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# INTERNATIONAL ENERGY OUTLOOK 1985



With Projections  
to 1995

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# **INTERNATIONAL ENERGY OUTLOOK 1985**

**Energy Information  
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Office of Energy Markets  
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**With Projections  
to 1995**

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# Preface

This report presents the current Energy Information Administration (EIA) assessment of the outlook for international energy markets. This assessment has previously been included in EIA's Annual Energy Outlook. However, as a means of making that document more readable its scope has been reduced to address overall domestic energy markets with the international and individual fuel assessments published separately. The plan is to update this International Energy Outlook annually with its publication date being about one month after that of the domestic assessment in the Annual Energy Outlook.

The user of this report is cautioned on the uncertainty of the various projections and is reminded that the report is provided, as are other EIA reports, as a statistical service for use by managers and international energy analysts and not as a government energy plan. Current U.S. government policies and foreign government policies are assumed to hold over the projection interval which extends to 1995.

This issue emphasizes oil market developments, particularly future world oil prices and oil production potential. This emphasis in no way minimizes the importance of other energy markets; moreover, the analysis recognizes that the development of alternative energy sources impacts directly on the world oil market. The world oil price projections developed in this international setting are, in turn, used as assumptions for analyses of the U.S. domestic energy market provided in the Annual Energy Outlook 1985. Since the U.S. energy market affects and is affected by the international market, the methodology incorporates this interaction to the extent possible. Sources providing more detailed discussions on the U.S. domestic markets are referenced throughout the report.

The analysis of the international energy markets begins with an assessment of world energy growth prospects, followed by an assessment of fuel substitution possibilities. Requirements for oil are then compared to oil production potential, first by non-OPEC producers, leaving the remaining requirements to be supplied by OPEC. The oil pricing behavior of OPEC is based on historical relationships between price changes and the use of available oil production capacity. As oil prices change, substitution to or away from oil is allowed to take place.

Within the analytic framework are several major assumptions which, in large part, determine the accuracy of the projections. Much professional judgement, based on recent trends, reviews of many country reports, and projections made by other energy forecasters, went into the development of forecast assumptions and into the projected overall energy balances. The major assumptions made include estimates of the annual rates of change in country ratios of total energy consumption to economic activity, oil production capacities, and the rate of incremental energy requirements met by alternatives to oil.

Logically, the projections call for fairly smooth patterns of growth and changes in underlying parameters over the next 10 years. However, over the last 10 years, the world energy market is characterized by major swings in most market indicators. These projections assume "no surprises," but

day-to-day energy markets defy such logic. The uncertainty of the projections is conveyed by the projection ranges, point estimates are deemphasized. Even so, the reader is reminded that although the course of the world oil market in early 1986 is highly uncertain, the integrity of the basic energy projections still remains since the fundamental message in this issue is that real prices of crude oil are likely to come down from 1985 levels and stay low for the next few years, but that they will recover and begin upward once again well before the end of the projection period.

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# Executive Summary

The world energy market has changed dramatically during the last few years. The sharp increases in the price of oil that occurred during the 1970's have resulted in improvements in energy conservation, energy efficiency, and the use of alternative fuels to oil throughout the world. The effects of these changes on the world oil market have been most pronounced, especially since the second major price increase that occurred at the end of the decade.

Nominal oil prices peaked in the United States in February of 1981 when the average price to refiners of imported crude oil (referred to as the world oil price) reached \$39 per barrel. By November of 1985, that price had declined to about \$27 per barrel, a decrease of over 30 percent. When one adjusts these prices for inflation, the price decline has been even larger. On an annual basis, real oil prices (adjusted for inflation) peaked in 1980 and 1981 at just under \$44 per barrel when expressed in 1985 dollars. Therefore, the real price decline by the end of 1985 has been almost 40 percent, and there is every indication that oil prices will continue to decline from that level during 1986.

The changes on the supply side have been equally impressive. Between 1979 and 1984, primary energy production worldwide has increased by about 0.4 percent per year, with all energy forms except oil registering steady growth. Coal, natural gas, and hydroelectric power consumption all grew between 2 and 3 percent per year over this 5-year period while nuclear power grew at almost 13 percent per year. Oil production, on the other hand, fell by almost 3 percent per year. During this period of an overall decline in oil production, the Organization of Petroleum Exporting Countries<sup>1</sup> (OPEC) share of that market has also been decreasing. By the third quarter of 1985, OPEC's production had declined by 50 percent from 1979 levels, and production of its largest member (Saudi Arabia) had declined by over 70 percent. These changes have resulted in a large amount of oil production capacity standing idle worldwide and significant downward pressures on oil prices.

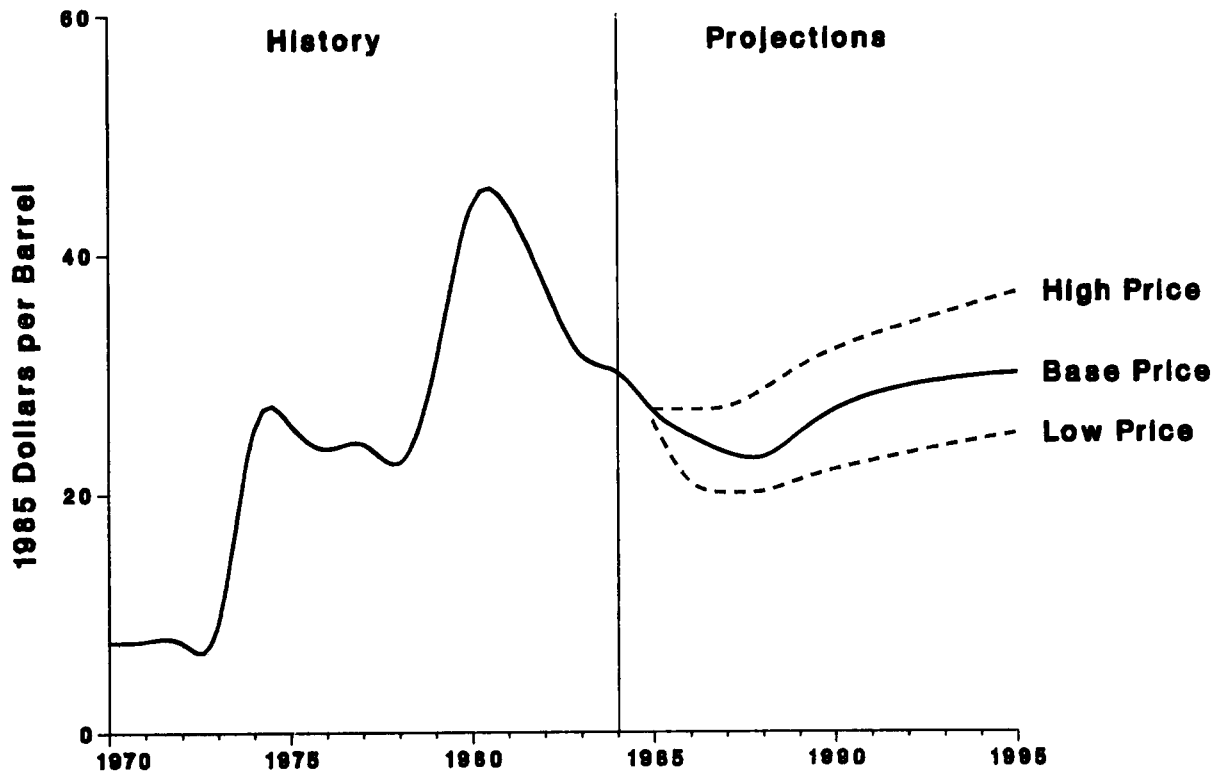
The highlights from the international energy projections are as follows:

- o This analysis indicates that real oil prices (expressed in 1985 dollars) are likely to decline from 1985 levels to between \$20 and \$27 per barrel by 1987 and then rise to between \$25 and \$37 per barrel by the end of the forecast period in 1995 (Figure ES1 and Table ES1).

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<sup>1</sup>The members of OPEC include Algeria, Ecuador, Gabon, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates, and Venezuela.

**Figure ES1. World Oil Prices, 1970-95**



Note: All prices are the cost of imported crude oil to U.S. refiners.

Sources: o History: Energy Information Administration, Annual Energy Review, 1984, DOE/EIA-0384(84) (Washington, DC, 1985). o Projections: Table 2 of this report.

**Table ES1. Summary of Assumptions and Projections for the Market Economies<sup>a</sup>**

Assumptions/Projections	History			Projections	
	1983	Preliminary 1984	Estimated 1985	1990	1995
<b>Assumptions</b>					
Economic Growth Rates (percent per year) .....	1.9	4.2	2.6	2.5-3.3	2.5-3.3
OPEC Oil Production Capacity <sup>b</sup> (million barrels per day) .....	27.2	27.2	27.3	28-30	29-32
<b>Projections</b>					
Oil Prices <sup>c</sup> (1985 dollars per barrel) ..	31.50	29.93	27	22-32	25-37
Oil Production <sup>d</sup> (million barrels per day)					
Non-OPEC .....	24.3	25.7	26.4	26-27	24-26
OPEC .....	18.6	18.6	17.0	19-21	23-27
Energy Consumption					
Oil (million barrels per day) .....	45.5	46.2	45.6	47-49	49-52
Gas (trillion cubic feet) .....	33.9	36.3	38.1	44-47	49-56
Coal (million short tons) .....	1,942	2,031	2,135	2,300-2,400	2,600-2,800
Other <sup>e</sup> (quadrillion Btu) .....	26	28	29	35-36	39-41
Total Energy <sup>f</sup> (quadrillion Btu) ...	190	198	202	223-227	244-251

<sup>a</sup> Includes all countries except those with centrally planned economies, Eastern Europe, the Soviet Union, China, Cuba, Kampuchea, North Korea, Laos, Mongolia, and Vietnam.

<sup>b</sup> Production capacity is defined as maximum sustainable production adjusted to reflect current operable capacity in some countries.

<sup>c</sup> Oil prices are defined as the U.S. refiner acquisition cost of imported crude oil.

<sup>d</sup> Includes crude oil, lease condensate, natural gas liquids, other liquids, and refinery gain.

<sup>e</sup> Includes nuclear, hydroelectric, geothermal, and other energy sources.

<sup>f</sup> Average conversion factors used to compute British thermal units (Btu) are (1) Oil - 5.5 Million Btu/barrel, (2) Gas - 1,020 Btu/cubic feet, and (3) Coal - 20.3 Million Btu/short tons.

OPEC=Organization of Petroleum Exporting Countries.

Sources: o History: Energy Information Administration, Monthly Energy Review, DOE/EIA-0035(85/09), International Energy Annual 1984, DOE/EIA-0219(84), and Short-Term Energy Outlook, DOE/EIA-0202(85/4Q) (Washington, DC, 1985); Wharton Econometric Forecasting Associates, World International Data Banks, May 1985, (Philadelphia, PA, 1985). o Projections: Tables 1, 2, 5, 8, 9, 11, 12, 13, and 14 of this report; Energy Information Administration, Office of Energy Markets and End Use.

- o The base case outlook is essentially a "no surprises" projection which includes continued price declines from 1985 levels for the next 2 or 3 years, gradual increases in oil demand, a peaking in non-OPEC oil production in the late 1980's, and production restraints by OPEC in order to prevent a major price collapse. However, history shows that the oil market exhibits many short-term ups and downs, and there is no reason to expect that the next 10 years will be any different. The present price declines in early 1986 are a clear example of this market behavior.
- o An excess of 10 to 11 million barrels per day in world oil production capacity may cause world oil prices to decline from their 1985 levels for the next 2 or 3 years. However, non-OPEC production is expected to peak in the late 1980's and decline during the 1990's. Oil exports from the Soviet Union are also projected to decline over the projection period.
- o Recent evidence indicates that proved oil reserves in the "market economies"<sup>2</sup> are about 600 billion barrels and that the mean value of the estimated undiscovered recoverable oil resources are in excess of another 520 billion barrels. However, approximately 4 of every 5 barrels of the proved reserves and almost half of the undiscovered resources are estimated to exist in the OPEC countries.
- o Energy consumption in the market economies is projected to grow about 2 percent per year over the next 10 years, or about 70 percent as fast as projected economic growth. Energy consumption in the developing countries is projected to grow about two and a half times as fast as in the industrialized countries of the Organization for Economic Cooperation and Development (OECD).<sup>3</sup>
- o Economic activity over the next 10 years is projected to be more energy intensive in the developing countries than in the OECD countries. Energy consumption in the developing countries is expected to grow at about the same rate as economic growth, i.e., an energy/Gross Domestic Product (GDP) growth ratio of about unity. The energy/GDP growth ratio for the OECD countries between 1985 and 1995 is projected to average only about 0.6. (GDP is the conventional international economic measure as opposed to Gross National Product, GNP.)

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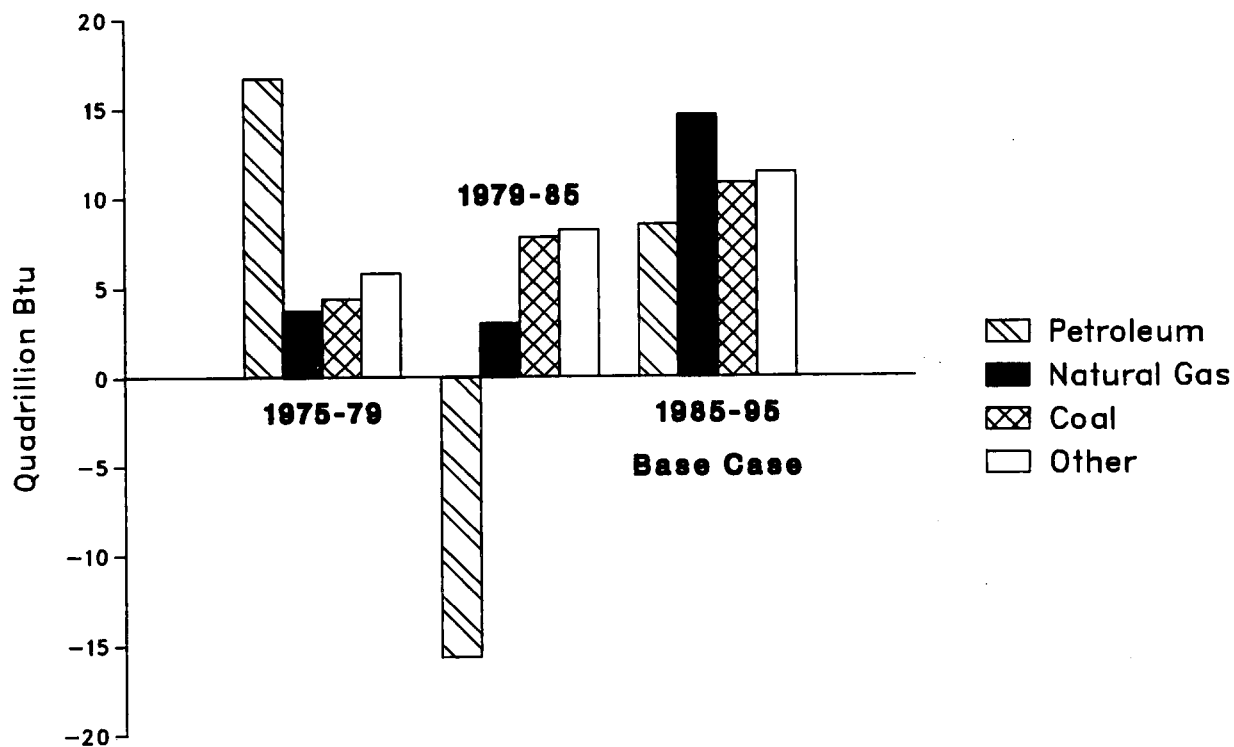
<sup>2</sup>The "market economies" are defined as all countries other than the centrally planned economies of Eastern Europe, the Soviet Union, China, Cuba, Kampuchea, North Korea, Laos, Mongolia, and Vietnam. Also referred to as "free world" or "world outside communist areas."

<sup>3</sup>The OECD members are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, West Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States.



- o Though energy consumption is expected to expand the most in the developing countries, the economic prospects for several of these countries are uncertain because of large external debts. Some Latin American countries in particular have had difficulty servicing their external debt, due partly to high interest rates and to a strong dollar eroding earnings from exports.
- o Consumption of oil in the market economies is projected to increase by 3 to 6 million barrels per day between now and 1995, to a level of 49 to 52 million barrels per day (Table ES1). To meet growing demands, OPEC oil production (including natural gas liquids) is projected to rise from about 17 million barrels per day in 1985 to between 23 and 27 million barrels per day by 1995.
- o Oil consumption continued historic growth trends after the first oil price shock, 1973-74 (due to the Arab embargo) but it fell sharply after the second price shock, 1979-80 (due to the Iranian revolution). Although oil consumption is projected to start increasing again, its share of total energy consumption is projected to decline, going from about 45 percent of the total in 1985 to about 40 percent by 1995 in the base case.
- o Natural gas consumption in the market economies is projected to grow in the base case at an average annual rate of 3.3 percent between 1985 and 1995, accounting for almost one-third of the increase in total energy demand over this period. The fastest growth is projected to occur in developing countries (10.3 percent annual growth rate), followed by Japan (4.3 percent), OPEC (4.2 percent), Australia and New Zealand (3.8 percent), and Western Europe (3.4 percent). Much of the growth in non-OPEC countries may be attributed to energy policies aimed at reducing dependence on imported oil by taking advantage of domestic energy reserves and securing imports from a diversity of supply sources. The impetus for increased consumption in OPEC nations is twofold: to reduce flaring of associated gas in oil production and to allow additional oil supplies for export (or conserve petroleum resources for future export) by substituting natural gas for oil in domestic energy markets (Figure ES2).
- o Growth in coal demand through 1995 is projected to occur primarily in the steam coal market in response to rising coal use by electric utilities and industrial use in Western Europe and Asia. Figure ES2 shows that during the next decade coal consumption is projected to account for almost one quarter of the increase in energy consumption in the market economies in the base case. Although both coal consumption and coal trade in the market economies are projected to increase, coal's share of total energy consumption is expected to increase only slightly.
- o Nuclear power is expected to be the fastest growing energy source (average annual growth rate of about 4 percent) in the market economies over the projection period. Growth is expected to be

**Figure ES2. Shifts in the Composition of Market Economies Fuel Consumption Between Periods**



Notes: o These bars represent the "change," during each period, in specific fuel consumption. The sum of the changes equals the change in total energy consumption. o This illustration highlights continued high levels of oil consumption for the 5 years (1975-79) after the first price shock in 1973-74 due to the Arab oil embargo; the downturn in oil consumption in 1979 after the second price shock due to the Iranian revolution and a period (1979-85) where total energy consumption was relatively flat (the change in oil consumption practically offsets the sum of the changes in other fuels); and the base case projection (1985-95) of increasing total energy consumption but a declining oil share (indicated as the smallest increase across fuels).

Sources: o History: United Nations, 1979 Yearbook of World Energy Statistics (New York, NY, 1981); and Energy Information Administration, International Energy Annual, DOE/EIA-0219 and International Petroleum Annual, DOE/EIA-0042, selected issues (Washington, DC). o Projections: Table 10 of this report.

particularly strong in the United States, Japan, and France. Growth of U.S. nuclear power is only strong through 1989. Hydroelectric power is projected to grow fastest in the developing countries. The combined growth rate of nuclear and hydroelectric power between 1985 and 1995 is projected to be 3.4 percent in the base case or slightly higher than the growth in natural gas in the market economies.

- o The contribution of synthetic fuels, such as shale oil and liquefied coal, is projected to remain small through 1995. Development of synthetics will be hampered by the lower prices of conventional fuels.

Energy consumption is projected to increase over the next 10 years with the energy sources aside from oil accounting for a larger share of total energy consumption. Even though oil's share of energy consumption is projected to decline, oil remains the major energy source for the market economies. Though world oil supplies are plentiful at the present time, they could once again become a cause for concern to the United States in the years ahead. Proved crude oil reserves in the United States were estimated at 28.4 billion barrels<sup>4</sup> at the end of 1984, equivalent to less than 9 years supply at 1985 production rates. Although additional reserves will continue to be discovered in the United States, the outlook is for U.S. oil production to begin to decline soon. In contrast, proved crude oil reserves within OPEC were estimated at 477 billion barrels at the end of 1984, over 80 years supply at their 1985 production rates. Reserves in Saudi Arabia alone stood at 172 billion barrels, over 6 times the level of reserves in the United States and about 28 percent of the reserves of the market economies as a whole. Given this distribution of oil reserves, it is clear that OPEC will continue to play a major role in the world oil market for the foreseeable future. However, a large excess of world oil production capacity should keep prices down for the next 2 or 3 years. But, growing oil demands and a leveling off of production in non-OPEC regions such as Alaska and the North Sea is projected to result in increased reliance on OPEC oil and a tightening of the oil market once again in the early 1990's.

The energy projections presented in this report are, of course, highly dependent upon the underlying assumptions used. Major assumptions deal with such key considerations as economic growth, the energy intensity of economic activity, supply availability of alternatives to oil, and the response of consumers to changes in energy prices. Alternative assumptions are used to demonstrate how changes in these basic assumptions can influence the international energy outlook.<sup>5</sup>

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<sup>4</sup> Proved crude oil reserve estimates are from Energy Information Administration, U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves 1984 Annual Report DOE/EIA-0216(84) and Annual Energy Review 1984, DOE/EIA-0384(84) (Washington, DC, 1985).

<sup>5</sup> The assumptions used in this report are consistent with those underlying the energy projections for the United States in Energy Information Administration, Annual Energy Outlook 1985, DOE/EIA-0383(85) (Washington, DC, 1986).

# 1. World Oil Prices

As past experience has shown, changes in world oil prices and the factors influencing those changes are the most important aspects of the international energy outlook. By examining a range of assumptions about key factors affecting world oil prices, including economic growth, the development of production capacity, and the behavior of energy producers and consumers, three world oil price scenarios have been projected for the period 1985 to 1995. The three world oil price projections indicate the high degree of uncertainty about future developments in the world oil market.

One of the uncertainties about future prices is the behavior of oil exporters. The basic assumption used in this report is that oil exporters will continue to follow the same general price behavior that they have exhibited over the past decade which indicates a strong relationship between price changes and the rate of utilization of available production capacity.

During the past decade, OPEC has raised prices sharply during periods of scarcity, but has been willing to restrict output in order to moderate the downward slides in the price of oil. Saudi Arabia has been the principal proponent of this policy and has seen its output decline from 10 to less than 3 million barrels per day between 1981 and the summer of 1985.

The OPEC Oil Ministers in their December 1985 meeting unanimously agreed to increase their production, but they still intend to produce far below their capacity. OPEC stated that they intend to produce at a rate that would maintain their fair share of the oil market and by implication, to allow world oil prices to decline. However, it is not expected that they will seek to increase their production in 1986 by any more than about 2 or 3 million barrels per day. World oil prices are likely to fall, and possibly fall precipitously if OPEC aggressively attempts to regain market share. Conversely, prices could rise if oil exporters seek to restrict supplies or if there is a major escalation in the Iran/Iraq war. Such market circumstances can cause wide swings in short-term oil prices and result in the large uncertainties in the outlook for the price of oil as shown in Figure ES1.

Unless otherwise stated, world oil prices are presented in 1985 constant dollars. That is, any projected change in price reflects a real change in the price of oil relative to the price of other goods and services, not simply a change in oil price due to inflation.

## Economic Growth and Energy Intensity

The rate of economic growth among the market economies is a major determinant of future oil demands. In the base case, economic growth in the market economies is assumed to average just under 3 percent per year over the forecast period (Table 1).



**Table 1. Annual Growth Rates of Real Gross Domestic Product (GDP) and Energy/GDP Growth Ratios, Base Case, 1975-95 (Percent)**

Country/Region	Average Annual GDP Growth Rates				Energy/GDP Growth Ratios	
	1980-85	1985-90	1990-95	1985-95	1975-85	1985-95
United States .....	2.7	3.1	2.5	2.8	0.2	0.4
Canada .....	2.3	2.5	2.3	2.4	0.7	0.8
Japan .....	4.2	2.9	3.6	3.2	0.5	0.5
OECD Europe .....	1.3	2.3	2.2	2.3	0.5	0.8
Total OECD .....	2.2	2.7	2.5	2.6	0.3	0.6
OPEC .....	(2.8)	2.9	4.5	3.7	NA	1.0
Other Countries .....	3.0	3.7	4.2	4.0	NA	1.0
Developing Countries .....	1.4	3.5	4.3	3.9	1.3	1.0
Total Market Economies .....	2.1	2.9	2.9	2.9	0.5	0.7

NA=Not Available

( ) Indicates a negative number

OECD=Organization for Economic Cooperation and Development.

OPEC=Organization of Petroleum Exporting Countries.

Note: Aggregate growth rates are calculated from aggregate real gross domestic product in 1980 dollars at 1980 exchange rates.

Source: Wharton Econometric Forecasting Associates, World International Data Banks, May 1985, (Philadelphia, PA, 1985); Table 11 of this report, Energy Information Administration, Office of Energy Markets and End Use.

The effects of economic growth on future world oil demand may be less pronounced than it has been in the past. An important long run trend tending to reduce energy consumption has been the reduction in the amount of energy required to produce a given amount of total output. The ratio of energy consumption to real GDP has been declining for years in the industrial nations, with the oil portion of consumption declining more than proportionately. This trend is largely the result of energy conservation induced by the two past oil price shocks plus some shifting away from energy-intensive heavy manufacturing towards the less energy-intensive services and high-technology sectors. In contrast, energy per unit of real GDP for the developing countries reflects their movement away from labor-intensive agriculture and toward energy-intensive manufacturing sectors such as steel manufacturing.

Since 1980, declines in energy/GDP ratios have accelerated in the industrial countries of the OECD. Energy consumption per unit of GDP in the OECD declined by about 1 percent per year between 1973 and 1979 and by about 2.9 percent per year between 1979 and 1984 (Figure 1). The decline of the energy/GDP ratio in OECD North America (Canada and the United States) has been the major factor reducing the overall OECD energy/GDP ratio. The amount of oil consumption per unit of GDP declined even faster during this period, down about 1.8 percent per year from 1973 to 1979 and about 5.7 percent per year between 1979 and 1984. These rates of decline in energy use per unit of real GDP are not expected to continue in the projection period. As indicated in Table 1, energy/GDP growth ratios are in general larger than those during the turbulent period of 1975 to 1985. In the developed countries of the OECD, the ratios are projected to remain significantly below unity. In contrast, in the developing countries energy consumption is projected to grow at the same rate as economic activity.

## International Finance

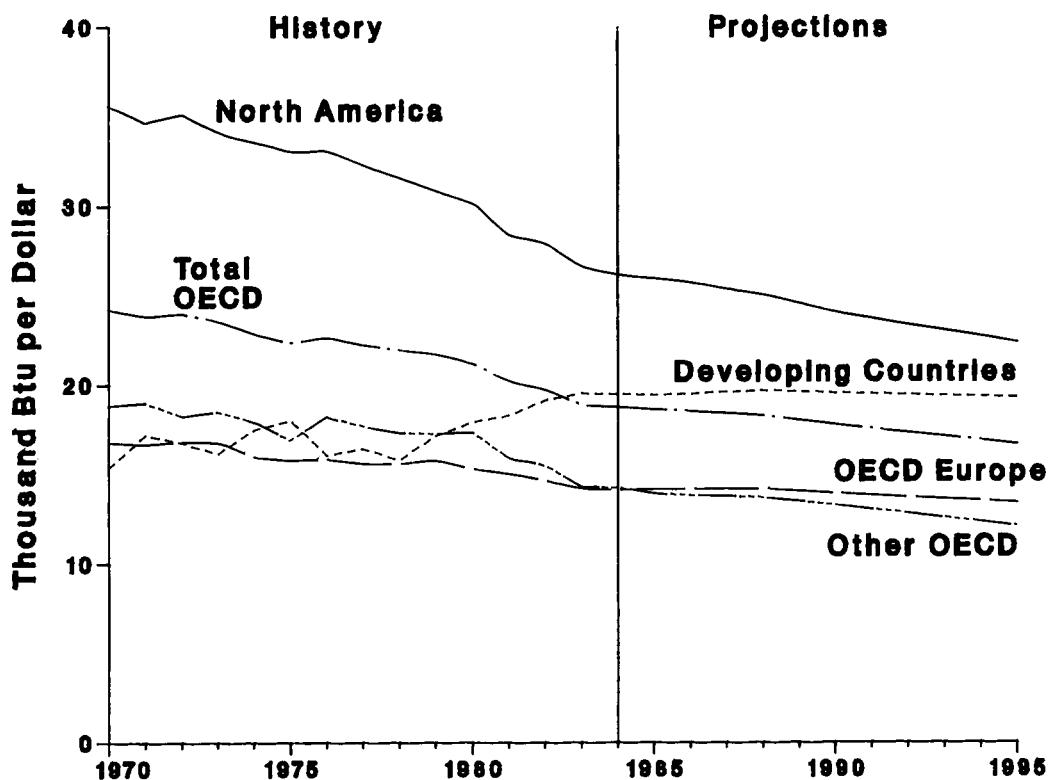
The world oil market outlook is also influenced by the international financial markets. Internationally traded oil is paid for in U.S. dollars. The local currency cost of oil to the United States is not the same as that paid by others because of the differences in currency exchange rates (Figure 2). The effective exchange rate index of the U.S. dollar rose by about 62 percent from its base year value of 100 in 1980 to its peak in March of 1985.<sup>6</sup> This performance reflects the strength of the U.S. economy, the large interest rate differentials--nominal and real--between the United States and other countries, and the safe haven effect. Since March of 1985, the effective exchange rate index of the U.S. dollar has declined by 14 percent. The slowdown in U.S. economic growth, the continuing large U.S. trade deficits, the narrowing of interest rate differentials, and the recent foreign exchange market intervention by the Group of Five (the United States, the United Kingdom, West Germany, France, and Japan) have been the major contributing factors to the decline in the value of the dollar. Depending on the currency, this depreciation of the U.S. dollar is equivalent to a 14 to 25 percent cut in the price of world oil.

Though oil consumption is projected to increase in the developing countries, the economic prospects for several of these countries are uncertain because of large external debts. During the past few years, some Latin American countries in particular have had difficulty servicing their external debt, due partly to the high interest rates and to a strong dollar eroding earnings from exports. Oil exporting countries are also affected by the

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<sup>6</sup>The effective exchange rate of the U.S. dollar against eighteen major currencies is a weighted index, with weights derived from the International Monetary Fund (IMF) multilateral exchange rate model. International Monetary Fund, International Financial Statistics and International Financial Statistics: Supplement on Exchange Rates (Washington, DC, 1985).

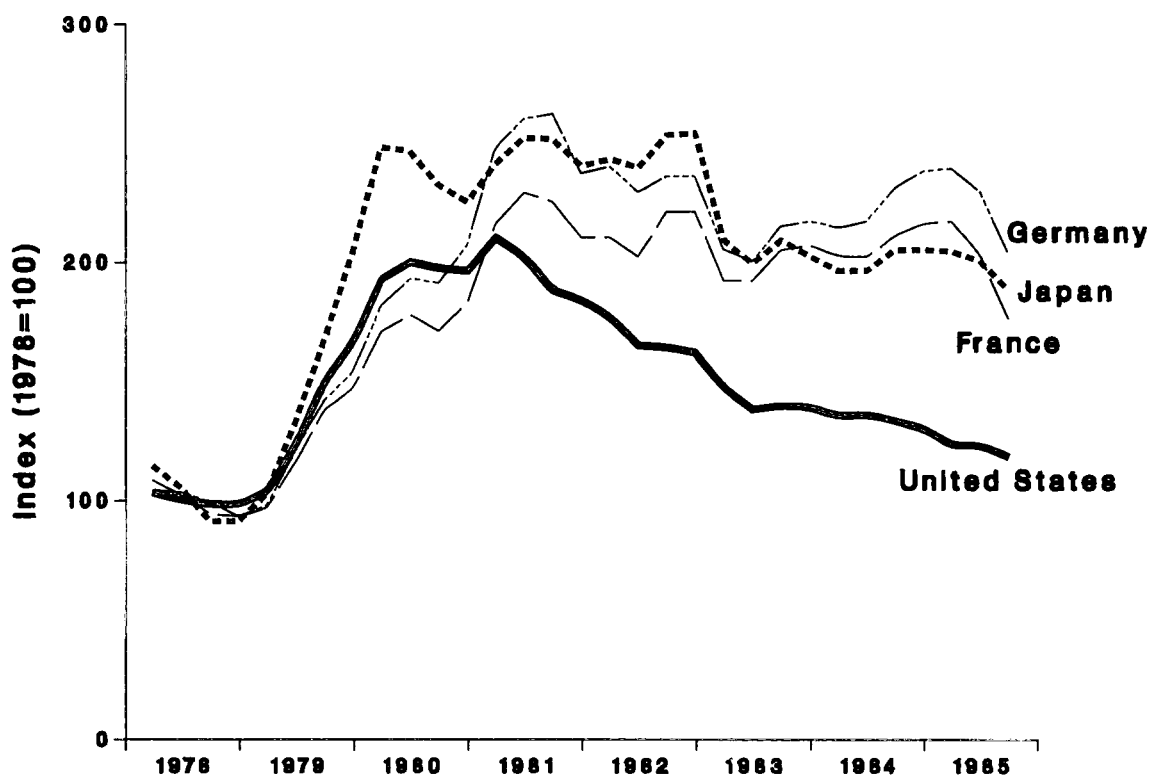
**Figure 1. Energy/GDP Ratio: Base Case, 1970-95  
(1980 Dollars at 1980 Exchange Rates)**



OECD=Organization for Economic Cooperation and Development.

Sources: o History: Wharton Econometric Forecasting Associates, World International Data Banks, May 1985 (Philadelphia, PA, 1985); United Nations, 1979 Yearbook of World Energy Statistics (New York, NY, 1981); and Energy Information Administration, International Energy Annual, DOE/EIA-0219 International Petroleum Annual, DOE/EIA-0042, selected issues (Washington, DC). o Projections: Derived from Tables 1 and 11 of this report.

**Figure 2. Real World Oil Prices in Major Industrial Countries  
Based on National Currencies, 1978-85**



Note: The average refiner acquisition cost of imported crude oil in the United States is used as the world oil price for each country. The world oil price is converted to the national currency by using the appropriate exchange rate. This value is then converted to an index by dividing each quarterly value by the average value for 1978. Inflation rates for each country are used to determine real prices.

Sources: Energy Information Administration, Monthly Energy Review, DOE/EIA-0035(85/08) (Washington, DC). Data Resources, Inc., U.S. Central, Europe, and Japan data bases.



international financial market. More recently, the depreciation of the dollar relative to other major currencies reduces the oil exporters' purchasing power. In turn, this loss reduces the ability of certain oil exporters such as Mexico, Venezuela, and Nigeria to service their external debts. Maintenance of purchasing power has always been a stated objective of OPEC; but, with erosion of the dollar, OPEC must increase oil prices and/or oil sales in order to avoid a loss in purchasing power.

## Changes in Market Structure

In addition to general economic forces affecting oil market trends, the oil industry itself has undergone tremendous changes over the last 15 years, and is likely to continue to evolve in response to changing circumstances. In the 1970's, for example, OPEC gained control of the world oil market. By the 1980's, however, the reaction of non-OPEC nations to the market turbulence of the 1970's (increased exploration, energy conservation, and fuel substitution) succeeded in increasing the non-OPEC share of the market while reducing demand for OPEC oil and threatening OPEC's influence in the world market. The role of Saudi Arabia became crucial. As swing producer, Saudi Arabia had been absorbing OPEC production decreases until September 1985, when the Saudis announced a new strategy to regain market share through the adoption of netback pricing arrangements. In December 1985 OPEC as a whole agreed to pursue the objective of protecting market share rather than price. The resulting increase in OPEC, mainly Saudi Arabian, production in the fourth quarter of 1985 precipitated the dramatic decreases in world oil prices that occurred in January 1986. Having demonstrated their willingness to let oil prices fall, Saudi Arabia has put the pressure on major non-OPEC exporters (Egypt, Great Britain, Norway, and Mexico) and other OPEC members to restrain their production in order to support prices in the short term. In the longer term, however, lower oil prices could have the effect of improving OPEC's market position by reducing oil production outside OPEC and discouraging investment in alternative energy sources and in energy conservation.

In addition to these changes in the relative influence of the various players in the world petroleum market, the market itself has evolved in several important ways. Foremost is the diminishing market influence of long-term contracts at fixed official prices, which are being replaced by term contracts with increasingly flexible, market-responsive pricing clauses, barter deals, and netback pricing agreements. Under a netback sales agreement the price of crude oil is equal to the market value of the refined products, minus transportation and refining costs. The spot and futures markets, meanwhile, have grown in importance. Prices on these markets have been a major focus both in monitoring the price declines that began in January 1986 and in anticipating future price paths. With prices expected to continue downward in the near term, spot market activity could remain strong. In addition, the relatively young petroleum futures market developing in the United States could continue to grow, possibly expanding to other countries. Once a new market equilibrium has been established, and prices resume their upward trend in the longer term, fixed price contracts could regain a more important influence on the market.

Producers had already begun restructuring their internal organizations in response to market conditions, even prior to the January 1986 price decreases. Shut-in production capacity, expectations of slow growth in demand, and continued expansion of non-OPEC production have encouraged the entry of OPEC into downstream markets in order to secure long-term reliable outlets for crude and products. Kuwait acquired all of Gulf Oil's assets in several European countries, while Venezuela is participating in joint ventures in overseas downstream markets. Saudi Arabia is now involved in large-scale refining activities, and other state-owned companies outside OPEC are also exploring downstream operations. Such diversification of historical sales channels, geographical areas, and product slates could help to stabilize income and foreign exchange earnings for these producers. At the same time, refinery overcapacity and sluggish demand are encouraging the traditionally integrated major oil companies to assess the profitability of each phase of their operations. Fewer refineries and more efficient marketing outlets are the likely outcome.

The structure of the market will continue to evolve, but is not expected to undergo any radical changes through 1995. OPEC will probably regain some influence once the current supply-demand imbalance is settled, although its power is unlikely to rival that of the 1970's. Term contracts could regain their importance as supplies become less plentiful exerting upward pressure on prices. The futures market could also continue to play a role in balancing the expectations of buyers and sellers. Despite pressure on major oil companies to divest they are likely to remain highly integrated, although perhaps become less geographically dispersed. OPEC could increase its share of the product market, but it is difficult to assess the future extent of its penetration.

## World Oil Price Outlook

The base case outlook is essentially a "no surprises" projection which includes continued price declines from 1985 levels for the next 2 or 3 years, gradual increases in oil demand, a peaking in non-OPEC oil production in the late 1980's, and production restraints by OPEC in order to prevent a major price collapse. However, history shows that the oil market exhibits many short-term ups and downs, and there is no reason to expect that the next 10 years will be any different. The present price declines in early 1986 are a clear example of this market behavior.

Consequently, it is important that we seek to understand not only the underlying supply and demand forces that prevail in the oil market, but also the sensitivity of the oil market outlook to changes in the basic assumptions. By conducting such a sensitivity analysis, a range of oil price projections has been estimated that attempts to capture a reasonable range of possible oil prices over the next 10 years. This analysis indicates that oil prices are likely to range between \$20 and \$27 per barrel by 1987 and then rise to between \$25 and \$37 per barrel by the end of the projection period in 1995 (Table 2).

**Table 2. World Oil Prices, 1979-95  
(1985 and Nominal Dollars per Barrel)**

Year	Price Case		
	Low	Middle	High
<u>1985 Dollars per Barrel</u>			
1979		\$30.70	
1980		43.98	
1981		43.85	
1982		37.45	
1983		31.50	
1984		29.93	
1985	\$26	27	\$27
1986	21	25	27
1987	20	23	27
1988	20	23	29
1989	21	25	31
1990	22	27	32
1991	23	28	33
1992	23	29	34
1993	24	29	35
1994	24	30	36
1995	25	30	37
<u>Nominal Dollars per Barrel</u>			
1979		\$21.67	
1980		33.89	
1981		37.05	
1982		33.55	
1983		29.30	
1984		28.88	
1985	\$26	27	\$27
1986	22	26	28
1987	22	25	29
1988	23	26	33
1989	25	30	37
1990	28	34	40
1991	30	37	44
1992	32	41	48
1993	35	43	52
1994	38	47	56
1995	41	50	61

Notes: o Prices represent the U.S. refiner acquisition cost of imported crude oil.  
o The inflation rates used to estimate nominal prices for 1986 through 1995 are derived using the base case GNP price deflators from Energy Information Administration, Annual Energy Outlook 1985 DOE/EIA-0383(85) (Washington, DC, 1986).

Source: o History: Energy Information Administration, Monthly Energy Review, DOE/EIA-0035(85/09) (Washington, DC, 1985). o Projections: Energy Information Administration, Office of Energy Markets and End Use.

Even this range of prices does not capture extreme market scenarios such as a supply disruption or an oil price war which could easily cause prices to fall outside of the projected range for at least short periods of time. An example of such a supply disruption scenario is discussed in Chapter 2 which could cause prices to rise to as much as \$55 per barrel in 1990. Alternatively, an oil price war could cause prices to collapse to well below \$20 per barrel during 1986. However, such extreme outcomes would probably be short lived and the general outlook depicted by the estimated price ranges shown in Table 2 are expected to prevail on average over the next 10 years.

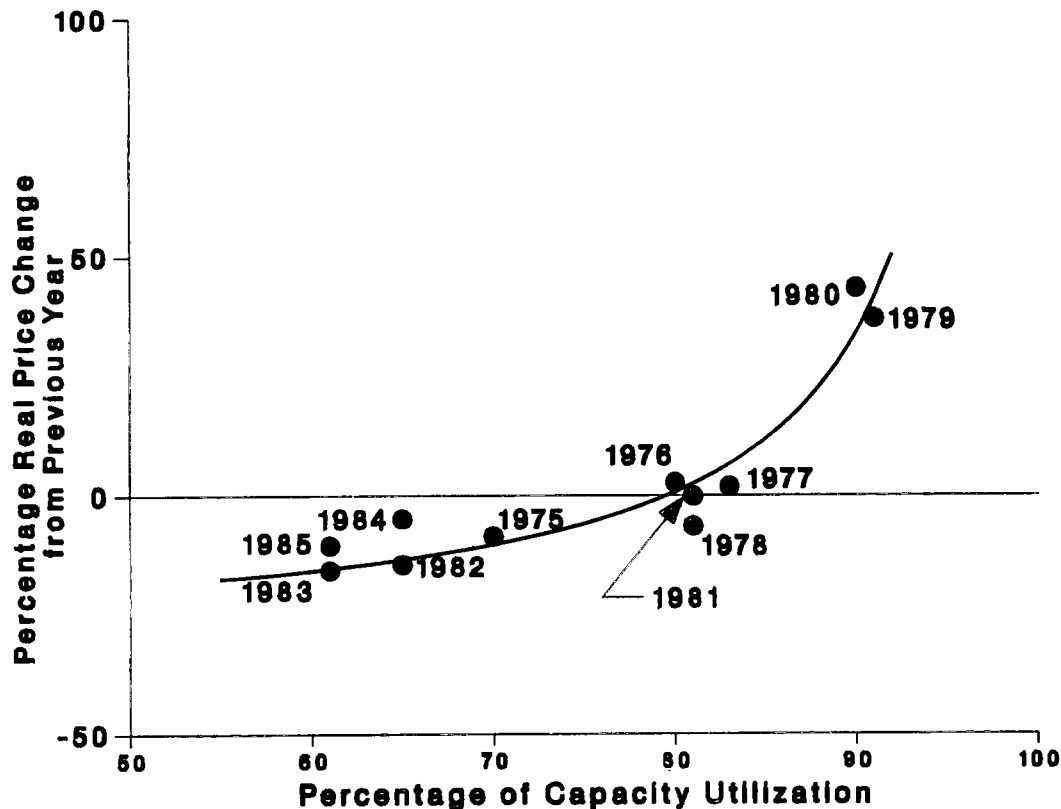
The base case oil price outlook assumes midlevel projections of future oil supply and demand and a continuation of past production restraints by OPEC in order to sustain oil prices. The supply and demand projections are discussed in detail in Chapters 2 and 3, respectively. The quantification of OPEC production restraints is best discussed in reference to the OPEC pricing behavior curve depicted in Figure 3. This price behavior curve shows that OPEC has tended to raise and lower prices over the last 10 years in relation to the percent of its production capacity that is needed to satisfy world oil demand. OPEC has tended to raise prices sharply whenever the demand for its oil is high, but has allowed prices to decline only gradually when the demand for its oil is low. These gradual price declines have been brought about by production restraints on the part of OPEC. The base case oil price outlook assumes that this general price behavior will continue over the next 10 years. The near-term price estimates (between now and 1990) are based on the assumption that the degree of production restraint shown by OPEC over the last 2 years will continue through 1990. The post-1990 price estimates are then based on a gradual return to the price behavior curve by 1995 (Figure 3).

A number of sensitivity cases were then investigated around this base case in which several basic assumptions were altered. The sensitivities that were addressed are as follows:

<u>Assumptions</u>	<u>Sensitivity Range</u>
o Economic Growth	Plus or minus 0.4 percentage points per year
o Energy/GDP ratio	Plus or minus 10 percent
o Oil price elasticities	Plus or minus 25 percent
o Non-OPEC oil production	Range shown in Table 5
o OPEC production capacity	Range shown in Table 5.

The price impacts of these variations in assumptions were first estimated individually and then a combined uncertainty range was derived. The individual impact estimates were combined by the use of a statistical technique which calculates the combined uncertainty as the square root of the sum of the squares of the individual uncertainties. This technique is used in order to avoid the highly improbable price ranges that would be implied by artificial scenarios that assume the simultaneous occurrence of several extreme assumptions.

**Figure 3. OPEC Pricing Behaviour, 1975-85**



OPEC=Organization of Petroleum Exporting Countries.

Note: Percentage of capacity utilization is derived by dividing OPEC crude oil production for a given year by OPEC maximum sustainable capacity for that year. Production capacity is defined as the maximum production rate that can be sustained for several months. The percentage of real price change for the previous year is derived using the average price of imported crude oil to U.S. refiners. The curve is fitted to historical data using least squares regression. The 1985 value was not used to fit the curve but is presented to demonstrate the applicability of this relationship.

Sources: Energy Information Administration, Monthly Energy Review, DOE/EIA-0035(85/08) (Washington, DC 1985); Central Intelligence Agency, International Energy Statistical Review, selected issues (Washington, DC).

## 2. Oil Production Potential

The prospects for future oil supply depend largely on the size and location of the reserves and resource base. In recent years the development of oil reserves in non-OPEC countries has allowed their production to move ahead of the oil supply from OPEC. However, relative to OPEC, non-OPEC production prospects are more limited because of lower production capacity, reserve levels, and rates at which new oil is being found. Middle East OPEC countries, on the other hand, have a high degree of discretion in choosing production levels. OPEC production levels will depend in large part on the organization's market strategies and its ability to implement those strategies. Two key developments within OPEC which are underway already are the expansion of export refinery capacity and the expansion of pipeline distribution capacity.

### World Oil Resources

The projected future availability of crude oil is based primarily on estimates of proved reserves, a continuation of present trends in exploration activity, and expansion of production capacity. Information on the world's oil reserves and resources is estimated by engineers and geologists using various techniques for determining the likely amount of recoverable oil in an oil reservoir. The terms reserves and resources require some explanation and definition. Reserves in this report refer to "proved reserves" or oil which geological and engineering data demonstrate with reasonable certainty to be recoverable in future years from known reservoirs under existing economic and operating conditions. Resources refer to "undiscovered recoverable resources" or oil which is not yet discovered but is thought to exist in a geologic setting that is favorable for oil extraction. Estimates of oil reserves and resources are presented in Table 3.

Because reserves and resources are based on estimation and judgment, it is important to recognize that there may be significant year-to-year shifts in the opinion of experts as to reserves and resources in a reservoir or country. Nevertheless, certain general statements can be made that are indicative of the future sources of petroleum supply.

- o Recent evidence indicates that oil reserves in the market economies are about 600 billion barrels (Table 3) and the mean value of the estimated undiscovered recoverable resources is in excess of another 520 billion barrels (United States Geological Survey).
- o Crude oil reserves increased between 1980 and 1985 in spite of real price declines and an average crude production level of only about 41 million barrels per day. From 1980 to 1985, the market economies produced an average of 15 billion barrels of crude oil per year while reserves increased by about an additional 10 to 13 billion barrels per year in excess of production.
- o About 3 of every 5 barrels of the market economies' oil reserves are in the Middle East (virtually all in the Persian or Arabian Gulf). Countries in OPEC account for about 4 of every 5 barrels of total reserves.



**Table 3. Crude Oil Reserves and Resources in the Market Economies  
(Billion Barrels)**

Country/Region	Crude Oil Reserves <sup>a</sup>			Undiscovered Recoverable Resources	
	Oil and Gas Journal (12/31/84)	World Oil (12/31/84)	FESAP (Various Dates)	Statistical Mean	Range
North America .....	83.0	83.0	NA	194.1	104-322
Canada .....	7.1	6.5	NA	31.4	19-48
Mexico .....	48.6	49.3	27.2 (12/81)	78.2	26-170
United States .....	27.3	27.2	<sup>b</sup> 28.4 (12/84)	82.9	64-105
Central & South America ..	34.7	36.2	NA	39.9	20-69
Ecuador .....	1.4	0.8	1.2 (12/82)	1.5	1-6
Venezuela .....	25.8	28.0	18.5 (12/78)	22.7	12-38
Western Europe .....	24.4	18.7	NA	23.4	13-49
United Kingdom .....	13.6	5.8	12.6 (12/81)	2.3	1-4
Other North Sea .....	9.0	11.5	7.0 (12/81)	17.9	9-34
Other Western Europe ...	1.8	1.4	NA	3.2	1-10
Middle East .....	398.5	373.5	419.2	173.9	72-337
Iran .....	48.5	37.5	62.5 (12/81)	26.4	11-51
Iraq .....	44.5	38.5	34.5 (12/81)	77.4	32-150
Kuwait <sup>c</sup> .....	92.7	82.7	95.7 (12/81)	3.2	1-7
Qatar .....	3.4	4.5	7.1 (12/81)	0.5	1-3
Saudi Arabia <sup>c</sup> .....	171.7	167.1	173.2 (12/81)	56.0	23-109
United Arab Emirates ...	32.5	36.3	43.0 (12/81)	6.9	3-13
Africa .....	55.6	59.1	NA	58.8	28-105
Algeria .....	9.0	7.1	10.4 (12/81)	8.2	3-17
Egypt .....	3.2	4.0	2.4 (12/81)	4.6	1-12
Gabon .....	0.5	0.6	NA	2.0	1-6
Libya .....	21.1	22.8	21.0 (12/81)	11.7	4-25
Nigeria .....	16.7	16.9	12.6 (12/75)	8.9	2-23
Other Africa .....	5.1	7.7	NA	23.4	10-45
Far East/Oceania .....	18.7	19.9	NA	33.9	16-70
Australia/New Zealand ..	1.6	1.6	NA	7.0	4-11
Indonesia .....	8.7	9.1	9.5 (12/82)	10.0	5-18
Total Market Economies ...	614.9	590.5	NA	524.0	250-950

<sup>a</sup> Reserves include proved reserves and indicated additional reserves in this table. Some foreign countries have a less restrictive definition than EIA of proved reserves that are reported to and published by the various trade journals.

<sup>b</sup> Energy Information Administration figure published separately (see sources).

<sup>c</sup> Includes 50 percent of the Neutral Zone reserves and resources.

NA=Not available.

FESAP=Foreign Energy Supply Assessment Program.

Sources: o Oil: Oil and Gas Journal 82, 53 (December 31, 1984); World Oil 201, 3 (August 15, 1985); Energy Information Administration, Foreign Energy Supply Assessment Program Series regional reports, selected issues, and U.S. Crude Oil, Natural Gas and Natural Gas Liquids Reserves, DOE/EIA-0216(84) (Washington, DC, 1975-1985). o All resources: U.S. Department of the Interior, Geological Survey, Distribution and Quantitative Assessment of World Crude-Oil Reserves and Resources, Open-File Report 83-728 (Reston, VA, 1983).

- o About one-third of the market economies' undiscovered recoverable resources (mean value) are in the Middle East and Persian Gulf area. OPEC also accounts for almost half of the remaining undiscovered resources.
- o Five countries--Canada, Mexico, Norway, the United Kingdom, and the United States--hold the vast majority of non-OPEC oil reserves and resources in the market economies. This group accounts for about one-sixth of reserves and about two-fifths of remaining undiscovered resources in the market economies.

The search for oil in the market economies peaked in 1981. Exploratory activity is the initial step in finding additional reserves. There were over 6,200 active rigs in December of 1981--about 4,500 of these were in the United States. By the end of 1985, there were about 3,500 active rigs in the market economies and about 1,900 in the United States, a decline of 2,600 rigs in the United States. The number of crews involved in seismic exploration is also an important indicator of petroleum exploration activity. According to the Society of Exploration Geologists, there were about 1,260 active seismic crews in the market economies at the peak in 1981. Since then, the number of seismic crews declined to less than 1,000 at the end of 1985. In the United States, there was a drop of about 300 crews during this period. Thus, outside the United States there has been only a modest decline in the number of active rigs and little change in the number of active seismic crews in recent years. As a result of the new free-market policies that have turned around a severely depressed oil industry, Canada is experiencing an increase in oil exploration.

These various trends suggest a base of oil for production that is sufficient today but is being depleted. Geographically, most of that base is in a few regions--North America (including Mexico), the North Sea, the Middle East, and four other OPEC countries outside of the Middle East. OPEC continues to hold the preponderance of reserves and resources; and there are no indicators that this is likely to change.

## **Historical Oil Production Trends**

Overall oil production (including natural gas liquids, other liquids, and refinery gain) in the market economies was about 44 million barrels per day in 1985. This was about a 8.5 million barrels per day decrease from the historical peak in 1979 and over 5 million barrels per day below the average production levels in 1973 when Arab oil supplies were reduced to Israel, the Netherlands, and the United States in an international oil embargo. Table 4 shows the trends in world oil supply from 1973 to 1985.

There have been significant changes in the origin and composition of oil supplies between 1973 and 1985. During this time OPEC experienced a significant loss of market share. In 1973 OPEC accounted for over 3 out of every 5 barrels of oil produced in the market economies. In 1985 OPEC provided only about 2 out of every 5 barrels of oil production. Iran and

**Table 4. Oil Supply in the Market Economies, 1973-85  
(Million Barrels per Day)**

Year	United States	Persian Gulf	Market Economies		
			OPEC	Non-OPEC	Total
1973 .....	11.4	20.9	31.3	17.4	48.8
1974 .....	11.0	21.5	31.1	17.1	48.2
1975 .....	10.5	19.2	27.6	16.8	44.4
1976 .....	10.3	21.8	31.2	17.0	48.2
1977 .....	10.4	22.1	31.8	18.2	50.0
1978 .....	10.8	21.0	30.4	19.3	49.7
1979 .....	10.7	21.5	31.7	20.5	52.1
1980 .....	10.8	18.5	27.7	21.4	49.1
1981 .....	10.7	15.8	23.6	22.1	45.8
1982 .....	10.8	12.8	19.9	23.1	43.0
1983 .....	10.8	11.6	18.6	24.3	42.9
1984 .....	11.1	11.4	18.6	25.7	44.4
1985 <sup>a</sup> .....	11.1	10.1	17.0	26.4	43.5

<sup>a</sup> Estimate for 1985.

OPEC=Organization of Petroleum Exporting Countries.

Notes: o Supply includes production of crude oil (including lease condensate), natural gas liquids, other hydrogen and hydrocarbons for refinery feedstock, refinery gains, alcohol, and liquids produced from coal and other sources. o Persian (Arabian) Gulf includes Bahrain, Iran, Iraq, Kuwait, Qatar, Saudi Arabia, and the United Arab Emirates. o Numbers may not add to totals due to independent rounding.

Sources: Energy Information Administration, International Energy Annual 1984, DOE/EIA-0219, Monthly Energy Review, DOE/EIA-0035 (85/10), and Petroleum Supply Monthly, DOE/EIA-0109 (85/11) (Washington, DC, 1985-1986).

Saudi Arabia each had major declines. Their production on a combined basis decreased by about 8 million barrels per day between 1973 and 1985. In the meantime, oil resources were developed outside OPEC; and non-OPEC oil production increased from 17 million barrels per day in 1973 to 26 million barrels per day in 1985. Production in the United States declined slightly over the period. The key increases occurred in countries that had not been among the major oil producers in the early 1970's--Egypt, Mexico, Norway, and the United Kingdom. Other developing countries such as Brazil, India, and Malaysia also had important production increases. Thus, there has been a general dispersion of important sources of supply that has adversely affected market domination by OPEC.

Also, the threat of oil supply cutoffs and the rapid rise of oil prices in the 1970's encouraged the development of liquid fuels (including alcohol fuels) from coal and from biomass materials such as bagasse. Two countries made significant progress in developing these fuels--South Africa and Brazil. In 1985 these countries provided about 300 thousand barrels per day of liquids for use as fuels. The United States and other nations also made progress in developing alcohol production for fuel use.

Concerns about the adequacy of short-term supplies of oil have been minimized by the dispersion of oil production sources, the existence of excess production capacity (particularly in OPEC), the persistent need for revenues in many producing countries, and the slow growth in oil consumption. These factors indicate that oil supplies were plentiful at the end of 1985. However, one important international oil production problem did emerge in 1985. The Soviet Union experienced a downturn in oil production (about 200 to 300 thousand barrels per day during the first half of the year). The production cuts diminished overall exports of the centrally planned economies to the market economies by the same amount. In the midst of plentiful oil supplies, this curtailment did not have a major impact on the overall oil market. Soviet oil production increased again in the second half of 1985 to more normal levels. In recent years, the market economies have used about 1.5 to 2 million barrels per day of oil from the centrally planned economies.

## **Future Oil Production Potential**

Estimated ranges of oil production capacities for OPEC and for other major producing regions are presented in Table 5. These regions show a wide diversity in production potential. In the non-OPEC group, production and production capacity increases are expected for Mexico and Canada by 1995, which are two countries believed to have large amounts of proved reserves and undiscovered resources relative to current production levels. However, these increases are projected to be more than offset by declines in production in the United States and the United Kingdom. The Alaskan North Slope and British North Sea areas are mature oil fields and production is expected to peak in the late 1980's and decline steadily thereafter.

Other non-OPEC countries as a group are expected to produce increasing amounts in the next few years, but to be producing at roughly current levels by 1995. Although the African countries are estimated to have significant amounts of undiscovered resources, exploration and development have been slow due to factors such as the lack of a large concentration of resources in any one area. Continued production increases are expected through 1990 in the Far East and South America (mainly Colombia).

**Table 5. Oil Production Capacity,<sup>a</sup> 1985-95  
(Million Barrels per Day)**

Country/Region	Estimated 1985	Projection	
		1990	1995
United States .....	11.2	9.9-10.4	8.3- 9.3
Canada .....	1.8	1.8- 2.0	1.8- 2.3
Mexico .....	3.2	3.2- 3.5	3.5- 4.0
North Sea .....	3.9	3.6- 4.0	3.3- 3.9
Other Non-OPEC .....	7.1	7.1- 7.7	6.5- 7.5
<b>Total Non-OPEC .....</b>	<b>27.2</b>	<b>26.1-27.1</b>	<b>24.3-25.9</b>
Algeria .....	1.2	0.8- 1.2	0.6- 0.9
Ecuador .....	0.3	0.2- 0.3	0.1- 0.2
Gabon .....	0.2	0.1- 0.2	0.1- 0.2
Indonesia .....	1.7	1.4- 1.6	1.2- 1.4
Iran .....	3.2	2.5- 3.5	2.5- 3.5
Iraq .....	1.3	2.5- 3.5	4.0- 5.0
Kuwait <sup>b</sup> .....	1.6	1.6- 1.8	1.7- 2.0
Libya .....	1.8	1.8- 2.2	1.8- 2.2
Nigeria .....	2.2	1.9- 2.1	1.6- 2.0
Qatar .....	0.6	0.5- 0.7	0.4- 0.6
Saudi Arabia <sup>b</sup> .....	9.2	9.2-10.2	9.2-11.2
United Arab Emirates .....	1.6	1.6- 2.0	2.0- 2.2
Venezuela .....	2.4	2.0- 2.4	1.8- 2.2
<b>Total OPEC .....</b>	<b>27.3</b>	<b>27.9-29.9</b>	<b>29.0-31.6</b>
Net CPE Exports .....	1.7	0.5- 1.5	0.0- 1.0
<b>Total Market Economies .....</b>	<b>56.2</b>	<b>55.3-57.7</b>	<b>54.4-57.4</b>

<sup>a</sup>Capacity is defined as maximum sustainable production capacity adjusted to reflect current operable capacity in selected countries. The range of U.S. production capacity is derived from production estimates from the Annual Energy Outlook 1985 plus surge production estimates of about 100,000 barrels per day.

<sup>b</sup>Includes 50 percent of Neutral Zone capacity.

CPE=centrally planned economies.

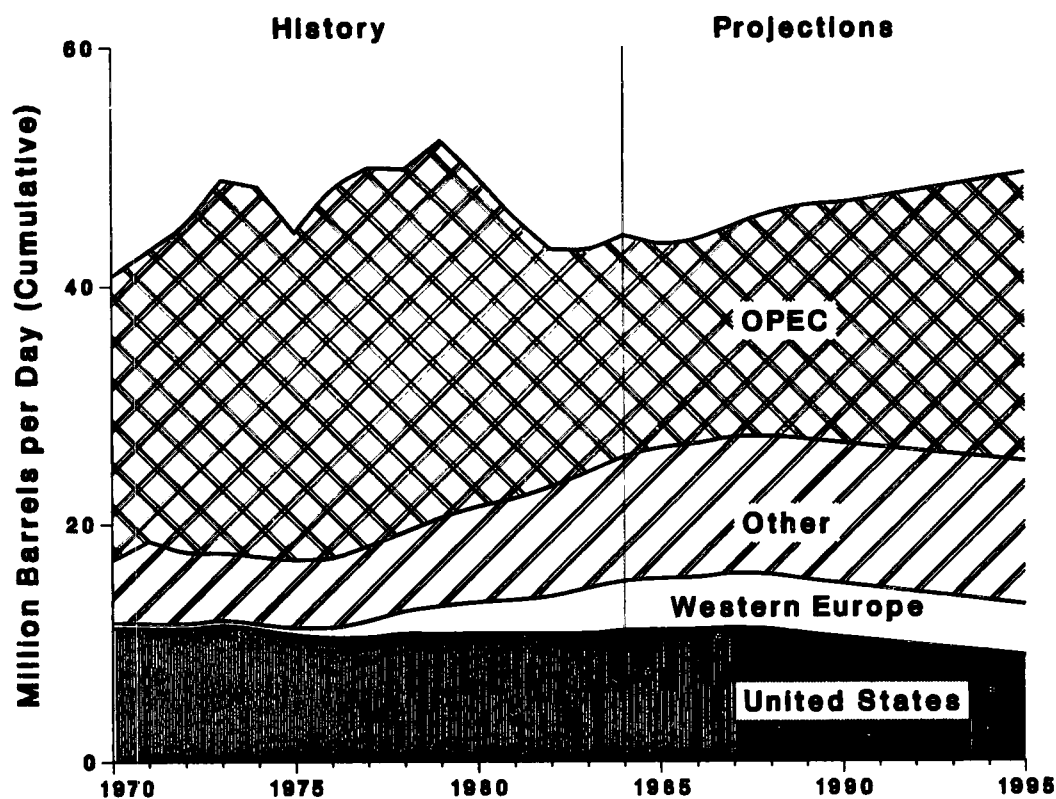
OPEC=Organization of Petroleum Exporting Countries.

Notes: o Production includes crude oil, natural gas liquids, refinery gains, hydrogen, and other hydrocarbons. o Numbers may not add to totals due to independent rounding. o All uncertainty ranges are derived independently and do not necessarily add to totals.

Source: Energy Information Administration, Office of Energy Markets and End Use.

Production capacity is projected to decline in non-OPEC countries which are currently producing near full capacity. In contrast, production capacity for OPEC is projected to increase by as much as 4 million barrels per day even though OPEC currently has excess capacity which will allow them to expand production in response to increased demands. Figure 4 shows projected oil production. Figure 5 shows the range of projected consumption and production capacity.

**Figure 4. Market Economies Oil Production:  
Base Case, 1970-95**



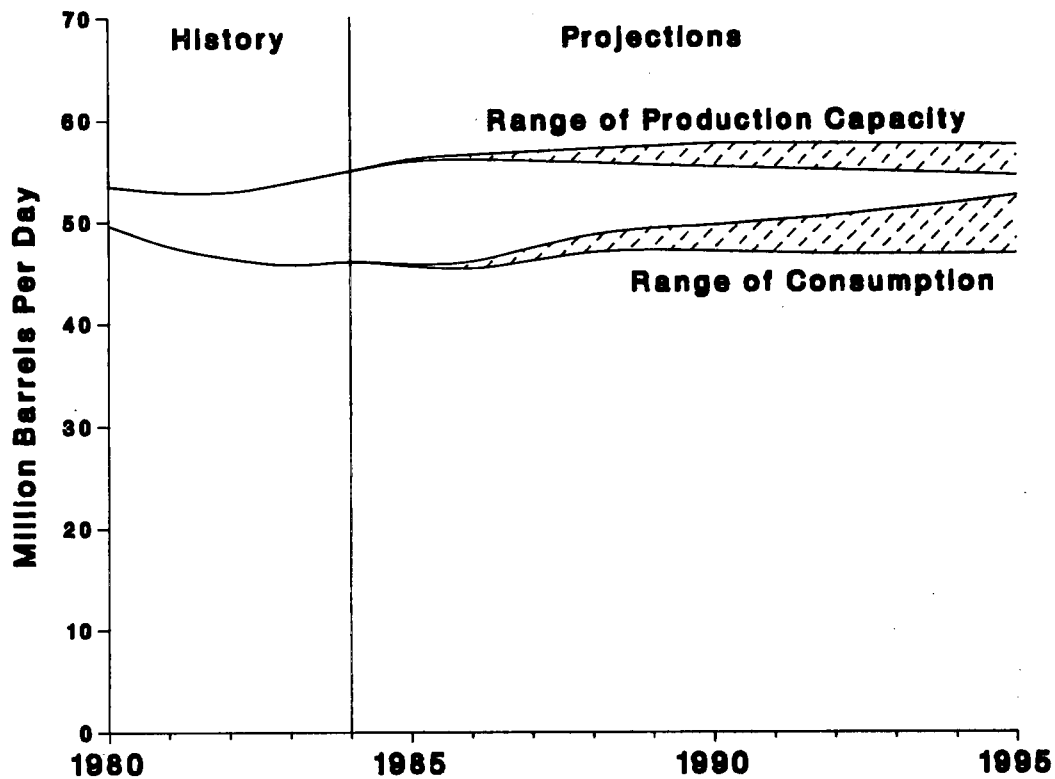
OPEC=Organization of Petroleum Exporting Countries.

Note: Production includes natural gas liquids, other liquids, and refinery gains.

Sources: o History: Energy Information Administration, International Energy Annual, DOE/EIA-0219, selected issues (Washington, DC).

o Projections: Table 9 of this report.

**Figure 5. Uncertainty Range of World Oil Production Capacity, Consumption, and Excess Production Capacity, 1980-95**



Note: The range of excess production capacity is the range of the difference between production capacity and consumption in different sensitivity cases. Current excess petroleum production capacity (mainly in OPEC) of 10-11 million barrels per day is projected to drop significantly in 1995.

Sources: o History: Energy Information Administration, International Energy Annual, DOE/EIA-0219, selected issues (Washington, DC).  
o Projections: Tables 5 and 8 of this report.



Other supply sources for the market economies are not expected to add significantly to future oil supplies. The Soviet oil production problems and lowered expectations for production offshore China indicate level or diminished oil supplies within the centrally planned economies in the coming years. Net exports from the centrally planned economies are projected to decline from current levels of 1.7 million barrels per day to between zero and 1 million barrels per day by 1995. Continued increases in alcohol and synfuels production in Brazil and South Africa are anticipated.

As in the past, production rates for any country or region, OPEC or non-OPEC, are expected to continue to be dictated by the ups and downs of the international oil market. Where supply is necessary for indigenous needs, production can be expected to remain at high levels; production by oil exporters is expected to be dominated by the economics of the international oil market as well as individual country revenue needs and government policies.

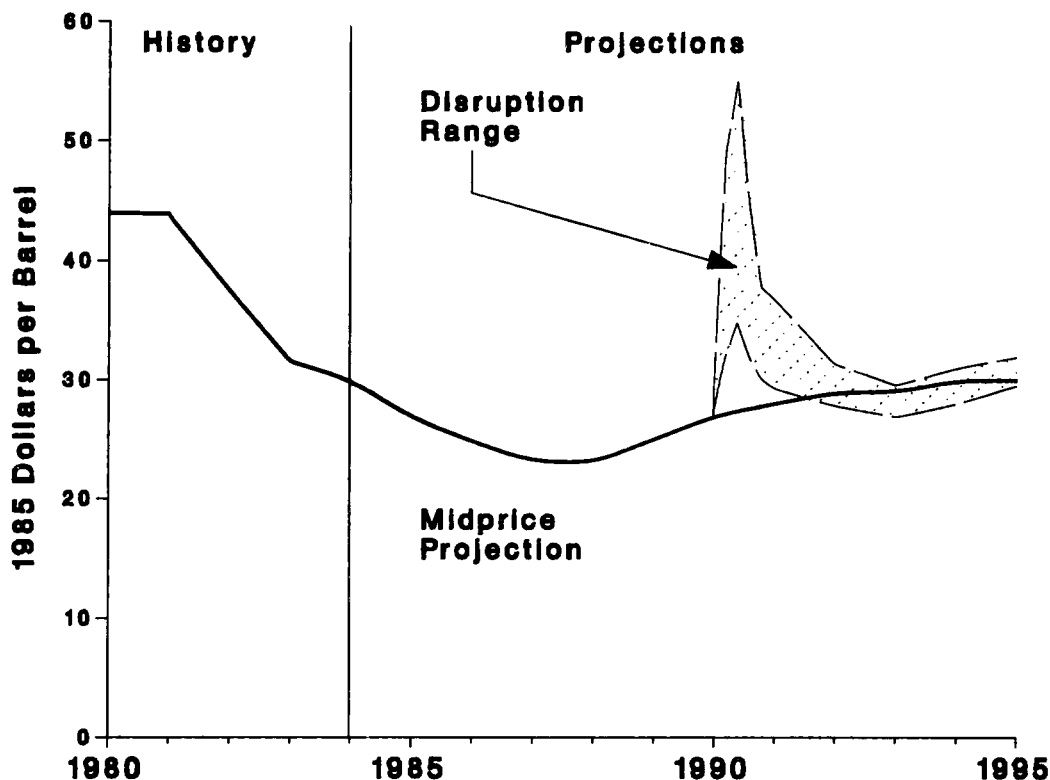
## **Petroleum Supply Vulnerability**

A return to concentration of remaining oil reserves and production in the Middle East (especially in the Persian Gulf) increases the potential for a serious disruption in oil supplies and increases the likelihood of significant upward pressures on world oil prices. As an example, Figure 6 illustrates a hypothetical disruption in oil supplies in 1990. The example assumes a net disruption of approximately 5 million barrels per day (after allowance for the use of excess production capacity) at the beginning of the first quarter of 1990. The origin, cause, or probability of any disruption is not considered. There is a substantial range of uncertainty about the price impacts from the assumed reduction in world oil availability (Figure 6). The uncertainty range depends primarily on the response of oil consumption to higher prices (elasticity of demand) and changes in inventory levels by suppliers and consumers.

A large inventory build-up caused, for example, by expectations of higher price and uncertainty regarding the duration and magnitude of the disruption, could intensify price increases, while a drawdown of commercial inventories could dampen the price increase. Drawing down the U.S. Strategic Petroleum Reserve and government-controlled stocks in the market economies could also substantially reduce the increase in oil prices during a disruption. In this hypothetical disruption, it was assumed that the U.S. Strategic Petroleum Reserve is drawn down at its current maximum drawdown rates during the disruption. Assumptions regarding foreign government-controlled stocks and total market economies commercial stocks were varied between a drawdown and build up of inventories.

Depending on what is assumed about inventory behavior and the responsiveness of demand to price increases, Figure 6 shows that a net supply disruption of 5 million barrels per day could increase prices to between \$35 and \$55 per barrel.

**Figure 6. Range of World Oil Prices with Hypothetical Disruption in Supply, 1980-95**



Note: This disruption price range is based on a hypothetical disruption that assumes that world oil availability is cut by 5 million barrels per day on January 1, 1990, for a period of 6 months.

Sources: o History: Energy Information Administration, Annual Energy Review, 1984, DOE/EIA-0384(84) (Washington, DC). o Midprice Projection: Table 2 of this report.

The aftermath of a disruption is also unpredictable. When oil supplies are restored (assumed in this example to occur in the third quarter of 1990), world oil prices could fall below base case levels. A cyclical pattern might then develop as a result of the continuing effects on oil demand in the post-disruption period caused by past high prices and reduced economic activity. The actual price levels described in this analysis are of less interest than this erratic pattern of price movements and its potential adverse effects on the world economy.

## Worldwide Trends in Refinery Capacity

Prior to the 1973-74 oil price shock, world oil consumption and world refinery capacity were closely matched in growth. Afterwards the growth in demand slowed significantly at first but then recovered at a rate that was even greater than that experienced prior to 1973. Refinery expansion, which at a minimum requires 3 to 5 years to come onstream even after design completion and start of construction, had understandably continued because the oil industry was witnessing a strong recovery of demand. The 1979-80 price shock brought about by the effects of the Iranian Revolution and subsequently the Iran/Iraq War caused oil demand to decline by over 6 million barrels per day from 1979 to 1983. While oil demand was plunging during this period, refinery capacity continued to expand until it peaked at about 64.8 million barrels per day of operable distillation capacity in the market economies in January, 1981.

The excess capacity in refining created major problems for the oil industry. From 1981 to the present, large-scale closures and scrappings of refineries around the world have brought the operable capacity for crude oil distillation down to about 55.6 million barrels per day. However, there still remains a significant gap between demand and refining capacity that accounts for the low and even negative refinery margins that the industry is currently experiencing. A distillation capacity utilization rate of between 85 to 90 percent is generally required by refiners in order to achieve maximum efficiency of fuel use and minimized overhead. Current utilization rates for the world's major refining centers are running around 65 to 70 percent.

At the end of 1981 there were plans for about 10.2 million barrels per day of capacity additions in the market economies. However, given the current, gloomy operating environment for refineries and the limited prospects for demand growth for the remainder of this decade, at least 7 million barrels per day of capacity not under construction has been, or is likely to be, shelved by nations with a current refining surplus. Approximately 1.4 million barrels per day of capacity actually came onstream from 1981 to 1985, while another 1.4 million barrels per day is now under construction. It is likely that the other 0.4 million barrels per day will also come onstream in this decade.

Table 6 presents recent preliminary projections of refining capacity in the market economies made by the Worldwide Refining Trends Task Group of the National Petroleum Council Refining Study. Capacities are given for crude oil distillation, as well as the downstream unit capacities for catalytic cracking and catalytic reforming. The peak historical year (1981) for crude oil distillation capacity and the current (January 1, 1986) capacities are presented for reference purposes.

**Table 6. Worldwide Refinery Unit Capacities, 1981-90**  
(Million Barrels per Day)

Country/Region	Crude Distillation			Catalytic Cracking			Catalytic Reforming		
	1981	1986	1988-1990	1981	1986	1988-1990	1981	1986	1988-1990
OECD .....	48.17	38.27	38.31	7.71	7.79	7.84	7.89	6.93	7.07
United States .....	18.47	16.44	16.52	5.53	5.21	5.21	4.05	3.67	3.70
Puerto Rico/Virgin Islands ....	1.01	0.72	0.72	0.05	0.01	0.01	0.15	0.14	0.14
Canada .....	2.17	1.80	1.80	0.51	0.38	0.38	0.43	0.34	0.34
Japan .....	5.45	4.52	4.52	0.34	0.45	0.48	0.54	0.53	0.53
Australia/New Zealand .....	0.82	0.77	0.81	0.16	0.17	0.17	0.18	0.18	0.19
Europe .....	20.25	14.02	13.94	1.11	1.57	1.59	2.53	2.07	2.17
Norway/Sweden/Finland .....	1.04	0.91	0.91	0.01	0.07	0.07	0.11	0.16	0.16
United Kingdom/Ireland .....	2.69	1.85	1.96	0.19	0.36	0.36	0.45	0.38	0.38
Benelux <sup>a</sup> /Denmark .....	3.10	2.29	2.29	0.16	0.25	0.25	0.38	0.22	0.31
West Germany .....	3.02	1.93	1.93	0.18	0.18	0.18	0.40	0.36	0.36
France .....	3.34	1.95	1.95	0.20	0.26	0.26	0.43	0.27	0.27
Austria/Switzerland .....	3.38	0.34	0.34	0.02	0.02	0.02	0.04	0.06	0.06
Spain/Portugal .....	1.81	1.66	1.66	0	0.10	0.12	0.24	0.23	0.23
Italy .....	4.09	2.74	2.55	0.28	0.27	0.27	0.41	0.31	0.32
Greece/Turkey .....	0.78	0.35	0.35	0.06	0.06	0.06	0.06	0.08	0.08
OPEC .....	4.77	6.88	7.55	0.16	0.13	0.17	0.28	0.61	0.63
Venezuela/Ecuador .....	1.44	1.50	1.50	0.08	0	0	0.02	0.02	0.02
Libya/Algeria .....	0.26	0.83	0.83	0	0	0	0.04	0.07	0.07
Nigeria/Gabon .....	0.18	0.30	0.45	0.03	0.05	0.05	0.02	0.04	0.04
Indonesia .....	0.45	0.76	0.81	0.01	0.01	0.02	0.03	0.07	0.09
Iran .....	1.12	0.61	0.61	0.04	0	0	0.09	0.08	0.08
Persian Gulf (Arab OPEC) .....	1.33	2.88	3.35	0	0.07	0.10	0.08	0.33	0.33
Other Developing Countries .....	11.88	10.47	10.50	1.07	1.16	1.16	0.66	0.83	0.84
Non-U.S. Caribbean .....	1.81	0.69	0.69	0.07	0.07	0.07	0.05	0.06	0.06
Mexico .....	1.39	1.27	1.27	0.30	0.30	0.30	0.08	0.16	0.16
Bolivia/Brazil/Colombia/Peru ..	1.84	1.82	1.82	0.32	0.38	0.38	0.04	0.04	0.04
Egypt/Syria/Bahrain .....	0.76	0.86	0.91	0.03	0.03	0.03	0.04	0.07	0.07
Angola/Congo/Zaire .....	0.05	0.05	0.05	0	0	0	0	0	0
Other Petroleum Exporters ....	1.28	0.87	0.87	0	0	0	0.05	0.07	0.07
Other Americas .....	1.05	1.09	1.09	0.13	0.14	0.14	0.07	0.08	0.08
Other Africa .....	0.86	0.79	0.79	0.10	0.06	0.06	0.11	0.12	0.13
Other Asia .....	2.82	3.03	3.01	0.12	0.18	0.18	0.21	0.23	0.23
Total Market Economies .....	64.82	55.62	56.36	8.94	9.08	9.17	8.82	8.37	8.54

<sup>a</sup> Belgium, Netherlands, Luxembourg.

OECD=Organization for Economic Cooperation and Development.

OPEC=Organization of Petroleum Exporting Countries.

Sources: o History: International Petroleum Encyclopedia 1981 (Tulsa, OK, 1981). o Projections: Preliminary projections from the Worldwide Refinery Trends Task Group of the National Petroleum Council Refinery Study.  
o Persian Gulf (Arab OPEC) includes Bahrain, Iraq, Kuwait, Qatar, Saudi Arabia, and the United Arab Emirates.

Of the 3.2 million barrels per day of distillation capacity coming onstream in this decade, OPEC is expected to account for about 2.8 million barrels per day. Following this expansion, OPEC is projected to have a refinery capacity of around 7.6 million barrels per day by 1990, of which about 4 to 4.5 million barrels per day will be available for export. The arrival of refined products from North Africa and Persian Gulf sources will no doubt strike another blow to refinery utilization rates in OECD Europe. In fact, European distillation capacity is projected to further decline for the remainder of the decade. Likewise, the traditional Far East export refiners in Singapore will be impacted by capacity additions in Indonesia as well as in the Persian Gulf. Most of the non-OPEC distillation capacity increases for the remainder of the decade are projected to occur in developing countries. Nations such as India, Egypt, Mexico, and Brazil are expanding refinery capacity because of their rapid growth in demand. It is anticipated that these new refineries in developing countries will not have a significant impact on the refined product export market.

Whereas crude oil distillation capacities are projected to remain virtually level for the remainder of the decade in OECD countries, there is considerable investment in downstream conversion facilities, especially in OECD Europe. There are several reasons for this trend. First, the average world crude oil being processed in refineries has become heavier and is therefore in need of increased cracking. Secondly, refiners in OECD Europe believe that they are responding to a trend that has not yet run its course. Currently, gasolines and middle distillates account for about 61 percent of OECD Europe's refined product demand against about half a decade ago. In the same period, residual fuel oil demand has been nearly halved. The third reason for increased downstream conversion capacities in OECD Europe are the requirements caused by the introduction of lower gasoline lead limits and eventual lead-free gasoline production. The year 1989 has been stipulated by the European Economic Community as the target year for new car models to burn only lead-free gasoline. While margins are projected to remain near the break-even point for distillation, many refiners are now looking to their upgrading investments to provide the returns to cover any distillation losses. In fact, utilization rates for cracking are becoming a significant factor in assessing the success of a refinery operation.

World products trade is expected to continue its shift from predominantly residual fuel oil to gasoline and the middle distillates. The Middle East is projected to move ahead of Latin America as the world's largest refined products export source. The centrally planned economies are projected to fall from second largest to third. Western Europe, due to its massive refinery shutdowns of the past 5 years is expected to move ahead of the United States as the largest importer of refined products.

### 3. Oil Consumption Trends

Oil consumption in the longer term is projected to increase for the total market economies even at the low end of the projected uncertainty range. (Some countries may experience declines, but total market economies' consumption is projected to increase.) This projection appears counter-intuitive given the significant decline in oil consumption that has occurred in the market economies following the price shock of 1979-80. However, there are a host of factors that would indicate an upward trend in total market economies' oil consumption even where alternative energy resources are readily available. The major factors are a growing world economy and population; oil prices remaining competitively priced and probably declining over the next several years; an increasing base load for petroleum needs in the transportation sector (including international travel and trade) and in the petrochemical industry; and a growing heavy-industries sector as well as household and commercial sectors in the developing countries. Although petroleum consumption is expected to continue to provide a smaller share of total energy consumed, oil is projected to remain the leading form of energy consumed.

#### Oil Consumption in the Market Economies

Oil consumption in the market economies peaked in 1979 at 52 million barrels per day, declined to 45.5 million barrels per day by 1983, and then increased in 1984 to 46.2 million barrels per day (Table 7). Much of the

**Table 7. Oil Consumption in the Market Economies, 1973-84  
(Million Barrels per Day)**

Year	United States	Market Economies		
		OECD	Non-OECD	Total
1973	17.3	39.6	8.0	47.6
1974	16.7	38.1	9.5	47.5
1975	16.3	36.1	10.1	46.2
1976	17.5	38.5	8.9	47.4
1977	18.4	40.3	9.8	50.2
1978	18.8	40.8	9.7	50.6
1979	18.5	41.6	10.3	52.0
1980	17.1	38.6	11.0	49.6
1981	16.1	36.3	11.3	47.4
1982	15.3	34.7	11.6	46.3
1983	15.2	33.9	11.6	45.5
1984 <sup>a</sup>	15.7	34.7	11.5	46.2

<sup>a</sup>Estimates for non-OECD countries.

OECD=Organization for Economic Cooperation and Development.

Notes: Numbers may not add to totals due to independent rounding.

Sources: Energy Information Administration, International Energy Annual 1984, DOE/EIA-0219, Monthly Energy Review, DOE/EIA-0035 (85/10), and Petroleum Supply Monthly, DOE/EIA-0109 (85/11) (Washington, DC, 1985-1986).

increase in 1984 is attributable to the prolonged coal strike in the United Kingdom, unusually cold weather, and high economic growth in Japan and the United States. The estimate for 1985 reflects a return to 1983 levels and a continuation of the conservation impacts of the two price shocks. Even though oil prices have declined in the United States since 1981, they continued to increase in many regions as a result of changes in the exchange rate. However, with continued low oil prices, oil consumption in the market economies is projected to increase to between 48.5 and 51.5 million barrels per day by 1995 (Table 8). For the base case shown in Figure 7 and Table 9, this increase translates into an annual growth rate of about 1 percent, approximately one-half the growth rate for total energy consumption. Between 1985 and 1995 the projected growth rates for refined product demand differ significantly, with middle distillates growing the fastest at 1 to 2 percent per year, gasolines growing, at most, 1 percent per year, and residual fuel oils growing the slowest at much less than 1 percent per year.

## Oil Consumption in the OECD Countries

There have been important shifts during the 1973 to 1984 period in the consumption behavior of the industrialized countries in the OECD. These countries experienced significant declines in oil demand between 1980 and 1983, following the second price shock in 1979-80. Consumption increased in 1984 due to the coal strike and weather, but is estimated to have returned to 1983 levels in 1985. In 1973 the OECD consumed almost 40 million barrels per day of petroleum or about 8 out of every 10 barrels of oil consumed in the market economies. In 1984 the OECD consumed less than 35 million barrels per day, though their proportion of demand in the market economies declined only slightly (to between 7 and 8 of every 10 barrels of oil used in the market economies). The United States' oil consumption declined by over 3 million barrels per day from the peak consumption year in 1978 and by about 2 million barrels per day from 1973. Throughout the period the United States' economy used about 1 out of every 3 barrels consumed in the market economies. Oil consumption by most countries in the OECD declined in the 1973 to 1984 period.

There is a general consensus that alternatives to oil will be pursued not only in response to market forces but also for political and national security reasons. Based on the projected range of uncertainty, oil consumption in the OECD region in 1995 is projected to increase only slightly, about 0.7 million barrels per day from the 1985 consumption estimate of 34 million barrels per day. Most of any increase that occurs is expected between 1985 and 1990. There are several reasons for such a growth profile. If oil prices remain low or decline over the next several years, oil will remain more competitive and market incentives for switching to alternative energy sources may be diminished. A general stimulus to consume more for the same level of output could also occur. However, as non-OPEC oil production begins to diminish, oil prices are projected to increase, creating the opposite set of market forces in the 1990's.



**Table 8. Oil Consumption in the Market Economies, 1983-95  
(Million Barrels per Day)**

Country/Region	History			Projections			
	1983	1984	1985	1990		1995	
	Actual	Preliminary	Estimate	Base	Range	Base	Range
United States .....	15.2	15.7	15.7	16.1	15.4-16.6	16.5	15.6-17.8
Canada .....	1.5	1.5	1.5	1.6	1.5- 1.6	1.6	1.5- 1.7
Japan .....	4.4	4.6	4.4	4.5	4.5- 4.6	4.4	4.3- 4.5
OECD Europe .....	11.8	11.8	11.4	12.1	11.9-12.4	12.2	11.5-12.8
United Kingdom .....	1.5	1.8	1.7	1.8	1.7- 1.9	1.8	1.6- 2.0
France .....	1.9	1.9	1.8	1.8	1.7- 1.9	1.7	1.5- 1.9
West Germany .....	2.3	2.3	2.2	2.4	2.2- 2.5	2.4	2.0- 2.6
Italy .....	1.7	1.6	1.7	1.8	1.7- 1.8	1.8	1.6- 2.0
Netherlands .....	0.6	0.6	0.6	0.6	0.6- 0.6	0.7	0.6- 0.8
Other Europe .....	3.8	3.6	3.5	3.9	3.6- 4.0	3.8	3.3- 4.3
Other OECD .....	1.0	1.1	1.0	1.1	1.1- 1.1	1.2	1.1- 1.2
Total OECD .....	33.9	34.7	34.0	35.4	34.7-36.0	35.9	34.7-37.3
OPEC .....	3.3	3.2	3.2	3.7	3.5- 3.8	4.5	4.1- 5.0
Other Developing Countries .....	8.3	8.3	8.3	8.9	8.6- 9.1	9.5	8.8-10.0
Total Market Economies ..	45.5	46.2	45.6	48.0	47.2-48.6	49.9	48.5-51.5

OECD=Organization for Economic Cooperation and Development.

OPEC=Organization of Petroleum Exporting Countries.

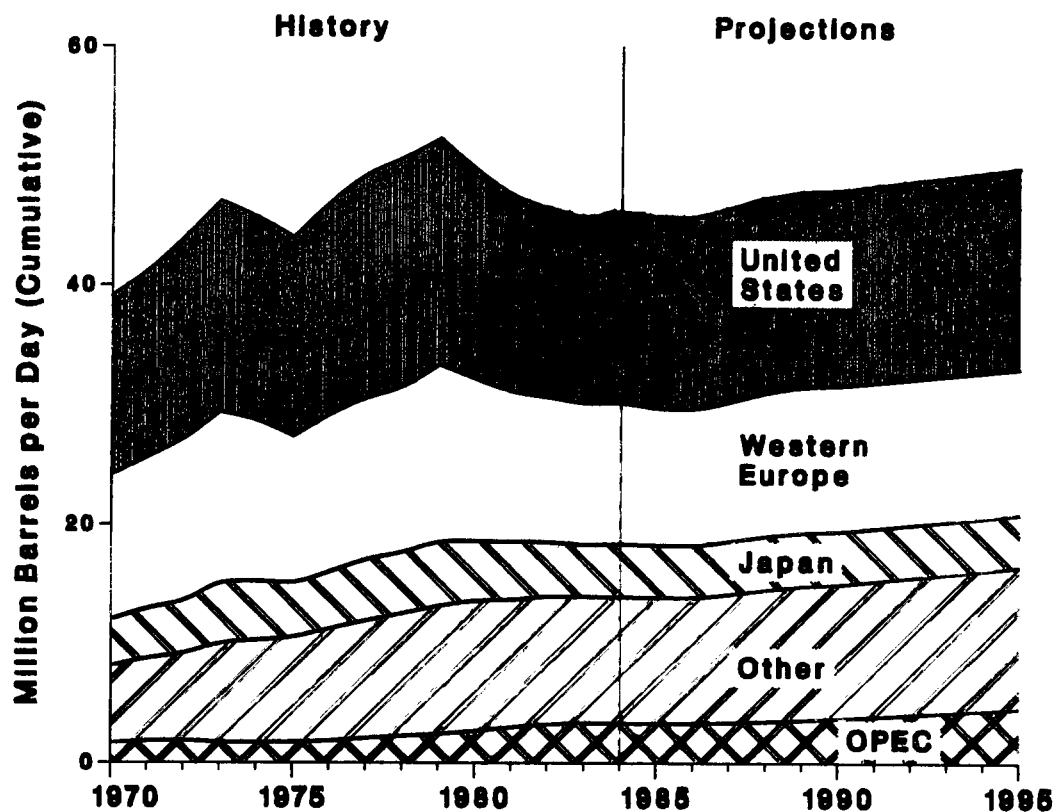
Notes: o Numbers may not add to totals due to independent rounding. o All uncertainty ranges are derived independently and do not necessarily add to totals.

Sources: o History: Energy Information Administration, International Energy Annual 1984, DOE/EIA-0219 and Short-Term Energy Outlook, DOE/EIA-0202(85/4Q) (Washington, DC, 1985).

o Projections: Energy Information Administration, Office of Energy Markets and End Use.

There are some exceptions to increasing oil growth resulting from government policy toward national security. In particular, Japan's stated goal is to diversify energy mix while simultaneously increasing energy efficiency and conservation. Oil consumption in Japan is projected to remain near 1985 consumption levels even though economic growth is projected to be the highest among the OECD countries. French policy toward nuclear power development combined with projected increases in natural gas imports may lead to further decreases in oil consumption even with higher than average European economic growth. The United States oil consumption growth depends heavily on market uncertainty of coal and nuclear power generation as well as natural gas reserve depletion. In all regions, oil's share of energy is projected to continue to decline but, with the notable exception of the Netherlands where gas consumption is highest, oil is projected to be the primary fuel source. Much of the latter is a consequence of the need for petroleum in the transportation sector and for petrochemical process.

**Figure 7. Market Economies Oil Consumption:  
Base Case, 1970-95**



OPEC=Organization of Petroleum Exporting Countries.

Sources: o History: Energy Information Administration, International Petroleum Annual, 1978, DOE/EIA-0042(78) and International Energy Annual, DOE/EIA-0219, selected issues (Washington, DC). o Projections: Table 9 of this report.

## Oil Consumption in the Developing Countries

Oil consumption in the developing countries (including OPEC) is projected to increase by over 20 percent in the base case between 1985 and 1995 (Table 9). This is about double the rate of consumption growth projected for the industrial countries of the OECD. As a group, OPEC is projected to have the highest growth in oil consumption, approximately 3.5 percent per year as compared to 1 percent for the total market economies. However, there is considerable uncertainty around this base case projection. As indicated (Table 9), OPEC consumption by 1995 could increase by 0.9 to 1.8 million barrels per day from a 1985 estimate of 3.2 million barrels per day; other developing countries by 1995 could increase by 0.5 to 1.7 million barrels per day from a 1985 estimate of 8.3 million barrels per day. Capital intensive projects such as coal and nuclear power plants and natural gas pipelines are less prevalent in most developing regions due in part to scarce capital resources and the inability to borrow due to the large external debt positions of most of these nations. Thus, there are fewer alternatives to oil in these regions. Though heavily dependent on oil as a primary energy source, the developing countries are expected to make every effort to exploit domestically produced energy sources in order to reduce oil imports and conserve foreign exchange.

The twelve largest oil consumers outside of the OECD are Mexico, Brazil, Argentina, Venezuela, Egypt, Iran, Saudi Arabia, Indonesia, India, Taiwan, South Korea, and South Africa. Collectively, these countries represent 65 per cent of non-OECD oil consumption, or about 7.5 million barrels a day. Recent trends in oil consumption among the developing countries show various patterns. The pattern exhibited relates to the particular position of each country in terms of indigenous resources, industrial development, foreign exchange position, current account status, and external debt situation. In this context, the twelve major consuming countries are grouped as follows:

- o Argentina and Brazil
- o Mexico and Venezuela
- o Egypt, Indonesia, Iran, and Saudi Arabia
- o South Africa, South Korea, and Taiwan
- o India.

The middle-income commodity-exporting countries of South America, such as Argentina and Brazil, are expected to have a much smaller GDP growth rate over the remainder of the decade from that achieved during the 1970's. The growth rate for oil consumption should reflect this trend. Service payments on existing debt are expected to remain high and act as a drag on capital investment. The outlook for Brazil is brighter than for Argentina. The revival in the growth rate for Brazil after the poor performance of 1981 to 1983 has been quite sharp. This revival is expected to continue during the balance of the decade. Argentina's economic recovery is closely related to the economic reforms instituted by the relatively new democratically elected government. The Argentines are making progress on their debt problem and, as of December 1985, became current for the first time in 3 years on all interest owed to foreign commercial banks on the public sector debt.

**Table 9. Oil Consumption and Production in the Market Economies: Base Case, 1979-95  
(Million Barrels per day)**

Supply and Disposition	History						Projections						
	1979	1980	1981	1982	1983	Preliminary 1984	Estimated 1985	1986	1987	1988	1989	1990	1995
<b>Consumption</b>													
United States .....	18.5	17.1	16.1	15.3	15.2	15.7	15.7	15.7	16.0	16.0	16.1	16.1	16.5
Canada .....	1.9	1.9	1.8	1.6	1.5	1.5	1.5	1.5	1.5	1.6	1.6	1.6	1.6
Japan .....	5.5	5.0	4.8	4.6	4.4	4.6	4.4	4.4	4.5	4.5	4.5	4.5	4.4
OECD Europe .....	14.7	13.5	12.5	12.1	11.8	11.8	11.4	11.4	11.7	12.0	12.2	12.1	12.2
Other OECD <sup>a</sup> .....	1.1	1.2	1.2	1.1	1.0	1.1	1.0	1.0	1.1	1.1	1.1	1.1	1.2
Total OECD .....	41.6	38.6	36.3	34.7	33.9	34.7	34.0	34.0	34.6	35.2	35.4	35.4	35.9
OPEC .....	2.4	2.7	3.0	3.2	3.3	3.2	3.2	3.3	3.4	3.5	3.6	3.7	4.5
Other Countries .....	8.0	8.4	8.3	8.3	8.3	8.3	8.3	8.3	8.5	8.8	8.9	8.9	9.5
Total Consumption ..	52.0	49.6	47.4	46.3	45.5	46.2	45.6	45.6	46.5	47.5	47.9	48.0	49.9
<b>Production</b>													
United States .....	10.7	10.8	10.7	10.8	10.8	11.1	11.1	11.2	11.3	11.1	10.7	10.4	8.8
Canada .....	1.8	1.8	1.6	1.6	1.7	1.8	1.8	1.8	1.8	1.8	1.8	1.9	2.1
OECD Europe .....	2.4	2.6	2.9	3.1	3.9	4.2	4.4	4.4	4.6	4.6	4.6	4.5	4.3
OPEC .....	31.7	27.7	23.6	19.9	18.6	18.6	17.0	17.2	17.8	18.9	19.9	20.4	24.4
Other Countries .....	5.6	6.2	6.9	7.6	8.0	8.7	9.2	9.4	9.7	9.8	9.9	10.0	10.0
Total Production ..	52.1	49.1	45.8	43.0	42.9	44.4	43.5	43.9	45.0	46.2	46.8	47.1	49.6
Net CPE Exports .....	1.1	1.2	1.5	1.7	1.8	2.0	1.7	1.7	1.5	1.3	1.1	1.0	0.5
<b>Stock Withdrawals and Discrepancies ...</b>													
	-1.2	-0.7	0.1	1.6	0.8	-0.2	0.4	0	-0.2	-0.1	-0.1	-0.1	-0.2

<sup>a</sup> Includes Australia, New Zealand, and the U.S. Territories.

CPE=centrally planned economies.

OECD=Organization for Economic Cooperation and Development.

OPEC=Organization of Petroleum Exporting Countries.

Notes: o Numbers may not add to totals due to independent rounding. o Production includes crude oil, natural gas liquids, refinery gains, hydrogen, and other hydrocarbons.

Sources: o History: Energy Information Administration, Annual Energy Outlook 1984, DOE/EIA-0383(84), Monthly Energy Review, DOE/EIA-035(85/07), and International Energy Annual 1984, DOE/EIA-0219 (Washington, DC, 1985); Organization for Economic Cooperation and Development/International Energy Agency, Quarterly Oil Statistics, Fourth Quarter 1984 (Paris, France, 1985); Petroleum Economics Limited, Quarterly Supply/Demand Outlook (London, England, 1985). o Projections: Energy Information Administration, Office of Energy Markets and End Use.

The debt problem remains the largest single economic obstacle for Mexico and Venezuela. This phenomenon is expected to have an adverse effect on the same Latin American countries, where a large percentage of any increase in export earnings will be allocated to debt servicing rather than investments for growth. Not until the 1990's, when the price and volume of oil exports are expected to recover, are export earnings projected to enable a stronger real growth pattern in Mexico and Venezuela.

In Indonesia, economic growth is expected to average about 4 percent per year through the end of this decade. The expectation for domestic oil consumption in Indonesia is projected to mirror the rate of economic growth. Both Egypt and Indonesia could do better economically than the Latin American oil exporters, due to relatively smaller debt servicing requirements. Egypt is expected to continue the subsidization of domestic consumption of refined petroleum products. Therefore, Egypt could have increasing domestic oil consumption for the balance of the 1980's, regardless of the economic growth forecast. In 1984 there was a negative GDP rate of 3.5 percent, yet domestic oil consumption is estimated to have increased by 12 percent.

The GDP growth rates of oil exporting countries with small populations, such as Saudi Arabia, are expected to be only moderate until the early 1990's. These nations have generally toned down their economic expansion plans. This caution contrasts to the large infrastructure expansion projects launched in the 1970's, when petroleum exports generated a large capital surplus. The export earnings from oil are not expected to grow significantly until the 1990's, at the earliest. At that time, with increased export earnings, GDP could once again expand at a robust rate, as could oil consumption.

Although South Africa is included in the developing countries group, it is in reality an industrialized nation that is not a member of the OECD. Economic growth in South Africa in recent years reflects the factors that have affected all industrialized economies, with the added depressant of political unrest.

The newly industrializing countries of the Pacific Rim could have the highest GDP growth rates of any class of oil consumer for the balance of the decade. Exports from Taiwan and South Korea are heavily dominated by labor-intensive products such as textiles, electronic equipment, and footwear. As the 1980's close and the next decade begins, major market growth will probably slow in these countries, as competition from lower wage countries such as Sri Lanka, the Philippines, Indonesia, and China increases rapidly.

Taiwan and South Korea will undoubtedly gravitate toward export products with higher value added content (products that are technologically sophisticated). This development strategy would mirror Japan's economic experience in the 1950's to 1970's. The favorable outlook for industrial growth over the next 10 years, with growing consumer demand based upon a rising wage scale, could lead to an increase in oil consumption in these countries.

The outlook for India's economy during the remainder of the 1980's is for growth at a rate of 4.5 to 5.5 percent per year. The industrial sector is expected to grow between 7 and 8 percent per year and agriculture at 4 percent per year. Oil consumption has also been increasing rapidly in recent years, reflecting the sharp industrial growth and a shift from noncommercial to commercial fuel consumption in the residential sector. The growth of indigenous energy production, especially of petroleum, is allowing the increase in domestic consumption to occur with little additional strain on the current account deficit.

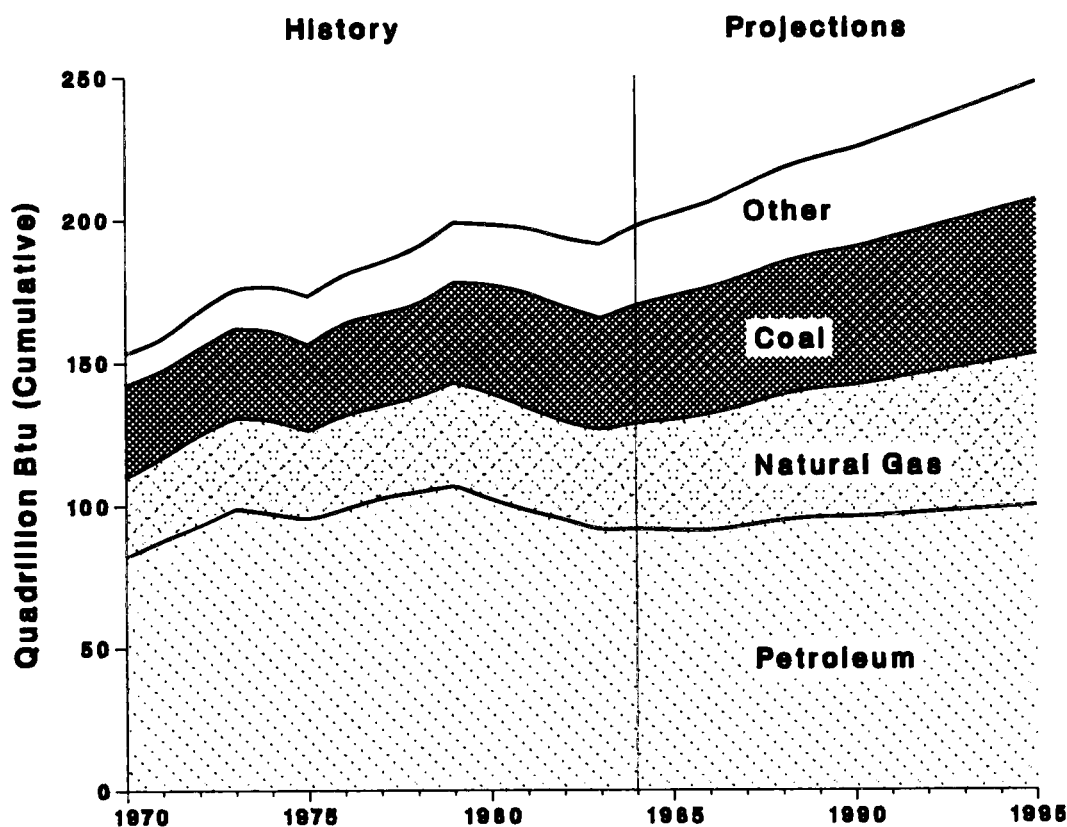
Most of the economies in South America and Africa, as well as those in OPEC, are sensitive to the prices and demands for the commodities they export. Greater demands with better prices than is the case at present would enable these countries to service their debt as well as attract additional development capital. Of course, if the industrial world does not grow sufficiently, the demands for these export commodities, as well as the foreign exchange earnings, would suffer accordingly. In such a scenario, both economic growth and oil consumption in these developing countries would be lower than is currently anticipated.

## 4. World Energy Consumption

The outlook for the world oil market is made in the context of oil's changing role in the world energy market. As with the oil market, there are many uncertainties concerning the future development and use of other energy sources, such as coal, natural gas, nuclear power, and hydroelectric power. The future role of the Soviet Union as an exporter of oil and natural gas is an uncertainty with important energy security implications. The ability of certain developing countries to fulfill energy requirements given their current debt situation represents another major uncertainty.

Projections of total primary energy consumption by energy source are presented in Figure 8 and Table 10. Oil's share of total energy consumed declines through 1995 while those of the other fossil fuels--natural gas and coal--increase. However, nuclear power is assumed to be the fastest growing energy source over the projection period. This chapter considers the prospects and problems associated with the consumption of nuclear power and the other fuel sources as well as energy consumption trends.

**Figure 8. Market Economies Consumption of Energy by Type: Base Case 1970-95**



Sources: o History: United Nations, 1979 Yearbook of World Energy Statistics (New York, NY, 1981); and Energy Information Administration, International Energy Annual, DOE/EIA-0219 and International Petroleum Annual, DOE/EIA-0042, selected issues (Washington, DC). o Projections: Table 10 of this report.



**Table 10. Energy Consumption in the Market Economies By Fuel, 1983-95  
(Quadrillion Btu)**

Energy Source	History			Projections			
	1983	1984	1985	1990		1995	
	Actual	Preliminary	Estimate	Base	Range	Base	Range
Oil .....	90.7	92.3	91.0	95.6	94.0-96.9	99.6	96.7-102.7
Gas .....	34.5	36.9	38.7	46.2	44.8-47.4	53.4	50.0- 56.7
Coal .....	39.3	41.2	43.3	48.0	47.1-48.9	54.1	52.2- 56.3
Other Fuels .....	25.9	27.9	29.0	35.2	34.8-35.8	40.4	39.4- 41.4
Total Energy .....	190.4	198.3	202.0	225.0	223.0-226.9	247.4	243.8-251.1

Notes: o Energy totals exclude fuel wood and all noncommercial fuel sources. o Numbers may not add to totals due to independent rounding. o All uncertainty ranges are derived independently and do not necessarily add to totals. o Average conversion factors for the Market Economies for 1983-95 are the following: (1) Oil - 5.5 Million Btu/barrel, (2) Gas - 1,020 Btu/cubic foot, and (3) Coal - 20.3 Million Btu/short tons.

Sources: o History: Energy Information Administration, International Energy Annual 1984, DOE/EIA-0219 and Short-Term Energy Outlook, DOE/EIA-0202(85/4Q) (Washington, DC, 1985).

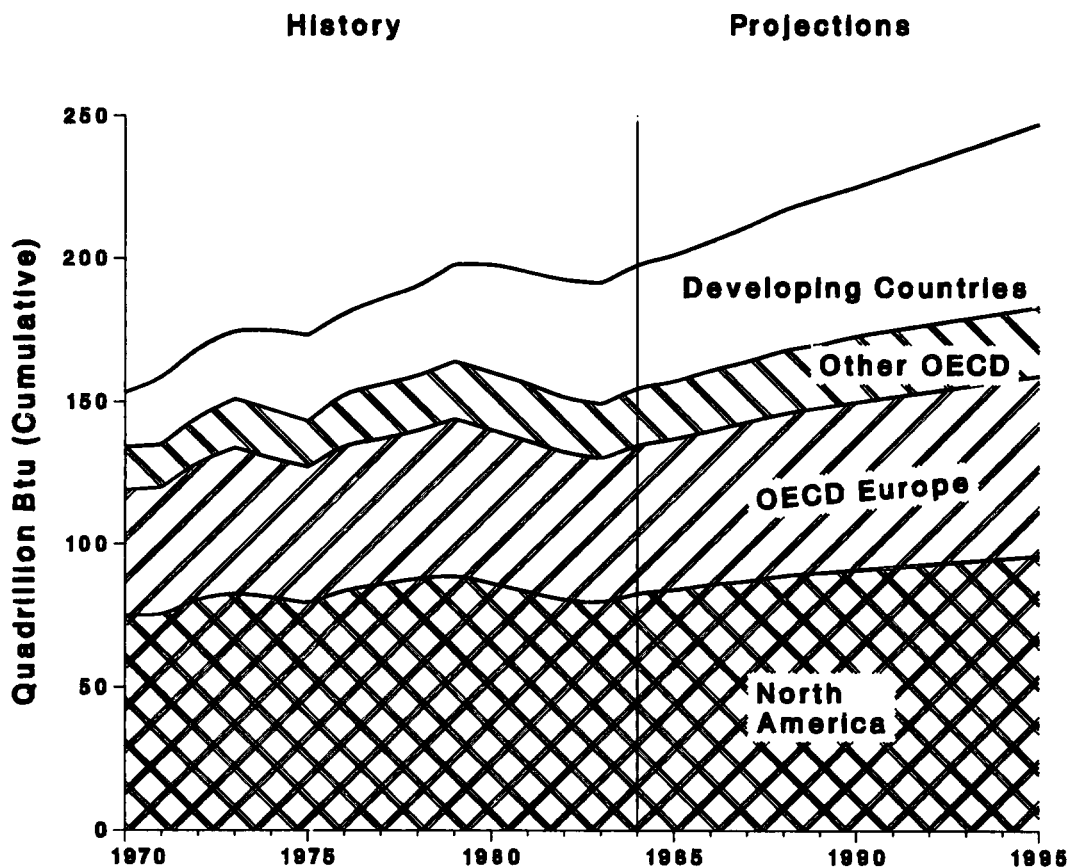
o Projections: Energy Information Administration, Office of Energy Markets and End Use.

## Regional Energy Consumption Patterns

Preliminary estimates indicate that total primary energy consumption in the market economies increased in 1984 for the first time since 1979. The largest 1984 increase of about 20 percent, occurred in nuclear power consumption. Natural gas consumption rose about 7 percent in 1984, and coal consumption rose about 5 percent, despite the coal strike in the United Kingdom. Higher consumption rates reflect higher rates of economic growth, particularly in the United States, Canada, Australia, and Japan.

Energy consumption between 1985 and 1995 is projected to grow at a rate of about 2 percent in the market economies (Figure 9). As with oil consumption, the fastest rate of growth in total energy consumption is expected in the developing countries (Table 11). Energy consumption in the developing countries from 1985 to 1995 is projected to grow between 3.4 and 4.4 percent per year. In contrast, energy consumption in the OECD is projected to grow only 1.3 to 1.6 percent per year. The difference in energy growth rates between the OECD and developing countries reflects more energy-intensive economic activity and faster rates of economic growth assumed for the developing countries.

**Figure 9. Market Economies Consumption of Energy  
by Region: Base Case 1970-95**



OECD=Organization for Economic Cooperation and Development.

Note: Other OECD includes Japan, Australia, New Zealand, and the United States territories.

Sources: o History: United Nations, 1979 Yearbook of World Energy Statistics (New York, NY, 1981); and Energy Information Administration, International Energy Annual, DOE/EIA-0219 and International Petroleum Annual, DOE/EIA-0042, selected issues (Washington, DC). o Projections: Table 11 of this report.

In general, energy use per capita among the developing countries is much less than that among the OECD. Per capita energy use is projected to grow in many developing countries as incomes grow. For example, there is room for growth in the use of automobiles and the purchase of household appliances in many developing countries, while such markets are already highly saturated in the industrialized world. There is also a desire for greater electrification in most developing countries, a process that is highly energy-intensive. Further, there is a push for greater industrialization in the manufacturing and oil-exporting developing countries. Certain of these activities, such as petrochemical manufacturing, are very energy-intensive.

**Table 11. Energy Consumption in the Market Economies, 1983-95  
(Quadrillion Btu)**

Country/Region	History			Projections			
	1983	1984	1985	1990		1995	
	Actual	Preliminary	Estimate	Base	Range	Base	Range
United States .....	70.4	74.0	74.8	80.4	78.7-81.9	84.3	81.8-86.8
Canada .....	8.8	9.3	9.6	10.7	10.5-10.9	11.7	11.3-12.1
Japan .....	14.4	15.4	15.9	17.3	17.1-17.5	18.7	18.3-19.1
OECD Europe .....	51.1	52.1	53.4	58.9	58.5-59.3	63.2	62.3-64.0
United Kingdom .....	8.3	8.2	8.7	9.5	9.3- 9.6	10.0	9.8-10.3
France .....	8.1	8.5	8.6	9.4	9.3- 9.6	10.1	9.8-10.5
West Germany .....	11.0	11.3	11.5	12.7	12.5-12.9	13.5	13.1-13.9
Italy .....	5.6	5.7	5.8	6.6	6.4- 6.7	7.1	6.8- 7.4
Netherlands .....	2.8	2.9	2.9	3.2	3.1- 3.2	3.4	3.3- 3.5
Other Europe .....	15.3	15.6	15.9	17.6	17.3-17.8	19.0	18.4-19.6
Other OECD .....	4.2	4.5	4.6	5.2	5.2- 5.3	5.6	5.5- 5.8
Total OECD .....	148.7	155.4	158.2	172.6	170.7-174.2	183.5	180.8-186.2
OPEC .....	10.0	10.0	9.9	11.4	11.2- 11.7	14.3	13.6- 15.0
Other Developing Countries .....	31.6	32.9	33.9	41.0	40.1- 42.0	49.7	47.3- 52.1
Total Market Economies ..	190.4	198.3	202.0	225.0	223.0-226.9	247.4	243.8-251.1

OECD=Organization for Economic Cooperation and Development.

OPEC=Organization of Petroleum Exporting Countries.

Notes: o Numbers may not add to totals due to independent rounding. o All uncertainty ranges are derived independently and do not necessarily add to totals.

Sources: Energy Information Administration, International Energy Annual 1984, DOE/EIA-0219 and Short-Term Energy Outlook, DOE/EIA-0202(85/4Q) (Washington, DC, 1985). o Projections: Energy Information Administration, Office of Energy Markets and End Use.

In contrast to the developing countries, the OECD looks to the future with energy-intensive economies in place. Indeed, recent trends in the OECD have been towards the development of the less energy-intensive economic sectors, such as the services and the high technology industries. Conservation and efficiency gains have also kept energy consumption down in the early 1980's and should continue to help reduce future growth in energy consumption as well, particularly in oil consumption. The OECD is also making investments that will enable further switching from oil to natural gas, coal, and nuclear power. As the result of this fuel-switching potential, oil consumption in the OECD is expected to decline in the industrial, residential, and commercial sectors, but to remain the major fuel source in the transportation sector. Many developing countries do not have the financial ability to make fuel-switching investments and reduce their dependence on oil.

In the OECD, dependence on external sources of energy supplies varies considerably. For example, abundant resources allow the European countries of Norway, the United Kingdom, and the Netherlands to be net exporters of energy. Non-European net energy exporters among the OECD countries are Australia, which primarily exports coal, and Canada, which primarily exports coal and natural gas. At the other extreme, Japan produces less than one-fifth of its total energy requirements. In Europe, West Germany, Sweden, and Turkey produce less than half of their total energy requirements.

The OECD also varies considerably in terms of the energy intensity of their economies. At one extreme with highly energy-intensive economies are Canada and the United States. At the other extreme are Japan, Denmark, and Switzerland. Since the first oil price shock of 1973-74, Japan has made strong gains in reducing the amount of energy required per unit of GDP as has the United States. Progress towards greater energy efficiency has been somewhat slower in Western Europe. The energy intensity of economic activity in Australia and New Zealand has actually increased since 1973.

In the developing countries energy consumption between 1985 and 1995 is projected to grow about as fast as economic growth and account for about 44 percent of the increase in the market economies energy consumption between 1985 and 1995. Their share of total primary energy consumption among the market economies is projected to go from about 22 percent in 1985 to about 26 percent by 1995.

The energy/GDP ratios for the OECD are projected to decline through 1995. The energy intensity of economic activity is expected to decline in most of these countries due to increases in energy efficiency and changes in industry mix. The rate of decline in energy intensity is likely to be less in the future than it has been in the recent past, however, since the relatively easy measures to improve energy efficiency have already been taken. Nevertheless, energy intensities should continue to decline through 1995, with the largest reductions projected for the United States and Japan. The energy/GDP index for both of these countries is assumed to go from 100 in 1984, the base year, to 84 by 1995. The change in industry mix away from energy-intensive industries has been most pronounced in Japan. Japan is expected to continue to shift its economy towards those activities that require low energy inputs relative to the value of resultant outputs, such as electronics.

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<sup>7</sup>Energy self-sufficiency indices for the period 1973 through 1983 are presented in International Energy Agency, Energy Policies and Programmes of IEA Countries, 1984 Review, (Paris, France, 1985).

The projected reduction in the energy/GDP index for OECD Europe is considerably less than that projected for Japan and the United States. The European index is projected to go from 100 in 1984 to 95 by 1995. There is much less room for further energy conservation in Europe than there is in the United States. For example, total 1983 energy requirements per capita in OECD Europe were about the same as those in Japan but about two-fifths of those in the United States. In contrast to Japan, however, OECD Europe is expected to move more slowly in reducing the energy intensity of its economic structure.

## Prospects for Coal

Worldwide coal trade rose rapidly in 1984. The large increase in coal trade reflected expanded coal demand for steel production and electricity generation as a result of the recovery from a worldwide economic recession and expanded coal-fired electricity-generation capacity. Additionally, in the short-term, coal trade benefitted from a problem with nuclear power plants in Canada, a reduction in domestic coal production in the United Kingdom due to a coal strike, and a buildup of coal inventories in several countries in anticipation of a possible U.S. coal strike in 1984. The competitive price position of coal as compared to heavy fuel oil on the world market has also improved over the last two years. Coal is expected to retain a strong position with respect to competing fuels.

The increase in world coal imports in 1984 brightened the prospects for world coal trade over the next 10 years compared to those of a year ago.<sup>9</sup> Increased growth is expected in Mediterranean Europe, North Africa, the Middle East, and the Pacific Rim. Through 1995 growth is projected to occur primarily in the steam coal market, in response to rising coal demand by electric utilities and industrial users in Western Europe and in Asia. France is the notable exception in Western Europe where industrial coal use and large-scale central heating is being encouraged, yet, coal consumption for generation of electricity is expected to decline as nuclear power generation expands.

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<sup>8</sup>Energy requirements and population data are presented in International Energy Agency, Energy Balances of OECD Countries, 1982/1983 (Paris, France, 1985).

<sup>9</sup>Coal trade and import demand are analyzed in the Energy Information Administration, Outlook for U.S. Coal Imports, DOE/EIA-0483(85), (Washington, DC, 1986)

Australia, which has only an estimated 7 percent of world coal recoverable reserves, became the largest steam coal exporter in 1984. Due to the projected expansion of steam coal sales, Australia is expected to remain the major exporter through 1995. The United States is expected to continue to be the largest metallurgical coal exporter in the world. The United States with over 280 billion short tons of coal reserves is the world's leader accounting for 29 percent of total recoverable reserves. The Soviet Union<sup>10</sup> is second in estimated coal reserves with 27 percent of world reserves. Coal deposits show a wide geographic distribution but are concentrated in the developed and centrally planned economies. However, coal reserves data for the developing countries may be understated because coal exploration has been limited.

Although both coal trade and coal consumption in the market economies are projected to increase during the next 10 years, coal's share of total energy consumption is projected to increase only slightly to 21.8 percent. In the base case, for the market economies coal consumption is projected to increase at the rate of only 2.3 percent between 1985 and 1995 (Table 12). In Europe coal consumption in the base case is projected to increase in the next 10 years at the rate of only 1 percent. However, coal's share of total energy consumption in Europe is expected to increase in only the "other Europe" area slightly, and in Italy, from 11 percent in 1985 to almost 14 percent in 1995.

Coal's share of total energy consumption is projected to increase in the United States, Canada, and Japan. The average annual growth rate in coal consumption between 1985 and 1995 in these countries is expected to be 2 to 2.5 percent in the base case. Japan, in particular, has an active program for replacing oil-fired electricity plants with coal-fired plants. The only areas that are projected to have significantly higher growth in coal consumption during this period are Italy, where oil for electricity generation is expected to be replaced by coal and nuclear generation, and the "other developing countries." The growth rate in both areas is over 4 percent.

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<sup>10</sup>Energy Information Administration, International Energy Annual 1984, DOE/EIA-0219(84), (Washington DC, 1985).

**Table 12. Coal Consumption in the Market Economies, 1983-95  
(Million Short Tons)**

Country/Region	History			Projections			
	1983	1984	1985	1990		1995	
	Actual	Preliminary	Estimate	Base	Range	Base	Range
United States .....	735	792	818	891	889-916	1,008	963-1,036
Canada .....	48	56	62	71	65-78	79	64-93
Japan .....	102	114	124	138	132-145	153	134-169
OECD Europe .....	590	577	619	647	624-670	689	640-737
United Kingdom .....	123	87	110	111	103-117	111	99-124
France .....	47	48	48	47	42-55	45	30-63
West Germany .....	239	242	249	260	251-268	268	255-282
Italy .....	22	27	27	35	29-38	41	29-50
Netherlands .....	8	9	9	9	8-10	9	7-11
Other Europe .....	151	165	176	186	168-205	214	173-253
Other OECD .....	78	86	92	106	101-110	117	107-128
Total OECD .....	1,553	1,624	1,715	1,853	1,827-1,888	2,046	1,975-2,106
OPEC .....	3	3	3	3	3-3	3	3-3
Other Developing Countries .....	386	404	417	514	483-543	630	558-708
Total Market Economies ..	1,942	2,031	2,135	2,370	2,329-2,415	2,679	2,577-2,778

OECD=Organization for Economic Cooperation and Development.

OPEC=Organization of Petroleum Exporting Countries.

Notes: o Numbers may not add to totals due to independent rounding. o All uncertainty ranges are derived independently and do not necessarily add to totals.

Sources: o History: Energy Information Administration, International Energy Annual 1984, DOE/EIA-0219 and Short-Term Energy Outlook, DOE/EIA-0202(85/4Q) (Washington, DC, 1985).

o Projections: Energy Information Administration, Office of Energy Markets and End Use.

Coal consumption is expected to increase modestly in most areas, and much of the increased demand will be for steam coal for electricity generation. Industrial coal demand increases are expected to be reduced to the sectors in which coal has technical as well as cost advantages. For example, expansion of steel and cement output are expected to result in increased industrial demand for coal.

## Prospects for Natural Gas

Natural gas consumption in the market economies is forecast to increase steadily in the base case from 38.1 trillion cubic feet in 1985 to 45.5 trillion cubic feet in 1990 and 52.7 trillion cubic feet in 1995 (Table 13). Natural gas is expected to remain price-competitive with oil and to increase its share of total energy consumption, mainly at the expense of oil consumption, from 19.2 percent in 1985 to 20.5 percent in 1990 and to 21.6 percent in 1995. The developing countries are expected to experience the highest growth rates.

**Table 13. Natural Gas Consumption in the Market Economies, 1983-95  
(Trillion Cubic Feet)**

Country/Region	History			Projections			
	1983	1984	1985	1990		1995	
	Actual	Preliminary	Estimate	Base	Range	Base	Range
United States .....	16.8	17.7	17.8	18.7	18.5-19.4	18.8	17.5-19.0
Canada .....	1.8	1.9	2.1	2.4	2.2- 2.6	2.7	2.1- 3.2
Japan .....	1.0	1.4	1.7	2.1	1.9- 2.3	2.5	2.0- 3.1
OECD Europe .....	7.9	8.2	9.0	11.0	10.4-11.5	12.5	11.4-13.6
United Kingdom .....	1.8	1.8	2.0	2.3	2.2- 2.4	2.7	2.5- 3.0
France .....	1.1	1.2	1.2	1.6	1.4- 1.9	1.8	1.3- 2.4
West Germany .....	1.8	1.8	2.1	2.7	2.3- 3.0	3.1	2.4- 3.7
Italy .....	1.0	1.1	1.1	1.5	1.3- 1.6	1.6	1.2- 2.0
Netherlands .....	1.4	1.5	1.6	1.8	1.7- 1.9	1.8	1.6- 2.0
Other Europe .....	0.8	0.8	1.0	1.1	0.9- 1.4	1.5	0.9- 2.0
Other OECD .....	0.5	0.5	0.6	0.8	0.7- 0.8	0.9	0.8- 1.0
Total OECD .....	28.0	29.7	31.2	34.9	34.2-35.6	37.4	35.5-38.9
OPEC .....	2.7	2.8	2.8	3.3	2.8- 3.8	4.2	2.8- 5.5
Other Developing Countries .....	3.1	3.7	4.1	7.3	6.3- 8.2	11.1	8.7-13.7
Total Market Economies ..	33.9	36.3	38.1	45.5	44.2-46.8	52.7	49.3-55.9

OECD=Organization for Economic Cooperation and Development.

OPEC=Organization of Petroleum Exporting Countries.

Notes: o Numbers may not add to totals due to independent rounding. o All uncertainty ranges are derived independently and do not necessarily add to totals.

Sources: o History: Energy Information Administration, International Energy Annual 1984, DOE/EIA-0219 and Short-Term Energy Outlook, DOE/EIA-0202(85/4Q) (Washington, DC, 1985).

o Projections: Energy Information Administration, Office of Energy Markets and End Use.



In the United States, the largest market-economy consumer, natural gas consumption is expected to increase while its share of total energy consumption decreases. Anticipated economic growth and restoration of natural gas price-competitiveness in industrial uses could increase the volume of natural gas consumed through 1990. Natural gas usage in power generation is expected to continue to decline as a result of competition from coal and nuclear power. Through 1995, natural gas will remain important in the U.S. industrial, residential, and commercial sectors, although efficiency improvements are expected to offset any increase in the number of customers or conversions from other fuels. A major producer of natural gas, the United States is expected to continue to fill most of its domestic requirements through indigenous production, augmented mainly by imports from Canada.

The growth of natural gas consumption in Canada is expected to result from extension of the nationwide gas distribution grid to more remote residential and commercial consumers and the development of distribution networks for industrial users. A net exporter of natural gas, Canada is expected to continue to meet its consumption requirements from domestic supply.

The significant growth forecast in Japanese consumption is mainly due to planned increases in imports of liquefied natural gas (LNG) for power generation. Japan is in the process of substituting LNG for low sulphur fuel oil and, in some cases, crude oil and naphtha, as a clean-burning fuel for power station boilers. Based on existing supply contracts and power station construction plans, a doubling of 1983 levels of natural gas consumption in the power generation sector is possible by 1990. Incentives for increasing consumption in other sectors of Japan's energy market are: the increasing importance of LNG as a feedstock for manufacturing city gas; special rate structures and new technologies that are making natural gas more competitive in the air conditioning market; gas company programs for encouraging natural gas conversions; and increases in Japan's indigenous natural gas supply. Japan currently supplements its small quantities of indigenous supply with LNG imports mainly from Brunei, Indonesia, and Malaysia and smaller volumes from Alaska and Abu Dhabi. Since most of these LNG import contracts extend beyond 1995, Japan's supply prospects throughout the forecast period remain positive. New supplies are also planned from Australia by 1990. In the interest of diversifying future supply sources, Japan is also considering participation in projects to import LNG from Qatar, Thailand, the Soviet Union, and additional sites in Alaska and Indonesia.

European consumption of natural gas is projected to increase mainly as a result of growth in the residential and commercial sectors. For example, the United Kingdom is undertaking widespread installation of central heating systems; West Germany, Italy, and Austria are expanding their gas distribution grids; and Denmark, Ireland, Finland, Spain, and Sweden have relatively small markets with room for future development. The Netherlands already has a mature market, with a large share of its users already linked to the gas grid, so that no additional growth is projected beyond 1990. Industrial

consumption is projected to increase in Italy, Spain, and regions of Germany where the gas grid is expanding. Natural gas use in power generation is projected to decrease as major coal-fired and nuclear plants come onstream in France, the Netherlands, West Germany, Belgium, and Spain. Ireland and Italy are projected to continue to use gas for load-balancing purposes in power generation.

The three main sources of European supply are indigenous production, intra-OECD trade, and imports from outside the OECD. The United Kingdom, the Netherlands, West Germany, and Italy produce large volumes for internal consumption; other European producers include Austria, Denmark, France, Iceland, and Spain. The Netherlands, Norway, and Denmark export to other European countries, and are projected to remain important suppliers throughout the forecast period. These three natural gas exporters supplied over one-fourth of Western Europe's consumption requirements in 1983, and accounted for more than half the region's imports in that year. The balance of European consumption requirements is met, and is projected to continue to be met, by imports from Algeria, Libya, and the Soviet Union. Dependence on these non-OECD sources of supply, Soviet pipeline gas in particular, is a concern to European countries. Over one-fourth of Western Europe's natural gas imports came from the Soviet Union in 1983, and volumes have been increasing more recently as additional phases of Soviet pipeline construction have been completed. During 1984 France, Austria, West Germany, and Italy began receiving natural gas via the Siberian export pipeline from the Soviet Union's Urengoy field. In the interest of energy supply security, Western European countries are seeking to diversify future supply sources, encouraging development of additional fields in the North Sea, and formulating contingency plans for possible future supply interruptions. By 1995 additional supplies could be imported from a number of alternative sources such as Nigeria, Qatar, and the Cameroons, which are currently exploring the possibility of exports to Europe.

In its 1985 natural gas marketing plan, the Netherlands Gasunie announced a policy of more rapid exploitation of resources. This policy is aimed at continued conservation of Groningen (the main Dutch producing field) and depletion of smaller onshore and offshore fields. As a result, Groningen's share of Dutch natural gas production (60 percent in 1984) could decline to 40 percent by 1990, increasing thereafter as the smaller fields are depleted. In Norway, the three major fields currently in production are Ekofisk, Frigg, and Statfjord. Start-up on the giant Troll field, the largest of Norway's reserves, is planned for 1992 or 1993; however, development plans are still under study, and contracts need to be negotiated with buyers on the continent. Development of another large Norwegian field, Sleipner, was postponed in 1985, but could provide a secure supply source in the future given appropriate economic incentives for development.

Elsewhere in the OECD, Australia and New Zealand are increasing domestic consumption in parallel with development of domestic reserves. Australia is also investing in facilities for LNG exports.

The rationale for increased consumption of natural gas in OPEC is twofold: to reduce flaring of associated gas in oil production and to allow additional supplies of oil for export by substituting natural gas in domestic energy uses. Indonesia and Venezuela already have established domestic markets, while Iran, Qatar, and other OPEC nations have plans in various stages of development.

Developing countries as a group are expected to experience the most rapid growth in natural gas consumption, for a number of reasons. Oil-rich countries, such as Mexico, are encouraging domestic fuel-switching from oil, the more highly valued export fuel. Oil-poor countries, with World Bank and other international assistance, are investing in infrastructure for exploiting their domestic reserves of natural gas. Others are taking advantage of nearby supply sources for natural gas imports, in order to reduce their dependence on imported oil. For example, Bangladesh, Pakistan, and Argentina already have established markets that may be expanded; South Korea and Taiwan are expected to use imports from Indonesia and Malaysia to develop markets by the late 1980's or early 1990's; and indigenous reserves in India, Thailand, Malaysia, Brazil, Bolivia, Chile, Colombia, and Trinidad represent potential markets for further penetration of natural gas.

## Prospects for Other Energy Sources

The consumption of energy derived from nuclear, hydroelectric, and geothermal sources by the market economies in the base case is projected to increase from an estimated level of 29 quadrillion Btu in 1985 to 40.4 quadrillion Btu in 1995, or at a growth rate of 3.4 percent (Table 14). As a result, the share of total energy consumption contributed by these sources is projected to increase from 14.4 percent in 1985 to 16.3 percent in 1995. The outlook for nuclear power is one of continued growth. As a result of an improved financial situation in 1984 and 1985, there has been less of a reduction in world nuclear power plant construction programs than in the prior 2 years.<sup>11</sup> At the end of 1984, there were more nuclear power generating units in the early stages of construction than 1 year earlier. Nevertheless, the total amount of nuclear capacity in the construction pipeline continued to decline, as the capacity of newly ordered units fell short of the capacity of nuclear units that were completed and brought into operation. As a result, the growth of operable nuclear generating capacity is projected to continue to be high until 1990, but could then begin to drop off as the paucity of new orders and previous cancellations take effect.

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<sup>11</sup> This discussion is based on Energy Information Administration, Commercial Nuclear Power: Prospects for the United States and the World, DOE/EIA-0438(85) (Washington, DC, 1985).

**Table 14. Consumption of Other Energy Sources<sup>a</sup> in the Market Economies, 1983-95  
(Quadrillion Btu)**

Country/Region	History			Projections			
	1983	1984	1985	1990		1995	
	Actual	Preliminary	Estimate	Base	Range	Base	Range
United States .....	7.2	7.6	7.8	10.3	10.1-10.6	10.9	10.7-11.3
Canada .....	3.0	3.2	3.3	3.7	3.6- 3.7	4.2	4.1- 4.2
Japan .....	2.0	2.0	2.2	2.7	2.6- 2.8	3.3	3.1- 3.7
OECD Europe .....	8.6	9.7	10.1	11.7	11.5-12.0	13.6	13.3-14.1
United Kingdom .....	0.7	0.7	0.9	1.0	0.9- 1.0	1.1	1.0- 1.1
France .....	2.2	2.7	2.8	3.4	3.3- 3.5	4.0	3.8- 4.4
West Germany .....	0.8	1.1	1.1	1.2	1.1- 1.4	1.5	1.5- 1.6
Italy .....	0.6	0.6	0.6	0.7	0.7- 0.7	0.8	0.7- 0.9
Netherlands .....	*	*	*	0.1	* - 0.1	0.1	0.1- 0.1
Other Europe .....	4.2	4.6	4.7	5.4	5.3- 5.6	6.1	5.9- 6.3
Other OECD .....	0.4	0.4	0.4	0.4	0.4- 0.4	0.5	0.5- 0.5
Total OECD .....	21.2	22.9	23.8	28.8	28.5-29.2	32.5	31.8-33.1
OPEC .....	0.3	0.3	0.3	0.4	0.4- 0.5	0.6	0.4- 0.7
Other Developing Countries .....	4.3	4.6	4.9	6.0	5.8- 6.5	7.4	6.6- 8.1
Total Market Economies ..	25.9	27.9	29.0	35.2	34.8-35.8	40.4	39.4-41.4

<sup>a</sup>Other energy sources includes nuclear, hydroelectric, geothermal, and other renewables.

\*Number is less than 0.05.

OECD=Organization for Economic Cooperation and Development.

OPEC=Organization of Petroleum Exporting Countries.

Notes: o Numbers may not add to totals due to independent rounding. o All uncertainty ranges are derived independently and do not necessarily add to totals.

Sources: o History: Energy Information Administration, International Energy Annual 1984, DOE/EIA-0219 and Short-Term Energy Outlook, DOE/EIA-0202(85/4Q) (Washington, DC, 1985).

o Projections: Energy Information Administration, Office of Energy Markets and End Use.

Nuclear power is projected to be the fastest growing source of energy for the market economies between 1985 and 1995, with consumption in the base case increasing at an annual rate of about 4 percent. Consumption growth is projected to mirror the declining growth rate of nuclear generating capacity during this period. Thus, the growth rate of nuclear power consumption is projected to fall from about 5 percent for the period 1985 to 1990, to about 3 percent in the period 1990 to 1995. Also, despite its rather rapid rate of growth over the projection period, nuclear power will continue to contribute the smallest share of total energy consumption in the market economies. Nuclear power is estimated to account for about 6.1 percent of total energy consumption in 1985 and is projected to account for about 7.6 percent in 1995.

The increase in nuclear power consumption is not projected to be uniform across the countries and regions of the market economies during the projection period. In fact, three countries--the United States, France, and Japan are projected to account for about 75 percent of the projected increase in nuclear power consumption by the market economies between 1985 and 1990.

In the United States significant nuclear generating capability is projected to be added through 1989, with additions tapering off thereafter through 1995. All of the expected U.S. nuclear units are already under construction. France, which is estimated to be the second largest consumer of nuclear power among the market economies in 1985, trailing only the United States, is projected to retain that position throughout the projection period, as a result of its aggressive nuclear power construction program. Nuclear power's share of French energy consumption is estimated to be 25 percent in 1985 and is projected to increase to almost 33 percent in 1995. Some French nuclear electric power is now exported to other European countries, and this practice is projected to continue in the future.

Japan, which is estimated to rank third in nuclear power consumption among the market economies in 1985, also has a strong commitment to future growth in nuclear generating capacity. Nuclear power consumption is projected to increase by about 60 percent between 1985 and 1995, and to account for over 11 percent of Japanese energy consumption at the end of the period.

The uncertainties surrounding nuclear power planning and construction are captured in the projection ranges for the consumption of other energy sources in 1990 and 1995 (Table 14). It is generally true that the projections for 1990 are more certain than those for 1995. In addition, because world credit conditions continue to make it difficult for less developed countries to finance nuclear construction projects, the projections for the "other developing countries" are subject to more uncertainty than other regions.

The consumption of hydroelectric and geothermal energy by the market economies in the base case is projected to grow from almost 16.8 quadrillion Btu in 1985 to over 21.6 quadrillion Btu in 1995, for a growth rate of about 2.6 percent. As a result, their share of total energy consumption is projected to increase from 8.3 percent in 1985 to 8.7 percent in 1995.

Much of the growth in hydroelectric power capacity and consumption is projected to occur in the developing countries, especially in Latin America and Asia. In the base case, OPEC and the other developing countries together are projected to account for over 39 percent of the projected increase in the consumption of hydroelectric and geothermal energy by the market economies between 1985 and 1995.

Other Europe is projected to account for about another 23 percent of this increase. Countries in the other Europe region that are projected to develop sizeable new hydroelectric power projects are Norway, Finland, Portugal, Spain, Greece, and Turkey. As a result, hydroelectric power is projected to account for over 23 percent of the energy consumed in this region in 1995.

Japan is also expected to make important additions to its hydroelectric power capacity over the projection period, allowing the country to increase its consumption of hydroelectric and geothermal energy by almost 38 percent between 1985 and 1995. Hydroelectric power is also expected to continue to be very important in Canada, where it is projected to account for almost 28 percent of total energy consumption in 1995. Almost no growth of hydroelectric and geothermal power is expected in the United States over the next 10 years.

Geothermal electric power is expected to continue to grow rapidly, but it will still represent only a negligible part of electricity generation throughout the projection period. Countries where geothermal resources may be developed include Indonesia, Italy, Japan, the Philippines, and Taiwan.

# 5. Comparison of International Energy Projections

Forecasts of energy supply and demand may differ for many reasons. Much of the variation can be attributed to differences in underlying assumptions concerning future world oil prices, economic growth rates, demand elasticities, and other key determinants of supply and demand. Differences in analytical approaches and forecasting model structure also result in different sets of projections, although the implications of these types of differences are more difficult to detect and quantify. Additional deviations may arise from differences in definitions, in conversion factors, and in the timing of the analysis.

The projections presented in this International Energy Outlook reflect EIA's current understanding of the world energy market and changes that are likely to evolve in the future. These projections have been updated from those in the 1984 Annual Energy Outlook, based on the continued downward trend in world oil prices, stronger than previously expected economic recovery in some areas of the market economies, and other changes that have occurred in the interim. This chapter presents a comparison of the 1985 EIA base case given in this report with the 1984 Annual Energy Outlook base case and other widely used energy forecasts.

## Comparison of EIA Projections

Energy demand in the market economies is projected to grow somewhat less than in last year's Annual Energy Outlook. Most of the lowered energy demand forecasts is accounted for by a lower projection of oil demand. Even though the world oil price projection for 1990 has been decreased slightly from last year's report (from \$29 to \$27 per barrel in 1985 dollars) and world economic growth assumptions have been increased slightly (from 2.8 to 2.9 percent growth between 1985 and 1990), the lagged impact of conservation due to previous price shocks continues to decrease the demand for oil and energy in general. In addition, a significant reduction in economic growth in OPEC causes a sizable reduction in its oil demand relative to last year's report.

As the swing or marginal oil producer, OPEC production estimates have been lowered significantly reflecting both the decrease in oil demand and the increase in non-OPEC production relative to last year's report (Table 15). These energy demand and supply differences are projected to continue to 1995 although the extent of the differences increases due to a major reduction in last year's Annual Energy Outlook world oil price projections in the post-1990 period.

## Comparison of Alternative Projections

As indicated in Table 16, most other forecasters provided projections for 1990 and 2000 whereas the EIA projection interval is 1985 to 1995. Not unlike the EIA forecasting method, the three key demand driving variables of most forecasts are economic activity, oil prices (including exchange rates), and lagged conservation effects of previous price shocks. Although only base case estimates are shown, it is recognized that considerable

**Table 15. Comparison of 1984 and 1985 EIA Energy and Oil Projections  
for the Market Economies: Base Case, 1990**

Projection	International Energy Outlook 1985	Annual Energy Outlook 1984
<u>Energy Consumption</u> (quadrillion Btu)		
United States .....	80	84
Japan .....	17	18
OECD Europe .....	59	59
Other Countries .....	68	67
Total .....	225	228
<u>Petroleum Consumption</u> (million barrels per day)		
United States <sup>a</sup> .....	16.4	17.0
Japan .....	4.5	4.8
OECD Europe .....	12.1	12.6
Other Countries .....	14.9	15.9
Total .....	48.0	50.3
Stock Additions .....	0.1	0.3
<u>Petroleum Supply</u> (million barrels per day)		
OPEC .....	20.4	23.5
United States .....	10.4	10.3
Other Non-OPEC .....	16.3	15.8
Total Production .....	47.1	49.6
Net Imports from CPE .....	1.0	1.0
Total Available Supply .....	48.1	50.6

<sup>a</sup> Includes Puerto Rico and the Virgin Islands.

CPE=centrally planned economies.

OECD=Organization for Economic Cooperation and Development.

OPEC=Organization of Petroleum Exporting Countries.

Note: Numbers may not add to totals due to independent rounding.

Source: Energy Information Administration, Annual Energy Outlook 1984,  
DOE/EIA-0383(84) (Washington, DC, 1985).



**Table 16. Comparison of Energy Projections for the Market Economies, 1990, 1995, and 2000  
(Million Barrels per Day of Oil Equivalent)**

Projection	Consumption (Growth Rate) <sup>a</sup>				Petroleum Production	
	Energy	Oil	Energy	Oil	OPEC	Other
1985 EIA Estimate .....	101.2	45.6	NA	NA	17.0	26.4
1990 Projections			(1985 to 1990)			
Ashland (July 1985) .....	105.7	48.0	1.4	0.9	20.0-21.5	25.5-26.5
Conoco (April 1985) .....	108.0	49.0	2.0	1.0	NA	NA
DRI Winter 1985-1986 ...	NA	48.4	NA	1.5	21.0	26.4
EIA IEO 1985 .....	112.7	48.0	2.2	1.0	20.4	26.7
Texaco (March 1985) ....	110.9	49.7	2.5	1.3	NA	23.0-28.2
1995 Projections			(1990 to 1995)			
Ashland (July 1985) ....	116.7	51.5	2.0	1.4	23.5-27.0	23.5-26.5
DRI Winter 1985-1986 ...	NA	54.0	NA	2.2	28.2	25.1
EIA IEO 1985 .....	123.9	49.9	1.9	0.8	24.4	25.2
2000 Projections			(1990 to 2000)			
Chevron (June 1985) ....	NA	NA	2.2	1.1	30.4	24.1 <sup>b</sup>
Conoco (April 1985) .....	128.0	54.0	1.7	1.0	28.0	NA
DRI Winter 1985-1986 ...	NA	56.5	NA	1.5	33.1	23.5
Texaco (March 1985) ....	130.5	55.0	1.6	1.0	NA	19.0-26.2

<sup>a</sup> For the 1990 projections, these are the growth rates from 1985 to 1990; for the 1995 projections, from 1990 to 1995; and for the 2000 projections, from 1990 to 2000. Estimates where available are taken from source or computed using source base year estimate.

<sup>b</sup> Excludes refinery processing gain of approximately 0.5 million barrels per day.

NA=Not available.

OPEC=Organization of Petroleum Exporting Countries.

Note: Except where noted, production includes crude oil, natural gas liquids, other liquids, and refinery gain.

Sources: o Ashland: World Energy Outlook Through 1995 (Ashland, KY, 1985). o Conoco: World Energy Outlook Through 2000 (Wilmington, DE, 1985). o Data Resources, Inc.: International Energy Bulletin (Lexington, MA, 1985). o Energy Information Administration: International Energy Outlook 1985 DOE/EIA-0484(85) (Washington, DC, 1986). o Chevron Corp.: World Energy Outlook (San Francisco, CA, 1985). o Texaco Inc.: Free World Energy Review (White Plains, NY, 1985).

uncertainty surrounds these point estimates. Growth rates are provided in percentages in Table 16 to avoid forecast differences that appear in barrel terms but that might be due to variations in historical data bases and definitions, and particularly differences in conversion factors. In general, the estimates include refinery processing gains even though they are projected in million barrels of oil equivalent. With few exceptions, the alternative projections are highly consistent. Namely, the projections assume that energy/GDP growth ratios will continue to decline over time and average 0.6 to 0.75 for the market economies. Oil consumption as a share of total energy consumption is projected to continue to decline, particularly in the industrialized countries by all forecasters.

The lowest projection of energy consumption, made by Ashland, is primarily due to their low economic growth rate assumed for the market economies which averages approximately 2.3 percent per year between 1985 and 1995 as compared to approximately 3 percent underlying the other projections.

Differences in projected oil consumption in the market economies are primarily the result of differences in world oil price assumptions. Without exception, the projections assume that nominal world oil prices will decline over the next few years (constant dollar prices will fall more). Except for Ashland, all of the projections assume that world oil prices will increase in real terms in the post-1990 period (Ashland assumes that the Arab light crude oil price will increase with the rate of inflation in this period). The Data Resources, Inc. (DRI), projection assumes that the world oil price increases by \$2 per barrel in real terms between 1990 and 1995. The largest real price increases between 1990 and 1995 are assumed in the EIA projections. Prices are forecast to increase by \$5 in the EIA projections. Significant decreases in world oil prices between 1985 and 1990 are projected by Ashland (about \$10 per barrel), DRI (\$7 per barrel), and EIA (\$4 per barrel by 1987 before increasing in the 1990's). The significant reductions in world oil price before 1990 may explain the higher rates of growth in oil demand in the DRI projections. The higher growth in oil demand in the post-1990 period in the Ashland and DRI forecasts is due primarily to the lower assumed price increases.

Another major area of consensus in all the base case forecasts is the projected decline in the early 1990's in total non-OPEC production. Thus, there is general consensus that OPEC will supply about one-half of the market economies' oil by 1995 and more than half beyond 1995. There is also general agreement that net exports from the centrally planned economies will decline over time.

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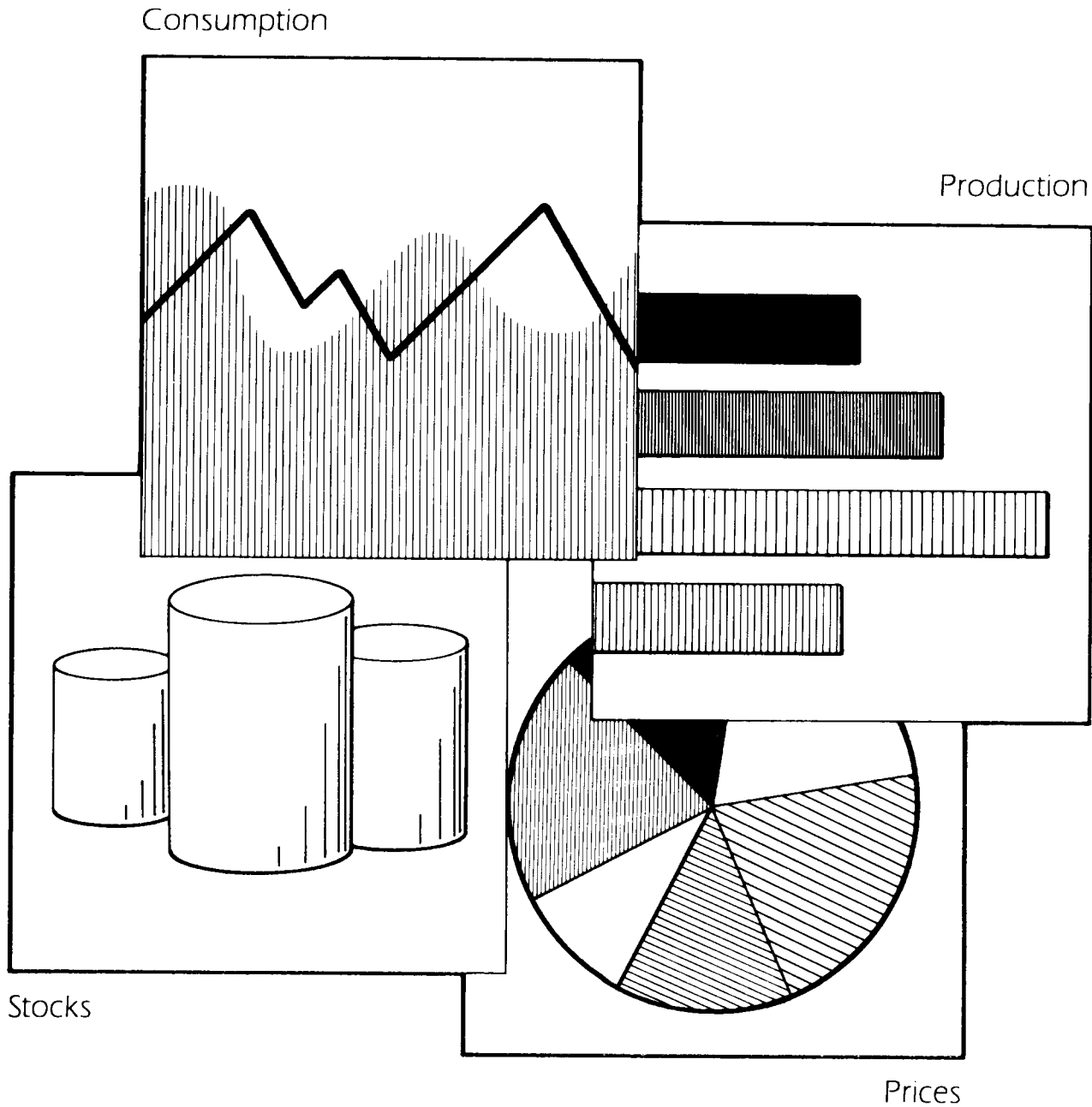
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