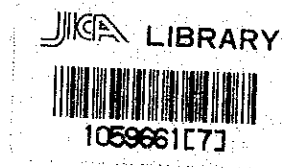


EVALUATION STUDY REPORT
FOR
THE ASEAN UREA PROJECT
IN
MALAYSIA

APRIL 1980

JAPAN INTERNATIONAL COOPERATION AGENCY

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No. 13909

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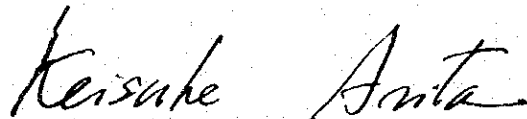
Japan, as a member of the Asian community, sincerely hopes for the prosperity of the ASEAN member states and the successful implementation of this ASEAN Urea Project in Malaysia which will be developed as one of the ASEAN Industrial Projects.

This report compiles the results of a study on the Project which has been undertaken by the Japan International Cooperation Agency in compliance with the agreement made between the Government of Malaysia and the Government of Japan.

I hope that the report will prove to be useful for the development of the Project and for the ASEAN cooperation, thereby contributing toward promoting the ties of amity and cooperation between the ASEAN and Japan.

I wish to express my deep appreciation to the officials concerned of both Governments of Malaysia and Japan for their close cooperation extended to the study team.

April, 1980



Keisuke Arita

President

Japan International Cooperation Agency

ABBREVIATIONS

General

C&F	Cost & Freight
CIF	Cost, Insurance and Freight
FOB	Free on Board
IRR	Internal Rate of Return
ROI	Return on Investment
N.A.	Not Available
M\$	Malaysian Dollar
Exchange Rate	US\$ 1 = M\$ 2.2 = ¥ 230

Company & Organizations

AFC	Atlas Fertilizer Corporation (The Philippines)
BDA	Bintulu Development Authority
CCM	Chemical Company of Malaysia
CFC	Chemical Fertilizer Company (Thailand)
FFC	Federal Fertilizer Company
FELCRA	Federal Land Consolidation and Rehabilitation Authority
FELDA	Federal Land Development Authority
FPA	Fertilizer & Pesticide Authority (The Philippines)
ICI	ICI (Malaysia) Sdn. Berhad
KADA	Kemubu Agricultural Development Authority
KPD	Korporasi Pembangunan Desa
KPM	KPM NIAGA Sdn. Bhd. (Subsidiary of Agricultural Bank Malaysia)
MADA	Muda Agricultural Development Authority
MARDI	Malaysian Agricultural Research and Development Authority
MCFC	Maria Cristina Fertilizer Corporation (The Philippines)
MLNG	Malaysia LNG Sdn. Berhad
PETRONAS	Petroleum Nasional Berhad
PWD	Public Works Department
RISDA	Rubber Industry Smallholders Development Authority
RRIM	Rubber Research Institute of Malaysia
SAFODA	Sabah Forest Development Authority
SEDCO	Sabah Economic Development Corporation
SESCO	Sarawak Electricity Supply Corporation
SLDB	Sabah Land Development Board
SLDB	Sarawak Land Development Board
SPB	Sabah Padi Board
SRFB	Sabah Rubber Fund Board
SSB	Sarawak Shell Berhad

Units

Acre	1 Acre = 4,047 m ²
BBL	Barrel
BSCF	Billion SCF
BSCFD	Billion SCF per Day
BTU	British Thermal Unit, 1 BTU = 0.252 Kcal
DWT	Deadweight Ton
EL	Elevation Level
ha	Hectare, 1 ha = 10,000 m ²
Imperial Gallon	1 Imperial Gallon = 0.004546 m ³
KVA	Kilovolt-ampere
KW	Kilowatt
KWH	Kilowatt Hour
MW	Megawatt, Million Watt
MMBTU	Million BTU
MMSCF	Million SCF
MMSCFD	Million SCF per Day
MSCF	Thousand SCF
MSL	Mean Sea Level
Nm ³	Normal Cubic Meter
psi	Pound per Square Inch 1 psi = 0.07031 kg/cm ²
SCF	Standard Cubic Feet, 1 SCF = 0.0283 Nm ³
SCFD	Standard Cubic Feet per Day
STB	Standard Tankage Barrel 1 STB = 0.159 Litre (60°F)
TSCF	Trillion SCF
M/T, t	Metric Ton

Fertilizer

FA	Farmers Associations
FC	Farmers Cooperatives
N	Nitrogen Nutrient
NPK	Compound Fertilizer which Consists of Nitrogen, Phosphate and Potash Nutrients

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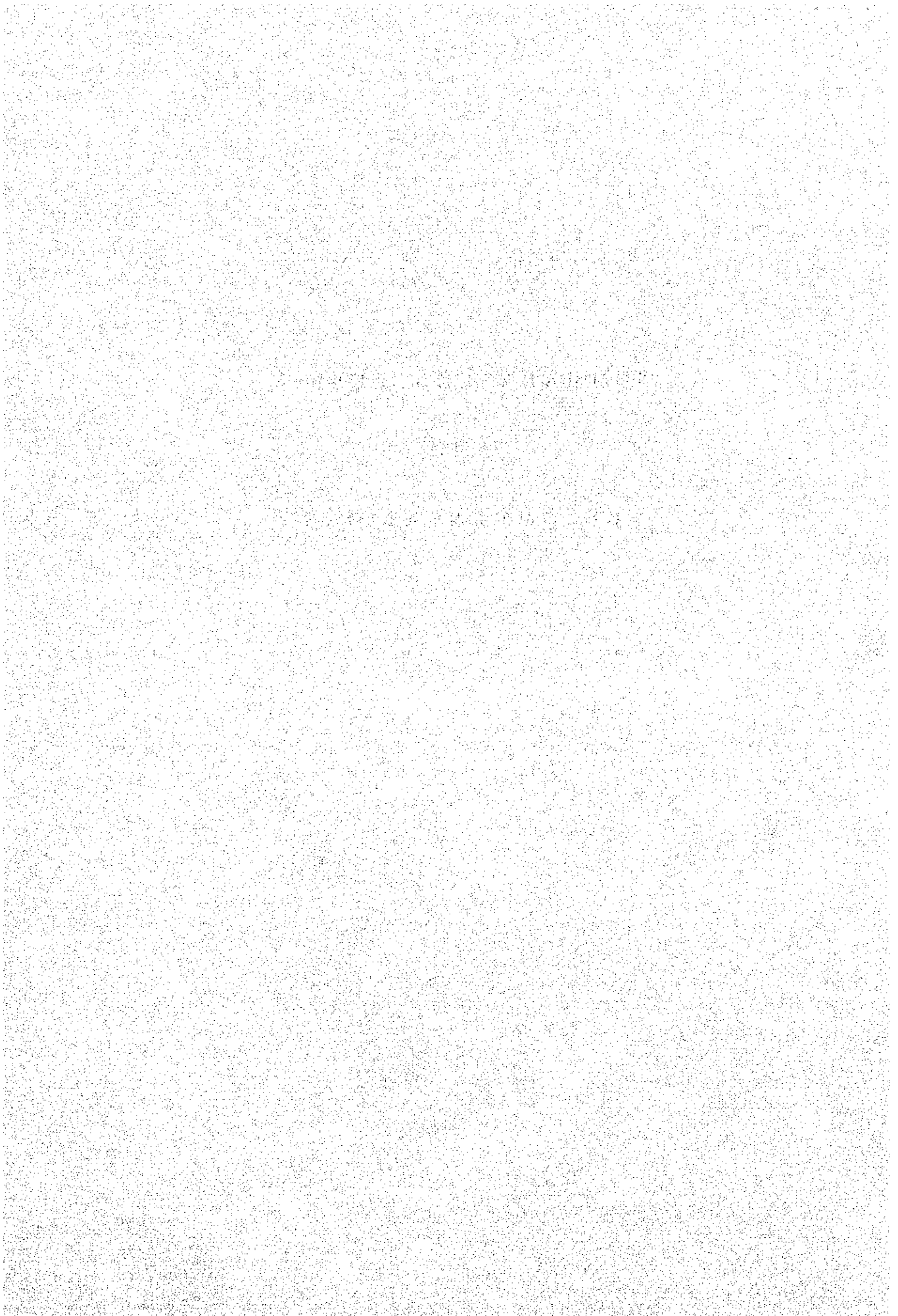
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SUMMARY, CONCLUSION

AND

RECOMMENDATIONS



SUMMARY

I. Outline of the Project (ASEAN Urea Project - Malaysia)

1) Products and production capacity

A. Production capacity

Ammonia: 1,000 t/d; 330,000 t/y
Urea: 1,500 t/d; 495,000 t/y
(330 stream days per calendar year)

B. End product production capacity

Ammonia: 130 t/d; 42,900 t/y
Urea: 1,500 t/d; 495,000 t/y

Note: Of the 1,000 t/d or 330,000 t/y capacity for production of ammonia, 870 t/d or 287,100 t/y will be used as material for production of urea. The ammonia requirement per ton of urea produced will be 0.58 ton.

2) Fuel and feedstock

Natural gas: Produced in gas fields (Central Luconia fields) scattered 130-180 km offshore, in Bintulu Bay, and supplied to the Ammonia and Urea Complex by a branch pipe from the pipeline by which the nearby LNG plant will be supplied with gas from the offshore wells.

3) Proposed site

Kidurong area, Bintulu, Sarawak State (approximately 25 km northeast of Bintulu town)

4) Marketing of products

- A. Urea: To be sold in the domestic Malaysian market as well as other ASEAN countries (except Indonesia). The Project will have prior right to supply the produced urea to the domestic Malaysian market as a whole and to the markets in the other ASEAN countries aside from Indonesia, the supply to which is to be in equal quantity to sale there of urea from the ASEAN Aceh Urea Complex in Indonesia. If there is a surplus after exports are made to the ASEAN countries, Malaysia is to assume responsibility to absorb the entire surplus by selling it in the Malaysian domestic market or exporting it to outside the ASEAN region, or both.
 - B. Ammonia: To be supplied to the domestic market.
- 5) Management of the venture

The five ASEAN countries are to jointly invest in and operate a company to be established in Malaysia. The equity capital of the joint-venture company will correspond to 30% of the total capital requirement, and is to be in the following equity ratio:

Malaysia	60%
Indonesia	13%
Philippines	13%
Singapore	1%
Thailand	13%

II. Market Study

1. Outlook for Marketing of Products (Urea and Ammonia)

1-1 Outlook for Demand for Urea, and Marketability

- 1) The outlook for demand for urea in Malaysia is shown in Table 1.
- 2) The outlook for demand in the non-Malaysian ASEAN market, and marketability of urea produced by this Project, is shown in Table 2. This projection indicates that during four years of sales in the Malaysian and ASEAN markets (1985-1988), there will be a surplus of 20,000 to 50,000 tons every year and it will be necessary to export this quantity to outside the ASEAN region. However, there is a possibility that the domestic demands for urea in Malaysia may grow to a larger extent than

that projected as the above. In the event that this possibility is realized it is likely that all the produced urea will be absorbed within the ASEAN markets.

1-2 The Outlook for Demand for Ammonia (in Malaysia) and Marketability of Ammonia Produced by this Project

The outlook for demand for ammonia in the domestic Malaysian market, and quantity of ammonia which is expected to be sold, are shown in Table 3. The domestic Malaysian market is considered to be likely to absorb about 11,000 tons a year (equal to about 28.5% of marketable surplus, with the plant operating at 90% of design capacity). However there is a possibility that the existing ammonia plant shuts down its production in the near future, and also another possibility that the domestic production of NPK compound fertilizers will be expanded. Under these possibilities, it seems likely that all surplus ammonia yielded at 90% capacity utilization will be absorbed by sales in the domestic market.

1-3 Major Problems to be Solved as Prerequisites for Success in Marketing Urea

1-3-1 Major problems in the domestic Malaysian market, and countermeasures

- 1) The domestic Malaysian market shows a traditional bias in favor of NPK fertilizer (compound fertilizer and mixed fertilizer), and nitrogen fertilizers in forms other than urea, such as ammonium sulphate and ammonium nitrate, have been used as the nitrogen source for NPK fertilizer. In recent years there has been a rapid increase in the use of urea either as straight fertilizer or in mixed fertilizer for padi and for oil palm cultivated in coastal soil, but the proportion of nitrogen fertilizer which is accounted for by urea is not high. (The ratio of urea -- in nitrogen equivalent -- in total nitrogen fertilizer consumed, including use in mixed fertilizer, is about 40%).
- 2) Nevertheless, the increase in consumption of urea owes much to the Government's aggressive promotion of schemes for increasing the production of padi and development of agriculture (especially the smallholders sector), through subsidies for the purchase of fertilizer.
- 3) There are two types of distribution channels, those organized by the fertilizer makers (CCM, FFC), and those organized by the importers. Thus, distribution is wholly handled by private entities who necessarily make decisions largely on the

basis of the potential profitability of their alternative courses of action. In the case of urea in particular, the entire present supply of which is imported, sales are done through the importers' channels. The importers treat urea as just one of the several fertilizers they handle, and follow market trends rather than seek to expand the sale of urea in particular.

- 4) Extension services to farmers are entirely a matter of the Government authorities but such action cannot be said to be aggressively oriented to increasing the use of urea. Recently, government-related institutions have begun to study the potential of using urea as straight fertilizer or in mixed fertilizer for crops other than padi and oil palm (in coastal soil) because of high prices of imported nitrogen fertilizers other than urea (especially compound fertilizer), but such efforts have not gone beyond the phase of experimentation.
- 5) The following two sets of countermeasures are of particularly high importance in view of the foregoing conditions, and implementation of both may be deemed vital for success of the Project:
 - (a) Continued expansion of the fertilizer purchase subsidy and grant arrangements; enhancement of extension services activities; further efforts by the governmental institutions at study of urea application techniques and methods; and efforts to have the results of such study put to actual use.
 - (b) Establishment of a means of organizing importers and distributors, and intensive performance of promotion activities closely linked to the government practices for the greater use of urea as straight fertilizer and in mixed fertilizer.
- 6) The projection of Malaysian demand for urea, as is shown in Table 1, which is the basis for the projected urea sales for the Project, is based on the assumption that the measures such as advocated above are vigorously carried out.
- 7) PETRONAS Project Team, as the executing agency for the Project, intends to engage a consultant for assistance in establishing a detailed marketing and distribution system, while planning to organize a new marketing company which will undertake, on behalf of the Malaysian Government, offtake and marketing of urea from the Ammonia and Urea Complex. In view of the prevailing conditions in Malaysia, the Evaluation Study Team presumes that such steps would favorably facilitate

success in urea marketing in Malaysia. Therefore, it is recommended that immediate action be taken to establish that system and set up the marketing company because considerable time is needed to attain these working objectives. At the same time, it would be necessary to implement a national level program for promotion of urea usage through joint efforts with relevant authorities or institutions. If these measures are taken with the right timing, it is likely that the projected sales for urea in connection with the Project will be attained.

1-3-2 Export of urea to outside the ASEAN region

The projected supply/demand indicates that there is a possibility that some part of the produced urea would have to be exported to outside the ASEAN region. In this case, the new marketing company, which PETRONAS Project Team presently plans to form, will have to establish organization and function not only for domestic sales but also exports.

It is recommended that an experienced Marketing Advisor be engaged and brought to Malaysia from abroad, and that the advisor's assistance be used in establishing both a domestic marketing system as well as export marketing system. It is expected that the major countries outside the ASEAN region which would be importers include India, Vietnam and China. However, it will be necessary for Malaysia to be fully competitive not only in terms of price but also in terms of the organization for and functioning in regard to marketing, in an environment during the first half of the 1980's which is one of a surplus of world urea supply and hence one of heightened competition among the urea exporting countries. However, if such a system is established, and can function in a competitive manner, it is believed fully possible that urea export sales to the markets outside the ASEAN region can be attained, in view of the relatively small volume of such export sales even if it is required.

1-4 Major Problems in Marketing of Ammonia, and Countermeasures

The present scale of the domestic ammonia market is relatively small to absorb the anticipated surplus of ammonia for this Project. However, there is a possibility that the salable demand will be increased by means that recommended measures are taken henceforward. For example, expansion or new construction of NPK compound fertilizer plants using ammonia as a raw material may be promoted by the marketing company itself, or through a tie-up between existing compound/mixing fertilizer manufacturers, with a view to promoting the substitution

of imported NPK compound fertilizer. It is recommended that such steps be simultaneously taken by PETRONAS Project Team, parallel with the development of the Project. Further, it is recommended that systems and facilities for transportation and distribution of ammonia be well equipped by the time when commercial operation of the Complex is started.

1-5 Projection of the Sales of the Project's Products

Given the assumption that the measures recommended above are properly implemented, for the evaluation of this Project the sales of the Complex's products is projected as follows:

- (A) Urea: The projected urea sales for the Project is summarized below. This projection assumes that all of the quantity of urea remaining after subtracting a suitable level of inventory in the Complex from the quantity produced by the 1,500 t/d urea plant (operating at 70% of capacity in the first year, 80% of capacity in the second year, and 90% of capacity in the third and subsequent years), is to be absorbed by the domestic Malaysian market and the market in other ASEAN countries; however, if there is some surplus after sale within the ASEAN markets, it will be exported to outside the ASEAN region.

Projected Sales for Urea

	(Urea '000 ton)			
	1984	1985	1986	1987 and on
Capacity utilization (%)	(70 x 10/12)	(80)	(90)	(90)
(1) Production volume ¹⁾	288.8	396.0	445.5	445.5
(2) Complex inventory ²⁾	28.9	33.0	37.1	37.1
(3) Increase in annual inventory ³⁾	28.9	4.1	4.1	—
(4) Sales volume [(1) - (3)]	259.9	391.9	441.4	445.5

- Notes:
- 1) [Annual production capacity: 1,500 t/d x 330 days] x operational rate
 - 2) One-twelfth of annual production volume
In 1984, however, it is expected that there would be 10 months of production activities and hence one-tenth of annual production is used.
 - 3) [(The year's inventory) - (inventory carried over from the previous year)]

- (B) Ammonia: The projected ammonia sales for the Project is 9,000 tons in the first year (1984) and 11,000 tons in the subsequent years; however, there is a possibility that all the surplus ammonia yielded at capacity utilization of 70% in the first year, 80% in the second year and 90% in the third year onwards can be absorbed by sale in the domestic market.

2. Outlook for Sales Price of Products

2-1 Urea Sales Price (See Figs. 1 and 2)

- 1) As an internationally-traded commodity, there is free competition in the buying and selling of urea, and from year to year there has been fluctuation in the international price, which has tended to be led by the export prices set by major exporters who are highly cost-competitive. The international price is therefore seen as reflecting both supply and demand conditions in the world on one hand and the cost aspect in major exporters on the other. Reflecting over-supply conditions in international markets as well as cost reduction in major exporters (primarily Japan and West European countries) which were both derived from the start-up of a number of large-scale ammonia and urea plants there during the late 1960's, the international urea price declined year by year up to the early 1970's.
- 2) After 1972/73 the urea price began to rise, and with the "oil crisis", the price rose sharply, to C&F US\$285 per ton, but thereafter, in accordance with a settling down after the initial phases of reaction to the "oil crisis" were past, the price declined to US\$124 a ton in 1976/77. After that, there have been increases in the cost of materials needed to produce urea, and there has been a change of the supply and demand conditions resulting in increases in the equilibrium price, and by 1979/80 the price had risen to C&F US\$205-210 a ton. (In the foregoing instances, all prices are for bagged urea.)
- 3) Hereafter urea exporters among the industrial countries (especially in the case of countries using naphtha and heavy oil for feedstock) are expected to lose their export competitiveness as a result of price increases made unavoidable by increases in urea production cost to which rising oil prices geared. Therefore, countries using natural gas as feedstock are expected to become the major exporters in the future. The cost of urea produced in gas-producing countries also is increasing from year to year. On the other hand, however, it is likely that urea importing countries will

substantially improve their self-sufficiency through the first half of the 1980's and there will be a tendency for the volume of international trade in urea to decline, so that potential export capacity of urea will tend to show a surplus. This condition will persist to the middle of the 1980's, and the outlook is that there will be movement toward international equilibrium after that.

- 4) Judging from this, it is expected that during the early part of the 1980's the international market prices will continue to increase, but their increase will not be such as have currently taken place. In due consideration of these factors, it is projected that the international urea price will be as follows (in US\$/ton):

	<u>79/80</u>	<u>80/81</u>	<u>81/82</u>	<u>82/83</u>	<u>83/84</u>	<u>84/85</u>	<u>85/86</u>	<u>86/87</u>
C&F (Bag)	204	206	208	210	213	216	220	235
FOB (Bulk)	175	175	175	175	175	176	178	191

- 5) Therefore, given the assumption that the Complex commences production in March, 1984, the sales price of urea for the Project is projected at US\$175/ton, FOB bulk (the projected 1983/84 price).

2-2 Ammonia Sales Price

- 1) The ammonia market in Southeast Asia is relatively small, and the only important ammonia importers are the Philippines and Malaysia. On the other hand ammonia exporters in or near the area are Japan, Indonesia, Australia, and Korea, but in the case of Japan, just as is being seen with regard to urea, competitiveness is being lost and the outlook is for Indonesia to become the leading exporter. Therefore, it is foreseen that the Southeast Asian price will be determined on the basis of the Indonesian export price.
- 2) Projection was first made on Indonesian export prices for ammonia, and FOB Bintulu prices for ammonia, as being those comparable to the projected Indonesian export prices are projected to be as follows (in US\$/ton):

	<u>83/84</u>	<u>84/85</u>	<u>85/86</u>	<u>86/87</u>
FOB price	205	206	228	253

- 3) On the basis of the above projections, the sales price of ammonia for the Project is projected at US\$205/ton FOB (1983/84 price).

3. Organization Needed for Marketing and Distribution of the Products

- 1) PETRONAS Project Team, in conjunction with this Project, will establish a fertilizer marketing company, which is to be responsible on behalf of the Malaysian Government for marketing all of the urea remaining after the requirements of the other participating ASEAN countries (the Philippines, Singapore and Thailand) are met, such marketing to be both in the domestic Malaysian market and outside the ASEAN region. In addition the marketing company will undertake marketing and distribution in the domestic market of the salable ammonia produced by the Complex.
- 2) In view of the volume of projected sales of urea, it is presumed that the overwhelming majority of the marketing company's sales of urea will be those to the domestic Malaysian market. Ammonia will be sold only within Malaysia. Therefore, the main task which the new marketing company will face is the marketing and distribution of these products in the domestic market. Nevertheless there is a possibility that during the period of a few years after the Complex commences operation, the Complex will have a surplus of urea, although it will be not so large, which should be absorbed by exports to outside the ASEAN markets. In such event, it will be necessary that the marketing company be equipped with export marketing capability, although the establishment of a domestic system for marketing and distribution must be assigned highest priority. Because a considerable period of time is needed to establish such a system, it is necessary that work toward that end begin at the earliest possible date, so that the system may be ready to function from the time of the first shipments from the Complex.

III. Natural Gas Study

1. Natural Gas Reserves, and the Supply/Demand Balance of Gas

- 1) It is planned that the supply source of natural gas for the LNG plant as well as the Ammonia and Urea Complex will be five gas fields (E11, F23, F6, E8 and F13) in the Central Luconia fields. According to estimates by Sarawak Shell Berhad (a subsidiary of Shell) which is undertaking exploration and exploitation activities as

a production-sharing contractor, the recoverable reserves are 10.6 TSCF (Mean Reserve). Further, gas has been discovered in structures near these five fields, and their recoverable reserves are estimated to be 3.7 TSCF (Mean Reserve). Therefore it is estimated that the total recoverable reserves of the Central Luconia fields are 14.3 TSCF (Mean Reserve).

- 2) The gas requirement for the LNG plant is 1,250 MMSCFD, and over the project life of 20 years for the plant the total requirement will be about 7.41 TSCF. The gas requirements for the Ammonia and Urea Complex will be 46.4 MMSCFD, and over the project life of 15 years this amounts to 0.23 TSCF. Therefore, even if there is a 10% error in the estimation of the recoverable reserves, there will still be ample natural gas for these two projects.

2. Composition of Natural Gas

It has been ascertained that the composition of the natural gas to be supplied to the Complex is suitable for use as its feedstock.

3. Supply of Natural Gas to the Complex

- 1) With regard to the actual supply of gas to the Complex, PETRONAS-Upstream Division will undertake, at its own expense, to lay a branch line from the main pipeline (supplying gas to the LNG plant) to the Ammonia and Urea Complex battery limits. However, because the tender for pipeline construction is to be at some time in the future, the specifications for the pipelines are not now known, and hence their suitability cannot be evaluated. However, according to PETRONAS-Upstream Division, gas supply facilities are to be designed on the basis of the volume of supply gas of 1,340 MMSCFD. In view of this figure compared to the gas requirement for both projects (1,296 MMSCFD) it is believed that the design capacity of the pipeline is quite adequate and no problem is anticipated in that regard.
- 2) Shipment of LNG is to begin during 1983, and according to the present construction schedule the facilities for supply of gas to the LNG plant are to be completed by the end of 1982. The branch line for the supply of gas to the Ammonia and Urea Complex will not require a long time to construct. Therefore it is judged that there is ample time for pipeline construction and that the pipeline and other gas supply facilities will be ready in time for the projected start-up of the Ammonia and Urea

Complex (the beginning of October, 1983) without fail. Nevertheless, it is still necessary that close contact be maintained with the parties responsible for gas supply and for production of LNG, and that, prior to implementation of this Project, it is confirmed that there are no problems regarding the supply of gas to the Complex.

IV. Study of Technical Aspects Related to the Ammonia and Urea Complex

1. Locational and Site Conditions of the Proposed Site

1-1 Topography and Soil Characteristics of the Proposed Site

1) PETRONAS Project Team plans that the Ammonia and Urea Complex will be constructed on a site, already selected by the Project Team, in the Kidurong area which is about 25 km northeast of Bintulu town, in Sarawak.

The site's strongly undulating topography will make high site preparation costs unavoidable, but because the site is located adjacent to the Bintulu Deepwater Port and the new electric power station, and relatively close to the LNG plant, in overall terms it is judged that the location of the proposed site is satisfactory for use by the Complex.

2) Boring tests are presently being conducted, and until the results of those tests are available final judgement on the suitability of the site from the viewpoint of soil qualities cannot be made, but to the extent that observations may be made on the basis of information from the LNG site study, conditions are believed to be favorable.

3) This site is under the jurisdiction of the Bintulu Development Authority (BDA). The BDA has already given approval for its use as the site of the Complex. The site will be leased from the BDA in its present condition, and improved at the expense of the Project's sponsor.

1-2 Utilities Supply

A. Water

- 1) Use of soft water supplied by the Public Works Department of Sarawak State is planned by PETRONAS Project Team, and has been approved by the ASEAN Economic Ministers Meeting, so study has been undertaken on the basis of that plan.
- 2) The Public Works Department at present takes water from the Sungai Sibiu and processes it for supply in the Bintulu area, and plans to expand its capacity for processing and supplying water there. These plans are as follows:
 - (A) Phase I: Estimated date of completion, end of 1979. Objective: to increase capacity for intake of water from Sungai Sibiu and processing water from the present level of 1,000,000 gallons per day (4,500 m³/d) to 2,500,000 gallons per day (11,360 m³/d).
 - (B) Phase II:
 - Because the limit for intake of water from the Sungai Sibiu will have been reached, a pumped storage dam will be built on the Sika river, one of the Sungai Sibiu's tributaries; it is to have storage capacity of 350 million gallons (1.6 million m³) and is to be completed by the end of 1982.
 - A 750 mm pipe will be laid from the dam to the Kidurong area and an emergency water storage facility (capacity: 3,600,000 gallons = 16,370 m³) will be installed.
 - By means of the above-mentioned construction, by 1985 supply capacity will be increased to 10 million gallons per day (45,460 m³/d) and by 1995 it will be further increased to 14 million gallons per day (63,640 m³/d).
- 3) As a consequence of study of the plans for the above-mentioned construction and capacity expansion, it was determined by the Evaluation Study Team that if the Sika Dam is completed, the water supply required for the Complex (5.2 million gallons or 23,640 m³ per day) can be supplied even in the dry season. However, a potential problem exists regarding the target completion date for the pipeline, 1985, and this requires further close study and coordination, and adjustment of the construction schedule. The Public Works Department is of the intention of modi-

ying its schedule when construction plans for the Ammonia and Urea Complex are finalized. It would therefore be recommendable to undertake the required coordination at the earliest date possible, and if construction proceeds according to plan there will be no problem related to the start of the supply of water to the Complex.

- 4) The water to be supplied by the Public Works Department will be high-purity potable water. Considering that it will be used as industrial water, the price necessarily will be high, especially with regard to use as cooling water (the cost will be the equivalent of US\$0.20 per cubic meter). The Team is of the opinion that in order to improve the project economics of this Ammonia and Urea Complex it is necessary that negotiations be performed in order to lower cost, even if it would result in low-purity water to be supplied. If such a supply cannot be arranged, then a study of the relative costs and merits of adopting alternative cooling systems such as seawater cooling, air cooling, or a combination in order to reduce the volume of potable water used should be carried out, and the final decision on what type of cooling system to use may then be made.

B. Electric power

- 1) PETRONAS Project Team plans for the Complex to use power supplied from the new electric power station now under construction (designed for dual use of diesel oil and natural gas; 2 x 4MW; estimated date of completion, end of 1979; one additional unit to be built by the end of 1980). Completion of this power station will provide assurance that adequate power supply is available, and because of the proximity of the power station and hence assurance of a stable supply of power for the Complex, the present plan based on the power to be supplied from the external source seems to present no inherent obstacle.
- 2) However, it is recommended by the Evaluation Study Team that in order to obtain further guarantee of the stability of power characteristics, proper actions be taken to install an exclusive-use line from the power station, or to make arrangements through negotiations with the Sarawak Electricity Supply Corporation (SESCO) so that other power users, the peak demand of which may fluctuate greatly, will be excluded from the supply network to the Complex.

1-3 Availability of Related Infrastructure

A. Port and harbor facilities

The Bintulu Deepwater Port is now being constructed, in the vicinity of the Project site, and is to be completed by the end of 1982.

In view of its facilities and draught (15 m) it is judged that the port is adequate for use in connection with shipment of products of the Ammonia and Urea Complex. Further, use may be made of the temporary construction jetty for the port which will be completed in July, 1981, for the landing of equipment and materials for construction of the Complex.

However, because it is anticipated that ships to be loaded with bulk urea from the Complex will occupy the pier to a large extent, in order to avoid a possible future problem, coordination should be undertaken to insure that the Bulk Cargo Pier will be available for use when needed, without interference from shipments related to other projects.

B. Housing for employees

- 1) Bintulu is a small town which has a population of only about 14,000, and the supply of housing in this area is limited. It is expected that this area will undergo rapid growth in population subsequent to the establishment of not only the LNG plant and the Ammonia and Urea Complex but also other projects, and need will exist to increase the supply of housing (and community services) in the area in order to accommodate the influx of persons.
- 2) The Bintulu Development Authority, which is proceeding with plans for constructing a large industrial estate in the area, is also working on a large-scale housing development project and PETRONAS Project Team anticipates that it will be able to use or participate in the housing development program.
- 3) Because it was agreed at the meeting of the ASEAN Economic Ministers that a housing colony for Complex workers would not be included within the scope of the Project, the present study has not been directly concerned with housing, but it is evident that close contact needs to be maintained with the BDA on this matter, and

that PETRONAS Project Team must make certain that planning and construction of housing is completed according to the requirements of Project planning.

1-4 Overall Observations Regarding the Proposed Site for the Complex

The site which has been selected for construction of the Ammonia and Urea Complex presents no inherent problems. For the supply of utilities (water and power) as well as the availability of the port and supply of housing, the Complex will rely on agencies of the Malaysian Government, which are now proceeding with related development projects. These projects are still in the initial stage of development, so that at present it may not be said that there is no possibility of problems arising, but to the extent that the content and schedule of those projects have been made known, if such necessary steps as stated above are properly taken, it is expected that no serious problems which make major change in this Project necessary will arise in the future. However, it will be necessary for PETRONAS Project Team to keep in close contact with these various governmental agencies, to insure that no great discrepancy in individual plans develops and also to closely monitor the progress of work to insure that no problems arise relative to the Complex.

2. Facilities to be Constructed within the Scope of this Project

On the basis of prerequisites mentioned above, facilities of the Ammonia and Urea Complex are defined as follows:

— Ammonia and urea plants

— Utilities plants and facilities within the Complex

Offsite facilities

- Product storage and shipping facilities
- Auxiliary (common service) facilities (offices, maintenance shops, effluent treatment facilities, etc.)

3. Project Implementation and Management

3-1 Complex Construction Schedule

In the view of the Evaluation Study Team, the construction schedule for the Complex would be as follows:

Commencement of design: January, 1981

Mechanical completion of the Complex: End September, 1983

Starting of commercial operation: March, 1984

3-2 Construction/Contracting Method

In accordance with the stated policy of the Malaysian Government, it is assumed that a turn-key lump-sum contract will be used.

3-3 Need for Technical Assistance Services

It is expected that it will be necessary to obtain the following services from an internationally-experienced consultant:

- (1) Technical assistance services related to preparation of tender specifications and documents for the selection of contractors as well as to project management, during construction of the Complex.
- (2) Technical assistance service related to Complex operation and maintenance, for a period of two to three years following start-up.

It is therefore necessary to make budgetary arrangements to cover the costs of these services.

3-4 Organization, Staffing, and Human Resources Development

It is planned to locate the head office of the new joint-venture company in Kuala Lumpur. The staffing of the entire company, including the Complex in Bintulu and the head

office, will be as follows:

Executives	5
Head office staff	34
Complex staff	611
Total	650

Because training of operators would have to be begun during the construction period, the cost of that training is estimated as a pre-operation expense.

3-5 Project Management Organization Required for Implementation of the Project

It is anticipated that PETRONAS Project Team which is the executing agency of the Malaysian Government, the primary sponsor of this Project, will continue to perform in that capacity in the future, but in order to insure continuity as progress is made toward the implementation stage, even after the joint-venture company is established, the staff members who are now in charge of this Project and are expected to be affiliated with the joint-venture company in the future should be increased, and the PETRONAS Project Team should be strengthened, so as to establish the system for implementation of the work of project management. As is stated above, because there are very many areas where close liaison and coordination with other governmental agencies are required for successful implementation of the Project, need exists for formation of a coordinating committee within the national government as well as a working team, so that an organization is created which can swiftly respond to any problems that may arise. Further it is recommended that PETRONAS Project Team recruit and train at a suitably early date the staff which will be required for project management work and the operation of the Complex after completion of construction.

V. Capital Requirements and Financing Plan

1. Capital Requirements

The capital required for this Project, with the exception of interest during construction, is estimated as follows:

	('000 U.S. dollars)
Foreign exchange portion:	222,160
Local currency portion:	61,270
Total:	<u>283,430</u>

Of the total capital requirements, 30% will be financed from the equity capital of the joint-venture company, and the remaining 70% will be financed through long-term loans. At the stage of the present study, there is no firm basis to assume a certain interest rate to be used for financial projections, because financing sources which provide loans for the Project are not determined yet. If the interest rate of 6 to 4 % per annum, as a hypothesis, is used for this estimation, the capital requirements, including interest during construction, are projected as follows (for details, see Table 4):

	('000 U.S. dollars)		
	Foreign exchange portion	Local currency portion	Total capital required
Interest 6% p.a.	242,690 (79.8%)	61,270 (20.2%)	303,960 (100%)
Interest 5% p.a.	239,070 (79.6%)	61,270 (20.4%)	300,340 (100%)
Interest 4% p.a.	235,530 (79.4%)	61,270 (20.6%)	296,800 (100%)

The above figures are based on calculations using prices as of the end of 1979, and with provisions for price escalation up to early 1984 which were estimated at a rate of 9% per annum in compound for the foreign exchange portion and 7% per annum in compound for the local currency portion. The capital budget is based on the assumption that the Complex starts commercial operation in March, 1984. If there is a delay of, say, six months, in commencement of Complex construction, the required capital would be increased by about 4.3%, and if there is a delay of 12 months, an increase of about 8.6% is expected.

2. Financing Plan

The financing plan for the Project based on the above capital requirements, is projected as follows:

('000 U.S. dollars)

	<u>Equity Capital</u>	<u>Long-term Loan</u>
Interest 6% p.a.	91,188	212,772
Interest 5% p.a.	90,102	210,238
Interest 4% p.a.	89,040	207,760

VI. Financial Analysis

1. Assumptions Used for Production Cost Estimates and Financial Projections

On the assumption that the Complex will commence commercial operation in March, 1984, financial projections are made in terms of 1984 current price, as a constant, over a project life of 15 years. Major assumptions used for the production cost estimates and financial projections are as follows:

(1) Projected production and sales

As a basis for analyzing sensitivity of financial returns and financial structure of the Project affected by changes in the production and sales volume, with regard to production and sales of urea, three alternative projections are set as follows:

Case A: Urea – In this case, it is assumed that the product urea would be sold only to the domestic Malaysian markets and other ASEAN markets, but there would be no exports to markets outside ASEAN region. The projected urea sales in this Case is identical to the projected demand in Malaysia (Table 1) plus available ASEAN markets (Table 2) for urea from the Complex. Production is projected so as to meet the projected sales.

Ammonia – Sale of ammonia is to be limited to the domestic Malaysian

market. In addition to the quantity of ammonia needed to produce the above quantity of urea, the quantity of ammonia which is marketable within Malaysia is assumed to be produced.

Case B: Urea — It is assumed that production will be made at capacity utilization of 70% in the first year, 80% in the second year, and 90% in the third year and on, and the surplus after marketing the product in Malaysia and the ASEAN region is taken to be exported to outside the region. (There is a possibility that all the produced urea can be absorbed by sale within the ASEAN markets.)

Ammonia — Sale of ammonia is to be limited to the domestic Malaysian market, and ammonia produced is to be the amount needed to produce urea as in the above production plan plus the amount to be sold in the domestic market.

Case C: Both urea and ammonia plants are to operate at 70% of capacity during the first year, 80% of capacity during the second year, and 90% of capacity during the third and later years, and the entire output is to be sold within Malaysia or exported.

(2) Sales price

Urea: US\$ 175/ton FOB (Bulk)

Ammonia: US\$ 205/ton FOB

(3) Natural gas price

Using the January 1, 1979 price of US\$0.70/MMBTU, and 7% p.a. escalation (in accordance with the pricing formula approved by the ASEAN Economic Ministers), to obtain a 1984 price of US\$ 0.98/MMBTU.

(4) Electric power charge

Using the present rate of M\$0.09/KWH (US\$0.04/KWH) and allowing for escalation, the 1984 price obtained is US\$0.06/KWH.

(5) Water charge

Using the present rate of M\$2.0/1,000 gallons (US\$0.20/m³) and allowing for escalation, the 1984 price obtained is US\$0.28/m³.

(6) Land lease cost

Taken to be US\$ 0.17/m², the cost in 1984.

(7) Taxes

A. Corporate tax

It is assumed that, under the Malaysian tax law, the joint-venture company will be provided with a tax holiday of 10 years, after which the company will be subject to corporate tax to be imposed at 50% of taxable income.

For the computation of taxable income, no depreciation is deductible, but deduction is allowed for the initial capital allowance and annual capital allowance. Applicable rates of these allowances are assumed as follows:

— Initial capital allowance:

20% of the value of total fixed assets.

— Annual capital allowance:

7.5% of the value of total fixed assets remaining after deduction of capital allowance applied in the previous years.

B. Import duty, sales tax and surtax

To be exempted.

2. Production Cost of Ammonia and Urea

- 1) On the basis of the assumptions mentioned above, and also on the assumption that the production and sales will be carried out as in Case B, the production cost of ammonia and urea in 1990 was calculated in terms of a 1984 constant price. Because the interest rate for loans is not determined at the present stage of project preparation, rates of 6%, 5% and 4% were used as a hypothesis in calculating production cost, with the following results:

Production Cost of Ammonia and Urea (bulk)

(As of 1990, in 1984 constant price)

	Ammonia (US\$/ton)	Urea (US\$/ton)
Interest rate 6% p.a.	155.2	140.8
Interest rate 5% p.a.	151.7	137.6
Interest rate 4% p.a.	148.3	134.4

(Including costs for interest and 15 years straight-line depreciation)

- 2) Although there is a degree of difference in the production cost of both ammonia and urea depending on the interest rate used, there is not a decisively great difference in cost among the three, and as long as the rate of operation is maintained at the levels postulated for purposes of the present calculations, it is judged that the Complex's products will have a degree of international competitiveness.
- 3) Because there is a constraint to the quantity of ammonia which will be possible to market, the capacity utilization rate of the ammonia plant will not exceed about 80%, but if the measures recommended in this report are adopted and carried out, so as to increase the sale of ammonia, it will be possible to make a significant contribution to the reduction of the production cost of both ammonia and urea. As a hypothesis, if the ammonia plant is kept operating at the level of 90%, the ammonia production cost would be reduced by about US\$19.3/ton, and the urea production cost would be reduced by about US\$11.2/ton.

3. Financial Analysis

The results of financial analysis, using the above assumptions and a project life of 15 years, are as follows:

1) Financial returns and overall profitability of the Project

Financial returns of the Project will be greatly affected by changes in the production and sales volumes. For each of the cases given in the sub-section (1) in the preceding section, the financial internal rate of return (IRR) is as follows:

	<u>Before tax</u>	<u>After tax</u>
Case A:	8.9%	8.4%
Case B:	9.5%	9.0%
Case C:	10.8%	10.4%

Case A represents the most conservative sales projection of the alternatives considered, and even in this case it is expected that the financial returns exceed the minimum acceptable level which was agreed upon by the ASEAN Economic Ministers. In Case B, the returns are somewhat better than in Case A. Although the financial returns may not be substantially high, they are enough to justify proceeding with this Project. The reason which may be indicated for this Project not having high rates of returns in the case of Case B is that the capacity utilization in ammonia production is projected to be kept at the level of 80% over the project life. The analysis of Case C, as is given in the above, indicates that if there are increases in the volume of ammonia marketing, financial returns of the Project will be assured that much more. Therefore it will be essential to take measures for increasing ammonia demand as recommended earlier, and if such measures are successfully carried out, a great contribution will be made to improvement of the financial returns. The results of sensitivity analysis (see Fig. 3) indicate that the major elements which will affect the returns are the sales price of urea and the total amount of required capital. It is not probable that there will be a great change in either of these from the projected level, unless the economic environment substantially changes in the future, so that the above figures may be judged to be suitable indications of the financial returns of the Project.

2) Financial structure of the Project

The financial structure of the Project, on the basis of Case B, is analyzed as follows. In examining the likely financial structure, the influence of the financing terms must be taken into consideration. However, as has been noted, since the source of financing has not yet been determined, the terms and conditions of such financing are not yet known. Nevertheless, the financial projections of this Project which had been prepared by the Malaysian Government and had been approved by the ASEAN Economic Ministers, used assumptions of the interest rate of 5% per annum and the repayment period of 15 years (including a 4-year grace period).

For this study the same terms as above are applied in respect of loan repayments, while the interest rates used as a hypothesis are in a range from 6% to 4% per annum. The results of the Evaluation Study Team's calculations are as follows:

	Interest Rates		
	6% p.a.	5% p.a.	4% p.a.
(1) Debt service coverage ratio of 1.5 or more	In and after 6th year	In and after 5th year	In and after 3rd year
(2) Operational level to attain profit break-even point			
– First year	76.8%	72.9%	68.9%
– 15-year average	64.8%	63.0%	61.2%
(3) Operational level to attain cash break-even point			
– First year	78.0%	74.1%	70.3%
– 15-year average	59.0%	57.3%	55.6%
(4) Internal rate of return on equity (IRRE)	12.0%	13.4%	14.9%

As may be seen from the above indexes, the financial structure of this Project does not allow for an overly optimistic view to be taken during the first three to four years. However, taking the entire project life into consideration, it is evaluated that the Project will be financially capable to liquidate debts.

To sum up the above evaluation, although the profitability of this Project may not be expected to be very high, it is evaluated that in addition to there being justification for the view that a sufficient return on investment will be made to make the investment worthwhile, the Project is fairly sound financially, and that as presently planned it is financially viable.

VII. Economic Evaluation

- 1) For Malaysia which is the host country for this Project, the economic importance of the Project would primarily be the contribution to her national economy in terms of better value added of indigenous natural resources (natural gas) and also of foreign exchange savings/earnings which are gained through substitution for imports of urea and ammonia as well as the exportation of urea to other ASEAN countries. At the same time, for the other ASEAN countries (in particular, the Philippines and Thailand which are reliant on imports for urea which they require), this Project could contribute to the expansion of their economies, because their participation in the Project would result either in the increased investment opportunities or the assurance of a stable supply source of low-cost urea or both.
- 2) The economic returns of this Project, if it is assessed from the viewpoint of Malaysia as the country most directly involved, shows 9.4% as the economic internal rate of return (IRR), over the project life of 15 years, which is close to the financial internal rate of return before tax.
- 3) For Malaysia, as this is the first occasion to establish a large-scale chemical industry, this Project will make the great contribution to the establishment of the foundation for further development of the basic chemical industry. In addition it will make the contribution to increasing employment opportunities and to regional development of Sarawak, which is now underdeveloped, and moreover it will have the direct or indirect effects on further development of related industries. These are the significance of indirect benefits to her national economies which may be expected in connection with the implementation of the Project. In view of these direct and indirect benefits, this Project must be evaluated as having the potential to make a major contribution to the economic development of Malaysia.
- 4) Further, for the ASEAN countries, this Project, following the ASEAN Aceh Urea Project in Indonesia which is the first joint project by the ASEAN countries, must be evaluated as making a major contribution to the promotion of the economic

development of the ASEAN region as a whole, as the ASEAN countries continue to develop a common market, and to industrialize on the basis of seeking economies of scale and use of each country's comparative advantage through joint investment.

CONCLUSION

The conclusion of this study with regard to the feasibility of the Project, based on the results of the study as summarized in the foregoing pages, is as follows.

1. Marketability of the Products

1) The scale of the market for nitrogen fertilizer in Malaysia is large in overall terms, but because traditionally Malaysian farmers have used either ammonium nitrate or ammonium sulphate - i.e., not urea - as straight nitrogen fertilizer or NPK fertilizer (either as compound or mixed fertilizer) in which, similarly, sources of nitrogen other than urea have been used, the use of urea as a fertilizer has been limited and at the present time it is used only for padi and some of the oil palm. In order to expand the demand for urea, it is necessary, in addition to expanding and continuing the fertilizer purchase subsidy arrangements which are now in existence, strengthening extension service activities, and providing strong governmental support for research on the methods of applying urea fertilizer, that the marketing company which is being planned by PETRONAS Project Team be established, and that it carry out extension and marketing activities in close coordination with various governmental agencies. It is believed that if these measures are carried out in proper manner, there will be a great increase in the consumption of urea fertilizer in Malaysia. Further, it is necessary that the marketing company undertake to establish a distribution and transportation system which enables efficient movement of urea to the farmer level while including the distribution-related activities and facilities of the existing importers, distributors, and fertilizer mixturers.

2) It is believed that consumption of urea fertilizer in the other ASEAN countries (notably the Philippines) will also continue to steadily increase, but when the supply of urea from the ASEAN Aceh Urea Project in Indonesia is taken into consideration, it is seen that there is some possibility that during the first four or five years of the operation of the Malaysian Ammonia and Urea Complex it may be difficult to expect that the Malaysian domestic market and the ASEAN market will absorb all of the urea produced in Malaysia (about 450,000 t/y). In such event, during this period it may be necessary to export 20,000 to 50,000 t/y to countries outside the ASEAN region.

The surplus which cannot be absorbed by the ASEAN countries is to be purchased by the Malaysian Government, for sale within the Malaysian domestic market as well as exportation outside the ASEAN region, and PETRONAS Project Team, which is the executing agency for this Project, plans to establish a marketing company which would be responsible for the domestic sale and distribution of urea and ammonia produced by the Complex, and would set up a suitable system to do so. It is anticipated that during the first half of the 1980's there will be a surplus of world supply of urea, in global terms, and that therefore competition among urea exporters will become more intensified. Under such conditions, the outlook for exports of urea beyond the ASEAN region cannot be said to present a favorable appearance, but the cost of urea which would be produced by this Project is expected to be competitive in the future and, furthermore it should be possible for Malaysia to export urea to importer countries which are relatively close to Malaysia, such as India and Vietnam, as well as China, in particular, so the marketing company must have the capability to undertake export marketing of urea to these countries. If the company is provided with the ability to undertake such export marketing, it should be able to export as required to outside the ASEAN region, especially in view of the outlook that those quantities will not be so large as to present a problem. Therefore, on the assumption that the various measures recommended herein are properly carried out by Malaysia, it is judged that the projected sales levels for urea are fully attainable, and that therefore the scale of the urea plant which has been planned by the Malaysian Government (1,500 t/d) is feasible.

- 3) Because the Malaysian market for ammonia from the Complex at present, is small in scale, it is estimated that the actual marketable volume (about 11,000 t/y) of ammonia, after a portion is used for production of urea, will be only about 30% of the total surplus volume available for sale (about 39,000 t/y). However, the major share of ammonia produced in this Project (about 300,000 t/y) will be consumed in the production of urea within the Complex, so that the scale of production of ammonia for sale outside the Complex corresponds to about 13% of the total volume of ammonia production. Even after production is adjusted in accordance with the above sales constraint it should be possible to maintain production at a capacity utilization rate of about 80%, which would not impart a strong influence on the economics of ammonia production compared to that in a smaller scale ammonia plant. Further, there is a possibility that the domestic demand for this Project will be increased to such an extent that all the surplus can be absorbed. Therefore, it is judged that the scale of ammonia plant planned by the Malaysian

Government for this Project (1,000 t/d) is that of appropriate selection. However, this judgement is based on the assumption that the marketing company resolves all matters related to ocean transport and distribution after delivery to destination ports. Moreover, as a measure to expand the demand for ammonia, it would be desirable for the marketing company to devote, acting on its own or in conjunction with existing compound or mixed fertilizer manufacturers, for expansion of compound fertilizer production, which will also have the effect of reducing Malaysian dependence on imported compound fertilizer.

2. Supply of Natural Gas

The natural gas to be used as feedstock and fuel for the Complex is to be supplied from the Central Luconia gas fields, offshore Bintulu, in Sarawak, and it is believed that this will be an adequate, stable source of supply. The LNG plant to be constructed in the vicinity of the Ammonia and Urea Complex will be the major consumer of the gas produced in these fields. A trunk line will be laid from the offshore gas fields to the LNG plant. The gas to the Complex is to be branched from the trunk line and to be transmitted to the gate of the Complex by a branch pipeline which will be constructed at the expenses of PETRONAS. Under these arrangements, it is observed that there is no underlying problems on gas supply systems, but it must be noted that coordinations with the gas supplier will be required in order to insure that gas supply facilities will be completed in time to provide gas to the Complex.

3. Locational and Site Conditions of the Proposed Complex Site

- 1) A large-scale industrial estate is to be developed in the Kidurong area in Bintulu, in which the proposed site for the Ammonia and Urea Complex is located, and at the present time progress is being made in the development of water and electric power supply capability, improvement of the area's port and harbor facilities through construction of a deepwater port, and improvement of infrastructure, including housing. In order to obtain assurance that the required factors for the Project are in fact available, it is necessary that PETRONAS Project Team continue to maintain close contact with the related agencies of the Government so as to coordinate the contents of plans and implementation schedules, so that these various facilities may be used in connection with the implementation and operation of the Complex plans. The matters for which coordination is particularly important are listed below.

(1) Water supply

It is necessary to obtain assurance that the pumped storage dam which is planned to be built along the Sika river to impound water to be supplied to the Complex, a pipeline connecting the dam with the Complex, as well as related water supply facilities, are completed and usable by early 1983, so that the required volume of water can be supplied to the Complex in time.

(2) Electricity power supply

Power is to be supplied from the generating station which is being built on a site adjacent to the Ammonia and Urea Complex; assurance must be obtained that the Ammonia and Urea Complex is given priority in the planning of supply of power from this station. Further, in order to obtain a qualitatively stable supply of power, measures must be taken to have a sole-use transmission line installed, or otherwise to have the Complex supplied with power in a supply network preventing from consumers which may cause unstable conditions in the supply of power to the Complex. (If permission can be obtained, it would be desirable for the Complex to generate its own power.)

(3) Port facilities

- (a) Approval must be obtained so that the construction jetty which is to be built for use in connection with the construction of the Bintulu Deepwater Port is made available for use in connection with construction of the Ammonia and Urea Complex.
- (b) Assurance must be obtained that the Bulk Cargo Pier, planned to be constructed in Bintulu Deepwater Port, will be completed on schedule, and approval must be obtained for priority to be given to the entity operating the Complex, in the use of the pier for shipment of the products of the Complex.

(4) Housing colony

Guarantee must be obtained that provision will be made for the supply of housing for employees working at the Complex, in the housing development project which the Bintulu Development Authority is proceeding with implementation.

If the above requirements are satisfied, it is judged that there will be no major problem in carrying out the plan which the Malaysian Government has made for this Project.

- 2) Because the soil survey of the site is being carried out at the present time, final judgement about the suitability of the proposed site should be reserved until results of the soil survey are presented. Nevertheless, as may be induced from information available on other nearby sites, it is presumed that the proposed site may be suitable for construction of the Complex. The topography is strongly undulating, which will make it necessary to bear relatively high site preparation costs, while the location is geographically convenient. Therefore, in overall evaluation the site is favorably suited for the Complex. It is judged that there is essentially no problem with regard to either construction or operation of the Ammonia and Urea Complex on the proposed site.

4. Construction and Operation of the Ammonia and Urea Complex

- 1) The Ammonia and Urea Complex is to have a production capacity of 1,000 t/d of ammonia and 1,500 t/d of urea. There are a number of plants of this scale that have been built and are operating in various countries of the world. Internationally, there are many engineering firms which are experienced and fully qualified in the design and construction of such plants, and it is believed that there will be little technical risk if the Malaysian Government contracts with an experienced, qualified engineering firm for the design and construction of the Complex on a turn-key basis as it contemplates.
- 2) However, since Malaysia has not had prior experience in constructing an ammonia and urea plant of such large-scale as this one, establishing a suitable project management system, establishing a suitable system for operation of the Complex, and training of operators are vital for attainment of success. It is therefore necessary to obtain the support services of an internationally-experienced consultant or production company for work during the stages of preparation for contracting, construction, and initial operation period after completion of construction, and it is further necessary that the requisite organization for this be established at the earliest possible date, and that the training of personnel be begun.

5. Financial and Economic Evaluation of the Project

- 1) This Project, by benefiting from the Malaysian Government's ongoing development of infrastructure in the Bintulu area, can be accomplished with a relatively low level of capital investment, but it is unavoidable that capital-related costs will be high, due to the worldwide trend for prices of equipment, supplies and materials to increase at a high rate, and in comparison to fertilizer plants which have been constructed in other countries in the past. However, the high capital-related costs would be partially offset by relatively low costs of natural gas to be used by the Complex and hence the outlook is that the cost of the Project's products will be located just within the range of internationally competitive cost.
- 2) The rates of financial returns on investment for this Project cannot be said to be high, but are deemed to be adequate for sustaining the Project and for providing a return to investors which is within the range of a suitable profit. Financially, the Project will not give cause for optimism during the first three or four years of operation, but there is no danger of such an order as would threaten the continued viability of the Project itself. Further, even if there is a degree of change in the conditions used for determining sales prices, this too would not present a risk which would threaten the continued existence of the Project. Therefore, it is judged that this Project has a financially viable base.
- 3) On the other hand, in terms of the economic outlook for the Project, it is judged that a proper return on investment may be obtained, and that the Project will bring about economic benefits in keeping with its original intent.

Thus, in summary, to the extent that the various problems which have been identified in the foregoing sections are resolved, it is judged that this Project is technically and economically feasible, and is financially viable.

RECOMMENDATIONS

The following recommendations are made as being essential to insure the success of the Project.

1. Based on results of the marketing and distribution study which PETRONAS Project Team plans to conduct in the near future to formulate a detailed plan for establishment of marketing and distribution systems to be set up by the new marketing company, promptly start on organizing the marketing and distribution functions and activities and training manpower, and establish the overall organization through implementation of a premarketing program. Arrangements must be made with regard to improvement and expansion of transport and distribution facilities for both urea and ammonia.
2. Monitor and coordinate the progress of work regarding the utilities facilities, port, housing colony, etc., while maintaining close contact with related government offices, in order to insure that the various problems identified in Section 3 of the "CONCLUSION" section above are resolved. For this purpose, in addition to establishing a coordinating function within the organization of PETRONAS Project Team, it would be effective to establish within the national government a means of coordinating plans and activities.
3. Improve project management capabilities and organization for the promotion of this Project, and carry out the organization of the work force and managerial team, and training, at an early possible date.
4. Proceed with discussions with related government agencies in an effort to obtain the supply of utilities at the lowest possible cost.
5. In order to guard against an increase in the capital requirements, carry out the following work in parallel as quickly as possible so that, after this Project enters the implementation phase, a contract could be signed with a contractor at the earliest possible date:
 - 1) Confirmation that the site is suitable, and completion of site acquisition procedures
 - 2) Finalization of the design bases and design criteria
 - 3) Preparation of tender documents

Table 1 PROJECTED SUPPLY/DEMAND OF UREA IN MALAYSIA

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
											(Urea '000 ton)
Supply:											
- Production											
ASEAN Urea Project (a)	-	-	-	-	288.8	396.0	445.5	445.5	445.5	445.5	445.5
(Assumed Capacity Utilization Rate) (%)					(70)	(80)	(90)	(90)	(90)	(90)	(90)
- Inventory Increase (b)					28.9	4.1	4.1	-	-	-	-
Supply ability (A) = (a - b)	-	-	-	-	259.9	391.9	441.4	445.5	445.5	445.5	445.5
Demand:											
Fertilizer Use	105.4	111.5	117.4	123.0	128.5	135.0	139.5	145.2	150.9	156.3	162.0
Industrial Use	13.0	13.9	15.0	15.9	17.0	17.8	18.7	19.6	20.4	21.3	22.2
Total (B)	118.4	125.4	132.4	138.9	145.5	152.8	158.2	164.8	171.3	177.6	184.2
Surplus (or Deficit) (A - B)	(118.4)	(125.4)	(132.4)	(138.9)	114.4	239.1	283.2	280.7	274.2	267.9	261.3

Table 2 PROJECTION ON AVAILABLE ASEAN MARKET FOR MALAYSIAN UREA

(Urea '000 ton)

	1984	1985	1986	1987	1988	1989	1990
Supply/Demand Balance of Urea in ASEAN Countries:							
Indonesia	2,932	2,932	2,932	2,932	2,932	2,932	2,932
Supply Ability	1,707	1,751	1,806	1,856	1,901	1,941	1,980
Demand	1,225	1,181	1,126	1,076	1,031	991	952
Balance	4	4	4	4	4	4	4
Thailand	66	77	88	99	111	124	138
Supply Ability	-62	-73	-84	-95	-107	-120	-134
Demand	-	-	-	-	-	-	-
Balance (A)	327	343	359	373	388	403	419
The Philippines	-327	-343	-359	-373	-388	-403	-419
Supply Ability	-	-	-	-	-	-	-
Demand	17	17	17	17	17	17	17
Balance (B)	-17	-17	-17	-17	-17	-17	-17
Singapore	-	-	-	-	-	-	-
Supply Ability	203	217	230	243	256	270	285
Demand	114	239	283	281	274	268	261
Balance (C)	-	22	53	38	18	-	-
Available ASEAN Market for Malaysian Urea:							
(D) = [-(A + B + C)] x ½	203	217	230	243	256	270	285
Exportable Surplus Urea from ASEAN Fertilizer Project (Malaysia) (E) ¹ :	114	239	283	281	274	268	261
Surplus Urea after Exporting to the ASEAN Countries (E - D):	-	22	53	38	18	-	-

Note: 1) As for the exportable surplus urea, see Table 1.

Table 3 PROJECTED SUPPLY/DEMAND OF AMMONIA IN MALAYSIA

	1984	1985	1986	1987	1988	1989	1990
	(NH ₃ '000 ton)						
Supply/Demand of Ammonia without ASEAN Fertilizer Project:							
Supply							
Esso Malaysia (A)	41.7	41.7	41.7	41.7	41.7	41.7	41.7
Demand							
CCM	42.6	42.6	42.6	42.6	42.6	42.6	42.6
FFC	8.5	8.5	8.5	8.5	8.5	8.5	8.5
Ajinomoto	1.3	1.5	1.5	1.5	1.6	1.6	1.6
Total (B)	52.4	52.6	52.6	52.6	52.7	52.7	52.7
Deficit (C) = (B - A)	10.7	10.9	10.9	10.9	11.0	11.0	11.0
Marketable Surplus Ammonia from ASEAN Fertilizer Project (D) ¹⁾ :							
	22.5	33.9	38.3	38.6	38.6	38.6	38.6
Surplus Ammonia with ASEAN Fertilizer Project (D - C):							
	11.8	23.0	27.4	27.7	27.6	27.6	27.6

Note: 1) Operational rate of the plant is assumed to be 70 % in 1984, 80 % in 1985, and 90 % in 1986 and after.

Table 4 ESTIMATED CAPITAL REQUIREMENTS

(US\$ '000)

	Foreign	Local	Total
A. Site Preparation	770	6,320	7,090
B. Plant Direct Cost	100,070	22,080	122,150
C. Construction Equipment	7,530	1,390	8,920
D. Ocean Freight, Insurance & Local Hand'g	14,630	1,070	15,700
E. Indirect Field Expenses	1,990	1,420	3,410
F. Services	37,740	3,630	41,370
G. Project Management	6,960	1,360	8,320
H. Pre-operation Expenses	2,070	5,090	7,160
<u>Base Project Cost (B/C)</u> (in End-1979 Prices)	<u>171,760</u>	<u>42,360</u>	<u>214,120</u>
I. Physical Contingency (% of B/C)	12,040 (7.0 %)	4,960 (11.7 %)	17,000 (7.9 %)
J. Price Contingency (% of B/C)	34,840 (20.3 %)	8,900 (21.0 %)	43,740 (20.4 %)
K. Initial Working Capital (in Beg.-1984 Prices)	3,520	5,050	8,570
<u>Total Project Cost</u>	<u>222,160</u>	<u>61,270</u>	<u>283,430</u>
L. Interest during Construction			
Interest Rate: 6 %	20,530	0	20,530
5 %	16,910	0	16,910
4 %	13,370	0	13,370
<u>Total Financing Required</u>			
Interest Rate: 6 %	<u>242,690</u> (79.8 %)	<u>61,270</u> (20.2 %)	<u>303,960</u> (100 %)
5 %	<u>239,070</u> (79.6 %)	<u>61,270</u> (20.4 %)	<u>300,340</u> (100 %)
4 %	<u>235,530</u> (79.4 %)	<u>61,270</u> (20.6 %)	<u>296,800</u> (100 %)

Table 5 PROJECTED PRODUCTION AND SALES (CASE A)

	1984 ¹⁾	1985	1986	1987	1988	1989	1990 onwards
Ammonia (Rated Capacity: 330,000 ton/year)							
1. Ammonia Production	177,392	225,700	237,170	248,149	259,806	268,390	269,390
2. (Capacity Utilization) (%) ²⁾	(64.5 x 10/12)	(68.4)	(71.9)	(75.2)	(78.7)	(81.6)	(81.6)
3. Consumption for Urea ³⁾	167,475	214,700	226,170	237,149	248,806	258,390	258,390
4. Marketable Surplus [(1) - (3)]	9,917	11,000	11,000	11,000	11,000	11,000	11,000
5. Inventory	917	917	917	917	917	917	917
6. Increase in Inventory ⁴⁾	917	0	0	0	0	0	0
7. Sales [(4) - (6)]	9,000	11,000	11,000	11,000	11,000	11,000	11,000
Urea (Rated Capacity: 495,000 ton/year)							
8. Urea Production	288,750	370,173	389,948	408,877	428,975	445,500	445,500
9. (Capacity Utilization) (%) ⁵⁾	(70 x 10/12)	(74.8)	(78.8)	(82.6)	(86.7)	(90)	(90)
10. Inventory	28,875	30,848	32,496	34,073	35,748	37,125	37,125
11. Increase in Inventory ⁶⁾	28,875	1,973	1,648	1,577	1,675	1,377	0
12. Sales [(8) - (11)]	259,873	368,201	388,300	407,300	427,301	444,123	445,500

Notes: 1) - 6); See the notes in Table 7.

Table 6 PROJECTED PRODUCTION AND SALES (CASE B)

	1984 ¹⁾	1985	1986	1987	1988	1989	1990 onwards
Ammonia (Rated Capacity: 330,000 ton/year)							
1. Ammonia Production	177,392	240,680	269,390	269,390	269,390	269,390	269,390
2. (Capacity Utilization) (%) ²⁾	(64.5 % x 10/12)	(72.9)	(81.6)	(81.6)	(81.6)	(81.6)	(81.6)
3. Consumption for Urea ³⁾	167,475	229,680	258,390	258,390	258,390	258,390	258,390
4. Marketable Surplus [(1) - (3)]	9,917	11,000	11,000	11,000	11,000	11,000	11,000
5. Inventory	917	917	917	917	917	917	917
6. Increase in Inventory ⁴⁾	917	0	0	0	0	0	0
7. Sales [(4) - (6)]	9,000	11,000	11,000	11,000	11,000	11,000	11,000
Urea (Rated Capacity: 495,000 ton/year)							
8. Urea Production	288,750	396,000	445,500	445,500	445,500	445,500	445,500
9. (Capacity Utilization) (%) ⁵⁾	(70 x 10/12)	(80)	(90)	(90)	(90)	(90)	(90)
10. Inventory	28,875	33,000	37,125	37,125	37,215	37,125	37,125
11. Increase in Inventory ⁶⁾	28,875	4,125	4,125	0	0	0	0
12. Sales [(8) - (11)]	259,875	391,875	441,375	445,500	445,500	445,500	445,500

Notes: 1) - 6); See the notes in Table 7.

Table 7 PROJECTED PRODUCTION AND SALES (CASE C)

	1984 ¹⁾	1985	1986	1987	1988	1989	1990 onwards
Ammonia (Rated Capacity: 330,000 ton/year)							
1. Ammonia Production	192,500	264,000	297,000	297,000	297,000	297,000	297,000
2. (Capacity Utilization) (%) ²⁾	(70 x 10/12)	(80)	(90)	(90)	(90)	(90)	(90)
3. Consumption for Urea ³⁾	167,475	229,680	258,390	258,390	258,390	258,390	258,390
4. Marketable Surplus [(1) - (3)]	25,025	34,320	38,610	38,610	38,610	38,610	38,610
5. Inventory	2,503	2,860	3,218	3,218	3,218	3,218	3,218
6. Increase in Inventory ⁴⁾	2,503	357	358	0	0	0	0
7. Sales [(4) - (6)]	22,522	33,963	38,252	38,610	38,610	38,610	38,610
Urea (Rated Capacity: 495,000 ton/year)							
8. Urea Production	288,750	396,000	445,500	445,500	445,500	445,500	445,500
9. (Capacity Utilization) (%) ⁵⁾	(70 x 10/12)	(80)	(90)	(90)	(90)	(90)	(90)
10. Inventory	28,875	33,000	37,125	37,125	37,125	37,125	37,125
11. Increase in Inventory ⁶⁾	28,875	4,125	4,125	0	0	0	0
12. Sales [(8) - (11)]	259,875	391,875	441,375	445,500	445,500	445,500	445,500

Notes: 1) 10 months production (March to December, 1984)

2) % of production against a rated capacity of 330,000 ton/year (1,000 ton/day x 330 on-stream days)

3) Computed at a consumption rate of 0.58 tons of ammonia per ton of urea

4) Increase in ammonia inventory against the previous year

5) % of production against a rated capacity of 495,000 ton/year (1,500 ton/day x 330 on-stream days)

6) Increase in urea inventory against the previous year

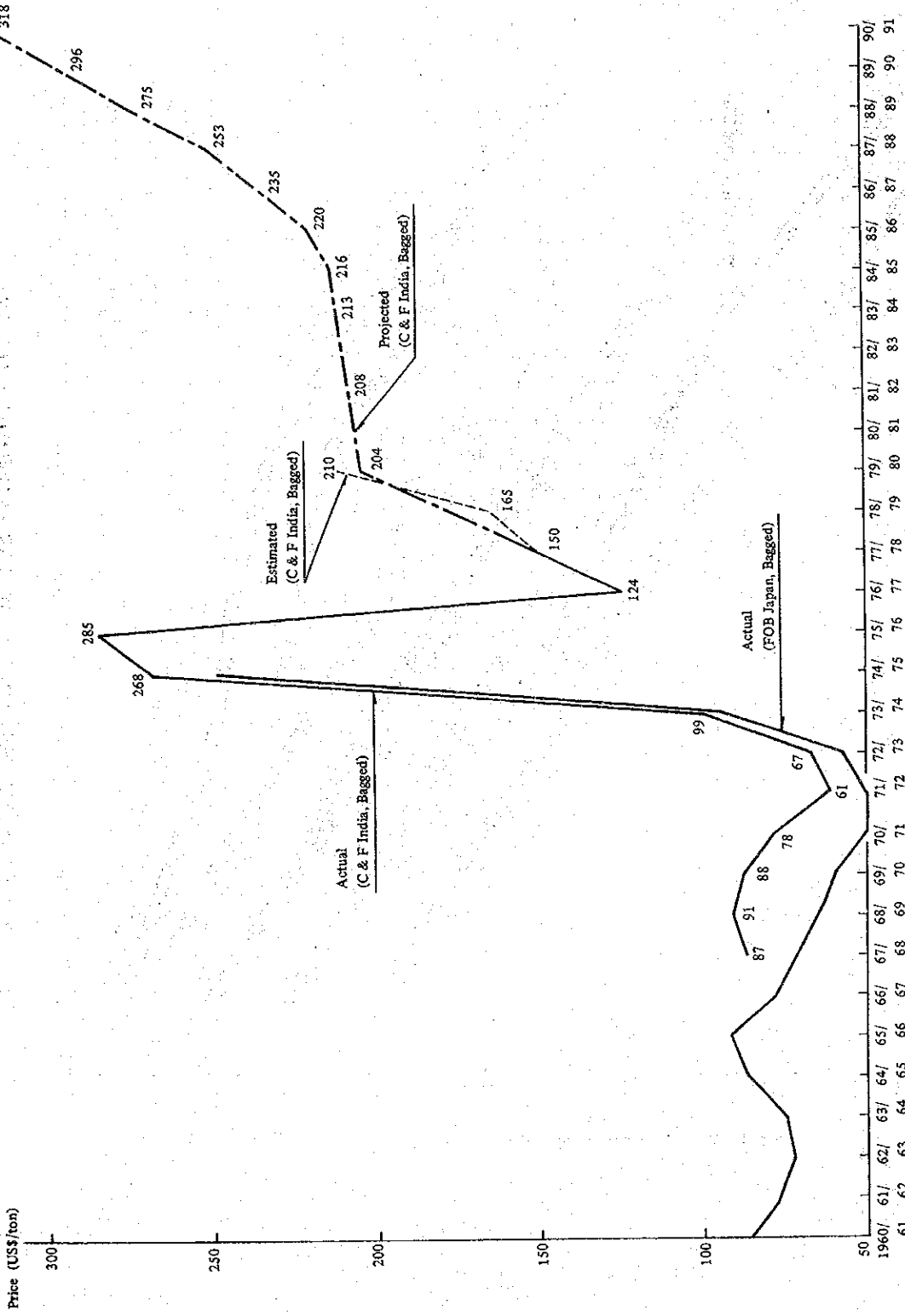


Fig. 1 PAST TREND AND PROJECTION OF INTERNATIONAL PRICE OF UREA

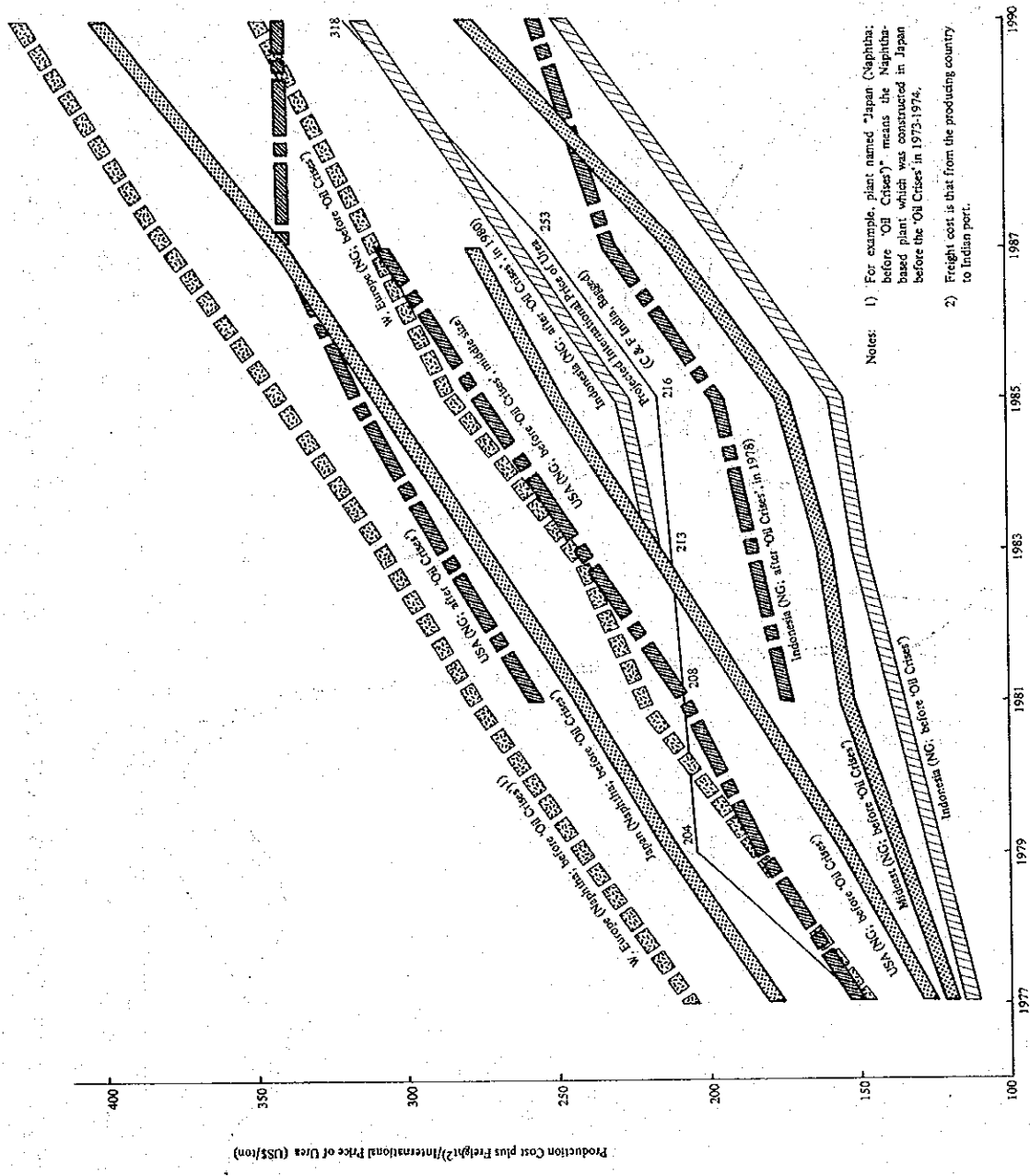


Fig. 2 SENSITIVITY TEST ON THE MAJOR ECONOMIC FACTORS

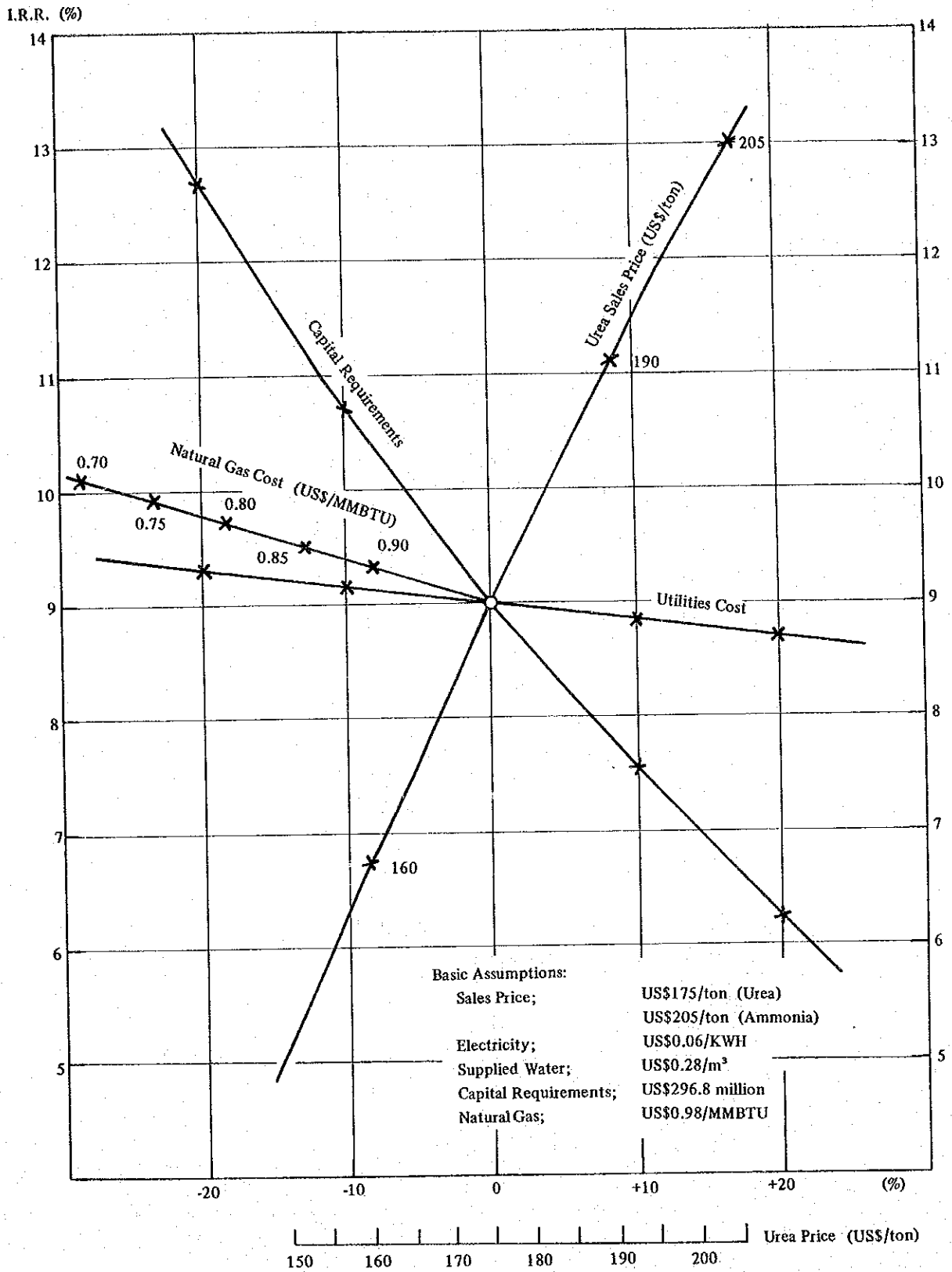


Fig. 3 SENSITIVITY TEST ON THE MAJOR ECONOMIC FACTORS

