation to domestic coal consumption, and formulating a master plan for the training of thr manpower necessary to increase production in the existing coal mines and new coal mines to be developed.

1-3 Objectives of the Study

The objectives of the Study are :

1) to conduct a study on the present situation of coal mining industry in response to the required coal production expansion
2) to forecast country's future coal demand / supply scenario
3) to analyze the quantity and quality of the manpower needed for development of new coal mines
4) to propose plans for training measures and quantities of manpower
5) to prepare the final report after drawing up an action plan for executing such proposed plans
6) to make practical proposals for introduction of technology on underground mining and safety

1-4 Contents of the Study

Contents of the Study are :

1) Study of the present situation of coal mining industry including a forecast of coal demand / supply scenario

   1- Present situation of coal mining industry (coal reserves, mining system)
   2- Present situation of underground mining system
   3- Future plan of underground mining by type of exploitation
   4- Analysis and evaluation of the production plans for existing coal mines and for the development plans for new coal mines
   5- Analysis and evaluation of the coal demand forecast

2) Study on Human Resources Development

   1- Present situation of manpower and human resources development
   2- Analysis and evaluation of the manpower forecast

3) Master plan

   1- Conception of the action plan

   To plan long-term coal production and manpower in mining industry

To estimate employee's skill and manpower to be required

To design manpower training center and training system

Analysis of items to be considered on human resources development

2- Action plan

Education of mining college

Training center

On-the-job training

Qualification system

3- Comment for mining operation

4) Holding seminar

1- Present energy policy and coal demand / supply scenario in Japan

2- Development of coal mines and coal mining technology

3- Coal demand for power plants in Japan

4- Problem in executing long-term coal demand / supply scenario

1-5 Basic Policy of Execution of the Study

The master plan for the training of manpower includes proposals concerning definite approaches to the training of the personnel of individual coal mining companies being suitable with each respective management system and proposals concerning a training institution for manpower development based on the result of a careful study of the personnel of the objective level to be trained. The results of the Study is summarized in the following items.

1) Sharing of roles between private companies and governmental agencies for the manpower training projects
2) Positioning of the proposed manpower training center as a technology training and professional education institute
3) Consideration of the contents and method of education and training including consideration of curricula

4) Training of trainers

5) Study of necessary facilities and equipment

6) Making proposals concerning safety management system, mine safety laws, and qualifications of safety specialists in coal mines

7) Making proposals concerning underground mining systems being suitable for the Indonesia

8) Estimating the execution cost of the proposed training center and financial analysis of the project, and Studies of the supporting systems for execution of the project

1-6 Period of the Study

The Study is conducted from January, 1996 to March 1997.

The first phase (January to March,1996) is for the collection of data and a review of the estimated demand / supply scenario on coal and the development plan for coal mines in order to prepare an interim report and an action plan (draft)

The second phase (July to October) is for conferences with Indonesian authorities based on the interim report and action plan (draft) to prepare action plan and draft final report.

The third phase (November to March) is used for a seminar to be held locally to introduce Japanese coal mining technology and also draw up a final report on the master plan for human resources development of the coal mining industry.

Table 1-1 Study Schedule

Study Items	F Y 1995			FY 1996									FY 1997		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
I. Preparatory Study Work															
1. Orderly use of existing information and data	····														
2. Preparing Inception Report	····														
II. First On-site Study															
1. Explanation and discussion of Inception Report	**														
2. Situation of coal mining industry	——														
3. Study on human resources development	——														
4. Discussion of concepts relating to the action plan	——														
III. First Work in Japan															
1. Analysis of situation of coal mining industry		——													
2. Analysis of human resources development		——													
3. Preparation of the essentials of the action plan		——													
4. Preparing Interim Report			——												

····· Preparatory Study —— On-site Study —— Work in Japan ****** Explanation of Report

Table 1-1 Study Schedule

Study Items	F Y 1995			FY 1996									FY 1997		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
IV. Second On-site Study															
1. Explanation and discussion of Interim Report							**								
2. Additional study							—								
3. Collection of economic and financial data							—								
4. Manpower instruction and training plan							—								
V. Second Work in Japan															
1. Consideration of manpower required for execution								—	—	—					
2. Preparation of action plan								—	—	—					
3. Preparation of seminar plan										—					
4. Preparing Draft Final Report								—	—	—					
VI. Third On-site Study															
1. Explanation and discussion of Draft Final Report														**	
2. Holding of seminar														—	
VII. Report	▲		▲										▲		▲
	IC/R		IT/R										DF/R		F/R

..... Preparatory Study — On-site Study — Work in Japan ****** Explanation of Report

2. Economic Trends and Performance

2-1 Economic Trends

In the first half of the 1980s, oil and gas accounted for nearly 70% of Indonesia's foreign-exchange earnings. The downward trend in oil price caused by its the world oversupply has forced the government to place greater emphasis on non-oil exports, including both commodities and industrial goods. The government's deregulation policy in effect since 1986 is designed to stimulate such exports and has influenced banking and financial services, trade, oil and gas, and internal and foreign capital investment. Indonesia's growth in the long term is likely come from the extractive, agricultural and manufacturing sectors. Consequently, foreign investment is actively encouraged in these sectors.

The primary economic goal of the Indonesian government is to increase national wealth and communal prosperity on an equitable basis within a stable sociopolitical environment. This goal has remained unchanged since the New Order came to power in the late 1960s, but the methods used to achieve the goal have changed. In particular, since the mid-1980s the government has adopted various policies which have private sector developed. These have included the abolition of several state sponsored trading monopolies, reforms in the financial sectors, the opening up of new sectors to foreign investors and the streamlining of bureaucratic procedures, particularly in relation to trade.

Overall, the government has pursued a broad mix of development strategies including deregulation, import substitution, export orientation, and an encouragement of state and private sector activity. The priority on growth, stability and equity will continue to dominate the economic policy governing Indonesian's development.

Indonesia's economy has grown rapidly during the past five years. The growth rate in Gross Domestic Product (GDP) was 6.9% a year on average over the period 1989-1993 Indonesia's GDP in 1993 was almost Rupiah 300 trillion (US$142 billion). In 1993, Indonesia's population stood at 189.7 million. The annual population growth rate was 2% during the period 1980-1990, compared with the

currently level of 1.8%. The growth of urban population has been much more rapid than that of the rural population and there are marked differences in growth rates across the major islands. A slowly declining rate of growth is projected over the long term, down to 1.6% by 2000 and 1.0% by 2010.

Growth in Indonesia's manufacturing industries and construction sectors supports Indonesia's GDP growth. The rapid growth of manufacturing compared with mining and agriculture has led to substantial change in the structure of Indonesia's economy. In 1988, the combined share in GDP of the agriculture and mining sector was 38%. By 1992, this had fallen to 33%. Over the same period the GDP share of manufacturing, infrastructure and construction rose from 24% to 33%. In 1993, growth in the industrial and construction sectors continued to exceed average growth in GDP.

The rapid growth of the Indonesian economy and the associated structural changes in the composition of the GDP have brought about a significant change in the composition of export. In 1988, the foreign currency saving by oil and natural gas accounted for 40% of total export revenue. By 1993, however, their contribution to the total export revenue had declined to 26.5% of total export revenue.
Indonesia's total export revenues grew by 8.2% during 1993. The slowdown in growth from 1992 was caused mainly by declined oil prices and reduced revenue expansion from exports of textiles and clothing, which are now Indonesia's largest source of export earnings.

Indonesia's foreign debt is around US$83 billion, is growing. This is very high relative to exports. The growth in debt stems mainly from rapidly expanding private sector debt, which accounts for around 40% of total foreign debt. The government is aiming to reduce its indebtedness percentage export, from 34% in 1989 to 20% by 2000. Severe capital constraints are likely to apply as a result.

2-2 Economic Structure

The Indonesian government implements economic and social strategy to its broader development goals through five-year development plans, known as Repelita. These

in turn are framed within the context of a more broadly defined 25-year plan. The government has released Repelita 6, its sixth five-year development plan, and effective from 1 April 1994. Under this plan, the government is aiming to achieve an annual economic growth rate of 6.2%. On the basis of growth rates achieved in recent years, this figure would appear to be realistic goal. Rates above this level would lead to problems such as inflation and current account difficulties.

The government is also presently overseeing the formulation of the second 25 year plan. The government is presently projecting an annual economic growth rate of 7% over the next 25 years. This would increase Indonesia's real per capita income to US$ 1,000 in 1999 and US$ 2,600 by Indonesia's real per capita income to US$ 1,000 in 1999 and US$ 2,600 by 2010. This would, however only occur with continued economic reform-including reform of land ownership, increasing the skills of the work-force and expanding infrastructure.

Table 2-1 The Second Long-term 25 Year Plan

	Unit	1993	REPELITA				
		Estimate	VI	VII	VIII	IX	X
I .Population							
1.Population	Million	189.1	204.4	219.4	233.6	246.5	258.1
2.Population Growth Rate	%	1.66	1.51	1.37	1.20	1.01	0.88
II .Manpower							
1.Working Population	Million	78.8	91.4	105.2	119.7	133.9	147.9
III .GDP							
1.GDP Growth Rate	%	6.6	6.2	6.6	7.1	7.8	8.7
a.Agriculture	%	2.4	3.4	3.5	3.5	3.5	3.5
b.Manufacture	%	10.0	9.4	9.4	9.4	9.1	8.7
Non-Oil,Gas	%	11.0	10.3	10.2	10.0	9.5	9.0
c.Others	%	7.2	6.0	6.3	6.8	8.0	9.5
2.GDP per Capita	Rp.'000	1,188	1,487	1,903	5,525	3,483	5,016
3.Industrial Structure Ratio							
a.Agriculture	%	20.2	17.6	15.2	12.8	10.5	8.2
b.Manufacture	%	20.8	24.1	27.4	30.5	32.4	35.5
Non-Oil,Gas	%	17.6	21.3	25.1	28.7	31.0	31.5
c.Others	%	59.0	58.3	57.4	56.7	57.1	59.4

Source : Repelita 6

3. Review of Present Status of Coal Mining Industry

Indonesia has a history of about one and half century for coal industry. After the first oil crises, the government of Indonesia adopted a policy of energy diversification and the coal is counted on as the important energy source.
State owned coal mines and Coal Contractors, which are mainly owned by foreign investors, are operating open cut mines that can operate simply and safely, and also economically. Coal production in 1980 was only 0.34 million tons, but increased until 42 million tons in 1995. Coal producers have an intention to increase the production for a while.

However, currently most of the mines are producing bituminous coal, and the minable resources of bituminous coal for open cut method is limited. It is difficult to continue the open cut mining for a long time, and the time will come to move to the underground mines.

Coal producers are very much interested in open cut method, because they would like to find the profit, and they don't have enough technology for underground mining. In order to emphasize the underground operation, government have to support the industry, for example to reduce the 13.5% of royalty until attractive percentage for the coal producers. And also it is necessary to make the good industrial structure which will improve the technology even if it take the time.

3-1 Historical Review of Coal Industry

The first commercial coal mining operation in Indonesia was opened at East Kalimantan in the year 1849. The industry has a long history and the production peaked at about 2 million tons during the Second World War period, and then dropped to less than 1 million tons. As oil and oil products became much lower in price and more convenient to use as a fuel throughout the world, coal production decreased continuously. Indonesia was no exception. Production reached the bottom level at 148,000 tons in 1973. After the First Oil Crisis in 1973, the importance of coal was recognized again as an alternative fuel to oil. A new national energy policy was formulated in 1976 for the purpose of reducing oil

dependency and promoting the use of coal as a replacement.

Under the new National Coal Policy, the government established PT. Tambang Batubara Bukit Asam (PTBA), a state-owned coal company. In 1981, the first coal contract agreement based on the regulations as detailed in Presidential Decree No.49 of 1981 was signed between PTBA and contractors. The contract was based on the role of Production Sharing. 11 contracts had been signed by 9 foreign contractors and 2 domestic contractors as the First Generation contractors by 1987.

Among these 11 contractors, 9 have already started production. One is planning to start production from March, 1997. The remaining one contractor has completed exploration work and is making a feasibility study.

The government of Indonesia announced its new policy in 1992 to open new coal mines operated by Contract of Work. Following this policy the government issued the Presidential Decree No.21 in 1993. Based on this, the second contracts were signed between PTBA and 19 contractors (21 concessions). These contractors are at the exploration or feasibility study stage. It is estimated that some of the companies will start production in this century, and the others will start production from early next century. As PT.Supra Blakindo Mineral has dropped out due to financial problems, 18 contractors remain.

A total of 132 companies are nominated as the 3rd Generation. 53 of them have already signed the basic agreement. Among them, 19 companies have received the exploration license for one year. Locations of the 1st and 2nd Generation contractors are shown in Figure 3-1. Locations of the 3rd Generation contractors are partly shown in Figure 3-2.

Coal Cooperation Contract (CCC) was amended and Coal Contract of Work (CCOW) will be effective from 25 September, 1996. The detail will be described in Chapter 6.
As shown in Figure 3-3, major producers are PTBA mines located in Sumatera and CCOW mines located in South and East Kalimantan.

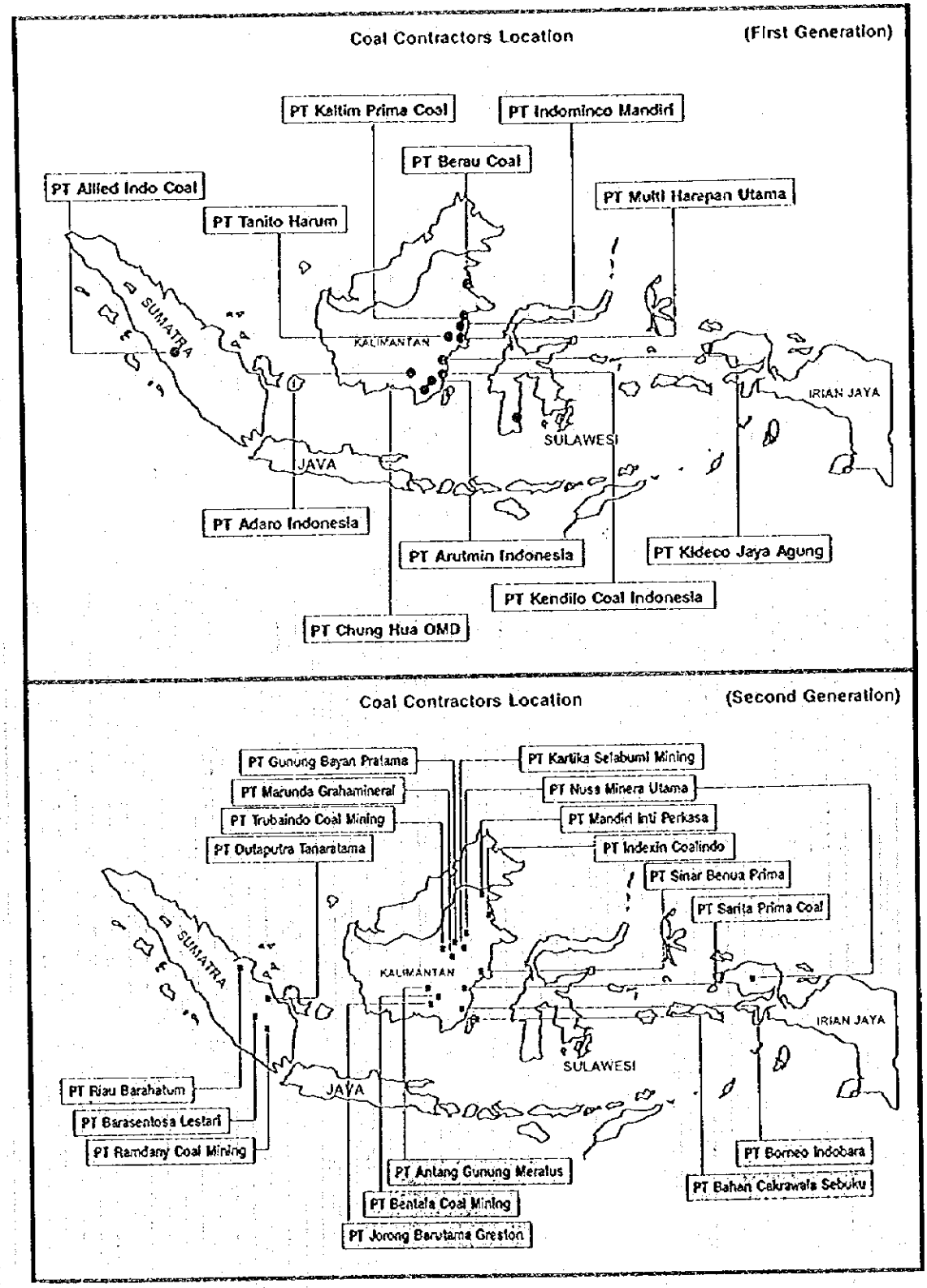


Figure 3-1 Coal Contractors Locations (First, Second Generation)

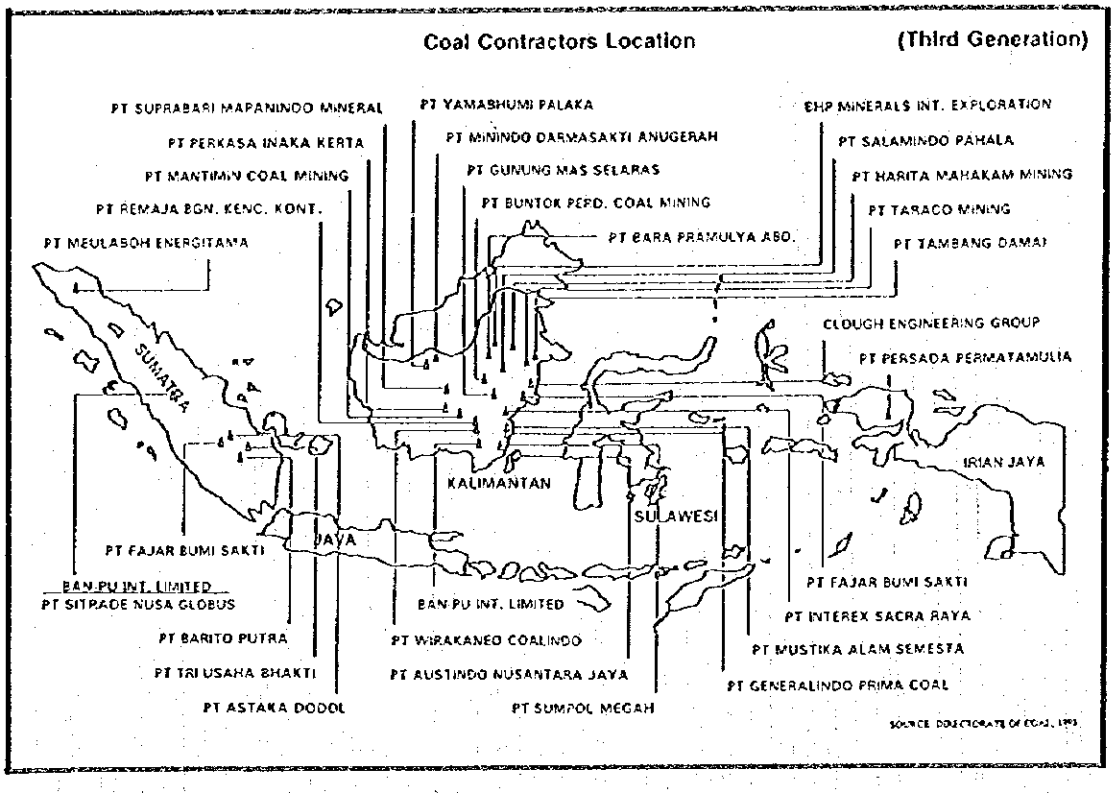


Figure 3-2 Coal Contractors Locations (Third Generation)

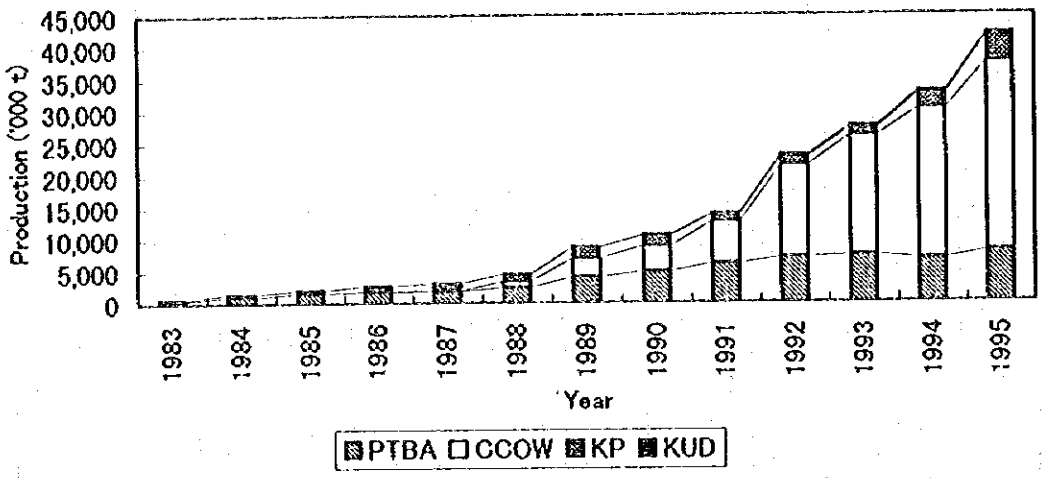


Figure 3-3 Production Records of Indonesia

3-2 Coal Geology and Reserves

The geological age of Indonesian coal dates back to the Palaeogene to Pliocene. Wide and thick coal reserves are found in the basins of the Middle and Late Miocene to Pliocene. In general, geological structures of the older formations are complicated and highly dipped, but steeper dips than 40 degrees are very rare. Regarding the coal quality, older coals are more carbonized, with a low moisture content and a high calorific value.

The following are the coal quality of the main regions:

Region	Calorific Value (kcal/kg)	Ash (%)	Sulfur (%)	Total Moisture (%)
South Sumatra	3700-5700	3-12	1 (max)	11-27
Central Sumatra	4500	11-14	0.5	17
East Kalimantan	5000-6900	1-15	1	4-22

According to the data prepared by DOC, total coal reserves are 36 billion tons. 70% of them are located in Sumatra and 30% are located in Kalimantan. Only around 1% of the reserves are located in other regions, such as Sulawesi or Irian

Jaya. It is estimated that the estimated reserves will increase after further exploration work to be conducted in other regions, i.e. Irian Jaya, etc. Measured reserves are estimated at 4.8 billion tons, consisting of sub-bituminous and lignite (85%) and bituminous coal (15%) suitable for export as shown in Table 3-2.

Table 3-1 Coal Reserves in Indonesia

(Million tons)

Regions	Mesured	Indicated	Inferred	Hypothetic	Total	%
SUMATRA	2, 888	11, 166	2, 280	8, 343	24, 677	68
North	-	1, 272	2	433	1, 707	5
Central	718	2, 371	58	1, 019	4, 166	11
South	2, 143	7, 506	2, 204	6, 891	18, 744	52
Bengkulu	27	17	16	-	60	0
KALIMANTAN	1, 986	1, 494	3, 789	4, 231	11, 500	32
West	2	69	211	1, 838	2, 120	6
South	1, 113	668	1, 848	-	3, 629	10
East	871	757	1, 730	1, 957	5, 315	15
Central	-	-	-	436	436	1
JAVA	12	29	-	20	61	0
SULAWESI	5	12	7	-	24	-
IRIAN JAYA	-	79	4	-	83	0
Sub-Total	4, 891	12, 780	6, 080	12, 594	36, 345	100
Total Production(1965-1993)	75	-	-	-	75	
Total	4, 816	12, 780	6, 080	12, 594	36, 270	

Source : DOC 1993

Table 3-2 Coal Reserves by Rank

(Million Tons)

Regions	Anthracite	Bituminous	Sub-Bituminous	Lignite	Total
SUMATRA	132	651	2, 585	21, 309	24, 677
North			1, 707		1, 707
Central	4	473	380	3, 309	4, 166
South	128	178	438	18, 000	18, 744
Bengkulu			60		60
KALIMANTAN		4, 560	6, 940		11, 500
West		1, 976	144		2, 120
South		1, 323	2, 306		3, 629
East		825	4, 490		5, 315
Central		436			436
JAVA		15	46		61
SULAWESI			24		24
IRIAN JAYA			83		83
Total	132 (0.4%)	5, 226 (14.4%)	9, 678 (26.6%)	21, 309 (58.6%)	36, 345

Source: DOC, 1993

3-3 Production Method

There are four groups of coal producers in Indonesia i.e., PTBA, CCOW, KP and KUD. The production records of the companies are shown in Figure 3-3, of which the PTBA and CCOW contractors are major producers.

There are three underground coal producers in Indonesia i.e., the Ombilin mine of PTBA, and two coal mines in Mahakam area, East Kalimantan. A total of 115 concessions has been registered as KP mines in the country, of which 10 mines are operating. The mines, except for 3 underground coal mines, are producing coal by open cut mining method.

3-3-1 Open Cut Mining

Only Air Laya pit of PTBA's Tanjung Enim mine is producing coal with the Bucket Wheel Excavator mining system. The other open cut mines of PTBA, CCOW and KP are using a Truck and Shovel method.

At present, around 70% of the coal is produced by CCOW contractors.

The production records of the 1st Generation contractors are shown in Table 3-3.

3-3-2 Underground Mining

Currently only three coal mines are producing coal from underground operation. These are the Ombilin mine (Sawahluhung pit) of PTBA, Embalut mine of PT.KITADIN and Kutai mine (Loa Ulung pit) of PT.Fajar Bumi Sakti (PT.FBS). Total production is around 0.7 million tons per year. Production of these coal mines is shown in Table 3-4.

Until early 1990's, Mahakam mine (Meovndai pit) of PT. Bukit Baiduri Enterprise produced coal from underground, but it was closed due to underground fire. Now the mine is producing coal by the open cut method. There are plans to open the underground mine again in the future.

No mines of CCOW contractors have started major underground operation so far.

3-3-3 Others

KUD mines located near Banjarmasin, South Kalimantan are producing coal by the open cut mining method using bulldozers or manually.
Some of the KUD mines located in West Java are producing coal from small scale underground mines by manual methods.

3-4 Environmental Protection Measures in Coal Industry

CCOW contractors stated that the mining activities have to be implemented based on good standards of mining practice, including the protection of the environment. Mining regulations also demand environmental protection.
Inspection for environmental conditions by the Government is scheduled two times a year, and similar to safety inspections are held.
Regarding water pollution, the waste water from the washing plant is treated by thickener or settling pond and drained to the river. The condition of the water is monitored and reported. Compared with advanced countries, the waste water treatment technology is still at a low level and it is necessary to improve technology. In the Ombilin mine, research work for waste water treatment is scheduled to be carried out with the Japanese assistance. The regulations demand the rehabilitation of mined out areas in open pit mines. Mined out areas of open pit mines have to be reclaimed and vegetated. Rehabilitation technology is still at a low level compared with that of advanced countries, and it is necessary to improve the technology.

Table 3-3 Production Records of First Generation Contractors

(Thousand tons)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
ARUTMIN INDONESIA			60		105	687	1,297	2,215	3,342	4,158	4,606	5,355
ALLIED INDO COAL				53	444	513	455	542	451	599	798	1,190
ADARO INDONESIA									934	1,353	2,414	5,553
KALTIM PRIMA COAL						344	655	2,104	7,014	8,872	9,932	10,208
MULTI HARAPAN UTAMA					240	761	859	810	1,307	1,629	1,651	1,974
BERAU COAL											301	666
TANITO HARUM					184	673	794	921	1,233	1,087	1,115	1,108
UTAH INDONESIA											701	1,022
KIDECO JAYA AGUNG									82	1,171	2,038	2,501
INDOMINCO MANDIRI												
CHUNG HUA OMD												
TOTAL	0	0	60	53	973	2,978	4,060	6,592	14,363	18,869	23,556	29,557

Table 3-4 Production from Underground Mines

(Thousand tons)

	1991	1992	1993	1994	1995
Ombilin (PTBA)	147	150	75	104	60
Embalut (PT. KITADIN)	249	359	398	386	420
Kutai (PT. FBS)	176	185	179	169	176
Total	572	694	652	659	656

4. Current Underground Mining Technology

Currently, three coal mines are producing the coal from underground operations. In this study, technology level of each mines were researched and analyzed. Due to the management problems and technical problems, production level of the mines are below the production capacity of the equipment.

4-1 Present Underground Technology

4-1-1 PTBA Mine

1) Ombilin Mine

Pt.Tambang Batubara Bukit Asam has two coal mines located in Sumatra. One is the Ombilin mine in West Sumatra and the other is Tanjung Enim mine in South Sumatra. Ombilin mine has an underground and open pit mines. The mine is located in the Sawahlunto city in the center of West Sumatra. Distance from Ombilin mine to Teluk Bayur, which is a loading port of Padang, capital city of the province, is around 95km by road and 155km by railway.

Concession of the Ombilin mine occupies for around 15,499 ha and is divided into 9 mining areas. The mine was opened more than one hundred years ago and is thus the oldest mine in Indonesia. Formerly labor intensive production methods were applied, but are now replaced by modern fully-mechanized mining systems.

Ombilin mine has been receiving much technical assistance from overseas countries such as Poland, Holland, Canada, Australia, U.K. and Japan.

Geological age of the coal seams is the early Tertiary (Eocene). The coal seams are intercalated in the Sawahlunto Formation spread in the Ombilin Basin. The coal seams are named as Seam A, Seam B, and Seam C in descending order. Thickness of them ranges 2m, 0.8-1m and 6-8m, respectively. Dip of the coal seams changes from 8 to 25 degrees and overburden and interburden consist mainly of clay, silt and sandstone. Insitu reserves are around 155 million tons, with about 80 percent requiring underground mining.

Safety Department, Underground Department, Open pit Department, Technical Department, Planning Department, General Affair Department, Finance Department and Shipping Department are under the control of General Manager of the Ombilin mine.

The Ombilin mine is the only one in Indonesia utilizing fully-mechanized mining system in Indonesia. But annual underground production is very low, less than 200,000 tons due to many reasons.

Current underground mining area is in Sawahluhung with one longwall panel and some excavation faces. Total length of the gallery is maintained at about 12km length. Length of the longwall face is about 70-150m and length of the panel is less than 800 m due to the complicated geological conditions.

Manpower for underground operation is about 300 including 60 staff members, such as supervisors, assistant managers and managers. The other 125 employees work in the operation support areas.

a) Longwall Mining

Around ten years ago, 2 sets of Semi-mechanized equipment and 1 set of Fully-mechanized equipment were introduced from the U.K. The operation by 2 units of semi-mechanized mining system, which consist of sliding bars, single props, AFC and Double ranging drum shearer, was applied from 1985 to 1989.
Now, only one fully-mechanized system is operating in the mine. Type of Power roof support is 4 leg chock shield and its supporting capacity is 325 ton. The supports have a rigid canopy, except for the face end supports. Sometimes the canopy downs lower than the shearer height caused by the roof pressure and shearer cannot pass under the canopy. Once the face conditions become bad, it is difficult to maintain roof conditions. Cutting and supporting method is one-web-back or immediate roof support system. AFC is a conventional sigma section type, and a shearer is the double haulage chainless type. Belt conveyor trouble is one of the major reasons of low productivity. The following are the main equipment for longwall operation:

- Power Roof Support	Dowty 4 leg x 325 ton	102 unit
- Shearer	Anderson AB 200kW	1 unit
- AFC	MECO TOC 600-FM 90kW	1 unit
- Power Pack	Dowty 327-FM 150kW	1 set

b) Development

Alpine F-6A Road Header or blasting systems are utilized for in-rock excavation. In case of the road heading machines, excavated materials are directly loaded onto a belt conveyor, and Load Haul Dump (LHD) loads the materials onto a chain conveyor after blasting.

Four units of Dosco MK-2A Road Headers are utilized for in seam development. In 1993, the roof bolting technology was introduced through an Australian consultant. More than 2,500 m have been covered with roof bolting and the advancing rate has been improved from 3 supports per day with conventional support to 5 straps per day with bolting system. Psychological problems of the workers have been removed by now. The roof bolting technology also has an advantage due to the low material cost. Results of the roof monitoring conducted near the incline show that deformation is only 5mm during 2 years, and this means that the roof bolting technology is suitable to Ombilin's geological conditions. Diameter of the bolt is 24mm and the length is 2.4 m. 5 bolts are installed with 4.5 m wide W-strap and fixed by full capsulated resin. Interval of the strap is 0.8 m in normal conditions. Drilling is conducted by Australian made pneumatic hand - held bolting machines. Two bolting machines are operating in one development face. Thickness of the coal seam is around 2 m and the roof materials are weak in strength. Floor material is a little harder but the cutting force of Road Header is not strong enough for an effective advance rate.

- Road Header		
Dosco MK-2A	75kw (68kW cutting)	4 unit
Alpine F-6A	75kW	1 unit
- Load Haul Dump	EIMCO 811-FD 39kW	3 unit
- Side Dump Loader	EIMCO 625	1 unit

Rear conveyor of the Dosco is overlapping with the gate conveyor, but the conveyor system is not extensible. This is a reasons for the long conveyor stoppages for extension, with too many belt connections of the belt rubber cause the some trouble. A forcing fan and an exhausting fan are used for the ventilation of the development face. Formerly, materials were transported by reverse operation of the belt conveyor, but now transportation is easier because the materials for roof supporting become small amount. The following are the major equipment for development.

c) Transportation

- Material Transportation

Materials and equipment are loaded onto flat cars or mine cars and transported from the Sawahluhung adit to the sites by an endless winch. There are no double tracks in the underground and sometimes small winches are used at transfer places. Winches are installed for incline transportation but the galleries are poorly designed for rail transportation. It is anticipated that transportation to the deeper areas will be more difficult. There are no transportation measures for manpower so far.

- Coal Transportation

All materials, such as coal and rock excavated, are transported by belt conveyors. Main belt conveyors are installed through the old mining area of Sawah Rasau V. From the excavation faces to the surface, more than 20 units of conveyor are installed without automatic operation systems. The direct start up system and too many connections are the reasons for frequent belt damage. Capacity of the excavation conveyors is 200 ton per hour with a width of 800mm. For coal transportation from the longwall faces, 1,000mm conveyors with 900 ton per hour capacity are installed. So far no, crushing system is installed at the Stage Loader of the longwall panel and this causes size problems with the hauling materials.

d) Ventilation

Two exhausting type main fans are operating near the pit mouth of Sawahluhung. Capacity of the fan is 40 m^3 per second. The transportation gallery is used for intake air. There is no overcast in underground, and series ventilation systems are

applied for the development faces and longwall panel.
Ventilation of the development faces is carried out by the combination of forcing and exhausting fans.

e) Drainage

Quantity of drainage is small. Multiple stage electric pumps are used for main drainage. Small capacity submersible pumps are used for local drainage.

f) Safety

The safety manager is responsible for all safety matters. Gas and ventilation measurements are conducted on a routine basis. Safety inspections are carried out periodically. No central monitoring system has been created so far.
Rescue team is formed for emergencies. There is a smoke gallery at the surface for training purposes. Fatality rate is not very high at present.

g) Power Distribution and Communication

The electricity required for the town and the mine are supplied from the captive coal fired power station named Salak. Installed capacity is 12 MW and normally 6 MW is in operation. The power station was built nearly 30 years ago and its energy efficiency is not very high.
High voltage explosion proof cables and transformers are used for underground power distribution. Gas interlock system is not yet been introduced so far.
Paging systems and telephones are used for underground communication.

h) Preparation, Transportation and Sizing

All coal produced from underground mine is washed in the preparation plant. Coal from the open pit mines is washed depending on the ROM quality.
Australian equipment is installed, including the baum jig, cyclone and spiral as well as hand picking belt. Yield of the clean coal is about 80-84%. Capacity of the washing plant is 200 ton per hour per module. There are two modules and one unit is in operation.

i) Surface Facilities

Main office is located in the center of Sawahlunto city. There are train loading facilities, a main workshop and sizing plant close to the main office. An overland conveyor transportation system is provided for the transportation of coal from the preparation plant to the sizing plant.
The underground mine office is located at the pit mouth of Sawahluhung, and the workshop and warehouse are located at the Sawah Rasau V area.

j) Loading Port

Loading port of Teluk Bayur is located in the south of Padang city. Coal is transported by truck or railway wagon. Maximum size of the vessel is 35,000DWT and the loading rate is 1,000 ton per hour. Due to the use of single track system and steep slope railway conditions, transportation capacity of railway is limited to only around 1 million tons per year.

k) Open Pit Mine

Contract mining is carrying out at Tanah Hitam pit and Kandi pit. Conventional Truck and Shovel operation is applied for these pits and the stripping ratio is about 9 to 1 on a bcm/t basis. Minable reserves are limited within 3 to 4 years. Around 35% of the overburden and interburden are blasted by ANFO. The powder factor is about 0.26kg per BCM.

4-1-2 CCOW Mines

There is no coal mine which is operating by underground mining method so far. But in the future, by the end of 1998, PT.Tanito Harum will commence underground mining in Sukodadi and Pondok Labu areas. Some other coal mines are also planning to has the underground mining method.

4-1-3 KP Mines

The Embalut mine of PT.KITADIN and the Kutai mine of PT.Fajar Bumi Sakti, which are located in East Kalimantan, are producing coal from underground. Some coal mines may be planning to start underground operation in the future.

1) Embalut Mine, PT.KITADIN

The mine is located near the bank of the Mahakam river. Its distance from Samarinda, the capital city of the province, is about 20 km. There are two access routes to the mine site. One is by road and other by ship. The distance between the mine and the city by the above two ways is around 25 km and 40 km, respectively.

The mine was opened in August 1982 with the assistance of Taiwanese engineers. In the first stage, more than 40 Taiwanese engineers were working in the mine. Taiwanese engineers have been gradually reduced and replaced by Japanese engineers.
The mine concession occupies about 930 ha and the coal seams are spread in the Kutai basin. There exist more than 23 coal seams and the geological age of the coal seams is the Middle to Late Miocene. Thickness of coal seams ranges from 1 to 7 m. The strike of coal seams is nearly in the north-south direction. On the western side of the concession, there is another syncline. Dip of the coal seams ranges from 15 to 30 degrees. Most coal seams have weak sandstone or mudstone roofs and floors.

a) Coal Quantity and Coal Quality

Insitu coal reserves are around 33 million tons, of which 16 million tons are recoverable. The rank of coal is sub-bituminous and clean coal is supplied as a high grade steaming coal. Calorific value ranges 6,300-6,500 kcal/kg on an air dry basis and maximum sulfur content is about 0.8%.

b) Organization and Manpower

There are Production, Planning and production control, Engineering,Administration, Logistic and Personnel departments under the mine management. There are also a Safety department and a Special team under the mine manager directly. Total manpower of the mine is about 2,700, and among them 1,700 manpower works for underground operation. As a labor intensive method is applied, productivity is not very high at the moment.

c) Open Pit Mining

A conventional truck and shovel operation is used for open pit mines. Average stripping ratio is about 7 to 1, and maximum is up to 15 to 1 depending on the mining conditions. Because of the weak overburden materials, ripping by bulldozer is conducted without blasting. Coal getting takes place by backhoes and coal is hauled by rear dump trucks.

d) Underground Mining

There are three underground mines in the Embalut mine. Three-shift-6-days operation is the rule. The deepest working area is about 240m from the surface. Length of the incline is about 750m.

e) Longwall Mining

Incline shafts are excavated in the rock under the coal seam, and connected to the coal seams by horizontal cross cut operation. Length of the gate roadway is less than 1,000m. The raised connecting upper and lower galleries form a longwall face. The longwall retreating system is applied and longwall length is about 100 m. Formerly wooden chocks were used for face support and the coal was got by pneumatic picks. The single hydraulic props and link bars system was introduced in 1990 and all the wooden chock longwalls were replaced by single props. Both manual (inner pump type) and outer pump type single props are used in the longwall faces. Coal getting is by blasting and pneumatic picks. Coal excavated goes down to the gateway by gravity through vinyl trough, and loaded into small mine cars. Manpower for one longwall face is about 40-50.

f) Development

Development is mainly conducted by blasting or pneumatic picks. A wooden three piece support is mainly used for gallery support. The excavated materials are loaded into mine cars manually. Manpower of the face is about 7 persons, including transportation. As the development follows the constant seam dip, so that the galleries have to wind the materials. Average advance rate is about 50 m per month in the coal seam and 25 m per month in the rock.

g) Ventilation

Main exhaust fans are installed at each pit. Small forcing fans and ventilation tubes are used for local ventilation. Capacity of the main fan is 100 HP with 1,800 m^3 /min air at 140 mmAq. There is no ventilation air bridge in the mine.
Maximum temperature at the working area is about 30 degrees centigrade. Both wooden and metal ventilation doors are utilized.

h) Transportation

300 HP or 200 HP hoisting machines are installed at the main incline of each pit for the purpose of coal, rock, material and man transportation. Maximum hauling capacity is 10 mine cars per haul. Capacity of the wooden mine cars is 0.93 ton on a raw coal basis. There is a plan to replace the wooden cars with metal mine cars. Small hoisting machines are installed for local transportation. Formerly, mine cars were pushed manually in the gateway, but replaced by the endless winch hauling systems, thereby supporting an improved productivity of the longwall face. Rotary tippler is installed for dumping the coal to the coal bin. Man transporting cars are used only in the No.1 mine.

i) Drainage

Drainage Mine water is gathered via the pump station through ditches, and pumped up to the surface by electric pumps with a capacity of 75 HP. Mainly 4 inches pipe-lines are used for this purpose.

j) Power Distribution

Diesel powered generators with a total capacity of 3 MW are installed near the main office to supply electricity to the mine and surface facilities. In order to avoid transmission losses, the 380 V generating voltage is stepped up to 3,000 V and transmitted to the underground transformer. Most of the underground equipment is operated at 380 V.

Telephone and wireless communication systems are utilized for surface communication. Underground wireless communication system has been utilized in a part of the underground.

k) Safety

Mine supervisors check the gas content by portable gas detectors. The safety department is responsible for checking ventilation and other conditions. Safety inspections are conducted every month. Breathing apparatuses are available for mine rescue, but systematic training will be required for their effective use.

l) Training

Safety training is conducted for new employees, and brush-up training is conducted every year for all employees. Special training sessions are held for hoist and other operators, etc. There are about 40 blasting license holders in the mine.

m) Surface Facility

Office, workshop, warehouse, power center, explosive magazine, water treatment and accommodation for staff members are available as surface facilities.

n) Transportation, Preparation

Coal produced from the underground and open cut mines are transported to the ROM stock yard near the preparation plant by 10 ton rear dump trucks. Distance from the mine to the yard is about 6km. There are two modules of the preparation plant near Mahakam river. Washeries with hand picking and baum jig are used for

quality control. Blending and sizing are conducted subject to the user's requirement. Coal yield is around 90%.

o) Stock yard, Shipping

Coal is fed into the loading hopper from the clean coal stock yard and loaded onto barges with a maximum capacity of 8,500 ton. Loading rate is about 500 ton per hour. Barges are pulled by tug boat to the open sea for transshipment to ocean going vessels. Distance is about 100 m, and it takes one day to the open sea. Sometimes barges are directly pulled to the domestic consumer's sites or the Philippines without transshipment.

2) Kutai Mine, PT.FAJAR BUMI SAKTI

The company belongs to the Bakri group. The mine is located near the bank of Mahakam river in the East Kalimantan Province. The distance from Samarinda is about 35km by road. The mine is producing high quality steaming coal with the calorific value of 6750- 6800 kcal/kg both from open pit mine and underground mine. Underground production was commenced in 1983 and maximum production was recorded at 185,199 ton in 1992. Open cut production was commenced in 1992 and temporarily stopped in 1995. It has started again in 1996 because the coal price is more attractive. Minable reserves for open pit mining are limited and minable reserves for existing underground mine are also limited. Development of the new underground mine has already started and new incline shafts are under construction.

Production in 1995 records 628,851 tons and the plan of 1996's is set at 558,000 tons in which 199,000 tons are from existing underground mine, 139,000 tons are from the new underground mine and 220,000 tons are from the open cut mine. Maximum production of existing underground mine is limited by the hoisting capacity of the incline shaft.

There are several coal seams in the area and they are named Seam AA, Seam A, Seam B, Seam C, Seam D, Seam E and Seam F in descending order. Dip of coal seams ranges about 6 to 7 degrees. Existing mine is producing coal from Seam C and Seam D. Depth of the working area is about 180 m from the surface.

Production from existing mine in 1995 was 176,000 tons. Due to the limited capacity of the incline transportation, it is difficult to increase the production from the present level.

Total manpower of the mine is 1,175 including foremen and supervisors.

a) Longwall Mining

There are two longwall faces in Seam D, and one face each is operating alternately. Two-shift operation is the rule, one shift is for producing and another shift for maintenance. Gate roadway are excavated following the coal seam, so the galleries need a winding pattern. Longwall retreating system with 50-70 m length are supported by single props and link bars, are operating. For the purpose of supporting the goaf side areas, a release chock system is utilized. Coal getting is by pneumatic picks and shovels. In longwall faces, a small chain conveyor is installed for the purpose of transporting coal to the gallery. Compressed air is supplied from surface compressors through air pipe lines. In the longwall face, a pickman and a shovelman are posted every 3 or 4 m and a supporting man is distributed every 7 m.

b) Room and Pillar Mining

Seam C is undulating and not suitable for longwall operation, so room and pillar operation is applied for this seam. The roof is supported by slim wooden props, and coal getting is by pneumatic picks. Manual transportation using bags is carried out for transportation from the face to the mine cars. There are 9 rooms and pillar faces in total and 6 workers are posted for each face. Productivity is about 15 tons/shift/face. Mining recovery of this system is up to 75% dependent on the mining conditions.

c) Transportation

300 HP hoisting machine is installed at the pit mouth. Length of the incline is 600 m and the maximum dip is 14 degrees. Hauling capacity of the hoisting machine is 15 cars for coal and 10 cars for rock materials. Capacity of one mine car is 0.91 ton on a raw coal basis. Each 100 HP hoisting machine is installed

at No.2 underground incline and No.3 underground incline, respectively.
A main & tail endless winch hauling system with 2 hoisting machines is applied for gallery transportation.

d) Drainage

Mine water of the galleries is drained through ditches and by small submersible pumps. Main drainage is discharged to the surface by 150 HP multiple stage electric pumps.

e) Power Distribution

There is a power station at the surface to supply electricity to the mine. From the power station to underground transformer, 3,300 V cables are installed. A telephone system is available for some locations for the purpose of communication.

f) Ventilation

A 75HP main fan is installed at the surface and a 60HP booster fan is installed in the underground. An exhaust system is used for main ventilation and a forcing system for local ventilation.

g) Safety

The mine experienced a gas explosion caused by a spark from non-explosion proof electric devices. Currently the fatality rate is improving year by year.

h) Training

For new employees, safety instruction and safety operation procedures are taught, and every year brush-up training is carried out for all workers. Staff members join the training programs provided by the government or overseas organizations.

i) Surface Facilities

Office, explosive magazines, preparation plant, loading facilities and power station are present as a surface facilities. Workers are living near the mine site.
The baum jig made in China was introduced half a year ago and about 35% of the coal were fed into the baum jig. Washed coal is stocked at the stock yard with a 75,000 tons capacity. The capacity of the loading conveyor is 1,000 ton per hour. The coal is loaded into the barge and pulled to the open sea by tug boat for transshipment to ocean-going vessels.

4-1-4 KUD Mines

Most of the KUD mines are producing coal from open cut mines. Some KUD mines at South Java and South Kalimantan are producing coal from underground mines. The mining system is rather primitive and the production level is very low. The mining method is that of a highwall mining system mixed with manual method. After getting and excavating the coal by open cut mining, coal is got from highwall by coal picks and transported to the surface by manual transportation. There are no ventilation and lighting systems and supports.

5. Future Trend of Underground Mining

At present, open cut method is the major mining method because the method can produce the coal easily and economically. In the future it is recommended to increase the underground production for the purpose of conserving the resources and producing the working opportunity. In this case, it is necessary to consider technical matter and economical matter simultaneously. Probably due to the complicated geological and mining conditions, it is difficult to achieve the high productivity like advanced country. According to the comparison study of the mining method, underground mining method can compete with open cut method if the technology level will be improved through training.

The result of the mining method comparison study shows that the labor intensive method will be the economical method for a while. But considering the economical growth of the country and increase tendency of the labor cost, semi-mechanized method or full-mechanized method will be the more economical method in the future. When coal producers make the mine development plans, they have to consider the financial background of the company, geological condition of the concession and long term economical situation of the country.

Production technology and safety technology are closely connected with each other. It is difficult to achieve the stable production without improving the safety technology. It is necessary to improve the safety inspection and management system.

5-1 Underground Development Plan of the Companies

5-1-1 PTBA

1) Ombilin-II

Latest Feasibility study was done by CDF International, a French consulting firm. The study was completed in September 1994, and the recommended mining method was the Longwall Sub-level caving method for Seam C which is a thicker seam in

the area. Production level is 1.5 million tons per year and mine life is about 20 years. Total investment costs for the project are about 170 million US dollars. Estimated IRR is 12% based on the 35 US$ of coal sales price. Main incline shafts will be excavated from behind the main office and coal will be supplied without a washing process.

According to the mining engineers of CDF International, theoretically the caving method can be applied because the uniaxial compressed strength of the roof material is 25 Mpa and that of coal is from 15 to 20 Mpa.

Contract mining system is planned for the development of Ombilin-II mine and PTBA is preparing the tender documents now. In the earliest case, development will be commenced in August 1996. Three or four years will be required for development and target production in 1998/99 will be 1.4 million tons. The thickest part of the Seam C is about 19 m and 2.75 meter from the floor will be excavated with power roof supports and double ranging drum shearer. The upper part of the coal seam will be caved and recovered from the windows of the power roof supports. The coal will be loaded onto the AFC installed behind the goaf side of the supports. Methane gas drainage must be taken into consideration and investment for gas drainage will be required. This mining method is successfully applied at Indian and Chinese coal mines. Coal sales and exports will be managed by PTBA.

It is estimated that two years will be required for the incline development and three years will be required for panel development. Production will increase gradually from 350,000, and planned maximum production will be 1.5 million tons from two longwall faces and 5 development faces. Total production until year 28 will be about 28.4 million tons. Estimated manpower for this mine is about 500-580 persons.

2) Ombilin-III

Exploration work by NEDO/Sumitomo Coal Mining Co., Ltd. was completed in March 1996 and the report has already been submitted. Geophysical survey and the simple mining plan was included in the study of last year. PTBA is planning

to operate by themselves and manpower will be transferred from the existing Ombilin-I. It is planned to start incline excavation from 1996. Longwall mining method will be applied for this mine and annual production level is from 300,000 to 500,000 tons. Total production until 2018 will be 7.9 million tons. Results of the geophysical survey show that there are many small faults in the area so that a thoughtful panel layout will be required.

5-1-2 CCOW

Most of the First Generation coal mines have big minable reserves for open cut method and just few mines have underground plans. PT.Tanito Harum has a plan to open underground mines and now they are conducting the exploration work and mining study. Mine construction will be commenced from the end of 1997 and coal production will start from 1998 at a small production level. Longwall mining method will be applied and single props used for roof supporting. Planned annual production will be 0.5 million tons from 2 areas. Required manpower for underground operation will be around 650 including 590 of underground manpower. The personnel has no experience of underground operation so that the plan is to employ foreign engineers. Overburden of Satui mine, PT.Arutmin is hard and blasting is required for overburden removal. As the blasting is conducted, the economic stripping ratio is low. The company is planning to start auger mining from the highwall of the open cut mine.

One of the 2nd Generation contractors, PT.Kartika Selabumi Mining, is planning to open an underground mine after 7 years of open cut mine operation. At that time all coal will be produced from underground mines. The company has not yet made a concrete underground plan.

One of the 3rd Generation company PT.Wahana Baratama Mining is planning to start its underground mine at Satui area. The mine will produce 0.6 million tons from 4 underground pits, and start production from 1999. Required manpower for mine operation will be 3,200, including foreign expatriates.

5-1-3 KP Mines

1) Embalut Mine, PT.KITADIN

Currently, the bottleneck for productivity is the limited capacity of incline transportation. In order to overcome this problem, there is a plan to install a belt conveyor at the new incline shaft excavated between the No.1 and No.2 mines. The conveyor system can be utilize both for the No.1 and No.2 mines. For the purpose of improving gallery transportation, small chain conveyors are to be introduced for the No.3 mine. For the purpose of improving the excavation ratio, a research program of a small electric/hydraulic excavating machine is carried out at the mine with the assistance of The Coal Mining Research Center Japan. There is a plan to open a No.4 underground mine.

2) FBS New Mine

As the minable reserves at the current mine are limited, a new pit mouth is prepared for future production. Feasibility study has already been completed by an overseas consultant. Minable reserves of the new mine are about 11 million tons. The company plans to transfer its mining activities from the existing to the new mine.

Transfer period is around ten years. Additional 100 manpower will be required for the new mine. Scheduled operation is by four shifts, in which three shifts are for production and one shift for maintenance. Operation days per year is about 300 days.

Seam A, Seam B and Seam C are the targetted coal seams and thickness are from 1.4 to 2.7 m. First field will be prepared in Seam B, thickness of 2.2 m. Washout is present for some part of the seam, and the floor and roof materials are mudstone. The area with a distance from the Mahakam river less than 250, is not included in the mining plan.

Surface of the scheduled underground mining area was excavated by open pit operation, and the depth from the surface to the seam is only 20 to 60 m. Some of the mined area is filled with water and this is a cause of anxiety.

The planned production method is similar to that of the existing mine, except for

the transportation system. Width of the faces is 120 m and the length of the galleries ranges from 800 to 1,000 m. Multiple gallery system will be applied for the new mine. Iron bars and hydraulic props will be used for face support. Blasting and pneumatic picks will be used for coal getting and the coal will be loaded onto an AFC. Target production will be 0.8 million tons per year from 3 longwall faces.

Considering the production bottleneck of the existing mine, a belt conveyor system will be selected for coal transportation.

Two incline shafts are now prepared for the new mine. Length of Incline A is 312 m and dip is 10.95 degrees. A hoisting machine will be installed for material transportation, and the incline will be used for the intake air. Length of Incline B is 347 m and dip is 12.4 degrees. A belt conveyor system will be installed for coal transportation, and the incline will be used for exhaust air.

Distance between two shafts is 55 m. The excavation of these incline shafts has been placed on order with an Australian construction firm. This firm uses a S65 type road heading machine for excavation and a scoop tram for transportation. Excavation work was discontinued because of a face collapse of Incline A due to the limited skill of the contractor in soft rock conditions. From February 1996, FBS started the work on its own, and is planning to complete the work until December 1996. Development system by FBS is the conventional method using blasting, pneumatic picks, mine cars and hoisting machines. Iron supports are used near the pit mouth and wooden supports for the deeper areas. Forced ventilation is planned.

Required manpower for the new mine is 1,736 persons at the production level of 0.6 million tons. It is estimated that the recruit of the skilled manpower is not so easy. Foreign expatriates will be employed if necessary.

3) Bukit Baiduri Mine

Formerly the company produced coal from underground and open cut mines, but now produces only from its open cut mine. The company is planning to open an underground mine again in the future. According to its plan, the semi-mechanized longwall mining method will be applied for coal getting. Friction props and iron bar system will be used for face support, and AFC will be installed for coal

transportation at the longwall face. A single drum shearer will be used for coal getting.

4) Bukit Sunur Mine

The group owns one CCOW concession in South Kalimantan and another CCOW concession in East Kalimantan as well as more than 20 KP concessions. Currently Bukit Sunur mine and Bukit Bara Utama mine located in Bengkulu Province are producing coal by the open cut method.

Concession area of Bukit Sunur mine is 885 ha and divided into three areas i.e., Arantiga Selatan, Lubuk Bungin Utara and Selung Barat. Dip of the each area is 8, 10 and 8 degrees, respectively. Conventional truck and shovel operation is applied, and the current stripping ratio is about 6 to 1. Another 6 million tons of minable reserves remain in the Arantiga Selatan area if a stripping ratio will be acceptable until 9 to 1.

There is a plan to open underground mines at Arantiga Selatan and Seluang Barat area. Development plan was made by Morison Kunudson and exploration work has been carried out at 200 m spacing. There are three boring machines with coring systems, two units of which are in operation.

Exploration and mining study for Seluang Barat were conducted by Morrison Kunudson and NEDO. At the moment, open cut operation has been stopped because the stripping ratio reached 10:1. The company is planning to start its open cut operation again until 14:1 of stripping ratio if the coal price improves. So the starting time of the underground operation is not yet decided.

Room and Pillar with cut and fill mining method will be planned for the Main seam. The seam is thick enough and pillar extraction is also planned for the purpose of increasing the mining recovery. Wooden materials will be used for supporting, but it is worrying that the wooden material will be more difficult to purchase in the future.

The company is planning to recruit about 70 Chinese engineers for the purpose of technology transfer. After the transition period, the number of foreign expatriates will be gradually reduced.

Currently 10 ton dump trucks are used for the coal transportation from the washing plant to the intermediate stock yard. In rainy weather, trucks are not able to operate

because of the slippery road conditions. But this does not interrupt production because open cut operation is also stopped by slippery conditions. There is a plan to install a ropeway system for coal transportation in mountainous areas for the purpose of supporting continuous operation of the underground mine.

5-1-4 KUD Mines

Open cut mining method is also the major production method at the KUD mines. No systematic geological survey, have been carried out. It seems that a minable reserve study and mining plan have not reached the desired level. Open pit reserves will be exhausted earlier due to the non-systematic operation. Under these circumstances, the KUD mines appreciate the importance of underground operation. But due to the lack of financial and technical resources, they have not yet concluded any suitable plans.

5-2 Selection and Recommendation of Underground Technology for Each Type of Mines in Indonesia

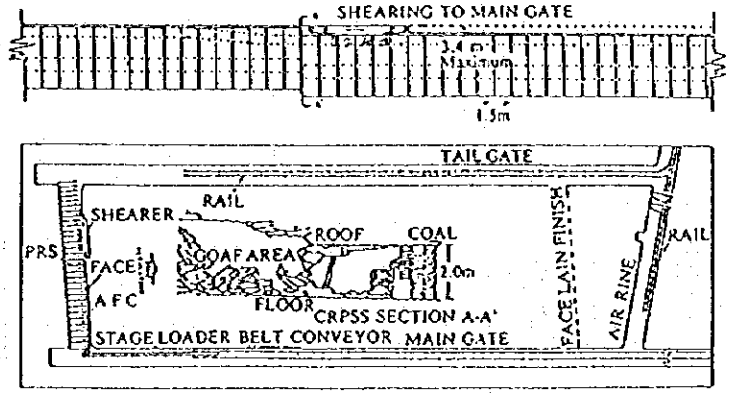
5-2-1 Applicable Underground Mining Method

Longwall mining method, Room & Pillar mining method and Highwall mining method are the applicable mining methods for underground operation. Manual, Semi-mechanized and Full-mechanized method are considered for each method. It is necessary to analyze each method not only from the technology view-point but also from the economic view-point. Future human resources development will be important for underground operation.

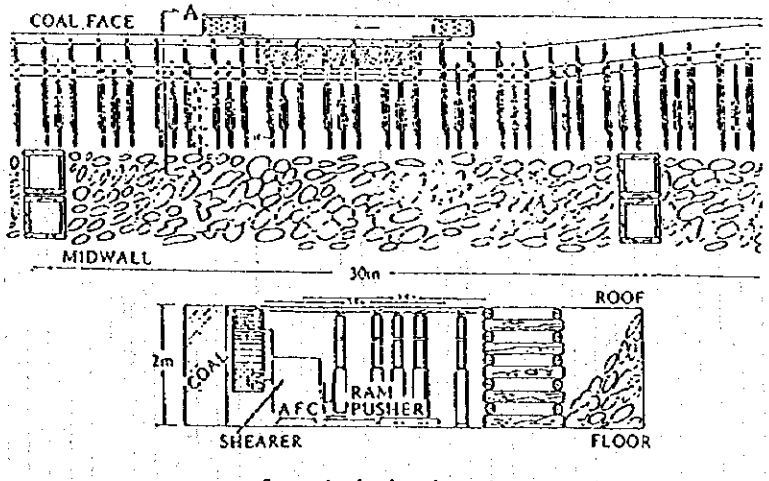
Some of the open cut mines have already selected 120 ton dump trucks for overburden transportation. This selection was made from the economical consideration that even if the labor cost is cheap bigger fleet will be economical for the total production cost.

Geological structure in Indonesia is more complicated compared with Australia or the United States of America, and it is hard for the indonesian coal industry to achieve the same productivity. But it is estimated that labor costs will be going up in conjunction with economic growth. So the economic situation must be taken into consideration for the selection of the mining method.

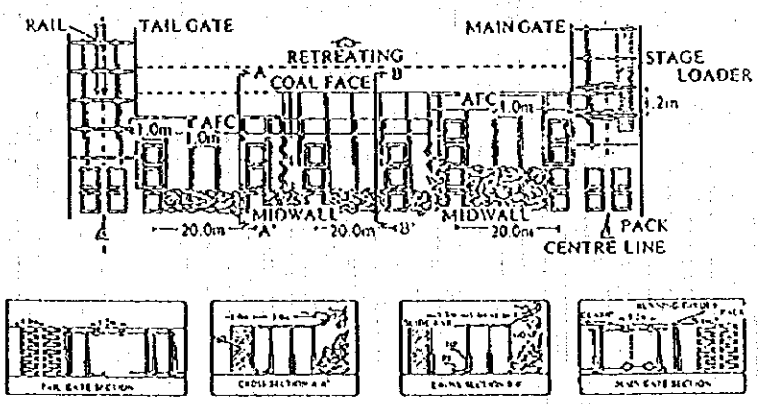
Comparative study of the production cost for each mining method was conducted. This study is like a model case study for stable geological condition, in other words this study is not a feasibility study for specified mine or specified coal quality. Main purpose of this study is to compare Manual, Semi-Mechanized and Full-Mechanized mining method. This comparison can be utilized for studying the possibility to open underground mines as Satellite mines of open cut mines which have already been developed. It is also possible to utilize them for an economic study of the underground coal mines to be newly opened. Most of the open cut mines at remote areas and have low grade coal. These are not considered for underground operation. But if the coal will be consumed near the pit mouth, the situation will change. For example, if a coal fired power station will be constructed at the pit mouth, the economic stripping ratio will be increased and underground operation will become competitive. By this arrangement, minable coal resources will increase in favor of better energy source utilization. This kind of



Conceptual planning of Longwall method
Full-Mechanized System



Conceptual planning of Longwall method
Semi-Mechanized System



Conceptual planning of Longwall method
Manual System

Figure 5-1 Concept of Mining Method

situation can be achieved by appropriate measures such as government instruction.

The following basic parameter are for a comparison study of the longwall mining method. Details of the study and the equipment list are attached in the Appendix V-I. In view of the geological conditions, lower advance rate of the faces have been used.

	Full-Mechanized	Semi-Mechanized	Manual
Face support	Power-Roof Support	Single props & iron bars	Single props & iron bars
Cutting machine	DERDS	Coal cutter	Pneumatic pick
Face length (m)	150	100	60
Working height (m)	2	2	2
Advance rate (m/shift)	3	1.2	0.6
Production (ton/shift)	1,125	300	90
Face number	1	2	4
Operation days	250	280	300
Salable coal (1,000 ton/y)	893	547	358
Manpower	210	420	660
Productivity (ton/man-year)	4,250	1,300	540
Initial investment (Mill.US$)	45	24	13

Remarks : DERDS:Double Ended Ranging Drum Shearer
Manpower and productivity is just for underground operation.

In case of the manual method, production from one face is at a low level. In order to achieve the similar production, the number of faces must be increased. Manual methods can create big employment opportunities, but productivity is low.

The following basic parameter are for a comparison study for the Room & Pillar method. Details of the study and equipment list are attached in the Appendix V-II.

	Full-Mechanized	Semi-Mechanized	Manual
Cutting machine	Road Header	Hydraulic cutter	Pneumatic pick
Face support	Roofbolt	Wooden props	Wooden props
Face section (m^2)	15	12	8
Advance rate (m/shift)	6	3	1.2
Production (ton/shift)	113	45	12
Face number	2	5	15
Operation days	300	300	300
Salable coal (1,000 ton/y)	187	186	149
Manpower	90	210	330
Productivity (ton/man-year)	2,100	890	450
Initial investment (Mill.US$)	8	6	4

Needless to say that productivity of the Full-Mechanized method is the highest. Compared with the longwall mining method, productivity is lower. If Continuous miners will be used for cutting machine, productivity will become higher.

Following the productivity comparison study, an economic comparison study was conducted. Local conditions were considered for material and utility costs. The main purpose of the study is to compare each type of method,but interest rates are not considered. Future coal prices are not estimated at this comparison and IRR was not calculated. The following result was calculated with using the current labor cost level. Indicated production costs don't included preparation, handling, shipping, marketing, taxes, etc. Details are given in the Appendix V-III.

	Full-Mechanized	Semi-Mechanized	Manual
Longwall:			
Labor cost (Mill.Rp/year)	630	1,200	1,700
Other cost (Mill.Rp/year)	28,270	15,900	9,900
Total cost (Mill.Rp/year)	28,900	17,000	11,600
Production (1,000 ton)	893	547	358
Production cost(US$/ton)	14.1	13.6	14.1
Room & Pillar:			
Labor cost (Mill.Rp/year)	270	590	830
Other cost (Mill.Rp/year)	6,030	5,410	4,270
Total cost (Mill.Rp/year)	6,300	6,000	5,100
Production (1,000 ton)	187	186	149
Production cost(US$/ton)	14.6	14.3	14.9

Results of the study show similar production costs for each mining method, but Semi-mechanized method is the most economic for both Longwall and Room & Pillar. If the interest rate is taken into consideration, the result will be different. Even though the production costs are not competitive with open cut mining at a low stripping ratio, 14- 15 US$/ton is still marketable. Some coal mines are producing from underground mines and some companies are planning to start underground mining. Considering these facts, the result of this comparison seems to be a reasonable one. It is remarkable that the labor cost portions are still small for each method.

Open cut production costs vary by geological and mining conditions, and are most strongly influenced by the stripping ratio. Indonesian coal mines have the maximum stripping ratio, but these figures are calculated from coal prices, transportation costs, etc. In other words, the figures are not calculated from the comparison results for the open cut production and underground production costs.
Generally speaking, the maximum stripping ratio is lower for coal mines with a poor infrastructure and higher for the coal mines with a good infrastructure. Underground mining cost will be affected by the depth or dip of the coal seam, but not so strongly influenced by the above factors. As shown in Figure 5-2, underground mining is more economical compared with open cut mining with a high stripping ratio. If the infrastructure is not good enough, underground mines cannot compete with open cut mines. Geological conditions can't be changed, but infrastructure conditions can be improved. For example, if a coal fired power station is constructed at the mine site, the maximum stripping ratio will become higher. Under these condition, minable reserves will be increased and underground production will become competitive. If labor costs will increase, underground mining costs will increase also, but the situation is the same for open cut mining.

As Indonesia is seeking rapid economic growth, labor cost will is steadily increase. For the purpose of estimating future production costs, a sensitivity analysis has been carried out. Input data for labor costs was changed from the developing country level to the advanced country level. It is clear that Full-Mechanized method is more economical for a higher labor cost level where the manual method is not economical. This macro analysis is shown in Figure 5-3. Three lines are crossed at the left side of the Figure. Current Indonesian situation is exactly at this crossing situation.

In order to analyze the Indonesian situation, a comparison study was carried out for the lower labor cost level. The results are shown in Figure 5-4. The macro view shows one crossing point but the micro view result shows that there are two crossing points. This shows that the most economical method will change depending on the labor cost level. At the very low labor cost level, the manual method is the most economical one, while production output and productivity are low. Labor costs will increase until the turning point, the Semi-Mechanized method becomes the economical method. When labor costs will rise to the second turning point, the Full-Mechanized method will be the most economical.

The actual differences in production costs for each method are not so big at this moment. But if labor costs will increase around 2,000 US$/year, the cost difference between Semi-Mechanized and Full-Mechanized will be not so big, but the manual method will clearly not be economic. Mechanization is one of the answers for ensuring economic viability in underground mining. This tendency is similar to the open cut mines where the fleet become bigger and bigger.

Improvements in living condition and increased wage levels are the national dream. In order to compete with overseas coal producers, mechanization will therefore be essential in the future. All advanced countries have experienced this conditions. Considering the rapid growth rate of GDP, the time will surely come when it will be necessary to abandon labor-intensive thinking.

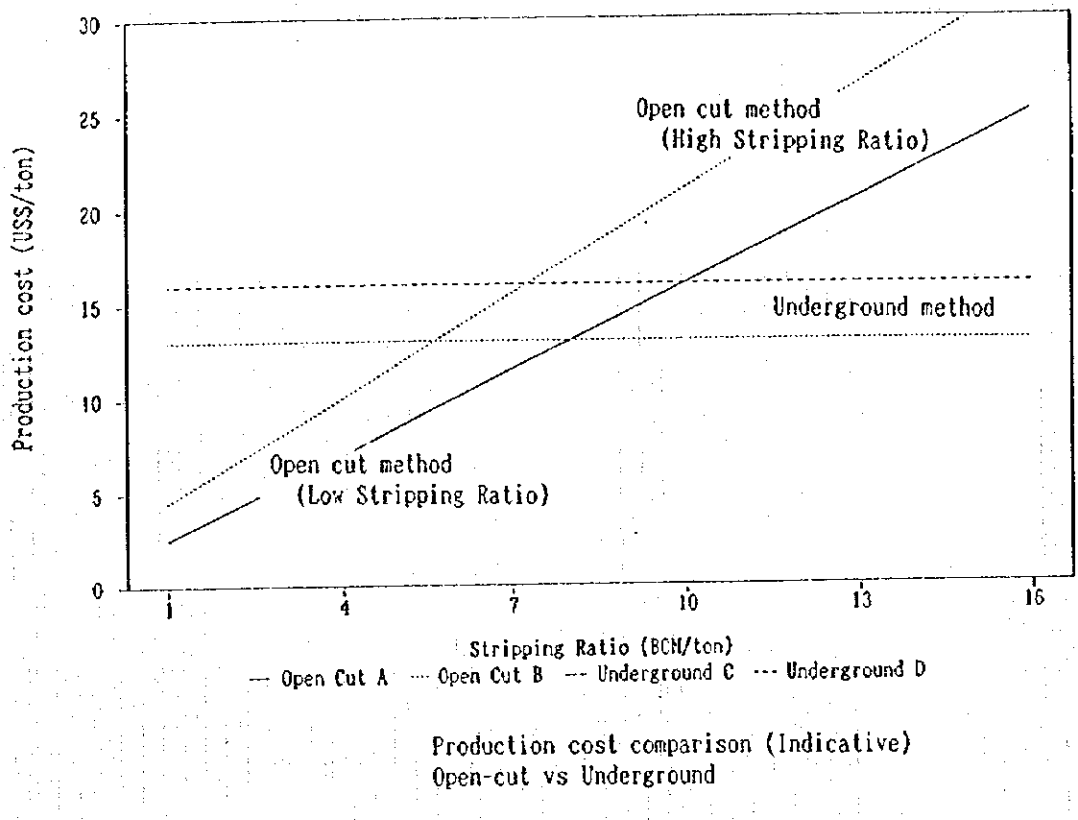
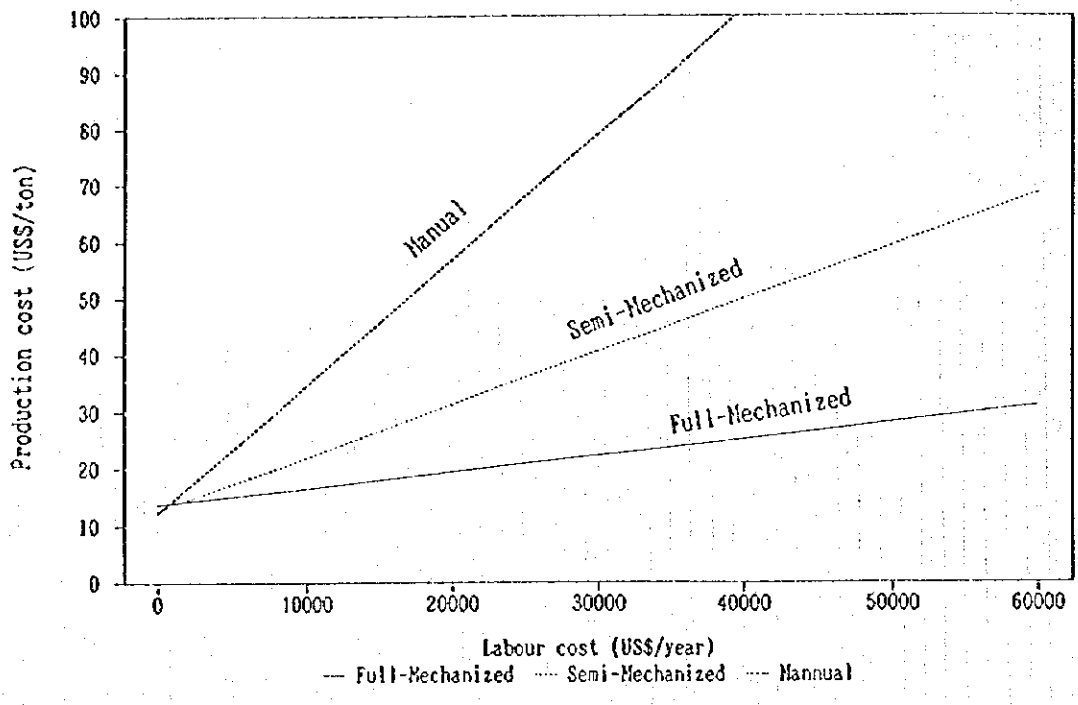
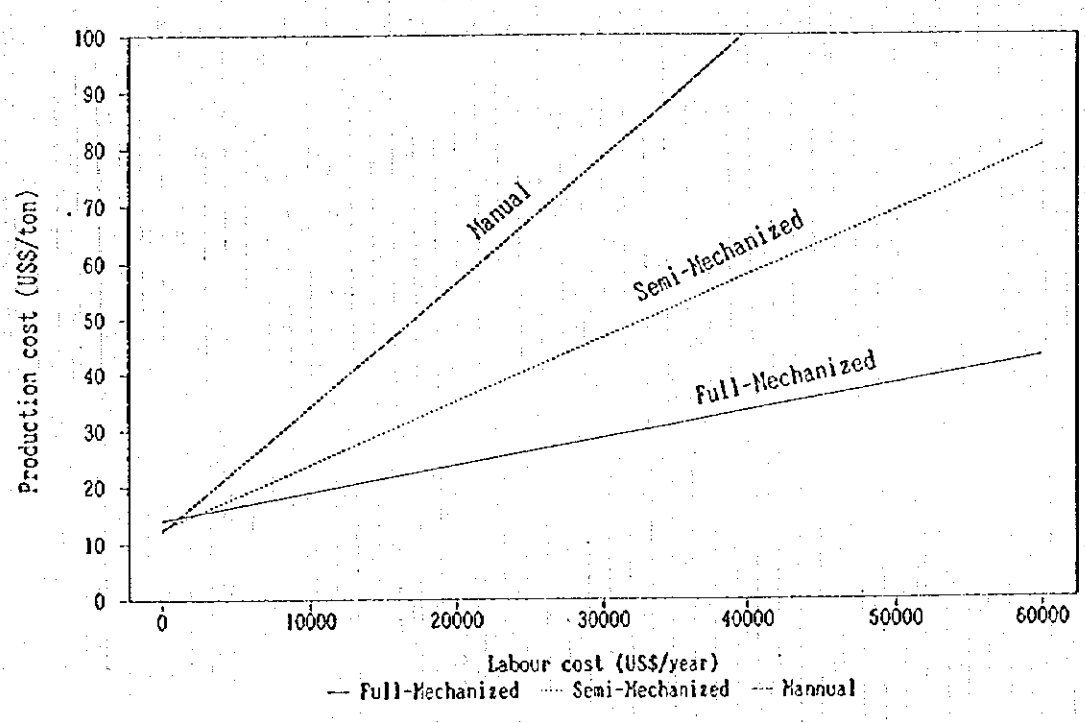


Figure 5-2 Production Cost Comparison (Indicative) Open-cut vs Underground

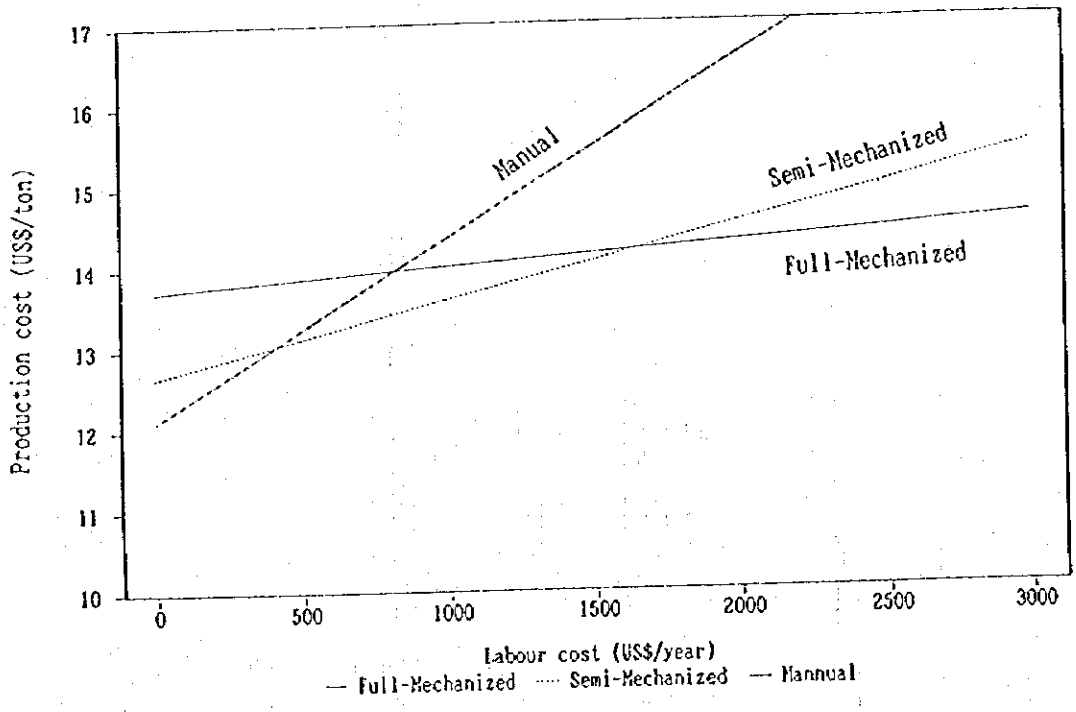


Production cost comparison
Longwall method, Macro view

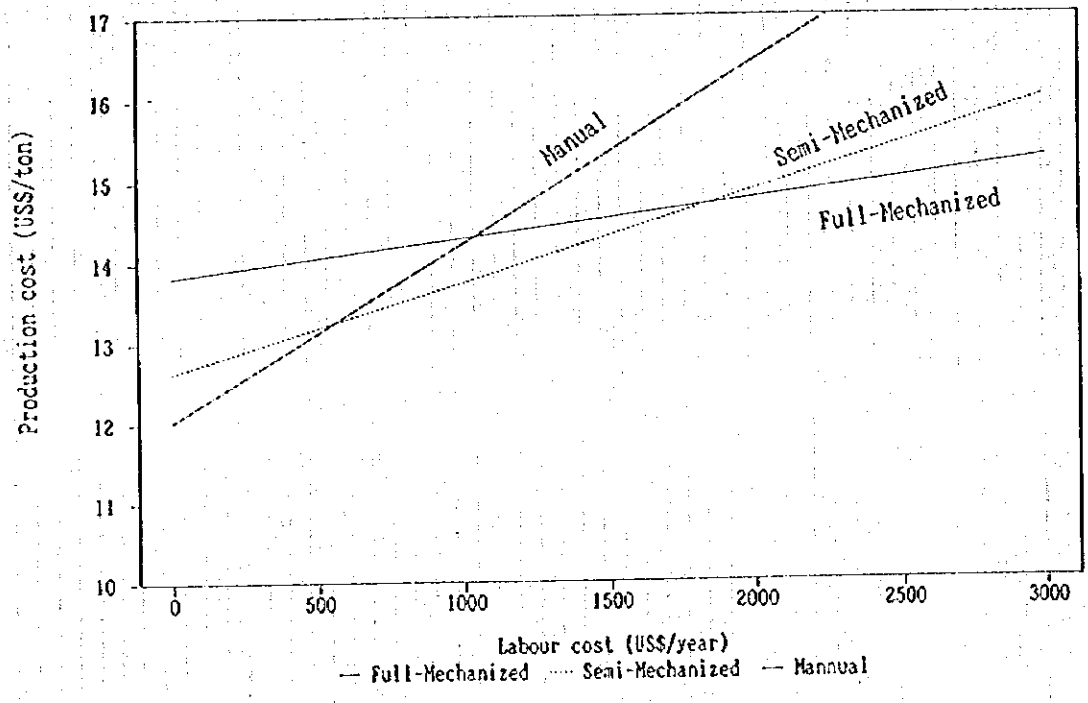


Production cost comparison
Room & Pillar method, Macro view

Figure 5-3 Production Cost Comparison Longwall and Room & Piller Method, Macro View

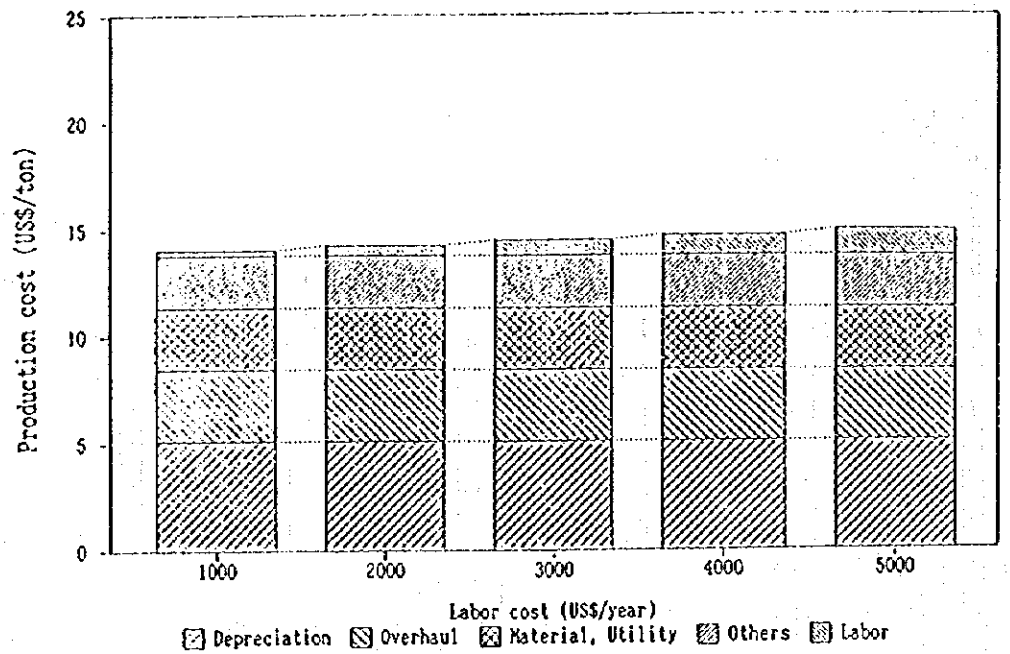


Production cost comparison
Longwall method, Micro view

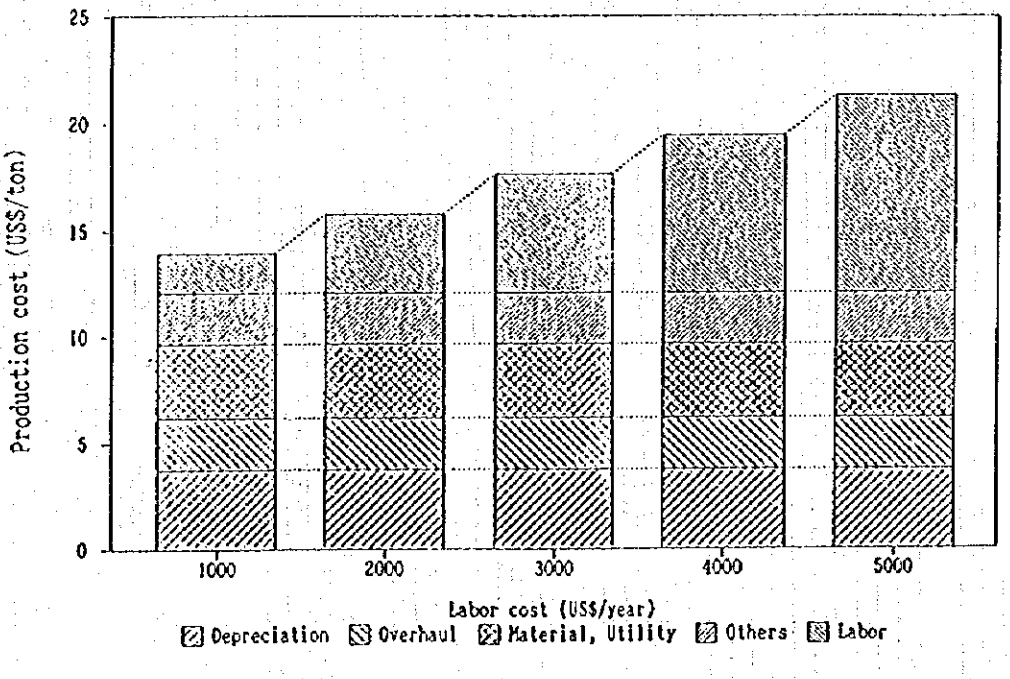


Production cost comparison
Room & Pillar method, Micro view

Figure 5-4 Production Cost Comparison Longwall and Room & Piller Method, Micro View



Production cost component
Longwall, Full-Mechanized



Production cost component
Longwall, Manual

Figure 5-5 Production Cost Comparison Longwall, Full-Mechanized and Manual

5-2-2 Recommendable Underground Mining Technology

1) PTBA Mines

Ombilin mine must keep the production level for the purpose of filling the regional coal demand such as power generation and cement factory. As a leading mine in Indonesia, it is recommended to utilize the advanced technology in order to find out the proper technical level for the future Indonesian coal industry. Ombilin mine is one of the candidate for the training location of Indonesian coal industry.

Development plan of Ombilin-II is the largest underground development plan so far with utilizing full-mechanized mining system. Sub-level caving system is actually applied for India and China but other advanced countries are not thinking about the introduction of this system. It is estimated that long time and big effort will be required for master this mining method. Mining method planned for Ombilin-III is an ordinary method, and it is estimated that not so difficult to apply for the mine. However more higher productivity of the longwall face and advance rate of the development will be desired for the mine, even though the geological condition is not so stable.

2) CCOW Mines

It is estimated that the minable reserve for the open cut is still big enough. Coal contract stated that all the reserves should be exploited as far as economical. So CCOW companies have to make their best effort to get the coal as possible as they can. Coal getting from the deeper area must be studied for the long term planning. Once mined out area will be reclaimed, it is difficult to access to the underground from the highwall. Considering the heavy rainfall of the country, separated development is thoughtful. If the geological condition is good enough for big scale underground mine, full mechanized mining should be considered for the high production.

3) KP Mines

As government policy is to make the employment opportunity in coal mining

industry, it is recommended to apply the semi-mechanized system for this category. Of course economical method must be selected. It is not recommended to select the mining system with high wood consumption, because it will be the reason of the deforestation.

Some coal mines are planning to develop the new underground coal mines and they selected not the advanced technology but the improved technology. These ideas are conform to the government policy and reasonable selection. High production level is difficult to achieve by the system but economical operation can be achieved.

Steep coal seams are more difficult to develop compared with flat coal seams. If mining technology for steep coal seams will be improved, minable reserve will be increased.

Almost all the KP mines have a tendency to apply mechanized system, so human resources development will be essential. Followings are the development plan of underground mines.

4) KUD Mines

In general, concession is not so big enough and reserve is not so big. It is difficult to produce the coal as a bigger scale mine. Regarding the open cut operation, it is recommended to improve the survey technology and planning technology so that increase the mining recovery. It is recommendable to start the Manual Room & Pillar method for a while. That kind of system can start without big investment and high technology. After the safety management can be achieved, manual longwall method will be recommendable. If the labor cost become higher, Semi- Mechanized Room & Pillar will be the recommendable method.

5-3 Recommendation for Safety Management System

5-3-1 Coal Companies

Improvement in advanced education and training systems for workers and staff will be required. Ability of the safety section must be improved, including organization and facilities. Utilization of the communication system will be recommended. It is recommended to consider the introduction of central monitoring system for the future. It is recommended to have an internal qualification system for special jobs at each mine.

It is recommended to form an inspector division in each mine.

5-3-2 Rescue Station

As it is estimated that underground mining will increase, it is better to organize the rescue station at the areas where the underground mines will be located. It will also be necessary to train rescue teams. Formation of a rescue station in Samarinda area will be required as early as possible.

5-3-3 Government Organization

In order to maintain the safety of operation of the coal mines, the inspector's office must be improved in quality and quantity. It is recommended to reinforce the investigation section for the underground equipment, including explosion proof equipment.

Formation of a qualification system for foremen or supervisors must be taken into consideration in the future.

6. Development for Coal Mines

6-1 Development Policy in Coal Mining

In order to support national economic growth, the government of Indonesia decided to produce and utilize domestic coal which is abundant in Indonesia. The main portion of the investment plan of the Repelita 6 (1994-1998) for the infrastructure is for coal fired electricity generation. Investment plan for the next Repelita will be also the same condition.

As a big investments will be required, foreign investment or BOO schemes by the private sectors will be emphasized for power generation.

In order to achieve production increases, a flexible royalty system should be considered by changing coal cooperation contracts from a production sharing basis (CCC) to royalty basis (CCOW), and privatization of PTBA.

Major modifications in the contract scheme from CCC to CCOW are as follows:

1) CCOW is a contract agreement between Coal Contract Company and the Government.
2) Royalty and coal levies of 13.5% of the coal produced in the agreement area will be paid to the Department in Cash, not through PTBA.
3) The rate of 13.5% maybe re-evaluated by negotiation between Company and the Government because:

- New contractors need more infrastructure cost for the development due to the mine location.
- Geological conditions, the quantity and quality of the reserves are not superior to the First Generation.
- National companies have less financial and technical background
- Shift to the underground mining

4) Coal contractors should provide security deposits of US$100,000, 50% of which will be returned to the Contractor at the end of the General Survey Period.
5) Rate of income tax become lower.
6) Bureaucracy procedures for application is simplified.
7) Duration of the validity of CCOW is 30 years and can be extended.

6-2 Coal Production Scheme

6-2-1 Existing Coal Mines

As mentioned in the Chapter 3, present coal mines in operation are 2 coal mines of PTBA, 9 contractors of CCOW, 10 companies of KP and 6 companies of KUD, respectively. The total coal production in 1995 was about 4.2 million tons, of which 70% are produced from the mines of the CCOW.

The annual coal production projections of the existing coal mines are made based on the results of the Questionnaires dispatched to the coal companies and the Hearing at the visit of main coal companies.
The results are summarized in Figure 6-1 after referring Appendix VI- I, VI- IIa, VI- IIb and VI- IIc.

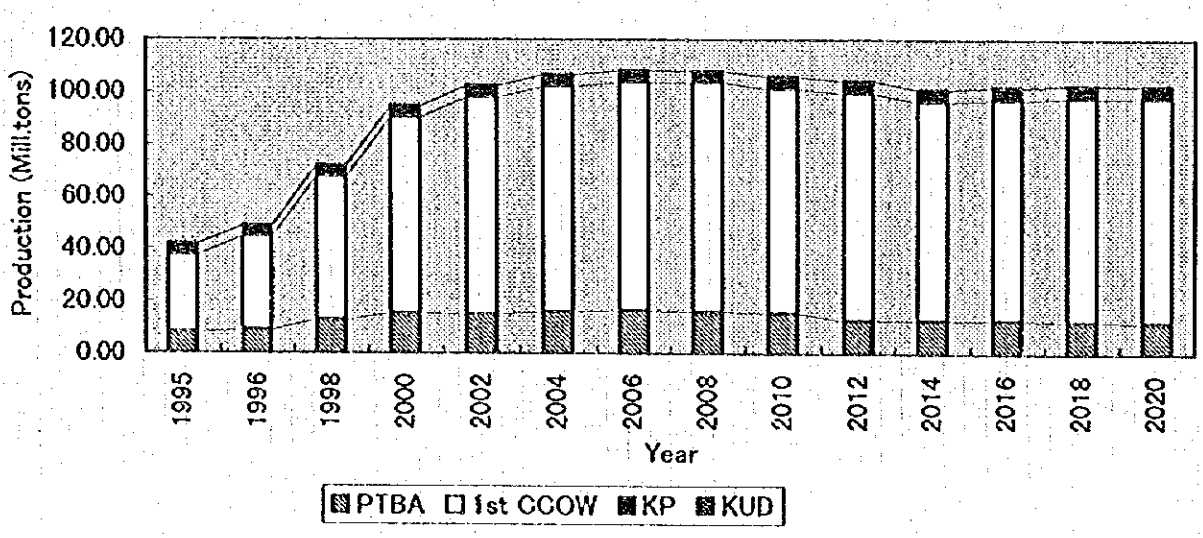


Figure 6-1 Coal Production Projections of the Existing Coal Mines

As a result, approximately 100 million tons of coal production, which are 2.4 times of the present production, are projected in 2020. Especially the CCOW mines are expecting to establish their production expansion into 3 times of the present level in order to respond rapid expansions of the coal export and the long-term contract with new domestic coal-fired thermal power plants to be constructed in near future.

Major changes of mining method with the existing coal mines would not be happened at present. As underground coal mines, 2 new mines, consisting of one from the CCOW contractors and another from the KP mines, will be developed in addition to the existing 3 underground coal mines.

6-2-2 New Coal Mines

New coal mines to be developed are consisting of CCOW contractors of 2nd and 3rd generation, KP mines and KUD mines. As an additional production projection, those of the 2nd and 3rd generation CCOW contractors are considered in the report because the information of KP and KUD coal mines is very few and the total production of them is very minor against the whole country's coal production.

The coal companies of the 2nd generation CCOW, which are under exploration, are 18 in number while those of 3rd generation CCOW, which are under the stage of contract negotiation or application, are counted into 91.
Therefore, the annual production projections of these new CCOW contractors are made as shown below under the following assumptions:

1) The total coal production of CCOW 2nd generation contractors in 2020 is computed under the following formula:

   18 Companies x 50%(Success ratio) x 2 Mill.tons/company = 18 Mill.tons

2) The total coal production of CCOW 3rd generation contractors in 2020 is calculated under the following formula:

   91 Companies x 50%(Success ratio) x 1.5 Mill.tons/company = 68.25 Mill.tons

3) The proportion between the open pit mines and the underground mines of the 2nd and 3rd CCOW contractors is assumed into 80:20.

4) The success ratio and the annual production of the 2nd and 3rd generation contractors are decided after the mutual discussion between the DOC and the JICA mission.

Also the saleable amount of each coal product in the coal market has to be reviewed in the future because the new contractors are under the exploration stage and the exact quality of each coal product is not available in the study period.

The transition of coal production projections from the new CCOW coal contractors by the year 2020 is shown in Figure 6-2.

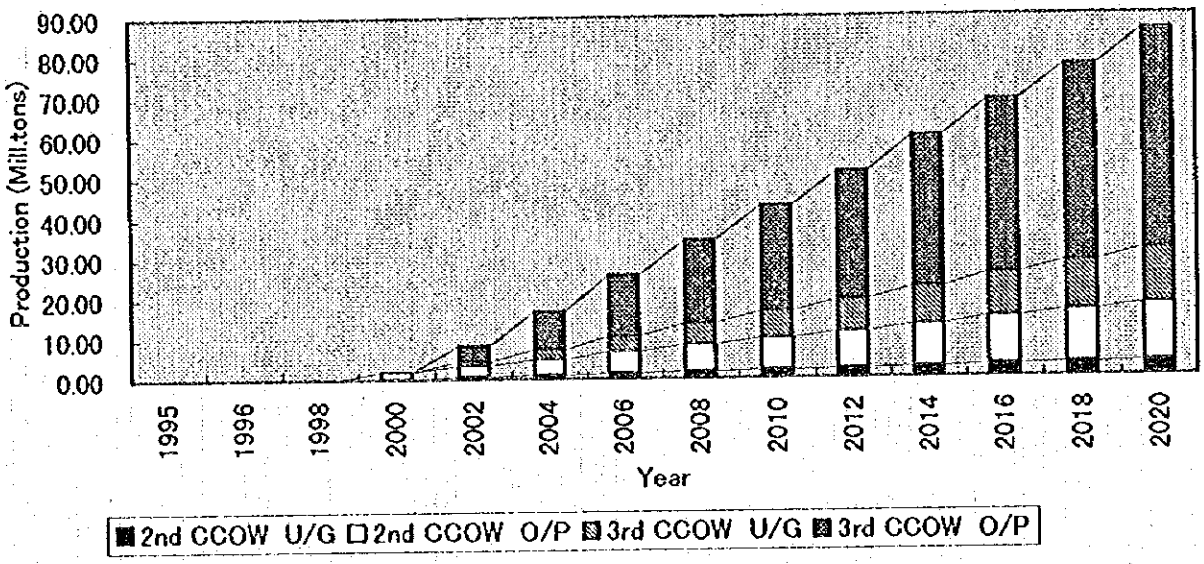


Figure 6-2 Coal Production Projections of The New Coal Mines

The coal production of new CCOW mines is estimated to start from the year 2000 and will reach to approximately 90 million tons in 2020.
The development of underground coal mines which need more costs for operation will be concentrated in the Kalimantan island where the higher quality coals are abundant.

6-3 Analysis and Evaluation of Coal Production Projections

The annual coal production projections for existing and new coal mines are summarized in Table 6-1, and the total coal production is estimated to approximately 190 million tons per annum in 2020.

Table 6-1 Coal Production Forecast (1995 - 2020)

Company	Mines (Mining Method)	Coal Quality			Annual Coal Production Forecast (Mil. tons)														Remarks
		H.V.	Ash	T.S.	1995	1996	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	
PT Bukit Asam	Ombilin (U)	6,880	7.43	<1.00	0.06	0.05	0.05	-	-	0.11	0.60	1.00	1.40	1.50	1.50	1.50	1.20	1.00	
	Sigalut (U)	6,880	7.40	<1.00	-	-	-	0.07	0.06	0.05	0.05	0.30	0.53	0.54	0.56	0.57	0.50	0.50	
	Ombilin (O)	6,940	7.13	0.60	1.11	0.90	0.60	0.40	0.40	0.40	-	-	-	-	-	-	-	-	
	Ombilin Total				1.17	0.95	0.65	0.47	0.46	0.56	0.65	1.30	1.93	2.04	2.06	2.07	1.70	1.50	
	Air Laya (O)	5,240	7.80	0.40	4.48	3.00	3.00	5.00	5.30	5.70	6.00	4.50	3.00	-	-	-	-	-	
	N. Muara Tiga B. (O)	4,850	6.50	<1.00	2.30	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	
	W. Banko (O)	4,840	6.85	0.50	-	-	3.90	4.50	4.70	4.90	5.10	5.30	5.60	5.60	5.60	5.60	5.60	5.60	
	Bukit Kendi (O)	6,760	<4.00	<0.05	-	0.30	0.60	1.00	-	-	-	-	-	-	-	-	-	-	
	S. Muara Tiga B. (O)	5,220	5.00	<0.92	-	0.60	0.50	0.40	0.60	0.80	0.80	0.80	1.00	1.00	1.00	1.00	1.00	1.00	
	Tanjung Enim Total				6.78	7.90	12.00	14.90	14.60	15.40	15.90	14.60	13.60	10.60	10.60	10.60	10.60	10.60	
	U/G Sub-total				0.06	0.05	0.05	0.07	0.06	0.16	0.65	1.30	1.93	2.04	2.06	2.07	1.70	1.50	U
	O/P Sub-total				7.89	8.80	12.60	15.30	15.00	15.80	15.90	14.60	13.60	10.60	10.60	10.60	10.60	10.60	
	Total				7.95	8.85	12.65	15.37	15.06	15.96	16.55	15.90	15.53	12.64	12.66	12.67	12.30	12.10	
PT Arutmin Indonesia	Senakin	6,900	9.00	0.80	5.36	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	-	-	-	-	
	Satui	6,800	8.00	0.80		2.00	2.00	2.00	2.20	2.20	2.20	2.20	-	-	-	-	-	-	
	Mulia	-	-	-	-	-	0.60	1.50	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	
	Asam Asam	4,680	3.30	0.19	-	-	-	0.39	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	
	Batulicin	-	-	-	-	-	0.50	1.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	
	Total (O/P)				5.36	6.00	7.10	8.89	13.40	13.40	13.40	13.40	11.20	11.20	7.20	7.20	7.20	7.20	
PT Kendilo Coal	Petnagie	6,700	12.00	0.8~1.4	1.02	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
	Bindu	6,090	17.90	2.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Total (O/P)				1.02	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
PT Berau Coal	Lati	5,110	4.00	0.70	0.67	1.10	2.00	4.50	5.00	5.70	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	
	Binungan	6,200	3.50	0.80	-	0.50	1.70	3.20	3.60	3.80	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	
	Total (O/P)				0.67	1.60	3.70	7.70	8.60	9.50	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	
PT Multi Harapan Utama	Buseng	6,400	4.00	<1.00	1.40	1.40	1.40	1.00	0.80	0.80	-	-	-	-	-	-	-	-	
	Jonggon				0.57	0.70	1.00	1.00	1.00	1.00	1.00	0.50	-	-	-	-	-	-	
	Citen	6,000	4.00	0.40	-	-	-	-	-	-	-	-	0.50	0.80	0.80	0.80	0.80	0.80	
	Loakulu				-	-	-	0.80	1.00	1.00	1.00	1.30	1.30	1.20	1.00	1.00	1.00	1.00	
	La Hau	7,100	2.00	0.70	-	-	-	-	-	-	1.00	1.20	1.20	1.20	1.20	1.20	1.20	0.70	
	Putak				-	-	-	-	-	-	-	-	-	-	-	-	-	0.50	
	Total (O/P)				1.97	2.10	2.40	2.80	2.80	2.80	3.00	3.00	3.00	3.20	3.00	3.00	3.00	3.00	
PT Kideco Jaya Agung	Roto I	5,830	1.20	0.10	-	2.00	2.20	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	
	Roto II				-	0.80	1.80	2.50	2.80	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	
	Samu				-	-	0.50	1.00	1.30	1.50	1.50	1.50	1.50	1.80	2.00	2.40	2.70	3.00	
	Sasubeng				-	-	-	0.50	0.80	1.00	1.20	1.40	1.50	1.80	2.00	2.20	2.50	2.50	
	Samarangau	4,910	2.10	0.10	-	-	-	0.20	0.60	1.00	1.20	1.50	1.50	2.00	2.50	2.70	3.00	3.00	
	Pinang				-	-	-	0.30	0.70	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
	Total (O/P)				2.50	2.80	4.50	7.00	8.70	10.00	10.40	10.90	11.00	12.10	13.00	13.80	14.70	15.00	
PT Kaltim Prima Coal	Pinang	7100(U)	4.00	0.50	10.21														
		6,300	7.00	0.40															
	Bintang																		
	Bengalon	6,000																	
	Separi-Santan																		
	Total (O/P)				10.21	11.50	16.00	20.00	21.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	
PT Allied Indo Coal	Parambahan	7,800	0.80	0.60		1.20	1.20	1.00											
		7,000	8.00	1.20															
	Total (O/P)				1.20	1.20	1.20	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
PT Tanito Harum	Mine I and II (O/P)	6,400	5.00	0.80		1.30	1.40	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	
	Pondok/Lobu (U/G)	6,400	5.00	0.80		-	0.30	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	
	Total				1.10	1.30	1.70	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	
PT Adaro Indonesia	Paringin	5,900	1.00	0.10		7.20	7.00	6.00	2.00	-	-	-	-	-	-	-	-	-	
	Tutupan	5,600	1.50	0.10		-	7.00	8.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	
	Wara	4,680	2.50	0.18		-	2.00	6.00	8.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	
	Total (O/P)				5.55	7.20	16.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	
PT Chung Hua Overseas	Coal Belt III, IV & V (O/P)	7,120	0.90	0.60	-	0.20	0.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
PT Indominco Mandiri	Western Block	6,400	5.50	<0.80															
	Eastern Block	6,250	3.00	<1.90															
	Total (O/P)				-	0.86	1.00	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	
CCOW	U/G				-	-	-	0.30	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	U
	O/P				29.58	35.76	54.80	74.39	82.50	85.70	86.80	87.30	85.20	86.50	83.20	84.00	84.90	85.20	
	Total				29.58	35.76	55.10	74.89	83.00	86.20	87.30	87.80	85.70	87.00	83.70	84.50	85.40	85.70	
PTBA+CCOW	U/G				0.06	0.05	0.35	0.57	0.56	0.66	1.15	1.80	2.43	2.54	2.56	2.57	2.20	2.00	U
	O/P				37.47	44.56	67.40	89.69	97.50	101.50	102.70	101.90	98.80	97.10	93.80	94.60	95.50	95.80	
	Total				37.53	44.61	67.75	90.26	98.06	102.16	103.85	103.70	101.23	99.64	96.36	97.17	97.70	97.80	
PT Bukit Baiduri	Merandai	6,900	9.00	<1.00	-	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	-	By 2000
	Galaxy				-	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.70	0.70	0.70	0.70	0.70	0.70	
	N. Teluk Dalam	6,000	2.50	0.60	-	0.30	0.30	0.30	0.30	0.30	0.30	0.30	-	-	-	-	-	-	
	Total (O/P)				0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.70	
PT Fajar Bumi Sakti	Mine I (U/G)	6,700	4.00	0.40	0.58	0.60	0.10	-	-	-	-	-	-	-	-	-	-	-	
	Loa Ulung (U/G)				-	0.05	0.55	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	
	Total				U 0.58	0.65	0.65	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	
PT Kitadin	Mine I, II, III (U/G)	6,500	7.00	<0.80	U 0.42	0.40	0.40	0.50	0.50	0.50	0.50	0.50	0.60	0.60	0.60	0.60	0.70	0.70	
	#19 (O/P)	5,700			O 0.30	0.10	0.10	-	-	-	-	-	-	-	-	-	-	-	
	Total				0.72	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.60	0.60	0.60	0.60	0.70	0.70	
PT Bukit Sunur	Arantigee (O/P)	6,300	7.00	<0.80		0.80	0.70	-	-	-	-	-	-	-	-	-	-	-	
	Lubuk Bungin (U/G)	6,800	12.00	<0.80		-	-	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	
	Sukuang Barat (U/G)	6,800	12.00	<0.80		-	U 0.10	0.30	0.30	0.30	0.30	0.30	0.50	0.50	0.50	0.50	0.50	0.50	
	Total				0.80	0.80	0.80	1.00	1.00	1.00	1.00	1.00	1.20	1.20	1.20	1.20	1.20	1.20	
PT Danau Mas Hitam	Danau M. Hitam	6,200	<12.00	<1.00	0.67	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.30	-	-	-	-	
	Other areas				-	-	-	-	-	-	-	-	-	0.20	0.50	0.50	0.60	0.60	
	Total (O/P)				0.67	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.60	0.60	
PT Bukit Bara Utama	No information				0.08	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	
PT Karbindo Abesyapradhi	No information				0.36	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	
Other Mines					0.26	-	-	-	-	-	-	-	-	-	-	-	-	-	
KP Mines	U/G				1.00	1.05	1.05	1.30	1.30	1.30	1.30	1.30	1.40	1.40	1.40	1.40	1.50	1.50	
	O/P				3.22	2.90	2.90	3.00	3.00	3.00	3.00	3.00	3.20	3.20	3.20	3.20	3.20	3.00	
	Total				4.22	3.95	3.95	4.30	4.30	4.30	4.30	4.30	4.60	4.60	4.60	4.60	4.70	4.50	
KUD Usaha Karya Cempaka	O/P	6,700	0.86	0.56	0.04	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	
KUD Bersama	O/P				0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	
KUD Maduretna	O/P (70%)	6,700	?	<1.00	0.06	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	
KUD Bina Bersama	U/G?				0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	
KUD Makmur	O/P?				0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	
KUD Karya Mumi	O/P?				0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
U/G					0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	U
O/P					0.19	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	
Total					0.23	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	
Current Oper.U/G					1.10	1.15	1.45	1.92	1.91	2.01	2.50	3.15	3.88	3.99	4.01	4.02	3.75	3.55	
〃 O/P					40.88	47.71	70.55	92.94	100.75	104.75	105.95	105.15	102.25	100.55	97.25	98.25	98.95	99.05	
〃 Total					41.98	48.86	72.00	94.86	102.66	106.76	108.45	108.30	106.13	104.54	101.26	102.27	102.70	102.60	
CCOW 2-Gen.U/G					-	-	-	0.20	0.70	1.00	1.40	1.70	2.00	2.30	2.60	3.00	3.30	3.60	
〃 O/P					-	-	-	1.80	2.50	4.00	5.40	6.80	8.00	9.20	10.60	12.00	13.20	14.40	
〃 Total					-	-	-	2.00	3.50	5.00	6.80	8.50	10.00	11.50	13.20	15.00	16.50	18.00	
CCOW 3-Gen U/G					-	-	-	-	1.00	2.40	3.80	5.20	6.60	8.00	9.40	10.80	12.20	13.65	
〃 O/P					-	-	-	-	4.00	9.60	15.20	20.80	26.40	32.00	37.60	43.20	48.80	54.60	
〃 Total					-	-	-	-	5.00	12.00	19.00	26.00	33.00	40.00	47.00	54.00	61.00	68.25	
Grand Total U/G					1.10	1.15	1.45	2.12	3.61	5.41	7.70	10.05	12.48	14.29	16.01	17.82	19.25	20.80	
Grand Total O/P					40.88	47.71	70.55	94.74	107.55	118.35	126.55	132.75	136.65	141.75	145.45	150.45	160.95	168.05	
Grand Total Total					41.98	48.86	72.00	96.86	111.16	123.76	134.25	142.80	149.13	156.04	161.46	171.27	180.20	188.85	

6-3-1 Analysis of Coal Production Projections by Contract System

The annual coal production projections by contract system are shown in Figure 6-3. In the figure, the coal production of the 1st generation CCOW coal mines will reach to nearly its peak in 2000, and those of the 2nd and 3rd generation CCOW coal mines will start to increase after the year 2000. Therefore, the securing of future coal production is practically depending on the result of coal mine development by 2nd and 3rd generation CCOW contractors.

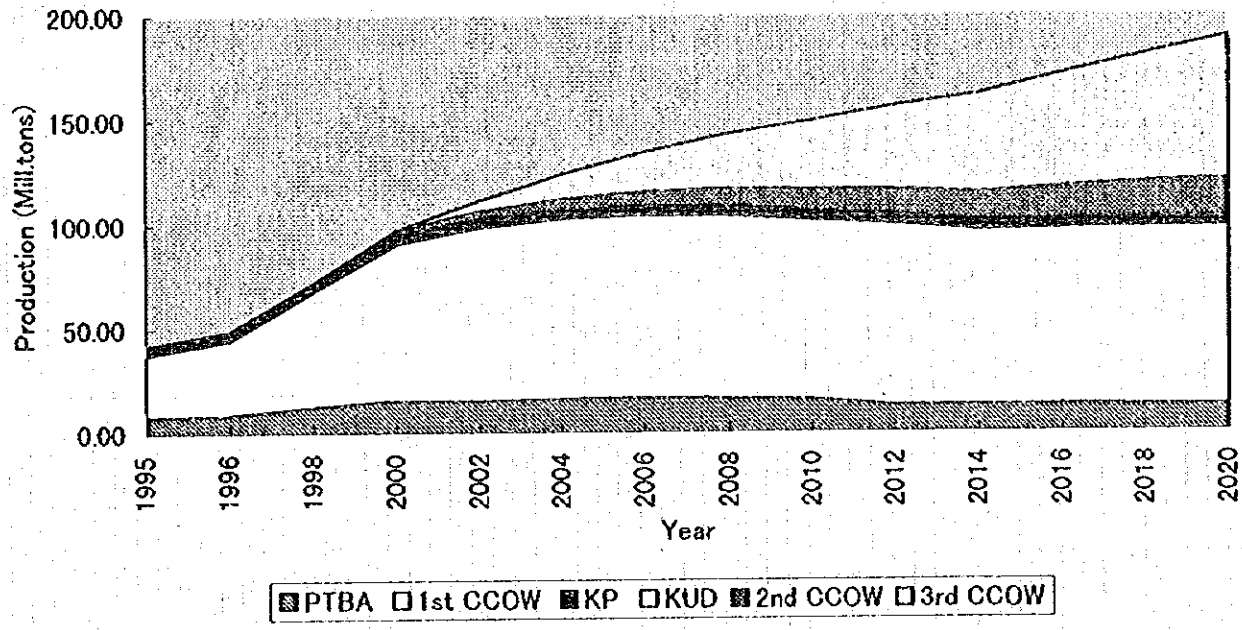


Figure 6-3 Coal Production Projections by Contract System

6-3-2 Analysis of Coal Production Projections by Region

The main active coalfields in the country are distributing in Sumatra and Kalimantan islands. Further, the Kalimantan island is classified into East Kalimantan, South Kalimantan and the others. In 1995, the coal production from Sumatra (mainly from 2 mines of PTBA), South Kalimantan (mainly from PT Adaro Indonesia and PT Arutmin Indonesia) and East Kalimantan (mainly from PT Kaltim Prima Coal) was reached to 11 million tons, 11 million tons and 20 million tons, respectively.

The progress of coal production projections by region is shown below under the assumption that the production from 2nd and 3rd generation CCOW coal mines is allocated by number of coal mines in each region :

(Million Tons)

Region	1995	2000	2010	2020
Sumatra	11.06	18.81	30.38	38.90
Kalimantan				
* South Kalimantan	11.14	30.75	40.35	44.00
* East Kalimantan	19.78	47.19	70.22	89.20
Others	0.00	0.11	8.17	16.75
Total	41.98	96.86	149.13	188.85

The progress of coal production projections by region is shown in Figure 6-4, in which a marked increase in coal production from the Kalimantan island is recognized, and the production from the Kalimantan island is estimated to 70% of the whole domestic production.

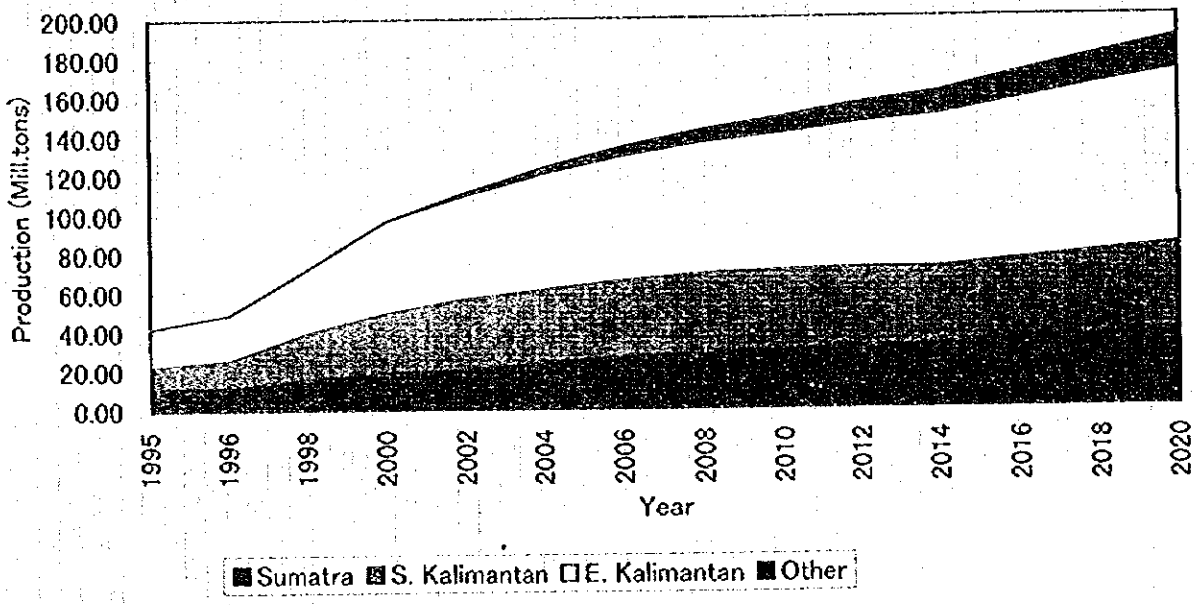


Figure 6-4 Coal Production Projections by Region

6-3-3 Analysis of Coal Production Projection by Mining Method

At present, 97% of the total coal production are coming from the open pit coal mines, and this trend may continue to 2020 without any marked changes. And the various reasons, such as

a) increment in strip ratio of the present open pit mines
b) stop of strip mining due to run out of minable coal reserves in the contract area
c) strict control of surface reclamation after open pit mining, etc.,

will allow to increase the proportion of underground coal production from about 3% at present to about 11% by 2020 gradually.

The coal production projections by mining method until 2020 are shown in Figure 6-5.

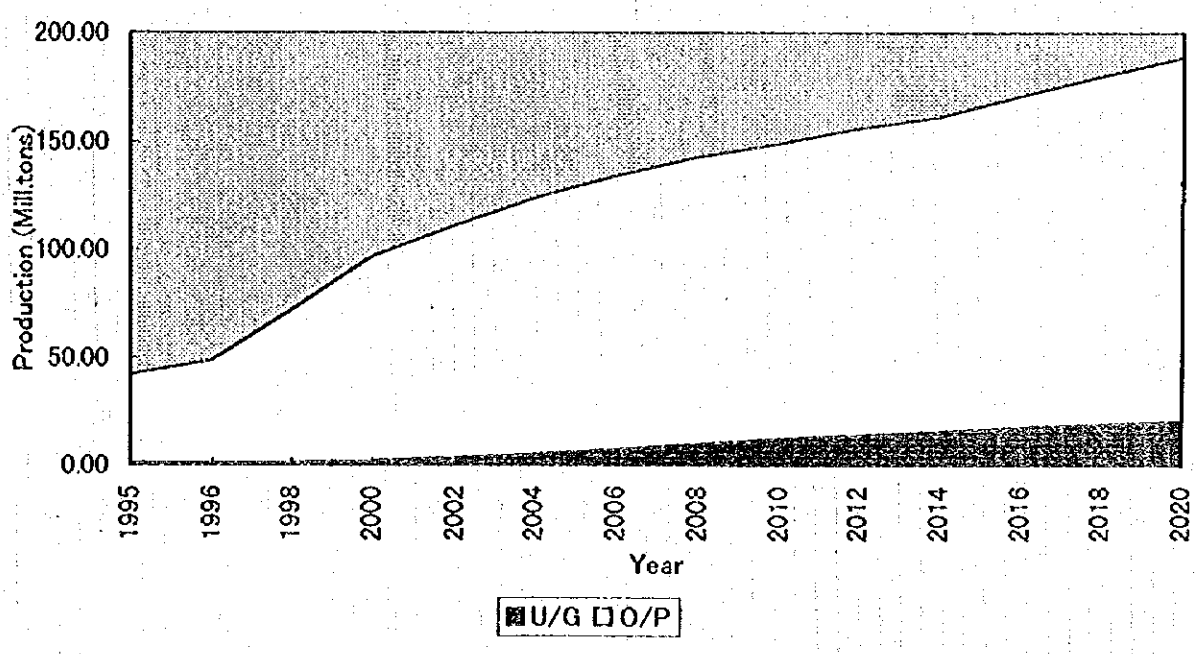


Figure 6-5 Coal Production Projections by Mining Method

6-3-4 Three Scenarios

In order to minimize the risks on long term coal production projections by 2020, the three scenarios, such as the High Scenario, the Base Scenario and the Low Scenario, are considered based on the Base Scenario which is made from the data in Table 6-1. The High Scenario is set at 20% up of the Base Scenario, and the Low Scenario is set at 10% down of the Base Scenario.

The annual coal production projections of the Base, High and Low Scenarios in 2020 result in approximately 189, 227 and 170 million tons, respectively as shown in Table 6-2. Also the annual coal production projections of 3 scenarios in every 2 year by 2020 are shown in Table 6-3.

6-3-5 Evaluation of Coal Production Projections

A total of approximately 190 million tons is projected as a final figure on base scenario of the coal production in 2020, of which 170 million tons are come from the open pit coal mines and 20 million tons are from the underground coal mines.

At present, a total of about 36 billion tons of coal reserves, consisting of about 4.78 billion tons of Measured reserves, about 12.8 billion tons of Indicated reserves, about 5.9 billion tons of Inferred reserves, and about 13 billion tons of Hypothetic reserves, is calculated. is calculated. The future exploration will bring the class of reserves up in some amount, but could not be a critical amount. So, it is desired to classify the coal reserves in quality ranks and to allocate each rank coal for appropriate utilization in order to use them in efficient manners and environmentally friendly ways.

To achieve the programmed coal production target, which is approximately 200 million tons per annum in 2020, it is essential to develop the coal mines of the 2nd and 3rd generation CCOW contractors as scheduled.

Table 6-2 Proposed 3 Scenarios on Coal Production Projection in 2020

Base Scenario	No. of Contractor	Success Ratio	Production Scale (Mill. tons/y)	Total Production (Mill. tons/y)
PTBA	-	-	-	12.10
1st Gen. CCOW	-	-	-	85.70
KP Mines	-	-	-	4.50
KUD Mines	-	-	-	0.30
Sub-total				102.60
2nd Gen.CCOW	18	50%	2.0	18.00
After 3rd Gen.	91	50%	1.5	68.25
Total Base Scenario				188.85 ≒ 189
High Scenario (20% up of Base Scenario)				
PTBA	-	-	-	14.52
1st Gen.	-	-	-	102.84
KP Mines	-	-	-	5.40
KUD Mines	-	-	-	0.36
Sub-total				123.12
2nd Gen.	18	60%	2.0	21.60
After 3rd Gen.	91	60%	1.5	81.90
Total				226.62 ≒ 227
Low Scenario (10% down of Base Scenario)				
PTBA	-	-	-	10.89
1st Gen.	-	-	-	77.13
KP Mines	-	-	-	4.05
KUD Mines	-	-	-	0.27
Sub-total				92.34
2nd Gen.	18	45%	2.0	16.20
After 3rd Gen.	91	45%	1.5	61.43
Total				169.97 ≒ 170

Remarks: a) 1st Gen. - CCOW Contractors of First Generation; b) 2nd Gen. - CCOW Contractors of Second Generation; c) After 3rd Gen. - CCOW Contractors after Third Generation

Table 6-3 Coal Production Projections for 3 Scenarios in every 2 Year by 2020

(Million tons)

		PTBA			CCOW(1st Generation)			KP & KUD Mines			CCOW(2nd Generation)			CCOW(After 3rd Generation)			Grand Total		
Year	Scen.	O/G	O/P	Total	O/G	O/P	Total	O/G	O/P	Total	O/G	O/P	Total	O/G	O/P	Total	O/G	O/P	Total
1996	High	0.06	10.56	10.62	-	42.91	42.91	1.32	3.78	5.10	-	-	-	-	-	-	1.38	57.25	58.63
	Base	0.05	8.80	8.85	-	35.76	35.76	1.10	3.15	4.25	-	-	-	-	-	-	1.15	47.71	48.86
	Low	0.05	7.92	7.97	-	32.18	32.18	0.99	2.84	3.83	-	-	-	-	-	-	1.02	42.94	43.97
1998	High	0.06	15.12	15.18	0.36	65.76	66.12	1.32	3.78	5.10	-	-	-	-	-	-	1.74	84.66	86.40
	Base	0.05	12.60	12.65	0.30	54.80	55.10	1.10	3.15	4.25	-	-	-	-	-	-	1.45	70.55	72.00
	Low	0.05	11.34	11.39	0.27	49.32	49.59	0.99	2.84	3.83	-	-	-	-	-	-	1.31	63.50	64.80
2000	High	0.08	18.36	18.44	0.60	89.27	89.87	1.62	3.90	5.52	0.24	2.16	2.40	-	-	-	2.54	113.69	116.23
	Base	0.07	15.30	15.37	0.50	74.39	74.89	1.35	3.25	4.60	0.20	1.80	2.00	-	-	-	2.12	94.74	96.86
	Low	0.06	13.77	13.83	0.45	66.95	67.40	1.22	2.92	4.14	0.18	1.62	1.80	-	-	-	1.91	85.27	87.17
2002	High	0.07	16.20	18.07	0.60	99.00	99.60	1.62	3.90	5.52	0.84	3.36	4.20	1.20	4.80	6.00	4.33	129.06	133.39
	Base	0.06	15.00	15.06	0.50	82.50	83.00	1.35	3.25	4.60	0.70	2.80	3.50	1.00	4.00	5.00	3.61	107.55	111.16
	Low	0.05	13.50	14.36	0.45	74.25	74.70	1.22	2.92	4.14	0.63	2.52	3.15	0.90	3.60	4.50	3.25	96.79	100.04
2004	High	0.19	18.96	19.15	0.60	102.84	103.44	1.62	3.90	5.52	1.20	4.80	6.00	2.88	11.52	14.40	6.49	142.02	148.51
	Base	0.16	15.80	15.96	0.50	85.70	86.20	1.35	3.25	4.60	1.00	4.00	5.00	2.40	9.60	12.00	5.41	118.35	123.76
	Low	0.14	14.22	14.36	0.45	77.13	77.58	1.22	2.92	4.14	0.90	3.60	4.50	2.16	8.64	10.80	4.87	106.52	111.38
2006	High	0.78	19.08	19.86	0.60	104.16	104.76	1.62	3.90	5.52	1.68	6.48	8.16	4.56	18.24	22.80	9.24	151.86	161.10
	Base	0.65	15.90	16.55	0.50	86.80	87.30	1.35	3.25	4.60	1.40	5.40	6.80	3.80	15.20	19.00	7.70	126.55	134.25
	Low	0.59	14.31	14.90	0.45	78.12	78.57	1.22	2.92	4.14	1.26	4.86	6.12	3.42	13.68	17.10	6.93	113.89	120.82
2008	High	1.36	17.50	19.10	0.60	104.76	105.36	1.62	3.90	5.52	2.04	8.16	10.20	6.24	24.96	31.20	12.06	159.18	171.36
	Base	1.30	14.60	15.90	0.50	87.30	87.80	1.35	3.25	4.60	1.70	6.80	8.50	5.20	20.80	26.00	10.05	132.65	142.80
	Low	1.17	13.14	14.31	0.45	78.57	79.02	1.22	2.92	4.14	1.53	6.12	7.65	4.68	18.72	23.40	9.05	119.38	128.52
2010	High	2.32	16.32	18.64	0.60	102.24	102.84	1.74	4.14	5.88	2.40	9.60	12.00	7.92	31.68	39.60	14.98	163.98	178.96
	Base	1.93	13.60	15.53	0.50	85.20	85.70	1.45	3.45	4.90	2.00	8.00	10.00	6.60	26.40	33.00	12.48	136.65	149.13
	Low	1.74	12.24	13.98	0.45	76.68	77.13	1.31	3.10	4.41	1.80	7.20	9.00	5.94	23.76	29.70	11.23	122.98	134.22
2012	High	2.45	12.72	15.17	0.60	103.80	104.40	1.74	4.14	5.88	2.76	11.04	13.80	9.60	38.40	48.00	17.15	170.10	187.25
	Base	2.04	10.60	12.64	0.50	86.50	87.00	1.45	3.45	4.90	2.30	9.20	11.50	8.00	32.00	40.00	14.29	141.75	156.04
	Low	1.84	9.54	11.38	0.45	77.85	78.30	1.31	3.10	4.41	2.07	8.28	10.35	7.20	28.80	36.00	12.86	127.57	140.44
2014	High	2.47	12.72	15.19	0.60	99.84	100.44	1.74	4.14	5.88	3.12	12.72	15.84	11.28	45.12	56.40	19.21	174.54	193.75
	Base	2.06	10.60	12.66	0.50	83.20	83.70	1.45	3.45	4.90	2.60	10.60	13.20	9.40	37.60	47.00	16.01	145.45	161.46
	Low	1.85	9.54	11.39	0.45	74.88	75.33	1.31	3.10	4.41	2.34	9.54	11.88	8.46	33.84	42.30	14.41	130.91	145.31
2016	High	2.48	12.72	15.20	0.60	100.80	101.40	1.74	4.14	5.88	3.60	14.40	18.00	12.96	51.84	64.80	21.38	184.14	205.52
	Base	2.07	10.60	12.67	0.50	84.00	84.50	1.45	3.45	4.90	3.00	12.00	15.00	10.80	43.20	54.00	17.82	153.45	171.27
	Low	1.86	9.54	11.40	0.45	75.60	76.05	1.30	3.11	4.41	2.70	10.80	13.50	9.72	38.88	48.60	16.04	138.10	154.14
2018	High	2.94	12.72	14.76	0.60	101.88	102.48	1.86	4.14	6.00	3.96	15.84	19.80	14.64	58.56	73.20	23.10	193.14	216.24
	Base	1.70	10.60	12.30	0.50	84.90	85.40	1.55	3.45	5.00	3.30	13.20	16.50	12.20	48.80	61.00	19.25	160.95	180.20
	Low	1.53	9.54	11.07	0.45	76.41	76.86	1.39	3.11	4.50	2.97	11.88	14.85	10.98	43.92	54.90	17.33	144.85	162.18
2020	High	1.80	12.72	14.52	0.60	102.24	102.84	1.86	3.90	5.76	4.32	17.28	21.60	16.38	65.52	81.90	24.96	201.66	226.62
	Base	1.50	10.60	12.10	0.50	85.20	85.70	1.55	3.25	4.80	3.60	14.40	18.00	13.65	54.60	68.25	20.80	168.05	188.85
	Low	1.35	9.54	10.89	0.45	76.68	77.13	1.39	2.93	4.32	3.24	12.96	16.20	12.29	49.14	61.43	18.72	151.25	169.97

Remarks: High & Low scenarios are 20% up and 10% down of Base scenario