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A PROGRAM TO DEVELOP THE DOMESTIC NATURAL GAS INDUSTRY IN INDONESIA: CASE HISTORY OF TWO WORLD BANK PROJECTS

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ABSTRACT

Indonesia depends heavily on revenues from the export of LNG and oil, the availability of which appears to be decreasing. It is therefore making a strong effort to accelerate development of a domestic natural gas industry. A high priority has been given to the conversion of power plants and city gas systems, including local industries and commercial facilities, from liquid fuels to natural gas. This will release more oil for export, help to meet the objectives of Repelita V, and provide substantial environmental benefits. The World Bank recently provided loans to the Indonesian Government for two projects that are aimed at substituting natural gas for oil and manufactured gas in domestic markets. One project involves expansion of the gas distribution systems of Indonesia's natural gas utility (PGN) in three cities: Jakarta and Bogor in Java, and Medan in Sumatra. Approximately 350 new industrial, 800 new commercial, and 12,700 new residential natural gas customers are expected from this project. Incremental gas sales are projected to be about 54.3 million CF/d when the project is completed in 1992. The project also includes training programs for PGN staff and an energy pricing policy study to be carried out by Indonesia's Ministry of Mines and Energy. The second project involves expansion of the supply of natural gas for Surabaya and twelve other towns in its vicinity in East Java, and further expansion of Medan's supply system. The gas for Surabaya will be used for about 400 industrial and 150 commercial customers, and 3,600 households. The additional gas supply for Medan will be used for two power plants operated by the state electric utility, PLN. Incremental natural gas sales from this project are projected to be 68 million CF/d when it is completed in 1996, and to reach a total of 150 million CF/d by 2005. Technical assistance will be provided to enhance the skills of PGN and the Ministry of Mines and Energy, and a Gas Technology Unit similar to the Institute of Gas Technology will be established at Indonesia's Research and Development Center for Oil and Gas (LEMIGAS) in Jakarta.

A PROGRAM TO DEVELOP THE DOMESTIC NATURAL GAS INDUSTRY IN INDONESIA: CASE HISTORY OF TWO WORLD BANK PROJECTS

INTRODUCTION

From an energy perspective, Indonesia is a unique study in contrasts. It has an impressive history of hydrocarbon exploration spanning over 100 years, and has pioneered production-sharing contracts (PSC) with many international oil companies to develop Indonesian oil and gas resources (Chart 1). It has about 2 percent of the world's proved oil reserves (Table 1), and is the world's largest producer and exporter of LNG. Yet, Indonesia has a very low per-capita energy consumption level as illustrated by the data in Table 2 for the six countries that make up the Association of Southeast Asian Nations (ASEAN).*

Indonesia depends strongly on the export of oil and LNG as a source of revenue (Table 3 and Figure 1), and is therefore quite vulnerable to any major slowdown in the industrial world (3). The oil and LNG sectors have been critical to economic development. While comprising only about 20 percent of the gross domestic product (GDP), these sectors have contributed about one-half of foreign exchange earnings and about one-half of the Government's tax revenues (3). Before the fall in oil prices in the early 1980s, oil and LNG exports accounted for about 80 percent of the country's export revenues as shown in Figure 1 and 70 percent of the Government's revenues. Growth in GDP averaged about 7.5 percent per year in the 1970s through 1981 (3). Since then, annual GDP growth has been in the 3-4 percent range.

Indonesia is making a strong effort to open the domestic economy as much as possible to stimulate development and to absorb the two million new workers who join the labor force each year. Indonesia is depending heavily on the private sector to meet this challenge in its fifth 5-year plan (Repelita V, April 1, 1989 to April 1, 1994). The Government has emphasized industrial growth supported by a strong agricultural sector and has chosen a target of 5 percent growth per year in GDP.

Although the rate of domestic oil consumption is increasing slowly, oil production has decreased significantly since its peak in 1977 (Figure 2). Indeed, the availability of oil for export in the 1990s is expected to fall off sharply and may decrease to less than 100 million bbl/d by the end of this century (4). Some believe that Indonesia may even become a net importer of oil unless new reserves are found (3-7). One approach to this apparent dilemma is to displace oil with natural gas in domestic

*All monetary units used in this paper are in U.S. dollars unless stated otherwise.

Chart 1. A CHRONOLOGY OF SOME HIGHLIGHTS OF INDONESIAN GAS AND OIL RESERVES, PRODUCTION, AND EXPORTS 1871-1990

1871 - Search for oil initiated in West Java.

1885 - First commercial oil produced from Telaga Said in North Sumatra.

1911 - Oil production about 34,000 bbl/d in Java, Sumatra, and Kalimantan.

1930 - Associated gas reinjected for pressure maintenance in South Sumatra oil fields.

1940 - Oil production about 169,000 bbl/d.

1952 - Oil production resumes after revolution.

1958 - Gas reserves of about 6 TCF discovered in South Sumatra.

1960 - Three national oil companies established - PN Pertamin, PN Permina, and PN Permigan.

1964 - First production-sharing contracts (PSCs).

1965 - PN Permigan dissolved.

1966 - Four PSCs signed for onshore and offshore Java, Sumatra, and Kalimantan.

1966 - First exploration for gas in West Java resulting in reserves of about 2 TCF.

1966 - Offshore drilling started.

1968 - PN Pertamin and PN Permina merger forms PERTAMINA.

1971 - Arun field discovered in North Sumatra with nonassociated gas reserves of about 17.1 TCF.

1972 - Badak field discovered in East Kalimantan with nonassociated gas reserves of about 6.2 TCF.

1977 - First exports of LNG from Arun and Badak.

1977 - LPG plants completed onshore and offshore West Java and in East Kalimantan.

1977 - Initial discoveries made of gas in the Natuna offshore area in South China Sea with reserves estimated at 38 TCF.

1982 - Proved oil and gas reserves about 11.0 billion bbl (63.8 quad) and 90.0 TCF (90 quad).

1990 - Oil and gas production about 1.3 million bbl/d (2.8 quad/yr) and 4.7 billion CF/d (1.7 quad/yr).

1990 - Oil and LNG exports are about 255 million bbl/yr (1.5 quad/yr) and 20.5 million t/yr (1.08 TCF/yr, 1.1 quad/yr).

1990 - Oil and gas revenues account for about 40% of export revenue and 35% of state revenue.

1990 - 85 PSCs in operation.

Table 1. PROVED COAL, OIL, AND NATURAL GAS RESERVES FOR INDONESIA, THE FAR EAST, AND THE WORLD, 1989[a]

	Coal[b]		Oil		Natural Gas	
	10^6 Short ton	Quad[d]	10^6 bbl	Quad[f]	10^9 CF	Quad[h]
Indonesia	3,306	61.7	10,085	58.5	86,358	86.4
Far East	880,949[c]	19,743	44,054[e]	255	260,520[g]	261
World	1,791,631	38,554	967,248	5,610	4,080,876	4,080

[a]Source: IGT's archives, Energy Statistics, and gasLine®.

[b]Coal includes subbituminous, bituminous, and anthracite coals, and lignite.

[c]"Far East" includes China, India, Indonesia, Japan, Korea (North and South), Pakistan, Taiwan, Thailand, Vietnam, and unidentified others (minor reserves).

[d]World average heating values for subbituminous, bituminous, and anthracite coals assumed to be 24 x 10^6 Btu/short ton. World average heating value for lignite assumed to be 14 x 10^6 Btu/short ton.

[e]"Far East" includes Brunei, Burma, China, India, Indonesia, Malaysia, Pakistan, Philippines, Thailand, and unidentified others (minor reserves).

[f]World average heating value for oil assumed to be 5.8 x 10^6 Btu/bbl.

[g]"Far East" includes Bangladesh, Brunei, Burma, China, India, Indonesia, Malaysia, Pakistan, Thailand, and unidentified others (minor reserves).

[h]World average heating value for natural gas assumed to be 1,000 Btu/CF.

Table 2. SELECTED STATISTICS FOR ASSOCIATION OF SOUTHEAST ASIAN NATIONS[a]

	Indonesia	The Philippines	Thailand	Malaysia	Singapore	Brunei
Area[b]						
10^3 km^2	1,905	300	513	330	0.62	5.77
10^3 mi^2	735.5	116	198	127	0.24	2.23
Population, 10^6						
25-30 Years Ago	105	32	31	9.5	1.887	0.105
15-20 Years Ago	133	43	41	12.26	2.263	0.156
1989	178	61	55	17.34	1.684	0.249
Population Density, 1989						
Per km^2	93	203	107	53	4,330	43
Per mi^2	242	526	278	137	11,200	112
Gross National Product Per Capita, $ U.S.						
25-30 Years Ago	30	180	140	320	530	--
15-20 Years Ago	210	360	360	820	2,550	--
1989	500	700	1,230	2,160	10,450	14,220
Energy Consumption Per Capita, Barrels of Oil Equivalent Per Year[c]						
25-30 Years Ago	0.60	1.05	0.54	2.06	14.52	10.3
15-20 Years Ago	0.87	1.69	1.37	3.04	23.55	35.5
1989	1.41	1.58	2.16	5.06	29.08	48.8

[a]Adapted from Ref. 1.

[b]km^2 in Ref. 1 converted to mi^2 by 0.3861 multiplier.

[c]kg of oil equivalent converted to barrels of oil equivalent by 0.00656131 multiplier.

Table 3. INDONESIAN OIL, LNG, AND TOTAL EXPORT REVENUES, 1977-1990[a] (10^6)

Year	Oil	LNG	Total
1977	7,194	88	10,793
1978	6,900	535	11,094
1979	8,559	1,122	15,260
1980	13,423	2,281	21,784
1981	15,174	2,513	22,119
1982	12,405	2,641	18,924
1983	11,303	2,506	18,802
1984	11,756	3,470	21,002
1985	8,977	3,802	18,762
1986	5,167	2,805	14,628
1987	6,114	2,708	17,412
1988	5,755	2,539	19,998
1989	6,004	2,467	22,399
1990[b]	7,590	2,884[c]	23,330[d]

[a]Adapted from Table 8 of Ref. 2. Values are based on actual price.

[b]Provisional figures.

[c]Does not include November and December values.

[d]Does not include November and December values for LNG nor the December values for non-oil exports.

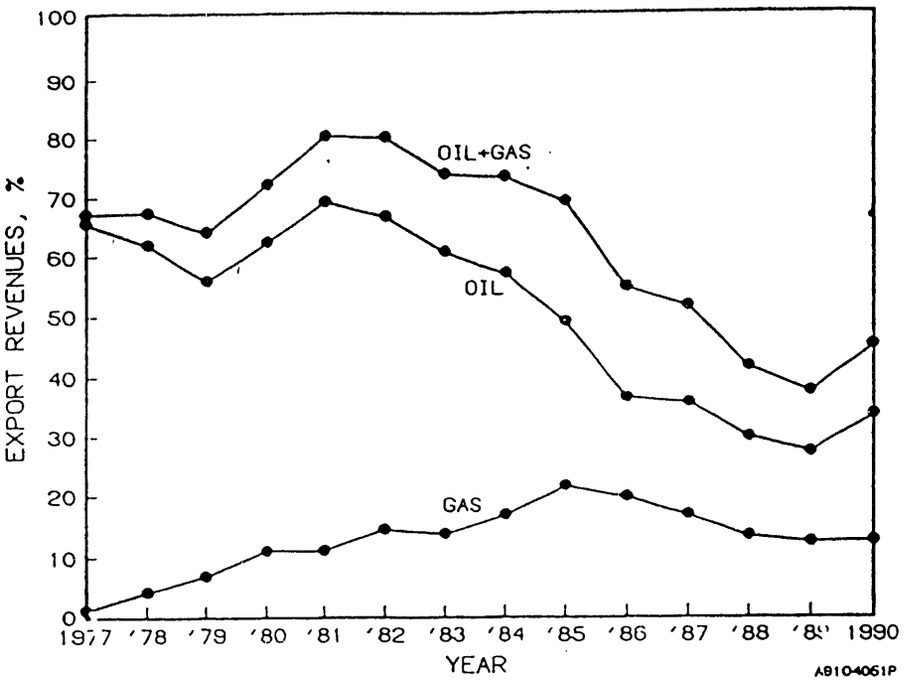

Figure 1. INDONESIA: OIL AND NATURAL GAS EXPORT REVENUES AS PERCENT OF TOTAL EXPORT REVENUES VS. YEAR
(Percentages calculated from data in Table 3)

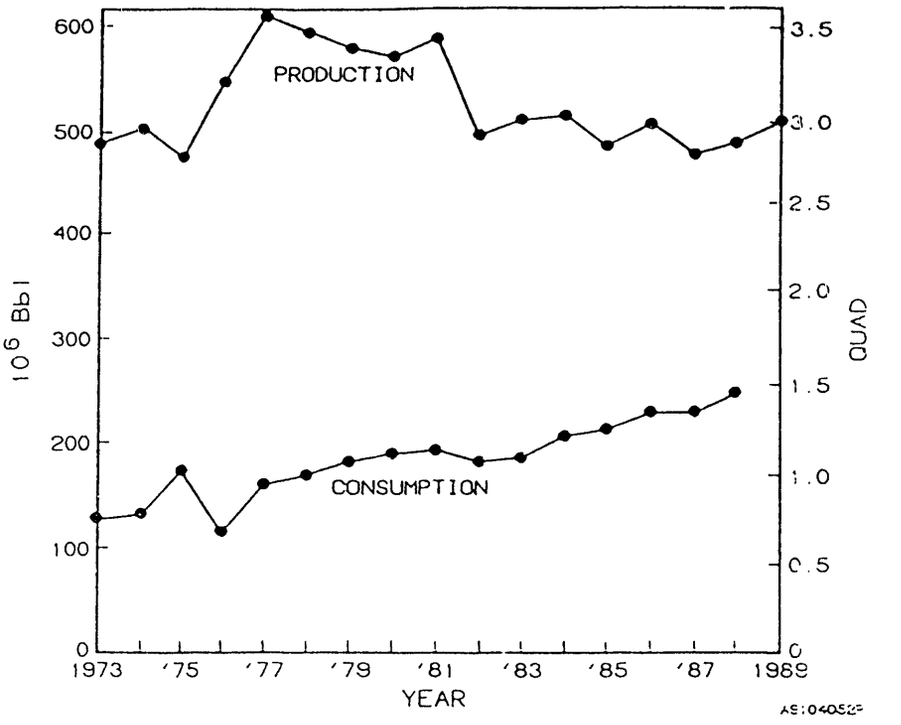

Figure 2. INDONESIA: OIL PRODUCTION AND CONSUMPTION FROM 1973 TO 1989

Source: IGT's archives, Energy Statistics, and gasLine®.
Production includes lease condensate, 1.0 bbl equals 5.8×10^6 Btu, 1.0 quad equals 10^{15} Btu.

applications where appropriate, since Indonesia's proved reserves-to-consumption ratios are considerably higher for natural gas (about 50 years) than for oil (about 20 years). This would release more oil for export to help maintain foreign exchange, help to meet the objectives of Repelita V, and provide substantial environmental benefits because of the clean-burning characteristics of natural gas.

The purpose of this paper therefore is to review the long-range program initiated by The World Bank (Bank) to assist in the development of Indonesia's domestic gas industry.

HISTORY OF MANUFACTURED AND NATURAL GAS UTILIZATION

Domestic Distribution

Manufactured gas from the gasification of coal was first introduced for city distribution in Jakarta in 1863, and subsequently in Surabaya, Bandung, and Ujung Pandang (8). After World War II, all gas plants were consolidated under a single Dutch company, N.V. OGEM, and oil progressively replaced coal as a feedstock. In 1958, OGEM's activities were nationalized and placed under a newly created state gas utility which was called Perusahaan Umum Gas Negara (PGN). As natural gas became available in West Java, several local distribution systems wholly or partially converted to natural gas: Cirebon in 1976, Jakarta in 1979, Bogor in 1982, and Medan in 1986; manufactured gas was still supplied to Bandung, Semarang, Surabaya, Ujung Pandang, and Medan. In 1986, PGN distributed both natural and manufactured gas in eight cities: Jakarta, Bogor, Bandung, Cirebon, Semarang, and Surabaya in Java, Medan in North Sumatra, and Ujung Pandang in Sulawesi (Chart 2). In fiscal 1984-85, PGN's sales were about 70 percent natural gas and 30 percent manufactured gas and totaled about 7.4 million CF/d (76.5 million m^3/yr). PERTAMINA, Indonesia's national oil and gas company, is the exclusive supplier of natural gas to PGN. PERTAMINA has also been supplying natural gas directly to fertilizer, cement, and steel industries in West Java and Sumatra.

Production, Consumption, and Export

The net production and domestic consumption of natural gas from 1973 to 1989 are illustrated by the curves in Figure 3. The difference between the two curves is approximately equal to the LNG exported by Indonesia. It is clear that growth in LNG exports was much higher than domestic natural gas consumption over this period, but the latter also increased somewhat. Current projections for LNG indicate that production and export will increase substantially. Annually, Indonesia currently exports about 18.7 million tons of LNG (2.7 billion CF/d avg.) to Japan, 2.2 million tons (320 million CF/d avg.) to South Korea, and 1.65 million tons (240 million CF/d avg.) to Taiwan, all under long-term, 20 year-agreements (7). Indonesia is also

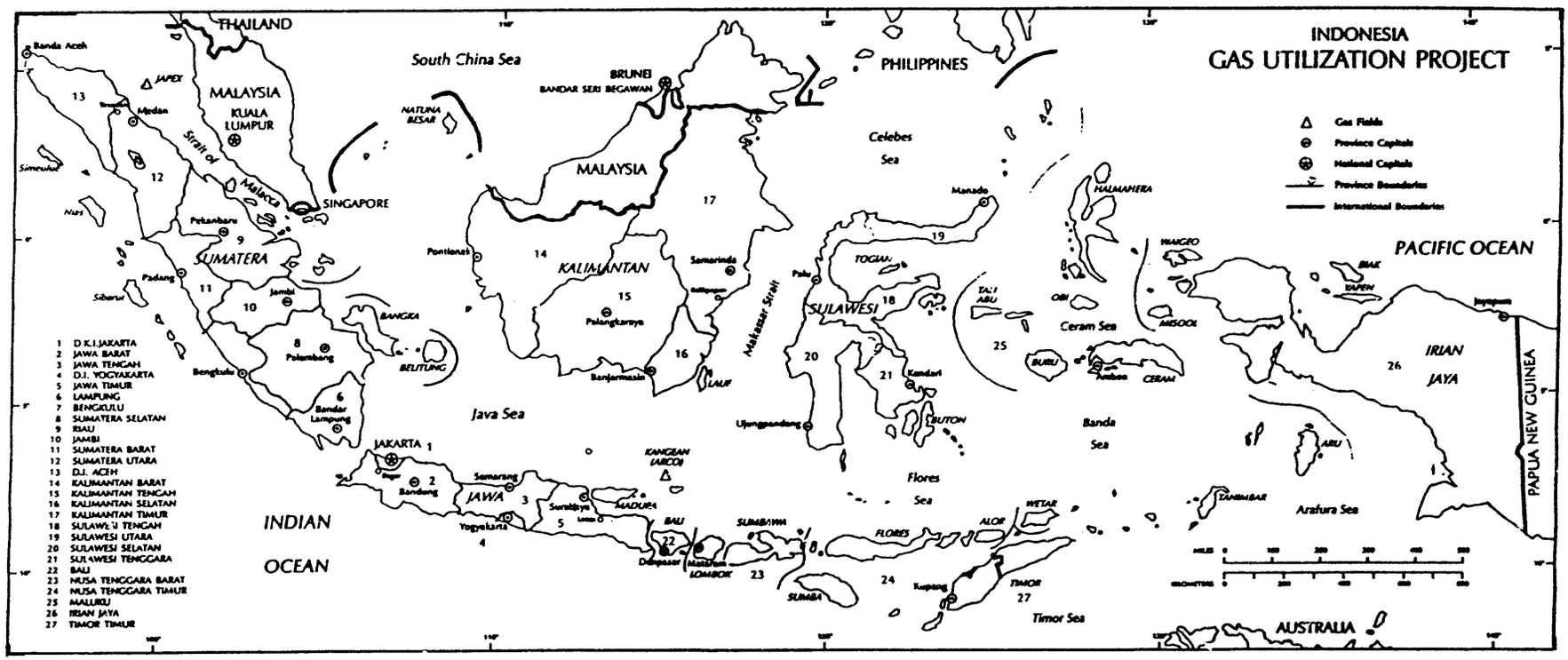

Chart 2. MAP OF INDONESIA SHOWING NATURAL GAS PRODUCTION AREAS AND CITIES INVOLVED WITH DISTRIBUTION AND SUPPLY SYSTEM EXPANSION

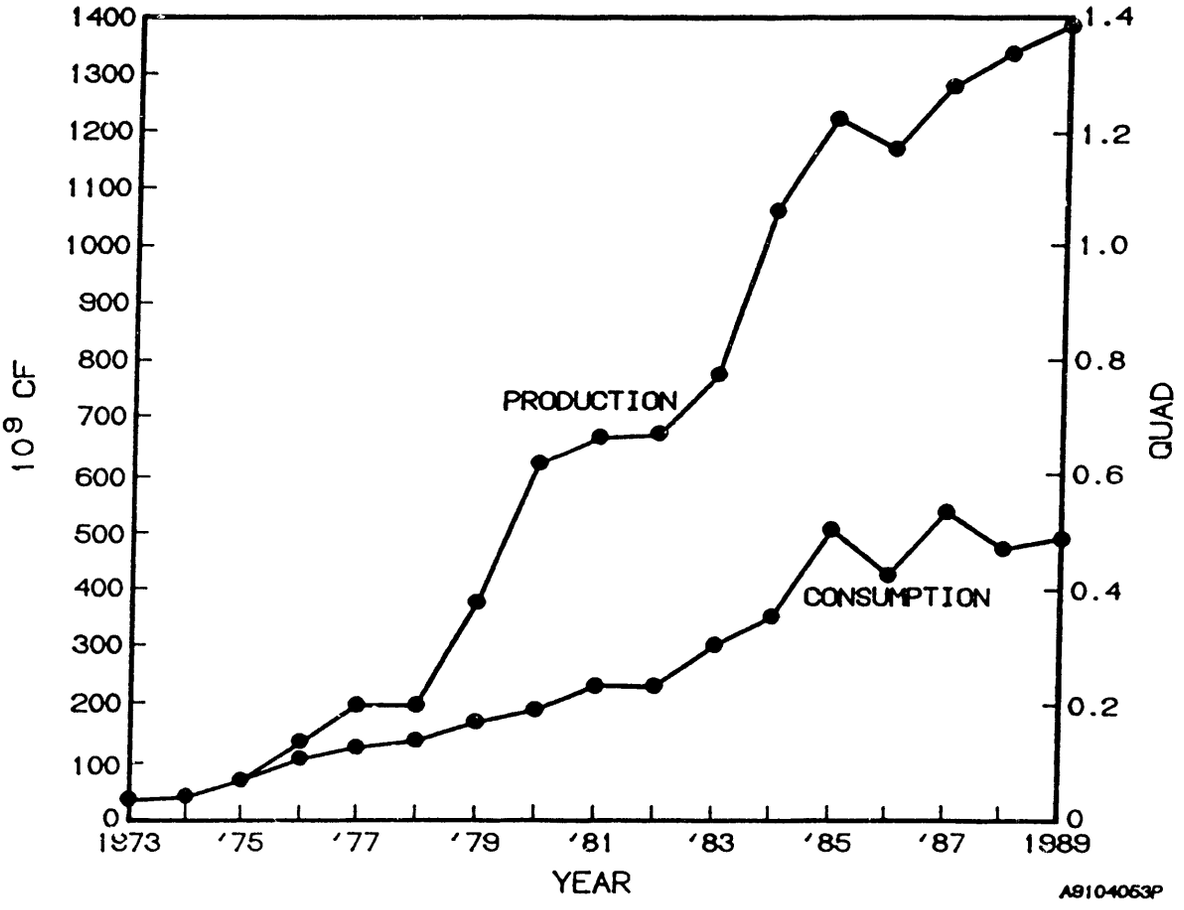

Figure 3. INDONESIA: DRY NATURAL GAS PRODUCTION AND CONSUMPTION FROM 1973 TO 1989

Source: IGT's archives, Energy Statistics, and gasLine®. Dry production equals gross withdrawals less gas used for reinjection into reservoirs for repressuring; gas flared, vented, or lost in transmission; and shrinkage. Consumption equals dry gas production minus exports. 1.0 CF equals 10^3 Btu, 1.0 quad equals 10^{15} Btu.

planning to build three more LNG trains of 2.5 million tons/yr each (370 million CF/d avg. each), which would bring total LNG production capacity to about 29.2 million tons/yr (4.23 billion CF/d avg.), and to transport natural gas by pipeline to Singapore at the rate of about 140 million CF/d (1.45 billion m^3/yr) from Indonesia's Natuna Sea Field (7). If the latter project is implemented, this would represent the first export of natural gas in non-liquid form by Indonesia.

Utilization by Sector

A more detailed breakdown of how natural gas production was utilized in 1985, 1986, and 1987 is shown in Table 4. After LNG, the largest application of natural gas was for the manufacture of fertilizer. It is apparent that the non-industrial use of natural gas in urban areas was very small and averaged only about 5 million CF/d (52 million m^3/yr) in 1987. This is quite unexpected, even though Indonesia is located in the tropics and has little need for space heating, because some of the highest population density centers in the world are the urban communities of Indonesia. For example, the national capital, Jakarta, which is located in Java, a territory about the size of England and where about two-thirds of Indonesia's 179 million people live, has a population of over 7 million people. Jakarta and other Indonesian cities would be expected to offer large ready-made commercial and residential markets for natural gas in addition to the growing industrial markets. But as is apparent from Table 4, conventional commercial and residential natural gas applications such as hot water, cooking, clothes drying, and air conditioning are obviously minimal. Natural gas utilization is very small relative to its economic potential in Indonesia.

Regarding electric power generation, gas-fueled systems have exhibited a high growth rate. The electric power sector is expected to undergo increases in installed capacity of more than 500 percent in the next decade, while a reduction in oil-fired capacity is expected to occur over the same period as shown in Table 5. It is noteworthy that even though natural gas fired, installed electric generating capacity is projected to be less than that of oil-fired installed capacity in 1999, the power output is greater for gas-fired systems. This is undoubtedly due to the higher efficiencies of the new combined-cycle, gas turbine power plants as compared to those of conventional steam plants (11).

Another interesting observation from the data in Table 5 is the large increase in installed capacity projected for coal-fired and hydro plants. The decision to build more coal-fired and hydro plants was made by the Indonesian Government in 1975-1977 to enable the state electric utility, Perusahaan Umum Listrick Negara (PLN), to diversify its fuel base and maintain a substantial reserve capacity in the 1980s (12). As shown in Table 1, Indonesia has

Table 4. INDONESIAN NATURAL GAS PRODUCTION AND UTILIZATION, 1985, 1986, 1987[a]
(10^9 CF)

	1985	1986	1987
Gross Production	1,580.0	1,628.9	1,732.1
Captive Use			
Gas Injection	253.7	245.7	249.7
Gas Lift	48.7	52.9	58.7
Fuel Gas	75.1	83.1	88.0
	377.5	381.7	396.4
Net Production	1,202.5	1,247.3	1,335.7
Sales			
Electricity	0.1	2.8	5.2
City Gas	1.3	1.3	1.7
Cement	1.0	2.1	2.7
Refinery Fuel	12.9	19.0	20.9
Cilamaya[b]	66.7	76.5	77.8
Fertilizer Plants	127.6	136.1	138.3
LPG Plants	47.1	41.0	24.5
LNG Plants	816.8	834.4	917.0
Others	0.1	0.2	0.3
	1,073.6	1,113.4	1,188.4
Flared	129.1	134.0	147.3

[a]Adapted from Ref. 9; 10^9 CF equals 28.32×10^6 m^3.

[b]Delivered to Kujang Fertilizer Plant, Krakatua Steel, Cibinong Cement, and city gas for Jakarta and Bogor.

Table 5. INDONESIAN ELECTRIC POWER CAPACITY AND OUTPUT BY ENERGY SOURCE, 1989 AND 1999[a]

	1989		1999	
	Installed, MW	Output, GWh	Installed, MW	Output, GWh
Coal	1,730	8,073	9,740	56,232
Oil	4,066	11,246	3,537	8,124
Natural Gas	576	1,453	2,972	13,694
Peat	0	0	22	150
Hydro	2,175	7,233	3,716	10,984
Geothermal	140	986	395	2,779
	8,687	28,891	20,382	91,963

[a]Adapted from Ref. 10. Figures for 1989 are "expected" and figures for 1999 are "forecast".

substantial proved coal reserves, and is also estimated to have 32,000 MW of proved hydro capacity (10).

Government Policies and Logistics

The position of the Government up until recently was that non-associated natural gas has a higher intrinsic value as LNG for export than as domestic fuel, while associated gas has been used mainly for oil field maintenance. Because of this philosophy, a suitable infrastructure that would facilitate transmission and distribution of natural gas to markets within the country has not been installed. Another factor that has hindered development of domestic natural gas markets is geography. Indonesia consists of 13,677 islands, including the five main islands of Sumatra, Java, Kalimantan, Sulawesi, and Irian Jaya (Western New Guinea), and extends over about 3,000 miles (about 5,000 km) of tropical seas. This distance exceeds the distance between California and Florida. The locations of natural gas production and markets and the fact that modern delivery systems are not in place have presented significant barriers to the development of a domestic natural gas industry. Simply stated, these obstacles must be overcome to stimulate the growth of domestic natural gas utilization.

PGN has been limited in its role as Indonesia's natural gas distributor because of the age and disrepair of large portions of its distribution system and the difficulty of obtaining natural gas from PERTAMINA in quantities needed to meet customer demand. For example, gas leakage from corroded pipelines was reported to be widespread and resulted in gas losses of about 30 percent of sales volume (8). Apart from creating hazardous conditions, gas leakage resulted in a substantial loss of revenue. Modern gas distribution systems usually have leakage rates that are much less than 1.0 percent of gas usage. An extensive program of repair, maintenance, and modernization was therefore necessary to update the system and make it capable of economic operation. These aspects are being addressed in the on-going gas distribution project; gas losses due to leakage have already been reduced to 5 percent of gas usage.

Regarding PGN's natural gas supply, it should be less of a problem in the future because of the Government's recent decision to accelerate development of gas reserves in Java and some areas of Sumatra and to give high priority to the conversion of power plants and city gas systems, including local industries and commercial facilities, from liquid fuels to natural gas. This decision resulted from gas utilization studies to evaluate the potential of domestic natural gas markets and a review of Indonesia's natural gas policy (8).

DISTRIBUTION SYSTEM IMPROVEMENT

Role of The World Bank

The Bank has been involved in Indonesia's natural gas sector since 1981 when the Bank's Energy Assessment Report concluded that alternative energy sources could be developed economically to replace domestic oil consumption to conserve oil reserves for export. This study was followed by additional studies in 1984 and 1985 for natural gas utilization and city gas distribution which supported the policy of developing large-scale domestic markets for natural gas as a substitute for oil. The Government's decision to give natural gas a major role in its energy diversification strategy is based in part on these studies. The studies supported a policy that expansion of natural gas' domestic markets would complement LNG exports, fertilizer production, and other large-scale industrial applications, but that its implementation would require institutional and policy changes.

This initial effort resulted in the first gas sector project that involved the Bank and that had the objective of effecting institutional changes and policy modifications to facilitate the penetration of natural gas into the domestic economy. The specific objectives of this first project were: a) To encourage the use of natural gas by constructing new gas distribution facilities, b) To replace and/or rehabilitate portions of PGN's existing distribution system where needed, c) To build up the managerial and technical capabilities of PGN to plan and implement distribution system expansion and operate it efficiently and cost effectively, d) To establish standards on which to base future distribution system expansion or the creation of new systems, and e) To support the Government's efforts in the review and modification of energy policy, particularly with regard to energy pricing.

In addition to supplying funding to implement the project, the Bank played a key role in initiating the project by promoting the necessary degree of Government support, by assisting PGN in all steps of project preparation, and by direct participation in many other essential activities to ensure successful project completion. These activities included providing technical and business guidance to PGN on such issues as marketing targets, optimum operating conditions, customer assistance on conversion to natural gas, and the "twinning" of PGN with an established gas utility to help achieve the project's institution-building objectives. The concept of "twinning" has been eminently successful during the course of the project.

Project Description

This project involves the detailed design and construction of extensions to PGN's gas distribution networks in three cities - Jakarta and Bogor in Java, and

Medan in Sumatra (Chart 2). The existing systems served only limited areas of each of these cities, generally providing mixed gas to domestic consumers, and supplying only a few industrial customers. New supply lines to industrial and commercial areas and local distribution networks are included in the project. Specific items include design services, construction of distribution pipelines, regulator stations and customer meter stations, and installation of monitoring systems whenever economically justified. Installation of supply and feeder lines is included to nine areas of industrial and commercial concentration in the three cities along with substantial local networks. PGN's existing distribution networks are being upgraded to adequate standards whenever economically justified. The project also includes training programs for PGN staff and an energy pricing policy study which was recently completed by Indonesia's Ministry of Mines and Energy.

The expansion of the gas transmission and distribution systems in this project includes the installation of:

- 135 miles (218 km) of high-pressure transmission pipelines and supply mains including cathodic protection.
- 332 miles (535 km) of medium-pressure polyethylene distribution pipelines.
- 10 Pressure-reducing stations and odorizing units.
- Service lines and meter stations for an initial core group of approximately 350 new industrial, 800 new commercial, and 12,700 new domestic customers.
- A meter-maintenance workshop and telecommunication, pressure, and flow-monitoring systems.

Project Costs, Financing, and Schedule

The total project cost was estimated to be $86 million of which about $47 million was foreign exchange. The Bank provided $34 million. Details of the estimated costs of this project and the sources of funds are shown in Table 6.

The project is expected to be completed over a 6-year period ending in 1992. The projected schedule of pipeline construction and customer conversion is summarized in Table 7.

Project Benefits

In addition to the long-range benefits to Indonesia of expanding the domestic natural gas industry and diversifying its national energy strategy, there are several localized benefits on successful completion of this project. Regarding gas applications in the cities affected by the project, they consist primarily of industrial and commercial markets which will substitute natural gas for fuel and

Table 6. ESTIMATED COST AND FINANCING SUMMARY FOR NATURAL GAS DISTRIBUTION SYSTEM IMPROVEMENTS IN JAKARTA, BOGOR, AND MEDAN, TECHNICAL ASSISTANCE, AND TRAINING[a]

Project Component	Estimated Cost, 10^6		
	Local	Foreign	Total
Distribution Systems			
Jakarta	10.4	9.7	20.1
Bogor	2.6	2.2	4.8
Medan	2.6	2.3	4.9
Network Upgrading Other Cities	0.8	1.5	2.3
	16.4	15.7	32.1
Technical Assistance	--	3.0	3.0
Training	--	0.5	0.5
Equipment	--	1.5	1.5
Customer Conversion	2.6	13.8	16.4
LPG and Energy Pricing Studies	--	1.2	1.2
Taxes and Duties	11.9	--	11.9
	14.5	20.0	34.5
Physical Contingencies	3.1	3.6	6.7
Price Contingencies	5.4	7.3	12.7
	8.5	10.9	19.4
Total Project:	39.4	46.6	86.0
Funding Source			
The World Bank	--	34.0	34.0
Bilateral Assistance	--	3.8	3.8
PGN Internal Cash Generation	6.5	--	6.5
Government of Indonesia	18.3	--	18.3
Commercial Loans	10.4	--	10.4
Customers	4.2	8.8	13.0
Total Project:	39.4	46.6	86.0

[a]Adapted from Ref. 8.

Table 7. PROJECTED SCHEDULE OF PIPELINE CONSTRUCTION AND CUSTOMER CONVERSIONS FOR NATURAL GAS DISTRIBUTION SYSTEM IMPROVEMENTS IN JAKARTA, BOGOR, AND MEDAN[a]

Fiscal Year	Pipeline Construction, miles (km)	Additional Customers[b]		
		Industrial	Commercial	Residential
1987	25 (40)	0	0	0
1988	162 (261)	30	50	400
1989	129 (207)	60	100	1,250
1990	102 (164)	70	180	2,150
1991	50 (81)	114	260	3,800
1992	0	79	210	5,100
	468 (753)	353	800	12,700

[a]Adapted from Ref. 8.

[b]Additional customers include a substantial number to be connected as a result of on-going expansion work prior to this project.

diesel oils, and to a lesser extent, LPG and kerosine. The gas sales at the start and completion of the project are illustrated in Table 8. Industrial, commercial, and residential natural gas sales in the three cities are projected to increase by factors of about 27, 3, and 2, respectively.

The fuel demand in Jakarta, Bogor, and Medan is such that about 45 percent of the natural gas utilized is expected to serve as a substitute for fuel oil, 43 percent for diesel oil, 5 percent for LPG, and 5 percent for kerosine in the industrial and commercial sectors. Natural gas will be used for generating process steam and as a source of heat in such industries as textiles, printing, and food processing, and in the manufacture of glass, ceramics, chemicals, and fabricated metals. Commercial customers include office buildings, hotels, restaurants, and small businesses. The market surveys undertaken during project preparation indicated that there is a large potential industrial demand for natural gas, particularly in Jakarta, as well as a large untapped demand by small and medium-size commercial establishments. However, although the total number of residential customers served by PGN in the three cities on initiation of the project was only 7,500, large-scale increases in residential service were not included in this project because of the low economic return, except in high population-density areas, the disproportionate share of administrative and managerial requirements relative to total sales, and the antiquated residential networks. Upgrading service to residential customers was therefore limited to selective replacement of existing piping and service to new customers in high-density areas adjacent to industrial and commercial service lines.

The environmental benefits of increased natural gas usage are well established because of the clean-burning characteristics of natural gas relative to those of coal and oil (13). Emissions of CO, NO_x, and SO_x are low and therefore natural gas substitution for other fossil fuels results in less smog and acid rain. In addition, the repair and replacement of gas piping and other equipment will reduce gas leakage substantially thereby contributing to a safer environment.

The financial benefits of meeting the project's objectives are significant due to incremental gas sales, which were forecast to increase by 54.3 million CF/d (561 million m^3/yr) in the three cities by fiscal 1992 (8). The incremental natural gas sales for fiscal 1992 were estimated to be $62.1 million (Rp 102.1 billion, avg. of 1,644 Rp/$) in Jakarta, Bogor, and Medan. And PGN's rate of return on net fixed revalued assets is estimated to be 13 percent. At the start of this project, natural gas prices were about 15 percent less than those of fuel oil and diesel fuel, the principal fuels for which natural gas will substitute, and were midway between the prices for kerosine and LPG. It was recommended by the Bank that this relationship be maintained to help provide incentives for conversion to natural gas.

Table 8. ESTIMATED NATURAL GAS SALES AT START AND COMPLETION OF SUPPLY SYSTEM IMPROVEMENTS FOR JAKARTA, BOGOR, AND MEDAN[a]

	Gas Sales, 10^6 CF/d (10^6 m^3/yr)[c]							
	Industrial		Commercial		Residential		Total	
Jakarta								
Start	0.5	(5)	1.6	(16)	0.4	(4)	2.4	(25)
Completion	32	(335)	3.5	(36)	0.9	(9)	37	(380)
Bogor								
Start	1.1	(12)	0.06	(0.6)	0.06	(0.6)	1.3	(13)
Completion	5.4	(56)	0.7	(7)	0.2	(2)	6.2	(64)
Medan								
Start[b]	0.05	(0.5)	--		0.1	(1)	0.2	(2)
Completion	8.2	(85)	0.3	(3)	0.3	(3)	8.8	(91)
Total								
Start	1.7	(17)	1.6	(17)	0.6	(6)	3.9	(40)
Completion	46	(476)	4.5	(46)	1.3	(14)	52	(535)

[a]Adapted from Ref. 8. Project started in 1988 and completed in 1992.

[b]Manufactured gas before 1986.

[c]Sales reported as 10^6 m^3/yr. In this table, figures may not add due to rounding.

The use of gas in small and medium-size industries in West Java, for example, is expected to yield a netback value to the country of up to $5/MBtu, depending on the type of industry, as compared to netback values of about $2.50/MBtu in the cement industry and $2.40/MBtu in power plants. The estimated gas supply cost is $1.50/MBtu at the city gate. This project provides the necessary infrastructure for continued expansion of the domestic gas industry. Jakarta, Bogor, and Medan were chosen as project sites because of the availability of natural gas in each area. Other cities that PGN serves are supplied with manufactured gas, which is more expensive than natural gas and prevents expansion outside the residential sector.

It should be emphasized that the project is expected to have a large impact on the economic future and stability of Indonesia, especially if the domestic natural gas industry continues to grow toward its full potential. The principal economic reasons for investment in this project are the cost savings and generation of foreign exchange by substituting non-exportable surplus natural gas for exportable petroleum.

Project Participants

In addition to Government agencies, the Bank, PGN, and PERTAMINA, several other organizations have been involved in implementing the project. Included among them is British Gas plc as the "twinning" consultant.

FOLLOW-UP PROJECT

The success of the first Bank-funded project in the gas sector to modernize the distribution systems in Jakarta, Bogor, and Medan resulted in a second project to accelerate the substitution of exportable petroleum fuels in domestic consumption with non-exportable natural gas. This project is a follow-up to consolidate the gains made in the first project. The specific objectives were: a) To assure a supply of natural gas, at competitive prices, to power plants, manufacturing industries, and commercial facilities in Surabaya and its vicinity in East Java and further expansion in Medan in North Sumatra, b) To provide for the integration of gas utilization plans and operations to achieve economies of scale in the development and operation of the gas supply infrastructure, and c) To provide for institution building, technology transfer, and marketing studies to accelerate safe and efficient utilization of natural gas and to help define its long-term development plans.

The Bank is again playing a key role in project implementation, as it did in the first project, and is also providing the majority of the funding.

Project Description

This project involves the detailed design and construction of gas transmission and distribution networks in Surabaya and Medan. The system for Surabaya includes the city and twelve other towns in East Java within 62 miles (100 km) of Surabaya. The gas will be used for power generation, manufacturing industries, and commercial facilities, as well as for households.

The additional expansion of the Medan system involves installation of a high-pressure transmission pipeline from Wampu to Payapasir to supply additional gas to two power stations operated by PLN at Payapasir and Belawan.

Technical assistance will also be provided to enhance PGN's skills and implementation of its expansion project, to upgrade the skills of the Directorate General of Oil and Natural Gas, Ministry of Mines and Energy (MIGAS), and to establish a Gas Technology Unit (GTU) similar to the Institute of Gas Technology at Indonesia's Research and Development Center for Oil and Gas Technology (LEMIGAS). Feasibility studies for natural gas marketing will also be performed for marketing natural gas in Palembang, South Sumatra; Jambi, Central Sumatra; Batam Island, Riau; and Balikpapan, Kalimantan.

Expansion of the natural gas system for Surabaya and the surrounding area consists of the installation of:

- 50 miles (80 km) of high-pressure transmission pipelines.
- 118 miles (190 km) of medium-pressure steel pipelines.
- 103 miles (165 km) of medium-pressure polyethylene pipelines.
- 5 Gas-metering, pressure-regulating, and odorization stations.
- 4 Pressure-reducing stations.
- Service lines and pressure-regulating and flow-metering stations for 375 medium-size industries, 150 commercial/facilities, and a paper mill in Leces.

In addition, a manufactured gas distribution system that supplies 3,600 households in Surabaya will be rehabilitated for distribution of natural gas.

In Medan the expansion consists of installation of:

- 15 miles (24 km) of high-pressure transmission pipelines and associated cathodic protection.
- 3 Pressure-reducing stations.

- Service lines and pressure-regulating and flow-metering stations for two PLN power plants.

Apart from the expansion of infrastructure, the building of institutions to sustain the growth and to ensure efficient utilization of natural gas is a key component in this project. In the first project, PGN is being transformed into a modern gas utility through a Bank-designed long-term technical collaboration ("twinning") with British Gas, and an Energy Pricing Policy Study to provide a basic framework to promote the efficient use of fuels. In this project, the Government plans to develop and institutionalize Indonesian expertise to promote safe and efficient gas usage through the establishment of the GTU, to provide for long-term planning and growth management of the gas utility business by enhancing PGN's capabilities, and to provide for coordination of development and planning in the gas sector and improvement of gas safety regulation by upgrading the capabilities of MIGAS.

The formation of the GTU within LEMIGAS will enable it to assist MIGAS in carrying out the task of developing codes, standards, and regulatory procedures for the domestic gas industry. The GTU will also assist the Government in the coordinated development and regulation of the gas industry. The main functions of the GTU will be to develop standards and codes of practice, appropriate to the Indonesian environment, for all activities, infrastructure, materials, and equipment involved in the transportation of natural gas and its usage; to perform studies and research in gas utilization, interfuel substitution, and energy conservation for suppliers, distributors, and users; to conduct analyses of fuels and materials for efficient gas utilization and environmental protection; and to be directly involved in human resource development and the collection and dissemination of technical information.

Initial support for the GTU will be provided by the Bank, but after the GTU is established, operating and capital budgets must come from the Government, industry, and the fees generated by the users of the GTU's services.

Project Costs, Financing, and Schedule

The total project cost was estimated to be $119 million of which about $99 million was foreign exchange. The Bank provided $86 million. Details of the estimated costs of the project and the sources of funds are shown in Table 9. The Bank loan became effective on April 4, 1991.

The project is expected to be completed over a 5-year period ending in 1996. The projected schedule of pipeline construction and customer conversions is summarized in Table 10.

Table 9. ESTIMATED COST AND FINANCING SUMMARY OF NATURAL GAS SUPPLY SYSTEM IMPROVEMENTS FOR SURABAYA AND MEDAN, TECHNICAL ASSISTANCE, AND ESTABLISHING A GAS TECHNOLOGY UNIT[a]

Project Component	Estimated Cost, 10^6		
	Local	Foreign	Total
Supply Systems			
Surabaya	9.2	59.2	68.4
Medan	2.6	3.5	6.1
	11.8	62.7	74.5
Technical Assistance			
PGN	0.5	8.1	8.6
LEMIGAS	1.3	7.5	8.8
MIGAS	--	0.5	0.5
	1.8	16.1	17.9
Marketing Studies	--	0.3	0.3
Physical Contingencies	2.2	4.0	6.2
Price Contingencies	1.4	8.0	9.4
Interest During Construction	2.5	8.0	10.5
	6.1	20.3	26.4
Total Project:	19.7[b]	99.1	118.8
Funding Source			
The World Bank	--	86.0	86.0
Bilateral Assistance	--	5.0	5.0
PGN Internal Cash Generation	9.7	--	9.7
Government of Indonesia	10.0	8.1	18.1
	19.7	99.1	118.8

[a]Adapted from Ref. 9.

[b]Includes $11.0 million in taxes and duties.

Table 10. PROJECTED SCHEDULE OF PIPELINE CONSTRUCTION AND CUSTOMER CONVERSIONS FOR NATURAL GAS SUPPLY SYSTEM IMPROVEMENTS FOR SURABAYA AND MEDAN[a]

Fiscal Year	Pipeline Construction, miles (km)		Additional Customers Connected in Surabaya[b]	
	Surabaya	Medan	Industrial	Commercial
1992	62 (100)	15 (24)	30	--
1993	80 (129)	--	50	--
1994	45 (72)	--	70	50
1995	44 (71)	--	90	50
1996	37 (59)	--	135	50
	268 (431)	15 (24)	375	150

[a]Adapted from Ref. 9.

[b]No additional customers are listed for Medan because the gas will be an additional supply to an existing power plant.

Project Benefits

The long-range benefits from this project apply equally as well to Indonesia as those of the first Bank-funded gas distribution project started in 1988. The local benefits are also apparent. In the Surabaya area, PGN's market at the start of the project was limited to distribution of manufactured gas and LPG to 38 small industrial and commercial customers and 3,572 domestic customers in downtown Surabaya. Gas sales in fiscal 1989 consisted of 0.2 million CF/d (2.1 million m^3/yr) of manufactured gas to industrial and commercial customers and 1,290 tons of LPG to domestic customers. There were about 3,000 industries and commercial facilities that used oil in the Surabaya area at the start of the project, of which 340 medium-size industries and 150 commercial facilities accounted for about 70 percent of total demand. These have been targeted for conversion to natural gas in this project. There is also a large paper mill at Leces about 50 miles (80 km) southeast of Surabaya that would like to convert from fuel oil to natural gas. As a result of this project, natural gas sales in the Surabaya area are projected to increase from an average of about 10 million CF/d (103 million m^3/yr) in fiscal 1994 to 90 million CF/d (930 million m^3/yr) in fiscal 2005.

In Medan, PGN currently supplies natural gas to about 100 medium-size industrial and commercial customers, 2,000 households, and PLN's power plant at Payapasir. The industrial, commercial, and household customers are PGN's, while the PLN power plant is PERTAMINA's customer. PGN is paid a carrying charge by PERTAMINA for transporting gas to the power plant. In fiscal 1990, PGN's average gas sales to its customers and PLN's power plant were 5 million CF/d (52 million m^3/yr) and 30 million CF/d (310 million m^3/yr), respectively. The projected increase by fiscal 1993 because of this project is 60 million CF/d (620 million m^3/yr) including 48 million CF/d (496 million m^3/yr) for the power plant. The PLN power plants will remain PERTAMINA's customers and PGN will be paid a carrying charge for gas transport.

The estimated natural gas sales at the start and completion of this project are shown in Table 11. The natural gas sales are estimated to be 103 million CF/d (1,065 million m^3/yr) by the end of the project in 1996, and are projected to increase to 150 million CF/d (1.6 billion m^3/yr) by 2005. The netback value of natural gas in Medan was discussed for the "three-cities" project. In Surabaya, the use of natural gas by small and medium-size industries is about $4.10/MBtu compared to an estimated supply cost of $1.50/MBtu. For power generation, the netback value for gas is estimated to exceed $3.00/MBtu relative to a plant using industrial diesel oil.

Table 11. ESTIMATED NATURAL GAS SALES AT START AND COMPLETION OF SUPPLY SYSTEM IMPROVEMENTS FOR SURABAYA AND MEDAN[a]

	Gas Sales, 10^6 CF/d (10^6 m^3/yr)[b]			
	Industrial-Commercial	Paper Mill	Power Generation	Total
Surabaya				
Start	0	0	0	0
Completion	23 (238)	20 (207)	0	43 (445)
Medan				
Start	5 (52)	--	30 (310)	35 (362)
Completion	12 (124)	--	48 (496)	60 (620)
Total				
Start	5 (52)	0	30 (310)	35 (362)
Completion	35 (362)	20 (207)	48 (496)	102 (1,065)

[a]Adapted from Ref. 9. Project started in 1991 and completed in 1996.

[b]Average gas sales.

Project Participants

Various Government agencies, the Bank, PGN, and PERTAMINA are again involved in implementing the project as well as several other organizations. British Gas plc is the "twinning" consultant and the Institute of Gas Technology, which has completed a planning study on the structure of the Gas Technology Unit for LEMIGAS, will serve as consultant for this facility and for training.

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