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Energy Market Vulnerabilities in the 1980s

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A Research Paper

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December 1983
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A Research Paper

This paper was prepared by the Energy Issues Branch, Office of Global Issues, with contributions from Analytic Support Group. Comments and queries are welcome and may be directed to the Chief, Energy Issues Branch, OGI,

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Energy Market Vulnerabilities in the 1980s

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Key Judgments

Information available as of 25 October 1983 was used in this report.

Energy use in non-Communist countries is expected to grow slowly through the balance of the decade, increasing by 20 million barrels per day oil equivalent (b/doe) to 112 million b/doe in 1990. On the basis of our own analysis and a review of these forecasts, we believe the present supply cushion, particularly for oil, will gradually erode during the decade, increasing market vulnerability to an unexpected cutoff of supplies. Although overall OECD energy requirements will increase only marginally, the forecasts indicate that Japan and Western Europe will remain dependent on imports for more than 80 percent and 40 percent of total requirements, respectively. While the United States will import only about 15 percent of energy needs according to these assessments, the US economy will remain vulnerable to an energy supply disruption.

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consumption of all major fuels will increase. Oil consumption is expected to rise gradually to about 50 million b/d by 1990 with demand for OPEC oil approaching 25 million b/d. The forecasts suggest that at this level of demand surplus capacity will approximate 6 million b/d, leaving the market with some cushion to cope with a supply disruption. Should demand approximate 53 million b/d, as our econometric model forecasts, there would be little spare capacity to offset an unexpected disruption. In any event, oil will continue to supply more than 40 percent of non-Communist energy needs, and Japan and Western Europe will remain heavily dependent on imports to meet their oil demand.

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The forecasts indicate moderate growth in gas demand and ample supplies. Gas consumption is expected to increase from about 18 million b/doe in 1980 to less than 21 million b/doe in 1990. Still, the major gas-consuming regions—Western Europe, Japan, and the United States—will become increasingly dependent on imported natural gas. By 1990 Western Europe is expected to rely on imports for as much as 30 percent of total gas requirements, with the bulk coming from the Soviet Union. The Europeans have contracted for more-than-sufficient supplies to meet projected 1990 demand; the surplus, however, could delay or prevent development of more costly Norwegian gasfields needed to limit West European dependence on non-OECD gas supplies after 1990.

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The outlook for other fuels in non-Communist countries indicates that:

- Coal consumption will approximate 25 million b/doe by 1990; roughly 80 percent of this consumption is expected to occur in the OECD.
- Nuclear power consumption will grow 5 million b/doe during the decade, rising to 8 million b/doe in 1990.

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Even though the forecasts suggest that energy supplies should be adequate for future demand, continued high reliance on imports will leave the industrial countries vulnerable to energy supply cutoffs. Disruptions have occurred frequently in the past, and we believe the probability that some sort of future disruption will occur is quite high, particularly for oil and natural gas. We estimate that the volatile Persian Gulf region, for example, will account for 20 million b/d of production capacity in 1990—more than one-third of total non-Communist oil supply availability. Indeed, recent threats by Iran to close the Strait of Hormuz highlight the vulnerability of the region's oil supplies. Our analysis of a worse-case scenario, such as the closure of the strait, indicates that with a 6-million-b/d net oil supply shortfall, oil prices would more than double and GNP loss in the OECD countries would amount to about 2.8 percentage points. In addition, rising prices following a major prolonged interruption could have severe repercussions on the international financial system, particularly in the near term because of existing LDC payment problems. In the case of natural gas, increased dependence on imports from the Soviet Union and Algeria raises the risk of a natural gas disruption in Western Europe. Because the Soviet Union is a net exporter of both oil and natural gas, Moscow is a major beneficiary in a large disruption of non-Soviet supplies.

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Most long-term forecasters have had limited success in predicting future events, and we believe there is a substantial risk that the present forecasts overestimate the supply cushion available to the market late in the decade. We believe lower oil and energy prices will dampen conservation and substitution while boosting economic growth and energy demand. At the same time, prospects of weak prices are already discouraging investment in new high-cost supply projects. The falloff in investment will affect energy supply availability later in the decade, given the long leadtimes of many of these projects. Lower demand expectations are already changing the outlook for future oil supply availability in OPEC, which currently is suffering from an abundance of unused capacity. Most importantly, Saudi Arabia has decided to reduce its operating capacity by 2 million b/d to 8 million b/d.

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We believe that a combination of such trends could reduce the oil supply cushion by 3-4 million b/d below levels currently estimated in other forecasts. Moreover, we expect that by 1985 only a small part of that supply cushion—perhaps 1 million b/d—will be located outside the volatile Persian Gulf region. And much of that could be unavailable to help stabilize the market during a disruption because it will be located in Libya. While these considerations in and of themselves do not suggest that we should expect upward price pressures to develop late in the decade, our analysis indicates that the market will become vulnerable to even minor supply disturbances.

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Contents

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Appendixes

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Energy Market Vulnerabilities in the 1980s

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Introduction

During the past decade, two major disruptions in oil supplies—the Arab oil embargo in 1973 and the Iranian revolution in 1978—sparked massive changes in the world economy and sent governments scrambling to devise policies to promote energy security. In the upheaval following the ninefold increase in oil prices during the 1970s, economic growth slowed considerably, unemployment rose, and inflation increased sharply. At the same time, however, the rapid rise in oil and energy prices touched off a wave of new investments in energy conservation that, coupled with sluggish economic growth, caused a sharp decline in oil and energy use.

By early 1983 the drop in oil demand was so severe that members of OPEC were forced to initiate a first-ever reduction in the price of the benchmark crude. This event and continued weakness in the demand for oil and energy have prompted some observers to herald an end to the energy crisis. Even though structural changes continue to reduce energy needs of the United States and its allies, we believe energy remains vital to the economic interests of these countries. Oil still supplies about one-half of non-Communist energy requirements, and nearly 70 percent of non-Communist oil reserves are located in the volatile Middle East. As long as the United States and its allies must depend on imports for oil and other fuels, the threat of supply disruptions will continue to make energy a strategic concern.

Current Oil Market Situation

Non-Communist oil consumption should approximate 44 million barrels per day (b/d) this year, some 2 percent below 1982 levels. Demand for OPEC oil is now about 19 million b/d, roughly 8 million b/d below available capacity and nearly 13 million b/d less than peak 1979 production levels. Increased production in non-OPEC countries—mainly Mexico, the United Kingdom, and Norway—have added to available capacity. At the same time, the recession and conservation gains have held down oil consumption. OPEC producers have attempted to adjust to sharply declining revenues that have resulted from dwindling demand for their oil. Earlier this year, market pressures forced the OPEC cartel to reestablish production quotas and lower the benchmark crude oil price from $34 per barrel to $29 per barrel.

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Most OPEC members have thus far largely abided by the cartel's production and pricing guidelines. Recent gains in OPEC oil production have signaled a return to more stable conditions in the oil market. Whether the organization can prevent a further decline in nominal oil prices during the coming year or so, however, will depend on several factors, the most important being a recovery in oil consumption.

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Barring a major supply disruption, oil market conditions will remain soft in the near term. Even though OPEC was successful in holding the line on prices through yearend, the cartel will continue to face a number of problems during the next year or so. One major hurdle will be the manner in which OPEC members allocate production above the present production ceiling of 17.5 million b/d. Because of pressing financial needs, we believe there will be a great temptation to produce too much too soon. Indeed, if consumption continues to fall, major oil companies would accumulate excess inventories and cause a return to the weak market conditions that prevailed in early 1982 and 1983. Should the Iran-Iraq war end unexpectedly in the coming months, attempts by those two countries to raise production would also sharply increase downward price pressures.

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Key Assumptions

Assumptions about economic growth and oil prices, as well as future conservation and substitution trends, are critical to long-term energy market projections. In assessing recent energy market forecasts, we concluded that key assumptions made by the forecasters appear to be reasonable

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Economic Growth. *Most forecasts assume average annual real economic growth of 2.7 to 3.4 percent (2.9-percent midrange estimate) during 1981-90 for the non-Communist world. Projections of economic growth for the OECD countries range from 2.2 to 2.8 percent annually, with Japan and the United States expected to experience stronger growth than the West European countries. To meet projections of 2.6-percent average annual growth for the decade, GNP growth in the combined OECD economies would have to exceed 3 percent per year for the rest of the 1980s. Economic growth in the developing countries is expected to average 4 percent per year for the 1980-90 period.*

Prices. *Most recent energy supply/demand projections assume declining real oil prices to 1985 and flat or moderately increasing real oil prices to 1990. Although forecasters agree on this general trend in crude oil prices, they point out that the price path may not be a smooth one. On the basis of past experience, forecasters believe sharp oil price increases are more likely to occur as a result of a supply disruption than growth in oil consumption. Exchange rate fluctuations can also have a considerable impact because crude oil prices are denominated in dollars. Most forecasters do not, however, factor exchange rate fluctuations into their long-term forecasts. In current projections, the forecast of the OPEC benchmark oil price, expressed in constant 1982 dollars, ranges from $22 to $31 in 1985 and $28 to $43 in 1990. The wide range in the oil price forecast is attributable, at least in part, to attempts by some forecasters to consider alternative demand and price scenarios. The midrange estimate of the OPEC benchmark oil price in 1990 approximates $30 per barrel (1982 dollars).*

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Assumptions about other energy prices are less precise, but in general coal and natural gas prices are expected to move in line with oil prices. While we believe the trend in crude oil prices will largely determine the pattern for prices of alternative fuels, we expect natural gas prices to rise relative to the price of oil products because of the increase in residential gas use, where gas commands a higher price. Coal prices will vary among major consuming regions because of differences in production and transportation costs; surplus production capacity and flat real oil prices are expected to keep coal prices soft through the decade.

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Conservation and Substitution. *Assumptions about future conservation and substitution trends are also critical to long-term energy demand projections. Most analysts expect to see continued gains in efficiency during the decade, albeit at a slower rate than in recent years.*

past conservation efforts will cause relatively slow growth in energy demand in the long term because the effect of some past investments may take 20 years to be fully felt. Other efficiency improvements, however, might erode as oil prices decline. Residential consumers may turn up thermostats, abandon car pools and mass transit travel, and increase miles driven in private vehicles.

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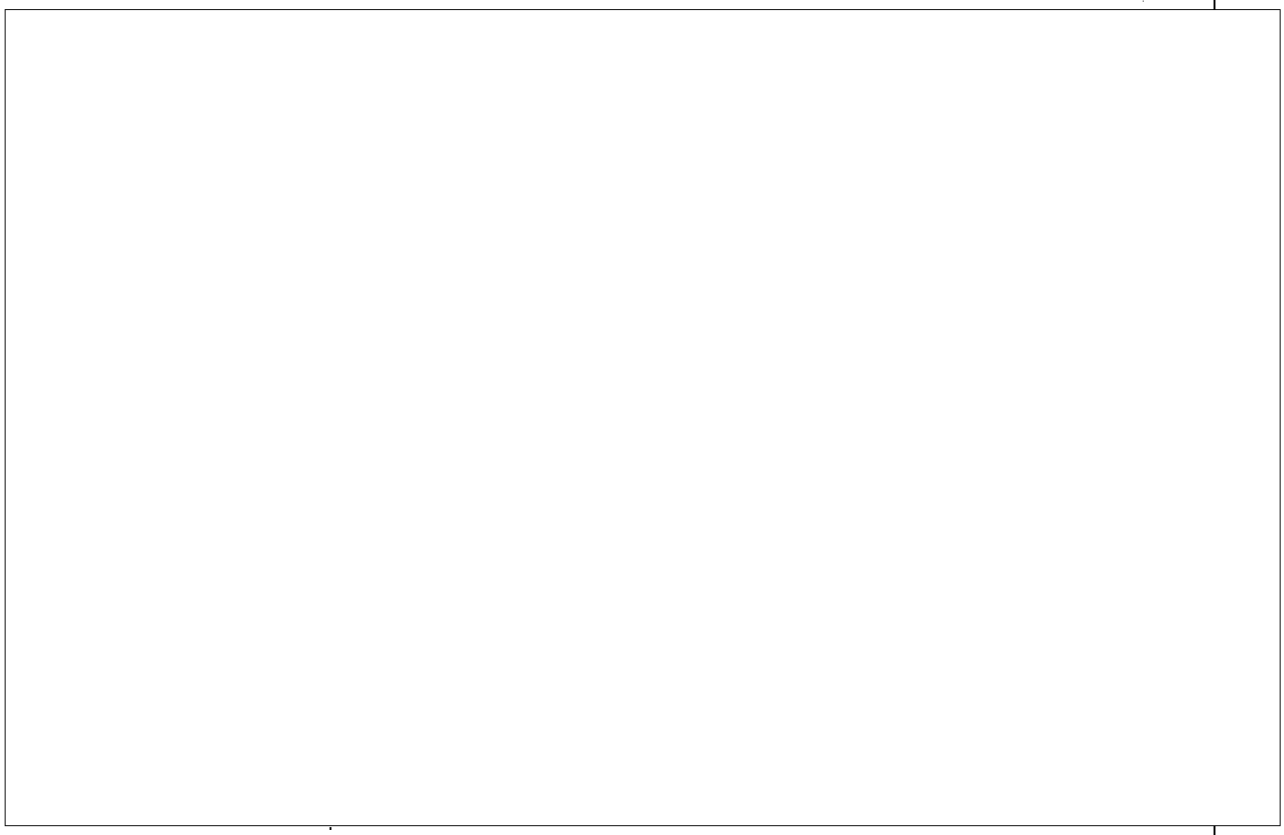

The Outlook to 1990

Assessing the Future: The Methodology

To assess energy market conditions through the remainder of the decade, we examined an array of long-term forecasts completed during the past nine months. Our survey included forecasts by major oil companies, consulting firms, financial institutions, and governments (see appendixes). We examined the forecasts for reasonableness of assumptions and internal consistency. In deriving our base or summary case, we attempted to represent the consensus opinion, tempered when necessary by our judgment. At times, even the range of forecasts did not accommodate all reasonable possibilities and, in these cases, alternative estimates are presented and discussed. In other instances, the forecasts did not present detailed estimates for certain fuels or regions. In these cases—particularly for electricity and oil production in individual LDCs—we provided our own estimates. We also used the CIA linked econometric model to assess long-term energy demand, as well as to test sensitivity to changes in key assumptions and to measure the impact of supply disruptions.

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The CIA's Linked Econometric Model: Estimates of Non-Communist Oil Consumption

The 1,800-equation linked econometric model is an annual model based on interrelated macroeconomic and energy behavior for the seven major industrialized countries individually and the smaller OECD countries as a group. OPEC demand and other LDC demand are also included, and the country and subgroup models are linked together by trade, including energy

Each OECD submodel calculates energy demand based on historical relationships with real GNP and the real end-use energy price. Real end-use energy prices are weighted average prices of petroleum, gas, coal, and electricity deflated by the GNP deflators. The income elasticity, or ratio between energy demand growth and GNP growth when energy prices remain constant, is assumed to be 1.0 in the OECD countries. The long-run price elasticity—which determines the impact of energy price changes on energy demand—ranges from −0.5 to −0.6 in the OECD countries with up to an eight-year lag. The shares in total demand by individual fuels—oil, natural gas, coal, and electricity—are generally determined by the prices of individual fuels relative to the end-use energy price. Estimates of OPEC and LDC oil demand are based on historical relationships between oil demand, GNP, and oil prices; judgmental factors are also included

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Oil supply availability, including OPEC and non-OPEC production as well as net Communist exports to the non-Communist world, is determined judgmentally and exogenously imposed on the model. Energy supplies in OECD countries for hydropower and nuclear power are also exogenous variables based on current capacity plans. In some cases—coal in the United States and natural gas in Canada, for example—supplies are not constrained and are assumed to be adequate to meet demand.

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The model calculates a demand path based on growth and price assumptions. As oil demand reaches available supply, the model determines a higher market-clearing price and feeds back the effects to determine new, lower levels of economic growth. The model is also used to estimate the impacts of oil supply disruptions and the sensitivity of energy demand to changes in growth and price assumptions.

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Energy Demand

Recent long-term projections of energy supply and demand indicate only moderate growth in non-Communist energy demand through 1990 (see table 2). Non-Communist energy consumption is expected to rise at an average annual rate of 1.7 percent for the decade—from 94 million barrels per day oil equivalent (b/doe) in 1980 to about 112 million b/doe in 1990. Given the worldwide economic recession and the accompanying decline in energy demand early in the decade, however, much higher energy demand growth of about 2.3 percent per year is expected from 1985 to 1990. Most of this growth is expected to be met by nonoil fuels, primarily coal and nuclear power.

Coal's share of total non-Communist energy consumption is expected to increase from 19 percent in 1980 to 21 percent by 1990. Nuclear energy and hydropower combined are expected to meet 15 percent of non-Communist primary energy requirements by the end of the decade, compared with 10 percent in 1980. Although consumption of natural gas is projected to increase during the period, forecasters expect gas to maintain its 19-percent share of total energy demand through the 1980s. In sharp contrast to all other fuels, oil's share of energy consumption is projected to decline, falling from 52 percent in 1980 to 44 percent by 1990.

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Table 2
Non-Communist World: Summary of Energy Supply and Demand Projections

Million b/doe

	1980	1982 [a]	1985		1990	
			Range [b]	Midrange Estimate	Range [b]	Midrange Estimate
Total non-Communist energy consumption	**94**	**92**	**97.4-112.2**	**99.7**	**101.6-126.5**	**111.5**
Non-Communist oil consumption	49.5	45.5	44.0-50.8	47.0	46.7-52.8	49.5
OECD	38.0	33.7	32.1-38.7	34.2	32.3-39.0	34.6
Rest of non-Communist world	11.5	11.8	11.8-13.2	12.8	13.5-15.6	14.9
Non-Communist oil supply	49.9	44.2	44.2-51.1	47.6	46.5-53.1	49.5
OECD	14.8	15.3	13.9-15.9	15.6	12.2-15.6	14.2
OPEC	27.7	19.9	18.6-25.8	22.0	21.6-27.7	24.4
Other LDCs	5.6	6.9	8.0-8.7	8.4	9.1-10.2	9.5
Centrally planned economies' exports	1.2	1.5	0.8-1.8	1.0	0.0-1.8	0.8
Refinery gain	0.6	0.5	0.6-0.8	0.6	0.6-0.7	0.6
Stock change	0.4	−1.3	0.0-1.3	0.6	−0.2 to 0.5	0.0
US total energy consumption	**37.5**	**34.9**	**34.2-37.9**	**36.5**	**35.4-41.4**	**38.7**
Oil	17.0	15.2	14.4-18.0	15.4	14.4-17.4	15.3
Nonoil	20.5	19.7	18.0-23.0	21.1	20.6-25.8	23.4
Net imports						
Oil	6.2	4.2	4.4-8.0	4.8	4.4-7.7	5.5
Gas	0.4	0.5	0.1-1.0	0.7	0.0-1.6	1.0
Coal	−1.2	−1.3	−0.9 to −2.6	−1.5	−0.9 to −3.3	−2.5
West European total energy consumption	**25.6**	**24.3**	**25.3-28.4**	**26.2**	**27.4-31.2**	**28.7**
Oil	13.3	11.7	11.7-13.0	12.0	11.7-13.5	12.2
Nonoil	12.3	12.6	13.3-15.4	14.2	14.7-18.3	16.4
Net imports						
Oil	10.4	8.7	8.1-9.5	8.4	8.4-10.5	9.2
Gas	0.4	0.4	0.8-1.1	1.0	0.8-2.7	1.1
Coal	1.1	1.0	1.0 to −1.5	1.2	0.3-1.8	1.5
Japanese total energy consumption	**7.5**	**7.3**	**7.1-8.1**	**7.6**	**7.6-9.5**	**8.4**
Oil	5.0	4.5	4.1-5.0	4.5	3.9-5.4	4.7
Nonoil	2.5	2.8	2.5-3.5	3.1	3.1-4.6	3.7
Net imports						
Oil	5.1	4.5	4.1-5.0	4.5	3.9-5.4	4.7
Gas	0.4	0.4	0.6-0.7	0.6	0.6-1.0	0.9
Coal	1.0	1.0	1.1-1.2	1.1	1.2-1.4	1.4

[a] Preliminary.

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Recent Energy Consumption Trends

The consumer response to the 1979/80 oil price increase has been much greater than generally had been expected. Oil consumption in the OECD countries dropped by about 20 percent or nearly 7 million b/d from 1979 to 1982. During the same period, energy consumption in the industrialized countries fell by 8 percent or roughly 7 million b/doe. Although slower economic growth affected demand, most analysts believe increased conservation was the main factor behind the decline. The ratio of energy consumption to GNP, a yardstick of conservation, declined at an average annual rate of 3.6 percent from 1979 to 1982, while GNP rose at an average annual rate of 0.7 percent. By 1982 it took 3.4 barrels of oil equivalent to produce $1,000 of GNP (1980 dollars) compared with about 3.8 barrels in 1979.

The 7-million-b/d decline in oil consumption reflects a combination of price-induced conservation, substitution of other forms of energy for oil, and slower economic growth. Consumers directly cut oil use and accelerated investment in energy saving devices. In addition, many large consumers such as electric utilities switched to alternative energy sources including coal, hydropower, and nuclear power. Nonoil energy supplies increased by about 700,000 b/doe or 2 percent in the four years following the oil price increases of 1979 and now account for half of the OECD's energy requirements. As a result of conservation and substitution, the ratio of oil consumption to economic activity in the OECD countries has dropped by 20 percent since 1979.

[a] The United States, Canada, Japan, France, Italy, the United Kingdom, and West Germany.

Analysis of energy data indicates that the 1979/80 oil price runup had a more pronounced impact on conservation than the 1974 price increase (see figure 1):

- *Continuing effects of earlier price increases and structural shifts in industrial output contributed to efficiency gains.*
- *Although crude prices rose more in percentage terms in 1973/74, the absolute oil price increase was substantially larger in 1979—$16 per barrel compared with $8 per barrel.*
- *Because of earlier price increases, crude oil now constitutes a larger share of final product prices than in the early 1970s.*
- *Governments have relaxed price controls and allowed a more complete passthrough of crude oil costs than in the early 1970s.*

Led by falling real oil prices in the United States, however, the real energy price to final consumers in the seven major industrialized countries fell by about 1 percent in 1982, while the combined Big Seven [a] oil price fell 5 percent (see figure 2). The drop in real crude oil prices slowed the rate of conservation in 1982. Moreover, lower oil prices and the continuing recession reduced the competitive advantage of other fuels because downward movement in other energy prices lagged the oil price decline. Future substitution patterns will hinge on the price competitiveness of fuels to users in the major sectors. Preliminary data indicate that prices of natural gas in several major markets have started to flatten or decline in recent months, and we expect other real energy prices also to show declines in 1983.

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Figure 1
OECD: Energy/GNP and Oil/GNP Ratios, 1973-82

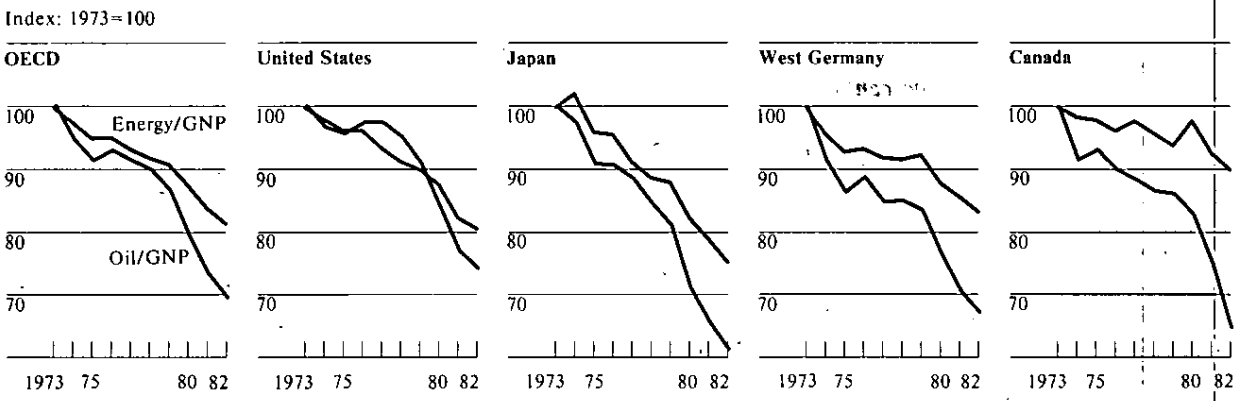
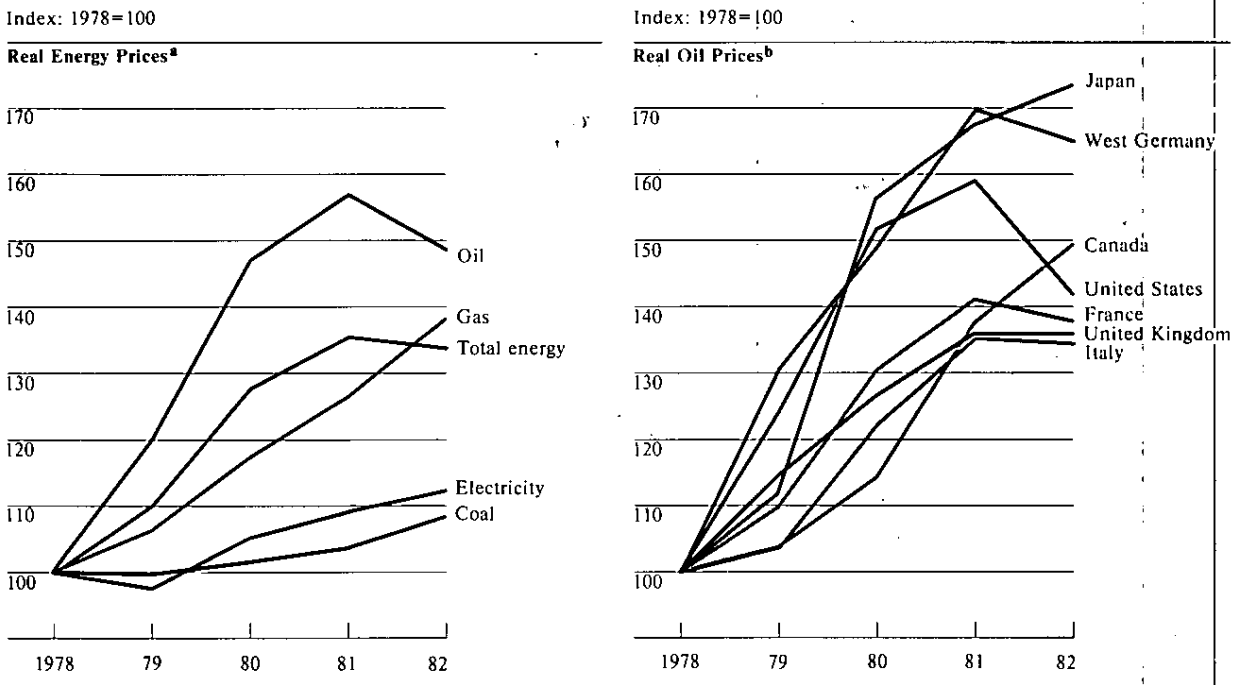


Figure 2
Big Seven: Real Energy Price Trends, 1978-82



[a] Weighted average.
[b] Weighted average of real retail oil prices.

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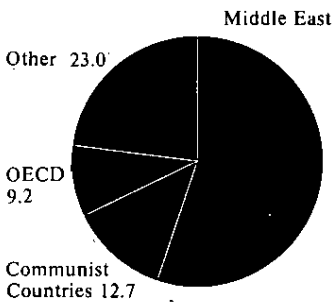
Figure 3
World Energy Reserves, 1983

Percent

Oil

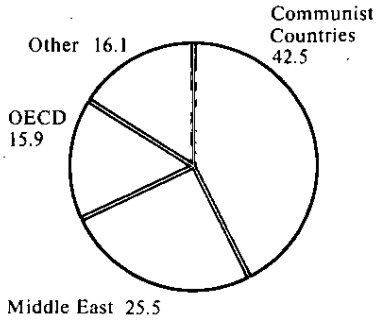
670 billion barrels



OECD	9.2
United States	4.4
Other	4.8
Communist Countries	12.7
USSR	9.4
Other	3.3
Middle East	55.1
Saudi Arabia	24.2
Kuwait	9.6
Iran	8.3
Other	13.0
Other	23.0
Mexico	7.2
Libya	3.2
Venezuela	3.2
Other	9.4

Gas

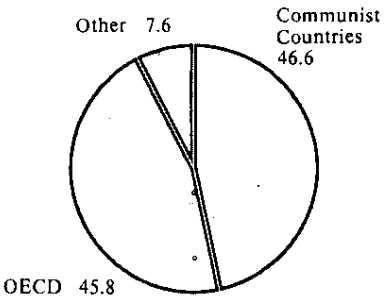
540 billion barrels of oil equivalent



OECD	15.9
United States	6.7
Canada	3.2
Other	6.0
Communist Countries	42.5
USSR	41.0
Other	1.5
Middle East	25.5
Iran	16.0
Saudi Arabia	3.9
Other	5.6
Other	16.1
Algeria	3.7
Mexico	2.5
Other	9.9

Coal

3,400 billion barrels of oil equivalent



OECD	45.8
United States	27.8
United Kingdom	6.5
Australia	5.3
West Germany	5.0
Other	1.2
Communist Countries	46.6
USSR	24.1
China	14.4
Poland	4.5
Other	3.6
Other	7.6
South Africa	3.7
Other	3.9

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Energy demand is projected to increase significantly faster in the developing countries than in the OECD countries because of expectations of higher economic growth, more rapid population increases, and the growing tendency for energy intensive industries to migrate to the LDCs. OECD demand is expected to increase slowly as the effects of past conservation investments and long-term structural changes in energy use continue to reduce energy requirements per unit of economic output. By 1990 OECD's share of non-Communist energy demand is expected to decline to about 76 percent, compared with a share of 85 percent in 1980.

The Resource Base

The size and location of energy reserves vary among fuels, according to industry estimates. Proved reserves of all fuels, however, appear adequate to sustain present rates of consumption well into the next century:

- Proved world oil reserves approximate 670 billion barrels, equal to more than 30 years of supply at current rates of consumption. More than half of total world oil reserves are in the Middle East and another 13 percent rests in Communist countries (see figure 3).
- World gas reserves approximate 540 billion barrels oil equivalent, equal to more than 50 years at current consumption levels. Gas reserves are also found predominantly in politically sensitive areas of the world with Communist countries and the Middle East containing over two-thirds of proved world gas reserves. OECD countries—which account for more than half of world consumption—contain only about 16 percent of the world's reserves.
- World coal reserves are sufficient to last more than 225 years at current rates of consumption. Moreover, OECD countries contain nearly half of proved coal reserves.

Energy Supplies

While the resource base is ample, translating reserves into production will be the key in determining supply availability. Development of supply capacity depends largely on expectations of future demand and price levels. Producing-country tax policies also influence company investment decisions. In general, forecasters believe the proper investment climate and government policies exist to ensure development of supplies sufficient to meet projected demand requirements. The supply situation will vary, however, among fuels and for each major consuming region. None of the supply/demand forecasts assumes any supply disruptions in this decade.

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The Oil Market

Demand Projections. non-Communist oil consumption range from 44 to 51 million b/d in 1985 and 47 to 53 million b/d in 1990 (see table 3). Although we believe that our midrange consumption estimate of about 47 million b/d in 1985 and 50 million b/d in 1990 is a reasonable base case, the wide range in the forecasts indicates the considerable uncertainty inherent in predicting future oil consumption patterns.

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at least half of the loss in consumption is likely to be permanent.

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All the projections we examined indicate that oil consumption in the OECD countries will be stagnant for the balance of the decade. Consumption estimates for OECD in 1990 cluster at around 35 million b/d, some 3 million b/d less than consumption in 1980 and only about 1 million b/d above depressed 1982 levels:

- US oil consumption is projected to recover to about 15.4 million b/d in 1985, then decline to 15.3 million b/d in 1990.
- West European oil consumption is expected to increase moderately during the decade to 12 million b/d in 1985 and to 12.2 million b/d in 1990.
- Little or no growth is expected in Japanese oil consumption to 1985, but forecasters project a slight increase in the late 1980s with consumption growing to about 4.7 million b/d by 1990

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Table 3
Non-Communist Oil Supply and Demand

Million b/d

	1980	1982 [a]	1985 [b]		1990	
			Range	Midrange Estimate	Range	Midrange Estimate
Non-Communist consumption	**49.5**	**45.5**	**44.0-50.8**	**47.0**	**46.7-52.8**	**49.5**
Total OECD	**38.0**	**33.7**	**32.1-38.7**	**34.2**	**33.0-39.0**	**34.6**
United States	17.0	15.2	14.4-18.4	15.4	14.5-17.4	15.3
Western Europe	13.3	11.8	11.7-13.0	12.0	11.7-13.5	12.2
Japan	5.0	4.5	4.1-5.0	4.5	3.9-5.4	4.7
Canada	1.9	1.6	1.2-1.9	1.6	1.2-2.0	1.6
Other	0.8	0.7	0.7-0.8	0.7	0.8-0.9	0.8
Total LDCs	**11.5**	**11.8**	**11.8-13.2**	**12.8**	**13.5-15.6**	**14.9**
OPEC	2.9	3.2	3.1-3.8	3.7	3.2-5.0	4.8
Non-OPEC	8.6	8.6	8.3-9.5	9.1	9.0-10.9	10.1
Supply	**49.9**	**44.2**	**44.2-51.1**	**47.6**	**46.5-53.1**	**49.5**
Total OECD	**14.8**	**15.3**	**13.9-15.9**	**15.6**	**12.2-15.6**	**14.2**
United States	10.1	10.2	9.1-10.1	10.0	8.0-10.1	9.2
Canada	1.7	1.5	1.3-1.6	1.5	1.0-1.7	1.4
Western Europe	2.5	3.2	3.0-3.8	3.6	2.8-3.6	3.1
Other	0.5	0.4	0.4-0.7	0.5	0.5-0.7	0.5
Non-OPEC LDCs	5.6	6.9	8.0-8.7	8.4	9.1-10.2	9.5
Of which:						
Mexico	2.1	3.0	3.3-3.7	3.5	3.5-4.5	4.1
Refinery gain	0.6	0.5	0.6-0.8	0.6	0.6-0.7	0.6
Net centrally planned economies' exports	1.2	1.5	0.7-1.8	1.0	0.3-1.8	0.8
Total non-OPEC supplies	**22.2**	**24.2**	**23.4-26.4**	**25.6**	**23.8-27.5**	**25.1**
Demand for OPEC oil	**27.7**	**19.9**	**18.6-25.8**	**22.0**	**21.6-27.7**	**24.4**
Inventory change	**0.4**	**−1.3**	**0.0-1.3**	**0.6**	**−0.2-0.5**	**0.0**

[a] Preliminary.

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According to the forecasts, more than 75 percent of the growth in non-Communist oil consumption from 1982 to 1990 is expected to occur in the developing countries, particularly the oil-producing countries. Oil demand growth is also projected to be strong in the non-oil-producing LDCs, where a lack of infrastructure and funds to support investment in alternative energy sources will constrain oil substitution efforts. Total LDC oil demand is projected to increase about 3 percent per year, rising to 12.8 million b/d in 1985 and 14.9 million b/d in 1990. About half of the 3-million-b/d increase in total LDC oil demand during the period is expected to occur within OPEC, where consumption is projected to approximate 3.7 million b/d in 1985 and 4.8 million b/d by 1990 compared with consumption of 3.2 million b/d in 1982.

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Supply Outlook. *Non-OPEC Supplies.* Most forecasters expect non-OPEC supplies including net Communist exports and refinery gain to rise through 1985, peaking at 25.6 million b/d and remaining near that level through 1990. Most of the increased production during the decade is expected to occur in Mexico and other developing countries. Oil production in the North Sea should increase to a peak of 3.2 million b/d in 1985 before falling sharply in 1990 as substantial declines in UK production more than offset gains in Norwegian oil output. Oil production in most other developed countries is also projected to decline by 1990 as are net Communist exports:

- Estimates of US production range from 9.1 million to 10.1 million b/d in 1985 and 8.0 million to 10.1 million b/d in 1990. Although there is a wide range in the projections, the consensus opinion has US oil production declining by 1 million to 1.5 million b/d during the decade to about 9 million b/d in 1990.

- Estimates of Canadian oil production cluster at around 1.5 million b/d in 1985 and 1.6 million b/d in 1990. These estimates assume that the disputes between Ottawa and the provinces that have slowed development of promising frontier areas will be resolved. Otherwise, Canadian oil production probably will approximate 1.4 million b/d in 1990.

- West European oil production is projected to peak at 3.6 million b/d in 1985 then decline to 3.1 million b/d in 1990. All of the increase through 1985 is expected to occur in the North Sea, but by 1990 increased production in Norway and Denmark will be insufficient to offset declines in West Germany, France, Italy, and the United Kingdom. Crude oil production in the United Kingdom is projected to fall from about 2.6 million b/d in 1985 to nearly 1.6 million b/d by 1990.

- Net Communist oil exports are also projected to decline during the 1980s. Although estimates vary, generally expect exports to decline from a peak of 1.5 million b/d in 1982 to roughly 1 million b/d in 1985 and about 800,000 b/d in 1990.

In general, most projections indicate that oil production in the non-OPEC LDCs will increase during the decade, rising to roughly 8.4 million b/d in 1985 and 9.5 million b/d by 1990. About 40 percent of this increase is expected to occur in Mexico, where forecasters estimate production at around 3.5 million b/d in 1985 and 4.3 million b/d in 1990. While we expect Mexican production to grow substantially during the decade, we believe that production could be as much as 200,000 b/d less in 1990 because the poor quality of onshore reserves will limit Mexico's ability to offset declines in older producing areas. In addition, financing problems and soft oil demand are delaying investment in new offshore capacity that will be needed to achieve the higher estimates of output.

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According to our analysis, only a few other developing countries will show significant increases in oil production in the rest of this decade. Brazil and Angola will each add more than 100,000 b/d to their output from 1982 to 1990, and we expect Indian oil production to increase by about 200,000 b/d during the balance of the decade. The Ivory Coast, Malaysia, and Egypt are each expected to show an increase of 50,000 b/d or less from 1982 to 1990, and oil production in other LDCs is expected to peak around 1985. On balance, our assessment of oil supplies available from developing countries in 1990 is about 500,000 b/d below the midrange industry estimate derived from current forecasts. In our judgment, the combined prospects of moderate growth in oil consumption and flat real oil prices will discourage exploration and investment in Third World areas that may be perceived as high risk.

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OPEC Supply Availability. Lower oil revenues have already led to substantial cutbacks in spending on development and maintenance of available capacity in OPEC countries. As well as having less money to invest, oil companies and producing-country governments are discouraged from adding production capacity for oil that forecasts indicate will not be needed. As a result, most oil companies have trimmed their projections of future OPEC supply availability and now expect most of the anticipated gains in available capacity from Iran and Iraq in a postwar environment to be partly offset by erosion in other producers. Given the demand outlook, we believe OPEC's available capacity in 1990 probably will be on the order of 30 million b/d.

Surplus capacity in OPEC will be increasingly concentrated in the Persian Gulf region. On the basis of industry demand forecasts, we expect that by 1985 only about 1 million b/d of excess capacity will be located in OPEC producers outside the Persian Gulf—down from nearly 3 million b/d at present. Much of the remaining surplus in several years will be in Libya and could be unavailable to counter a supply disruption elsewhere.

In the Persian Gulf, an end to the Iran-Iraq war would lead to an increase in production capacity in these two countries as they attempt to rebuild their economies. Within a few years after the war, Iraq and Iran combined could have about 8 million b/d of capacity. The reemergence of Iraq, in particular, would reinforce pressure on other producers to restrict oil sales—especially Saudi Arabia. The Saudis already have decided to reduce operating capacity by about 2 million b/d to 8 million b/d, partly by "mothballing" certain equipment. Other Persian Gulf states with surplus capacity—such as Kuwait and the United Arab Emirates—have taken similar steps to save money. Outside the Persian Gulf, Venezuela has drastically scaled down development plans for its vast Orinoco heavy crude reserves, and other producers are taking similar cost-saving measures that will postpone further capacity development.

Demand for OPEC Oil: Market Implications. Despite the outlook for lower capacity in OPEC, industry forecasts indicate that capacity will be ample to cover the range of projected demand for OPEC oil through 1990. Based on estimates of non-Communist oil demand and non-OPEC supply availability, demand for OPEC oil will rise gradually during the remainder of the decade and range from 20 million to 26 million b/d (22 million b/d midrange estimate) in 1985 and 22 million to 28 million b/d (24-25 million b/d midrange estimate) in 1990. While this outlook implies surplus available capacity of about 6 million b/d for the midrange case in 1990, only about 2 million b/d would be surplus should oil consumption approach the high end of industry forecasts.

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Natural Gas Markets

Recent forecasts project non-Communist natural gas consumption to increase from about 18 million b/doe in 1980 to 18.4 million b/doe in 1985 and 21 million b/doe by 1990. Although the developing countries' share of non-Communist gas demand is expected to remain relatively small compared to that of the OECD, more than half of the increase in non-Communist consumption through the rest of this decade is expected to occur in the LDCs. LDC gas consumption is projected to increase 6 to 7 percent per year to about 4.6 million b/doe in 1990. Most of this increase is expected to occur in the oil-producing countries. As with forecasts of oil demand, projections for gas demand growth in the developed countries have been scaled back from year earlier levels. Most forecasters now project gas demand growth in the OECD of about 2.3 percent per year for the rest of the 1980s. Even with these revised growth estimates, however, the OECD countries are still expected to account for about 80 percent of non-Communist gas consumption in 1990.

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The three major consuming OECD regions—Western Europe, Japan, and North America—are separate natural gas markets in terms of consumption trends, major sources of natural gas supplies, and import dependence (see table 4). During this decade, both Western Europe and Japan are expected to experience stronger growth in gas consumption than North America.

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Table 4
International Natural Gas Trade by Major Consuming Region, 1990

Million b/doe

	Western Europe Midrange Estimate	Japan Midrange Estimate	North America Midrange Estimate
Consumption	4.3	0.9	11.2
Domestic production	3.2 [a]	NEGL	10.2
Net import requirement	1.1	0.9	1.0 [b]
Contracted supplies	1.2-1.3	0.96	0.95
Soviet, OPEC, and Far East exporters			
Algeria [c]			0.1 [d]
Minimum	0.4		
Maximum	0.44		
Libya	0.05		
USSR	0.7-0.8		
Existing	0.4		
Urengoy [e]			
Minimum	0.3		
Maximum	0.4		
Sakhalin		0.075	
United Arab Emirates		0.055	
Brunei		0.13	
Indonesia		0.385	
Malaysia		0.155	
Australia		0.155	
North American exporters			
Canada		0.75 [f]	0.8 [g]
Mexico			0.05 [h]
Supply gap	−0.1 to −0.02	−0.06	−0.08 [i]

Note: 1 billion cubic meters equal approximately 16,400 b/doe.
[redacted] West European production have increased from forecasts of last year probably because of expected increases in Dutch production as export policies are liberalized. Estimates of UK gas production have also increased slightly.
[b] US import requirement only.
[c] Algerian contract estimates do not include Spain as contracts are being renegotiated.
[d] Under US regulatory review.
[e] Soviet contract estimates exclude any Soviet gas from Urengoy for Italy as volume probably will be renegotiated.
[f] Potential.
[g] Volumes currently authorized for export.
[h] US/Mexican gas import contract has no specific term but will remain in force subject to gas availability and the discretion of both seller and buyer.
[i] Considering currently licensed exports only, potential US shortfall in 1990 could be as high as 11 billion cubic meters (0.18 million b/doe) if midrange gas demand estimate is accurate and Algerian liquefied natural gas deliveries cease.

[redacted]

Estimates place *West European* gas consumption at approximately 4 million b/doe in 1985 and 4.3 million b/doe in 1990. The decline in West European gas consumption from 3.6 million b/doe in 1980 to 3.3 million b/d in 1982 means that forecasters expect gas demand growth in Western Europe to average about 3.0 percent per year from 1982 to 1990. All major countries except the United Kingdom are expected to register substantial increases in gas use, although a lack of infrastructure could moderate gas demand growth in Italy in the early years. [redacted] 25X1

Projections of indigenous gas production in Western Europe hover at around 3 million b/doe in 1985 and 3.2 million b/doe in 1990. These production estimates are more optimistic than forecasts of a year ago, largely because of industry expectations that Dutch gas production in 1990 will be higher than previously anticipated. The Hague has already given the authorization to expand gas exports because of increased reserves and lower projections for domestic consumption, although specific volumes have not been formalized. Estimates of UK gas production have also increased slightly in view of recent North Sea tax modifications. [redacted] 25X1

According to the midrange consumption and production projections, Western Europe will require net natural gas imports of 1.1 million b/doe in 1990, or about 20 percent less than the 1990 import requirement anticipated last year. Supply contracts with the USSR, Algeria, and Libya currently total 1.2-1.3 million b/doe, more than sufficient to meet the projected 1990 requirement. This surplus in contracted supplies for the 1980s will allow some countries to reduce or defer gas purchases from certain suppliers or shut in domestic production. We believe the surplus could also delay or prevent development of more costly Norwegian gasfields, which will be needed to limit Western Europe's dependence on non-OECD gas supplies in the mid-1990s. [redacted] 25X1 25X1

Japanese gas consumption is also projected to increase rapidly during this decade, growing about 10 percent per year from about 450,000 b/doe in 1982 to 700,000 b/doe in 1985 and 900,000 b/doe in 1990. Most of this increase is projected to occur in the

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electricity generation sector as utilities construct new gas-fired facilities and continue conversions away from oil. Japan's domestic production of natural gas is expected to remain negligible at about 50,000 b/doe through 1990, and Japan will therefore continue to rely on imports of liquefied natural gas (LNG) to meet gas needs. Virtually all of Japan's gas import requirements during this decade are expected to be met by scheduled projects or currently contracted supplies. Indonesia will be Japan's largest supplier of LNG, providing more than 40 percent of total needs in 1990.

In the *North American* market, the recession and sharply escalating natural gas prices caused gas consumption in the United States to decline by about 1 million b/doe from 9.9 million b/doe in 1980 to 8.9 million b/doe in 1982. Beginning early this year, however, falling oil prices caused some moderation in gas price increases. Most forecasts now project US gas demand to recover and to increase by about 1 percent per year from current levels to 9.2 million b/doe in 1990. Estimates of US gas production in 1990 approximate 8.2 million b/doe, resulting in an import requirement of about 1 million b/doe. Canada and Mexico are expected to remain key suppliers of natural gas to the United States through the 1980s, with contracts to supply 800,000 b/doe and 50,000 b/doe, respectively. Algeria is also contracted to provide about 100,000 b/doe of LNG to the US market. We believe any shortfall between currently contracted supplies, domestic production, and US demand could be met by additional supplies from Canada and perhaps Mexico. Domestic gas consumption in Canada and Mexico is expected to grow from about 1.4 million b/doe in 1982 to approximately 2.0 million b/doe by 1990.

Coal and Nuclear Prospects

Demand for coal, nuclear power, and hydropower will depend in large part on electricity requirements. Roughly two-thirds of coal consumed in the industrialized countries is used to generate electricity. We estimate that OECD electricity demand growth will approximate 2 percent per year during the remainder of the decade. Nuclear power is expected to meet the bulk of the increase in demand, and we expect continued conversion away from oil in this sector. In most foreign markets nuclear power has the competitive edge for electric power generation, followed by coal-fired plants. 25X1

analysts have recently trimmed projections of non-Communist coal consumption for the 1980s, primarily as a result of lower expectations for electricity and energy demand growth in the OECD countries. Lower oil prices and the prospect of a soft energy market have also had a dampening effect on some industrial plans to convert to coal because lower prices extend the payback period on fuel switching. Our analysis of key coal-use sectors agrees with projections that coal demand in the industrial countries will increase more moderately than previously anticipated, growing about 3 percent per year to nearly 20 million b/doe by 1990: 25X1 25X1

- West European consumption is expected to approximate 6.3 million b/doe in 1990, up about 900,000 b/doe from present levels.
- Japan is projected to increase coal consumption by only 100,000 to 200,000 b/doe through the decade to a total of about 1.6 million b/doe in 1990.
- The United States is expected to continue as a major consumer and producer of coal. About 60 percent of the projected increase in OECD consumption is expected to occur in the United States, where demand probably will reach 9-10 million b/doe in 1990. 25X1

Coal supplies are expected to be abundant in this decade. According to some estimates based on expansion programs planned or under way, supply availability in 1990 could be 40 percent above projected demand. While we agree that coal use is unlikely to be constrained by supply in this decade, we believe that several capacity additions will have to be delayed or deferred to bring supply and demand into better balance by 1990 without major erosions in the price of coal. 25X1 25X1

We expect most countries to continue development of hydropower wherever possible, although nuclear capacity additions probably will not reach the levels projected in 1982. Industry forecasts indicate that non-Communist nuclear power consumption will rise from about 3 million b/doe in 1980 to roughly 8 million b/doe in 1990, while hydropower is expected to rise by only about 1 million b/doe during the period. Government policies could largely determine the relative contributions of nuclear power and coal to OECD energy requirements in 1990. For example, the governments in the United Kingdom and West Germany subsidize coal production and encourage the use of domestic supplies, while French energy policy strongly promotes the use of nuclear power.

Market Vulnerabilities

Near-Term Market Risks

Based on the continued uncertain political climate in the Middle East and especially the growing economic pressure that may compel Iraq to escalate the war with Iran, we believe there is an increased probability of the Persian Gulf oil production capability being damaged or of supplies through the Strait of Hormuz being interdicted. The impact of any disruption of Gulf oil exports in the near term would depend on the duration of the disruption and the availability of non-Gulf oil, alternative fuels, and petroleum stockpiles. The current combination of surplus production capacity and weak consumption affords industrialized countries considerable protection against a short-term oil supply disruption. Current available surplus capacity that could offset a supply cutback stands at about 8 million b/d, but only some 3 million b/d of that surplus is outside the Persian Gulf.[1]

If only Iranian exports were disrupted, the impact would be minimal for most consumers. Surplus available capacity is sufficient to absorb the loss of Iranian exports, currently averaging 1.9 million b/d. Spot prices would begin to rise, however, if buyers anticipated a further spreading of the conflict. At a minimum, Iran's customers would be forced to line up alternative supplies. Turkey, Spain, and Italy rely on Iranian oil for at least 16 percent of import needs, and Iranian oil accounts for 13 percent of Japanese oil needs.

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If Jazireh-ye Khark (Khark Island) were shut down, the Iraqi pipeline through Turkey severed, and Kuwaiti exports cut off, the impact would be substantially more severe. The loss of 3.5 million b/d of exports from these countries would eliminate most of the remaining surplus capacity in the market and leave oil-importing countries in a high-risk situation. While other producers could replace most of these lost supplies by increasing production, the uncertainty surrounding the length of such a disruption and the risk to other supplies in the Gulf would almost certainly cause upward price pressures. Among major importing countries, Brazil and Turkey rely on imports from Iraq and Kuwait for more than 20 percent of their oil supplies. Whether price increases could be sustained would depend largely on market perceptions of the length and severity of the disruption.

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The United States has a large stake in the continued flow of oil from the Persian Gulf even though US oil imports from the Gulf are small (2 percent of US oil consumption). Gulf oil constitutes about 30 percent of non-Communist world oil supply. Last year about 40 percent of Western Europe's and 60 percent of Japan's oil needs came from Persian Gulf countries. Denial of all or most of the source of supply for a substantial period of time would create a worldwide oil shortage much greater than the 1973 and 1979 shortages. Our analysis indicates that a prolonged closure of the Strait of Hormuz would stop current exports of 8-9 million b/d and cause oil prices to double or triple, depending on the level of demand in consuming countries. The economic recovery in OECD countries would be slowed or interrupted. LDC oil importers also would be hurt and their ability to service foreign debt greatly reduced. The United States could not insulate itself from the disruption of the world oil market. In addition, under the International Energy Agency (IEA) agreement, the United States is obligated to share in the supply shortfall.

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The longer term impact would depend on how the Persian Gulf political and military situation was finally settled.

We believe that rising prices following a major prolonged interruption of Persian Gulf oil exports would have severe repercussions on the international financial system, which is already strained from LDC payment problems. The initial oil price shock would be destabilizing, particularly for those banking centers and countries with high exposure to LDCs that do not export oil. The major industrialized countries would be faced with the prospect of full-fledged recessions. International Monetary Fund resources would be inadequate to handle the new large loan requests.

Implications of Import Dependence

Despite prospects for ample energy supplies through 1990, forecasts indicate that the major industrialized countries will remain heavily dependent on imported energy, particularly oil. Japan and Europe are expected to depend on imports for more than 80 percent and 40 percent of their energy supplies, respectively, while the United States will import about 15 percent of total energy supplies:

- Although West European oil use is projected to hold fairly steady during the decade, oil imports are projected to increase to about three-fourths of total oil demand by 1990. Western Europe could be importing nearly one-third of total gas needs from non-OECD sources in 1990, and foreign coal will supply about one-fifth of requirements.
- Japan will continue to rely on imports for nearly all of its oil, gas, and coal requirements.
- Projections indicate that the United States will depend on oil imports to meet about one-third of requirements in 1990. Foreign gas supplies are expected to meet about 10 percent of gas needs by the end of the decade.

Supply Disruptions

The threat posed by Iran and Iraq is not the only event that could disrupt the flow of oil in the Persian Gulf region. Because of the concentration of highly vulnerable oil facilities, most producing countries in the Gulf are susceptible to having supplies disrupted by foreign military or terrorist attack. Most oil in the region must transit the Strait of Hormuz; an action such as sinking a tanker or mining the Strait could effectively close the area to commercial shipping. A change in regime or political policies could also pose a threat to oil flow patterns. While it is difficult to predict a major internal or external disruption in oil exports in any particular exporting nation or region, we believe that the probability of some sort of disruption occurring within non-Communist countries is quite high.

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Energy supply disruptions have occurred frequently in the past, and the probability that some future disruption will occur is quite high, particularly for oil and natural gas. Since a large proportion of oil used by consuming countries will continue to be imported, the industrialized countries will remain vulnerable to unexpected supply cutoffs. Indeed, as long as the Iran-Iraq war continues, the supply outlook from these countries remains uncertain and the potential exists for spreading the supply disruption to other regions in the Persian Gulf. Increased dependence on natural gas imports also raises the risk of an oil and gas disruption, particularly in Western Europe and Japan.

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Technical and accidental supply disruptions, such as pipeline leaks or fires, are generally limited in duration, severity, and impact. Deliberate supply disruptions resulting from political, military, or other disputes—such as disagreements on price—are more serious. In these circumstances the duration and magnitude of supply losses are more difficult to predict. Specific conditions on the eve of disruptions also significantly influence market reaction, including:

- Availability and location of excess supply capacity.
- Level of commercial and strategic stocks.
- Position in the business cycle and the strength of energy consumption growth.
- Fuel-switching capabilities.
- The extent of international cooperation.

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Since 1950 oil supplies from major exporting countries have been interrupted on 14 occasions. Although most of these disruptions have had little impact on the oil market, three separate incidents during the 1970s caused severe price pressures:

- Libya's move to reduce foreign company production in 1970, coupled with the pipeline sabotage in Syria, resulted in a 25-percent rise in oil prices.
- The 1973/74 Arab oil embargo helped support a quadrupling of crude oil prices and contributed to a sharp drop in worldwide GNP growth.
- Supply losses resulting from the Iranian revolution more than doubled oil prices between late 1978 and early 1980.

Losing the Supply Cushion

The present excess in production capacity will protect the market from all but a major supply disruption for at least the next year or two. Toward the end of the decade, however, the expected erosion of excess production capacity points to a return to a period of increased energy vulnerability. Our own analysis, using CIA's linked econometric model and assuming a healthy recovery in 1984 and an OECD growth rate of 2.7 percent during 1985-90, indicates that oil demand would rise to about 53 million b/d by 1990. Under these conditions, oil demand would approach our estimates of available capacity and create pressures for real price increases.

Expected prices and demand levels are major factors influencing supply availability, as are the tax policies in countries with production potential. prospects of ample supplies and soft prices, even without a further oil price decline, are discouraging investments in new high-cost supply projects and prolonging industrialized countries' heavy reliance on imported energy, particularly oil. Because of the long leadtime in finding and developing new resources, any delays in new investment would facilitate the erosion of the supply cushion that protects the market against unexpected disruptions. Further declines in oil prices would exacerbate ongoing events and further reduce future supply availability. Current soft market conditions and cutbacks in demand projections have already caused delays and cancellations in several investment projects (see table 5).

Oil and gas exploration activity are down sharply in response to weak oil prices, and we believe this trend will cause the present supply cushion to erode more rapidly than most forecasts expect. The number of active drilling rigs at the end of March 1983 in non-Communist countries stood at 3,447—only half the level recorded at the end of 1981 (see figure 4). All major producing areas except the Middle East have experienced a drop in activity with the United States and Canada suffering the sharpest decline, largely the result of a general trimming of budgets by oil companies. We expect the prospect of weak energy prices to continue to discourage development of new energy supply capacity in this decade. Less capacity development will bring supply and demand nearer equilibrium; we believe the adjustment process will also shorten the period in which the market will be relatively immune to real price pressures and increase its vulnerability to supply disruptions. In the case of oil, for example, we believe that the combination of these events could reduce the supply cushion 3-4 million b/d below levels currently estimated in other forecasts.

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Other Risks

In addition to the possibility of supply interruptions, we believe there is substantial risk that current forecasts have failed to accurately gauge trends in key economic variables. Forecasts of long-term energy markets have been off the mark in the past: in 1975, for example, some long-term forecasts indicated that non-Communist oil consumption would exceed 60 million b/d in 1980; actual use in 1980 was 50 million b/d. As was the case with the past projections, uncertainties regarding economic growth, price

Table 5
Selected Energy Investments Recently Canceled or Postponed in IEA Countries

Project	Original Completion Date	Status	Projected Output
Oil sands			
Alsands (Canada)	1988	Indefinitely postponed (May 1982)	137,000 b/d
Cold Lake (Canada)	1987-89	Indefinitely postponed	70,000-140,000 b/d
Gas pipelines			
Alaska (United States/Canada)	1985	Completion date now 1989 (April 1982)	180,000 b/doe
Coal gasification			
Wycoalgas (United States/West Germany)	1987	Canceled	25,000 b/doe
Ohio Valley Synthetic Fuels (United States)	NA	Canceled (December 1981)	68,000 b/doe
Moerdijk (Shell) (Netherlands)	NA	Canceled	NA
Troup, Texas Lignite (United States)	NA	NA	60,000 b/doe
Coal liquefaction			
SRC II (United States/West Germany/Japan)	NA	Canceled	15,000 b/doe
Hampshire (United States)	2000	May be cut to half (November 1982)	20,000 b/doe
Breckinridge (United States)	2000	NA	20,000 b/doe
Oil shale			
Colony (United States)	1987	Indefinitely postponed (May 1982)	50,000 b/d
Rundle (Australia)	1985	Delayed, pending further study	NA
New coal-fired power plants			
Hat Creek (Canada)	1992	Indefinitely postponed (January 1983)	2,000 MW
Hemweg (Netherlands)	NA	Canceled (January 1983)	500 MW
Dordrecht (Netherlands)	NA	Canceled	600 MW
Nuclear plants			
26 plants (United States)	Late 1980s through 1995	Canceled	32 GW

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trends, and the responsiveness of supply and demand to changes in energy prices hinder current efforts to predict long-term energy market trends. Small changes in key variables compounded over time can considerably alter long-term supply and demand balances. For example, using an annual economic growth rate of 3 percent versus 2 percent for the period results in an increase of 6 million b/d in energy demand by 1990.

We also believe there is a tendency among forecasters to underestimate future energy requirements because many simply extrapolate the declines in oil and energy use during the last three to four years. In addition, there is little empirical evidence from past events to suggest how the market will react over time to the decline in real and nominal energy prices that is now taking place. While we believe that additional investment in energy-saving equipment will take place, further erosion in energy prices could cause much of this investment to be shelved and necessitate the continued use of more energy-intensive capital stock.

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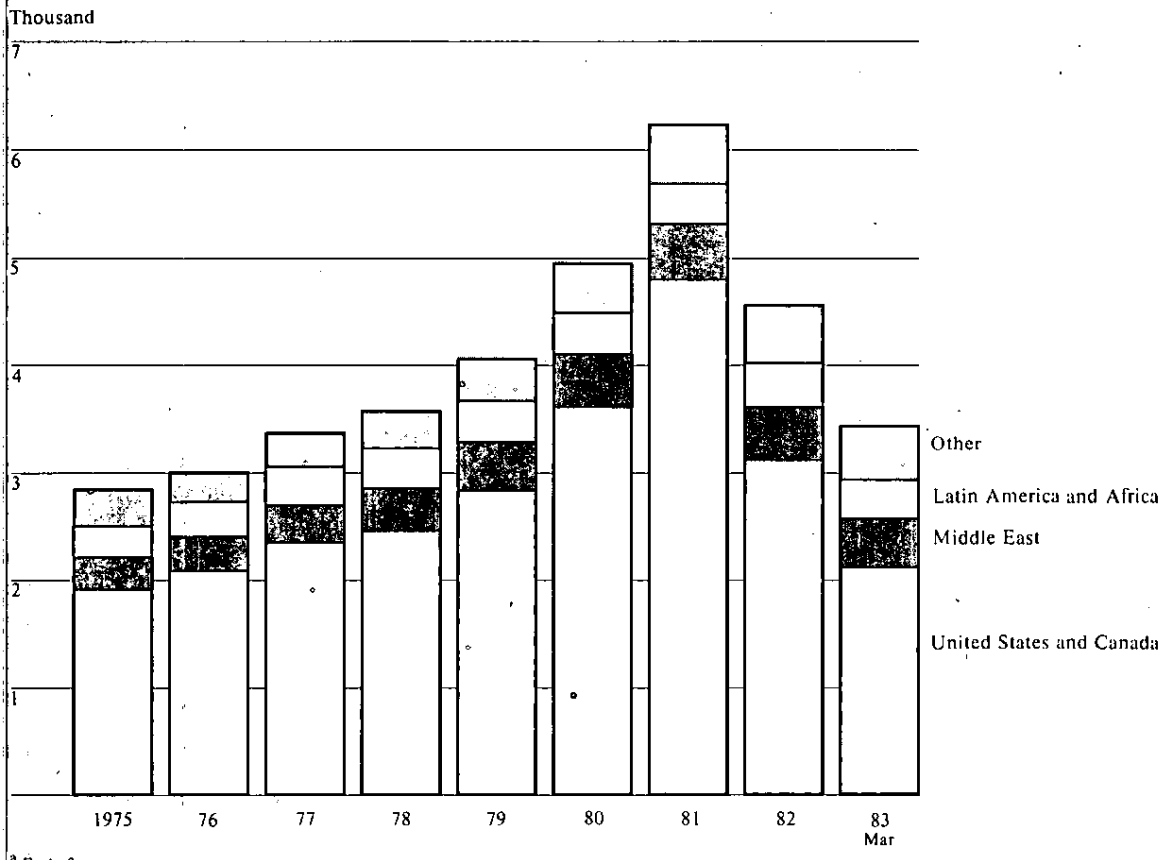
Figure 4
Estimated Number of Active Drilling Rigs, 1975-83[a]



[a] End of year.

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Another factor which could cause differences in oil requirements during any period up to 1990 is the business cycle. Since most projections do not attempt to account for variations in the business cycle, considerable caution must be used in assessing the market trends presented in the forecasts. Even if GNP growth averages 2.7 percent annually during the period, there would probably be sharp variations from year to year, which would cause differences in the level of energy and oil demand. The observed annual growth pattern in OECD countries over the course of the most recent business cycle (1976-82) yields an average growth rate of about 2.7 percent, although year-to-year variations ranged from 4.9 percent in 1976 to -0.1 percent in 1982. Replicating these year-to-year growth patterns through 1990, instead of using a smooth 2.7-percent annual growth rate, yields a difference of as much as 3.6 million b/doe in OECD energy consumption in certain years. Given these conditions, 1990 energy consumption and oil use would be 1.8 million b/doe and 1 million b/d, respectively, below levels projected under a steady growth path scenario.

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An Oil Price Weakness Scenario

Continued soft energy markets could considerably alter long-term supply and demand prospects. If non-Communist oil consumption continues to decline in the short term, nominal prices could again come under downward pressure, which in turn could increase future demand requirements.[2] Under this circumstance, we would expect other energy prices to decline also, perhaps with a short time lag. Weak energy prices would dampen conservation and substitution efforts while, at the same time, encouraging more rapid economic growth and higher energy demand. In the United States, for example, price declines are already reducing incentives to conserve gasoline, as evidenced by a pickup in the sales of large cars. During the first half of 1983, intermediate, standard, and luxury cars accounted for 45 percent of the new car registrations, compared with 35 percent in 1981 (see figure 6). Using the CIA linked econometric model, we estimate that a fall in the price of crude oil from $29 to $25 per barrel in 1984 would lead to an increase of 1.4 million b/d in OECD energy demand by 1985. The model estimates that nearly 90 percent of this increase in energy demand would be met by oil, with natural gas and coal accounting for the balance of increased requirements.

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Supply Disruption Scenarios and Impacts

Oil Cutoff

In the current market, excess available capacity of 8 million b/d is sufficient to absorb all but a major supply disruption. From our survey of recent market forecasts, however, we have concluded that gradual erosion of surplus available capacity will make energy markets increasingly vulnerable to supply disruptions around 1990. at least 2-3 million b/d of surplus capacity is needed to keep the oil market stable. We have examined two oil disruption scenarios for 1990, each lasting one year

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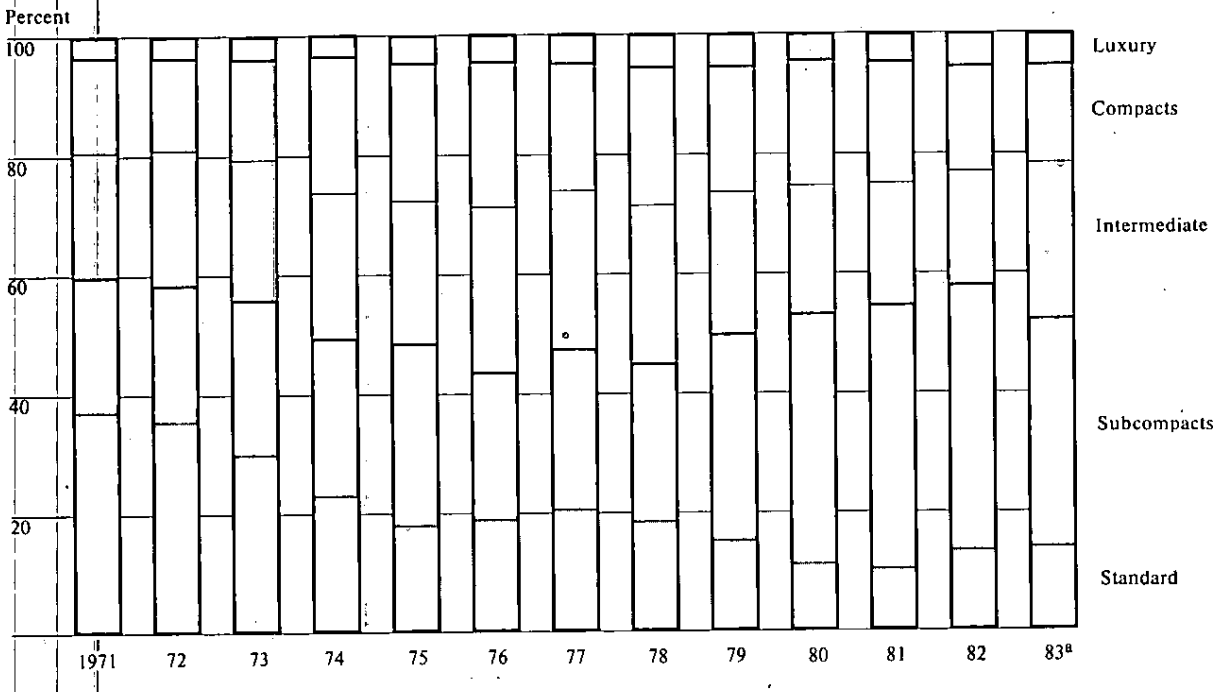
Figure 6
US Market: New Car Registrations, 1971–83



[a] First six months.

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under midrange supply and demand forecast conditions. Commercial stockpiles are assumed to be in the normal operating range, based on the historical relationship between stock levels and expected consumption. No attempt was made to estimate the amount of government-owned stocks that would be used during the disruption because governments have not yet established definite plans to use compulsory stocks during disruptions.

The two scenarios are:

- ***Case I.*** A loss of 12 million b/d in production capacity resulting from, for example, a cutoff of oil flows through the Persian Gulf.
- ***Case II.*** A loss of 7 million b/d in capacity associated with an escalation of the Iran-Iraq war that affects neighboring countries

The oil supply cutoffs in 1973 and 1979 and the subsequent oil price runups resulted in higher inflation, increased unemployment, and lower GNP growth. Both oil price shocks appear to have contributed to adverse trends for the OECD economies for three to five years (see figure 7). Because of the many economic variables that come into play, the precise impacts of future supply disruptions are difficult to gauge. Using the CIA linked econometric model, however, we have attempted to measure the order of magnitude of economic impacts from a supply disruption. On the basis of the midrange supply and demand forecast for 1990, a net oil reduction was calculated

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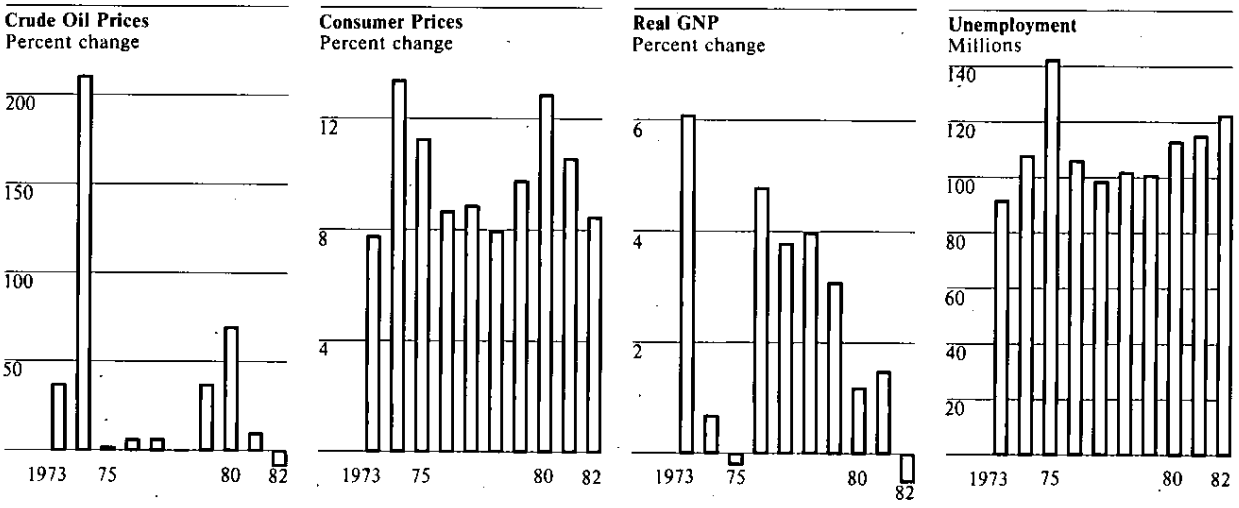
Figure 7
OECD Economic Indicators and Oil Price Trends, 1973–82



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for each hypothetical disruption after adjusting for the 2-million-b/d cushion that industry believes is needed to keep the market in equilbrium. The CIA model was then used to calculate the impact on GNP and oil prices. Simulations for the first-year effect on OECD economies contrasted to a base case (no disruption) showed that:

- For ***Case I,*** GNP loss amounts to 2.8 percentage points, and real oil prices rise about 100 percent above the base case level.
- For ***Case II,*** GNP is reduced by roughly 1 percentage point, and real oil prices rise by 35 percent above the base case.

Making oil available from stocks during a disruption, however, would help to mitigate these price effects

Gas Disruptions

By 1990 gas supplies from Algeria and the Soviet Union could supply one-third of overall gas demand in *Western Europe* and a much higher percentage in France and Italy. The seasonal nature of gas requirements would tend to magnify the potential impacts if a disruption occurred in the winter, when average gas requirements are double those of summer. The availability of possible supply offsets would help determine the vulnerability of individual countries, including:

- The level of potential surge capacity from excess indigenous production.
- The volume of gas made available by cutting off interruptible contracts.
- Surge capacity from the Netherlands.
- Stock draws from gas storage.

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In the event of a supply disruption of Soviet or Algerian gas lasting 12 months, Western Europe probably could compensate for the shortfall by increasing domestic production, withdrawing gas from storage, and increasing imports from uninterrupted sources. While the physical distribution system could handle such a disruption, we believe West European countries have not yet achieved the planning and

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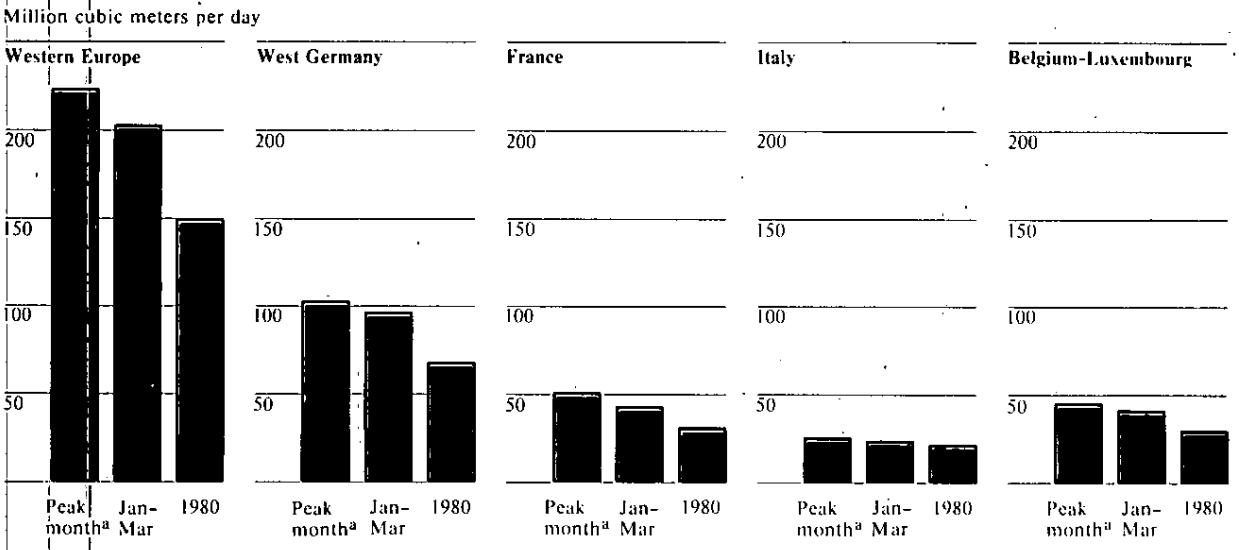
Figure 8
Gas Flows From The Netherlands, 1980



[a] The peak month is January for all countries except France, for which the peak month is November 1979.

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cooperation necessary to avoid problems.[3] Moreover, the effect of the disruption would vary from country to country because much of the present and planned gas storage capacity could be needed just to meet seasonal increases in winter demand (see figure 8). For example, our analysis indicates that Italy would have a difficult time coping with a disruption in Soviet and Algerian gas supplies in 1990 because of limited flexibility to increase Dutch imports and insufficient storage. France and West Germany probably would have to cut back service to some customers and draw down inventories to dangerously low levels. All European purchasers would also need assurances from The Hague that the Dutch would be willing to surge production during a supply cutoff.

Japan is expected to remain heavily dependent on LNG imports from Indonesia and Malaysia through the decade. Based on estimated supply and demand requirements in 1990, Japan will rely on Malaysia and Indonesia to supply about 60 percent of total gas needs. Japan's dual switching capability would help offset a major gas supply disruption as long as alternative oil supplies were available: Japanese electric utilities—the principal gas consumers—maintain a significant ability to switch to alternative fuels. Currently, 62 percent of LNG-fired capacity can be switched to alternative fuels, and by 1990 the utilities will have the capability to cut gas consumption by nearly 40 percent of total gas use.

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Simultaneous Oil and Natural Gas Disruption

The impact of a simultaneous oil and gas disruption would be most severe in Western Europe. A dual supply disruption, particularly in the winter, would eliminate most of Western Europe's contingency options for coping with a supply cutoff since the bulk of fuel-switching capability in industry is between oil and gas. A disruption in gas supplies from Algeria and the Soviet Union, combined with the Case I oil disruption, could cause a 3-million-b/doe energy supply shortfall equal to more than 10 percent of estimated 1990 energy requirements. In addition to a sharp runup in prices, physical shortages would probably occur in the residential sector.

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oil and gas combined will supply about two-thirds of energy consumption in the residential sector in Western Europe by 1990.

Benefits to the USSR

Because the Soviet Union is a major net exporter of both oil and natural gas, Moscow is a major beneficiary in a large disruption of non-Soviet supplies. With the price increases resulting from the Case I disruption scenario, Soviet oil export earnings would approximately double, rising to about $17 billion (1982 dollars) in 1990, assuming net Soviet oil exports of 800,000 b/d. Our Case II disruption scenario would generate $3 billion (1982 dollars) in additional earnings for the USSR in a single year for oil exports alone. These calculations could underestimate the increase in Soviet hard currency earnings following a disruption because the USSR sells most of its oil on the spot market, where prices would be likely to increase more rapidly than the average world oil price. Because natural gas prices are linked to a combination of crude and oil product prices, the USSR would also gain substantial incremental earnings from natural gas sales to Western Europe in the event of an oil supply disruption. Assuming that natural gas prices rise in line with crude and oil product prices, Moscow would earn an additional $8 billion (1982 dollars) from gas exports under the Case I disruption scenario.

The Importance of Policy

Given the potential risks inherent in the energy market and continued heavy reliance by the OECD on imported energy, government policies designed to reduce oil dependence and increase energy security will be critical in avoiding a recurrence of the economic problems associated with the oil price runups in the 1970s. The prospect of flat or declining real oil prices through the balance of the decade will encourage private industry to be increasingly selective about new exploration and development expeditures. Tax policies and the general environment toward foreign investment in prospective oil-producing OECD and LDC countries will therefore largely determine the extent of industry activity. Some OECD members have already recognized this trend:

- The United Kingdom, faced with little industry interest in marginal North Sea oilfields and forecasts of sharply declining production after 1985, made significant modifications to offshore petroleum taxes in early 1983. As a result of these changes, several applications for development of small fields have already been filed. 25X1

- Although Norwegian officials have stated that alterations to Norway's present tax structure are not required, special tax incentives were recently granted to Phillips Petroleum to make an enhanced oil recovery project at Ekofisk economically feasible.

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Implementation of reasonable tax policies will play a key role in future non-OPEC LDC oil and energy production. According to the World Bank, LDCs must attract the capital of the international oil companies to optimize potential resource development. Funds will also be required from international financial institutions to enable development projects designed to enhance domestic energy supplies where there is no prospect for an export project. This will especially be the case for natural gas development in the LDCs. 25X1

In addition to measures encouraging new production of oil and natural gas, we believe the OECD countries should continue to develop policies encouraging conservation and substitution and build strategic inventories of oil and natural gas: 25X1

- Countries other than the United States, West Germany, and Japan could consider establishing strategic oil reserves, which would facilitate the use of government stocks during emergencies. 25X1

- The growing use of gas in Western Europe and Japan and the expected increase in gas use in the less flexible residential sector will also make adequate gas storage an important security consideration for the future.

- Finally, we believe energy policies promoting diversification of suppliers of oil and natural gas and encouraging more development and trade of indigenous OECD energy supplies would help promote energy security. 25X1

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Appendix C

Appendix C

Future OPEC Supply Availability

Lower projections for non-Communist oil demand and prospects for lower revenues because of the soft oil market have significantly changed the outlook for development and maintenance of crude oil production capacity in OPEC countries. Oil producers have little incentive to invest in capacity to produce oil they will be unable to market until late in the decade, and reduced income resulting from lower prices and production levels also provides less money to invest in the oil sector. On balance, in our estimation, the OPEC production capacity for crude oil and natural gas liquids (NGLs) that would be available almost immediately in the event of a disruption will total about 30 million b/d by 1990 (see table C-1), as gains from Iran, Iraq, and the United Arab Emirates (UAE) are partially offset by eroding capacity in other countries. Allowing for an anticipated rise in domestic oil consumption in OPEC countries from an estimated 3.5 million b/d in 1983 to 5 million b/d in 1990, OPEC's available export capability would rise only modestly from about 23 million b/d currently to about 25 million b/d in 1990.

Table C-1
OPEC: Available Capacity [a]

Million b/d

	1983	1990
Total OPEC	**26.8**	**30.3**
Algeria	0.9	0.6
Ecuador	0.2	0.2
Gabon	0.2	0.1
Indonesia	1.6	1.4
Iran	3.2	3.5
Iraq	1.0	4.5
Kuwait	1.2	1.2
Kuwait–Saudi Arabia Neutral Zone	0.6	0.4
Libya	2.1	2.2
Nigeria	2.1	1.8
Qatar	0.6	0.5
Saudi Arabia	8.1	8.0
United Arab Emirates	1.6	2.0
Venezuela	2.4	2.2
Natural gas liquids	1.0	1.7

[a] Available capacity includes those facilities on line and capable of responding almost immediately to a decision to raise production. Production ceilings imposed by individual producers for policy reasons are taken into account where applicable, as are physical limitations on Iraq's exports attributable to the Iran-Iraq war and the closure of the Iraq-Syria pipeline. Our estimates for OPEC's maximum sustainable production capacity—the level that can be reached within three months with no political constraints—are 34 million b/d in 1983 and 32 million b/d in 1990.

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The projection of a slight rise in available capacity stems primarily from an assumption that the Iran-Iraq war will end and the expectation that politically imposed production ceilings in several other countries will be lifted, rather than from an expectation that additional capacity will be developed. We believe that OPEC's maximum sustainable capacity—the level of output that could be reached within 3 months without regard to political constraints—will actually decline from an estimated 34 million b/d currently to about 32 million b/d by 1990. This discussion focuses on available capacity, which more accurately measures the capability of producers to respond quickly to a supply disruption.

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We expect most of the erosion in available production capacity to occur in Saudi Arabia, where crude oil production in the first half of 1983 was less than 5 million b/d. The Saudis already are taking steps to reduce operating capacity to 8 million b/d from a level of 10 million b/d in 1982. The lower operating capacity will include only those facilities on line and capable of responding almost immediately to a Saudi decision to raise production. This will remove 2 million b/d of capacity that would have been readily available to offset a disruption elsewhere. The Saudis at this stage still intend to maintain the capability to

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restore capacity to 10 million b/d within a year, but problems in maintaining mothballed equipment— put into question Saudi ability to restore production much above 8 million b/d under any circumstances.

Kuwait's position resembles the Saudis'. A combination of lower oil revenues and the lack of a market for additional output are reinforcing Kuwait's longstanding policy of conserving oil resources. Like the Saudis, the Kuwaitis have reduced their expenditure projections for maintaining oil production capacity, and we believe available capacity in 1990 will be close to the current self-imposed production ceiling of 1.25 million b/d.

Of the remaining OPEC countries, Iraq, Libya, and the UAE have the most resource potential to raise production capacity. Limited demand is likely to constrain capacity development in all three. Iraqi production has not exceeded 1 million b/d for more than a year because of a lack of export outlets, and ongoing efforts to develop new routes are not likely to improve export capabilities much before 1985. Once hostilities with Iran cease, we expect Baghdad to move aggressively to restore its export capability. Baghdad also still intends to implement prewar plans to develop substantial additional capacity, but we believe limited finances and the difficulty Iraq faces in marketing additional output will slow development. If the war were to end in the next several years, Iraqi efforts to increase output without offsetting reductions by other OPEC members could force oil prices to drop sharply. In our judgment, the Iraqis are likely to build capacity to a level of about 4.5 million b/d by 1990, which, according to industry demand forecasts, would still be more capacity than they can use.

Libya's capacity will probably remain fairly stable despite the potential for growth. Development of promising offshore deposits involving extensive outside participation has been slowed by the combined effects of the weak market, a border dispute with Tunisia, and a poor business climate. The withdrawal of US companies also is contributing to the erosion of capacity in onshore fields. On balance, the slowed rate of expansion of offshore capacity will probably roughly offset the erosion of onshore capacity, resulting in a capacity level of about 2.2 million b/d in 1990.

The UAE is proceeding with plans to develop the supergiant Upper Zakum reservoir, which will provide the largest addition to capacity. Most of this will be offset by declines in capacity at more mature fields in Abu Dhabi; production of crude oil in the other emirates probably will continue to decline as well. Some new condensate finds will boost output of gas liquids. Abu Dhabi has long made it clear that conservation will remain an important consideration in production. In recent years this policy has led to the imposition of ceilings on production considerably below the level of technical capacity. We expect available capacity to be about 2 million b/d by 1990.

Iran and Venezuela both have resources available to raise capacity sharply, but only at considerable expense—Iran by installing an extensive gas injection system at its major onshore oilfields and Venezuela by developing its heavy oil reserves in the Orinoco Belt. Tehran has begun resurrecting plans for more gas injection, albeit at a much reduced scale from that planned before the revolution. Although successful implementation of these plans could boost Iranian capacity to a level of about 4-4.5 million b/d for several years, production at this level probably would result in declining capacity by the end of the decade. In view of marketing constraints caused by the weak oil market and pressure from Iran's clerics for a conservative approach toward economic growth, we believe Tehran is more likely to maintain capacity near 3.5 million b/d. Even this strategy would require considerable investment either in gas injection for onshore fields or in offshore development.

Venezuela postponed plans for development of its heavy oil reserves following the $5 per barrel drop in OPEC's benchmark price in early 1983. Consequently, most replacement capacity in the years ahead will come from improved recovery methods and from deeper exploration in currently producing basins. Because the Venezuelan oil industry is fully nationalized, we expect cash flow problems resulting from lower oil revenues to have a detrimental impact on exploration and development. Venezuela's available capacity, therefore, is likely to erode to about 2.2 million b/d by 1990.

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Nigeria and Indonesia both rely heavily on production from numerous, relatively small offshore fields, which require a high level of exploration to sustain capacity. Both also rely on foreign oil companies for exploration. The pace of future exploration—as in the past—will be largely determined by the attractiveness of the terms offered by Lagos and Jakarta. Although Indonesia has shown a willingness to be flexible in its contract terms, resource limitations are likely to constrain its capacity level to about 1.4 million b/d by 1990. Because of pressing financial needs and excess capacity, Nigeria has cut outlays for exploration. We expect revenue problems to continue to hamper capacity development, resulting in a level of about 1.8 million b/d in 1990.

The smaller producers in OPEC—Algeria, Qatar, Ecuador, Gabon, and the Kuwait–Saudi Arabia Neutral Zone—are largely resource constrained from developing higher capacity. Qatar is delineating its potential giant offshore Northwest Dome gasfield but has not developed plans for exploitation or marketing the gas and associated small quantities of condensate. In general, total crude capacity for these areas, which now approximates 2.5 million b/d, is likely to fall to only about 1.8 million b/d by 1990.

While overall crude oil production capacity is likely to deteriorate, NGL production will probably expand by 700,000 b/d during the decade. Most of the increase will come from the development of nonassociated natural gasfields as well as some condensate fields. Algeria and Indonesia will be the major contributors to the expansion. Development of gasfields in the UAE, Qatar, and Nigeria could also offer some potential, particularly given recent condensate discoveries in the UAE. The Saudi and Kuwaiti gas-gathering systems are essentially complete, and additional expansion of Saudi Arabia's network is unlikely to occur unless demand for crude oil improves significantly later in the decade.

Rising domestic consumption of petroleum products by OPEC countries will account for most of the growth in LDC oil use and will begin to reduce OPEC's exportable surplus by the late 1980s. Internal oil use by members amounted to 1.6 million b/d in 1973—less than 5 percent of their available production capacity. Spearheaded by a 350-percent increase during the past decade in gasoline and distillate fuel oil consumption in the transportation and electric power sectors, oil demand within OPEC today has risen to about 3.5 million b/d, approximately 13 percent of available capacity. While we estimate that growth in consumption will slow for the remainder of this decade to annual increases of about 5 percent—3 percentage points lower than the previous 10-year average—internal demand within OPEC will still rise to about 5.0 million b/d by the end of the decade.[4]

The countries with the largest exportable surpluses— Saudi Arabia, Iran, and Iraq—have invested their oil revenues heavily in energy-intensive development projects and account for the largest block of OPEC consumption. Currently they use 1.7 million b/d, which we estimate will rise to more than 2.3 million b/d by 1990. OPEC's "high absorbers," the countries with large populations relative to their oil export earnings—Indonesia, Nigeria, Algeria, Venezuela, Ecuador, and Gabon—are expected to show the greatest overall increase in share of total demand, and by the end of the decade this group probably will be using 2.1 million b/d. Kuwait, the UAE, Qatar, and Libya—the "low absorbers"—will increase domestic petroleum use by only about 125,000 b/d between now and 1990, to about 550,000 b/d.

[4] This figure is slightly higher than the midrange of recent industry estimates but includes bunkers and refinery losses, which are omitted in some forecasts.

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Appendix D

Non-OPEC LDC Oil Outlook

The 100 non-OPEC LDCs constitute about 20 percent of oil production and 15 percent of oil consumption in the non-Communist world. According to some forecasts, they could account for more than 30 percent of both oil supply and demand in the non-Communist countries by 1990. Although these countries are not homogeneous and have vastly different consumption patterns and production capabilities, as a group they will have a substantial impact on the international oil market in the coming years.

Oil Supply Through 1990

Non-OPEC LDC production capability toward the end of the decade will be primarily determined by exploration and development programs undertaken during the 1980-85 period. Such programs have been cut back or curtailed in many countries during the past two years because of the soft world oil market, country financial constraints, and poor geological prospects. A number of small non-oil-producing LDCs—with some oil reserve potential—have recently revised existing or instituted new petroleum laws to stimulate exploration investment. response by foreign firms has been lukewarm in most instances. Industry forecasts for total non-OPEC LDC oil production range from 9.1 million to 10.2 million b/d in 1990. Because of the slowdown in activity in recent years, we believe actual production will peak around 1987 and decline slightly—because of natural field depletion—toward the lower end of the range by 1990.

During the decade, relatively substantial production increases from Angola, Brazil, India, and Mexico will largely offset production declines in many of the smaller producers. By 1985 these four countries will account for more than 50 percent of total non-OPEC LDC oil output; their share will rise to about 60 percent by 1990:

- *Mexico* will continue to be the non-OPEC LDC production leader, with crude output probably rising by just over 1 million b/d to around 3.8 million b/d by 1990, and NGL production remaining at about 300,000 b/d. The soft oil market apparently has led Mexico to shelve plans for a faster rate of development aimed at raising production to 4.5 million b/d by the late 1980s. We believe that the poor quality of much of Mexico's unexploited oil reserves and limited new geologic prospects would have prevented Mexico from fulfilling this goal in any case. In addition, current financial difficulties have led to cutbacks in exploration and development that will keep Mexico's capacity below its resource potential for most of the decade. 25X1

- Petrobras budget cuts have led to a scaling down of *Brazil*'s oil exploration program during the past year. Although even small discoveries are being brought on line continuously via early production systems, Brazil's oil production is not likely to exceed 425,000 b/d by 1990. We question Brazil's ability to sustain output above that level in view of the country's seemingly limited geologic potential.

- Gulf Oil's Cabinda gas-injection program will raise *Angolan* oil production by 15,000 to 20,000 b/d by 1985, and the Takula field development program could add another 75,000 b/d by that time if oil market conditions are favorable. In addition, development of some offshore oil discoveries in Block 3 by Elf Acquitaine will contribute to the doubling of Angola's current oil production to at least 250,000 b/d by 1987. 25X1 25X1 25X1

- We expect an extensive 1980-85 oil exploration and development program to lead to a 200,000-b/d increase—to a level of 600,000 b/d—in *India*'s crude output by 1990. Domestic technology and financial resources will not be sufficient to meet the government's ambitious goal of producing 600,000 b/d by 1985. 25X1

Egypt, whose 1982 oil production totaled 665,000 b/d, will continue to rank second among non-OPEC LDC producers through the decade. We judge oil production to be geologically constrained at some 850,000 b/d. If the oil market tightens and production is pushed, this peak could occur around 1985.

We also expect small production increases from Ivory Coast, Sudan, and Colombia through the end of the decade. If further testing bears out optimistic estimates of reserve prospects for *Ivory Coast*'s Espoir and Gulf fields, production could hit 120,000 b/d by 1986 rather than the 40,000 b/d currently anticipated *Sudan*'s Unity-area fields are likely to come on stream around 1986 at an initial output level of 50,000 b/d. Recent exploration activity in *Colombia* has given promising indications that a string of small- and medium-sized finds may occur during the next few years, adding to the country's production potential.

Oil Demand Through 1990

Consumption data for many non-OPEC LDCs is poor, and industry analysts do not adequately understand the relationship between oil demand and economic activity in these countries. Our analysis of past trends in apparent oil consumption in the non-OPEC LDCs indicates that there is no consistent relationship between oil demand growth and the rate of GNP growth. Estimates of future oil demand/GNP relationships, therefore, are largely subjective, and there is room for a wide margin of error.

Other factors that complicate the non-OPEC LDC oil demand equation include:

- The duration and extent of the economic recovery and its unknown impact on LDC GNP growth and energy intensity.
- The current and future financial situation in many LDCs and the extent to which they can finance oil imports.
- The rapidity and degree of the shift from agriculture to industry in the LDCs.
- The implementation and effectiveness of LDC oil conservation measures.

Given a weak market over the medium term, some LDC governments may postpone politically sensitive moves such as removing subsidies on oil products. In addition, weak oil prices would dampen the incentive to shift to alternative energy sources. 25X1

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Because of these uncertainties, industry projections of LDC oil consumption through 1990 vary widely. Current industry estimates of non-OPEC LDC oil demand in 1985 range from 8.3 million to 9.5 million b/d; for 1990 the range is 9.0-10.9 million b/d. We estimate oil use in 1983 at about 8.6 million b/d. Slower economic growth and recent LDC financial problems will probably cause continued delays or curtailments of alternative energy projects in major oil-consuming countries. At the same time, however, these problems may also limit oil imports and force delays in developing new energy-intensive industry. While conservation measures in some of the largest consumers—Mexico and Egypt—are difficult to impose for political reasons, financial needs may force price hikes and the elimination of subsidies that would curtail oil use. Until recently, oil demand in these countries had been increasing at annual rates exceeding 10 percent and is projected to continue to grow at relatively high levels. 25X1 25X1 25X1

Since seven countries—Mexico, Brazil, India, Argentina, Egypt, South Korea, and Taiwan—account for 60 percent of total non-OPEC LDC apparent oil consumption, factors affecting their demand growth will have a substantial impact on the aggregate. During the decade, alternative energy development plans in each of these countries could be changed because of economic, financial, or political factors: 25X1

- Phase II of *Mexico*'s nuclear program was suspended last year because of budgetary problems. Conventional oil-fired power plants will probably fill a large portion of the expected gap for electricity generation because of the country's limited hydropower and coal resources. We believe the growing transport sector will also place greater demands on Mexico's oil resources despite some inevitable product price increases.

- *Brazil*'s development of nuclear and hydropower resources has been pushed back substantially because of financial problems and the government's lower estimates for electricity demand. Further delays in the future could cause higher-than-anticipated oil demand. According to the World Bank, however, Brazil's commercial energy intensity has declined in recent years through improved efficiency and conservation measures. Brazil's alcohol program is unique among the non-OPEC LDCs because of both its size and its success. Industry experts estimate that alcohol production will rise to 160,000 b/doe by 1990.

- Oil consumption in *India* will continue to grow at a healthy pace through the decade. However, the government plans to increasingly satisfy electricity demand with coal. Possible future delays and cost overruns—which have been prevalent in the past—in India's nuclear power development program would cause higher oil consumption.

- Budgetary restrictions have hit *Argentina*'s nuclear program hard, and plans to have six reactors on stream by the end of the century are likely to go unfulfilled. Hydropower has been given the highest priority under the national energy development program. Several large projects are under way, and the government plans massive expenditures to raise hydro's contribution to electricity generation to more than 60 percent by 1990. Financial difficulties, however, are likely to force a slowdown in this program as well.

- Oil consumption in *Egypt* has been growing at a rate of some 13 percent annually since 1975, and we believe it will continue to rise at a rapid rate because of population expansion and the country's limited choice of alternative energy sources.

- According to government officials, *South Korea* plans to run its burgeoning industrial sector on coal and some of its power plants on Indonesian LNG to cut oil intensity during the 1980s. In addition, several oil-fired power plants are being converted to run on coal, and new coal-fired plants will be built. South Korea's ambitious nuclear power program envisions 11 reactors by 1990.

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Appendix F

International Natural Gas Markets in the 1980s

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Almost all industry projections of the natural gas markets through the 1980s indicate only moderate growth in consumption with ample supplies. Still, the major gas-consuming regions—Western Europe, Japan, and the United States—will become increasingly dependent on imported natural gas:

- By 1990 Western Europe is expected to rely on imports for as much as 30 percent of total gas requirements, with the bulk coming from the Soviet Union.
- Japan will be importing around 95 percent of its total gas supplies by the end of the decade.
- In the United States, if recent demand/supply estimates prove accurate, dependence on imported gas supplies will double to around 10 percent of total requirements by 1990.

Although surplus capacity in all three regions is currently sufficient to handle even a major supply disruption, growing dependence on imported gas could pose some problems for Western Europe in the late 1980s, especially in the event of a coincident disruption of supplies from the USSR and Algeria. Moreover, unless West European purchasers make a political commitment during the 1980s to subsidize high-cost indigenous projects, such as Norway's Troll field, no new North Sea supplies would be available to help offset disruptions in the following decade because of the long leadtimes required to bring gas reserves on stream.

Recent Trends

After growing from 1 trillion cubic meters (tcm) in 1973 to 1.1 tcm in 1980, non-Communist gas consumption has declined during the last two years, dropping to about 1.0 tcm in 1982. In Western Europe demand for natural gas declined abruptly in 1980 after two decades of uninterrupted growth and has continued to slide. West European gas use declined about 3 percent in 1981 and slipped an additional 6 percent in 1982. In Japan, although gas use has increased steadily since 1973, the rate of growth has fallen sharply, averaging less than 3 percent per annum during the last two years. US gas consumption has fallen by more than 10 percent since 1980.

The falloff in non-Communist gas consumption can be traced to the economic slowdown that began in late 1980 combined with the sharp escalation in gas prices. In Western Europe the nominal price of Dutch gas exports, the basis for most European gas pricing, has more than doubled since 1979, eliminating most of the price advantage gas maintained over competing fuels throughout the 1960s and 1970s (see figure F-1). Gas prices in Japan and the United States have followed a similar upward pattern.

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Demand Outlook

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Because of the decline in gas use and reduced prospects for economic growth during the next decade, have trimmed 25X1
their projections of non-Communist gas consumption. These revised forecasts suggest to us that non-Communist gas demand will increase to about 1.12 tcm in 1985 and 1.25 tcm in 1990. If this 25X1
demand materializes, gas would probably retain its share—roughly 19 percent—of total projected non-Communist energy requirements in 1990. While demand growth is expected to be most rapid in the LDCs, OECD countries are still expected to account for about 80 percent of non-Communist gas use in 1990. Western Europe and Japan are expected to experience stronger growth in gas consumption than the United States during the 1980s.

Western Europe

Forecasts of West European gas consumption approximate 245 billion cubic meters (bcm) in 1985 and 260 bcm in 1990, compared with about 205 bcm in 1982. All major countries except the United Kingdom are expected to register substantial increases in gas use. 25X1

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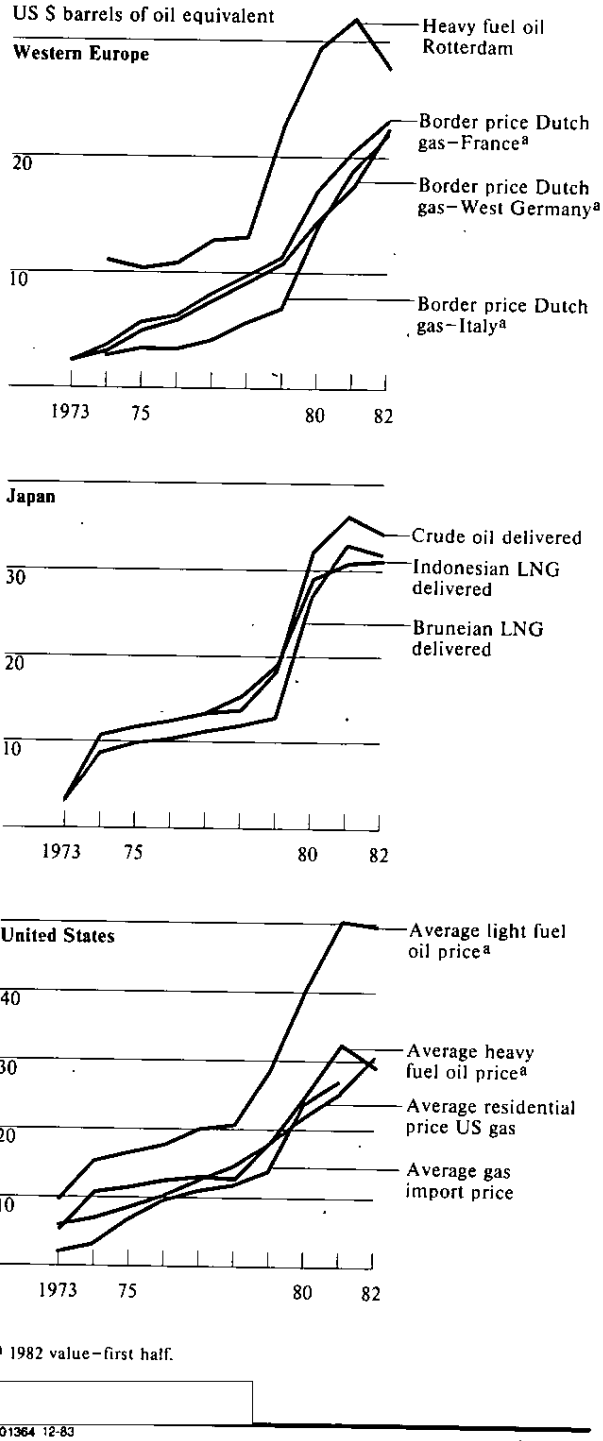
Figure F-1
Average Prices for Oil and Natural Gas, 1973–82



[a] 1982 value–first half.

[redacted]

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West Germany, Italy, and France combined are expected to account for more than half of all West European gas consumption in 1990. Most of the growth in West European gas demand probably will occur in the residential/commercial sector, and one major firm expects this sector to account for nearly half of European gas demand in 1990. [redacted] 25X1

Japan

Because of Japanese efforts to reduce oil use and the clean-burning properties of gas, demand for natural gas is likely to grow rapidly during the 1980s. [redacted] 25X1 25X1 Japanese gas use will rise from about 26 bcm in 1982 to 42.5 bcm in 1985 and 55 bcm in 1990—about 12 percent of total Japanese energy use. The bulk of the increase in gas demand will occur in electric utilities, which currently account for more than three-fourths of Japanese gas consumption. Although gas use in the residential/commercial sector will also trend upward, the increase in this sector will be constrained by the lack of a gas distribution infrastructure outside Japan's major cities. [redacted] 25X1

United States

Because of recent moderations in gas price increases, most forecasters now project some growth in US gas use during the 1980s. Midrange estimates place 1990 gas consumption at 560 bcm—some 7 percent above the depressed 1982 level. [redacted] 25X1

Gas Supplies

[redacted] 25X1

natural gas supplies available to the OECD countries outside North America are expected to increase by around 80 bcm during the 1980s. Imports, as in 1982, will account for most of increased supplies (see figure F-2):

- Completion of the Soviet gas export pipeline project will add some 20 bcm to contracted European supplies, with the potential for deliveries of another 20 bcm.

[redacted] 25X1

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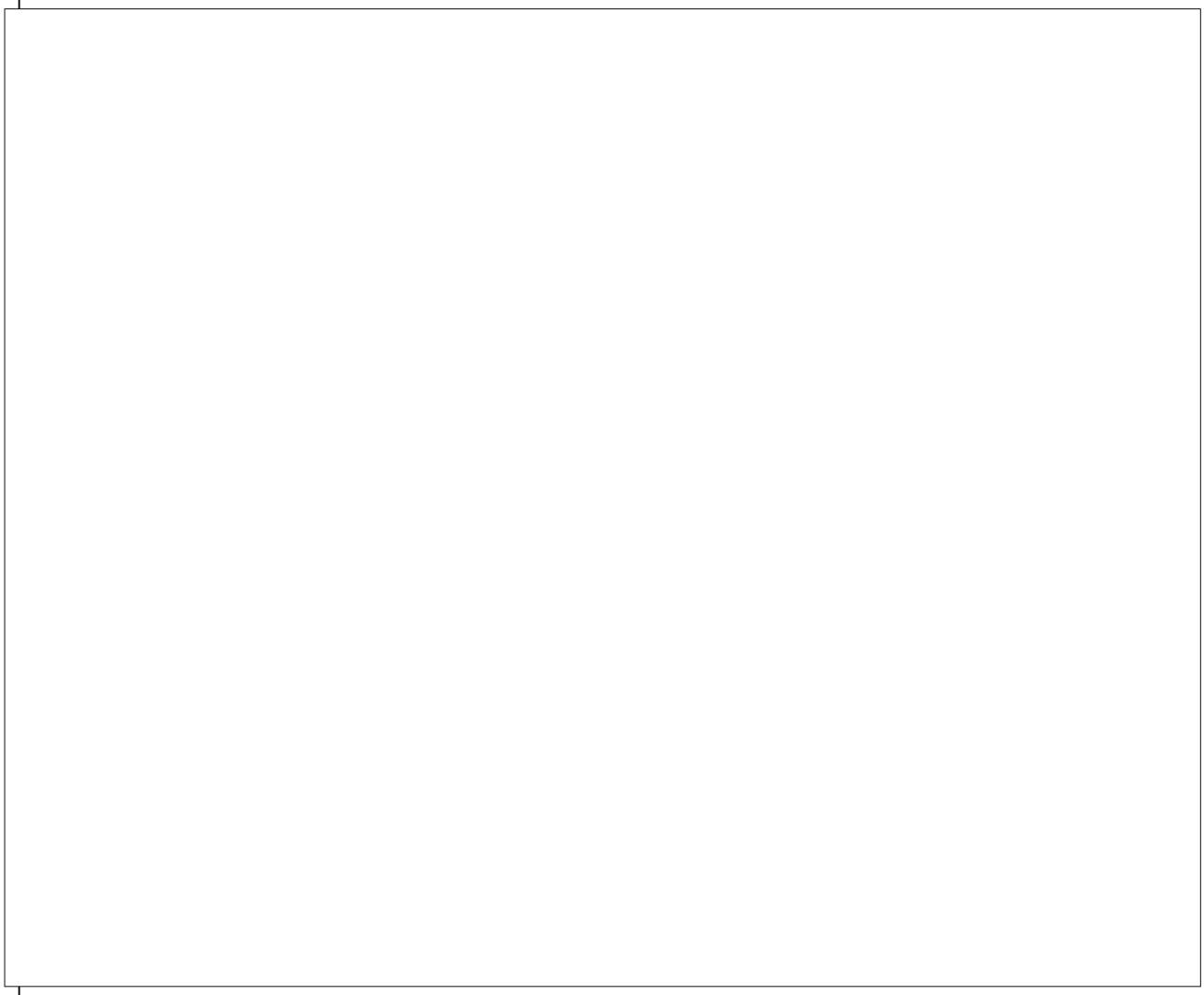

- On the basis of current contracts, Algeria is slated to triple gas shipments to Western Europe to about 26 bcm by 1990. We believe production problems will keep deliveries well below this level.

- Norway is expected to supply around 29 bcm of natural gas to West European countries in 1990—approximately the 1980 level. Increased production from Statfjord and associated fields will be offset by declining output from Ekofisk.

- Although Dutch gas exports are scheduled to dwindle to around 20 bcm by 1990, additional gas export commitments are possible. Spurred by increasing gas reserves and a need to increase budget revenues, Gasunie, the government gas marketing company, has recently stated that an increase in gas sales is justified, and we expect sales of an additional 5-10 bcm annually to be authorized.

- In the Far East, Indonesia is expected to nearly double gas shipments to Japan in the 1980s. Malaysia has recently begun shipments, and we expect Australia to enter the gas export market around 1990.

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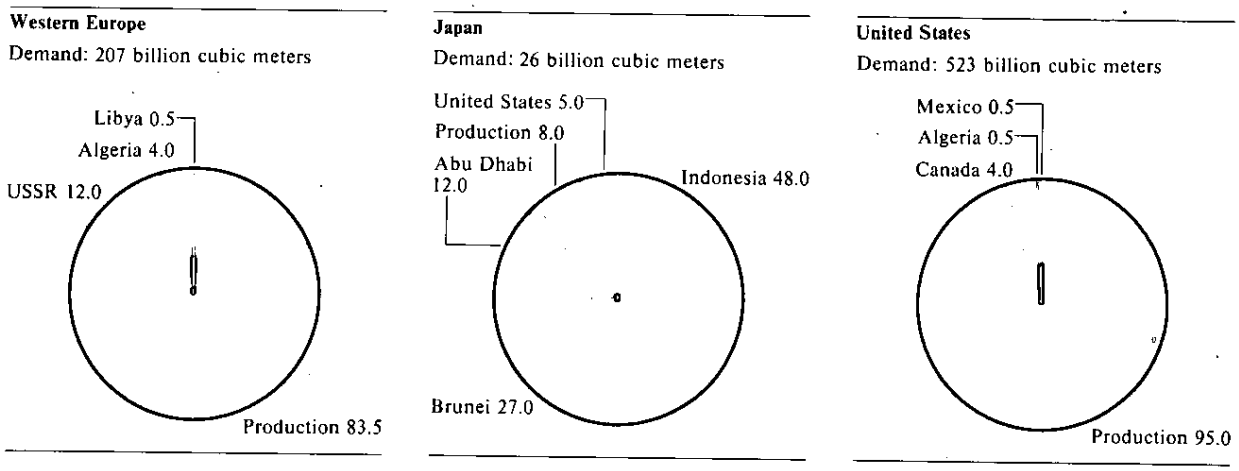
Figure F-2
Major Natural Gas Market: Sources of Gas Supply, 1982

Percent



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The bulk of internationally traded gas, we believe, will continue to move via pipeline during the 1980s. Pipeline gas exports totaled about 150 bcm in 1982 or 80 percent of total gas exports, with the Netherlands, USSR, Norway, and Canada accounting for 95 percent of pipeline exports (see table F-2). Only a small number of countries have the facilities to receive and distribute LNG, and many countries have been dissuaded from importing LNG by the high capital and transport costs associated with such projects (see figure F-3).

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Import Dependence

Western Europe, Japan, and the United States will become increasingly dependent on imported natural gas during the 1980s. Import dependence and major sources of supply, however, vary between the three regions.

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Table F-2
Estimated World Gas Trade in 1982

Billion cubic meters

Exporters	Importers																	
	Argentina	US	Mexico	Austria	Belgium	Denmark	Finland	France	Italy	Luxembourg	Netherlands	Spain	Switzerland	UK	West Germany	East Europe	USSR	Japan	Total
Total gas	**2.4**	**27.1**	**0.3**	**3.0**	**8.7**	**0.1**	**0.8**	**20.2**	**14.6**	**0.4**	**2.7**	**2.2**	**1.3**	**10.7**	**33.2**	**33.1**	**2.5**	**23.7**	**187.0**
Total natural gas	**2.4**	**24.8**	**0.3**	**3.0**	**8.4**	**0.1**	**0.8**	**13.3**	**14.6**	**0.4**	**2.7**	**0**	**1.3**	**10.7**	**33.2**	**33.1**	**2.5**	**0**	**151.6**
Canada	0	22.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22.1
United States	0		0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3
Bolivia	2.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.4
Mexico	0	2.7		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.7
West Germany	0	0	0	0	0	0.1	0	1.1	0	0	0	0	0.4	0		0	0	0	1.5
Norway	0	0	0	0	1.8	0	0	2.2	0	0	2.7	0	0	10.7	6.8	0	0	0	24.3
Netherlands	0	0	0	0	6.6	0	0	5.9	5.3	0.4		0	0.9	0	15.8	0	0	0	34.9
USSR	0	0	0	3.0	0	0	0.8	4.1	9.3	0	0	0	0	0	10.6	33.1		0	60.9
Afghanistan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	2.5
Total LNG	**0**	**2.3**	**0**	**0**	**0.3**	**0**	**0**	**6.9**	**0**	**0**	**0**	**2.2**	**0**	NEGL	**0**	**0**	**0**	**23.7**	**35.4**
United States	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.3	1.3
Algeria	0	2.3	0	0	0.3	0	0	6.9	0	0	0	1.4	0	NEGL	0	0	0	0	10.9
Libya	0	0	0	0	0	0	0	0	0	0	0	0.8	0	0	0	0	0	0	0.8
United Arab Emirates	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3.0	3.0
Indonesia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12.4	12.4
Brunei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7.0	7.0

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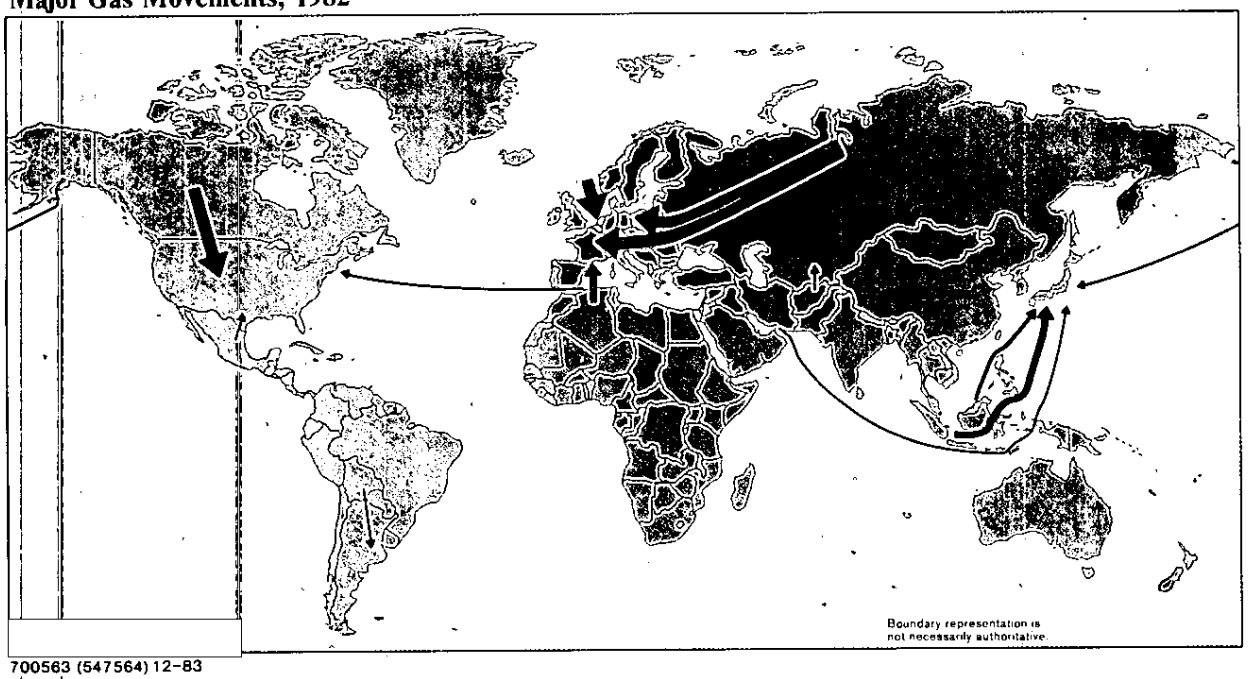
Figure F-3
Major Gas Movements, 1982



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Western Europe

On the basis of the midpoint estimate of gas consumption and production in recent forecasts, we estimate that West European natural gas import demand will approximate 67 bcm in 1990. Reliance on non-OECD gas supplies could vary from 25 to 30 percent depending on how the projected supply surplus is eliminated (see table F-3). For some countries, however, levels of dependence will be higher:

- *West Germany*—Europe's largest gas consumer—is expected to rely on the Soviet Union for more than a third of its 1990 gas requirements.
- *France* has supply contracts with the Soviet Union and Algeria to cover more than a half of its 1990 gas needs.
- *Italy* may sign to take additional Soviet gas to cover import needs through 1990, thus bringing Italian reliance on Soviet gas to around a third by the end of the decade

Although we believe contracted supplies should be ample to meet projected demand in Western Europe through 1990, growing dependence on imported gas could pose problems in the late 1980s. France, Belgium, and Italy, for example, could realize a shortfall in contracted supplies from Algeria because of production problems in Algeria's largest gasfield. We estimate that on average Algeria will meet only about half its annual gas export commitments in the late 1980s and early 1990s. If demand materializes as expected, such a shortfall could result in additional European purchases of Soviet gas late in the decade or higher levels of domestic production unless additional Dutch gas supplies are available. Moreover, the Soviets—who will supply around 20 percent of West European gas requirements by 1990—have on occasion been forced to curtail deliveries to Western Europe and could repeat this action for technical or other reasons.

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Table F-3
Western Europe:
Natural Gas Supply and Demand

Billion cubic meters

	1982	1990 Midrange Estimate
Consumption	206.9	262
Domestic production	172.6 [a]	195
Net import requirement	34.3	67
Contracted supplies		71-77
Algeria [b]	8.7	
Minimum		25
Maximum		27
Libya	0.8	3
USSR	24.8	43-47
Existing	24.8	26
Urengoy [c]		
Minimum		18
Maximum		22
Supply surplus		4-10

[a] West European production have increased from forecasts of last year, probably because of expectations of increased Dutch production as export policies are liberalized. Estimates of UK gas production have also increased slightly because of recent North Sea tax modifications.
[b] Algeria contract estimates do not include Spain because contracts are being renegotiated. Spain may agree to import 2 bcm (0.03 million b/doe) from Algeria.
[c] Soviet contract estimates exclude any Soviet gas from Urengoy for Italy because volume (and/or price) will probably be renegotiated downward from the 6 to 8 bcm originally discussed.

On balance, the available alternatives—increased domestic production, additional Dutch imports, and storage withdrawals—appear to be adequate to balance a Soviet gas disruption in 1990, provided steps are taken to ensure cooperation among European purchasers and suppliers. Still, this does not preclude some upward pressure on energy prices. Moreover, in the event of an embargo lasting 12 months, storage would be depleted, leaving Europe extremely vulnerable to major gas shortages should the embargo continue.

Table F-4
Japan: Natural Gas Supply and Demand

Billion cubic meters

	1982	1990 Midrange Estimate
Consumption	25.7	55.0
Domestic production	2.0	2.0
Net import requirement	23.7	53.0
Contracted supplies [a]		58.0
USSR (Sakhalin)		4.6
United Arab Emirates	3.0	3.4
Brunei	7.0	7.9
Indonesia	12.4	23.5
Malaysia		9.5
Australia		9.5
Alaska	1.3	
Supply surplus		5.0
Potential suppliers		
Canada		4.3 [b]

[a] Based on projects under construction or agreed to.
[b] Subject to approval by Canadian federal and provincial authorities.

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Japan

Current forecasts indicate that Japan will rely on imports for around 95 percent of its gas needs by the end of the decade. Indonesia and Malaysia are expected to supply around 60 percent of 1990 requirements (see table F-4). If all of the LNG projects now agreed to or under construction are completed as scheduled, we believe supplies to Japan will begin to exceed demand in the mid-1980s. Based on the prospect of a surplus, the Japanese are not concerned over potential delays in development projects with the Soviet Union, Australia, and Canada.

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Although Japan will rely on imports for the bulk of its natural gas needs, increasing fuel-switching capability will give the Japanese some measure of protection

against a gas disruption. The Japanese electricity generating industry—the principal gas consumer—maintains a significant ability to switch to alternative fuels. Currently 62 percent of LNG-fired capacity can be switched to alternative fuels, and by 1990 the utilities will have the capability to cut gas consumption by nearly 40 percent of total gas use. Moreover, Japan is expected to be importing LNG from six sources at that time.

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United States

US dependence on imported gas supplies is expected to double to around 10 percent of total gas requirements by the end of the decade. If recent demand/supply estimates prove accurate, the United States could experience a gas supply shortfall of about 5 bcm in 1990 unless contracts are arranged for additional supplies (see table F-5). We believe incremental gas exports would be available from Canada and perhaps Mexico to meet most potential shortfalls; such exports would require authorization from regulatory agencies in these countries.

Table F-5
United States: Natural Gas Supply and Demand

Billion cubic meters

	1982	1990 Midrange Estimate
Consumption	523	561.0
Domestic production	497	500.0
Net import requirement	26	61.0
Contracted supplies		56.0
Algeria	2	6.0 [a]
Canada	22	47.0 [b]
Mexico [c]	2	3.0 [d]
Supply gap		5.0 [e]

[a] Under US regulatory review.
[b] Volumes currently authorized for export. In addition to long-term licenses, volumes of up to 2 bcm may be exported for periods of two years. In our judgment, it is likely that Canada's NEB will also license natural gas exports from offshore fields along the east coast to the northeastern United States.
[c] Net.
[d] US-Mexican gas import contract has no specific term but will remain in force subject to gas availability and the discretion of both seller and buyer. Volume of gas provided may also be renegotiated upward at the discretion of both parties.
[e] Considering currently licensed exports only, potential US shortfall could be as high as 11 bcm if midrange gas demand estimate is accurate and Algerian LNG deliveries were to cease.

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Security Implications and Options for Western Europe

On the basis of existing contracts and market forecasts, European countries will import increasing amounts of natural gas during the next several years. Because of the long leadtime required to bring new gas supplies on stream, the Europeans have few options to expand indigenous gas production before the mid-1990s. Given the high cost of developing Norwegian gasfields and the present weak market, we believe it is extremely doubtful that projects would be undertaken on economic considerations alone. Indeed, present market conditions will require a political commitment by the Europeans to ensure timely development in the 1990s.

The Dutch could substantially minimize non-OECD gas imports in the future if they are willing to extend export contracts. West European purchasers probably would have to show their willingness to maintain Dutch supplies by paying higher prices. The Netherlands might also be persuaded to sell more gas with a commitment from Norway to replace these supplies in later years. Such an arrangement would have to be commercially attractive to the Dutch, however, before it would be attempted. The Dutch could also increase European energy security by maintaining strategic gas reserves. Commitments between individual countries and the Netherlands would need to be clearly defined, however, and the Netherlands probably would demand a premium price to maintain this capacity.

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Appendix G

Coal Outlook: A Buyer's Market

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In the past one to two years, [redacted] have trimmed their estimates of non-Communist coal consumption in 1990 by 10 to 20 percent. If all expansion programs under way or planned in the major coal-exporting countries are realized, supply availability on the international market in 1990 could be some 40 percent above projected demand. Because of the industry's high fixed costs, aggressive price competition among suppliers is likely, and we would expect the current downward pressure on coal prices to continue in the absence of a major oil or coal supply disruption. As a result, West European countries and Japan—which will become increasingly dependent on imports—should have little difficulty in securing ample coal supplies at relatively stable prices, but we expect the United States to be hard pressed to compete with the lower prices and aggressive marketing tactics of competitors. [redacted]

Recent Trends

The oil shocks of the 1970s sharply increased coal consumption and trade. Between 1973 and 1981 non-Communist coal use rose by about 25 percent (3.5 million b/doe) and provided half of the growth in Western energy requirements. With fairly flat domestic production in Western Europe and Japan during the 1970s, non-Communist trade in coal rose rapidly, from around 1.7 million b/doe in 1973 to nearly 2.9 million b/doe in 1981. The surge in demand following the 1979 oil shock, combined with supply disruptions in Poland and Australia during 1980 and 1981, led to tight market conditions, and prices soared. Prices for steam coal delivered to Western Europe and Japan jumped by more than 50 percent during 1980 and 1981 and cost the European Community an additional $500 million in 1981 alone. [redacted]

Rapid growth in demand and tight market conditions, however, ended abruptly in 1982, when non-Communist coal use and trade virtually stagnated. Depressed demand arising from the world economic recession, high stocks, and rapidly rising supply availability created a buyer's market. [redacted] place surplus export capacity at around 30 percent this year, compared with less than 5 percent in 1981. Spot prices for steam coal delivered to West European ports plummeted nearly 25 percent last year and continued to slide in 1983. This spring major coal purchasers in Western Europe and Japan obtained 15- to 25-percent price reductions in annual contract negotiations with international suppliers. [redacted]

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Demand Outlook for the 1980s

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Because of reduced prospects for economic growth through the balance of the decade, most government and industry analysts have trimmed their projections of non-Communist coal consumption [redacted]

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- Current country coal forecasts by the International Energy Agency are 700,000 b/doe below projections made in 1981. [redacted]

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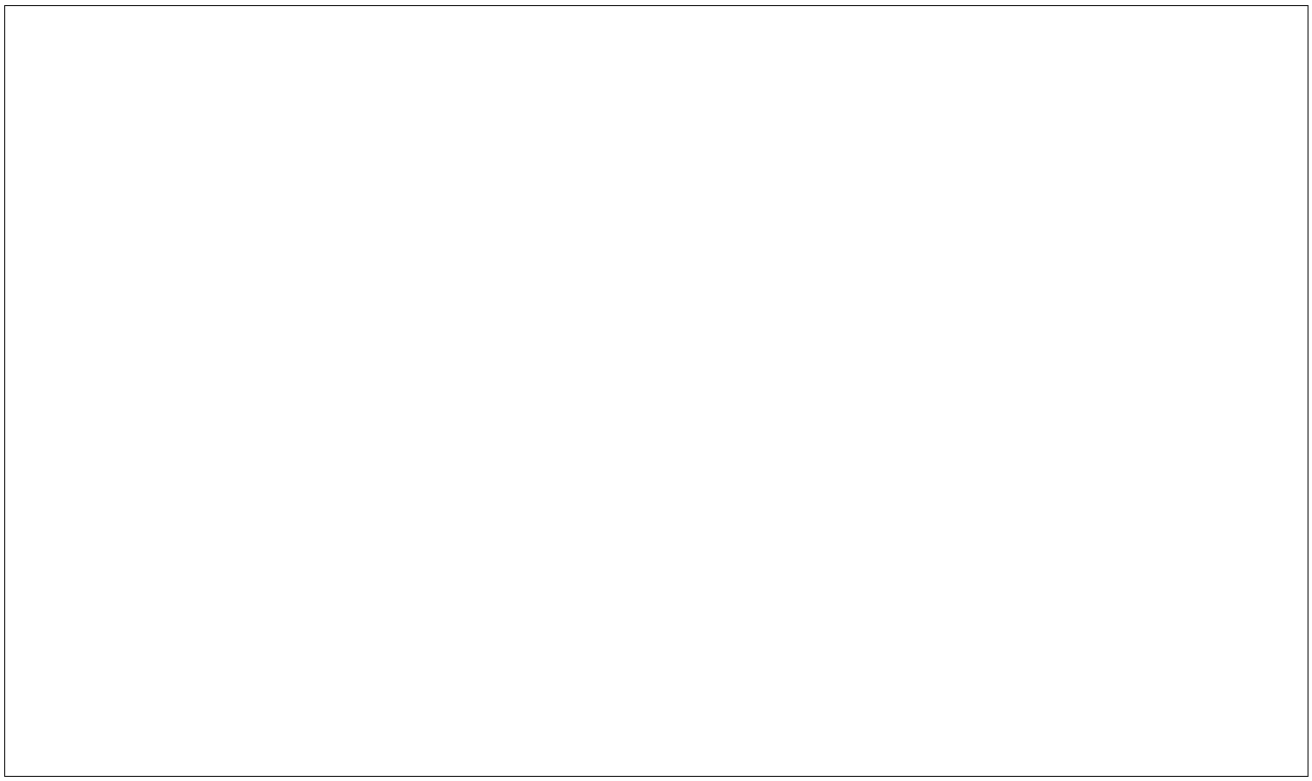

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These revised forecasts and our own analysis of key coal use sectors suggest that non-Communist coal consumption will increase from 18.9 million b/doe in 1982 to about 23 million b/doe in 1990 (see table G-2), with coal's share of total energy use holding steady at about 21 percent. Economic growth prospects lead us to agree with those forecasts that put non-Communist coal demand at the low end of the projected range in 1990. The lower projections generally assume a moderate rate of economic growth in non-Communist countries—averaging around 2 to 3 percent annually for the balance of the 1980s. This, in turn, will lead to a more moderate rate of growth in coal use because two-thirds of non-Communist consumption is used to generate electricity, which is still closely linked to economic growth (see figure G-1).

In the industrial sector, only a slight increase in metallurgical coal requirements for steel production is likely, based on the economic outlook and continued technological improvements in steel production. The recent decline in oil prices will tend to dampen conversions to coal in other industries because relatively lower oil prices extend the payback period of fuel switching. As for synfuels, growth in coal use will be small: escalating capital costs, declining oil prices, and reduced government funding have led to many cancellations and delays in synfuel projects around the world.

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Regional Outlook

coal use in the OECD is projected to grow from around 16 million b/doe in 1982 to about 19 million b/doe by 1990. Although this forecast is nearly 10 to 15 percent

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Table G-2
Non-Communist Coal Supply and Demand Projections

Million b/doe

	1980	1982 [a]	1985		1990	
			Range	Midrange Estimate	Range	Midrange Estimate
Non-Communist demand	18.8	19.6	18.6-22.4	20.4	20.5-26.9	23.0
Consumption	18.2	18.9	18.6-22.4	20.4	20.5-26.9	23.0
OECD	16.2	16.2	15.8-17.9	17.5	16.4-20.6	19.0
Rest of non-Communist world	2.0	2.7	2.0-5.4	2.9	2.1-6.3	4.0
Inventory change	0.6	0.7	0.0	0.0	0.0	0.0
Non-Communist supply	18.8	19.6	18.6-22.4	20.4	20.5-26.9	23.0
Production	18.4	19.3	18.6-22.4	20.4	20.5-26.9	23.0
OECD	15.9	16.3	15.2-21.0	17.0	15.7-24.6	19.0
Rest of non-Communist world	2.5	3.0	3.8-4.9 [b]	3.0	4.3-7.0	4.3
Net Communist exports	0.4	0.3	0.4	0.4	0.3-0.5	0.5
United States						
Consumption	7.5	7.5	8.0-8.8	8.4	8.3-10.9	9.5
Production	9.0	9.0	8.9-11.0	9.6	9.2-13.3	11.0
Net exports	1.0	1.2	0.9-2.6	1.2	0.9-3.3	1.5
Western Europe						
Consumption	5.4	5.4	5.2-6.0	5.6	5.4-8.4	6.3
Production	4.4	4.4	4.3-4.4	4.5	4.4-8.1	4.5
Net imports	1.2	1.2	1.1	1.1	0.3-1.8	1.8
Japan						
Consumption	1.2	1.3	1.3-1.6	1.4	1.4-2.0	1.6
Production	0.2	0.2	0.2-0.3	0.2	0.2-0.3	0.2
Net imports	1.0	1.1	1.1-1.2	1.2	1.2-1.4	1.4

Note: Both Western Europe and the United States accumulated coal inventories in 1980 and 1982.

[a] Preliminary.
[b] Midrange estimate of LDC coal production in 1985 excludes nonconventional solids.

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below individual government submissions to the IEA, coal is still likely to expand its share of total energy use from 22.5 percent in 1982 to around 25 percent by 1990. Because the bulk of OECD coal reserves are in North America and Australia, OECD coal trade will expand to help meet the increased demand, but non-OECD sources will still account for about 5 percent of OECD coal imports in 1990 (see figure G-2).

United States

Coal use in the United States—the world's largest coal producer, consumer, and exporter—is likely to rise from 7.5 million b/doe in 1982 to between 9 and 10 million b/doe in 1990. Production will be increased to

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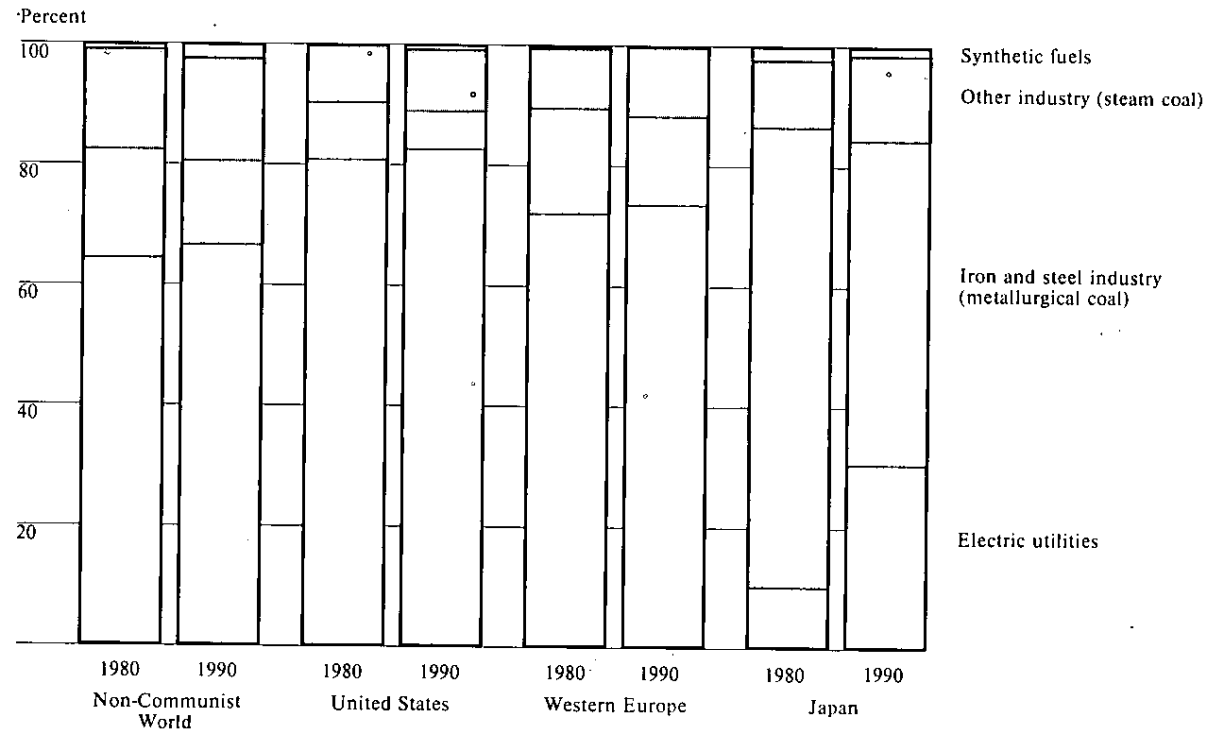
Figure G-1
Sectoral Coal Use, 1980 and 1990



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meet the added demand in both domestic use and export sales. Coal mines in development, expansion, or planning stages could increase production capacity by more than 5 million b/doe by the end of the decade,

Western Europe

Recent forecasts of West European coal needs indicate only moderate demand growth through the end of the decade. Most forecasters place 1990 coal requirements at about 6.3 million b/doe, compared with consumption of approximately 5.4 million b/doe in 1982. Rising consumption combined with fairly flat domestic production is expected to increase West European dependence on imported coal from about 20 percent in 1982 to around 30 percent by 1990.

Japan

Sharply lowered prospects for economic growth have transformed the outlook for Japanese coal demand. In the past year alone, have cut their estimates of 1990 coal requirements by nearly 15 to 25 percent. These recent forecasts lead us to believe that Japanese coal use will approximate 1.6 million b/doe in 1990—only some 200,000 to 300,000 b/doe above the 1982 level. With domestic production likely to stagnate or decline during the remainder of the decade, Japanese dependence on imported coal will climb from about 85 percent in 1982 to about 90 percent by 1990.

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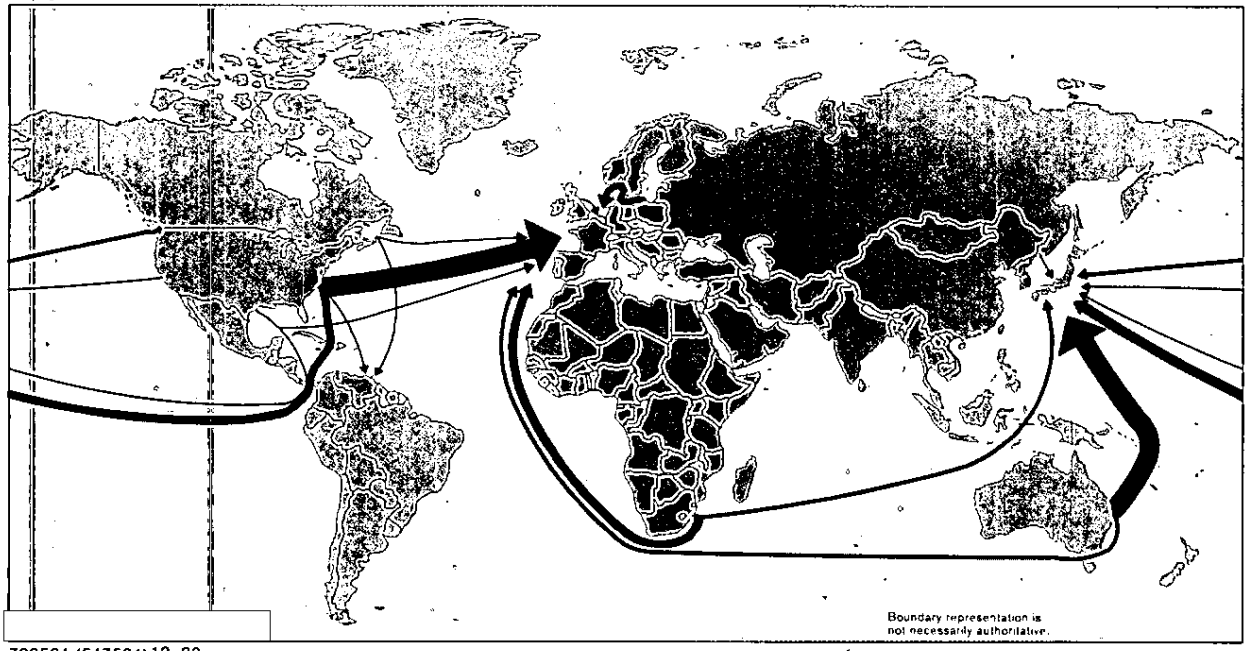
Figure G-2
Major Coal Movements by Sea, 1982



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Implications for Coal Trade

Prospects for reduced growth in demand, combined with rapidly rising supply availability, should cause the buyers' market in coal to persist for the remainder of the 1980s. Completion of planned expansion programs in the major coal-exporting countries could raise export capacity in 1990 to about 7 million b/doe—around 40 percent above projected import demand (see table G-3). Because of the industry's high fixed costs, aggressive competition among suppliers is likely, and we would expect the downward pressure on coal prices to continue in the absence of a major oil or coal supply disruption. In turn, West European countries and Japan should have little difficulty in securing ample supplies of coal at relatively stable prices. As the high-cost supplier, however, the United States will be hard pressed to compete with the bargain basement prices and aggressive marketing tactics of competitors. The National Coal Association is already projecting a 30-percent drop in US coal exports this year. Last year, US coal exports contributed nearly $6 billion to the US balance of trade and provided more than 50,000 jobs in the coal-mining industry.

Table G-3
Potential Seaborne Coal Export Capability and Projected Imports

Million b/doe

	1981	1985	1990
Seaborne coal demand	2.4	2.8	4.0
Supply availability	2.6	5.7	7.0
United States	1.0	2.8	3.3
Australia	0.6	1.1	1.4
South Africa	0.4	0.5	0.6
Canada	0.2	0.3	0.5
West Germany	0.1	0.1	0.1
United Kingdom	0.1	0.1	0.1
Colombia			0.2
Poland	0.1	0.2	0.3
China	NEGL	0.1	0.2
Other	NEGL	0.1	0.2
Surplus capacity	0.2	2.5	2.9

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Appendix H

OECD Electricity Prospects

Despite recent cutbacks in electricity demand forecasts, we expect electric power generation to account for an increasing share of total energy consumption in the industrialized countries. On the basis of our analysis, we believe OECD electricity consumption will rise from 23.6 million b/doe in 1982 to about 28 million b/doe in 1990 with nuclear power, coal, and hydropower meeting both the higher electricity input requirements and reducing the amount of oil used. Although oil's share of electric power generation is expected to continue its downward trend during the remainder of the decade, continued heavy reliance on oil-fired generating capacity will leave Italy and Japan particularly vulnerable to oil supply disruptions.

Recent Trends

Electricity demand growth has consistently outpaced GDP growth in the OECD countries. From 1960 until 1973 electricity demand grew at a rate of nearly 7.5 percent, while economic growth averaged slightly higher than 5 percent. Electricity demand in the OECD countries now accounts for about 15 percent of total final energy consumption, compared with about 9 percent in 1960. Because of the thermodynamic inefficiencies of converting heat to electricity, power generation requires the consumption of nearly three times as much energy as is generated in the form of electricity. Thus, while electricity demand currently accounts for less than one-sixth of total final energy consumption, energy inputs into electric power generation account for nearly one-half of total final energy demand.

The 1973/74 oil embargo and subsequent energy price increases have altered the relationship between energy consumption, electricity demand, and economic growth. From 1973 to 1980 the rapid increase in the real price of all forms of energy kept total energy demand from increasing in the OECD countries. The price of electricity, however, was held down by government regulation, low-cost supplies of hydropower, and increasing quantities of nuclear-electric power. As a result, electricity prices increased only half as fast as oil and gas prices, and electricity demand grew at a 3.0-percent annual rate while GNP grew 2.5 percent annually. 25X1

With the price increases of the 1970s many countries decided to diversify their sources of electric power generation and reduce their relative dependence on politically unstable sources of oil supply. Substantial increases were planned for nuclear, coal-fired, and hydroproduction. France, for example, in 1974 increased its planned nuclear-electric generating capacity for both 1980 and 1985 by two-thirds. Orders for new nuclear units in the OECD countries, which had averaged 33 per year since the mid-1960s, reached a peak of 62 in 1974. Rapidly escalating construction costs, high interest rates, more stringent environmental requirements, and slowing growth rates for electricity demand, however, led to the deferral or cancellation of many of these projects in the ensuing years. A total of 90 nuclear power reactor orders have been canceled in the United States alone since 1974, and additional reactor plans have been delayed. 25X1

Outlook

Continued conservation gains, lower growth prospects, and increasing real electricity prices should further reduce the growth rate for electricity demand. We expect electricity prices to increase in real terms as large new and expensive generating capacity enters the rate base and as regulatory bodies pass through cost increases to improve the utilities' financial health. Electricity demand forecasts for OECD countries have been reduced repeatedly in the past few years. For example, IEA forecasts of projected electricity use in 1990 for the Big Seven OECD countries, which account for about 85 percent of OECD electricity 25X1

Table H-1
OECD: IEA Projections of Electricity Consumption for 1990

Terawatt-hours [a]

Country	Forecast Date		
	1978	1980	1982
Total OECD	**8,696**	**7,473**	**6,384**
Big Seven	7,392	6,352	5,426
Canada	535	535	438
France [b]	460	455	336
Italy	420	313	271
Japan	1,091	937	822
United Kingdom	396	337	252
United States	3,855	3,274	2,862
West Germany	635	501	445
Other OECD [c]	1,304	1,121	958

[a] One terawatt-hour represents the equivalent of 5,041 b/doe primary energy.
[b] Not estimated by IEA.
[c] Extrapolated from IEA data.

Table H-2
OECD: CIA Estimates of Electricity Consumption

Terawatt-hours

Country	1980	1982 [a]	1985	1990
Total	**4,634**	**4,673**	**4,843**	**5,513**
Canada	308	313	317	381
France [b]	219	224	238	293
Italy	166	165	170 [c]	188 [c]
Japan	531	527	536 [c]	626 [c]
United Kingdom	242	232	240	261
United States	2,191	2,183	2,282 [c]	2,563
West Germany	329	328	341 [c]	378
Other OECD	648	701 [b]	719 [c]	824

[a] Preliminary.
[b] Extrapolated from IEA data.
[c] Adjusted.

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consumption, were cut by nearly 27 percent from 1978 to 1982 (see table H-1). Indeed, we believe that these forecasts are still too high, and we project total 1990 electricity demand in these countries to be some 14 percent below the current IEA projections.

We also expect the relationship between electricity demand and economic growth to weaken further. During the remainder of the 1980s, we project electricity demand growth to average about 2.1 percent, compared with recent forecasts of GNP growth of about 2.5 percent. As a result, we now project OECD electricity demand in 1990 at 5,510 terawatt-hours (TWh)—27.8 million b/doe—up about 19 percent from 1980 demand (see table H-2). The majority of this increase will be met by nuclear power generation (see table H-3), with the remaining portion filled mostly by coal and hydropower.

Nuclear Power

Nuclear plants remain cost competitive with coal-fired plants in Europe, Canada, and Japan. Even in the United States, nuclear power enjoys a small cost advantage in urban areas because coal plants must be built with extensive antipollution equipment. As a result, current electric power construction programs in the OECD countries are heavily dominated by nuclear power, despite the fact that numerous nuclear power plants have been canceled, postponed, or delayed primarily as a result of slack growth in electricity demand.

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At the present time, 141 nuclear power plants totaling more than 139,000 megawatts-electric (MWe) are under construction in the OECD countries. Eleven of these units are undergoing low-power startup and testing operations. A total of 223 nuclear power plants are in operation in the OECD countries with an installed capacity of more than 139,000 MWe. Based on current construction schedules and electricity demand forecasts, we believe that nearly all of this nuclear power capacity will be fully utilized as it comes on line. France, however, will have considerable surplus nuclear generating capacity by the end of the decade.

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Table H-3
OECD: Net Nuclear-Electric Power Generation

Terawatt-hours

Country	1980	1982	1990
Total	**562**	**718**	**1,415**
Canada	36	36	94
France	58	103	172
Italy	2	6	17
Japan	76	98 [a]	135
United Kingdom	32	39	68
United States	251	283	626
West Germany	41	60	110
Other OECD	66	93 [a]	193

[a] Preliminary.

Table H-4
OECD: Changing Fuel Mix for Electricity Generation

Percent

Fuel Type	1980	1990
Nuclear	11.7	25.1
Hydro/Geothermal	20.2	20.5
Coal	42.6	36.7
Natural Gas/LNG	10.5	8.2
Petroleum	15.6	9.6

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Coal

According to a number of recent studies in the OECD countries, coal has a substantial economic advantage over oil and gas for electricity generation and is the primary fuel for new thermal-electric power plants. Coal-fired generating capacity is expected to grow most rapidly in Japan, West Germany, and the United States. The electric power industry in Japan is reducing its dependence on imported oil by diversifying its fuel mix with moves to coal and LNG. West Germany has an aggressive construction program for coal-fired electric power plants, in part to maintain employment in its coal-mining industry. In addition, the construction of new oil- and gas-fired electric generating units is prohibited by West German law. Because of problems with nuclear plant construction, we expect coal to be the preferred fuel for new power plants constructed in the United States.

Lower projections for electricity demand, however, are severely affecting coal-fired electric power plant construction programs. Based on the long construction leadtimes and large capital investment costs, we believe nuclear power plants already under construction are likely to proceed at the expense of planned coal-fired capacity. In France, for example, Paris expects its aggressive nuclear power program to cut electric utility coal consumption by more than half by 1990. Even in Japan, where our analysis indicates that coal consumption by electric utilities will increase substantially during the decade, lower-than-expected growth in electricity demand has reduced the need for new coal-fired electric power plants and has resulted in some plants' being delayed or postponed.

9,000 MWe of coal-fired capacity already have been scrapped or delayed until the 1990s. As a result of these conflicting trends, coal's share of electric power generation is expected to decline from 43 percent in 1980 to about 37 percent in 1990 (see table H-4).

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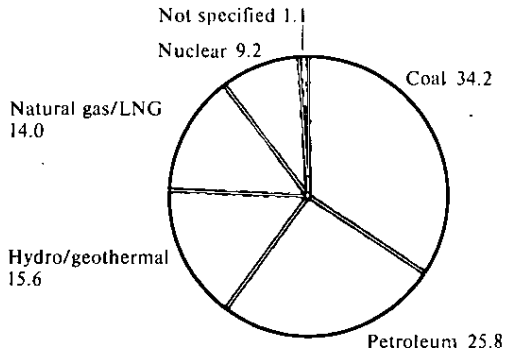
Figure H-1
Big Seven: Net Installed Generation Capacity at Yearend, 1982

Percent



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Fuel-Switching Capability

Significant progress has been made in reducing OECD dependence on gas and oil as fuel for electric power generation. Indeed, gas and oil inputs to electric power generation have declined from 36 percent in 1973 to 23 percent in 1981, the last year for which complete OECD data is available. Taking the Big Seven countries as a proxy for the OECD as a whole, oil- and gas-fired units currently account for nearly 40 percent of total electricity generating capacity and only about 20 to 25 percent of total electricity production (see figure H-1). The shift from oil-fired electricity generation, combined with the introduction of dual-fired generating capacity (see figure H-2), is increasing the flexibility of OECD countries to deal with energy supply disruptions. As a result, we believe the OECD countries as a whole are better able to withstand an oil supply disruption in the electric power generation sector than they were a few years ago. The situation, however, varies considerably from country to country.

Since Italy is almost totally dependent on imported oil, its electric power generating sector is particularly vulnerable to an oil supply disruption. Indeed, such a disruption would adversely affect about 36 percent of Italy's electric power generating capacity. Because natural gas is a backup fuel at many oil-fired electric power plants in Italy, a simultaneous disruption of oil and gas supplies could idle more than half of the country's generating capacity, according to our analysis. With only two nuclear power plants under construction, Italy will remain highly vulnerable to oil supply disruptions.

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Japan also is almost totally dependent on imported oil. An oil supply disruption would adversely affect nearly 41 percent of Japan's electric power generating capacity. Natural gas accounts for another 14 percent of electric power generating capacity, according to OECD data, and Japan plans to increase gas imports in an effort to decrease dependence on oil. While an ambitious nuclear power program, combined with the slowing growth rate for electricity demand, should cushion Japan against potential energy supply disruptions, heavy dependence on imported oil and gas will leave the country highly vulnerable to energy supply disruptions through the balance of the decade.

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France and West Germany are both heavily dependent on oil imports, but both have made considerable progress in reducing their dependence on oil-fired electric generating capacity. Industry statistics show that oil-fired capacity now is aimed primarily at meeting peak-load demand for electricity. Slowing growth for electricity demand and increases in nuclear generating capacity will further insulate the electric power sectors in these countries from energy supply disruptions. Indeed, we believe that unless economic growth rebounds substantially, France will be able to phase out all of its oil- and gas-fired electric generating capacity by the end of the decade.

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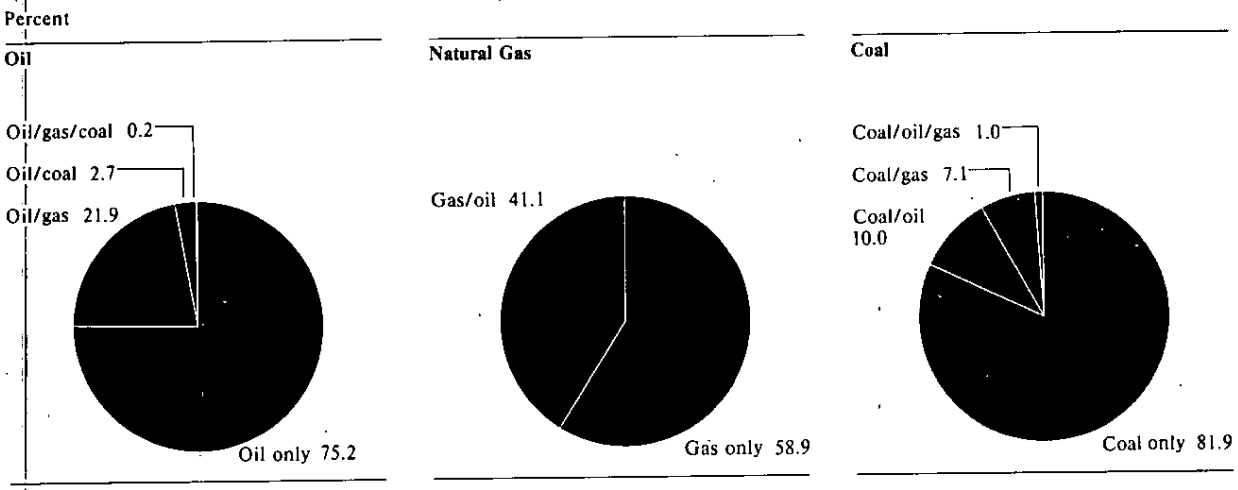
Figure H-2
Big Seven: Electricity Generation Dual Switching Capacity at Yearend, 1982



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In the United Kingdom only about 10 percent of electric power production comes from oil- and gas-fired generating capacity. In Canada the corresponding figure is 4 percent. The Provinces of New Brunswick, Nova Scotia, and Newfoundland, however, depend on oil and gas for a disproportionate share of their electricity supply. According to recent OECD data, Canada and the United Kingdom are nearly self-sufficient in oil and gas production, decreasing the threat of energy supply disruptions to their electric power sectors. As is the case in other countries, slowing demand growth for electricity and increased nuclear power generation should act to ease the impact of supply disruptions in the next few years.

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