INTERNATIONAL CONFERENCE
ON NUCLEAR POWER AND ITS FUEL CYCLE
SALZBURG, AUSTRIA • 2–13 MAY 1977

IAEA - CN - 36/175

NUCLEAR POWER PROSPECTS IN AN OIL AND COAL PRODUCING COUNTRY.

by

J. ILJAS

and

I. SUBKI

National Atomic Energy Agency

Bandung Reactor Centre

Bandung, Indonesia.

for presentation at

INTERNATIONAL CONFERENCE ON NUCLEAR POWER

AND ITS FUEL CYCLE

May 2 - 13, 1977

SALZBURG, AUSTRIA.

I. INTRODUCTION

Economic growth of a developing country is mainly dependent on three factors, which are affecting each other, namely :

a. availability of natural resources

b. growth of population

c. status of technology

Since energy supply is a prerequisite for the development of industry, it is obvious that a firm national energy policy should be established at an early date. However a large number of developing countries often are prone to take short-term views, since generally they are occupied with tactics dealing with economic problems of the present rather than with long-term strategy. Especially in the energy field it would be necessary to think about the long-term future, notably for such an oil producing country as Indonesia, where oil exports constitute more than 50% of government's revenues and where energy consumption is mostly dependent on oil, which makes up about 90% of the total.

After the upheavels of 1973 - 1974 it was not more than logic that government's officials who were associated with the energy area strove for an early establishment of a national energy policy, in which diversification of energy resources would constitute a major theme while minimizing dependence on oil as an energy source. Projection of a conclusive energy strategy would only be possible if it is based on the knowledge of potential energy reserves. This effort of gathering information on fossil fuel deposits, hydro potential, radioactive mineral

deposits and geothermal potential is still going on. In 1975 a study was jointly conducted by the International Atomic Energy Agency and the Government of Indonesia on the electricity generation expansion programme on the island of Java, the most populous island in the Indonesian Archipelago (Fig.1). The study could also be considered as a general survey of the available energy recources in the country. Here a situation arises which could be called unique. Java, as the smallest of the four Greater Sunda Islands, is inhabited by almost 2/3 of the total population in Indonesia. The population problem has been and will be, in the future, difficult to manage because it has been left to grow unchecked for decades. Density on Java increased from 565 per square km in 1971 to 620 per square km in 1975, and is expected to grow to about 750 per square km in 1985 and 1100 per square km in the year 2000.

In future greater effort will be devoted to disperse the population. Apart from the kind of programmed transmigration which is now taking place by moving certain groups of people from densely populated Java to remote areas in the outer region, special attention should ge given to instigate spontaneous transmigration. The latter could be made possible by establishing a number of separate economic regions located in the vicinity of energy centres on the larger islands outside of Java. Fortunately geological and geographical circumstances allow such a kind of development pattern for the whole of Indonesia. The larger Sunda Islands, such as Sumatra, Kalimantan and Sulawesi, have rich mineral and energy resources, but no doubt at the intial stage industry will grow rapidly on Java Island, evidently because of the presence of abundant labour force on this island and the proximity of government's agencies, financial institutes and other services. It is on this island that

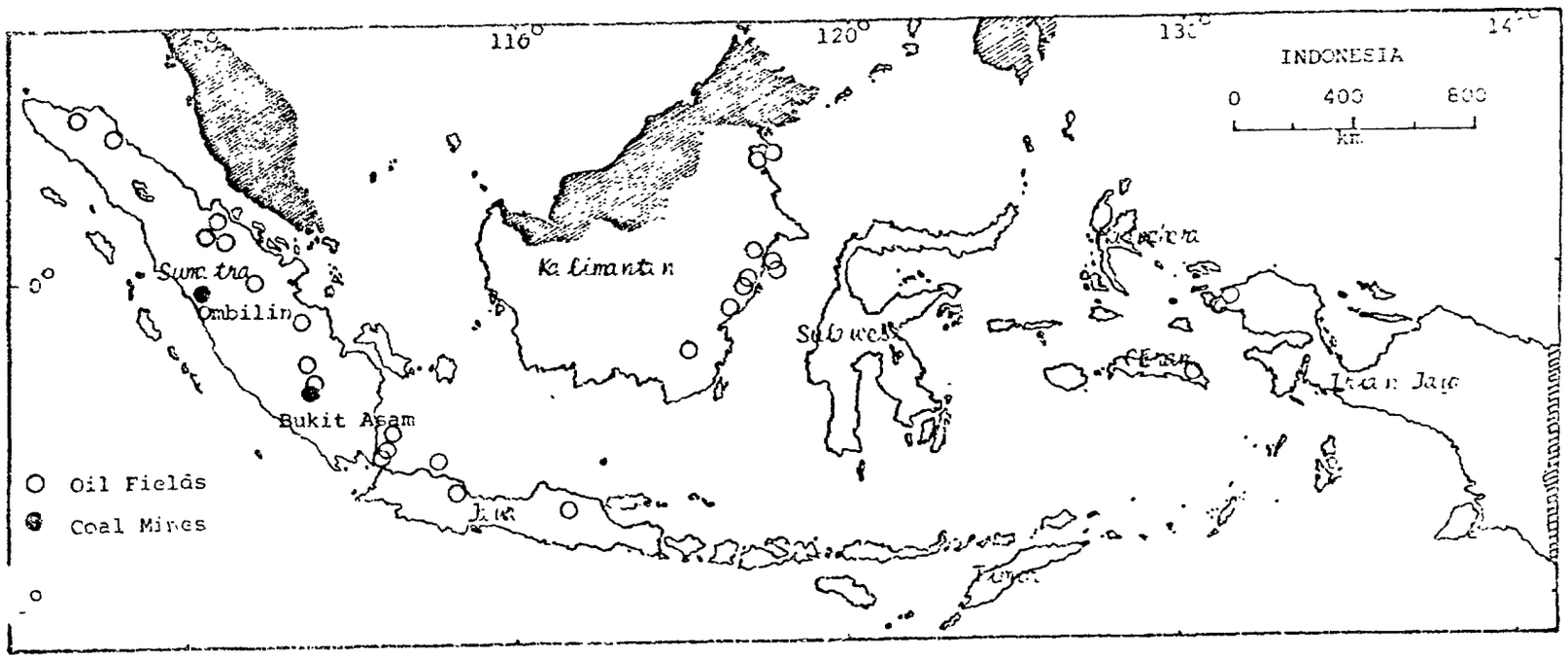

Fig. 1. : OIL AND COAL MINING AREAS IN INDONESIA.

nuclear power would play a significant role in accelerating the growth of industry. It would reduce the share of oil to be burnt as fuel,while forming an indispensable addition to new coal generating stations which are to be constructed in the early eighties and to the already projected hydro power stations and geothermal plants. Under this development pattern less developed regions, geographically more or less isolated from the richer island of Java, could benefit from the experiences, manpower and revenues obtained from enterprises operating in the most populated area of the Archipelago.

II. NATIONAL ENERGY RESOURCES.

II.1. OIL AND GAS

II.1.1. General

Since the birth of modern industry Indonesia has produced nearly 2% of the world's oil. It will continue to play a modest role as an oil producer in comparison to the big oil countries, as Indonesia is estimated to have some 2% of the world's proven oil reserves. However , in terms of higher quality crude oil, defined as low sulfur and high gravity, Indonesia's share of quality proven reserves is more like 20 percent of the world's total (see TableI). Only 10 percent of Indonesia's vast area has been actively explored. The high success ratio of drilling, 30 percent average since 1970 and amounting to 39 percent in 1975, the workability of the present contractual arrangements between the Government of Indonesia and the operating foreign oil companies (about which more in a later paragraph) and the ever increasing demand for hydrocarbon products are all positive factors, which may lead Pertamina (the state oil and gas company) and the various oil contractors to enhance exploration activities. Figure 1. illustrates the various oil mining areas in the Indonesia Archipelago.

TABLE I : ENERGY RESOURCES, CURRENT PRODUCTION
(FEBRUARY 1977)

	PROVEN RESERVES (RECOVERABLE)	CURRENT PRODUCTION
O I L	15 - 17 x 10^9 bbl	1.5 x 10^6 bbl/day
G A S	760 x 10^9 m^3	8.8 x 10^9 m^3/yr
C O A L	> 10 x 10^9 tons	0.3 x 10^6 tons/yr
HYDRO	30 000 MW (2500 MW on Java)	-

II.1.2. The role of oil in the Indonesian economy.

Indonesia counts on oil earnings for the bulk of its foreign exchange and budgetary revenues. The petroleum sector contributes roughly about 15 percent to the annual GNP. Therefore its potential as the main energy resource for domestic use should be considered against its significance in gaining export earnings. In the financial year 1975/ 1976 petroleum exports accounted for 73% of total gross foreign exchange earnings and similarly petroleum tax revenues accounted for 56% of total budgetary earnings.

TABLE II : Budgetary revenues from oil (in million US $ and as a percentage of total domestic revenues).

	1966 value %	1974/1975	1975/1976	1976/ 1977 (etc)
Total Petroleum Revenue	$ 2 (5)	2307(56)	3009(56)	3992(59)
a. Corporate Tax on Oil Companies	NA	2345(56)	3009(56)	3992(59)
b. Oil Products sales receipts	NA	-38(-1)	0	0
Total Non-Oil Revenue	$ 34(95)	1900(45)	2393(44)	2763(41)
Total domestic revenue	$ 36(100)	4207(100)	5402(100)	6755(100)

Table II illustrates the importance of petroleum tax revenues and highlights the enormous growth of the oil sector since 1966.

The other main component of oil-related budgetary income consists of the sale of petroleum products in the domestic market. Because of strong consumer pressure, however, the Government has held certain petroleum

product prices to a minimum, thus limiting net receipts to zero. This system of implicit subsidies reflects a current policy of pricing some products such as premium gasoline at or near market levels and using receipts thereof to subsidize other items such as kerosene which are widely utilized by the greater part of the population.

II.1.3. Production of crude oil.

The basic philosophy of the Government regarding natural resources is clearly stipulated in Article 33 of the 1945 Constitution, which states that "all the natural wealth on land and in the waters are under the jurisdiction of the State and should be used for the utmost benefit of the people". Therefore all mineral resources, including petroleum deposits and natural gas, can be explored and processed only by state companies.

The nucleus of the national petroleum industry is Pertamina, the state oil and gas company, which has been created in 1958 out of the remnants of three smaller national companies. Indisputably foreign oil companies have played a key role in helping the country develop its oil and gas resources. Oil companies engaged in exploration and production activities in Indonesia operate under two forms of contractual arrangements with the Government. The first group operate under Contract of Work agreements which were concluded prior to 1967. Basically these agreements provide for a 60 - 40 split of profits with the Government taking the larger share, while management and marketing control are vested with the companies.

A new form of contract has been introduced in 1967, known as the production-sharing agreement. The production-sharing concept features a number of specific assumptions in the relationship between Pertamina

and the foreign oil companies. According to this type of agreement crude oil, and not profits, is divided between the company and Pertamina, while the latter provides overall management control. Thus the foreign companies act more or less as a contractor. These relationships have been profitable for all parties involved. Another advantage for the foreign investors in these contracts lies in the provision for capital cost recovery "up-front", which allows the investors to recover their outlays relatively early in the economic life of their investment. These types of agreements will retain their attractiveness, since both parties involved stand to profit from the arrangement, and it should be borne in mind that oil remains the major foreign exchange earner for Indonesia for the next decades. A larger Government's take may perhaps discourage a re-investment in new exploration areas, but on the other hand a lower oil investment could be compensated by capital inflows towards investments in other areas of energy in the country. It would be part of the national energy policy to determine priorities, especially with regard to their relationship to domestic energy consumption.

The principle of production-sharing arrangements has been adopted for South Sumatra coal (see Section II.2.3.) and it is apparent that these types of contracts, probably appearing in various versions, will be applied to other commodities as well, evidently in the development of various mineral deposits.

II.1.4. Production and consumption of natural gas.

In the past natural gas has been mostly produced in association with oil. Not much use has been found for this associated gas, which

was mainly due to lack of sufficient funds to build collecting systems and gas pipe lines. This was the main reason that the acquired gas, aside from a small fraction for own use in the processing plant, was disposed of as flare gas. The production of gas is now gradually being increased, since a large fraction of gas will be used for the domestic production of fertilizers and petrochemicals, for heating in industry and for household purposes, mainly in large cities which already have an existing gas piping system.

The amount of gas discarded as flare gas is significant, it amounted in 1976 to about 60% of the total produced gas, but plans are being developed to make a more efficient use of this gas.

Large reserves of non-associated natural gas have been discovered lately. They are mostly located in remote areas, namely in East Kalimantan and Aceh in North Sumatra, totalling some 0.4×10^{12} m^3, or the equivalent of 3.2×10^9 bbl oil. The major part will be exported as liquefied natural gas.

II.2. COAL

II.2.1. Coal Production and Consumption.

The most important coal mines in Indonesia are located in Ombilin (West Central Sumatra) and Bukit Asam (South Sumatra), while those in the Mahakam area (East Kalimantan), the oldest in the Archipelago, have been temporarily closed down. Indonesian coal has been produced mainly for domestic consumption, attaining a total production peak of 2 million tons in 1940. The availability of cheap and abundant oil evidently has caused a steady decline of coal usage, so that in 1973 an all-time low production figure of 148 800 tons was reached. (6)

Presently coal is mainly used for railways (in South and West Sumatra), local industries (mainly the cement industries and in tin smelters) and for small generating plants situated near the coal mines. Since 1970 the operating agency for coal is P.N. Batubara (Coal State Enterprise).

As in many other coal producing countries the sharp increase of fuel oil prices by the end of 1973 may have brought a much brighter future for the domestic coal mining industry. Furthermore recent discoveries of huge coal deposits in South Sumatra have assured a more prominent role of coal in the Indonesian economy.

II.2.2. Projected markets for Indonesian coal.

For the near future the potential market for Bukit Asam and Ombilin can be found in the expanding industries located in the same region, the railways (currently steam locomotives are being employed) and, more significantly, the generation of power. The first coal based electricity generating plants are assumed to be at minemouth. Other stations

with a larger capacity will follow at a later stage, presumably near industry centres in South Sumatra and also in various locations on the North and West Coast of Java Island. For the two Batubara mines a pre-World War II production level is being envisaged towards the year 1982 with an estimated allocation for electricity plants of 1.5 million tons in 1982, which may increase to 2 million tons by the year 1985. However, this amount would be sufficient to serve as fuel for the planned three 25 MW units in Ombilin, four 25 MW units near Bukit Asam and two larger units of 375 MW each on the Northwest Coast of Java only. A more detailed description of the electricity expansion programme will be given in the next chapters.

II.2.3. Coal reserves.

As with oil, the search for coal is still continuing. Rio Tinto Bethlehem has, on the basis of a contract with the Government, conducted explorations in Central Sumatra. It has discovered reserves of about 80 million tons in a region situated between Ombilin and Bukit Asam. Further detailed studies are being carried out.

A large reversal in the future energy outlook has been accomplished recently by the discovery of huge coal reserves by Shell Company. This company has been carrying out explorations in South Sumatra since the days before World War II when the target was to find oil. It found considerable reserves of coal instead, of which the total in this region has been estimated at 10 billion tons, located at a depth of less than 100 m. This figure on reserves would compare to other large coal producing countries such as Australia (with economically recoverable reserves of 13.8 billion tons), South Africa (10.6 billion tons) and India (10.6

billion tons), but still behind the large coal producers such as USSR, USA, China and the Federal Republic of Germany.

According to the exploitation agreement concluded with the Government of Indonesia, Shell will finalize its exploration activities in the concession area by the end of 1977, and meanwhile develop a working programme for coal production with a target of 25 million tons annually to be achieved by 1987. This coal would be mainly for export purposes, but the agreement does not exclude the possibility of allocating a certain quantity to the domestic market when specifically requested by the Government. This is the first time that the production-sharing formula, which has been found satisfactory in the oil industry, has been applied in a significant way in another sector, such as here in the coal mining industry.

II.3. URANIUM

Since 1969 the National Atomic Energy Agency BATAN (Badan Tenaga Atom Nasional) has been carrying out various surveys for radioactive minerals in Kalimantan in close co-operation with a team of geologists from the French Atomic Energy Commission. Lately the prospecting activities are being concentrated on two specific areas in West Kalimantan and in East Kalimantan, where a number of promising indications of radioactive ores have been observed. Final conclusions can be given only after the results of drilling work, which are now going on, become available.

BATAN is also carrying out explorations in West Central Sumatra together with a team of specialists from the Federal Republic of Germany.

Another team from BATAN has also been making surveys in South Sumatra where a number of radioactive anomalies have been observed.

II.4. OTHER SOURCES OF ENERGY

A number of reports have shown that a rather substantial unexploited hydro reserve still exists in Indonesia. Most of these reserves are on the large islands outside Java. Java, as the most densely populated island, has currently an installed hydropower capacity of 372 MW. Its potential has been estimated at a total of 2500 MW, but it should be kept in mind that a large portion of this potential is emanating from small rivers. But there is no doubt that the existing and planned hydropower projects are very attractive because of their multi purpose character, notably for use in irrigation and in flood control. By 1986 a substantial amount of hydropower, totalling some 1380 MW, will be added to the interconnected grid of Java. This additional power will be supplied by 5 new stations and extension units in existing hydro power stations. In view of the sharply increasing electricity demand in the coming years, however, other types of generating stations should be considered.

The other Sunda Islands have a more favourable hydropotential due to the presence of large rivers. In 1976 an agreement was concluded by a consortium of Japanese companies with the Government of Indonesia to build a large hydropower station in Asahan (North Sumatra). The power will be mainly used for aluminium processing. At a later stage the station will also provide electricity for the surrounding region.

Indonesia is also planning some geothermal power stations. A precise figure of the total geothermal potential is not yet known, since exploratory drilling are still being carried out. A small pilot plant of 30 MW located in West Java will come into operation in 1980. Another geothermal plant of the same size is being projected in a mountainous plateau in Central Java.

With regard to such exotic sources of energy as wind power and solar energy, it seems that only the islands in the Eastern part of the Archipelago would be suitable for these kinds of energy sources, since it generally has a favourable climatic condition. However, as long as their economic feasibility has not yet been proven, it is more likely that for the time being this Eastern region will be dependent on diesel generating units.

III. REVIEW OF ENERGY STUDIES.

III.1. The Impact of the Energy Crisis.

The upheavals during 1973 - 1974 brought also their impact in Indonesia. Although the sharp increase of oil prices signified a windfall to the country and to all parties which are associated with the oil industry, the depletable character of this fuel became a point of concern for the Government authorities who are closely connected to energy problems. A national seminar on energy matters was held in July 1974 with the aim of exchanging views in order to find ways of minimizing dependence on oil as an energy source. This was clearly enunciated at a subsequent symposium on Energy, Resources and the Environment held in February 1975. At this meeting a number of officials made the forecast that per capita consumption of commercially produced energy on an annual basis would increase by about 600 percent in the year 2000, or from 0.6 barrel equivalent to 4 barrels. This increase was based on the assumption of a doubling of the population from 120 million in 1971 to about 250 million in the year 2000.

A joint study was conducted by the IAEA and the Government of Indonesia of which the results were published in a report entitled "Nuclear Power Planning Study for Indonesia (Java Island)". The objective of the study was to determine the optimal timing of the introduction of nuclear power on Java Island and to evaluate the appropriate plant sizes. In view of its wide scope the study could also be considered as a general survey of the available energy resources in the country. The report of the study described the optimum electricity generation expansion programme for Java, which was determined for a high and a low load forecast.

The main findings of the study were as follows :

a. Installation of coal-fired plants would be the economic choice for the period 1980 - 1985. Hydroelectric power, oil-fired steam plants, gas turbines and diesel plants would continue to have a significant share in the installed capacity until 1985.

b. The first nuclear power station would be permitted by the mid - eighties. By using a low load forecast the introduction of the first 600 MW nuclear power unit is indicated in 1985.

c. For the period after 1990 the study indicated that the expansion of the power system would include a substantial capacity in nuclear power, apart from coal-fired generating stations.

It should be pointed out that the study was based on a number of assumptions, of which in the first place was the availability of vital reactor components in a free and open market. Furthermore the study did not consider such important constraints such as the availability of financing and skilled manpower required to undertake the projects being forecast.

The Nuclear Power Planning Study did stimulate a number of activities in the energy region. Most significant is the projection of a regenerate coal mining industry, while the development of a domestic uranium mining industry should be viewed in a much broader perspective. A feasibility study will be carried out shortly, which should give the final outcome on the exact timing of the first nuclear power station.

III.2. Electricity Demand.

The demand for electricity has been ever increasing during the last decade, especially on Java Island. In s of a progressive

construction programme of the PLN (State Electricity Enterprise), it is still not possible to fulfil the large demand for electricity. The current share of electricity in commercial energy consumption is rather small, it amounted to 8 percent in 1971 and 12 percent in 1975, but it is expected to rise in the near future. At the moment a significant part of the generated electricity stems from units outside the PLN, mostly from industries which operate their own diesel generating sets.

The results of the NPPS [3] give a low and a high forecast for the electricity demand on Java (see Table III). The figures between brackets show the minimum installed capacity, which is needed to fulfil the demand. The figures in the right column refer to an analytical study made by a PLN consultant. This study was mainly based on an actual demand for electricity as shown by waiting lists. [2]

TABLE III: PROJECTION OF DEMAND FOR ELECTRICITY ON JAVA ISLAND (in MW)

Year	N P P S		P L N
	Low	High	
1978	1 187	1 603	1 564
	(1 784)	(1 784)	(1 832)
1980	1 585	2 802	2 136
	(1 984)	(3 584)	(2 500)
1985	3 593	8 045	5 404
	(4 146)	(9 546)	(6 700)
1990	8 1[illegible]9	18 405	10 625
	(9 664)	(22 664)	(12 500)

IV. ENERGY ALTERNATIVES

IV.1. Oil as the major energy source.

More than 80 percent of Indonesia's oil is exported, while the domestic share of oil forms the major part (about 90 percent) of the total energy consumption in the country. It is not likely that for the next coming decade a radical change will take place in the situation; by 1985 the share of oil in domestic energy consumption may still amount to 80 percent.

If the increase in demand for the various petroleum products varies between 8 percent and 14 percent annually this would mean that in 1990 the country has to produce 1.2 million bbl/d solely to meet domestic requirements, which in 2000 may rise to 2.0 million bbl/d, unless the Government undertook a major diversification programme. It will be the task of a newly formed inter-departemental committee, the "National Committee for Inventorying and Evaluating National Resources", to give recommendations in this respect to the Government.

The country, notably the PLN, is faced with the problem of "suppressed demand", which has been described in Section III.2. More hydropower stations and a geothermal pilot plant will come into operation by 1980, but as pointed out before, these units will not be sufficient to meet the demand for electricity. It is therefore more likely that in these comming years more gas turbines and diesel units will be installed on Java, since the fuel oil is there. Steam generating units based on coal with a larger capacity (200 MW or more) will come into operation only in the beginning of the eighties, keeping step with the development of Batubara's coal mining industry in South Sumatra. In view of the lead time of coal exploitation it is most probable that

until 1985 electricity expansion units on Java will consist for the greater part of an energy mix of coal and oil.

IV.2. The Use of Coal in Generating Stations.

The NPPS has indicated that commissioning of coal fired plants in the beginning of the eighties would be the logical economic choice. The optimal expansion plan for the high load forecast contains three coalfired units of 400 MW each in both 1980 and 1981, one unit of 600 MW in 1982, followed by another 600 MW unit in 1983. By using the low load forecast, however, the expansion plan calls for 1 unit of 200 MW in 1981,1 unit of 400 MW in 1983 and 1 unit of 600 MW in 1986.

Table IV shows the annual requirements of coal imposed by the optimum generating system expansion programme for both the high and the low load forecasts. The column on the right gives the amount of coal, which has been allocated by Batubara, the state coal company , for coal fired generating plants, including those units which will be installed at mine mouth.

TABLE IV: COAL REQUIREMENTS ACCORDING TO NPPS, SCHEDULED COAL PRODUCTION (in 10^3 t)

(1) Year	(2) High	(3) Low	( ) Total scheduled production	(5) Allocated for coal-fired units
1980	2647	-	790	150
1981	4991	464	840	150
1982	6325	464	2580	1500
1983	6531	1346	2545	1500
1984	6749	1346	3155	2100
1985	6685	1346	NA	NA
1986	5286	2255	NA	Na

The figures in Table IV show that by using a high load forecast the supply of coal, as scheduled by Batubara, would not be sufficient to fuel the suggested coal-fired plants (compare column 2 with column 5). On the other hand, if a low projection is being used (see column 3), then the Batubara mines would be able to supply fuel through 1985, not only for the mine power stations but for the coal-fired units on Java as well.

IV.3. The Role of Nuclear Power.

The NPPS suggested the introduction of two 600 MW nuclear units in 1985 and 1986 respectively. The various factors which might cause postponement of their commissioning have been discussed in the previous chapter. In the event of a delay shortage of power during the period 1985 - 1988 could only be compensated by oil-fired plants, since the Batubara coal mines would not be able to supply an additional 3 million tons annually which would be at least required for two 600 MW coal-fired plants. Moreover the extra amount of coal would necessitate substantial enlargement of transportation and coal handling facilities.

Failure to add two 600 MW units to the electricity grid by the end of 1986 would mean, by observing the total installed capacity on Java at that time based on the low projection, that growth of electricity would decrease from 23.1. percent to 8.4 percent annually taking 1984 as the base year, and from 19,5 percent to 9.8 percent annually when taking 1983 as the base year.

According to a study of Chas.T. Main [7] relevant to the conditions in West and Central Java, a decrease in electricity growth rate of 9.7%-14.7% would correspond to a decrease of 2.9% - 4.4% in the growth of GDP.

Such a set-back would certainly create some constraints in the further economic development of Java particularly and of the remainder of the Indonesian Islands in general.

Construction of a 600 MW oil-fired unit, to replace nuclear, would create an extra financial burden. Apart from the loss in foreign ex - change earnings, a 600 MW oil-fired unit shows a differential fuelling coat of 15 mills/kWh, while the generating cost shows a figure which is about 8 mills higher than that for nuclear. In the calculation a price of US $ 40/lb yellowcake has been used. [4]

The preceding arguments may have demonstrated that a nuclear power unit of 600 MW capacity commissioned in the mid-eighties could be attractive for the island of Java, provided that the terms for financing are within the country's budgetary capabilities. Furthermore, in esta - blishing a nuclear power programme, (commissioning of the first unit would mean the first step only), it would be requisite to assure a con- tinous supply of the fuel. Here the condition prevails that drawing upon its indigenous resources would put a country closer to the realization of its nuclear power project.

The great challenge that currently faces the Government authorities associated with energy problems represents problems of wide character and dimension. In addition to the various constraints mentioned earlier one could also note the accessability to advanced technology. In the first instance this problem can be tackled by an effective and cordial interregional co-operation. It would be appropriate to state within this context that Indonesia is a devoted member of the ASEAN countries. But where economic and technological development are concerned one can- not abandon their universal feature. A triangular system of relations

between advanced technology in co-operation with the capital inflows from its own resources should be able to assist the country in narrowing the gap between rich and poor. Indonesia has demonstrated that such kind of technical co-operation is possible, with such examples as the oil industry and the interinsular satellite communication system, it should be workable also for the energy sector.

REFERENCES

1. SALIM, E., "The Direction of Economic Development of Indonesia in the Future", Economics and Finance in Indonesia 24 no. 4.(Dec.1976) 295.

2. BALQUNI,A., SUDARSONO, B. "First Steps towards a Nuclear Power Program: the Indonesian Experience and Prospects ", First Pacific Basin Conference on Nuclear Development and the Fuel Cycle, Honolulu, Oct. 1976.

3. INTERNATIONAL ATOMIC ENERGY AGENCY, "Nuclear Power Planning Study for Indonesia",Vienna (1976).

4. ILJAS, J., SURJADI, A.J.,"Nuclear Power Generating Costs and Comparisons with other Generating Costs for the 1980'S" Majalah BATAN (Journal of the Indonesian Atomic Energy Agency),8 no. 3 - 4,(Dec.1975) (in Indonesian)

5. World Coal. (Nov. 1976).

6. A Proposal for Investing in the Bukit Asam Coal Mine, P.N. Batubara and Shell Mijnbouw N.V. (June 1975).

7. Planning Study for the West Java and Central Java Interconnected Systems, Chas. T. Main International, Inc., Boston (Oct. 1974).