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International Energy Outlook 1987

Projections to 2000

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International Energy Outlook 1987

Projections to 2000

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Preface

This report presents the current Energy Information Administration (EIA) assessment of the long-term outlook for international energy markets. This 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 the year 2000.

This report 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 EIA's *Annual Energy Outlook 1987*. Since the U.S. energy market affects and is affected by the international market, the methodology incorporates this interaction to the extent possible. The domestic energy projections shown in this report are the same as those contained in the *Annual Energy Outlook 1987*. Sources providing more detailed discussions on the U.S. domestic markets are referenced throughout the report. Projections in this report are also consistent with those published in EIA's January 1988 *Short-Term Energy Outlook*.

The analysis of the international energy markets considers world energy growth prospects and fuel substitution possibilities. Requirements for oil are 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 resulting projections. Much professional judgment, based on recent trends, reviews of many country reports, and pro-

jections 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 between now and the year 2000. However, over the past 15 years, the world energy market has been characterized by major swings in most market indicators. The uncertainty of the projections is conveyed by the projection ranges. Point estimates are deemphasized.

Projections for the United States are from the *Annual Energy Outlook 1987* and were prepared with a set of spreadsheet models of the U.S. energy economy. Projections of foreign oil production and consumption and prices of world oil were prepared using the Oil Market Simulation (OMS) model. Projections of foreign nuclear generating capacity and foreign nuclear power consumption are based on an independent analysis of the results of the World Integrated Nuclear Evaluation System (WINES) model used to prepare the Energy Information Administration, *Commercial Nuclear Power 1987: Prospects for the United States and the World*, DOE/EIA-0438(87) (Washington, DC, 1987). Inquiries concerning the availability and documentation of these models should be directed to EIA's National Energy Information Center (202/586-8800).

Projections of foreign gross domestic product (GDP) are from Wharton Econometric Forecasting Associates, Wharton World Economic Model, September 1987 and *World Economic Outlook* (Philadelphia, PA, December 1987). Assumptions about total energy requirements of projected economic growth and about marginal changes in the makeup of that total (fuel shares) are used to complete the projections presented in this report. In turn, these assumptions are based on the review of energy forecasts submitted annually to the International Energy Agency by member countries and of other international energy forecasts produced by various public and private organizations.

Contents

	Page
Executive Summary	vii
1. World Oil Prices	1
World Oil Prices Trends	1
International Oil Market Considerations	3
Economic Growth and Energy Intensity	5
2. Oil Production Potential	7
World Oil Resources	7
Historical Oil Production Trends	8
Future Oil Production Potential	9
Petroleum Supply Vulnerability	12
Worldwide Trends in Refinery Capacity	13
3. Oil Consumption Trends	15
Oil Consumption in the OECD Countries	16
Oil Consumption in the Developing Countries	17
4. World Energy Consumption	19
Regional Energy Consumption Patterns	19
Energy Consumption by Economic Sector	22
Prospects for Coal	22
Prospects for Natural Gas	23
Prospects for Nuclear and Other Energy Sources	26
5. Comparison of International Energy Projections	29
Comparison of EIA Projections	29
Comparison of Alternative Projections	30
Appendices	
A. International Petroleum Balance	33
B. OECD Members Energy Demand by Sector	37
C. Operable Nuclear Capacities in the Market Economies	45
D. International Energy Production Data	49

Tables

	Page
1. World Oil Prices, 1979-2000	2
2. Annual Growth Rates of Real Gross Domestic Product (GDP) and Energy Consumption/ GDP Growth Ratios, Base Case 1970-2000	5
3. Crude Oil Reserves and Resources in the Market Economies	8
4. Oil Supply in the Market Economies, 1973-1986	9
5. Oil Production Capacity, 1987-2000	10
6. Oil Consumption in the Market Economies, 1973-1986	16
7. Oil Consumption in the Market Economies, 1985-2000	16
8. Energy Consumption in the Market Economies by Fuel, 1985-2000	20
9. Energy Consumption in the Market Economies, 1985-2000	22
10. Coal Consumption in the Market Economies, 1985-2000	23
11. Natural Gas Consumption in the Market Economies, 1985-2000	24
12. Consumption of Nuclear Energy in the Market Economies, 1985-2000	27
13. Consumption of Other Energy Sources in the Market Economies, 1985-2000	28
14. Comparison of 1986 and 1987 EIA Energy and Oil Projections for the Market Economies: Base Case, 1995	29
15. Comparison of Energy Projections for the Market Economies, 1990, 1995, 2000	30
A1. Oil Consumption and Production in the Market Economies: Base Case, 1979-2000	33
B1. Consumption by Major Fuels and End-Use Sectors: United States	37
B2. Consumption by Major Fuels and End-Use Sectors: Canada	38
B3. Consumption by Major Fuels and End-Use Sectors: Japan	39
B4. Consumption by Major Fuels and End-Use Sectors: OECD Europe	40
B5. Consumption by Major Fuels and End-Use Sectors: Other OECD	41
B6. Consumption by Major Fuels and End-Use Sectors: Total OECD	42
C1. Operable Nuclear Capacities in the Market Economies, 1986-2000	45
D1. International Production of Crude Oil, 1973-1986	49
D2. International Coal Production, 1973-1986	50
D3. International Production of Natural Gas (Dry), 1973-1986	51
D4. International Hydroelectric Power Generation, 1973-1986	52
D5. International Net Nuclear Electric Power Production, 1973-1986	53

Illustrations

	Page
1. OPEC Pricing Behavior, 1975-1987	2
2. Real Cost of World Crude Oil in Major Industrial Countries Based on National Currencies, 1978-1987	4
3. Energy Consumption/GDP Ratio; Base Case, 1970-2000	6
4. Uncertainty Range of World Oil Production Capacity, Consumption, and Excess Production Capacity, 1980-2000	11
5. Market Economies Oil Production: Base Case, 1970-2000	12
6. Range of World Oil Prices with Hypothetical Disruption in Supply, 1980-2000	13
7. Market Economies Oil Consumption: Base Case, 1970-2000	15
8. Market Economies Consumption of Energy by Type: Base Case, 1970-2000	20
9. Market Economies Consumption of Energy by Region: Base Case, 1970-2000	21

Executive Summary

World Oil Markets Likely to Remain Volatile for Next Several Years

Despite the relative stability of oil prices in 1987, the world oil market could easily experience large swings in prices over the next several years. Excess capacity and international tensions will exert conflicting market pressures.

Despite the large drop in crude oil prices during 1986 (about a 50-percent drop in the United States, and even more abroad because of exchange rate changes), the demand for oil from the Organization of Petroleum Exporting Countries (OPEC)¹ rose only slightly. Thus, excess oil production capacity continues to be the major problem facing OPEC in the near term.

There are several reasons why lower prices have brought only a modest rise in the demand for OPEC oil:

- The intensity of oil use in the market economies is declining.²
- Consumers outside the United States have been able to take advantage of only part of the price drop (especially in their use of gasoline), because some countries increased taxes to offset part of the decline in prices for crude oil.
- Several oil-producing countries that are not members of OPEC (including Canada and the United Kingdom) adjusted their tax regimes in such a way as to preserve economic incentives for domestic oil production. This helped to maintain their production levels, even in the face of falling prices.

Overall, significant excess production capacity within OPEC is expected to persist well into the 1990's, until an anticipated increase in worldwide demand (particularly in the developing countries) and a fall off in oil output from outside that organization combine to call upon OPEC production at levels that are closer to capacity. Past experience suggests that projections like these often involve uncertainties, yet most of the oil reserves in the market economies are located in the

Middle East, and it seems inevitable in the long run that the world will become more dependent on OPEC supplies.

Although excess capacity may keep prices low for the next several years, continuing tensions in the Persian Gulf would have the opposite effect on the market--by maintaining the threat that supplies in the market economies can be squeezed down suddenly. About 6 to 8 million barrels per day are now being exported through the Persian Gulf via the Strait of Hormuz, and this is a significant portion of OPEC's total production of about 19 to 20 million barrels per day. While the United States receives a relatively small amount of this oil, a sharp reduction in these supplies could force prices up wherever petroleum is consumed. That would affect national economies all over the world.

Even though the United States and many other countries have developed strategic petroleum reserves to draw upon during a disruption, a prolonged disturbance could have significant market impacts. An escalation of hostilities between Persian Gulf countries over a prolonged period would be bound to increase oil prices as excess capacity was effectively reduced. If prices increased rapidly, the market economies could face economic dislocations.

In the Long Run, Oil Prices Depend on the Costs of Substitutes and on OPEC Capacity

The wide range of world oil prices for the year 2000 considered in this report (between \$25 and \$40 per barrel in 1987 dollars) reflects many uncertainties (Figure ES1). The point that prices actually reach will be determined by factors such as:

- **Consumer and Government expectations.** If consumers and governments believe that prices will rise, they will tend to make investments that restrain demand growth and stimulate production. On the other hand, these actions introduce a coun-

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

²The "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, Vietnam, and Yugoslavia.

tervailing influence in themselves, because they encourage lower prices.

- **The cost in real resources of developing alternative energy sources.** If alternatives to oil (most likely natural gas and, to some extent, coal) can be developed at a relatively low real resource cost, there will be pressure to keep oil prices low. Attempts to raise oil prices will be met by fuel-switching and reduced demand.
- **Prospects for non-OPEC supply.** Much of the world outside the United States has not yet been explored extensively for oil. Many non-OPEC regions have favorable geology, and new production from those areas would tend to keep oil prices lower than would otherwise be the case.
- **OPEC's willingness to increase capacity.** At present, certain OPEC countries that are rich in oil reserves could increase production dramatically and rapidly at essentially no additional cost. Such nations might perceive it to be in their own best interest to do so, because this could help ensure a long-term future market for their low-cost oil by preventing significant price increases.

Any action by consumers or governments that limits growth in demand for oil will tend to limit increases in its price. For example, if consumers are concerned

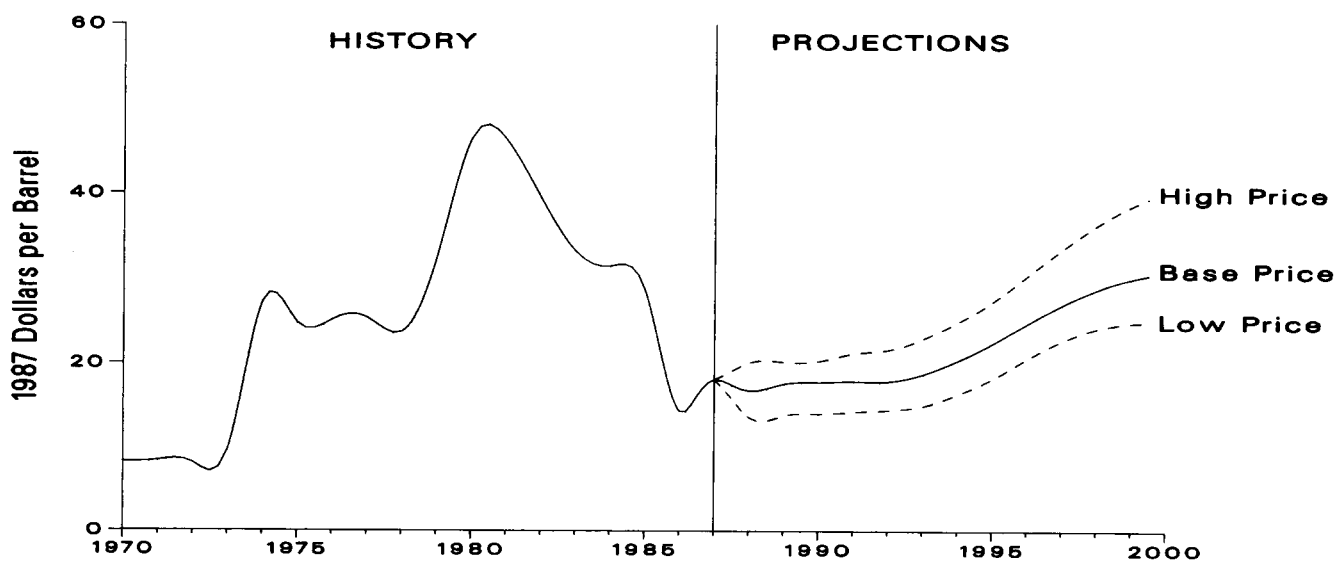
about the possibility or even the likelihood that oil prices will escalate, the investments that are prompted in equipment that uses alternative fuels or is more efficient in its use of oil will moderate growth in oil demand. Likewise, government policies of any sort to promote alternate energy sources among the market economies would constrain oil demand.

In this country, most oil is used by the transportation sector, where substitution is difficult. Outside the United States, however, significant volumes of oil are used for other purposes--such as heating and boiler fuel. As a boiler fuel, oil can be replaced by natural gas. Therefore, if natural gas supplies (both here and abroad) remain relatively inexpensive to develop, use of this fuel should help to curb oil price increases through 2000. Beyond that date, coal gasification and other processes to produce liquid or gaseous fuels will become more important in limiting rises in oil price.

U.S. Vulnerability to Interruptions in Supply Expected to Increase

U.S. oil imports are projected to increase in all the cases considered by the Energy Information Administration (EIA) in the 1987 *Annual Energy Outlook*. Moderate growth in demand, combined with falling domes-

Figure ES1. World Oil Prices, 1970-2000



Note: All prices are the cost of imported crude oil to U.S. refiners.
Sources: • History: Energy Information Administration, *Annual Energy Review 1986*, DOE/EIA-0384(86) (Washington, DC, 1987). • Projections: Table 1 of this report.

Table ES1. Summary of Assumptions and Projections for Market Economies

Assumptions/Projections	History		Projections		
	1985	1986	1990	1995	2000
Assumptions					
Economic Growth Rates ^a (percent per year)	3.0	2.7	2.2-3.0	2.3-3.1	2.4-3.2
OPEC Oil Production Capacity ^b (million barrels per day)	28.4	28.9	28-31	30-34	31-35
Projections					
Oil Prices ^c (1987 dollars per barrel)	\$28.52	\$14.40	\$14-20	\$18-27	\$25-40
Oil Production ^d (million barrels per day)					
Non-OPEC	26.8	26.7	26-28	24-26	23-26
OPEC	17.4	19.7	20-23	23-30	23-32
Energy Consumption^e					
Oil (million barrels per day)	46.7	48.0	49-53	49-57	48-58
Gas (trillion cubic feet)	37.7	37.0	40-43	46-52	53-63
Coal (million short tons)	2,083	2,069	2,217-2,314	2,444-2,662	2,705-3,053
Nuclear (terawatthours)	1,203	1,312	1,515-1,630	1,685-1,851	1,809-2,043
Other ^f (terawatthours)	1,642	1,643	1,792-1,861	1,919-2,073	2,049-2,263
Total Primary Energy ^g (quadrillion Btu)	207	209	225-234	243-261	257-285

^a The 1990, 1995, and 2000 projections represent average annual rates of growth from 1986 to 1990, 1986 to 1995, and from 1986 to 2000, respectively.

^b Production capacity is defined as maximum sustainable production adjusted to reflect current operable capacity in some countries.

^c Oil prices are defined as the U.S. refiner acquisition cost of imported oil.

^d Includes crude oil, lease condensate, natural gas liquids, other liquids, and refinery gain.

^e Consumption amounts for 1986 are preliminary.

^f Includes hydroelectric, geothermal, and other energy sources.

^g Average conversion factors used to compute British thermal units (Btu) are (1) Oil--5.6 Million Btu/barrel, (2) Gas--1,014 Btu/cubic foot, (3) Coal--20.6 Million Btu/short ton, and (4) Nuclear--10.8 Million Btu/terawatthour.

OPEC=Organization of Petroleum Exporting Countries.

Note: Market economies include all countries except those with centrally planned economies: Eastern Europe, the Soviet Union, China, Cuba, Kampuchea, North Korea, Laos, Mongolia, Vietnam, and Yugoslavia.

Sources: ●History: Energy Information Administration, *Monthly Energy Review*, DOE/EIA-0035(87/09), *International Energy Annual 1986*, DOE/EIA-0219(86), and *Short-Term Energy Outlook*, DOE/EIA-0202(87/4Q) (Washington, DC, 1987); Wharton Econometric Forecasting Associates, *World Economic Outlook*, (Philadelphia, PA, December 1987). ●Projections: Tables 1, 2, 5, 7, 8, 10, 11, 12, and 13 of this report; Energy Information Administration, Office of Energy Markets and End Use.

tic production, will increase the need for such imports. In addition, the market economies as a whole are projected to increase their dependence on OPEC oil. This dependence is a key measure of oil-supply vulnerability, because the economic impact of any supply disruption will be shared (though not necessarily equally) by all consuming nations as oil prices increase.

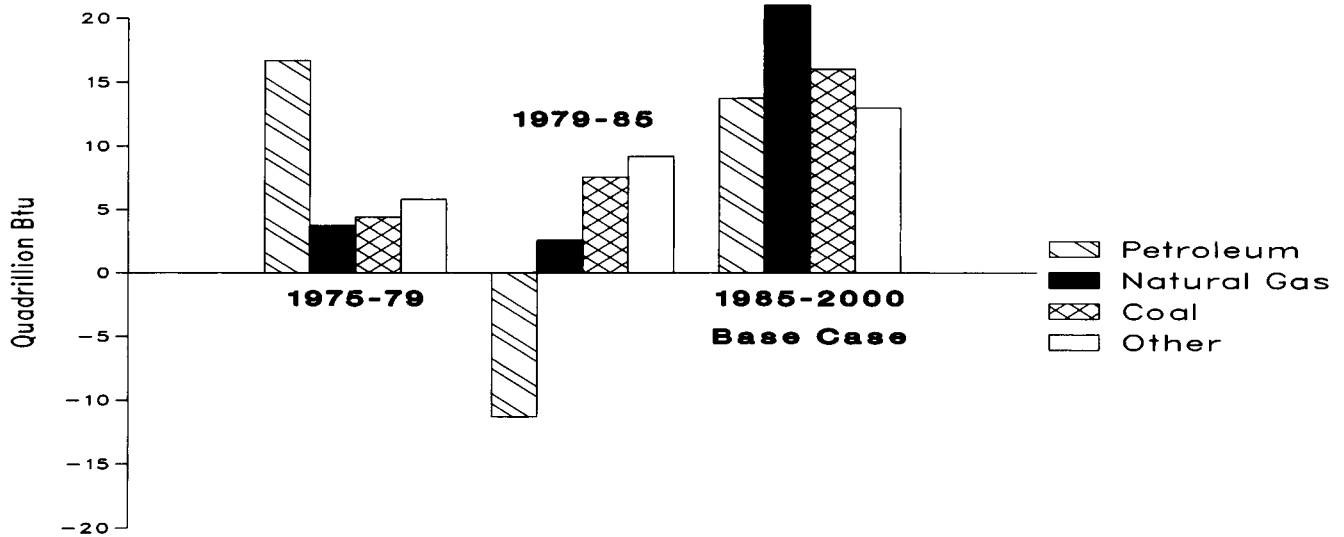
Oil imports by the United States increased in 1986, when domestic production began to drop off in response to falling oil prices. Such production should continue to decline over the projection period, because prices are not expected to be high enough (even in the "high-price case") to foster the levels of drilling that are deemed necessary to sustain domestic oil output at current levels. At the same time, although EIA projects that significant conservation efforts will cause the intensity of U.S. oil use to diminish, it foresees an increase in demand of 1.8 million barrels per day between 1987 and 2000 in the base-case scenario. In fact, this demand growth is moderate when compared to an increase of about 5.5 million barrels per day that would result if the intensity of oil consumption (measured as oil use per dollar of GNP) remained at 1987 levels throughout the projection period.

One factor that tends to moderate U.S. oil vulnerability, of course, is the U.S. Strategic Petroleum Reserve. This reserve already contains more than 540 million barrels, and it is assumed to reach 750 million barrels by the mid-1990's. Nations outside the United States also maintain emergency oil stocks that could be used during emergency shortages. These stocks are large enough to provide a cushion in the event of a short-term supply disruption, significantly reducing the adverse effects that might otherwise be felt by the market economies.

Oil's Share of World Energy Consumption Expected to Decline

Total primary energy requirements in the market economies are projected to expand by 23 percent to 36 percent between 1986 and the year 2000 (Table ES1). Oil's share of total consumption is projected to decline over this period while those of natural gas, coal, and nuclear power are all expected to increase. Changes in the consumption of these energy sources in absolute terms are presented in Figure ES2. This figure displays the shift in consumption of fuels in response to the oil price shocks of the 1970's and early 1980's.

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



Note: These bars represent the "change" during each period in specific fuel consumption. The sum of the changes equals the change in total energy consumption. Oil consumption recovered quickly after the first oil price shock of the 1970's (1975-1979) but fell sharply after the second (1979-1985). The base case projection (1985-2000) shows increasing oil consumption but a declining oil share.
 Sources: • 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). • Projections: Table 8 of this report.

Energy consumption in the developing countries taken as a group is projected to grow about twice as fast as that in the industrialized countries of the Organization for Economic Cooperation and Development (OECD).³ The difference results from a faster rate of economic growth projected for the developing-countries group and a higher level of energy intensity associated with that growth. However, the energy intensity of economic activity for all the market economies is assumed to decline about 1 percent per year between now and the year 2000.

The major assumptions used to make the projections presented in this report deal with such key considerations as economic growth, the energy intensity of economic activity, supply availability, changes in energy prices, the response of consumers to changes in energy prices, and the expected growth rate of nuclear generation. The energy projections are highly dependent on these assumptions. Thus, basic assumptions are modified to provide a range of energy projections by fuel type. These ranges help demonstrate the uncertainty as to how these and other factors might influence world energy markets in the future.

³The 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.

1. World Oil Prices

World oil prices⁴ stabilized in 1987 in the \$16-19 per barrel range in the first year following the 1986 price collapse. These price levels are also indicative of the price ranges expected for the next few years. While world oil prices are projected to increase again gradually, they are not expected to attain their 1981 level of \$46 per barrel (in 1987 dollars) for the foreseeable future. The base-case projections for the next 13 years show prices rising to about \$31 per barrel by the year 2000, the level they were at in 1984. Even the high end of the estimated price range for the year 2000 is \$6 lower than the 1981 price (Table 1).

As the past decade has shown, movements in world oil prices can be very unpredictable. Changes in policy decisions and market conditions have caused wide price swings. Given the political and economic uncertainties that exist in the world, there is no reason to believe that projecting oil prices will be any easier in the future, particularly in the short run. Over the long term, however, trends in world oil supplies and demands point to broad indications about longer term world oil prices.

The base-case outlook reflects this view. While extreme circumstances such as oil price wars and supply disruptions could cause major price swings for a few years, over the long run the underlying market forces of oil supply and demand will determine price levels. The price projections made here are not to be understood as predictions of what oil prices will actually be, but as indicators of the trends that they are expected to follow in accordance with these market forces.

World Oil Prices Trends

Near Term Influences

World oil price projections for 1988-1989 are made differently than those for other years because short term forecasts must incorporate judgments on OPEC's ability to restrain production as well. The base case projection assumes that OPEC will be able to bring

production more into line with demand during 1988 and continue doing so in 1989.

The alternative cases reflect the uncertainty in the oil markets today. The high-price case assumes that not only will OPEC be able to restrain its production, but that it will adhere fairly strictly to its production quotas after allowing for overproduction by Iran and Iraq. The low-price case, on the other hand, assumes that OPEC countries continue to overproduce by several million barrels per day, and must discount prices heavily to continue selling. Another price war, however, is not believed to be imminent and is not addressed in this price case. The near-term behavior underlying each of the three price paths sets the stage for the price trends over the remainder of the projection period.

Longer Term Trends

The market forces of supply and demand will be the principal determinants of world oil prices over the longer term. Prices are not expected to rise rapidly over the next few years because of the current surplus in world oil production capacity (the maximum production rate that could be achieved within 90 days and sustained for a year). Figure 1 indicates how OPEC pricing behavior has been a function of its capacity utilization over time. As long as the demand for OPEC oil remains weak, OPEC will be limited in its ability to raise prices.

Oil demand in the market economies is projected to show only a very gradual growth. Most of the growth is expected in the next 5 years in response to low world oil prices and economic growth. Oil demand is expected to grow from over 48 million barrels per day in 1987 to over 52 million barrels per day by 1993. Dampened by rising prices, oil consumption is expected to increase only slightly after that and remain relatively flat until the year 2000.

On the supply side, non-OPEC production is expected to remain in the 27-29 million barrel per day range until the early 1990's. Declines in production in the United States are expected to be offset by new discoveries in the developing countries. Other regions, such

⁴In this report, the world oil price is defined as the average cost of imported crude oil to U.S. refiners. Unless otherwise noted, all prices are presented in constant 1987 dollars.

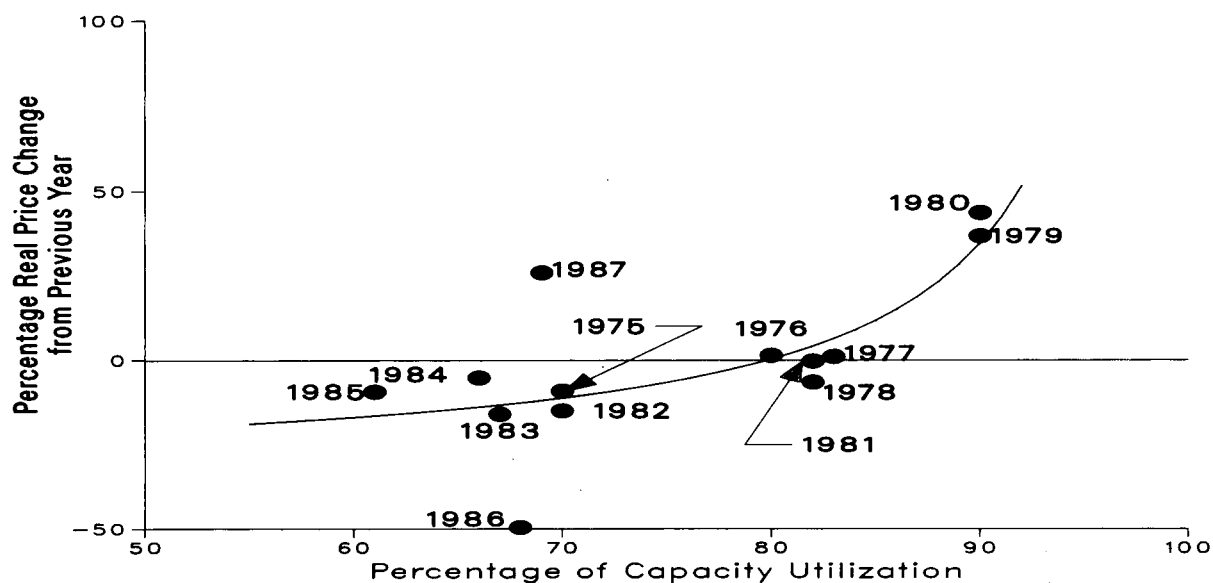
Table 1. World Oil Prices, 1979-2000
(1987 and Nominal Dollars per Barrel)

Year	Price Case--1987 Dollars per Barrel			Price Case--Nominal Dollars per Barrel		
	Low	Middle	High	Low	Middle	High
1979	--	\$32.39	--	--	\$21.67	--
1980	--	46.47	--	--	33.89	--
1981	--	46.31	--	--	37.05	--
1982	--	39.42	--	--	33.55	--
1983	--	33.17	--	--	29.30	--
1984	--	31.45	--	--	28.88	--
1985	--	28.52	--	--	26.99	--
1986	--	14.40	--	--	13.98	--
1987	--	18.11	--	--	18.11	--
1988	\$13.60	16.80	\$20.10	\$14.00	17.30	\$20.80
1989	13.80	17.60	20.20	14.70	18.90	22.00
1990	14.10	17.80	20.30	15.50	19.90	23.20
1991	14.30	17.90	21.20	16.40	20.90	25.40
1992	14.50	17.90	21.60	17.30	21.80	27.20
1993	15.00	18.80	22.90	18.80	24.00	30.50
1994	16.40	20.40	24.90	21.60	27.50	35.20
1995	18.30	22.40	27.30	25.40	32.00	41.10
1996	20.60	24.70	30.30	30.40	37.50	48.60
1997	22.70	26.90	33.50	35.30	43.20	57.10
1998	24.10	28.70	36.30	39.50	48.60	65.70
1999	24.80	30.00	38.60	42.70	53.40	74.10
2000	24.90	30.80	40.20	45.00	57.70	81.90

Notes: ●Prices represent the U.S. refiner acquisition cost of imported crude oil. ●The inflation rates used to estimate nominal prices for 1987 through 2000 are derived using the GNP price deflators from Energy Information Administration, *Annual Energy Outlook 1987*, DOE/EIA-0383(87) (Washington, DC, 1988).

Sources: ●History: Energy Information Administration, *Monthly Energy Review*, DOE/EIA-0035(87/10) (Washington, DC, 1988). ●Projections: Energy Information Administration, Office of Energy Markets and End Use.

Figure 1. OPEC Pricing Behavior, 1975-1987



OPEC = Organization of Petroleum Exporting Countries.
Sources: Energy Information Administration, *Monthly Energy Review*, DOE/EIA-0035 (87/10) (Washington, DC, 1988); Central Intelligence Agency, *International Energy Statistical Review*, selected issues (Washington, DC).

as the centrally planned economies (CPE) and the North Sea, are expected to maintain exports and production roughly at current levels through the 1980's.

As non-OPEC production declines and demand remains flat in the next 5-10 years, world excess production capacity should decrease. When this happens, the world oil markets will tighten and world oil prices are projected to rise again in the mid 1990's. After remaining in the \$17-22 range from 1987-1995, world oil prices are projected to rise to about \$31 in the year 2000.

The base-case projection shows the expected trends in world oil prices. Given the uncertainty regarding assumptions about future oil discoveries, economic growth rates, oil's share of energy markets, Oil/GDP (gross domestic product) ratios and other factors, other reasonable assumptions are possible which would lead to different price paths. The low- and high-price paths associated with the base case form a band of uncertainty about world oil prices.

While oil prices in any given year could lie outside the band of uncertainty, it is expected that price fluctuations outside this band are not sustainable. This is because prices in all three cases are assumed to be influenced principally by the trends of supply and demand in the world oil market. Prices above this band of uncertainty should encourage the higher cost non-OPEC production and discourage demand. This would lead to increased excess oil production capacity in the OPEC countries, and prices would fall. Prices below this band would encourage consumption and discourage non-OPEC production, leading to increases in the demand for OPEC oil and decreases in excess production capacity, with the result that prices would rise again. Given these market pressures, prospects for prices to be sustained outside this band are not impossible, but are considered unlikely.

International Oil Market Considerations

Oil is one of the world's most actively traded commodities. Oil prices and oil markets are therefore greatly influenced by world economic and financial trends. At the same time, oil production must fluctuate with the level of demand. Oil refining and distribution operations must respond to changes in the mix of products demanded by oil consumers and in the locations of final consumption. Finally, oil products must be marketed at prices competitive with the prices of available substitutes.

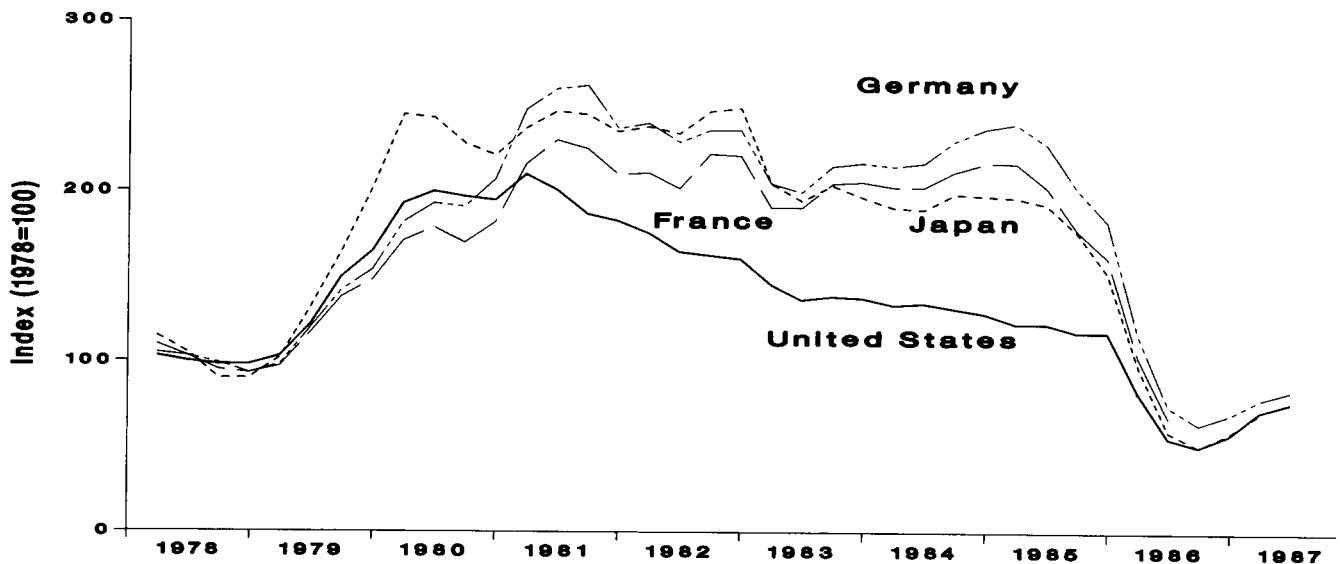
The medium of exchange for world oil trade is the United States dollar. Consequently, as the exchange rates of other currencies vary against the dollar so will the cost of crude oil measured in the domestic currency

units of those countries. The cost of crude oil measured in domestic currency units was falling in many non-U.S. countries even before the 1986 oil price collapse because of the declining value of the U.S. dollar (Figure 2). The value of the U.S. dollar had peaked in March 1985. The subsequent depreciation of the U.S. dollar had, by December 1985, reduced the domestic currency cost of crude oil to West Germany, France, and Japan by 22 to 26 percent, while the cost declined by only 4 percent in the United States. As oil prices plunged in 1986, the difference between the cost of crude oil to the United States and the price in most foreign countries continued to narrow because of further reductions in the value of the dollar. The combination of the drop in oil prices and the weak dollar pushed the domestic currency costs of crude oil to their lowest levels in the third quarter of 1986. These declines brought a reduction in crude oil costs of between 69 to 74 percent (measured from March 1985) for West Germany, France, and Japan. Not all of this reduction in the cost of crude oil was passed on to the consumer level, as governments raised taxes and refiners/suppliers increased margins. A partial return to official crude oil prices by OPEC in February 1987 helped the prices of major crude oils to stabilize around \$18 per barrel in 1987. However, the U.S. dollar continued to lose value against other major currencies in 1987. The U.S. dollar did have some mid-year strength, but declined at the end of the year to finish down by 17 to 24 percent against the French franc, German mark, and Japanese yen.

Market-linked crude oil pricing contributed to the dramatic fall in world oil prices in 1986. During that year, about 60 percent of globally traded oil was priced in some market-sensitive manner. These pricing techniques created more price volatility in petroleum markets and increased the importance of spot and futures markets. The return to official prices by OPEC in February 1987 decreased the volatility of oil prices, as most crude oil prices ranged between \$17 and \$19 per barrel in 1987.

Depreciation of the U.S. dollar in international financial markets has compounded the impacts of lower world oil prices on the oil exporting nations. As the U.S. dollar depreciates, it lessens the purchasing power of dollar-denominated oil revenues received by oil exporters and, when combined with the sharply lower revenue intake from lower crude oil prices, reduces the ability of oil-exporting debtor nations to service their debt and purchase imports. A comparison of OPEC oil revenues in 1986 with those received in 1982 dramatically illustrates how large the drop in oil revenues has been. Despite producing approximately the same amount of oil in both years, OPEC revenues (measured in 1987 dollars) fell by almost two-thirds. Several OPEC countries, most notably Iran, have taken the position that OPEC's official crude oil price structure must be increased to adjust for the decline in oil revenues associated with the depreciation of the dollar. Although it will continue to remain a subject

Figure 2. Real Cost of World Crude Oil in Major Industrial Countries Based on National Currencies, 1978-1987



Note: The average refiner acquisition cost of imported crude oil in the United States is used as the world oil price for each country and is converted to the national currency by using the appropriate exchange rate. Inflation rates are used to determine real prices, which are then converted to an index.
 Sources: Energy Information Administration, *Monthly Energy Review*, DOE/EIA-0035 (87/10) (Washington, DC, 1988). Data Resources, Inc., U.S. Central, Europe, and Japan data bases.

of discussion, the OPEC nations as a group have made no moves to adjust their oil prices accordingly. In the long run, OPEC revenues should increase as the demand for OPEC oil and world oil prices both increase. OPEC revenues are projected to increase gradually in the base case, but they are not expected to return to 1982 levels (measured in 1987 dollars) until the late 1990's.

The ability of participants in the oil industry to maintain market share is contingent on their ability to adapt their structure to the changing oil market environment. The market structure of the oil industry is constantly evolving in response to the competition from substitutes, the changing patterns of oil consumption, and the impact of government policies. Further, as the international oil industry has matured, internal competition between participants for market share and profits has required continuous restructuring to increase or maintain market position.

Recently, oil-producing nations have moved toward vertical integration by purchasing downstream (that is, refining and marketing) operations to ensure stable markets for their crude oil and to capture downstream profits. Diversification of sales channels and product slates could help to stabilize income and foreign exchange earnings for these producers. At the same time, low world oil prices should encourage the traditionally integrated major oil companies to assess the profitability of each phase of their operations. Oil companies, faced with declining revenues and shrinking profit margins, have retrenched through selloffs of less profitable operations and/or through consolidations of operations to reduce expenses. The net result of these actions by oil-producing nations and major oil companies will probably be a reduction in the number of refineries and more efficient marketing outlets.

Table 2. Annual Growth Rates of Real Gross Domestic Product (GDP) and Energy Consumption/GDP Growth Ratios, Base Case 1970-2000 (Percent)

Country/Region	Average Annual GDP Growth Rates				Energy Consumption/GDP Growth Ratios			
	1970-1980	1980-1985	1985-1990	1990-2000	1970-1980	1980-1985	1985-1990	1990-2000
United States ^a	2.7	2.6	2.6	2.2	0.41	-0.19	0.62	0.50
Canada	4.3	2.6	2.7	2.2	0.81	0.35	0.63	0.50
Japan	4.9	4.1	2.8	3.4	0.61	-0.05	0.68	0.44
OECD Europe	3.0	1.4	2.5	2.6	0.67	0.14	0.76	0.50
Total OECD	3.2	2.3	2.6	2.5	0.59	-0.13	0.69	0.48
Developing Countries	5.4	1.1	2.9	3.8	1.31	4.45	1.00	0.79
Total Market Economies	3.6	2.0	2.6	2.8	0.75	0.40	0.77	0.61

^a Projected growth rates are of Gross National Product (GNP).

OECD = Organization for Economic Cooperation and Development.

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

Sources: ●History: United Nations, *1979 Yearbook of World Energy Statistics* (New York, NY, 1981); Energy Information Administration, *International Energy Annual*, DOE/EIA-0219 and *International Petroleum Annual*, DOE/EIA-0042, selected issues (Washington, DC); and Wharton Econometric Forecasting Associates, *World Economic Service Historical Data*, January 1987 (Philadelphia, PA, 1987). ●Projections: Energy Information Administration, *Annual Energy Outlook 1987*, DOE/EIA-0383(87) (Washington, DC, 1988) and Table 9 of this report; Wharton Econometric Forecasting Associates, Wharton World Economic Model, September 1987 and *World Economic Outlook* (Philadelphia, PA, December 1987).

Economic Growth and Energy Intensity

The energy intensity of economic activity, defined as the ratio of energy consumption to GDP, is projected to decline steadily between now and the year 2000 (Table 2). This decline should occur in all regions of the market economies, but the energy intensity of economic activity is projected to remain the highest in the developing regions. Reduced energy intensity, particularly in the industrial economies, is expected to result from efforts to increase energy conservation and efficiency and from shifts in economic activity away from energy-intensive heavy manufacturing towards less energy-intensive services and new technologies.

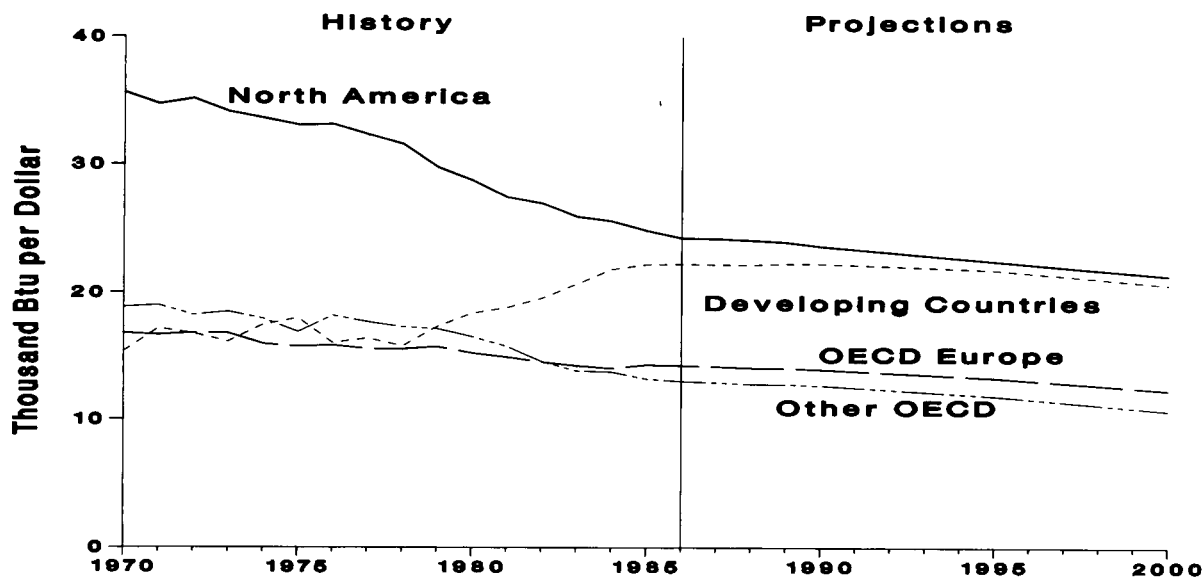
Movement toward less energy-intensive economic activity in the industrial countries would continue past trends (Figure 3). A particularly rapid decline in the ratio of energy to GDP occurred in the early 1980's as accelerating energy prices encouraged energy conservation. The rate of decline in this ratio of energy to GDP has leveled off in recent years, however, because of declining energy prices.

The energy/GDP ratio actually rose in the developing countries during the early 1980's. Between 1980 and 1985, energy consumption in the developing countries grew almost 5 percent per year. These countries, taken

together, had difficulty reducing the rate of growth in energy consumption, even though economic activity between 1980 and 1985 grew at a rate only slightly more than 1 percent per year. The poor economic performance in the developing countries mirrored a similar performance in all market economies during the early 1980's, particularly in Europe. The level of economic activity in the OPEC countries, included in the "Developing Countries" group in Table 2, was actually lower in 1985 than in 1980, reflecting falling oil consumption worldwide.

Oil's share of total energy consumption is projected to decline through the year 2000. Thus, the oil intensity of economic activity should decline at a rate faster than that of total energy. Oil's share of total energy will decline if countries continue efforts to substitute other fuels--such as nuclear power, natural gas, and coal--for oil. In the OECD countries, oil consumption is projected to grow about half as fast as economic activity through 1990 and then to remain virtually unchanged through the year 2000. Oil consumption is expected to grow not quite half as fast as economic activity in the developing countries taken as a group. Many developing countries will find it difficult to generate the capital and technology needed to shift away from oil. The greatest potential for fuel substitution is usually in the process of electric generation, where nuclear, hydro, and other fossil fuels are feasible substitutes for oil.

Figure 3. Energy Consumption/GDP Ratio; Base Case, 1970-2000



OECD = Organization for Economic Cooperation and Development
 Sources: • History: Wharton Econometric Forecasting Associates, World Economic Service Historical Data, January 1987 (Philadelphia, PA, 1987); United Nations, 1979 Yearbook of International 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). • Projections: Derived from tables 2 and 9 of this report.

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 have spare production capacity but have had to restrain production to support world oil prices.

World Oil Resources

The projected future availability of crude oil is based primarily on current estimates of proved reserves and a continuation of present trends in exploration activity and the expansion of production capacity. Estimates of the world's oil reserves and resources are made 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 total resources, that is, identified reserves and undiscovered recoverable resources--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.

- Recent evidence indicates that oil reserves in the market economies are in excess of 630 billion barrels and may exceed 800 billion barrels (Table 3). The probability range (95 percent to 5 percent) of total resources including identified reserves and undiscovered recoverable resources is about

880 billion barrels to 1,330 billion barrels (United States Geological Survey).

- Crude oil reserves (as published in the *Oil and Gas Journal*) increased between 1980 and 1987 in spite of real price declines and an average crude production level between 40 and 41 million barrels per day.
- More than 60 to 70 percent 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.
- 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.

The search for oil in the market economies peaked in 1981. Exploratory activity is the initial step in finding additional reserves. According to Baker Hughes Inc., 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 1987, there were about 2,300 active rigs in the market economies and about 1,160 in the United States, a decline of about 3,300 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 about 550 crews at the end of 1987. In the United States, there was a drop of about 500 crews during this period. Thus, outside the United States there has been a less dramatic decline in the number of active rigs and little change in the number of active seismic crews in recent years.

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 indications that this is likely to change.

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

Region/Selected Countries	Crude Oil Reserves ^a			Total Resources ^b U.S. Geological Survey (1/1/85)
	Oil and Gas Journal (12/31/87)	World Oil (12/31/86)	FESAP (Various Dates)	
North America	80.7	87.0	NA	139.1-280.5
Canada	6.8	4.8	NA	15.3-62.6
Mexico	48.6	54.9	27.2 (12/81)	45.0-105.0
United States	25.3	27.3	^c 30.4 (12/86)	70.4-118.4
Central & South America	65.7	64.6	NA	74.6-135.6
Ecuador	1.6	1.3	1.2 (12/82)	3.1-8.5
Venezuela	56.3	55.5	18.5 (12/78)	53.7-81.7
Western Europe	22.4	18.9	NA	45.1-78.1
United Kingdom	5.2	5.3	12.6 (12/81)	19.0-23.2
Other North Sea	15.3	11.7	7.0 (12/81)	17.7-40.7
Other Western Europe	1.9	1.9	NA	5.2-14.2
Middle East	564.7	387.1	419.2	482.9-619.9
Iran	92.9	36.5	62.5 (12/81)	71.1-95.1
Iraq	100.0	40.0	34.5 (12/81)	65.7-130.7
Kuwait ^d	94.5	94.6	95.7 (12/81)	80.8-88.3
Qatar	3.2	3.4	7.1 (12/81)	2.0-7.0
Saudi Arabia ^d	169.6	169.6	173.2 (12/81)	193.1-239.6
United Arab Emirates	98.1	36.2	43.0 (12/81)	48.7-58.7
Africa	55.2	57.0	NA	88.5-158.5
Algeria	8.5	4.8	10.4 (12/81)	11.8-16.3
Egypt	4.3	4.5	2.4 (12/81)	5.7-16.7
Gabon	0.6	0.6	NA	5.0-7.0
Libya	21.0	22.8	21.0 (12/81)	29.9-40.9
Nigeria	16.0	16.0	12.6 (12/75)	23.2-37.2
Other Africa	4.8	8.3	NA	12.1-36.1
Far East/Oceania	19.4	21.1	NA	41.2-94.2
Australia/New Zealand	1.9	1.9	NA	4.3-12.5
Indonesia	8.4	8.5	9.5 (12/82)	13.6-26.6
Total OPEC	670.7	489.6	NA	602-838
Total Market Economies	808.1	635.7	NA	880-1330

^a 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. Resource data include, in addition to reserves, undiscovered recoverable resources and unproven reserves that are inferred or indicated by engineering or geologic evidence.

^b Includes a probability range from 95 percent to 5 percent of identified reserves and undiscovered resources.

^c Energy Information Administration figure published separately (see Sources). This figure includes 26.9 million barrels of proved reserves and 3.5 million barrels of indicated additional reserves.

^d Includes 50 percent of the Neutral Zone.

NA=Not Available.

OPEC=Organization of Petroleum Exporting Countries.

FESAP=Foreign Energy Supply Assessment Program.

Sources: ●Oil: *Oil and Gas Journal* 82, 53 (December 28, 1987); *World Oil*, 201, 3 (August 1987); 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(86) (Washington, DC, 1987). ●All resources: U.S. Department of the Interior, Geological Survey, *World Resources of Crude Oil, Natural Gas, Natural Bitumen, and Shale Oil* (Assessment as of 1/1/85 in Paper delivered at 12th World Petroleum Congress in 1987).

Historical Oil Production Trends

Overall oil production (including natural gas liquids, other liquids, and refinery gain) in the market economies, excluding net CPE exports, was about 46.4 million barrels per day in 1986. This was about a 6.3 million barrels per day decrease from the historical peak in 1979 and about 2.7 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 1986.

There have been significant changes in the origin and composition of oil supplies between 1973 and 1986. 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 1986 OPEC provided only about 2 out of every 5 barrels of oil production. Iran and Saudi Arabia each had major declines. In the meantime, oil resources were developed outside OPEC; and non-OPEC oil production increased from 17.7 million barrels per day in 1973 to almost 26.7 million barrels per day in 1986. Production in the United States declined

Table 4. Oil Supply in the Market Economies, 1973-1986
(Million Barrels per Day)

Year	U.S. Production	Persian Gulf Production	Market Economies			
			OPEC Production	Non-OPEC Production	Net CPE Exports	Total Supply
1973	11.4	20.9	31.4	17.7	0.8	49.9
1974	11.0	21.6	31.2	17.3	0.9	49.4
1975	10.5	19.2	27.6	17.2	1.1	45.9
1976	10.3	21.8	31.3	17.4	1.2	49.8
1977	10.4	22.1	31.9	18.5	0.9	51.3
1978	10.8	21.1	30.5	19.7	1.0	51.2
1979	10.7	21.6	31.8	20.9	1.1	53.8
1980	10.8	18.5	27.8	21.7	1.2	50.8
1981	10.7	15.9	23.7	22.3	1.5	47.5
1982	10.8	12.8	19.9	23.4	1.7	45.0
1983	10.8	11.7	18.6	24.4	1.8	44.9
1984	11.1	11.4	18.7	26.0	2.1	46.7
1985	11.2	10.3	17.4	26.8	2.0	46.2
1986	10.9	12.5	19.7	26.7	2.1	48.5

CPE=Centrally Planned Economies.

OPEC=Organization of Petroleum Exporting Countries.

Notes: ●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. ○Persian (Arabian) Gulf includes Bahrain, Iran, Iraq, Kuwait, Qatar, Saudi Arabia, and the United Arab Emirates. ●Totals may not equal sum of components because of independent rounding.

Sources: Energy Information Administration, *International Energy Annual 1986*, DOE/EIA-0219(86) (Washington, DC, 1987); *Monthly Energy Review*, DOE/EIA-0035(87/07), and *Petroleum Supply Monthly*, DOE/EIA-0109(87/08) (Washington, DC, 1987).

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. South Africa and Brazil have made significant progress in developing these fuels.

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 are likely to remain plentiful over the near term.

Future Oil Production Potential

Crude oil production capacity in the market economies is projected in the range of 57.0 to 60.3 million barrels per day in 1990. This range becomes 56.4 to 61.1 million barrels per day in 1995 and 55.5 to 61.1 million barrels per day in 2000. At the lower end of the projection, capacity of the market economies shows a de-

clining trend from an estimated 1987 capacity level of 57.7. At the upper end, production capacity for the market economies is projected to increase steadily from the 1987 capacity level. The share of non-OPEC oil production in the market economies shows a declining trend in both the lower-end and upper-end projections. Table 5 shows the projected crude oil production capacity ranges for the non-OPEC and OPEC countries. These projections show that the production capacities of OPEC will increase over time, both absolutely and in terms of market share. Figure 4 compares projected ranges for total production capacity with projected ranges for total oil consumption.

The growing importance of OPEC oil production in the world market is the result of huge proved reserves of these countries. Proved reserves in OPEC have been reported as high as 670 billion barrels (Table 3). In contrast, proved reserves in the non-OPEC market economies have been reported at about 140 billion barrels. This big difference in proved reserves between OPEC and non-OPEC could be translated into an even bigger difference in production capacity if the market can absorb additional crude oil production; an increase in production in a proved oil field can be easily achieved by simply drilling more producing oil wells at relatively low cost.

Several important factors could change the production capacity and the relative market share of non-OPEC and OPEC. The first factor is crude oil prices. Crude oil price in the world market is determined by market demand and supply. For non-OPEC oil producers, oil production is very sensitive to oil prices. A decrease in the price of oil will induce a decrease in oil production; an increase in the price of oil will stimulate non-

Table 5. Oil Production Capacity, 1987-2000
(Million Barrels per Day)

Country/Region	Estimated 1987	Projections		
		1990	1995	2000
United States	10.7	9.8-10.2	8.4-9.4	7.8-9.1
Canada	1.8	1.6-1.7	1.4-1.8	1.3-2.1
Mexico	3.1	3.2-3.3	3.4-3.7	3.4-3.8
North Sea	3.9	3.9-4.1	3.3-3.9	3.1-3.9
Other Non-OPEC	7.6	7.8-8.5	6.9-8.1	6.5-7.7
Total Non-OPEC	27.1	26.5-27.7	23.8-26.4	22.7-26.0
Algeria	1.2	0.9-1.1	0.8-1.0	0.7-0.9
Ecuador	0.1	0.2-0.3	0.1-0.2	0.1-0.2
Gabon	0.2	0.1-0.2	0.1-0.2	0.1-0.2
Indonesia	1.5	1.3-1.5	1.2-1.4	1.2-1.4
Iran	3.4	3.0-4.0	3.5-4.5	3.1-4.1
Iraq	2.2	2.5-3.0	4.0-5.0	4.5-5.5
Kuwait ^a	2.1	2.5-2.8	2.5-2.8	2.5-2.8
Libya	1.8	1.6-1.8	1.7-1.9	1.8-2.0
Nigeria	1.7	1.6-1.8	1.6-1.8	1.6-1.8
Qatar	0.6	0.5-0.7	0.4-0.6	0.3-0.5
Saudi Arabia ^a	9.2	9.0-10.0	9.5-11.0	10.0-12.0
United Arab Emirates	2.0	2.0-2.2	2.0-2.2	2.0-2.2
Venezuela	2.4	2.2-2.5	2.1-2.4	2.0-2.4
Total OPEC	28.4	28.1-31.2	30.3-34.2	30.8-35.1
Net CPE Exports	2.2	1.7-2.2	0.9-1.9	0.5-1.5
Total Market Economies	57.7	57.0-60.3	56.4-61.1	55.5-61.1

^a Includes 50 percent of Neutral Zone Capacity.

CPE=Centrally Planned Economies.

OPEC=Organization of Petroleum Exporting Countries.

Notes: ●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 1987* plus surge production estimates of about 100,000 barrels per day. ●Production includes crude oil, natural gas liquids, refinery gains, hydrogen, and other hydrocarbons. ●All uncertainty ranges are derived independently and do not necessarily equal totals. ○Totals may not equal sum of components because of independent rounding.

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

OPEC oil production and delay the declining production trend or even raise non-OPEC oil production capacity. The general consensus is that non-OPEC oil producers are price takers, not price makers.

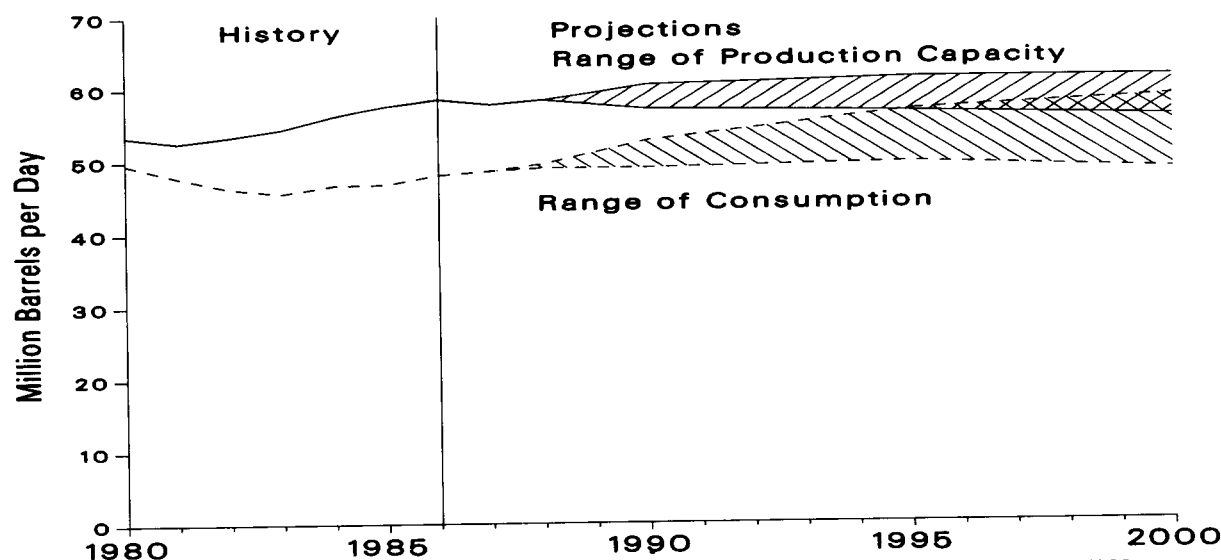
For OPEC oil producers, there is an estimated excess production capacity of about 9-10 million barrels per day. Clearly, there could be a trade off between OPEC market share and crude oil prices; an increase in OPEC oil production could expand its market share but would likely drive down crude oil prices. The experiences in the late 1970's and the 1980's showed that OPEC could raise the price of crude oil at the expense of shrinking market share in the short run; but, in the longer run, OPEC could lose market share and receive a lower price. Market stability, therefore, is sensitive to the ability of OPEC members to pursue a goal that is consistent with their long-term economic objectives. It is assumed in this report that OPEC pursues a stable price path.

The second factor that can affect production capacity is total resources: the sum of proved reserves and undiscovered resources. Proved reserves can be put into production by drilling more producing wells. Undiscovered recoverable resources could be translated into

production capacity if the price of crude oil is high enough to warrant a reasonable return on risky oil exploration activities. In 1987, total resources in the market economies were estimated to be in the range of 880 to 1,330 billion barrels. Total resources for OPEC were estimated in the range of 602 to 838 billion barrels (Table 3). The wide range of total resources reflects a distinct possibility that non-OPEC production capacity could also swing widely, depending on the projected price profile and assumed OPEC pricing behavior. Estimated production capacity for each country is based on the mean value of estimated undiscovered recoverable resources, and the allowed range is a 10-percent deviation from the mean value.

In addition to crude oil prices and estimated undiscovered recoverable resources, the cost of secondary production and enhanced oil recovery could also play an important role in changing the reserve to production (R/P) ratio and future oil production capacity. Historical R/P ratios are good indicators for the potential increase in production capacities. These ratios show the development intensity of proved reserves. The estimated 1987 R/P ratios for the United States, Canada, and United Kingdom are all less than 15; the R/P ratios for Norway and Mexico are greater than 25. In contrast,

Figure 4. Uncertainty Range of World Oil Production Capacity, Consumption, and Excess Production Capacity, 1980-2000



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 9-10 million barrels per day is projected to drop significantly in the 1990's.
 Sources: • History: Energy Information Administration, *International Energy Annual*, DOE/EIA-0219, selected issues (Washington, DC).
 • Projections: Tables 5 and 7 of this report.

the calculated R/P ratios for all the OPEC countries are greater than 15 and most of the R/P ratios in the OPEC group are greater than 30. The R/P ratio for Saudi Arabia exceeds 100 and that for Kuwait exceeds 200.

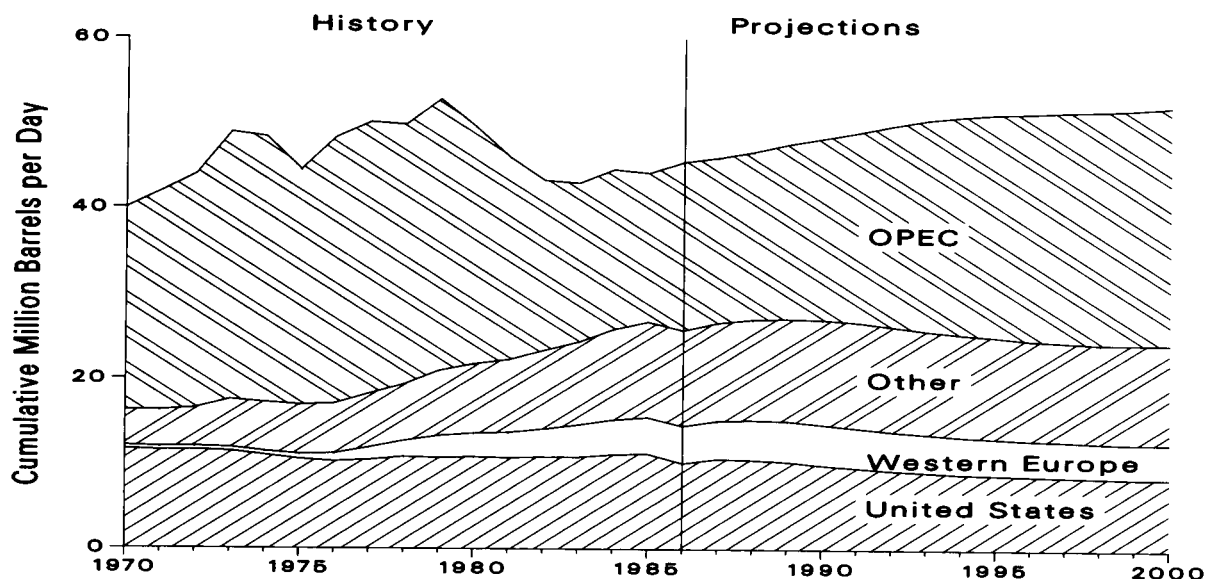
Given oil production technology, additional oil production from countries like the United States, Canada, and the United Kingdom could come from more active exploration drilling activities, but would likely require a very high oil price to support the more intensive drilling and enhanced oil production processes.

Mexico, Norway, and North Yemen are the only major non-OPEC oil producers that can continue to expand their production capacity in the 1990's and impact on the world oil supply. Mexico, which has large proved reserves, a high R/P ratio, and large undiscovered recoverable resources could easily expand its oil production capacity to a much higher level, provided the price of crude oil is high enough to stimulate production. Norway has much smaller proved reserves than

Mexico. However, its production capacity could be increased with relative ease due to its good sized undiscovered recoverable resources and a high R/P ratio. North Yemen is a new player in the oil market. Its production in 1988 is expected to be about 200,000 barrels per day. The trend for North Yemen is upward until 1995.

In contrast to non-OPEC oil producers, most OPEC producers have relatively large proved reserves and high R/P ratios. Among OPEC oil producers, Iran, Iraq, Kuwait, Libya, Saudi Arabia, United Arab Emirates, and Venezuela have significant amounts of proved reserves and high R/P ratios. Kuwait and Saudi Arabia are expected to have a more dominant role in the second part of the 1990's. This is due to their large proved reserves and slower rate of production, which keep their production capacity at a higher level. Following the current production trend and the projected price profile, it is expected that the market share of OPEC oil producers will continue to increase (Figure 5), and the impact of OPEC in the world oil market could be dominant again.

Figure 5. Market Economies Oil Production: Base Case, 1970-2000



OPEC—Organization of Petroleum Exporting Countries.
 Note: Production includes natural gas liquids, other liquids, and refinery gains.
 Sources: • History: Energy Information Administration, *International Energy Annual*, DOE/EIA-0219, selected issues (Washington, DC).
 • Projections: Appendix Table A1 of this report.

Petroleum Supply Vulnerability

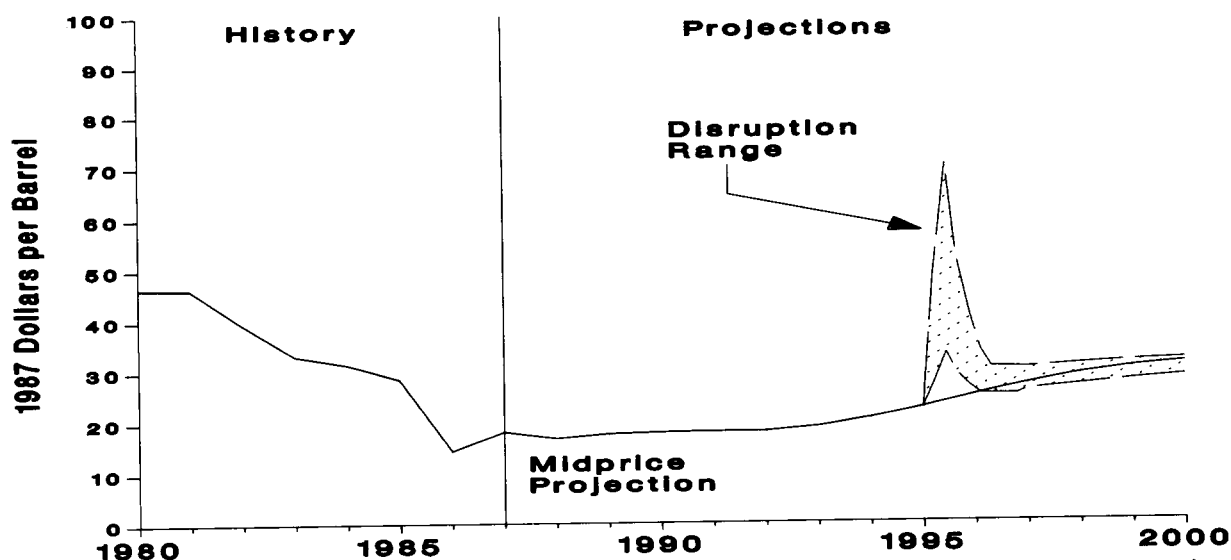
The growing concentration of remaining oil reserves and production in the Middle East (especially in the Persian Gulf) during the forecast period not only is likely to exert upward pressure on oil prices, but also could increase the potential for a serious disruption in oil supplies. Figure 6 illustrates what effects a closure of the Strait of Hormuz occurring in 1995 could have on world oil prices. This hypothetical disruption, although considered to be highly unlikely, could result in a net loss of about 9 million barrels per day, even after allowing for the use of excess production capacity and a surge in exports via alternative pipeline routes out of the Persian Gulf region. The hypothetical disruption begins on January 1, 1995 and lasts for 6 months. This example assumes that the United States responds to the disruption by drawing down the Strategic Petroleum Reserve at maximum rates at the same time that other countries in the market economies draw down their own government-controlled stocks.

Figure 6 shows that a hypothetical net disruption of 9 million barrels per day could increase oil prices by \$10

and \$48 per barrel, depending upon what is assumed about commercial inventory behavior and the responsiveness of demand to price increases (i.e., elasticity of demand). The wide range of uncertainty reflects the substantially different ways in which the market may respond to a disruption in oil supplies. If suppliers and end-users draw down commercial inventories in an effort to fill the supply gap, while consumers reduce energy use in response to higher prices, the economic effects of the disruption would be dampened and prices would tend toward the lower end of the range. Conversely, if consumption remains close to predisruption levels while commercial inventories are built up in anticipation of future price increases (caused by uncertainty over the disruption's duration or magnitude), the economic effects of the disruption would be intensified and prices would tend toward the higher end of the range.

The aftermath of such a supply disruption is also highly uncertain. When oil supplies are restored (assumed in this example to occur in the third quarter of 1995), world oil prices could actually fall below base-case levels. A cyclical pattern of price changes 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

Figure 6. Range of World Oil Prices with Hypothetical Disruption in Supply, 1980-2000



Note: This disruption price range is based on a hypothetical distribution that assumes that world oil availability is cut by 9 million barrels per day on January 1, 1995, for a period of 6 months.

Sources: • History: Energy Information Administration, *Annual Energy Review 1986*, DOE/EIA-0384(86) (Washington, DC, 1987).
• Midprice Projection: Table 1 of this report.

than this erratic pattern of price movements and its potential adverse effects on the world economy.

Worldwide Trends in Refinery Capacity

World oil refining capacity is trending upward again after a steady decline beginning in 1981. This new trend reflects a number of changes in the world oil market. First, world oil demand is not only growing again, but the composition of the demand is continuing to shift from a heavier product slate to a lighter product slate. Second, to meet the growing and changing demand, both the world refining capacity and refinery configuration have been enhanced. As a result of the changing demand and changing refinery configuration, refinery output, which is characterized by joint-product effects, should affect product trade patterns in the near future.

World oil demand started declining in 1979 when the Iranian revolution caused a steep rise of crude oil prices. Refining capacities, which reflect the ability of the refining industry to meet the demand for refined products, also underwent a transition following the decline in demand. Adjustments of refining capacities lag, however, because of the delay between the planning of and the actual completion of new capacities and the shutdown of existing refining facilities.

Declining world oil demand reversed in 1984, and the collapse of world oil prices in 1986 stimulated oil demand further. This increase in demand finally caught up with world refining capacity and changed near-term prospects for the refining industry. A general rule is that for refineries to be profitable, the utilization rate must be around 85 percent. In 1987, world oil consumption exceeded 85 percent of crude capacity. This relationship indicates that world refining capacity has reached a stage that is more compatible with world demand for oil. In the near future, crude capacity is expected to grow as oil demand grows.

Several noticeable changes have been observed in the refining industry since 1981. Most significantly, capacities of downstream conversion units such as catalytic-cracking and thermal-cracking units have been increasing, while crude distillation capacity has been steadily decreasing.⁵ Both catalytic cracking and thermal cracking units are aimed at converting the bottom of the barrel to lighter and more valuable products such as gasoline and distillates. The deviation between the trend of the crude distillation capacity and capacities of downstream units reflects a fundamental change in the composition of demand for refined products and the economics of petroleum refining. For example, market economy output levels for gasoline, jet fuel, and distillate declined in 1981 from the 1980 level, but started to increase in 1982, despite the fact that total output continued to decline in 1982 and 1983. The output share of gasoline and distillate continued to increase through 1987.

The shift of product share from residual fuel to more valuable gasoline and distillate has dictated trends in refinery configurations. Capacity of crude distillation units declined steadily from 1981 through 1986. Catalytic cracking capacity increased from 1981 through 1984, declined in 1985 and 1986, but increased again in 1987. Thermal cracking capacity showed a steady increase from 1981 through 1987. These changes in the configuration of refining capacities reflect a fundamental change in the operation of refineries to meet product demand.

In addition to the changes in world refinery configurations, the distribution of world refining capacity should also be noted. After the 1979 oil price shock, world oil demand experienced a significant downturn. The reduction in oil consumption, however, came mainly in the OECD countries. Demand for oil actually rose in the developing countries.

It is expected that the increase in demand for oil in developing countries will play a more important role in the addition of world refining capacity. Refinery output from these countries should affect future product trade significantly because of the joint-product effect of the refinery process. An increase in demand for middle distillates in Saudi Arabia, for example, would increase the production not only of distillate, but also of gasoline and residual fuel oil. Excess supply of refined by-products would be sold in the international market and would have an impact on both the product prices and trade flows.

World refining capacity is projected to grow in both crude units and downstream units in the next few years to keep up with growing demand. The 1988 world refining capacity, published in the December 1987 *Oil and Gas Journal*, showed an increase from the 1987 level. This trend is consistent with growing world oil demand and is expected to continue with the growth in world oil demand.

⁵Historical data on the refining industry are presented in Energy Information Administration, *International Energy Annual*, DOE/EIA-0219, selected issues (Washington, DC).

3. Oil Consumption Trends

Oil consumption in the market economies is expected to increase significantly over the near term, with slower growth occurring in the 1990's as oil prices rise (Figure 7). Although the world oil price was a few dollars more in 1987 as compared to 1986, it still is substantially lower than prices were in the early 1980's. Lower world oil prices in the late 1980's and early 1990's are expected to be a major factor in determining the future course of oil consumption. Economic growth is expected to be another important factor, especially among the developing countries. Oil consumption in the developing countries taken as a group is projected to sustain steady growth between 1986 and 2000, with an annual growth rate of between 1.0 percent and 2.3 percent per year. In contrast, the annual growth rate for the OECD countries averages between -0.3 and 1.1 percent per year. The net effect is that oil consumption

in the market economies is expected to rise from 48.0 million barrels per day in 1986 to between 48.2 and 58.3 million barrels per day in the year 2000 (Table 6 and Table 7).

As mentioned earlier, world oil prices dropped dramatically in 1986 before rising slightly in 1987. However, prices are still much lower than they were just two years ago. The price drop in 1986 set in motion a string of events that will likely affect oil consumption into the 1990's. Low prices, for example, could encourage less conservation and a shift back to oil, reversing the experience of recent years. As consumer habits change, oil demands could exceed low-cost oil supplies. If this happens, the price of oil could increase substantially. In the projections, this acceleration begins to occur in the middle 1990's. Such price increases would

Figure 7. Market Economies Oil Consumption: Base Case, 1970-2000

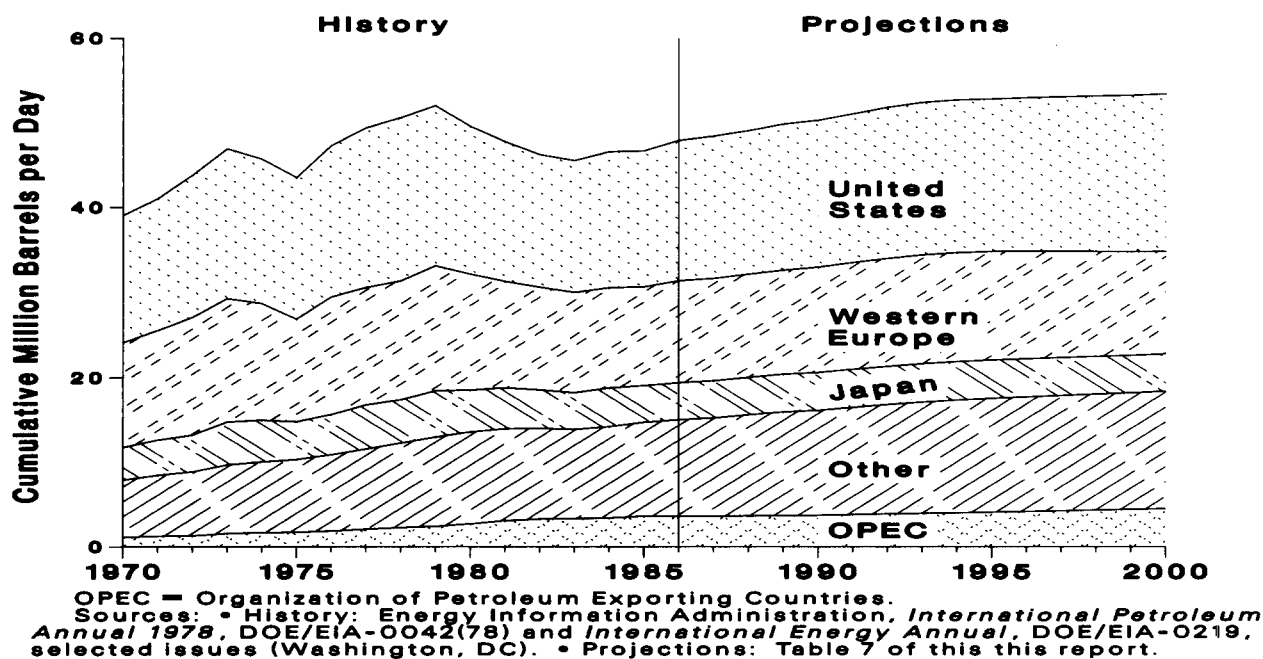


Table 6. Oil Consumption in the Market Economies, 1973-1986
(Million Barrels per Day)

Year	United States ^a	Other OECD	Total OECD	Non-OECD	Total Market Economies
1973	17.3	22.3	39.6	7.3	47.0
1974	16.7	21.5	38.1	7.6	45.7
1975	16.3	20.3	36.6	7.9	44.5
1976	17.5	21.4	38.9	8.5	47.4
1977	18.4	21.9	40.4	9.1	49.4
1978	18.8	22.0	40.9	9.8	50.6
1979	18.5	23.1	41.6	10.4	52.1
1980	17.1	21.5	38.6	11.0	49.6
1981	16.1	20.2	36.3	11.5	47.8
1982	15.3	19.2	34.5	11.8	46.3
1983	15.2	18.6	33.8	11.8	45.6
1984	15.7	18.8	34.6	12.1	46.6
1985	15.7	18.5	34.2	12.5	46.7
1986	16.3	18.8	35.1	12.8	48.0

^a Geographic coverage is the 50 States and the District of Columbia. U.S. Territories are included in "Other OECD."
OECD=Organization for Economic Cooperation and Development.

Note: Totals may not equal sum of components because of independent rounding.

Sources: Energy Information Administration, *International Energy Annual 1986*, DOE/EIA-0219(86) (Washington, DC, 1987); *Monthly Energy Review*, DOE/EIA-0035(87/07), and *Petroleum Supply Monthly*, DOE/EIA-0109(87/08) (Washington, DC, 1987).

likely encourage conservation, and oil consumption would level off again. This cyclical interaction with prices is reflected in the oil consumption projections.

Oil Consumption in the OECD Countries

There have been important shifts during the 1973-to-1986 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 because of the

Table 7. Oil Consumption in the Market Economies, 1985-2000
(Million Barrels per Day)

Country/Region	History		Projections					
	1985 Actual	1986 Preliminary	1990		1995		2000	
			Base	Range	Base	Range	Base	Range
United States ^a	15.7	16.3	17.1	16.5-17.9	17.7	16.6-18.7	18.3	16.7-19.5
Canada	1.5	1.5	1.6	1.5-1.7	1.7	1.5-1.8	1.6	1.4-1.8
Japan	4.3	4.4	4.5	4.3-4.7	4.5	4.1-5.0	4.4	3.9-5.0
OECD Europe	11.6	12.0	12.4	12.0-13.0	12.7	11.8-14.0	12.0	10.6-13.6
United Kingdom	1.6	1.6	1.6	1.5-1.7	1.6	1.5-1.8	1.5	1.3-1.7
France	1.8	1.8	1.9	1.9-2.0	2.0	1.8-2.2	1.9	1.6-2.1
West Germany	2.4	2.5	2.6	2.5-2.8	2.7	2.5-3.0	2.6	2.3-2.9
Italy	1.7	1.7	1.7	1.7-1.8	1.8	1.7-2.0	1.7	1.5-2.0
Netherlands	.6	.7	.7	0.7-0.7	.7	0.6-0.7	.6	0.5-0.7
Other Europe	3.6	3.7	3.8	3.7-4.0	4.0	3.6-4.3	3.7	3.3-4.2
Other OECD	1.0	1.0	1.0	1.0-1.1	1.0	1.0-1.1	1.0	1.0-1.1
Total OECD	34.2	35.1	36.5	35.3-38.3	37.6	35.0-40.6	37.3	33.5-40.9
OPEC	3.6	3.6	3.7	3.6-3.8	4.1	3.9-4.3	4.5	4.1-4.9
Other Developing Countries	8.9	9.2	10.2	9.9-10.4	11.1	10.5-11.8	11.6	10.6-12.6
Total Market Economies	46.7	48.0	50.3	48.8-52.6	52.8	49.4-56.6	53.4	48.2-58.3

^a Geographic coverage is the 50 States and the District of Columbia. U.S. Territories are included in "Other OECD." United States 1986 amount is actual.

OECD=Organization for Economic Cooperation and Development.

OPEC=Organization of Petroleum Exporting Countries.

Notes: ●All uncertainty ranges are derived independently and do not necessarily equal totals. ●Totals may not equal sum of components because of independent rounding.

Sources: ●History :Energy Information Administration, *International Energy Annual 1986*, DOE/EIA-0219(86) (Washington, DC, 1987); and *Monthly Energy Review*, DOE/EIA-0035(87/09) (Washington, DC, 1987). ●Projections: Energy Information Administration, Office of Energy Markets and End Use.

coal strike in the United Kingdom and colder than normal weather, but demand decreased once again in 1985. However, the price drop in 1986 increased petroleum consumption in the OECD back to pre-1981 levels. In 1973, the OECD consumed almost 40 million barrels per day of petroleum, or over 8 out of every 10 barrels of oil consumed in the market economies. In 1986, the OECD consumption dropped to approximately 35 million barrels per day, though their proportion of demand in the market economies declined only slightly (to about three out of every four barrels of oil used in the market economies). The United States' oil consumption declined by over 2.5 million barrels per day from the peak consumption year in 1978 and by about 1 million barrels per day from 1973. Throughout the period the United States' economy used about one out of every three barrels consumed in the market economies. Oil consumption by most countries in the OECD declined in the 1973-to-1986 period.

There is a general consensus that alternatives to oil have been pursued not only in response to market forces but also for political and national security reasons. However, with the 1986 price drop making alternatives to oil less economically sound, the pursuits for alternatives to oil may have been delayed for several years. Based on the projected range of uncertainty, oil consumption in the OECD countries in 2000 is projected to range from 33.5 to 40.9 million barrels per day. Most of the potential increase is projected to occur by 1995. There are several reasons for such a growth profile. If oil prices remain low over the next several years, oil will remain more competitive and market incentives for switching to alternative energy sources may be diminished. However, as non-OPEC oil production begins to diminish, oil prices are projected to increase, creating the opposite set of market forces in the late 1990's.

Government policies toward national security could also act to constrain growth in oil consumption. In particular, Japan's stated goal is to diversify energy mix while simultaneously increasing energy efficiency and conservation. If successful, oil consumption in Japan could remain level 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 economic growth. The U.S. 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 oil's ongoing importance is a consequence of the need for petroleum in the transportation sector and for petrochemical processes.

The lightening of the barrel (a shift towards gasoline) in Western Europe should not affect the total demand for petroleum, but should affect how that demand in Western Europe is divided among individual products. As Western Europe phases in lead-free gasoline restrictions for new cars, European refiners will refine a higher yield of light products, such as gasoline, in the future. The extent of this shift in refinery yields will depend on how quickly European consumers make the switch to lead-free cars or to using lead-free fuel in cars that do not technically need it.

Oil Consumption in the Developing Countries

Much of the increase in oil consumption in the market economies between 1986 and 2000 is projected to occur in the developing countries. Oil consumption in these countries taken as a group is projected to increase between 1.0 and 2.3 percent per year over this period (Table 7). The longer term trend of increasing oil consumption in the developing-countries group should result in part from their relatively rapid rate of economic growth (Table 2). In addition, many of these countries have limited ability to generate the capital needed to develop alternative sources of energy. Projects such as nuclear power plants and natural gas pipelines require large investments up front. Still, other countries will be able to exploit indigenous energy resources, including oil.

Oil consumption in the near term, as over the recent past, is likely to be encouraged by low world oil prices. The distribution of oil consumption among the developing countries should continue to be concentrated among a few countries. Currently, five countries-- Mexico, Brazil, India, South Korea, and Egypt--account for about half of all oil consumed among the "Other Developing Countries" group (Table 7).

Uncertainty concerning economic growth and, therefore, oil demand in the developing countries arises from the Third World debt that, according to the World Bank, has grown persistently through much of the 1980's to a level above \$1 trillion. Brazil and Mexico, the largest consumers of oil and the largest debtor nations among the developing countries, each have debts over \$100 billion. Though debtor nations have sought agreements for debt reduction and debt relief and commercial banks have increased loan loss reserves and sought other financial approaches to reduce Third World loan exposure, a comprehensive solution to the debt problem has not yet been formulated by the financial community. The resultant uncertainty could influence international economic and energy activity for some time into the future.

4. World Energy Consumption

Total primary energy consumption in the market economies is projected to grow at an average rate of 1.5 to 2.2 percent per year between 1986 and the year 2000. Though oil is projected to continue to be the major source of energy over this period, its relative importance is projected to decline steadily, going from about 47 percent of total energy consumption in 1986 to a range between 39 and 40 percent by 2000. Oil's share of total energy consumption has already declined significantly, as it represented just over 50 percent of the total in 1980. Other fossil fuels--natural gas and coal--are projected to increase in relative importance between now and the year 2000, as is nuclear power. Projections of total primary energy by energy source are presented in Figure 8 and Table 8.

One reason for the projected decline in oil's share of total energy consumption is the assumption that changes that have occurred in the structure of the electricity supply industry since the oil crisis of 1973 will continue in the future. For example, it is estimated that between 1973 and 1985 electricity consumption rose 40 percent among the member countries of the International Energy Agency (IEA).⁶ At the same time, oil consumption for electric generation was cut in half. Thus, increased use of other energy sources, primarily nuclear and coal, not only allowed for the increase in electricity consumption but also made up for the decline in oil inputs as well. It is estimated that oil consumption by public power systems increased in 1986, however, as oil prices fell. In terms of energy security, this change in 1986 is favorable if it reflects increased flexibility among the IEA countries. The change would be cause for concern, however, if it signals a new upward trend in oil consumption. Projections of energy use by electric utilities for the OECD and selected OECD countries are presented in Appendix B.

Regional Energy Consumption Patterns

Energy consumption in the market economies increased about 2.4 percent in 1985 and is estimated to

have increased again in 1986 by about 1 percent. Almost all of the increase in energy consumption in 1986 was attributable to increased oil consumption, as consumers took advantage of the collapse in world oil prices. However, the fastest growing energy source in 1986 continued to be nuclear power. Total energy consumption is estimated to have increased again in 1987, continuing the upward trend in energy consumption among the market economies that started in 1983.

Regionally, much of 1986 energy growth is estimated to have occurred in the OECD countries, with about two-thirds of the OECD growth occurring in Europe. In contrast, total energy consumption among the OPEC countries is estimated have declined slightly in 1986.

Between 1986 and the year 2000, energy consumption in the market economies is projected to grow the fastest in the developing countries (Figure 9). Energy consumption is projected to grow between 2.3 and 3.4 percent per year in OPEC and between 2.6 and 3.7 percent per year in the non-OPEC developing countries. Slower growth in energy consumption is projected for the OECD countries, averaging between 1.1 and 1.7 percent per year over the 14-year period (Table 9). Faster growth in economic activity is projected to be accompanied by faster growth in energy consumption among the developing countries relative to the OECD countries.

The energy intensity of economic growth is also projected to be higher in the developing countries than in the OECD countries (Table 2). Growth in industrial activity will add to the energy intensity of economic activity in certain developing countries. Growth in services and high-technology sectors should have the reverse effect in the OECD countries. Motorized transportation is expected to grow rapidly in many developing countries. Growth in the number of vehicles in OECD countries is expected to be offset by growth in fuel efficiency. Additional gains in the OECD countries are anticipated as new and more efficient buildings, appliances, heating boilers, and other industrial equipment--and processes--replace existing stocks.

⁶France, Finland, and Iceland are members of the OECD but not the IEA. A discussion of the electricity supply industry is presented in International Energy Agency, *Energy Policies and Programmes of IEA Countries, 1986 Review*, (Paris, France, 1987).

Table 8. Energy Consumption in the Market Economies by Fuel, 1985-2000
(Quadrillion Btu)

Energy Source	History		Projections					
	1985 Actual	1986 Preliminary	1990		1995		2000	
			Base	Range	Base	Range	Base	Range
Oil	95	98	103	100-107	108	101-116	109	99-119
Gas	38	37	42	40-44	50	46-53	59	54-64
Coal	43	43	47	46-48	53	50-55	59	56-63
Nuclear	13	14	17	16-18	19	18-20	21	20-22
Other	17	17	19	19-19	21	20-22	22	21-24
Total Primary Energy	207	209	228	225-234	251	243-261	270	257-285

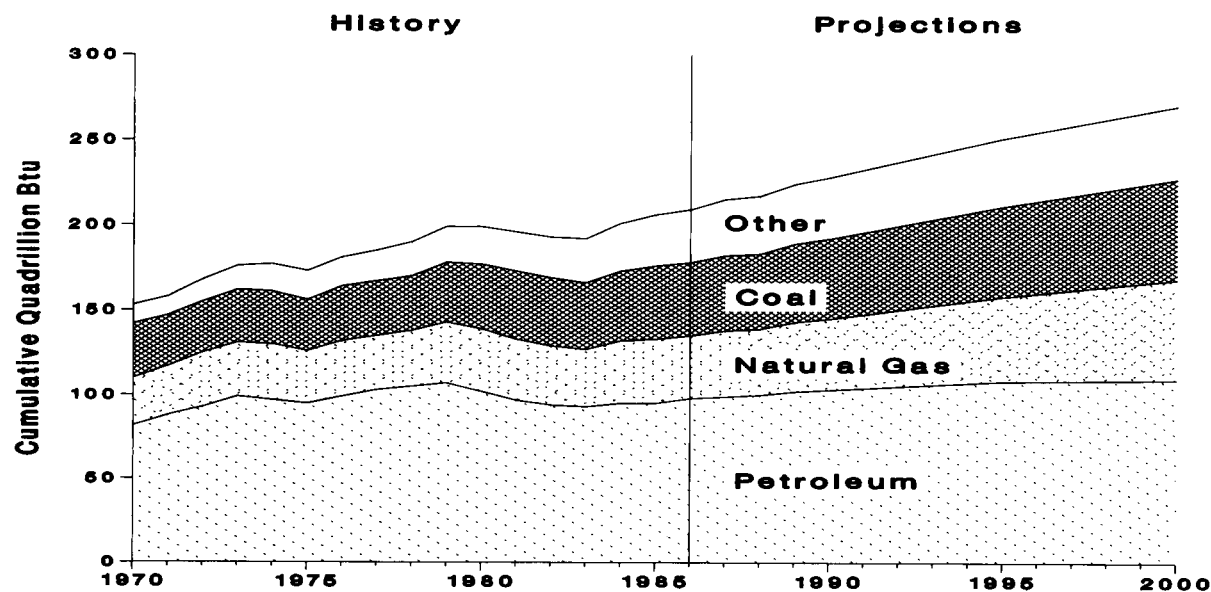
Notes: ●Energy totals exclude fuel wood and all noncommercial fuel sources. ○All uncertainty ranges are derived independently and do not necessarily add to totals. ●Totals may not equal sum of components because of independent rounding. ●Average conversion factors for the Market Economies for 1985-2000 are the following: (1) Oil--5.6 Million Btu/barrel, (2) Gas--1,014 Btu/cubic foot, (3) Coal--20.6 Million Btu/short ton, and (4) Nuclear--10.8 Million Btu/terawatt-hour.

Sources: ●History: Energy Information Administration, *International Energy Annual 1986*, DOE/EIA-0219(86) and *Monthly Energy Review*, DOE/EIA-0035(87/09) (Washington, DC, 1987). ●Projections: Energy Information Administration, Office of Energy Markets and End Use.

Energy consumption is expected to grow in the developing countries as electrification expands. Latin America, in particular, has considerable potential for growth in hydroelectric power. In contrast, there is growing opposition to further development of hydroelectric power in many of the OECD countries for environ-

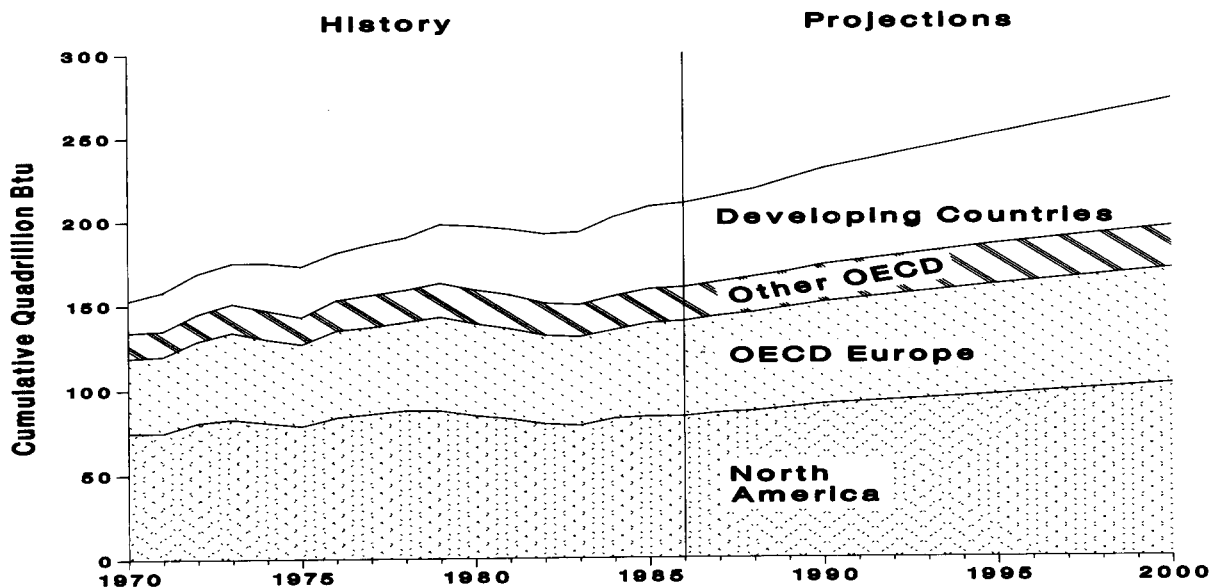
mental reasons. In Norway, for example, there is strong interest in shifting away from a predominantly hydroelectric power system toward a system based on gas-fired stations. Norway is rich in both of these resources.

Figure 8. Market Economies Consumption of Energy by Type: Base Case, 1970-2000



Sources: ● 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). ● Projections: Table 8 of this report.

Figure 9. Market Economies Consumption of Energy by Region: Base Case, 1970-2000



OECD = Organization for Economic Cooperation and Development.
 Sources: • 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). • Projections: Table 9 of this report.

The oil intensity of economic activity is also expected to decline more rapidly in the OECD countries than in the developing countries. Oil will remain relatively more important in certain developing countries because of their inability to obtain the capital needed for fuel-switching investments. Other countries, such as those in the Persian Gulf region, will use oil simply because it is abundant. Depending upon how well they remember the lessons of the past, the OECD countries should continue efforts at increasing fuel-switching and fuel-substitution capabilities for purposes of energy security.

Among the OECD countries, those with highly energy-intensive economies could, conceivably, conserve the most energy in the future. Canada and the United States have relatively high energy-intensive economies, while Switzerland, Denmark, and Japan have relatively low energy-intensive economies. The

ratio of total primary energy requirements (TPER) to gross domestic product (GDP) was about three times as great in Canada in 1986 as in Switzerland.⁷ The 1986 TPER/GDP ratio for the United States was about twice that of Japan.

In terms of energy per capita, Turkey, Portugal, Spain, and Greece use the least amount of energy among the OECD countries. In 1986, for example, the TPER/Per Capita ratio in Canada was 11 times as great as that in Turkey. At the same time, Greece and Portugal are relatively more dependent on oil than are the other OECD countries as measured by Oil/GDP ratios. This characteristic also holds for many developing countries that have had difficulty shifting away from oil. Of course, the incentive to shift away from oil was reduced by the oil price drop of 1986 in all countries, as the cost-effectiveness of fuel-substitution and oil-conservation investments became less certain.

⁷TPER/GDP, TPER/Per Capita, and Oil/GDP ratios for the period 1973 through 1986 are presented in International Energy Agency, *Energy Policies and Programmes of IEA Countries, 1986 Review* (Paris, France, 1987).

Table 9. Energy Consumption in the Market Economies, 1985-2000
(Quadrillion Btu)

Country/Region	History		Projections					
	1985 Actual	1986 Preliminary	1990		1995		2000	
			Base	Range	Base	Range	Base	Range
United States ^a	73.9	74.3	79.9	78.7-81.6	85.0	82.4-87.2	89.6	85.3-92.8
Canada	9.7	9.8	10.6	10.5-10.8	11.4	11.1-11.7	11.9	11.4-12.3
Japan	15.6	15.7	17.1	16.8-17.4	18.7	18.2-19.2	19.8	19.1-20.6
OECD Europe	54.6	55.7	60.0	59.2-61.2	64.9	63.1-67.6	68.3	65.7-71.5
United Kingdom	8.5	8.8	9.3	9.2-9.5	9.8	9.6-10.1	10.1	9.8-10.6
France	8.3	8.6	9.1	9.0-9.2	10.0	9.7-10.5	10.6	10.2-11.2
West Germany	12.2	12.4	13.1	12.9-13.2	13.8	13.5-14.1	14.2	13.8-14.6
Italy	6.0	6.0	6.6	6.5-6.8	7.2	7.0-7.5	7.6	7.3-8.0
Netherlands	2.9	3.0	3.2	3.2-3.3	3.4	3.4-3.5	3.5	3.4-3.6
Other Europe	16.6	16.9	18.6	18.3-19.8	20.6	19.9-22.6	22.3	21.3-24.9
Other OECD	4.1	4.1	4.5	4.4-4.6	4.9	4.8-5.1	5.2	5.0-5.5
Total OECD	157.9	159.6	172.1	169.6-175.6	184.9	179.5-190.8	194.9	186.6-202.7
OPEC	11.5	11.4	12.1	11.8-12.3	14.3	13.7-15.0	16.6	15.6-18.2
Other Developing Countries	37.2	38.4	44.4	43.2-46.4	51.8	49.3-55.4	59.1	55.2-64.1
Total Market Economies	207	209	228	225-234	251	243-261	270	257-285

^a Geographic coverage is the 50 States and the District of Columbia. U.S. Territories are included in "Other OECD." United States 1986 amount is actual.

OECD=Organization for Economic Cooperation and Development.

OPEC=Organization of Petroleum Exporting Countries.

Notes: ●All uncertainty ranges are derived independently and do not necessarily equal totals. ●Totals may not equal sum of components because of independent rounding.

Sources: ●History: Energy Information Administration, *International Energy Annual 1986*, DOE/EIA-0219(86) (Washington, DC, 1987); and *Monthly Energy Review*, DOE/EIA-0035(87/12) (Washington, DC, 1988). ●Projections: Energy Information Administration, Office of Energy Markets and End Use.

Energy Consumption by Economic Sector

Projections of energy consumption by fuel and by major economic sector for the OECD countries are presented in Appendix B. OECD energy consumption in the industrial and residential-commercial sectors is projected to grow about 1 to 2 percent per year between 1985 and 2000, while that in the transportation sector is projected to grow between 0.4 and 1 percent per year over the same period. Consumption of electricity accounts for much of the increase in energy consumption in the residential-commercial and industrial sectors. The fuel mix used to produce increasing levels of electric power should continue to change over the projection period, with natural gas increasing in relative importance. Oil remains the dominant fuel in the transportation sector, but gains in automobile efficiency should help to limit consumption growth in this sector.

Prospects for Coal

Total coal consumption is projected to increase from 2,069 million short tons in 1986 to between 2,705 and

3,053 million short tons in 2000 (Table 10). This represents about 22 percent of total energy, up from 21 percent in 1986.⁸ Regionally, most of the increased consumption is projected to occur in the OECD countries, notably in the United States and in Southern Europe. Almost all of the increase is to fuel electricity generation. To meet this projected increase, coal trade is projected to increase substantially, with Australia, the United States, South Africa, and Poland being the principal exporters. U.S. exports are projected to remain fairly constant at the 1986 level. Competition between coal and natural gas fuel may steadily increase in Western Europe generally, but more significantly in the developing countries.

During 1985, electric utilities consumed about 70 percent of all coal in the OECD countries (Appendix B). This share is projected to increase to over 75 percent by 2000, with consumption projected to increase between 1.9 and 2.7 percent per year between 1985 and 2000. Whereas industrial demand for coal in the OECD represented about 26 percent of total coal consumption in 1985, its share of OECD consumption is actually expected to decline to about 22 percent by 2000. The notable exception to this coal consumption pattern within the OECD is Japan. In 1985, the industrial sector consumed 70 percent of Japan's coal while electric utilities consumed only 30 percent. Japan has an active program for replacing oil-fired electricity plants with

⁸All fuel shares are derived by converting amounts in Tables 10, 11, 12, and 13 to quadrillion Btu and comparing them with amounts in Table 9.

Table 10. Coal Consumption in the Market Economies, 1985-2000
(Million Short Tons)

Country/Region	History		Projections					
	1985 Actual	1986 Preliminary	1990		1995		2000	
			Base	Range	Base	Range	Base	Range
United States ^a	818	804	879	873-882	975	962-983	1,059	1024-1090
Canada	54	51	56	54-57	60	56-64	70	64-76
Japan	120	115	140	129-147	158	135-175	178	150-205
OECD Europe	575	568	594	572-609	655	610-693	739	684-793
United Kingdom	111	121	120	117-122	127	121-132	131	124-137
France	47	39	40	40-40	42	42-42	43	43-43
West Germany	205	200	201	197-204	208	199-215	219	209-229
Italy	26	25	31	28-33	38	31-43	44	37-52
Netherlands	11	11	13	12-13	14	13-15	15	14-16
Other Europe	175	172	188	177-196	227	204-245	285	256-313
Other OECD	51	58	64	63-65	73	71-75	78	75-82
Total OECD	1,618	1,596	1,732	1,690-1,760	1,921	1,833-1,990	2,124	1,997-2,246
OPEC	3	3	4	4-4	8	7-8	12	11-12
Other Developing Countries	462	470	537	523-549	634	603-664	745	697-795
Total Market Economies	2,083	2,069	2,274	2,217-2,314	2,564	2,444-2,662	2,881	2,705-3,053

^a Geographic coverage is the 50 States and the District of Columbia. U.S. Territories are included in "Other OECD." United States 1986 amount is actual.

OECD=Organization for Economic Cooperation and Development.

OPEC=Organization of Petroleum Exporting Countries.

Notes: ●All uncertainty ranges are derived independently and do not necessarily equal totals. ●Totals may not equal sum of components because of independent rounding.

Sources: ●History: Energy Information Administration, *International Energy Annual 1986*, DOE/EIA-0219(86) (Washington, DC, 1987); and *Monthly Energy Review*, DOE/EIA-0035(87/09) (Washington, DC, 1987). ●Projections: Energy Information Administration, Office of Energy Markets and End Use.

coal-fired plants. It is expected that coal consumption in Japan's electric utility sector will double by the year 2000.

Total OECD coal consumption is projected to grow between 1.6 percent and 2.5 percent per year between 1986 and 2000, increasing coal's share of total energy consumption from 21 percent in 1986 to about 23 percent by 2000. Growth is expected to occur mainly in the Pacific Rim and Mediterranean European countries. However, coal's share of total energy consumption in several OECD countries is expected to remain relatively flat or actually to decline. France has a program for systematic replacement of coal-fired generating capacity as additional nuclear capacity is brought on line. As a result, coal's share of total energy consumption in France is projected to fall from 9 percent in 1986 to about 8 percent by 2000. Though coal is currently the predominant fuel source for power generation in the United Kingdom and some new capacity is under construction, many existing coal plants are slated for retirement through the 1990's. Similarly, new electricity generating facilities in Canada are expected to be either nuclear or hydroelectric. Heavy government subsidies and long-term contracts with the utility and industrial sectors should hold coal consumption in West Germany at least at current levels throughout the projection period. The Italian government is experiencing considerable public opposition to both nuclear and coal-fired generating plants. Therefore, the projected growth for Italy could be optimistic.

The prospects for coal growth outside the OECD are more favorable, although uncertain. In the developing countries, coal's share of total energy consumption is projected to increase slightly over the projection period.

Prospects for Natural Gas

Natural gas consumption in the market economies is forecast to increase from an estimated 37 trillion cubic feet in 1986 to a projected range of 53.3 to 63.0 trillion cubic feet by the year 2000 (Table 11). Growth rates through the year 2000 could average from 2.6 to 3.9 percent per year. Natural gas is estimated to account for about 18 percent of total energy consumption in 1986. At the low end of the range, natural gas could experience a slight loss of market share to other fuels before 1990, but would regain and increase its market share by 2000. At the high end of the range, natural gas would gradually increase its share of total energy demand to about 22 percent by 2000. The primary factors influencing future natural gas consumption are economic growth, natural gas prices relative to other fuels, capital investments in gas distribution systems, and the continued development of more competitive markets.

In the United States, the bulk of the expected increase in natural gas demand is in the electric utility sector, spurred by the growth of low capital cost combined

Table 11. Natural Gas Consumption in the Market Economies, 1985-2000
(Trillion Cubic Feet)

Country/Region	History		Projections					
	1985 Actual	1986 Preliminary	1990		1995		2000	
			Base	Range	Base	Range	Base	Range
United States ^a	17.3	16.2	17.3	17.0-17.3	18.3	18.3-18.3	19.7	19.5-19.8
Canada	2.1	2.0	2.2	2.1-2.3	2.5	2.2-2.7	2.8	2.5-3.1
Japan	1.4	1.5	1.9	1.7-2.0	2.2	1.8-2.5	2.4	2.0-2.8
OECD Europe	8.6	8.9	9.8	8.9-10.4	11.7	9.9-13.1	14.2	12.0-16.3
United Kingdom	2.0	2.1	2.2	2.1-2.2	2.4	2.2-2.6	2.7	2.5-3.0
France	1.1	1.1	1.3	1.0-1.4	1.6	1.2-1.9	1.9	1.4-2.4
West Germany	2.1	2.2	2.2	2.0-2.3	2.5	2.1-2.8	3.0	2.5-3.4
Italy	1.2	1.3	1.5	1.4-1.5	1.7	1.5-1.9	1.9	1.7-2.2
Netherlands	1.3	1.3	1.5	1.4-1.5	1.6	1.5-1.7	1.8	1.7-1.9
Other Europe	0.9	0.9	1.2	1.0-1.3	1.8	1.5-2.2	2.9	2.4-3.4
Other OECD	0.6	0.6	0.7	0.7-0.7	0.9	0.8-0.9	1.0	0.9-1.1
Total OECD	30.0	29.2	31.8	30.4-32.7	35.5	33.0-37.5	40.1	36.9-43.1
OPEC	3.4	3.3	3.7	3.6-3.7	4.9	4.7-5.1	6.1	5.8-6.5
Other Developing Countries	4.3	4.5	6.3	6.0-6.7	9.0	8.2-9.8	12.0	10.7-13.4
Total Market Economies	37.7	37.0	41.8	39.9-43.1	49.4	45.8-52.4	58.2	53.3-63.0

^a Geographic coverage is the 50 States and the District of Columbia. U.S. Territories are included in "Other OECD." United States 1986 amount is actual.

OECD=Organization for Economic Cooperation and Development.

OPEC=Organization of Petroleum Exporting Countries.

Notes: ●All uncertainty ranges are derived independently and do not necessarily equal totals. ●Totals may not equal sum of components because of independent rounding.

Sources: ●History: Energy Information Administration, *International Energy Annual 1986*, DOE/EIA-0219(86) (Washington, DC, 1987); and *Monthly Energy Review*, DOE/EIA-0035(87/09) (Washington, DC, 1987). ●Projections: Energy Information Administration, Office of Energy Markets and End Use.

cycle units and the recent unprecedented growth of nonutility electric generation, the majority of which is fueled by industrial gas-fired cogeneration units. By 1990, natural gas demand is expected to range from 17.0 to 17.3 trillion cubic feet, reaching 19.5 to 19.8 trillion cubic feet by 2000.

Canada has an expanding domestic market for natural gas, and is a major producer and net exporter as well. Expected increases in consumption of natural gas may be attributed to economic growth, combined with extension of the nationwide grid system to more remote residential and commercial customers and the development of distribution networks for industrial users. Canada has also made significant in-roads into the structural network of U.S. gas markets, both with increased transmission access and competition in U.S. markets. While the United States remains almost completely self-sufficient in natural gas supplies, continued regulatory developments in the United States and approval of the U.S.-Canadian Free Trade Agreement may notably improve U.S. buyer access to Canadian gas.

Japan, the largest importer of liquefied natural gas (LNG), produces only a minuscule amount of natural gas domestically. Japan's relatively high projected rate of growth in natural gas consumption throughout the forecast period is mainly due to continued economic growth and a preference for imported LNG over im-

ported crude oil for environmental reasons. LNG is used mainly for power generation, and is expected to become more important in the electric utility sector as Japan continues to substitute LNG for oil because of its cleaner burning properties. Although Japan will inevitably remain import dependent, its reliance on a diversity of suppliers is designed to minimize the risk of supply interruptions or shortages.

Recent structural changes in the European natural gas market may result in significant expansion of gas markets throughout Europe. If the European Community is able to resolve transmission access constraints among European suppliers and buyers, gas supplies may become more competitively priced not only with other gas suppliers, but with competing fuels, particularly coal. This could serve to encourage greater development and production of indigenous gas supplies and imports.⁹ The development of more fuel efficient generation technologies utilizing gas may also enable gas to compete head on with coal for new generating capacity.

Throughout the forecast period, declining oil demand is expected to be replaced by gas and coal consumption. By 2000 natural gas demand in Europe is expected to almost reach coal demand, with natural gas representing about 21 percent of total primary energy demand and coal representing about 22 percent. The outlook

⁹Comments of James Neukim, Coordinator of Natural Gas, Cambridge Energy Research Associates, (Cambridge, MA, February 8, 1988).

for natural gas consumption in Western Europe varies from country to country within the region:

- In the United Kingdom, widespread installation of natural gas central heating systems, the availability of secure supply from domestic reserves and nearby European exporters, and economic growth could encourage increases in consumption. The privatization of British Gas, the state-owned transmission and distribution company, and regulatory incentives for increased interfuel competition may improve natural gas price competition in England's energy markets. Of notable importance to the new regulatory setting will be the development of more flexible direct sale arrangements among competing gas suppliers and their industrial customers, and the opening of publicly authorized gas suppliers to new suppliers. The success of these regulatory reforms in the United Kingdom may set a precedent for similar regulatory liberalization among continental gas markets.
- In France, start-up of new nuclear power plants, coupled with the availability of relatively low-priced oil, could reduce natural gas consumption throughout the forecast period. In the high range, demand is expected to recover somewhat after 1990, due to economic growth, but is unlikely to recoup all of the share previously lost to other fuels.
- West Germany is not only Europe's biggest importer of natural gas, it also provides transmission links for almost 90 percent of European gas imports, particularly from Norway and the Soviet Union. The share of total energy supplied by natural gas is expected to increase from 17 percent in 1986 to about 21 percent by 2000.
- Italian natural gas consumption is expected to increase more than previously forecasted primarily in response to public pressure to halt the country's development of nuclear power and curtail its development of coal-fired generation, in order to meet environmental air quality concerns. Italy is expected to increase gas consumption from about 21 percent of its total energy demand in 1986 to about 26 percent in 2000.
- The Netherlands, with a mature market and adequate domestic reserves, is expected to maintain its consumption at close to the 1986 level through 1990 and to increase moderately thereafter. Environmentalists' pressure to improve air quality standards may enhance the growth of natural gas demand with the development of gas-fired combined cycle plants. Concerns about future shortages of Dutch natural gas reserves have been temporarily relieved with a major gas reserve discovery in Rotterdam, representing the first medium to large

reserve discovery since 1985. The Netherlands is currently the fourth largest gas producer in the world and the second biggest exporter. However, with almost half of the Netherlands' energy demand met by natural gas, domestic use of gas reserves and development restraint take precedence over European gas market exports.

- Elsewhere in Europe, natural gas consumption is expected to grow rapidly as the result of improved gas transmission access throughout Europe and the increasing trend to restrict coal-fired electric generation because of environmental concerns.

Western European natural gas requirements are currently supplied by indigenous production for local use (about 50 percent), intra-OECD trade (almost 30 percent), and non-OECD trade (about 20 percent). On balance, the European gas supply "bubble" is even greater than that of the United States. The major European suppliers, including the Soviet Union, Algeria, and Norway, each have enough gas reserves to meet European gas demand well into the next century. Deliveries from Norway's Troll and Sleipner fields are scheduled to begin in the 1990's under an agreement among a European consortium that includes West Germany, France, Belgium, and the Netherlands. Western Europe also receives ample indigenous supplies from the Netherlands, the United Kingdom and to a lesser extent West Germany and Italy. As demand increases, the incremental requirements are likely to be met by supplies outside the OECD. Nevertheless, Western Europe is expected to continue to rely on indigenous production and intra-OECD trade for about two-thirds of the region's requirements.

Although Soviet gas production is intended primarily for domestic consumption, oil and gas exports represent a major source of foreign exchange to the Soviet Union. A weak oil export market resulting from a depressed international oil market may act as an incentive for the Soviets to increase their gas exports. Currently, new Soviet gas pipeline extensions are being developed through Austria and negotiations are underway for a pipeline through Finland. Due to European natural gas import ceilings, restricting the level of dependence on any one foreign importer, future increases in competitively priced Soviet gas supplies may be tied to increase by other gas importers to Europe, and in particular the growth of Norwegian gas sales.¹⁰

A "spot" market for liquefied natural gas, initiated by Indonesia toward the end of 1986, established new LNG markets in the United States, France, Germany, and Italy. Following Indonesia's lead, Algeria and Libya have also established LNG spot markets. Industry negotiations have also resulted in Algeria's first LNG deliveries to the United States since 1985.

¹⁰Rahmani, Noreng, and Treverlan, Energy and Environmental Policy Center, Harvard University, *Natural Gas in Western Europe: Structure, Strategies, and Policies*(Cambridge, MA, 1987).

Rapid natural gas demand growth is also forecast to occur in OPEC and other developing countries. Short-term growth in OPEC countries could be tempered, however, by the currently lower oil prices that limit revenues available for natural gas infrastructure investments. In the longer run, however, OPEC is expected to accelerate domestic use of natural gas both to reduce flaring of associated gas during oil production and to reduce domestic consumption of oil to make more crude oil available for export. Gas demand is expected to increase in South Asian markets as the result of increased LNG exports from Indonesia.

Developing countries that currently import oil are expected to increase consumption of natural gas supplied from domestic production or nearby exporters as they strive to reduce dependence on imported oil. The extent to which these new markets develop will depend largely on the availability of financing from government revenues, private investments, and international organizations.

Prospects for Nuclear and Other Energy Sources

The outlook for the consumption of energy derived from nuclear and "other commercial energy" sources, including hydroelectric, geothermal, and other renewables, is now less optimistic than it was last year. In the last year, the prospects for nuclear energy have suffered definite damage as a result of the increase in public apprehension and political opposition, based on safety concerns that developed following the April 1986 reactor accident at Chernobyl. Meanwhile, the prospects for renewable energy sources have been dampened by the decrease in oil prices and the improved outlook for oil and natural gas consumption, discussed earlier.

The consumption of energy derived from nuclear and other commercial sources by the market economies is projected to increase from an estimated level of 31 quadrillion Btu in 1986 to between 41 and 46 quadrillion Btu in 2000, or at an average annual growth rate of between 2.0 and 2.9 percent (Table 8). As a result, the share of total energy contributed by these sources is projected to increase from about 15 percent in 1986 to 16 percent in 2000. An in-depth look at the prospects, first, for nuclear power, and then for hydroelectric, geothermal, and other renewable energy sources follows.

Consumption of nuclear power by the market economies is projected to increase from an estimated level of 1,312 terawatt-hours (TWh) in 1986 to between 1,809 and 2,043 TWh in 2000, or at an average annual growth rate of between 2.3 and 3.2 percent (Table 12). The growth of consumption is expected to be much slower

after 1990 than in the four preceding years, however, reflecting the sharp drop in the growth rate of nuclear generating capacity (Appendix C). Thus, the growth rate of nuclear power consumption is projected to fall from 3.7 to 5.6 percent between 1986 and 1990 to 1.8 to 2.3 percent between 1990 and 2000. Nuclear power, which was estimated to account for less than 7 percent of total energy consumption in 1986, is projected to account for as much as 8 percent in 2000.

As was implied above, the projected growth rate of nuclear power consumption over the forecast period is largely determined by the growth of nuclear generating capacity, as determined by the commissioning of new commercial reactors and/or the decommissioning of existing reactors. This fact alone would suggest that the prospects for nuclear power consumption can best be discussed by looking at projections of nuclear generating capacity on a country-by-country basis (Appendix C). Another significant factor that argues for this approach is that France, which is currently estimated to be exporting roughly 30 net TWh of nuclear-generated electricity to other European nations, is projected to be exporting between 40 and 50 net TWh of nuclear-generated electricity by 2000. Estimates of French nuclear exports have been excluded from French nuclear power consumption in Table 12 and have been included in the consumption figures for traditional French customers, including the United Kingdom, West Germany, Italy, the Netherlands, and three countries, Belgium, Spain, and Switzerland, in the "Other Europe" region. Thus, the projections of nuclear consumption for these countries do not necessarily reflect the trends in their domestic nuclear power programs.

Earlier, it was stated that the prospects for nuclear energy suffered during 1987 as a result of increased public apprehension and political opposition in the wake of the 1986 nuclear reactor accident at Chernobyl. Most of this damage occurred in countries of the OECD Europe region, as discussed below.

- The most immediate damage occurred in Italy, where the government had already temporarily shut down the three existing commercial reactors by April 1987. After Italian voters approved three antinuclear power referenda in November, the government announced that the oldest existing reactor, at Latina, would be closed permanently. It also suspended construction on a planned two-reactor plant at Trino, the first of a series of 10 or 12 standardized units that were to have been built by 2000. Although the government indicated that the other two existing reactors could be restarted after further safety tests and that construction could continue on a partially-completed two-reactor plant at Montalto di Castro, it is still possible that Italy could have no operating commercial reactors for the rest of this century.
- In Switzerland, opponents of nuclear power collected sufficient signatures in 1987 to place two

Table 12. Consumption of Nuclear Energy in the Market Economies, 1985-2000 (Terawatthours)

Country/Region	History		Projections					
	1985 Actual	1986 Preliminary	1990		1995		2000	
			Base	Range	Base	Range	Base	Range
United States ^a	384	414	543	543-543	581	581-581	593	593-593
Canada	60	71	98	91-98	105	99-112	107	107-114
Japan	144	157	164	151-170	220	192-248	272	255-299
OECD Europe	554	600	702	636-714	766	710-784	819	737-878
United Kingdom	57	60	102	100-104	104	102-110	110	108-110
France	192	218	236	222-244	284	275-279	330	305-342
West Germany	122	115	146	112-147	149	123-150	151	129-154
Italy	14	15	14	8-15	18	14-30	25	10-28
Netherlands	6	6	6	6-6	6	6-6	6	6-12
Other Europe	163	188	198	189-199	206	192-209	197	179-232
Other OECD	0	0	0	0-0	0	0-0	0	0-0
Total OECD	1,141	1,242	1,507	1421-1525	1,672	1583-1725	1,790	1691-1883
OPEC	0	0	0	0-0	0	0-0	0	0-0
Other Developing Countries	62	70	100	95-105	110	103-127	132	118-161
Total Market Economies	1,203	1,312	1,607	1515-1630	1,782	1685-1851	1,922	1809-2043

^a Geographic coverage is the 50 States and the District of Columbia. U.S. Territories are included in "Other OECD." United States 1986 amount is actual.

OECD=Organization for Economic Cooperation and Development.

OPEC=Organization of Petroleum Exporting Countries.

Notes: ●All uncertainty ranges are derived independently and do not necessarily equal totals. ●Totals may not equal sum of components because of independent rounding.

Sources: ●History: Energy Information Administration, *International Energy Annual 1986*, DOE/EIA-0219(86) (Washington, DC, 1987); and *Monthly Energy Review*, DOE/EIA-0035(87/10) (Washington, DC, 1988), with adjustments for estimated French nuclear exports. ●Projections: Energy Information Administration, Office of Energy Markets and End Use.

antinuclear power referenda before Swiss voters. One calls for a 10-year moratorium on any new nuclear reactor construction and the other calls for a medium-term decommissioning of Switzerland's five existing nuclear power plants. It had been expected that final approval for a proposed nuclear plant at Kaiseraugst would be delayed at least until after a vote on the referendums, expected sometime in 1990, but recent indications are that the Kaiseraugst project is near cancellation.

- In Sweden, where a nonbinding 1980 referendum had recommended that the twelve existing nuclear power plants be phased out by 2010, the government is now reported to be planning to decommission the first two plants as early as 1996.
- In June 1987, contractors began the task of dismantling Austria's only commercial reactor, the completed but never commissioned plant near Zwentendorf. The plant had been sitting dormant for 9 years, the victim of a public referendum to close the facility.
- In both Finland and the Netherlands, the governments have decided to continue to delay any decision on new plant orders for a few years.
- In Belgium, the government has delayed a go-ahead decision on the country's eighth reactor, a proposed joint project with France. Recent indications are that Belgian voters are now opposed

to the new reactor and that it may not receive government approval.

Countries which currently have the most optimistic prospects for nuclear power are France and Japan in the OECD and South Korea in the developing-countries group. In each of these countries, the nuclear power program is the result of a strong government commitment to nuclear power, a lack of indigenous energy resources, and the selection of a standard nuclear plant design. There is, however, growing public opposition to nuclear power even in these three countries. It is related to concerns over safety in France and Japan and to concerns over future excess capacity in France and South Korea.

The high capital cost of nuclear plants and the continued scarcity of investment capital are expected to continue to be important factors limiting the prospects for nuclear power in the OPEC and "Other Developing Countries" regions. There are indications, however, that Indonesia and Egypt may place their first orders for nuclear reactors in the near future.

The consumption of energy derived from hydroelectric, geothermal, and other renewable sources by the market economies is projected to grow from an estimated 1,643 TWh in 1986 to between 2,049 and 2,263 TWh in 2000, or at an average annual growth rate of between 1.6 and 2.3 percent (Table 13). As a result, their share of total energy consumption, which was

estimated to account for about 8 percent of total energy consumption in 1986, is projected to not be significantly different in 2000.

The developing countries, consisting of both the "Other Developing Countries" group and the member nations of OPEC, are expected to account for between 43 and 50 percent of the projected increase in the consumption of energy derived from hydroelectric, geothermal, and other renewable sources by the market economies between 1986 and 2000. Most of this increase will be in the consumption of hydroelectric power, as developing countries, such as Argentina, Brazil, India, Pakistan, and Venezuela, continue to construct large and small dams to realize their large hydroelectric power potential. The developing countries are also expected to increase their use of geothermal, wind, wave, and waste power, as they attempt to maximize their usage of indigenous energy resources. In 1985, the last year for which complete data are available, the consumption of geothermal energy by the developing countries (specifically the Philippines, Mexico, El Salvador, Kenya, Nicaragua, and Indonesia) was over 8.5 TWh, an increase of 8.0 TWh from the level in 1975.

Countries in the "Other Europe" region are expected to account for between 21 and 23 percent of the projected increase in the consumption of energy derived

from hydroelectric, geothermal, and other renewable sources by the market economies between 1986 and 2000. Much of this increase will be in the consumption of hydroelectric power. Countries in the region are, however, becoming more interested in developing other renewable resources such as wind, wave, and solar power. The reasons for this are threefold. First, most of the hydroelectric power potential of the "Other Europe" region has been developed or has been set aside for environmental reasons. Second, countries such as Sweden and Switzerland, where the use of nuclear power will be or may be reduced, are studying the possibility of replacing part of this lost nuclear energy with energy from renewable sources. Finally, countries in the region which have limited reserves of traditional energy resources are attempting to develop indigenous renewable resources. A good example of this is Denmark, which has become the leading supplier of wind power equipment, and which, along with Iceland, has increased its utilization of geothermal power.

Japan, which also has limited reserves of oil, natural gas, and coal, is projected to increase its consumption of energy from renewable sources by between 46 and 58 percent from 1986 to 2000. Japan already has an impressive record in the development of its geothermal potential, having increased its consumption from about 0.4 TWh in 1975 to almost 1.5 TWh in 1985.

Table 13. Consumption of Other Energy Sources in the Market Economies, 1985-2000 (Terawatthours)

Country/Region	History		Projections					
	1985 Actual	1986 Preliminary	1990		1995		2000	
			Base	Range	Base	Range	Base	Range
United States ^a	345	352	369	369-369	381	381-381	397	397-397
Canada	261	272	276	269-279	290	279-298	301	288-308
Japan	83	79	92	87-96	114	106-115	120	115-125
OECD Europe	447	427	522	510-529	557	539-577	572	548-596
United Kingdom	7	7	6	6-10	7	7-10	7	7-10
France	64	64	69	67-69	71	67-77	73	67-77
West Germany	17	18	23	19-23	24	19-29	26	26-29
Italy	47	46	55	55-58	58	58-58	62	58-67
Netherlands	0	0	0	0-0	0	0-0	0	0-0
Other Europe	312	291	369	365-375	396	385-414	406	385-423
Other OECD	37	36	39	39-39	43	39-48	47	47-48
Total OECD	1,172	1,166	1,299	1273-1312	1,385	1342-1419	1,437	1395-1474
OPEC	36	37	43	39-48	57	48-58	71	58-77
Other Developing Countries	435	441	489	481-500	565	529-596	653	596-712
Total Market Economies	1,642	1,643	1,831	1792-1861	2,007	1919-2073	2,161	2049-2263

^a Geographic coverage is the 50 States and the District of Columbia. U.S. Territories are included in "Other OECD." United States 1986 amount is actual.

OECD=Organization for Economic Cooperation and Development.

OPEC=Organization of Petroleum Exporting Countries.

Notes: ●Other energy sources include hydroelectric, geothermal, wood, waste, wind, wave, photovoltaic, and solar sources connected to electric utility distribution systems. U.S. consumption includes imports of electricity. ●All uncertainty ranges are derived independently and do not necessarily equal totals. ●Totals may not equal sum of components because of independent rounding.

Sources: ●History: Energy Information Administration, *International Energy Annual 1986*, DOE/EIA-0219(86) and *Monthly Energy Review*, DOE/EIA-0035(87/09) (Washington, DC, 1987); ●Projections: Energy Information Administration, Office of Energy Markets and End Use.

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 structures 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 1986 *International Energy Outlook* based on a downward revision to world oil price

forecasts and other changes that have occurred in the interim. This chapter presents a comparison of the 1987 EIA base case given in this report with the 1986 *International Energy Outlook* base case and other widely used energy forecasts.

Comparison of EIA Projections

As indicated in Table 14, energy consumption in the market economies in 1995 is projected to be somewhat higher in the current forecast than in the 1986 *International Energy Outlook*. This is due to lower oil prices over the longer term than previously forecasted. Non-OPEC supplies are stronger than previously forecasted, while OPEC production is reduced. By 1995,

Table 14. Comparison of 1986 and 1987 EIA Energy and Oil Projections for the Market Economies: Base Case, 1995

Projection	International Energy Outlook	
	1986	1987
Energy Consumption (quadrillion Btu)		
United States ^a	83.1	85.0
Japan	18.7	18.7
OECD Europe	62.8	64.9
Other Countries	80.2	82.3
Total	244.8	250.9
Petroleum Consumption (million barrels per day)		
United States ^a	16.5	17.7
Japan	4.6	4.5
OECD Europe	12.6	12.7
Other Countries	16.7	17.9
Total	50.4	52.8
Stock Change and Discrepancy	0.1	-0.3
Petroleum Supply (million barrels per day)		
OPEC	26.4	26.1
United States	8.3	8.8
Other Non-OPEC	14.9	16.2
Total Production	49.6	51.1
Net Imports from CPE	0.9	1.4
Total Available Supply	50.5	52.5

^a Geographic coverage is the 50 States and the District of Columbia. U.S. Territories are included in "Other Countries."

CPE=Centrally Planned Economies.

OECD=Organization for Economic Cooperation and Development.

OPEC=Organization of Petroleum Exporting Countries.

Note: Totals may not equal sum of components because of independent rounding.

Source: Energy Information Administration, *International Energy Outlook 1986*, DOE/EIA-0484(86) (Washington, DC, 1987).

OPEC production is reduced by 0.3 million barrels a day while non-OPEC production is increased by about 1.8 million barrels a day between the 1986 and 1987 reports.

Comparison of Alternative Projections

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 generally only base-case estimates are shown, it is recognized that considerable uncertainty surrounds these point estimates. Varying expectations for economic growth, particularly after the stock market plunge of October 1987, may play a significant role in determining long-term energy demand. EIA estimates of total energy consumption are higher than other forecasts until the year 2000, when Chevron has the highest total energy forecast (Table 15). In general, the estimates include refinery processing gains. The alternative projections are generally consistent. Namely, the projections assume that energy/GDP growth ratios will continue to decline over time and that oil consumption as a share of total energy consumption will also continue to decline.

Table 15. Comparison of Energy Projections for the Market Economies, 1990, 1995, and 2000
(Million Barrels per Day of Oil Equivalent)

Projection	Consumption				Petroleum Production	
	Energy	Oil	Growth Rate ^a		OPEC	Other
			Energy	Oil		
1985 EIA Estimate	100.8	46.7	NA	NA	17.4	26.8
1990 Projections (1985 to 1990)						
EIA IEO 1987	111.6	50.3	+2.1	+1.5	21.2	26.9
Ashland (August 1986)	104.2	49.8	+1.2	+1.8	22.8-25.3	23-25
Chevron (July 1987)	109.2	48.3	+1.7	+1.1	19.8	25.0
Conoco (Sept. 1986)	107.0	49.0	+2.2	+2.0	NA	NA
DRI Winter 1987-1988	NA	49.6	NA	+1.6	21.7	25.1
1995 Projections (1990 to 1995)						
EIA IEO 1987	122.3	52.8	+1.8	+1.0	26.1	25.0
Ashland (August 1986)	114.0	52.8	+1.8	+1.2	28.3-30.8	21-23
Chevron (July 1987)	120.7	50.7	+2.0	+1.0	23.2	24.1
DRI Winter 1987-1988	NA	52.7	NA	+1.2	26.4	24.4
2000 Projections (1990 to 2000)						
EIA IEO 1987	131.5	53.4	+1.7	+0.6	27.8	24.3
Ashland (August 1986)	125.9	52.6	+1.9	+0.5	28.1-32.6	19-23
Chevron (July 1987)	132.1	52.8	+1.9	+0.9	27.6	22.3
Conoco (Sept. 1986)	125.0	53.0	+1.6	+0.8	28.0	^b 18.5
DRI Winter 1987-1988	NA	55.0	NA	+1.0	30.0	24.2

^a 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.

^b Excludes refinery processing gain of approximately 1.0 and natural gas liquids of 4.0-5.0 million barrels per day (including OPEC).

NA=Not available.

OPEC=Organization of Petroleum Exporting Countries.

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

Sources: ●Ashland: *World Energy Outlook Through 1995* Ashland, KY, 1986). ●Conoco: *World Energy Outlook Through 2000*; (Wilmington, DE, 1986). Data Resources, Inc.: *International Energy Bulletin* (Lexington, MA, 1987). ●Energy Information Administration: *International Energy Outlook 1987*, DOE/EIA-0484(87) (Washington, DC, 1988). ●Chevron Corp.: *World Energy Outlook* (San Francisco, CA, 1987).

Appendix A

International Petroleum Balance

Appendix A

International Petroleum Balance

Table A1. Oil Consumption and Production in the Market Economies: Base Case, 1979-2000
(Million Barrels per Day)

Supply and Disposition	History								Projections					
	1979	1980	1981	1982	1983	1984	1985	1986	Preliminary 1987	1988	1989	1990	1995	2000
Consumption														
United States ^a	18.5	17.1	16.1	15.3	15.2	15.7	15.7	16.3	16.5	16.7	17.0	17.1	17.7	18.3
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	1.7	1.6
Japan	5.5	5.0	4.8	4.5	4.4	4.6	4.3	4.4	4.4	4.4	4.4	4.5	4.5	4.4
OECD Europe	14.7	13.6	12.5	12.1	11.8	11.8	11.6	12.0	12.0	12.1	12.2	12.4	12.7	12.0
Other OECD ^b	1.1	1.1	1.1	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Total OECD	41.6	38.6	36.3	34.5	33.8	34.6	34.2	35.1	35.4	35.8	36.2	36.5	37.6	37.3
OPEC	2.4	2.7	3.1	3.3	3.3	3.4	3.6	3.6	3.6	3.6	3.7	3.7	4.1	4.5
Other Countries	8.0	8.3	8.4	8.5	8.4	8.7	8.9	9.2	9.4	9.7	10.0	10.2	11.1	11.6
Total Consumption	52.1	49.6	47.8	46.3	45.6	46.6	46.7	48.0	48.5	49.1	49.9	50.3	52.8	53.4
Production														
United States ^a	10.7	10.8	10.7	10.8	10.8	11.1	11.2	10.9	10.6	10.5	10.3	9.9	8.8	8.4
Canada	1.9	1.8	1.6	1.6	1.7	1.8	1.8	1.8	1.9	1.8	1.7	1.7	1.6	1.7
OECD Europe	2.6	2.8	3.0	3.3	3.8	4.1	4.3	4.5	4.5	4.7	4.8	4.8	4.3	4.1
OPEC	31.8	27.8	23.7	19.9	18.6	18.7	17.4	19.7	19.3	19.6	20.4	21.2	26.1	27.8
Other Countries	5.8	6.4	7.0	7.7	8.1	8.9	9.5	9.5	9.7	10.1	10.4	10.7	10.4	10.1
Total Production	52.7	49.6	46.1	43.4	43.0	44.6	44.2	46.4	46.0	46.7	47.6	48.1	51.1	52.1
Net CPE Exports	1.1	1.2	1.5	1.7	1.8	2.1	2.0	2.1	2.2	2.1	2.0	1.9	1.4	1.0
Stock Withdrawals and Discrepancies	-1.7	-1.2	0.3	1.2	0.7	-0.1	0.5	-0.5	0.2	0.3	0.3	0.3	0.3	0.3

^a Geographic coverage is the 50 States and the District of Columbia.

^b 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: ●Production includes crude oil, natural gas liquids, refinery gains, hydrogen, and other hydrocarbons. ●Totals may not equal sum of components because of independent rounding.

Sources: ●History: Energy Information Administration, *International Energy Annual 1986*, DOE/EIA-0219(86) and *Monthly Energy Review*, DOE/EIA-0035(87/09) (Washington, DC, 1987); Organization for Economic Cooperation and Development/International Energy Agency, *Quarterly Oil Statistics Fourth Quarter 1986* (Paris, France, 1987); Petroleum Economics Limited, *Quarterly Supply/Demand Outlook* (London, England, 1987). ●Projections: Energy Information Administration, Office of Energy Markets and End Use.

Appendix B

OECD Members Energy Demand by Sector

Appendix B

OECD Members Energy Demand by Sector

**Table B1. Consumption by Major Fuels and End-Use Sectors:
United States
(Quadrillion Btu)**

Sector and Fuel	1985	1990		1995		2000	
		Base	Range	Base	Range	Base	Range
Industrial							
Petroleum	7.7	8.6	8.2-9.0	9.1	8.4-9.6	9.4	8.5-10.0
Natural Gas	7.1	7.5	7.4-7.7	7.8	7.6-8.1	7.7	7.2-8.1
Coal	2.8	2.7	2.6-2.8	2.7	2.6-2.8	2.8	2.7-2.9
Electricity	9.5	10.0	9.8-10.2	11.6	11.1-12.0	13.9	13.0-14.6
Total	27.1	28.9	28.1-29.7	31.3	29.7-32.5	33.8	31.4-35.6
Transportation							
Petroleum	19.6	21.1	20.7-21.8	21.4	20.5-22.2	21.7	20.3-22.8
Natural Gas	0.5	0.5	0.5-0.5	0.6	0.6-0.6	0.6	0.6-0.6
Coal	0.0	0.0	0.0-0.0	0.0	0.0-0.0	0.0	0.0-0.0
Electricity	0.0	0.0	0.0-0.1	0.1	0.0-0.1	0.1	0.0-0.1
Total	20.1	21.7	21.3-22.3	22.0	21.1-22.8	22.3	20.9-23.4
Residential/Commercial							
Petroleum	2.6	2.6	2.6-2.7	2.6	2.5-2.6	2.4	2.3-2.5
Natural Gas	7.1	7.1	7.1-7.1	7.2	7.2-7.3	7.2	7.0-7.3
Coal	0.2	0.2	0.2-0.2	0.2	0.2-0.2	0.2	0.2-0.2
Electricity	16.9	19.5	19.4-19.5	21.8	21.7-21.9	23.6	23.5-23.8
Total	26.8	29.4	29.3-29.5	31.7	31.5-32.0	33.4	33.0-33.7
Electric Utilities							
Petroleum	1.1	1.3	1.0-2.0	2.1	1.4-2.9	2.8	1.9-3.4
Natural Gas	3.2	2.6	2.2-2.8	3.3	2.9-3.6	4.8	4.5-5.2
Coal	14.5	16.0	15.9-16.0	17.9	17.7-18.0	19.6	19.0-20.2
Nuclear/Other ^a	7.7	9.7	9.7-9.7	10.2	10.2-10.2	10.5	10.5-10.5
Total	26.5	29.5	29.3-29.8	33.5	32.8-33.9	37.6	36.6-38.5
Primary Energy Consumption							
Petroleum	30.9	33.7	32.5-35.5	35.1	32.7-37.2	36.3	33.0-38.7
Natural Gas	17.8	17.8	17.5-17.8	18.9	18.8-18.9	20.2	20.1-20.4
Coal	17.5	18.8	18.7-18.9	20.8	20.5-21.0	22.6	21.8-23.2
Nuclear/Other ^a	7.7	9.7	9.7-9.7	10.2	10.2-10.2	10.5	10.5-10.5
Total	73.9	79.9	78.7-81.6	85.0	82.4-87.2	89.6	85.3-92.8

^a Includes hydroelectric, geothermal, and other renewables.

Notes: ●Geographic coverage is the 50 States and the District of Columbia. ●All uncertainty ranges are derived independently and do not necessarily equal totals. ●Totals may not equal sum of components because of independent rounding.

Sources: ●History: Energy Information Administration, *Monthly Energy Review*, DOE/EIA-0035(87-11) (Washington, DC, 1988). ●Projections: Energy Information Administration, Office of Energy Markets and End Use.

Table B2. Consumption by Major Fuels and End-Use Sectors: Canada
(Quadrillion Btu)

Sector and Fuel	Estimate 1985	1990		1995		2000	
		Base	Range	Base	Range	Base	Range
Industrial							
Petroleum	1.0	1.0	1.0-1.1	1.1	1.0-1.2	1.0	0.9-1.1
Natural Gas	1.1	1.2	1.1-1.3	1.2	1.0-1.3	1.3	1.1-1.4
Coal	0.3	0.4	0.3-0.4	0.4	0.4-0.4	0.3	0.3-0.3
Electricity	2.1	2.4	2.3-2.4	2.6	2.5-2.7	2.9	2.7-3.1
Total	4.5	4.9	4.9-5.0	5.3	5.1-5.4	5.5	5.3-5.7
Transportation							
Petroleum	1.6	1.7	1.7-1.8	1.8	1.6-1.9	1.7	1.5-1.9
Natural Gas	0.0	0.0	0.0-0.0	0.0	0.0-0.0	0.0	0.0-0.0
Coal	0.0	0.0	0.0-0.0	0.0	0.0-0.0	0.0	0.0-0.0
Electricity	0.0	0.0	0.0-0.0	0.0	0.0-0.0	0.0	0.0-0.0
Total	1.6	1.7	1.7-1.8	1.8	1.7-1.9	1.7	1.6- 1.9
Residential/Commercial							
Petroleum	0.4	0.4	0.4-0.4	0.5	0.4-0.5	0.4	0.4-0.5
Natural Gas	0.9	0.9	0.8-0.9	0.9	0.8-1.0	1.0	0.9-1.1
Coal	0.0	0.0	0.0-0.0	0.0	0.0-0.0	0.0	0.0-0.0
Electricity	2.3	2.6	2.6-2.7	2.9	2.8-3.0	3.2	3.0-3.4
Total	3.6	3.9	3.9-4.0	4.3	4.2-4.4	4.7	4.5-4.8
Electric Utilities							
Petroleum	0.1	0.1	0.1-0.1	0.1	0.1-0.1	0.1	0.1-0.1
Natural Gas	0.1	0.1	0.1-0.1	0.4	0.3-0.4	0.5	0.4-0.6
Coal	0.8	0.8	0.7-0.8	0.8	0.8-0.9	1.2	1.0-1.3
Nuclear/Other ^a	3.4	4.0	3.9-4.0	4.2	4.0-4.4	4.4	4.2-4.5
Total	4.4	5.0	5.1-5.1	5.5	5.3-5.7	6.1	5.7-6.5
Primary Energy Consumption							
Petroleum	3.1	3.2	3.1-3.4	3.4	3.1-3.7	3.3	2.8-3.6
Natural Gas	2.1	2.2	2.1-2.3	2.5	2.2-2.7	2.8	2.5-3.1
Coal	1.1	1.2	1.1-1.2	1.3	1.2-1.3	1.5	1.3-1.6
Nuclear/Other ^a	3.4	4.0	3.9-4.0	4.2	4.0-4.4	4.4	4.2-4.5
Total	9.7	10.6	10.5-10.8	11.4	11.1-11.7	11.9	11.4-12.3

^a Includes hydroelectric, geothermal, and other renewables.

Notes: ●All uncertainty ranges are derived independently and do not necessarily equal totals. ●Totals may not equal sum of components because of independent rounding.

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

Table B3. Consumption by Major Fuels and End-Use Sectors: Japan
(Quadrillion Btu)

Sector and Fuel	Estimate 1985	1990		1995		2000	
		Base	Range	Base	Range	Base	Range
Industrial							
Petroleum	3.9	3.1	3.1-3.3	3.3	3.0-3.6	3.2	2.8-3.6
Natural Gas	0.0	0.0	0.0-0.0	0.0	0.0-0.0	0.0	0.0-0.0
Coal	2.1	2.5	2.3-2.6	2.5	2.1-2.8	2.5	2.1-2.9
Electricity	3.8	4.3	4.2-4.4	5.0	4.8-5.2	5.8	5.5-6.1
Total	9.8	9.9	9.8-10.1	10.8	10.5-11.1	11.6	11.1-12.0
Transportation							
Petroleum	2.3	2.5	2.4-2.7	2.7	2.5-3.0	2.6	2.3-2.9
Natural Gas	0.0	0.0	0.0-0.0	0.0	0.0-0.0	0.0	0.0-0.0
Coal	0.0	0.0	0.0-0.0	0.0	0.0-0.0	0.0	0.0-0.0
Electricity	0.0	0.0	0.0-0.0	0.0	0.0-0.0	0.0	0.0-0.0
Total	2.3	2.5	2.5-2.7	2.7	2.6-3.0	2.6	2.5-2.9
Residential/Commercial							
Petroleum	0.9	1.3	1.3-1.4	1.5	1.4-1.6	1.5	1.4-1.7
Natural Gas	0.3	0.7	0.6-0.7	0.8	0.6-0.9	0.7	0.6-0.8
Coal	0.0	0.0	0.0-0.0	0.0	0.0-0.0	0.0	0.0-0.0
Electricity	2.3	2.6	2.5-2.6	3.0	2.9-3.1	3.5	3.3-3.7
Total	3.5	4.6	4.5-4.7	5.2	5.1-5.4	5.7	5.5-5.9
Electric Utilities							
Petroleum	1.7	2.0	2.0-2.1	1.7	1.6-1.9	1.6	1.4-1.8
Natural Gas	1.1	1.2	1.1-1.3	1.4	1.2-1.6	1.7	1.4-2.0
Coal	0.9	1.0	0.9-1.0	1.3	1.1-1.5	1.9	1.6-2.1
Nuclear/Other ^a	2.4	2.7	2.5-2.8	3.5	3.2-3.9	4.1	3.9-4.5
Total	6.1	6.9	6.7-7.0	8.0	7.7-8.3	9.3	8.8-9.8
Primary Energy Consumption							
Petroleum	8.8	9.0	8.8-9.5	9.1	8.4-10.1	8.9	7.8-10.1
Natural Gas	1.4	1.9	1.7-2.0	2.2	1.8-2.5	2.4	2.0-2.8
Coal	3.0	3.4	3.2-3.6	3.9	3.3-4.3	4.4	3.7-5.1
Nuclear/Other ^a	2.4	2.7	2.5-2.8	3.5	3.2-3.9	4.1	3.9-4.5
Total	15.6	17.1	16.8-17.4	18.7	18.2-19.2	19.8	19.1-20.6

^a Includes hydroelectric, geothermal, and other renewables.

Notes: ¶All uncertainty ranges are derived independently and do not necessarily equal totals. ●Totals may not equal sum of components because of independent rounding.

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

**Table B4. Consumption by Major Fuels and End-Use Sectors:
OECD Europe
(Quadrillion Btu)**

Sector and Fuel	Estimate 1985	1990		1995		2000	
		Base	Range	Base	Range	Base	Range
Industrial							
Petroleum	8.6	7.9	7.6-8.3	8.2	7.6-9.1	7.5	6.6-8.5
Natural Gas	3.8	4.1	3.7-4.4	4.1	3.5-4.6	5.1	4.3-5.8
Coal	3.7	4.4	4.2-4.5	4.6	4.2-4.8	4.2	3.9-4.5
Electricity	7.8	11.5	11.3-11.7	13.0	12.8-13.2	14.5	14.2-14.8
Total	23.9	27.9	27.5-28.5	29.8	29.0-31.1	31.4	30.2-32.8
Transportation							
Petroleum	9.0	10.7	10.3-11.3	10.9	10.1-12.0	10.3	9.1-11.7
Natural Gas	0.0	0.0	0.0-0.0	0.0	0.0-0.0	0.0	0.0-0.0
Coal	0.0	0.0	0.0-0.0	0.0	0.0-0.0	0.0	0.0-0.0
Electricity	0.6	0.5	0.5-0.5	0.6	0.6-0.6	0.7	0.7-0.7
Total	9.6	11.2	11.0-11.4	11.4	11.1-11.9	11.0	10.6-11.5
Residential/Commercial							
Petroleum	4.6	4.9	4.7-5.2	5.1	4.7-5.6	5.0	4.4-5.7
Natural Gas	3.7	3.8	3.5-4.1	5.0	4.2-5.6	5.8	4.9-6.7
Coal	0.9	1.1	1.1-1.1	1.0	0.9-1.0	0.8	0.8-0.9
Electricity	11.9	11.1	10.9-11.3	12.6	12.4-12.8	14.3	14.0-14.6
Total	21.1	20.9	20.7-21.4	23.7	23.0-24.6	25.9	24.9-27.1
Electric Utilities							
Petroleum	1.8	2.1	2.0-2.2	2.1	1.9-2.3	1.9	1.7-2.2
Natural Gas	1.1	1.8	1.7-1.9	2.6	2.2-2.9	3.3	2.8-3.8
Coal	6.9	6.4	6.1-6.5	7.6	7.0-7.9	9.7	9.0-10.4
Nuclear/Other ^a	10.5	12.8	12.1-13.1	13.9	13.3-14.3	14.6	13.5-15.5
Total	20.3	23.1	22.7-23.6	26.2	25.7-26.7	29.5	28.9-30.1
Primary Energy Consumption							
Petroleum	24.0	25.6	24.7-27.0	26.3	24.3-29.0	24.8	21.9-28.1
Natural Gas	8.6	9.8	8.9-10.4	11.7	9.9-13.1	14.2	12.0-16.3
Coal	11.5	11.9	11.4-12.1	13.1	12.2-13.8	14.7	13.6-15.8
Nuclear/Other ^a	10.5	12.8	12.1-13.1	13.9	13.3-14.3	14.6	13.5-15.5
Total	54.6	60.0	59.2-61.2	64.9	63.1-67.6	68.3	65.7-71.5

^a Includes hydroelectric, geothermal, and other renewables.

OECD=Organization for Economic Cooperation and Development.

Notes: ●All uncertainty ranges are derived independently and do not necessarily equal totals. ●Totals may not equal sum of components because of independent rounding.

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

**Table B5. Consumption by Major Fuels and End-Use Sectors:
Other OECD
(Quadrillion Btu)**

Sector and Fuel	Estimate 1985	1990		1995		2000	
		Base	Range	Base	Range	Base	Range
Industrial							
Petroleum	0.4	0.5	0.5-0.5	0.4	0.4-0.4	0.4	0.4-0.4
Natural Gas	0.7	0.7	0.7-0.7	0.9	0.8-0.9	1.0	0.9-1.1
Coal	0.1	0.3	0.3-0.3	0.3	0.3-0.3	0.2	0.2-0.2
Electricity	0.7	0.8	0.8-0.8	0.9	0.9-0.9	1.0	0.9-1.0
Total	1.9	2.3	2.2-2.3	2.5	2.4-2.6	2.7	2.5-2.7
Transportation							
Petroleum	1.3	1.2	1.2-1.3	1.3	1.2-1.3	1.3	1.2-1.3
Natural Gas	0.0	0.0	0.0-0.0	0.0	0.0-0.0	0.0	0.0-0.0
Coal	0.0	0.0	0.0-0.0	0.0	0.0-0.0	0.0	0.0-0.0
Electricity	0.0	0.0	0.0-0.0	0.0	0.0-0.0	0.0	0.0-0.0
Total	1.3	1.2	1.2-1.3	1.3	1.3-1.3	1.3	1.3-1.4
Residential/Commercial							
Petroleum	0.0	0.0	0.0-0.0	0.0	0.0-0.0	0.0	0.0-0.0
Natural Gas	0.0	0.0	0.0-0.0	0.0	0.0-0.0	0.0	0.0-0.0
Coal	0.0	0.0	0.0-0.0	0.0	0.0-0.0	0.0	0.0-0.0
Electricity	0.9	1.0	1.0-1.0	1.1	1.1-1.2	1.3	1.2-1.3
Total	0.9	1.0	1.0-1.0	1.1	1.1-1.2	1.3	1.2-1.3
Electric Utilities							
Petroleum	0.3	0.3	0.3-0.3	0.3	0.3-0.3	0.3	0.3-0.3
Natural Gas	0.0	0.0	0.0-0.0	0.0	0.0-0.0	0.0	0.0-0.0
Coal	0.9	1.1	1.0-1.1	1.3	1.2-1.3	1.4	1.4-1.5
Nuclear/Other ^a	0.4	0.4	0.4-0.4	0.4	0.4-0.5	0.5	0.5-0.5
Total	1.6	1.8	1.8-1.8	2.0	2.0-2.1	2.3	2.1-2.3
Primary Energy Consumption							
Petroleum	2.0	2.0	1.9-2.1	2.1	1.9-2.1	2.1	1.9-2.1
Natural Gas	0.7	0.7	0.7-0.7	0.9	0.8-0.9	1.0	0.9-1.1
Coal	1.0	1.4	1.3-1.4	1.6	1.5-1.6	1.7	1.6-1.8
Nuclear/Other ^a	0.4	0.4	0.4-0.4	0.4	0.4-0.5	0.5	0.5-0.5
Total	4.1	4.5	4.4-4.6	4.9	4.8-5.1	5.2	5.0-5.5

^a Includes hydroelectric, geothermal, and other renewables.

OECD=Organization for Economic Cooperation and Development.

Notes: ●"Other OECD" includes Australia, New Zealand, and the U.S. Territories. ○All uncertainty ranges are derived independently and do not necessarily equal totals. ●Totals may not equal sum of components because of independent rounding.

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

**Table B6. Consumption by Major Fuels and End-Use Sectors:
Total OECD
(Quadrillion Btu)**

Sector and Fuel	Estimate 1985	1990		1995		2000	
		Base	Range	Base	Range	Base	Range
Industrial							
Petroleum	21.6	21.2	20.4-22.2	22.1	20.5-23.8	21.6	19.3-23.7
Natural Gas	12.7	13.5	12.9-13.9	14.0	13.0-14.8	15.0	13.9-16.3
Coal	9.0	10.3	10.0-10.4	10.6	10.0-10.9	10.1	9.4-10.6
Electricity	23.9	28.9	28.8-29.1	33.1	32.6-33.7	38.1	37.6-38.6
Total	67.2	73.9	72.8-75.4	79.7	77.4-82.2	84.8	81.2-88.2
Transportation							
Petroleum	33.8	37.3	36.0-39.1	38.0	35.3-40.9	37.6	33.6-41.3
Natural Gas	0.5	0.5	0.5-0.5	0.6	0.5-0.6	0.6	0.6-0.7
Coal	0.0	0.0	0.0-0.0	0.0	0.0-0.0	0.0	0.0-0.0
Electricity	0.6	0.5	0.5-0.5	0.6	0.6-0.6	0.8	0.8-0.8
Total	34.9	38.4	37.8-39.2	39.2	38.0-40.4	38.9	37.3-40.5
Residential/Commercial							
Petroleum	8.5	9.3	9.0- 9.7	9.6	8.9-10.3	9.4	8.4-10.3
Natural Gas	12.0	12.5	11.9-12.8	13.9	12.9-14.7	14.7	13.6-15.9
Coal	1.1	1.3	1.2-1.3	1.1	1.1-1.2	1.0	0.9-1.0
Electricity	34.3	36.8	36.7-36.9	41.4	40.9-41.9	45.9	45.5-46.3
Total	55.9	59.8	59.0-61.0	66.0	64.1-68.1	71.0	68.0-73.8
Electric Utilities							
Petroleum	5.0	5.8	5.6-6.0	6.3	5.8-6.7	6.7	6.0-7.4
Natural Gas	5.5	5.8	5.5-5.9	7.7	7.1-8.1	10.3	9.5-11.1
Coal	24.0	25.1	24.4-25.4	28.9	27.5-29.9	33.8	31.7-35.6
Nuclear/Other ^a	24.4	29.7	28.7-30.1	32.3	31.1-33.4	34.1	33.0-36.0
Total	58.9	66.3	66.0-66.5	75.1	74.1-76.2	84.8	83.9-85.7
Primary Energy Consumption							
Petroleum	68.8	73.5	70.9-77.1	76.0	70.4-81.7	75.3	67.4-82.8
Natural Gas	30.6	32.4	30.9-33.3	36.1	33.5-38.2	40.6	37.4-43.9
Coal	34.1	36.7	35.6-37.1	40.6	38.6-42.0	44.9	42.1-47.4
Nuclear/Other ^a	24.4	29.7	28.7-30.1	32.3	31.1-33.4	34.1	33.0-36.0
Total	157.9	172.1	169.6-175.6	184.9	179.5-190.8	194.9	186.6-202.7

^a Includes hydroelectric, geothermal, and other renewables.

OECD=Organization for Economic Cooperation and Development.

Notes: ●All uncertainty ranges are derived independently and do not necessarily equal totals. ●Totals may not equal sum of components because of independent rounding.

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

Appendix C

Operable Nuclear Capacities in the Market Economies

Appendix C

Operable Nuclear Capacities in the Market Economies

Table C1. Operable Nuclear Capacities in the Market Economies, 1986-2000
(Net Gigawatts-Electric)

Country	1986 ^a	1990		1995		2000	
		Base	Range	Base	Range	Base	Range
United States ^b	85.3	103.9	103.9-103.9	105.5	105.5-105.5	106.5	106.5-106.5
Canada	11.0	13.6	12.7-13.6	14.5	13.6-15.4	15.4	15.4-16.2
Japan	24.8	29.3	26.9-30.4	36.9	32.3-41.6	45.0	42.1-49.4
OECD Europe	101.9	120.6	113.2-123.1	131.7	125.7-134.7	138.6	127.7-147.7
United Kingdom	11.7	14.5	14.5-14.5	14.5	14.5-15.6	15.6	15.6-15.6
France	44.9	53.4	49.6-55.9	62.5	59.9-62.5	67.5	62.5-70.6
West Germany	17.4	23.0	21.5-23.0	23.0	22.7-23.0	23.0	22.7-23.0
Italy	1.3	1.2	0.0-1.2	1.2	0.0-3.1	3.1	0.0-3.1
Netherlands	0.5	0.5	0.5-0.5	0.5	0.5-0.5	0.5	0.5-1.5
Other Europe	26.1	28.0	27.1-28.0	30.0	28.1-30.0	28.9	26.4-33.9
Belgium	5.5	5.5	5.5-5.5	5.5	5.5-5.5	5.5	5.5-6.8
Finland	2.3	2.3	2.3-2.3	2.3	2.3-2.3	3.0	2.3-3.0
Spain	5.7	7.6	6.7-7.6	9.6	7.7-9.6	9.6	9.6-10.5
Sweden	9.7	9.7	9.7-9.7	9.7	9.7-9.7	7.9	7.1-9.0
Switzerland	2.9	2.9	2.9-2.9	2.9	2.9-2.9	2.9	1.9-3.9
Turkey	0.0	0.0	0.0-0.0	0.0	0.0-0.0	0.0	0.0-0.7
Other OECD	0.0	0.0	0.0-0.0	0.0	0.0-0.0	0.0	0.0-0.0
Total OECD	223.0	267.4	256.7-271.0	288.6	277.1-297.2	305.5	291.7-319.8
OPEC	0.0	0.0	0.0-0.0	0.0	0.0-0.0	0.0	0.0-0.7
Other Developing Countries	14.0	17.5	16.5-18.3	19.1	17.9-22.0	22.9	20.3-27.9
Argentina	0.9	0.9	0.9-0.9	0.9	0.9-1.6	1.6	0.9-1.6
Brazil	0.6	0.6	0.6-0.6	0.6	0.6-1.9	1.9	0.6-3.1
India	1.2	1.2	1.2-1.4	1.6	1.6-1.6	1.6	1.6-1.6
Mexico	0.0	0.7	0.7-0.7	1.3	0.7-1.3	1.3	1.3-1.3
Pakistan	0.1	0.1	0.1-0.1	0.1	0.1-0.1	0.1	0.1-0.1
Philippines	0.0	0.0	0.0-0.6	0.6	0.0-0.6	0.6	0.0-0.6
South Africa	1.8	1.8	1.8-1.8	1.8	1.8-1.8	1.8	1.8-3.7
South Korea	4.5	7.3	6.3-7.3	7.3	7.3-8.3	9.3	9.3-9.3
Taiwan	4.9	4.9	4.9-4.9	4.9	4.9-4.9	4.9	4.9-6.8
Total Market Economies	237.0	284.9	273.2-289.3	307.7	295.0-319.2	328.4	312.0-347.7

^a Status as of December 31, 1986.

^b Geographic coverage is the 50 States and the District of Columbia. U.S. territories are included in "Other OECD."

OECD=Organization for Economic Cooperation and Development.

OPEC=Organization of Petroleum Exporting Countries.

Notes: ●Totals may not equal sum of components because of independent rounding. ●All uncertainty ranges are derived independently and do not necessarily equal totals.

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

Appendix D

International Energy Production Data

Appendix D

International Energy Production Data

Table D1. International Production of Crude Oil, 1973-1986
(Million Barrels per Day)

Country	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Organization of Petroleum Exporting Countries														
Indonesia	1.34	1.38	1.31	1.50	1.69	1.64	1.59	1.58	1.61	1.34	1.34	1.41	1.33	1.39
Iran	5.86	6.02	5.35	5.88	5.66	5.24	3.17	1.66	1.38	2.21	2.44	2.17	2.25	1.88
Nigeria	2.05	2.26	1.78	2.07	2.09	1.90	2.30	2.06	1.43	1.30	1.24	1.39	1.50	1.47
Saudi Arabia ^a	7.60	8.48	7.08	8.58	9.25	8.30	9.53	9.90	9.82	6.48	5.09	4.66	3.39	5.05
Venezuela	3.37	2.98	2.35	2.29	2.24	2.17	2.36	2.17	2.10	1.90	1.80	1.80	1.68	1.79
Other OPEC	10.77	9.61	9.29	10.42	10.37	10.56	11.98	9.52	6.31	5.64	5.67	6.05	6.09	6.93
Total OPEC	30.99	30.73	27.16	30.74	31.30	29.81	30.93	26.89	22.65	18.87	17.58	17.48	16.24	18.51
Canada	1.80	1.55	1.43	1.31	1.32	1.32	1.50	1.44	1.29	1.27	1.36	1.44	1.47	1.47
China	1.09	1.32	1.49	1.67	1.87	2.08	2.12	2.11	2.01	2.05	2.12	2.30	2.51	2.61
Mexico	0.47	0.57	0.71	0.83	0.98	1.21	1.46	1.94	2.31	2.75	2.69	2.78	2.75	2.43
United Kingdom	(b)	(b)	0.01	0.25	0.77	1.08	1.57	1.62	1.81	2.07	2.29	2.48	2.53	2.55
United States	9.21	8.77	8.38	8.13	8.25	8.71	8.55	8.60	8.57	8.65	8.69	8.88	8.97	8.68
U.S.S.R.	8.33	8.86	9.47	9.99	10.49	10.95	11.19	11.46	11.55	11.62	11.68	11.58	11.25	11.62
Other Non-OPEC	3.69	3.84	4.12	4.30	4.55	4.72	5.04	5.17	5.36	5.64	6.24	6.92	7.57	7.88
Total World	55.57	55.64	52.76	57.21	59.52	59.87	62.36	59.23	55.55	52.90	52.66	53.85	53.28	55.74
Non-Communist World	45.69	45.00	41.32	45.07	46.68	46.37	48.60	45.23	41.55	38.79	38.39	39.52	39.07	41.06

^a Saudi Arabia includes one-half of the production in the Partitioned Zone (formerly Neutral Zone).

^b Less than 5,000 barrels per day.

Note: Amounts include lease condensate and exclude natural gas plant liquids.

Source: Energy Information Administration, *International Energy Annual*, DOE/EIA-0219, selected issues (Washington, DC).

Table D2. International Coal Production, 1973-1986
(Million Short Tons)

Region/Country	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
North, Central, and South America														
Canada	23	23	28	28	32	34	37	40	44	47	50	63	67	66
United States	599	610	655	685	697	670	781	830	824	838	782	896	884	890
Other	12	15	15	16	17	17	24	24	22	25	25	28	30	31
Total	634	648	697	729	746	721	842	894	890	910	857	987	981	987
Western Europe														
Germany, West	238	244	238	247	229	228	239	239	241	247	236	233	231	222
Spain	14	15	15	16	19	22	24	32	38	43	44	44	44	42
Turkey	12	11	12	11	13	15	22	18	19	24	32	38	43	48
United Kingdom	143	121	142	137	135	136	135	141	138	137	127	55	104	115
Yugoslavia	36	37	39	41	43	44	46	52	58	60	65	72	75	72
Other	65	60	63	66	67	64	63	61	67	66	67	68	73	72
Total	508	488	509	518	506	509	529	543	561	577	571	510	570	571
Eastern Europe and U.S.S.R.														
Bulgaria	30	27	31	28	28	28	31	33	32	35	36	36	34	39
Czechoslovakia	120	122	127	130	134	136	137	136	137	139	140	143	140	141
Germany, East	272	269	272	273	280	279	282	285	294	304	309	327	344	343
Poland	216	222	233	241	250	258	264	254	219	250	258	267	275	286
U.S.S.R.	736	755	773	784	796	798	792	790	776	792	789	785	798	825
Other	57	59	61	57	58	61	65	68	72	73	69	77	80	80
Total	1,431	1,454	1,494	1,513	1,546	1,560	1,751	1,566	1,529	1,593	1,601	1,635	1,671	1,714
Africa														
South Africa, Republic of	69	73	77	85	94	100	114	127	144	151	161	179	192	196
Other	6	5	6	6	6	6	7	6	5	6	6	5	6	6
Total	75	78	82	91	100	106	121	133	149	157	167	184	198	202
Middle East, Far East, and Oceania														
Australia	94	94	98	109	111	114	119	116	130	140	146	153	186	210
China	520	548	570	586	606	681	698	684	683	734	788	870	931	959
India	89	96	109	116	115	116	118	125	142	148	158	168	173	184
Other	97	98	105	101	103	104	108	112	114	116	113	117	128	131
Total	800	836	882	912	935	1,015	1,043	1,037	1,069	1,138	1,205	1,308	1,418	1,484
World Total	3,447	3,505	3,665	3,763	3,833	3,911	4,105	4,173	4,198	4,375	4,402	4,623	4,839	4,959

Note: Totals may not equal sum of components because of independent rounding.

Sources: Energy Information Administration, *International Energy Annual*, DOE/EIA-0219 and *Monthly Energy Review*, DOE/EIA-0035, selected issues (Washington, DC).

Table D3. International Production of Natural Gas (Dry), 1973-1986
(Trillion Cubic Feet)

Region/Country	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
North, Central, and South America														
Argentina	0.24	0.26	0.27	0.27	0.28	0.28	0.26	0.28	0.35	0.40	0.44	0.49	0.50	0.50
Canada	2.45	2.42	2.45	2.46	2.59	2.47	2.66	2.65	2.47	2.45	2.52	2.61	2.98	2.96
Mexico	0.50	0.52	0.52	0.51	0.54	0.67	0.81	1.01	1.03	1.11	1.10	1.04	0.95	0.93
United States	21.73	20.71	19.24	19.10	19.16	19.12	19.66	19.40	19.18	17.76	16.03	17.39	16.38	15.99
Venezuela	0.40	0.42	0.42	0.40	0.39	0.40	0.46	0.49	0.52	0.60	0.58	0.61	0.62	0.67
Other	0.51	0.35	0.30	0.33	0.40	0.53	0.61	0.53	0.44	0.43	0.47	0.61	0.64	0.65
Total	25.83	24.68	23.19	23.07	23.36	23.48	24.46	24.36	23.99	22.75	21.14	22.75	22.07	21.70
Western Europe														
Germany, West	0.71	0.73	0.67	0.68	0.68	0.72	0.73	0.67	0.68	0.59	0.62	0.66	0.61	0.60
Italy	0.54	0.54	0.52	0.55	0.48	0.48	0.46	0.42	0.49	0.51	0.46	0.49	0.50	0.50
Netherlands	2.50	2.87	3.21	3.50	2.93	2.50	2.72	3.38	3.15	2.67	2.58	2.65	2.73	2.60
Norway	0.00	0.00	0.01	0.01	0.09	0.39	0.76	0.88	0.89	0.90	0.86	0.93	0.94	0.94
United Kingdom	1.00	1.21	2.16	1.32	1.38	1.30	1.31	1.23	1.22	1.36	1.40	1.42	1.52	1.57
Other	0.40	0.41	0.40	0.40	0.45	0.38	0.41	0.44	0.40	0.41	0.42	0.44	0.45	0.38
Total	5.15	5.76	6.07	6.46	6.01	5.77	6.39	7.02	6.83	6.44	6.34	6.59	6.75	6.59
Eastern Europe and U.S.S.R.														
Romania	0.93	0.96	1.04	1.14	1.20	1.07	1.20	1.20	1.24	1.35	1.40	1.34	1.27	1.35
U.S.S.R.	8.35	9.20	10.22	11.33	12.22	13.14	14.36	15.37	16.43	17.68	18.93	20.74	22.71	24.19
Other	0.68	0.70	0.69	0.80	0.83	0.89	0.76	0.77	0.82	0.76	0.85	0.94	0.98	0.97
Total	9.96	10.86	11.95	13.27	14.25	15.10	16.32	17.34	18.49	19.79	21.18	23.02	24.96	26.51
Middle East and Africa														
Algeria	0.17	0.20	0.21	0.28	0.21	0.66	0.55	0.41	0.77	0.94	1.31	1.36	1.36	1.27
Iran	0.52	0.57	0.57	0.58	0.55	0.50	0.54	0.25	0.21	0.25	0.31	0.48	0.60	0.54
Other	0.61	0.58	0.82	0.84	1.01	1.14	1.45	1.36	1.76	1.28	1.33	1.96	2.28	2.45
Total	1.30	1.35	1.60	1.70	1.77	2.30	2.54	2.02	2.74	2.47	2.95	3.80	4.24	4.26
Far East and Oceania														
Australia	0.14	0.17	0.18	0.21	0.24	0.26	0.28	0.32	0.38	0.38	0.39	0.40	0.45	0.45
Brunei	0.07	0.15	0.19	0.25	0.29	0.30	0.29	0.32	0.34	0.32	0.33	0.30	0.29	0.30
China	0.25	0.29	0.33	0.36	0.41	0.50	0.51	0.50	0.45	0.38	0.43	0.44	0.63	0.63
Indonesia	0.03	0.04	0.08	0.13	0.20	0.20	0.39	0.63	0.66	0.67	0.78	1.06	1.23	1.26
Pakistan	0.13	0.15	0.16	0.16	0.18	0.19	0.23	0.29	0.32	0.35	0.34	0.35	0.36	0.37
Other	0.30	0.29	0.33	0.37	0.41	0.39	0.31	0.32	0.42	0.57	0.69	0.95	1.19	1.21
Total	0.92	1.09	1.27	1.48	1.73	1.84	2.01	2.38	2.57	2.67	2.96	3.50	4.15	4.22
World Total	43.15	43.74	44.10	45.98	47.14	48.50	51.73	53.11	54.62	54.12	54.57	59.66	61.17	63.28

Note: Totals may not equal sum of components because of independent rounding.

Sources: Energy Information Administration, *International Energy Annual*, DOE/EIA-0219 and *Monthly Energy Review*, DOE/EIA-0035, selected issues (Washington, DC).

Table D4. International Hydroelectric Power Generation, 1973-1986
(Billion Kilowatthours)

Region/Country	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
North, Central, and South America														
Argentina	3	5	5	5	6	8	11	15	15	17	18	20	20	21
Brazil	58	66	74	82	94	103	115	127	130	140	150	165	177	180
Canada	193	211	202	213	220	234	243	251	263	255	263	283	301	308
Colombia	8	9	10	10	11	12	13	15	18	18	19	19	19	20
Mexico	16	17	15	17	19	16	18	17	25	23	21	24	26	27
United States	275	304	303	287	224	284	283	279	264	312	335	324	284	294
Venezuela	6	7	9	11	12	12	13	15	15	16	18	20	21	21
Other	17	19	20	21	21	23	25	28	29	37	37	39	41	40
Total	577	637	638	646	606	692	721	747	757	815	861	894	889	911
Western Europe														
Austria	19	22	24	20	25	25	28	29	31	31	30	29	31	32
Finland	10	13	12	9	12	10	11	10	13	13	13	13	12	12
France	48	57	60	49	76	69	67	69	73	71	71	67	64	64
Germany, West	15	18	17	14	17	18	18	21	20	19	19	18	17	18
Italy	39	39	42	41	53	47	48	49	45	44	44	45	44	44
Norway	72	76	77	81	72	80	88	83	92	92	105	105	102	96
Portugal	7	8	6	5	10	11	12	8	5	7	8	10	11	8
Spain	29	31	26	22	40	41	47	31	23	28	29	33	33	27
Sweden	59	57	57	54	53	57	60	59	60	55	64	67	70	60
Switzerland	29	29	34	27	36	33	32	34	36	37	36	31	32	34
Yugoslavia	16	21	19	20	24	25	26	28	25	23	22	25	24	27
Other	14	15	17	19	20	22	24	25	26	29	25	30	28	29
Total	358	384	391	362	437	436	461	444	450	449	466	473	468	451
Eastern Europe and U.S.S.R.														
Romania	8	8	9	8	9	11	11	13	13	12	10	11	12	12
U.S.S.R.	121	131	125	134	146	168	170	182	185	173	179	201	204	211
Other	9	11	11	11	13	13	13	15	14	13	14	14	15	14
Total	137	150	145	154	168	191	195	210	212	198	203	226	231	237
Middle East and Africa														
Egypt	5	6	7	8	9	9	9	10	10	10	10	10	11	11
Zambia	5	6	6	7	9	8	9	9	10	10	10	10	10	10
Other	27	29	30	34	37	39	46	50	43	42	41	36	38	38
Total	37	40	43	49	54	56	64	68	63	62	61	56	59	59
Far East and Oceania														
Australia	12	14	15	15	14	15	16	17	15	14	13	13	15	15
China	38	43	45	51	47	44	50	58	65	74	86	86	92	92
India	29	28	33	35	38	47	45	46	49	48	49	53	57	58
Japan	71	84	85	88	76	74	84	91	90	83	87	73	81	78
Korea, North	12	14	16	17	17	19	20	22	23	25	26	27	28	29
New Zealand	14	14	17	15	14	16	15	16	19	18	19	20	20	20
Other	16	17	19	21	20	21	27	28	28	30	32	41	45	44
Total	191	213	230	241	226	236	257	278	289	292	312	313	338	336
World Total	1,301	1,425	1,445	1,450	1,491	1,611	1,698	1,747	1,771	1,816	1,903	1,961	1,984	1,995

Notes: ●Data include industrial and utility generation of hydroelectric power. ●Totals may not equal sum of components because of independent rounding.

Source: Energy Information Administration, *International Energy Annual*, DOE/EIA-0219, selected issues (Washington, DC).

**Table D5. International Net Nuclear Electric Power Production,
1973-1986**
(Billion Kilowatthours)

Region/Country	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
North America														
Canada	17.4	14.6	12.6	17.1	25.4	31.3	36.5	38.4	41.1	40.4	50.4	51.1	59.7	70.9
United States	83.5	114.0	172.5	191.1	250.9	276.4	255.2	251.1	272.7	282.8	293.7	327.6	383.7	414.0
Total	100.8	128.6	185.1	208.2	276.3	307.7	291.6	289.5	313.8	323.2	344.1	378.7	443.4	484.9
Central and South America														
Argentina	0.0	1.0	2.4	2.4	1.6	2.8	2.6	2.2	2.7	1.8	3.2	4.3	5.5	5.4
Brazil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	2.0	3.2	0.1
Total	0.0	1.0	2.4	2.4	1.6	2.8	2.6	2.2	2.7	1.8	3.4	6.3	8.7	5.6
Western Europe														
Belgium	0.0	0.1	6.4	9.5	11.3	11.9	10.8	11.9	12.2	14.8	22.8	26.3	32.8	36.7
Finland	0.0	0.0	0.0	0.0	2.5	3.1	6.3	6.6	13.7	15.7	16.6	17.6	17.8	17.8
France	11.0	14.0	17.4	14.8	17.0	29.0	37.9	58.2	100.0	103.4	137.0	181.6	212.8	241.6
Germany, West	11.3	11.4	20.6	23.3	34.0	34.1	40.1	41.5	50.7	60.2	61.5	88.0	119.4	111.5
Italy	3.0	3.2	3.6	3.6	3.2	4.2	2.5	2.1	2.6	6.5	5.5	6.5	6.7	8.2
Netherlands	1.1	3.1	3.2	3.7	3.5	3.9	3.3	4.0	3.5	3.7	3.4	3.6	3.7	4.0
Spain	6.2	6.9	7.2	7.2	6.2	7.3	6.4	4.9	9.0	8.3	10.2	21.9	26.6	35.6
Sweden	2.0	1.6	11.4	15.2	18.9	22.6	20.0	25.4	35.8	36.8	38.5	48.7	55.7	66.5
Switzerland	5.9	6.7	7.3	7.5	7.7	7.9	11.3	13.6	14.4	14.2	14.8	15.5	21.3	21.3
United Kingdom	26.6	32.3	29.0	35.0	36.2	34.8	36.6	35.3	36.9	41.9	47.5	51.4	56.7	55.3
Yugoslavia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	2.4	3.7	4.2	3.8	3.8
Total	67.1	79.3	106.1	119.7	140.5	158.8	175.1	203.5	279.0	308.1	361.4	465.4	557.3	602.3
Eastern Europe and U.S.S.R														
Bulgaria	0.0	0.9	2.4	4.7	5.6	5.6	5.9	5.9	8.7	10.2	11.7	12.1	12.5	12.5
Czechoslovakia	0.2	0.5	0.2	0.4	0.1	0.1	1.8	4.3	4.5	5.5	5.8	6.9	11.2	11.8
Germany, East	0.3	2.1	2.6	5.0	4.9	6.3	9.3	11.3	11.3	10.3	11.6	11.2	12.1	12.3
Hungary	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	2.4	6.2	7.0
U.S.S.R.	11.1	17.1	19.2	23.8	32.3	42.5	52.1	69.3	64.6	76.0	104.3	134.9	161.5	167.0
Total	11.7	20.5	24.4	33.9	42.9	54.5	69.1	90.7	89.0	102.1	135.8	167.5	203.4	210.6
Middle East	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Africa														
South Africa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	5.5	8.9
Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	5.5	8.9
Far East and Oceania														
India	1.8	2.4	2.4	3.0	2.6	2.2	3.0	2.7	2.9	2.0	2.7	3.9	4.3	4.9
Japan	9.0	17.2	21.1	35.0	26.7	50.5	58.9	78.7	79.3	99.3	103.6	120.8	144.4	156.6
Korea, South	0.0	0.0	0.0	0.0	0.1	2.2	3.0	3.3	2.8	3.6	8.5	11.2	15.7	24.8
Pakistan	0.4	0.6	0.5	0.5	0.3	0.2	(*)	0.1	0.2	0.1	0.2	0.3	0.2	0.5
Taiwan	0.0	0.0	0.0	0.0	0.1	2.5	6.0	7.8	10.1	12.4	18.0	23.1	27.3	25.6
Total	11.2	20.1	24.0	38.5	29.8	57.6	71.0	92.6	95.3	117.4	133.1	159.3	191.9	212.4
World Total	190.8	249.5	341.9	402.8	491.2	581.3	609.4	678.5	779.8	852.6	977.7	1,181.2	1,410.2	1,524.6

* Denotes less than 50 million kilowatthours.

Notes: ●Figures are reported for net generation as opposed to gross. Net figures exclude the energy consumed by the generating plants. ●Totals may not equal sum of components because of independent rounding.

Source: Energy Information Administration, *International Energy Annual*, DOE/EIA-0219, selected issues (Washington, DC).

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