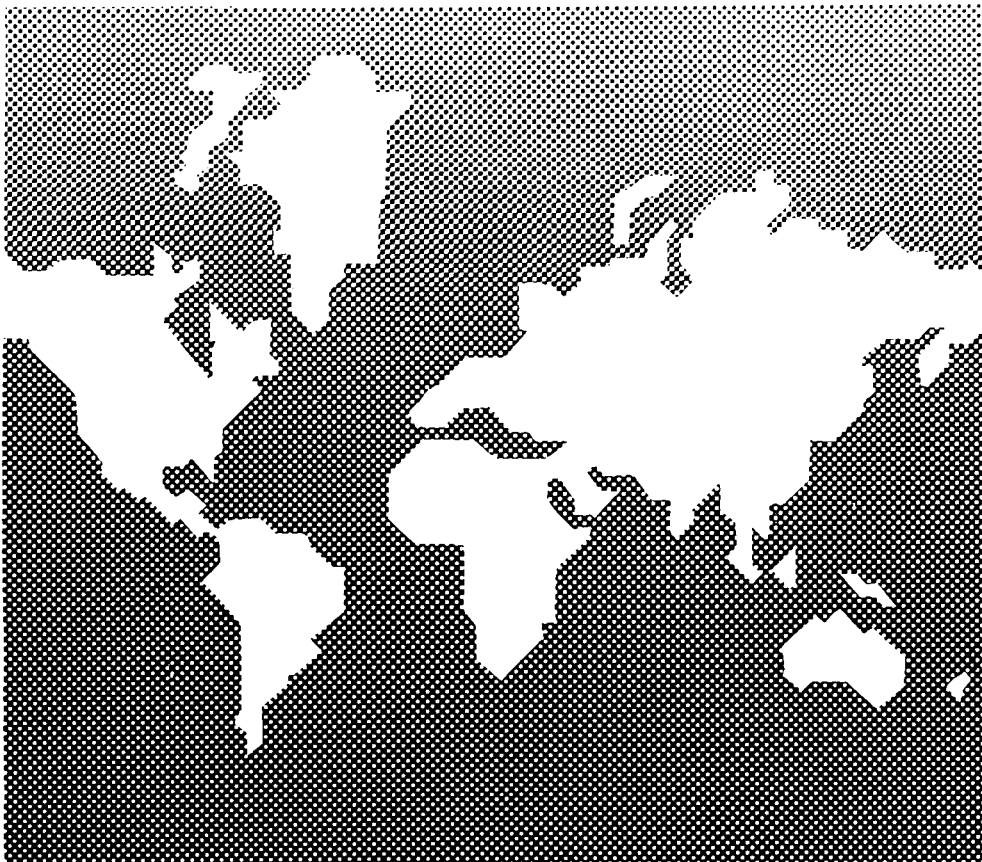


Energy Information Administration

International Energy Outlook 1989

Projections to 2000



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International Energy Outlook 1989

Projections to 2000

**Energy Information Administration
Office of Energy Markets and End Use
U.S. Department of Energy
Washington, DC 20585**

This report was prepared by the Energy Information Administration, the independent statistical and analytical agency within the Department of Energy. The information contained herein should not be construed as advocating or necessarily reflecting any policy position of the Department of Energy or any other organization.

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Preface

This report presents the current Energy Information Administration (EIA) assessment of the long-term outlook for international energy markets. The *International Energy Outlook 1989* (IEO89) follows IEO87. Due to a change in the naming convention, there is no IEO88. 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 1989*. 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 1989*. 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 October 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 assumed in this report 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 that, in large part, determine the resulting

projections. Much professional judgment, based on recent trends, reviews of many country reports, and projections made by other energy forecasters, went into the development of forecast assumptions and into the projected overall energy balances. The major assumptions made include estimates of the annual rates of change in country ratios of total energy consumption to economic activity, oil production capacities, and the rate of incremental energy requirements met by alternatives to oil. The projections call for fairly smooth patterns of growth and changes in underlying parameters between now and the year 2000. However, since 1973, 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 1989* 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 power consumption are based on capacity figures contained in Energy Information Administration, *Commercial Nuclear Power 1988: Prospects for the United States and the World*, DOE/EIA-0438(88) (Washington, DC, 1988). 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, July 1988 and *World Economic Outlook* (Philadelphia, PA, October 1988). 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. These assumptions are made after considering energy forecasts submitted annually to the International Energy Agency by member countries and other international energy forecasts produced by various public and private organizations.

Contents

	Page
Executive Summary	vii
1. World Oil Prices	1
Near-Term Influences	1
Longer Term Trends	2
International Oil Market Considerations	2
Economic Growth and Energy Intensity	4
2. Oil Production Potential	5
World Oil Resources	5
Historical Oil Production Trends	6
Financial and Investment Trends	7
Future Oil Production Potential	9
Worldwide Trends in Refinery Capacity	12
Petroleum Supply Vulnerability	16
3. Oil Consumption Trends	19
Oil Consumption in the OECD Countries	19
Oil Consumption in the Developing Countries	21
4. World Energy Consumption	23
Regional Energy Consumption Patterns	23
Energy Consumption by Economic Sector	26
Prospects for Coal	26
Prospects for Natural Gas	28
Prospects for Nuclear and Other Energy Sources	31
5. Comparison of International Energy Projections	37
Appendices	
A. International Petroleum Balance	41
B. OECD Members Energy Demand by Sector	45
C. International Energy Production Data	53

Tables

	Page
1. World Oil Prices, 1979-2000	1
2. Crude Oil Reserves and Resources in the Market Economies	6
3. Oil Supply in the Market Economies, 1973-1987	7
4. Oil Production Capacity, 1988-2000	10
5. Crude Oil Production, Proved Reserves, and Reserve-to-Production Ratios in the Market Economies, 1987	13
6. Oil Consumption in the Market Economies, 1973-1987	19
7. Oil Consumption in the Market Economies, 1986-2000	20
8. Total Energy Consumption in the Market Economies by Type, 1986-2000	23
9. Total Energy Consumption in the Market Economies, 1986-2000	25
10. Coal Consumption in the Market Economies, 1986-2000	27
11. Natural Gas Consumption in the Market Economies, 1986-2000	29
12. Nuclear Energy Consumption in the Market Economies, 1986-2000	32
13. Other Energy Consumption in the Market Economies, 1986-2000	34
14. Comparison of EIA Energy and Oil Projections for the Market Economies: Base Case, 1995	37
15. Comparison of Energy Projections for the Market Economies, 1990, 1995, and 2000	38
A1. Oil Consumption and Production in the Market Economies: Base Case, 1979-2000	41
B1. Consumption by Major Fuels and End-Use Sectors: United States	45
B2. Consumption by Major Fuels and End-Use Sectors: Canada	46
B3. Consumption by Major Fuels and End-Use Sectors: Japan	47
B4. Consumption by Major Fuels and End-Use Sectors: OECD Europe	48
B5. Consumption by Major Fuels and End-Use Sectors: Other OECD	49
B6. Consumption by Major Fuels and End-Use Sectors: Total OECD	50
C1. World Crude Oil Production, 1977-1987	54
C2. World Natural Gas Plant Liquids Production, 1977-1987	55
C3. World Dry Natural Gas Production, 1977-1987	56
C4. World Coal Production, 1977-1987	57
C5. World Net Hydroelectric Power Production, 1977-1987	58
C6. World Net Nuclear Electric Power Production, 1977-1987	59

Illustrations

	Page
1. Real Cost of Crude Oil in Major Industrial Countries Based on National Currencies, 1978-1988	3
2. Petroleum Rates of Return for FRS Companies, Domestic and Foreign, 1977-1987	8
3. Uncertainty Range of World Oil Production Capacity, Consumption, and Excess Production Capacity, 1980-2000	11
4. Oil Production and Proved Reserves in the Market Economies, 1987	14
5. Oil Production in the Market Economies: Base Case, 1970-2000	15
6. Range of World Oil Prices with Hypothetical Disruption in Supply, 1980-2000	17
7. Oil Consumption in the Market Economies: Base Case, 1970-2000	20
8. Total Energy Consumption in the Market Economies by Type: Base Case, 1970-2000	24
9. Total Energy Consumption in the Market Economies by Region: Base Case, 1970-2000	25
10. Coal Consumption in the Market Economies, 1987 and 2000	27
11. Natural Gas Consumption in the Market Economies, 1987 and 2000	30
12. Nuclear Energy Consumption in the Market Economies, 1987 and 2000	33
13. Nuclear Energy Consumption in OECD Europe, 1987 and 2000	35

Executive Summary

Instability was the prime characteristic of the oil market in 1988 as OPEC's internal problems led to overproduction by many members and, as a result, a rapid decrease in price.¹ This is the second time in 2 years that prices have shown extreme variation and may be an indicator of the state of the oil market for the next several years. The forecasts contained in this volume illustrate a range of rather smoothly changing oil prices over the next several years before reductions in excess production capacity allow modest price increases near the end of the 1990's (Figure ES1). Currently, excess capacity in the market economies is estimated at about 10 million barrels per day.² These forecasts are not meant to convey the impression that the world oil market will be stable but rather to indicate a likely range of prices over the foreseeable future. Within this range no one price level is more likely than another. It is clear, given recent history, that prices could well vary considerably within this range on a year to year basis. However, some fundamental market realities are likely to prevail. First, the longer prices remain at the low end of the range--everything else equal--the more likely they would tend to be higher later in the projection period. Conversely, higher prices in the near future could moderate price increases in later years. Second, it is likely that oil prices and economic growth will continue to be the driving factors behind changes in all energy markets as other fuels attempt to compete with oil.

In the petroleum market, prices are projected to remain below \$20 per barrel in real terms until the mid 1990's when reductions in excess capacity allow moderate price increases. In the low price case, prices remain below \$22 through 2000. As stated earlier, prices could easily vary within the range presented for any particular year. At present, there is no way to determine how this variation will take place. To date, OPEC has not exhibited the type of restraint necessary to stabilize prices. Until this restraint is applied consistently, price variation will likely be the norm. These price projections are based on the assumption of a moderate increase in oil demand in the market economies between 1987 and 1995 of about 5 million barrels per day and little increase after that as oil prices increase. Non-OPEC production is expected to increase between

1987 and 1990 before declining moderately in response to the present low prices.

Near-Term Price Determination--The Continued Influence of OPEC

The stability of world oil prices has long been dependent on the management of excess production capacity. In the early 1970's, excess production capacity that had previously existed in the United States diminished, and the capability to control the market shifted to OPEC, which increased its share of the world oil market to well over 60 percent in the mid-1970's (Figure ES2). The oil price shocks of the 1970's and the resulting decreases in demand and increases in non-OPEC supplies caused OPEC's share of the market to drop to about 38 percent by 1985. Currently at about 42 percent, OPEC's market share is expected to rise to about 53 percent by 2000.

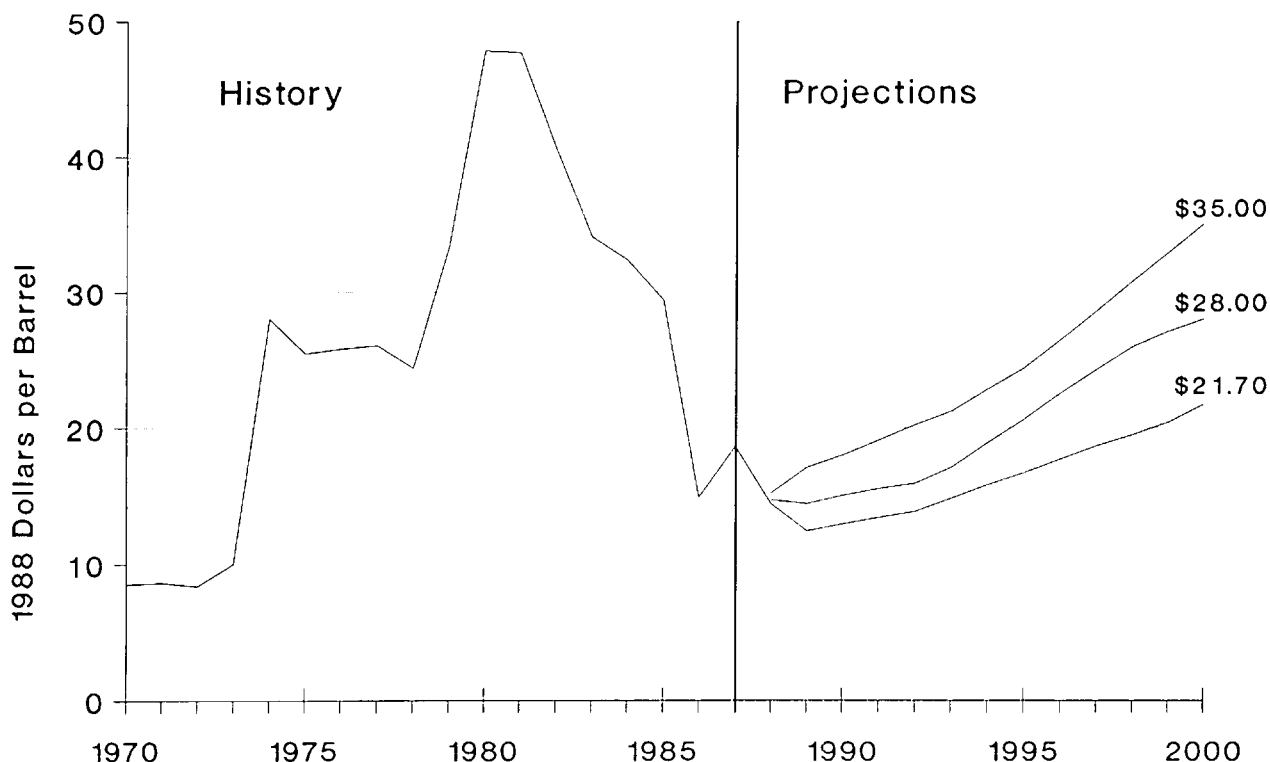
In 1986, Saudi Arabia, which attempted to regulate prices by acting as the "swing producer" within OPEC, responded to continued overproduction by some members by increasing its own production. As a result, prices plunged below \$10 per barrel briefly for some types of crude oil. Again in late 1988, overproduction by some members led Saudi Arabia to increase its production, and prices again fell dramatically. As long as OPEC as a whole, or any dominant producer within OPEC, is unwilling to adjust production to stabilize prices while excess production capacity exists, it is likely that wide variations in prices will continue.

OPEC has had a difficult time controlling output because it is composed of countries with widely divergent social and economic problems and interests. It is this diversity of social, political, and economic situations that makes it difficult to establish and hold to a production policy. For example, some countries such as Saudi Arabia have extensive oil reserves that will last well into the next century (Figure ES3). Given this fact, Saudi Arabia desires to maintain production and prices in a manner that will guarantee a market for its oil over the long run. Other countries with smaller

¹The members of the Organization of Petroleum Exporting Countries (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.

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 1987* (1988). **Projections:** Table 1 of this report.

reserves, such as Algeria, Libya, and Indonesia, are more interested in receiving higher prices in the near term.

Low prices over the past few years have resulted in only moderate increases in demand, mainly in the United States and in the developing countries. On the supply side, however, non-OPEC production has continued to increase even though the rate of increase is slowing. One reason why demand and supply have not responded more strongly to lower prices is that governments have changed policies to counteract some of the impacts of the fall in prices. For example, some non-OPEC producing countries decreased taxes on producers to maintain domestic profitability. In Europe, taxes on petroleum products have increased as crude oil prices have fallen. Therefore, in the near term, world oil prices should continue to be volatile and low, as the diverse OPEC countries struggle with internal production management problems and with continued competition from non-OPEC sources.

Mid-Term Price Determination and the Role of Technology

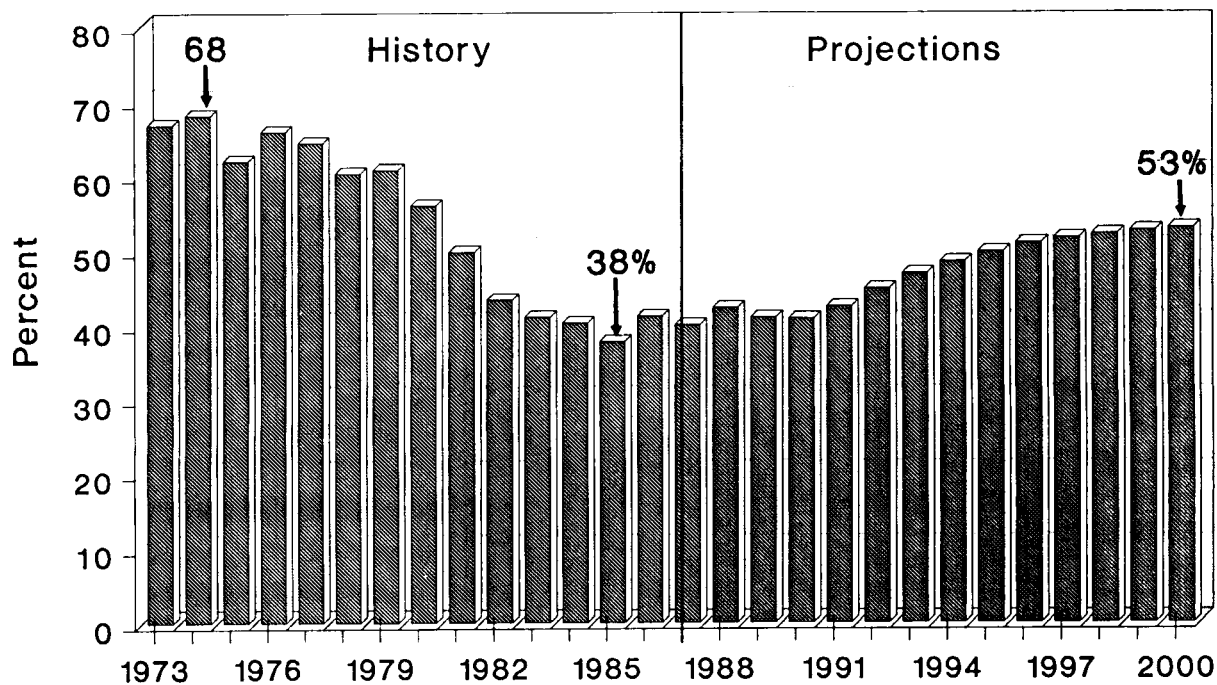
In the longer term, more fundamental market forces should again help to determine oil prices, as excess world production capacity is diminished. These eco-

nomical forces are those which determine the supply and demand for oil and, therefore, are dependent on such factors as economic growth, technological change in both the production and consumption of energy, and the size of the resource base.

Improvements in the technology of finding, developing, and producing oil reserves have long played an important role in bringing additional oil supplies to market. This explains in part how oil reserves in the market economies grew from 550 billion barrels to 810 billion barrels between 1978 and 1988—even though they produced 155 billion barrels of crude oil during this period. Figure ES3 includes oil reserves for the market economies and the centrally planned economies. It is likely that future technological change will also play a critical role in determining the supply of oil and therefore the price. Should improvements in technology lower the cost of finding and developing oil reserves, especially in smaller fields, oil prices will likely remain lower than would otherwise be the case. Oil prices will also be influenced by the cost of developing natural gas resources. Should natural gas turn out to be relatively inexpensive to develop and distribute, there will be additional competition to keep oil prices relatively low.

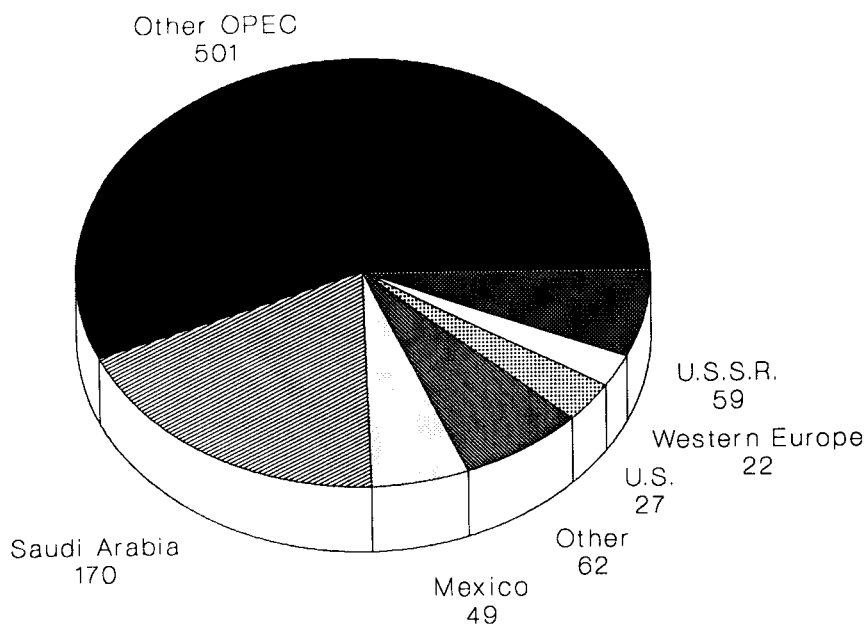
Technology also has an important role in determining energy use per unit of output. Figure ES4 shows trends

Figure ES2. OPEC Oil Production as a Percentage of Oil Demand in the Market Economies, 1973-2000



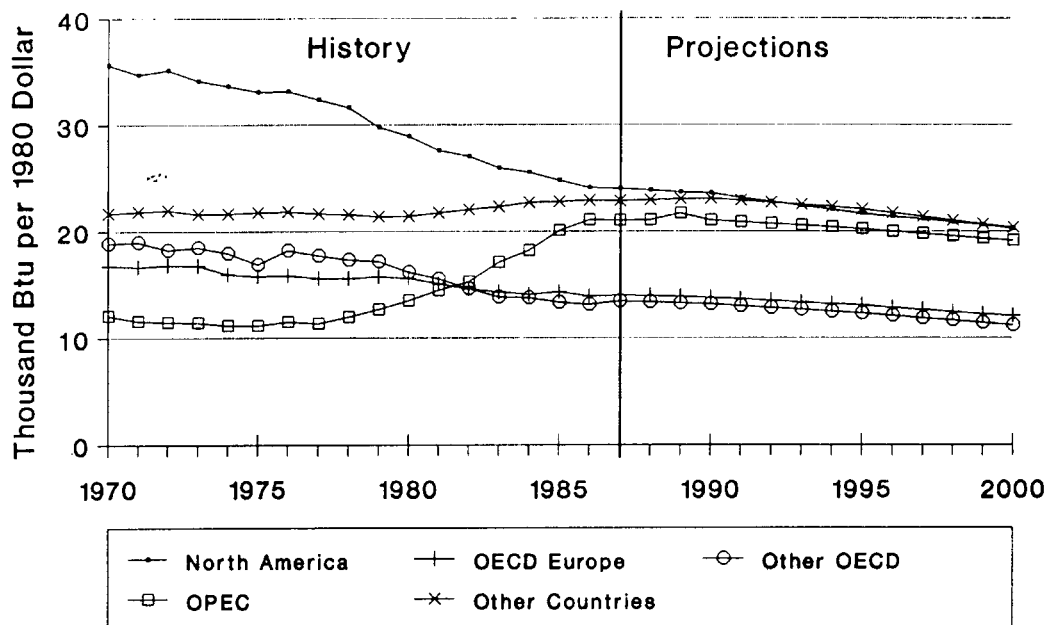
Sources: **History:** Energy Information Administration, *International Energy Annual*, selected issues and *International Petroleum Annual 1978*. **Projections:** Appendix Table A1 of this report.

Figure ES3. World Oil Reserves of Major Producers, 1987 (Billion Barrels)



Note: Saudi Arabia has recently increased its reserve estimate to 252 billion barrels.
 Source: Energy Information Administration, *International Energy Annual 1987* (1988).

Figure ES4. Energy Consumption/GDP Ratio: Base Case, 1970-2000



Sources: **History:** Wharton Econometric Forecasting Associates, *World Economic Service Historical Data* (1987 and 1988); United Nations, *1979 Yearbook of International Statistics* (1981); and Energy Information Administration, *International Energy Annual* and *International Petroleum Annual*, selected issues. **Projections:** Derived from Tables ES2 and 9 of this report.

in energy use per dollar of real domestic product (GDP) in major consuming regions over the last 17 years. With the exception of the developing countries, which have had rising energy consumption per real gross domestic product in recent decades, the main consuming regions have become increasingly energy efficient. This, the broadest measure of energy conservation, is projected to improve for all regions for the remainder of this century.

Growing Importance of Other Energy Sources

Past oil price hikes and prospects of higher prices in the future are expected to encourage continued substitution of alternative energy sources for oil. Though oil will continue to be the single most important source of energy in the market economies over the next 12 years, its consumption is expected to grow at a much slower rate than that of natural gas, coal, nuclear, and hydroelectric power.

Increased economic activity projected for the market economies results in increased use of all energy sources (Tables ES1 and ES2). Economic growth and energy

consumption are expected to grow at a faster rate in the developing countries as a group than in the industrialized countries of the Organization for Economic Cooperation and Development (OECD).³ Energy consumption is expected to grow as certain countries build their industrial sectors and as countries build their electricity and transportation networks. The rate of growth in energy consumption in the group of developing countries could be twice that in the OECD countries between now and the year 2000.

Natural gas is projected to be the fastest growing energy source in the market economies through 2000. Natural gas supplies are estimated to be relatively abundant worldwide. Countries are planning to use natural gas to reduce dependence on oil and to reduce the environmental problems associated with other fossil fuels, such as coal. Despite these problems, coal consumption is expected to grow, primarily to help meet increasing demands for electricity. Hydro and nuclear power will also be used to meet these demands. However, all three of these energy sources have environmental costs associated with their use. The approaches and technologies used to address these costs will influence the extent to which these resources are developed 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.

Table ES1. Summary of Assumptions and Projections for Market Economies

Assumptions/Projections	History		Projections		
	1986	1987	1990	1995	2000
Assumptions					
Economic Growth Rates ^a (percent per year)	2.8	3.1	2.5-3.3	2.6-3.4	2.5-3.3
OPEC Oil Production Capacity ^b (million barrels per day)	28.9	28.4	29-32	31-35	31-36
Projections					
Oil Prices ^c (1988 dollars per barrel)	\$14.85	\$18.65	\$13-18	\$17-24	\$22-35
Oil Production ^d (million barrels per day)					
Non-OPEC	26.6	27.0	27-28	24-26	22-24
OPEC	19.7	19.5	20-22	24-29	26-34
Energy Consumption^e					
Oil (million barrels per day)	48.0	48.9	50-53	51-57	51-60
Gas (trillion cubic feet)	37.0	39.3	43-45	49-54	57-64
Coal (million short tons)	2,190	2,270	2,400-2,450	2,650-2,750	2,850-3,050
Nuclear (terawatt-hours)	1,306	1,405	1,564-1,628	1,703-1,804	1,811-1,970
Other ^f (quadrillion Btu)	17.3	17.6	18-20	20-23	21-25
Total Primary Energy ^g (quadrillion Btu)	211	218	232-237	250-263	264-284

^a The 1990, 1995, and 2000 projections represent average annual rates of growth from 1987 to 1990, 1987 to 1995, and from 1987 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 1987 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--1,020 Btu/cubic foot, and (3) Coal--20 million Btu/short ton, (4) Nuclear--10.7 Million Btu/terawatt-hour.

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(88/08), *International Energy Annual 1987*, DOE/EIA-0219(87), and *Short-Term Energy Outlook*, DOE/EIA-0202(88/4Q) (1988); Wharton Econometric Forecasting Associates, *World Economic Outlook*, (October 1988). **Projections:** Tables 1, 4, 7, 8, 10, 11, 12, and 13 of this report; Energy Information Administration, Office of Energy Markets and End Use.

**Table ES2. Annual Growth Rates of Real Gross Domestic Product (GDP)
Base Case 1970-2000
(Percent)**

Country/Region	Average Annual GDP Growth Rates			
	1970-1980	1980-1985	1986-1990	1990-2000
United States ^a	2.7	2.7	3.2	2.5
Canada	4.6	2.8	3.2	3.0
Japan	4.6	3.9	4.0	3.1
OECD Europe	3.0	1.5	2.7	2.4
Total OECD	3.1	2.3	3.0	2.6
Developing Countries	5.4	1.3	2.9	4.0
Total Market Economies	3.6	2.1	3.0	2.9

^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:** Wharton Econometric Forecasting Associates, World Economic Service Historical Data, April 1988 (1988). **Projections:** Energy Information Administration, *Annual Energy Outlook 1989*, DOE/EIA-0383(89) (1989); and Wharton Econometric Forecasting Associates, Wharton World Economic Model, July 1988 and *World Economic Outlook* (October 1988).

1. World Oil Prices

The price outlook for the near term is for continued high volatility as the market reacts to developments in the Organization of Petroleum Exporting Countries' (OPEC) search for a new strategy. World oil prices are expected to range from \$12 to \$17 per barrel in 1989.⁴ While prices are expected to increase gradually over the longer term, they are not expected to reach the levels they reached just 8 years ago of \$48 (in 1988 dollars) for the foreseeable future. They are projected to increase to the \$22-to-\$35 range by 2000, again in 1988 constant dollars (Table 1).

Near-Term Influences

World oil markets were volatile in 1988 as oil prices dropped sharply from \$16 per barrel in January to \$12 per barrel in November. Internal dissension between the various OPEC factions led to overproduction in

1988. In late August, it appeared that OPEC was beginning to move toward an agreement on production quotas that could have led to firmer prices in late 1988 and throughout 1989. Developments during September, however, rapidly halted any movement toward agreement and, instead, demonstrated that OPEC was becoming even more split by internal dissension.

The inability of OPEC to negotiate quotas for Iran and Iraq in the wake of the cease-fire in their 8-year war, higher quota demands by the United Arab Emirates, quota violations by several countries, and attempts by Saudi Arabia to force a quota agreement by opening its taps resulted in the world oil markets being flooded with oil. Disagreements abounded over such issues as the appropriate quotas for member countries, the inclusion of condensates and Neutral Zone production in future agreements, and the more basic and divisive question of what OPEC wants as its primary goal. Does it want to produce freely and let the market determine price, or does it want to set a refer-

Table 1. World Oil Prices, 1979-2000
(1988 Dollars per Barrel)

Year	Price Case--1988 Dollars per Barrel		
	Low	Middle	High
1979	--	\$33.33	--
1980	--	47.81	--
1981	--	47.65	--
1982	--	40.56	--
1983	--	34.13	--
1984	--	32.36	--
1985	--	29.40	--
1986	--	14.85	--
1987	--	18.65	--
1988	--	14.70	--
1989	\$12.40	14.40	\$17.10
1990	12.90	15.00	18.00
1991	13.40	15.50	19.10
1992	13.80	15.90	20.20
1993	14.80	17.10	21.20
1994	15.80	18.90	22.80
1995	16.70	20.60	24.40
1996	17.70	22.50	26.50
1997	18.70	24.30	28.60
1998	19.50	26.00	30.80
1999	20.40	27.10	32.90
2000	21.70	28.00	35.00

Note: Prices represent the U.S. refiner acquisition cost of imported crude oil.

Sources: **History:** Energy Information Administration, *Monthly Energy Review*, DOE/EIA-0035(88/08) (1988). **Projections:** Energy Information Administration, Office of Energy Markets and End Use.

⁴The world oil price is defined as the average cost of imported crude oil to U.S. refiners.

ence price and then adjust production to attain that price?

Agreement on a new, more realistic strategy reached in November 1988 should contribute to higher prices than would otherwise be the case. However, the current high inventory levels that resulted from the overproduction limit the extent to which any OPEC strategies would result in significantly higher prices in the very near future.

Longer Term Trends

The market forces of supply and demand will be the principal determinants of world oil prices over the longer term. The expected increase in Iraqi export capacity in late 1989 and early 1990 and increases in overall non-OPEC supplies that are expected to continue through the early 1990's will also exert downward pressure on world oil prices over the next few years by maintaining a surplus in world oil production capacity.

It is expected that this situation will change by the mid-1990's as non-OPEC production declines and world oil demand increases. When this happens, world oil markets should tighten, with the result that world dependence on OPEC will increase and prices will rise again. Non-OPEC supplies are expected to drop as mature oil producing regions such as the United Kingdom sector of the North Sea and the United States (both the North Slope and the lower 48 States) drop in production faster than new supplies are added and as low prices discourage exploration and development of new supplies. Demand will increase as world economies expand and respond to the earlier low prices (Table ES1).

While oil prices in any given year could lie outside this band of uncertainty, it is believed that price fluctuations outside this band are not sustainable. Prices above this band of uncertainty would discourage demand, encourage the higher cost non-OPEC production, and lead to increased excess oil production capacity in the OPEC countries, with the result that prices would fall. Prices below this band would have the opposite effect. Given these market pressures, prospects for prices to be sustained outside this band are considered unlikely.

The price outlook given here is not a prediction of what oil prices will actually be, but an indicator of the trends that prices will follow in accordance with market forces. As the past decade has shown, movements in world oil prices can be very unpredictable. Changes in market conditions and policy decisions have resulted in wide price swings. Given the political and economic uncertainties that exist in the world, the price outlook could change.

The future of OPEC and the strategies it might pursue are a major source of uncertainty. While OPEC is limited by market forces in its ability to influence prices, OPEC actions are still able to keep prices higher than they otherwise might be. OPEC has survived internal dissension and low prices before, and it will probably continue to survive; the strategies it will pursue and their effectiveness are, of course, unpredictable.

Another source of uncertainty is the amount of production from non-OPEC sources. It is believed that new supplies will be forthcoming from regions such as Norway, Mexico, North and South Yemen, and Colombia that will offset, to a large extent, future declines elsewhere in regions like the United States and the United Kingdom. However, the extent to which these future supplies are forthcoming is unknown. Such supplies have been forthcoming at higher levels than first expected, and continued discovery and development of new fields could keep prices down longer than expected. Unconventional supplies other than heavy oils and enhanced oil recovery are not expected to be a major factor because the price range projected for the next decade is too low to encourage their development unless dramatic unforeseen breakthroughs occur.

The demand response to lower prices could also change. It is believed that conservation will continue even with lower prices. However, the rate at which this will occur is uncertain, as is the rate of economic growth and the rate at which alternate fuels such as natural gas will substitute for oil in the face of weak oil prices.

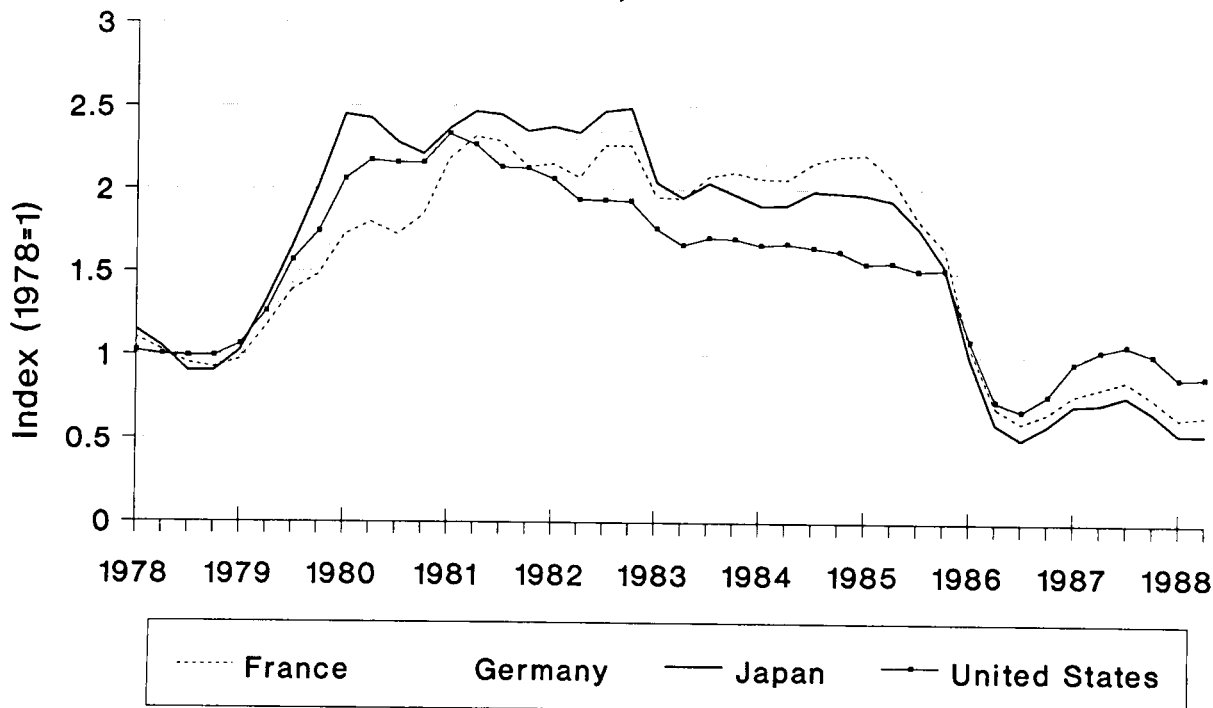
Government policies to reduce oil demand increase uncertainty further. Already, many countries such as those in Western Europe and Japan have increased oil taxes that discourage demand, and many have actively promoted nuclear power to replace oil. In addition, it is possible that governments' increasing environmental concerns could act to reduce the consumption of fossil fuels. Political uncertainty will invariably lead to uncertainty over oil prices.

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. 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 U.S. dollar. Consequently, as the exchange rates of

Figure 1. Real Cost of Crude Oil in Major Industrial Countries Based on National Currencies, 1978-1988



Note: The world oil price is converted to national currency using exchange rates. Inflation rates determine real prices.

Sources: Energy Information Administration, *Monthly Energy Review*, July 1988 (1988). Data Resources, Inc., U.S. Central, Europe, and Japan data bases.

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 countries even before the 1986 oil price collapse because of the declining value of the U.S. dollar (Figure 1). 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 2 percent in the United States. The oil price plunge during 1986 narrowed, then reversed, the difference between the cost of crude oil to the United States and other major world economies. 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 73 to 74 percent (measured from March 1985) for West Germany, France, and Japan. Not all of the reduction in the cost of crude oil was passed on to the consumer, especially outside of the United States, as governments raised taxes and refiners/suppliers increased margins. The cost of crude to the United States declined by 56 percent during the same time period.

Market-linked crude oil pricing contributed to the dramatic fall in world oil prices in 1986. An estimated 60

percent of globally traded oil was priced in some market-sensitive manner during 1986. In early 1987, oil prices strengthened due to a partial return to official crude oil pricing and production quotas by OPEC. Oil prices peaked at \$19 per barrel in the third quarter 1987. However, OPEC production discipline faltered in the second half of 1987 and the use of market-linked crude oil pricing resumed a predominant role. Through most of 1988 weak crude oil prices have plagued OPEC. During the second quarter 1988, the cost of crude oil in domestic currencies for France, West Germany, and Japan declined to near the lows reached in 1986, and the United States was 13 percent above its 1986 low. Recently, severe over-quota production by OPEC has created oil market conditions similar to those preceding the crude oil price collapse of 1986. OPEC is attempting to establish workable production quotas to prevent further crude oil price weakness, an indication that OPEC members recognize that control of oil supply is the best way to strengthen crude oil prices and raise oil revenues.

Depreciation of the U.S. dollar in international financial markets has compounded the impact 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 1988 dollars) fell by almost two-thirds. 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 1988 dollars) until the late 1990's.

To maintain market position and improve oil revenues, OPEC member nations and other oil exporting nations, as well as international oil companies, continuously restructure their operations. 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.

OPEC member nations now own or are partners in downstream refining/marketing operations worldwide, with production levels over 2 million barrels per day. This vertical integration by oil-producing nations should slow from the pace of the past few years. Countries seeking future downstream acquisitions face a shortage of cash and increasing difficulties in finding suitable candidates. Oil-producing countries are reevaluating the benefits of downstream moves. Producers question whether or not downstream operations can provide the revenue security desired or make balancing supply to demand easier. Competition for downstream markets could weaken crude oil prices and lessen the ability of OPEC countries to meet production quotas. At the same time, low world oil prices will, no doubt, continue to 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.

Economic Growth and Energy Intensity

The energy intensity of economic activity (defined as the ratio of energy consumption to GDP) declined markedly in the market economies after the oil price shocks of the early 1970's and is projected to continue to decline throughout the 1990's (Figure ES4). The rate of improvement in the industrial countries of the OECD is likely to decline in the 1990's, however, because relatively low energy prices provide less incentive for investments in energy conservation and efficiency.

The makeup of economic activity in the industrial countries is expected to continue recent trends, moving away from more energy-intensive manufacturing towards less energy-intensive services and high technology. Innovations in heavy manufacturing are also expected to reduce energy intensity. Additionally, a significant amount of traditional heavy manufacturing, such as steel manufacturing, has moved and is likely to continue to move to newly industrialized countries.

Many developing countries will find it difficult to improve upon the energy intensity of economic activity. Economic growth in many developing countries is dependent on energy-intensive natural resource development. Desired growth in motor transportation and in electrification would also encourage increased energy consumption in the developing world.

It will also be difficult for many developing countries to reduce the oil intensity of economic activity over the projection period. Much of the potential for fuel substitution is in the electric utility sector, where nuclear, hydro, and other fossil fuels are feasible substitutes for oil. However, these energy activities require large start-up capital expenditures, and foreign investors are likely to be more cautious in the future than in the past, given low energy prices and given the large foreign debt carried by many countries--particularly in Latin America.

In the OECD countries, the oil intensity of economic activity should continue to decline at a faster rate than that of total energy. These countries are continuing efforts to increase energy diversity and security, though these efforts have diminished somewhat recently, given surplus energy supplies and low oil prices worldwide.

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 dominate both the reserves and spare production capacity within OPEC.

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. Reserves in this report refer to "proved reserves" or oil that 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 that 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 2.

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 720 billion barrels and may exceed 800 billion barrels (Table 2). 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 (U.S. Geological Survey).

- Crude oil reserves (as published in the *Oil and Gas Journal* and *World Oil*) increased between 1980 and 1987 despite real price declines and an average crude oil production level (including lease condensate) of between 40 and 41 million barrels per day, or about 120 billion barrels over the period.
- More than 60 to 70 percent, depending on the source, 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. There were over 6,200 active rigs in the market economies in December 1981--about 4,500 of these were in the United States. By the end of June 1988, there were about 2,100 active rigs in the market economies and about 900 in the United States. Thus, the decline of 3,600 active rigs in the United States accounted for almost 90 percent of the overall drop in active rigs. The number of crews involved in seismic exploration is also an important indicator of petroleum exploration activity. According to the Society of Exploration Geophysicists, there were about 1,260 active seismic crews in the market economies and about 740 active crews in the United States at the peak in September 1981. Since then, the number of seismic crews in the market economies declined to 415 crews in September 1988. The United States accounted for about 180 of the total. Thus, the decline of 560 seismic crews in the United States accounted for about two-thirds of the decline in the number of active crews.

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 2. 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 (12/31/87)	FESAP (Various Dates)	
North America	80.7	84.3	NA	139.1-280.5
Canada	6.8	4.8	NA	15.3-62.6
Mexico	48.6	54.1	27.2 (12/81)	45.0-105.0
United States	25.3	25.3	^c 30.9 (12/87)	70.4-118.4
Central & South America	65.7	66.9	NA	74.6-135.6
Ecuador	1.6	1.6	1.2 (12/82)	3.1-8.5
Venezuela	56.3	56.8	18.5 (12/78)	53.7-81.7
Western Europe	22.4	20.1	NA	45.1-78.1
United Kingdom	5.2	5.2	12.6 (12/81)	19.0-23.2
Other North Sea	15.3	13.5	7.0 (12/81)	17.7-40.7
Other Western Europe	1.9	1.5	NA	5.2-14.2
Middle East	564.7	470.6	419.2	482.9-619.9
Iran	92.9	35.6	62.5 (12/81)	71.1-95.1
Iraq	100.0	100.0	34.5 (12/81)	65.7-130.7
Kuwait ^d	94.5	98.1	95.7 (12/81)	80.8-88.3
Qatar	3.2	3.5	7.1 (12/81)	2.0-7.0
Saudi Arabia ^d	169.6	170.0	173.2 (12/81)	193.1-239.6
United Arab Emirates	98.1	56.2	43.0 (12/81)	48.7-58.7
Africa	55.2	54.2	NA	88.5-158.5
Algeria	8.5	4.9	10.4 (12/81)	11.8-16.3
Egypt	4.3	4.7	2.4 (12/81)	5.7-16.7
Gabon	0.6	1.0	NA	5.0-7.0
Libya	21.0	22.6	21.0 (12/81)	29.9-40.9
Nigeria	16.0	15.8	12.6 (12/75)	23.2-37.2
Other Africa	4.8	5.2	NA	12.1-36.1
Far East/Oceania	19.4	20.9	NA	41.2-94.2
Australia/New Zealand	1.9	2.4	NA	4.3-12.5
Indonesia	8.4	8.5	9.5 (12/82)	13.6-26.6
Total OPEC	670.7	574.5	NA	602-838
Total Market Economies	808.1	717.0	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 27.3 billion barrels of proved reserves and 3.7 billion 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*, 207, 2 (August 1988); 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) (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 was about 46.5 million barrels per day in 1987. This was about 6.3 million barrels per day less than the historical peak in 1979 and about 2.8 million barrels per day less than the average production levels in 1973 when Arab oil supplies were cut off to Israel, the Netherlands, and the United States in an international oil embargo. Table 3 shows the trends in world oil supply from 1973 to 1987.

There have been significant changes in the origin and composition of oil supplies between 1973 and 1987. 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 1987, 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 17.9 million barrels per day in 1973 to almost 27.0 million barrels per day in 1987. Production in the United States declined slightly over the period. The key increases occurred in countries that had not been among the major oil producers in the early 1970's--Egypt, Mexico, Norway,

Table 3. Oil Supply in the Market Economies, 1973-1987
(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	17.9	0.8	50.0
1974	11.0	21.5	31.1	17.3	0.9	49.4
1975	10.5	19.2	27.6	17.2	1.1	46.0
1976	10.3	21.8	31.3	17.4	1.2	49.8
1977	10.4	22.1	31.9	18.6	0.9	51.4
1978	10.8	21.1	30.5	19.8	1.0	51.3
1979	10.7	21.6	31.7	21.0	1.1	53.9
1980	10.8	18.5	27.8	21.8	1.2	50.8
1981	10.7	15.9	23.8	22.4	1.5	47.6
1982	10.8	12.8	20.1	23.4	1.7	45.2
1983	10.8	11.7	18.8	24.4	1.8	45.0
1984	11.1	11.4	18.8	25.9	2.1	46.8
1985	11.2	10.3	17.5	26.8	2.0	46.3
1986	10.9	12.4	19.7	26.6	2.2	48.5
1987	10.6	12.6	19.5	27.0	2.3	48.8

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 1987*, DOE/EIA-0219(87) (1988); *Monthly Energy Review*, DOE/EIA-0035(88/05); and *Petroleum Supply Monthly*, DOE/EIA-0109(88/06) (1988).

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. 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.

Financial and Investment Trends

Tracing the financial, investment, and operating performance of U.S. companies included in the Energy Information Administration's (EIA) Financial Reporting System (FRS) helps to describe and interpret the changing balance of market forces in the oil and gas

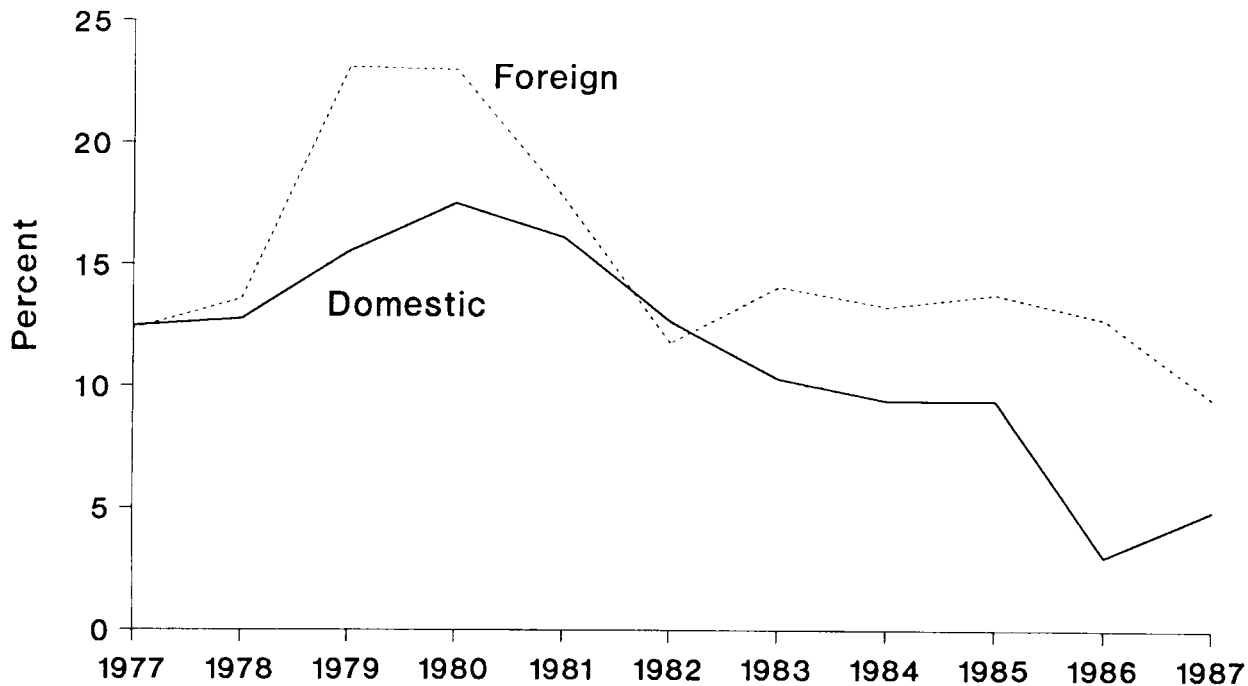
industry.⁵ Worldwide petroleum investment by the FRS companies declined in 1987 by 12 percent. The decline was due entirely to reductions in the United States. Investment abroad rose by nearly 30 percent, for the most part because of increased upstream commitments. Much of the increase reflects acquisitions of proved properties in Canada and Australia. However, even excluding such purchases, exploration and development expenditures abroad rose about 4 percent while they declined 20 percent in the United States.

The FRS companies' foreign petroleum capital expenditures totaled \$9.9 billion in 1987, exceeding the previous high levels attained in 1985. Most of the expenditures were for upstream operations, and the largest companies accounted for most of the increase. These same companies dominate the FRS companies' refining/marketing activity abroad.

Generally, the FRS companies' foreign operations have had a higher rate of return than in the United States. In 1986, for the first time, total foreign profits exceeded those gained from U.S. petroleum operations. The price collapse of 1986 provided extraordinary opportunities for profits from refining, marketing, and trading while depressing returns from upstream operations. The oil price recovery in 1987 reversed this process, and foreign refinery operations were the most adversely affected, so that in 1987 overall domestic profits again exceeded those gained abroad. Nonetheless, overall rates of return relative to net fixed assets are greater in areas outside the United States. Upstream

⁵The information presented in this section is from Energy Information Administration, *Performance Profiles of Major Energy Producers 1987*, DOE/EIA-0206(87) (Washington, DC, January 1989), Chapter 6.

Figure 2. Petroleum Rates of Return for FRS Companies, Domestic and Foreign, 1977-1987



Note: FRS=Financial Reporting System.

Source: Energy Information Administration, *Performance Profiles of Major Energy Producers 1987* (January 1989), Chapter 6.

profit rates contributed most to this difference. Although these rates have declined by almost 50 percent since 1985, upstream profitability abroad was more than double that attained within the United States in 1987 (Figure 2).

The FRS companies' foreign oil production declined slightly in 1987, reversing a steady upward trend evident since 1980. The decline occurred despite higher oil prices and even while foreign non-OPEC production rose. Noneconomic factors explain the decline. Government mandated withdrawal from Libya in late 1986 and an earthquake in Ecuador in 1987 caused a net reduction in the FRS companies' oil production from Africa and South America. Elsewhere, the FRS companies registered production gains generally in line with the industry as a whole.

In recent years, natural gas production has assumed increasing significance in the FRS companies' foreign operations. In 1987, production gains equaled 11 percent and totaled 2.8 trillion cubic feet, 25 percent higher than in 1981. Generally, gas production gains are outpacing those of oil in most areas of the world. Over the past decade, substantial investments in infra-

structure for pipeline delivery and natural gas liquids production have been put in place.

Efforts to control production costs to compensate for lower selling prices have met with considerable success in recent years. In 1987, lifting costs averaged \$4.71 per barrel in foreign areas, compared with \$4.60 in the United States.⁶ As recently as 1985, lifting costs equaled nearly \$7.00 per barrel in the United States and \$6.50 abroad. They were even higher in earlier years, primarily because of higher taxes. As oil prices began to deteriorate after 1981, production taxes tended to decline. In the United States, since production taxes are approximately proportional to prices, they declined with the fall in oil prices. In other areas, governments tended to make administrative adjustments to try to compensate for declining profits from ongoing operations.

Severe downward pressure on prices in 1986 finally reversed an upward trend in direct lifting costs, which exclude taxes. This reversal was accomplished through the shutdown of higher cost facilities (such as stripper wells and some tertiary operations in the United States) and through wage and material cost reductions and improved management of producing facilities.

⁶When compared to selling prices in excess of \$10 per barrel, oil production tends to be price insensitive in the short run. In the long run, these costs plus exploration and development costs must be recovered if new production is to be found and made available for use.

Lifting costs differ widely across regions. Generally, direct lifting costs are highest in the United States, Canada, and the North Sea. In other areas where direct lifting costs tend to be lowest, taxes tend to be highest. Thus, producing areas in Africa, the Middle East, and other parts of the Eastern Hemisphere, which have the lowest direct lifting costs, have total lifting costs in excess of the United States, Canada, and Europe, because of taxes.

The FRS companies committed \$9.2 billion for foreign exploration and development in 1987. Of that amount, \$1.6 billion was for proved properties. The balance of \$7.6 billion resulted in direct new exploratory and development efforts, including the completion of 1,617 wells. Although new spending rose by 3 percent between 1986 and 1987, the number of well completions fell by 8 percent, compared with a 4-percent gain for industry as a whole.

In general, exploration and development efforts yielded improved results as reserve holdings for both oil and gas rose. For the third year in a row, finding costs moved downward. However, differences between regions remain large. The most recent data indicate that finding costs in Canada and areas in South America were at the bottom of the scale, half the average for the United States; African areas were at the top of the scale, nearly twice the U.S. average. Outside of the United States and Canada, results can change dramatically because relatively few wells (in aggregate) have been drilled and those that are successful tend to yield substantial additions.

The FRS companies' foreign refining/marketing financial results were adversely affected by the narrowing spread between crude oil and refined product prices in 1987. After near record earnings of \$2.9 billion in 1986, the FRS companies' foreign refining/marketing income fell by 67 percent to \$1.0 billion in 1987. The fall in income was entirely attributable to the almost \$2.0 billion fall for the top four companies. The remaining FRS companies increased their foreign refining/marketing net income.

The FRS companies outside of the top four have substantially less foreign refining capacity on average (100,000 barrels per day) than do the top four companies (1 million barrels per day). Further, the refinery utilization rate for the smaller companies is substantially greater than for the larger ones. The refinery utilization rate of the top four improved from 67.2 percent in 1986 to 72.2 percent in 1987. Even though the utilization rate of the smaller companies fell 4 percentage points to 90.8 in 1987, this remained 18 percentage points above the top four companies.

While the foreign distillation capacity of the FRS companies remained about constant from 1986 to 1987, their share of foreign capacity continued to slip as a small amount of additional capacity became available in 1987. In 1974, the FRS companies' share of foreign

refining capacity was 22.5 percent. Their share fell to only 12.0 percent in 1986 and 11.7 percent in 1987.

Substantial investments continue to be made in foreign refining/marketing to upgrade refineries. The capital expenditures for foreign refining/marketing operations by the FRS companies increased by 14 percent to \$2.4 billion in 1987. In the past, foreign refineries were less sophisticated than U.S. refineries because the product slate was less oriented toward gasoline production. However, increased gasoline yields have provided the route to growth and more favorable price-cost margins in both U.S. and foreign refining. Accordingly, the share of gasoline in the FRS companies' foreign refined product slate increased from 22 percent in 1981 to 29 percent in 1987. An additional stimulus to refinery investment abroad has been the institution of more rigorous environmental standards. In Western Europe, increasingly stringent lead and sulfur content regulations have required upgrading investments to produce the lower lead products. Western European refiners also will be required to produce a lead-free premium gasoline by 1989. These requirements necessitate increased unleaded and octane-enhancing capacity, as well as increased heavy, sour capacity particularly for desulfurization.

Future Oil Production Potential

World oil supplies in 1988 were characterized by above-quota production among the OPEC countries and increased production among the non-OPEC countries, resulting in reduced and unstable world oil prices. Prospects for future oil supplies depend largely on the size and location of oil reserves. In recent years, the development of oil reserves in non-OPEC countries has allowed their production to move ahead of that from OPEC. However, relative to OPEC, non-OPEC production prospects are more limited because of lower production capacity and reserve levels. Middle East OPEC countries, in particular, have excess production capacity, and their ability to control production and to maintain stable world oil prices will be very important in determining future prospects for non-OPEC oil producers.

For example, since the cease-fire between Iran and Iraq, there has been wide speculation as to the post-war oil production behavior of these two countries. One argument was that the cease-fire would bring both parties to the negotiating table and that OPEC would be able to reach a firm agreement on production quotas. As a result, so went the argument, prices for crude oil would stabilize. A second argument suggested that the need to reconstruct war-torn economies would be the top priority of these two countries and that they would increase oil exports to gain the revenue to meet

Table 4. Oil Production Capacity, 1988-2000
(Million Barrels per Day)

Country/Region	Estimated 1988	Projection Ranges		
		1990	1995	2000
United States	10.6	9.8-10.2	8.4-9.4	7.8-9.1
Canada	2.0	1.9-2.1	1.6-1.8	1.4-1.6
Mexico	2.9	2.9-3.1	3.1-3.4	3.1-3.5
North Sea	3.9	4.0-4.3	3.4-3.9	2.9-3.4
Other Non-OPEC	8.1	8.4-9.2	7.4-8.5	6.0-7.2
Total Non-OPEC	27.5	27.2-28.6	24.3-26.6	21.6-24.3
Algeria	1.2	0.9-1.1	0.9-1.1	0.7-0.9
Ecuador	0.3	0.2-0.3	0.2-0.3	0.2-0.3
Gabon	0.2	0.2-0.3	0.2-0.3	0.1-0.2
Indonesia	1.5	1.4-1.5	1.2-1.4	1.0-1.2
Iran	3.0	3.0-4.0	3.5-4.5	3.5-4.5
Iraq	2.7	3.5-4.5	4.0-5.0	4.5-5.5
Kuwait*	2.5	2.8-3.0	3.0-3.5	3.0-3.8
Libya	1.6	1.5-1.7	1.3-1.7	1.3-1.7
Nigeria	1.7	1.5-1.7	1.2-1.6	1.1-1.5
Qatar	0.6	0.5-0.6	0.4-0.6	0.3-0.5
Saudi Arabia*	8.5	8.0-9.5	9.0-10.5	9.5-11.0
United Arab Emirates	2.0	2.0-2.2	2.2-2.6	2.5-3.0
Venezuela	2.4	2.4-2.6	2.5-2.9	2.5-3.0
Total OPEC	28.2	28.6-32.3	30.6-35.0	31.3-36.0
Net CPE Exports	2.4	2.2-2.7	1.4-2.4	1.0-2.0
Total Market Economies	58.1	58.8-62.7	57.7-62.7	55.4-60.9

* 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 1989* 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.

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

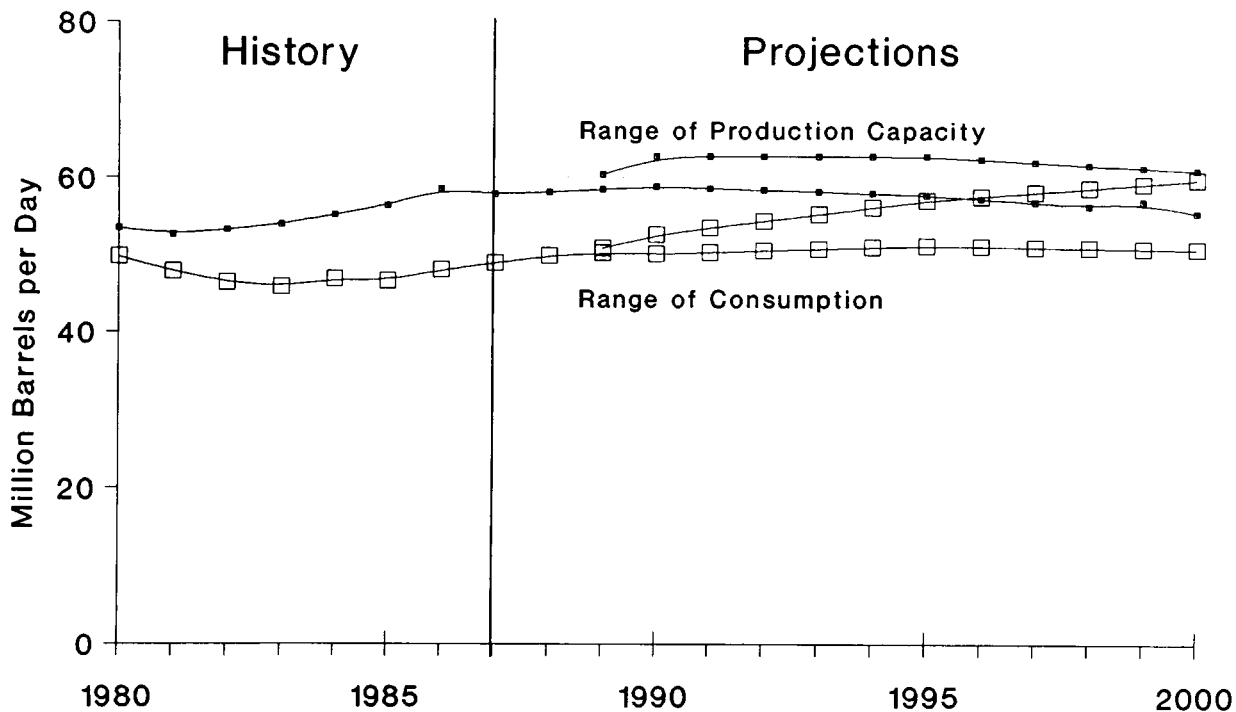
this objective. Be this as it may, neither Iraq nor Iran, after joining OPEC's quota system, seem to have encountered serious problems in filling their production quotas. Especially Iran's ability to step up production by half a million barrels per day between January and December of 1988 came as a surprise to many analysts.

Crude oil production capacity in the market economies is projected to range between 58.8 and 62.7 million barrels per day in 1990, 57.7 and 62.7 million barrels per day in 1995, and 55.4 and 60.9 million barrels per day in 2000 (Table 4). World crude oil production capacities are projected to trend upward from the estimated 1988 level and to continue upward through the early 1990's. Projected production capacity trends for non-OPEC countries are mixed through the early 1990's and steadily decline in the late 1990's. Production capacities for the OPEC countries trend upward both at the lower and upper end of the projection range. OPEC market share would be expected to increase along with production capacity. A comparison of the projected oil production capacity with projected oil consumption in the market economies indicates that excess capacity will prevail well into the 1990's (Figure 3). The magnitude of the excess would decline over time.

The near-term increase in production potential in the non-OPEC countries comes mainly from the North Sea and the "Other Non-OPEC" group. Despite the collapse of the world oil price in 1986, production from "Other Non-OPEC" countries has been on the rise. This continuing increase in production reflects a fundamental difference in production economics between this group and the rest of non-OPEC countries, such as the United States and Canada. In general, direct lifting costs in the United States and Canada are much higher than among "Other Non-OPEC" countries, due to the age, size, and geographical location of the Canadian and U.S. oil fields.

Some of the non-OPEC oil currently being produced was discovered in the early 1980's when the price of crude oil was still very high. The development of these new discoveries required not only the drilling of oil-producing wells but also the infrastructure needed for distribution. For example, oil was discovered in North Yemen in 1984, but there was no significant production of oil until late 1987 and 1988. In this case, production of oil lagged behind discovery by about 3 years. The development of proved reserves discovered in the early 1980's should allow the non-OPEC countries to increase production through the early 1990's, but this increase in production is projected to peak in 1993 or

Figure 3. Uncertainty Range of World Oil Production Capacity, Consumption, and Excess Production Capacity, 1980-2000



Sources: **History:** Energy Information Administration, *International Energy Annual*, selected issues. **Projections:** Tables 4 and 7 of this report.

1994 and to decline thereafter, as most of the existing proved reserves are developed and the discoveries can not replace the production of crude oil, due to low world oil prices and consequently low exploration activities.

Current and projected low world oil prices should impact more on exploration drilling activities than on development drilling activities, since there is less uncertainty concerning the cost of developing proved oil reserves and the rate of return on investments. As long as the economics of development permit, new production will be put on line from proved reserves. The situation is quite different for exploration drilling activities, however, because the uncertainties and risks involved are much higher than they are in development drilling.

The increased importance of OPEC oil projected for post 1995 is based on production made possible by huge proved reserves. Proved reserves in OPEC have been reported as high as 670 billion barrels (Table 2). In contrast, proved reserves in the non-OPEC market economies have been reported at about 140 billion barrels. OPEC's vast proved reserves could easily be translated into increased production capacity, given the market's readiness to absorb additional crude oil supplies. Increased production in a proved oil field can be

achieved by simply drilling more producing oil wells, usually at relatively low cost.

Several factors could influence production-capacity trends among and relative market shares between non-OPEC and OPEC countries. The first factor is the price of crude oil. Non-OPEC oil producers are very sensitive to oil prices. An extended decrease in the price of oil is likely to induce a decrease in oil production; an extended increase in the price of oil will likely stimulate non-OPEC oil production and even delay the inevitable decline in non-OPEC production by raising non-OPEC oil production capacity. The general consensus is that non-OPEC oil producers are price takers, not price makers.

In contrast, there is an estimated excess in production capacity of about 8 to 9 million barrels per day for OPEC oil producers. Clearly, this excess creates a trade-off situation for OPEC between market share and oil price; an increase in oil production could expand market share but would likely drive down the price. In the late 1970's and the 1980's, OPEC raised the price of crude oil at the expense of market share; but very high prices encouraged non-OPEC production, and eventually OPEC not only lost market share but also received a lower price as well. Market stability should continue to be sensitive to the actions OPEC members take in pursuing their short and longer term goals. It

is assumed in this report that OPEC pursues actions that result in a relatively 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 2). 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 15-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 (Table 5). 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, 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 (Figure 4). 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 countries that can continue to expand their production capacity in the 1990's and affect 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 because of 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 reach 180,000 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, Saudi Arabia, the United Arab Emirates, and, to a lesser extent, Venezuela have significant amounts of proved reserves and high R/P ratios. Kuwait, Saudi Arabia, the United Arab Emirates, and Iraq 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 (Figures ES2 and 5), and the impact of OPEC in the world oil market could be dominant again in the late 1990's.

Worldwide Trends in Refinery Capacity

World refining capacity is projected to grow in both crude distillation units and conversion units in the next few years to keep up with growing demand. World refining capacity in 1988, 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.

The trend of world oil refining capacity is 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 in 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.

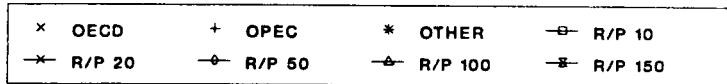
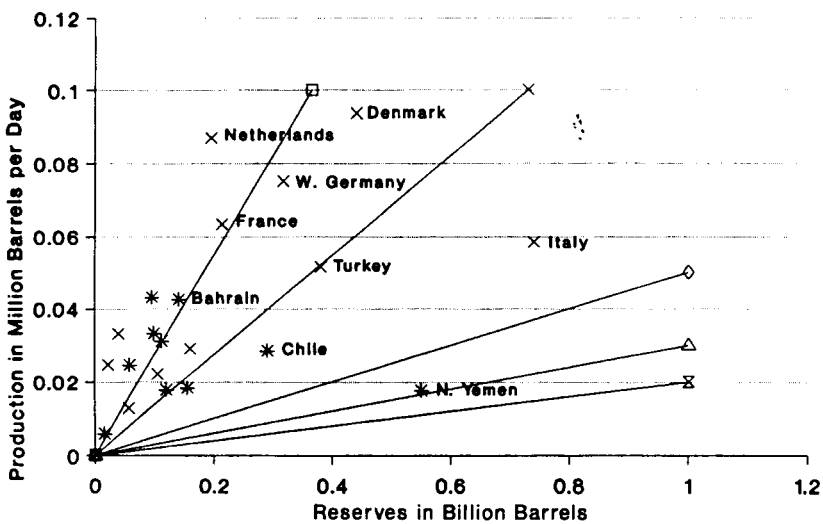
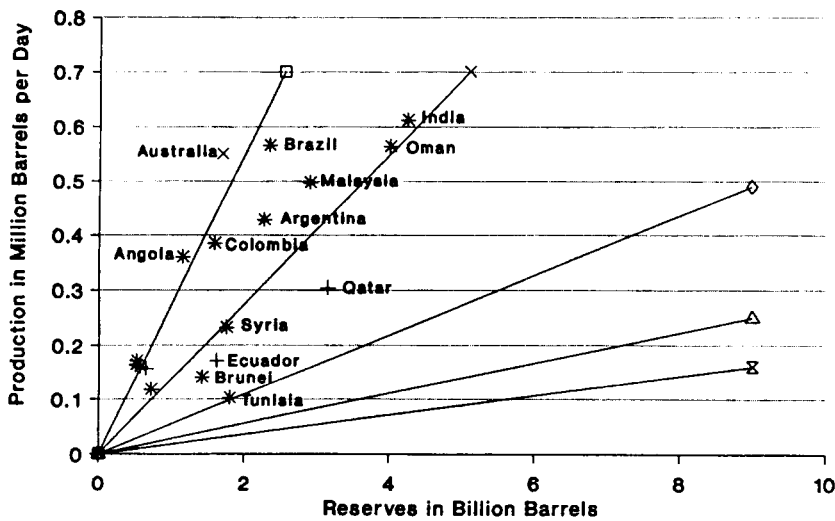
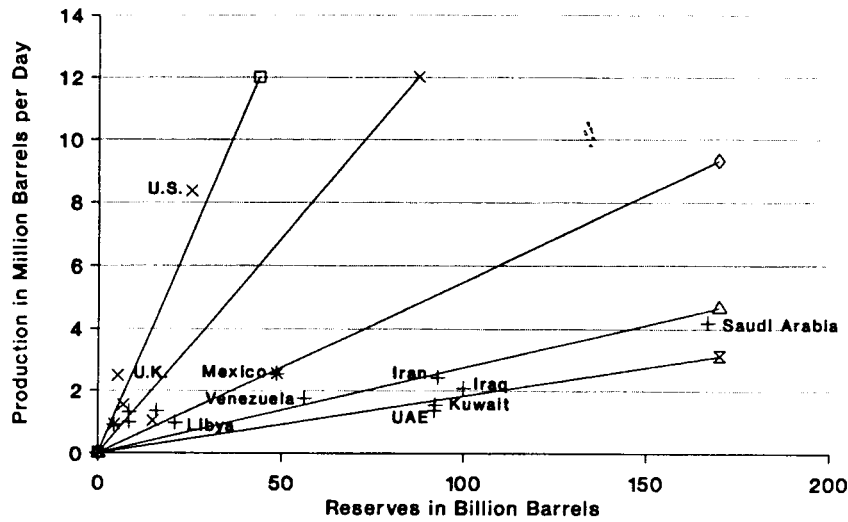
Table 5. Crude Oil Production, Proved Reserves, and Reserve-to-Production Ratios in the Market Economies, 1987

Countries	Production (million barrels per day)	Proved Reserves (billion barrels)	Reserve/Production Ratio
United States	8.349	25.27	8.3
Saudi Arabia	4.186	166.98	109.3
Mexico	2.540	48.61	52.4
United Kingdom	2.476	5.20	5.8
Iran	2.426	92.85	104.9
Iraq	2.079	100.00	131.8
Venezuela	1.751	56.30	88.1
United Arab Emirates	1.541	92.20	164.0
Canada	1.533	6.83	12.2
Kuwait	1.361	91.92	185.0
Nigeria	1.340	15.98	32.7
Indonesia	1.311	8.40	17.6
Norway	1.015	14.80	40.0
Algeria	0.985	8.50	23.6
Libya	0.972	21.00	59.2
Egypt	0.898	4.30	13.1
India	0.612	4.25	19.0
Brazil	0.566	2.34	11.3
Oman	0.564	4.01	19.5
Australia	0.550	1.69	8.4
Malaysia	0.497	2.90	16.0
Argentina	0.428	2.27	14.5
Colombia	0.385	1.59	11.3
Angola/Cabinda	0.360	1.15	8.7
Qatar	0.304	3.15	28.4
Syria	0.232	1.75	20.7
Cameroon	0.172	0.52	8.3
Ecuador	0.172	1.62	25.8
Peru	0.164	0.51	8.5
Trinidad & Tobago	0.160	0.57	9.7
Gabon	0.156	0.65	11.3
Brunei	0.140	1.42	27.8
Congo	0.118	0.72	16.8
Tunisia	0.103	1.80	48.1
Denmark	0.094	0.44	12.9
Netherlands	0.087	0.20	6.1
Germany, West	0.075	0.32	11.5
France	0.063	0.21	9.2
Italy	0.058	0.74	34.7
Turkey	0.051	0.38	20.3
Pakistan	0.043	0.10	6.1
Bahrain	0.043	0.14	9.1
Thailand	0.033	0.10	8.2
Spain	0.033	0.04	3.2
Zaire	0.031	0.11	9.8
New Zealand	0.029	0.16	15.1
Chile	0.029	0.29	27.9
Burma	0.025	0.06	6.5
Greece	0.025	0.02	2.4
Austria	0.022	0.11	13.1
Bolivia	0.018	0.16	23.5
Ivory Coast	0.018	0.12	18.6
Yemen, North	0.018	0.55	85.6
Japan	0.013	0.06	12.3
Benin	0.008	0.10	34.2
Philippines	0.006	0.02	7.6
Guatemala	0.004	0.04	27.1
Jordan	0.004	0.01	8.2
Yemen, South	0.003	0.00	0.0
Taiwan	0.002	0.01	6.4
Barbados	0.002	0.00	5.0
Suriname	0.002	0.03	37.0
Israel	0.001	0.01	27.4

Note: The R/P ratio equals the quantity (reserves times 1000) divided by the quantity (production times 365).

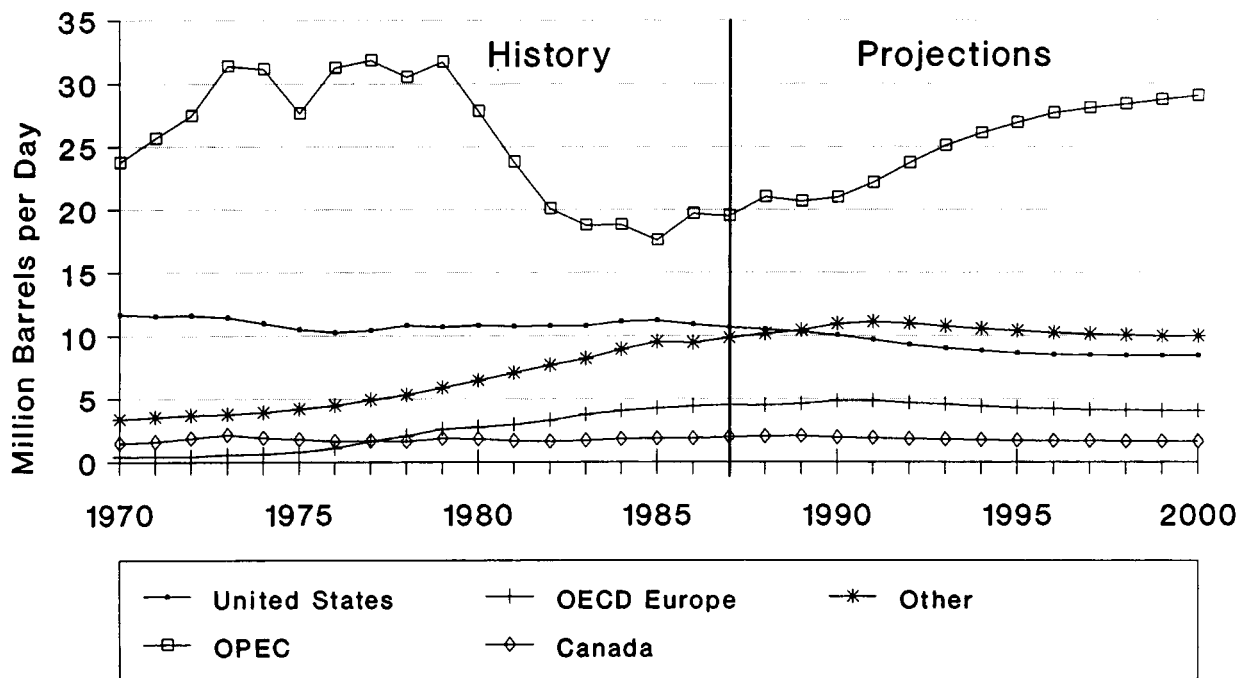
Sources: History: Energy Information Administration, *International Energy Annual 1987*, DOE/EIA-0219(87) (1988); and *Oil and Gas Journal*, December 28, 1987.

Figure 4. Oil Production and Proved Reserves in the Market Economies, 1987



Sources: Energy Information Administration, *International Energy Annual 1987* (1988) and *Oil and Gas Journal*, December 28, 1987.

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



Note: Production includes natural gas liquids, other liquids, and refinery gains.
Sources: **History:** Energy Information Administration, *International Energy Annual*, selected issues. **Projections:** Appendix Table A1 of this report.

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 oil distillation 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 oil distillation capacity has been steadily decreasing.⁷

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 both product demand and changes in product specifications.

Recent policy developments in the United States and Europe will also have profound effects on refinery configurations in the near future. The lead phasedown

⁷Historical data on the refining industry are presented in Energy Information Administration, *International Energy Annual*, DOE/EIA-0219, selected issues (Washington, DC).

program in the United States has increased the need to produce gasoline blending components capable of raising octane numbers. The phasedown program will continue to result in added downstream capacity such as alkylation units, reforming units, and isomerization units.

A proposed U.S. regulation on Reid vapor pressure would decrease the demand for butane as a gasoline blending component. Since butane is a good source of octane, a reduction in the use of butane would raise the burden on refiners to increase the production of other gasoline-blending components in order to raise the octane number. At the same time, the release of butane as a gasoline component would likely lower its market value and, consequently, affect refiners' profit margins. Industry adjustments to regulations on Reid vapor pressure are expected to include options such as use of higher octane catalysts in the fluid catalytic cracker, increased reforming severity, and the use of high octane blending stock such as methyl tertiary butyl ether (MTBE).

In Europe, the conversion of military jet fuel from naphtha type to kerosene type will raise the demand for kerosene but decrease the demand for naphtha. The change will also reduce military demand for gasoline. The switch of naphtha from military use to commercial use would increase feedstocks for use as petrochemicals or for use in reformers to augment the supply of higher octane blending components for gasoline. In a period of high demand for petrochemical products, this shift of jet fuel usage is welcomed. However, the increase in worldwide petrochemical production capacity in recent years and the prospect that natural gas may compete with naphtha in the petrochemical industry could diminish the benefits of this change to European refiners. All these changes will influence the economics of refinery operations and the development of refinery configurations.

In addition to the changes in world refinery configurations, there will likely be changes in the distribution of world refining capacity as well. After the 1979 oil price shock, world oil demand experienced a significant downturn. The reduction in oil consumption, however, came mainly from the OECD countries. Demand for oil actually rose in the developing countries. The increase in oil demand in the developing countries was very steep in the OPEC nations themselves, but the non-OPEC developing countries experienced demand increases as well. It is expected that the increase in demand for oil in developing countries will play an important role in determining the distribution of additional world refining capacity.

Refinery output itself should affect future product trade significantly because of the joint-product effect of the refinery process. For example, the 1984 coal strike in the United Kingdom increased demand for heating oil, but the result was not only increased production of fuel oil but also of gasoline and other light

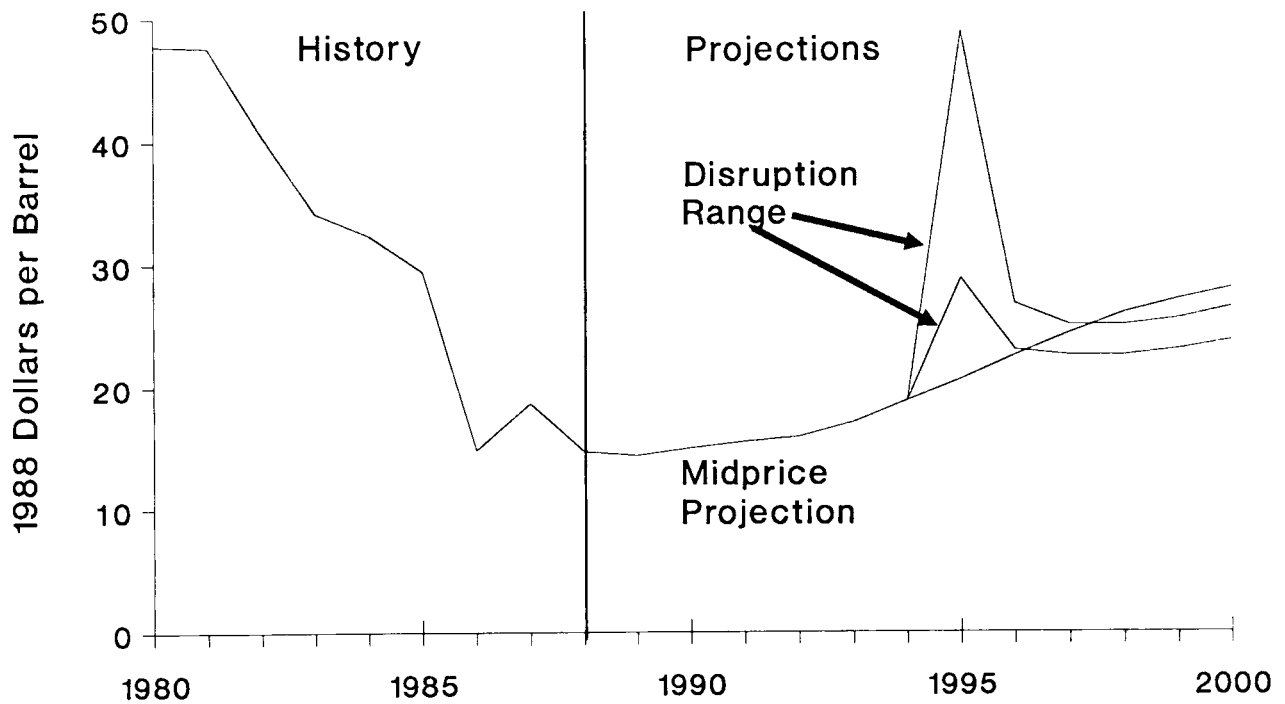
products as well. Excess supplies of these refined by-products were then sold in international markets and affected both product prices and trade flows.

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 is not only 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 10 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 10 million barrels per day could increase oil prices by \$10 to \$33 per barrel, depending upon what is assumed about commercial inventory behavior and the responsiveness of demand to price increases (that is, 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 predisturbance 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 than this erratic pattern of price movements and its potential adverse effects on the world economy.

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



Note: World oil availability cut 10 million barrels per day in 1995 for 6 months.

Sources: **History:** Energy Information Administration, *Annual Energy Review 1987* (1988). **Projections:** Table 1 of this report.

3. Oil Consumption Trends

Oil consumption in the market economies has accelerated since the major oil price decline in 1986 (Table 6) and is projected to continue growing between now and the year 2000, with slower growth occurring in the mid and late 1990's when oil prices begin to rise (Figure 7). Lower world oil prices, as projected for the late 1980's and early 1990's, would encourage increased oil consumption. Projected increases in economic activity worldwide would also be a major factor encouraging increased oil consumption.

As with economic activity, oil consumption is projected to grow the most in the developing countries, especially OPEC, with a joint annual growth rate from 1987 to 2000 between 1.0 percent and 2.4 percent (Table 7). The annual growth rate for the OECD countries over this period is projected to be from zero to 1.2 percent. Lower growth rates in oil consumption for the OECD countries reflect lower projected rates of economic growth, shifts towards less energy-intensive economic activities, and greater ability to shift away from oil for energy-security purposes. A projected tightening of world oil markets in the late 1990's, as non-OPEC oil supplies begin to decline, is accompanied by increasing world oil prices and decreasing rates of growth in oil consumption during the late 1990's.

Oil Consumption in the OECD Countries

Oil consumption in the OECD countries declined markedly after the first oil price shock of 1973-74, but then began to increase again, reaching a peak in 1979 (Table 6). The second oil price shock in 1979-80 caused oil consumption in the OECD countries to tumble once again, reaching a low in 1983. Oil consumption has grown subsequently, increasing markedly in 1986 and 1987 after the oil price collapse of 1986. Interestingly, oil consumption in the non-OECD countries has increased steadily over this entire period (Table 6), demonstrating less flexibility in reducing total energy requirements and in shifting away from oil when prices rise. As a result of these different consumption patterns, the OECD countries now account for about 3 of every 4 barrels of oil consumed in the market economies, down from about 4 of every 5 barrels consumed in 1973. The United States has accounted for roughly one-third of all oil consumed in the market economies since 1973.

Table 6. Oil Consumption in the Market Economies, 1973-1987
(Million Barrels per Day)

Year	United States*	Other OECD	Total OECD	Non-OECD	Total Market Economies
1973	17.3	22.3	39.6	7.4	47.0
1974	16.7	21.5	38.1	7.7	45.8
1975	16.3	20.3	36.6	8.0	44.6
1976	17.5	21.4	38.9	8.6	47.5
1977	18.4	21.9	40.4	9.1	49.5
1978	18.8	22.0	40.9	9.8	50.7
1979	18.5	23.1	41.6	10.6	52.2
1980	17.1	21.5	38.6	11.1	49.7
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	12.0	45.8
1984	15.7	18.8	34.5	12.3	46.8
1985	15.7	18.4	34.1	12.4	46.5
1986	16.3	18.8	35.1	12.8	48.0
1987	16.7	19.1	35.8	13.1	48.9

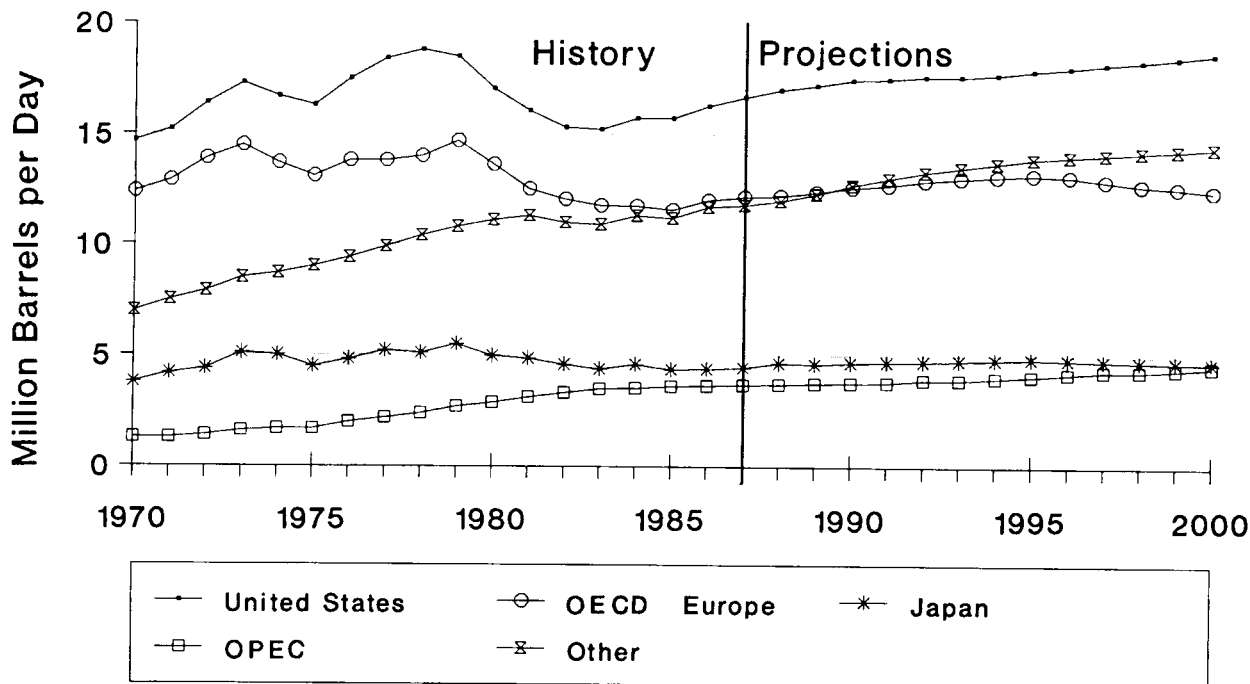
* Geographic coverage is the 50 States and the District of Columbia. U.S. Territories are included in "Other OECD."

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 1987*, DOE/EIA-0219(87) (1988); *Monthly Energy Review*, DOE/EIA-0035(88/05); and *Petroleum Supply Monthly*, DOE/EIA-0109(88/06) (1988).

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



Sources: **History:** Energy Information Administration, *International Petroleum Annual 1978* and *International Energy Annual*, selected issues. **Projections:** Table 7 of this report.

Table 7. Oil Consumption in the Market Economies, 1986-2000
(Million Barrels per Day)

Country/Region	History		Projections					
	1986 Actual	1987 Preliminary	1990		1995		2000	
			Base	Range	Base	Range	Base	Range
United States*	16.3	16.7	17.4	17.0-17.8	17.8	17.3-18.5	18.6	17.8-19.5
Canada	1.5	1.6	1.7	1.7-1.8	1.8	1.7-1.9	1.8	1.6-2.0
Japan	4.4	4.5	4.7	4.5-4.8	4.9	4.5-5.2	4.7	4.2-5.3
OECD Europe	12.0	12.2	12.6	12.1-13.0	13.2	12.2-14.1	12.4	11.1-14.1
United Kingdom	1.6	1.6	1.7	1.7-1.8	1.7	1.5-1.8	1.6	1.4-1.8
France	1.8	1.8	1.9	1.8-1.9	2.0	1.9-2.2	1.9	1.7-2.2
West Germany	2.5	2.4	2.6	2.5-2.7	2.8	2.6-3.0	2.7	2.4-3.0
Italy	1.7	1.8	1.8	1.7-1.8	1.9	1.7-2.0	1.8	1.6-2.0
Netherlands	0.7	0.7	0.7	0.7-0.7	0.7	0.6-0.7	0.7	0.6-0.7
Other Europe	3.7	3.8	3.9	3.8-4.0	4.1	3.8-4.4	3.9	3.5-4.4
Other OECD	0.9	0.9	1.0	0.9-1.0	1.0	1.0-1.0	1.1	1.1-1.1
Total OECD	35.1	35.8	37.4	36.4-38.2	38.7	36.6-40.7	38.5	35.7-42.0
OPEC	3.6	3.7	3.8	3.7-3.9	4.1	3.9-4.3	4.5	4.1-4.9
Other Developing Countries	9.2	9.4	10.2	10.0-10.6	11.3	10.7-12.0	11.8	10.9-12.9
Total Market Economies	48.0	48.9	51.4	50.1-52.6	54.1	51.1-57.0	54.9	50.7-59.7

* Geographic coverage is the 50 States and the District of Columbia. U.S. Territories are included in "Other OECD." United States 1987 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 1987*, DOE/EIA-0219(87) (1988); and *Monthly Energy Review*, DOE/EIA-0035(88/08) (1988). **Projections:** Energy Information Administration, Office of Energy Markets and End Use.

Much of the recent growth in oil consumption has been in the transportation sector. Thus, policies addressing automobile fuel efficiency could play an important role in determining future oil consumption or oil conservation among the OECD countries.

Prospects for oil consumption in the motor vehicle transportation sector will also be influenced by policies that address environmental concerns. For example, the European Community is currently attempting to fashion emission standards that would apply equally to all member countries. Agreement on such standards has been difficult, however, as certain countries consider proposed measures insufficient while others consider them discriminatory. The latter countries, particularly France, argue that the standards would effectively limit future exports of their products to prospective markets. Though environmental restrictions would not necessarily reduce the total amount of oil consumed, they would probably have some effect. Restrictions would definitely influence refinery yields, however, continuing recent trends towards lighter products, including lead-free gasoline.

In the industrial and electric utility sectors, environmental and security concerns should continue to encourage reduced use of oil. For example, natural gas produces less sulfur dioxide and less carbon dioxide than oil or coal. Similarly, nuclear power lacks associated problems of air pollution, though there continues to be concern over waste management and plant safety associated with the use of this energy source. Switching away from oil to natural gas and nuclear power not only addresses air-pollution questions but also serves to diversify the fuel mix used in manufacturing and electricity generation. The use of these alternatives to oil, plus the use of coal, is sought to increase energy security through diversification of energy supplies.

Oil Consumption in the Developing Countries

Much of the increase in oil consumption in the market economies between 1987 and 2000 is projected to occur

in the developing countries. Developing countries that import oil have little capability to shift their dependence from oil to other fuels. As a general rule, developing countries that have the lowest income have the highest percentage of oil imports, relative to their level of exports. Projects such as nuclear power plants and natural gas pipelines require large up-front investments. Still, other countries will be able to exploit indigenous energy resources, including oil.

Oil consumption in developing countries as a group is projected to increase between 1.0 and 2.4 percent per year between 1987 and 2000. The longer term trend of increasing oil consumption in the group of developing countries should result in part from their relatively rapid rate of economic growth, particularly among the newly industrialized countries of Asia.

In the near term, oil consumption 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 group of "Other Developing Countries" (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

As with oil, low prices and abundant supplies should encourage increased consumption of all major energy sources, particularly in the late 1980's and early 1990's. Between 1987 and 2000, total primary energy consumption in the market economies is projected to grow at an average rate of 1.5 to 2.1 percent per year. Oil should continue to be the most important single source of energy over this period, but its relative importance to total consumption is projected to decline steadily, from about 46 percent of the total in 1987 to a range of between 39 and 43 percent by 2000. In 1980, the share of oil in total energy consumption was just over 50 percent, thus its relative importance has already declined significantly. The other fossil fuels, natural gas and coal, are projected to increase in relative importance between 1987 and 2000, as is nuclear power. Projections of total primary energy by energy source are presented in Table 8 and Figure 8.

The relative decline in oil consumption is due in large part to changes that have occurred in the structure of the electricity supply industry since the oil crisis of 1973. Between 1973 and 1986, consumption of oil for electricity generation among the member countries of the International Energy Agency (IEA) was cut in

half, even while consumption of electricity was rising by 40 percent.⁸ Nuclear power and coal were the major substitutes for oil. With lower oil prices since 1986, oil consumption by electric power systems has increased in certain countries, but this trend is not considered to be a permanent reversal. 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 is estimated to have increased by about 3 percent in 1987, continuing an upward trend in energy consumption among the market economies that started in 1983. Over one fourth of the increase in energy consumption in 1987 was due to increased oil consumption, as lower oil prices continued to encourage the consumption of this fuel. Oil consumption in the market economies increased by about 3 percent in 1986 and about 2 percent

Table 8. Total Energy Consumption in the Market Economies by Type, 1986-2000
(Quadrillion Btu)

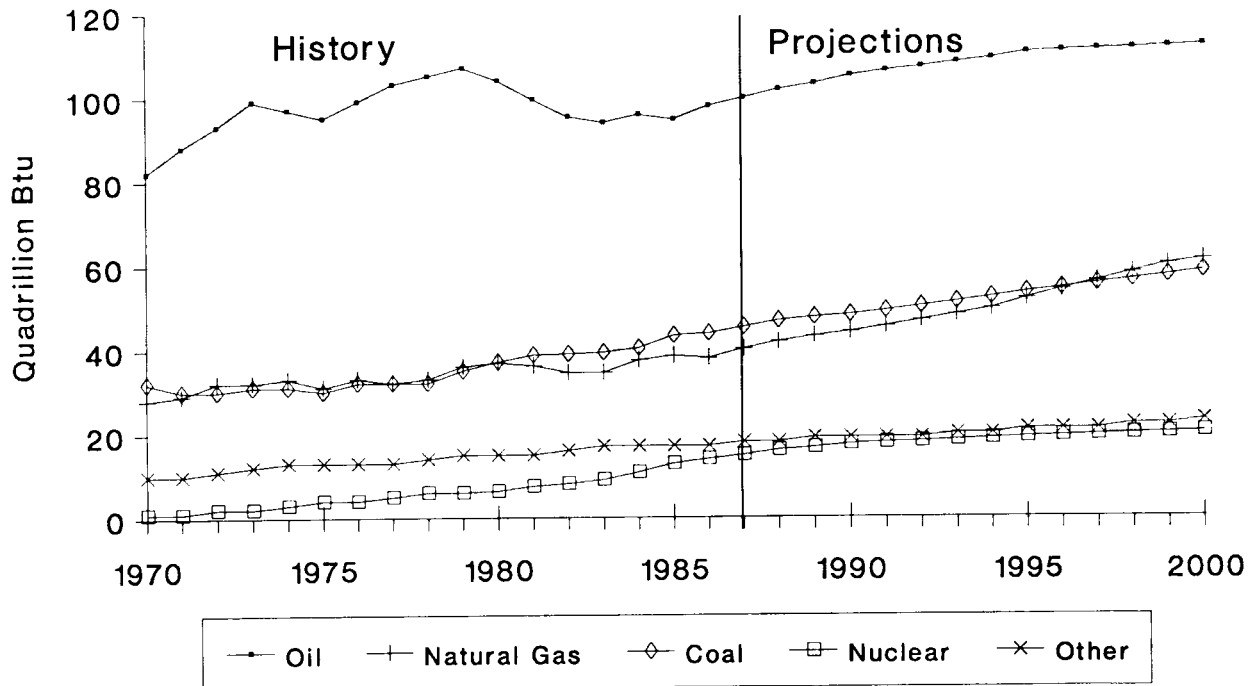
Energy Source	History		Projections					
	1986 Actual	1987 Preliminary	1990		1995		2000	
			Base	Range	Base	Range	Base	Range
Oil	98	100	105	102-107	110	104-116	112	103-122
Gas	38	40	44	44-46	52	51-56	60	58-66
Coal	44	45	48	48-49	53	53-55	58	57-61
Nuclear	14	15	17	17-18	19	19-20	20	20-22
Other	17	18	20	18-20	22	20-23	23	21-25
Total Primary Energy	211	218	234	232-237	256	250-263	274	264-284

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 1986-2000 are the following: (1) Oil--5.6 Million Btu/barrel, (2) Gas--1,020 Btu/cubic foot, and (3) Nuclear--10.7 Million Btu/terawatt-hour.

Sources: **History:** Energy Information Administration, *International Energy Annual 1987*, DOE/EIA-0219(87); and *Monthly Energy Review*, DOE/EIA-0035(88/08) (1988). **Projections:** Energy Information Administration, Office of Energy Markets and End Use.

⁸France, Finland, and Iceland are members of the OECD but not the IEA. Data for the electricity supply industry are presented in International Energy Agency, *Energy Policies and Programmes of IEA Countries, 1987 Review*, (Paris, France, 1988).

**Figure 8. Total Energy Consumption in the Market Economies by Type:
Base Case, 1970-2000**



Sources: **History:** United Nations, *1979 Yearbook of World Energy Statistics* (1981); and Energy Information Administration, *International Energy Annual* and *International Petroleum Annual*, selected issues. **Projections:** Table 8 of this report.

in 1987. However, the fastest growing energy source in 1987 continued to be nuclear power, increasing by about 7 percent. Nuclear power is estimated to have increased markedly again in 1988. Total energy consumption is also estimated to have increased again in 1988.

Most of the 1987 growth in total energy consumption occurred in the OECD countries, with the United States accounting for about 45 percent of the OECD growth. The developing countries, including OPEC, accounted for about one-sixth of the 1987 increase in total energy consumption in the market economies.

Differences in the prospects for economic growth among the market-economy regions as well as differences in basic economic structure will influence energy consumption prospects among these regions. Starting at a lower base, economic activity and energy consumption should grow most rapidly in the group of developing countries over the projection period (Table 9 and Figure 9). Growth in motor transportation and in electrification in many developing countries should contribute to higher growth in energy consumption relative to the OECD countries. However, a major question concerning the prospects of economic growth in certain key developing countries arises from their foreign debt situation. Solutions to and, therefore, impacts on international financial markets and on eco-

conomic systems of the foreign debt problem currently remain undetermined.

Given widely differing energy resources, energy growth patterns among the OECD countries will also differ. With few indigenous energy resources of its own, Japan must import much of the energy required to meet its needs. To reduce this lack, Japan is expected to expand nuclear production substantially between now and the year 2000. Japan will also seek to decrease its energy vulnerability by diversifying, to the largest extent possible, its sources for expanding natural gas imports.

Like Japan, many of the OECD countries in Europe are also expected to increase natural gas imports. Natural gas is desired not only because it serves to diversify energy requirements but also because of its clean-burning characteristics, a property that has grown in importance as environmental concerns have grown. Growing natural gas imports to Europe, and elsewhere, from the Middle East and from the Soviet Union could have an important influence on future energy trade patterns and prices and, therefore, on the economic prospects in the importing countries as well as in the exporting countries.

France, like Japan, is promoting its nuclear industry to help make up for the lack of indigenous energy re-

Table 9. Total Energy Consumption in the Market Economies, 1986-2000
(Quadrillion Btu)

Country/Region	History		Projections					
	1986 Actual	1987 Preliminary	1990		1995		2000	
			Base	Range	Base	Range	Base	Range
United States ^a	74.2	76.8	81.6	80.7-82.5	85.8	84.3-87.3	90.6	88.6-92.9
Canada	9.7	9.8	10.6	10.5-10.7	11.8	11.5-12.1	12.5	12.0-13.0
Japan	15.8	16.3	17.9	17.7-18.2	19.7	19.2-20.2	20.7	19.9-21.4
OECD Europe	55.7	57.5	61.3	60.6-62.0	66.0	64.3-67.7	68.5	66.2-70.7
United Kingdom	9.1	9.3	9.8	9.7-9.9	10.5	10.3-10.7	10.8	10.5-11.1
France	8.4	8.8	9.5	9.4-9.6	10.4	10.1-10.7	10.9	10.5-11.4
West Germany	12.2	12.3	12.9	12.8-13.0	13.6	13.4-13.9	13.9	13.6-14.3
Italy	6.2	6.3	6.9	6.8-6.9	7.5	7.3-7.7	7.8	7.5-8.0
Netherlands	3.1	3.1	3.2	3.2-3.3	3.4	3.3-3.5	3.5	3.4-3.6
Other Europe	16.7	17.7	19.0	18.7-19.2	20.6	20.0-21.2	21.6	20.9-22.4
Other OECD	4.2	5.0	5.4	5.3-5.4	5.8	5.6-6.0	6.0	5.8-6.2
Total OECD	159.6	165.4	176.8	174.7-178.8	189.1	184.9-193.3	198.3	192.6-204.1
OPEC	12.7	12.9	13.9	13.7-14.1	16.4	15.8-17.0	18.8	17.8-19.8
Other Developing Countries	38.3	39.2	43.5	42.7-44.2	50.9	49.0-52.8	57.0	53.9-60.0
Total Market Economies	211	218	234	232-237	256	250-263	274	264-284

^a Geographic coverage is the 50 States and the District of Columbia. U.S. Territories are included in "Other OECD." United States 1987 amount is actual.

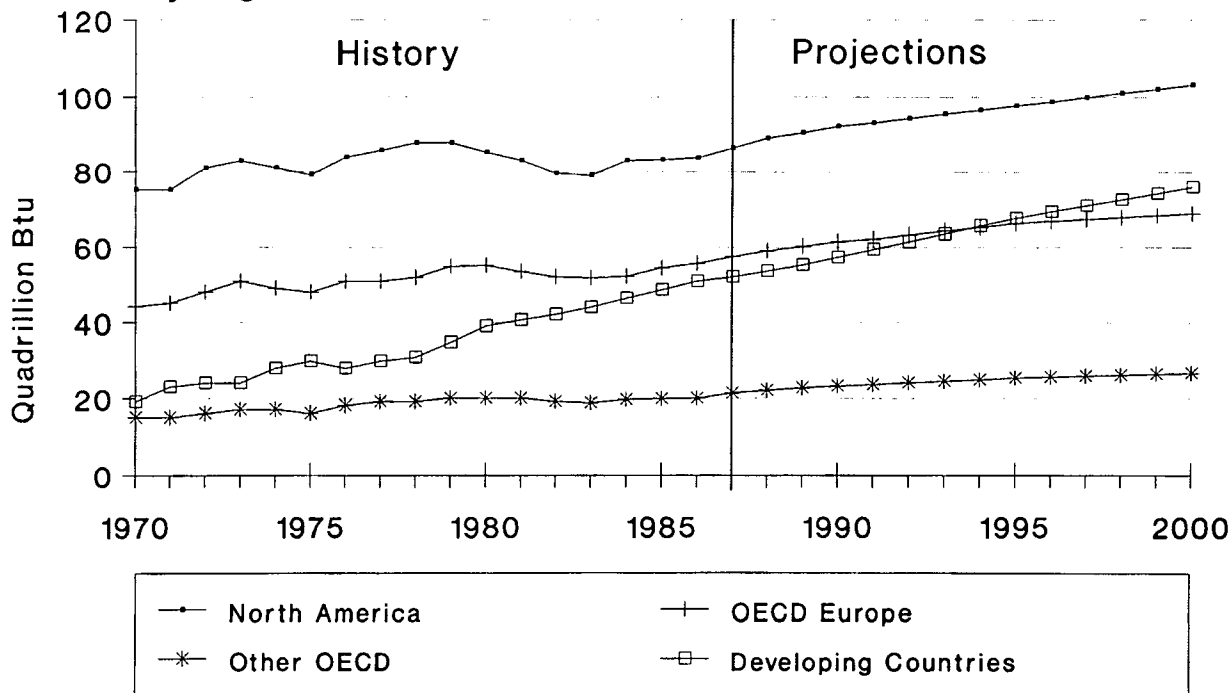
OECD=Organization for Economic Cooperation and Development.

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 1987*, DOE/EIA-0219(87) (1988); and *Monthly Energy Review*, DOE/EIA-0035(88/08) (1988). **Projections:** Energy Information Administration, Office of Energy Markets and End Use.

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



Sources: **History:** United Nations, *1979 Yearbook of World Energy Statistics* (1981); and Energy Information Administration, *International Energy Annual* and *International Petroleum Annual*, selected issues. **Projections:** Table 9 of this report.

sources. Most of the consumption of nuclear energy has occurred and is expected to continue to occur among the OECD countries, such as France, Japan, and the United States. However, prospects for nuclear power vary considerably among the other OECD countries, primarily because of different policies regarding environmental objectives. Interestingly, nuclear power production in the Soviet Union was up substantially in 1987, reversing the decline in 1986 following Chernobyl (Table C6). The Soviets could be encouraging nuclear power for domestic use in order to have more oil and natural gas to export and obtain needed foreign exchange.

The OECD countries also differ in terms of the energy intensity of their economies. For example, the ratio of total primary energy requirements (TPER) to gross domestic product (GDP) was about twice as great in the United States in 1987 as it was in Japan.⁹ Countries with highly energy-intensive economies could, conceivably, conserve the most energy in the future. Canada is the most energy-intensive country as measured by the TPER/GDP ratio, but the IEA points out that the Canadian ratio is artificially high because of the relatively large share of total energy requirements provided by hydro and nuclear power and because of the method used to calculate the energy equivalents of these two sources. The substitution of hydro and nuclear power for oil that has occurred in Canada accentuates this measurement problem.

Among the members of the IEA, Turkey, Portugal, Greece, and Spain used the least amount of energy in 1987 on a per-capita basis. The TPER/Per Capita ratio in the United States was somewhat over seven times as great as that in Turkey. Portugal and Turkey also had the highest Oil/GDP ratios among the IEA countries. These countries have had difficulty shifting away from oil. With lower oil prices, incentives to shift away from oil have been reduced further in these and other countries, as the benefits from fuel substitution and oil conservation become less certain.

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. Increased consumption of electricity accounts for much of the increased consumption of energy in the residential/commercial and industrial sectors. In the OECD taken as a whole, the relative

importance of oil as a fuel to produce increased amounts of electric power should continue to decline over the projection period while that of natural gas and coal should rise. As is the case currently, about one-half of all oil consumed in the OECD countries is projected to occur in the transportation sector. Fuel-efficiency gains should help limit oil consumption growth in this sector.

Prospects for Coal

Total coal consumption in the market economies is projected to grow at a rate of between 1.8 and 2.3 percent per year between 1987 and 2000 (Table 10 and Figure 10). Its share of total energy consumption is projected to remain at about 21 to 22 percent over the projection period.¹⁰ The demand for coal by electric utilities is expected to grow as the desire for electrification and for supply-diversification grows. Since Western Europe and Asia, excluding China, have minimal reserves that are economical to mine, international trade in coal is expected to increase. The traditional exporters of coal, including the United States, Australia, South Africa, and Poland, are expected to face increased competition from new suppliers, including China, Colombia, and Venezuela. Abundant supplies of coal worldwide should help to keep prices down over the projection period.¹¹

As with other energy prices, coal prices are expected to remain depressed for several years. Such a situation could discourage the investments needed to ensure future supplies. Even today, the current level of coal prices is cause for concern among mining operators and developers who made investment decisions in the early 1980's, when energy prices were high.

Low prices have also contributed to a major restructuring of the coal industry in Europe, where countries are attempting to reduce high-cost production operations. In Europe and Japan, governments must reduce inefficient operations and yet limit the regional economic impact of mine closures. Measures to protect indigenous coal operations could act to reduce the growth in coal trade somewhat.

Exports by the United States, just under 80 million short tons in 1987, are expected to remain relatively flat over the projection period. In 1988, however, coal exports traveling through the St. Lawrence Seaway are expected to be the highest in 6 years. Contributing to increased 1988 demands for U.S. coal were a lower value of the dollar, competitive ocean-freight rates

⁹TPER/GDP, TPER/Per Capita, and Oil/GDP ratios for the period 1973 through 1987 are presented in International Energy Agency, *Energy Policies and Programmes of IEA Countries, 1987 Review* (Paris, France, 1988).

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

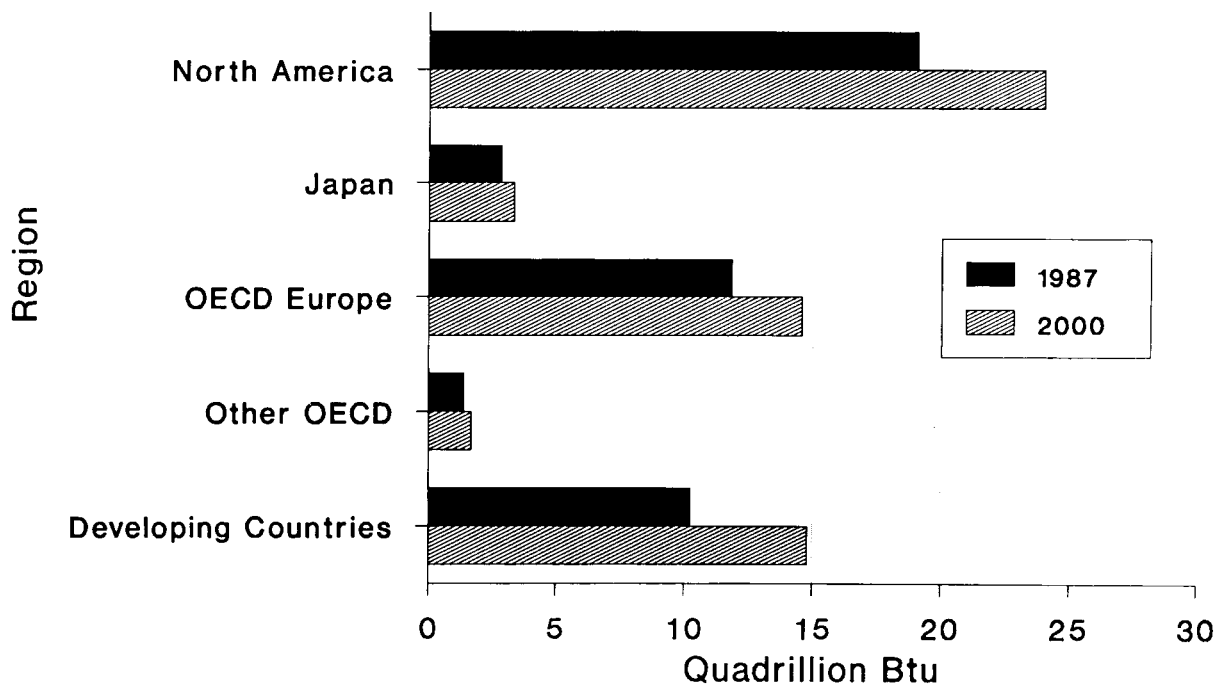
¹¹International coal trade is explored in detail in *Annual Prospects for World Coal Trade 1988*, DOE/EIA-0363(88) (Washington, DC, 1988).

Table 10. Coal Consumption in the Market Economies, 1986-2000
(Quadrillion Btu)

Country/Region	History		Projections					
	1986 Actual	1987 Preliminary	1990		1995		2000	
			Base	Range	Base	Range	Base	Range
United States*	17.3	18.0	19.1	19.1-19.1	21.0	20.9-21.0	22.5	22.3-22.5
Canada	1.0	1.0	1.1	1.0- 1.1	1.2	1.2- 1.3	1.5	1.4- 1.6
Japan	2.8	2.8	3.1	3.0- 3.1	3.2	3.1- 3.4	3.3	3.2- 3.5
OECD Europe	11.5	11.9	12.4	12.3-12.6	13.4	13.1-14.0	14.6	14.2-15.3
United Kingdom	2.7	2.7	2.9	2.9- 2.9	3.2	3.1- 3.3	3.3	3.2- 3.4
France	0.9	0.9	0.9	0.9- 0.9	0.9	0.9- 0.9	0.9	0.9- 0.9
West Germany	3.8	3.7	3.8	3.8- 3.9	3.9	3.8- 4.0	4.1	3.9- 4.2
Italy	0.6	0.7	0.7	0.7- 0.8	0.9	0.8- 1.0	1.1	0.9- 1.2
Netherlands	0.3	0.3	0.3	0.3- 0.3	0.3	0.3- 0.4	0.4	0.4- 0.4
Other Europe	3.3	3.6	3.8	3.7- 3.9	4.2	4.1- 4.6	4.9	4.7- 5.4
Other OECD	1.3	1.4	1.5	1.4- 1.5	1.6	1.6- 1.7	1.7	1.6- 1.7
Total OECD	33.8	35.1	37.1	37.0-37.5	40.4	40.1-41.5	43.5	43.1-45.1
OPEC	0.2	0.2	0.2	0.2- 0.2	0.3	0.3- 0.3	0.4	0.3- 0.4
Other Developing Countries	9.8	10.1	11.0	10.8-11.2	12.8	12.4-13.3	14.4	13.8-15.4
Total Market Economies	43.8	45.4	48.2	48.0-48.9	53.4	52.9-55.2	58.3	57.3-61.1

* Geographic coverage is the 50 States and the District of Columbia. U.S. Territories are included in "Other OECD." United States 1987 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 1987*, DOE/EIA-0219(87) (1988); and *Monthly Energy Review*, DOE/EIA-0035(88/08) (1988). **Projections:** Energy Information Administration, Office of Energy Markets and End Use.

Figure 10. Coal Consumption in the Market Economies, 1987 and 2000



Sources: **History:** Energy Information Administration, *International Energy Annual 1987* (1988); and *Monthly Energy Review*, July 1988 (1988). **Projections:** Table 10 of this report.

worldwide, lower coal supplies from Australia caused by industry disputes last summer, sanctions against South African coal, and production problems and rising production costs in Poland.

Increased consumption of coal is expected to come mainly from demand for steam coal rather than for metallurgical coal, which is used for steel production. Slower growth in the demand for metallurgical coal is expected as substitutes for steel increase and as steel production technology improves.

Growth in the consumption of steam coal is expected to accompany growth in the consumption of electricity. In 1985, electric utilities consumed about 70 percent of all coal in the OECD countries (Appendix B). This share is projected to increase to about 77 percent by the year 2000. OECD coal consumption in the industrial sector, which accounted for 26 percent of the total in 1985, is projected to account for about 19 percent of the total by 2000. Britain, given the current situation of abundant and inexpensive oil, recently terminated a program to encourage conversion of industrial boilers to coal.

Environmental concerns about sulphur dioxide and carbon dioxide emissions could constrain the growth of coal consumption. There is strong opposition to the construction of new coal-fired power stations in Italy, for example. Sulphur dioxide is a contributor to acid rain. Carbon dioxide is said to be contributing to the greenhouse effect, the consequences of which would be a general warming trend of the earth's atmosphere. These emission concerns do not arise with respect to nuclear power, though this energy source raises other environmental concerns. Emissions from natural gas are also far less than those from coal. Thus, natural gas and nuclear power could capture markets potentially open to coal, particularly in the generation of electric power.

Prospects for Natural Gas

World natural gas reserves in many regions of the world have increased beyond the expectations of energy industry and government analysts. Proven world natural gas reserves have risen from about 45 percent of the level of proven oil reserves in 1970 to about 98 percent of those reserves in 1986.¹² The viability of natural gas as a dominant source of world energy demand may soon no longer be a question of adequate supply, but rather the political and economic viability of its transport capability to distant regions and shores. The primary factors influencing future natural gas consumption are: natural gas prices relative to other fuels, capital investments in gas distribution systems, the con-

tinued development of more competitive markets, environmental pressure for a cleaner fuel and more efficient fuel use, and overall economic growth.

Natural gas consumption in the market economies is forecasted to increase from an estimated 39.3 trillion cubic feet in 1987 to a range of 56.8 to 64.0 trillion cubic feet by the year 2000 (Table 11 and Figure 11). Natural gas accounted for about 18 percent of total energy consumption in 1987.

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-cycle units and increased utilization of existing gas-fired plants. The recent unprecedented growth of nonutility electric generation, the largest share of which is fueled by industrial gas-fired cogeneration units, may spur gas demand as well. Environmental regulations regarding emission levels may also reduce coal and oil use in favor of natural gas in many areas. By the early 1990's existing EPA regulations, for instance, will require bus manufacturers to produce vehicle engines that run on fuels with lower emission levels than diesel fuel, encouraging the commercial use of natural gas and methanol vehicles. By 1990, natural gas demand is expected to range from 17.9 to 18.2 trillion cubic feet, reaching 20.2 to 20.6 trillion cubic feet by 2000.

Canada has an expanding domestic market for natural gas, and is a major producer and net exporter. 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 inroads into the structural network of U.S. gas markets, both with increased transmission access and competition in U.S. markets.

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 due mainly to continued economic growth and a preference for imported LNG over imported crude oil for environmental reasons. Although Japan will inevitably remain import-dependent, its reliance on a diversity of suppliers is designed to minimize the risk of supply interruptions and shortages.

The European natural gas market is projected to grow from 16.1 percent of total primary energy demand in 1987 to 19.4 in 2000, cutting into the oil market share through its price competitiveness, and matching the market share of coal because of a probable constraint in coal use to meet environmental concerns. By 2000, natural gas demand in Europe is expected to reach

¹²International Gas Union, "World Gas Supply and Demand 1986-2020," 17th World Gas Conference, Washington, DC, June 5-9, 1988.

Table 11. Natural Gas Consumption in the Market Economies, 1986-2000
(Trillion Cubic Feet)

Country/Region	History		Projections					
	1986 Actual	1987 Preliminary	1990		1995		2000	
			Base	Range	Base	Range	Base	Range
United States*	16.2	17.1	17.9	17.9-18.2	18.9	18.7-19.1	20.3	20.2-20.6
Canada	2.0	2.0	2.1	2.1-2.2	2.6	2.5-2.9	3.0	2.8-3.3
Japan	1.5	1.6	2.5	2.5-2.9	3.1	2.9-3.7	3.6	3.2-4.5
OECD Europe	8.6	9.1	9.6	9.4-10.0	11.0	10.5-12.1	13.3	12.5-14.8
United Kingdom	2.0	2.2	2.6	2.6-2.7	3.1	3.0-3.3	3.4	3.3-3.7
France	1.1	1.1	0.8	0.7-1.0	0.8	0.5-1.2	1.2	0.8-1.8
West Germany	2.0	2.1	2.0	1.9-2.1	2.2	2.0-2.5	2.6	2.3-3.0
Italy	1.3	1.4	1.4	1.4-1.5	1.6	1.5-1.8	1.9	1.7-2.2
Netherlands	1.4	1.4	1.4	1.4-1.5	1.6	1.6-1.7	1.8	1.7-1.9
Other Europe	0.9	0.9	1.3	1.3-1.5	1.7	1.6-2.1	2.3	2.1-2.8
Other OECD	0.6	0.7	0.7	0.7-0.8	0.9	0.9-0.9	0.9	0.9-1.0
Total OECD	29.0	30.5	32.9	32.5-34.0	36.5	35.4-38.7	41.1	39.6-44.2
OPEC	4.3	4.7	5.3	5.3-5.3	6.9	6.7-6.9	8.2	7.8-8.2
Other Developing Countries	3.7	4.2	5.4	5.2-5.7	7.9	7.4-8.8	10.3	9.5-11.7
Total Market Economies	37.0	39.3	43.6	43.0-45.0	51.3	49.4-54.4	59.6	56.8-64.0

* Geographic coverage is the 50 States and the District of Columbia. U.S. Territories are included in "Other OECD." United States 1987 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 1987*, DOE/EIA-0219(87) (1988); and *Monthly Energy Review*, DOE/EIA-0035(88/08) (1988). **Projections:** Energy Information Administration, Office of Energy Markets and End Use.

about 13.3 trillion cubic feet, up from 9.1 trillion cubic feet in 1987.

The future increase in European natural gas demand and its competitive penetration of other fuel markets will be determined by the ability of interconnecting gas transmission companies and their suppliers to establish flexible market-responsive contracts, particularly with their industrial and electric utility customers. Flexible contracts will provide suppliers access to new demand markets, while providing buyers access to a more diverse source of competitively priced natural gas from both European and foreign supplies. The upcoming 1992 completion of the European Economic Community accord on commodity trading may pressure major European natural gas pipelines to establish more flexible transmission access.

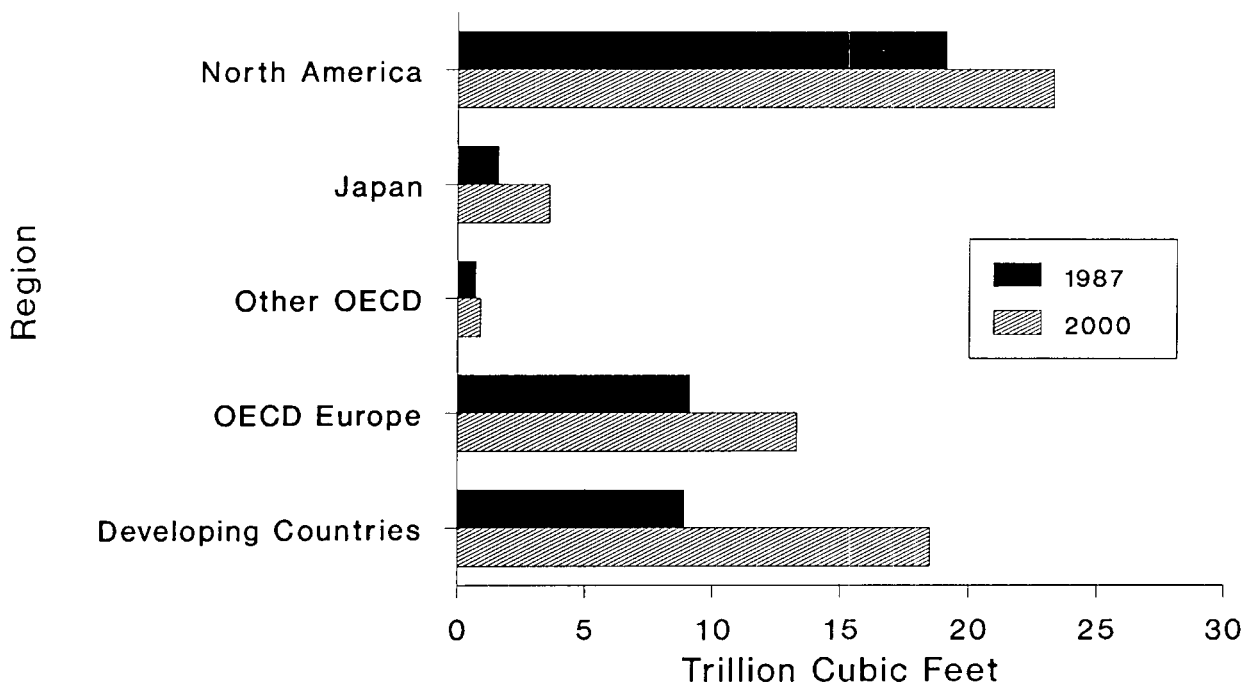
Recent trends, however, already indicate the growth and increased competitiveness of natural gas in European energy markets. Natural gas contracts, on the whole, are no longer pegged to crude oil prices as they once were. Negotiations between Dutch electric utilities and Norwegian suppliers, for instance, have resulted in gas import contracts indexed to coal prices. Political considerations aside, increasing French gas

import prices indirectly compete with the price of surplus domestic nuclear power generation.¹³ The development of more fuel-efficient generation technologies utilizing gas may also enable gas to compete with coal for new generating capacity. The outlook 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 fully integrated gas company, and new regulatory mandates for increased interfuel competition may improve natural gas 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 authorized gas supplies.
- 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. However, low oil

¹³Estrada, Bergesen, Moe and Sydnos, Fridtjof Nansen Institute, *Natural Gas in Europe: Markets, Organization and Politics* (Pinter Publishers, London, 1988), p. 125.

Figure 11. Natural Gas Consumption in the Market Economies, 1987 and 2000



Sources: **History:** Energy Information Administration, *International Energy Annual 1987* (1988); and *Monthly Energy Review*, July 1988 (1988). **Projections:** Table 11 of this report.

prices and a continued surplus of nuclear power may serve as a disincentive to new nuclear power construction, which may in turn result in increased gas use. Natural gas imports are state controlled and tied directly to the country's trade balance. Therefore, increased gas imports are often negotiated in association with increased industrial exports.

- 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. While Germany itself has significant gas reserves, by the early 1990's Soviet gas import sales are expected to increase to over one-third of its total gas demand. Soviet imports have already increased from about 18 percent of German gas demand in 1980 to about 26 percent in 1986.¹⁴ The share of total energy supplied by natural gas is expected to increase from 14.5 percent in 1987 to about 18.7 percent in 2000.
- Natural gas consumption in Italy 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. With only about 20 percent of its energy supply coming from indigenous sources, Italy has traditionally received gas from a diverse group of suppliers as a hedge against overdependence on any one source. Italy is expected to increase gas consumption from about 21 percent of its total energy demand in 1987 to about 25 percent in 2000.

- The Netherlands, with a mature market and adequate domestic reserves, is expected to maintain its consumption at close to the 1987 level through 1990 and to increase modestly 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. The Netherlands is currently the fourth largest gas producer in the world and the second biggest exporter.
- 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.

¹⁴Energy Information Administration, *International Energy Annual, 1986* DOE/EIA-0219(86) (Washington, D.C., 1987).

Western European natural gas demand requirements are currently supplied by indigenous production (about 50 percent), intra-OECD trade (about 25 percent), and non-OECD trade (about 25 percent). Non-OECD gas trade is expected to meet an ever-increasing percentage of European gas demand. According to present contract arrangements, it should meet over 33 percent of OECD European gas demand by 1990, up from about 14 percent of gas demand in 1980. 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. Western European gas reserves can meet European gas production (R/P ratio) for approximately 42 years.¹⁵ 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. As natural gas demand increases, the incremental requirements are likely to be met by supplies outside the OECD. Nevertheless, Western Europe is expected to maintain its indigenous production and intra-OECD trade at no less than two-thirds of the region's supply requirements.

Soviet energy planners have focused great attention on their gas industry, both to meet domestic demand and as a source of foreign exchange revenues through its export to Western Europe. By 1990, natural gas demand is expected to represent about 40 percent of total energy demand, according to Soviet energy planners. While the Siberian oil industry is accounted for by one major "supergiant" field, natural gas is dispersed among six major fields in northwestern Siberia. A weak oil export market resulting from a depressed international oil market serves as an incentive for the Soviets to increase their gas exports. The Soviet's plans are to continue to increase their long-term gas production growth past 2000.¹⁶ 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 increases by other gas suppliers to Europe, and in particular the growth of Norwegian gas sales.

Rapid growth in natural gas demand is also forecasted to occur in OPEC and other developing countries. Short-term growth in OPEC demand could be tempered, however, by 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 in-

crease in South Asian markets as the result of increased LNG exports, principally 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, and private and international organization investments.

Prospects for Nuclear and Other Energy Sources

The outlook for the consumption of energy derived from nuclear power remains less optimistic than before the Chernobyl reactor accident of April 1986. The future of nuclear power development continues to be undermined by post-Chernobyl public anxieties over nuclear power plant safety and nuclear waste disposal problems, as well as by financial difficulties in developing countries. The prospects for renewable energy sources, including hydroelectric, geothermal, and other renewables, continue to be hampered by low oil prices, relatively slow growth in energy demand, and erratic government support. On the other hand, many countries will continue to look towards development of renewable resources as a means of reducing their reliance on potentially vulnerable oil imports.

The consumption of energy derived from nuclear and "other" commercial sources by the market economies is projected to increase from an estimated level of 33 quadrillion Btu in 1987 to between 41 and 47 quadrillion Btu in 2000, or at an average annual growth rate of between 1.7 and 2.8 percent (Table 8). As a result, the share of total energy contributed by these sources is projected to increase from about 15 percent in 1987 to about 16 percent in 2000, with nuclear and "other" sources contributing in roughly equal proportions.

Consumption of nuclear power by the market economies is projected to increase from an estimated level of 1405.2 terawatt-hours (TWh) in 1987 to between 1811 and 1970 TWh in 2000, or at an average annual growth rate of between 2.0 percent and 2.6 percent (Table 12 and Figure 12). The growth of consumption is expected to be slower after 1995 than in the 8 preceding years, however, reflecting the drop in the growth rate of nuclear generating capacity. Thus, from 1987 through 1995, nuclear power consumption is projected to grow from 2.4 percent to 3.2 percent annually,

¹⁵Masters, Attanasi, Dietzman, Meyer, Mitchell and Root, *World Resources of Crude Oil, Natural Gas, Natural Bitumen, and Shale Oil*, 12th World Petroleum Congress Conference Report.

¹⁶Jonathan P. Stern, Royal Institute of International Affairs, *International Gas Trade in Europe: The Role of the Soviet Union*, 1988 IAEE Conference Report, Houston, Texas, p. 332.

but only 1.2 percent to 1.8 percent annually from 1995 through 2000. Nuclear power, which was estimated to account for less than 7 percent of total energy consumption in 1987, is projected to account for about 7.4 percent in 2000.

Table 12 has been adjusted to reflect the fact that France is currently estimated to be exporting roughly 32 net TWh of nuclear-generated electricity to other European nations and is projected to be exporting between 41 and 52 net TWh of nuclear-generated electricity by 2000. Estimates of nuclear exports from France have been excluded from their nuclear consumption in Table 12 and Figure 13 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.

The prospects for nuclear power have continued to suffer because of heightened public apprehension and political opposition in the wake of the Chernobyl accident. The negative repercussions of this accident continue to affect nuclear power development adversely, particularly in countries of the OECD Europe region.

- The prospects for nuclear power in Italy were severely damaged by the Chernobyl accident. At

present, Italy does not produce any nuclear power, with its two existing plants shut down for technical reasons, and with a 5-year moratorium in place on the construction of any new plants. Italy's national energy plan for the year 2000 calls for phasing out nuclear power completely, and turning instead to increased use of natural gas and coal, as well as to energy conservation.

- In Sweden, current plans call for a complete phaseout of nuclear power by the year 2009, beginning with the shutdown of two reactors (at Barseback and Ringhals) in 1995 and 1996. Sweden plans to replace this lost power by building additional gas, oil, or coal-fired plants.
- Nuclear power has suffered a setback in West Germany for two main reasons: adverse reaction to the Chernobyl accident and fallout from the Transnuclear Nukem bribery and corruption scandal. For the first time, anti-nuclear movements have formed within the Christian Democratic Union (CDU) and the Christian Socialist Union of Bavaria (CSU).
- In Belgium, after years of debate on the issue, the center-left government announced in December that it would not proceed with plans to build the country's eighth nuclear power plant. It decided instead that it was cheaper and safer to rely on traditional fuel sources, such as natural gas and coal, for the country's future energy needs.

Table 12. Nuclear Energy Consumption in the Market Economies, 1986-2000
(Terawatt-hours)

Country/Region	History		Projections					
	1986 Actual	1987 Preliminary	1990		1995		2000	
			Base	Range	Base	Range	Base	Range
United States ^a	414	455	535	535-535	562	562-562	576	576-576
Canada	64	69	98	91-98	106	106-106	106	106-117
Japan	157	177	180	151-180	224	204-238	284	255-310
OECD Europe	599	616	699	695-713	762	728-787	787	758-840
United Kingdom	61	62	72	71-73	70	70-77	76	69-78
France	217	223	273	273-276	320	320-323	347	347-369
West Germany	114	126	146	146-147	149	125-150	151	131-162
Italy	15	12	14	12-15	14	14-21	10	10-27
Netherlands	6	5	6	6-6	6	6-6	6	6-6
Other Europe	188	189	189	188-197	203	194-210	198	196-198
Other OECD	0	0	0	0-0	0	0-0	0	0-0
Total OECD	1,234	1,318	1,512	1,472-1,527	1,654	1,600-1,693	1,753	1,695-1,842
OPEC	0	0	0	0-0	0	0-0	0	0-0
Other Developing Countries	72	88	101	92-101	108	103-111	127	117-127
Total Market Economies	1,306	1,405	1,614	1,564-1,628	1,761	1,703-1,804	1,880	1,811-1,970

^a Geographic coverage is the 50 States and the District of Columbia. U.S. Territories are included in "Other OECD." United States 1987 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 1987*, DOE/EIA-0219(87) (1988); and *Monthly Energy Review*, DOE/EIA-0035(88/08) (1988), with adjustments for estimated French nuclear exports. **Projections:** Energy Information Administration, Office of Energy Markets and End Use.

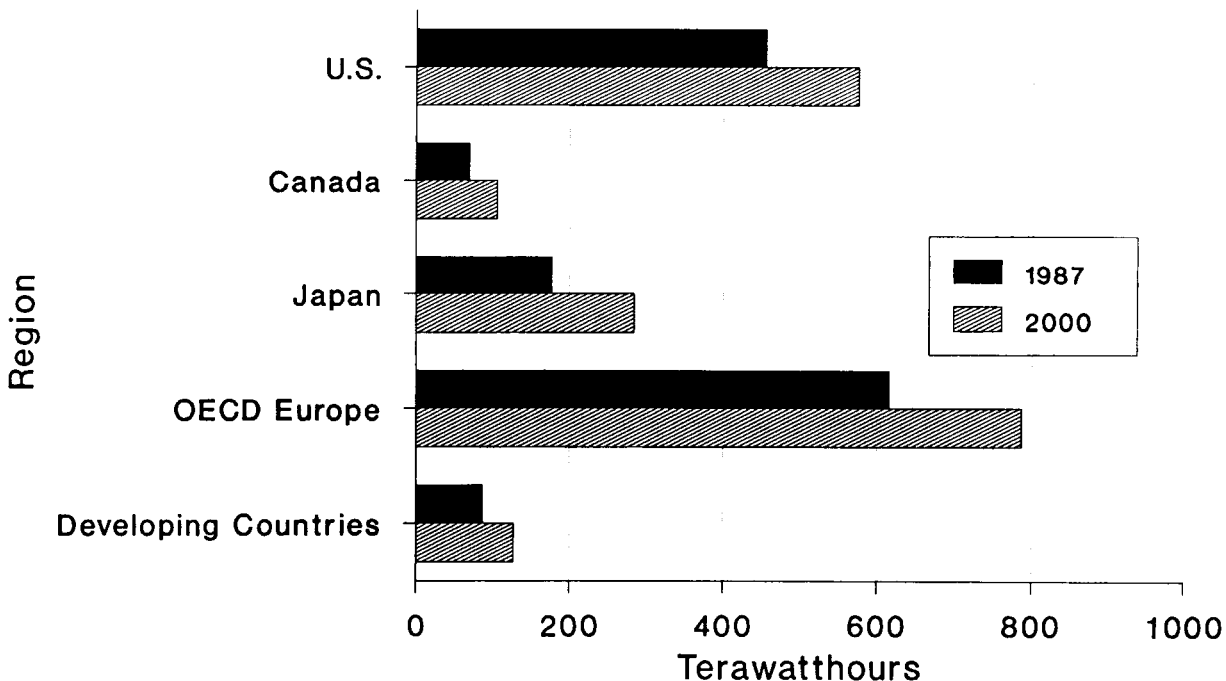
- The Swiss nuclear program remains stalemated. The Swiss Nationalrat voted in late September to abandon the Kaiseraugst nuclear plant project, but to maintain nuclear power as an option for Switzerland's future energy needs.
- Plans for a fifth Finnish nuclear plant remain on hold, as they have been since the Chernobyl accident.

Countries that currently have the most optimistic prospects for nuclear power are France and Japan in the OECD and South Korea in the group of developing countries. 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, related mainly to concerns over safety in France and Japan and to concerns over future excess capacity in France and South Korea. In Japan, although overall public support for nuclear power remains solid, anti-nuclear sentiment has been increasing since Chernobyl. Citizen campaigns against nuclear power have become more frequent, more widespread, and much more noticeable than before the accident, perhaps complicating Japan's plans to add 25,000 megawatts-electric (MWe) of power over the next 12 years.

The consumption of energy derived from hydroelectric, geothermal, and other renewable sources by the market economies is projected to grow at an average annual rate of between 1.3 and 2.8 percent between 1987 and the year 2000 (Table 13). Their share of total energy consumption, which was estimated to account for about 8 percent of total energy consumption in 1987, is projected not to be significantly different in 2000.

The developing countries, consisting of both the group of "Other Developing Countries" and the member nations of OPEC, are expected to account for between 40 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 1987 and 2000. Hydroelectric power in particular is a potentially vast resource in many developing countries, but its development is limited by financial and environmental problems. The developing countries are also expected to increase their use of geothermal, biomass, and waste power, as they attempt to maximize their usage of indigenous energy resources. In 1986, 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 7.8 TWh, an increase of 7.3 TWh from the level of 1975, and basically unchanged from 1985.

Figure 12. Nuclear Energy Consumption in the Market Economies, 1987 and 2000



Sources: **History:** Energy Information Administration, *International Energy Annual 1987* (1988); and *Monthly Energy Review*, July 1988 (1988). **Projections:** Table 12 of this report.

Table 13. Other Energy Consumption in the Market Economies, 1986-2000
(Quadrillion Btu)

Country/Region	History		Projections					
	1986 Actual	1987 Preliminary	1990		1995		2000	
			Base	Range	Base	Range	Base	Range
United States*	3.6	3.3	3.8	3.8-3.8	4.0	4.0-4.0	4.2	4.2-4.2
Canada	2.8	2.8	2.9	2.8-2.9	3.1	2.8-3.3	3.3	2.9-3.6
Japan	0.9	0.9	1.0	0.9-1.1	1.2	1.1-1.3	1.3	1.2-1.4
OECD Europe	4.4	4.8	5.7	5.2-5.9	6.1	5.4-6.4	6.4	5.4-6.9
United Kingdom	0.1	0.1	0.1	0.1-0.1	0.1	0.1-0.1	0.1	0.1-0.1
France	0.7	0.7	0.8	0.7-0.8	0.9	0.7-0.9	0.9	0.7-0.9
West Germany	0.2	0.2	0.2	0.2-0.2	0.2	0.2-0.3	0.3	0.3-0.3
Italy	0.5	0.5	0.7	0.5-0.9	0.7	0.5-1.0	0.8	0.5-1.0
Netherlands	0.0	0.0	0.0	0.0-0.0	0.0	0.0-0.0	0.0	0.0-0.0
Other Europe	2.9	3.3	3.9	3.8-3.9	4.2	3.9-4.3	4.4	3.8-4.8
Other OECD	0.4	0.4	0.5	0.3-0.6	0.5	0.4-0.7	0.6	0.4-0.7
Total OECD	12.1	12.3	13.9	13.1-14.3	15.0	13.7-15.8	15.8	14.0-16.8
OPEC	0.4	0.4	0.5	0.4-0.6	0.7	0.4-0.9	0.8	0.6-1.0
Other Developing Countries	4.7	4.8	5.2	4.9-5.4	6.0	5.5-6.3	6.7	6.2-7.4
Total Market Economies	17.3	17.6	19.6	18.3-20.4	21.7	19.5-22.9	23.3	20.8-25.2

* Geographic coverage is the 50 States and the District of Columbia. U.S. Territories are included in "Other OECD." United States 1987 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.

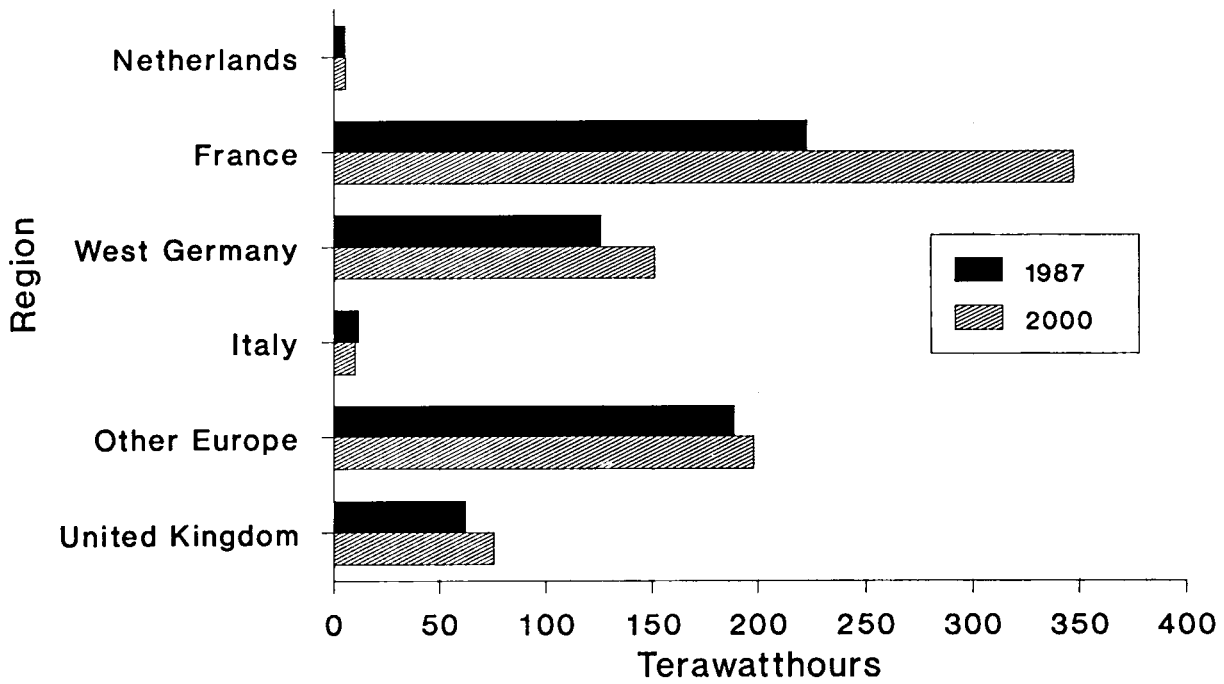
Sources: **History:** Energy Information Administration, *International Energy Annual 1987*, DOE/EIA-0219(87); and *Monthly Energy Review*, DOE/EIA-0035(88/08) (1988); **Projections:** Energy Information Administration, Office of Energy Markets and End Use.

Countries in the "Other Europe" category are expected to account for between 16 percent and 20 percent of the projected increase in the consumption of renewable energy sources by the market economies between 1987 and 2000. Much of this increase will be in the consumption of hydroelectric power, but European countries are also looking into the development of other renewable energy resources, such as wind, solar, and biomass. In countries like Sweden, Switzerland, and Italy, a large part of the motivation for this search for alternate fuel sources stems from the need to replace part of lost nuclear capacity with other energy sources. Italy has undertaken to increase the percentage share of hydroelectric, solar, and geothermal energy sources; Swit-

zerland is considering the increased use of geothermal, solar, and biomass; and Sweden has begun experimenting with wind power turbines and investing in waste power. Other countries are increasing their use of solar (Spain, West Germany, and Greece), wind (Denmark and the Netherlands), and geothermal (Italy).

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 33 and 56 percent from 1987 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 over 1.5 TWh in 1986.

Figure 13. Nuclear Energy Consumption in OECD Europe, 1987 and 2000



Sources: **History:** Energy Information Administration, *International Energy Annual 1987* (1988); and *Monthly Energy Review*, July 1988 (1988). **Projections:** Table 12 of this report.

5. Comparison of International Energy Projections

Forecasts of energy supply and demand from alternative forecasters 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 published last year in the *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 EIA base case given in this report with the *International Energy Outlook* base case published last year and with other widely used energy forecasts.

As indicated in Table 14, energy consumption in the market economies in 1995 is projected to be somewhat higher in the current forecast than compared to last year. Oil consumption is also higher than previously forecasted and remains higher through the year 2000. As a result, OPEC production in 2000 is about 1.2 million barrels a day greater than previously forecasted while non-OPEC production is reduced by about 100,000 barrels a day.

The energy projections for the market economies presented in Table 15 are generally consistent with the EIA base-case projections. All the projections reflect

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

Energy Source/Region	Projections for 1995	
	Last Year	EIA-89
Energy Consumption (quadrillion Btu)		
United States*	85.0	85.8
Japan	18.7	19.7
OECD Europe	64.9	66.0
Other Countries	82.3	84.9
Total	250.9	256.4
Petroleum Consumption (million barrels per day)		
United States*	17.7	17.8
Japan	4.5	4.9
OECD Europe	12.7	13.2
Other Countries	17.9	18.2
Total	52.8	54.1
Stock Change and Discrepancy	-0.3	-0.3
Petroleum Supply (million barrels per day)		
OPEC	26.1	26.9
United States	8.8	8.6
Other Non-OPEC	16.2	16.4
Total Production	51.1	51.9
Net Imports from CPE	1.4	1.9
Total Available Supply	52.5	53.8

* 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 1987*, DOE/EIA-0484(87) (1988).

respective "base case" assumptions. Changes in these assumptions would alter the projections, as is the case with the EIA projected ranges of uncertainty.

In all cases, oil consumption is projected to grow, but not as fast as total energy consumption. In turn, total energy consumption is not expected to grow as fast as gross domestic product. Thus, all projections assume that the energy efficiency of economic activity will continue to improve over the projection period.

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

Projection	Consumption		Growth Rate ^a			Petroleum Production	
	Energy	Oil	Energy	Oil	Gross Domestic Product	OPEC	Other
1986 EIA Estimate	103.3	48.0	NA	NA	NA	19.7	26.6
1990 Projections							
EIA International Energy Outlook 1989	114.8	51.4	+2.7	+1.8	+3.0	21.0	27.6
DOE Long Range Energy Projections	108.8	49.8	+1.7	+1.1	+3.4	22.7	25.9
Ashland (December 1988)	NA	50.8	NA	+1.7	+2.4	22.3	26.3
CONOCO (December 1988) ^b	112.4	51.3	+2.2	+1.9	NA	19.9	23.4
DRI Winter 1988-1989	NA	51.0	NA	+1.5	+3.3	22.2	25.7
1995 Projections							
EIA International Energy Outlook 1989	125.8	54.1	+1.8	+1.0	+3.1	26.9	25.0
DOE Long Range Energy Projections	117.6	52.0	+1.6	+0.9	+2.7	27.3	24.1
Ashland (December 1988)	NA	52.0	NA	+0.5	+2.0	23-24	26-27
CONOCO (December 1988) ^b	124.0	55.4	+2.0	+1.5	NA	24.1	22.9
DRI Winter 1988-1989	NA	54.5	NA	+1.3	+3.4	27.5	24.7
2000 Projections							
EIA International Energy Outlook 1989	134.4	54.9	+1.3	+0.3	+2.7	29.0	24.2
DOE Long Range Energy Projections	127.2	54.1	+1.6	+0.8	+2.7	31.0	22.9
Ashland (December 1988)	NA	52.5	NA	+0.2	+2.5	24-27	24-27
CONOCO (December 1988) ^b	136.7	59.8	+2.0	+1.5	NA	28.2	22.2
DRI Winter 1988-1989	NA	57.4	NA	+1.0	+3.5	31.6	24.5

^a For the 1990 projections, these are the growth rates from 1986 to 1990; for the 1995 projections, from 1990 to 1995; and, for the 2000 projections, from 1995 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: Energy Information Administration: *International Energy Outlook 1989*, DOE/EIA-0484(89) (1989). Department of Energy: *Long Range Energy Projections to 2010*, Office of Policy, Planning and Analysis (1988). Ashland: *The Outlook for Oil and Natural Gas Markets* (1988). CONOCO: "World Energy Outlook Through 2000" (unpublished). Data Resources, Inc.: *International Energy Bulletin* (1988).

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	1987	Preliminary 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	16.7	17.0	17.2	17.4	17.8	18.6
Canada	1.9	1.9	1.8	1.6	1.4	1.5	1.5	1.5	1.6	1.6	1.7	1.7	1.8	1.8
Japan	5.5	5.0	4.8	4.6	4.4	4.6	4.4	4.4	4.5	4.7	4.6	4.7	4.9	4.7
OECD Europe	14.7	13.6	12.5	12.1	11.8	11.7	11.6	12.0	12.2	12.2	12.4	12.6	13.2	12.4
Other OECD ^b	1.1	1.1	1.1	1.0	1.0	1.0	1.0	0.9	0.9	1.0	1.0	1.0	1.0	1.1
Total OECD	41.6	38.6	36.3	34.5	33.8	34.5	34.1	35.1	35.8	36.5	36.9	37.4	38.7	38.5
OPEC	2.7	2.9	3.1	3.3	3.5	3.5	3.6	3.6	3.7	3.7	3.8	3.8	4.1	4.5
Other Countries	7.9	8.2	8.4	8.5	8.5	8.8	8.8	9.2	9.4	9.6	9.9	10.2	11.3	11.8
Total Consumption	52.2	49.7	47.8	46.3	45.8	46.8	46.5	48.0	48.9	49.8	50.5	51.4	54.1	54.9
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	10.0	8.6	8.5
Canada	1.9	1.8	1.6	1.6	1.7	1.8	1.8	1.8	1.9	2.0	2.0	1.9	1.7	1.6
OECD Europe	2.6	2.8	2.9	3.3	3.7	4.1	4.3	4.4	4.5	4.5	4.6	4.8	4.3	4.1
OPEC	31.7	27.8	23.8	20.1	18.8	18.8	17.5	19.7	19.5	21.0	20.7	21.0	26.9	29.0
Other Countries	5.9	6.4	7.1	7.7	8.2	8.9	9.5	9.5	9.8	10.1	10.4	10.9	10.4	10.0
Total Production	52.7	49.6	46.2	43.5	43.2	44.7	44.4	46.3	46.5	48.2	48.0	48.7	51.9	53.1
Net CPE Exports	1.1	1.2	1.5	1.7	1.8	2.1	2.0	2.2	2.3	2.4	2.3	2.4	1.9	1.5
Stock Withdrawals and Discrepancies	-1.6	-1.1	0.2	1.2	0.8	0.0	0.2	-0.6	0.1	-0.7	0.2	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 1987*, DOE/EIA-0219(87) and *Monthly Energy Review*, DOE/EIA-0035(88/05) (1988); Organization for Economic Cooperation and Development/International Energy Agency, *Quarterly Oil Statistics Fourth Quarter 1987* (Paris, France, 1988); Petroleum Economics Limited, *Quarterly Supply/Demand Outlook* (London, England, 1988). 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	8.5	8.2-8.8	8.7	8.5-9.0	9.2	8.9-9.6
Natural Gas	7.1	7.5	7.5-7.7	7.6	7.4-7.8	7.5	7.2-7.8
Coal	2.8	2.7	2.7-2.8	2.7	2.7-2.8	2.8	2.8-2.8
Electricity	9.5	10.4	10.4-10.5	12.2	12.1-12.3	14.2	14.1-14.4
Total	27.1	29.2	28.7-29.7	31.2	30.6-31.8	33.6	32.8-34.6
Transportation							
Petroleum	19.6	21.9	21.5-22.1	22.0	21.4-22.5	22.6	21.8-23.4
Natural Gas	0.5	0.5	0.5-0.5	0.5	0.5-0.6	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	0.0-0.0	0.1	0.1-0.1	0.1	0.1-0.1
Total	20.1	22.4	22.1-22.7	22.5	22.0-23.1	23.2	22.4-24.1
Residential/Commercial							
Petroleum	2.6	2.7	2.7-2.8	2.6	2.5-2.6	2.4	2.4-2.5
Natural Gas	7.1	7.5	7.5-7.5	7.4	7.3-7.5	7.2	7.1-7.4
Coal	0.2	0.2	0.2-0.2	0.2	0.2-0.2	0.1	0.1-0.1
Electricity	16.9	19.6	19.5-19.6	22.0	21.8-22.1	23.9	23.8-24.1
Total	26.8	29.9	29.8-30.1	32.1	31.8-32.4	33.7	33.3-34.2
Electric Utilities							
Petroleum	1.1	1.3	1.2-1.5	2.0	1.7-2.4	2.5	2.0-3.1
Natural Gas	3.2	3.0	3.0-3.0	4.0	3.8-4.1	5.7	5.4-6.0
Coal	14.5	16.2	16.2-16.3	18.1	18.1-18.1	19.5	19.4-19.6
Nuclear/Other*	7.7	9.5	9.5-9.5	10.0	10.0-10.0	10.4	10.4-10.4
Total	26.5	30.0	29.8-30.2	34.1	33.9-34.3	38.1	37.8-38.5
Primary Energy Consumption							
Petroleum	30.9	34.4	33.6-35.1	35.2	34.0-36.6	36.8	35.1-38.7
Natural Gas	17.8	18.5	18.4-18.7	19.5	19.2-19.6	20.9	20.8-21.2
Coal	17.5	19.1	19.1-19.1	21.0	20.9-21.0	22.5	22.3-22.5
Nuclear/Other*	7.7	9.6	9.6-9.6	10.1	10.1-10.1	10.4	10.4-10.4
Total	73.9	81.6	80.7-82.5	85.8	84.3-87.3	90.6	88.6-92.9

* 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(88-08) (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	1.1	1.0-1.1	1.1	1.0-1.2	1.2	1.0-1.3
Natural Gas	1.1	1.1	1.1-1.2	1.2	1.1-1.3	1.2	1.2-1.4
Coal	0.3	0.2	0.2-0.2	0.2	0.2-0.2	0.2	0.2-0.2
Electricity	2.1	2.4	2.3-2.5	2.8	2.6-3.0	3.0	2.7-3.3
Total	4.5	4.8	4.8-4.9	5.4	5.2-5.5	5.7	5.3-5.8
Transportation							
Petroleum	1.5	1.8	1.8-1.9	1.9	1.7-2.0	1.9	1.6-2.1
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	1.5	1.8	1.8-1.9	1.9	1.9-2.0	1.9	1.8-2.1
Residential/Commercial							
Petroleum	0.4	0.4	0.4-0.4	0.5	0.5-0.5	0.5	0.4-0.5
Natural Gas	0.9	0.8	0.8-0.9	1.0	0.9-1.1	1.0	1.0-1.2
Coal	0.0	0.0	0.0-0.0	0.0	0.0-0.0	0.0	0.0-0.0
Electricity	2.2	2.6	2.5-2.6	3.1	2.8-3.2	3.4	3.1-3.8
Total	3.5	3.9	3.9-3.9	4.5	4.4-4.6	5.0	4.7-5.1
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	0.5	0.4-0.5	0.6	0.6-0.7
Coal	0.8	0.9	0.8-0.9	1.0	1.0-1.1	1.4	1.2-1.4
Nuclear/Other ^a	3.3	4.0	3.9-4.0	4.4	4.0-4.5	4.5	4.1-5.0
Total	4.3	5.1	5.0-5.1	5.9	5.8-6.1	6.7	6.3-6.8
Primary Energy Consumption							
Petroleum	3.0	3.4	3.3-3.5	3.6	3.3-3.9	3.6	3.2-4.0
Natural Gas	2.1	2.1	2.1-2.2	2.7	2.5-2.8	3.0	2.8-3.3
Coal	1.1	1.1	1.0-1.1	1.2	1.2-1.3	1.5	1.4-1.6
Nuclear/Other ^a	3.3	4.0	3.9-4.0	4.4	4.0-4.5	4.5	4.1-5.0
Total	9.5	10.6	10.5-10.7	11.8	11.5-12.1	12.5	12.0-13.0

^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	3.6	3.5-3.7	3.7	3.4-4.0	3.6	3.2-4.1
Natural Gas	0.1	0.4	0.4-0.5	0.7	0.7-0.9	0.9	0.9-1.2
Coal	2.1	1.4	1.4-1.5	1.1	1.0-1.1	0.5	0.5-0.5
Electricity	3.8	4.5	3.9-4.8	5.2	4.7-5.5	5.9	5.4-6.5
Total	9.9	9.9	9.8-10.1	10.7	10.4-10.9	10.9	10.6-11.3
Transportation							
Petroleum	2.3	2.9	2.8-3.0	3.0	2.8-3.2	2.9	2.5-3.2
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	2.9	2.8-3.0	3.0	3.0-3.2	2.9	2.7-3.2
Residential/Commercial							
Petroleum	0.9	1.5	1.5-1.6	1.7	1.5-1.8	1.7	1.5-1.9
Natural Gas	0.3	0.4	0.4-0.5	0.4	0.4-0.6	0.4	0.4-0.5
Coal	0.0	0.5	0.5-0.5	0.7	0.7-0.7	1.2	1.1-1.2
Electricity	2.3	2.7	2.3-2.9	3.1	2.8-3.3	3.6	3.3-3.9
Total	3.6	5.1	5.1-5.2	6.0	5.8-6.2	6.9	6.6-7.1
Electric Utilities							
Petroleum	1.7	1.5	1.4-1.5	1.4	1.3-1.5	1.3	1.2-1.5
Natural Gas	1.1	1.7	1.7-2.0	1.9	1.9-2.5	2.2	2.1-3.0
Coal	0.9	1.2	1.2-1.2	1.4	1.4-1.5	1.7	1.6-1.8
Nuclear/Other ^a	2.5	2.9	2.5-3.1	3.6	3.3-3.8	4.3	3.9-4.7
Total	6.1	7.2	7.1-7.3	8.4	8.2-8.6	9.5	9.2-9.9
Primary Energy Consumption							
Petroleum	8.9	9.5	9.2-9.7	9.8	9.0-10.5	9.5	8.4-10.7
Natural Gas	1.5	2.5	2.5-3.0	3.1	3.0-4.0	3.6	3.4-4.7
Coal	3.0	3.1	3.0-3.1	3.2	3.1-3.4	3.3	3.2-3.5
Nuclear/Other ^a	2.5	2.9	2.5-3.1	3.6	3.3-3.8	4.3	3.9-4.7
Total	15.8	17.9	17.7-18.2	19.7	19.2-20.2	20.7	19.9-21.4

^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	8.0	7.8-8.3	8.6	7.9-9.1	7.9	7.0-8.9
Natural Gas	3.8	4.1	3.9-4.2	4.3	4.0-4.7	4.8	4.4-5.3
Coal	3.7	4.8	4.6-4.8	4.6	4.2-4.6	4.2	3.8-4.2
Electricity	7.8	9.0	8.8-9.4	10.2	9.7-10.9	11.3	10.5-12.5
Total	23.9	26.0	25.5-26.2	27.7	26.8-28.2	28.2	27.0-28.9
Transportation							
Petroleum	9.0	10.9	10.6-11.2	11.3	10.4-12.1	10.8	9.6-12.1
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	0.7	0.7-0.7	0.7	0.7-0.8	0.8	0.8-0.9
Total	9.6	11.6	11.4-11.7	12.1	11.7-12.3	11.6	11.2-12.1
Residential/Commercial							
Petroleum	4.6	5.0	4.9-5.2	5.3	4.9-5.6	5.3	4.7-5.9
Natural Gas	3.7	3.9	3.7-3.9	4.3	4.0-4.6	5.4	5.1-6.0
Coal	0.9	1.2	1.2-1.2	1.2	1.1-1.2	0.8	0.7-0.8
Electricity	11.8	13.8	13.5-14.4	15.7	14.9-16.8	17.4	16.2-19.2
Total	21.1	23.9	23.6-24.1	26.4	25.8-27.1	28.9	28.0-29.9
Electric Utilities							
Petroleum	1.8	2.1	2.1-2.2	2.1	2.0-2.3	1.9	1.7-2.2
Natural Gas	1.1	1.8	1.8-1.9	2.6	2.5-2.8	3.2	3.0-3.6
Coal	6.9	6.4	6.4-6.7	7.7	7.7-8.3	9.6	9.6-10.4
Nuclear/Other ^a	10.6	13.2	12.6-13.5	14.3	13.2-14.8	14.8	13.4-15.8
Total	20.2	23.5	23.2-23.8	26.7	26.0-27.3	29.5	28.5-30.4
Primary Energy Consumption							
Petroleum	24.0	26.1	25.3-26.9	27.3	25.2-29.2	25.8	23.1-29.1
Natural Gas	8.6	9.6	9.4-10.0	11.0	10.5-12.2	13.3	12.5-14.8
Coal	11.5	12.4	12.3-12.6	13.4	13.1-14.0	14.6	14.2-15.3
Nuclear/Other ^a	10.5	13.2	12.6-13.5	14.3	13.2-14.8	14.8	13.4-15.8
Total	54.6	61.3	60.6-62.0	66.0	64.3-67.7	68.5	66.2-70.7

^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.

**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	0.7	0.6-0.7	0.6	0.6-0.6	0.6	0.6-0.6
Natural Gas	0.6	0.7	0.7-0.9	0.9	0.9-1.0	0.9	0.9-1.0
Coal	0.2	0.4	0.4-0.5	0.4	0.4-0.5	0.4	0.4-0.4
Electricity	0.7	0.8	0.5-1.0	0.9	0.7-1.2	0.9	0.6-1.1
Total	1.8	2.6	2.6-2.8	2.9	2.8-3.0	2.9	2.7-2.9
Transportation							
Petroleum	1.3	1.7	1.6-1.7	1.9	1.7-1.9	1.9	1.9-2.0
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	0.0	0.0	0.0-0.0	0.0	0.0-0.0	0.0	0.0-0.0
Total	1.3	1.7	1.6-1.7	1.9	1.7-1.9	1.9	1.9-2.0
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	0.6-1.3	1.2	0.9-1.5	1.3	0.9-1.6
Total	0.9	1.0	1.0-1.3	1.2	1.1-1.5	1.3	1.2-1.6
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	1.0	1.0-1.0	1.2	1.1-1.2	1.4	1.2-1.4
Nuclear/Other ^a	0.4	0.5	0.3-0.6	0.5	0.4-0.7	0.6	0.4-0.7
Total	1.6	1.8	1.8-1.8	2.1	2.0-2.1	2.3	2.1-2.3
Primary Energy Consumption							
Petroleum	1.9	2.7	2.5-2.7	2.8	2.6-2.8	2.9	2.8-2.9
Natural Gas	0.6	0.7	0.7-0.8	0.9	0.9-0.9	0.9	0.9-1.0
Coal	1.1	1.5	1.4-1.5	1.6	1.6-1.7	1.7	1.6-1.7
Nuclear/Other ^a	0.4	0.5	0.3-0.6	0.5	0.4-0.7	0.6	0.4-0.7
Total	4.0	5.4	5.3-5.4	5.8	5.6-6.0	6.0	5.8-6.2

^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	21.6	21.1-22.5	22.7	21.3-24.0	22.5	20.7-24.4
Natural Gas	12.7	13.9	13.7-14.4	14.6	14.1-15.7	15.3	14.5-16.7
Coal	9.0	9.6	9.4-9.6	9.0	8.6-9.1	8.1	7.7-8.1
Electricity	23.9	27.2	25.9-28.2	31.3	29.8-32.8	35.4	33.3-37.2
Total	67.2	72.6	71.6-73.6	77.6	75.8-79.5	81.3	78.4-83.5
Transportation							
Petroleum	33.7	39.3	38.3-39.9	40.1	38.1-41.7	40.0	37.6-42.8
Natural Gas	0.5	0.5	0.5-0.5	0.5	0.5-0.6	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	0.6	0.7	0.7-0.8	0.8	0.8-0.8	0.9	0.8-1.0
Total	34.9	40.5	39.8-40.8	41.4	40.2-42.3	41.4	39.9-42.8
Residential/Commercial							
Petroleum	8.5	9.7	9.4-10.0	10.0	9.4-10.6	9.9	9.0-10.9
Natural Gas	12.0	12.5	12.4-12.8	13.1	12.6-13.8	14.1	13.5-15.1
Coal	1.1	1.8	1.8-1.8	2.0	1.9-2.1	2.1	2.0-2.2
Electricity	34.2	39.8	38.5-40.9	45.0	43.3-46.9	49.6	47.3-52.6
Total	55.9	63.8	63.3-64.4	70.2	68.9-71.5	75.7	73.8-77.6
Electric Utilities							
Petroleum	4.9	5.3	5.0-5.6	5.9	5.7-6.7	6.1	5.3-7.2
Natural Gas	5.4	6.6	6.6-7.0	9.0	8.8-9.5	11.7	11.7-12.7
Coal	24.0	25.7	25.7-26.0	29.4	29.4-30.1	33.6	33.0-34.4
Nuclear/Other ^a	24.5	30.1	28.7-30.7	32.8	30.9-33.9	34.6	32.2-36.6
Total	58.8	67.6	67.0-68.2	77.1	75.8-78.4	86.1	83.9-87.9
Primary Energy Consumption							
Petroleum	68.7	76.1	73.9-78.0	78.7	74.2-83.0	78.4	72.6-85.4
Natural Gas	30.6	33.4	33.2-34.7	37.1	36.1-39.5	41.7	40.4-45.1
Coal	34.1	37.1	37.0-37.5	40.4	40.1-41.5	43.5	43.1-45.1
Nuclear/Other ^a	24.5	30.2	28.8-30.7	32.9	30.9-33.9	34.7	32.2-36.6
Total	157.9	176.8	174.7-178.8	189.1	184.9-193.3	198.3	192.6-204.1

^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

International Energy Production Data

Appendix C

International Energy Production Data

Table C1. World Crude Oil Production, 1977-1987
(Thousand Barrels per Day)

Region Country	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987*
NORTH AMERICA											
Canada	1,321	1,316	1,500	1,435	1,285	1,271	1,356	1,438	1,471	1,474	1,533
Mexico	981	1,209	1,461	1,936	2,313	2,748	2,689	2,780	2,745	2,435	2,540
United States	8,245	8,707	8,552	8,597	8,572	8,649	8,688	8,879	8,971	8,680	8,349
Total	10,547	11,232	11,513	11,968	12,170	12,668	12,733	13,097	13,187	12,589	12,422
CENTRAL AND SOUTH AMERICA											
Argentina	431	453	473	491	496	491	491	478	460	434	428
Brazil	161	160	166	182	213	260	339	475	564	572	566
Colombia	138	131	124	126	125	141	152	168	176	305	385
Ecuador	183	202	214	204	211	211	237	258	281	293	172
Peru	102	151	195	195	193	195	171	184	190	178	164
Trinidad and Tobago	230	232	215	211	240	180	160	170	175	168	160
Venezuela	2,238	2,165	2,356	2,168	2,102	1,895	1,801	1,798	1,677	1,787	1,751
Other	63	57	59	70	76	84	81	81	79	76	76
Total	3,546	3,550	3,802	3,647	3,656	3,457	3,432	3,612	3,602	3,813	3,702
WESTERN EUROPE											
Denmark	9	10	8	6	15	35	45	46	58	76	94
Germany, West	108	101	95	92	89	84	81	79	81	80	75
Italy	22	30	35	38	37	35	45	45	45	49	58
Netherlands	28	28	27	25	27	38	53	61	76	93	87
Norway	280	356	403	528	501	520	614	697	788	870	1,015
Spain	16	16	23	33	25	30	58	46	44	38	33
United Kingdom	768	1,082	1,568	1,622	1,811	2,065	2,291	2,480	2,530	2,539	2,476
Yugoslavia	79	83	85	86	86	87	83	80	86	84	84
Other	109	111	111	100	113	131	128	125	138	153	160
Total	1,419	1,817	2,355	2,530	2,704	3,025	3,398	3,659	3,846	3,982	4,082
EASTERN EUROPE AND U.S.S.R.											
Albania	43	44	44	44	44	64	75	55	55	55	55
Romania	303	284	255	238	241	242	240	237	220	221	215
U.S.S.R.	10,485	10,950	11,187	11,460	11,552	11,615	11,684	11,576	11,250	11,540	11,690
Other	54	57	53	51	51	52	50	51	50	51	54
Total	10,886	11,335	11,540	11,793	11,888	11,973	12,049	11,919	11,575	11,867	12,014
MIDDLE EAST											
Iran	5,663	5,242	3,168	1,662	1,380	2,214	2,440	2,174	2,250	2,035	2,426
Iraq	2,348	2,563	3,477	2,514	1,000	1,012	1,005	1,209	1,433	1,690	2,079
Kuwait	1,969	2,131	2,500	1,656	1,125	823	1,064	1,157	1,023	1,419	1,361
Oman	341	315	295	282	319	324	375	414	498	560	564
Qatar	445	487	508	472	405	330	295	394	301	308	304
Saudi Arabia	9,245	8,301	9,532	9,900	9,815	6,483	5,086	4,663	3,388	4,870	4,186
Syria	188	170	166	164	166	160	167	170	178	194	232
United Arab Emirates	1,999	1,831	1,831	1,709	1,474	1,250	1,149	1,146	1,193	1,330	1,541
Other	58	70	80	83	82	45	43	42	43	56	76
Total	22,255	21,108	21,557	18,442	15,766	12,641	11,624	11,369	10,307	12,462	12,769
AFRICA											
Algeria	1,152	1,231	1,224	1,106	1,002	987	968	1,014	1,037	945	985
Angola	194	131	147	150	130	122	177	208	231	282	360
Cameroon	0	13	34	58	87	109	114	135	185	177	172
Congo	33	33	57	65	83	89	87	121	120	119	118
Egypt	415	485	525	595	598	670	727	822	887	813	898
Gabon	222	209	203	175	151	156	157	157	172	166	156
Libya	2,063	1,983	2,092	1,787	1,140	1,150	1,105	1,087	1,059	1,034	972
Nigeria	2,085	1,897	2,302	2,055	1,433	1,295	1,241	1,388	1,495	1,484	1,340
Tunisia	95	100	100	110	118	120	120	120	114	111	103
Other	24	19	22	24	30	35	55	69	71	61	55
Total	6,284	6,100	6,706	6,125	4,772	4,733	4,751	5,121	5,371	5,192	5,159
FAR EAST AND OCEANIA											
Australia	431	432	441	380	394	370	416	492	575	520	550
Brunei	210	205	234	235	163	154	162	160	153	166	140
China	1,874	2,082	2,122	2,114	2,012	2,045	2,120	2,296	2,505	2,620	2,690
India	199	226	245	182	325	390	480	519	620	630	612
Indonesia	1,686	1,635	1,591	1,577	1,605	1,339	1,343	1,412	1,325	1,390	1,311
Malaysia	184	217	283	283	264	306	365	440	440	504	497
Other	68	62	88	77	59	83	94	107	140	154	148
Total	4,652	4,860	5,004	4,848	4,822	4,687	4,980	5,426	5,758	5,984	5,948
WORLD TOTAL	59,589	60,003	62,477	59,353	55,778	53,184	52,967	54,203	53,646	55,889	56,096

* Preliminary.

Notes: Crude oil includes lease condensate. Totals may not equal sum of components because of independent rounding.

Source: Energy Information Administration, *International Energy Annual 1987*, DOE/EIA-0219(87) (1988).

Table C2. World Natural Gas Plant Liquids Production, 1977-1987
(Thousand Barrels per Day)

Region Country	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987 ^a
NORTH AMERICA											
Canada	290	281	331	331	330	318	309	336	337	328	367
Mexico	105	115	150	193	241	255	265	257	271	352	340
United States	1,618	1,567	1,584	1,573	1,609	1,550	1,559	1,630	1,609	1,551	1,595
Total	2,013	1,963	2,065	2,097	2,180	2,123	2,133	2,223	2,217	2,231	2,302
CENTRAL AND SOUTH AMERICA											
Argentina	11	13	13	13	12	12	8	15	20	31	31
Bolivia	5	5	5	5	4	6	6	6	6	5	6
Brazil	6	5	5	6	7	8	11	15	17	20	25
Chile	12	12	12	12	10	10	10	11	11	10	10
Colombia	6	5	5	6	6	6	4	4	4	5	8
Cuba	1	1	1	1	1	1	1	1	2	2	2
Peru	2	2	2	3	4	4	1	1	1	1	1
Trinidad and Tobago	2	2	2	5	5	3	3	3	3	3	3
Venezuela	78	61	69	60	55	60	57	57	63	97	95
Other	(*)	2	2	2	2	2	2	2	2	2	2
Total	123	108	116	113	106	112	103	115	129	176	183
WESTERN EUROPE											
Austria	1	1	1	1	1	1	1	1	1	1	1
France	26	26	26	26	27	20	20	20	17	14	12
Greece	0	0	0	0	0	1	2	2	2	2	2
Italy	1	1	1	1	1	1	1	1	1	1	1
Netherlands	7	7	7	6	6	7	9	9	11	11	11
Norway	20	35	40	40	31	33	38	36	41	53	55
United Kingdom	30	40	45	45	50	78	111	136	145	152	162
Yugoslavia	(*)	1	1	2	2	2	4	4	4	4	4
Other	0	0	0	0	0	0	0	0	0	8	11
Total	85	111	121	121	118	143	186	209	222	246	259
EASTERN EUROPE AND U.S.S.R											
Hungary	11	15	19	20	20	21	21	22	25	25	27
Poland	(*)	1	1	1	1	1	1	1	1	1	1
Romania	11	11	11	14	14	14	15	15	15	15	15
U.S.S.R.	353	410	467	531	598	612	618	625	685	795	825
Other	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)
Total	375	437	497	566	633	647	655	663	726	836	868
MIDDLE EAST											
Bahrain	0	0	0	8	8	8	9	9	6	8	9
Iran	40	45	10	9	9	9	8	10	10	15	20
Iraq	5	5	10	8	5	5	5	5	10	10	10
Kuwait	55	75	95	95	60	40	55	67	54	75	70
Qatar	5	5	10	10	24	30	25	28	30	22	25
Saudi Arabia	215	250	303	369	433	430	330	355	316	304	345
United Arab Emirates	15	30	30	35	60	90	120	130	160	185	145
Other	1	1	1	2	2	2	2	3	4	4	4
Total	336	411	459	536	601	614	554	607	590	623	628
AFRICA											
Algeria	19	25	30	36	49	58	56	105	120	120	90
Egypt	12	17	17	17	17	20	25	25	27	24	25
Libya	40	40	40	40	35	40	30	37	26	30	30
Total	71	82	87	93	101	118	111	167	173	174	145
FAR EAST AND OCEANIA											
Australia	55	60	60	60	60	52	52	54	65	60	65
Brunei	30	30	35	35	25	25	25	15	15	15	15
Indonesia	10	30	40	70	95	80	94	75	44	30	30
Malaysia	0	0	0	0	0	0	0	10	10	9	11
Pakistan	(*)	(*)	(*)	(*)	(*)	1	1	1	1	1	1
New Zealand	(*)	(*)	(*)	1	1	1	2	2	3	3	3
Other	3	3	3	3	7	10	12	16	23	25	25
Total	98	124	139	169	188	169	186	173	161	143	150
WORLD TOTAL^b	3,102	3,235	3,484	3,695	3,927	3,926	3,928	4,158	4,218	4,429	4,535

^a Preliminary.

^b Does not include China for which data are unavailable.

(*) Denotes less than one-half the unit of measure.

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

Source: Energy Information Administration, *International Energy Annual 1987*, DOE/EIA-0219(87) (1988).

Table C3. World Dry Natural Gas Production, 1977-1987
(Trillion Cubic Feet)

Region Country	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987*
NORTH AMERICA											
Canada	2.59	2.47	2.66	2.65	2.47	2.45	2.52	2.61	2.98	2.77	2.90
Mexico .....	.54	.67	.81	1.01	1.03	1.11	1.10	1.04	.95	.92	.93
United States	19.16	19.12	19.66	19.40	19.18	17.76	16.03	17.39	16.38	15.99	16.34
Total	22.29	22.27	23.13	23.06	22.68	21.32	19.65	21.04	20.31	19.69	20.17
CENTRAL AND SOUTH AMERICA											
Argentina .....	.28	.28	.26	.28	.35	.40	.44	.49	.50	.55	.54
Bolivia .....	.07	.06	.07	.08	.08	.08	.08	.09	.09	.09	.09
Brazil .....	.04	.04	.03	.04	.04	.05	.06	.07	.09	.09	.10
Colombia .....	.11	.13	.12	.10	.11	.11	.10	.14	.14	.14	.14
Trinidad and Tobago .....	.08	.10	.12	.08	.08	.10	.13	.19	.22	.15	.14
Venezuela .....	.39	.40	.46	.49	.52	.60	.58	.61	.62	.67	.70
Other .....	.11	.20	.28	.23	.14	.10	.10	.10	.10	.08	.58
Total	1.07	1.21	1.33	1.30	1.31	1.43	1.49	1.71	1.76	1.78	2.30
WESTERN EUROPE											
France .....	.26	.23	.24	.27	.22	.23	.24	.22	.19	.15	.13
Germany, West .....	.68	.72	.73	.67	.68	.59	.61	.66	.61	.54	.62
Italy .....	.48	.48	.46	.42	.49	.51	.46	.49	.50	.56	.58
Netherlands	2.93	2.50	2.72	3.38	3.15	2.67	2.58	2.65	2.73	2.57	2.66
Norway .....	.09	.39	.76	.88	.89	.90	.86	.93	.94	.96	1.04
United Kingdom	1.38	1.30	1.31	1.23	1.22	1.36	1.40	1.42	1.52	1.60	1.68
Yugoslavia .....	.07	.07	.07	.06	.07	.06	.06	.07	.08	.09	.10
Other .....	.12	.07	.11	.11	.11	.13	.13	.15	.19	.20	.53
Total	6.01	5.77	6.39	7.02	6.83	6.44	6.34	6.59	6.75	6.67	7.34
EASTERN EUROPE AND U.S.S.R											
Germany, East .....	.30	.30	.23	.30	.35	.29	.39	.44	.46	.40	.42
Hungary .....	.23	.26	.23	.21	.21	.23	.23	.24	.26	.25	.26
Poland .....	.26	.28	.26	.22	.22	.19	.19	.22	.22	.20	.20
Romania	1.20	1.07	1.20	1.20	1.24	1.35	1.40	1.34	1.27	1.34	1.32
U.S.S.R.	12.22	13.14	14.36	15.37	16.43	17.68	18.93	20.74	22.71	24.19	25.67
Other .....	.04	.05	.04	.03	.04	.04	.04	.04	.04	.04	.05
Total	14.25	15.10	16.32	17.34	18.49	19.79	21.18	23.02	24.96	26.44	27.92
MIDDLE EAST											
Bahrain .....	.08	.08	.10	.10	.12	.13	.14	.13	.16	.18	.21
Iran .....	.55	.50	.54	.25	.21	.25	.31	.48	.60	.54	.56
Kuwait .....	.13	.18	.22	.14	.17	.13	.12	.14	.14	.17	.17
Qatar .....	.06	.05	.15	.18	.16	.19	.17	.21	.19	.19	.19
Saudi Arabia .....	.28	.33	.41	.37	.69	.20	.19	.62	.72	.89	.94
United Arab Emirates .....	.19	.17	.19	.20	.23	.20	.27	.34	.48	.54	.60
Other .....	.06	.07	.08	.08	.12	.13	.05	.08	.08	.13	.21
Total	1.35	1.38	1.70	1.33	1.70	1.23	1.26	2.00	2.38	2.63	2.89
AFRICA											
Algeria .....	.21	.66	.55	.41	.77	.94	1.31	1.36	1.36	1.33	1.48
Egypt .....	.03	.04	.04	.03	.05	.09	.11	.14	.17	.20	.21
Libya .....	.14	.18	.18	.18	.11	.12	.14	.16	.18	.20	.18
Nigeria .....	.02	.02	.05	.04	.08	.05	.08	.10	.11	.12	.13
Other .....	.02	.02	.03	.03	.03	.03	.04	.04	.03	.03	.13
Total .....	.42	.92	.84	.69	1.04	1.24	1.69	1.80	1.86	1.88	2.13
FAR EAST AND OCEANIA											
Australia .....	.24	.26	.28	.32	.38	.38	.39	.40	.45	.48	.50
Bangladesh .....	.03	.04	.05	.05	.06	.06	.07	.09	.10	.11	.13
Brunei .....	.29	.30	.29	.32	.34	.32	.33	.30	.29	.29	.30
China .....	.41	.50	.51	.50	.45	.38	.43	.44	.46	.48	.49
India .....	.04	.06	.04	.05	.06	.09	.11	.11	.13	.18	.29
Indonesia .....	.20	.20	.39	.63	.66	.67	.78	1.06	1.23	1.18	1.29
Japan .....	.10	.09	.04	.03	.04	.07	.08	.08	.09	.07	.08
Malaysia .....	.03	.04	.01	.04	.04	.06	.15	.32	.44	.53	.53
New Zealand .....	.05	.05	.05	.04	.05	.09	.09	.09	.11	.14	.14
Pakistan .....	.18	.19	.23	.29	.32	.35	.34	.35	.36	.39	.41
Thailand .....	.00	.00	.00	.00	.04	.05	.06	.07	.13	.11	.15
Other .....	.16	.11	.12	.11	.14	.14	.15	.16	.18	.18	.18
Total	1.73	1.84	2.01	2.38	2.57	2.67	2.96	3.50	3.98	4.16	4.51
WORLD TOTAL	47.14	48.50	51.73	53.11	54.62	54.12	54.57	59.66	62.00	63.25	67.28

* Preliminary.

Notes: Totals may not equal sum of components because of independent rounding. Temperature and pressure at measurement are not reported.

Source: Energy Information Administration, *International Energy Annual 1987*, DOE/EIA-0219(87) (1988).

Table C4. World Coal Production, 1977-1987
(Million Short Tons)

Region Country	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987*
NORTH AMERICA											
Canada	32	34	37	40	44	47	50	63	67	64	67
Mexico	7	7	8	8	8	8	10	10	9	9	9
United States	697	670	781	830	824	838	782	896	884	890	917
Total	736	711	826	878	876	894	841	969	960	964	993
CENTRAL AND SOUTH AMERICA											
Brazil	4	4	8	9	6	7	7	8	9	8	8
Chile	1	1	1	1	1	1	1	1	2	2	2
Colombia	4	4	5	6	6	7	6	8	11	12	13
Other	1	1	1	1	1	1	1	1	1	1	1
Total	10	10	16	16	14	16	16	18	21	23	24
WESTERN EUROPE											
Austria	3	3	3	3	3	4	3	3	3	3	3
Belgium	8	7	7	7	7	7	7	7	8	6	4
France	27	26	23	23	24	22	22	21	19	18	16
Germany, West	229	228	239	239	241	247	236	233	231	222	211
Greece	26	25	26	26	30	30	33	35	40	42	47
Italy	2	2	2	2	2	2	2	2	2	2	2
Norway	1	(*)	(*)	(*)	(*)	(*)	1	(*)	1	(*)	(*)
Spain	19	22	24	32	38	43	44	44	44	42	45
Turkey	13	15	22	18	19	24	32	38	43	51	52
United Kingdom	135	136	135	141	138	137	127	55	104	119	115
Yugoslavia	43	44	46	52	58	60	65	72	75	77	83
Other	(*)	(*)	(*)	(*)	(*)	1	(*)	(*)	(*)	(*)	(*)
Total	506	509	529	543	561	577	571	510	570	584	577
EASTERN EUROPE AND U.S.S.R											
Albania	1	1	1	2	2	2	2	2	2	3	3
Bulgaria	28	28	31	33	32	35	36	36	34	35	39
Czechoslovakia	134	136	137	136	137	139	140	143	140	139	139
Germany, East	280	279	282	285	294	304	309	327	344	343	342
Hungary	28	28	28	28	29	29	28	28	27	25	25
Poland	250	258	264	254	219	250	258	267	275	286	293
Romania	30	32	36	39	41	42	39	49	51	52	52
U.S.S.R.	796	798	792	790	776	792	789	785	798	825	830
Total	1,548	1,590	1,571	1,566	1,529	1,593	1,801	1,635	1,671	1,709	1,723
MIDDLE EAST											
Iran	1	1	1	1	1	1	1	1	1	1	1
Total	1	1	1	1	1	1	1	1	1	1	1
AFRICA											
Morocco	1	1	1	1	1	1	1	1	1	1	1
Mozambique	(*)	(*)	(*)	(*)	1	1	1	(*)	(*)	(*)	(*)
South Africa	94	100	114	127	144	151	161	179	192	195	194
Zambia	1	1	1	1	(*)	(*)	(*)	1	1	1	1
Zimbabwe	3	3	4	4	3	3	4	3	3	4	4
Other	1	1	1	(*)	1	1	1	1	1	(*)	1
Total	100	106	121	133	149	157	167	184	198	201	201
FAR EAST AND OCEANIA											
Australia	111	114	119	116	130	140	146	153	186	187	206
China	606	681	698	684	683	734	788	870	937	959	1,014
India	115	116	118	125	142	148	158	168	173	188	203
Indonesia	(*)	(*)	(*)	(*)	(*)	(*)	1	1	2	3	3
Japan	20	21	19	20	20	19	19	18	18	18	15
Korea, North	45	45	48	50	50	52	50	51	53	54	54
Korea, South	19	20	20	21	22	20	21	23	26	28	28
Mongolia	4	4	4	5	5	6	6	6	7	7	7
New Zealand	3	2	2	2	2	2	2	3	3	3	2
Pakistan	1	1	1	2	2	2	2	2	2	2	3
Philippines	(*)	(*)	(*)	(*)	(*)	1	1	1	1	1	1
Thailand	(*)	(*)	1	2	2	2	2	3	6	6	8
Vietnam	6	6	6	6	7	6	7	6	6	6	6
Other	3	3	3	3	3	4	3	3	3	2	2
Total	934	1,014	1,042	1,036	1,068	1,136	1,205	1,307	1,422	1,463	1,552
WORLD TOTAL	3,834	3,911	4,105	4,173	4,198	4,375	4,402	4,623	4,844	4,944	5,071

* Preliminary.

(*)Denotes less than one-half the unit of measure.

Notes: Coal includes anthracite, subanthracite, bituminous, subbituminous, lignite, and brown coal. Totals may not equal sum of components because of independent rounding.

Source: Energy Information Administration, *International Energy Annual 1987*, DOE/EIA-0219(87) (1988).

Table C5. World Net Hydroelectric Power Production, 1977-1987
(Billion Kilowatthours)

Region Country	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987*
NORTH AMERICA											
Canada	220.3	234.0	243.0	251.0	263.2	255.3	263.4	283.4	300.7	307.7	313.2
Mexico	19.1	16.2	17.9	16.9	24.6	22.9	20.7	23.6	26.2	27.5	28.0
United States	223.6	283.5	283.1	279.2	263.8	312.4	335.3	324.3	284.3	294.0	252.9
Total	462.9	533.7	544.0	547.1	551.6	590.6	619.4	631.3	611.3	629.1	594.0
CENTRAL AND SOUTH AMERICA											
Argentina	5.7	7.7	10.5	15.0	14.5	17.4	18.2	19.7	20.4	20.8	21.0
Brazil	93.5	102.7	115.1	127.4	129.5	139.7	150.0	164.9	176.6	180.8	185.0
Chile	6.4	6.8	6.9	7.3	7.5	8.4	8.8	9.2	10.3	11.2	11.2
Colombia	10.5	12.1	13.2	14.5	17.5	18.4	19.4	19.1	19.3	19.5	19.6
Peru	6.0	6.1	6.5	7.5	7.1	8.3	8.0	8.5	9.2	9.9	10.0
Uruguay	1.6	1.6	1.3	2.3	3.8	5.0	7.1	7.0	6.4	7.2	7.5
Venezuela	11.8	12.0	13.3	14.5	14.9	15.8	17.5	19.5	20.5	21.1	21.5
Other	7.5	9.0	10.0	11.1	11.0	11.1	12.2	14.3	16.1	17.2	17.6
Total	143.0	158.0	176.8	199.6	205.9	224.1	241.3	262.2	278.8	287.7	293.4
WESTERN EUROPE											
Austria	24.6	24.6	27.8	28.8	30.5	30.6	30.3	29.2	31.3	31.5	32.0
Finland	12.0	9.6	10.7	10.0	13.4	13.0	13.4	13.2	12.0	12.1	13.4
France	76.1	68.5	67.0	69.2	72.7	71.0	70.7	67.4	63.7	64.0	71.6
Germany, West	17.3	18.2	18.2	20.6	19.8	19.3	18.6	18.2	17.4	18.3	20.3
Iceland	2.5	2.6	2.8	3.0	3.1	3.4	3.6	3.7	3.7	3.8	3.9
Italy	52.5	47.1	47.9	48.5	45.3	43.8	43.9	44.9	44.0	44.0	41.9
Norway	71.5	80.1	88.1	83.0	92.1	92.0	105.0	105.3	101.8	95.8	102.8
Portugal	9.9	10.6	11.6	8.0	5.1	6.8	7.9	9.7	10.6	8.4	9.1
Spain	40.3	41.1	46.9	30.5	22.7	27.8	28.6	33.1	32.8	26.9	27.7
Sweden	52.8	57.0	60.3	58.7	59.6	55.0	63.7	67.4	70.3	60.1	70.3
Switzerland	36.3	32.5	32.3	33.5	36.1	37.0	36.0	30.9	31.7	33.6	35.0
Turkey	8.5	9.3	10.2	11.2	12.5	14.0	11.2	13.3	11.9	11.8	18.5
United Kingdom	5.2	5.2	5.4	5.1	5.4	5.6	6.4	6.0	6.8	7.0	6.0
Yugoslavia	24.1	24.9	26.3	27.9	25.1	23.3	21.6	24.9	23.2	26.5	27.0
Other	3.7	4.8	5.8	5.7	6.3	6.3	5.2	5.8	5.9	6.7	6.3
Total	437.4	436.3	461.3	443.8	449.6	449.0	466.3	472.8	467.1	450.5	485.8
EASTERN EUROPE AND U.S.S.R.											
Czechoslovakia	4.3	4.0	4.1	4.7	4.2	3.7	3.8	3.2	4.3	4.0	4.0
Poland	2.4	2.4	2.4	3.2	3.0	2.6	3.3	3.3	3.9	3.7	3.6
Romania	9.3	10.5	11.2	12.5	12.6	11.7	9.9	11.2	11.8	12.0	12.0
U.S.S.R.	145.5	168.0	170.3	182.0	184.9	172.9	178.6	200.8	212.4	213.6	215.0
Other	6.5	6.1	6.6	7.3	7.6	7.1	8.3	8.4	7.4	7.6	7.8
Total	168.0	191.0	194.7	209.8	212.2	198.1	204.0	226.9	239.7	240.8	242.4
MIDDLE EAST											
Iran	4.0	4.0	4.0	3.0	6.2	6.4	6.1	6.3	6.3	6.1	6.2
Other	3.1	3.5	3.9	4.1	4.2	4.2	3.9	4.0	4.0	3.7	3.8
Total	7.1	7.5	7.8	7.1	10.3	10.6	10.1	10.3	10.3	9.8	10.0
AFRICA											
Egypt	8.9	9.2	9.4	9.5	10.1	10.3	10.4	10.4	10.5	10.5	10.5
Zaire	4.0	4.1	4.2	4.3	4.1	4.4	4.4	4.4	4.5	4.5	4.5
Zambia	8.5	7.8	8.7	8.8	9.7	10.0	10.0	9.8	10.1	10.1	10.1
Zimbabwe	3.5	3.8	3.5	4.0	4.1	3.6	3.7	3.5	3.1	3.2	3.2
Other	22.3	23.8	30.3	34.9	24.4	23.1	22.1	18.4	19.8	19.8	20.0
Total	47.3	48.7	56.0	61.5	52.4	51.4	50.6	46.5	48.0	48.0	48.3
FAR EAST AND OCEANIA											
Australia	13.6	14.5	16.0	16.9	14.7	14.4	12.8	13.4	14.9	14.5	13.7
China	47.1	44.2	49.6	57.6	64.9	73.7	85.5	85.9	91.5	99.0	100.0
India	37.6	46.7	45.1	46.1	49.1	47.9	49.5	53.4	50.5	53.2	53.5
Japan	75.5	73.9	84.2	91.2	89.7	83.2	87.1	72.7	87.1	85.7	86.0
Korea, North	17.3	19.3	20.3	22.3	22.8	24.8	25.7	26.7	27.7	28.7	29.7
Korea, South	1.4	1.8	2.3	2.0	2.7	2.0	2.7	2.4	3.6	4.0	5.3
New Zealand	14.4	16.1	15.3	16.2	19.3	17.9	19.4	20.0	19.9	21.6	22.0
Pakistan	5.4	5.8	8.3	8.6	9.0	9.4	11.3	12.7	12.1	13.7	14.0
Philippines	2.2	2.8	2.8	3.5	3.7	4.2	4.0	7.3	5.5	6.0	6.0
Thailand	3.2	2.1	3.2	3.7	2.9	3.8	3.6	4.0	3.7	5.5	5.5
Other	11.8	13.8	14.4	13.3	14.9	15.2	19.3	22.4	26.0	27.8	27.9
Total	229.7	240.9	261.5	281.3	293.6	296.5	320.9	320.9	342.5	359.7	363.6
WORLD TOTAL	1,495.3	1,616.2	1,702.2	1,750.2	1,775.6	1,820.2	1,912.5	1,970.9	1,997.7	2,025.6	2,037.5

* Preliminary.

Notes: Totals may not equal sum of components because of independent rounding. World net hydroelectric power production includes industrial and utility production of hydroelectric power.

Source: Energy Information Administration, *International Energy Annual 1987*, DOE/EIA-0219(87) (1988).

Table C6. World Net Nuclear Electric Power Production, 1977-1987
(Billion Kilowatthours)

Region Country	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987*
NORTH AMERICA											
Canada	23.6	28.0	31.6	34.1	35.9	34.4	43.9	46.8	54.2	63.9	69.2
United States	250.9	276.4	255.2	251.1	272.7	282.8	293.7	327.6	383.7	414.0	455.3
Total	274.5	304.4	286.8	285.2	308.6	317.1	337.6	374.4	437.9	477.9	524.5
CENTRAL AND SOUTH AMERICA											
Argentina	1.6	2.8	2.6	2.2	2.7	1.8	3.2	4.3	5.5	5.4	6.1
Brazil .....	.0	.0	.0	.0	.0	.1	.2	2.0	3.2	.1	.9
Total	1.6	2.8	2.6	2.2	2.7	1.8	3.4	6.3	8.7	5.6	7.1
WESTERN EUROPE											
Belgium	11.3	11.9	10.8	11.9	12.2	14.8	22.8	26.3	32.8	36.7	39.8
Finland	2.5	3.1	6.3	6.6	13.7	15.7	16.6	17.6	17.8	17.8	18.4
France	17.0	29.0	37.9	58.2	100.0	103.4	137.0	181.6	212.8	241.5	252.2
Germany, West	34.0	34.1	40.1	41.5	50.7	60.2	61.5	88.0	119.4	111.5	124.0
Italy	3.2	4.2	2.5	2.1	2.6	6.5	5.5	6.5	6.7	8.2	.2
Netherlands	3.5	3.9	3.3	4.0	3.5	3.7	3.4	3.6	3.7	4.0	3.4
Spain	6.2	7.3	6.4	4.9	9.0	8.3	10.2	21.9	26.6	35.6	39.2
Sweden	18.9	22.6	20.0	25.4	35.8	36.8	38.5	48.7	55.7	66.5	63.9
Switzerland	7.7	7.9	11.3	13.6	14.4	14.2	14.8	15.5	21.3	21.3	21.8
United Kingdom	36.2	34.8	36.6	35.3	36.9	41.9	47.5	51.4	56.7	56.1	53.4
Yugoslavia .....	.0	.0	.0	.0	.3	2.4	3.7	4.2	3.8	3.8	4.3
Total	140.5	158.8	175.1	203.5	279.0	308.1	361.4	465.4	557.3	603.1	620.5
EASTERN EUROPE AND U.S.S.R.											
Bulgaria	5.6	5.6	5.9	5.9	8.7	10.2	11.7	12.1	12.5	11.5	12.3
Czechoslovakia .....	.1	.1	1.8	4.3	4.5	5.5	5.8	6.9	11.2	16.9	20.9
Germany, East	4.9	6.3	9.3	11.3	11.3	10.3	11.6	11.2	12.1	10.4	11.4
Hungary .....	.0	.0	.0	.0	.0	.0	2.3	2.4	6.2	7.0	10.4
U.S.S.R.	32.3	42.5	52.1	69.3	64.6	76.0	104.3	134.9	159.0	153.0	160.0
Total	42.9	54.5	69.1	90.7	89.0	102.1	135.8	167.5	200.9	198.8	215.1
MIDDLE EAST											
.....	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
AFRICA											
South Africa .....	.0	.0	.0	.0	.0	.0	.0	4.0	5.5	8.9	6.3
Total .....	.0	.0	.0	.0	.0	.0	.0	4.0	5.5	8.9	6.3
FAR EAST AND OCEANIA											
India	2.6	2.2	3.0	2.7	2.9	2.0	2.7	3.9	4.3	4.9	5.2
Japan	26.7	50.5	58.9	78.7	79.3	99.3	103.6	120.8	144.4	156.6	176.9
Korea, South .....	.1	2.2	3.0	3.3	2.8	3.6	8.5	11.2	15.9	26.9	37.3
Pakistan .....	.3	.2	(*)	.1	.2	.1	.2	.3	.2	.5	.3
Taiwan .....	.1	2.5	6.0	7.8	10.1	12.4	18.0	23.1	27.3	25.6	31.5
Total	29.8	57.6	71.0	92.6	95.3	117.4	133.1	159.3	192.2	214.4	251.2
WORLD TOTAL	489.4	578.0	604.5	674.2	774.6	846.6	971.2	1,176.9	1,402.5	1,508.6	1,624.6

* Preliminary.

(*) 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 1987*, DOE/EIA-0219(87) (1988).

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