THE INTERIM REPORT FOR THE FEASIBILITY STUDY ON EFFECTIVE UTILIZATION OF BANKO COAL IN THE REPUBLIC OF INDONESIA

May, 1985

JAPAN INTERNATIONAL COOPERATION AGENCY

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THE INTERIM REPORT FOR THE FEASIBILITY STUDY ON EFFECTIVE UTILIZATION OF BANKO COAL IN THE REPUBLIC OF INDONESIA (SUMMARY)

In response to the request of the government of the Republic of Indonesia, the Government of Japan decided to conduct the Feasibility Study on Banko Coal Effective Utilization as one of the international cooperation programs for the social and economic development of developing countries.

Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of the technical cooperation programs of the government of Japan, and Agency for the Assessment and Application of Technology (Badan Pengkajian dan Penerapan Teknologi: BPPT) as a counterpart agency concluded the Agreement (Scope of Work) on February 24, 1984.

The Institute of Energy Economics, Japan (IEE, Japan), as the consultant for the implementation of the Study, (Japanese Study Team), is undertaking the Study in close cooperation with the counterpart.

This Interim Report illustrates and reports the results of the strategic investigation (1st stage) carried out in FY 1984.

1. Outline of the Study

The objective of the Study is to establish an appropriate master plan of effective utilization of Banko coal and to examine its technical, economic and financial feasibility, including coal gasification test, and to prepare a proposed project.

TYPE OF PROGRAM	Government-sponsored technical cooperation
AGENCY FOR THE IMPLEMENTATION Japanese side Indonesian side	 JICA (Japan International Cooperation Agency) BPPT (Agency for the Assessment and Application of Technology)
OBJECTIVE	Feasibility study on effective utilization of Banko coal in Indonesia
COAL RESOURCES	Non-transportable brown coal reserved in Banko area of South Sumatra
APPLICATION TECHNOLOGY	Coal gasification
PRODUCTS	Synthetic fuel oil, chemicals
SCOPE OF THE STUDY	1) Market survey on alternative liquid fuel and basic chemicals in Indonesia 2) Survey on reserves, quality and mining cost of Banko coal 3) Survey on gasification characteristics of Banko coal, using a small scale test plant 4) Investigation of a master plan for effective utilization of Banko coal 5) Financial analysis and economic evaluation for proposed project
DURATION	1984 - 85 (5 years) 1) Strategic Investigation Stage: One year 2) Coal Gasification Test Stage : 2.5 years 3) Feasibility Study Stage : 1.5 years

2. Outline of the Strategic Investigation (1st stage)

(1) Objective of the strategic investigation

The strategic investigation in FY 1984 puts emphasis on establishment of an appropriate master plan of Banko coal effective utilization.

(2) Method of the strategic investigation

The Study encompasses a wide variety of subjects to be investigated because the production of synthetic fuel (methanol) from brown coal belongs to rather new technical and economic field and has less commercial experiences through the world.

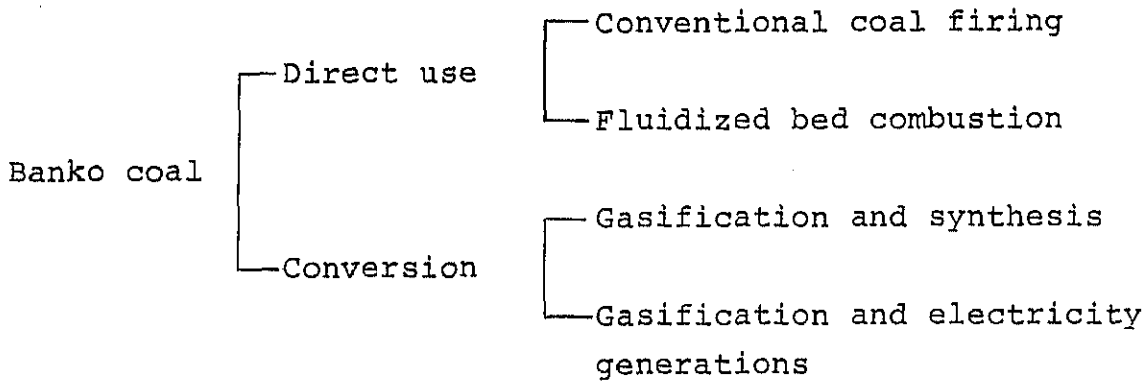
Therefore, the strategic investigation implemented in FY 1984 was planned to investigate the following principal elements by four of study teams.

1) Study team No. 1 : Preliminary survey on markets (May, June)
2) Study team No. 2 : Survey on Banko coal resources (July, Aug.)
3) Study team No. 3 : Survey on brown coal utilization technology (Sept. - Dec.)
4) Study team No. 4 : Strategic investigation on Banko coal effective utilization (Jan. - March)

The data and information collected and analyzed by study team No. 1 - No. 3 were synthesized and summerized into the master plan.

3. Scope of Study for Banko Coal Utilization

Principle technology of coal utilization was widely investigated and selected for Banko coal as follows:



Coke production and direct liquefaction were excluded from scope of study because:

Coke production	:	There is no technology for brown coal
Direct liquefaction	:	Technical development is still at the beginning stage of pilot plant and technical and economic data for a commercial plant can not be obtained for the time being.

4. Summary on Background, and Market Survey of Lignite and its Derivatives

(1) Background of this Study

1) Role of Crude oil

Production capacity of crude oil in Indonesia is estimated to be about 1,600 x 10^3 B/D and oil had 64% share in total export revenue in FY 1983.

2) Trend on domestic energy consumption

Domestic energy consumption has increased by 13.6%/yr. during ten years from 1972 to 1982. And also, share of oil in total energy consumption is as high as 80%. As a result of high increase rate of domestic oil consumption and level off in crude oil production capacity, oil export is declining after 1977 of peak year.

Crude oil consumption in Indonesia has been slow in its increase trend these few years, because of high price policy.

3) Energy policy

The Government aims to decrease its oil dependence from 78% to 62% in 1988/89 at the end of REPELITA-IV through promotion of alternative energy sources to oil and energy conservation.

In REPELITA-IV, the economy and energy consumption is to grow by 5%/yr. and 7%/yr. respectively. On the other hand, domestic petroleum consumption is expected to grow by less than 3%/yr.

By these policies, oil export capability in Indonesia is expected to be assured in the level of above 1 million B/D.

4) Coal utilization policy

Alternative energy sources such as coal, hydro and geothermal are planned to be developed in REPELITA-IV and, above all, special emphasis is to be laid upon development of coal utilization.

5) Long-term prospect of energy supply and demand

Migas model which was jointly developed through the study on Indonesia Data Bank by Indonesia and Japan (JICA), was used in this long term demand projection.

According to long term energy projection, total commercial primary energy demand and petroleum products will increase by 6.8%/yr. and 5.0%/yr. respectively. Primary energy demand and oil demand in 1995 will be 2.36 times and 1.89 times respectively as large as that in 1982. These figures show that potential energy demand in Indonesia still remains bull. And therefore, demand for petroleum product would increase significantly than originally expected unless present high fuel-price policy and development of alternative energy resources are retained.

Exogenous Variables Used in Long-term Projection of Energy Supply and Demand

	%/Yr. 1995/82	Remarks
Growth rate of crude oil production	0.35	1982; 133.7 $x10^4$ B/D 1995; 140 $x10^4$ B/D
Growth rate of exported crude oil price	3.5	29.53 $/BBL ('83)
Deflator for agricultural goods export price	7.1	
Index for international export price	7.1	
Exchange rate of Rp. relative to U.S.$	-5	
Population	2.0	2.3 (80/71) 158 million ('83)
Government consumption expenditure	14.0	6831 x 10^9 Rp. ('82)

Long-term Prospect of Energy Supply and Demand

	1982			1995			95/82 (%/yr)
	10^3tce	Physical Unit	%	10^3tce	Physical Unit	%	
National Gas	12,781		23.1	21,968		16.8	4.3
Coal	217		0.4	19,160		14.6	41.2
Hydro Power	1,060		1.9	10,626		8.1	19.4
Geo-thermal	0		0	1,029		0.8	-
Oil	41,357	206,371 565 x 10^3 B/D	74.6	78,073	389,584 1067 x 10^3 B/D	60.0	5.0
Grand Total	55,415	276,521 758 x 10^3 B/D	100	130,856	652,971 1789 x 10^3 B/D	100	6.8

(2) Market Survey on Derivatives from Banko Coal

1) Utilization of direct combustion

There are coal-fired power plant construction plans of about 5,000 MW next decade and Banko coal utilization as a power generating fuel is very promising.

However the feasibility study on power generation through direct combustion or combined cycle with gasification at mine mouth should be necessary because of difficulty in long-distance transportation of Banko coal.

2) Methanol as fuel for specific usage

Methanol production from synthesis gas is promising as an alternative fuel to oil and especially there would be very big economic impact by substituting methanol for diesel oil, which has big domestic demand for power generation.

3) Methanol for blended gasoline

R&D activities in some western countries are active for methanol blended gasoline these days. As a matter of fact, blending methanol with gasoline (about 3% of blending ratio) is being considered also in Indonesia.

4) Fertilizer

Domestic demand for fertilizer has been growing by as high as 10%/yr. Though natural gas has been used as its feedstock, the feedstock price for fertilizer company has been kept in low level from policy consideration. If this feedstock price should be decontrolled and increased to international market price level, fertilizer production from synthesis gas via coal could find some outlet in domestic market.

5. Results of Survey on Banko Coal Resources and Preliminary Estimation of its Mining Cost

The major objectives of the survey were as follows:

a) To clarify Banko coal resources and its quality

b) To grasp preliminarily coal mining cost.

(1) Coal reserves in Banko area

Coal exploration in Banko area was carried out by Shell in 1974 through 1978.

The survey revealed the following amount of coal reserves in Banko area (up to 100 m in depth).

COAL RESERVES IN BANKO AREA

Area	Measured Reserves 10^6 tons	Strip Ratio m^3/t coal	Coal Quality
Block A (North West Banko)	129.5	2.0	Total Moisture 28 - 35%
Block B (West & Central Banko)	178.5	1.5	Ash 4 - 16% (dry base)
Block C (Central Banko)	127.5	2.5	Volatile Matter 40.5-48.5% (dry base)
Total	435.5	-	Total Sulfur 0.15-2.4% (dry base) Calorific value 6100 - 7100 (dry base)

(2) Coal quality in Banko area

1) Banko coal is classified into non-transportable coal because of such troublesome features as its easy spontaneous combustion, fragility during transportation and stock, and high moisture content.

2) Banko coal contains high Na_2O of more than 0.6% within coal and ash fusion temperature of some coal seams is very low (around 1,150°C). Therefore fouling and slagging may be caused on tubes in case of a conventional boiler.

3) Coal quality of North West Banko is summarized by Shell as follows:

COAL QUALITY OF NORTH WEST BANKO COAL

(Average coal, dry base)

Ash (%)	6.7	
Volatile Matter (%)	45.4	
Gross C.V. (Kcal/kg)	6820	
Total Sulphur (%)	0.59	
In-situ Moisture (%)	25-35	(Range)
Sodium Oxide in Ash (%)	4-40	(Range)
" " below 40 m (%)	12	(Average)

(3) Site Reconnaissance and Chip Sampling

1) Outcrops and chip sampling

Slight amounts of coal samples were taken from shallow underground of 12 outcrops in the Banko, Suban Jeriji and Baturaja areas.

The analysis data suggest that the weathering of all samples has advanced because of sampling from near surface of the outcrops.

2) Study on sampling spot and method for coal gasification test.

Considering the purpose of coal gasification test, further study for selection of sampling spots and method shall be carried out in FY 1985, using small boring machine.

a) Analysis for an affect of weathering vs depth using small boring machine (up to 50 m depth)

b) To find out outcrops of each coal seem using small diameter auger drillings (up to 10 m depth)

c) To decide sampling spot and method based on a) and b)

(4) Preliminary study on plant site

During site reconnaissance, possible plant sites for commercial plants have been visited.

a) Banko site
b) Lematang River site
c) Musi River site

Considering major conditions for plant site selection such as distance to mining area, availability of river water and arranged infrastructures, Banko site seems to be the most potential candidate at this moment.

(5) Preliminary Estimation of Coal Mining Cost

1) Mining conditions and parameters

Mining conditions and mining parameters were studied as pre-conditions for preliminary cost estimation of coal mining.

i) Mining conditions

a) Coal prospect : North West Banko (Block A)
b) Mining area : about 4 km^2
Strike side length: about 8 km
Width (average) : 520 m
c) Mining depth : 100 m
d) Dip : 10 - 15°
e) High wall angle : 20°
f) Strip ratio (actual): 2.82 bank m^3/t. coal.
g) Overburden materials: Clay stone and tuff

ii) Mining parameters

a) Coal reserves in situ: 123 million tons

b) Minable coal : 98 million tons assuming
wheathering loss of 5%
geological loss of 10%
mining loss of 5%

c) Coal production (assumed): 3 million tons/year

d) Mine life : 33 years

e) Required processing materials
Coal as product : 2.3 million bank m^3/year
Overburden as spoil: 8.5 million bank m^3/year
(Total: 10.8 million bank m^3/year)

2) Conceptual plan of coal mining method
Conceptual plans of two different types, continuous mining method and non-continuous mining method are studied based on the above conditions and parameters.

i) Continuous mining method

a) Equipment and system
Bucket wheel excavators: For digging and loading
Belt conveyors : For transportation

b) Face arrangement : Five tiers of benches and faces in five blocks

c) Actual equipment driving hours:
3,863 hours/year assuming 3 shift operation and suspending time of 1605 hr due to rainfall.

d) Required capacity for equipment design:
2,800 bank m^3/hr

e) Major equipment design
Bucket wheel excavators
Nominal cutting capacity: 1,000 bank m^3/hr.
unit
Total units : 5 (4 in operation)

Face conveyors and cross pit conveyors

Capacity : 2,000 losse m^3/hr x 5 units

Total length : 10,800 m

Trunk belt conveyors and overland belt conveyors

Capacity : 4,000 loose m^3/hr x 3 units

Total length : 9,600 m

f) Manpower planning : 1,289 persons

ii) Non-continuous mining method

a) Equipment and system

Rope shovels : For digging and loading

Rear dump trucks : For face transportation

Belt conveyors : For overland transportation

b) Face arrangement : Six tiers of benches and faces in four blocks.

c) Actual equipment driving hours: 3,018 hours/year assuming 3 shift operation and suspending time of 1,566 hr due to rainfall.

d) Required capacity for equipment design: 3,580 bank m^3/hr

e) Major equipment design

Rope shovels

Bucket capacity: 13 m^3

Total units : 6 (5 in operation)

Rear dump trucks

Nominal capacity: 77 tons per unit

Total units : 29 (23 in operation)

Belt conveyors (coal)

Capacity : 2,800 loose m^3/hr

Total length : 1,500 m

Belt conveyor (spoil)

Capacity : 5,600 loose m^3/hr

Total length : 1,500 m

f) Manpower planning : 1,000 persons

3) Preliminary estimation of coal mining cost

i) Assumptions for coal mining cost

a) Equipment and facilities cost: Based on the costs in Japan in the second quarter of 1984 and no price escalation.

b) Funds : 100% on loan

c) Depreciation:

Period: Service life for equipment and 33 years for facilities

Method: Straight line method

d) Interest: 10 percent per year for depreciated value (assumed as 50% of initial investment for each year)

e) Labor cost: 3,300,000 Rp per year

f) 1 US$ = 240 Yen = 960 Rp

ii) Continuous mining method

a) Investment

Initial investment	158 x 10^6US$
Additional investment (up to 30th year)	128 "
Total	286 "

b) Coal mining cost

Operating/labor	4.13	US$/ton-coal
Depreciation	6.80	"
Interest	3.03	"
Administration	3.28	"
Total	19.70	"

iii) Non-continuous mining method

a) Investment

Initial investment	61 x 10^6	US$
Additional investment (up to 30th year)	184	"
Total	245	"

b) Coal mining cost

Operation/labor	6.58	US$/ton-coal
Depreciation	3.04	"
Interest	1.95	"
Administration	2.31	"
Total	13.88	"

iv) Above coal mining costs are not including costs for royalty, taxes if there are, and infrastructure such as housing, hospital, school and other necessary supporting facilities as well as costs for coal transportation over 1,500 m.
Also above preliminary cost estimations include some assumptions and preconditions as described in each chapter.
Therefore, needless to say, more accurate and rigid estimation is required for the feasibility study.

6. Results of Survey on Banko Coal Utilization Technology

The following fields of brown coal utilization technology were studied and it was clarified that commercial technology in each field is well developed and ready for commercialization.

a) Brown coal gasification technology
b) Technology for derivative production
c) Technology for electricity generation
d) Neat methanol engine

(1) Survey on coal gasification technology

1) Required performance for coal gasification technology

Required performances clarified by survey on market and coal resources are as follows:

a) To be superior for synthesis gas production to produce synthetic fuel oil and urea

b) To be superior for electricity generation

c) To be applicable for high sodium-in-ash and a wide range of ash fusion temperature as well as coal quality

2) Classification of coal gasification

More than ten of advanced coal gasification technology has been developed since the first oil crysis mainly in U.S.A., W. Germany, England and Japan and are evaluated to be ready for commercialization.

The reaction mechanism and structure of these advanced gasifiers are different, but can be classified into the four types.

a) Fixed bed gasifier ——┐
b) Fluidized bed gasifier ——┘—— suitable for electricity generation

c) Entrained flow gasifier ——┐
d) Molten iron bath gasifier ——┘—— available for synthesis and electricity generation

3) Technology development in Japan

In Japan, five types of coal gasification technology have been developed by Sun Shine project of MITI or private company.

i) CMRC/EPDC/NEDO

a) Air blow-pressurized type of fluidized bed gasifier having two reactors.
b) Development of coal gasification combined cycle system.
c) Under test operation using 40 T/day pilot plant.
d) Under basic design of 1,000 T/day demonstration plant.

ii) SUMITOMO Steel Industry

a) Oxygen blow atmospheric pressure type of molten iron bath gasifier
b) Production of synthesis gas
c) Completed the test operation using 60 T/day pilot plant
d) Under construction of 240 T/day demonstration plant with slightly pressurized type (Joint work with KHD of W. Germany)

iii) EPDC/NEDO

a) Oxygen blow-pressurized type of fluidized bed gasifier for coal and tar mixture
b) Production of town gas and fuel gas
c) Under test operation using 12 T/day pilot plant (20 T/day coal equivalent)

iv) CRIEPI/MHI

a) Air/oxygen blow-pressurized type of entrained flow gasifier

b) Production of fuel gas and synthesis gas

c) Under test operation using 2 T/day pilot plant

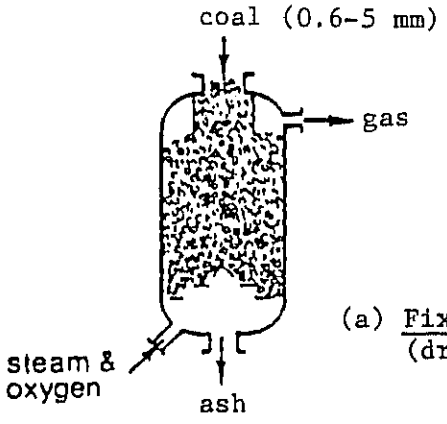
v) HITACHI/NEDO

a) Oxygen blow-pressurized type of entrained flow gasifier (two stage reaction in one reactor)

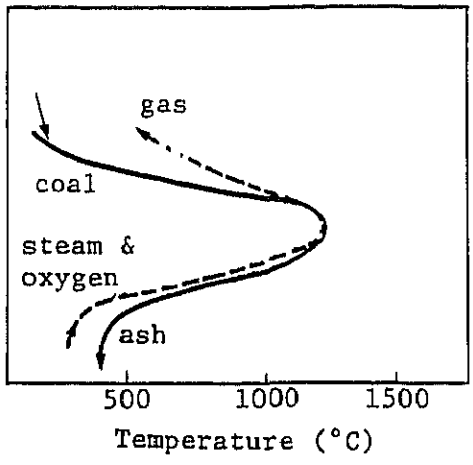
b) Production of fuel gas and synthesis gas

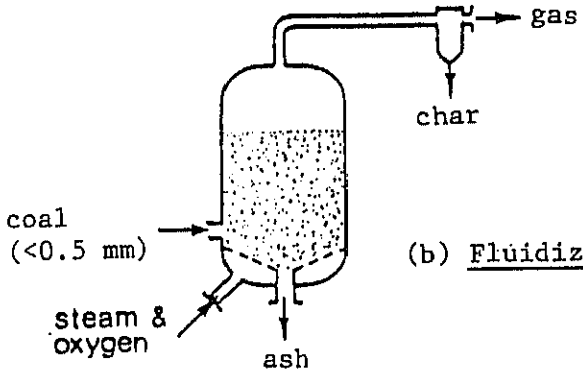
c) Under test operation using 1 T/day pilot plant

CLASSIFICATION OF PRINCIPAL COAL GASIFIER TYPES

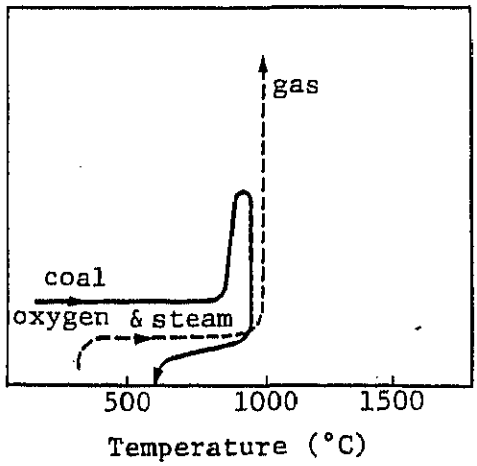


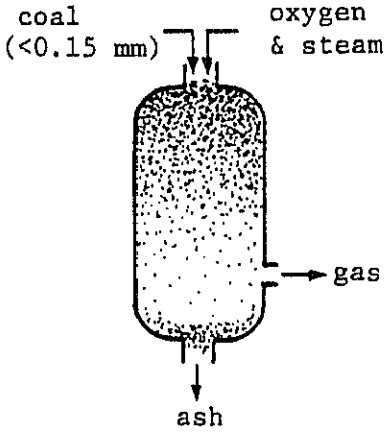
(a) Fixed Bed
(dry ash)



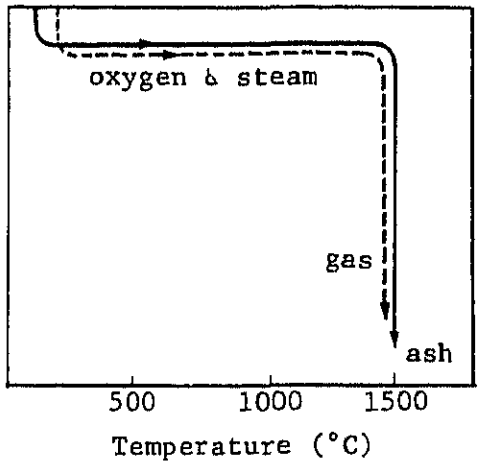


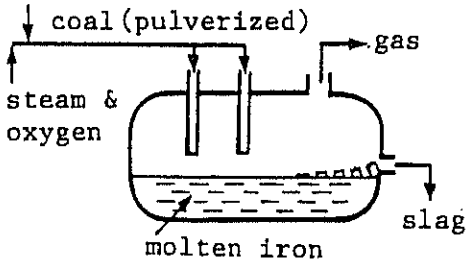
(b) Fluidized Bed



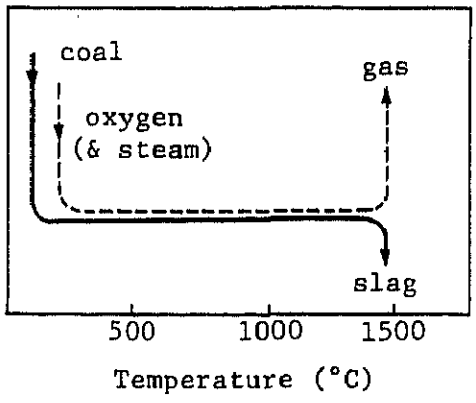


Entrained Flow





Molten Iron
Bath



SUMMARY OF OPERATIONAL AND PERFORMANCE CHARACTERISTICS
FOR JAPANESE GASIFIERS

	Fluidized Bed		Entrained flow		Molten Iron Bath
Name and/or Developpers	CMRC EPDC NEDO	-HYBRID- EPDC NEDO	CRIEPI MHI	HITACHI	-CGS PROCESS- SUMITOMO
Gasifying Medium	Air/Steam	O_2/Steam	Air,O_2/Steam	O_2/Steam	O_2
Coal Size & Feed Method -Size -Feed	1.5 mm Lock-hopper	< 1 mm Resid.Oil Slurry	200 mesh under 80-90 % Pneumatic	200 mesh under 70 % Pneumatic	200 mesh under 70 % Pneumatic
Ash State	Dry	Dry	Slag	Slag	Slag
Operating Press. & Temp. -Pressure kg/cm^{2}G -Temperature °C	20 840-920	30 750-950	20 1000-1600	9 1300-1600	Atm. 1400-1600
Efficiencies -Carbon Conversion % -Cold Gas Efficiency %	94 71	87.7 71.5		93 70	> 98 74-80
Steam & O_2 Requirement -Steam kg/kg-coal -O_2 〃	1.0 Air 2.1Nm^3	2.2 0.5-0.7		0.8	0.05-0.15 0.5
Gas Composition Typical (vol%,Dry) H_2 CO CH_4 CO_2 N_2	 14.5 9.2 5.6 16.5 53.3	 31 14 21 32 --	 8.4 18.1 1.6 8.0 60.7	 32.3 55.0 0.2 12.4 --	 32.7 61.1 -- 3.0 --
Capacity T/D(One Unit)	40	20 (equivalent)	2	1	60
Application	Power	SNG	Power	Multi-use	Multi-use
Remarks	◦Combination with Dry Desulf. System ◦Two Stage F.B.	•Coal:4 T/D H.Oil:8 T/D	◦Two Stage entrained flow -combustor -reductor	◦Two Stage Reaction	◦Lime & Flux ◦240 T/D Pilot Plant in Sweden under construction

CMRC: Coal Mining Research Center
EPDC: Erectric Power Develop. Co.
NEDO: New Energy Development Organization
CRIEPI: Central Research Institute for Erectric Power Industries
MHI: Mitsubishi Heavy Industries

CGS: Creative Gas and Steel

(2) Survey on technology for derivative production
The following technology was investigated, considering possibility of production in Indonesian.

a) Methanol as fuel and chemicals

b) Synthetic fuel oil (F/T process)

c) Ammonia and urea

d) Single cell protein

e) Gasoline from methanol (MTG process)

It was clarified that commercial technology for above products is well developed and ready for commercialization.

(3) Survey on technology for electricity generation

i) Conventional coal firing power plant
Banko coal is difficult to utilize in a conventional coal firing power plant, because high sodium-in-ash will cause severe fouling and slagging on heat transfer surfaces within the boiler.

ii) Fluidized bed combustion power plant
Fluidized bed combustion boiler seems to be suitable for Banko coal, because low combustion temperature eliminates the potential for fouling and slagging. The details will be studied in further study.

iii) Coal gasification combined cycle power plant
CGCC power plant seems to be more suitable for Banko coal, if high temperature gas turbine and hot gas clean-up system will be developed. However more concrete evaluation will be done in further study, watching the technical development.

(4) Survey on neat methanol engine

According to the market survey, it was pointed out that the production of fuel methanol is hopeful for substitution of diesel oil, especially for special-purpose-utilization such as electricity generator, city bus, agricultural equipment and mining equipment which are operated within rutined route. The objective of the survey was to cralify utilization technology of neat methanol as engine fuel.

1) Gas turbine

Gas turbine is highly suitable engine for neat methanol. In case of the existing gas turbine, neat methanol can be easily applied by minor changes of fuel supply system and combustion chamber.

2) Gasoline engine (Otto cycle)

Gasoline engine is also suitable engine for fuel methanol. However, commercial application of neat methanol car for multi-purpose utilization will not be easy because of "chicken and egg" dilemma between car manufacturers, methanol producers and methanol distributors.

3) Diesel Engine (Sabathe cycle)

Ordinary diesel engine is unsuitable engine for neat methanol because methanol is low in its cetane value.

However spark assist diesel engine developed by Komatsu in Japan can be applied for neat methanol as well as diesel oil.

It is notable that spark assist diesel engine designed for neat methanol has flexibility for fuel selection, neat methanol or diesel oil.

7. Preliminary evaluation of coal gasification technology

(1) Technology for synthesis gas production

All taking into the consideration, overall evaluation shows that oxygen blow-molten iron bath gasifier is superior for production of synthesis gas from Banko coal. Pressurized molten iron bath gasifier will be more better, if such a technology will be developed.

Evaluation of Coal Gasification Technology
for Synthesis Gas Production

	Fixed bed (dry ash)	Fludizied bed (oxygen blow)	Entrained flow (oxygen blow)	Molten iron bath (oxygen blow)
Gas composition	5	4	2	1
Impurity	4	3	2	1
Flexibility for coal quality	4	3	2	1
Overall thermal efficiency	3	2	3	1
Gas pressure	1	1	1	3
Operatability and safety	1	1	3	1
Construction cost	3	2	2	1
Commercial experience	1	1	1	2
Total	22	17	16	11
Overall evaluation (ranking)	4	2	2	1

(2) Technology for coal gasification combined cycle power generation

Overall evaluation shows that air blow-pressurized type of fluidized bed gasifier is superior for CGCC power generation, providing that the technical development of hot gas clean-up system will be completed.

Evaluation of Coal Gasification Technology for CGCC Power Generation

	Fixed bed (dry ash. air blow)	Fluidized bed (pressurized. air blow)	Entrained flow (pressurized. oxygen blow)	Molten iron bath (atm. pressure. oxygen blow)
Gas pressure	1	1	1	10
Oxygen.steam consumption	2	1	3	2
Tar content	3	1	1	1
Impurity	3	2	2	1
Gas calorific value	1	1	1	1
Carbon conversion	1	2	1	1
Operatability and safety	2	1	4	1
Construction cost (including air separation)	5	1	4	3
Commercial experience	1	1	1	2
Flexibility for coal quality	4	3	2	1
Total	23	14	20	23
Overall evaluation (ranking)	3	1	2	3

(3) Technology for coal gasification test

JICA study team and the counterpart (BPPT) have discussed and evaluated on the choice of the technology for the coal gasification test plant in PUSPIPTEK and agreed that the Molten Iron Bath process shall be selected.

The details of discussion are described on attached "Minutes of Meeting - Technology for coal gasification test plant" signed on Nov. 1, 1984.

Evaluation of Coal Gasification Technology
for the Coal Gasification Test Plant

	Entrained Flow	Molten Iron Bath
Synthesis Gas Production		
CO and H2	o	o
Sulfur compounds	x	o
Flexibility for coal quality	x	o
Tested with Banko coal	x	o
Experience	o	x
Operatability	x	o
Maintenability	o	x
Technology transfer	x	o
Conclusion	x	o

Legend : o = good
x = average

8. Prospect of Effective Utilization of Banko Coal

(1) Technical feasibility of Banko coal utilization

1) Coal gasification and derivatives of synthesis gas
Coal gasification technology for production of synthesis gas, synthetic technology of derivative production and the utilization technology of derivatives production are well developed and ready for commercialization.

2) Direct combustion
It is evaluated that Banko coal is difficult to use in a conventional boiler because Banko coal contains high-sodium-in ash.
A fluidized bed combustion boiler seems to be superior for Banko coal because of its low combustion temperature. However the technical and economic feasibility shall be studied in further stage because the survey for the technology is insufficient at this moment.

3) Coal gasification combined cycle electricity generation
Coal gasification technology for CGCC is almost developed. However the technical development of high temperature gas turbine (1,300°C class) and hot gas clean-up system is still under development.
Therefore, the evaluation of technical feasibility will be carried out in due cource watching the development of above subjects.

(2) Economic Possibility of Banko Coal Utilization

1) Method of Study
For the time being, some of principal factors for financial and economic analysis are not yet studied. Therefore, the economic possibility is discussed on the basis of published literatures using the estimated preliminary selling price of Banko coal.

2) Estimated preliminary selling price of Banko coal

The selling price of Banko coal was preliminarily estimated on the basis of "cost and profit" for coal mining, because non-transportable coal can not be affected by the world market price. The formula is as follows:

$$\text{Selling price (dry base)} = \frac{A}{(1 - B)} \times (1 + C) \times (1 + D)$$

Here A : mining cost (wet base)
B : weight loss by drying (% of A)
C : drying cost (% of A)
D : profit (% of dry coal cost)

In case of Banko coal, each figure is as follows:

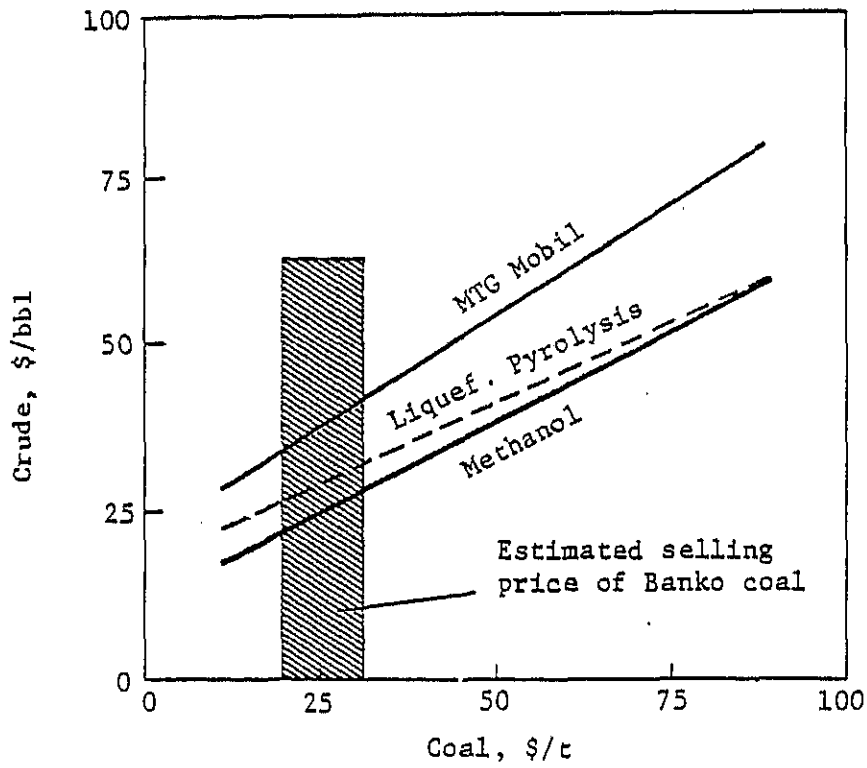
A = 14 $/ton : estimated for non-continuous method
B = 0.25)
C = 0.10) : estimated from coal quality
D = 0.20 : assumed

According to above formula and assumption, the estimated selling price of Banko coal is approximately 25 $/t (dry coal).

3) Economic possibility of methanol production

Production cost was estimated by correlation between coal price and production cost of methanol taken from Hydrocarbon processing. Aug., 1984.

Crude Oil/Synthetic Gasoline Equivalence (Coal)



The Source: Hydrocarbon Procersing. Aug., 1984.

25 $/ton of the estimated selling price of Banko coal gives approximate production cost as follows:

Methanol : equivalent to 25 $/bbl of crude oil

For the time being, the price of crude oil is FOB 27 - 29 $/bbl.

Therefore economic possibility of methanol production seems to be high, because it is estimated that the price of crude oil will be increased in future.

4) Economic possibility of methanol to gasoline (MTG)
The economics of MTG will be not feasible if the price of crude oil is not higher than 36 - 37 $/bbl.
However, the merit of gasoline produced by MTG is not to require any special delivery facilities.

Therefore the economic feasibility will depend on the price prospect and Indonesian Government policy on price for petroleum gasoline.

5) Economic possibility of urea production
Production cost is estimated by correlation between coal price and production cost of urea taken from "Coal Gasification for Ammonia/Urea plant in Palembang" by Ir Kresno Sunarto and P.T. PUPUK SRIWIDJATA in May, 1983. 25 $/ton of coal price gives 160 $/ton of urea production cost. FOB price of urea in export market is around 170 - 180 $/ton for the time being. Therefore economic possibility of urea production from Banko coal depends on natural gas price in Indonesia.

6) Economic possbility of electricity generation
Coal gasification combined cycle electricity generation at mine mouth and supply to Java by high voltage direct current transmission line seems to be hopeful because the estimated coal price is enough low compared with exportable coal.
However, economic possibility of above system will be evaluated in further study, watching the technological development, especially 1,300°C gas turbine and hot gas clean-up system.

9. Master Plan for Banko Coal Effective Utilization

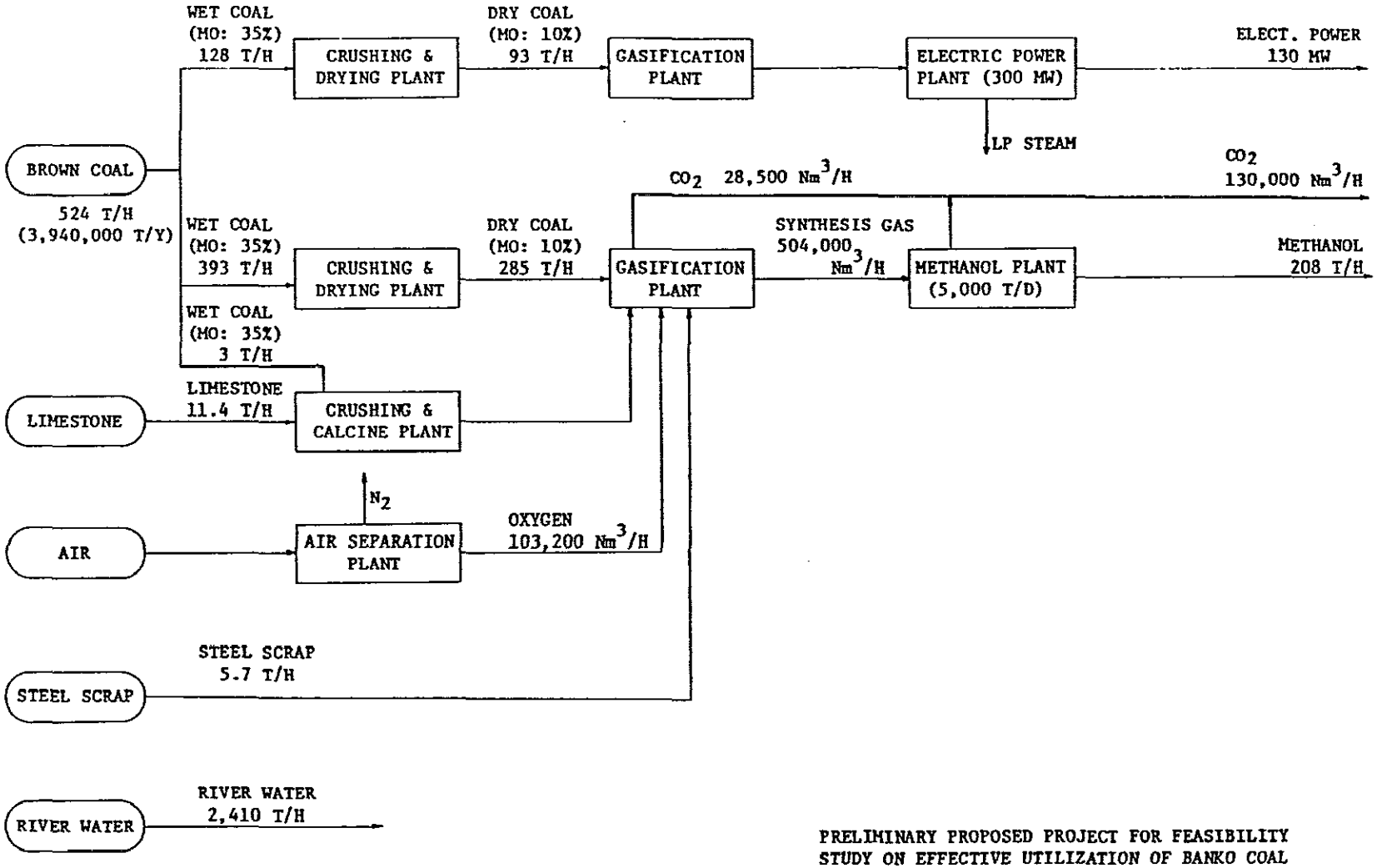
1) The following two cases were selected as principal utilization of Banko coal, reflecting the study results for market, coal resources and utilization technology.
   a) Fuel methanol and mine mouth power generation
   b) Fuel methanol, and urea, and mine mouth power generation

   Furthermore, according to the different capacities of mine mouth power generation, six cases of heat and material balances (required coal demand, production capacity and utilities consumptions) were studied to select the master plan.

2) According to the heat and material balance, all of six cases were evaluated to be available for commercialization.

3) As conclusion, the following two cases were selected as the master plan of Banko coal effective utilization. The suitable power generation capacity will be studied in further study, including the economics of high voltage transmission line.

Power generation capacity	MW	300	1,000
Required coal (wet)	million ton/year	3.9	6.0
(dry)	"	2.8	4.8
Methanol production	"	1.6	1.6
Quality of methanol	-	Chemical grade	Chemical grade
Electricity to JAWA	MW	85	800
Required cooling water	ton/hr	2,400	5,100



PRELIMINARY PROPOSED PROJECT FOR FEASIBILITY
STUDY ON EFFECTIVE UTILIZATION OF BANKO COAL

10. Plan of Coal Gasification Test

(1) Objectives of coal gasification test are as follows;

1) To grasp the gasification characteristics of different type of brown coal reserved in Banko area.

2) To prepare necessary technical data for the feasibility study (3rd stage), synthesizing with existing large scale pilot plant data.

Note: The objective of the coal gasification test is not for the development of new technology nor collection of engineering data.

(2) Capacity of test facilities

The capacity of the test facilities is 20 kg/hr as coal feed rate.

Such a capacity was selected on the basis of sufficient capacity necessary to grasp characteristics of gasification of Banko coal.

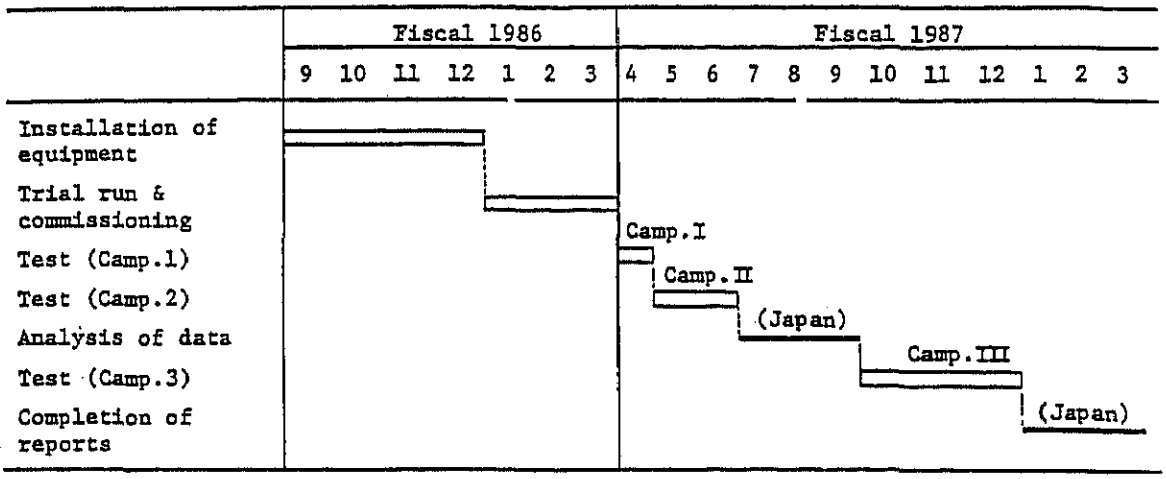
The basic specification required for the experimental equipment is as follows.

Basic specifications required for the experimental equipment

Item	Amount required	Remarks
Molten iron bath	300 kg	
Coal feeding rate	20 kg/h	Dry coal
Blowing oxygen	575 Nm^3/coal-t, 12 Nm^3/h	Standard value, varies with kind of coal.
Carrier gas	150 Nm^3/coal-t, 3 Nm^3/h	N_2
Product gas	2000 Nm^3/coal-t, 40 Nm^3/h	Standard value, varies with kind of coal.
Calcined lime	30 kg/coal-t, 0.6 kg/h	Standard value, varies with kind of coal.
Slag production	78 kg/coal-t, 1.6 kg/h	

(3) Test schedule

Overall schedule of Banko coal gasification experiment



It is so scheduled that installation, trial run and commissioning of the experimental equipment and also a cold test (drying, pulverizing and feeding of the actual Banko coal) will be completed at or before the end of March, 1987.

The gasification test will be conducted in a period of one year, from April, 1987 to March, 1988, and is divided into 3 steps of Campaign I to Campaign III by the purposes of the test.

During Campaign I, preparatory test will be conducted to examine and grasp the characteristics of the test facilities.

During Campaign II, essential test will be conducted to grasp the characteristics of Banko coal gasification.

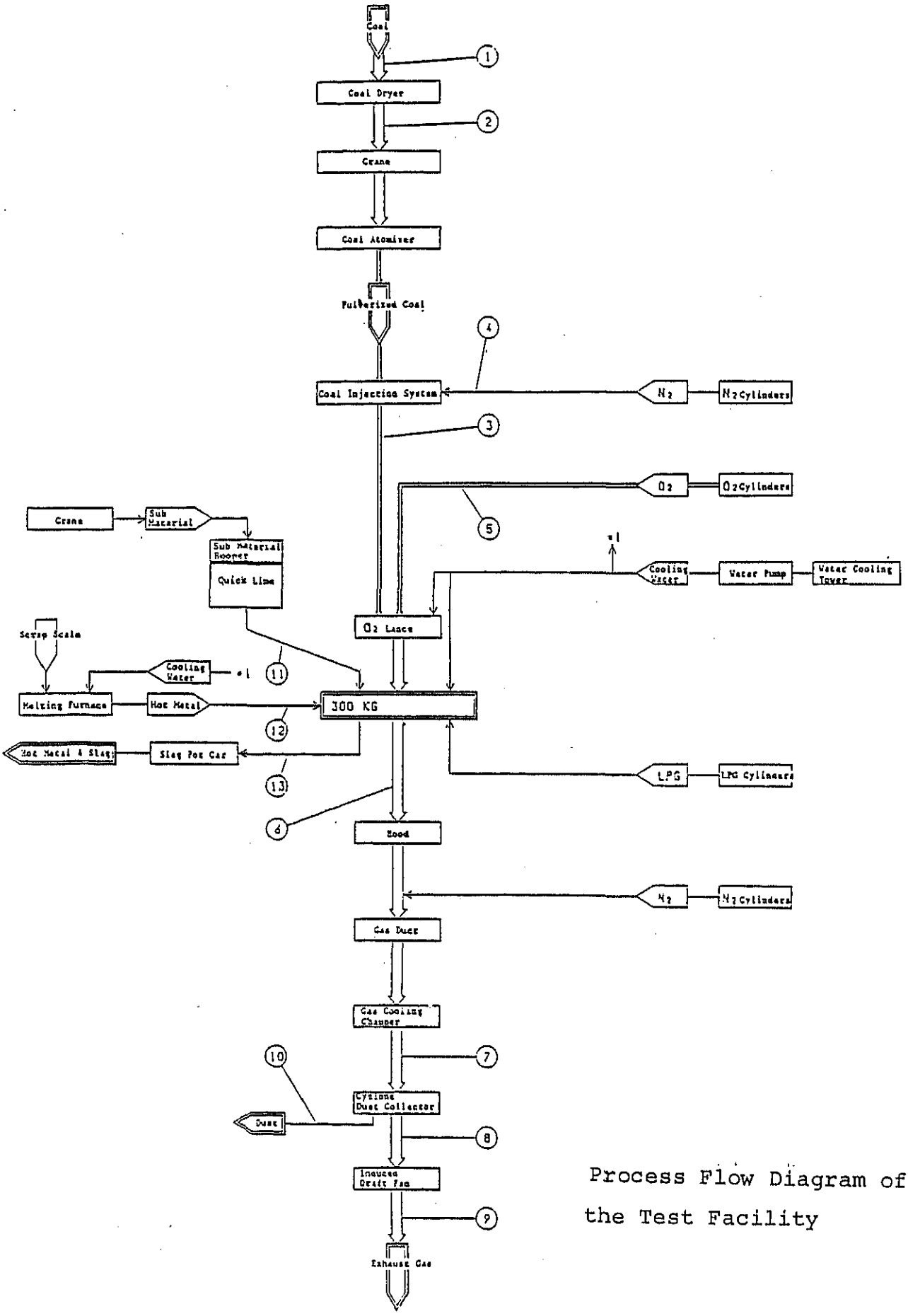
During Campaign III, supplementary experiment will be conducted in consideration of the results of previous test data.

(4) Basic design of the coal gasification test facilities

Basic design was carried out and the following technical information was clarified,

1) Basic design of the test facilities
   - i) Process design conditions
   - ii) Simplified process flow diagram
   - iii) Preliminary piping and instrument diagram
   - iv) Equipment list
   - v) General layout

2) Working plan of the counterpart



Process Flow Diagram of the Test Facility

11. Conclusion and Recommendation

(1) Conclusion

1) The stratigic investigation for effective utilization of Banko coal was carried out through FY 1984. The study includes the principal fields as follows:

   a) Preliminary market survey of Banko coal and its derivatives

   b) Survey on Banko coal resources and preliminary estimation of coal mining cost

   c) Survey on effective utilization technology

   d) Stratigic study for Banko coal effective utilization

   e) Study for coal gasification test

2) The most possible utilization of Banko coal is production of fuel mathanol, urea and electricity generation by coal gasification in view of market, technology, economics and Indonesian Government policy.

3) The measured reserves of Banko coal is enough for commercialization, 435 million tons. However the quality of Banko coal is "non-transportable-problem coal" because of spontaneous combustion and fragility during transportation and stock as well as high sodium-in-ash.

4) The preliminary mining cost of Banko coal is estimated as 14 $/t (wet base) by non-continuous mining method. The selling price is estimated as approximately 25 $/t (dry base) on the basis of "cost and profit" for coal mining.

5) Molten iron bath gasifier for synthesis gas production and fluidized bed gasifier for electricity generation are evaluated as the most superior technology for the time being.

6) It was revealed that spark assist diesel engine designed for neat methanol as fuel is ready for commercialization and has flexibility for fuel selection, diesel oil or neat methanol.

7) Master plan and preliminary proposed projects for Banko coal effective utilization were proposed.

   However such a plan and projects must be studied furthermore in due course.

8) Economic possibility of Banko coal utilization was studied on the basis of the estimated selling price of Banko coal and production cost data obtained from published literatures.

   Production of fuel methal is "hopeful", but MTG (mobil) and urea depend on price of crude oil in future and Government price policy for petroleum gasoline and natural gas.

   Possibility of electricity generation by CGCC depends on future's technical development.

9) As conclusion of the stratigic investigation, the effective utilization of Banko coal seems to be feasible in technical and economic stand point.

   Therefore it is recommended that the coal gasification test stage shall be proceeded as scheduled on Scope of Work.

(2) Recommendation

As the results of the stratigic investigation of effective utilization of Banko coal, the following subsidary subjects are proposed to be carried out in further study period.

1) Maps of Banko area will be prepared for the further study of coal sampling spot and method.

2) Water resources data and soil data will be additionally required for selection of plant site.

3) Market survey on fuel methanol for gas turbine generator and diesel engine generator as well as city bus in Indonesia will be carried out to grasp practical specified demand of fuel methanol.

4) Preliminary feasibility study on high voltage-direct current transmission line between Banko area and Java will be carried out to evaluate mine mouth electricity generation.

THE INTERIM REPORT
FOR
THE FEASIBILITY STUDY
ON
EFFECTIVE UTILIZATION OF BANKO COAL
IN
THE REPUBLIC OF INDONESIA

CONTENTS OF INTERIM REPORT

1. Introduction

In response to the request of the government of the Republic of Indonesia, the Government of Japan decided to conduct the Feasibility Study on Banko Coal Effective Utilization as one of the international cooperation programs for the social and economic development of developing countries.

Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of the technical cooperation programs of the government of Japan, and Agency for the Assessment and Application of Technology (Badan Pengkajian dan Penerapan Teknologi: BPPT) as a counterpart agency concluded the Agreement (Scope of Work) on February 24, 1984.

The Institute of Energy Economics, Japan (IEE, Japan), as the consultant for the implementation of the Study, (Japanese Study Team), is undertaking the Study in close cooperation with the counterpart.

The Study will be carried out in the following three (3) stages:

First stage : Strategic Investigation Stage (1 year)
Second stage: Coal Gasification Test Stage (2.5 years)
Third stage : Feasibility Study Stage (1.5 years)

The strategic investigation stage is to establish a master plan of Banko coal effective utilization and to select optimum technology for the Banko coal gasification test stage.

The coal gasification test stage is to grasp characteristics of gasification of Banko coal and to select coal basin to be studied in the following stage.

The feasibility study stage encompasses analysis and synthesis of collected information and data at the previous stages, investigation of various project plans of Banko coal effective utilization, and preparation of the proposed Project.

This Interim Report has been prepared to report the results of the 1st stage of the Study carried out in FY 1984 and will provide basic data and information as well as the master plan of the Project for further studies.

2. Background of the Study

During the past decade, the environment of energy problems has greatly changed with the two oil crises as turning points. That is, the oil crises triggered sharp oil price increases followed by worldwide recessions and developments of alternative energy resources, resulting to urge for oil producing countries to cut its crude oil prices as well as the amount of export. These structural changes in oil supply-demand and prices have naturally produced great impacts on national alternative energy development policies throughout the world.

In particular, development plans of synthetic fuel, from coal through gasification and liquefaction, which have brilliantly started after the first oil crisis under the initiative taken by Japan, the United States and West Europe, are recently exposed to a severe trial because of surplus and price down of crude oil.

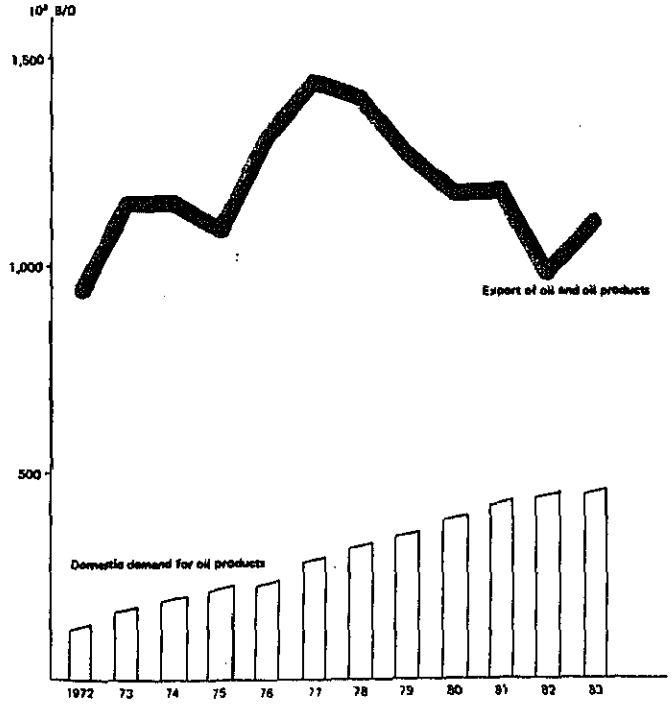
However, during the past decade, conventional alternative energies, including coal, natural gas and nuclear power, have constantly expanded their shares in primary energy, thus greatly contributing to save the oil consumption.

On the other hand, alternative energy development in developing countries has various aspects different from development plans designed for advanced countries. In other words, alternative energy development in developing countries should not merely pursue introduction of energy sources to substitute for oil but be closely related to their industrialization plans.

This means needs to promote industries, expand employment and improve income levels through energy development. In this point Indonesia is not exceptional.

To maintain exports of oil and natural gas at the maximum possible level, the Indonesia Government have been taking the policies to save domestic consumption of those energy resources and to facilitate the development of

Fig. 2-1 OIL EXPORT AND PRODUCTS DEMAND IN INDONESIA



alternative energies.

Among national programs, given priorities by the Indonesian Government are to develop alternative energies, to promote the transmigration and to develop industries.

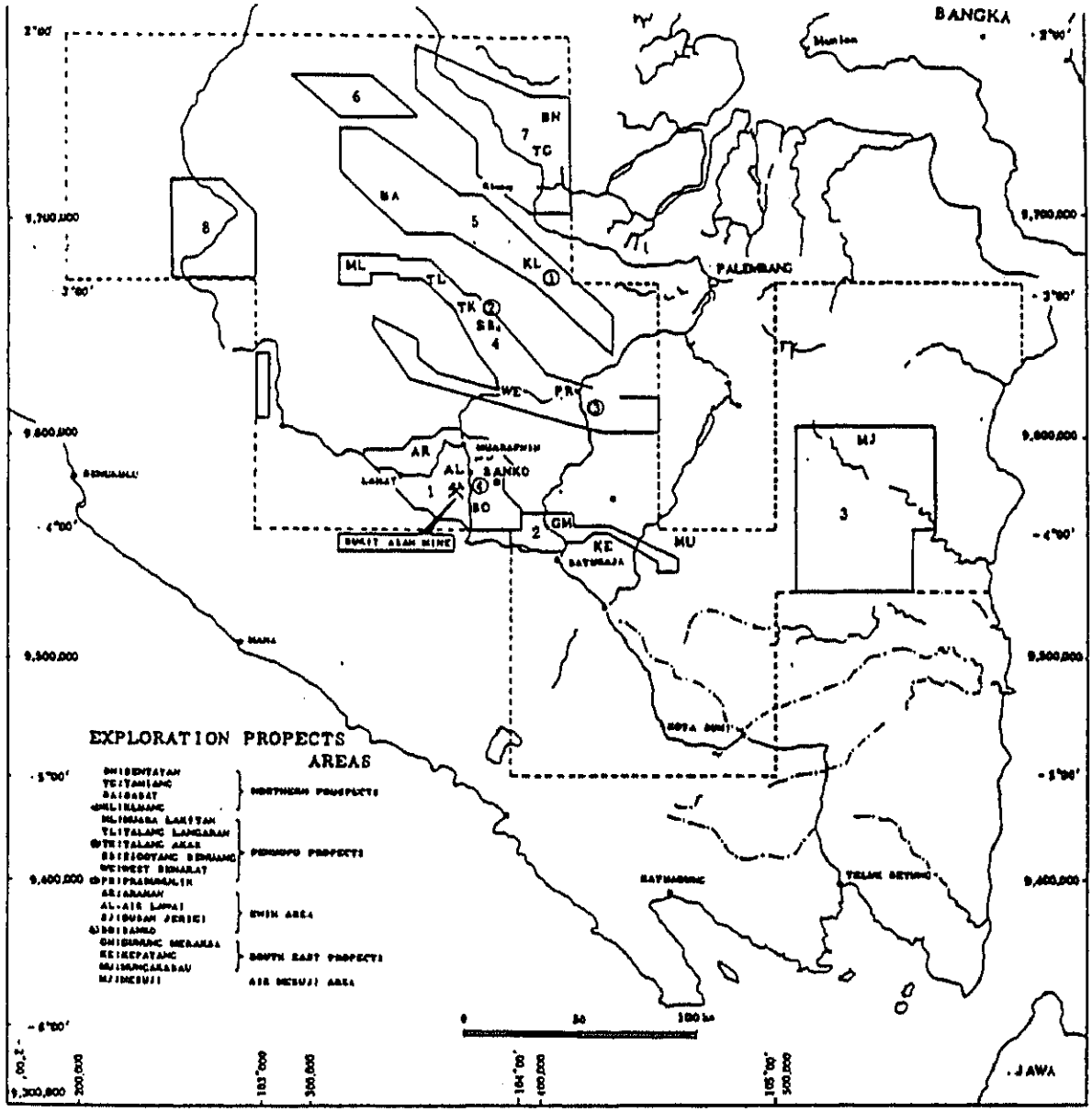
Banko coal available in South Sumatra is the most potential natural resources in view of above mentioned programs, because its estimated reserves are abundant (see Fig. 2-2 and 2-3) and South Sumatra is nominated as one of the most prospective sites for the transmigration from Jawa.

The other hand, Banko coal, classified into brown coal which has low calorific value as fuel and troublesome features so called as spontaneous combustion, denies long-distance transport from both technical and economic aspects.

Therefore the typical utilization as fuel for electric generation or industrial heat source is practically difficult in view of technical and economic aspects.

From technical stand point of view, gasification of Banko coal and production of the derivatives seem to be a potential plan. (see Fig. 2-4)

Fig. 2-2 Map of Blocks for Coal Exploration in South Sumatra



Estimated Reserves in Major Blocks of South Sumatra Coal Field (up to 50 m in depth)

Area	Approximate volumes of coal resources to 50 m. depth. million cubic metres
Bentayan	75
N. Tamiang	100
S. E. Tamiang	40
① N. Kluang	200
S. Kluang(Musi)	1,300
N. Babat	220
S. Babat	90
N. Pendopo(Muara Lakitan, Talang Langaran)	300
② Pendopo North Flank(Talang Akar, Sigoyang Benuang)	1,330
③ Prabumulih	400
West Enim(Arahan, Air Lawai)	120
④ East Enim(Banko, Suban Jerigi)	450
Merakas	110
Baturaja(Kepayung, Muncakabau)	150
Mesuji	250
Total :	5,135

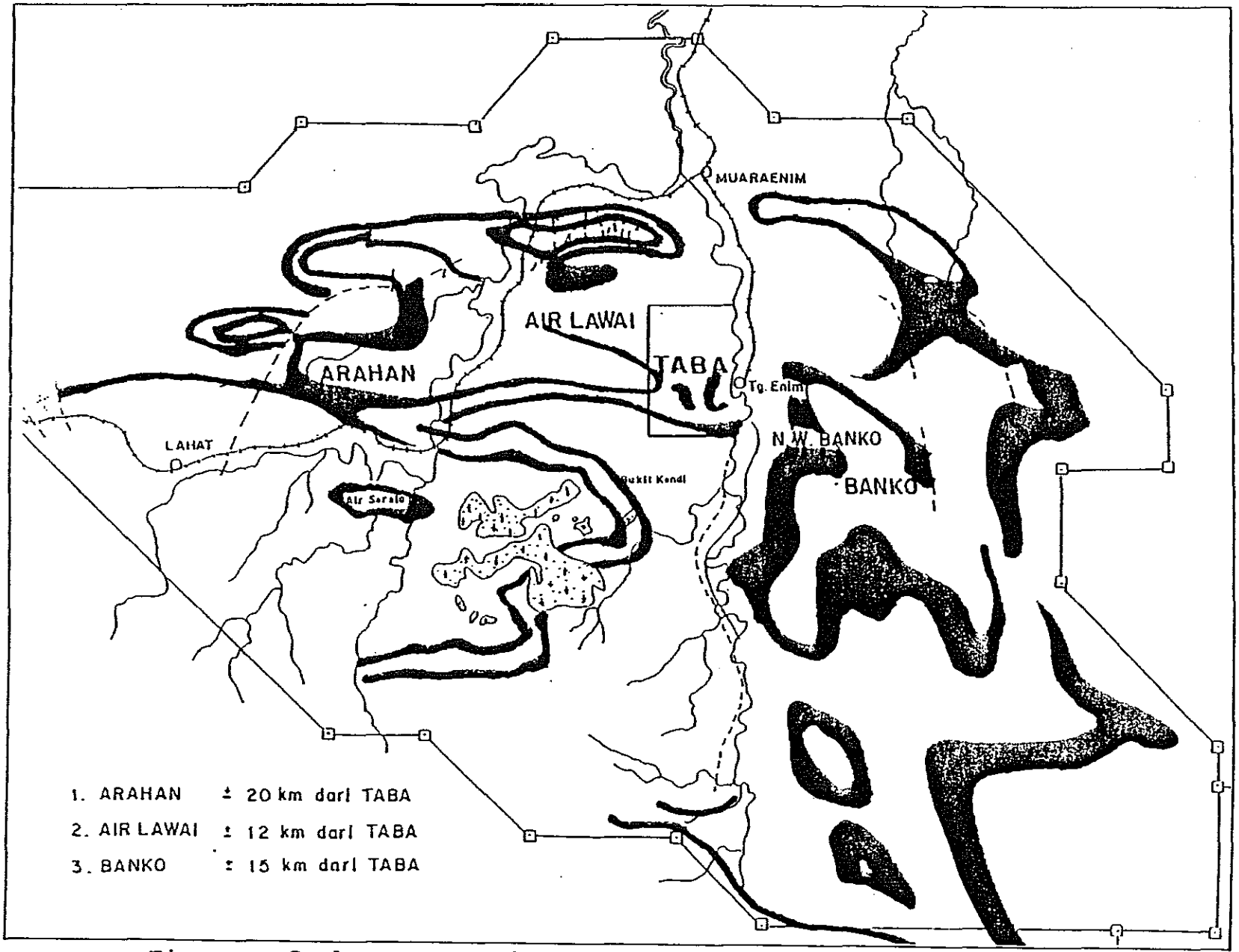
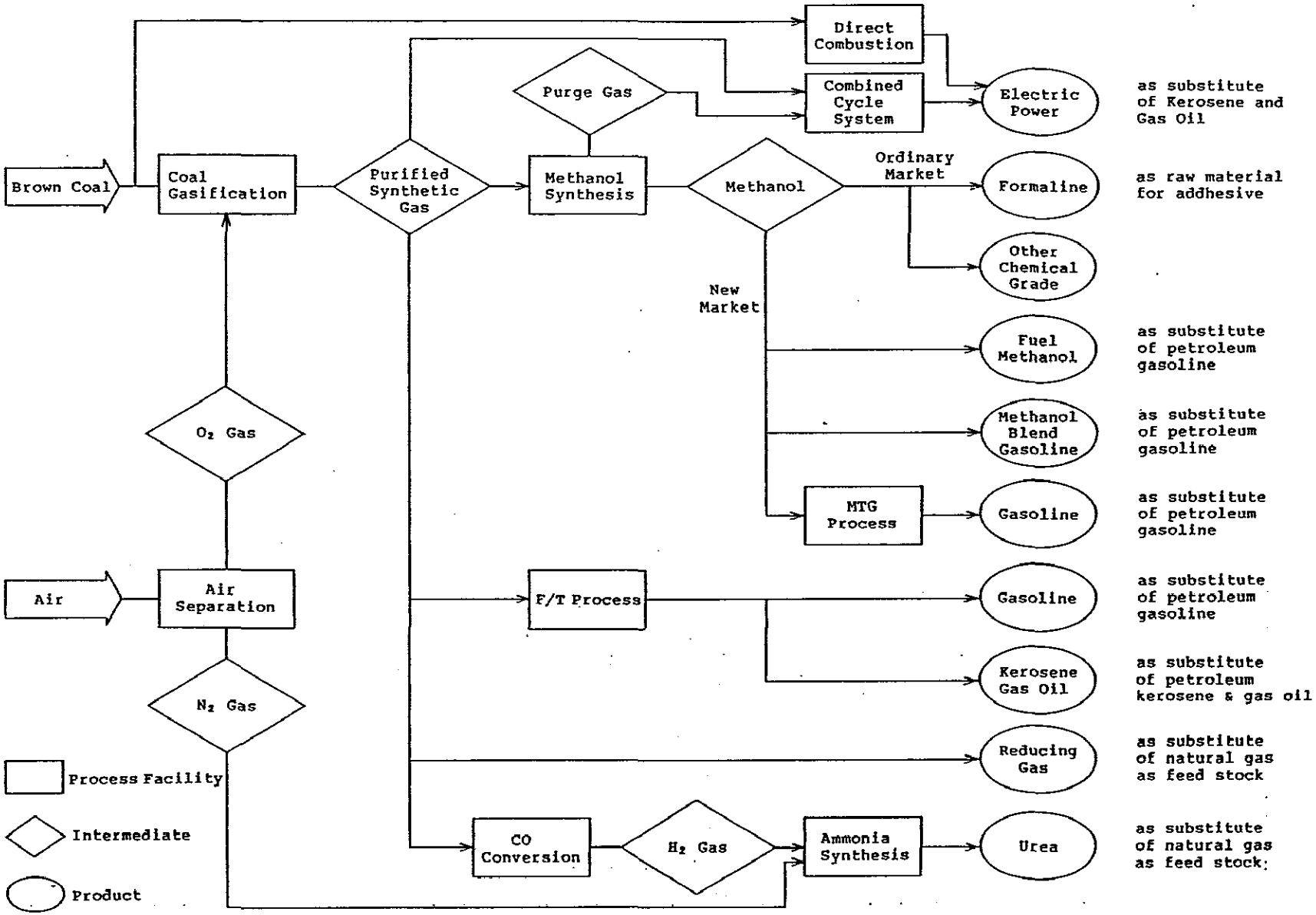


Fig. 2-3 Coal resources in Western part of South Sumatora area.

Fig. 2-4 PRELIMINARY FLOW SCHEME
FOR
BROWN COAL UTILIZATION



From these prospective, the Indonesian Government requests to the Japanese Government to conduct a development survey which will be essential for the preparation of the Banko coal development and its utilization plan.

3. History of the Agreement

(1) In November 1981, the Ministry of International Trade and Industry (MITI) dispatched a mission to Indonesia to investigate preliminarily the feasibility of producing methanol from coal.
As a result of this investigation, Japanese Government found a possibility to produce methanol from Banko coal.

(2) In March 1982, Prof. Dr. Ing. B.J. Habibie, the Minister of Research and Technology, made a request to MITI and the Ministry of Foreign Affairs for the implementation of the feasibility study by Japanese experts when Prof. Dr. Habibie visited Japan.

(3) In the 6th Indonesia-Japan Technology Cooperation Conference held in June 1982, Japanese and Indonesian Governments agreed on the implementation of the study in their research and development program.

(4) Following this agreement, in November 1982, JICA dispatched a delegation in order to confirm the policy and implementation plan of the Indonesian Government.

(5) In February 24, 1984, JICA concluded the Agreement with BPPT for the implementation of this study and recorded the details in the Scope of Work.

4. Outline of the Study

(1) Agreement

Based on the above mentioned background, BPPT and JICA agreed upon the development survey which is titled as "Effective Utilization of Banko Coal", on 24 February, 1984.

The Agreement sets forth the scope of work in details with regard to the Study.

The contents of the Agreement are as follows:

I. Introduction
II. Objective of the Study
III. Scope of the Study
IV. Schedule of the Study
V. Reports
VI. Undertaking of the Government of the Republic of Indonesia
VII. Undertaking of the Government of Japan
VIII. Technical Undertaking of both Governments
IX. Consultation

APPENDIX

I. Flow Chart of the Implementation Plan
II. Schedule of the Study
III. Division of Technical Undertaking

(2) Objective of the Study

The objective of the Study is to establish an appropriate master plan of effective utilization of Banko coal and to examine its technical, economic and financial feasibility, including coal gasification study, and to prepare the reports synthesizing the result of overall investigations and studies.

(3) Scope of the Study

The Study will be carried out in the following three (3) stages:

1. Strategic Investigation Stage
2. Coal Gasification Test Stage
3. Feasibility Study Stage

The stratetic investigation stage is to establish a master plan of Banko coal effective utilization and to select optimum technology for the Banko coal gasification test stage.

The coal gasification test stage is to grasp characteristics of gasification of Banko coal and to select coal basin to be studied in the following stage.

The feasibility study stage encompasses analysis and synthesis of collected information and data at the previous stages, investigation of various project plans to Banko coal effective utilization, and preparation of the proposed Project.

The outline of the Scope of the Study and the consulting procedure for the Scope of Work of each stage are summarized on the flow chart of the implementation plan attached as Fig. 4-1.

(4) Schedule of the Study

Total period required for the Study will be about Five (5) years, and is divided into three (3) stages.

Strategic Investigation Stage : One (1) year
Coal Gasification Test Stage : Two and half (2.5) years
Feasibility Study Stage : One and half (1.5) years

The overall schedule of the Study is detailed in Fig. 4-2.

(5) Strategic Points of the Study

1) Coal Gasification Technology

For the Study on Banko coal effective utilization, coal gasification and synthesis process was selected as principle technology as well as direct use as energy.

Fig. 4-1. Flow Chart
of
IMPEMENTATION PLAN

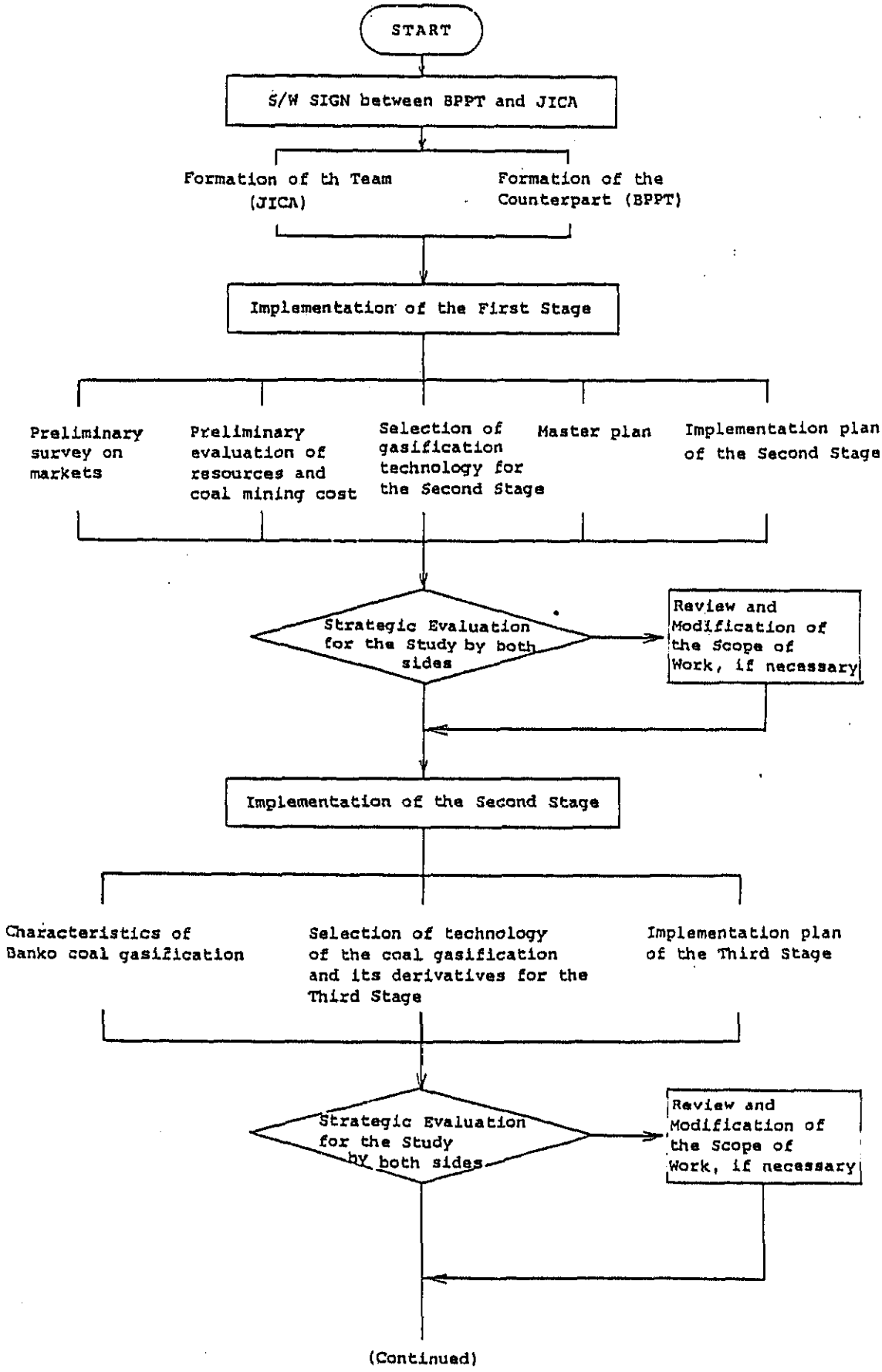
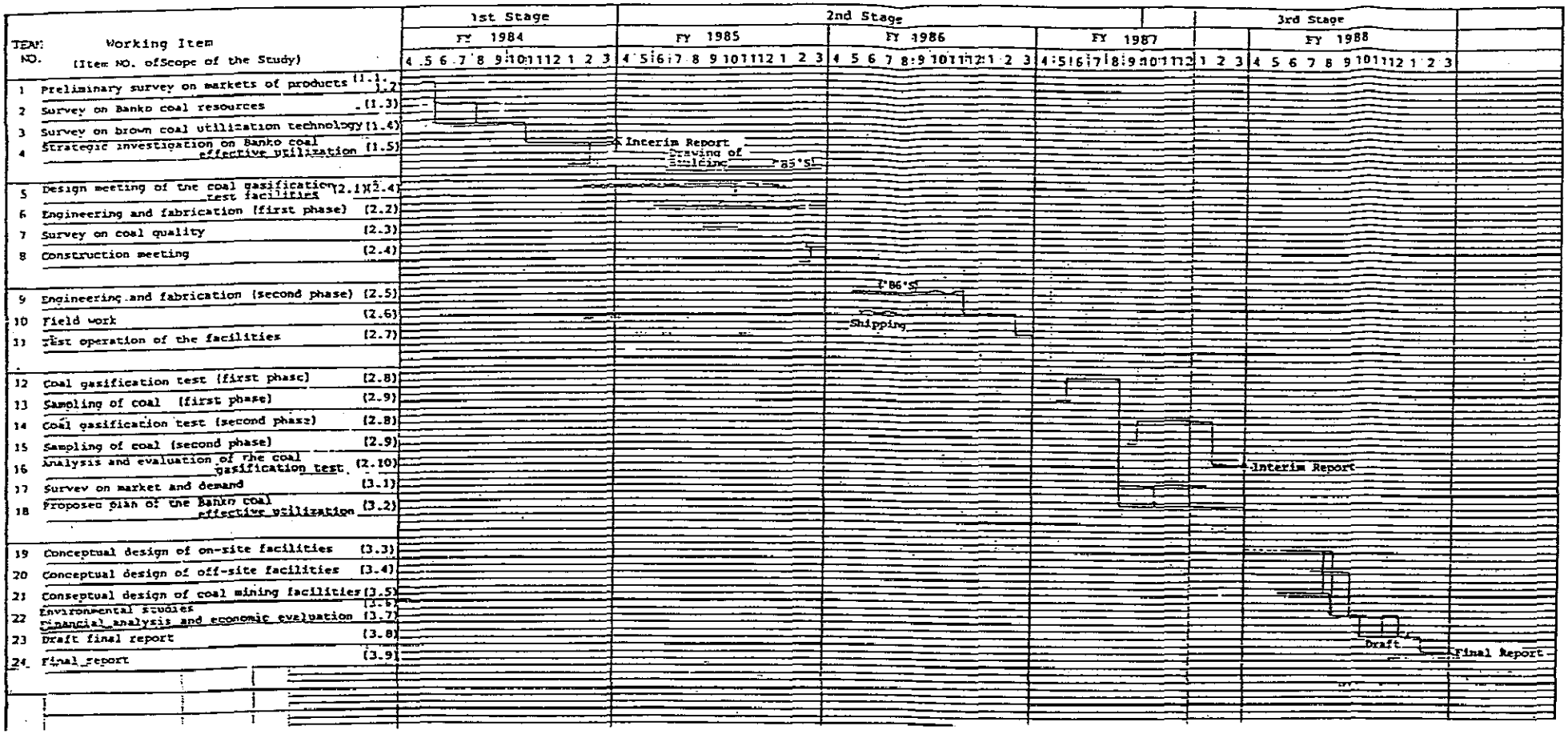
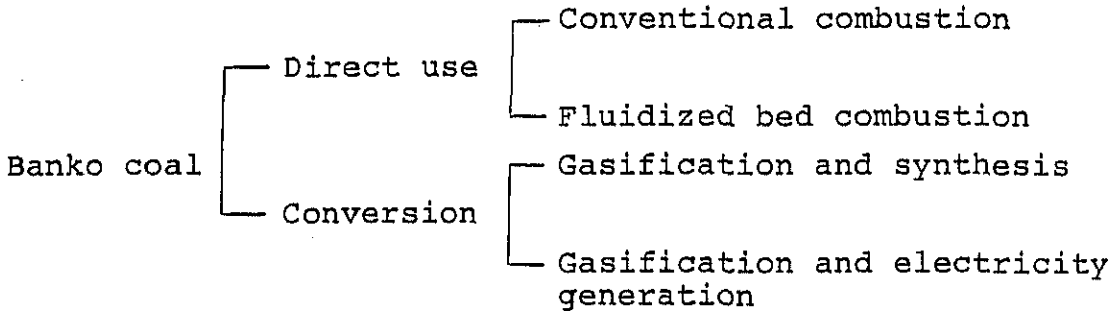


Fig. 4-2 PROJECT NAME: EFFECTIVE UTILIZATION OF BANKO COAL

SCHEDULE OF THE STUDY





Coke production and direct liquefaction were excluded from scope of study, because there is no technology for coke production from brown coal and direct liquefaction is still at the beginning stage of technical development.

In particular, the study shall put emphasis on coal gasification technology, including coal gasification test, because it is reported that the type of coal of Banko area has wide variety by area and seam.

Therefore, the coal gasification technology to be selected for the Project must be able to gasify such a wide variety of brown coal without any technical difficulty.

The selection of the coal gasification technology shall also be influenced on the field of utilization of produced gas, either electric generation or synthesis of produced gas.

The reliability of the technology in commercial operation is also other important factor. Such a study mentioned above shall be deeply investigated through the Study.

2) Market of Derivatives/Energy policy

As described in the Fig. 2-4 synthetic fuel and basic chemicals such as methanol, gasoline, kerosene, gas oil and urea can be produced by coal gasification and synthesis of produced gas in technical stand point of view.

It is needless to say that the kinds and amount of derivatives to be produced in the Project shall be selected in accordance with the demand in Indonesia, considering some amount of export.

The production costs and prices of the derivatives shall be carefully studied, since the prices of energy and chemicals for the domestic market are estimated to be

supported and controlled by the government in a view of the national economic and energy policy and will influence the financial feasibility of the Project.

It is obvious that the demand of products is greatly influenced on the price.

Therefore, the demand and price of the derivatives must be carefully investigated with the highest priority in relation with economic and energy policy of Indonesia.

Required endeavor for the market development of the derivatives shall be also studied in the course of the Study.

3) Mining Cost and Quality of Coal

Roughly speaking, the production cost of synthetic gas is shared in 30% for coal, 20% for Oxygen, 20% for facilities and 30% for utilities and others.

Therefore the mining cost is one of important factors for economic and financial feasibility of the Project. It is important to investigate the mining cost of coal as feed stock for gasification, considering geological features, coal seam structure, coal quality, infrastructure required and mining system to be employed.

In particular, mining system to be employed shall be studied in relation with transmigration policy and labor cost in BANKO area.

Coal quality is another important subject to be investigated because coal quality is one of the key factors for selection of coal gasification technology to be employed in the Project.

4) Labor cost/Transmigration policy

It is estimated that labor cost of the Project has deep relation with transmigration policy and industrialization plan of BANKO area.

In particular, the development of Banko coal resources and the effective utilization are expected to contribute for not only production of alternative energy and basic chemicals but also promotion of transmigration policy with reasonable working gain for transmigrator.

In view of national economy, working gain at transmigration area are to be evaluated as benefit for the country.

From above mentioned prospects, the estimated labor cost for the Project should be discussed and decided in the course of the Study.

5) Infrastructure Development Plan of the South Sumatra

The infrastructure and the investment required for the Project shall be studied in relation with development plans of the South Sumatra.

In particular, the development plans related to the expansion project of the BUKIT ASAM shall be studied in details.

Plant site shall be decided considering the development plans, distance from transmigration area and the coal mining field as well as other industrial projects in future.

Required infrastructure shall be designed to contribute to and harmonize with the overall development plan of the South Sumatra.

The undertaking of the Indonesian Government and the Project for the construction of the infrastructure shall be discussed and clarified in the course of the Study.

5. Implementation of the Study in FY 1984

(1) Detailed Scope of the Study

In accordance to Scope of Work, the study for the following subjects was carried out in FY 1984.

Note: Item number of the following subjects is the same number with Scope of Work.

1.1 Survey on background of the Project

1.1.1 National policy on energy in Indonesia

(1) National development plan in REPELITA-VI

- (i) Basic philosophy of the New Development Plan
- (ii) Average GDP growth rate by economic activity sector during the period of the Plan
- (iii) Prospect for growth of export/import by main commodities and balance of payment
- (iv) Investment plan of main industrial development projects
- (v) Other relating matters for REPELITA-IV

(2) National policy on energy

- (i) Domestic energy supply
- (ii) Export of energy
- (iii) Development of alternative energy sources
- (iv) Diversification of domestic energy
- (v) Management of energy resources
- (vi) Subsidy for energy sector

1.1.2 Present situation and the estimation of demand for, and supply of, energy in short, medium and long term

(1) Energy supply structure

- (i) Crude oil
- (ii) Natural gas
- (iii) Coal
- (iv) Electricity and the primary energy
- (v) Imported crude oil and oil products

(2) Energy consumption structure
  (i) Industrial sector
  (ii) Thermal power generation sector
  (iii) Transportation sector
  (iv) Household sector
  (v) Export of crude oil and oil products
  (vi) Energy loss during energy conversion, delivery and transmission.

(3) Energy consumption by area
  (i) Oil products
  (ii) Natural gas
  (iii) Coal
  (iv) Electricity

(4) Energy price in domestic market
  (i) Oil products
  (ii) Natural gas
  (iii) Coal
  (iv) Electricity

1.1.3 National Policy on, and present situation of, coal industry in Indonesia

(1) Coal reserves by area

(2) Production of coal
  (i) PTTA
  (ii) PNTB

(3) Development plan of coal resources
  (i) PTTA
  (ii) PNTB
  (iii) Others, if there are

(4) Price structure of coal

(5) Subsidy for coal industry

1.1.4 National policy on, and present situation of, Banko coal utilization

(1) Present situation

(2) Prospects for exploration, development and utilization

(i) N.W. Banko

(ii) Other basins

(3) National policy for development of Banko coal as gasification feed stock.

(i) Organization for development plan

(ii) Organization for exploration and development

(iii) Organization for mining

(iv) Royalty and tax

(v) Subsidy

(vi) Price structure

(vii) Undertaking of infrastructure

(viii) Finance policy for investment

1.1.5 National policy on industrialization

(1) General policy

(2) Government organization in charge for coal gasification and synthesis of produced gas.

(3) Major industries existing in South Sumatra

(4) Major projects planned in South Sumatra

1.1.6 National policy on transmigration and rural development

(1) General policy

(2) Transmigration policy in South Sumatra

(i) Area and number of transmigrator

(ii) Development plan of the area

(iii) Subsidy

1.2 Preliminary survey on markets of brown coal and its derivatives

1.2.1 Direct combustion of brown coal as fuel

1.2.2 Combined generation as fuel gas

(1) Demand and supply of electricity in South Sumatra area and Sumatra.

(2) Projects of thermal power plant using coal in Sumatra and Jawa.

(3) Plan of electricity transmission line between Jawa and Sumatra, if there is.

(4) Plan of natural gas pipe line between Jawa and Sumatra, if there is.

1.2.3 Synthetic fuel oil as derivatives of synthetic gas such as methanol, gasoline, kerosene and gas oil.

(1) Automotive fuel

(2) Train and ship fuel

(3) Electric generation fuel

(i) PLAN

(ii) non-PLN

(4) Household fuel

(5) Delivery system of oil products.

1.2.4 Chemicals as derivatives of synthetic gas such as fertilizer, methanol and its derivatives

(1) Present situation and future prospect of demand for some chemical products such as urea, formaline, acetic acid, and methanol

(2) Present production capacity and future expansion plan of producing facilities for some chemical products of item (1) as mentioned above

(3) Import and export of chemical products

(4) Natural gas utilization plan as a feed stock for chemical products

(5) Pricing system or price structure of chemical products in the domestic market

(6) Basic condition for utilization of synthetic gas as feed stock to produce of chemical products.

1.3 Survey on Banko coal resources

1.3.1 Survey on Banko coal resources

Based on Indonesian survey reports dealing with Banko coal, the following facts about the coal resources are clarified.

(1) Coal reserves and distribution

(2) Mining conditions and method

(3) Coal grade

1.3.2 Survey on quality of Banko coal

(1) Analysis on samples of several basins

(2) Distribution of coal by quality

1.3.3 Site reconnaissance of Banko area

(1) Site reconnaissance of coal basins

(2) Site reconnaissance of plants area

1.3.4 Preliminary cost estimation of coal mining

(1) Conceptual plan of the coal mining

(2) Preliminary estimation of the cost of the coal mining

1.4 Survey on Brown coal utilization technology

1.4.1 Gasification technology

(1) Survey on brown coal gasification technology in Japan

(i) Fluidized bed process

(ii) Entrained bed process

(iii) Molten iron bath process

(2) Evaluation of the technology
  (i) Adaptability for brown coal gasification
  (ii) Expected composition of produced gas
  (iii) Estimated utilities consumption
  (iv) Estimated construction cost
  (v) Commercialization experiences expected in 1990

(3) Selection of the technology for the 2nd stage
  (i) Flexibility for coal quality as feed stock
  (ii) Operability/Stability on a small scale test

1.4.2 Technology for derivatives production

(1) Survey on synthesis technology for products investigated by above 1.1 and 1.2
  (i) Methanol
  (ii) Gasoline, kerosene and gas oil
  (iii) Basic chemicals

(2) Evaluation of technologies
  (i) Consumption ratio of feed stock and utilities
  (ii) Construction cost
  (iii) Commercial experiences expected in 1990

1.4.3 Technology for electric generation

(1) Direct combustion technology

(2) Combined generation technology

(3) Economics of (1) and (2)

1.4.4 System study of brown coal utilization in view of technology

(1) Technical prospects of brown coal utilization

(2) Preparation of master plans considering reports on 1.1, 1.2, 1.3 and 1.4

(3) Stratetic points of proposed master plan in 1.4.4 - (2).

1.5 Strategic investigation on Banko coal effective utilization

Based on above mentioed works, collected information and data shall be analyzed and synthesized in the following fields;

1.5.1 Master plan of Banko coal effective utilization

1.5.2 Selection of brown coal gasification technology for the coal gasification test stage

1.5.3 Preliminary evaluation of the Banko coal effective utilization in view of technical, economic and strategic aspects

1.5.4 Implementation plan of the coal gasification test stage

(1) Work item

(2) Basic plan and design of the coal gasification test facilities

(3) Gasification test schedule

2. Coal Gasification Test Stage

2.1 Design meeting of the coal gasification test facilities

2.1.1 Basic design data

(1) Civil and architecture

2.1.2 Explanation and discussion of the test facilities

(1) Results of basic design of the test facilities carried out in FY 1984.

(2) Plan of basic design to be carried out in FY 1985.

2.1.3 Explanation and discussion of the conceptual design of civil and architecture

(1) Discussion of the conception of architecture

(2) Conceptual plan of architecture

(i) Space

(ii) Layout

(iii) Required performance for service facilities

2.2.2 Basic design of civil and architecture and design meeting with the counterpart

(1) Conceptual design of architecture

(2) Basic design and engineering of architecture

2.4 Construction meeting of the coal gasification test facilities

2.4.1 Detailed design and engineering of civil and architecture (by the Counterpart)

(1) Consultation for the detailed engineering of civil and architecture, which is carried out by the Counterpart.

(2) Method of the Study

The Study was carried out systematically in accordance with the Agreement and the Inception Report, in the following method

i) The preparation work

The preparation work of each study team was carried out in Home Office of IEE.

ii) Site survey and discussion

JICA dispatched four (4) of study teams in total to Indonesia for site survey, data and information collection

and discussion with the counterpart and relevant organizations.

iii) Analysis, synthesis and preparation of reports

The work for analysis and synthesis of data and information obtained in Indonesia and Japan were carried out in Home Office or IEE.

(3) Organization and Personnel of the Team

Fig. 5-1-1 and 5-1-2 show organization and personnel of the Team for the Study in FY 1984.

The counterpart organized the Indonesian Team, corresponding to the Japanese Team, as follows:

1) Advisory Committee

The Advisory Committee was organized with senior experts relating to the Study and the Project. The committee shall evaluate and advise for the Report and also make necessary consensus for political matter, principal policy and guidance for the Study through discussion with the Team.

The member of the Advisory Committee also made necessary arrangements for mobilization of his staff to cooperate with the Team.

The members of the Indonesian Advisory Committee are as follows:

BPPT
BAPPENAS
DGM
DGP & NE
MIGAS
DGBCI
PERTAMINA
PTBA
PNTB
ITB
MTDC

Fig. 5-1-1 Organization and Personnel of the Team

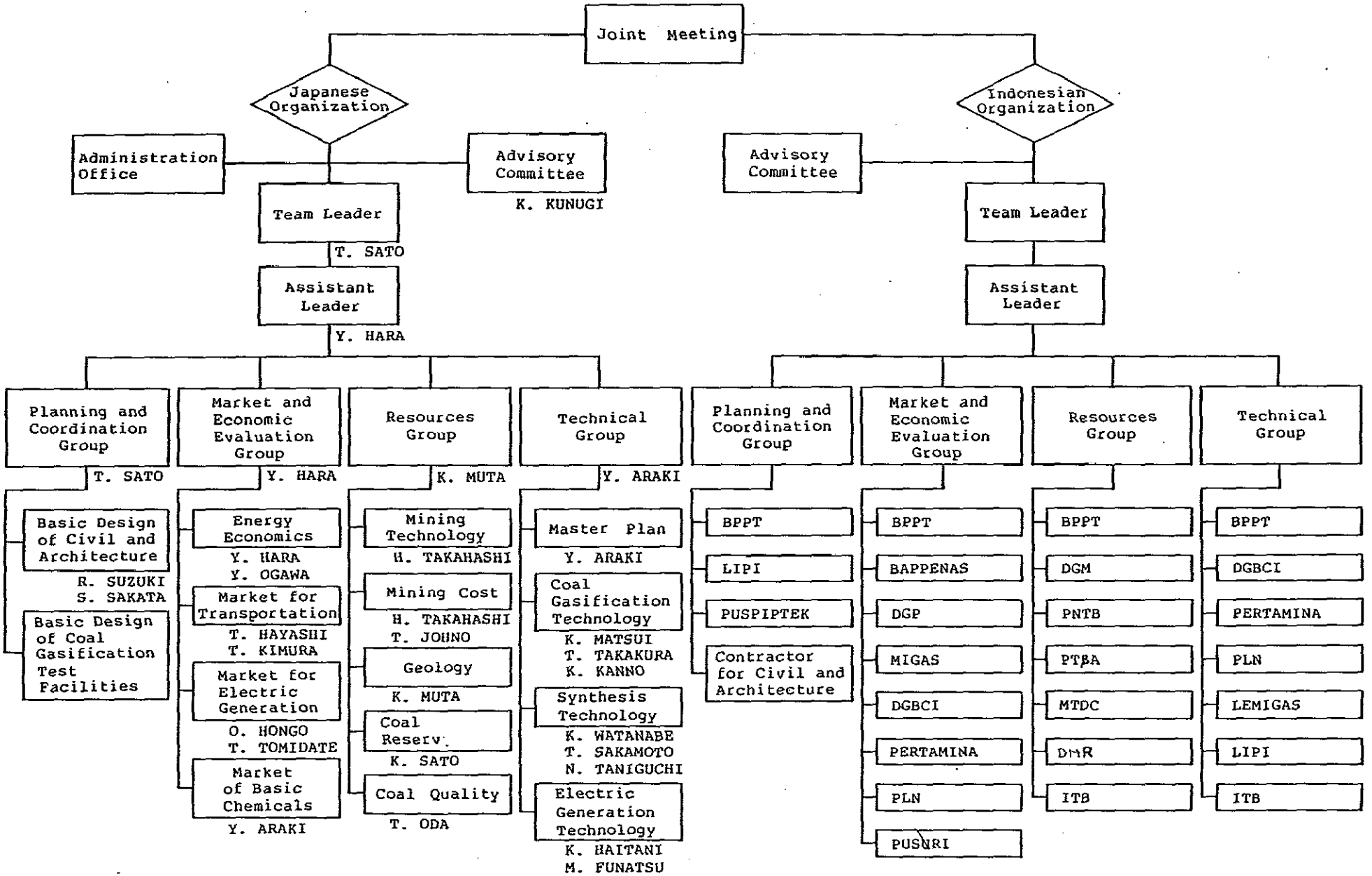
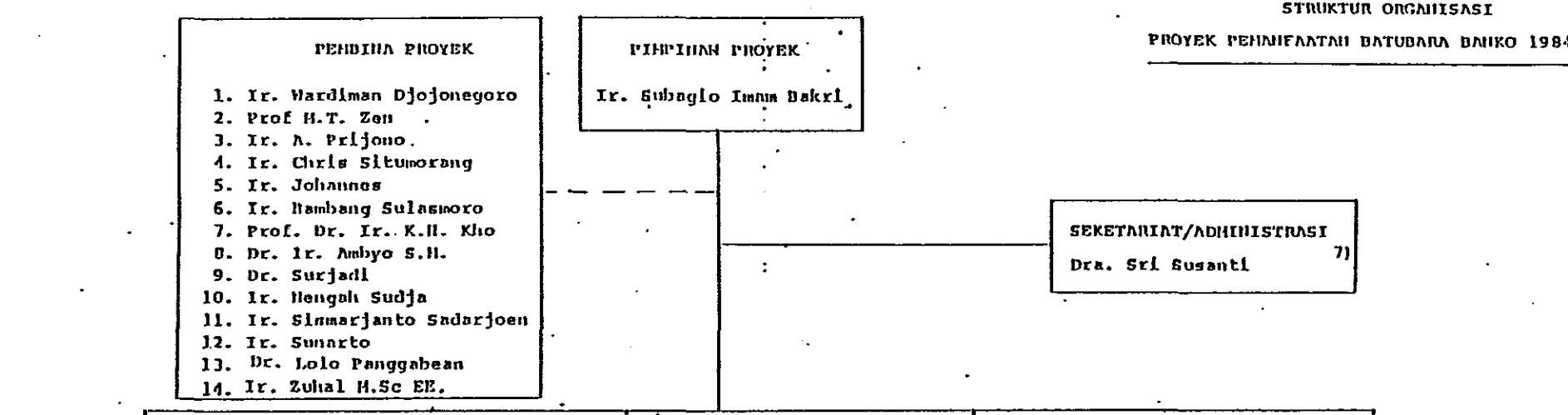


Fig. 5-1-2 Organization and Personnel of the Counterpart

STRUKTUR ORGNIISASI

PROYEK PENNIFAATNI BATUBARA BANKO 1984/1985



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4. Ir. Mochtar Azis 4)
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10. Dra. Churlyah 1)
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10. Djapran 2)
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12. JICA TEAM

MENGETAHUI
PROYEK PENANFAATAN BATUBARA BANKO
Pembina,

Ir . Wardiman Djojonegoro

NOTE :
1) = BPPT
2) = PTBA
3) = PN Batubara
4) PPTM
5) LEMIGAS
6) PERINDUSTRIAN
7) RISTEK
8) PUSPIPTEK
9) ITB

2) The counterpart

The counterpart is organized with experts selected from BPPT and other related organizations to cope with Indonesian undertaking set force in Chapter VI and VII of the Agreement.

The member of the counterpart carried out the necessary implementation works such as data and information collection, site survey and administrative works in accordance with the instruction of the advisor or team leader of the Indonesian team.

(4) Relevant Department, Agency and Institute

To establish an appropriate master plan of effective utilization of Banko coal and to examine its technical, economic and financial feasibility, the following five fields must be investigated,

(a) Markets survey on alternative energy and chemicals
(b) Reserves, quality and mining cost of coal
(c) Coal gasification technology and synthesis technology
(d) Master plan
(e) Proposed project and the feasibility

The data and information obtained through the investigation of (a), (b) and (c) shall be analyzed and synthesized into (d) and (e).

As above mentioned, the Study requires wide variety of data and information including Government policy, and also wide variety of experts.

The Study in FY 1984 was carried out in cooperation with the following relevant department, agency, and Institute for the project and for the study.

BPPT
BAPPENAS
DGM
DMR
DGP & NE
MIGAS
DGBCI

PERTAMINA
PLN
PNTB
PTBA
PUSRI
LEMIGAS
LIPI
MTDC
ITB
PUSPIPTEK

(5) Study Team

Four (4) of study teams were dispatched to Indonesia. The objectives and special notes of the each study team are as follows:

1) No. 1 study team

Objective: 1.1 Survey on background of the project
1.2 Preliminary survey on markets of brown coal and its derivatives
2.1.3 Conceptual design of architecture

The team also prepared and explained the Inception Report and made necessary arrangements for the No. 2 study team.

2) No. 2 study team

Objective: 1.3 Survey on Banko coal resources
2.2.2 Basic design of architecture

The team also discussed and made the necessary arrangements for the study of the 2nd stage in relation with survey on coal quality.

3) No. 3 study team

Objective: 1.4 Survey on brown coal utilization technology
2.2.2 Basic design of civil and architecture

The team also discussed and selected the coal gasification technology to be employed in the 2nd stage.

4) No. 4 study team

Objective: 1.5 Strategic investigation on Banko coal effective utilization

2.4.1 Detailed design and engineers of civil and architecture (advise for counterpart)

The team also prepared the Interim Report.

The each study team prepared and sent to the counterpart, prior to the departure to Indonesia, the questionnaire and preliminary schedule with list of visiting organization and personnel. The counterpart made necessary appointments and prepared detailed schedule as well as necessary measures to facilitate the smooth implementation of the Study.

During the period of the visit of the study team, the team leader and related experts of the counterpart attended to the team through the time, and prepared necessary arrangements and joined to the investigation and discussion.

6. Preliminary Survey on Markets

6-1 Survey on Background of the Project

(1) Energy Policy in Indonesia

Indonesia is blessed with an abundance of various energy resources. Since the last 15 years, because of the economic growth, population growth, industrial expansion, and wider electricity distribution, the domestic energy consumption has been rising very rapidly, although in terms of total energy consumption of Indonesia still ranks among the lowest consumption group.

The biggest problem is on the supply side. The mix of energy sources in domestic consumption pattern has grown too dependent upon oil and oil products during the same period.

In particular, during the decade in the period of 1972-82 the average energy growth was 12% per annum. This fast growth of the energy consumption has made sharp increasing of dependency on oil. So that, the country has found herself in the situation that more than 80% of the commercial energy consumption comes from oil, which is also main source of foreign exchange in the country. Unless Indonesia takes some action, it will be consumed all of oil domestically, thereby depriving herself from one of the main sources of foreign currency needed for the national development.

The Indonesian government has formulated a comprehensive energy policy aimed at minimizing the domestic consumption of oil and refined products and maximizing the non-exportable energy and thereby conserving oil for export.

The policy consists of four main pillars:

i) intensification

To accelerate and intensify the survey and exploration of all energy resources, as an effort for a better identification of their potentials for an economical development program.

ii) diversification

To reduce the dependence on oil in the overall domestic energy consumption and replace it with other available energy recourses. Priorities were set to develop non-exportable and renewable sources of energy, first hydropower and geothermal, followed by coal.

iii) conservation

To economize the energy use as well as to ensure its more efficient and wise use. This conservation program is implemented through the following steps:

a) Sectoral identification of wasteful energy use
b) Providing information and educational programmes
c) Implementation through legislation and directives

iv) idexation

To apply the best and most efficient energy source for each particular energy demand

This policy is then elaborated as follows:

a) The domestic energy supply

To guarantee the domestic energy supply in amount and quality according to the demand and with a price affordable to the public, with the objective of improving the welfare of the Indonesian people and providing the necessary support for rapid socio-economic growth

b) The export of energy

To secure the supply of energy, not only for domestic use but also for export, to provide foreign exchange which can be used also for the development of new energy sources

c) The development of alternate energy sources

To develop alternate energy source which are renewable but not exportable in order to lessens the consumption growth rate of exportable energies and ultimately replace the non-renewable energy sources

d) Conservation of oil
Oil should be used as economically as possible, and possibly only for those application where the use of other forms of energy is not possible.

e) The protection of the environment
In the development of energy resources, the protection of the environment should be maintained, to accomplish an improvement in the quality of life of the Indonesian people.

f) National resilience
The overall effort of providing energy and the management of the energy resources should bring an increase of national resilience which will enable the Indonesian people to face the future with more skill and confidence.

(2) Supply and Demand for Energy

1) Past trend of primary energy demand

Since 1969 Indonesia initiated the first five year plan (REPELITA-I) and currently the country has just ended REPELITA-III. In the 70's, the Indonesian economy expanded and its average growth rate per annum reached to 7.6%.

In accordance with this rapid economic growth, energy consumption in the country sharply increased. The commercial energy consumption, in particular, has quardrupled in the last fourteen years, admittedly it started from a low base. During the decade in the period of 1972-82 the average energy growth recorded 13.6%. This remarkable growth of energy was not only caused by the population growth (2.34% p.a.), but could also be traced to growing demand from the Industry, transportation, and the wider distribution of electricity in the country.

Table 6-1-1 shows the actual results of energy consumption by energy source in the last 14 years. From

this table, it can be concluded that the dominating part of energy consumption in the period has been held by oil with share of 80% in the total consumption.

Since 1970, moreover, oil share very frequently exceeded 90% in the total energy consumption. So that, the average growth rate of oil consumption during the period in 1974-79 accounted for 13.0% per annum and the demand elasticity of oil against GDP growth rate reached 2.0 in the same time. However, after second oil crisis, energy consumption in Indonesia changed to downward in terms of the growth rate.

Since 1980, in accordance with decreasing of energy demand, the share of oil consumption downed less than 80% in the total energy demand.

Table 6-1-2 shows the actual results of the primary energy consumption by energy source in REPELITA-II and III. It is clear from this table that non oil energy such as natural gas, coal, hydropower, geothermal increased their share from 18% to 22% during both five year plans. Oil, on the other hand, diminished its share from 82% to 78% in the same period.

Table 6-1-1

Consumption of Commercial Energy
(In Milion BBL Oil Equivalent)

YEAR	OIL MBOE	%	NATURAL GAS MBOE	%	COAL MBOE	%	HYDRO MBOE	%	TOTAL MBOE	%
1968	36.62	84.4	5.37	12.4	0.69	1.6	0.67	1.6	43.35	100
1969	38.27	85.7	4.84	10.9	0.81	1.8	0.69	1.6	44.61	100
1970	41.07	87.9	4.17	8.9	0.76	1.6	0.73	1.6	46.74	100
1971	45.31	86.0	5.66	10.7	0.91	1.7	0.84	1.6	52.72	100
1972	52.01	91.1	3.43	6.0	0.89	1.6	0.75	1.3	57.09	100
1973	60.57	89.7	5.75	8.5	0.61	0.9	0.92	0.9	67.85	100
1974	69.09	92.2	4.13	5.5	0.71	0.9	1.07	1.4	75.00	100
1975	77.62	90.5	6.12	7.1	0.90	1.1	1.16	1.3	85.81	100
1976	87.40	90.7	7.11	7.4	0.74	0.8	1.06	1.1	96.32	100
1977	102.82	88.9	10.99	9.5	0.84	0.7	1.039	0.9	115.70	100
1978	117.48	83.7	20.91	14.8	0.75	0.5	1.49	1.0	140.63	100
1979	129.12	80.8	24.46	15.3	0.77	0.5	5.45	3.4	159.80	100
1980	142.08	81.9	26.197	15.1	1.22	0.6	4.21	2.4	178.14	100
1981	155.54	78.8	34.88	17.7	1.01	0.5	5.87	3.0	197.30	100
1982	156.80	79.2	33.78	17.0	0.94	0.5	6.52	3.3	198.05	100

Source : Department of Mines and Energy (PTE).

Growth rate					
1968-1982	10.9%	14.0%	2.3%	17.7%	11.5%
1972-1982	11.6%	25.7%	0.6%	24.1%	13.2%

Table 6-1-2 Primary Energy Consumption in REPELITA II and III

Unit: ,000 bbl

	Primary energy source	Energy Consumption REPELITA-II	%	REPELITA-III	%
1	natural gas (including LPG)	24,495	(15.31)	37,164	(17.7)
2	coal	647	(0.40)	1,109	(0.53)
3	hydro power	3,852	(2.41)	7,761	(3.69)
4	geothermal	-	(-)	367	(0.17)
	(total non oil)	28,994	(18.12)	46,401	(22.09)
5	oil	131,009	(81.88)	163,661	(77.91)
	(grand total)	160,003	(100.0)	210,062	(100.0)

2) Energy demand by sector

It is shown in Table 6-1-3 that the commercial energy consumption in 1982 is composed from 37.3% of industry, 25.9% of transportation, 11.6% of electricity, and 25.1% of household respectively. The industry sector took the biggest share in total commercial energy consumption. On the other hand, though the energy consumption in the transportation and household sectors held the same share, the growth rate of consumption in both sectors has been diminishing since 1980 due to price hike in the domestic energy market.

However, household sector consumes large amount of non-commercial energy such as wood and agriculture waste. The total energy consumption (commercial, non-commercial), accordingly, in the household sector takes a share of more than 60% of all energy consumption in Indonesia.

Table 6-1-4 shows a share of oil products consumption by each demand sector since 1980. Transportation and household sectors held around 30% respectively in the total consumption of oil products.

However, the share of household sector has been decreasing year by year during the same period. The main reason of this diminishing should be the current huge price increasing of products due to cutting oil subsidy.

Though oil consumption in electricity sector is relatively very low at this moment, the increasing of consumption has been so fast because of expansion of electricity generating capacity for these years.

It is important to note that the energy consumption for electricity generation by private sector is not included in electricity sector but included in industry and household sectors. The capacity of private power generators is estimated to be more than double of that of PLN.

Table 6-1-3 Consumption of Commercial Energy by Demand Sector (In Milion BBL Oil Equivalent)

YEAR	INDUSTRY MBOE	%	TRANSPORTATIN MBOE	%	ELECTRICITY MBOE	%	HOUSHOLD MBOE	%	TOTAL MBOE	%
1968	15.25	35.2	11.90	27.4	2.45	5.7	13.76	31.7	43.35	100
1969	12.91	28.9	13.28	29.8	2.22	5.0	16.21	36.3	44.62	100
1970	14.00	29.9	13.74	29.4	2.61	5.6	16.40	35.1	46.75	100
1971	18.41	34.9	14.56	27.6	2.85	5.4	16.92	32.1	52.72	100
1972.	13.85	25.8	16.60	30.9	3.38	6.3	19.88	37.0	53.71	100
1973	21.94	32.3	20.06	29.5	3.79	5.6	22.15	32.6	67.95	100
1974	22.05	29.3	23.30	31.0	4.15	5.5	25.66	34.1	75.16	100
1975	27.22	31.8	24.43	28.6	4.92	5.7	28.99	33.9	85.55	100
1976	28.87	29.9	29.74	30.8	6.09	6.3	32.01	33.1	96.70	100
1977	37.58	32.8	34.06	29.7	7.46	6.5	35.58	31.0	114.69	100
1978	53.16	35.4	45.37	30.3	9.81	6.5	41.87	27.8	150.35	100
1979	59.38	36.0	50.11	30.4	11.31	6.8	33.51	27.0	165.08	100
1980	63.51	36.5	46.29	26.6	16.92	9.7	47.10	27.1	173.83	100
1981	69.65	36.7	49.90	26.3	19.97	10.5	50.21	26.5	189.71	100
1982	73.82	37.3	51.29	25.9	23.00	11.6	9.74	25.1	197.86	100

Source : Department of Mines and Energy (PTE).

Table 6-1-4 Share of Oil Consumption by Sector (%)

	Demand Sector				
	Transportation	Industry	Electricity	Household	Total
1980	33.7	24.8	7.9	33.6	100.0
1981	33.0	24.5	9.4	33.1	100.0
1982	33.9	23.9	10.6	31.6	100.0
1983	32.8	25.6	12.2	29.4	100.0

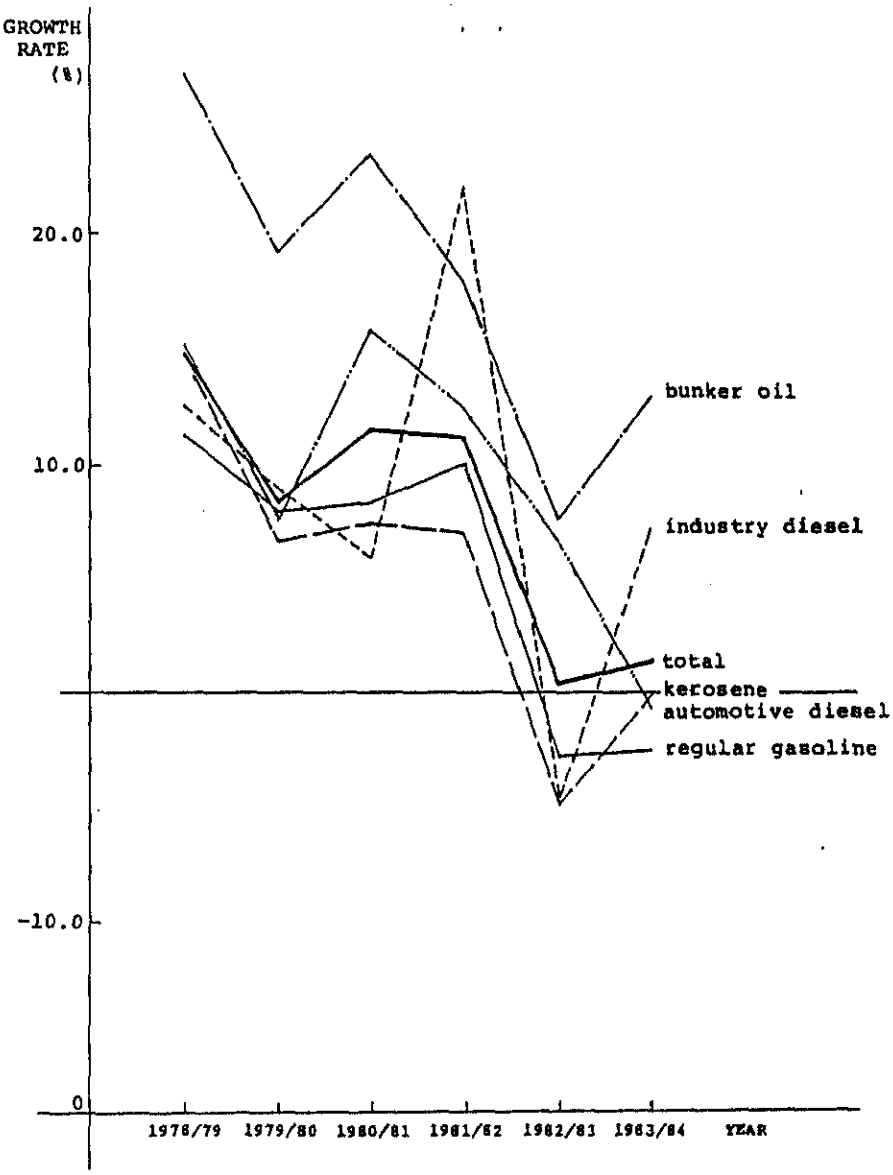
(3) Actual Demand of Oil Products in the Domestic Market

The reduction in curde oil production and export in the period of 1981 and 1982 was due to the OPEC decision to decrease the production quota in each member country, responding to softened demand in international crude oil market. Indonesia was forced to decrease its crude oil production level to 1,300 x 10^3 B/D from 1,600 x 10^3 B/D.

Crude oil production in Indonesia was 57.22 million bbl or 1,580 x 10^3 B/D in FY 1979 and was decreased to 45.903 million bbl or 1,260 x 10^3 B/D in FY 1982.

The domestic petroleum demand in the period of REPELITA-III was met with refined product in domestic refinery and in foreign refinery, and imported petroleum products. The volume of crude oil for refining was 184.237 million bbl/yr. or 505 x 10^3 B/D in REPELITA-III and of which, 65% was refined in domestic refinery and rest in foreign refinery. In order to expand domestic refining capacity, refining capacity in Cilacap and Balikpapan was expanded and cracking facility was constructed in Dumai. Domestic refining capacity was expanded and modernized with the completion of these refining facility in the last year of REPELITA-III. And also, distribution network was improved in terms of transportation, storage and distribution facilities for meeting expanding domestic petroleum demand year by year. Therefore, imbalance between domestic supply and demand is to be corrected significantly and also, import of refined product and the volume in commissioned refining in foreign country is to be decreased rapidly and no further addition to refining capacity is to be needed at least in REPELITA-IV according to the prospect by Pertamina.

Fig. 6-1-1 Growth Rate of Demand for Main Oil Products



(4) Actual Supply and Demand of Natural Gas

Natural gas utilization was also expanded continuously in the period of REPELITA-III. Natural gas was used as an energy source in cement factory and iron & steel plant and was used as feed stock in fertilizer plants. Furthermore, it has been used in some big cities for manufacturing town gas by PGN. And also, natural gas has been processed to LNG and LPG for export.

The expansion in production and export of LNG was carried out through that of LNG facilities in Badak and Arun. The expansion work in these two LNG plants was finished in FY 1983 and, as a result, LNG plants were expanded to 4 lines in Badak and 5 lines in Arun.

The production and export of LNG in REPELITA-IV is expected to keep increasing based upon LNG export contracts since 1973 (Duration period: 15-20 years). To match this increasing demand of LNG, further expansion by one line of LNG plant in Arun is planned. The total volume of LNG production was estimated to be 684.3 million MMBTU in FY 1984 and is estimated to be 870.2 million MMBTU by the end of REPELITA-IV. Natural gas consumption in fertilizer plants such as Iskandal Muda plant, Asean plant, East Kalimantan plant has also been increased. Furthermore, natural gas has been processed to LPG in refineries such as Mundu, Rantau, Arjuna and Tanjung Santang. LPG as a by-product has been produced in refineries of Balikpapan, Cilacap, Dumai and Musi, and also expansion in LPG producing capacity is to come into with completion of expansion projects in refineries of Balikpapan, Cilacap and Dumai. The LPG demand in REPELITA-III increased year by year.

(5) Actual Supply and Demand of Coal

Significant development activity of coal mining were expanded stage by stage during the period of REPELITA-III in order to replace a part of petroleum demand used for electricity generation and for industry sector. Coal

production at the end of REPELITA-III was expanded very much compared with that at the end of REPELITA-II. This gradual development could be not only for meeting present coal demand but also for preparation for significant expansion of coal production during REPELITA-IV.

At present, coal reserves at Bukit Asam is proved to be around 200 million ton and surface mining is possible there. And also in south Sumatra, there are around 6.5 billion ton of reserves with lower grade coal. Therefore, this reserve can be expected to be a big potential for meeting energy demand in future. Ombilin coal reserve is proved to be around 100 million ton and the exploration work for additional reserves has been carried out for meeting industrial demand in west Sumatra. In Ombilin area, underground mining is expected to be prevailing, for the most reserves there is deposited in deep under the earth. Other coal deposited areas are in east Kalimantan and south Kalimantan. In these areas, coal reserve survey has been still undertaking to meet future coal demand in domestic market and for export. Several foreign enterprises have participated in coal mining business in east Kalimantan. At present, activities there is in the stage for development preparation and mining in very small scale has just started.

Coal production in 1983 is roughly 500 x 10^3 t, of which 320 x 10^3 t is from Ombilin and rest is mainly from Bukit Asam. Coal export has been rapidly expanded from 119 x 10^3 t in 1982 to 284 x 10^3 t in 1983. On the other hand, domestic coal demand was mainly shared with power generating sector and cement industry. And also, coal demand for power generation will increase significantly.

Table 6-1-5 Indonesian Coal Production & Export

Year	Export (tons)	Production (tons)
1981	127,637	350,350
1982	119,484	480,987
1983	283,772	485,630

Table 6-1-6 Domestic Coal Consumption From Ombilin Coal Mine

	1981	1982	1983
PT Sement Padang (cement)	120,945	123,846	146,316
PJKA (railway)	5,067	5,161	1,714
Private Company	6,186	4,750	5,405
PT Inco Indonesia	3,037	9,079	-
PLTU Salak (Electricity)	17,798	20,518	20,639
Export	91,938	103,884	143,225
TOTAL	244,971	267,235	317,329

(6) National Policy on Industrialization

1) Past trend of industrial growth

Industrial development from REPELITA-I to REPELITA-III has contributed significantly especially to improvement of national economic force. This can be understood from the fact that industrial production has been kept increasing even in world-wide economic recession. Furthermore, this made it possible to supply necessary goods for people's life & production activity, and also made it possible to export several industrial goods.

As a whole, high level of industrial growth has been attained in this period. That is, higher rate of industrial growth has been recorded such as 12.98% in REPELITA-I, 13.70% in REPELITA-II and 11.40% in REPELITA-III. And also, such quite high rate as 35.6%/yr., of industrial goods production in large scale and medium scale industry was recorded during first three years in REPELITA-III. In 1981, such high growth rates as 34.9%/yr., 18.1%/yr. were recorded in food, beverage and tobacco industry, chemical and fine chemical industry and metal goods, machinery and equipment industry respectively. On the other hand, such lower growth rates as 2%/yr. and 3 %./yr. were recorded in paper and pulp industry, and basic metal industry respectively. Growth rate in other industrial sector were ranged from 4%/yr. to 12%/yr.

In terms of added value, such higher annual growth rates of 51.31%, 40.8%, 39.77% and 37.8% were recorded in non-ferrous metal industries, wood and wood product industry, food, beverage and tobacco industry and metal products, machinery and equipment industry respectively.

Utilization of natural resources as feed stock such as natural gas in fertilizer industry has expanded significantly in REPELITA-III.

And also, production trends in industrial goods to support necessary goods for people's life, and such other sectors as agriculture, communication and education were shown in Table 6-1-7.

2) Industrial development policy

Such factors as change in economic structure, expansion of employment opportunities, equalization in venture opportunities, reduction in import dependence, expansion in export of industrial goods, local industrialization and effective utilization of natural resources, energy resources and human resources are included in term of industrial development.

Industrial development policy which is to be pursued in REPELITA-IV will include following guidelines.

i) Industrial development should be toward improving national economic structure by developing harmonized program among industrial sectors and other sectors.

ii) Industrial development should be toward strengthening industrial structure itself. In order to do so, close relationship among industrial sectors should be assured. And also, domestic industry protection policy and pricing & tax policy should be pursued in order to develop small scale industry furthermore.

iii) The development of small scale industry should be continuously promoted not only for increasing employment opportunities but also for increasing its contribution in forming added value.

iv) Contribution by Indonesian people to industrial development should be increased through improvement of designing capability, business management capability, production management methodology and development capability. The program for speeding up in technology transfer and increasing the capability in software should be continuously promoted.

v) Expanding export of industrial goods might be a national venture. Such efforts are to be pursued toward strengthening international competitiveness as improvement in price, quality and services in the

field of diversification of industrial goods and its export expansion.

vi) As a whole, industrial development program, which is based upon the Main State Policies and pursue shift from agriculture weighted economic pattern to industry weighted one, should realize autonomous progress, prosperity and fair society.

Based on above-mentioned guidelines, each annual growth rate in each industrial sector is envisaged as shown in Table .

Remarkably high growth rate of 9.5%/yr. is envisaged in manufacturing industries and, as a result, significant shift in economic structure will be expected even compared with other south-east Asian countries.

Through this industrial development, the following targets will be achieved.

- to increase opportunity for employment
- to promote export
- to save foreign currency
- to assist regional development
- to utilize natural resources, energy resources and human resources
- to prepare equitable environment for business opportunities

In growth rates in export, which are shown in Table , manufacturing industry has big increase rate in its export.

Average growth rate of 9.5%/yr. in manufacturing industries, envisaged in REPELITA-IV can be broken down as follows.

- machinery industry	17%/yr.
- basic chemicals industry	17.2%/yr.
- small-scale industry	6%/yr.
- miscellaneous industry	6%/yr.

Table 6-1-10 shows production capacities in some industries in 1983/84 (actual figures) and 1988/89 (estimates).

In the group of basic chemicals industry, special emphasis was laid on industries which will contribute to more solid industrial structure and which will improve technological capability in processing natural resources. Newly established job opportunities in manufacturing industries as a whole in REPELITA-IV will be $1,400 \times 10^3$, of which 400×10^3 is for miscellaneous goods industry, 930×10^3 is for small-scale industry and remaining is for other industries.

Though national industrial policies mentioned above are for REPELITA-IV, these will be succeeded after REPELITA-IV.

2) Governmental organization on coal gasification and synthetic gas

Present development program by the Government, of coal industry is limited to direct combustion of coal and does not include coal gasification and its liquefaction. And so, there is no governmental organization, responsible for these new categories and their derivatives. It will be expected for the Government to establish such new governmental organization which should be responsible for the study like Banko Coal Utilization Project and can embody such concrete project.

Table 6-1-7 PERKBMBANGAN PRODUSKI BEBERAPA HASIL IMDUSTRI, 1977/78 - 1982/83

No.	Hasil Produksi 生産品目	Satuan 単位	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83
1.	Minyak goreng 食用油	Ribu ton 千トン	31,3	37,8	266,2	278,9	326,4	780,9
2.	Rokok (kretek dan putih) タバコ	Milyar batang 10億本	64,0	69,2	70,1	83,9	84,0	86,2
3.	Tekstil 繊維	Juta meter 百万M	1.332,5	1.576,5	1.910,0	2.027,3	2.094,0	1.708,0
4.	Benang tenun 紡織糸	Ribu bal 千ベル	678,3	837,3	998,0	1.184,0	1.233,0	1.370,0
5.	Kayu lapis 合板	Ribu m3 千m³	217,9	424,0	525,0	1.144,6	1.609,9	2.577,2
6.	Pupuk urea 尿肥料	Ribu ton 千トン	990,0	1.437,2	1.827,0	1.985,1	2.006,7	1.994,1
7.	Alat penyemprot 散布機具	Buah 個	15.300,0	36.480,0	78.000,0	134.160,0	154.284,0	159.740,0
8.	Semen セメント	Ribu ton 千トン	2.878,6	3.629,0	4.705,2	5.851,7	6.844,2	7.650,6
9.	Kertas 紙	Ribu ton 千トン	83,5	155,2	214,2	232,0	246,6	296,9
10.	Besi dan baja 鉄鋼	Ribu ton 千トン	405,2	598,3	859,9	1.334,6	1.509,9	1.841,8

Table 6-1-8 SECTORAL GROWTH RATES AND STRUCTURAL CHANGES
(based on 1973 constant prices)

Sector	Estimated Share in GDP, 1983/84	Average Annual Growth Rate, Repelita IV	Projected Share in GDP, 1988/89
1. Agriculture	29.2%	(3.0%)	26.4%
2. Mining	7.4%	(2.4%)	6.6%
3. Manufacturing	15.8%	(9.5%)	19.4%
4. Construction	6.3%	(5.0%)	6.3%
5. Transport and Communication	6.0%	(5.2%)	6.0%
6. Other Sectors	35.3%	(5.0%)	35.3%
Gross Domestic Product	100.0%	(5.0%)	100.0%

Table 6-1-9 Gross Value of Exports (F.O.B.), 1983/84 - 1988/89

(US$ million, current prices)

Item	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	Average Rate of Growth (%)
Oil and LNG (Gross)	14,140	13,825	15,424	17,317	19,008	20,363	7.6
1. Crude Oil and Oil Products	11,861	10,644	11,873	13,463	14,664	15,766	5.9
2. Liquefied Natural Gas	2,279	3,181	3,551	3,854	4,344	4,597	15.1
Non-oil and non-LNG	5,170	6,050	7,009	8,015	9,215	10,753	15.8
1. Agricultural Products	2,597	2,859	3,123	3,395	3,717	4,160	9.9
2. Mining Products	652	740	841	963	1,066	1,166	12.3
3. Manufactured Products	1,921	2,451	3,045	3,657	4,432	5,427	23.1
TOTAL EXPORTS	19,310	19,875	22,433	25,332	28,223	31,116	10.0

Table 6-1-10

SELECTED TARGETS: MANUFACTURING, 1983/84 and 1988/89

SUBSECTOR/PRODUCT	UNIT	PRODUCTION CAPACITY 1983/84	PRODUCTION CAPACITY 1988/89
A. INDUSTRIAL MACHINERIES AND BASIC METAL			
Industrial Machineries	unit	1,550	3,600
Airplanes	unit	24	35
Helicopters	unit	48	66
Freight Wagons	unit	300	600
Passenger Wagons	unit	-	50
Ships	000 dwt	195	493
Ships Repairs	000 dwt	1,150	3,150
Steel Slab	000 tons	1,100	1,600
Hot Rolled Coil	000 tons	1,100	1,700
Cold Rolled Coil	000 tons	-	1,150
Steel Plates	000 tons	491	780
Pipes	000 tons	-	130
Steel Profile	000 tons	-	100
Aluminium Ingot	000 tons	225	300
Aluminium Sheets	000 tons	21	40
Aluminium Wire	000 tons	-	15
Copper Cathodes	000 tons	-	100
Copper Wire Rods	000 tons	36	50
B. BASIC CHEMICALS			
Urea	000 tons	2,190	5,610
ZA	000 tons	150	650
TSP	000 tons	500	1,500
Cement	000 tons	10,290	21,000
Newsprint	000 tons	-	90
Craft Paper	000 tons	-	90
C. MISCELLANEOUS INDUSTRY			
Car Tires	000 units	4,335	10,290
Cooking Oil	000 tons	1,226	1,967
Textiles	million meters	2,130	2,860
Garments	000 dozens	20,300	26,000
Weaving Yarns	000 bales	1,540	1,740
Salt	000 tons	1,100	2,100

4) Main Industries in South Sumatra

Main manufacturing facilities in South Sumatra are as followings.

i) Oil refinery

Plaju refinery owned by Pertamina

atmospheric distillation plant	95,000 B/D
vacuum distillation plant	
thermal cracking plant	
alkylation plant	
isomerization plant	
steam reforming plant	
sulphur recovery plant	
de-asphalization plant	
polypropylene plant	

Sungaigerong refinery owned by Pertamina

atmospheric distillation plant	65,000 B/D
vacuum distillation plant	
catalytic reformer plant	
isomerization plant	
de-waxing plant	

ii) Chemical industry

Palembang plant owned by Pusri

No.I plant	ammonia 180 t/d,	urea 300 t/d
No.II plant	ammonia 660 t/d,	urea 1,150 t/d
No.III plant	ammonia 1,000 t/d,	urea 1,725 t/d
No.IV plant	ammonia 1,000 t/d,	urea 1,725 t/d

iii) Main power generating facility

Boombaru	12,500 KW	(gas turbine)
Karomasan	29,560 KW	(gas turbine)
	25,000 KW	(diesel)
Tanjung Karang	16,376 KW	(diesel)
Bukit Asam	130,000 KW	(coal fired power plant)*

* under construction

iv) Cement plant

P.T. Semen Baturaja	500,000 t/yr.

5) Main Project Underway in South Sumatra

i) Oil Refinery

There is no significant expansion plan at present.

ii) Chemical Plant

Pusri is planning to replace No.I fertilizer plant. With this replacement, urea production capacity will be increased to 1,725 t/d. And also, Pertamina was planning to build an aromatic complex but abandoned it. However, there still remains the possibility of its revival.

iii) Power Generating Plant

There is no major new project at present.

(7) Transmigration Policy

Indonesia has big population of more than 150 million people, of which 62% live in Java island in 1980 which occupies less than 7% of total land. Java island has 690 men/km^2 of population density compared with 77 men/km^2 in Indonesia as a whole. Growth rate of population during 1980/1971 in Java island was almost leveled to 2.0%/annum compared with 1.9%/annum during 1971/1961 and this growth rate was rather small compared with 3.3%/annum in Sumatra, 3.2%/annum in Kalimantan and 2.8%/annum in Nusa Tenggara.

The transmigration program is construed to be a multi-objective program. It is intended to provide land for the landless on Java, Bali and Lombok, to improve the distribution of population and at the same time provide manpower for the labor-scarce areas outside Java, Bali and Lombok so that the latter areas can develop as new centers of production, particularly agricultural production. The program is also seen as a vehicle to promote national stability and integration.

According to the results of general transmigration in 1981, 28% of total 90,000 families flowed to southern part of Sumatra, 14% or Riau (Central Sumatra), 8% to southern part of Kalimantan and 7% to south-east of Sulawesi.

Transmigration from eastern part of Java and central part of Java is prevailing, which occurpies about 40 to 60% in each region of destination. An overall trend is that from Java to Sumatra, Kalimantan and Sulawesi.

During the period of REPELITA-IV, the Government expects 750 thousand families to transmigrate. As to this transmigration plan, voluntary transmigration program, called Swakarsa is to be encouraged due to budgetary limit, and will reach 250 thousand families of achieved level during REPELITA-IV.

During the period of REPELITA-III, there were 527 thousand families of transmigration, which surpassed the target of 500 thousand families. On the other hand there are still cases of abandoning the newly established settlement by many families.

There are several patterns as to transmigration. There are 1) food crop 2) fishery 3) plain estate 4) cattle breeding 5) industry and mining 6) transmigration for defense manpower or retired army 7) agro-forestry.

There are concrete programs under way as to 1) and 3) and concrete programs will be implemented during REPELITA-IV as to 2) and 4). Furthermore 5) and 6) will be implemented beyond REPELITA-VI. As to 7), there is no concrete program but just in the stage of idea.

As to the project of effective utilization of Banko coal, transmigration might be in the category of 5) industry and mining. This will be different from present pattern of being settled in land based on agricultural activity. Furthermore, in this case there will be the necessity of skilled labor force. Therefore, the pattern of the category of 5) industry and mining must be studied based on basic transmigration policy as well as industrialization policy.

It is considered that the Project is a model case to examine the probability of implementing new transmigration plan concerning 5) industry and mine.

Table 6-1-11 GENERAL TRANSMIGRATION SITUATION 1981

REGION OF ORIGIN

Transmigration REGION	Total		Local Transmigration		Jakarta		West Java		Central Java		Yogyakarta		East Java		Bali		NTB	
	Family Head	Share (%)	Family Head	Share (%)	Family Head	Share (%)	Family Head	Share (%)	Family Head	Share (%)	Family Head	Share (%)	Family Head	Share (%)	Family Head	Share (%)	Family Head	Share (%)
D.I. Aceh	3,783	4.2	858	7.3	-	-	531	4.0	1,049	3.8	243	5.6	1,102	4.1	-	-	-	-
North Sumatra	954	1.1	105	0.9	50	7.8	100	0.8	449	1.6	100	2.3	150	0.6	-	-	-	-
Riau	12,938	14.3	1,400	11.9	-	-	2,231	16.9	4,139	15.1	649	14.9	4,519	16.9	-	-	-	-
		(100.0)		(10.8)		(-)		(17.2)		(32.0)		(5.0)		(34.9)		(-)		(-)
Jambi	4,067	4.5	395	3.4	-	-	782	5.9	1,477	5.3	202	4.6	1,211	4.5	-	-	-	-
West Sumatra	742	0.8	289	2.5	-	-	-	-	303	1.1	-	-	150	0.6	-	-	-	-
Bengkulu	2,105	2.3	100	0.9	-	-	-	-	1,805	6.6	200	4.6	-	-	-	-	-	-
South Sumatra	25,530	28.3	2,782	23.7	133	20.7	4,266	32.3	8,152	29.7	1,120	25.7	9,077	33.9	-	-	-	-
		(100.0)		(10.9)		(0.5)		(16.7)		(31.9)		(4.4)		(35.6)		(-)		(-)
Lampung	1,354	1.5	1,354	11.6	- *)	-	-	-	-	-	-	-	-	-	-	-	-	-
West Kalimantan	5,881	6.5	724	6.2	21	3.3	694	5.3	2,022	7.4	288	6.6	2,132	8.0	-	-	-	-
Central Kalimantan	3,813	4.2	441	3.8	-	-	-	-	1,708	6.2	200	4.6	1,464	5.5	-	-	-	-
South Kalimantan	7,231	8.0	993	8.5	-	-	592	4.5	1,650	6.0	772	17.7	1,672	6.2	723	18.0	829	37.3
		(100.0)		(13.7)		(-)		(8.2)		(22.8)		(10.7)		(23.1)		(10.0)		(11.5)
East Kalimantan	2,858	3.2	200	1.7	100	15.6	569	4.3	699	2.6	-	-	1,290	4.8	-	-	-	-
South Sulawesi	1,798	2.0	100	0.9	37	5.8	100	0.8	470	1.7	-	-	191	0.7	500	12.4	400	18.0
Central Sulawesi	4,672	5.2	800	6.8	148	23.0	1,511	11.4	346	1.3	100	2.3	325	1.2	990	24.6	450	20.3
South-East Sulawesi	6,190	6.9	610	5.2	54	8.4	990	7.5	1,356	4.9	310	7.1	1,416	5.3	1,012	25.1	442	19.9
		(100.0)		(9.9)		(0.9)		(16.0)		(21.9)		(5.0)		(22.9)		(16.3)		(7.1)
North Sulawesi	1,665	1.8	150	1.3	100	15.6	199	1.5	-	-	-	-	466	1.7	650	16.2	100	4.5
Maluku	2,050	2.3	58	0.5	-	-	125	0.9	938	3.4	24	0.6	905	3.4	-	-	-	-
Irian Jaya	2,712	3.0	363	3.1	-	-	517	3.9	845	3.1	150	3.4	688	2.6	149	3.7	-	-
Total	90,343	100.0	11,722	100.0	643	100.0	13,207	100.0	27,408	100.0	4,358	100.0	26,758	100.0	4,024	100.0	2,221	100.0
		(100.0)		(13.0)		(0.7)		(14.6)		(30.3)		(4.8)		(29.6)		(4.5)		(2.5)

*) Lampung Resettlement

Source: Directorate General of Transmigration

6-2 Energy Supply Program in REPELITA-IV

(1) The Guideline for REPELITA-IV

REPELITA-IV is a continuation and enhancement of the previous plans and built on the achievements of REPELITA-I, II and III. While REPELITA-I dealt with the urgent needs for stabilization, rehabilitation, and the first stages of development, REPELITA-II was designed to deal with the problems of expanding employment opportunities, raising the level of income, a more equitable distribution of income, a more even distribution of the gains of development among the various regions, provision of adequate supplies of basic human needs, improving the nutritional status of the population and enhancing the quality of life.

REPELITA-II continues to treat these problems as central problems of development and sets the order of priorities accordingly. The accomplishment of REPELITA-III will enhance the nation's ability in REPELITA-IV to alleviate those problems.

The essential goals of REPELITA-IV are to raise the living standards and levels of knowledge of the Indonesian people, to strive for a more equal and just distribution of welfare for the whole population, and to lay a strong foundation for the next stage of development. Based on the experiences and results of the previous REPELITA's, it is decided to accelerate the achievement of the long-range goals of development. It is envisaged that during REPELITA-IV the basic framework for growth and development can be developed so that Indonesia can reach the take-off stage during REPELITA-VI.

To summarize these descriptions, under REPELITA-IV Indonesia Government is to pursue following items.

i) Improvement of living standard, intellectual capability and welfare of nation, and construction of strong foundation toward next step of national development

ii) Participation in the construction of effective infrastructure for systematic development in the future and national development efforts, and preparation of favourable environment providing incentive and opportunities to parties concerned

iii) Paying much more attention to social development with emphasizing self supply of agricultural goods and industrial machine supplying industry for light and heavy industries, and development of non-economic fields contributing to systematic national development

iv) Carrying out REPELITA-IV based upon Trilogi Pembangunan, which comprises equity, fully high economic growth and national stability with regularity and vividness

And also, in REPELITA-IV, policies and concrete programme are noted to increase overall income level and to change economic structure.

(2) Main Economic Indices in REPELITA-IV

Though GDP real growth rate in REPELITA-III was 5.7 %/yr., about 5%/yr. growth rate is envisaged in REPELITA-IV. Taking 2%/yr. of population growth into account, growth of GDP/capita will be 3%/yr. Annual GDP growth rate of 5%/yr. is the result of potential growth rate in each sector and some changes in industrial structure. Each annual growth rate in agriculture industry, mining industry, manufacturing industry, construction industry, transportation and communication industry and other industry is 3%, 2.4%, 9.5%, 5%, 5.2% and 5% respectively.

As a result of economic development in REPELITA-IV the weight of agriculture in total GDP will be decreased to 26.4% at the end of REPELITA-IV from 29.2% at the end of REPELITA-III. And also, the weight of mining industry will be down to 6.6% from 7.4%. On the other hand, the weight of

manufacturing industry will be up to 19.4% from 15.8%, and that of construction industry, transportation and communication industry, and other sector will be roughly levelled off at 6.3%, 6.0%, 35.3% respectively.

In national economy through REPELITA-IV, imbalance between agriculture and manufacturing industry is expected to be corrected.

Indonesia's total population is estimated to have reached 158.1 million persons by the end of 1983. As a result of the active national family planning programme undertaken in the past, total population is projected to grow at an annual rate of 2.0% during REPELITA-IV as compared to 2.3% during REPELITA-III. Total population will therefore reach about 175.6 million people by the end of 1988.

The persistently high percentage of youth (under 20 years of age) in the total population will continue to pose a number of development problems. The overall population increase of 17.5 million during the planning period will place heavy demands on total resources available, particularly the demand on basic necessities such as food, clothing and housing. The high proportion of persons under 20 years of age will also put a heavy strain on the nation's ability to provide basic social services, particularly education and health and creates an even greater urgency for expanded employment opportunities.

Table 6-2-1 Setoral Growth Rates and Structural Change

Sector	Estimated share in GDP, 1983/84	Average annual growth rate, Repelita IV.	Projected share in GDP 1988/89
1. Agriculture	29.3 %	3.0 %	26.5 %
2. Mining	7.0 %	2.4 %	6.1 %
3. Industry	15.8 %	9.5 %	19.4 %
4. Construction	6.7 %	5.0 %	6.7 %
5. Transport and Communication	6.0 %	5.2 %	6.1 %
6. Other sectors	35.2 %	5.0 %	35.2 %
	100.0 %	5.0 %	100.0 %

Table 6-2-2 Projection of Fuel Demand in Indonesia During Repelita IV

'10³ B/D

Products	1984/85	1985/86	1986/87	1987/88	1988/89	85/86 ~ 88/89
Av. Gasoline	0.25 (10.7) (-)	0.25 (0) (-)	0.25 (0) (-)	0.25 (0) (-)	0.25 (0) (-)	2.1
Jet Fuel	110.5 (8.1) (2.5)	112.7 (2.0) (2.6)	116.0 (2.9) (2.6)	120.7 (4.1) (2.6)	126.8 (5.1) (2.5)	4.4
Motor Gasoline	72.63 (-6.8) (16.7)	74.08 (2.0) (16.8)	76.29 (3.0) (16.9)	79.31 (4.0) (16.8)	83.24 (5.0) (16.7)	1.4
Kerosine	132.54 (0.4) (30.4)	133.87 (1.0) (30.4)	137.0 (2.3) (30.4)	143.71 (4.9) (30.5)	152.75 (6.3) (30.6)	3.0
ADO	135.71 (-2.4) (31.1)	136.94 (0.9) (31.1)	140.11 (2.3) (31.1)	146.76 (4.7) (31.1)	155.74 (6.1) (31.2)	2.5
IDO	25.78 (-7.8) (15.9)	26.02 (0.9) (5.9)	26.58 (2.2) (5.9)	27.8 (4.6) (5.9)	29.42 (5.8) (5.9)	1.1
FO/Bunker	57.65 (-19.8) (13.2)	58.14 (0.8) (13.2)	59.36 (2.1) (13.2)	62.03 (4.5) (13.1)	65.62 (5.8) (13.1)	-1.5
Total	435.7 (-2.9) (100.0)	440.56 (1.1) (100.0)	451.2 (2.4) (100.0)	471.94 (4.6) (100.0)	499.75 (5.9) (100.0)	2.2

Source: MIGAS

(3) Primary Energy Supply Plan by Each Source

Based on the overall objectives of and the national policies for REPELITA-IV the major objectives of the Indonesian energy policy are (a) to assure a gradual shift from a mono-energy to a poly-energy economy, (b) to assure the availability of energy at reasonable prices for the domestic market, and (c) to ensure a continuous and positive contribution to the balance of payment and public revenues.

Accordingly, the following policy measures will be taken during REPELITA-IV.

(a) Increasing and expanding surveys and explorations of energy resources.

(b) Reducing dependence on petroleum in the overall energy consumption, by developing and using non-oil energy resources. Measures will also be adopted to develop non-exportable and renewable sources of energy for domestic uses. Non-renewable and exportable resources (such as oil) would be used primarily as a means of increasing foreign exchange earnings. Non-commercial

energy, which is still the prime source of supply throughout the rural areas of the country, will also be developed in accordance with a plan to meet the rural needs with due regard to environmental considerations. Solar and wind energy will be developed and utilized if and where they are economically justifiable.

(c) Economizing energy use and using energy efficiently and wisely.

(d) Indexation, i.e. matching each energy need with the most appropriate energy source available in the country.

Commercial energy consumption will increase at an average of 6.8 percent per year, so that at the end REPELITA-IV energy consumption will amount to 292.2 million BOE. Of this amount the household sector, which includes home industries and small businesses, is estimated to consume 20 percent during fiscal year 1988/1989, the industrial and power sector 56 percent and the transportation sector 25 percent. Based on data on commercial energy consumption during the first semester of fiscal year 1983/84 (the final year of REPELITA-III), the share of each sector during 1983/84 would be 23 percent for the household sector, 52 percent for the industrial and power sector, and 25 percent for the transportation sector, respectively.

On the supply side, it is planned to meet the demand by a mix of commercial energy sources. It may be seen that the Government's policy since the beginning of REPELITA-III to diversify the use of energy sources would start to bear fruit as the share of oil in the total commercial energy consumption would decrease from 77.9 percent in 1983/84 to 62.4 percent in 1988/89, the final year of REPELITA-IV.

The growth of consumption of non-commercial energy (firewood, agricultural waste, etc) during REPELITA-IV is expected to be less than that of commercial energy as a result of development and the rise of the standard of living

of the people, especially those in the rural areas, industrialization and modernization in general, and the natural tendency to shift from the more cumbersome and inconvenient form of non-commercial energy to commercial energy uses. Consequently, it is anticipated that by the end of REPELITA-IV the share of non-commercial energy will be only 40 percent of the total energy consumption.

Supply projection by each energy source in REPELITA-IV is as following.

(a) Crude oil

There are several oil fields where contractors finished its exploration activity during REPELITA-III. As to these oil fields, no production activity has started yet because of poor economics. During REPELITA-IV economic studies about these newly found oil fields should be carried out once again.

Crude oil production during REPELITA-IV is expected to increase due to projected expanding exploration, crude oil market and increasing domestic demand of petroleum products.

Crude oil production is projected to be 1,400 x 10^3 B/D in 1984/85 and 1,700 x 10^3 B/D in 1988/89.

(b) Natural gas

The role of natural gas during REPELITA-IV will be increased furthermore because of exportability as LNG, projected expansion of demand as an alternative fuel to oil and feed stock for basic industry. Production of natural gas during REPELITA-IV is projected to increase from 1766 billion to 1980 billion cubic feet, with an effective utilization from 1626 billion to 1799 billion cubic feet. The biggest reason for this expansion of production and consumption of natural gas is LNG refinery expansion in Arun and Bontang.

(c) Geothermal

It is estimated that the total potential may reach 10,000 MW. Potential geothermal energy reserve is estimated to be 3,300 MW in Java, Bali, West Sumatra and North Sulawesi. At present, a 30 MW geothermal plant and a monoloc of 2 MW have been operating successfully. Geothermal energy will be developed primarily for electric power generation and a total of 220 MW will be added during REPELITA-IV.

(d) Hydropower

Total potential of Indonesia has been estimated at 75,000 MW. Currently about 1,316 MW of hydropower capacity has been installed. According to REPELITA-IV, an additional 1,475 MW of hydropower capacity will be added, including 50 MW for minihydropower plants.

(e) Coal

In REPELITA-IV, coal is expected to play much greater role in energy balance of Indonesia. The figure in total (commercial) energy consumption will increase to 9.7% (28.24 million BOE) 1988/89 from 0.5% (1.11 million BOE) in 1982/83 and coal and hydropower is expected to increase the share significantly from 4.2% to 18%.

Coal will be supplied primarily to power generating sector (70-80%) and then to cement industry (15-20%) according to DGM projection. In REPELITA-IV, coal production is to increase to 9.39 million ton in 1988/89 from 0.9 million ton in 1984/85. This great expansion of coal will comprise expansion of Bukit Asam coal mine (3.5 million ton/yr.), opening new mine in Muara Tiga (3.0 million ton/yr.), and rehabilitation of existing underground mine and open pit mine by PN Tambang Batubara, and also development of new mine in Ombilin located in West Sumatra (1.5 million ton/yr.) and perhaps, southern and eastern part of Kalimantan.

However, some problems such as the delay in the construction of infra-structure will be expected to occur. The Bukit Asam Project by P.T. (Persero) Bukit Asam started in 1981 to develop Air Laya, which was supported by World Bank loan. This project is an integrated one from mine development to transportation system, involving coal mine, mine town site, railway, Tarahan terminal, Kertapati terminal and sea transportation. For the time being, P.T. (Persero) Bukit Asam has been concentrating on achieving 3.2 million ton/yr. by the beginning of 1987. That figure is consisted

of 2.5 million ton for Suralaya 1&2, 0.4 million ton for Bukit Asam mine mouth power station (65 MW x 2), and 0.1 million ton for cement plant in Sumatra etc. When supplying coal to Suralaya 1&2, coal fired power plants in west Java which is starting in 1984 and 1985 respectively, it will be necessary to depend on imported coal temporarily in their early stage of operation due to the delay of mine development.

Though further expansion program of Suralaya coal fired power plants is scheduled in REPELITA-IV the program might have difficulty in railroad upgrading and mine development.

(4) Demand of Petroleum Product and Electricity

1) Petroleum product demand in REPELITA-IV

The growth of energy demand in Indonesia was decreased significantly because of economic recession after Second Oil Crisis. Average growth rate of petroleum products in this period is envisaged to be slightly higher than 2%/yr. On the other hand, product supply from domestic refineries is to grow by around 5%/yr. mainly because of recent expansion of refining capacity. And therefore, short supply of kerosene and diesel oil is expected to be resolved and some people are afraid of over supply.

Crude oil production is restricted to be not more than $1,200 \times 10^3$ B/D due to OPEC decision. Present crude oil production capacity is estimated to be $1,600 \times 10^3$ B/D, according to the projection of Migas and Pertamina.

As a matter of fact, the production level of $1,700 \times 10^3$ B/D is technically feasible if OPEC restriction is to be removed and, as a result, export of about 1 million B/D is probably assured.

Demand of petroleum product during REPELITA-IV, shown in Table 6-2-2, is to grow in the rate of 2.2%/yr. in the period of 1984/85 - 1988/89 in terms of total BBM. This low growth rate is due to projected negative growth in 1984/85 and demand restricting measure of keeping higher pricing policy.

Petroleum product demand is projected to grow in the latter half during REPELITA-IV. And also, composition of crude oil is not projected to change during REPELITA-IV.

2) Electricity demand

PLN's electricity in 1973 was 2,174 GWH, of which 49% was consumed in residential sector and 9.63%, 15.2% in commercial and industrial sector respectively. However, in 1983, the share of residential sector is decreased to 45.5% and that of industrial sector is increased to 34.4%. Therefore, annual growth rates in this period are 26.4% in industrial sector, 16.9% in commercial sector and 15.6% in residential sector. Higher growth rate in industrial sector was characteristic in this period. The annual growth rate of 23.4% in industrial sector and commercial sector is much higher than the average growth rate of 16.5% in total PLN's electricity. This implies very active industrial activity in Indonesia in this period.

The number of houses electricity is being supplied is $4,406 \times 10^3$ in 1983 and this number is 600×10^3 more than that of the previous year. Because of rural electrification policy since 1970s, the number of villages where electricity supply is available is 8,000 in total villages of 63,000.

The electric power sector in Indonesia will be further expanded with additional generating capacity of about 5,255 MW, reaching to 9,190 MW of total generating capacity at the end of REPELITA-IV (1988/89). Of this additional capacity, the biggest share (34.8%) is occupied with 1,830 MW of coal fired power plant, 28.1% with 1,425 MW of hydropower and 20.9% with 1,100 MW of diesel power. The projected expansion of diesel power plant is because Indonesia consists of many isolated islands.

On the other hand, projected expansion of 630 MW is smaller share in total additional capacity. Of this figure, 130 MW (2 x 65 MW, Belawan in north Sumatra) is occupied with dual fuel (oil and gas) fired power plant. And also, 220 MW of expansion in geothermal is envisaged but no addition

capacity in gas turbine power plant is planned during REPELITA-IV.

Big increase in hydropower capacity is another important factor during REPELITA-IV. That is, average growth rate in REPELITA-IV is 30.2%/yr., which is compared with 4.7%/yr. in 1978/1973 and 8.7%/yr. in 1983/1978. Average growth rate in oil fired power plant capacity is envisaged to be dropped to 7%/yr. from 19.8%/yr. in 1978/1973 and 22.8%/yr. in 1983/1978. As a result, the share of oil fired power plant in total electricity generated is projected to be down to 52.2% in 1988/89 from 83.3% in 1983.

Anyway, the role of coal fired power plant and hydropower will be remarkably increased in total electricity supplied.

Demand structure of electricity has been remarkably changed during last decade, from residential sector weighted pattern to industrial & commercial sector weighted pattern. This tendency will be kept during REPELITA-IV.

Rural electrification will be further reinforced and electricity supply will be newly available to 7,000 villages, about 1.6 million people during REPELITA-IV. As a result, the total number of villages where electricity supply will be available by the end of REPELITA-IV will be 12,265 villages, which is 12.7% in total of 63,358 villages.

Table 6-2-3 Consumption of PLN's Electricity by Consumer Types

(kWh)

Year	Type of Consumer								Total	Growth (%)
	Residential	Growth (%)	Commercial	Growth (%)	Industrial	Growth (%)	Public	Growth (%)		
1973	1 065 929 793 (49,01)	-	209 399 493 (9,63)	-	330 652 261 (15,20)	-	568 763 174 (26,16)	-	2 174 744 721 (100%)	-
1974	1 162 577 041 (47,57)	9,1	225 535 659 (9,22)	7,7	737 747 953 (30,18)	123,0	318 246 635 (13,03)	(44,0)	2 444 107 288 (100%)	12,7
1975	1 290 212 130 (46,02)	11,0	280 023 592 (9,99)	24,1	880 214 163 (31,40)	19,3	353 163 070 (12,59)	11,0	2 803 612 955 (100%)	14,7
1976	1 419 532 394 (46,06)	10,0	317 632 669 (10,31)	13,4	978 493 158 (32,75)	11,2	366 158 809 (11,88)	3,7	3 081 817 030 (100%)	10,0
1977	1 609 498 861 (45,63)	13,4	362 552 512 (10,23)	14,1	1 141 670 214 (32,37)	16,7	413 382 071 (11,77)	12,9	3 527 103 658 (100%)	14,4
1978	1 962 212 884 (45,77)	21,9	430 893 527 (10,05)	18,8	1 443 400 868 (33,67)	26,4	450 413 571 (10,51)	9,0	4 286 920 850 (100%)	21,5
1979	2 427 611 189 (45,43)	23,7	518 695 395 (9,70)	20,4	1 909 900 741 (35,74)	32,3	487 198 974 (9,13)	8,2	5 343 406 299 (100%)	24,6
1980	2 909 447 083 (44,35)	19,8	982 379 514 (14,97)	89,4	1 662 318 310 (25,34)	13,0	1 006 017 377 (15,34)	106,5	6 560 162 284 (100%)	22,8
1981	3 425 260 927 (43,66)	27,9	1 069 503 418 (13,63)	18,3	2 240 302 207 (26,55)	46,4	1 110 399 535 (16,16)	19,9	7 845 466 087 (100%)	19,6
1982	3 892 102 476 (42,76)	13,6	953 477 114 (10,48)	-10,8	3 017 265 806 (33,15)	34,7	1 238 288 979 (13,60)	11,5	9 101 134 375 (100%)	16,0
1983	4 554 947 634 (45,55)	17,0	1 002 534 369 (10,03)	5,1	3 435 865 753 (34,36)	13,9	1 006 360 342 (10,06)	-18,7	9 999 708 098 (100%)	9,9

Source: PLN
Note : Number in parentheses are percentages of total

Table 6-2-4 Generation Expansion Plan in 1984/85 - 1988/89

			MW	Year
Hydro Power Plant :				
Saguling	4 x 175	=	700	85/86
Cirata	4 x 125	=	500	87/88
Wadaslintang	2 x 8	=	16	87/88
Sengguruh	2 x 14.5	=	29	87/88
Tes	4 x 4	=	16	88/89
Tenggari	2 x 8.5	=	17	86/87
Bakaru	2 x 62	=	124	87/88
Pade Kembayung #1	1 x 10	=	10	88/89
Sentani	2 x 6.5	=	13	88/89
			1425	
Geothermal Power Plant :				
Kamojang #2, 3	2 x 55	=	110	87/88
Dieng #1	1 x 55	=	55	88/89
Salak #1	1 x 55	=	55	88/89
			220	
Steam Power Plant :				
Gresik #3	1 x 200	=	200	87/88
Gresik #4	1 x 200	=	200	87/88
Belawan #1, 2	2 x 65	=	130	84/85
Combine Cycle		=	100	86/87
			630	
Steam Coal Power Plant :				
Suralaya #1	1 x 400	=	400	84/85
#2	1 x 400	=	400	85/86
#3-4	2 x 400	=	800	88/89
Bukit Asam #1, 2	2 x 65	=	130	86/87
Ombilin #1, 2	2 x 50	=	100	87/88
			1830	
Mini Hydro Power Plant : (scattered)			50	
Diesel Power Plant : (scattered)			1100	

Table 6-2-5

Projection of PLN Electric Power Production (1984/85 - 2003/04)

Subject	1984/85		1985/86		1986/87		1987/88		1988/89	
	GWh	%	GWh	%	GWh	%	GWh	%	GWh	%
Non Oil	2 990	19,0	6 891	35,4	10 366	44,8	12 645	45,6	15 359	47,8
. Hydro PP	2 780	17,7	3 206	16,5	4 866	21,0	5 497	19,8	6 907	21,5
. Steam Coal PP	-	-	3 475	17,9	5 290	22,8	6 199	22,4	7 471	23,2
. Geothermal PP	210	1,3	210	1,0	210	1,0	949	3,4	981	3,1
O i l	12 714	81,0	12 551	64,6	12 795	55,2	15 064	54,4	16 795	52,2
. Diesel PP	1 911	12,2	2 762	14,2	3 126	13,5	3 390	12,2	3 983	12,4
. Gas Turbine PP	1 608	10,2	1 472	7,6	1 411	6,1	2 372	8,6	2 967	9,2
. Steam Oil PP	9 195	58,6	8 317	42,8	8 258	35,6	9 302	33,6	9 845	30,6
Grand Total	15 704	100,0	19 442	100,0	23 161	100,0	27 709	100,0	32 154	100,0

Source: PLN

6-3 Long-term Supply and Demand Prospects for Energy

(1) Purpose of the Long-term Forecast

Since 1969, the Indonesian government has implemented a series of five year development plan. The first plan (REPELITA-I) aimed to keep relatively lower economic growth rate less than 5% per annum in real term and to eliminate the various kinds of inflation factors. Moreover, the government investment expenditure in the plan was weighted upon the development of agriculture and the improvement of infrastructure as the social capital stocks.

In the second plan (REPELITA-II), the real economic growth rate was set up at 7.5% per annum. Moreover, such points as increasing opportunities for employments, promoting of industrialization and ensuring social welfare were enphasized as the main government objectives.

The third plan aimed at 7.5% per annum in terms of real economic growth rate. Also was considered the plan for fair distribution of results which would be harvested through various kinds of development projects, and for discharging high dependency of national economy on oil.

Succeeding previous three development plans, the fourth plan has just started as REPELITA-IV from the beginning of 1984 fiscal year.

Basic preconditions and political targets in REPELITA-IV are settled as follows. Such annual growth rates as population, labor force, inflation, and gross domestic products (GDP) during a period of the plan are expected to be 2.0%, 2.74%, 8%, 5% respectively. On the other hand, the main indicators in the field of energy are estimated as follows. Firstly, crude oil production level will sharply increase from 1,400 x 10^3 B/D in 1984 to 1,700 x 10^3 B/D in 1988, and its price level will also increase US$29.0/bbl in 1984 to US$36.0/bbl in 1988.

On the contrary, dependency on oil and gas revenue is expected to fall from 71% to 65% in terms of the nation's

total export value and from 64% to 55% in national annual revenue. Oil demand in domestic market is forecasted to be in not so high level through the new plan, the growth rate of demand for oil is prospected to be slightly higher than 2% per year. As a result, the dependency on oil in total energy consumption is expected to drop from 78% to 62% in the final stage of the plan.

As mentioned above, the Indonesia Government aims to have a medium growth in its economy through REPELITA-IV and to establish the economic foundation for further development. Consequently, the Indonesia economy can be expected to take off and to build a fair and abundant society in the future.

In the meantime, as far as this project is concerned, even if the feasibility study will smoothly go ahead and also could be confirmed technical and economic viabilities of the project, establishment of the commercialized plant may be realized after 1995 or so.

Accordingly, it is very important to forecast supply and demand of energy and chemical products around the year of 1995. It is needless to say that there are many unknown factors in this kind of forecast. Nevertheless, to judge feasibility of the project based on the long term forecast is to say in a very meaningful manner. Anyhow, capacity of the plant, variety of energy (and/or chemical) products, and volume of them should be decided on the basis of future market condition estimated by this kind of long term forecast.

However, those results of the forecast calculated through computer model in this time are still preliminary in the initial stage of the project. So, it must be remembered that there are still some rooms for revision of those results.

(2) Structure and Features of the Model

In forecasting energy demand in the year 1995, the computer model was used, which was originally completed by MIGAS and JICA in 1982 and after that, was modified and maintained in some points by Indonesia side.

This model which we used in forecasting this time is that of July 1984 version. This model is characterized as a linked macro-economic model and energy supply-demand forecasting model in its structure. This original model had indigenous variables such as GDP, private consumption expenditure, production index of mining and industry and also had exogenous variables such as government consumption expenditure (at current prices), crude oil production, world import. Among these exogenous variables this model has government consumption expenditure as the most important one.

The original model was modified in terms of export, export deflator, import deflator and wholesale price index and, as a result, it has seven exogenous variables as follows.

* crude oil production
* deflator for agricultural goods export prices
* index of international export price
* exchange rate of Rp. relative to U.S.$
* population
* government consumption expenditure
* growth rate of exported crude oil price

Fig. 6-3-1 illustrates the outline of macro-economic model (original).

In this forecasting work, we improved the original model, which MIGAS allowed us to use, so as to estimate total energy consumption which was left for future in the point of the year 1982.

That is, in Migas model (version of July, 1984), at first, final energy consumption by each sector & each energy source was calculated from macro-economic frame. And, as a result, those accumulated figure tends to be over-estimated due to defects in statistics.

To correct this defect, at first we calculated total final energy consumption by each sector through model and in the next step, final energy consumption by each energy source & each sector was estimated mainly based upon past trend.

Fig. 6-3-2 shows the concept of revised model as in flow chart.

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As to original model, please refer to "Survey Report on The Energy Supply-Demand Data Bank System in the Republic of Indonesia, March 1981, JICA, MPN CR(3) 81-78" and "Survey Report on The Energy Supply-Demand Planning System in the Republic of Indonesia, Sept. 1982, JICA, MPN SC 82-87".

Fig. 6-3-1 Flow Chart for Outline of Indonesia's Macro-Economic Model (Original ...)

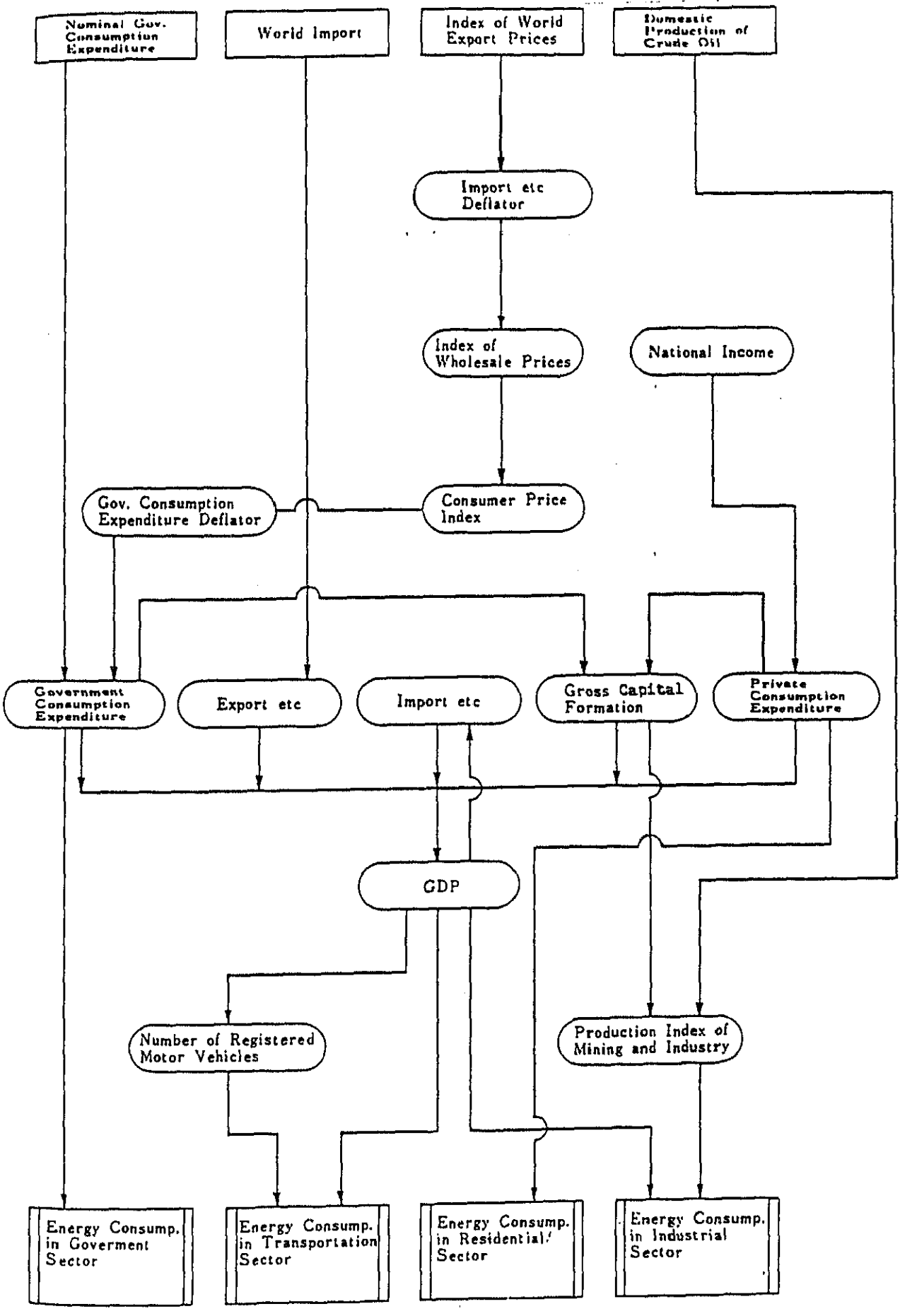

Fig. 6-3-2 Flow of Revised Model