UNITED STATES DEPARTMENT OF COMMERCE
International Trade Administration
Washington, D.C. 20230

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DEPARTMENT OF COMMERCE
OFFICE OF BASIC INDUSTRIES
Washington, D. C. 20230

Dear Ben Bonk:

The Department of Commerce Office of Basic Industries, Office of Energy Coal Staff, has prepared this report on the Korean coal market for the United States representatives to the United States-Korea Energy Subgroup.

Although its main focus is coal for both metallurgical and power generation applications, it does cover Korea's overall energy picture. It has been edited to include the latest revisions of the Fifth Five-Year Economic and Social Development by the Ministry of Energy and Resources.

Sincerely,

Gary Anderson

Gary Anderson
Acting Deputy Assistant Secretary for
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KOREAN COAL MARKET

by

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Office of Energy, Basic Industries
Trade Development
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U.S. Department of Commerce

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TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF TABLES

KOREAN COAL MARKET

1.0 INTRODUCTION

Korea has shifted from an almost exclusive reliance on indigenous energy resources in the early 1960s (almost 90 percent of total supply) to a dependency on imports, 75 percent in 1982, which will increase to 82 percent by 1986. Korea's oil imports are now a much larger share of imports than they were during the early 1970s, 25 percent in 1980, compared to 6.3 percent in 1970,[1] leaving Korea vulnerable to the vagaries of the world oil market.

Initially, Korea handled the supply disruptions and price increases in 1973 and 1979 by rapidly increasing exports and building up import substitution industries. The onset of the global recession in late 1979, mounting domestic inflation, and other internal difficulties, sharply reduced Korea's ability to maintain oil-import-generated external debt at reasonable levels.

Growing at an annual rate of about 25 percent per year between 1972 and 1980,[2] the external debt level reached over $35 billion by 1980. Currently, Korea spends over $6.5 billion, approximately one third of Korean export earnings, or 10 percent of the country's gross national product, on imported oil.

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[1]Economic Planning Board, Republic of Korea, The Fifth Five Year Economic and Social Development Plan 1982-86. (Seoul: September, 1981).

[2]Corazon Morales Siddayao, Asia's Energy Security: The Role of Demand and Supply Restructuring. (Honolulu, Hawaii: Resource Systems Institute, East-West Center, September, 1982).

Changes in the Korean industry and economy are likely to worsen this financial exposure. Korea's growth originated in less energy-intensive, light industries, but the present focus has shifted to more energy-intensive industries. Furthermore, reducing oil imports by cutting back on gasoline use offers little hope, since the Korean transport sector consumed only 14 percent of all energy demand in 1980.

At the same time, changing economic conditions in the oil-supplying countries of the Middle East have foreclosed another of Korea's traditional methods of financing oil-related external debt. In the 1970s, Korea paid for much of the increased costs of oil imports by building very large industrial projects in the Middle East. Faced with drastic cutbacks in world oil demand, the oil suppliers have greatly reduced their rate of industrialization. Many of these Korean projects have been completed or terminated.

Korea's future development will depend on the success of its policy of diversification away from oil to nuclear power and imported steam coal as the major energy supplies for the 1980s and 1990s.

Except for anthracite, Korea has no proven petroleum, bituminous coal, or natural gas reserves. Coal plays an important role in the Republic of Korea's economy, largely because it is the most widely used fuel for domestic space heating. Coal is Korea's only known fossil-fuel resource, as well as its single largest mineral product. Since 1973, coal production has increased significantly, but coal consumption has increased at an even faster rate. In the future, Korea will have to import large quantities of coal to meet its energy goals.

2.0 ENERGY BALANCE

2.1 ENERGY DEMAND

2.1.1 Energy Demand

During the 1950s, Korea's economy grew very rapidly, maintaining that high level into the 1960s. The average GNP growth rate increased 8.7 percent between 1962 and 1980.[1] Per capita income grew (in constant 1980 prices) by approximately 7 percent per year,[2] or by over 300 percent in total.[3]

The nearly 20 percent annual growth of the industrial sector between 1970 and 1980 was responsible for much of Korea's GNP expansion. During this same period, exports rose by 18.8 percent per year, accounting for 30 percent of total GDP by 1980.

The rapid growth in the economy led to crude oil imports of some $5.6 billion in 1980 (25 percent of total imports). This figure was larger than the total negative balance of trade of $4.8 billion in that same year.[3]

The four-fold increase in total energy consumption between 1965 and 1980 was brought on primarily by the rapid growth of Korea's industrial sector. This sector's consumption of Korea's total energy grew from 20 percent in 1965 to 47 percent in 1975, to 48 percent in 1980 (sixty-two percent fueled by petroleum).

In 1961, the "mining and manufacturing" sectors generated 10.4 percent of GNP, while "agriculture, forestry and fishing" generated 43.2 percent.[3] By 1980, "mining and manufacturing" had increased to 30.7 percent and "agriculture, etc." had declined to only 16.9 percent.[4]

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[1]Economic Planning Board, Republic of Korea, The Fifth Five Year Economic and Social Development Plan 1982-86. (Seoul: September, 1981).

[2]Argonne National Laboratory, Republic of Korea/United States Cooperative Energy Assessment, Main Report Vol. I. (Argonne National Laboratory: September, 1981).

[3]World Energy Industry, The Energy Decade, 1970-1980, (Cambridge, Mass: Ballinger Publishing Company, 1982).

[4]Korea Development Institute, Long-Term Prospect for Economic and Social Development 1977-1991. (Seoul, Korea: 1978).

Table 2-1

REPUBLIC KOREA: COMMERCIAL ENERGY BALANCE, 1980 (mtoe)

	Oil	Coal	Gas	Electricity	Total	% of Total
Industry	9.9	4.4	-	1.6	15.9	48
Transport	4.7	-	-	-	4.7	14
Household/ Commercial	3.4	8.8	-	0.8	12.9	38
Total Final Comsumption	18.0	13.2	-	2.4	33.6	

Source: Resources for the Future estimates based on Korea Energy Research Institute. Joy Dunkerley, August 12, 1982.

Recently, this shift to more energy-intensive industrial production has been compounded by a shift within the "manufacturing" sector away from less energy-intensive "light industry" toward even more energy-intensive."heavy and chemical" industries. In fact, Korea's overall energy demand grew faster than GNP during 1961-1979.

The transport sector's consumption grew from 10 percent in 1975 to 14 percent in 1980 -- a reflection of the small geographic size of the country and the limited use of personal transport.

In 1975, household and commercial uses of energy for heating and cooking stood at 35 percent. The sector's share of energy consumption has declined sharply in the past 15 years, although there was a positive growth rate in energy use of five percent per year as total energy use increased rapidly.

Economic growth continued uninterrupted through the oil shock of 1974, but at a lower rate). The break came in 1980, when GNP declined by about 6 percent (constant prices).[1] Part of this decrease was probably due to the oil price rise of 1979, but a poor harvest also contributed. In 1981 and 1982, however, the Korean economy returned again to a vigorous economic growth--approximately 6 percent per year.

The very large growth in energy demand in Korea in the past several decades is the result of rapid expansion in industrial production. Energy requirements for the other sectors grew much more slowly and reflect, in part, the slow rate of population growth.

Table 2-2
Composition of Primary Energy Consumption
(000 toe)

	1965	1973	1974	1978	1979	1980
Total Primary Energy Consumption	12,117	25,964	26,821	37,470	44,227	45,700
Commercial Consumption	6,973	22,292	23,296	34,432	41,335	43,000
Oil	1,513	14,139	14,532	22,560	26,410	25,400
Coal	5,274	7,817	8,264	10,788	13,487	15,900
Gas	--	--	--	--	--	--
Electricity	186	337	500	1,083	1,437	1,700
Traditional	5,144	3,672	3,525	3,038	2,892	2,700

Source: Republic of Korea, Resources for the Future, Joy Dunkerley, August 12, 1982

[1] Economic Planning Board, Republic of Korea, The Fifth Five Year Economic and Social Development Plan 1982-86. (Seoul: September, 1981).

2.1.2 Energy Demand Projections

Economic growth rates, energy-use intensity, and energy prices are the most critical factors in projecting future energy energy demand.

In the next decade, analysts expect that industrial consumption of total primary demand (TPD) to increase to over 60 percent of the total energy demand, while residential requirements will decline sharply as a portion of total requirements.

Buoyed by 10 percent GNP growth projections for the rest of the 1980s, Korea envisioned a 7.0 annual growth in energy demand during that period. Despite continuing economic growth in the early 80s, however, the government's efforts to conserve energy and enhance energy productivity reduced the rate of increase in energy consumption.

Table 2-3
Five-Year Economic Development Plan:
Energy Demand among Consumer Sectors

	1975		1986		1991	
	MMmtce	%	MMmtce	%	MMmtce	%
Total Primary Demand (TPD)	39.2	100.0	111.8	100.0	180.0	100.0
Of which:						
Industrial	18.2	46.5	68.2	61.0	112.5	62.5
Transportation	4.1	10.5	15.1	13.5	27.7	15.4
Residential	13.8	35.2	20.9	18.7	28.1	15.6
Other	3.1	7.8	7.6	6.8	11.7	6.5

Source: PACE

Table 2-4

Five-Year Economic Development Plan:
Korean Energy Resource Mix

Source	1980 Share (%)	1986 Share (%)
Oil	61.2	50.2
Coal	29.9	33.6
Hydro and Nuclear	3.1	10.8
LNG/LPG	-	3.0
Firewood	5.7	2.4
Total	100	100

In January 1983, the Korean Ministry of Energy and Natural Resources (MER) revised its energy plan to correspond to the remaining period (1984-1986) of the amended Fifth Five-Year Economic and Social Development Plan. MER lowered its estimate of average annual growth in energy consumption from 7.0 percent to 5.2 percent until 1986.

MER's revised estimates lowered the average annual rate of increase in national energy consumption between 1984-86 to 5.2 percent from 7.8 percent, including that of anthracite coal to 0.7 percent from 2.8 percent and that of total electric power generation to 9.9 percent from 11.1 percent, while increasing that of bituminous coal to 15.3 percent from 13.4 percent.

Accordingly, Korea's energy dependency on crude oil will drop from 56.8 percent of total energy requirements in 1983 to 50.9 percent in 1986, and anthracite coal from 20.1 percent to 17.4 percent. Dependence on bituminous coal will rise from 12.5 percent in 1983 to 16.8 percent in 1986, and nuclear power from 4.5 percent to 9.2 percent.

Along with this projection, MER readjusted investment plans in the energy sector. MER severely cut down it oil refinery expansion plan from an original expansion of 210 thousand barrels per day by 1986 to 60 thousand.

Based on a 7.0 percent per year economic growth rate in 1984-1989, and a 6.0 percent per year economic growth rate in 1989-2000, analysts still expect overall energy demand to grow at an average rate of 4.8 percent per year from 1980 to 2000.

The recent revisions by the Ministry of Energy and Resources and the changes in the Korean economy have prompted many analysts to issue their own projections. In addition to estimating the rate at which Korea will shift from non-commercial fuels, the analysts had differing views on MER's interpretation of key economic factors:

- current assessment of future rates of change in real world oil prices;
- GNP growth rates for Korea at future time periods;
- shifts in the GNP contributed by the various economic sectors; and
- shifts in the types of activities conducted within each of the producing sectors.

Table 2-5
Selected Projections of Korean Energy Consumption
(millions of tons oil equivalent)

				% Increase			Assumed GDP	Energy Elasticity
	1980	1986	1991	1980-86	1986-91	1980-91	Growth Rate %	1980-91
Korea Development Institute (KDI)	40	71	114	10	10	10	10 7.0(1986-91	1.00
Fifth Five year Plan (FYP)	40	61	n.a	7.3	n.a	n.a	7.6(1981-86	0.96
Kim: Korea International Economic Institute (KEI)	40	60	83	7.0	6.7	6.9	8	0.86
Korea Energy Research Institute (KERI)	40	63	92	7.9	7.9	7.9	8	0.99
Asian Development Bank (AD)	40	56	70	5.8	4.6	5.2	8	065
Resources for the Future (RFF)	40	58	74	6.4	50	5.8	6.9	0.85

Note: Includes non-commercial fuels (1980 = 2 mtoe) but excludes energy for non-energy p
rposes.

The consensus was that by about 1990, the share of oil (all still imported) will decline significantly, non-commercial fuel use will become unimportant, gas will enter the fuel supply market, coal will provide an important but declining share of energy supply, and the production of electricity will have grown very rapidly.

All the new projections begin with a standardized 1980 base of 40 mtoe (60 mtce). Differences among projections are due entirely to the different assumptions about GDP growth rates and energy electricity. Other key variables will be the share of energy used as electricity, the rate at which shifts are made from non-commercial to commercial fuels, and price levels for energy and their impact on encouraging conservation in energy use.

Comparing the projections, the high KDI estimate of 114 mtoe (171 mtce) results from the high estimate of GDP growth rates (10 percent per year). FYP, KIEI and KERI estimates for 1986 are close at about 60 mtoe (80 mtce), but lower than KDI's due to a GNP growth rate of 8 percent per year.[1] By 1991, the differences in energy elasticity estimates turn out to have a significant effect on projected consumption estimates--83 mtoe (124 mtce) for the KIEI estimate and 92 mtoe (138 mtce) for KERI.

The later estimates of the Asian Development Bank (ADB) and RFF factored in the impact of the 1979-80 worldwide recession on economic growth and of the world oil price increase of 1979. ADB used an 8 percent growth rate (compared with RFF's 6.5 percent), but a much lower energy elasticity (0.65 compared to RFF's 0.85). This resulted in very similar estimates of energy demand in 1991, 70 mtoe (105 mtce) for the ADB and 74 mtoe (111 mtce) for RFF.

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[1] Reducing KDI's growth rate from 10 percent per year to 8 would reduce the 1986 forecast to 63 mtoe (104 mtce).

In projecting demand for the year 2000, most analysts use an economic growth rate of seven to eight percent annually for 1983-1989, and an annual rate of six to seven percent for the 1989-2000 period.

Table 2-6

Korean Energy Demand - Year 2000[1]
(metric tons of coal equivalent)

GNP Growth Rate %	Energy Elasticity	
	1.0	0.85
6	192	163
7	231	196

The year 2000 projections range from 163 to 231 mtce. Taking into the account the difficulties of reducing energy elasticity to an average of 0.85 over this 20-year period and of maintaining an average economic growth rate as high as seven percent per year, the most probable range of projected demand as 180 to 195 mtce.

[1] Base year 60 mtce in 1980.

2.2 ENERGY SUPPLY

2.2.1 Energy Supply

Until the 1960s, Korea was mainly dependent on indigenous energy resources with about 90 percent of the demand supplied by coal (44%), noncommerical fuels (42%) and primary hydro-electricity (1.5%). Hydroelectric resources of Korea are comparatively small. Installed capacity in 1978 was 711 megawatts out of an ultimate capacity of 3000 megawatts.[2] The 711 megawatts of installed capacity only provided six percent of total electricity supply in 1978 and even full development of the hydropower resources would only make a minor contribution to total energy supply.

Non-commercial energy supplies (largely wood) have been of great importance to Korea in the past and their contribution is still significant, although it is a rapidly declining share of energy supply. In 1965, non-commercial fuels provided about 42 percent of total fuel consumption but declined to only six percent in 1980.[1] In spite of this sharp decline in the share of energy provided by non-commercial fuels it is still equivalent to 2.7 millions tons of oil equilvalent and its use represented a savings in oil imports of $0.5 billion in 1980. The use of non-commerical fuels, however, will continue its decline in the share of total energy consumed, although prospects for other types of renewable resources may become attractive in the decade of the 1990's.

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[1]Anthony Edwards, "Oil Imports of Developing Countries--Forecast to 1995," The Economist Intelligence Unit, (London: July 1982).

[2]Asian Development Bank, Asian Energy Problems, (New York: Praeger Publishers, 1982), p.84.

2.2.2 Energy Supply Projections

Table 2-7

Energy Supply Projections
(percentage)

	Year	Hydro & Nuclear Power	Anthracite & Bituminous Coal	Non-Commercial	Oil	Gas
Actual Energy Supply	1980	3.7	34.5	6	55.8	--
5th Five-Year Plan	1986	10.8	33.6	2.4	50.2	2.8
Korean Energy Research Institute	1991	19.3	11.4-13.5 24.9	3.7	41.5	10.6
Asian Development Bank	1990	37.3	18.0	2.3	35.1	7.2
Resources for the Future	1990	25.9	11.3-13.4	1.2	47.2 to 49.5	6.0
Cooperative Energy Assessement - Argonne Labs	1990	24.0 31.2	22.3-8.9	2.0	41.6	1.1
Economist's Intelligence Unit	1990	33.7	16.3	0.6	36.3	3.0

Sources: Calculated and estimated from data given in References in Table 4 of "Oil Imports and Developing Countries: Forecast to 1995, Anthony Edwards Economist, Intelligence Unit, 1982;" and "Republic of Korea/ United States Cooperative Assessments," Prepared by Argonne National Laboratory, September 1981.

The differences in absolute values of the energy supply projections as to the share of different fuels reflect differing weights attached to economic growth factors and to the degree of commitment to changing the fuel mix. All the projections call for massive increases in the amount of electricity that will be used (mostly produced from nuclear fuels), but there are major differences in exactly how much it will contribute to energy supply.

By 1990, most analysts believe that gas will still be only a small part of Korea's energy supply, differ as to the exact amount, the date of the initial LNG imports, and the rate of development for the associated infrastructure and markets. The differences in coal's share stem from differing assumptions about policy decisions, the intensity of the reliance on coal imports, and the emphasis to place on domestic coal production. Argonne's projection of the high coal share is based on the expected commericalization of synthetic oil and gas production from coal by 1990. Finally, all forecasts show a marked decline in oil's share, indicating a general agreement that Korea must shift from imported oil to maintain its high economic growth rate.

2.2.3 Energy Import Projections

Most fuel supply projections show large volumes of energy imports, depending on the level of energy use and the actual share that each fuel form will contribute. Korea will import all oil, natural gas and uranium at least until the early 1990s, with the amount of imported coal depending on the rapidity and extent of domestic coal production. The 1980 base and typical set of import requirements for 1986 and 1991 are shown below:

Table 2-8

Energy Imports
(mtoe)

	1980	1986	1991
Oil	25.0	32.0	47.3
Coal	6.3*	6.1**	6.2***
Primary Electricity (nuclear fuel)	0.8	4.2	7.4
TOTAL	32.1	42.3	60.9

*) Total use 15.9 mtoe; domestic production 9.6 mtoe
**) Total use 16.1 mtoe; domestic production 10.0 mtoe
***) Total use 16.2 mtoe; domestic production 10.0 mtoe

Analysts project energy imports to double between 1980 and 1991. Despite all efforts to minimize oil imports, analysts also anticipate them increasing about 85 percent. The effect of such a high import level on the economy is difficult to assess, although the financial requirements are obviously very large. The most complete analysis of the economic impact of high levels of energy imports on developing countries was made by the Economist.[1]

[1] Anthony Edwards, "Oil Imports of Developing Countries--Forecast to 1995," The Economist Intelligence Unit, (London: July 1982).

2.3 ENERGY POLICY

In January 1983, the Korean Ministry of Energy and Natural Resources (MER) revised its energy plan to correspond to the remaining period (1984-1986) of the amended Fifth Five-Year Economic and Social Development Plan (1982-86). Initially, the Fifth Five Year Plan envisaged a near doubling of total energy demand in the 1982-86 period. The Plan called for electric power demand to increase at an annual rate of 11.1 percent, but Korea's economic difficulties made attainment of this goal unlikely. Consequently, MER lowered its estimate of average annual growth in energy consumption from 7.0 percent to 5.2 percent until 1986.

Facing an increasing external debt for oil imports, the government designed a policy to cut back on oil imports, making it unlikely that Korea will build any additional oil-fired electric power plants. The basic components of this policy are:

- substitution for oil (coal, nuclear and LNG);
- diversification of supply sources;
- development of limited domestic energy sources, and
- conservation.

These principles aim to decrease the dependence on oil while maximizing the use of coal, promoting conservation, and stablizing crude oil use. In addition, the government has adopted economic and other national initiatives, supportive of these general energy objectives. These initiatives have recognized two time frames, over which energy issues must be resolved. These are:

- energy issues that need attention over the short term -- about five years -- to assure that other national goals can be attained -- economic growth, environmental protection social and welfare equity, etc.; and

- new policies that must be put into place immediately to ensure the orderly transition from oil-based imports to nuclear, coal and renewable resources and to reduce intensity of energy use per unit of GNP.

2.3.1 DIVERSIFICATION OF ALL ENERGY SUPPLY SOURCES

Diversification of energy supply sources minimizes the economic impact of any supply interruptions, is a strong incentive to individual suppliers to avoid interruptions, and helps to maintain effective competition among supply sources.

Korea now imports about 70 percent of its imports in the form of oil, about 20 percent as coal, along with small quantities of uranium oxide. Opportunities for diversification of energy growth imports include increasing the volume of fuels other than oil, and increasing the number of regions and countries from which oil and other energy resources are imported.

2.3.1.1 Oil

All of the oil imported by Korea to date has originated in the Persian Gulf states, although there has been some change in the shares supplied by different countries in that region during the past ten years. To increase the security of their critical oil reserve, Korea looks to participation in exploration for oil and gas resources abroad (e.g., Indonesia) and the diversification of oil supply sources. Joint ventures, if successful, provide greater assurance of reliable supplies. However, both the stockpile policy and the joint ventures for oil and gas appear to be only in the serious discussion stage rather than an established Korean government energy policy.

To broaden the oil import base, Korea negotiated contracts for oil with Nigeria, Mexico and Ecuador. Although the initial contracts were small (less than 100,000 bbl per day total) they represented the first step away from complete reliance on Persian Gulf oil. Further expansion in the size of the contracts can be expected in the future.

2.3.1.2 Uranium

The use of uranium fuel to produce electricity is a recent development in Korea, with first commercial electricity generated in 1978. Korea has identified 13 million metric tons of uranium reserves with a average grade of 0.04 percent of U_3O_8. This grade ore is expected to be mineable at between $80 and $130 per kilogram, or nearly double the cost of uranium oxide produced commercially in other countries.

Until recently Korea made no attempt to diversify its uranium import sources, In 1983, however, Korea signed a contract with France for the fuel for the two reactors acquired from France. In addition, to assure a stable supply of enriched uranium and to use it safely, the government entered into cooperative arrangements with the International Atomic Energy Agency for procuring up-to-date technical information and training nuclear engineers.

However, access to indigenous resources is not important in decisions relating to the use of nucluear fuels. Fuel costs represent only a fraction of the cost of producing electricity in nuclear plants and means of enriching the fuel, a complex and expensive process, is necessary before it can be utilized. Therefore, the uranium resouces of Korea are not an important issue in the decision to use uranium, at least for the balance of this century.

2.3.1.3 Liquefied Natural Gas

Gas is now produced in Korea by naphtha reforming but only small quantities are used. Korea Electric signed a contract with Indonesia in the summer of 1983 for the purchase of 2 million metric tons per year of LNG for a period of 20 years, starting in the 1985 to 1987 period. This will be the first LNG imported and will be used first for power generation. This will require development of an extensive infrastructure for transporting, receiving and vaporizing the LNG. Markets for the gas do not exist and will have to be developed. The government is considering policies to encourage the use of LNG (and possibly LPG) for use in heating, hot water and cooking in the residential sector. Government policies would also be necessary to ensure the use of LNG or LPG as an automotive fuel to replace gasoline, if that proves to be feasible.

2.3.1.4 Diversification Financing

As in Japan, Korea's offical policy of promoting oil substitution is linked to a wider policy of improving the reliability and security of both domestic and overseas energy supply sources for both economic and national security reasons. A principal instrument of this policy is finance.

The Export- Import (EXIM) Bank, a government-financed bank, will provide up to 70 percent of the long-term finance needed by Korean comapnies to participate in overseas ventures in which there is a significant component of supply to Korea. EXIM's financing activities cover several commodities but coal ventures account for the major proportion in money terms.

Another government-financed body, the Korean Mining Production Company (KMPC) will, like NEDO in Japan, provide up to 80 percent of the finance required for exploration and feasiability studies both for domestic and overseas mining ventures. The terms which KMPC is itself financed allow it to pursue a more risk-taking line than the EXIM Bank.

2.3.2 SUBSTITUTION FOR OIL

In accordance with its energy policy to reduce dependency on imported oil, the Korean Government plans to increase the use of the following energy sources in addition to coal:

2.3.2.1 Nuclear Power

Korea's nuclear development is more a matter of policy than price, and there is virtually no opposition to its use. The use of nuclear energy for power generation will expand rapidly. Even though indigenous uranium resources will not be used, the cost of the fuel is relatively small and stockpiling is so simple that it offers nearly the same benefits to Korea as indigenous fuels use, with respect to diversity and security of supply.

There should be no serious problems in providing greatly increased quantities of nuclear generated electricity. As of January 1, 1981 there was one 587 megawatt nuclear generating unit in operation, with eight additional units (total capacity 4,179 megawatts) under construction. The government has also awarded the contracts for construction of Nuclear Units 9 and 10, due to become operational in 1985.

The Korean Electric Company's 1980 annual report projected that 40 nuclear units will be operational by 2,000. Accordingly, the government anticipated that two more nuclear plants per year would come on stream (each 425 megawatts) in 1985, 1987 and 1989. However, the government postponed putting out tenders for Nuclear Units 11 and 12 for one-year. Most analysts believe a 2 to 3-year postponement is more likely.

There is no indication that the government has taken the necessary steps to ensure the effective use of the large quantities of electricity which these plants will produce. In fact, the government is now reconsidering its entire decision to proceed at this rapid pace in constructing nuclear plants, causing the delay in Units 11 and 12.

2.3.2.2 Liquefied Natural Gas (LNG)

The Korean Electric Power Company (KEPCO) and Indonesia signed a contract in 1983 for the purchase of 2 million metric ons of LNG for a period of 20 years. This was the first LNG import contract. KEPCO will have 350 MW of LNG-fired capacity on-line by 1991. The government is also considering policies to encourage LNG (and possibly LPG) for home heating, hot water, and cooking, including provisions for the infrastructure required to deliver LNG to consumers and the equipment that can utilize it.

The greatest percentage increases in rate of growth for nuclear power will occur in the early 1980s, while coal's most rapid growth will occur in the late 1980s. The use of oil will grow at approximately the same rate as total primary energy demand (TPD) through the mid-1980s and then gradually decline relative to TPD growth.

2.3.2.3 Renewable Resources

In the longer term, there is potential for the economic utilization of renewable resources. This includes solar, wind, biomass, ocean and small scale hydro-power. To make renewables commercial in a reasonable time-frame, the government would have to identify the resource base for each energy source. After an evaluation, the govenment would have to demonstrate a feasible technology for the resource's use. The final step would entail its promotion through financial incentives. Potential policies to stimulate the more rapid development of these renewable resources, could include:

- Increased taxes on oil derived fuels;
- Financial incentives (e.g., tax credits) for use of renewable resources;
- Low cost credit to residential consumers for using renewable resources;
- Modification of the current electricity pricing structure of excess power generation;
- Reduction of import surcharges on renewable resource utilization equipment; and
- Economic incentives of total manufacturing facilities for renewable resource utilization equipment.

2.3.3 DEVELOPMENT OF DOMESTIC ENERGY SOURCES

Korea announced its intention to reduce its oil imports partly through the increased use of domestic resources. The three currently used indigenous energy resources are non-commercial energy, hydroelectric power and coal. There is an outside possibility of the development of domestic oil and gas reserves.

2.3.3.1 Non-Commercial Resources

Non-commercial resources can be expected to continue to decline in importance and, for a variety of economic, environmental and social reasons, the government has adopted no policies to reverse or prevent this continuing trend.

2.3.3.2 Hydroelectric Power

The relatively few sites available for economic development in Korea limit the expansion of hydroelectric power. Installations are planned for the remaining sites but these are capital-intensive projects and investments must be made only after establishing "opportunity costs" for other energy options.

2.3.3.3 Offshore Oil and Gas

Although Korea produces no oil or gas, the government supports private sector exploration, alone or in joint ventures with private industry and/or other governments. The objective is to establish the potential for offshore oil and gas development. The government needs a policy of leadership and assistance if the potential of such resources is to be realized.

2.3.3.4 Coal

Domestic coal production (anthracite) is contributing a declining but important share of Korean energy supply. With the difficult geologic and mining conditions, poor quality coal and limited domestic reserves, government assistance is needed for the increased production and use of this domestic energy resource. Planned or actual government policies in this area include:

- Permitting an increase in the price of coal and a gradual elimination of subsidies that keep coal prices to the consumer low. The objective is to stimulate private investments in new mines and to rationalize government investments in coal production.

- Assisting producers in adopting new mining machinery and techniques, in importing advanced mining equipment and encouraging the expansion of larger, more efficient mines. Government domonstration of the use of new mining equipment and support of R & D on new mining techniques have been initiated.

- Investing government funds in the infrastruicture needed for coal transportation and coal distribution so that coal can compete more effectively with imported oil in power plant and industrial markets.

- Establishing vocational schools for training coal mining technicians.

- Introducing more generous and widely distributed welfare programs for miners and the mining community to assure continued availability of more labor.

- Supporting government geologic surveys and investigations leading to discovery of new coal resources and identification of reserves that can be currently exploited.

- Assisting in the necessary R & D and demonstration of technology developed abroad to utilize coal more efficiently and cleanly and in its conversion to liquid and gaseous fuels.

2.3.4 CONSERVATION

The issue of energy conservation was seriously addressed only last year, but it is unlikely to be pursued at the expense of continued economic and industrial expansion. Nevertheless, Korea's oil import reduction policy anticipates demand management of energy use. To cut back overall energy demand, the government has slowly increased coal prices (on a gradual basis to preclude economic disruptions).

Korean industry is considered by many to be very energy-inefficient. For industrial energy conservation to grow, a significant amount of work must be done in:

- installation of new boilers and process equipment, and
- education of industry about comprehensive energy management.

The government is now encouraging less energy-intensive industries, such as electronics and machinery. But the de-emphasis of some high energy consumers, such as the fertilizer industry, will not extend to others, including Korea's most internationally competitive industries, e.g. steel-making. Moreover, as per capita GNP grows so will the energy requirements for the residential and commercial sectors.

Other conservation methods which the government has considered include:

- Energy consumption tax;
- Tax exemptions and financial support for energy saving technologies;
- Dissemination of conservation information to consumers;
- Training of electricity users to reduce peak demand;
- Prohibition of power use by large electricity consumers at peak periods;
- Expansion of public sector transportation;
- Price adjustments and taxes to encourage purchase of small rather than large cars (to reduce gasoline consumption);
- Maintenance of relative prices of fuels to encourage use of fuels other than imported oil;
- Regulations to restrict energy use for specific purposes (e.g., neon signs, T.V. transmission);
- The specification of fuels for specific end-uses (e.g., coal in cement manufacture).

The government has also investigated the possibility of reducing the use of gasoline through the imposition of highway user fees, high vehicle license fees, lower rail rates, and very high parking fees. Other indirect methods for increasing the efficiency of energy use include improving traffic movement and road quality and encouraging better vehicle maintenance. At the macroeconomic level, the government has been invetigating how to continue GNP growth rates while shifting the economic structure toward less energy-intensive industries.

3.0 COAL DEMAND

The role of coal as an energy source in Korea is expected to increase in the next decade. Along with parallel plans for nuclear power and LNG, the government is presently considering a plan calling for 15 percent of Korea's total industrial energy to be generated by coal by 1991. While this will require much more study and research, successful implementation could increase coal demand by an additional six million tons annually by 1991.

Coal is the only energy resource present in Korea in significant amounts. Unfortunately, as Korean coal has declined in quality and in quantity, it has become more difficult to mine. Thus, as with other energy sources, in the foreseeable future Korea must look beyond its borders for most of its coal supply.

In Korea, there are four coal end-use sectors: the utility industry, the cement industry, the steel industry, and home heating and cooking.

3.1 COAL END-USERS

3.1.1 Power Generation

The largest demand for steam coal will come from Korea's electric utilities. Virtually all electric generating capacity is owned by the government-owned Korean Electric Power Company (KECO). In the 1960s, electricity use was largely confined to the industrial and commercial sectors. As the government implemented the nationwide rural electrification program in the 1970s, household use increased as well.

To meet the increased demand for electricity, the government took the following strategic steps:

- Curtailed construction of oil-fired plants.
- Converted some existing oil-fired plants to coal and LNG, which should be fully operational by 1986.
- Continued an ambitious policy of nuclear power plant construction.

Power-generation capacity increased from 367 MW in 1961 to 9,391 MW in 1980. In 1980, KECO had an installed generating capacity of 8,731 MW (92.9 percent of S. Korea's total) while Kyung-In Energy Company had an installed capacity of 325 MW (3.5 percent) and the Industrial Sites and Water Resources Development Corporation had 335 MW (3.6 percent).

Table 3-1

Planned electric generating capacity
(MW)

Historical	
1975	4,720
1976	4,810
1977	5,790
1978	6,916
1979	6,033
1980	9,391
Forecast	
1986	20,936
1991	27,404

Adjustments to electric power targets should not have a serious or immediate effect on anticipated KECO bituminous coal demand, because they would probably relate to LNG, nuclear or anthracite power plants. At the present time, KECO's power generation mix is scheduled to change as follows:

Table 3-2

KEPCO's power generating mix

	1981	1986
Bituminous Coal	8%	23%
Nuclear	6%	27%
Oil.	74%	26%
LNG	0%	11%
Hydro	12%	13%

At present, about 70 percent of KECO's power output comes from oil burning units, but KECO plans to reduce this figure to around 12 percent by the early 1990s by expanding nuclear, coal, and LNG fired capacity. KECO's plans for bituminous coal-fired power generation are nearly as ambitious as its plans for nuclear plants. By present plans, coal will account for one-fifth of power generation by 1986 and retain that proportion through to the 1990s.

KECO began constructing four bituminous coal-fired units (two in Samchonpo and two in Gojeong). The unit began operation in 1983 on imported coal. Four existing units (Yosu #1 and #2, Honam #1 and #2) are being converted from oil to coal and should be on stream by 1986. Four additional units are in the planning stage. They may be commissioned at the end of the 1980's and early 1990's. However these additional four units, could be delayed or cut back because of financial considerations and lower growth estimates.

KECO estimates that it will require 5 million metric tons in 1985, and an average of 7 million tons beginning in 1986, or about as much as all other users combined.

KECO also operates a number of small anthracite-fired plants which require 1.7 million metric tons of coal per year. Most of this anthracite is produced domestically and only 400,000-500,000 metric tons is imported annually.

3.1.2 Cement Industry

Presently, Korea's large cement industry is the major industrial market for imported bituminous steam coal. In 1980-81, this industry, like its Japanese coutnerpart, underwent a very rapid conversion from oil to coal in the manufacturing process. Cement is also a high-growth industry crucial to Korea's continued economic expansion and industrialization.

In 1980, when the conversion to coal from oil-fired facilities was less than two years old the cement industry consumed 420,000 metric tons of coal. In 1981, this figure rose to 1.8 million metric tons. The past two years have been marked by slumping demand for cement; the increasing coal demand has been sustained only by the rapid conversion process.

At its present consumption level of 2 million metric tons annually, the Korean cement industry has probably attained its maximum coal use. Any additional increases in coal consumption by the cement industry will depend on the ability of the industry to expand its domestic and overseas cement sales. Consumption will grow more slowly in future, possibly reaching 2.5 million metric tons by the mid 1980's. The industry expects as much as 5 million metric tons by 1987, in the hope of a building boom associated with 1988 Seoul Summer Olympics.

There are seven major cement manufacturers in Korea. The single exception is the market leader, the Ssangyong Cement Corporation which has a 50 percent cement market share and has long-term coal supply contracts with U.S. and Australian suppliers. The Ssangyong Cement Industrial Company is the original parent of the Ssaygyong group which now covers a wide range of manufacturing, construction and commericial activities. In the same way, Hyundai Cement, is part of the large Hyundai group. These Korean industry groups are more highly integrated than those of Japan, though clearly modelled on them.

3.1.3 Steel Industry

Korea has no indigenous resources of metallurgical coal. One of the cornerstones of Korea's continued economic development is the government-controlled Pohang Iron and Steel Co., Ltd. (POSCO), which is the largest steel producer and the largest user of metallurgical coal.in Korea. POSCO was incorporated in 1968 and first produced steel in 1973 with an annual production capacity of 1.03 million metric tons. In 1981, steel production was 8.5 million metric tons, and the demand for coking coal was 6.6 million tons. Coking coal imports are expected to increase to 7.1 million tons in 1986.

There are also a number of smaller steel manufacturers which require a limited amount of coking coal and usually import through trading agents. Over the next five years imports of coking coal should remain fairly constant with only a 1.4 percent annual growth rate forecast.

Since 1980, POSCO has used an all-coke operation in each of its blast furnaces. It is now studying the technology of direct injection of powdered coal into the blast furnace. In 1981, POSCO alone consumed 6.2 million metric tons of coking coal. If POSCO's Second Integrated Steel Mill in Kwaygyang Bay on Korea's south coast becomes operational as planned in 1988, demand for coking coal could increase dramatically. The facility would have steel making capacity of 2.7 million tons upon completion of its first phase. Kwangyang would initially require 2.124 million metric tons of coking coal annually, raising the total annual demand for coking coal to 12 million metric tons by 1991.

3.1.4 Home Heating and Cooking

Anthracite briquettes are the prime method of home heating and cooking in Korea. About 90 percent of Korea's anthracite production is used for home heating and cooking, with the remainder being used for power generation in four electric power plants which burn both pulverized anthracite coal and bunker oil. Overall, domestic production is insufficient to meet demand.

The low sulfur content of Korea's domestically-produced anthracite is a positive factor in both home heating and electric power generating, but its high ash content is detrimental to the utility boilers. Since the quality of briquet household heating fuel is substandard, and local low-Btu coal cannot upgrade briquet quality, the coal used for domestic purposes is converted into briquettes with no attempt to remove ash.

Since 1978, domestic anthracite production has been supplemented with imported anthracite. At best, domestic production will increase at a 2.5 percent annual rate over the next five years, and at worse, it will decline somewhat. Demand on the other hand is projected to increase 2.8 percent annually.

3.2 CONSTRAINTS ON COAL USE

3.2.1 Capital Costs

The use of imported coal, rather than oil, in large new plants producing stream and/or power involves no technical barriers. However, to estimate whether coal can replace oil in existing oil fired plants would require a detailed plant-by-plant analysis. Coal can be used for many of the same markets as oil, but more capital equipment is needed and operating costs are high. In a developing country like Korea, a major shift from oil to other forms of energy carries with it a massive bill for investments in new power plants, ports, storage and other infrastructure. These extra costs can often be justified if the price differential between coal and oil is sufficiently large. For the 1982-86 plan period, these cost are estimated at over 18 billion dollars.

In addition, Korea has one of the world's most ambitious nuclear power programs. To the extent that this program is delayed or encounters problems, pressure may build to burn coal to produce the required electricity.

Furthermore, complaints may be raised that the control of air pollution is not economically efficient, or that the costs of control exceed the benefits. Such a situation might arise since the current emission standard of 1800 ppm for SO_2 is a uniform one, applicable to all sources regardless of their size, nature, relative ability to control emissions, or the cost of controls.

In contrast to these possible problems, a shift from oil to bituminous coal may actually lead to reduced levels of SO_2 (but not necessarily of particulates). This reduction will occur if Korea substitutes natural gas, nuclear power, and low-sulfur bituminous coal for the high-sulfur fuel oil it now uses.[1]

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[1] Richard Tobin, Project Coordinator, Use of Coal in the Asia-Pacific Region: Achieving Energy and Environmental Goals (Honolulu, Hawaii: East-West Environment and Policy Institute, East-West Center, 1981.)

3.2.2 Pollution Standards

Since coal is usually considered to be the "dirtiest" fossil fuel, any increase in its use may bring on some environmental problems and, possibly some conflict between energy and environmental goals. This could result from increasing pressure to burn coal, due to either rapid price increases in imported oil or domestic consumption of oil exceeding projections as it has in the past.

Korea's first legislation directed at pollution was the "Prevention of Pollution Act of 1963," which provided measures to deal with pollution after it had already occurred. The "Prevention of Pollution Act of 1971" attempted to prevent pollution by requiring that all manufacturing facilities obtain permits before discharging pollutants. The "Environmental Protection Act of 1977", which became effective on July 1, 1978, was an omnibus bill covering air, water, and noise pollution and waste disposal. In Korea, these standards do not apply to industrial areas or "uninhabited or sparsely populated areas".

Air and water pollution are widely recognized as significant problems in Korea, particularly in such cities as Seoul, Pusan, and Taegu and in such industrial areas as Ulsan, Yeochon, and Pohang. One report, the Korea Annual (1978) noted that: "Pollution has emerged as one of the most serious problems facing the nation following rapid industrialization." A year later, the same source (1979) added that in Seoul, "the degree of air pollution has increased two times over that of 10 years ago, making the city one of the most polluted areas in the world".

Although the sulfur content of domestic anthracite coal is low, there are literally several million households that burn it and contribute to emissions of SO_2, CO, and particulate emissions. As Levine (1980) puts it: "The use of anthracite coal briquets for residential heating creates a pervasive air pollution problem in ubanized areas. There is a large number of these emission sources that operate uncontrolled, and collectively produce large quantities of emissions which are released from short vents."[1]

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[1] E.D. Levine, Republic of Korea Environmental Assessment Baseline Data, (Argonne, IL: Argonne National Laboratory, 1980).

Undesirable meterological factors as calm winds, frequent night time inversions, and highly stable atmospheric regimes, tend to exacerbate problems caused by these pollutants. In terms of pollution, a consensus seems to exit that in the past, "environmental policy was insignificant compared to the primary policy of fostering economic development."[1] There are a number of factories exceeding emission standards reportedly operating in Korea.[2]

In recent years, the attitude toward environment regulation and enforcement seems to have changed as knowledge of the country's pollution has become more widespread. Indications of this trend are seen in presidential statements, ministerial ordinances, the creation of a consolidated Office of Environment in January 1980, and the rapid expansion of modeling and monitoring capabilities.

The Office of Environment's air pollution abatement program (directed primarily at SO_2) currently include the following measures:

- o desulfurization of flue gasses;
- o substitution of nuclear power and natural gas for oil and anthracite coal;
- o redistribution of low-sulfur fuels to industrial facilities;
- o energy conservation; and
- o increased use of central district heating systems.[2]

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[1]I. Kato, Environmental Policy and Law in Asia and the West Pacific Region, (Tokyo: Japan Center for Human Environmental Problems, 1981).

[2]Richard Tobin, Project Coordinator, Use of Coal in the Asia-Pacific Region: Achieving Energy and Environmental Goals (Honolulu, Hawaii: East-West Environment and Policy Institute, East-West Center, 1981.)