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PROGRESS REPORT

ENERGY DEMAND AND FUEL SUPPLY IN DEVELOPING COUNTRIES
BRAZIL, KOREA AND THE PHILIPPINES

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INTRODUCTION

During the 1970s, energy use in developing countries increased at an average rate of 6.6%, more than four times the rate observed in the developed market economies. This pattern suggests that much of the future growth in world energy use will occur in the developing countries. The magnitude of this growth is closely related to the financial stability and overall socioeconomic progress of developing countries. Thus, the ten-fold increase in oil prices during the past decade makes it important to understand the factors that determine the need for different forms of energy in these countries in order to understand their future development.

In order to improve our understanding of the relationship between energy demand and development in developing countries, we have undertaken a study of their energy use patterns. For initial study, we have chosen 15 countries that account for over 75% of the energy demand in the developing countries. The countries are Argentina, Bangladesh, Brazil, Colombia, India, Indonesia, Korea, Malaysia, Mexico, Pakistan, Peru, Philippines, Taiwan, Thailand, and Venezuela.

National energy studies in developing countries are often limited to examining energy balances. While energy balances are useful, they are only the starting point in understanding energy use. Therefore, besides compiling energy balances for the countries under consideration, we seek to relate energy use to the production of goods and services.

We use time-series of indicators to analyze energy demand, an approach developed by our group for the study of energy demand in OECD countries. Indicators, which show the intensity of energy use, are defined according to the individual characteristics of each sector (see Table 1.) and can be as detailed as necessary. For specific countries, where detailed data are available, we have defined additional indicators.

Changes in indicators over time can be explained by observing the changes in structural composition, fuel shares and conservation. The analysis last year showed that the extent to which each factor influences energy demand varies among the study countries. In South Korea's industrial sector, for example, the decline in the intensity of energy use can be attributed to all

above factors, while in the Philippines, the decline was due mainly to conservation and fuel substitution. In the transportation sector, the of different fuels have changed rapidly. The number of two and three vehicles has increased, thus changing composition of the vehicle Additionally, the rapid increase in fuel prices has contributed to the in composition and to the resulting reduction in fuel use per vehicle. residential sector, there has been and increase in electricity use, on in the share of non-commercial fuel use, and an increase in the E LPG and electricity use.

SHMENTS DURING JAN.-MAR. 1984

ng this quarter, we completed studies of energy demand and reviewed ply options for Brazil, Korea, and the Philippines. A summary of these is presented below. Reports have been prepared for each country and ented in the appendices.

re updating the data base for our study to include the most recent ion for each country. At the end of last year, the data base had alances through 1980 for most of the study countries. We have updated o 1981 and 1982 for Brazil and Korea, and for 1983 for the Philip- e have supplemented energy balances with data on economic activity and ices. We will distribute the updated data at the end of May for Bra- ea and the Philippines.

ganizing the data base, we have found that the conventions- assump- heat value of fuels, inclusion of traditional fuels, accounting of l fuels for electricity generation, etc.- used by each country differ bly. These can be a source of major difficulty. Further, even within , conventions, and definitions of demand sectors have changed over s. This can change the allocation of diesel fuel to transportation or In order to eliminate these types of anomalies, we are updating the for the countries we study each quarter.

SPONSORS

The sponsors of the study this quarter include Exxon and Esso Eastern, Sohio, Socal, and Statoil, and the Department of Energy (DOE). Off-budget work has been sponsored by the Asian Development Bank in the Philippines and in Indonesia, and by the Asia Pacific Development Center in Malaysia. DOE has expressed renewed interest in this study since it is viewed as a major source of information for trade negotiations with the Western Pacific countries. Various departments within DOE have expressed interest in supporting the study. These include Policy and Planning, International Affairs, Fossil Fuels, and Emergency Preparedness. With support from these sponsors, the study will have 2.5 person years worth of effort during the period January-December 1984, excluding additional DOE funds made available after Oct. 1., 1984, the new fiscal year. The work scope will be expanded to include topics of interest to the departments in DOE. These will include additional Pacific Basin countries- Japan, New Zealand, and Australia- and a study of trade in energy resources among Pacific Basin countries, particularly as it affects the United States.

FUTURE PLANS

The plans for the remainder of this year are essentially unchanged from those outlined in our letter to you in February, except for a change in the schedule of coverage of Latin American countries. By July, we shall complete reports of Taiwan, Thailand, Venezuela and Argentina. By October, we shall complete reports of Malaysia, Indonesia, Mexico, and Colombia. A report on urban energy consumption in developing countries is planned at the request of the editors of the Annual Review of Energy. A draft report will be prepared in August this year for distribution to the project sponsors.

We plan a major briefing for November in San Francisco, immediately following the IAEE meeting. We will hold a short briefing in Washington DC in July, describing our findings on the countries studied till that date. We will provide additional information on the briefings as we get closer to the date.

SUMMARY OF COUNTRY STUDIES: BRAZIL, KOREA AND THE PHILIPPINES

INTRODUCTION

For each country, we examined the demand for petroleum, coal, gas, and electricity in each of the four major sectors. Energy use and fuel consumption were related to economic and structural activity. The effect of prices, particularly in the transportation sector, was also examined. Indicators were developed for each sector. These assisted in improving our understanding of changes in energy demand patterns, and in reviewing the projections of fuel demand.

The three countries together accounted for 112 MTOE or 25% of the commercial energy consumption in our study countries in 1980. Of this, Brazil accounted for 64 MTOE, Korea for 37 MTOE and the Philippines for 11 MTOE. Oil use in these countries amounted to 47 MTOE in Brazil, 23 MTOE in Korea, and 10 MTOE in the Philippines.

Since 1980, each country has faced enormous debt problems, partially caused by the oil price increase in 1979. The debt burden in Brazil and the Philippines, is much more severe than in Korea. At present, total debt exceeds US $100 billion in Brazil, and is $26 billion in the Philippines and Korea. In Brazil, the gross domestic product has declined since 1980. In the Philippines, it is expected that the enormous debt burden will result in a negative growth rate of GDP this year, with slower than historical increases in the future.

The fraction of exports required to pay for oil imports is a measure that points to the difficulties a country may have in raising hard currency to pay for oil imports. After 1979, the recession in developed countries reduced exports from developing countries. The sharp oil price increase coupled with these reduced exports made it much more difficult for the developing countries to pay for oil imports. In order to boost exports, nations devalued their currencies. This unfortunately, increased the amount of local currency needed to pay for imported oil.

In Brazil, the fraction of exports needed to pay for oil was 48% in 1980. In Korea, it was 35% in 1982. In the Philippines, 43% in 1983. In Korea, the ratio has declined from 38% in 1980, while in the Philippines it has increased from 38% in 1980. Projections show these ratios declining rapidly in a few years, as these countries reduce their dependence on imported oil, and as exports increase with economic recovery in the developed world. However, imports of oil will be replaced in part, by imports of coal and nuclear fuel. The fraction of exports going to pay for oil imports will decline, but the fraction going to pay for coal and nuclear fuel will increase. On the whole, the fraction going for energy is still expected to decline, but not as much.

PETROLEUM PRODUCTS

The following paragraphs describe the demand for each type of petroleum product, and evaluate the reasons for changes in demand for these products. We evaluate changes with respect to composition, fuel substitution, and energy conservation. We also examine the effect of pricing and non-pricing policies. Quantitative information is presented in the country reports.

Fuel Oil

Fuel oil use has declined in each country and further declines are expected (see Table 2.) Fuel oil is used in power plants and in industry in each country. Reducing fuel oil use is relatively easy, since coal can be used as an effective substitute in industrial and power plant boilers. Further, governments have encouraged industries to reduce fuel oil use through energy conservation.

The intensity of fuel oil use in industry has declined in these countries as a result of changes in composition, and through substitution and conservation. In the cement industry, coal has been used as an effective substitute. Most of the cement plants have already switched to using coal. In the Philippines, all the cement plants will switch over to coal by the end of this year. In Brazil, half the cement plants have switched to coal, further substitution will depend on the availability of capital for investment in coal-handling

equipment. In pulp and paper industry, of the Philippines and Brazil, wood waste is replacing fuel oil.

In other industries, intensity has declined both because of energy conservation, and due to change in industry composition. In Korea, the decline has occurred for both these reasons, while in Brazil and the Philippines conservation has been primarily responsible.

In power generation, fuel oil is being replaced by coal and non-fossil fuels. In the Philippines, fuel oil use is expected to decline to less than 25% of its current 20 MBOE consumption in the power sector, by 1987. Similar declines are also projected for Korea. In Brazil, there is virtually no fuel oil used in power plants.

Non-price policies have been primarily used to achieve this rapid decline in fuel oil consumption. In each country, planning for the power sector is done by government or quasi-government organizations. After the second oil price increase, coal and other non-fossil power plants became economically justifiable against the international price of fuel oil. As a result, nations have made every attempt to switch to non-oil power plants. The type of plant differs in each country according to the availability of domestic resources and of imported coal and nuclear power.

In the industrial sector, the cost of alternate fuels relative to fuel oil justify the switch to these fuels. However, governments have played a major role in promoting the switch to alternate fuels and to energy conservation. Companies are required to reduce their oil consumption in the Philippines and Korea. Incentives include awards for meeting administratively set conservation goals, and penalties for failing to meet these goals.

Diesel:

While the consumption of fuel oil is expected to decline, the consumption of diesel fuel is expected to increase, as is the share of diesel consumption, assuming that the price of diesel relative to the price of gasoline does not change (see Table 3.)

In the industrial sector, the main emphasis has been on reducing fuel oil use. Consumption of diesel has received less attention because of its relatively smaller share. Diesel is used in industry for various types of internal combustion engines, for power generation, and for motive power, and occasionally in heat treatment furnaces. In the Philippines, for example, the intensity of diesel use in industry has changed little since 1979. Further, in diesel intensive industries, such as logging, its use increased rapidly between 1979 and 1982. Surprisingly, the intensity increased further, despite a large increase in the price of diesel in 1983.

In the transportation sector, diesel use has increased because of the shift from gasoline to diesel engines, and an increase in the number of diesel vehicles. In Brazil and the Philippines, the price of diesel did not increase as rapidly as the price of gasoline, prompting vehicle operators to move from gasoline engines to diesel engines. In 1980, the price of gasoline was 2.5 times that of diesel in Brazil, and almost twice that of diesel in the Philippines and in Korea. Studies of transportation energy use in Brazil, and data for the Philippines show a rapid shift of commercial gasoline vehicles to diesel vehicles after 1980.

Pricing has been used as the primary tool in managing demand for diesel fuel in transportation and industry. The lower price of diesel relative to gasoline, has encouraged the use of diesel in place of gasoline. The rationale for encouraging the use of diesel is that it is essential for public transport and for the transport of crucial commodities, and it provides for more efficient use of oil. However, low diesel price encourages inefficient use of the fuel. Further,if the price is lower than the international price of diesel, it contributes to the balance of payments difficulties. Industrial demand for diesel does not appear to be price sensitive in the Philippines, judging from the increase in demand in 1983, despite an increase in the price of diesel. In addition, diesel use has brought about air pollution. The use of diesel in industry and transportation remains the most important element in understanding oil use in the economies of developing countries.

Other Fuels:

Gasoline is used primarily in the transportation sector. Since it is regarded as a "luxury" fuel, governments have not hesitated in passing along the increases in the price of imported oil. In the short run, gasoline use per vehicle and in absolute amounts has declined due to the increase in the price of gasoline. In the medium term, gasoline use may decline if the differential in the price of gasoline and diesel persists, thus prompting switching to diesel engines. In the long run, with an increase in per capita income and therefore in the ownership of automobiles, gasoline consumption should increase. Another factor that has affected gasoline consumption is the introduction of alternative fuels such as alcohol and LPG.

In managing gasoline consumption, pricing policy supplemented by non-price policies have been used effectively. Non-price policies include limited operation of gasoline stations, taxes and subsidies on new cars, stricter enforcement of speed limits, and electrification of mass transit systems.

Kerosene use in these countries is limited to lighting in rural households. Per capita kerosene use has been declining and is expected to decline further in the future. There is no price differential in the price of kerosene and diesel fuel. Thus, unlike countries like India, there is no incentive to use kerosene in diesel vehicles.

Gas is used for cooking (and in Korea, for heating) in urban households. In Korea, part of the households are connected to city gas systems. In each country, for those who can afford it, LPG is available in the urban areas. Per capita LPG use has declined in the Philippines and has increased only marginally in Korea. The decline in per capita LPG use may be due to substitution by electricity which is available at subsidized rates. The price of LPG is not subsidized in Korea and the Philippines. In the Philippines, per capita income is higher today than ever before. However, due to deteriorating income distribution over the last decade, there appears to be a switch to wood and charcoal, which are cheaper than LPG or electricity.

ELECTRICITY

In the 1970s, electricity was generated using primarily fuel oil in Korea and the Philippines, and using hydro in Brazil. Since the second oil price increase, Korea and the Philippines have made concerted efforts at shifting their reliance from fuel oil to a diversified mix of fuels. In Korea, coal and nuclear are expected to fuel bulk of the new power plants, while in the Philippines geothermal, hydro, coal and nuclear will provide bulk of the future electricity.

Demand for electricity has increased steadily over the last few years in each country. The increase in overall demand for electricity has been higher than energy demand. Electricity use per unit of GDP has increased rapidly in Korea, where it almost doubled from 1970 to 1981. In the Philippines, it increased very little during this period.

In the industrial sector, electricity use per unit of value added has not increased by much in Korea and the Philippines. In Korea, it increased by 10% from 1970 to 1979, and has remained unchanged since then. In the Philippines, it has declined since 1979. Data for earlier periods are insufficient to draw any conclusions. In Brazil, however, it increased by 22% prior to the second oil price increase from 1976 to 1979. Subsequently, it increased by 20% by 1982, due to further replacement of fuel oil by electricity in industries such as food processing.

The increase in use of electricity is being fueled by demand in the residential and commercial sectors. In Korea, residential sales of electricity have increased extremely rapidly due to electrification schemes in the rural areas, and to an increase in the number of appliances in the average household. Per capita use of electricity in the residential sector has increased several fold. Per customer use of electricity has increased less rapidly, as the number of persons per household has declined. In the Philippines, residential sales per capita have remained unchanged since 1979.

CONCLUSIONS

To summarize, in each country consumption of liquid fuels as a fraction of total energy has declined since 1979, and further declines are expected. However, the absolute amount of oil consumption may or may not decline, depending on the rate of economic growth, and the potential for substitution by other fuels. In the Philippines, the absolute amount of oil used is expected to decline, while in Korea, the absolute amount is expected to double in the next eight years. In Brazil it is expected to increase slightly.

Coal use, which was a small fraction of total energy use in 1980, is expected to increase several fold in the next few years in each country. In the Philippines and in Brazil, domestic coal resources are being developed. Imported coal will provide only about 15% of the energy from coal in the Philippines. On the other hand, in Korea, the economically recoverable domestic anthracite resource is limited, so imported bituminous coal is expected to replace oil in industry and power plants. The percentage of coal supplied by imports is projected to amount to 39% in 1991.

In Brazil, one nuclear power plant of 800 MW size is expected to supply 5% of the electricity. In Korea, nuclear power is expected to supply 15% of the primary energy use in 1991. In the Philippines, one 620 MW power plant will supply roughly 6% of the primary energy starting in 1985 and geothermal power plants will supply about 25% of the electricity in ten years.

TABLE 1

EXAMPLES OF INDICATORS

OVERALL	E/GDP
INDUSTRIAL	
	ENERGY/VALUE ADDED
	OIL/VALUE ADDED
	ELECTRICITY/VALUE ADDED
TRANSPORTATION	
	FUEL USE/ NO. OF VEHICLES
	CARS PER CAPITA/ PER CAPITA GDP
	FUEL USE/ PASS.-KM.
RESIDENTIAL	
	FUEL USE/ POPULATION
	ELECTRICITY/ NO. OF CUSTOMERS
POWER	
	ELECTRICITY GENERATION/ ELEC. SALES
	ELEC. GENERATION/ FUEL OIL USE

TABLE 2

DEMAND FOR FUEL OIL (THOUSAND BARRELS)

	1979	1982
INDUSTRY		
Brazil	88,400	48,700
Korea	46,200	30,800
Philippines	19,400	14,000
POWER		
Brazil	6,800	4,500
Korea	42,700	49,400
Philippines	17,800	17,500
INDUSTRY FUEL OIL/ VALUE ADDED*		
Brazil	37.0	21.4
Korea	7.55	4.55
Philippines	602	391
GENERATION / FUEL OIL+		
Brazil	18	34
Korea	770	1400
Philippines	880	1240

* - Brazil units are thousand barrels per billion 1980 cruzeiros.
Korea units are thousand barrels per billion 1975 won.
Philippines units are thousand barrels per billion 1972 pesos.

+ - Units are GWH per million barrel. The figures show total generation divided by total fuel oil use. Increase in the figure indicates, primarily, replacement of fuel oil by other fuels.

TABLE 3

DEMAND FOR DIESEL AND GASOLINE

(THOUSAND BARRELS)

	1979	1982
DIESEL		
TRANSPORTATION		
Brazil	80,300	86,000
Korea	22,900	24,800
Philippines	11,300	13,200
INDUSTRY		
Brazil	10,400	8,800
Korea	5,400	4,800
Philippines	5,400	5,700
GASOLINE		
TRANSPORTATION		
Brazil	85,100	66,400
Korea	7,300	3,500
Philippines	13,300	8,200
CARS PER THOUSAND PERSONS		
Brazil	69	80+
Korea	13	16
Philippines	-	6
GNP PER CAPITA (US$)		
Brazil*		1100
Korea		1630
Philippines		720

* - In 1980 dollars.

\+ - For 1980.

COUNTRY REPORT

BRAZIL

TRENDS OF ENERGY USE IN BRAZIL FROM 1970 TO 1982*

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* - Written by Andre' Ghirardi.

INTRODUCTION

During the last five years, there has been a noticeable decline in the rate of increase of energy use in Brasil, as well as a marked trend of replacement of petroleum products with electricity, coal, and alcohol. Inter-fuel substitution, combined with increased domestic production of crude oil, has lowered the share of imports in total petroleum use from 85 percent in 1978 to about 65 percent in 1983.

The reduction of petroleum imports coincided with a severe economic recession: in sharp contrast with the period between 1968 and 1973, when the economy grew at an average annual rate in excess of 11 percent, Brasil's GDP has declined since 1980. The energy trade balance is directly related to the well being of the Brasilian economy; petroleum is the country's largest import item in value and, in recent years, the sum of petroleum imports and the servicing of the external debt has exceeded the country's total export earnings. The reduction of petroleum imports is, therefore, a very necessary condition for economic recovery.

In order to reduce the dependence on imported oil, the government has enacted policies addressing both the supply and demand sides of the energy market. On the supply side, there has been expanded domestic production of petroleum as well as of alternative fuels such as coal, alcohol and, most importantly, hydroelectricity. On the demand side, prices and fiscal incentives have been used to create an environment favorable to energy conservation and inter-fuel substitution.

Despite the improvements achieved in the energy trade balance, an important policy question remains unanswered: what would happen to the country's dependence on imported petroleum if the economy experienced another period of continued growth? To what extent could the domestic production of petroleum and the availability of substitute fuels match increasing demand?

The following is a review of the trends in end-use of energy in the main sectors of the Brasilian economy, from 1970 to 1982. It reveals that most of the reduction in the use of petroleum products has taken place in the industrial sector, even though the transportation sector also shows evidence of successful implementation of conservation and substitution measures. Since 1979, the use of fuel oil has been reduced by nearly 40 percent, and could decline even further through continued fuel substitution. If a substantial reduction can also be achieved in the use of diesel oil, especially in the transportation sector, Brasil would likely avert any deterioration of its energy trade balance for the rest of the decade.

AGGREGATE ENERGY USE AND ECONOMIC PROFILE

Between 1970 and 1982, there were two periods with distinct growth of energy use in Brasil (Figure 1). The first was from 1970 to 1978, when energy use increased at an average rate of 8.2 percent; the second was from 1978 to 1982 when, as a consequence of higher energy prices and reduced economic activity, energy use increased at a rate of 3.8 percent.

In the early 1970s, the economy was still experiencing a period of unusually high growth, initiated in 1968. The favorable economic conditions were generated by positive trade balances which resulted from fiscal incentives to exports, as well as by a gradual decline in the rate of inflation. The advantageous trade position earned the necessary foreign exchange to import the materials and capital goods required to expand the productive capacity. Manufactured goods became an increasingly important item in the composition of exports, which were traditionally made up of agricultural products and minerals. During that period there was only a small increase in industrial production relatively to agriculture (Table 1).

During the period of strong economic performance, there was no significant change in the average energy intensity of output (dashed line in Figure 1). There was, however, a relative increase in the use of

petroleum products, due to the rapidly expanding demand for energy in the industrial and transportation sectors (solid line in Figure 1). The growth in the use of petroleum products occurred at an average yearly rate of 10 percent between 1970 and 1978, and was met primarily by imports, whose share of total petroleum supply went from 67 percent in 1970 to nearly 80 percent in 1973, and a high of 85 percent in 1977.

Since 1978, the trend of increasing use of petroleum products gave way to wider use of hydroelectricity, domestic coal, and alcohol fuels. Whereas hydroelectricity has always accounted for a large share of energy supply in Brasil, the large-scale use of domestic coal and alcohol fuels are new elements in the local energy policy. From 1978 to 1982, coal use increased at 8.5 percent, and alcohol fuels at 20 percent. During that same period, the use of petroleum products declined at an average rate of 1.6 percent, due mainly to reduced use of gasoline (in transportation) and fuel oil (in industry). The relative share of petroleum in total energy supply declined from a 45 percent in 1973 to 38 percent in 1982.

The reduction in petroleum imports resulted from higher domestic production of crude oil as well as lower oil demand. The domestic production of petroleum, on the strength of newly developed offshore fields, went from 8,000 TOE in 1978 (15 percent of total consumption) to over 19,000 TOE in 1983 (about 35 percent of total consumption).

The total demand for petroleum, curbed both by economic recession and substitution policies, declined from nearly 56,000 TOE in 1979 to 52,000 TOE in 1982. The poor economic conditions were created by a combination of a worldwide slowdown in economic activity, and by the increased cost of oil imports. The borrowing of foreign exchange used to finance the country's growth in the early and mid-1970s contributed to an uncontrolled increase in the external debt, which went from $13 billion in 1973 (6.5 percent of GDP) to $53.8 billion (19 percent of GDP) by the end of 1980, and currently stands in excess of $100 billion. The growth of the external debt has been particularly aggravated by the increases in the international interest rate (LIBOR), to which more than 70 percent of Brasil's external debt is tied (IDB, 1982). Between 1978

and 1980, the LIBOR rate increased from 8.8 to 14 percent, while, during the same period, the value of petroleum imports more than doubled, going from $4.1 billion to $9.4 billion. The servicing of the external debt went from $2.2 billion (35 percent of total exports) in 1973 to $11.3 billion (56 percent of total exports) in 1980 (IDB, 1981).

The deterioration of economic conditions affected the use of petroleum through the reduced activity in the most energy-intensive industries such as cement and steel. Since the recession began in 1980, production of steel and cement have declined at annual rates of 8 and 9 percent, respectively (Table 2).

In addition to that, and in accordance with the trend in the world oil market, the prices of most energy sources in Brasil increased after 1978-79. The real prices of gasoline, diesel oil, and kerosene were at least doubled, and the price of electricity for industrial users increased by 60 percent (Figure 2 and Table 3). In the case of fuel oil, there was a four-fold increase in order to update a price which had been kept below world-market levels. Despite the large relative increase, the price of fuel oil still remained well below that of electricity.

The only fuel whose price remained unchanged was LPG; considering that 90 percent of that fuel is used for cooking in the residential sector, and that most households have no alternative energy source for cooking (particularly in the urban areas*), the price may have been kept down deliberately.

The overall reduction in the use of petroleum fuels (Table 4) demonstrates the effectiveness of the policies aimed at reducing dependence on imported energy. The continued success of those policies will require that further measures be designed to reduce the use of diesel oil, which has become the most widely used petroleum fuel in the country. The following review of energy use patterns in individual sectors

*The number of electric stoves in Brasil is minimal. Virtually all the cooking in urban areas is fueled by gas, most of which is LPG.

illustrates how diesel oil has become the most widely used fuel in Brasil, a consequence of the sharply reduced use of fuel oil in industry.

TRANSPORTATION

Total energy use in transportation increased at an average rate of 8 percent between 1970 and 1978, experienced a slight decline in 1979-81, and increased back to its 1979 level in the next year. The growing automobile fleet (stemming from rising income per capita and declining real prices of automobile, Figure 3) and the continuous migration of population to the main urban centers were two of the main reasons for the increased use of energy in the sector.

Between 1970 and 1982, there was a major change in the structure of energy demand in the transportation sector. Gasoline had traditionally been the predominant fuel, accounting for nearly 60 percent of the total demand in the early 1970s. Since then, the use of diesel oil has increased and surpassed that of gasoline. By 1982, the relative shares of diesel and gasoline use in transportation were 45 and 31 percent, respectively. This major shift in the structure of demand was due mostly to a steady increase in the price of gasoline relatively to that of diesel and, to a smaller extent, to the increased use of alcohol fuels as a substitute to gasoline.

Throughout the late 1960s and early 1970s, the price of gasoline had usually been 20 percent higher than that of diesel. In 1974, in order to curb gasoline demand, a pricing policy was adopted which placed a surtax on gasoline, raising its price beyond the increases in the price of crude oil (Homem de Melo, Conjuntura Economica 1982). That surtax accounted for as much as 30 percent of the price of gasoline at the pump. By 1980, the price of gasoline was 2.5 times that of diesel.

The change in the relative price of fuels prompted a steady increase in the diesel truck fleet. A study of the cost of truck freight (Pinheiro, 1983) determined that trucks were used at an average 1300 km per month, and that, before 1974, the use of diesel trucks was

advantageous in fleets with an average vehicle use of at least 3000 km per month. By 1980, as a consequence of the surtax on gasoline, diesel trucks became economical at a much lower average vehicle use of 500 km per month, which explains the extreme change in the composition of the truck fleet (Figure 4). As of 1981, the policy of placing a surtax in the price of gasoline has been abandoned. If the relative price of gasoline and diesel oil returns to its pre-1974 levels, a gradual change in the composition of the truck fleet can be expected.

The conversion of the truck fleet to diesel engines was not the only factor determining the reduction of total gasoline use in transportation. Conservation of gasoline was also promoted through measures such as:

- limiting operation of gasoline stations from 6 a.m. to 9 p.m., Monday through Friday. Gasoline stations do not operate on weekends and holidays (thereby precluding long trips by private automobiles). On the other hand, alcohol fuel is made available throughout the weekend.

- providing tax and financial subsidies to buyers of cars equipped to run on pure alcohol fuels.

- converting federal and state agency vehicle fleets from gasoline to alcohol.

- stricter enforcement of speed limits on highways.

- increased use of electricity as a source of energy for public transportation, especially through the construction of subway systems in the main urban centers.

The higher gasoline prices, combined with the above conservation measures, resulted in a decrease in the use of vehicles as measured in kilometers per year (Figure 5). Consequently, the average use of gasoline per car also decreased, helped by a slight improvement in the average efficiency of cars (Figures 6 and 7).

A third factor contributing to the reduction in the use of gasoline is the expanded use of alcohol fuels. Since 1975, Brasil has intensified the use of ethanol made from sugar cane as a substitute for gasoline. Ethanol has been used both in mixture with gasoline (up to 20 percent in volume), and also as pure fuel in cars especially designed for that purpose. In 1982, alcohol fuels accounted for 10 percent of total energy use in transportation, up from less than 1 percent at the end of 1976 (Figure 8). This strategy has proven successful to the extent that production of alcohol has increased substantially, and its use as transportation fuel become more widespread. In 1982, a daily average of 53,000 barrels of alcohol were used as transportation fuel, compared to 161,000 barrels of gasoline. Through the National Alcohol Program, the government continues to provide incentives for increased production, hoping that, by the end of this decade, alcohol fuels will displace as much as 40 percent of the projected demand for gasoline.

INDUSTRY

The industrial sector typically accounts for over 70 percent of all fuel oil use in Brasil. Over the years, use of fuel oil in industry has been encouraged by low prices, and by the virtual nonexistence of coal as an alternative. Electricity has always been far more expensive and, besides, it is not necessarily a direct substitute for fuel oil.

The efforts to reduce the use of petroleum products in the industrial sector have been aimed at decreasing the use of fuel oil. Those efforts have proven very successful: during the 1970s, industry has been the sector which achieved the largest reduction in the use of petroleum products. That reduction was accomplished primarily by replacing fuel oil with electricity and coal: from 1973 to 1982, the share of fuel oil in total energy use in industry declined from 30 to 16 percent, while that of electricity increased from 32 to 45 percent.

The industries that managed most of the reduction in fuel oil use were: cement (52 percent), food and beverages (47 percent) and chemicals (43 percent).

The cement industry,which had been the largest single user of fuel oil, has been gradually shifting to coal and charcoal as its main sources of energy. Further reductions will be contingent upon the availability of capital for the required change in equipment, as well as on the existence of a reliable supply of domestic coal.

The use of fuel oil in steel production has also been sharply reduced (Figure 9), primarily through increased use of coke and hydroelectricity.

Substantial reduction in the use of fuel oil can also be achieved in the paper and pulp industry, which is in a very favorable position to increase the use of firewood. That has been taking place since 1980 by using the bark of the trees processed for production of paper, in addition to the use of fuelwood from commercial forests. Government financing has been available for commercial forestry, and is expected to continue, so that by 1985 fuelwood could account for 830 thousand TOE, a 27 percent increase over 1982 levels. The continued existence of financial subsidies is considered critical for the expanded use of firewood in the paper and pulp industry (Estado de Sao Paulo,1981).

The use of alternative fuels has clearly brought about a sizeable reduction in the use of fuel oil in industry. Further reductions will hinge upon the price of alternative energy sources, the reliability of domestic coal supply, and subsidies to the use of other fuels such as firewood.

It is important to notice that, despite the relatively higher increase in the price of fuel oil than in that of electricity, the latter is still far more expensive to the end-user. At 1981 levels, a ton of oil equivalent of fuel oil would cost approximately $230, whereas the equivalent amount of electricity (end-use equivalence, or 3413 Btu/kWh) would cost nearly $600.

RESIDENTIAL

The energy market in the residential sector can be divided into two groups with very distinct patterns of energy use. In the rural areas, most of the energy is used for cooking, which is fueled primarily by wood. Three-quarters of all wood stoves are concentrated in rural areas, and account for nearly two thirds of the fuelwood used in Brasil (IBGE,MME).

In urban households, cooking accounts for a smaller share of total demand for energy, because there is more use of electricity for lighting and appliances. Cooking is done primarily with gas, and accounts for nearly 90 percent of total LPG use in the country.

Between 1970 and 1982, there was a continued and intense migration of population towards urban areas, causing the energy-use patterns to change accordingly. In 1970, 56 percent of the population lived in urban areas; by 1982 that fraction had climbed to 70 percent. As expected, urbanization was accompanied by a steady decline in the use of firewood, and an increase in the use of electricity and LPG (Figure 10).

A marked characteristic of the substitution of electricity and LPG for firewood is the increase in end-use efficiency, evidenced by the declining total use of energy per household (Figure 10). Because electrical and gas appliances are usually more efficient than wood stoves, less energy is needed to perform the same services. That has led the total energy use in the residential sector to increase at a slower rate than the other sectors (2.7 percent in 1970 to 1982, compared to an overall average of 6.6 percent). The increase observed in the residential sector, even though smaller, has been steadier than in other sectors. While the industrial and transportation sectors were influenced by higher energy prices and sluggish economy, the residential sector posted a steady annual increase in its energy use (about 3 percent) regardless of economic conditions. The regularity of the increase in energy use indicates that, as urbanization progresses, households have to rely more heavily on LPG and electricity as energy sources, regardless of their prices. While the real

price of LPG has been kept constant, electricity rates for residential users doubled from 1978 to 1981, and yet, there was a 9 percent increase in the use of electricity in the residential sector.

From the standpoint of imports, the use of LPG in the residential sector does not appear to be a cause of concern. During most of the period between 1970 and 1982, Brasil has been self-sufficient in the production of LPG, that is, the fraction of each barrel of oil refined that is transformed into LPG has been, in most years, enough to meet the demand for that fuel (Table 5). Assuming that the use of LPG in the residential sector will continue according to the same pattern observed so far, and given that enough oil will have to be refined to satisfy the demand for diesel oil, the country should not have to import additional LPG to supply the residential sector.

CONCLUSIONS

Over the last 10 years, the main thrust of energy policy in Brasil has been the reduction of the country's dependence on imported petroleum. That has been achieved by increasing and diversifying the production of domestic energy sources, as well as by promoting conservation and inter-fuel substitution in the various sectors of the economy.

The implementation of new energy policies, combined with the severe recession that has beset the economy since 1980, has reduced Brasil's dependence on imported oil: petroleum imports now account for 65 percent of total oil supply, compared to 85 percent in 1977. Most of the reduction in the demand for petroleum products has occurred in industry, where fuel oil continues to be replaced with hydroelectricity, coal, and biomass fuels. In transportation, the use of gasoline has been substantially reduced as a consequence of higher prices and of the increased use of alcohol fuels.

With the decrease of fuel oil use in industry and gasoline in transportation, diesel oil has become the limiting factor for further reductions in aggregate demand for petroleum. It has become the most used petroleum product, and currently accounts for the largest share of petroleum refining (30 percent of each barrel). On the other hand, petroleum production in Brasil in 1983 averaged just under 400 thousand barrels per day, and it is expected that by 1985 it will reach 500 thousand barrels. Even though that is a remarkable increase, equivalent to an average yearly rate of 11 percent between 1973 and 1983, it just mathces the growth in the use of diesel oil in transportation. Furthermore, the expanded production is due primarily to the operation of the field of Campos, off the coast of Rio, which is the only large additon to reserves achieved during almost ten years of intense exploration for new oil fields.

Given the limitations to increased domestic oil production, and considering that even in a period of economic recession the use of diesel in transportation has been increasing rapidly, it seems that additional decreases in Brasil's dependence on imported oil will not be possible without reducing the use of diesel oil in transportation.

References

1. All information on energy use, both aggregate and by sector, was taken from MME, Ministerio de Minas e Energia - National Energy Balance, Brasilia, 1983.

2. Information on the structure of petroleum refining, and on the price of petroleum products was taken from CNP, Conselho Nacional do Petroleo - Anuario Estatistico, 1982, Brasilia, May 1982.

Homem de Melo, F.B. - A Questao dos "Subsidios" ao Oleo Diesel, Conjuntura Economica, vol.36, no.7, July 1982.

Anuario Estatistico, Conjuntura Economica, vol.38, no.2, Feb. 1984.

Caderno Especial de Energia, O Estado de Sao Paulo, 13 Nov. 1981.

Table 1. Brasil - Composition of GDP

(in %)

	1970	1975	1980
Agriculture	10	8	7
Mining	1	1	1
Manufacture	27	30	29
Electric Power	2	3	3
Construction	6	6	7
Commerce	16	15	15
Transp. +	5	6	6
Financial Services	14	13	14
Other Services	10	9	10
Government	9	9	9

Source: IDB, Economic and Social Progress in Latin - America

Table 2. Brasil Cement and Steel Production

(in 10^3 tonne)

	Cement	Steel
1973	13398	7150
1974	14919	7494
1975	16736	8309
1976	19146	9170
1977	21123	11166
1978	23239	12122
1979	24871	13866
1980	27194	15203
1981	26052	13108
1982	25434	12924
1983	20874	14603

Source: Conjuntura Economica,
Vol 38, No. 2, Feb. 1984

Table 3. Brasil Fuel Prices

(Constant dollars of 1980)**

	Gasoline ($/l)	Diesel ($/l)	Kerosene ($/l)	Fuel Oil ($/kg)	LPG ($/kg)	Electricity* (¢/kwh)
1976	0.42	0.21	0.21	0.06	0.36	4.8
1977	0.38	0.21	0.21	0.06	0.33	4.7
1978	0.37	0.21	0.20	0.05	0.31	4.8
1979	0.65	0.43	0.34	0.09	0.27	7.8
1980	0.80	0.31	0.31	0.23	0.30	7.9
1981	0.69	0.42	0.41	0.23	0.44	7.5

*For industrial users
**Exchange rate $64/US$

Source: CNP and CESP

	$/GJ	$/GJ	$/GJ	$/GJ	$/GJ	$/GJ
1976	12	5	6	1.4	7	13
1977	11	5	6	1.4	7	13
1978	11	5	5	1.2	6	13
1979	19	11	9	2	5	22
1980	23	8	8	5	6	22
1981	20	11	11	5	9	21

Table 4. Brazil - Final Energy Use by JSource4

(in %)

	1970	1975	1980	1982
Petroleum products	40	46	42	38
- Diesel	9	11	12	12
- Gasoline	12	12	7	6
- Fuel Oil	11	14	13	8
- Kerosene	2	2	2	2
- LPG	2	2	2	3
- Other	4	5	6	7
Electricity	18	21	27	30
Firewood	31	22	16	16
Others	11	11	15	16

Source: National Energy Balance (1983).

Table 5. Brasil - Use and Trade of LPG

(in 10^3 TOE)

	Consumption	Imports	Exports	(I-E)/C (%)
1970	1333	405	-	30
1973	1764	178	23	9
1974	1879	237	40	10
1975	1965	33	61	-
1976	2155	149	11	6
1977	2268	186	16	8
1978	2510	69	35	1
1979	2763	75	36	1
1980	3004	112	20	3
1981	3160	137	47	3
1982	3430	661	22	19

Source: MME, 1983

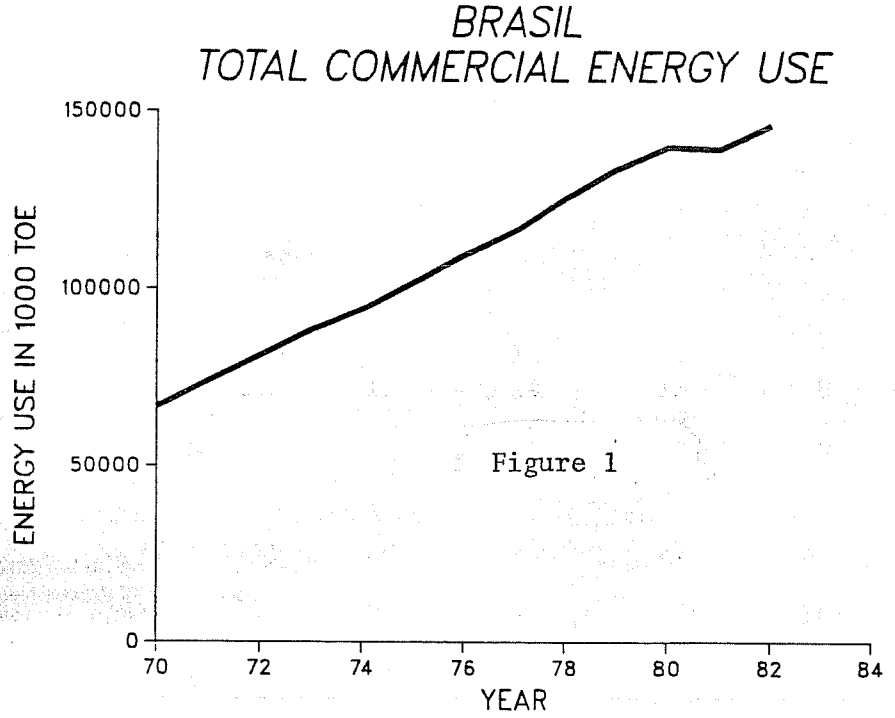


Figure 1

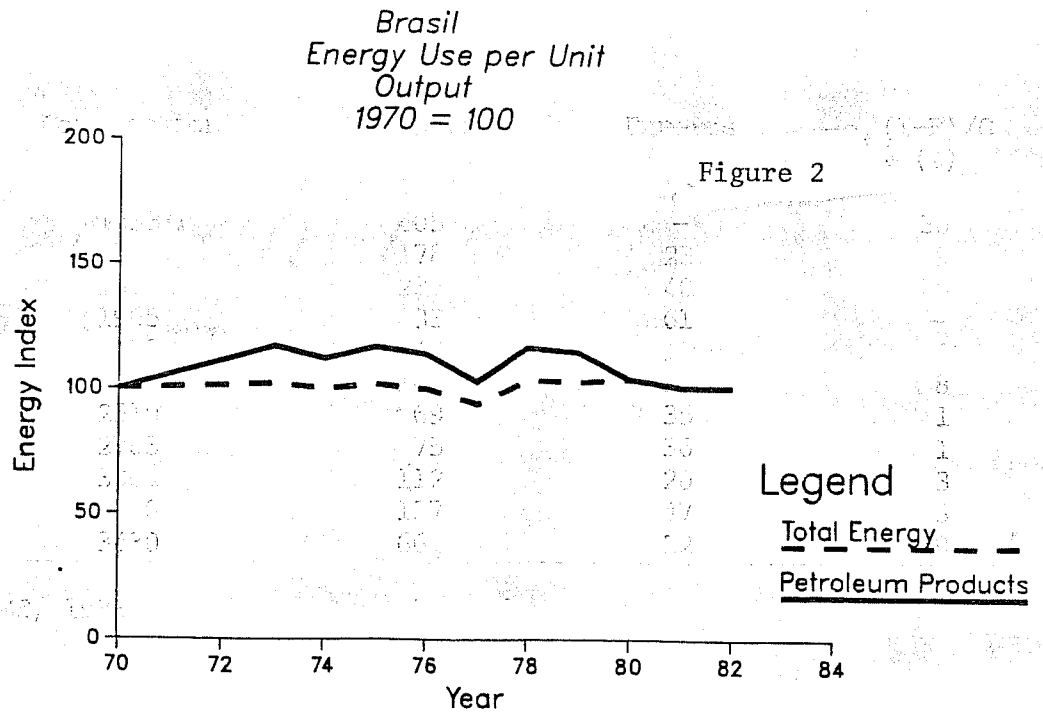
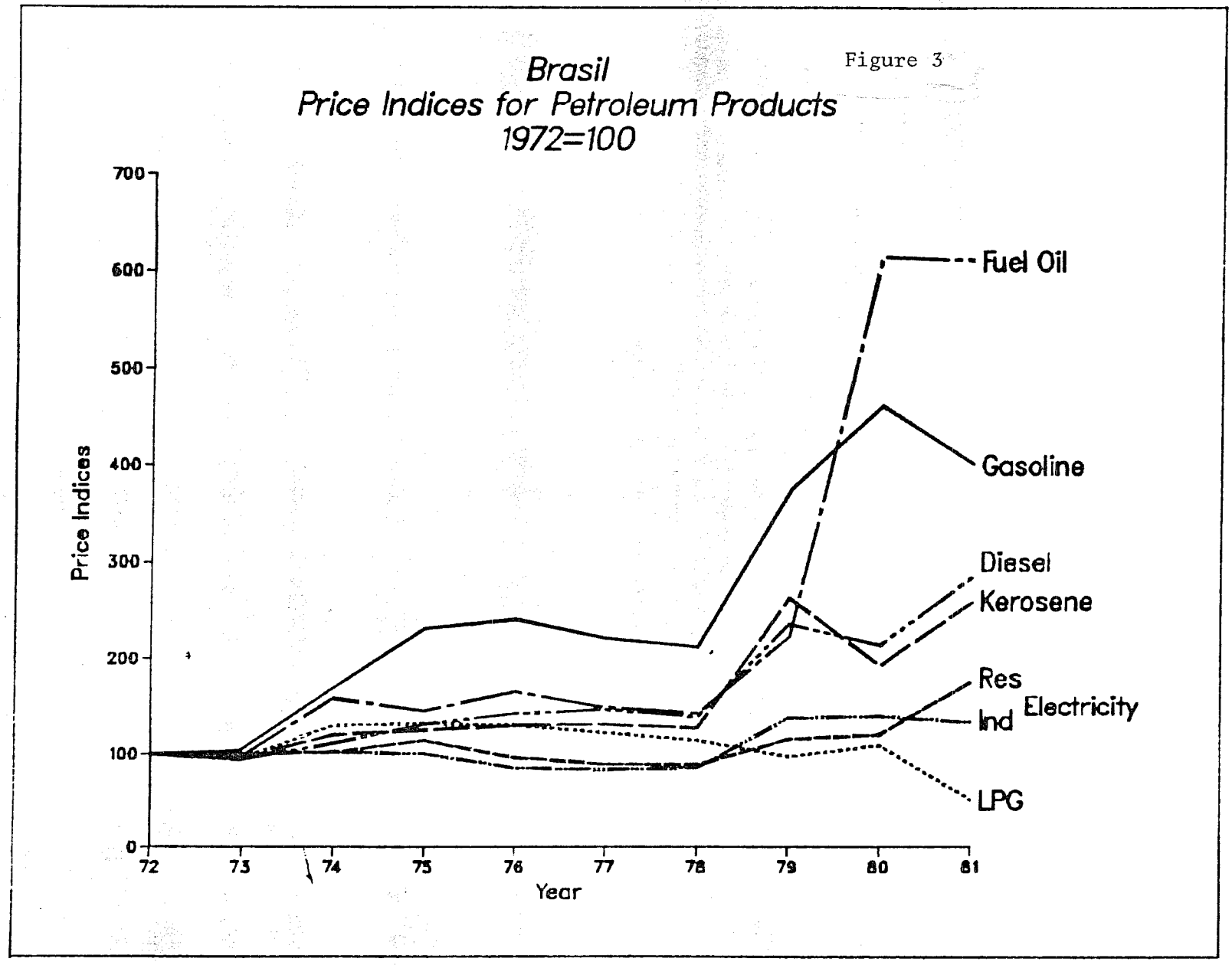


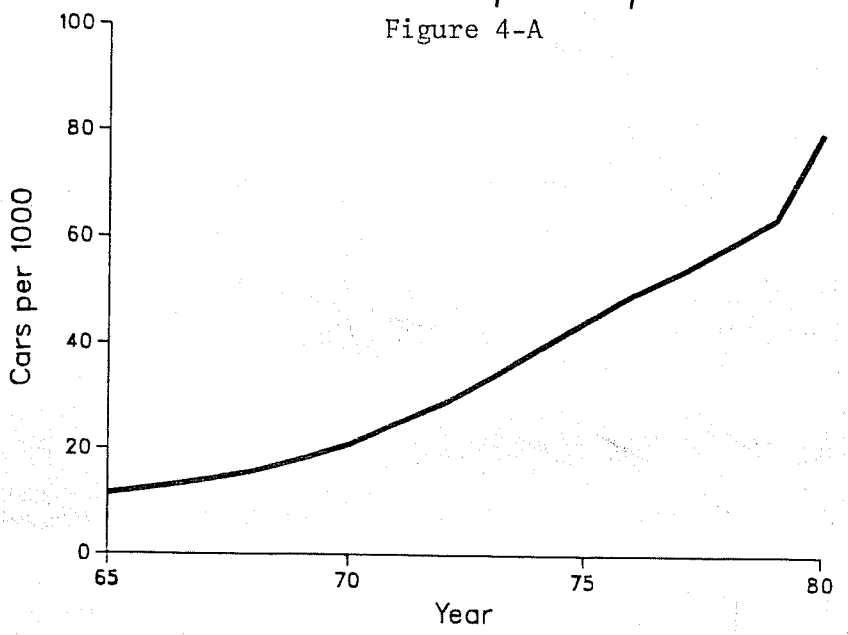
Figure 2

Figure 3


Brasil
Price Indices for Petroleum Products
1972=100
Price Indices
700
600
500
400
300
200
100
0
72
73
74
75
76
77
78
79
80
81
Year
Fuel Oil
Gasoline
Diesel
Kerosene
Res
Ind
Electricity
LPG

Brasil
Automobiles per Capita

Figure 4-A



Brasil
Personal Income
and Car Prices
1965 = 100

Figure 4-B

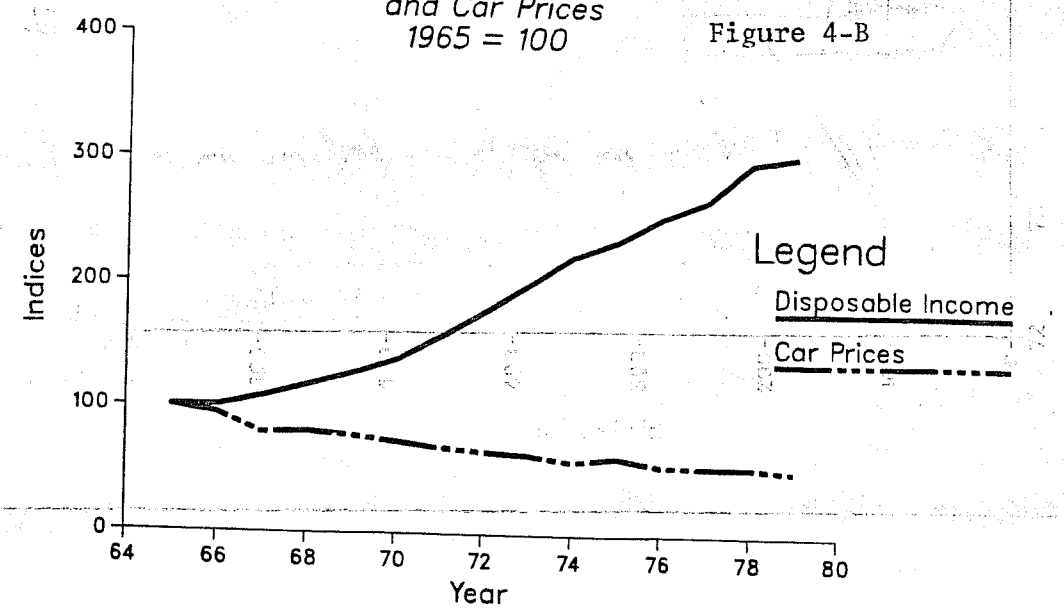
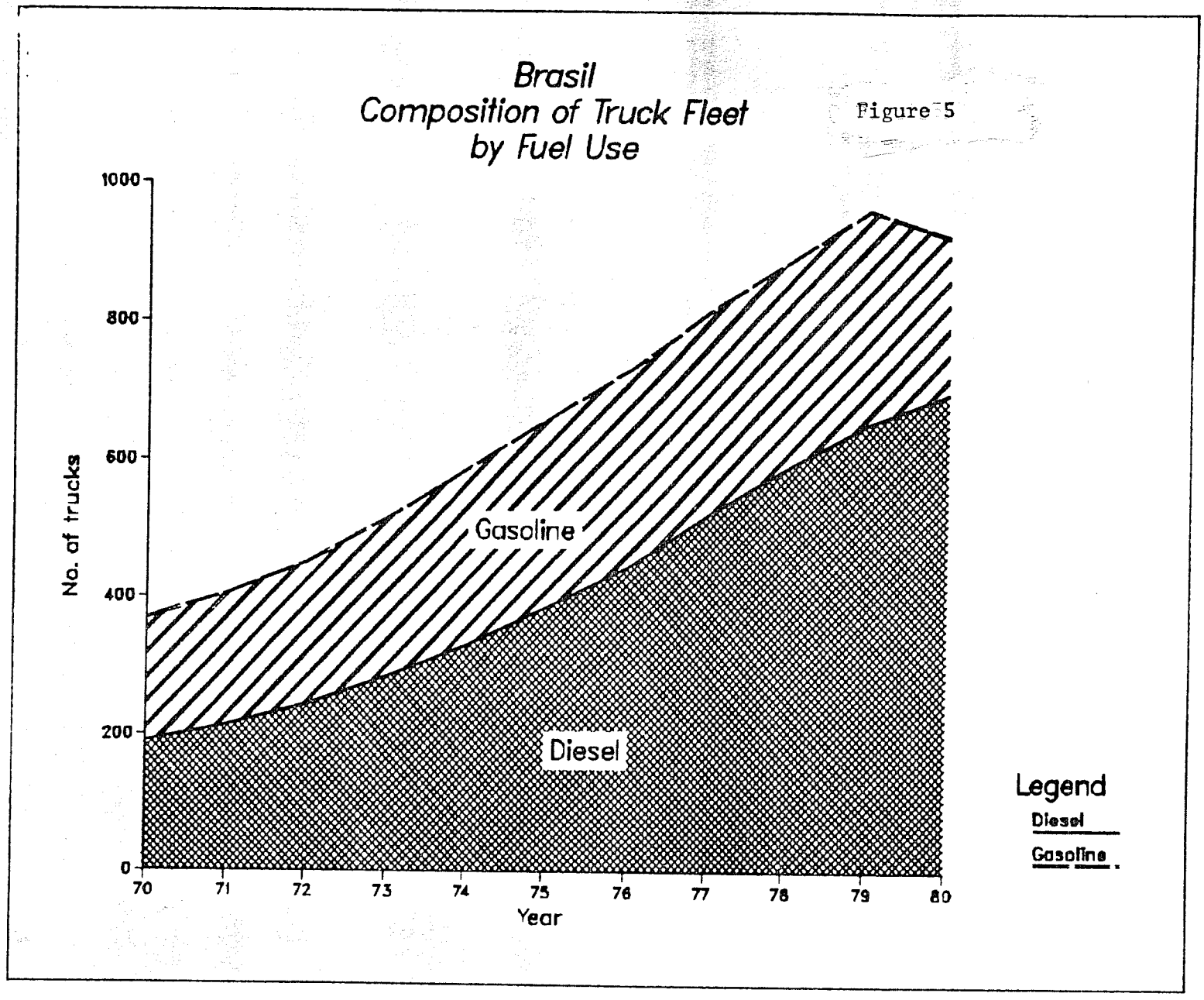


Figure 5


Brasil
Composition of Truck Fleet
by Fuel Use
No. of trucks
1000
800
600
400
200
0
Gasoline
Diesel
70
71
72
73
74
75
76
77
78
79
80
Year
Legend
Diesel
Gasoline

Brasil
Use of Vehicles
1000 km per vehicle per year

Figure 6

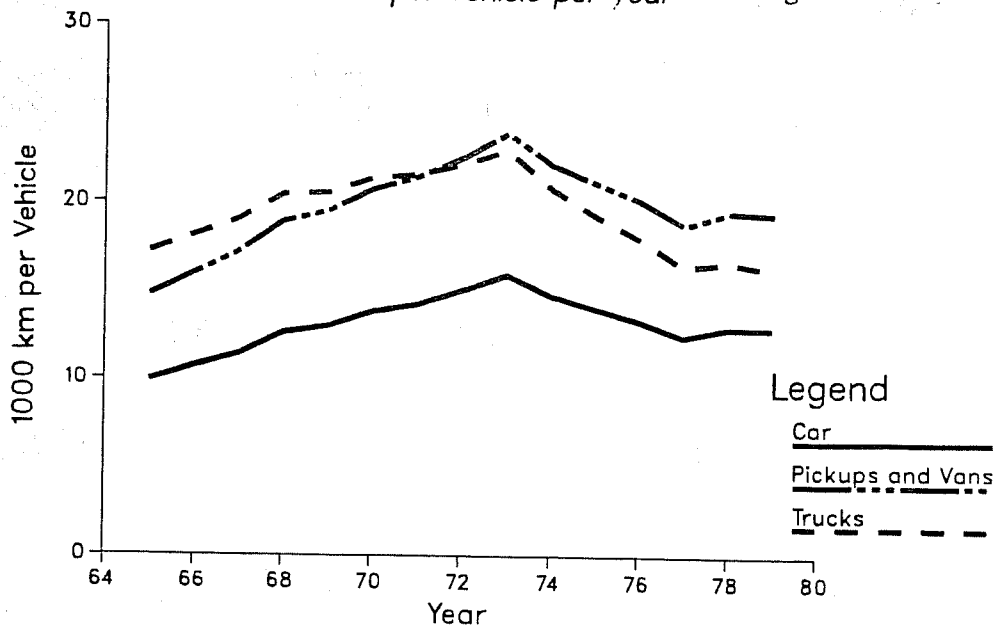


Figure 7

Brasil
Efficiency of Gasoline Cars

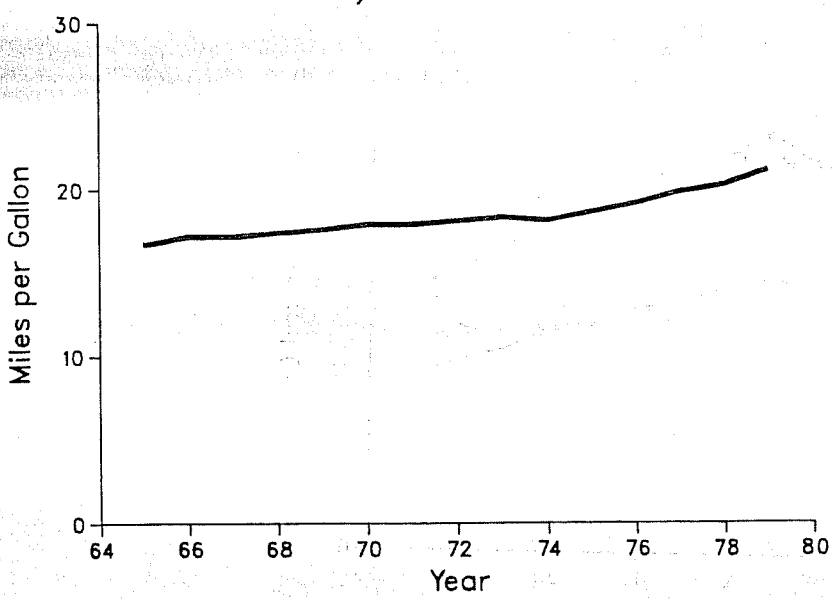


Figure 8

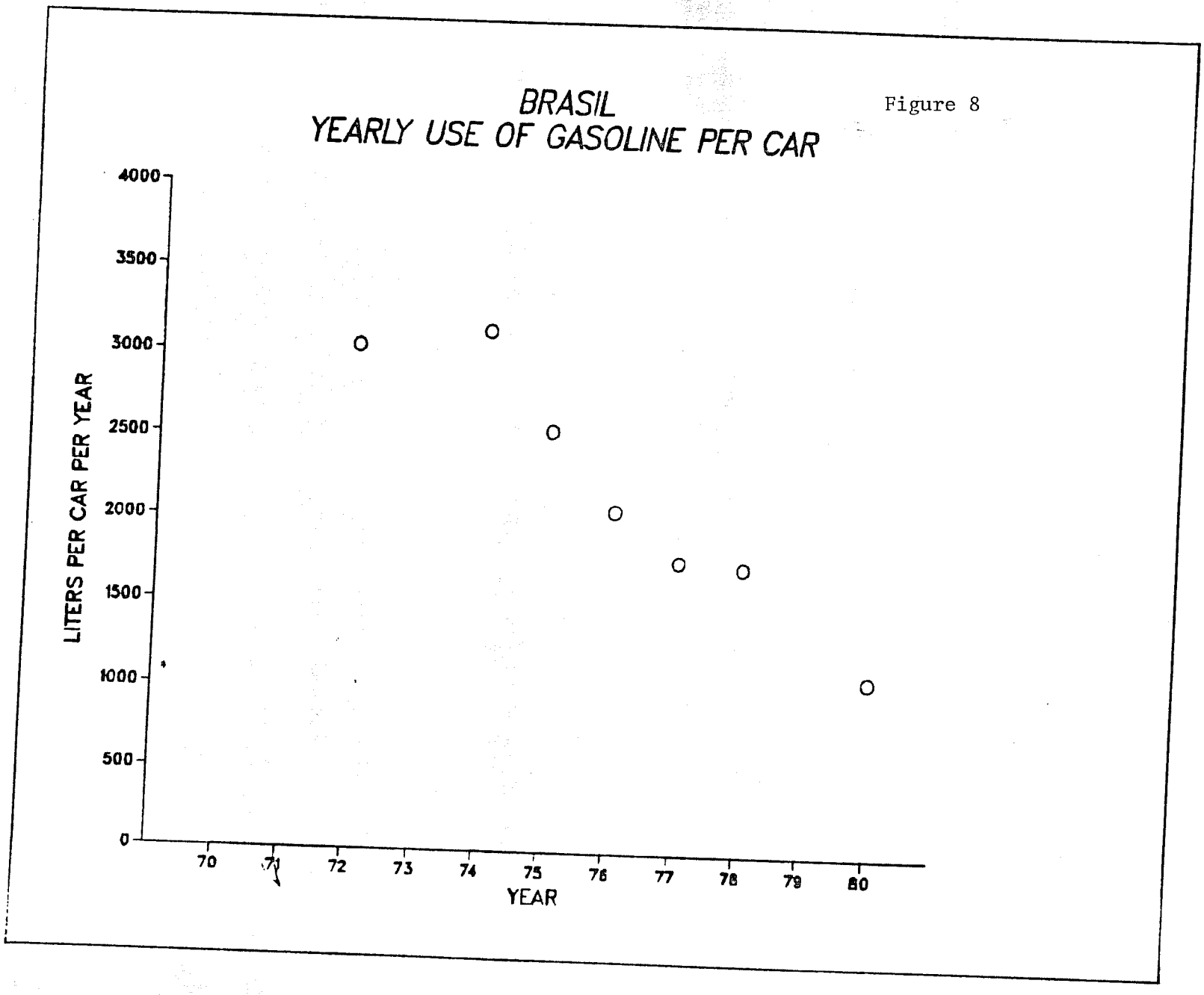
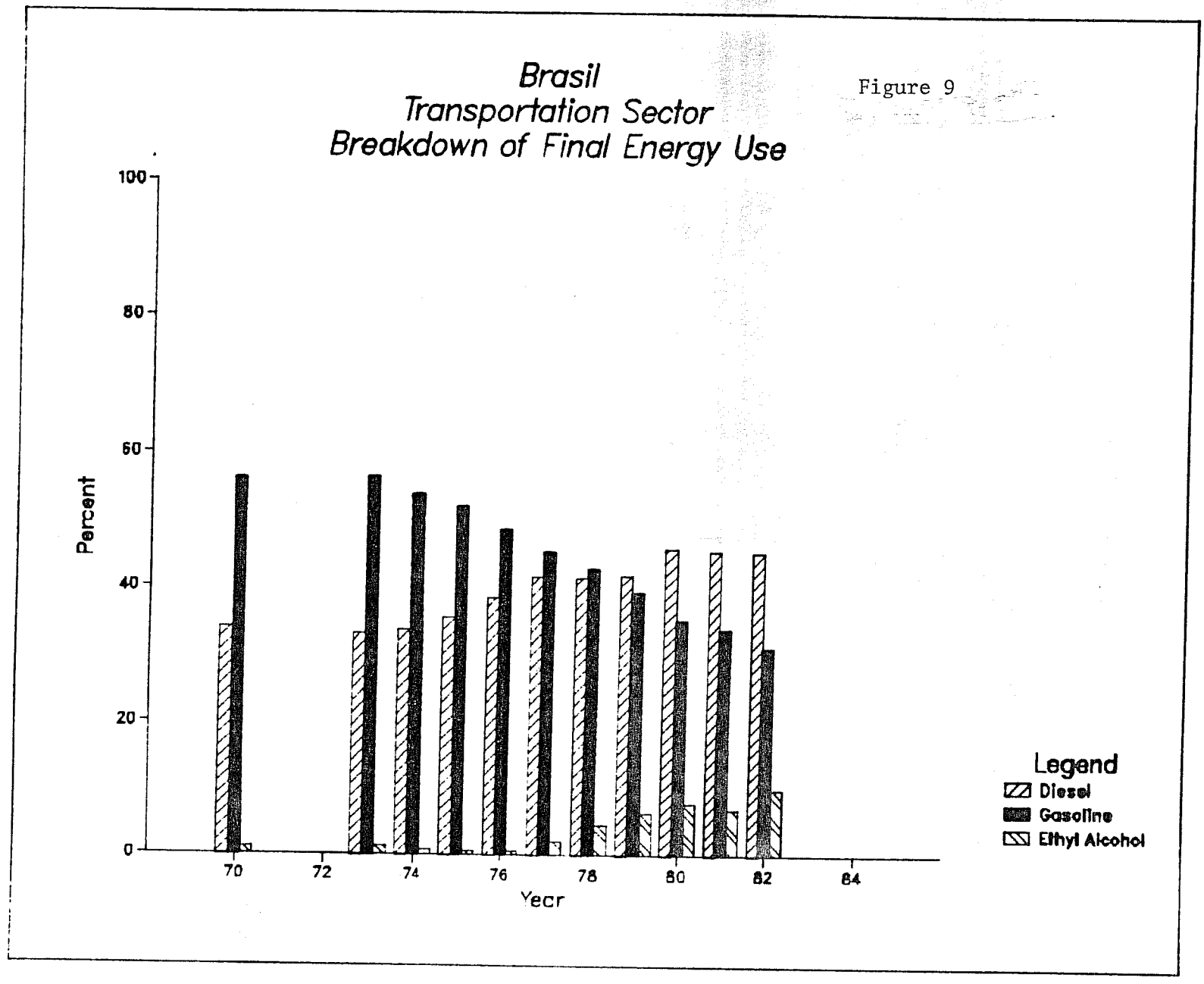

BRASIL
YEARLY USE OF GASOLINE PER CAR
LITERS PER CAR PER YEAR
4000
3500
3000
2500
2000
1500
1000
500
0
70
71
72
73
74
75
76
77
78
79
80
YEAR

Figure 9


Brasil
Transportation Sector
Breakdown of Final Energy Use
Percent
100
80
60
40
20
0
70
72
74
76
78
80
82
84
Year
Legend
Diesel
Gasoline
Ethyl Alcohol

Fuel Oil Use for
Cement and Steel Production
Tons of Oil Equivalent per Tonne of Output

Figure 10

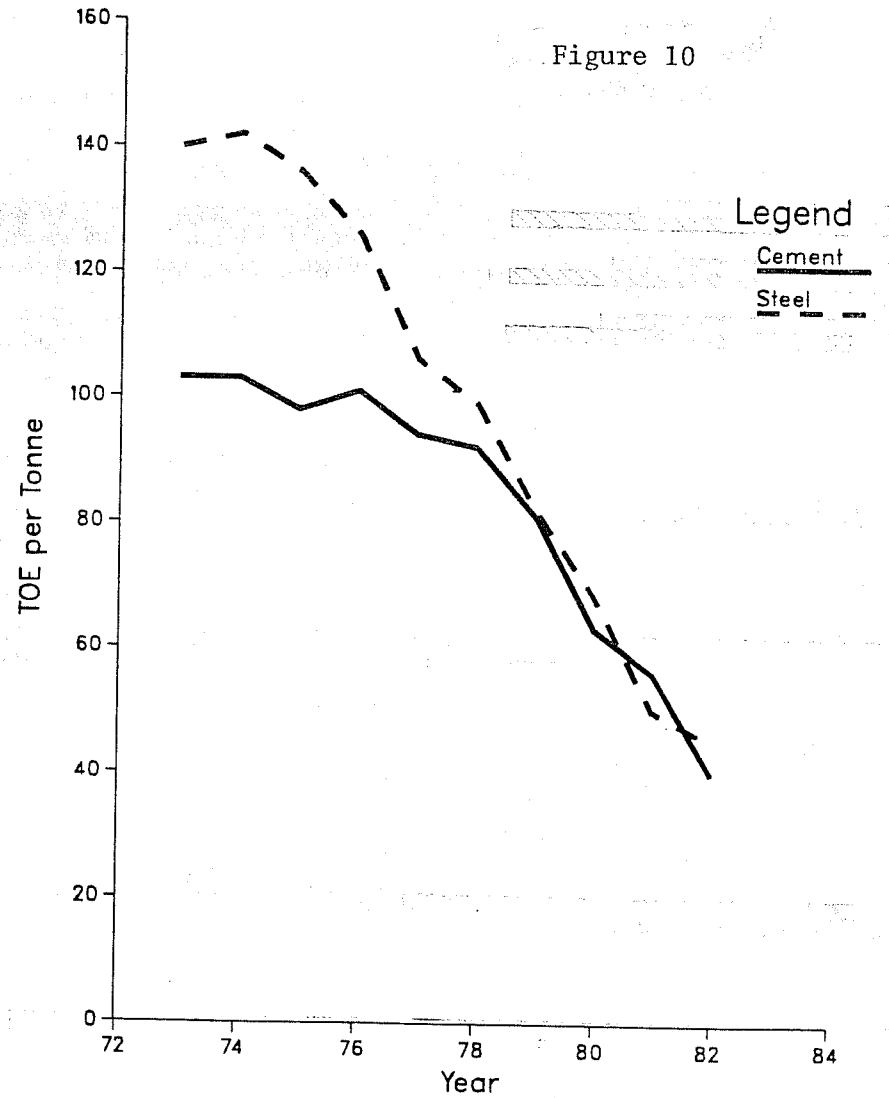


Figure 11

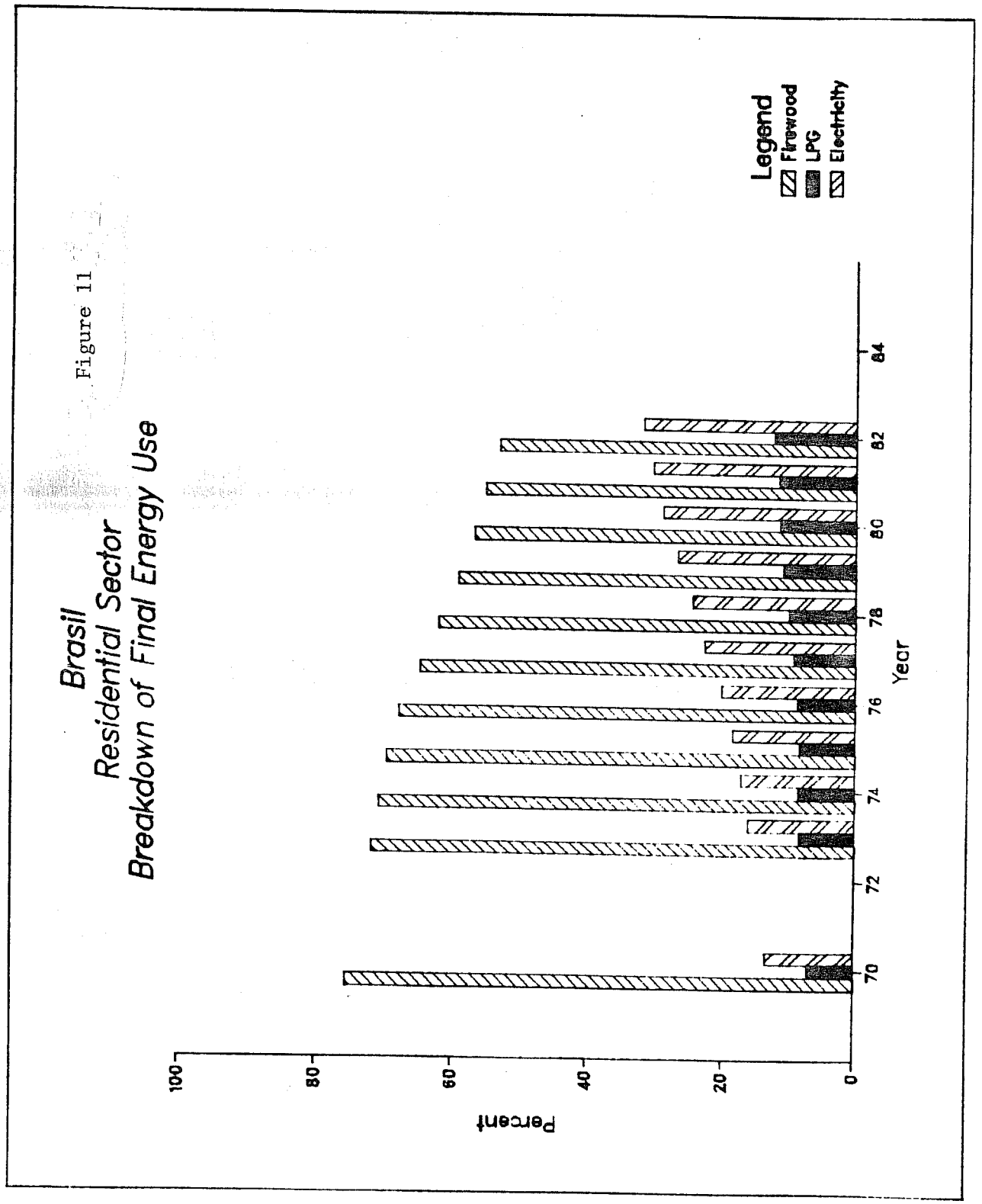
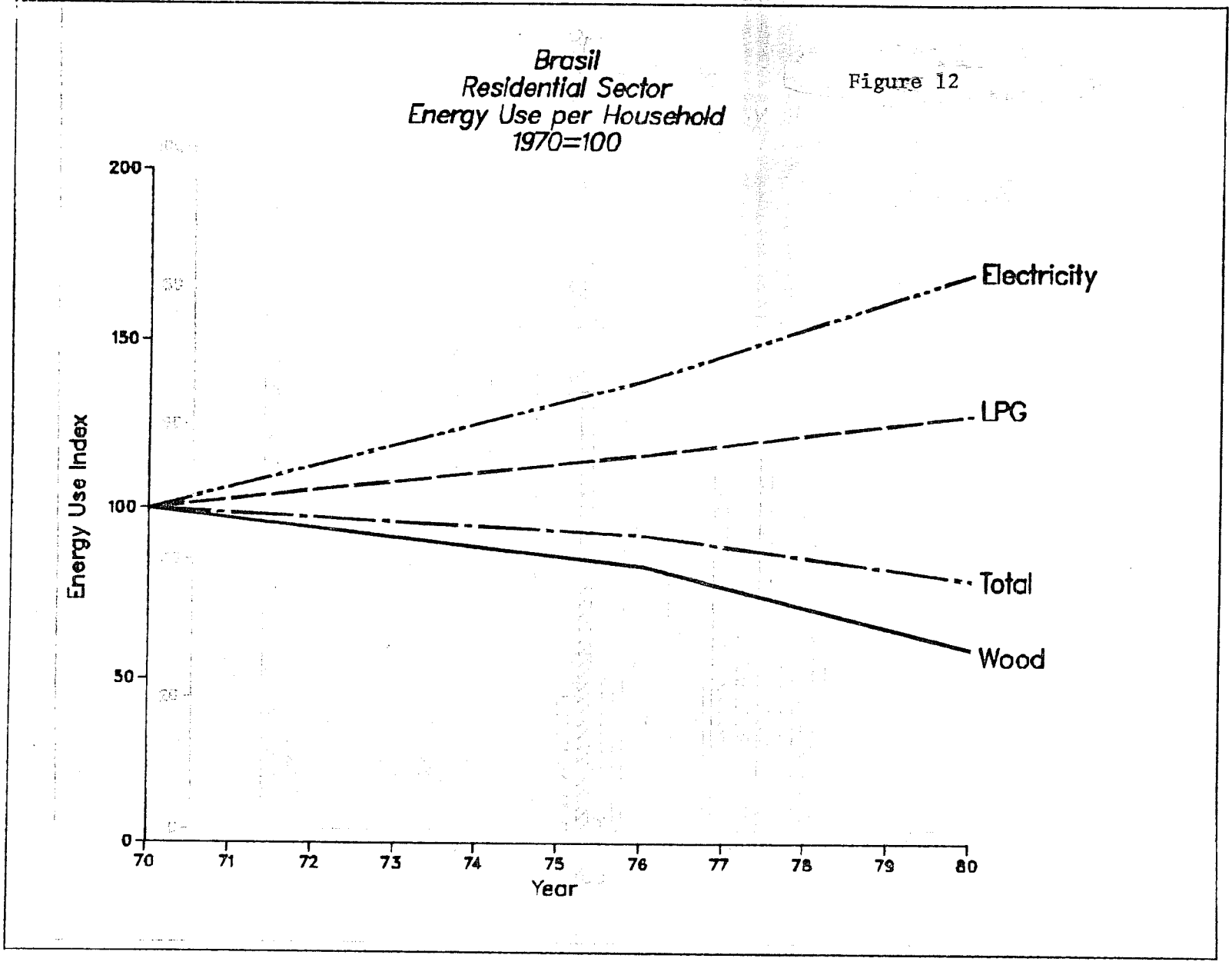

Brasil
Residential Sector
Breakdown of Final Energy Use
Legend
Firewood
LPG
Electricity
Percent
0
20
40
60
80
100
Year
70
72
74
76
78
80
82
84

Figure 12


Brasil
Residential Sector
Energy Use per Household
1970=100
Energy Use Index
200
150
100
50
0
70
71
72
73
74
75
76
77
78
79
80
Year
Electricity
LPG
Total
Wood

ENERGY DEMAND AND FUEL SUPPLY PROJECTIONS: KOREA

TABLE OF CONTENTS

INTRODUCTION

Rapid economic development helped Korea transform itself from a developing country into a newly industrialized country (NIC) in the past 20 years. This rapid change was accompanied by a twofold increase in commercial energy consumption per capita, and a decline in the consumption of non-commercial energy.

This paper reviews the economic development and the related changes in energy demand in Korea over the last decade. Projections of fuel supply are reviewed to evaluate the potential for imports of energy resources.

ENERGY AND ECONOMIC DEVELOPMENT

Since 1962, Korea has implemented a series of 5-year plans that transformed a largely agricultural, subsistence economy into a newly industrialised one. From 1962 to 1983, the Korean economy grew at an average annual rate of 8.4%. During this period, the share of manufacturing in GNP increased from 9.1% to 29.1%, and that of agriculture, forestry, and fisheries decreased from 43.3% to 15.9%. The share of primary products exports declined from 78% of total exports to 9%, and that of manufactured exports increased from 22% to 91%.

In 1981, Korea had a per capita GNP of US $1750 and a total GNP of US $67.9 billion. Among the Asian countries in the study, Korea ranks as the third largest country after India and Indonesia. Its per capita GNP also places it in the third place after Taiwan and Malaysia.

The period prior to 1962 was characterized by an economic development strategy based on import substitution. However, the small size of the domestic markets soon inhibited growth. GNP increased at only 3.7% a year prior to 1962. Per capita GNP in 1962 dollars was US$87. Despite the small per capita GNP, the country had enormous potential for development. Literacy rate increased from 22% in 1945 to 72% in 1960. Similar advances took place in other indicators such as the number of students enrolled in colleges, equitable distribution of land, decline in number of tenant farmers, etc.

Since 1962, because of its poor natural resource endowment, Korea adopted an outward looking development strategy, making use of the comparative advantage in labor intensive products. Growth in real GNP between 1962-71 was 8.7% and per capita growth was 6.9%. As the economy grew rapidly, important structural changes took place. The mining and manufacturing sector increased its share of GNP from 16% in 1962 to 22% in 1971, while the share of agriculture, forestry, and fisheries decreased from 37% to 27%. Employment in these sectors changed similarly.

The industrialization strategy of the 1970s included, expansion of heavy and chemical industries and the modernization of the agriculture sector. This strategy called for substitution of imported materials and capital goods, and the development of a new source of strategic export industries. This emphasis on one sector of the economy led to many imbalances unfavorable to economic development. It is argued that it caused income distribution to worsen, led to unjustified wage increases compared to other NICs, and to insufficient investment in light industry which was internationally competitive. [1]

The two oil price increases during the 1970s caused enormous difficulties to the industrialization program. The trade deficit quadrupled in 1973-74 and tripled in 1978-79. [2] The percentage of export earnings going to pay for oil imports increased from 9.2% in 1973 to 22.9% in 1974. They remained virtually unchanged till 1979, and then increased to 35.1% in 1980. [3] Despite a large increase in the trade deficit and in the fraction of exports needed to pay for oil, the share of liquid fuels as a fraction of total energy consumption increased from 63% in 1973 to 65% in 1978. [4] Partly, because other means were found to reduce the trade deficits, oil imports did not receive as much attention. However, the second oil price increase required immediate attention, since world recession prevented further exports and worker remittances from the Middle East tailed off. Consequently, the share of liquid fuels declined to 60% in 1981.

The development strategy for the 1980s calls for restructuring of the economy for continued high growth with price stability. To accomplish this, the government is pushing for improvement in energy, labor, and capital productivity.

PRIMARY ENERGY CONSUMPTION

From 1961 to 1982, Korea underwent three energy transitions. In the first transition, from 1961 to 1965, fuel-wood was substituted by coal. In the second, from 1967 to 1973, coal use in the non-residential sectors was replaced by oil, and in the third, from 1974 to date, oil use was replaced by a mix of fuels- imported coal, and nuclear. Projections call for continued use of these fuels, and imports of LNG.

Table 1 shows the primary energy supply in 1961 and 1965. The share of domestic coal increased and that of fuel-wood decreased during this period. The government encouraged use of domestic coal to avert deforestation caused by uncontrolled logging for fuel-wood use. Oil imports amounted to a very small fraction of the total energy supply.

Table 2 shows the primary energy supply in 1965 and 1973. Oil imports increased dramatically during this period. Rapid urbanization led to shortages of domestic coal. The percentage of population in the cities increased from 28% in 1960 to 48% in 1975. Oil imports were then encouraged to substitute for coal use in power plants and industries.

Table 3 shows the primary energy supply in 1973 and 1982. Although, the share of oil imports increased from 54.4% in 1973 to 56.4% in 1982, annual figures show the share increased from 1973 to 1978 and declined subsequently. Projections show the share declining for the forseable future. The emphasis on imports of non-oil fuels in the future is apparent in 1982. Shares of imported coal and nuclear were significant in 1982. The share of domestic coal has declined because coal resource is limited compared to demand, and domestic production is not expected to increase substantially in the future. The use of fuel-wood is also expected to decline in the future as it is replaced with more convenient domestic fuels. Imports of LNG from Indonesia are expected to begin in 1987.

Figure 1 shows the energy consumption per unit of GDP with and without the inclusion of wood and charcoal. Including wood and charcoal, it declines uniformly as commercial fuels substitute for these fuels. Excluding these two fuels, the ratio increases till 1975 and then declines to 1979. The figure is slightly misleading since it does not show annual data. Table 4 shows the

annual data after 1978. It shows that the ratio increased from 1978 to 1979 and further to 1980, but has declined since. The reasons for the increase in 1979 and 1980 are many, and are explained in the section on petroleum products.

POWER

Table 5 shows the fuel consumption for power generation from 1970 to 1982. The share of petroleum increased from 1970 to 1975 but has declined since then as nuclear power has replaced oil. The use of domestic anthracite will continue to play a minor role in the generation picture due to its limited availability. Future plans for expansion call for increased use of nuclear fuel, imported coal, and LNG in power plants. LNG use in power plants is being promoted, because it will serve to reduce the environmental pollution in metropolitan areas, and it will help in assuring summer demand for LNG. In winter, LNG will be supplied primarily to households for domestic heating. The introduction of these fuels will lead to a decline in the use of fuel oil for power generation. The present 80% use of oil would decline to 30% by 2000.

Table 6 shows the breakdown of electricity use by the three major sectors. The share of residential electricity use has increased rapidly from rather low levels in 1970. Shares of commercial and industrial sales have declined.

PETROLEUM PRODUCTS

In spite of the first oil price increase in 1973, domestic consumption of petroleum products continued to increase till 1979. In 1973, total consumption amounted to 94.7 million barrels. By 1979, it had almost doubled to 185.4 million barrels. Subsequently, in response to higher oil prices, it declined to 181.7 million barrels by 1982. Consumption of gasoline, kerosene, and fuel oil declined, and that of diesel increased after 1979. In 1982, gasoline consumption was little over half the 8.6 million barrels used in 1979. Fuel oil consumption declined more rapidly, by about 7.5 million barrels. Diesel fuel consumption increased by 3.5 million barrels. The change in demand for petroleum products has created an imbalance in refinery capacity, and may

affect the plans for imports of coal as a substitute for fuel oil. Oil use is heaviest in industry (37%), followed by transportation(22%), electricity(25%), and residential and commercial(16%). In the following paragraphs, we analyze the changes in consumption of, and the projected demand for petroleum products.

Industry:

Rapid economic growth permitted introduction of new industries in Korea, thus changing the composition of industry over the last two decades. Rapid growth also permitted investment in new and more energy efficient technology. As a consequence, the intensity of energy use in industry declined during this period. Further, oil price increases caused a reduction in the demand for oil and a switch to other fuels, such as coal and nuclear power.

In 1982, oil accounted for roughly 50% of the final energy used in industry; a sharp decline from the 90% level in 1973 (Figure 2). Most of the decline was made up by an increase in the use of coal, which raised the share of coal to 40% in 1982. Electricity made up the remaining decline.

The decline in oil consumption occurred primarily in fuel oil. In 1979, fuel oil use peaked in industry; consumption amounted to 46.2 MBBL or 60% of the total energy used in industry. The decline in fuel oil use was due to changes in composition of industry, replacement by coal in cement industry, and improved management of fuel oil use. In 1982, it declined to 30.8 MBBL, or 53% of total energy used in industry. Diesel consumption decreased during this period, although the share of diesel use increased from 7.0% in 1979 to 8.4% in 1982. Much of the remaining consumption is made up of oil used as raw material-naphtha, solvents, and asphalt. Their consumption and share increased during this period.

Intensity of oil and coal use increased sharply in 1979 and 1980, but has declined since then (Figure 3). Intensity of electricity use has not changed very much over the last decade. The sharp increase in intensity in 1979 may be attributed, partly, to an unusual and unexplained increase in kerosene consumption. Excluding kerosene, intensity still increases but not as sharply. Another,and probably a more important reason, is the low growth of GDP in 1979 and a decline of GDP in 1980.

The reciprocal of intensity is a measure of the productivity of energy use in industry. It is of some interest to examine the changes in energy productivity with respect to changes in labor productivity in developing economies. During 1979 and 1980, as energy productivity declined, labor productivity increased. It appears that during this period of recession, industries were able to lay off workers as a means of cutting production costs, which could not be achieved through reduction in energy costs. The government pronounced a policy of improving productivity in the 1980s. However, in 1983 energy productivity increased from 1982, while the labor productivity declined.

Korea provides a good example of composition change and conservation at work. Economic growth in Korea has averaged nearly 9% per annum over the last 20 years. The share of manufacturing in the GDP has grown substantially - from 18% in 1970 to 34% in 1980 (Table 7). [5] The manufacturing sector itself has become "heavier" as the combined share of "heavy and energy intensive" industry grew from 47% in 1970 to 56% in 1978 (Table 8). Within each of the manufacturing subsectors, however, intensity declined rapidly (Table 9). This drop is due both to energy conservation in factories existing in 1970 and to the addition of new factories that were more energy efficient than the old ones. The latter occurred to such a large extent in heavy manufacturers that the overall energy intensity of the subsector was reduced by over two thirds! This was not due to massive improvement in plant management, but rather to the very rapid expansion (from gross output of 300 billion won in 1970 to over 4000 billion won in 1978) of the heavy manufacturers subsector.

Assuming the price of oil increases in the future, projections of energy use in industry call for an increase in the share of imported coal used in industry. Shares of other fuels are expected to decline. Share of electricity use would increase marginally.

Transportation:

Only 12% of the commercial energy is consumed in the transportation sector. Compared to other countries in Latin America and Asia, this is a small fraction.

Diesel, gasoline and LPG are the three major fuels used in this sector. Diesel consumption in 1982 accounted for 58% of the demand, and gasoline and LPG for about 7% each (Figure 4). The share of diesel use increased from 1979 to 1981, in spite of a threefold increase in the price of diesel. The share of LPG consumption increased over the last few years as the share of gasoline consumption declined.

Gasoline use per car declined from 4350 liters per car in 1979 to 1950 liters per car in 1982. The decline in gasoline consumption can be attributed to an increase in the price of gasoline, and the introduction of LPG as a substitute for gasoline in commercial transportation vehicles. The vehicle miles traveled by commercial vehicles, such as taxis, are roughly five times those for personal cars. Conversion of taxis, a small fraction of the car fleet, to LPG thus accounts for the dramatic increase in the share of LPG consumption.

LPG use per vehicle declined during this period from 17,500 liters to 9050 liters. The decline in consumption per vehicle may be explained by the increase, in real price of LPG in 1981. However, the nominal price of LPG declined in 1982 to 570 won/kg. Surprisingly, per vehicle consumption declined in 1982 by 23%. Except in 1980, per capita GDP increased during this period. If non-commercial vehicles converted to LPG more frequently after 1979, and/or smaller LPG vehicles were introduced, it would explain the decline in per vehicle LPG consumption despite an increase in the GDP and a decline in the price of LPG.

The number of cars and the number of motorcycles per capita, increased rapidly prior to 1979. Reportedly, the number of motorcycles increased fifteen fold in 1979, from 12,000 to 180,000. [6] However, if the net imports of motorcycles are added to the number of motorcycles manufactured in the country, a smoother and more plausible increase in motorcycles can be estimated. Using these figures, we show the increase in cars and motorcycles per capita in Figure 5. The number of LPG vehicles per capita increased more rapidly than the number of cars per capita.

Diesel fuel is used in trucks, busses, marine transport, and fishing boats. It is difficult to evaluate diesel use per vehicle, unless it can be assumed that diesel use in non-road transport has increased at the same rate as total diesel use. Assuming this, diesel use per vehicle declined from 1979

to 1980 then increased to 1981 and declined again in 1982. The behavior is rather erratic, suggesting the need to disaggregate diesel use in its components. [7]

Recent projections of fuel use in the transportation sector show little or no change in the shares of fuels used in this sector in the long run. [8] In the short run, the share of LPG is expected to increase as the mandated conversion of taxis and other commercial vehicles is completed.

Residential and Commercial:

Because of the cold climate in Korea, a large fraction of energy goes to heating of buildings. In 1980, 26% of the energy used in Korea went to this sector, compared to 10% in Taiwan.

In the two decades since 1960 Korea urbanized rapidly. This urbanization was accompanied by a decline in the fraction of energy provided by wood, from 53% in 1960 to 7% in 1978. Wood was used primarily for cooking and heating of houses. In the 1960s, coal was promoted to replace wood in order to reduce the severe deforestation problems.

By 1980, the residential and commercial sector required 14 MTOE of which roughly 53% was heating and 9% was covered by oil products. The traditional ondol system of water circulating under floors was still primarily based on anthracite, which causes many deaths from carbon monoxide poisoning every year. Recently, use of diesel oil in single family homes and fuel oil in modern apartment buildings and for district heating is spreading, which helps in reducing the health hazard. Korea plans to import LNG starting in 1987. This will be used for city gas supply for cooking, and for heating buildings in Seoul, and in power plants in metropolitan areas. The city is served today by a small network of city gas, which will be expanded. Per capita consumption of kerosene has declined.

Sales of electricity have increased extremely rapidly, due to electrification schemes in the rural areas, and due to an increase in the number of appliances in each household. As a result, per capita use of electricity has increased several fold. Use of electricity per customer has increased less rapidly, as the number of persons per household has declined.

Electric appliance saturation has grown remarkably in the 1970s and early 1980s. Today's levels of ownership compare with those of France and Italy in the late 1960s, and are higher than was the case when those two countries had per capita incomes as high as those in Korea today. Not surprisingly, the rate of growth of electricity use per household has been high; most households are electrified so the growth represents increasing number of electric appliances. The major unsaturated users, clothes washers, dish washers, dryers, and of course air conditioners, will add considerably to per household consumption, and the last mentioned will undoubtedly cause peak load problems in the summer similar to those experienced in Japan.

The commercial sector shows the same potential. Buildings we visited were acceptably heated, but not warm, in the winter; lighting levels were moderate, but not high, and cooling was not universal. In Italy, France, Germany, and even Sweden and Denmark the commercial sector grew much more rapidly than the residential sector after the $2000 per capita income level was passed, suggesting that Korea will soon see this growth too.

Offsetting this potential growth, however, is the active policy promoting efficient energy use in new buildings, through, standards and better design of building shells and systems. We have no hard evidence of great improvements in equipment efficiency, but we have seen clear trends from neighboring Japan. Since both countries are competing for foreign markets for appliances, it is reasonable to assume that appliances will become more efficient in Korea as their numbers and size (or features) grow. Nevertheless, this increased efficiency will only moderate the growth in electricity use caused by the underlying expansion of the residential and commercial sectors in Korea.

Projections of consumption of fuels in this sector show a decline in the share of coal consumption, and an increase in the share of gas, after the LNG imports commence in 1987.

SUMMARY OF FUEL DEMAND

Economic development in Korea has been extremely rapid since the establishment of five year plans in 1962. This rapid development has been promoted by an outward looking attitude, which led to a growth in exports of manufactured goods that stimulated domestic industry. It also led to a marked increase in energy consumption, causing shortages of domestic supply of wood and coal. Oil imports were started in the mid-sixties to replace the diminishing wood and coal resources. Later, the uncertain oil price and supply situation led to diversified imports of coal and nuclear fuel.

Energy demand projections call for an increase in the demand from 46 MTOE in 1981 to 130 MTOE in 2001 with dramatic changes in the shares of different fuels (see Figure 6). In projecting the demand for fuels, a GNP growth rate of 7.3% was assumed to 1991, and a rate of 6.7% was assumed for the period 1991 to 2001. Crude oil price was assumed to increase at 3.0% annually. Total demand for energy may not increase as rapidly if economic growth is constrained by the external debt. On the other hand, it is likely that the prices of oil may not increase as rapidly, which would lead to increased demand for oil. The share of oil use will decline from roughly 57% in 1981 to 35% in 2001. Shares of coal and nuclear fuel are expected to increase markedly during this period. However, environmental considerations and the relative surplus of fuel oil may limit the increase in the share of coal.

The demand for oil and particularly fuel oil in the industrial sector has declined over the last few years. The intensity of oil use has also declined during this period. The decline has been caused by changes in composition of industry, coal substitution in cement industry, and by energy conservation brought about by new and more efficient plant and equipment, and better management of energy use in industry.

Projections call for expanded use of imported coal in the cement industry, and in other industries, where the boilers are sufficiently large and located near the coast to make coal use economical. Environmental concerns, however, may limit the use of coal. Fuel oil intensity will decline further, if coal use is expanded, otherwise fuel oil intensity will decline, but not as much.

In the transportation sector, due to the increase in price of gasoline the demand for gasoline has declined, in both absolute amounts and per car. The demand for diesel has increased due to an increase in the number of diesel vehicles. Projections call for an increase in the use of diesel. Gasoline use is expected to decline in the near future and increase in the long run.

Because of the decline in fuel oil use in industry, the share of industrial demand for oil will decline to 33% by 2001. The share of transportation demand will increase to 42%.

In the residential and commercial sector, coal use will be replaced by oil and gas. The rapid growth in electricity demand is expected to continue in the future. Dramatic changes are forecast for that sector. Coal share is expected to decline from 62% in 1980 to 26% in 2001, while the share of electricity is expected to increase from 3% to 22%.

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TABLE 1

STRUCTURE OF PRIMARY ENERGY SUPPLY

	1961		1965	
	1000 TOE	%	1000 TOE	%
DOMESTIC				
Coal	3,226	32.9	5,291	43.9
Hydro	163	1.7	178	1.5
Firewood	5,636	57.4	5,142	42.7
Sub-total	9,025	92.0	10,611	88.1
IMPORTS				
Oil	790	8.0	1,439	11.9
Sub-total	790	8.0	1,439	11.9
TOTAL	9,815	100.0	12,050	100.0

SOURCE: The Ministry of Energy and Resources, 1983 Yearbook o
Energy Statistics.

TABLE 2

STRUCTURE OF PRIMARY ENERGY SUPPLY

	1965		1973	
	1000 TOE	%	1000 TOE	%
DOMESTIC				
Coal	5,291	43.9	7,244	29.2
Hydro	178	1.5	306	1.2
Firewood	5,142	42.7	3,672	14.8
Sub-total	10,611	88.1	11,222	45.2
IMPORTS				
Oil	1,439	11.9	13,624	54.8
Sub-total	1,439	11.9	13,624	54.8
TOTAL	12,050	100.0	24,486	100.0

SOURCE: The Ministry of Energy and Resources, 1983 Yearbook Energy Statistics.

TABLE 3

STRUCTURE OF PRIMARY ENERGY SUPPLY

	1973		1982	
	1000 TOE	%	1000 TOE	%
DOMESTIC				
Coal	7,211	27.6	8,786	19.1
Hydro	477	1.8	501	1.1
Firewood	3,525	13.5	2,417	5.3
Sub-total	11,213	43.0	11,704	25.5
IMPORTS				
Oil	14,188	54.4	25,935	56.4
Nuclear	0	0	944	2.1
Coal	554	2.1	6,664	14.5
Gas	131	0.5	727	1.6
Sub-total	14,873	57.0	34,270	74.5
TOTAL	26,086	100.0	45,974	100.0

SOURCE: The Ministry of Energy and Resources, 1983 Yearbook c
Energy Statistics.

TABLE 4

PRIMARY AND FINAL E/GDP RATIOS
(THOUSAND TOE AND BILLION 1975 WON)

	1973	1975	1978	1979	1980	1981
PRIMARY ENERGY	25,627	27,645	38,252	43,463	44,115	46,052
FINAL ENERGY	22,810	23,516	32,584	37,195	37,804	39,323
GDP	8,504	9,952	13,885	14,870	14,342	15,368
PRIMARY E/GDP	3.01	2.78	2.75	2.92	3.08	3.00
FINAL E/GDP	2.68	2.36	2.34	2.50	2.64	2.56

TABLE 5

FUEL CONSUMPTION FOR GENERATION
(THOUSANDS TOE)

	1970 CONS.	%	1975 CONS.	%	1982 CONS.	%
ANTHRACITE	279	13	315	7	720	7
PETROLEUM	1,916	87	4,313	93	8,023	83
NUCLEAR	0	0	0	0	944	10
TOTAL	2,195	100	4,628	100	9,687	100

TABLE 6

ELECTRICITY SALES BY SECTOR
(GWH)

	1970		1975		1982	
	CONS.	%	CONS.	%	CONS.	%
RESIDENTIAL	796	10	2,026	12	6,599	17
COMMERCIAL	1,515	20	2,766	17	5,840	15
INDUSTRIAL	5,428	70	11,839	71	25,440	67

NOTE: Industrial includes agriculture, mining, and manufacturing.
Commercial includes all service, railway, and public.

TABLE 7

South Korea

Origin of GDP

(1975 constant prices)

	1961	1965	1970	1975	1980
		(percent)			
Manufacturing	8.3	11.0	17.9	26.5	34.4
Mining	1.7	2.0	1.6	1.5	1.2
Agriculture, forestry, fishing	47.0	43.2	30.4	24.9	15.9
Other	42.9	43.9	50.1	47.1	48.4

Source: Major Statistics of Korean Economy

TABLE 8

South Korea

Composition of the Manufacturing Sector

(1975 prices)

	1970	1978
	(percent of gross output)	
Light manufactures	52.6	44.2
Heavy manufactures	7.5	21.7
Energy-intensive manufactures	39.9	34.0

Source: Kim (1981)

Note:

(1) Heavy manufacturing consists of fabricated metal products, general machinery, electrical machinery and equipment, transport machinery.

(2) Energy-intensive manufacturing consists of paper and pulp; chemicals, coal, petroleum; non-metallic mineral products; primary iron and steel and non-ferrous metals.

TABLE 9

South Korea

Energy Intensity and Growth in the the Manufacturing Sector

	1970	1978
Energy intensity (TOE per million won at 1975 prices)		
Light manufactures	0.65	0.41
Heavy manufactures	1.28	0.36
Energy-intensive manufactures	2.10	1.65
Gross output (billion won at 1975 prices):		
Light manufactures	2053	8484
Heavy manufactures	294	4158
Energy-intensive manufactures	1560	6547

Source: Kim (1981)

Note:

(1) Excludes non-commercial energy.

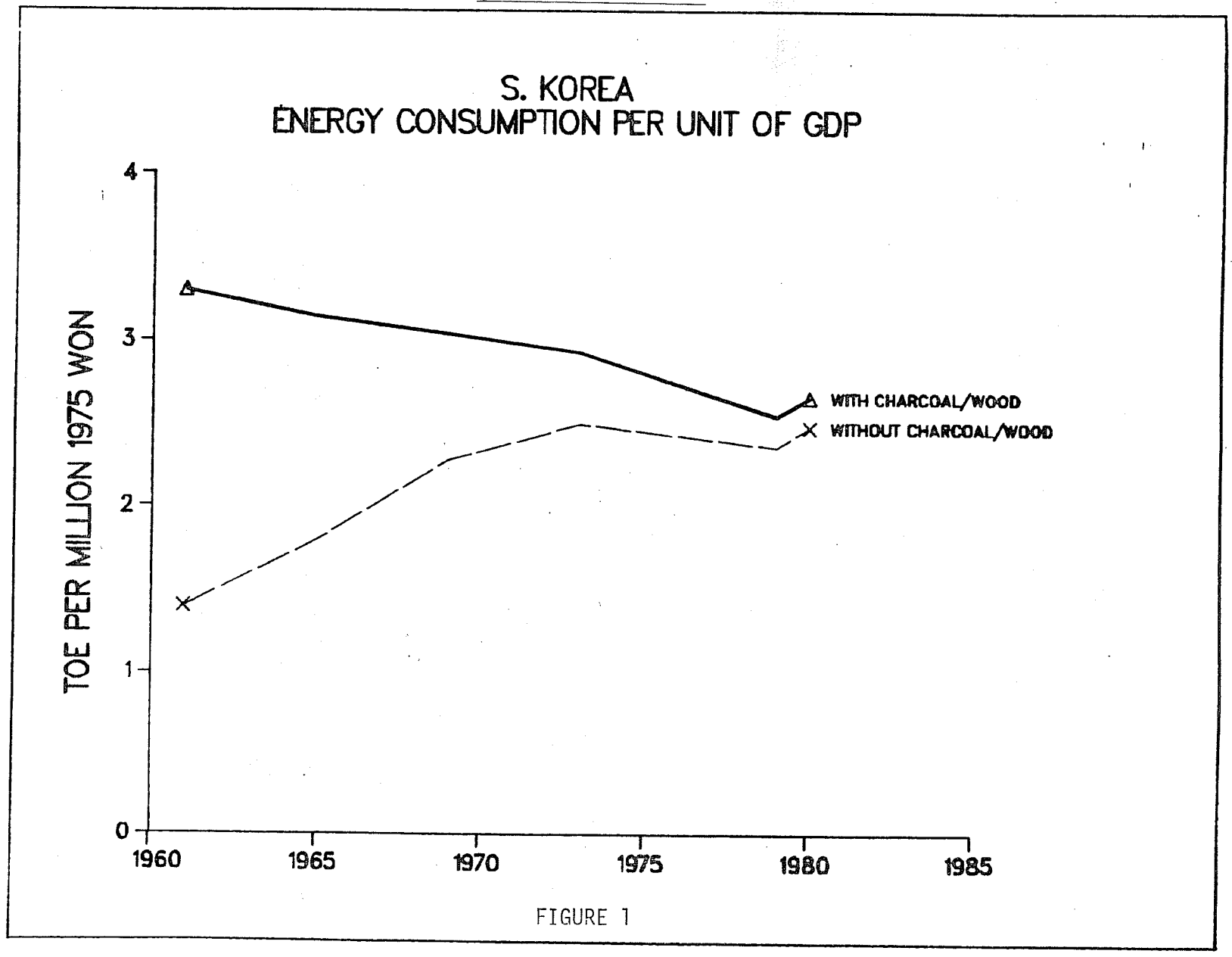
S. KOREA
ENERGY CONSUMPTION PER UNIT OF GDP
TOE PER MILLION 1975 WON
4
3
2
1
0
1960
1965
1970
1975
1980
1985
WITH CHARCOAL/WOOD
WITHOUT CHARCOAL/WOOD

FIGURE 1

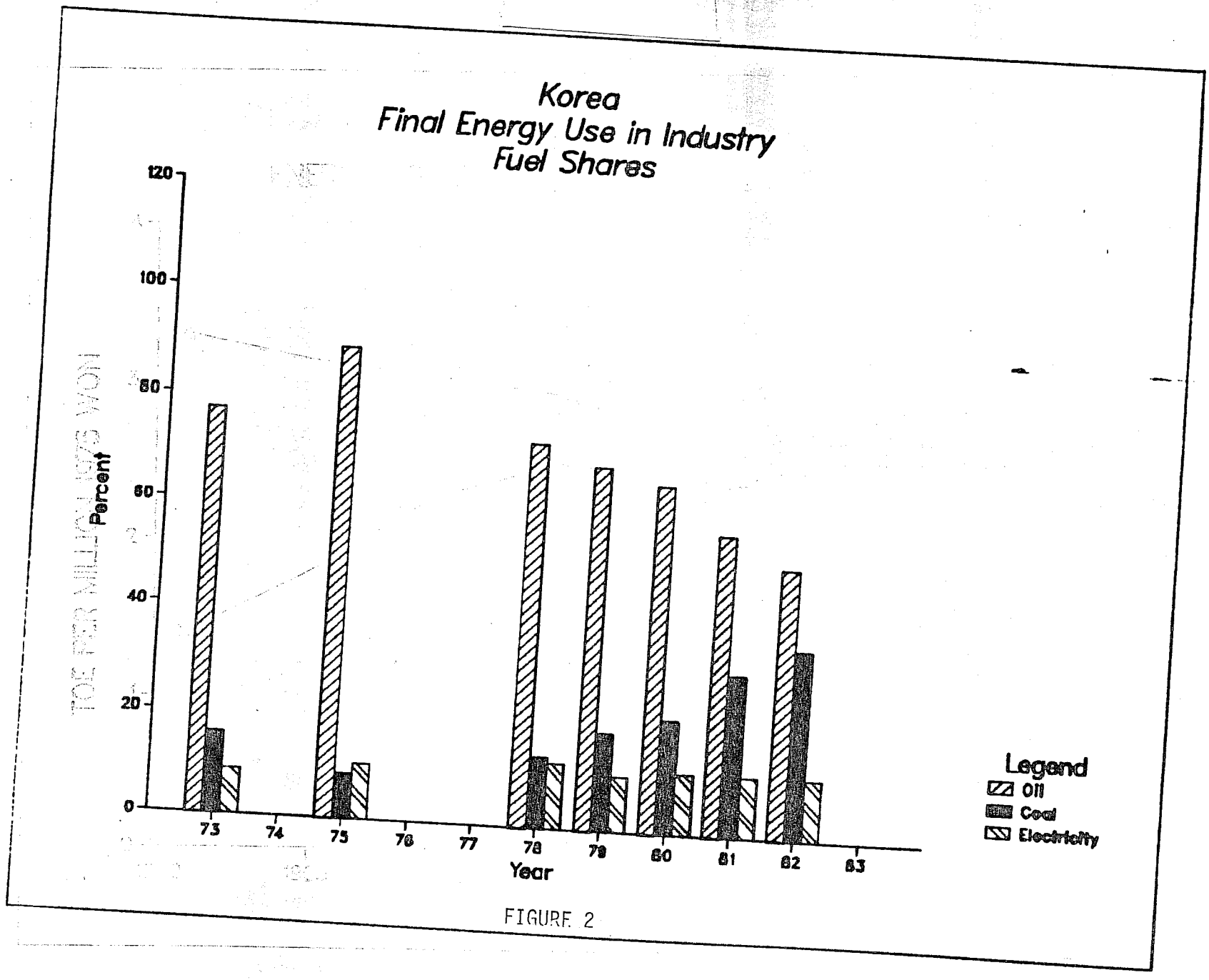
Korea
Final Energy Use in Industry
Fuel Shares
TOE PER MILLION WON
Percent
120
100
80
60
40
20
0
73
74
75
76
77
78
79
80
81
82
83
Year
Legend
Oil
Coal
Electricity

FIGURE 2

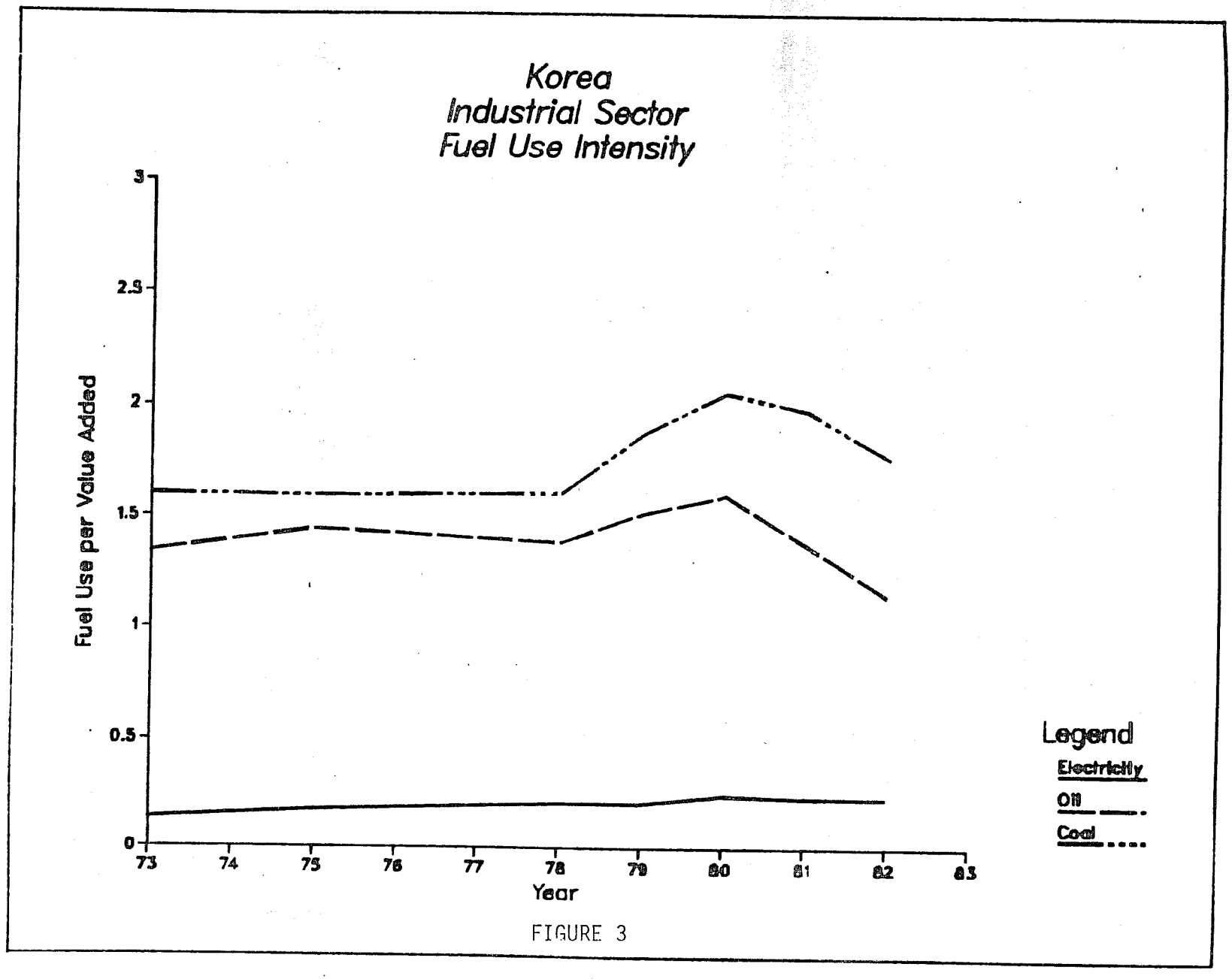
Korea
Industrial Sector
Fuel Use Intensity
Fuel Use per Value Added
3
2.5
2
1.5
1
0.5
0
73
74
75
76
77
78
79
80
81
82
83
Year
Legend
Electricity
Oil
Coal

FIGURE 3

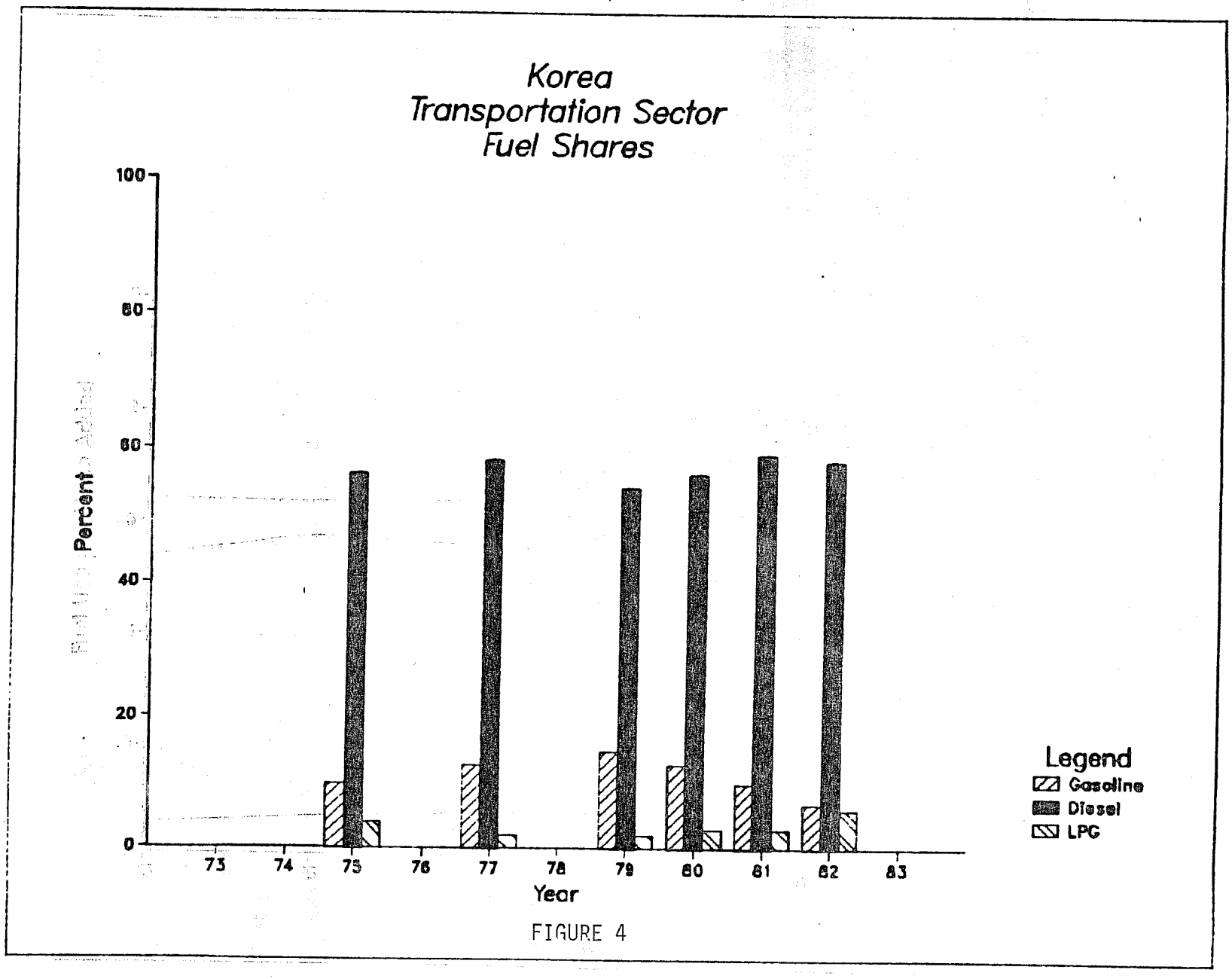
Korea
Transportation Sector
Fuel Shares
100
80
60
40
20
0
Percent
73
74
75
76
77
78
79
80
81
82
83
Year
Legend
Gasoline
Diesel
LPG

FIGURE 4

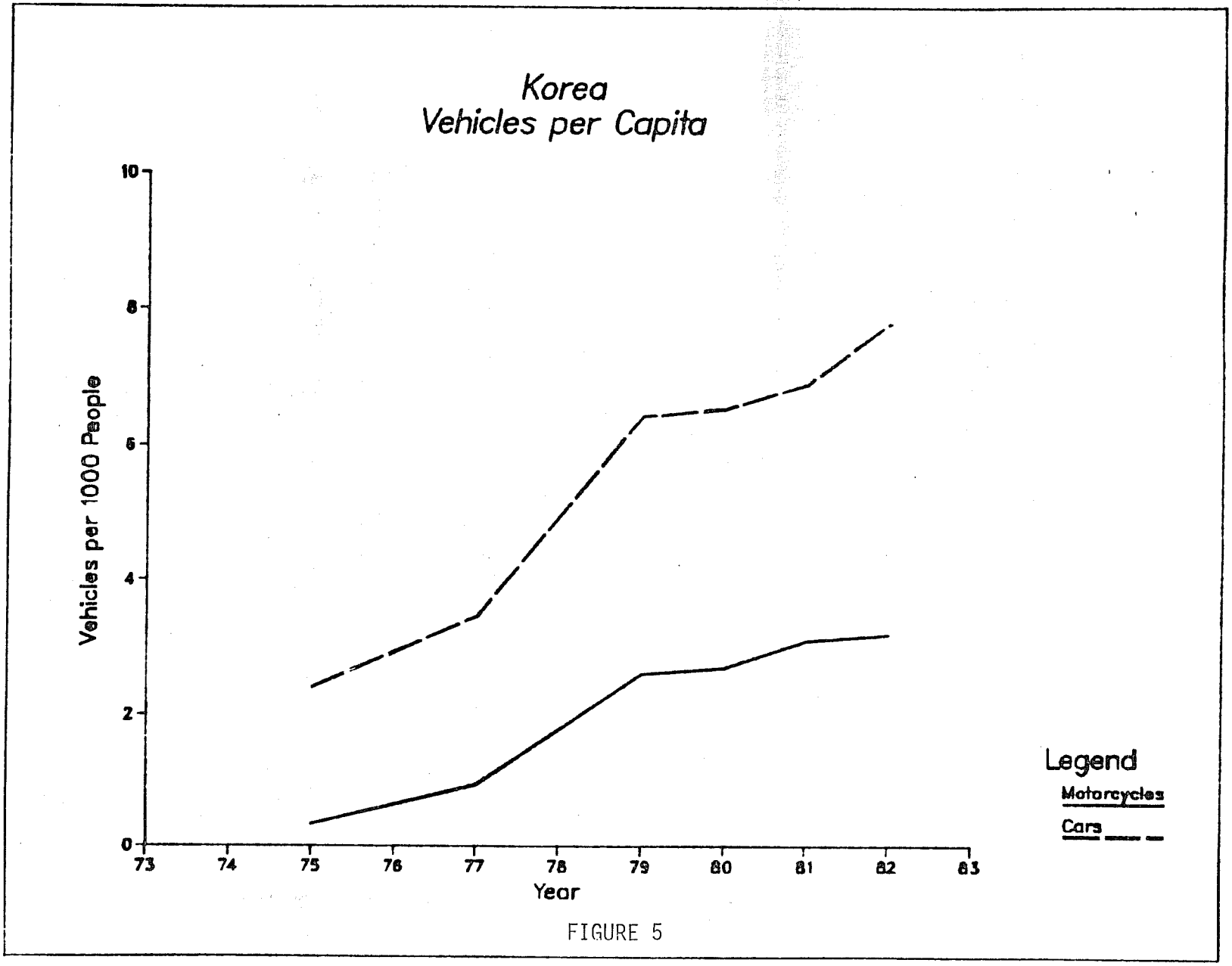
Korea
Vehicles per Capita
Vehicles per 1000 People
10
8
6
4
2
0
73
74
75
76
77
78
79
80
81
82
83
Year
Legend
Motorcycles
Cars

FIGURE 5

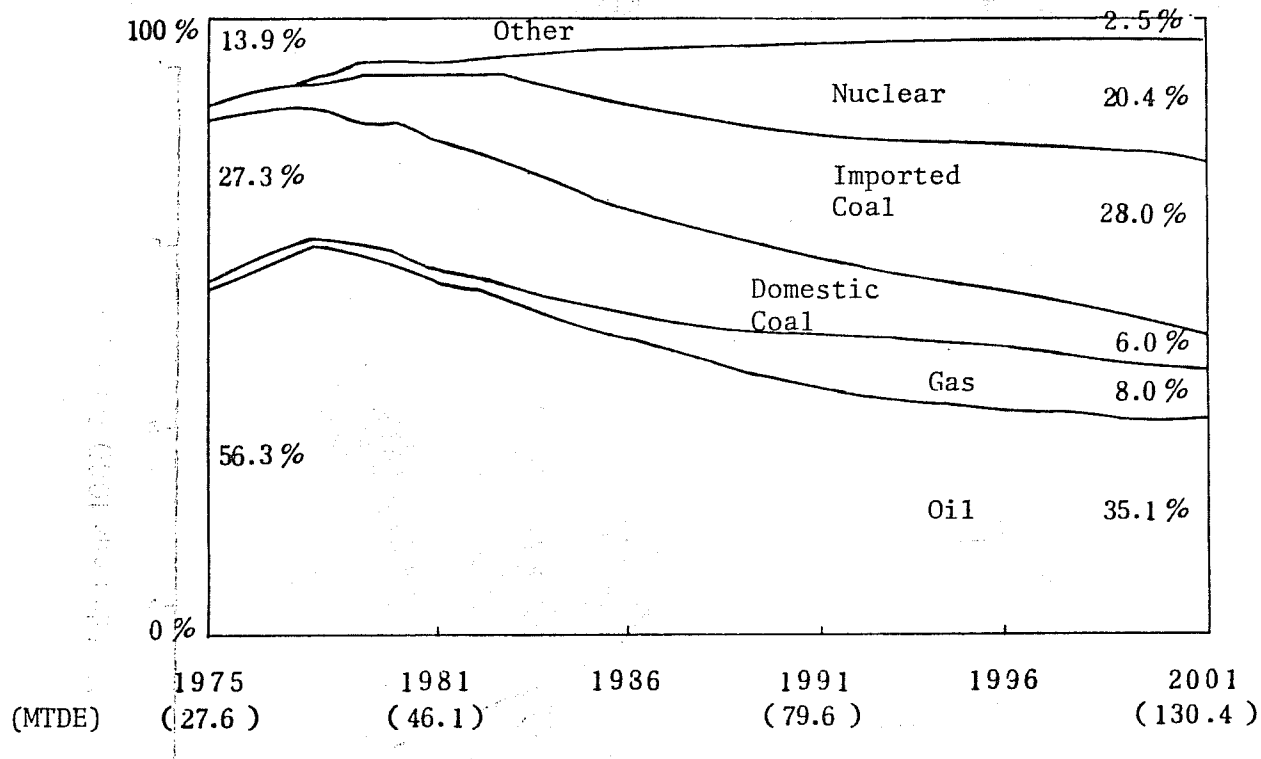

Figure 6: Projected shares of Primary Fuel Consumption

Source : Reference 7

COUNTRY REPORT

PHILIPPINES

ENERGY DEMAND AND FUEL SUPPLY PROJECTIONS : PHILIPPINES

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ENERGY DEMAND AND FUEL SUPPLY PROJECTIONS

I. INTRODUCTION

This study assesses energy supply and demand in the Philippines, and the prospective changes to ascertain the impact on demand for petroleum products. It includes:

(i) A discussion of the energy demand and supply balance in the Philippines over the last decade, focusing on changes in consumption and supply over the last three years 1981, 1982 and 1983;

(ii) A review of the most recent projection of energy demand and supply by subsectors;

(iii) An assessment of electricity demand and fuel supply plans in the power sector, the effect of energy conservation on demand for oil, substitution of oil with coal, wood and other agri-waste products;

(iv) potential changes in the composition of the industrial structure, and the transport sector.

These topics are discussed by fuel category. Prior to discussing the supply-demand balance, we present relevant economic data to place energy use in context of the economy in the Philippines.

The discussion on energy begins by considering fuel demand in the power sector, followed by a discussion of demand for oil products and coal.

II. REVIEW OF ENERGY DEMAND AND SUPPLY

This section provides a review of the energy situation, in context of the economic growth in the Philippines during the last decade. Changes in composition of value added in industry are analyzed, in order to examine their influence on energy use in industry.

Energy and Economic Development - During the 1970s, the Philippine economy grew at an annual rate of 6.0%. By 1981, per capita GNP amounted to US $790, a figure comparable to Thailand's per capita GNP of US $770. In the two decades since 1960, the Philippine economic structure changed; agriculture's share of GDP declined from 25% to 23%, while manufacturing share increased from 28% to 36%.

The economies in most Asian countries underwent similar changes. However, the rate of change in the Philippines was lower than in the newly industrializing countries, HongKong, Singapore, Taiwan and Korea, and the two oil exporters Indonesia and Malaysia. From 1975 to 1980 industry's share of GDP increased from 33% to 36% , and has since remained unchanged.

It is important to examine if the increase in industry's share of GDP was accompanied by a change in the composition of the industrial sector, since changing composition can reduce energy intensity without energy conservation in specific industries.

Table 1.
Shares of Value Added in Industry (%)

	1972	1982
Mining	7	6
Manufacturing	77	68
Electricity, Gas, Water	3	3
Construction	13	23

Source: ADB Key Indicators

Table 1 shows these shares for 1972 and 1982. It shows a 70% increase in the share of construction activity, accompanied by a decline in the share of manufacturing. As we will see later, this has implications for increased diesel consumption and reduced fuel oil use.

Table 2 shows the changes in composition of value added in manufacturing over the same period. The lack of major changes is apparent. Sectors with minor gains include basic metal, metal products, electrical machinery and footwear, while losers include textiles, and wood and cork industry. Since composition does not change, any change in the intensity in energy use in manufacturing would have been caused by other factors. This is in sharp contrast to South Korea or Taiwan, where the rapid growth of heavy and chemical industries during the 1970s was a major contributor to changing composition, and hence, energy intensity.

The two oil price increases during the 1970s contributed significantly to the foreign debt of many developing countries. In the Philippines, the recent debt problem was initiated by the second oil price increase. As a consequence of the first oil price increase in 1973-1974, the payment for imported oil as a fraction of total exports went from 9.9% in 1973 to 24% in 1974. This fraction climbed to 29.8% by 1979, despite a 57% increase in real export earnings from 1974-1979. The second oil price increase, in 1979-1980, raised the payments for imported oil, as a fraction of total exports, to 38.5% in 1980, and to 43% in 1983. Coal imports, which began in 1983, will add to the payments for imported energy in the future. However, the amount of imported fuels will be less than the current imports of oil. The fraction of exports required to pay for import of energy, therefore, is expected to decline in the future.

At the household level, the effect of the two oil prices increases was felt through increases in the prices of transportation and domestic fuels. Gasoline prices increased to 6.4 pesos a liter in 1983, from Similar but smaller increases occurred in

prices of other products. The fraction of personal consumption expenditure going to fuel, light and water doubled from 1970 to 1975, from 3.6% to 7.1%.

Primary Energy Consumption

Table 3 shows the primary energy use by fuel type for selected years between 1973 and 1983, illustrating the effects of the first and second oil price increase. Demand for conventional fuels declined between 1973 and 1974 and again between 1979 and 1981. After 1974, and again after 1981 demand for conventional fuels continued to increase.

From 1973 to 1983, total energy supply increased by 34% from 73.6 to 98.5 million barrels of fuel oil equivalent (MBFOE). However, the supply figures are not strictly comparable, since agriwaste was not included in the 1973 figure. If agri-waste use in 1973 is assumed the same as in 1978, the increase would be 21%. Fuel imports in 1983 were the same as in 1973, due to the development of a variety of domestic fuels, geothermal, hydro, oil and coal.

Since 1973, the ratio of energy imports to gdp has declined from 1.05 to 0.65 BFOE per thousand pesos. The total energy to gdp ratio also declined through 1982 but increased in 1983. The increase was caused by more use of coal and agri-waste, which offset a decline in use of hydro and bagasse, and little change in oil use. At the same time, GDP increased less than 1% in 1983, the smallest in the last ten years.

Table 4 shows the percentage share of demand for energy since 1975 by major sector. Industry assumes the largest share of total demand, followed by transportation, residential and commercial in every year. Between 1975 and 1979, partly due to stable or falling petroleum prices, there is little change in the shares. After 1979, the share of energy going to industry rises from 54.1% to 59.9% in 1983. This increase occurs at the expense of

transportation.

Table 5 shows the percentage consumption of oil by sector. The relative use of oil declines in the industrial and the residential and commercial sectors, whereas it increases in the transportation sector . A comparison of Tables 4 and 5, shows that in the residential/commercial sector oil is being substituted by other fuels, and in the industrial sector there is a decline in both oil and energy use.

III. POWER

During the last decade the power sector has undergone many institutional changes. In the early 1970s the power sector consisted of the government owned National Power Corporation (NPC), numerous privately owned utility companies, and small utilities operated by municipalities.

Initially NPC was responsible for only hydroelectric power development. Other companies generated their own power using oil. Today, NPC is responsible for construction and operation of all power generation facilities, and the establishment of inter-island transmission systems. Additionally, the National Electrification Administration (NEA), is authorized to develop generating facilities of 5 MW or less.

Electricity is distributed by over 130 private or municipal utilities, and 112 cooperatives which are organized under the supervision of NEA. MERALCO, which distributes power to the Manila Metropolitan area, is by far the largest private utility in the country.

Electricity supply is organized in three independent grids - Luzon, Visayas and Mindanao. The grids on Luzon and Mindanao are relatively complete and connected. The Visayas grid consists of independent grids on several small islands. These will be interconnected in the future.

Demand -Demand for Electricity can be analyzed for each grid. Electricity sales in Visayas and Mindanao are much lower than in Luzon. Per capita electricity sales were 26 and 145 kwh respectively in the two regions in 1980. In Luzon per capita electricity sales were 466 kwh. Total sales were 700 GWH in Visayas, 2,175 GWh in Mindanao, and 13,125 GWH in Luzon in 1982.

Projections of electricity sales and generation for the Philippines show additions in each fuel type, except oil. These capacity additions lead to very high reserve margins, but seem justified, since the single largest unit will be a 620 MW nuclear plant, and the second largest units will be 300 MW coal and oil plants.

Demand for oil declines by 53% by 1985. The sharp decline is due partly to the inflated oil demand caused by the drought in 1983. Demand for oil declines less slowly after 1985, as most of the non-oil generating capacity is built by 1985. By 1992, due to additional coal and geothermal capacity, demand for oil declines further to 7.2 million BFOE.

IV. PETROLEUM PRODUCTS

Demand for petroleum fuels increased rapidly after a short decline in 1973-1974 due to the first oil price increase (see Table 6). By 1979, petroleum demand had increased to 74.1 million barrels of fuel oil equivalent (MBFOE).* Demand for petroleum fuels declined after the second oil price increase in 1979-1980, However, it increased to make up for shortage of hydroelectric power in 1983.

* - The Philippine government reports data on petroleum fuels in BFOE.

Industry

Over 90% of the demand in the mining and manufacturing sector is satisfied by fuel oil and diesel. Since 1979, fuel oil demand has declined by 31% as industries have reduced fuel oil use through energy conservation and fuel substitution. The composition of the industrial sector has not changed and therefore has not been a factor in reducing petroleum use.

Table 7 shows the intensity of fuel oil use in industries where fuel oil use and value added data could be matched. Sharp declines in intensity can be seen in cement, paper, and sheet metal industry, three of the most oil-intensive industries in the Philippines. In cement industry, the decline will continue through 1984, when coal will completely replace fuel oil. In the paper industry, fuel oil has been replaced by wood and wood waste causing its use to decline through 1982. There are no apparent reasons for the observed increase in intensity in 1983. Much of the reduction in steel/metal industry is due to improved energy conservation.

Diesel fuel accounted for 26% of petroleum demand in the mining and manufacturing sector. Logging and wood, paper, mining, and cement are the four most diesel intensive sectors (see Table 8). Diesel intensity increased from 1981 to 1983 in the logging and wood and cement sector. In mining, and paper, declined in 1983.

Diesel use in industry does not appear to be price sensitive. Despite the 11% average increase in nominal increase in diesel prices in 1983 demand for diesel fuel increased 6% that year.

Transportation

Diesel accounts for 54% of total fuel demand in this sector, gasoline for 31% and aviation turbo and fuel oil for the remainder.

Demand for diesel fuel has increased continually since 1975. After the first and second oil price increase, demand increased due to switching of gasoline engines to diesel engines in commercial vehicles, primarily jeepneys, prompted by the difference in diesel and gasoline prices.

Diesel price increased far less than gasoline after the second oil price increase. In March 1979, premium gasoline cost 57% more than diesel, in March 1981, it cost 69% more. More importantly, the absolute differential was sufficient to pay for switching of gasoline engines to diesel engines. In 1983, diesel price was increased by 42% compared to a 26% increase in gasoline price. Consequently, the amount of diesel use did not increase in 1983.

Diesel and gasoline consumption per vehicle can be estimated for 1981 and 1982, the two years for which reliable statistics are available. Gasoline consumption per vehicle declined from 1520 liters in 1981 to 1400 liters in 1982. Diesel consumption per vehicle declined from 8250 liters in 1981 to 7380 liters in 1982.

The number of gasoline and diesel vehicles increased by 4% and 27% respectively. Vehicles include cars, motorcycles, utility vehicles, trucks, and busses. Cars and motorcycles are the only types of gasoline vehicles that increased. On the other hand, all types of diesel vehicles registered an increase. The number of gasoline vehicles per capita increased from 15.6 per thousand in 1981 to 15.9 per thousand in 1982. The number of diesel vehicles per capita increased from 4.4 per thousand in 1981 to 5.2 per thousand in 1982.

The increase in diesel trucks, busses, and utility vehicles occurs at the expense of gasoline vehicles. For example, the number of gasoline trucks declined by 6,900 while the number of diesel trucks increased by 10,600. Partly, the decline in diesel consumption per vehicle may be explained by an increase in the share of diesel utility vehicles, which are less fuel intensive than trucks and busses. Another reason for this decline is the addition of a large number of new vehicles which are more

efficient, because of their vintage and because of their age.

In projecting diesel consumption, two scenarios can be visualized based on anticipated increase in diesel prices. If the price of diesel relative to gasoline remains unchanged, diesel fleet will increase rapidly as the commercial gasoline fleet is phased out. Diesel use per vehicle will decline as new and more efficient vehicles are purchased. Total diesel use will increase because of additions of new vehicles.

If the price of diesel is increased to equal the price of gasoline, diesel fleet increase will slow down as switching from gasoline to diesel vehicles is reduced. Fuel consumption per vehicle will decline because of higher prices. However, vehicle efficiency would decline because of an aging fleet. Total diesel use will decline in the short run, when the price of diesel is increased. In the long run, diesel consumption will increase as more vehicles are purchased.

If price of diesel is not increased, gasoline consumption will continue its rapid decline. If price of diesel is increased, switching of gasoline to diesel vehicles will slow down, and gasoline consumption will increase as the number of gasoline vehicles increases.

Residential/Commercial:

In the residential/commercial sector kerosene and LPG use have declined since 1979. The consumption of kerosene per capita declined from 9 to 4 liters between 1979 and 1983. The consumption of LPG per capita declined from 3 liters to 2 liters over the same period.

Kerosene consumption is projected to decline in the future as electricity substitutes for kerosene use in lighting.

Future trend in consumption of LPG is not as clear. Use of LPG may increase if the subsidy to electricity, which is a substitute for LPG in cooking, is gradually removed as planned. On the other hand, LPG users may shift to wood and charcoal, which are cheaper, if the income distribution continues to deteriorate. In non-residential sectors, LPG use may increase if oil companies succeed in their effort at marketing LPG to industries, and to operators of fishing vessels and fleet vehicles.

V. COAL

Domestic coal consumption and production have increased steadily over the last ten years. In 1982, consumption amounted to 1.1 MBFOE and in 1983, it increased to 2.6 MBFOE. At the same time, the Philippines imported 0.9 MBFOE of coal. Coal imports are expected to increase further, despite sufficient domestic production capacity, because the low quality of domestic coal makes it unsuitable for direct combustion in cement plants without blending with high quality imported coal.

In 1983, cement plants used 41% of domestic coal. Power plants owned by industry and NPC used 37%, other industries used 22%, and non-energy consumers used less than 0.1%.

VI. SUMMARY OF FUEL DEMAND

Table 9 shows a set of projections of total energy consumption by source. Figures for 1983 are actual consumption.

For fuel oil, demand in the industrial sector is expected to decline based on the assumption that half the conservation potential will be realized by 1987. In the power sector, demand is expected to decline as more non-oil domestic substitutes are used to generate electricity.

For diesel, the projections assume that price of diesel will be increased. In the transportation sector, demand increases more slowly than before. In the industrial sector, the projected intensity of diesel use in major industries is assumed to increase slightly.

Demand for gasoline is projected to change inversely to demand for diesel. The decline in gasoline vehicles, either through attrition or through switching of engines, continued during 1981-1983 with a large potential for future conversions to diesel engines. Therefore, if diesel demand does not increase, gasoline demand is expected to increase.

For other fuels, the projections follow the trend. However, LPG demand may increase more rapidly in the industrial sector since oil companies are making a major effort to penetrate untrapped LPG markets in industries. This could reduce future demand for diesel.

Demand for coal is expected to increase five fold by 1992. Assuming that only the cement plants would need imported high quality coal, most of the coal demand would be met through domestic coal resources.

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Table 2

GROSS VALUE ADDED IN MANUFACTURING
(% Share)

INDUSTRY	1972	1983
Food Manufacturing	37.0	36.9
Beverage Industries	3.2	3.0
Tobacco	4.1	4.4
Textile	5.6	4.2
Footwear	3.7	4.9
Wood & Cork	3.3	2.8
Furnitures & Fixtures	0.7	0.6
Paper & Paper Products	0.8	0.8
Publishing and Printing	1.2	1.4
Leather and leather products	0.3	0.3
Rubber	1.8	1.3
Chemical and products	8.9	9.2
Petroleum and coal	7.6	5.4
Non-metallic minerals	2.3	2.4
Basic metal	2.7	3.8
Metal products	5.1	4.3
Machinery excl. electrical	3.5	3.2
Electrical Machinery	3.8	6.9
Transport Equipment	3.2	2.9
Misc. Manufactures	1.2	1.3
TOTAL	100.0	100.0
Billion 1972 Pesos	13.4	25.7

Table 3

PRIMARY ENERGY CONSUMPTION, 1973-83 (10^6 BFOE)

	1973	1974	1978	1979	1981	1982	1983
Imported	64.2	60.2	75.3	70.5	67.2	65.4	64.5
Oil	64.2	60.2	75.3	70.5	67.2	65.4	63.5
Coal							0.9
Conventional	3.1	4.1	5.5	13.9	13.5	17.1	19.4
Oil	-	-	-	7.2	1.4	3.0	4.7
Coal	0.1	0.2	0.9	0.8	0.9	1.1	2.6
Hydro	3.0	3.9	4.6	4.8	6.4	6.7	5.1
Geo	0	0	-	1.1	4.8	6.3	7.0
Non-conventional					0.3	0.1	0.1
Bagasse	6.3	6.1	5.5	5.3	6.2	7.4	5.5
Agri waste	na	na	7.8	7.8	6.3	5.8	9.0
Conventional (Import + Domestic)	67.3	64.3	80.8	84.4	80.7	82.5	83.8
Total	73.6	70.4	94.1	97.4	93.5	95.6	98.5
GDP (Constant 10^9 Pesos)	60.9	64.1	82.6	88.3	96.2	99.0	100.0
Eimp/GDP	1.05	0.94	0.91	0.80	0.70	0.66	0.65
Econv/GDP	1.11	1.00	0.98	0.96	0.84	0.83	0.85
Etotal/GDP	1.21	1.10	1.14	1.10	0.97	0.97	1.00
Oil/GDP	1.05			0.88		0.69	0.68
Coal/GDP	-			0.01		0.01	0.04
Hydro+Geo/GDP	0.05			0.07		0.13	0.12

Table 4

ENERGY CONSUMPTION BY SECTOR (% SHARE)

	1975	1978	1979	1981	1982	1983
Industry	52.2	52.1	54.1	58.4	57.8	59.9
Transportation	32.5	30.0	29.5	25.1	25.2	23.2
Commercial	6.7	8.3	6.9	7.1	7.4	7.3
Residential	8.6	9.6	9.5	9.4	9.6	9.6
Total	100.0	100.0	100.0	100.0	100.0	100.0

Table 5

OIL CONSUMPTION BY SECTOR (10^6 BFOE AND % SHARE)*

	1975	1979	1982	1983
Industry	36.7 (59%)	45.8 (62%)	38.3 (59%)	41.6 (62%)
Transportation	21.5 (35%)	24.2 (33%)	23.4 (36%)	22.2 (33%)
Residential/Commercial	4.0 (6%)	4.1 (6%)	3.5 (5%)	3.0 (4%)
Total	62.2	74.1	65.2	66.8

*Includes sugar, avturbo, gasoline, diesel, fuel oil, kerosene, LPG.

Table 6

PETROLEUM FUEL DEMAND - 1975, 1979 (10^6 barrels & 10^6 BFOE)

	1975		1979		1981		1982		1983	
	BBL	BFOE	BBL	BFOE	BBL	BFOE	BBL	BFOE	BBL	BFOE
Power Generation	14.0	14.0	18.2	18.2	17.6	17.6	17.8	17.8	20.9	20.9
Fuel Oil	13.5	13.5	17.8	17.8	17.1	17.1	17.5	17.5	20.5	20.5
Diesel	0.5	0.5	0.3	0.3	0.4	0.4	0.3	0.3	0.3	0.3
Other Products	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.1
Mining/Manufacturing Sector	23.2	22.7	27.5	26.8	24.7	24.1	21.2	20.5	21.2	20.4
Fuel Oil	15.9	15.9	19.4	19.4	17.3	17.3	14.0	14.0	13.3	13.3
Diesel	5.2	4.9	5.4	5.0	5.4	5.0	5.4	5.0	5.7	5.3
Gasoline	1.3	1.1	1.2	1.1	0.9	0.8	0.9	0.8	1.0	0.9
Kerosene	0.3	0.3	0.5	0.4	0.3	0.3	0.3	0.3	0.4	0.4
LPG	0.1	0.1	0.4	0.3	0.4	0.3	0.5	0.3	0.7	0.4
Others	0.4	0.4	0.6	0.6	0.4	0.4	0.1	0.1	0.1	0.1
Commercial/Residential Demand	5.1	4.0	5.4	4.1	4.6	3.6	4.5	3.5	3.9	3.0
Kerosene	2.9	2.6	3.0	2.6	2.6	2.3	2.5	2.2	2.2	1.9
LPG	2.2	1.4	2.4	1.5	2.0	1.3	2.0	1.3	1.7	1.1
Transportation	24.3	21.5	27.9	24.9	24.5	22.1	25.9	23.4	25.0	22.6
Diesel	7.5	7.0	11.3	10.5	12.4	11.6	13.2	12.3	13.2	12.3
Gasoline	14.0	12.0	13.3	11.4	8.7	7.4	8.3	7.1	8.2	7.0
Avgas	0.2	0.2	0.1	0.1	-		-		-	
Avturbo	2.2	1.9	2.7	2.4	2.6	2.3	3.5	3.1	2.7	2.4
Fuel Oil	0.4	0.4	0.5	0.5	0.8	0.8	0.9	0.9	0.9	0.9
Total Sales	66.6	62.2	79.0	74.1	71.4	67.4	69.4	65.2	70.9	66.8

Table 7

FUEL OIL - GVA RATIO
(Thousand barrels - million constant ₱)

	1975	1979	1981	1982	1983
Cement 1/	7.63	6.36	5.49	5.47	3.42
Sugar, Coco & Veg. Oil			0.201	0.167	0.173
Mining	1.246	1.218	1.116	1.016	0.644
Power 6/	22.240	20.483	17.153	16.120	17.373
Logging 2/			0.124	0.131	0.128
Paper	7.05	7.77	4.05	3.43	4.42
Lube Refining 3/	1.049	1.144	1.142	0.873	1.863
Textile	1.029	0.934	0.724	0.636	0.640
Fishing			0.0010	0.0018	0.0016
Steel/Metal 4/	4.836	4.162	4.203	2.370	1.661
Construction 5/			0.0135	0.030	0.026
Rubber			0.360	0.355	0.343
Chemicals			0.103	0.101	0.088
Tobacco			0.065	0.056	0.063

1/ Using GVA for non-metallic minerals.

2/ Using GVA for wood industry only.

3/ Using Petroleum GVA.

4/ Using Basic metal GVA.

5/ Using GVA for construction and fuel sales to contractors.

6/ Using GVA for electricity, gas and water.

Table 8

DIESEL - GVA RATIO
(Thousand barrels - million constant ₱)

	1975	1979	1981	1982	1983
Cement		0.105	0.098	0.114	0.127
Sugar & Coco Veg. Food		0.1000	0.080	0.083	0.089
Mining	0.554	0.515	0.534	0.524	0.432
Power 5/	0.824	0.345	0.375	0.248	0.236
Logging & Wood 2/	0.712	0.766	0.769	0.845	1.117
Paper		0.674	0.564	0.582	0.544
Textile		0.083	0.059	0.056	0.067
Fishing	0.156	0.190	0.158	0.159	0.198
Steel/Metal 3/		0.111	0.092	0.099	0.166
Construction 4/	0.152	0.133	0.091	0.086	0.097
Rubber		0.096	0.077	0.071	0.066
Chemicals		0.0185	0.019	0.020	0.021
Tobacco		0.005	0.012	0.015	0.018

1/ Using GVA for non-metallic minerals.

2/ Using forestry GVA.

3/ Using GVA for basic metal.

4/ Using GVA for construction and diesel sales to contractors.

5/ Using GVA for electricity, gas and water.

Table 9

Primary Energy Consumption by Source (10^6 BFOE)

	1983	1987	1992
Imported	64.5	54.6	57.0
Oil*	63.5	48.4	50.6
Coal	0.9	0.6	0.8
Nuclear	-	5.6	5.6
Conventional	19.4	32.4	39.2
Oil*	4.7	3.8	4.5
Coal	2.6	7.2	12.5
Hydro	5.1	12.1	14.6
Geothermal	7.0	9.3	11.6
Conventional (Import & Domestic)	83.8	87.0	96.2
Non-Conventional	0.1)		
Bargasse	5.5)	16.6	18.0
Agri-waste	9.0)		
Total	98.5	103.6	118.2

* Total oil use in 1983 exceeds oil use figures in Table 8 because it includes refinery losses 4.6%. However, user inventory changes are excluded.

Table 2. Brasil Cement and Steel Production

(in 10^3 tonne)

	Cement	10^3 Ton/10^9 CR$	Steel	10^3 Ton/10^9 CR$
1973	13398	8.3	7150	4.5
1974	14919		7494	
1975	16736		8309	
1976	19146	9.4	9170	4.5
1977	21123		11166	
1978	23239		12122	
1979	24871		13866	
1980	27194	10.4	15203	5.8
1981	26052		13108	
1982	25434	11.2	12924	5.7
1983	20874		14603	

Source: Conjuntura Economica,
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