THE INTERIM REPORT III

ON

THE FEASIBILITY STUDY

ON

EFFECTIVE UTILIZATION OF BANKO COAL

IN

THE REPUBLIC OF INDONESIA

(FY 1986)

SUMMARY

JULY 1987

JAPAN INTERNATIONAL COOPERATION AGENCY

1. OUTLINE OF THE STUDY

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

TYPE OF PROGRAM	Government-sponsored technical cooperation
AGENCY FOR THE IMPLEMENTATION	
Japanese side	JICA (Japan International Cooperation Agency)
Indonesian Side	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 chemical 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 - 88 (5 years) 1) Strategic Investigation Stage: One year 2) Coal Gasification Test Stage: 2.5 years 3) Feasibility Study Stage : 1.5 years

2. BACKGROUND OF THE STUDY IN FY 1986

2-1 STUDY IN FY 1984

In FY 1984, the following studies were carried out in view of strategic points.

1) Survey on background of the project
2) Preliminary survey on markets of brown coal and its derivatives
3) Survey on Banko coal resources and its preliminary mining cost estimation
4) Survey on Brown coal utilization technology
5) Strategic investigation on Banko coal effective utilization
6) Study of coal gasification test

As the results of the above strategic investigation, the following conclusions were obtained:

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

2) The measured reserves of Banko coal are 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 storing as well as high sodium in ash.

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

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

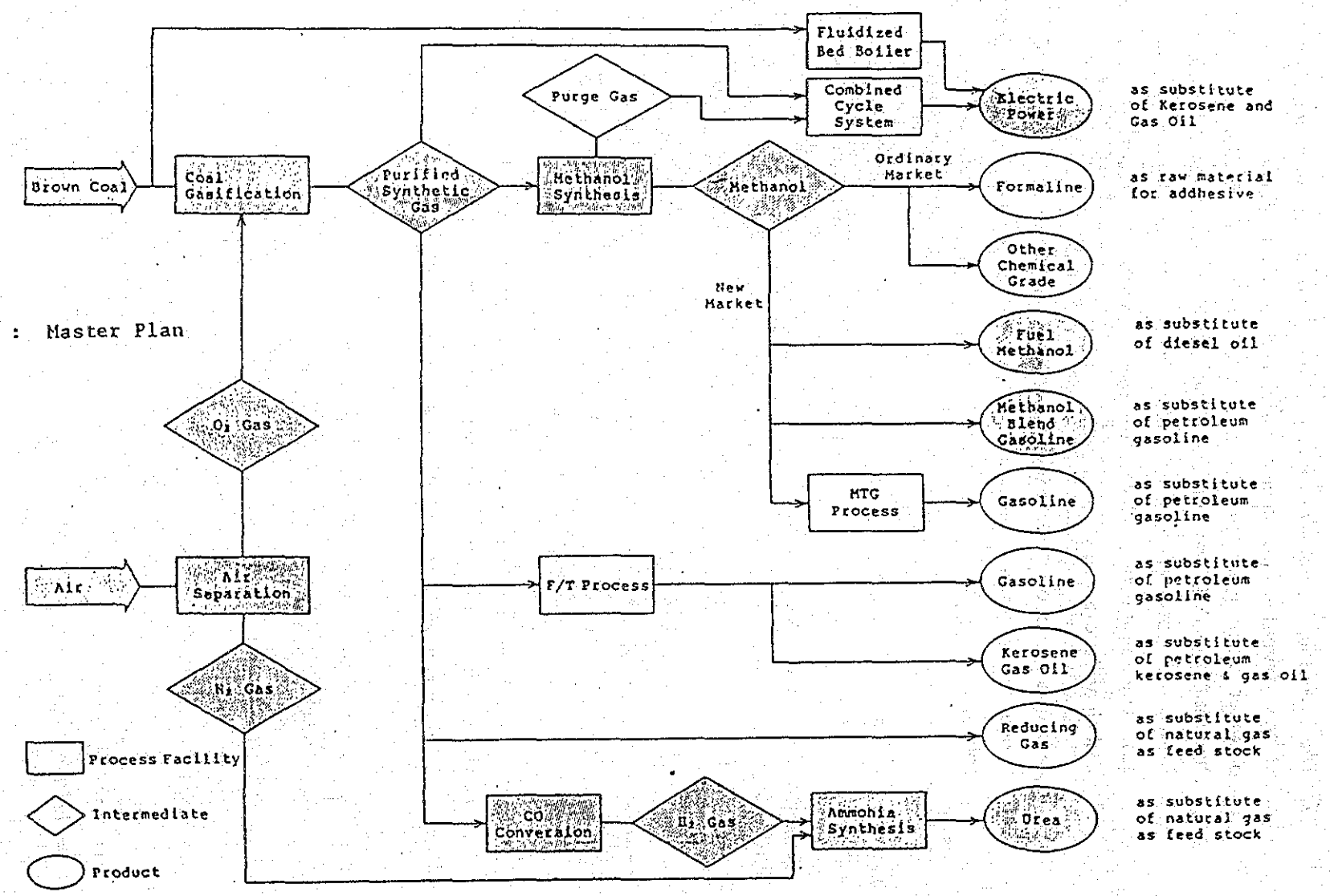
5) It was revealed that a spark assited diesel engine designed for neat methanol as fuel is ready for commercialization and has flexibility for fuel selection, diesel oil or neat methanol.

6) A master plan and preliminary proposed projects for Banko coal effective utilization were proposed. (See Fig. - III.) However, such a plan and projects must be studied furthermore in due course.

7) The economic feasibility 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 methanol is "hopeful", but MTG (mobil) and urea depend on the price of crude oil in future and Government price policy for petroleum gasoline and natural gas. The possibility of electricity generation by CGCC depends on future technical development.

8) As a conclusion of the strategic investigation, the effective utilization of Banko coal seems to be feasible from the technical and economic stand points.

FIG. III Preliminary Flow Scheme and Master Plan for Brown Coal Utilization



2-2 STUDY IN FY 1985

In FY 1985, a study of the 2nd stage shown on Fig. IV was started.
The scope of the study in FY 1985 was as follows:

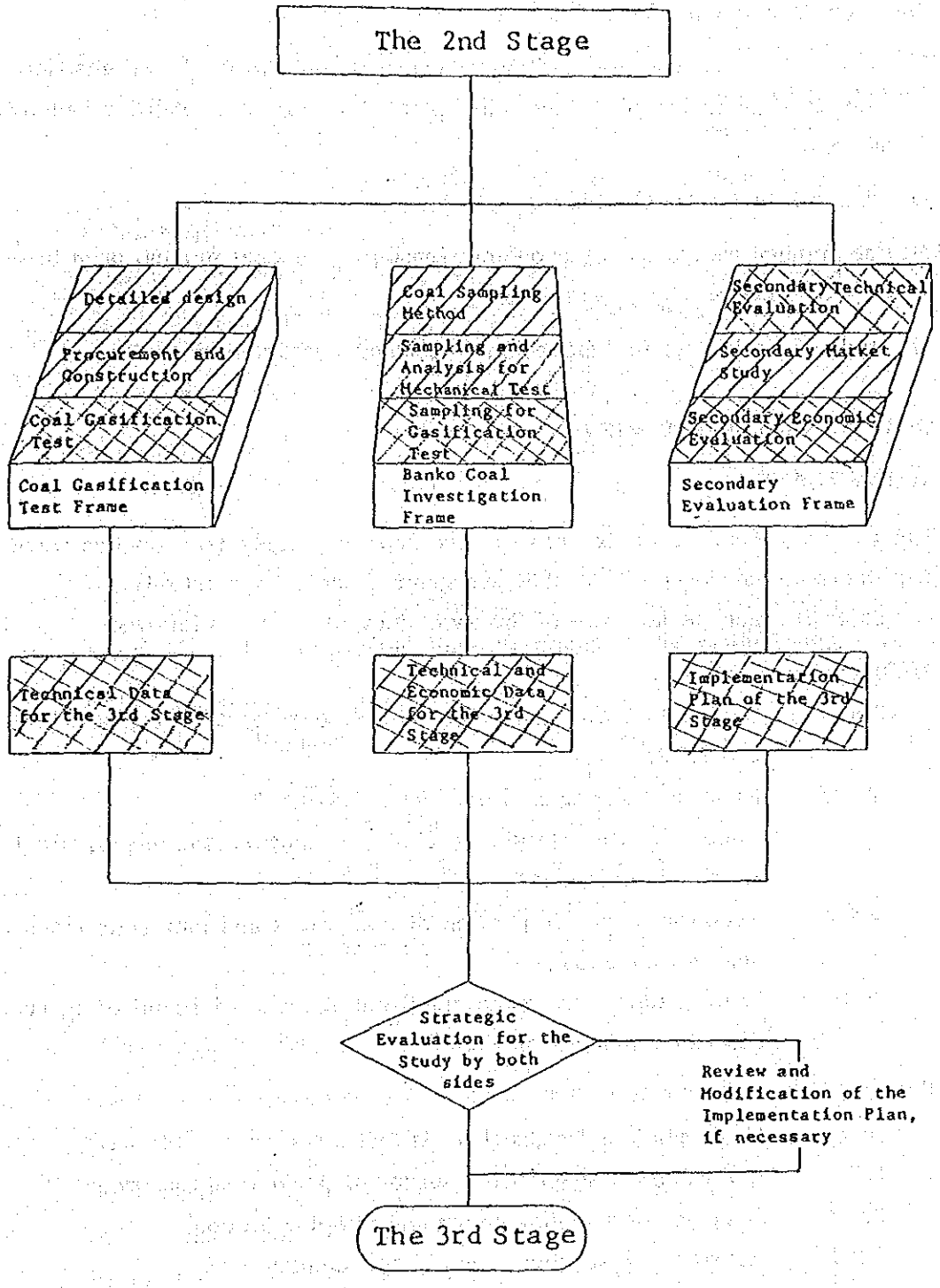
1) Detailed design on coal gasification test facilities
2) Survey on coal quality
3) Prelimianry evaluation of economic feasibility

All of the studies in F.Y. 1985 have successfully been completed and the results were as follows:

1) Detailed design of the coal gasification test facilities was carried out and completed in September, 1985.
   JICA has started procurement of the equipment in accordance with the Scope of Work.
   BPPT has continued the construction work of the pilot plant building in PUSPIPTEK and is almost completed, excepting maintenance facilities.
2) A coal sampling study was carried out including shallow boring and deep boring in North West Banko and West Banko (partially).
   i) The outcrop lines and coal seam structure in NW Banko and West Banko were grasped in detail.
   ii) Sodium content in coal is a maximum 0.6%; however, sodium in ash is in the range of 0 - 40%.
   iii) Coal samples (200 kg/sample x 10 samples) for the coal gasification test will be taken in NW Banko using two sets of 101 mm core drilling machines in FY 1986.
3) The project, producing 1,600,000 ton/year of methanol from Banko Coal, was preliminarily evaluated in terms of financial viability and profitability.
   i) The results show relatively low IRR of 13.5% (before tax) because the sales price of methanol (35¥/kg at gate, before tax) was assumed to be rather low, reflecting the current oil prices which have declined extremely. Since the viability as well as profitability of the project depend greatly on the sales price, there is a possibility that this project is appraised as viable in case of an oil price higher than 30$/bbl.

ii) Provided that produced methanol is imported to Japan as transportation fuel, the estimated methanol sales price in Japan (44¥/l before tax) is between those of gasoline (96¥/l) and diesel oil (81¥/l), considering the difference of overall energy efficiency for automobiles. Fuel methanol also benefits air pollution improvement.

Fig. IV Flow Chart of Implementation Plan of the 2nd Stage



: Scope of the Study

: Scope of the Study in 1986

3. SCOPE OF THE STUDY IN F.Y. 1986

The scope of work of the 2nd stage is shown in Fig. (IV).
The scope of study in FY 1986 is as follows:

1) Fabrication, construction and mechanical test operation of coal gasification test facilities including pilot plant building and utilities supply system.

2) Coal sampling work (1st phase)

3) Preliminary evaluation of economic feasibility of coal mining, urea production and electricity generation.

4) Study of market for fuel alcohol and its supply system in Indonesia.

4. OUTLINE OF THE SITE SURVEY

4-1 STUDY TEAM

The staff and his area of expertise of the Japanese study teams which were dispatched to Indonesia in F.Y. 1986 are summarized on Appendix-IV.
The objective and special notes of the each study team are as follows:

i) Study Team (A)

Objective: Explanation and discussion with Counterpart on items 2.10.3 and 2.6.2.

2.10.3 Kick-off meeting of "Fuel Alcohol Project"
(Study on the Marketing and Distribution System of Fuel Alcohol in Indonesia)

2.6.2 Acceptance and inspection of equipment and materials transported from Japan

Note: 2.10.3, 2.6.1 etc. mean the item number of scope of Study described in Scope of Work.

ii) Study Team (B)

Objective: Coal sampling for gasification test

2.9.1 Reconnaissance/scientific survey of Banko coal resources

2.9.2 Selection of sampling points and sampling of coal

2.9.3 Packing and transportaton of coal samples

iii) Study Team (C)

Objective: Survey on "Fuel Alcohol Project"

2.10.3 - Survey on utilizing technology for fuel alcohol
- Demand for petroleum products in Indonesia
- Potential demand for fuel alcohol in Indonesia
- Production and upstream distribution cost of fuel alcohol
- Issues and countermeasures for introducing fuel alcohol
- Programme for introducing fuel alcohol in Indonesia
- Policy and measures for introducing fuel alcohol

iv) Supervision Team

Objective: Supervision of field work of the coal gasification test facilities

2.6.2 Acceptance inspection of equipment and materials for the field work

2.6.3 Construction of the facilities

v) Operation Team

Objective: Test operation of coal gasification test facilities

2.7.1 Final inspection of the field work

2.7.2 Mechanical test of the facilities

2.7.3 Operation test and adjustment using specified coal

2.7.4 Final drawing, operation manual, and maintenance manual

vi) Study Team (D)

Objective: Explanation and discussion with Counterpart on following items based upon draft report of F.Y. 1986.
- Coal sampling for gasification test
- Mining cost estimation of N.W. Banko coal
- Study on "Fuel Alcohol Project"
- Test operation of the facilities

4-2 SCHEDULE OF THE SITE SURVEY

Six (6) JICA missions organized by the staffs of above mentioned team were dispatched to Indonesia for the site survey.

1st mission	June 16 - June 27	Jakarta, Serpong
2nd mission	June 30 - Oct. 4	Jakarta, Bandung, Banko
3rd mission	Aug. 13 - Sept. 11	Jakarta, Kupang, Balikpapan Palembang, Cilacap
4th mission	Oct. 6 - Nov. 11	Serpong
5th mission	Dec. 23 - March 15	Serpong
6th mission	March 1 - March 17	Jakarta, Serpong

The detailed schedule, organization and program visited by the each mission are attached as APPENDIX II.

4-3 SPECIAL NOTES OF THE SITE SURVEY

(1) 1st mission

The 1st mission was organized by the staffs of the study team A and B.

1) Implementation plan of the study in FY 1986 was discussed on the basis of the Inception Report and was agreed by both parties.

2) Budget for the study in FY 1986 was explained by both parties and confirmed that the study in FY 1986 will be proceeded on the same mode with Scope of Work.

3) Detailed implementation plan of coal sampling work in FY 1986 was discussed. Both sides agreed and confirmed the revised coal sampling schedule which topographic survey and drilling operation would be started from 6th of July and 17th of July respectively.

4) Construction procedure and schedule of the coal gasification test facilities were discussed and agreed on:

   i) The JICA's procedure of "bidding and order" of the construction work of the facilities to be installed at PUSPIPTEK in Serpong.

   ii) The expected schedule as follows:

   - o Explanation meeting to tenders: 20 June
   - o Closing date of quotation : 15 July
   - o Order of the Work : End of August
   - o Arrival of JICA equipment : Middle of Sept.
   - o Start of the work : Beginning of Oct.
   - o Completion of construction : End of Jan. '87

5) Implementation plan of the study on "market for fuel alcohol and its supply system in Indonesia" was discussed with the counterpart including relevant organizations.
Questionnaire of this study was explained at the first joint meeting held on June 20, 1986.

(2) 2nd mission

The 2nd mission was organized by the experts of the study team B and carried out the coal sampling work at N.W. anko as well as topographic survey at Suban Jeriji and Central Banko.

(3) 3rd mission

The 3rd mission was organized by the study team C, and carried out data collection and opinion building though discussions with the counterpart and relevant organizations including such site visits as Cilacap refinery, alikpapan refinery, diesel power plants in Kupang, and ethanol plant in

In Indonesia, introduction project of CNG (compressed natural gas) on fleet cars will start in April, 1987 in Jakarta city using natural gas from Cirebon gas pipe line.

ii) Ethanol is prospective as fuel because molasses from sugar plants and Cassava from transmigration area will be produced in accordance with related Government policies. Fleet test of low blending gasoline has been done by BPPT.

iii) Methanol utilization has been studied in PERTAMINA and LEMIGAS for blending into gasoline with/without an additive.

(4) 4th mission

The 4th mission is the supervision team and supervised the construction work of coal gasification test facilities, which was completed by the end of January 1987.

(5) 5th mission

The 5th mission is the operation team and carried out mechanical test and process test operation of the coal gasification test facilities. Technology transfer has proceeded using operation manual and maintenance manual as well as process test operation.

(6) 6th mission

The 6th mission was organized by the study team A, B, C and D.

i) The draft Interim Report (FY1986) was discussed and agreed upon.

ii) The implementation plan of the Study in FY 1987, including overall review and evaluation for the result of the coal gasification test stage,

was discussed and confirmed mutually that both sides shall continue necessary preparation work for the Study in FY 1987.

5. RESULTS OF THE ENGINEERING STUDY ON THE CONSTRUCTION WORK OF THE COAL GASIFICATION TEST FACILITIES

The engineering study on the construction work of the coal gasification test facilities that is constructed in PUSPIPTEK, SERPONG, was successfully finished in FY 1986.

The following were mainly studied:

1) Project Specification
2) Requisition
3) Request for Quotation
4) Operation Procedure & Maintenance Manual

5-1 PROJECT SPECIFICATIONS

The installation work of the coal gasification test facilities regarding the following items is specified:

1) Opening of the packed facilities which had been transported there
2) Arrangement
3) Supplementation of acceptance
4) Transportation to site
5) Temporary laying
6) Indoor foundation work
7) Painting (only touch up)
8) No-load test run
9) Attendance at individual load test
10) Attendance at integrated load test run
11) Cleaning and so forth.

The details are given in the separate volume of "Technical Specifications for the Construction Work of the Coal Gasification Test Facilities."

5-2 REQUISITION

This requisition includes the purchase conditions, the general conditions and the technical conditions.

The details are given in the separate volume of "Technical Specifications for the Construction Work of the Coal Gasification Test Facilities."

5-3 REQUEST FOR QUOTATION

The Japan International Cooperation Agency INDONESIA Office requested the bidder to quote in accordance with the applicable documents for the construction of the coal gasification test facilities. It was understood that unless exceptions, deviations or alternatives were clearly defined and listed separately and the documents would be deemed to be accepted by the bidder.

The details are given in the separate volume of "Technical Specifications for the Construction Work of the Coal Gasification Test Facilities."

5-4 OPERATION PROCEDURE & MINTENANCE MANUAL

The operation procedure shows separately the start, daily operation, stop and emergency stop procedures of the coal gasification test facilities.

The maintenance manual shows the procedures of maintenance and troubleshooting procedures for the individual equipments of the coal gasification test facilities.

The detailes are given the separate volume of in "The Operation Procedure of Coal Gasification Test Facilities" and "The Maintenance of Coal Gasification Facilities."

5-5 CONSTRUCTION AND OPERATION TEST

1) The construction work of the Pilot Plant Building in PUSPIPTEK was completed in September, 1986.

2) Fabrication and transportation of equipment for the coal gasification test facilities as well as utilities facilities was carried out and completed in September, 1986.

3) Field work of the coal gasification test facilities and utilities facilities was completed in January, 1987, including acceptance inspection of equipment.

4) Mechanical test and operation test of the facilities, including performance test, were successfully completed in March, 1987. The operation test result shows that the coal gasification test can be carried in FY 1987 as scheduled.

6. RESULTS OF THE COAL SAMPLING WORK AND GEOLOGICAL SURVEY

6-1 THE OBJECTIVES OF THE COAL SAMPLING WORK AND GEOLOGICAL SURVEY IN FY 1986

1) To take coal samples for mechanical and process test run of gasification facilities and regular gasification test.

2) To carry out a geological survey for selecting appropriate drilling spots for coal sampling to be done in FY 1987.

6-2 THE SURVEY WORK CARRIED OUT IN FY 1986

1) About 2,667 kilograms of coal samples for the test run of the gasification facilities were taken from pits dug in the Northwest Banko area.

2) About 2,236 kg of coal samples for the regular gasification tests were taken from different coal seams by large diameter core drilling in the Northwest Banko area.

3) The above coal samples for the regular tests were analyzed to check their quality.

4) Geological survey of several favorable places for coal sampling in FY 1987 was made in the Central Banko and North Suban Jeriji areas.

5) Appropriate drilling spots for coal sampling were selected on the basis of geological study.

6-3 RECOMMENDED COAL SAMPLING METHOD IN FY 1987

Places: Central Banko and North Suban Jeriji areas.
Weight of Samples: Total 2,000 kg (1,000 kg for each erea)
Method: Large diameter core drilling (core diameter: 101 mm)
Drilling Machine: 2 sets
Total
Drilling Length: 435m (Central Banko : 240m,
North Suban Jeriji: 195m)
Working System: 2 shifts/day
Working Period: 2 months

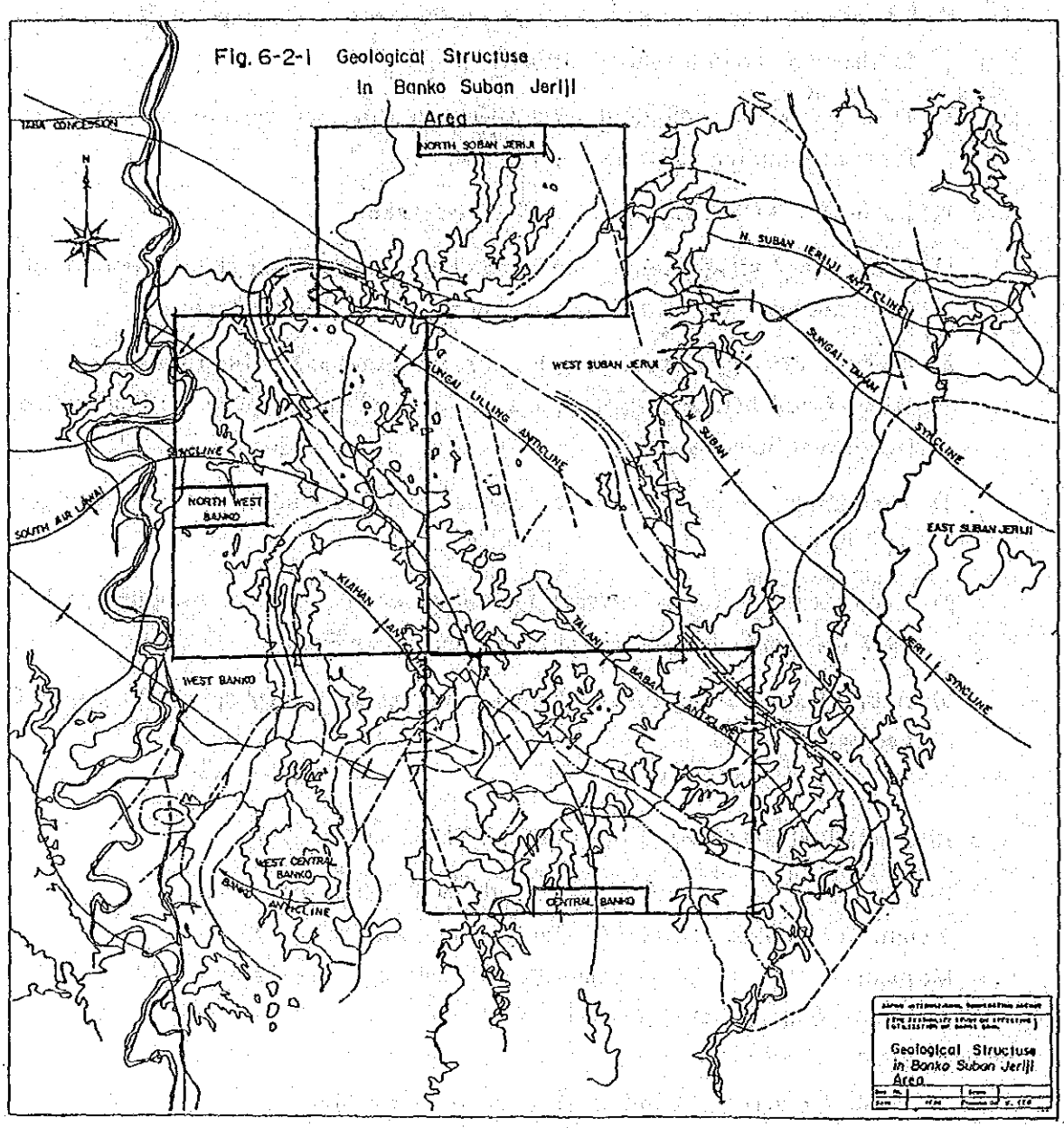
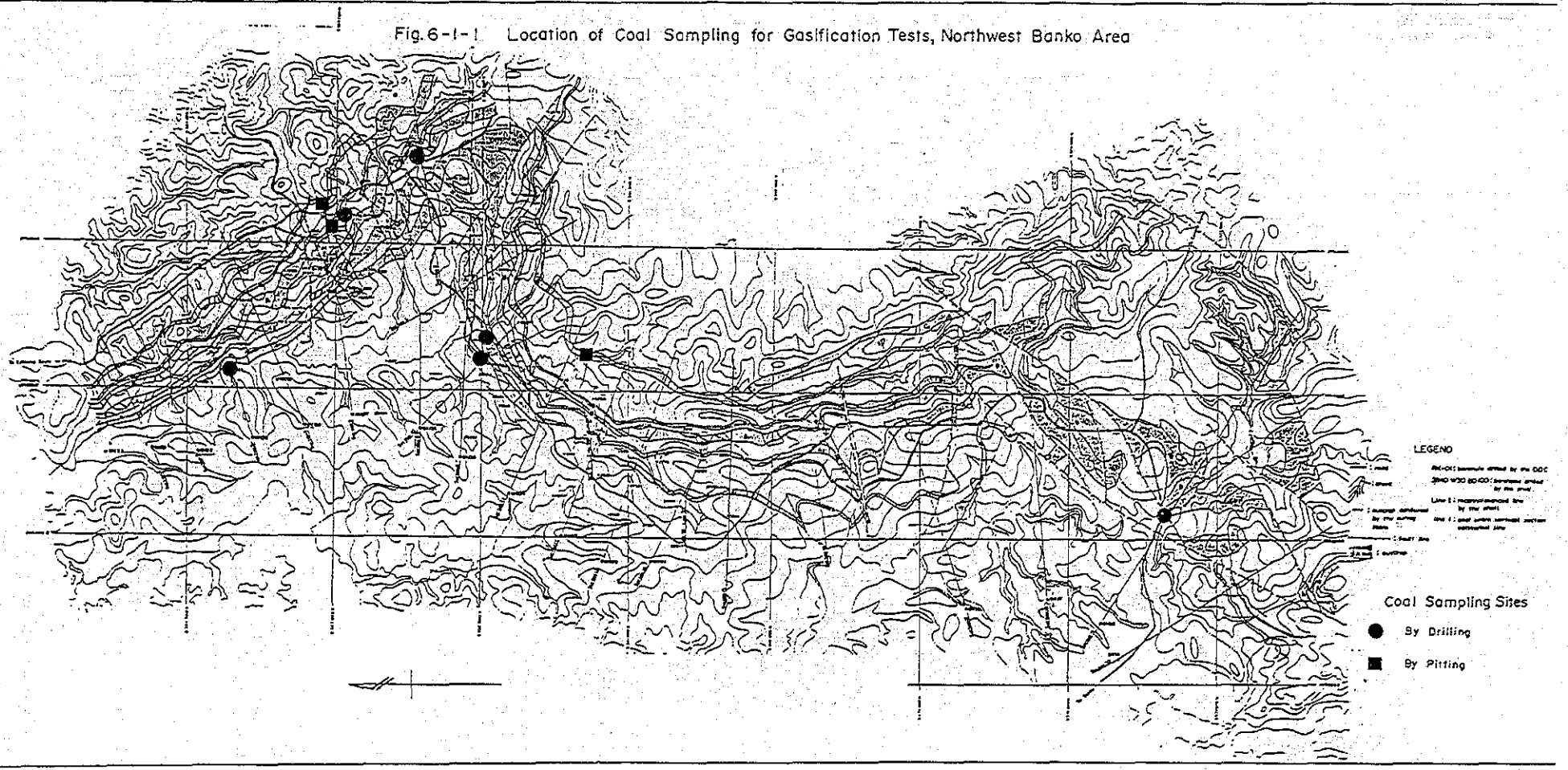


Fig. 6-2-1 Geological Structuse
In Banko Suban Jerlji
Area
NORTH SUBAN JERIJI
WEST SUBAN JERIJI
EAST SUBAN JERIJI
NORTH WEST BANKO
WEST BANKO
CENTRAL BANKO
WEST CENTRAL BANKO
SYNCLINE
ANTICLINE
Geological Structuse
in Banko Suban Jerlji
Area

Fig. 6-1-1 Location of Coal Sampling for Gasification Tests, Northwest Banko Area



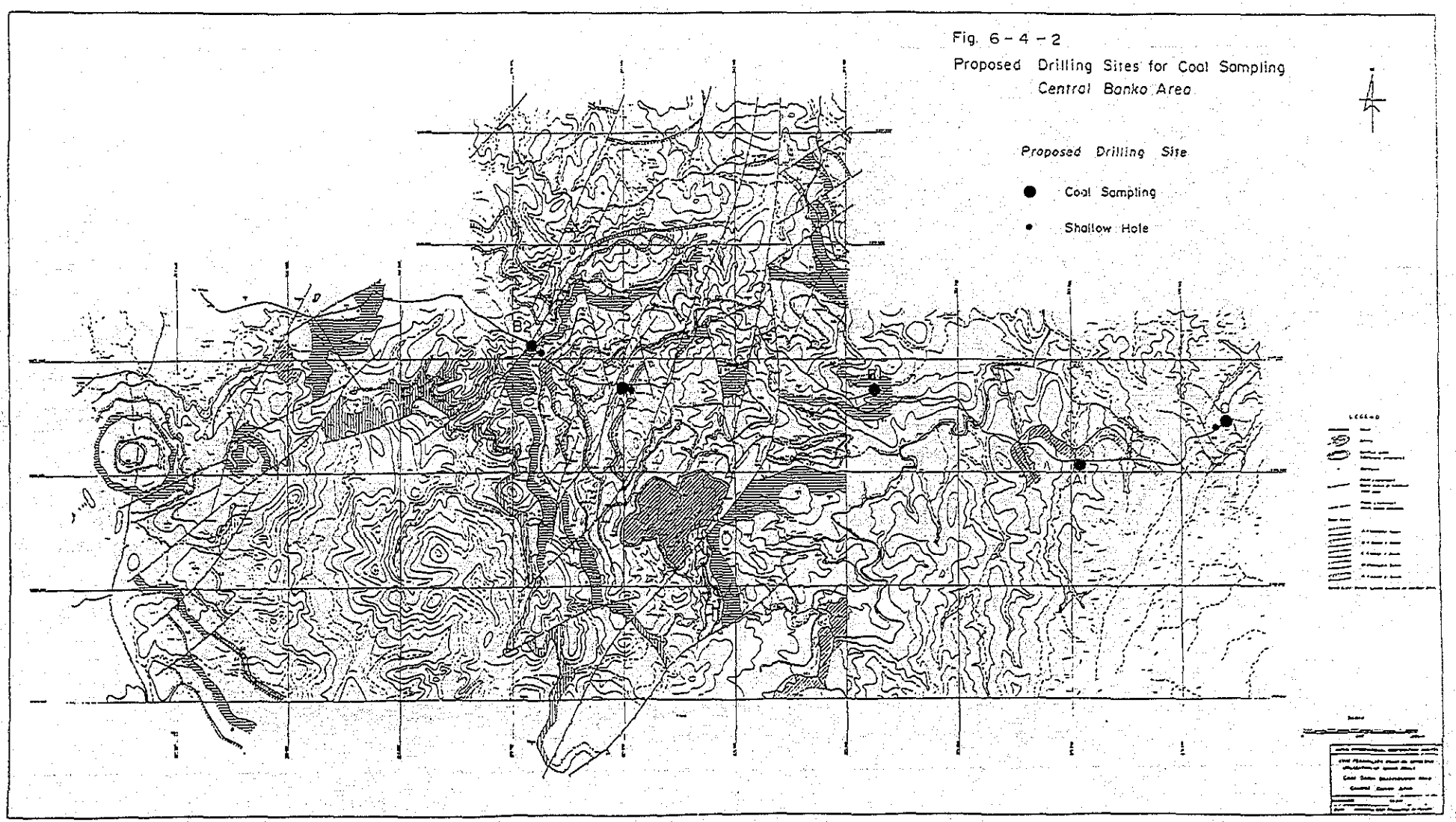
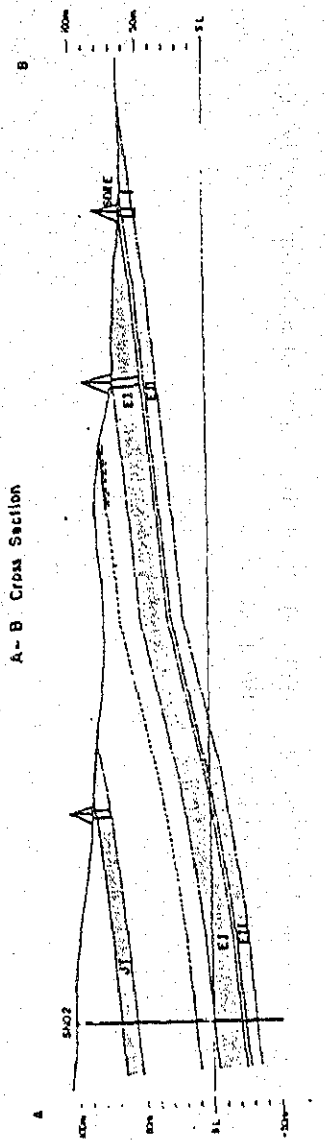
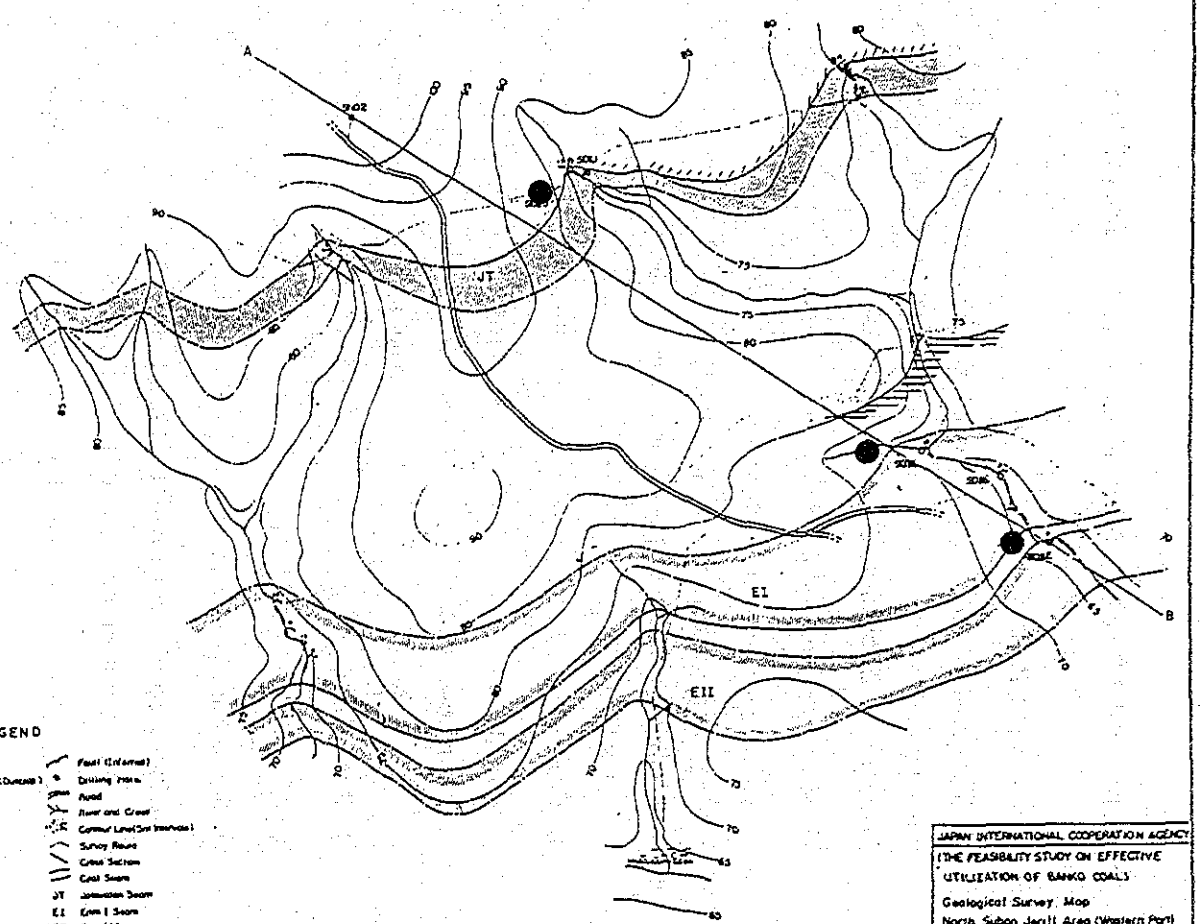


Fig. 6 - 4 - 2
Proposed Drilling Sites for Coal Sampling
Central Banko Area

Fig. 6 - 4 - 3

Proposed Drilling Sites for Coal Sampling
North Suban Jeriji Area





LEGEND

- Coal Outcrop
- Carbonaceous Shale(B: Outcrop)
- Claystone(C: Outcrop)
- Mudstone(M: Outcrop)
- Sandstone(S: Outcrop)
- Contact
- Drilling (Coal)
- Drilling (Other Rocks)
- Boundary (Observed)
- Boundary (Inaccurate)
- Boundary (Interred)
- Fault (Inferred)
- Drilling Hole
- Road
- River and Creek
- Contour Line (2m Interval)
- Survey Route
- Cross Section
- Coal Seam
- JT Jelawatan Seam
- EI Eram I Seam
- EII Eram II Seam

● Proposed Drilling Sites

JAPAN INTERNATIONAL COOPERATION AGENCY
(THE FEASIBILITY STUDY ON EFFECTIVE UTILIZATION OF BANKO COAL)
Geological Survey Map
North Suban Jeriji Area (Western Part)

7. PRELIMINARY EVALUATION OF ECONOMIC FEASIBILITY

7-1 COAL MINING COST

The preliminary evaluation of the mining cost of N.W. Banko coal has been investigated. The mining cost of N.W. Banko coal is estimated to be 14.5$/ton-coal by shovel and truck system.

1) Main Parameters and Assumptions

Coal reserves: N.W. Banko
Annual production: 3 million tons/year
Mining method: Shovel and truck system
Strip ratio: 1.63-1.95

2) Capital Investment Cost

Initial investment costs: 125 million $
Replacement costs: 186 million $
Total 311 million $

3) Coal Mining Cost

14.48$/ton-coal

4) Sensitivity Analysis

Increase of strip-ratio(%): 10, 20, 30
Increase of mining cost(%): 1.2, 5.4, 8.9

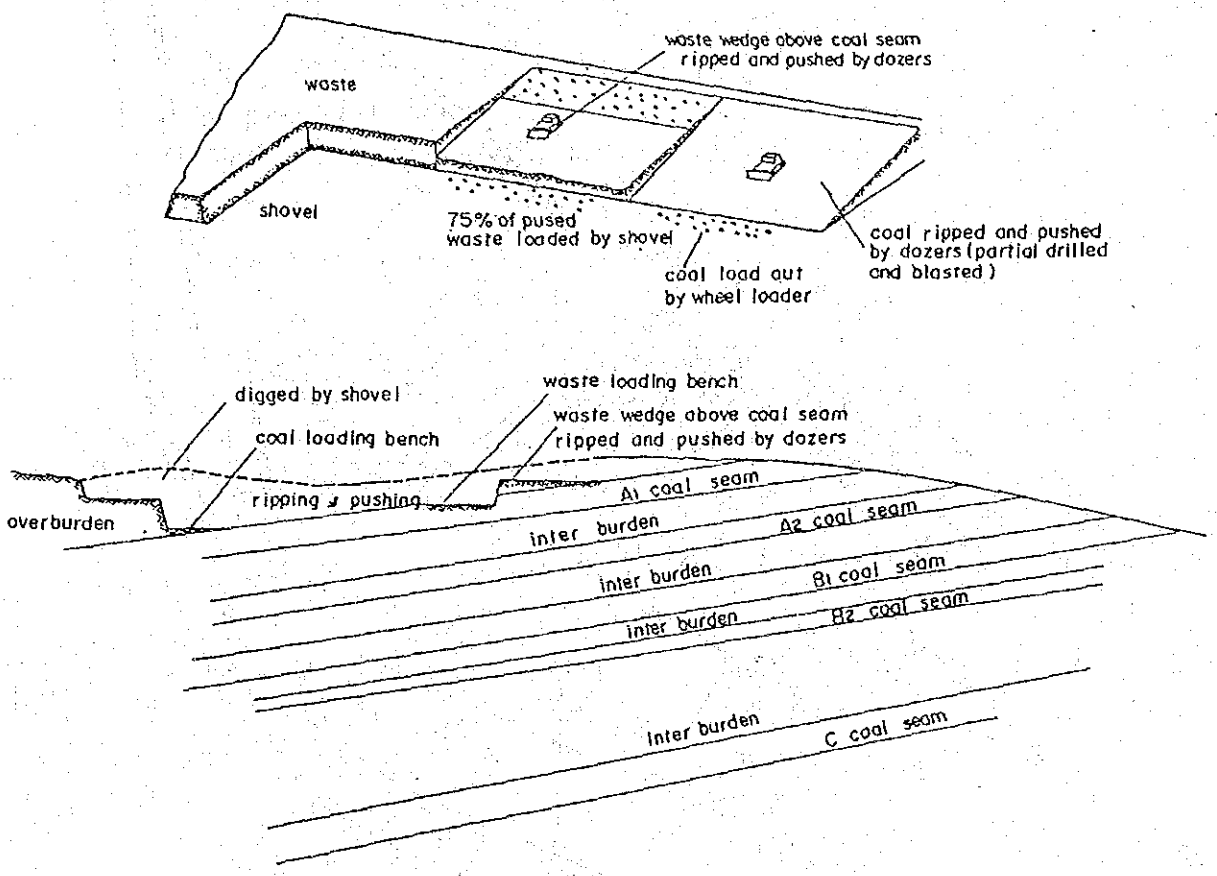
5) Evaluation

Previous evauation in 1985 shows 14.85$/ton.

Minus factors of mining cost are decrease of miscellaneous mining losses. On the other hand, plus factors of mining cost are change of preconditions such as addition of infrastructural cost and technical service fee.

A detailed study shall be done at the 3rd stage on the basis of selected coal reserves and type of expected coal production entity to be decided on by the Counterpart.

Fig. 7-1-1 Idealized Mining System in Three Dimensions



(note) working places will be developed horizontally and vertically

Fig. 7-1-3 Pit Outline at the Beginning of Production Period

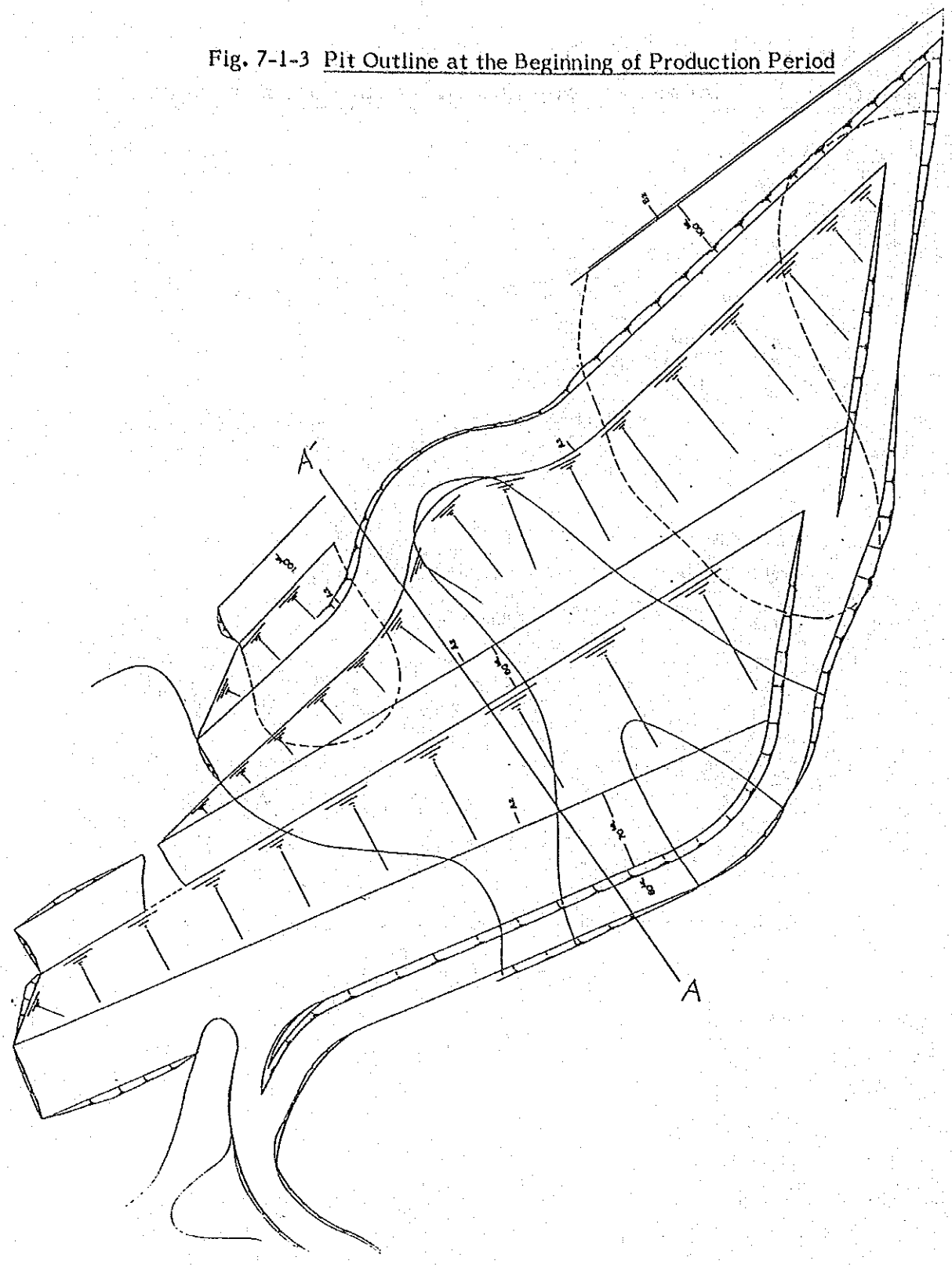
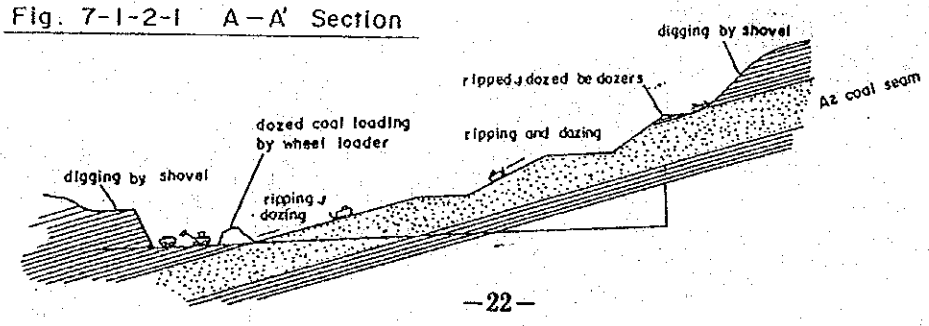


Fig. 7-1-2-1 A－A' Section



7-2 UREA PRODUCTION COST

A preliminary evaluation of urea production cost has been carried out on the basis of master plan-case 2A. (See attached Fig. 9-2-5.)

1) Main Parameters and Assumptions

Coal feed rate:	$4{,}120 \times 10^3$ t/y
Produced gas volume:	510×10^3 Nm^3/H
Methanol production:	$1{,}300 \times 10^3$ t/y
Urea production:	560×10^3 t/y

2) Capital Investment Costs (as of 1985)

	10^6 Rupiah
Coal gasification plant:	413,000
Methanol plant:	163,000
Urea plant:	154,000
Support facilities:	476,000
Total	1,206,000

3) IRR on Total Investment Costs

Urea sales price (at plant gate)		IRR
Rp/Kg	($/t)	(%)
111	100	10.6
160	150	12.3
222	200	13.8

Note a) Sales price (at plant gate) of methanol is 194Rp/Kg and fixed for each case.

b) IRR of methanol production in case of 194Rp/Kg is 13.5%.

4) Evaluation

i) The FOB cost at Palembang will be around 215$/ton including 25$/ton of inland transportation cost. On the other hand, the international FOB price in 1984 was 170-180$/ton at a crude oil price of 30$/bbl.

ii) The economics of urea production is inferior to that of methanol, and therefore it can be concluded that case 2 of the master plan (co-production of methanol and urea) will be eliminated from further study in the 3rd stage.

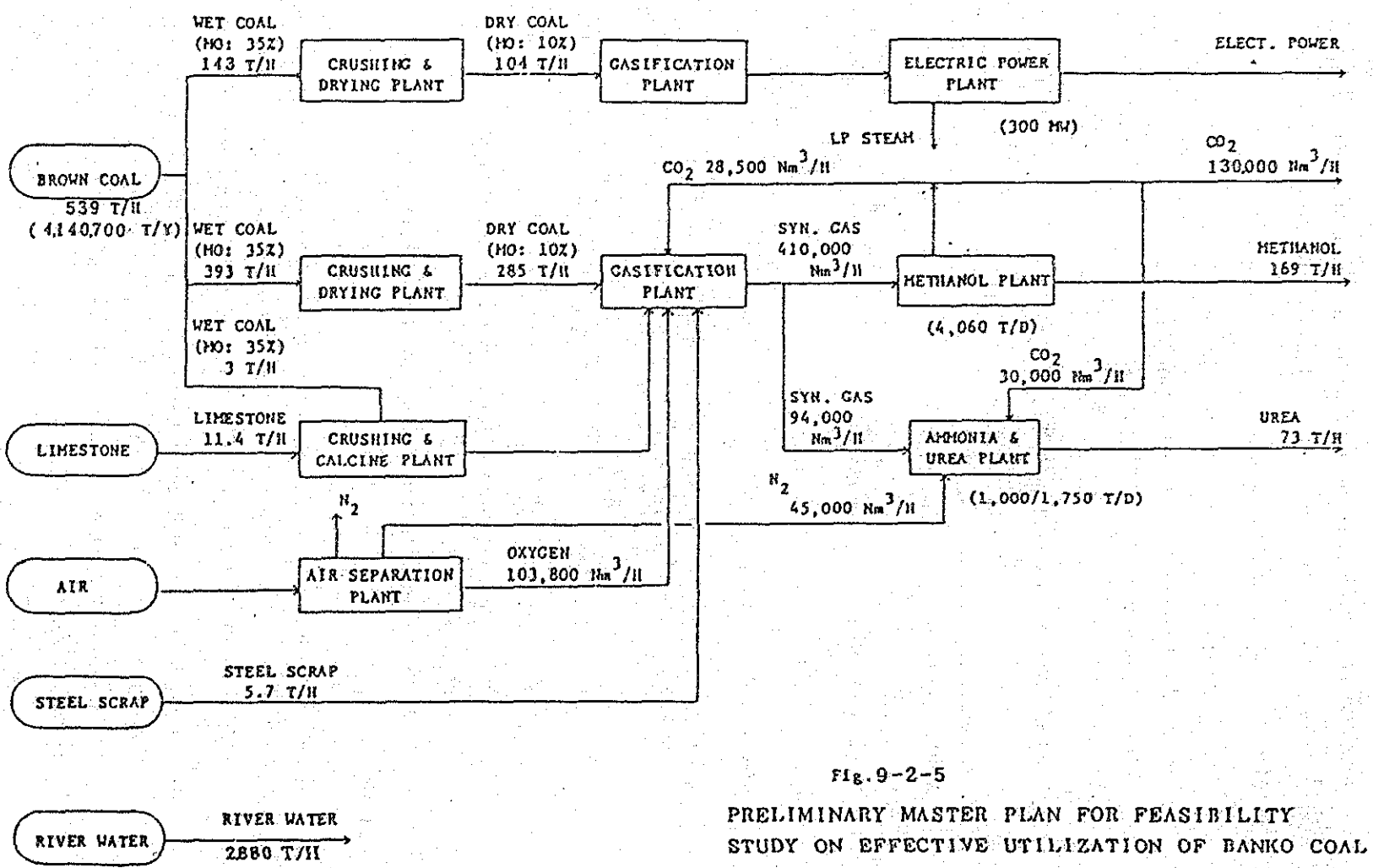


Fig.9-2-5

PRELIMINARY MASTER PLAN FOR FEASIBILITY STUDY ON EFFECTIVE UTILIZATION OF BANKO COAL

CASE 2-A

7-3 ELECTRICITY GENERATION COST

The preliminary evaluation of electricity generation cost has been studied on the basis of master plan-Case 1A. To compare the economics with that of methanol production, the coal feed rate was assumed to be the same as in the methanol production case (Case 1A. molten iron bath process).

1) Main Parameters and Assumptions

Maximum coal feed rate	:	495T/H
Average load factor	:	66% (average in Indonesia)
Average coal consumption	:	2.5 million tons per year
Power generation capacity	:	835MW
Power generation system	:	Coal gasification-combined cycle

2) Capital Investment Costs (as of 1985)

	10^6 Rupiah
Coal gasification plant: (including its support facilities)	502,000
Power plant: (including its support facilities)	438,000
Total	940,000

3) IRR on Total Investment Cost

	Electricity sales price (Rp/KWH at gate)	IRR (%)
Sales in Jakarta	43	6.9
	53	10.3
Sales in Banko	64	13.5
	78	17.0

Note a) The sales price is assumed to be 98 Rp/KWH as of 1985. Loss of distribution and overhead cost were changed for each case.

4) Evaluation

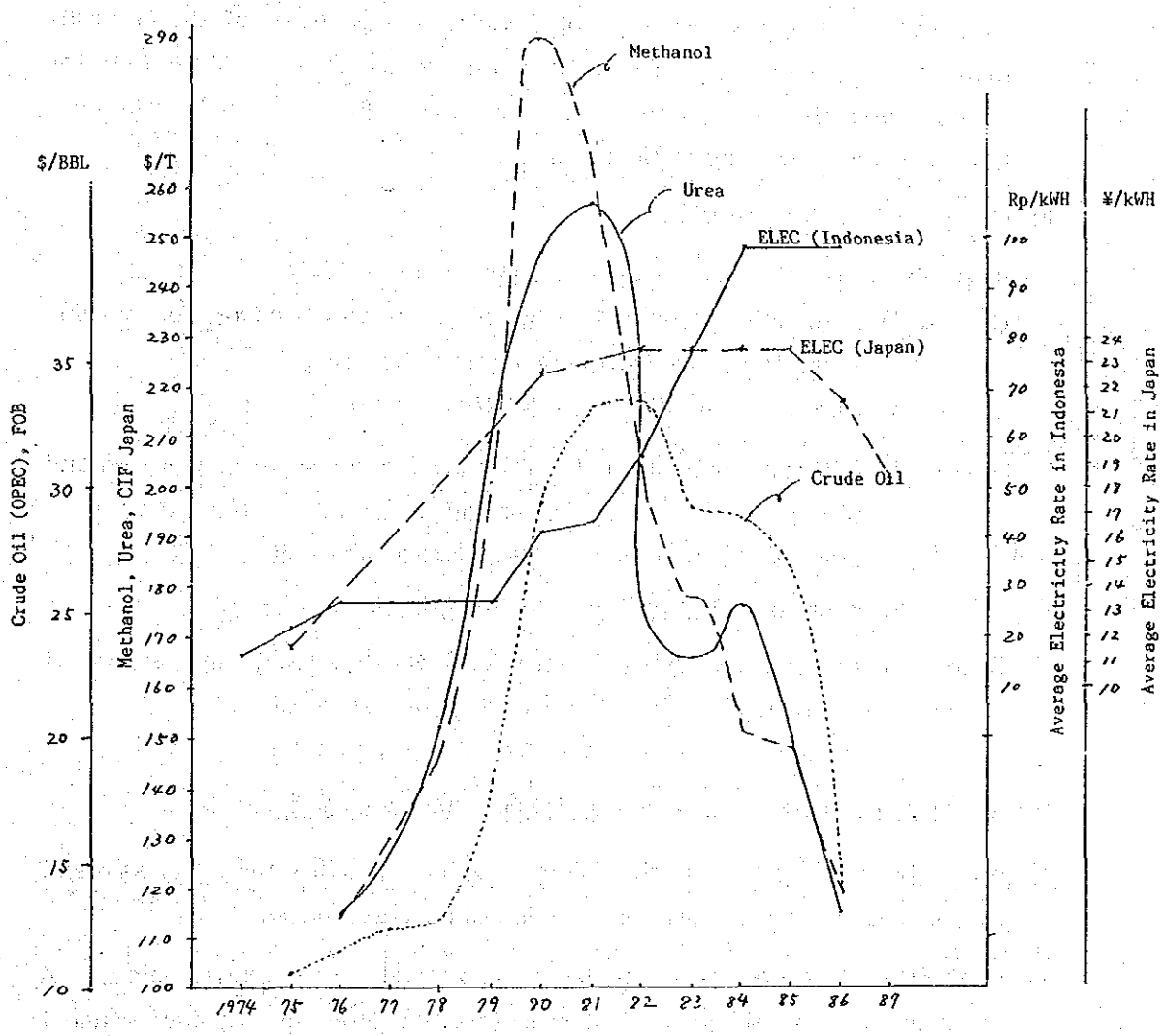
i) If the electricity is distributed to the Banko area, including the Project site, the IRR is expected to be 13.5% and almost the same as that of the methanol production case. In this case, it is evaluated to be viable in view of economic feasibility.

ii) IRR of sale in the Jakarta area is estimated to be 6.9-10.3% on the basis of 98 Rp/KWH of the sales price in Jakarta as of 1985. The economics may be inferior to that of methanol production.

iii) Fig. 7-2-8 illustrates the trend of prices of methanol, urea and electricity. The price of methanol and urea has great correlation with that of crude oil, however the price of electricity shows a different trend because the electricity sales price is decided on the basis of the energy and economic policies of each country.

iv) It is concluded that lower cost finance than 6.9%/year will be required for electricity plant and the study shall be investigated in more detail in the 3rd stage.

Fig. 7-2-8 Shifts in Price of Crude Oil (FOB OPEC), Methanol and Urea (CIF Japan), and Electricity Rate in Indonesia and Japan



8. RESULTS OF THE STUDY ON MARKET FOR FUEL ETHANOL AND ITS SUPPLY SYSTEM IN INDONESIA

8-1 INTERNATIONAL TRENDS ON FUEL ETHANOL UTILIZATION

1) Utilization Technology

Commercial utilization has been carried out in Brazil and the U.S.A. Ethanol has no special problems of toxicity and pollution of the environment and therefore, is most easily available as an alternative fuel for conventional oil products for automotive use. And also, only minimum modification of existing engines is necessary.

2) Consumption of Fuel Ethanol

Fuel ethanol is being used mainly as an automotive fuel.

U.S.A.: i) Fuel ethanol introduction is a countermeasure for surplus agricultural production and octane boosting

ii) Consumption is 1.7 million Kl/yr. (1983)

Brazil: i) Effective utilization for a by-product of sugar production and saving foreign currency on oil imports are the purpose of introduction.

ii) Consumption is 8.0 million Kl/yr(1985)

Others: In Philippines, Cuba, Ireland and South Afrca, fuel ethaol is reported to be used.

8-2 POTENTIAL DEMAND FOR FUEL ETHANOL IN INDONESIA

1) About 160 x 10^3 Kl/yr. in the Jakarta region and 950 x 10^3 Kl/yr as blend to gasoline in the long-term in all Indonesia are estimated.

2) Fuel ethanol is considered to be most feasible from technological and economical point of view. And therefore, no other use of fuel ethanol seems to be feasible from its cost competitiveness.

8-3 PROGRAM FOR INTRODUCING FUEL ETHANOL

1) Penetration Stage

i) Feedstock

Molasses as a by-product of sugar production

(170 x 10^3 Kl/yr of fuel ethanol equivalent is possible)

ii) Demand

Potential demand of 160 x 10^3 Kl/yr in case of 10% ethanol blend in gasoline in Jakarta and its surrounding region

iii) Facilities to be newly installed, on production and its distribution

a) Production facility of hydrous ethanol from molasses (10 x 10^3 Kl/yr x 16)
b) De-hydration facility (30 x 10^3 Kl/yr x 5)
c) Blending facility to gasoline
d) Upstream distribution facility of ethanol

2) Ultimate Stage

i) Feedstock

Cassave in transmigration area

ii) Demand

Potential demand of 950 x 10^3 Kl/yr in the long-term in case of 20% blending in gasoline in all Indonesia.

iii) Facilities to be newly installed, on its production and its distribution

a) Producion facility of hydrous ethanol from cassave (10 x 10^3 Kl/yr x 79)
b) De-hydration facility (160 x 10^3 Kl/yr x 6)
c) Blending facility to gasoline
d) Upstream supply facility of ethanol

8-4 ISSUES, POLICY AND MEASURES FOR INTRODUCING FUEL ETHANOL

1) Introducing fuel ethanol offers no problems of toxicity and pollution of the environment.

2) Introducing fuel ethanol causes no economic feasibility problems under a crude oil price of 30$/bbl from its financial analysis because of its high production cost.

3) It is substantially important how to evaluate such merits as environment-improving effect by use of unleaded gasoline, impact on transmigration policy and energy conservation, which are not included in the financial analysis.

4) In economic evaluation, such items as labor cost, tax, profit etc. can be classified as benefits of the project for Indonesia.
Under such conditions, ethanol production from molasses is evaluated as feasible in case of a crude oil price of 30$/bbl.

8-5 POLICY OF INTRODUCING FUEL ETHANOL

1) Entity for Producers and Distributors
Design of the organizations concerned about ethanol production and marketing should be planned as shown in Fig. 8-6-1.

2) Offering incentives for producers and consumers of fuel ethanol belong to policy matters. It requires coordination with conventional oil products in price competitiveness. And also, the following measures are required by the Government of Indonesia.

i) Standards and planning towards unleaded gasoline

ii) Standards for exhaust gas emission from automobiles

iii) Incentives for producers and consumers to promote introduction of fuel ethanol

As to item iii) mentioned above, the following measures can be suggested:

i) Incentives for molasses producers

a) Ethanol producer (enterprise B) gives an assurance to purchase molasses constantly
b) Price of molasses to be purchased is set to be equal to the export price
c) Preferential measure of tax for facilities of production and distribution of ethanol
d) Low interest-rate loan for enterprises concerned

ii) Incentives for cassava producers

a) Assurance to purchase cassava at the price which is set to assure transmigrants life
b) Low interest-rate loan for facilities of casssava production and transportation

iii) Incentives for fuel ethanol consumers

a) Preferential price-setting (ex. price increase of conventional oil products)

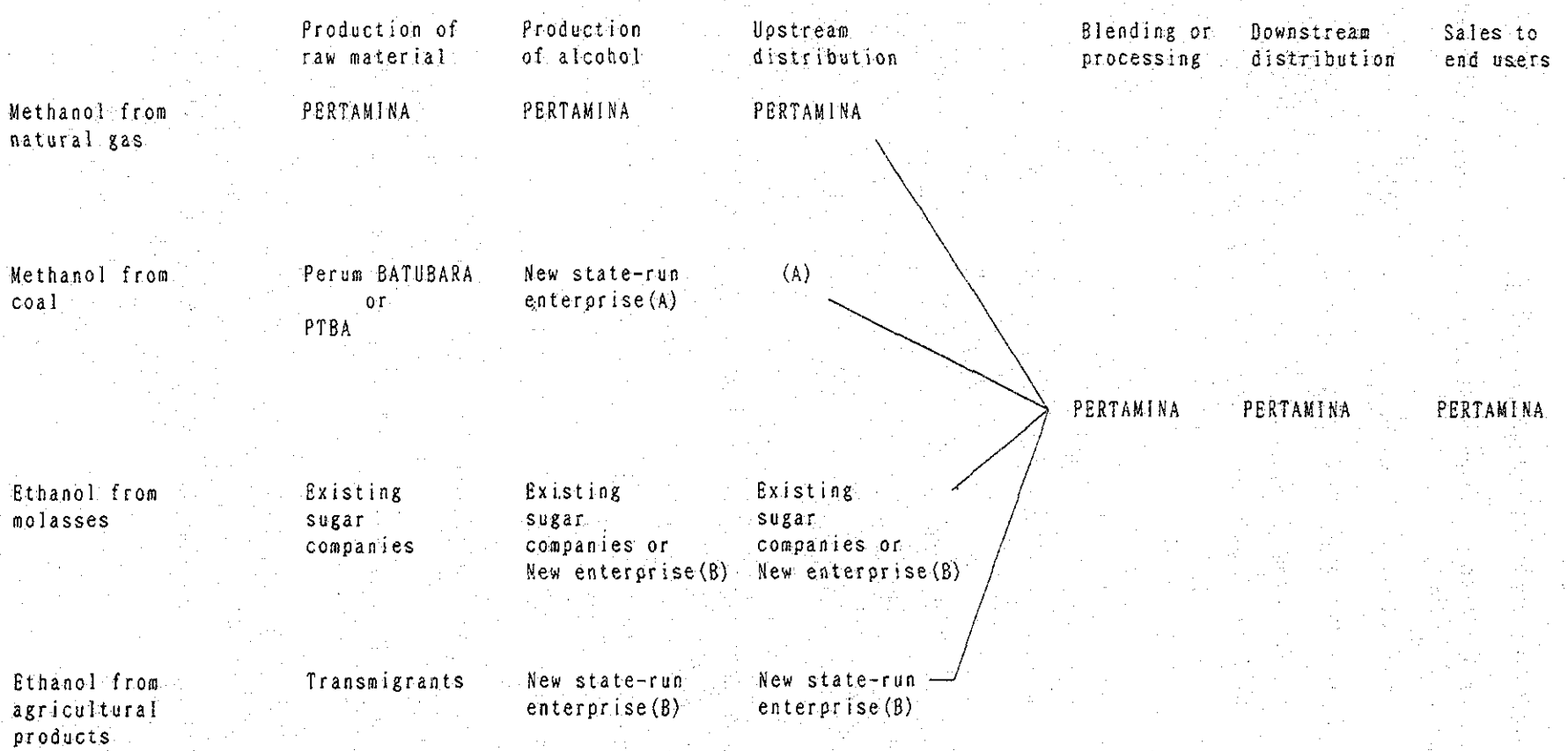
b) Tax reduction for alcohol-fueled vehicle

iv) Incentive for producers of fuel ethanol

a) Tax preferential measures for production facilities

b) Lower interest-rate for production facilities

Fig. 8-6-1 Suggested Production and Distribution Entity



8-6 IMPACTS OF INTRODUCING FUEL ETHANOL

1) Impacts on Consumpton of Oil Products

   950×10^3 Kl/yr of potential demand for fuel ethanol might be judged to have smaller impacts compared with the volume of methanol introduced. However, the impacts on oil refining will be great because of the role of octane booster.

2) Impacts on Effective Utilization of Energy Resources

   It can contribute to restrain consumption of exportable energy resources.

   As a result, it can contribute to

   a) Preservation of exportable energy resources
   b) Saving the development cost concerned

3) Impacts on Transmigration Policy

   It can give cash for transmigrants, which contributes to the promotion of transmigration policy and settlement of transmigrants.

4) Impact on Environmental Policy

   It is very effective as a measure for clean exhaust gas.

8-7 CONCLUSIONS AND RECOMMENDATIONS

1) The most preferable utilization of fuel ethanol is as an automobile fuel in low blend gasoline.

2) The production of fuel ethanol from molasses is desirable compared with that from cassava.
   However, it is estiamted to be difficult to be commercialized by private sector because of less profitability in view of financial analysis. In the case of production from cassava, the financial analysis shows rather worse economics than that from molasses.

3) On the other hand, the production and utilization of fuel ethanol can contribute to the policies of the Indonesian Government such as transmigration policy, energy policy and environmental policy.

9. RESULTS OF THE STUDY ON MARKET FOR FUEL METHANOL AND ITS SUPPLY SYSTEM IN INDONESIA

9-1 INTERNATIONAL TRENDS ON FUEL METHANOL UTILIZATION

1) Utilization Technologies in Gasoline Engines Base

i) Low blending with gasoline (M-3 or less) has already been done in R&D in the U.S.A. and West Germany, mainly for decreasing lead in gasoline or unleaded gasoline and as a gasoline extender.

ii) A Middle blending with gasoline requires modification of conventional engines and new distribution facilities and also has a small effect on gasoline substitution. Therefore, R&D efforts were stopped internationally.

iii) High blend (M-85, 90) or neat use of methanol is already completed as regards technology development. However, it is not commercialized yet because of its poor economics.

2) R&D on Utilization Technologies in Diesel Engines Base

i) R&D efforts have already been stopped in the field of low-and medium-blending to diesel oil because of poor economics.

ii) As to high blend or neat use, dual fuel method and ignition assist method have been developed in West Germany, Japan and the U.S.A., and they are in fleet test stage. These two methods seem to be promising in reducing exhaust gas emission like NOx and soot from conventional diesel engines.

3) R&D on Utilization Technology of Fuel Methanol in Non-vehicular Uses

i) Large scale power generation plant

-Boiler: finished R&D activity but economics seems to be a main obstacle

-Gas turbine: same as mentioned above

-Reforming-type gas turbine: 10% increase in thermal efficiency catches much attention. The technology is combination of existing ones and seems to be commercialized without big trouble.

ii) Small scale diesel-type power generation

It is the same as automotive engines in principle. High thermal efficiency of reforming-type catches much attention.

iii) Fuel cell

The phosphoric acid type is in the demonstration stage. However, the molten carbonate type and solid electrolyte type are still in the R&D stage. Fuel cells seem to be promising as a scattered-type small scale power sources. Methanol can be used as a power generating fuel through reformation.

iv) Feedstock of MTBE (Methyl Tertiary Butyl Ether)

Producing technology of MTBE is already completed, which can be used as an octane booster.

v) Feedstock of city gas

The technology has already been completed. A local gas utility company can use this technology instead of LPG or naphtha in the long term.

9-2 EXISTING DEMAND FOR FUEL METHANOL

1) Automobile Use

i) Low blend (less than 3%)

- U.S.A.: 520×10^3t (1984) (for blending into gasoline)
- West Germany: 300×10^3t (1983)

ii) High blend or neat use of methanol

There is no commercial demand for methanol. Small amount of methanol is being used for fleet test in several countries.

- U.S.A.: 300 vehicles by Bank of America
  600 vehicles by CEC (California Energy Commission)
  Small number of cars by DOE
- West Germany: 300 vehicles of M-93 for fleet test
- Japan: 120 modified vehicles started 3-year fleet test in 1986 by Ministry of Transport. Also, MITI has a plan of fleet test.

2) Other Uses

i) MTBE

World-wide production capacity is 4.9 million t/yr and 3.14 million t/yr of methanol demand is expected for this. However, the share of fuel of MTBE use is not clarified.

ii) Other uses

Recorded no commercial demand

9-3 POTENTIAL DEMAND FOR FUEL METHANOL IN INDONESIA

1) Demand for Oil Products

i) Oil share is still dominant at 72% of the energy supply in 1984 in Indonesia.

ii) The growth rate in total commercial energy was decreased to about 3% p.a. the last few years. Oil product demand in 1995 is estimated to level off according to ASCOPE estimation, where the increase in gasoline is remarkable.

Table 8-3-12 Estimates of Oil Products Demand in 1995

10^3KL/yr

	Sales Volume		Actual Data
	Pelita IV Base	ASCOPE	1985
Avgas	123.0 (0.3)	147.6 (0.6)	103.4 (0.4)
Avtur	604.7 (1.6)	620.5 (2.4)	619.0 (2.6)
Premium Gas	139.6 (0.4)	167.8 (0.7)	116.9 (0.5)
Regular Gas	4757.7 (13.0)	5720.3 (22.3)	3997.3 (16.5)
Kerosene	11751.5 (32.1)	7040.1 (27.4)	6983.3 (28.9)
ADO	11824.1 (32.3)	7163.3 (27.9)	7491.5 (31.0)
IDO	1968.5 (5.4)	1541.7 (6.0)	1612.3 (6.7)
Fuel Oil	5489.5 (15.0)	3250.0 (12.7)	3361.8 (13.9)
BBM Total	36658.6 (100)	25651.5 (100)	24192.4 (100)

NOTE: Ascope figures are taken from the document in the 3rd Conference of ASCOPE, Dec. 1985, the title of which is "Long Range Outlook of Petroleum Product Supply and Demand and Utilization of Refining Capacity in the ASEAN Region"

2) Prospects of Long-term Demand for Fuel Methanol

i) In case of a crude oil price of less than 25$/bbl, there is no demand for fuel methanol.

ii) In the case of a crude oil of price of 30$/bbl, there can be demand of 1.6 million ton for fuel methanol in 1995, if methanol can be supplied at less than 111 $/kl. 111 $/kl of methanol is the price corresponding to IRR 9.5% (8.0% of interest rate), and does not seem to be an attractive project. Low interest-rate finance is eagerly required.

iii) Fig. 8-3-3 shows the relation between crude oil price and fuel methanol volume to be introduced.

3) Potential Demand for Fuel Methanol

i) Transportation sector and power generation sector

a) Penetration stage: 50 - 80 x 10^3 kl/yr. of demand for blending into gasoline is expected in Jakarta and/or Surabaya regions.

b) Ultimate stage: 1100 x 10^3 kl/yr. of demand for power generation is expected in gas turbine and diesel power generators. (both will be retrofitted to reforming-type)

ii) Industrial sector

Estimation of potential demand in this sector is rather difficult because energy consumption in this sector is not sufficiently clear, and there will be 1400 x 10^3 kl/yr. of methanol demand if 10% of this sector demand for diesel oil would be converted to methanol.

iii) Household sector

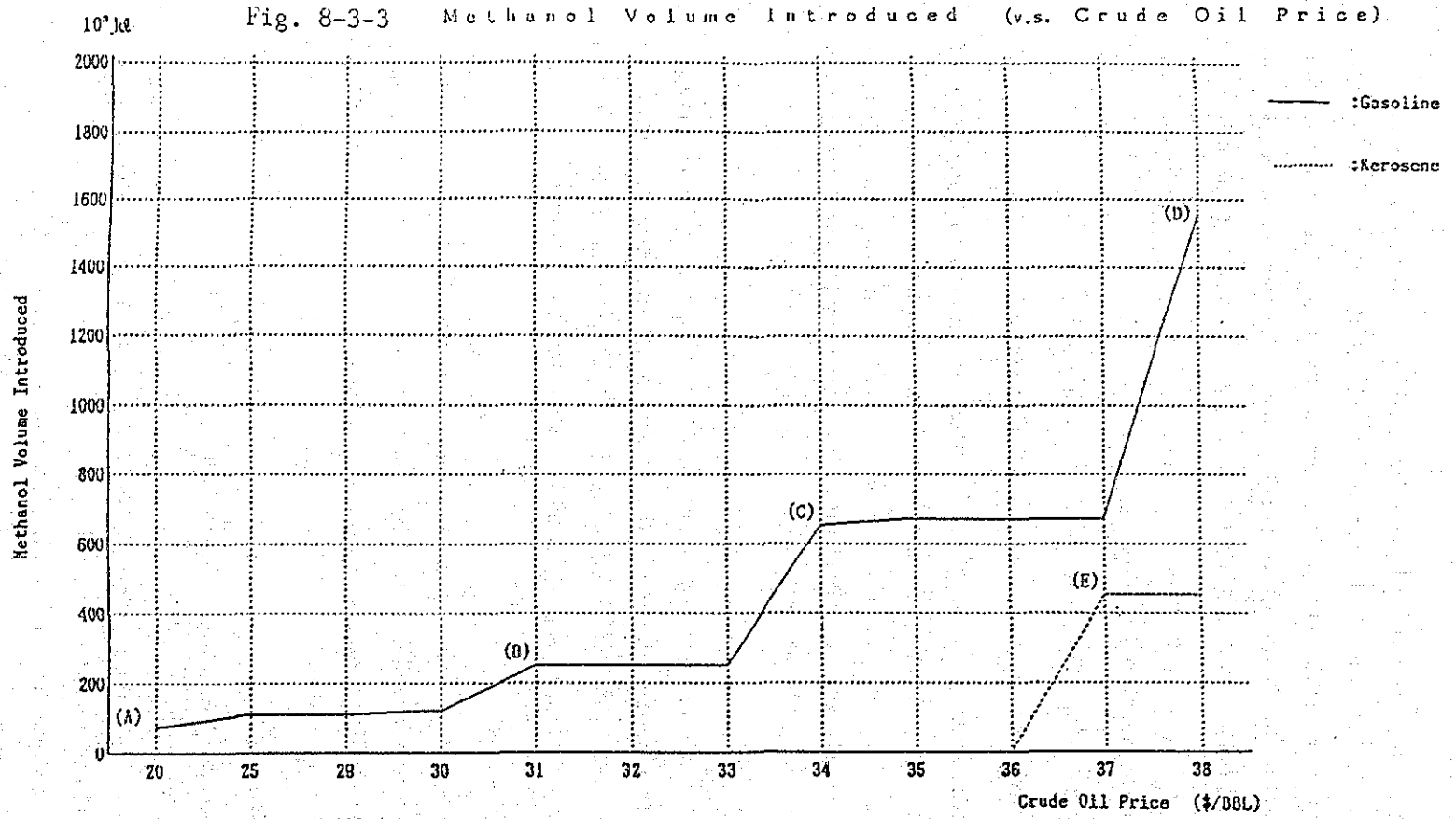
Fuel methanol is toxic and therefore, direct use in the household sector can not be expected. The results of long-term prospects show that the kerosene consumed in this sector will be substituted by electricity generated by fuel methanol.

iv) Summarizing above mentioned demands, total potential for fuel methanol is shown in the following table.

x 10^3 kl/yr.

	Penetration stage	Ultimate stage
Transportation sector	48 - 76	5650
Power generation sector	87	1100
Industrial sector	-	1400
Household sector	-	-
Total	140 - 160	8150

Fig. 8-3-3 Methanol Volume Introduced (v.s. Crude Oil Price)



Note: 1 Assumptions; Methanol Price 139$/kℓ
Domestic Oil Product Demand ASCOPE Case

2 Through methanol introduction, gasoline delivery for demand area 3 from Cilacap is reduced at such points as (A) (B) (C) (D).

At points (A) (B) (C), gasoline delivery for demand area 4 from Cilacap is increased and that from Dumai is decreased, leaving gasoline production in Dumai reduced.

At point(C), reformate export from Dumai is to start. At point(D), gasoline delivery for Area 5 from Cilacap is increased and gasoline production in Balikpapan is decreased, starting reformate export from that refinery.

At point(E), kerosene delivery for Area 2 from Plaju is to be replaced by methanol. This causes delivery for Area 3 from Plaju increased, that for Area 3 from Cilacap decreased, that for Area 4 from Cilacap increased and finally, that for Area 4 from Balikpapan decreased.

And as a result, kerosene production from Balikpapan is to be decreased.

9-4 PROGRAM FOR INTRODUCING FUEL METHANOL IN INDONESIA

1) Penetration Stage

Transportation sector: Methanol introduction is to be carried out in the form of low blend to gasoline in those regions of Jakarta and Surabaya.
Power generation sector: Along with rural electrification policy, methanol use is to be promoted in gas turbines and small scale diesel power generators.

In this stage, installed supply capacity of Bunyu seems to be sufficient to meet the amount of methanol demand.

2) Ultimate Stage

Transportation sector: Methanl is to be introduced as a substitution for ADO and gasoline in the form of high blend or neat use.
Power generation sector: Methanol is to be introduced as a fuel in the form of retrofitting conventional gas turbines (methanol-reforming type) and small scale diesel power generators.

Towards this ultimate stage, fixing and arrangement of distribution delivery system seems to be an important issue.

3) Facilities for Distribution and Delivery System

Existing distribution and delivery system for chemical methanol can be applied in its fundamental sense. However, increasing the size of barges, 1st depots and newly installed 2nd depots is to be sufficiently planned.

9-5 ISSUES AND MEASURES FOR INTRODUCING FUEL ALCOHOL IN INDONESIA

1) Production cost (139 $/kl : 13.5% IRR) is cheaper than that of ethanol because of its economy of scale. However, total investment costs are substantially big. (1000 billion Rp for 1.6 million t/yr. as of 1985 value)

2) It is necessary for the crude oil price to be more than 38 $/BBL to introduce 1.6 million ton of methanol from Banko coal under 139 $/kl of methanol price.
If one assumes 30 $/BBL of crude oil, the FOB price of methanol must be lower than 111 $/kl (corresponding to IRR of 9.5%) In that case, lower cost finance is required than 8% of interest.

9-6 POLICY AND MEASURES FOR INTRODUCING FUEL METHANOL

1) Entity for Producers and Distributors

It seems to be desirable to plan organizations as shown in Fig. 8-6-1.

2) Offering incentives for producers and consumers of fuel methanol belong to policy matters. However to control conventional oil products in price competitiveness and to actualize the policies of the Government of Indonesia. The following will be required:

i) Standards and planning towards use of unleaded gasoline

ii) Standards of exhaust gas emission from automobiles

iii) Safety mesures (methanol producers, distributors and consumers)

iv) Incentives for producers and consumers to promote introduction of fuel methanol

As to item iv) mentioned above, the following measures can be suggested:

a) Incentives for coal producers (probably Perum BATUBARA or PTBA) and planning for development of new coal field

b) Incentives for methanol producers for only low grade coal

- Though coal cost shares very small percentage in methanol production cost, acquired cost of coal should be kept as low as possible. (10% reduction of coal cost leads to 2-3% increase of IRR)
- In view of capital intensiveness, low cost financing from public sector or loan from international organizations are required.

c) Incentive for consumers of fuel methanol

- Reasonable price setting (ex. increase in prices of conventional oil products)
- Tax reduction for methanol fueled vehicle

9-7 IMPACTS OF INTRODUCING FUEL METHANOL

1) Impacts on Consumption of Oil Products

In case of a crude oil price of more than 25$/bbl, partial introduction of methanol from coal come to be feasible and that leads to reduction of oil products consumption.

Total volume of methanol from Banko coal come to be feasible in cases of more than 38 $/BBL of crude oil or less than 111 $/kl of methanol (price corresponding to 9.5% of IRR).

In these cases, the methanol share in oil related products is equal to 14% of gasoline production and 3% of kerosene production.

2) Impacts on Utilization of Energy Resources

It can restrain consumpton of domestic exportable energy resources and also can,

- Utilize low rank coal with little commercial value
- Utilize small scale natural gas in remote areas which can not be used for LNG

As a result, it can contribute to

- preservation of exportable energy resources
- saving resources concerned

3) Impact on Transmigration Policy

In addition to the conventional transmigration policy for agriculture, fishery and forestry, transmigration for industrial development is a new subject.

4) Impacts on Environmental Policy

Introducing fuel methanol can be expected to be effective for improving air quality in urban regions as a lead-reducing measure in gasoline and an improving measure for exhaust emission from diesel engines.

9-8 CONCLUSIONS ON FUEL METHANOL

1) It is recommended to utilize fuel methanol as automobile fuel (M3 gasoline) and fuel for existing gas turbine generators at the penetration stage.

Application of fuel methanol will be extended to gasoline engines base (M85-M90) and diesel engines base (neat). Such application will be beneficial to city buses and trucks of large cities, diesel engine generators and reformed type gas turbine generators in the long-term.

In the industrial sector, methanol has the possibility to be used as one of the power generating fuels.

2) A methanol plant (esp. from coal) is rather difficult for the private sector to commercialize because of its capital intensiveness.

3) The policy and incentives for introducing fuel methanol are worthy of concrete examination from the point of the national interests of Indonesia.