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ENERGY IN THE KOREAN ECONOMY

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## PREFACE

Next to national defense, energy policy, with clear economic and political implications, is the most critical issue confronting the Republic of Korea today. While considerable strides have been made in Korean energy policy, economic planners still consider energy to be a major limiting factor to Korea's continuing economic growth and development. This paper discusses three important dimensions of this argument: the role of energy in the Korean economy; the nature and extent of the energy constraints on the Korean economy today; and energy-economic policies that could alleviate energy constraints in the future.

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ENERGY IN THE KOREAN ECONOMY

## INTRODUCTION

Following the Korean War the Republic of Korea embarked upon a remarkably successful program of economic growth and development. The engine of progress was export-led industrialization, via successive economic policies of reconstruction, import substitution, and diversification. Coincident with this industrialization, Korea became heavily dependent upon imported energy sources, in particular upon imported oil. Following the rapid run-up in oil prices and the corresponding risk of oil supply interruptions, the Korean economy was forced into a period of readjustment.

In 1980 domestic inflation, which was largely induced by higher oil prices and a highly competitive world product export market, had brought the Korean economy to a standstill. The stark reality of the Korean economy today is that it has a marketable labor force and a reasonable capital base, but not much else in the way of productive resources. To realize its important multiple goals (national defense, economic stabilization, and continued economic growth and development), Korea must learn to manage its labor and capital base in the most efficient and effective possible way.

Korea is most likely to realize its economic objectives by doing well what it is already best at: industrial expansion and diversification for domestic and export consumption. A number of energy policies are especially appropriate to such an economic strategy: adoption of state-of-the-art, energy efficient equipment for all new installations, diversification of energy imports by fuel type and supplier, and stimulation of non-energy exports in order to generate the foreign exchange necessary to pay for energy imports.

## THE EVOLUTION OF KOREA'S ENERGY PROBLEM

Over 70 percent of Korea's energy comes from imported energy sources. It approaches self-sufficiency only in anthracite production. In 1953 Korea possessed and used little energy other than that of its human resources. The economy was primarily agrarian, and there was little unused land that could be brought into production. Coal production was low, timber resources had been depleted, and hydropower had not been developed. National defense and economic survival were Korea's foremost concerns.

During the 1950s the Korean economy made moderate progress. However, it grew from a small base with only a per

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## Energy Supply Projection

Unit: thousand ton-oil-equivalent

	1981		1986		1982-86 Average Annual Growth Rate(%)
Petroleum	25,396	62.1	28,667	48.4	2.5
Gas	569	1.4	2,904	4.9	38.5
Anthracite coal	10,198	24.9	12,116	20.5	3.5
Bituminous(1) coal	880 (4,939)	2.2	6,154 (11,183)	10.4	47.5
Hydro	537	1.3	726	1.2	6.2
Nuclear	774	1.9	6,561	11.1	53.3
Fire wood & charcoal	2,516	6.2	2,070	3.5	-3.8
Solar	--	--	5	--	--
<b>Total</b>	<b>40,871</b> <b>(44,930)</b>	<b>100.0</b>	<b>59,203</b> <b>(64,232)</b>	<b>100.0</b>	<b>7.7</b>

Note: (1) Numbers in parentheses include bituminous coal used for steel mills.

Source: The Fifth Five-Year Economic and Social Development Plan, 1982-1986. (Economic Planning Board, Republic of Korea, June 1981.)



capita income of \$100 as late as 1960. A small, import-substitution-oriented industrial sector was established, but the value of imports remained about ten times greater than the value of exports throughout this period. The energy sector was a relatively unimportant part of the total economy.

At the end of the 1950s Korea was still a net food importer. The economy still relied upon concessional foreign assistance to finance consumer and capital goods imports. Low labor productivity, due to capital scarcity and the unrestrained monetary and fiscal expansion of the 1950s, led to low income levels and high inflation. This in turn resulted in low savings and low investment levels.

In 1961, an economic planning policy with export promotion as its key objective was introduced. The official currency -- the won -- was devalued, financial institutions were reformed, and industry was given preferential interest rates and tax subsidies. The effect of these policies was a dramatic increase in GNP, averaging 9.6 percent throughout the 1960s.

The energy implications of the 1961 economic policy were initially very slight. However, a fundamental change occurred in the nature of Korea's pattern of energy use. The major change was in the increase of petroleum imports, primarily for use in the expanding industrial and transportation sectors. Also during the 1960s, production of anthracite\* increased for use in space heating and cooking, while oil and hydropower generation expanded.

Despite high levels of oil imports, Korea was in a strong competitive economic position when the oil price shock hit in 1973. Through currency devaluations, expansionary fiscal policies, and import restrictions, Korea was able to defend its economic position and achieve a real 1974-1975 GNP growth of 7.5 percent. Korea also took advantage of a large export surge to the Middle East in 1976 and strong domestic demand in 1977 and 1978. The real 1976-1978 GNP growth was over 12.0 percent. This high and prolonged economic growth in the 1960s and 1970s caused profound changes in the way that Korea used energy.

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\*Anthracite, or hard coal, has a high percentage of fixed carbon and a low percentage of volatile matter. It is used for space heating and, outside of Korea, for generating electricity. Korea's coal reserves, which are low in quality, are currently adequate to supply ninety (90) percents of its coal needs.

Productivity increases in the 1960s and 1970s required more capital and a greater use of energy. The rapidly growing industrial sector absorbed surplus labor and drove up wage rates. The rise in wage rates combined with a rapid monetary expansion to cause a strong inflationary bias within the economy, keeping an upward pressure on wages. The growing industrial sector absorbed an even higher proportion of capital and energy than of labor, while the costs of capital goods and energy remained relatively constant. The cost of labor then was increasing more rapidly than the cost of capital goods and the energy needed to make them functional. As a rational consequence, the substitution of labor for capital and human energy for energy derived from fossil fuels declined.

The high energy-dependent economic growth of the 1970s was most heavily dependent on imported petroleum, and to a lesser extent, imported bituminous coal. The transport and industrial sectors relied upon modern oil-using plants and equipment. The residential sector continued to use the traditional fuel, anthracite, which was being extracted at nearly the maximum possible rate. Bituminous coal was imported for other uses. Hydropower was being expanded at close to its maximum possible rate, and Korea's new nuclear plants had not yet begun operation. Increased electric power generation had to be oil-based.

When the fourth Five-Year Plan (1977-81) was formulated, it was clear that rising wages, resulting from the success of Korea's economic programs and prolonged inflation, made labor-intensive industries more vulnerable to industrial competition from abroad. With the goals of industrialization and maximum economic growth in mind, Korean planners made ready to phase out the least competitive of their industries and reallocate the necessary resources to capital-intensive industries which produced higher valued products. The energy and transport requirement for these industries were much greater and the immediacy of these needs caused Korea to depend even more on imported oil. By 1981 oil comprised 60 percent of Korea's energy use.

Inflationary pressures within the Korean economy continued. Money supply growth resulted from expansionary monetary and fiscal policies as well as from large foreign exchange inflows from the successful export program and Middle Eastern construction contracts. The effects of labor shortages began to be felt for perhaps the first time. Thus, in 1978, the Korean government began to take steps to cool off the economy. Contractionary economic policies and a second wave of oil price increases dampened the Korean economic boom by mid-1979.

Labor-intensive industries that were already losing competitiveness due to rising wages were hurt the most. The composition of Korea's industrial sector became even more capital intensive and energy-using as less competitive firms in labor-intensive industries shut down.

In 1980, the GNP fell nearly 6 percent overall due to decreasing domestic demand for consumables and a decline in agricultural output caused by bad weather. Utilization of industrial capacity fell below 70 percent and inventories grew to almost double the 1978 year end levels. The won was devalued and domestic prices for petroleum products were raised substantially. Korea's trade balance, excluding oil, rose from a 1979 deficit of \$1.1 billion to a surplus of \$1 billion. Oil costs caused the overall trade balance to fall into a substantial overall deficit of \$1.5 billion.

Today, Korea has limited anthracite reserves, minimal additional hydropower capacity, small renewable power potential, and practically no oil or gas. Anthracite production has leveled off at a maximum rate of 17-20 million tons per year and provides only about 25 percent of Korea's current total energy consumption. Very little additional hydropower capacity could be added, although pumped storage might enhance its contribution by a few percentage points of the total electric sector output. Solar/wind/wave power is not available economically, even in small quantities. The probability of Korea finding any oil or gas onshore or offshore is slight. Wood is relatively abundant, but Korea prefers not to use its biomass as an energy resource. For the foreseeable future, Korea will continue to import most of its energy needs.

Oil and Coal in 1980

Oil Imports:	560,000 barrels per day
Oil Import Cost:	\$5.4 billion
Coal Use:	
Domestic	18 million tons
Imports	4.5 million tons

ENERGY REQUIREMENTS AS A CONSTRAINT  
TO ECONOMIC GROWTH AND DEVELOPMENT

The lack of indigenous energy resources coupled with a dependence on high-priced imported energy will make Korean economic growth and development difficult in the future. For Korea to remain competitive, it must increase the productivity of its capital- and energy-intensive industries. These industries have historically been, and will probably continue to be, heavy energy users. National defense also dictates the need for more capital-intensive industries which tend to be heavy energy users. But domestic political stability requires Korea to generate jobs for about 400,000 new labor market entrants annually. Thus, Korea must carefully allocate scarce capital between the relatively higher technology, heavy energy-using industries needed to be economically competitive and militarily secure, and industries which can absorb the new members of the labor force each year.

In a developing country each dollar of additional investment in industrialization yields a relatively high return in increased labor productivity because capital is relatively more scarce than labor. To the extent that high and rising energy import bills siphon investment funds away from the industrialization programs of the developing country, the terms of trade are turned against it and in favor of the developed countries. Thus, high energy prices have a greater negative impact on the energy-poor developing country than on the the energy-poor developed countries.

As an energy-poor developing and industrializing country, Korea must expand the value of its industrial exports sufficiently to offset high and rising energy import bills. Otherwise these energy import bills will reduce funds available to finance industrialization and, without continuing rapid industrial expansion and diversification, Korea will find it increasingly difficult to develop new export markets.

It is readily apparent that higher energy import bills have severely and directly constrained the export-led Korean economy. This problem is most evident in the fact that Korea's formerly favorable balance of trade has disappeared. In the absence of surplus export earnings, the Korean economy stalled despite continued high domestic savings levels. It became necessary to use export earnings to pay for higher energy costs. Higher energy bills crowded out necessary industrial base investment. Thus, much of Korea's future economic base is being dissipated to pay for enlarged energy import bills.

As higher energy import expenditures have crowded out industrial investment and reduced labor productivity, they have

also caused a decline in the real income of wage earners. Higher energy prices have increased the cost of goods and services throughout the Korean economy. To compensate for the higher cost of living, labor has sought and will continue to seek wage increases. To the extent that labor has been successful in offsetting higher living costs with higher incomes, Korean labor productivity has declined and the terms of trade have deteriorated further. To the extent that the work force is not successful in maintaining or improving its standard of living, there is less incentive to improve labor productivity. Thus, there is no easy way for Korea to combat inflation except by increased earnings from abroad.

The deterioration of Korea's terms of trade has been evident in the continuing pressure to devalue the won. Devaluation of the won lowered the price of Korean exports and helped stimulate foreign demand for Korean imports. The devalued won also has meant higher prices for Korean imports, including primary materials and capital goods that are essential to Korea's industrializing economy. But, relatively higher prices for essential imports, other than for energy, are a further source of inflation.

The problem of inflation is worsened because the higher energy import bill impacts are not spread evenly throughout the economy. Generally, the heaviest energy-using economic activities in Korea have been impacted most severely. The industrial sector, which is essential to increased foreign exchange earnings, has been affected most. The construction and transportation sectors, which are essential to support the industrial sector, have also been strongly impaired.

Finally, as if the foregoing energy-related problems were not enough, the necessity of maintaining a strong defense posture makes the energy supply issue into an especially onerous economic problem. Korea continues to face the serious problem of an energy supply cutoff or disruption that could make the country vulnerable in the event of outside invasion. The financing of strategic energy stockpiles and energy import diversification means that funds must be spent upon essentially non-productive assets. These non-productive expenditures further erode Korea's ability to compete in export markets.

Percent of Energy Demand by Sector

	<u>1978</u>	<u>2008</u>
Industry	35	44
Residential/Commercial	38	26
Transportation	11	18
Public Sector	12	12

ENERGY POLICY OPTIONS

There are a number of energy policy options that Korea has implemented or could initiate to mitigate the recent negative economic impact of higher energy import bills and to reduce energy import vulnerability. In evaluating these options, it is necessary to consider each of them within the context of the complex interrelations between the energy sector and the economy as a whole. It is also important to recognize that most of these options require a substantial diversion of scarce capital away from other uses and future industrial production is reduced.

The most obvious energy policy option is to offset high energy bills through conservation -- by using less energy. Korea has already implemented a comprehensive energy conservation program and has already realized much of the potential to save energy through eliminating waste. Korea also has taken steps to improve the energy efficiency of its energy processing, transport and conversion technologies. The Korean energy systems technology is modern, and the replacement of most existing equipment with more energy-efficient equipment would not yield significant energy savings. In this situation, micro-level efforts to enforce current conservation rules or to identify additional areas of waste could result in some additional savings, but additional broad brush policies to improve the energy efficiency of the existing Korean energy system will not prove very effective.

In terms of Korea's future energy system, energy conservation policies could play a more significant role in reducing oil import bills. Present plans are to reduce energy use by 5 percent by 1983 and 15 percent by the end of the century.

If Korea can sustain a high rate of economic growth and development, it will have an excellent opportunity to install state-of-the-art technologies that provide maximum energy savings at little or no extra capital cost. To the extent that Korea's continued rapid economic progress is based upon industrialization, construction or other energy-using activities, it can realize an additional comparative advantage by becoming more energy efficient than its export market competitors. In view of the potentially large energy savings that could result from the adaptation of the best new energy conservation technologies, Korea's energy conservation efforts will be most productive if they are forward looking. The best energy policies in this regard will be those that draw attention to these important energy savings and advantages. One of the best ways to accomplish energy conservation is to provide economic incentives to local manufacturers and importers who develop or import the most energy-efficient technologies. Tax or tariff rebates come to mind as an efficient way to provide the appropriate incentives to adapt energy-efficient plants and equipment.

It is sometimes suggested that Korea could best pursue energy conservation by restructuring its economy to concentrate on activities which use less energy. This redirection of the economy could result in energy savings, but it is unrealistic for Korea to do this for two reasons: first, such a policy would put Korea in competition with less developed countries which have cheaper labor and, in labor-intensive industries, lower overall production costs. Second, this would detract from and, perhaps, severely impair the further development of the industrial base Korea requires to meet its national defense needs.

To some extent, Korea may be able to substitute non-energy-intensive technology and light industry for the heavy industrialization of the past. However, since Korea will experience intense competition in these markets from the highly skilled labor of other rapidly industrializing countries, its relatively high and rising wages may price its labor and production out of many export markets. It will also be some years before Korea's domestic R&D infrastructure expands to the point where it can substantially increase export revenues.

A better way to direct Korea's economy is to earn the foreign exchange needed to pay for energy imports. This could be accomplished best by promoting exports in the industrial and high technology areas where Korea has a clear comparative advantage. Korea is one of a very few middle-income industrializing countries that is in a position to compete with segments of the developed world. Korea's recent success in

achieving a world competitive steel industry gives some idea of what might be accomplished in the future. Bounties or awards to successful exporters could serve to stimulate free market competition and sales abroad. A policy of this type would allocate import licenses or foreign exchange rights on the basis of export successes.

The energy policy options discussed thus far do not address directly the problem of providing a secure energy supply. The use of less energy throughout the economy, or the development of a strong export base that can pay for needed energy, certainly could improve the overall energy supply situation but would not substantially reduce vulnerability to an oil supply cut-off. For this reason, the stockpiling of strategic energy supplies and an active energy import diversification program may also be needed. The government hopes to have a 60-day stockpile of oil by the mid-1980s. Among the options to stockpile energy, the Korean government should consider working with the private sector to increase storage facilities throughout the energy system. Also, attention should be directed toward the acquisition of different fuels from different suppliers. Another option is the massive nuclear power development program under consideration. By 1990 the Korean government plans to be generating 15 percent of the nation's total energy need through nuclear reactors and hopes to have as many as forty large nuclear generating plants operating early in the 21st century. The most cost effective energy security options are those that affect the future expansion of the Korean energy system rather than those that redirect the existing energy system.

Ultimately, Korea must fully develop a composite of these and other possible energy policy options. No one energy policy by itself is likely to resolve all or even most of Korea's energy problem. Therefore, it also is appropriate to consider new measures that could help forge the foregoing diverse policies into a more comprehensive energy policy program. Bilateral trade agreements may be a good approach to developing export markets for Korean goods and services while insuring safe and diversified sources for energy imports. Bilateral agreements have been used advantageously by Korea in the past and should be developed by Korea in the future. Similarly, the Government of Korea and private enterprise can further stimulate joint energy ventures with countries and companies abroad. In any case, it is essential that the Korean economy be open to foreign investors or exporters.



Korea realized the miracle of rapid economic growth and development because it was an open economy. To turn away from that successful formula in the face of the energy problem would be a grave mistake.

## STATISTICAL APPENDIX

REPUBLIC OF KOREA  
GROSS NATIONAL PRODUCT

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By Sector

(Billions of Korean Won at Constant 1975 Prices)

	GNP*	Agriculture	Mining	Manufacturing	Construction	Electricity, Gas & Water	Transportation & Communications
1950	1739.6						
1955	2422.6	1178.1	24.6	119.7	39.8	4.1	28.2
1960	2845.6	1256.7	49.4	192.4	58.2	8.1	54.5
1965	3885.0	1661.0	82.3	343.7	116.4	16.7	103.1
1966	4378.5	1853.7	86.2	403.1	140.7	19.8	128.4
1967	4669.4	1744.3	96.1	490.2	167.8	25.4	156.9
1968	5195.6	1767.0	94.6	623.5	232.5	31.6	205.2
1969	5911.4	1952.5	93.3	758.2	319.8	41.0	259.0
1970	6347.7	1911.5	108.8	909.1	335.8	48.9	308.2
1971	6908.7	1951.6	109.9	1080.0	328.4	58.2	343.4
1972	7305.0	1982.9	108.6	1231.2	324.8	65.3	377.0
1973	8377.1	2086.0	129.2	1590.6	416.4	79.6	476.9
1974	9009.4	2194.5	137.1	1842.0	427.3	90.3	511.7
1975	9644.2	2302.0	153.9	2074.0	486.6	107.6	571.1
1976	11016.4	2467.7	157.6	2542.8	546.5	127.3	670.5
1977	12175.2	2524.5	176.2	2908.9	684.2	147.1	791.8

\* The difference between GNP and the sum for the sectors equals (Net indirect taxes) + (Factor payments to abroad (net))

Source: World Bank, World Tables, Second Edition (1980)

## KOREAN ENERGY PRODUCTION AND CONSUMPTION

(10<sup>15</sup> Joules)

	Total Anthracite Production	Total	Agriculture and Fishing	Mining and Manufacturing	Transportation	Services	Residential
1970	231.8						
1971	239.1	821.0	49.0	221.0	95.0	168.0	287.0
1972	231.9	859.0	52.0	232.0	101.0	178.0	296.0
1973	253.8	969.0	70.0	296.0	140.0	155.0	308.0
1974	285.4	963.0	67.0	292.0	137.0	152.0	315.0
1975	329.0	1011.0	66.0	353.0	113.0	148.0	330.0
1976	307.2	1105.0	73.0	402.0	123.0	159.0	347.0
1977	322.9	1222.0	80.0	450.0	135.0	180.0	377.0
1978	337.6	1369.0	88.0	541.0	158.0	195.0	387.0
1979	340.5						

Source: Finocchi, R; Exhibit 2.5 in Hagler, Bailly & Co., "Fossil Energy Evaluation of the Republic of Korea"; U.S./ROK Cooperative Energy Assessment, U.S. Dept. of Energy (1980).

## REPUBLIC OF KOREA

## IMPORTS AND EXPORTS

(Billions of Korean Won at Constant 1975 Prices)

	Imports of Goods and N.F.S.	Exports of Goods and N.F.S.	(Exports-Imports)	(Exports-Imports) GNP
1950	262.6	38.7	- 223.9	- 0.129
1955	317.8	36.3	- 281.5	- 0.116
1960	348.6	77.2	- 271.4	- 0.095
1965	459.0	221.4	- 237.6	- 0.061
1966	717.0	315.2	- 401.8	- 0.092
1967	937.7	418.3	- 519.4	- 0.111
1968	1346.4	583.5	- 762.9	- 0.147
1969	1704.6	794.2	- 910.4	- 0.154
1970	1841.6	949.7	- 891.9	- 0.141
1971	2229.2	1143.5	- 1085.7	- 0.157
1972	2256.2	1565.4	- 690.8	- 0.095
1973	3087.9	2432.3	- 655.6	- 0.078
1974	3604.5	2357.0	- 1247.5	- 0.138
1975	3612.6	2748.4	- 864.2	- 0.090
1976	4582.6	3931.5	- 651.1	- 0.059
1977	5673.8	4941.9	- 731.9	- 0.060

Source: World Bank, World Tables, Second Edition (1980)

REPUBLIC OF KOREA  
STRUCTURE OF IMPORTS AND EXPORTS

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IMPORTS  
(Percent of Total)

	Food, Beverages	Nonfood Agriculture	Fuels, Minerals and Metals	Machinery and Equipment	Other Manufacturers	Total
1960	40.2	16.0	24.4	2.6	16.7	100
1965	16.7	8.5	15.4	3.1	56.3	100
1970	9.6	7.0	6.7	7.4	69.4	100
1977	10.6	2.2	2.3	17.4	67.6	100

Source: World Bank

EXPORTS  
(Percent of Total)

	Food, Beverages	Nonfood Agriculture	Non-fuel Minerals and Metals	Machinery and Equipment	Other Manufacturers	Fuels and Lubricants	Total
1960	12.5	20.9	1.7	16.5	41.1	7.3	100
1965	15.1	22.2	4.2	13.3	38.3	6.9	100
1970	17.1	15.4	5.7	29.7	25.0	6.9	100
1977	8.2	13.6	5.6	26.9	25.5	20.2	100

Source: World Bank, World Tables, Second Edition (1980)

REPUBLIC OF KOREA  
BALANCES OF TRADE AND PAYMENTS  
(Millions of Current \$ U.S.)

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	Balance of Trade	Current Balance of Payments
1970	- 922.0	- 623.0
1971	- 1046.0	- 848.0
1972	- 575.0	- 371.0
1973	- 567.0	- 309.0
1974	- 1937.0	- 2023.0
1975	- 1671.0	- 1887.0
1976	- 591.0	- 314.0
1977	- 477.0	+ 12.0
1978	- 1781.0	- 1085.0
1979	- 4565.0	- 4239.0

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Source: Economic Planning Board, Republic of Korea, Handbook of the Korean Economy