THE PROBABLE IMPACT ON THE U.S. PETROCHEMICAL INDUSTRY OF THE EXPANDING PETROCHEMICAL INDUSTRIES IN THE CONVENTIONAL-ENERGY-RICH NATIONS

Final Report on Investigation No. 332-137 Under Section 332(b) of the Tariff Act of 1930

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PREFACE

On February 4, 1982, the United States International Trade Commission, in accordance with the provisions of section 332(b) of the Tariff Act of 1930 (19 U.S.C. 1332(b)), instituted investigation No. 332-137 on its own motion for the purpose of gathering and presenting information on the expansion of the petrochemical industries in the conventional-energy-rich nations and the probable effects of such expansion on the U.S. petrochemical industry. The study was to assess possible changes in U.S. imports and exports of petrochemicals and in the structure and operation of the U.S. petrochemical industry through the analysis of data obtained during the course of the investigation. Notice of the investigation was published in the February 10, 1982 issue of the Federal Register (47 F.R. 6119).

Petrochemicals are defined as products derived from crude petroleum and natural gas. They may be gases, liquids, or solids, and are often classified into three subgroups: primary petrochemicals, intermediate petrochemicals, and petrochemical products. Petrochemicals are used in a wide variety of applications. Some applications are original; in others, the petrochemicals are used to replace a natural product, such as cotton or wood. The petrochemicals most familiar to consumers include automobile radiator antifreeze, plastic film and sheet, and synthetic fibers used in clothing, drapes, and carpet.

The petrochemical industry comprises various sectors, and can be thought of as situated between the feedstock industry and the petrochemical-dependent industries. The petrochemical industry uses natural gas and its components, and petroleum products, to produce primary and intermediate petrochemicals and petrochemical products which in turn are used in the petrochemical-dependent industries to make such items as coatings, drugs, textiles, and fabricated rubber and plastics products.

Ethylene, ammonia, and methanol are building-block petrochemicals; many further advanced petrochemicals are made from them. They are widely discussed in this report because of their importance in the manufacture of a large share of all petrochemicals, and because natural gas and its components, the principal feedstocks for their manufacture, are readily available and often at a price below world price levels in the newly emerging petrochemical-producing nations.

In reviewing the report, the reader should be aware of the current volatile swings in feedstock supply and prices. Radical long term changes in one or both of these could alter the anticipated outlook presented in this report.

The feedstock and energy price advantages of the newly emerging petrochemical-producing nations, as well as the availability of investment funds, could decrease in the future because of an oversupply of crude petroleum and the resulting lower prices. However, a price advantage would still remain, and coupled with low interest loans, tax holidays, and other incentives, the emerging petrochemical-producing nations should retain an advantage. Further, lower crude petroleum prices could prompt many of these nations to expand into petroleum-based petrochemicals more than originally planned; most of the announced plans concentrate on natural-gas-based petrochemicals because of the low economic value associated with the natural gas that is flared.

Lower crude petroleum prices could prompt crude-petroleum-exporting nations to increase their emphasis on petrochemical exports as a means of maintaining revenue. In the future, the petrochemical exports from the newly emerging petrochemical-producing nations could increasingly include those petrochemicals primarily made from petroleum, in addition to those made from natural gas.

It is also possible that certain traditional petrochemical-producing nations, including the United States, may implement some type of fee or duty to maintain crude petroleum import prices above world levels; the likelihood of such actions would increase as world prices decrease. Although such programs are designed to maintain conservation; domestic exploration, development, and production of conventional energy resources; and the continued research and development of alternate energy sources, they would present disadvantages to the petrochemical industries of the implementing countries.

The petrochemical industry essentially began in the United States in the 1920's, when isopropyl alcohol was successfully manufactured from a petrochemical feedstock. Since then it has grown rapidly and is now part of a worldwide chemical industry dominated by large, privately owned Western European multinational companies. Recently, government-owned companies, especially those involved in petroleum and natural gas, have taken an increasing interest in petrochemicals. The capital required for research and development activities and the construction of facilities is substantial, and large companies are better able to generate the funds required. For example, one large petrochemical plant can cost $800 million to $1 billion.

North America, Western Europe, and Japan account for more than 90 percent of the world's petrochemical production and 85 percent of the world's petrochemical consumption. Petrochemical trade exists primarily between those developed nations that are both producers and consumers of petrochemicals and between those nations and other nations.

The world petrochemical industry had a lackluster year in 1982, but some industry optimism has been expressed for 1983. Economic slowdowns in many of the major nations from the end of 1979 through 1982 had a negative influence. In addition, the petrochemical industries in many of the major industrialized countries appear to be reaching maturity. Since the early 1970's, the annual growth rates have been lower than in the 1950's and 1960's.

In 1981, U.S. petrochemical industry sales were estimated at more than $69 billion, or about 35 percent of the world's total petrochemical sales. The industry was estimated to have employed 283,000 persons in 1,638 establishments and invested about $5 billion in new plant and equipment. 1/

1/ U.S. Department of Commerce, 1982 U.S. Industrial Outlook, January 1982.

The U.S. petrochemical industry is highly integrated, both horizontally and vertically, owing to the industry's desire to assure access to feedstocks and have a broad product base. The petrochemical affiliates of petroleum companies have become significant factors in the petrochemical industry, particularly in the production of olefins, aromatics, and closely related derivatives.

This report presents the findings of the investigation. It includes sections on why the conventional-energy-rich nations are interested in developing petrochemical industries, profiles of those nations that could become significant world petrochemical sources by 1990, the implications of the move into petrochemicals by conventional-energy-rich nations, and possible reactions by other petrochemical-producing industries and nations. The last section of the report discusses possible future supply-demand scenarios for the three major natural-gas-based petrochemicals for which the conventional-energy-rich nations have facilities on-stream, under construction, or planned. This section, also includes a discussion of possible effects on the U.S. petrochemical industry that could result from the supply-demand scenarios and a quantification of possible future impact on U.S. industry production and employment, using the U.S. Department of Labor's input-output model of the U.S. economy. 1/

1/ Phillip M. Ritz, U.S. Department of Commerce, "The Input-Output Structure of the U.S. Economy," Survey of Current Business, 1972, p. 43. Although this article is dated 1972, it offers an analysis of the development of the original input/output model as well as an explanation for its continuing use.

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EXECUTIVE SUMMARY

Petrochemicals and their derivatives can be found in cars, clothes, food, pharmaceuticals, and other household items. In many of these applications they have replaced natural products on a price and/or performance basis. Because of their widespread use, it has been said that the development of a world-scale petrochemical industry has assumed a high degree of importance to many nations, and particularly to some of the developing nations. Often this importance is reportedly equivalent to that given the development of a national airline or a national steel industry. The appeal of a world-scale petrochemical industry is greater for those nations possessing large natural gas and crude petroleum reserves, as these materials are used by the petrochemical industry as both sources of energy and feedstocks.

Within the last 2 or 3 years, an increasing number of conventional-energy-rich nations (CERN's) 1/ with low per capita petrochemical consumption, have initiated programs to develop world-scale petrochemical industries on the basis of the export of as much as 90 percent of the domestic production. The announcements of these programs and the coming on-stream of some of the initial facilities, coupled with a weakened world economy and uncertainty about its future, have led to increasing concern particularly by certain companies and governments of developed petrochemical-producing nations.

The focus of this investigation is largely the future. Because of the weakened state of the world economy, and Organization of Petroleum Exporting Countries (OPEC) production, pricing, and revenue problems, some future plans have already been altered; some will probably be changed further. Therefore, the findings of the report will be affected by any deviation from the assumptions underlying the growth of CERN's petrochemical plans. However, if economic and political factors cause more change than generally expected, the overall thrust of this report could change appreciably.

The following highlights are the major discoveries of the Commission's investigation.

- The traditional petrochemical-producing areas of the world, including the United States, Western Europe, and Japan, are expected to have a lower future share of the world's production capacity for certain building-block petrochemicals and as a result could have a lower future share of the world's net exports of these petrochemicals and derivatives.

Petrochemical production capacity for ethylene, ammonia, and methanol has traditionally been located primarily in the United States, Western Europe, and Japan; however, as petrochemical production capacity for these building-block petrochemicals comes on-stream in the CERN's, the shares of world total capacity held by the traditional producing areas are expected to decline as

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1/ The term "CERN's" has been coined to represent nations such as those with an advantage in terms of crude petroleum or natural gas, as indicated in table 4 of this report.

indicated in the following tabulation which shows the shares in 1980 and the base supply-demand scenario 1/ for 1990 (in percent):

Area	Ethylene		Ammonia		Methanol	
	1980	1990	1980	1990	1980	1990
United States	35	29	18	13	25	19
Western Europe	33	27	16	12	26	19
Japan	12	10	3	2	9	6
Total	80	66	37	27	60	44

In each instance, the share of world capacity decreases between 1980 and 1990. One result of this shift is an expected decrease in net exports of ethylene, ammonia, their derivatives, and methanol from the United States, Western Europe, and Japan. The following tabulation shows these areas shares of net world exports of these petrochemicals in 1980 and the base scenario for 1990 (in percent):

Area	Ethylene		Ammonia		Methanol	
	1980	1990	1980	1990	1980	1990
United States	45	1/	8	1/	4	2
Western Europe	26	25	20	2/	11	2/
Japan	10	1/	1/	1/	1/	1/
Total	71	25	28	-	15	2

1/ Net importer status.
2/ Less than 0.5 percent.

Again, in each instance, a decrease is indicated. The United States, Japan, and certain Western European nations may even become net importers.

- The CERN's which are considered most likely to develop world-scale petrochemical industries by 1990 are Saudi Arabia, Indonesia, Kuwait, Canada, Mexico, the U.S.S.R., and the People's Republic of China (China).

1/ This scenario is one of three scenarios included in this report and most nearly represents a "business as usual" view of 1990. See page 198 for details on assumptions used in the construction of the scenarios.

The manufacture of most products requires the use of energy. As the average world price of energy has increased, the share of the production costs for these products attributable to energy has also increased, especially for those industries that require larger than average quantities of energy in the manufacturing process, i.e., energy-intensive industries, such as petroleum products, petrochemicals, cement, paper, aluminum, glass, and steel. Those nations with abundant energy supplies at prices below world levels could have a manufacturing cost advantage. Such nations include the CERN's.

Certain CERN's--Saudi Arabia, Indonesia, Kuwait, Canada, Mexico, the U.S.S.R., and China--are expected by most observers to develop world-scale petrochemical industries at least partially on the basis of their abundant energy and feedstock resources. The shares of estimated world proved reserves of conventional energy resources held by these CERN's are summarized in the following tabulation (in percent):

	Crude petroleum	Natural gas
Saudi Arabia----------	24.2	3.9
Indonesia-------------	1.4	1.0
Kuwait----------------	9.6	1.0
Canada----------------	1.0	3.2
Mexico----------------	7.2	2.5
U.S.S.R---------------	9.4	41.0
China-----------------	2.9	1.0
Total-------------	55.7	53.6

These CERN's have an advantageous position also in terms of other incentives, including low-interest loans, and have the infrastructure necessary to develop world-scale petrochemical industries by 1990. There are many other CERN's, such as Iran and Singapore, that have plans for petrochemical production, but it is unknown whether they could become world-scale producers by 1990.

- The CERN's are expected to have feedstock and energy cost advantages through the use of previously flared natural gas.

The value of flared natural gas (i.e., burned in the atmosphere) has been debated and various values assigned. However, irrespective of the actual value assigned to the flared natural gas, it is generally agreed that its value is low relative to world market prices for natural gas. Some CERN's have also established policies to maintain crude petroleum and natural gas prices at below world-market levels.

Industry estimates of 1982 natural gas prices varied from 50 cents per thousand cubic feet in some Persian Gulf nations to between $2.50 and $5.00 per thousand cubic feet in the United States, depending upon the customer and the specific type of service. The significance of this difference in price in terms of petrochemicals becomes more apparent when it is taken into consideration that, particularly for certain primary petrochemicals such as ammonia, methanol, and ethylene, the feedstock and energy costs may account for 60 to 70 percent of the costs of production in the traditional petrochemical-producing nations. The feedstock and energy advantages of the CERN's could increase in the future because of the anticipated increases in the price of U.S. natural gas.

- CERN's are interested in developing world-scale petrochemical industries to decrease imports and increase exports, thus improving their balance of trade, as well as to upgrade previously flared natural gas and provide an additional source of foreign revenue.

The development of a petrochemical industry, in addition to returning financial benefits, may also be a means for achieving goals in social, technological, educational, and other areas. Often these other areas may be the overriding consideration in the decision to develop a petrochemical industry.

A petrochemical industry can increase a nation's petrochemical self-sufficiency, eventually replacing most imports with domestic production. It allows the country to export petrochemicals, which can be looked upon as additional exports of crude petroleum or natural gas in a value-added form. This export scenario is particularly attractive to those nations requiring additional foreign exchange especially at those times when energy export revenues are diminished by a sluggish world economy.

- The impact of the development of export-oriented world-scale petrochemical industries by CERN's will be largely dependent upon their method of entry into the world market.

There is a wide variance in industry opinion as to what effect the entrance of new petrochemical-producing nations will have on the world petrochemical market and on individual established petrochemical-producing nations and companies, ranging from significant to slight. In general, there is the belief that the established petrochemical-producing nations cannot help but be negatively affected when the number of countries competing for the world petrochemical market is increased.

A factor determining the severity of the impact on the established petrochemical-producing nations will be the method of entry of the new petrochemical-producing nations into the world market. A traditional entry, wherein the petrochemicals marketed are produced in response to an increase in demand, would be the least disruptive. Such entry could allow established petrochemical-producing nations to maintain volume while the new petrochemical-producing nations were producing the volume of product needed to satisfy increases in world demand.

Potentially disruptive methods of market entry would include those wherein the new petrochemical-producing nations use some unique advantage to obtain market share or attempt to supplant current suppliers from established markets. Prices below world levels, the linkage of petrochemical exports to crude petroleum exports, and compensation agreements are methods of market entry that could give exporting nations competitive advantages. The extent to which such advantages are used will depend upon the intensity of market competition. The smaller the market and the larger the numbers of competing producers, the more likely are the new producers to use their potential advantages.

o Certain CERN's are expected to have a higher future share of the world's petrochemical production capacity for certain building-block petrochemicals and as a result have a higher future share of the world's net exports of these petrochemicals.

The following tabulation shows production capacity for key petrochemicals for Saudi Arabia, Indonesia, Kuwait, Canada, Mexico, the U.S.S.R., and China as a share of total world petrochemical production capacity for these petrochemicals in 1980 and the base scenario for 1990 (in percent):

Country	Ethylene		Ammonia		Methanol	
	1980	1990	1980	1990	1980	1990
Saudi Arabia	1/	2	1/	1/	2	4
Indonesia	1	1	1	2	1	1
Kuwait	1/	1	1	1	1/	1
Canada	3	6	2	3	3	7
Mexico	1	2	2	4	1	4
U.S.S.R	5	7	22	28	15	17
China	1	3	12	10	2	2
Total	11	22	40	48	24	36

1/ Less than 0.5 percent.

The share of world production capacity accounted for by these CERN's increased for almost all the petrochemicals between 1980 and 1990. This growth provides the basis for the concern expressed by many of the traditional petrochemical-producing nations and firms. The production capacity increases for these CERN's are particularly significant because most of the production is earmarked for export as ethylene, ammonia, their derivatives, and methanol. The following tabulation shows the shares of net world exports of these petrochemicals for certain CERN's in 1980 and the base scenario for 1990 (in percent):

Area	Ethylene		Ammonia		Methanol	
	1980	1990	1980	1990	1980	1990
Middle East-----------	12	21	11	6	13	13
Canada----------------	7	30	10	11	19	19
Mexico----------------	1/	3	5	13	4	11
U.S.S.R---------------	1/	6	33	49	18	25
China-----------------	1/	1/	1/	1/	1/	1/
Total--------------	19	60	59	79	54	68

1/ Less than 0.5 percent.

- Even though the individual CERN's previously cited operate under similar circumstances, each also has certain differences that may influence the relative degree of petrochemical industry development success of each CERN during the period 1980-90.

Saudi Arabia

The Saudi Arabian Government has entered into joint ventures with large petroleum and chemical companies to obtain expertise in production, management, and marketing. These ventures have enabled the Saudi Arabian Basic Industries Corporation (SABIC) to more confidently project market distribution for 1990 petrochemical production utilizing the marketing ability of its partners. The partners have received certain incentives in return, including crude petroleum offtake agreements, by which the partners are guaranteed a specified volume of crude petroleum.

Indonesia

Indonesia's development plans build upon trade experience gained from exporting fertilizers to many nations. Major goals for future petrochemical industry development include the export of additional natural-gas-based petrochemicals to those various Asian markets in which its exports would enjoy a transportation cost advantage particularly vis-a-vis other CERN's.

Kuwait

Kuwait was the first country in the Middle East to construct ammonia and urea facilities that use natural gas as a feedstock; it has developed this initiative to where it is currently one of the world's largest fertilizer producers. The future petrochemical plans of the state-owned Petrochemical Industries Company are based on utilizing the one-third of natural gas production that is now flared.

Kuwait is also interested in petrochemicals in other nations, particularly by means of joint ventures in the Persian Gulf region which include plans to develop a pharmaceutical industry with Saudi Arabia and the United Arab Emirates and ammonia and methanol facilities with Bahrain. Kuwait also owns a substantial interest in one of the world's major chemical companies headquartered in West Germany.

Canada

The basis of much of Canada's petrochemical expansion plans is the availability of natural gas in the Western Provinces, away from the major consuming areas in the Eastern Provinces. However, Government controls on crude petroleum and natural gas prices have forced feedstock and energy prices to increase at a time when they are decreasing in many other parts of the world. The Canadian petrochemical industry has indicated that lower prices are required to offset other costs associated with plants built in the Western Provinces, such as transportation to distant domestic or export markets.

Mexico

Mexico has one of the clearest policies concerning the production of petrochemicals: all basic petrochemicals are reserved for Petroleos Mexicanos (PEMEX), the state-owned petroleum company, and secondary petrochemicals may be produced by private companies, although such companies must have at least 60 percent Mexican ownership. The National Industrial Development Plan provides many industry incentives including tax breaks, power rate discounts, and price discounts on basic petrochemicals supplied by PEMEX for use as feedstocks in plants located in specified industrial areas.

U.S.S.R.

The future development plans and goals of the petrochemical industry in the U.S.S.R., already the world's fourth largest petrochemical producer, are included in the Eleventh Five-Year Plan, for 1981-85. Although past problems have prevented the attainment of overall petrochemical goals, and there appear to be no quick solutions, the future goals, which have been set using past experience, may be reached.

The U.S.S.R.'s petrochemical plans take into consideration the Eastern European countries. A series of agreements negotiated in June 1979 may guide future cooperative efforts, and if followed, would result in the U.S.S.R.'s becoming mainly responsible for the production of the primary petrochemicals and large-volume derivatives. The other Comecon nations would be the primary manufacturers of certain more advanced petrochemicals, often using imports of less advanced petrochemicals from the U.S.S.R. as raw materials.

China

China's main petrochemical industry emphasis has been on the production of the major plastics, elastomers, fibers, and fertilizers. Although 10 principal petrochemical complexes are operating, China's per capita petrochemical consumption has been less than that of other nations at comparable stages of development; this would indicate a potential for internal market growth.

Future petrochemical development plans are designed, among other things, to improve the Chinese standard of living by increasing the availability of food and clothing. For example, the use of agricultural chemicals can increase food production. Also, as production of synthetic fibers increases, additional land which had been used in the production of natural fibers becomes available for use by the agricultural industry for the production of additional food.

Increasingly, the U.S.S.R. and China have been seeking ways that do not involve cash to compensate free-world nations for acquired technology, plants, and equipment since there is a general shortage of hard currencies. One result of this trend is an increasing flow of petrochemicals into the world market, particularly from the U.S.S.R. Agreements have been made with companies in Western nations which involve payment through exports of petrochemicals such as ammonia and certain plastics. Additional future compensation agreements are likely to cause an increase in such exports.

- World trade in ethylene and its derivatives is expected to grow and increasingly involve exports from the new petrochemical-producing nations to other nations, particularly the traditional petrochemical-producing developed nations, including the United States.

The following tabulation lists net trade balances for 1980 and the 1990 base supply-demand scenario for ethylene, in terms of ethylene equivalents (in thousands of metric tons):

Area	1980	1990
United States	1,380	-1,280
Canada	215	1,815
Mexico	-264	185
Other Western Hemisphere	-320	-640
Western Europe	800	1,480
Japan	275	-352
Middle East	375	1,245
Africa	-195	365
Asia	-905	-2,825
U.S.S.R	-100	375
China	-120	-515
Eastern Europe	-75	-805

The tabulation indicates that the United States and Japan could become net importers of ethylene and its derivatives by 1990 although they were net exporters in 1980. They could be joined by many nations in Western Europe as petrochemical industry rationalization takes place, even though Western Europe is currently a net exporter. Nations in the Middle East and Africa, and probably Mexico and Canada would be the sources of most of the imports. However, Canada's national feedstock and energy pricing policies may limit future exports, and exports from Mexico may be limited if internal potential markets develop sufficiently fast to absorb future production.

As previously indicated, ethylene production capacity located in seven leading CERN's could approximately double between 1980 and 1990. Behind this expected performance are the following facts: (1) ethylene is consumed in large quantities worldwide; (2) it is a building-block petrochemical from which many other petrochemicals are made; (3) the technology is simple compared with that of many other petrochemicals, and essentially bug-free plants can be ordered from certain engineering-construction companies; (4) the often low-cost natural gas available in all of the CERN's is a source of ethane, the prime feedstock for the manufacture of ethylene; and (5) once ethylene is available, derivative plants can be constructed to make those derivatives currently in demand; if the demand decreases, other derivatives can be made, and thus there is a high probability of being able to continue to operate ethylene plants at high capacity utilization rates and thereby increase their efficiency and lower the cost of production.

The 1990 supply-demand scenarios for the United States discussed in the report indicate a net trade balance ranging from 1.3 million metric tons of exports to 2.0 million metric tons of imports. The base scenario shows imports of 1.3 million metric tons.

- <u>Ammonia and its derivatives are expected to continue to be widely traded, and net exports from the U.S.S.R., Mexico, Trinidad, and the Middle East to the United States, Western Europe, and Japan could increase.</u>

The following tabulation lists net trade balances (in thousands of metric tons) for 1980 and the 1990 base supply-demand scenario for nitrogen:

Area	1980	1990
United States	675	-3,670
Canada	875	2,080
Mexico	450	2,540
Trinidad	460	985
Other Western Hemisphere	180	180
Western Europe	1,725	25
Japan	-230	-685
Middle East	910	1,180
Africa	-1,275	-2,080
Asia	-1,860	2,450
U.S.S.R	2,820	9,275
China	-1,635	-1,730
Eastern Europe	455	185

The tabulation indicates that the United States and some Western European nations could become net importers of nitrogen in 1990 although they were net exporters in 1980. They could receive exports from many other nations, all of which have plans to enlarge current capacities to produce ammonia and its derivatives. Large capacity additions are expected in Canada, Mexico, Trinidad, the Middle East, Asia, and the U.S.S.R.

Future supply-demand scenarios that do not indicate a potential world nitrogen surplus are difficult to construct. A balanced scenario can be constructed only if future production capacity is decreased by certain planned facilities not being built and/or certain current operating production capacity being closed, and/or future consumption growth rates being above those expected by most observers.

Ammonia and its derivatives have been emphasized in the petrochemical industry development plans of most CERN's. These petrochemicals are attractive because their manufacture uses readily available natural gas; their use as sources of plant nutrients offers the potential of increasing food supplies; their manufacturing facilities and technology may be purchased; and they are easily moved in international trade.

Operating production capacity has already been closed in the United States; 36 ammonia plants were reportedly closed during the period from 1977-82. Industry sources see the potential for this trend to continue as new overseas facilities come on-stream and natural gas prices are decontrolled in the United States.

The supply-demand scenarios discussed in the report for the United States in 1990 indicate a net trade ranging from 3.7 million metric tons to 5.8 million metric tons of imports. The base scenario shows net imports of 3.7 million metric tons.

o <u>The extent of future world trade in methanol could depend on whether methanol becomes a major energy source.</u>

The following tabulation lists net trade balances for 1980 and the 1990 base scenario for methanol (in thousands of metric tons):

Area	1980	1990
United States----------------	40	120
Canada-----------------------	210	1,485
Mexico-----------------------	50	875
Other Western Hemisphere----	-40	615
Western Europe--------------	125	0
Japan------------------------	-100	-250
Middle East-----------------	150	1,025
Africa-----------------------	150	670
Asia-------------------------	-50	400
U.S.S.R---------------------	200	2,000
China------------------------	-40	0
Eastern Europe--------------	200	800

Methanol has traditionally been used as a solvent and as a feedstock for the manufacture of other chemicals. However, while these markets are expected to continue to increase, it is the fuel market that offers the greatest future potential. The extent to which this potential is realized is dependent upon, among other things, the future prices of petroleum-based fuels such as gasoline and diesel fuel and the construction of large methanol facilities. Anything that helps lower the production cost of methanol vis-a-vis competing fuels increases methanol's chance for success in the fuel market.

The base scenario data above for 1990 do not include any appreciable use of methanol as a fuel. The probability of this scenario's occurring would be greatest if petroleum prices remain soft, thus reducing the attractiveness of methanol as a subsitute for traditional fuels. Under these circumstances there could be a large methanol overcapacity in the world by 1990, which would lead to plant closures and reduced operating rates. Such a situation would favor the lowest cost producers and could lead to a highly competitive market, with the United States, Japan, and Western Europe becoming net importers.

A more stable world market would result from an alternate scenario that included the expanded use of methanol as a fuel in addition to its traditional uses. This would be limited to its use in low-level gasoline blends and as a feedstock for the manufacture of gasoline additives capable of increasing the octane level of the gasoline to which they are added.

Widespread use of methanol as a direct fuel and/or a feedstock for the manufacture of gasoline would necessitate additional world methanol capacity. It is probable that under such a scenario a large part of the additional methanol production would be based on coal. Those nations with extensive coal resources, including the United States, could be in an advantageous position.

The 1990 supply-demand scenarios for the United States discussed in the report indicate a net trade balance ranging from 120,000 metric tons of exports to 4.8 million metric tons of imports. The 1990 base scenario shows the United States with net exports of 120,000 metric tons.

- The United States in 1990 for ethylene, ammonia, their derivatives, and methanol could have net trade positions which range from -$140 million to -$3.8 billion; the base scenario gives a U.S. net trade position of -$1.8 billion.

In order to project changes in U.S. industry output and employment, the U.S. Department of Labor's input/output model was used. Net import trade figures 1/ based on the supply-demand scenarios of $140 million and $3.8 billion as input indicate a decline of $190 million to $5.1 billion in the output of the U.S. chemicals and allied products industry. Output of the U.S. petroleum-refining and related products industry would decline by $39 million to $1 billion; the U.S. crude petroleum and natural gas industry output would decline by $32 million to $0.9 billion; and output of the entire economy would decline by $365 million to about $10 billion. The base scenario

1/ In terms of 1982 dollars.

net import figure of $1.8 billion would cause output declines of $2.4 billion in the chemicals and allied products industry, $0.5 billion in the petroleum-refining and related products industry, $0.4 billion in the crude petroleum and natural gas industry, and $4.7 billion in total industry output.

Using the net import trade figures of $140 million and $3.8 billion as input, the model indicates a decline of 902 to 24,396 workers in the chemicals and allied products industry employment. The employment declines would range from 35 to 931 workers in the petroleum-refining and related products industry, from 31 to 836 workers in the crude petroleum and natural gas industry, and from 2,429 to 65,626 workers in the entire economy. The base scenario net import trade figure of $1.8 billion would cause employment declines of 11,556 workers in the chemicals and allied products industry, 441 workers in the petroleum-refining and related products industry, 396 workers in the crude petroleum and natural gas industry, and 31,086 workers in the entire economy.

- As a result of profitability problems, most U.S. firms have adopted, or are considering adopting, changes that will best enable them to remain competitive in the world market.

The U.S. industry consensus is that no one action, or combination of actions, is a remedy for its current and possible future problems. Observers believe that actions taken by any one company should be specifically tailored to enhance that company's assets, whether they be marketing, R. & D., natural resources, or some other area of expertise.

Companies may choose or be forced to close or sell facilities and withdraw from the market. For example, some U.S. petroleum companies are assuming lower profiles in the petrochemical industry by abandoning the production of plastics and high-volume primary petrochemicals. Others are planning to close U.S. facilities and import the petrochemicals from overseas joint ventures in areas having feedstock and energy price advantages.

Some U.S. companies have invested in petrochemical facilities in Canada and the Persian Gulf nations. Many of the CERN's diversifying into petrochemicals have recognized that they are deficient in one or more business areas, such as marketing, mangagement, and technology, and assume joint-venture partners noted for their expertise in one or more of these areas. Saudi Arabia is a leading proponent of this approach, and SABIC has entered into joint ventures with five U.S. companies. The U.S. companies have often obtained crude petroleum supply agreements and other incentives; some plan to close U.S. production facilities and import the lower cost joint-venture output for future upgrading in U.S. facilities.

Certain of the above companies and others are optimistic that the importation of reasonably priced primary and intermediate petrochemicals from the CERN's may enable U.S. companies to maintain or even expand upgrading facilities; exports of these further advanced petrochemicals may also be possible.

Increased emphasis on chemical specialties is another way some U.S. chemical companies may be able to minimize the impact of their deemphasis on the petrochemicals currently made, and to be made, in the CERN's. In 1981, for example, specialty chemical companies were major acquisition targets. However, some concern has been expressed in the industry that perhaps too many firms are turning toward specialty chemicals. It is possible that some firms may not have the technical, marketing, or management expertise to change from the more fungible petrochemicals to specialty chemicals, which are made in smaller volumes and usually for specific applications. Further, if the sheer number of firms turning to specialty chemicals is very large, profitability and survival could become problems.

U.S. companies are also searching for less expensive or more secure feedstocks and energy sources from which to make chemicals and are increasingly turning their attention to coal, acetylene chemistry, fermentation processes, biotechnology, and renewable biological materials, including molasses, starch, and cellulosic biomass. It has been stated by a senior official at a large U.S. chemical company that "biotechnology is not an opportunity for the chemical industry, it is the opportunity." Although not everyone may be of this persuasion, many U.S. chemical companies have committed heavily to R. & D. in biotechnology even though biotechnological techniques are not generally expected to be in widespread commercial use before the end of this decade.

Increasing involvement by many foreign governments in the chemical industry has prompted many U.S. petrochemical officials to believe that world petrochemical competition is moving away from company versus company and toward nation versus nation. Although it is believed to be doubtful that the U.S. Government would directly participate in the U.S. petrochemical industry, industry observers suspect that most of the private sector's requests would be in areas designed to help U.S. exports and/or limit U.S. imports. There has been an increasing interest in trade mechanisms, such as reciprocity and local content legislation, to aid U.S. industries, particularly since the relatively inconclusive General Agreement on Tariffs and Trade Ministerial meeting in the late fall of 1982.

In general, industry observers believe that the U.S. petrochemical industry should persist, although possibly in a changed form, and that the use of petrochemicals should not decrease or be replaced to any significant extent, if at all, by natural substitutes by 1990. It is probable that the industry will change in response to the new petrochemical facilities coming on-stream in many of the CERN's. The extent to which it will change depends upon many factors; overall, the greater the competitive pressures the greater the expected changes. However, it has been stated by an industry consultant that the changes will be "more than [the industry] would like," but "less than [the industry] thinks."

- Traditional petrochemical-producing nations are considering strategies in addition to those being considered by U.S. firms.

Many of the remedies taken, or under consideration, by the U.S. industry have also been taken, or are under consideration, in other developed petrochemical-producing nations. However, because of historical precedent, government-industry interaction, and government policies, some of the overseas remedies differ significantly from those of the United States.

The trading of product interests, wherein one company trades its total interests in a product (or group of products) for those of another company, continues to be explored. In spite of the practical difficulties involved, such trade practices have occurred in France, Italy, and the United Kingdom. In the latter country, for example, two major plastics producers exchanged their interests in low-density polyethylene (LDPE) and polyvinyl chloride (PVC); one producer now specializes in LDPE, and the other concentrates on PVC.

In Western Europe, there has been increasing government involvement in aiding the national chemicals industries and decreasing unemployment; these actions reflect an increasing interaction compared with past practices. The heavy chemicals industry in France is dominated by state corporations, and in 1982, several chemical companies in France were nationalized. One goal of this action was to improve the competitiveness of the French chemicals industry. The nationalized companies have been divided into the three groups, each of which is expected to concentrate on improvement in mutually exclusive, arbitrarily defined product sectors.

The Government now controls a large part of Italy's chemicals industry, and recent plant transfers have occurred between two of the major chemical companies. This effort furthers the Italian Government's goal of establishing national production monopolies in primary and secondary chemicals, including specialty and fine chemicals. The objectives are reported to be the elimination of duplicate production facilities and excessively competitive marketing.

Because the Japanese petrochemical industy is losing its ability to compete, certain countermeasures have been, are being, and will be implemented, according to industry sources. Since almost all Japanese petrochemical production is based on naphtha feedstocks, which must be either imported or made from imported petroleum, several countermeasures relate to naphtha and are designed to internationalize domestic naphtha prices and allow increasing imports. Historically, only the petroleum industry could import crude petroleum or products, including naphtha, and a domestic naphtha price above world levels was maintained by law. Guidelines established by the Japanese planning agency (MITI), effective April 1982, are designed to moderate both past practices. Petrochemical companies may freely import, and, beginning in 1984, import duties on naphtha should be removed.

Additional countermeasures include an MITI subcommittee recommendation at the end of 1982 establishing "scrap ratios" for existing capacity for many petrochemicals, including ethylene and many of its major derivatives. Early disposal of excess facilities is called for, as well as investment adjustments.

In the meantime, production cartels have been established. The most recent, for ethylene, is for the period October 16, 1982, through March 1983. Previous cartels have existed for PVC and LDPE. These cartels are designed to control capacity utilization and prevent overproduction.

THE PETROCHEMICAL INDUSTRY AND THE CONVENTIONAL-ENERGY-RICH NATIONS

At present, the production of petrochemicals is centered in the industrialized nations of the world. Leading international producers are the United States, the European Community (EC), and Japan. However, conventional-energy-rich nations (CERN's) are beginning to assume a role in the production of certain petrochemicals. These nations have a competitive advantage in the production of petrochemicals, which are highly energy intensive, because of relatively assured supplies of crude petroleum and natural gas at prices below world levels.

CERN's are those nations containing large reserves of conventional energy materials, such as crude petroleum and natural gas. These countries can easily produce, or are already producing, quantities in excess of their internal consumption at a lower cost than other nations with reserves. Free-world countries meeting this definition are believed to include members of the Organization of Petroleum Exporting Countries (OPEC), Canada, and Mexico.

When crude petroleum is extracted from the ground, associated natural gas is often obtained. In the past, this natural gas has been, and in some cases is still being, flared, or burned in the atmosphere without regard to economic value. Flaring takes place because there has been, and often still is, no other economic use for the natural gas, unlike the crude petroleum which is primarily exported. The flaring of natural gas has been extensively practiced by many nations, particularly those in the Persian Gulf. These nations have had no internal use for the natural gas, and to transport it overseas to nations such as Japan and the United States entails considerable expenditure for a collection network, liquefaction plants, and special tanker vessels. However, natural gas and its components, such as methane and ethane, can be used as feedstocks to produce such petrochemicals as ammonia and ethylene; the natural gas and petroleum can also be used as sources of the energy required to convert the feedstocks to petrochemicals. Many of the petrochemicals, which are "value-added higher order" forms of natural gas and its components, can be readily shipped around the world to many markets, including developing as well as developed nations. In addition, OPEC crude petroleum exports may have peaked for the next couple of years, according to industry observers. For these reasons, many of the CERN's are in the process of developing, or have already developed, petrochemical industries to additionally utilize their resources and further their economic development, as well as to diversify their exports.

The historical trend of petrochemical development in many developing nations has been toward small, local production facilities to serve small, local markets. Despite large revenues generated by the increases in the price of crude petroleum during the past decade, local infrastructure and markets in most of the developing nations, including the CERN's, have not been able to support the large-scale development of local petrochemical industries. Growth of infrastructure in these nations has been slow and extremely expensive, owing in part to the extreme climatic conditions in many of these areas, particularly northern Canada, the Persian Gulf, and equatorial Africa. This slow development has left many nations dependent upon imports of many petrochemicals and petrochemical products, even if some are manufactured locally, in order to satisfy their increasingly diversified local demand. For the first time, many of these nations are beginning to provide the bases upon which large, world-scale petrochemical industries may develop. It is the intent of many CERN's that these new petrochemical centers not only increase the flow of foreign exchange, but also serve social goals such as providing skills and on-the-job training for their domestic labor force.

Feedstocks and Energy Advantage

The abundance of energy resources in certain areas of the world allows for competitive cost advantages for these nations particularly in the manufacturing industries. However, there are a small number of industries, as classified by the Standard Industrial Classification (SIC) code, that are extremely energy intensive. In these energy-intensive industries, other cost factors, such as transportation, are often overshadowed by the costs of energy and energy-related feedstocks used in the production process. The 16 largest U.S. industrial consumers of energy in 1977, ranked in order of their consumption of energy in terms of British thermal units (Btu's), are given in table 1. Although there are no equivalent data available for later years, the relationship between the industrial sectors mentioned is assumed to have remained relatively stable.

Table 1.--U.S. industrial energy consumption, by SIC numbers, 1977

SIC No.	Industry	Energy as BTU's consumed	Cost of energy
		Trillions	Million dollars
3312	Blast furnaces and steel mills	1,519	4,160
2911	Petroleum refining	1,223	2,247
2869	Industrial organic chemicals	1,096	1,844
2621	Paper mills	588	1,294
2631	Paperboard mills	483	990
3241	Hydraulic cement	453	733
2819	Industrial inorganic chemicals	422	1,141
3334	Primary aluminum	328	695
2873	Nitrogenous fertilizers	252	421
2821	Plastics and resins	183	479
2865	Cyclic crudes and intermediates	172	385
2824	Organic fibers, non-cellulosic	148	365
3221	Glass containers	145	361
3079	Miscellaneous plastics products	140	568
3714	Motor vehicle parts	137	490
2812	Alkalies and chlorine	127	327

Source: 1977 Census of Manufactures.

In 1977, these 16 industries consumed, by quantity, approximately 57 percent of the energy consumed by all industries in the United States. 1/ Overall, more than 30 percent of all U.S. industrial energy use was accounted for by the domestic chemical industry.

Overall use of energy by all U.S. industrial sectors decreased from 31.2 quadrillion Btu's in 1977 to an estimated 27 quadrillion Btu's in 1982. 2/ The data also indicate that the U.S. chemical industry is decreasing its overall consumption of energy. This decline may be related in part to conservation efforts, as well as to the increase in the price of energy materials. 3/

However, it is more relevant in this study to compare the costs of petroleum and natural gas, as these materials confer certain competitive price and cost advantages to those nations which have them in readier supply. It is also important when discussing the chemical industry to include all uses of these energy materials, including their use as both direct and indirect energy sources, and as feedstocks. Table 2 contains petroleum and natural gas consumption data for the 16 domestic industries listed previously.

In order to obtain a truer comparison of these energy-intensive industries, the total consumption figures for petroleum and natural gas may be regarded in relation to such other industry factors as value of shipments, cost of all materials, or employment. This helps eliminate certain biases found in the raw cost figure by minimizing the effect of the different sizes of each of the industries. Table 3 shows that of the 10 industries which consumed the greatest amount of petroleum and natural gas per value of shipments, 9 are involved in some manner with the chemicals industry. Additionally, the six largest industrial consumers per value of shipments relate in some manner to the production of petrochemicals. 4/

As can be seen in Table 3, the U.S. petrochemical industry remains vulnerable to possible changes in the marketing strategies of CERN's. With readily available low-cost feedstocks, the opportunity exists for any of the CERN's to produce any number of petrochemicals. Although the feedstock advantage alone may not be sufficient to allow CERN's to increase their influence on the world petrochemical industry, much of the existing industry, particularly in the developed nations, is in the process of setting long-range directions and goals in order to preserve its place.

1/ 1977 Census of Manufactures.

2/ U.S. Department of Energy, Monthly Energy Review - October 1982, Oct. 22, 1982.

3/ It has been estimated that between 1972 and 1982 the chemical industry reduced its fuel consumption per unit of production by about 25 percent. Whereas in 1972 it required approximately 1.5 barrels of fuel for every 1.0 barrel of feedstock, by 1982 the ratio stood at about 1.1 to 1.0. Expectations are that it could decrease to 1.0 to 1.0 by 1985 and 0.9 to 1.0 by 1990. W. W. Reynolds, "Feedstock Economics and World Petrochemical Markets," The Energy Bureau, September 1982, p. 2.

5/ The products of SIC 2911, petroleum refining, include the fuels used for petrochemical production; the byproduct materials are also used as feedstocks for the manufacture of petrochemicals.

Table 2.--U.S. industrial consumption of petroleum and natural gas, by SIC numbers, 1977

(In millions of dollars)

SIC No.	Industry	Consumption as a fuel		Consumption as feedstocks	Total consumption
		Petroleum	Natural gas		
2911	Petroleum refining	109	1,486	63,215	64,810
3079	Miscellaneous plastics products	63	59	5,732	5,854
2869	Industrial organic chemicals	223	929	3,869	5,021
2821	Plastics and resins	92	121	4,308	4,521
2824	Organic fibers, non-cellulosic	112	22	1,600	1,734
3312	Blast furnaces and steel mills	597	891	-	1,488
2865	Cyclic crudes and intermediates	91	119	893	1,103
2621	Paper mills	417	258	-	675
2631	Paperboard mills	444	209	-	653
2873	Nitrogenous fertilizers	48	-	515	563
3714	Motor vehicle parts	30	97	312	439
2819	Industrial inorganic chemicals	81	200	-	281
3221	Glass containers	66	178	-	244
3241	Hydraulic cements	80	137	-	217
2812	Alkalies and chlorine	7	71	-	78
3334	Primary aluminum	4	-	-	4

Source: Derived from 1977 Census of Manufactures.

Table 3.--U.S. industrial consumption of petroleum and natural gas per production factor, by SIC number, 1977

SIC code	Industry	Ratio of consumption to--		
		Value of shipments	Cost of materials	Employment
		Percent	Percent	Per employee
2911	Petroleum refining	73.90	84.09	$638,716
2821	Plastics and resins	39.30	70.69	83,698
2824	Organic fibers, non-cellulosic	35.92	54.32	26,561
2873	Nitrogenous fertilizers	32.61	64.36	76,983
2869	Industrial organic chemicals	29.50	40.98	50,896
3079	Miscellaneous plastics products	26.41	52.05	13,898
3241	Hydraulic cement	24.67	54.58	26,367
2865	Cyclic crudes and intermediates	23.17	36.99	35,784
2812	Alkalies and chlorine	18.29	39.57	27,695
2819	Industrial inorganic chemicals	15.76	25.11	13,950
2631	Paperboard mills	13.87	24.39	14,614
3334	Primary aluminum	11.42	25.80	2,430
2621	Paper mills	10.24	17.89	10,173
3221	Glass containers	9.98	24.14	5,099
3312	Blast furnaces, steel mills	9.04	15.58	9,422
3714	Motor vehicle parts	4.13	4.06	100

Source: Derived from 1977 Census of Manufactures.

Within the time period chosen for this study, the apparent emphasis among CERN's is to utilize available natural gas to produce the primary petrochemicals--ethylene, methanol, and ammonia. Whereas ammonia and methanol can be transported using conventional methods, ethylene will probably be further processed into derivatives such as ethylene glycol and various polyethylene plastics materials to facilitate shipping.

Availability

As previously mentioned, there are certain world areas which are known to be advantaged in terms of crude petroleum and natural gas availability. We must first define the term "availability" and explain how we will use the concept in relation to crude petroleum and natural gas. The first distinction to be made is between "reserves" and "resources." According to the U.S. Department of Energy--1/

> The "total resource" of crude petroleum and natural gas, that is, the amount that existed before any production, consists of the total volume formed and trapped in place within the Earth. A portion of this total resource is not recoverable by current or forseeable technology, for two principal reasons. First, much of this portion is dispersed at very low concentrations throughout the Earth's crust and cannot be extracted without mining the rock or applying some other approach that could consume more energy than it covered. Second, an additional portion of the total resource volume cannot be recovered because available production technology cannot extract all of the in-place crude petroleum and natural gas. This technical inability to recover 100 percent of the in-place hydrocarbons in a producible deposit may result from the economics involved, intractable physical forces, or a combination of both. The concept of "recoverable resources" normally excludes these unrecoverable fractions.
>
> The "total recoverable resource" includes both discovered and undiscovered recoverable resources. "Discovered recoverable resources" consist of two major parts: cumulative production and reserves. "Cumulative production is the sum of the current year's production and the production that occurred in all prior years. "Reserves" are volumes estimated to exist in known deposits, and which are believed to be recoverable in the future through the application of present or anticipated technology. "Proved reserves," the major concern of this report, are those reserves of crude petroleum and natural gas which geological and engineering data demonstrate with reasonable certainty to be recoverable in the future under existing economic and operating conditions.

1/ U.S. Department of Energy, Office of the Oil and Gas Information System, U.S. Crude Oil and Natural Gas Reserves: 1978 Annual Report, September 1980, pp. 2-3.

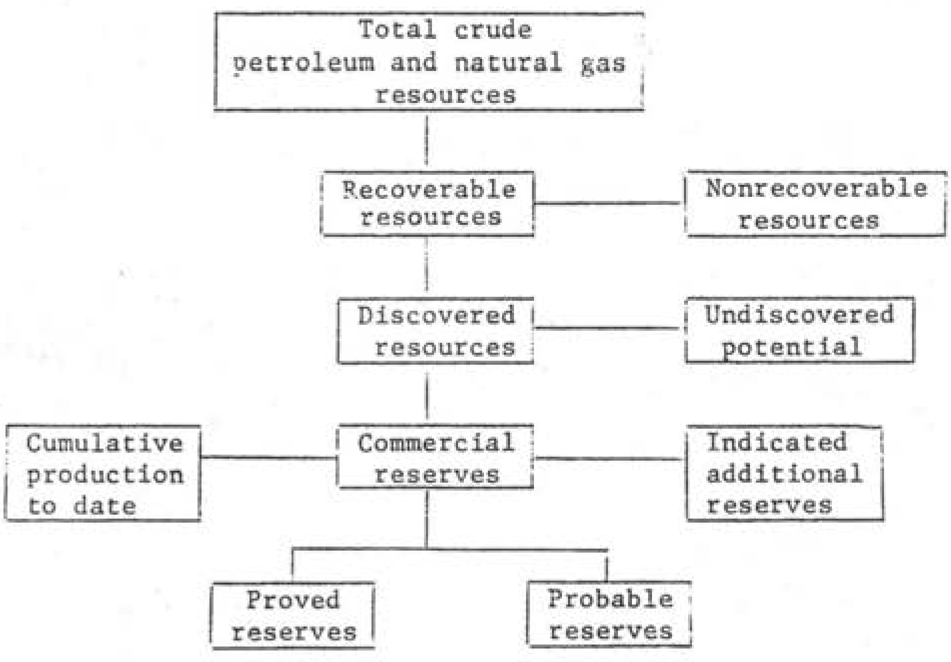
"Undiscovered recoverable resources" are those quantities of crude petroleum and natural gas which are as yet undiscovered but which are thought to exist in favorable geologic settings.

> "Indicated additional reserves" . . . are those quantities of crude petroleum, in addition to proved reserves, which in the future may become technically and economically recoverable from known productive reservoirs through the application of currently available but uninstalled recovery technology. Indicated additional reserves are not included in proved reserves.

. . . the estimate of proved reserves for any given [petroleum] fuel is dynamic over time and is influenced directly by the amount, kind, and quality of data that becomes available concerning that field.

The differences between reserves and resources can be clearly seen in figure 1.

Figure 1.--Hierarchical relationship of resource-related terms



As per the preceding definition, table 4 illustrates the significant differences between various nations and world areas when considering estimated proved reserves of both crude petroleum and natural gas.

Table 4.--Crude petroleum and natural gas: Estimated proved reserves as of Jan. 1, 1983

Area	Crude petroleum		Natural gas	
	Reserves	Share of total	Reserves	Share of total
	1,000 bbl.	Percent	10 ft.	Percent
Asia-Pacific	19,756,077	3.0	146,247	4.8
Indonesia	9,550,000	1.4	29,600	1.0
Australia	1,622,000	.2	17,768	.6
Western Europe	22,923,680	3.4	156,736	5.2
Netherlands	294,000	1/	51,920	1.7
Norway	6,800,000	1.0	58,000	1.9
United Kingdom	13,900,000	2.1	25,400	.8
Middle East	369,285,983	55.1	769,730	25.5
United Arab Emirates Abu Dhabi	30,510,000	4.6	19,260	.6
Iran	55,308,000	8.3	482,600	16.0
Iraq	41,000,000	6.1	28,800	1.0
Kuwait	64,230,000	9.6	29,900	1.0
Qatar	3,425,000	.5	62,000	2.1
Saudi Arabia	162,400,000	24.2	117,000	3.9
Africa	57,821,690	8.6	189,423	6.3
Algeria	9,440,000	1.4	111,250	3.7
Libya	21,500,000	3.2	21,500	.7
Nigeria	16,750,000	2.5	32,400	1.1
Western Hemisphere	115,287,066	17.2	487,591	16.1
Argentina	2,590,000	.4	25,200	.8
Brazil	1,750,000	.3	2,330	.1
Canada	7,020,000	1.0	97,000	3.2
Mexico	48,300,000	7.2	75,850	2.5
United States	29,785,000	4.4	204,000	6.7
Venezuela	21,500,000	3.2	54,079	1.8
Communist areas 2/	85,115,000	12.7	1,283,800	42.5
Peoples' Republic of China	19,485,000	2.9	29,800	1.0
U.S.S.R	63,000,000	9.4	1,240,000	41.0
World total	670,189,406		3,023,527	

1/ Less than 0.05 percent.
2/ Includes Albania, Bulgaria, Cuba, Czechoslovakia, East Germany, Hungary, Mongolia, North Korea, Poland, Romania, Viet-Nam, and Yugoslavia.

Source: "Worldwide Report," Oil & Gas Journal, Dec. 27, 1982, pp. 78-79.

There is a more detailed discussion of those individual nations which are considered to be advantaged in terms of crude petroleum and natural gas in the section of the report which discusses anticipated petrochemical industry expansion in CERN's. It is important to recognize, however, that the availability of the resources per se does not confer an advantage upon the country in question. It is the ability to exploit the resources and the cost of producing the crude petroleum and/or natural gas which are the main issues in assessing the relative advantages.

Table 5 indicates recent production capacities for crude petroleum, as well as production rates, by nations. These figures may, in conjunction with the data concerning proved reserves, better delineate the countries that are advantaged and those that are not. In general, advantaged nations have, along with the ability to exploit their resources and produce crude petroleum and natural gas at relatively low costs, production capacities larger than production rates, and reserves of such a size as to be capable of supporting production at those rates well into the future.

Relative costs of production are important in assessing future prices. The nation with the lower production cost will be able to maintain the lower selling prices. Therefore, in a price competition, the lower cost producer will generally have the advantage.

The price decreases of $3.00 to $5.50 per barrel of crude petroleum, because of lower than anticipated world demand and a resulting oversupply, will be easier to maintain or increase for those nations with the lower production costs, which includes the OPEC nations. 1/ Carried to an extreme, sufficiently low prices will shut-in certain production, reduce supply, and allow the lowest cost producers to again increase prices. For example, the cost of production of a typical barrel of crude petroleum in Saudi Arabia is $1.50 whereas for the North Sea it ranges from $4 to $20 per barrel and averages $12 per barrel. 2/ Clearly, Saudi Arabia could maintain profitable production long after North Sea producers.

The continued supply of feedstocks is one of the major concerns of the U.S. petrochemical industry. The continued availability, at reasonable prices, of the materials needed to manufacture the products which the consuming public has become accustomed to having has been threatened several times during the past 10 years. In order to assure a supply of feedstocks, U.S. firms have gone to extraordinary expense, such as back-integrating, as in the case of one major company which purchased its own petroleum-producing subsidiary. Such measures are suspected to have been at least partially prompted by the recognized ability of the CERN's to take advantage of their abundant reserves to create new centers for the manufacture of petrochemicals.

In addition to the current abilities of the CERN's to move into production of the petrochemicals now produced predominantly in the developed nations of the world, there exist other resources from which nations may one day extract the feedstocks to fuel a chemical industry. Such alternate energy sources as tar sands, oil shale, and deposits of "heavy oil" may within the coming decade be used to supply much of the world's energy needs as well as

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1/ "Gulf States To Mull Oil Cuts," Washington Post, Feb. 22, 1983, p. A-1.
2/ Rhonda Brammer and Jaye Scholl, "Decline and Fall of OPEC," Barron's, Feb. 28, 1983, p. 13.

Table 5.--Crude petroleum: Rate of production, productive capacity, and capacity utilization, by country, 1982

Country	Rate of production 1/	Productive capacity 2/	Capacity utilization
	1,000 barrels per day	1,000 barrels per day	Percent
OPEC member nations:			
Algeria	700	900	78
Ecuador	215	225	96
Gabon	150	150	100
Indonesia	1,240	1,650	75
Iran	2,200	3/ 5,500	40
Iraq	800	3/ 3,500	23
Kuwait	4/ 769	4/ 2,500	31
Libya	1,300	2,100	62
Nigeria	1,103	2,200	50
Qatar	341	600	57
Saudi Arabia	4/ 5,919	10,000	59
United Arab Emirates:			
Abu Dhabi	800	2,035	39
Dubai	374	370	95
Sharjah	7	10	70
Venezuela	2,000	2,400	83
Other nations:			
Argentina	483	5/	5/
Bahrain	45	5/	5/
Brazil	252	5/	5/
Canada	1,233	5/	5/
Mexico	2,734	5/	5/
Netherlands	28	5/	5/
Norway	488	5/	5/
People's Republic of China	2,050	5/	5/
United Kingdom	2,050	5/	5/
U.S.S.R	12,410	5/	5/
United States	8,655		
World total	53,002	5/	5/

1/ Rate of production as of January 1982 for OPEC member nations and as of July 1981 for all other nations.

2/ Productive capacity is the maximum production rate that can be sustained for several months; it considers the experience of operating the total system and is generally 90 to 95 percent of installed capacity. This concept does not necessarily reflect the maximum production rate sustainable without damage to the fields. This information is available only for OPEC member nations.

3/ Prior to Iran-Iraq war.

4/ Includes 50 percent of production in the Neutral Zone shared by Kuwait and Saudi Arabia.

5/ Not available.

Source: Central Intelligence Agency, Directorate of Intelligence, International Energy Statistical Review, Nov. 30, 1982; "Worldwide Report," Oil & Gas Journal, Dec. 27, 1982; and "Oil Price Cuts, Overproduction Jolt Solidarity Among OPEC Members," Oil & Gas Journal, Nov. 22, 1982, pp. 39-42.

Note.--The rates of production among individual OPEC member nations tend to vary in order to maintain a certain level of total OPEC crude petroleum production.

provide new sources of chemical precursors. 1/ Estimates of the amount of "synfuels" to have been in the world market by the end of 1982 range from approximately 350,000 barrels per day to 660,000 barrels per day. 2/

Oil shale

Synthetic crude petroleum from oil shale is obtained by heating the shale to approximately 900° F and treating the material obtained. Applicable technology has already been developed and some plants are in place; the uncertainties surrounding the oil shale industry primarily involve the price of crude petroleum. Conventional crude petroleum availability at prices below the price at which crude petroleum from oil shale can be produced has dampened investment plans to increase capacity for the production of petroleum from oil shale.

Oil shale resources are most abundant in the United States. The world's significant deposits of oil shale are estimated to be as follows: 3/

Nation	Oil shale resource (million metric tons)	Estimated recoverable petroleum (million barrels)
United States	145,000	1,062,850
Canada	24,860	182,225
China	21,000	153,930

It is estimated that these three nations possess more than 95 percent of the world's total resources of oil shale. However, only a small percentage of the crude petroleum is recoverable from the shale under the current economic conditions. The United States has been estimated to have approximately the equivalent in recoverable proved reserves of 80 billion barrels of crude petroleum associated with shale, approximately 80 percent of the total oil shale crude petroleum resources noted in the previous tabulation. Although not expected by industry analysts to ever fully supply the energy and feedstock needs of U.S. chemical producers, the gradual buildup of a synthetic fuels industry will give the producers some viable alternatives to conventional feedstock materials. 4/

1/ U.S. International Trade Commission, Study of the Petrochemical Industries in the Countries of the Northern Portion of the Western Hemisphere, USITC Publication 1123, January 1981, p. 19.

2/ "U.S. Synfuels Industry: Alive and Shrinking," Chemical Business, Oct. 18, 1982, pp. 29-34.

3/ Energy Fact Book, Tetra Tech, Inc., 1976, p. G-2; U.S. Geological Survey Circular No. 523, 1965; and Encyclopedia of Energy, McGraw-Hill, 1981, pp. 494-500.

4/ "U.S. Synfuels Industry: Alive and Shrinking," Chemical Business, Oct. 18, 1982, pp. 29-34.

Tar sands

A possible future source of feedstocks for petrochemicals is tar sands, which are an agglomeration of sand, water, and an organic bituminous material. The majority of tar sand exploration and development have been concentrated in Canada, with other significant resources of tar sands as follows: 1/

Nation	Estimated tar sands resources (billion barrels)
North America:	
Canada	895.0
Trinidad and Tobago	68.0
United States	27.0
South America:	
Colombia	1,139.1
Venezuela	74.3
Other:	
Malagasy Republic	1.7
Albania	.4
Romania	.03
U.S.S.R	.03

Although considered by many petroleum industry analysts to be a potential alternative feedstock source for the developed nations of the world in the future, tar sands projects have lost most of the support of the major petroleum corporations which had been active in their development. Reasons given have included the general change in the world petroleum situation, including overcapacity in the marketplace, dwindling demand, and falling prices. 2/

Coal

Another possible future source of energy and feedstocks for chemical manufacture is coal. Significant research is being done on both the gasification and liquefaction of coal. Both gases and liquids are easier to handle, and their use involves the production of less solid waste for disposal.

When coal is heated, a combination of hydrocarbons, including methane, is produced; these hydrocarbons may be further reacted with a mixture of steam and water to produce other gases which can be directly used to produce the same chemicals that are made from natural gas.

Coal may also be converted to a liquefied feedstock for chemicals. Although there is a technology for the liquefaction of coal, designed in Germany during World War II, the method is not economically attractive today,

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1/ The Energy Source Book, The Center for Compliance Information, 1978, p. 260.

2/ "Alsands Consortium, Exxon Quit U.S., Canadian Synfuels Plans," European Chemical News, May 10, 1982, p. 32.

according to industry sources. A newer technology involving an indirect method of liquefaction has provided the basis for the one full-scale operating liquefaction plant in the world, located in the Republic of South Africa. U.S. studies indicate that the price of crude petroleum would have to increase in real terms before coal liquefaction facilities would be commercially attractive in the United States.

The resources of coal, as well as the recoverable reserves, do favor the United States if raw-material availability becomes the limiting factor of production, instead of cost. Table 6 highlights those countries which possess the major shares of the world's coal resources and reserves.

Table 6.--Coal: Recoverable reserves, total reserves, and total resources, by nation

(In billions of metric tons)

Nation	Recoverable reserves	Total reserves	Total resources
Asia:			
People's Republic of China	87.5	300.6	1,002.1
India	11.6	23.2	83.1
U.S.S.R	149.3	277.0	5,716.7
North America:			
Canada	9.5	14.9	103.2
United States	216.3	397.0	3,607.3
Europe:			
West Germany	40.6	99.6	287.4
Yugoslavia	16.9	18.0	21.8
Other:			
Australia	48.3	102.4	351.1
Republic of South Africa	13.1	32.4	82.1
World total	617.4	1,370.0	11,504.8

Source: Survey of Energy Resources, United States National Committee of the World Energy Conference, 1976.

The U.S. Synthetic Fuels Corporation 1/ was expected to file letters of intent to fund a project for the production of methanol from peat, an incompletely formed developmental stage of coal. This project could be producing 202,000 metric tons per year of methanol by late 1985. 2/

1/ Created by the Energy Security Act of 1980.

2/ "Synfuel Funding Act for Methanol, Two More Projects," Chemical Marketing Reporter, Dec. 13, 1982, pp. 7 and 34.

Price

Many economic and political factors influence a nation's decision to develop a world-scale petrochemical industry. The prices of energy and feedstocks are two of the most important economic factors. When prices below world level for these items are combined with assured supplies, the decision to build world-scale facilities can be made with increased confidence.

CERN's are obviously advantaged in terms of two major manufacturing costs, those of energy and feedstocks. Many of these countries are currently flaring the natural gas that is associated with the crude petroleum deposits and obtained when the crude petroleum is produced, but in the future it may be used as a feedstock and as a source of energy for the plants. The major new expense involves the collection and transportion of the natural gas from the production fields to the petrochemical facilities. Many of the planned facilities are expected to be built close to the energy and feedstock sources. While this practice minimizes the required additional investment for the energy and feedstocks, it increases the transportation costs to the markets of the petrochemicals produced.

Several of the advantaged nations reportedly charge their petrochemical industries, often including government-owned or government-controlled corporations, for the feedstocks and fuels used in the plants. The charges are often arbitrary, minimal, and insignificant compared with other production costs and prevailing world prices, according to industry sources. For example, the U.S. Department of State has reported that--

> Petromin, Saudi Arabia's [supplier of natural] gas [is expected to] charge 50¢ per million British thermal units for [natural gas]. Although the government [was reported to] initially (have) considered a 70¢ figure, final discussions led to the lower price. Once a [petrochemical plant] exceeds a 25% return on equity, the cost escalates according to a formula related to costs of the master gas system and the price of Arabian light crude. By comparison, feedstock prices are considerably higher in the rest of the world. Regulated gas in the U.S., at $1 per million British thermal units--double the [reported] Saudi price--is the closest-priced feedstock currently available. 1/

However, natural gas prices are scheduled to be decontrolled in the United States in 1985; prices for the natural gas components, ethane and methane, are expected to increase. Estimates of future natural gas prices in the United States after the Natural Gas Policy Act expires in 1985 range from $5.40 to $9.50 per thousand cubic feet. The price is expected to increase to between $9.40 to $13.30 per thousand cubic feet by 1990. 2/

1/ U.S. Department of State, Saudi Arabia's Emerging Petrochemical Industry--Implications for the West, Oct. 31, 1982.

2/ Estimated by the American Gas Association.

Recent estimated average price ranges which give an indication of the feedstock and energy advantages of the CERN's are shown in the following tabulation (per metric ton): 1/

Area	Ethane	Naphtha	Methane
Canada	1/ $80-$100	-	2/ $50-$90
Mexico	45- 65	-	20- 30
Persian Gulf	20- 30	-	0- 30
Far East (except Japan)	20- 30	-	0- 30
United States	205- 225	$275-$285	205-230
Western Europe	-	320- 330	215-230
Japan	-	340- 350	310-320

1/ The average price range set for 1982/3 by the Canadian National Energy Plan was $160-$200 per metric ton.
2/ The average price range set for 1982/3 by the Canadian National Energy Plan was $65-$115 per metric ton.

The significance of the price advantages becomes even clearer when the proportion of average net production costs 2/ accounted for by price in a representative world-scale plant is compared. The following tabulation shows recent industry-generated estimates for 1980 of the share of the net production cost the previously tabulated feedstock and energy costs represent for each of the areas (in percent):

1/ Compiled from various industry estimates. Material may actually have moved at higher and lower prices depending upon individual contracts or spot-market purchases.
2/ Net production cost is equal to net cash cost plus depreciation, wherein net cash cost includes feedstock, energy, byproduct, general overhead, and other direct and fixed costs.

Area	Ethylene 1/	Methanol 2/	Ammonia 3/
Canada	4/ 15- 35	5/ 15-35	5/ 15-35
Mexico	4/ 35- 40	5/ 20-25	5/ 10-15
Persian Gulf	4/ 15- 20	5/ 15-20	5/ 15-20
Far East (except Japan)	4/ 15- 20	5/ 15-20	5/ 10-15
United States	4/ 75- 85	5/ 65-70	5/ 65-70
Western Europe	5/ 125-140	5/ 65-70	5/ 65-70
	6/ 200-210	6/ 70-75	6/ 70-75
Japan	6/ 200-210	5/ 70-75	5/ 70-75
		6/ 70-80	6/ 75-80

1/ 450,000-600,000 metric tons per year capacity plant.
2/ 600,000-650,000 metric tons per year capacity plant.
3/ 400,000-450,000 metric tons per year capacity plant.
4/ Ethane feedstock.
5/ Methane feedstock.
6/ Naphtha feedstock; may be greater than 100 percent of net production costs because byproduct credits are not included.

While the data in the previous tabulation support the decision made by many of the CERN's to develop world-scale petrochemical industries, estimates of the same data for 1985-90 are even more significant when assessing the probable future cost advantages the new producers will have when their products reach the world market. It is during this period that many of the announced facilities should be on-stream if the announcements prove to be accurate. However, not all announced facilities may be built, and not all of the facilities built may come on-stream in the announced year.

The following tabulation shows data for the 1985-90 period which indicate that although the forecast ranges of comparative feedstock and energy prices all prices (per metric ton) are expected to increase, the CERN's retain an advantage:

Area	Ethane	Naphtha	Methane
Canada	\$170-\$270	-	\$70-\$150
Mexico	50- 90	-	50- 100
Persian Gulf	60- 115	-	50- 100
Far East (except Japan)	75- 125	-	75- 100
United States	325- 375	\$415-\$465	320- 370
Western Europe	-	420- 470	325- 375
Japan	-	445- 480	330- 380

1/Compiled from various industry estimates.

The following tabulation (in percent) shows that although the estimated shares of net production costs represented by the above prices in 1985-90 may differ from those previously given for 1980, again the CERN's retain their advantage: 1/

Area	Ethylene 1/	Methanol 2/	Ammonia 3/
Canada	4/ 20- 50	5/ 20- 50	5/ 20- 50
Mexico	4/ 30- 50	5/ 20- 45	5/ 15- 30
Persian Gulf	4/ 20- 35	5/ 20- 35	5/ 15- 30
Far East (except Japan)	4/ 20- 40	5/ 20- 40	5/ 15- 25
United States	4/ 80-100	5/ 70- 85	5/ 70- 90
Western Europe	6/ 135-160	5/ 70- 95	5/ 70- 90
		6/ 75- 95	6/ 75- 95
Japan	6/ 200-250	5/ 75- 95	5/ 75- 95
		6/ 80-100	6/ 75-100

1/ 450,000-600,000 metric tons per year capacity plant.
2/ 600,000-650,000 metric tons per year capacity plant.
3/ 400,000-450,000 metric tons per year capacity plant.
4/ Ethane feedstock.
5/ Methane feedstock.
6/ Naphtha feedstock; may be greater than 100 percent of net production costs because byproduct credits are not included.

In some cases, feedstock and energy costs as a share of net production costs are estimated to decrease in 1985-90 compared with 1980 because other factors are expected to increase faster. In other cases, they increase because process improvements, or some other factors, do not increase as fast as the expected feedstock and energy prices. In most cases the future range is broader because of the uncertainty about other costs of production such as costs labor and insurance.

Based upon the above data, the following tabulation presents representative 1985-90 net production costs (per metric ton) at an average 80 to 90 percent capacity utilization rate for ethylene, methanol, and ammonia:

1/ Compiled from various industry estimates.

Area	Ethylene 1/	Methanol 2/	Ammonia 3/
Canada	4/ $250-$350	5/ $100-$150	5/ $130-$180
Mexico	4/ 230- 270	5/ 100- 140	5/ 125- 165
Persian Gulf	4/ 300- 340	5/ 110- 150	5/ 140- 180
Far East (except Japan)	4/ 355- 395	5/ 125- 165	5/ 170- 210
United States	4/ 540- 580	5/ 325- 375	5/ 315- 360
Western Europe	6/ 835- 875	5/ 380- 420	6/ 400- 440
Japan	6/ 825- 865	5/ 355- 395	5/ 355- 395
			6/ 430- 470

1/ 450-600,000 metric tons per year capacity plant.
2/ 600-650,000 metric tons per year capacity plant.
3/ 400-450,000 metric tons per year capacity plant.
4/ Ethane feedstock.
5/ Methane feedstock.
6/ Naphtha feedstock; may be greater than 100 percent of net production costs because byproduct credits are not included.

These data are not forecasts but rather indicators of possible advantages for CERN's in production costs. These cost advantages may also be reflected in lower manufacturing costs for derivatives made from ethylene, methanol, and ammonia. The advantages may be greater than indicated, for in market economies, a return on investment must be added to the net production cost to obtain a transfer price; facilities in nonmarket economies or those otherwise owned or controlled by governments may not require a return on investment, and ethylene, methanol, or ammonia may be transferred to derivative plants at cost.

If feedstocks and energy were to be made available at no cost to facilities located in areas where feedstock and energy prices were government-controlled, the net production costs would be even lower than those previously cited. The price advantage of the products from such facilities, relative to U.S. or other developed nations' facilities, would also be greater. Price and profit are most important in market economies but may be superseded in other nations by other items of national priority. Cognizant of such practices, certain nations in the free world are reportedly giving special tax consideration to ethane, administering naphtha prices, and exempting imports from certain taxes. 1/

Advantages Associated With a Petrochemical Industry

The advantages associated with the development of a petrochemical industry in the 1980's are rarely only economic. Aside from the financial benefits, social, educational, and nationalistic values all tend to be strengthened during periods of rapid industrial growth, such as that associated with the petrochemical development in CERN's. 2/

1/ "Uncertainty Hits Several Major Canadian Petrochemical Projects," ECN Petrochemicals '82 Supplement, Dec. 20, 1982, p. 10.
2/ "The Ambitions of the Rich," The Economist, Nov. 21, 1981, pp. 9-41; "Slaking the Saudis Thirst," The Economist, Feb. 6, 1982, pp. 76-77; and "Move Over," Forbes, Apr. 12, 1982, pp. 81-90.

There is a natural tendency for a country as a whole to experience a sense of national pride when it becomes a force in the world marketplace. This is especially true when the commodities involved are as ubiquitous and universally incorporated into virtually all manufactures as petrochemicals. All major fields of manufacture today require some form of petrochemical product for such diverse purposes as packaging, lightweighting various transportation vehicles, fertilizing farmland to improve the quantity and quality of yields, and improving certain qualities of textile materials. 1/

Petrochemical industry development also creates rapid technological advancement. In many cases technology borrowed from developed nations is used, along with the employment of foreign personnel for the managerial and science-oriented positions. The local citizenry often acquires both social and educational benefits from this arrangement; the host nations recognize the importance of educating their citizens and may begin emphasizing this value to the populace. In addition, governments may mandate a certain percentage of local employment, thus allowing the people to receive on-the-job training. 2/

Domestic Petrochemical Self-Sufficiency

The most immediate advantage to CERN's beginning production of petrochemicals such as ethylene, methanol, ammonia, and their downstream products is the relief from dependence on imports. This may also be reflected in an improved balance of trade and less need for foreign currencies to pay for the imports.

Many of the developing nations now in the process of establishing domestic petrochemical industries, either through government-owned corporations, private domestic firms, or joint ventures, are looking toward efficient, low-production-cost, world-scale facilities coupled with the production advantages of energy and feedstock prices below world levels and assured availability to allow them to compete effectively with traditional petrochemical producers in both their domestic and world markets. For example, Mexico's petrochemical corporation, PEMEX, had 72 plants on-stream in 1982, producing 38 different products. 3/ However, only 40 percent of the domestic demand for petrochemicals was met by this production. Imports continued to dominate the Mexican market and create negative trade balances. The future plans of PEMEX lean heavily toward development of increased capacities for fertilizer and certain plastics such as high-density polyethylene (HDPE), low-density polyethylene (LDPE), and polypropylene. Such expansion is expected to make Mexico increasingly self-sufficient in these petrochemical products, and to provide the base for future exports. The expansion plans that are now in place are also expected to generate revenues for the Mexican Government that could enable it to finance projects to upgrade the transportation systems and the infrastructure presently in place. 4/

1/ Ibid.

2/ Ibid.

3/ "The Mexican Report," Oil & Gas Journal, Aug. 30, 1982, p. 112.

4/ Jose Lopez Portillo, Fourth State of the Nation Report, Sept. 1, 1982, p. 3.

A different situation exists in Kuwait, a nation which already has a high standard of living, mainly derived from petroleum export revenues. Kuwait has had two major petrochemical facilities operating since the mid-1960's. These two plants produce ammonia and urea, which are used either directly as fertilizers or in the manufacture of fertilizers. Because Kuwait's domestic consumption is negligible, most of the fertilizer is exported, mainly to other developing countries. As shown in more detail in a later section, the goals of Kuwait's petrochemical expansion plans are different from those of Mexico.

Other significant trade advantages can be related to eligibility for membership in the General Agreement on Tariffs and Trade (GATT); 1/ members are generally granted most-favored-nation status in all trade with other member nations. Membership is the GATT depends upon the agreement of a nation to abide by a complex series of codes developed over a period of 30 years. 2/ Among the obligations assumed by a nation before it can become a member of the GATT is the submission of its tariff and trade laws to the body of the GATT for approval. 3/ The self-sufficiency of a nation in a major product field such as petrochemicals enables that nation to become less dependent upon high tariff rates and nontariff barriers (e.g. licensing requirements) thus allowing trade practices which conform to the GATT codes. The willingness of a developing nation to operate within the GATT, which is intended to promote lessened trade barriers between nations, is often taken as the first step toward full membership. 4/ Of the CERN's, the following are full members of the GATT: Australia, Canada, Gabon, Indonesia, Nigeria, and Norway. Algeria, Iran, Iraq, and Mexico participated in the Tokyo round of trade negotiations although they are not members. Mexico still maintains relatively high tariffs and various nontariff barriers for many commodities in an effort to attain a favorable balance of trade and protect the domestic industry.

Petrochemical Exports Vis-a-Vis Energy Exports

On two occasions during the 1970's, supplies of petroleum to certain parts of the world were disrupted. During these periods, prices of energy materials including gasoline and chemical feedstocks greatly increased. As a direct result of these supply disruptions and increases in price, the trend toward continuous increases in consumption of such products as gasoline, home heating oil, and other direct refinery products of petroleum have been sharply curtailed. Conservation methods in the United States range from a national

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1/ John M. Jackson, "The Birth of the GATT-MTN System: A Constitutional Appraisal," Law and Policy in International Business, vol. 12, No. 1, 1980, p. 60.

2/ General Agreement on Tariffs and Trade, art. 1, opened for signature on Oct. 30, 1947, 61 Stat. A3, T.I.A.S. No. 1700, 55 U.N.T.S. 187.

3/ The current version of the GATT is contained in 4 General Agreements on Tariffs and Trade, Basic Instruments and Selected Documents, 1969.

4/ John M. Jackson, "The Birth of the GATT-MTN System: A Constitutional Appraisal," Law and Policy in International Business, vol. 12, No. 1, 1980, p. 60.

highway speed limit to tax incentives for home insulation, and all have contributed at least partially toward the elimination of energy waste. 1/

The result of these conservation measures has been a decrease in the amount of crude petroleum imports needed to satisfy energy requirements in the United States. Many other developed countries are also exhibiting the same trend. As can be seen in table 7, imports of crude petroleum have been decreasing in these developed nations since 1979.

Table 7.--Crude petroleum: Imports by selected developed countries, 1978-82

Country	1978	1979	1980	1981	1982
	1,000 barrels per day				
United States	6,356	6,519	5,220	4,406	3,308
Canada 1/	621	616	557	521	2/ 366
Japan	4,662	4,846	4,373	3,919	3/ 3,657
Western Europe:					
France	2,302	2,520	2,182	1,804	3/ 1,511
Italy	2,212	2,292	1,860	1,816	2/ 1,690
United Kingdom	1,309	1,157	893	736	2/ 594
West Germany	1,913	2,147	1,953	1,591	1,448

1/ Although Canada is rich in natural gas, it remains a net importer of crude petroleum.
2/ Average based on data from January 1982 through September 1982.
3/ Average based on data from January 1982 through November 1982.

Source: International Energy Review, Feb. 22, 1983, pp. 8-10.

Other Advantages

Development of allied industries

Chemicals such as ethylene, ammonia, methanol, and the derivatives of these items are used in such frequency and in so many different and varied petrochemical products that it would be impossible to completely describe all of their applications, and because of the ubiquitous nature of petrochemicals, a great number of other industries which use them in some manner are attracted to the new industrial regions. This results in new investment, employment opportunities, and perhaps, more favorable balances of trade because of decreased imports or increased exports.

One major downstream chemical industry which many of the CERN's committed themselves to developing is the plastics industry. Saudi Arabia currently plans to have production capacity for LDPE and HDPE on-stream in four

1/ "The Leverage of Lower Oil Prices," Business Week, Mar. 22, 1982, pp. 66-68.

different locations along the Persian Gulf and the Red Sea by 1985. 1/ Mexico currently has a plastics industry which produces LDPE and HDPE and has plans to bring more LDPE capacity on-stream in the near future. There are approximately 50 small Mexican producers of other synthetic resins and 300 firms which convert the resins to final products. 2/

Other nations also have followed a similar pattern of development; the natural tendency is for industries which use the material produced by existing plants to locate nearby in an effort to take advantage of lower costs for raw materials. 3/ In addition to plastics, petrochemicals are used in such diverse final consumer products such as tires and tubes, synthetic detergents and shampoos, and herbicides, pesticides, and fertilizers. The growth of these industries in turn influences the growth of many other industries which are needed to support the infrastructure and the population which inevitably develop around the industrial centers.

In order to speed the development of other industries in the newly industrialized regions of the CERN's, incentives are often offered. The financing for these incentives may sometimes be derived from the revenues received from energy and feedstock exports. For example, Mexico is able to offer a 30-percent discount on feedstocks and electrical energy to privately-owned general manufacturing industries which elect to locate in a developing region. 4/ An implicit advantage to an industry planning to locate in such a region is the immediate availability of energy and the availability of petrochemical products such as plastics for such uses as packaging. These advantages can decrease the operating overhead and, together with government incentives, provide a significant cost advantage to a producer of consumer or industrial goods. Saudi Arabia offers production incentives through the Saudi Industrial Development Fund (SIDF) in order to promote private industrial development. Loans have been extended to such diverse firms as those engaged in the production of cement, foodstuffs, chemicals 5/, furniture, and electrical appliances. 6/ All of these industries benefit in some degree from the proximity of plants producing petrochemicals.

Education

Another natural outgrowth of a developing industry's locating in a previously undeveloped nation is the rapid increase in the proportion of managerial and technical manpower in the population compared with the situation before the development. Although at first much of the white-collar employment will be limited to those imported professionals associated with the nation or the multinational corporation participating in the development, eventually local personnel are expected to be trained to manage the plants through increased educational opportunities as well as on-the-job experience.

1/ "Move Over," Forbes, Apr. 12, 1982, p. 84.

2/ Made in Mexico, Vol. VI, No. 4, p. 34.

3/ Costs for transportation, and storage could be almost completely eliminated.

4/ "Mexican Petrochemicals: The Big Buildup," Chemical Week, May 27, 1981, pp. 30-34.

5/ Chemicals other than petrochemicals, such as inorganics.

6/ "Move Over," Forbes, Apr. 12, 1982, p. 84.

The educational programs instituted by governments of the developing nations not only benefit the prospective industry employee, but also affect the entire population. An example is the stress put on the development of a system for rapidly educating a population, which is needed in a developing society such as may be found in Saudi Arabia. Students in the Saudi educational program receive incentives such as free housing and reduced costs for educational materials and food, as well as significant stipends. 1/

Infrastructure

Other favorable consequences related to the development of a petrochemical industry include the government emphasis placed upon the construction of a modern infrastructure. Development of transportation, communications, and utilities becomes almost a necessity before world-scale petrochemical plants can come on-stream. The transportation of the feedstocks, however short the distance between the fields and the petrochemical plants, involves complex equipment such as pipelines, meters, and gauges. Transportation of the products via railcar or truck to the domestic markets or to industrial consumers depends upon modern highway and rail systems. Modern communications networks allow for instant transmittal of data; modern utilities supply the plants with necessary energy without interruption.

At the present time, many of the CERN's are supporting the organized growth of their infrastructures, mandating that private consumers, as well as industrial consumers, will have access to the benefits. The Saudis are providing electrical service to villages by means of a $20 billion gas-gathering system before the same system is used to provide power to the petrochemical plants. 2/

Another major project of many of the nations which will be exporting manufactured products for the first time on a world-scale basis is the construction of port facilities which could handle the ships necessary to economically transport the goods. Mexico, for example, expects to increase its shipping capacity, but the planned industrial port system is not expected to be completed before the year 2000. 3/ Qatar, whose port facilities are presently adequate, has plans to add several berths in the expectation of the need for more space in the next decade. 4/

Methods of Entry Into the World Petrochemical Market

The advantages afforded to the developing petrochemical industries in such locations as Canada, Mexico, and OPEC member nations, are expected by chemical industry analysts 5/ to possibly generate an impact on U.S. export

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1/ Ibid.

2/ Ibid., p. 87.

3/ "New Shipyards Will Enable Mexico To Haul Its Own Goods," R. & D. in Mexico, July 24, 1982, pp. 21-25.

4/ U.S. Department of Commerce, Marketing in Qatar, August 1981.

5/ Myron T. Foveaux, legislative representative for international trade and economic policy at the Chemical Manufacturers Association and Paul A. Cook, manager of chemical services at the Houston office of Data Resources Inc.

markets. 1/ These analysts predict that by the late 1980's, the present export market for many large-volume chemicals produced in the United States from natural gas, as well as their derivatives, may be smaller. Under certain circumstances, the United States could become a net importer of certain petrochemicals of which it is currently a net exporter. U.S. exports of chemicals such as ethylene decreased slightly between 1980 and 1981, but may be expected to hold their market share through 1985. 2/ After 1985, additional world-scale plants based on inexpensive feedstocks are expected to come on-stream and possibly have a greater impact on the U.S. chemicals industry, opinions as to the extent of effect vary among analysts.

However, other analysts feel that the entry into the world market for new producers of petrochemicals may occur by a different system, possibly through the countertrade, or barter, system. One barter system currently operating within the U.S. chemical industry involves ammonia/fertilizers, and phosphate/sulfur. 3/

Other industry sources feel confident that little or no market disruption related to new petrochemical capacity will occur. They feel that a shift in production patterns along with a traditional entrance into the market will provide new stability to the world petrochemical market.

Traditional Entry

The possibility that there will be absolutely no change in the structure of the world chemicals industry is believed by many analysts to be remote. 4/ A minimum amount of discomfort to the U.S. industry would occur if the plants that come on-stream between now and 1990 enter the market through a traditional method of entry. The materials which are to be marketed by a traditional method of entry, either the primary petrochemical or a derivative, would be produced and sold in response to an increase in the demand for that item.

In order to market their products without disrupting the present supply situation, the amount of material which the developing countries add to the world supply should not exceed the increase in world demand. In this scenario, the emphasis of the nations bringing new capacity on-stream would not be primarily on the export and capture of foreign market share, but on

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1/ "U.S. Chemicals Exports Face Sharp Decline," Chemical & Engineering News, May 24, 1982, pp. 21-22.

2/ Ibid.

3/ "Countertrade in Chemicals," Chemical & Engineering News, Aug. 14, 1978, pp. 32-44, and U.S. International Trade Commission, Analysis of Recent Trends in U.S. Countertrade, USITC Publication 1237, March 1982, p. vi.

4/ Myron T. Foveaux, legislative representative for international trade and economic policy at the Chemical Manufacturers Association, Paul A. Cook, manager of chemical services at the Houston office of Data Resources Inc. and Anantha K.S. Raman, Managing Director, First Boston Corporation; See also "U.S. Chemical Exports Face Sharp Decline," Chemical & Engineering News, May 24, 1982, pp. 21-22, and "Coping with Structural Change," Chemical Purchasing, July 1982, pp. 42-60.

first meeting the needs of their own populations. Mexico is an example of a nation with a number of petrochemical plants already on-stream and a negative balance of trade remaining in many of the chemicals produced locally. 1/ One of the major industrial development project areas currently emphasized by PEMEX is the plastics industry, particularly HDPE and LDPE. This emphasis is specifically designed, at least initially, to replace imported materials and to supply the increasing demand of the Mexican population.

In Saudi Arabia, recent projections of the Saudi Arabian Basic Industries Corporation (SABIC) indicate a faster growing domestic demand than originally anticipated. Therefore, the Saudi's new plans for the orderly marketing of their products include lower estimates of planned production possibly moving to the United States and other developed nations. 2/ If such additional exports were marketed without incentives, the impact on the U.S. and other world petrochemical industries could be minimized.

Other sources of new petrochemical capacity involve traditional petrochemical producers which have established joint ventures in CERN's. These projects are often established to take advantage of the energy and feedstock cost advantages. It is judged unlikely, except possibly under intense market competition, that U.S. firms or those in other traditional petrochemical-producing-nations involved in such joint ventures at home or abroad would seek to do other than to minimize the impact of these ventures on their home markets.

In the first 5 months of 1982, U.S. imports of crude petroleum declined to an average of approximately 2.8 million barrels per day compared with more than 6.5 million barrels per day in 1979. The U.S. Strategic Petroleum Reserve, which was established by Congress in 1975, contained 260 million barrels in 1982 compared with 91 million barrels in 1979. 3/

The emphasis on the study and production of petrochemicals by many of the CERN's may in part be the result of their attempt to replace their anticipated loss of revenue from the export of crude petroleum with revenue from the export of petrochemicals. The recent crude petroleum oversupply has caused the prices of crude petroleum to stabilize, and in some instances in the spot market, to decline. 4/ During 1981 and 1982 the price of light crude petroleum from Saudi Arabia varied by more than 25 percent, declining at one time to approximately $29 per barrel. 5/ During 1982, OPEC member nations produced about 18 million barrels per day of crude petroleum at an average price slightly less than $34 per barrel, incurring an current account deficit of approximately $14 billion. 6/ OPEC production of crude petroleum in early 1983 was estimated to have declined to 13.9 million barrels per day 7/ with

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1/ "The Mexican Report," Oil & Gas Journal, Aug. 30, 1982, p. 112.

2/ "Local Markets To Grow for Saudi Products," European Chemical News, June 7, 1982, p. 4.

3/ "OPEC's Threat to Use 'Oil Weapon' Again Causes Scant Concern in Industrial West," Washington Post, June 21, 1982, p. A2.

4/ Ibid.

5/ "The Mexican Report," Oil & Gas Journal, Aug. 30, 1982, p. 112.

6/ "Fear and Loathing in London," The Economist, Mar. 12, 1983, p. 68.

7/ "OPEC Cuts Oil to $29, Sets Production Quotas," Washington Post, Mar. 15, 1983, p. A-1.

spot market prices reported to be between $26.50 and $28 per barrel. 1/ On March 14, 1983, ministers from OPEC member nations announced an agreement to rearrange their individual production quotas and lower their official price of crude petroleum from $34 per barrel to $29 per barrel in an effort to maintain their share of the world crude petroleum market. The old and new crude petroleum production quotas are listed in the following tabulation (in millions of barrels per day) 2/:

Country	Old quota	New quota
Saudi Arabia-----------	7.65	1/ 5.0
Iran-------------------	1.2	2.4
Iraq-------------------	1.2	1.2
Kuwait-----------------	.8	1.05
United Arab Emirates---	1.0	1.1
Qatar------------------	.3	.3
Algeria----------------	.65	.725
Libya------------------	.75	1.1
Nigeria----------------	1.3	1.3
Venezuela--------------	1.5	1.675
Indonesia--------------	1.3	1.3
Gabon------------------	.15	.15
Ecuador----------------	.2	.2
Total--------------	18.0	17.5

1/ Saudi Arabia was designated as a "swing producer." If all other OPEC member nations produce a total of less than 12.5 million barrels per day, Saudi Arabia may produce a volume greater than their allocated share of 5.0 million barrels per day without exceeding the OPEC production limit.

Each barrel of crude petroleum could conceivably be increased in value if it and/or the natural gas associated with its production were to be used to manufacture petrochemicals which could then be exported. Total export revenues could be more nearly maintained if all natural gas, particularly that which is flared, is used to make petrochemicals for export.

Another mechanism, used by some OPEC nations, which may increase crude petroleum exports, is the granting of the rights to purchase certain quantities of crude petroleum (entitlements) to those firms which become involved in their petrochemical projects. Saudi Arabia has been reported to have granted crude petroleum entitlements to certain foreign companies which choose to invest in Saudi's petrochemical ventures. 3/ In return, the foreign investors are expected to provide technological and/or marketing assistance to the Saudis, and in many cases a certain amount of capital. Many of the favorable decisions of multinational petrochemical and petroleum corporations regarding investments in joint ventures with government-sponsored corporations

1/ "Anxious Gulf," Washington Post, Mar. 15, 1983, p. A-1.
2/ "OPEC Cuts Oil to $29, Sets Production Quotas," Washington Post, Mar. 15, 1983, p. A-1.
3/ "U.S. Petrochemical Firms Face Big Threat From New Plants in Cheap Energy Areas," Wall Street Journal, Feb. 17, 1982, p. 48.

in petroleum-rich nations reflect the desires of these firms to assure their supply of crude petroleum and petrochemicals, such as ethylene and methanol, for use as feedstocks for their own manufacture of specialty chemicals in other traditional locations. One U.S. chemical company is reported to have received a 1 billion barrel crude petroleum entitlement for its role in the construction and operation of an ethylene complex. Another U.S. firm is reported to have received entitlements totaling approximately 100,000 barrels of crude petroleum per day for its role in a complex which produces a variety of basic petrochemicals. 1/

Another drain on crude petroleum export revenues for the CERN's may result from the efforts of most developed countries to supplement their crude petroleum consumption with nontraditional alternative energy sources. Although several synthetic fuels projects were postponed during 1982, the threat of petroleum disruptions and shortages recurring in the future will continually spur some level of research into such energy sources as coal gasification and liquefaction, solar energy, wind power, geothermal energy, and energy from biomass. A new oil shale development program is currently being discussed as a joint venture between several large U.S. corporations with Federal Government assistance; lower crude petroleum prices make alternate energy source development less attractive. 2/ Development of an economical method for production and use of energy through any one of these alternate energy pathways could mean the end to petroleum dependence. Therefore, the creation of a petrochemical industry in the CERN's would serve as an assurance to them that if revenues from their crude petroleum exports may one day decrease or be unexpectedly curtailed, another use for the crude petroleum and associated natural gas will exist, along with a source of future income.

Dependence Upon Advantages

Various strategies exist for the entry into the international petrochemical marketplace aside from the traditional methods. Instead of responding to market forces, such as increased demand or oversupply, petrochemical producers in CERN's may rely upon the advantages inherent in the locations chosen for the plant development. These advantages are related to the proximity of the plants to the feedstock and energy sources and to the costs of the feedstock and energy materials to be used in the plants. They may allow the new petrochemical producers to price their products at a level below that of the traditional petrochemical producers located in the developed nations.

1/ "Move Over," Forbes, Apr. 12, 1982, pp. 81-99.
2/ "Mobil Assessing Interest in Shale Program," Oil & Gas Journal, Aug. 2, 1982.

Cost advantages

Possible cost advantages during 1985-90 for the petrochemical producers located in CERN's could result if the raw materials and feedstocks are made available at little or no cost. Other factors, such as low-interest loans, tax holidays, and export incentives, could also enhance the price advantage. 1/ Some industry analysts feel that the market entry of the new petrochemical producers may be based on this perceived price advantage. 2/ Their reasoning follows from the fact that the only major real cost of production will be the initial outlays for the construction and operating capital, as the energy and feedstock materials will probably be derived directly from the natural gas currently being flared and therefore, until used, of no real economic value. Other observers believe that at least part, if not most, of the perceived price advantage may be eroded by transportation, duty, and other costs associated with exports.

Add-ons

Another major advantage held, at least at present, by crude-petroleum-rich nations is the energy dependence of the developed nations upon the world's suppliers of crude petroleum. There have already been reports of plans for the linkage between the rights to purchase crude petroleum and mandatory purchases of the products of the new petrochemical facilities located in these nations, also known as add-ons. 3/ The mechanism of the linkage would, in theory, create a competitive arena in which developed nations would compete for the rights to purchase crude petroleum by bidding for larger quantities of the petrochemicals produced by the crude-petroleum-rich nations. In this scenario, domestic markets would be oversupplied with petrochemicals, and domestic production would be forced into a situation in which the price advantages and linkage policies of the new producers could allow them to become a significant market force. Industry analysts in the United States have stated that they feel that the domestic chemical firms should respond by increasing their focus on industry segments wherein they have a competitive advantage, such as specialty chemicals, and avoid direct price competition with imports. 4/ Other analysts differ in the forecasts for the period

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1/ Some observers believe that these factors may provide the bases for potential profits if feedstock and energy price advantages are used to offset higher construction costs, transportation changes, and duties. Tim B. Tarrillion, "Foreign Energy Factors Affecting the U.S. Petrochemical Industry," The Energy Bureau, September 1982, pp. 8-9.

2/ "U.S. Chemical Exports Face Sharp Decline," Chemical & Engineering News, May 24, 1982, pp. 21-23; "The World's Richest Jigsaw Slots Into Place," The Economist, Nov. 21, 1981, pp. 73-75; and "Chemical Industry Facing Structural Changes in 1980's; Market Analysts Eye Future," Chemical Marketing Reporter, May 17, 1982, pp. 3, 18-19.

3/ "Vast Saudi Gas Gathering System Moves into Final Phase," Oil & Gas Journal, Apr. 12, 1982, p. 76.

4/ Myron Foveaux in "U.S. Chemicals Exports Face Sharp Decline," Chemical & Engineering News, May 24, 1982, pp. 21-22.

1985-90, believing that the marketing and R. & D. experience of domestic firms will enable them to effectively compete with the new producers. 1/

Linkage

Other leverage which will serve to reinforce the strength of petrochemical industries in the CERN's includes the linkage of the prices of their petrochemical feedstock exports to their prices for crude petroleum. 2/ Producers in certain petrochemical-producing developed areas of the world, particularly Europe and Japan, depend to a great extent upon naphtha, a petroleum derivative, for their petrochemical production. The hoped-for diversification into the use of liquefied petroleum gas (LPG) feedstock imported from the new petrochemical-producing nations would give these producers a cost flexibility and a release from the dependence upon the petroleum-based feedstock. However, this hoped-for flexibility would be curtailed by a feedstock price linkage policy. 3/

Alliances

Organized groupings of developing petrochemical nations already in existence, such as OPEC, may exert significant influence concerning the method of entry of member nations into the petrochemical market. As the current crude petroleum marketing structure and price are negotiated among ministers of the participating nations, the same procedures could conceivably be followed for petrochemicals. This cartel-like structure could only have an effect if a significant amount of world capacity were involved, or if petrochemical purchases were to be linked to other commodities such as crude petroleum or LPG.

Counter-purchase

A method of entry into world chemical markets that is growing in popularity is countertrade. A recent report stated that--

> the industry sector experiencing the most demand for countertrade, particularly compensation agreements, is the chemical sector. [At the present time] these demands are found especially in West European and U.S. export markets of Eastern Europe and Latin America where most countries are encouraging the development and growth of their own chemical industry. Several oil-producing countries are supplying or are proposing to offer oil in exchange for plant, machinery, and training for the production of petrochemicals. Nonmarket economies have been rapidly

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1/ Anantha K. S. Raman, "Review and Forecast--Coping With Structural Change," Proceedings of the CMRA Meeting, May 10-13, 1982, p. 5.
2/ "European Firms Criticize Saudi LPG Crude-Linking Propsal," European Chemical News, Oct. 11, 1982, p. 15.
3/ Ibid.

> establishing their own chemical industries since the mid-1960's, using countertrade mechanisms to finance the chemical technology imports. 1/

One of the most popular forms of countertrade found in the petrochemical industry involves what are known as "buy-back" compensation agreements. Arrangements of this nature entail--

> the sale of plant, equipment, and/or technology by one party to another party and payment for such sales in the form of products resulting from the plant, equipment, and/or technology. These types of arrangements frequently involve the sale of a "turnkey" facility and specify that payment will consist of output of the plant once it becomes operational. 2/

Transactions involving buy-back compensation are often characterized in the following manner.

- o The value of the individual transaction is much higher than in any other form of countertrade, often measuring in the hundreds of millions of dollars.
- o The period of product take-back is relatively long, usually 5 to 20 years.
- o The value of product take-back during the contract period usually equals the value of the plant, technology, and/or equipment (minus the initial hard-currency down payment), plus an amount to cover interest expense during the period of take-back.

Developing nations engage in countertrade in order to assure that international payments will be balanced and that reserves of foreign exchange are preserved. 3/ These agreements also guarantee access to markets which may not be available through conventional methods. 4/ For example, a petrochemical facility could be designed and built by foreign interests with low-cost financing from the local government, and, when operational, have access to low-cost energy and feedstock materials. In return, the foreign interest guarantees that a certain percentage of the output (or in some cases a fixed quantity) will be bought back with a specified profit for the local interests.

National corporations

National corporations may be involved to a significant degree in the marketing of new petrochemical production. As detailed in the later sections, these corporations, with the full support of their governments, often exert

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1/ U.S. International Trade Commission, Analysis of Recent Trends in U.S. Countertrade, USITC Publication 1237, March 1982, pp. 16-17.
2/ Ibid, p. 5.
3/ Ibid.
4/ "Countertrade in Chemicals," Chemical & Engineering News, Aug. 14, 1978, pp. 32-44.

control over the production, sale, and marketing of petrochemicals, crude petroleum, and other energy materials. These corporations may pursue other than economic goals and use market tactics that make it difficult for private companies to compete.

CURRENT AND ANTICIPATED PETROCHEMICAL INDUSTRY EXPANSION IN THE CONVENTIONAL-ENERGY-RICH NATIONS

The nations to be separately discussed, Saudi Arabia, Indonesia, Kuwait, Canada, Mexico, and the nonmarket economies, have an advantageous position, not only in terms of crude petroleum and natural gas, but also the infrastructure necessary to develop world-scale petrochemical industries by 1990. Data available for these nations may differ. Although there are many other nations which have petrochemical production plans, it is unknown whether they could become world-scale producers by 1990; some of these nations are discussed together in the following sections.

For example, the nations of Australia, New Zealand, Argentina, and Brazil have plans for the construction of petrochemical complexes based on current and anticipated discoveries of natural gas. However, industry sources believe it is unlikely that these nations could become world-scale petrochemical producers within this decade. 1/

In September 1981, the British Government abandoned its plans for an integrated North Sea natural gas gathering system, after Norway announced its decision to build its own system instead of one in conjunction with the United Kingdom. The United Kingdom's offshore natural gas-gathering network was to have collected 11 trillion cubic feet of natural gas, and cost an estimated $5 billion to construct. The gas-gathering network was to have delivered approximately 2 million metric tons per year of ethane which was to have provided the basis for a massive expansion of ethylene production in the United Kingdom. 2/

As a result of the overcapacity of petrochemical production in Western Europe and the high costs of feedstocks, the United Kingdom reduced the number of petrochemical plants to be constructed from 14 announced in 1978 to 7 announced in 1981. 3/ At the same time, Norway had planned to construct one petrochemical plant in 1978, but cancelled the project in 1981. 4/

The association of South East Asian Nations (ASEAN) of Thailand, the Philippines, Malaysia, and Singapore are increasing their domestic consumption of petrochemicals and have petrochemical expansion plans based on domestically available hydrocarbon reserves. As of January 1, 1983, Thailand, the Philippines, and Malaysia had estimated proved reserves of crude petroleum and natural gas, as follows: 5/

Country	Crude petroleum (million barrels)	Natural gas (billion cubic feet)
Thailand----------	103	11,000
Philippines-------	36	16
Malaysia----------	3,325	34,000

1/ "World Petrochemicals: What's Ahead and Where?" Chemical Engineering, Mar. 8, 1982, pp. 48-49.
2/ "Petrochemicals-'81 Supplement," European Chemical News, Dec. 14, 1981, p. 24.
3/ "Worldwide Report," Oil & Gas Journal, Dec. 27, 1982, p. 78.
4/ "Picture Brightens for Petrochemicals," Oil & Gas Journal, Mar. 29, 1982, p. 82.
5/ "Worldwide Report," Oil & Gas Journal, Dec. 27, 1982, p. 78.

Thailand and Malaysia have petrochemical expansion plans which emphasize the production of olefins and olefin derivatives based on natural gas. 1/ The Government of Thailand is in the process of constructing a 73,000 metric tons per year LDPE plant to use imported ethylene which could come on-stream by late 1983 and a 150,000 metric tons per year ethylene plant which could come on-stream by 1987. Thailand also has development plans for ammonia and methanol facilities. The Philippines has plans for a 250,000 metric tons per year ethylene complex expected on-stream by 1987. 2/

Singapore, with no domestic hydrocarbon reserves, announced its intention in the early 1970's to produce petrochemicals. Singapore's proposed petrochemical complex, which is expected to be based on a mixture of naphtha and LPG, includes a 300,000 metric tons per year ethylene plant which could come on-stream by 1984. 3/

While these four ASEAN nations currently lack some of the infrastructure necessary for a world-scale petrochemical industry, they are strategically located on the primary shipping lanes between the Middle East and Japan. Although many of these petrochemical expansion plans are being initiated by state-owned companies, some of these nations have formed, or could be looking toward forming joint ventures with large multinational companies in order to have access to technology, training, and marketing expertise which are needed to enter the world petrochemical markets. 4/

Organization of Petroleum Exporting Countries

OPEC was founded in 1960 by Iran, Iraq, Kuwait, Saudi Arabia, and Venezuela in order to permit the crude petroleum-exporting nations to present a unified front in their dealings with the major international petroleum companies. 5/ The need for this collective strength arose from the major petroleum companies unilaterally cutting the "posted prices" for Middle East crude petroleum in 1959 and again in 1960. 6/ The first goal of OPEC was to restore the posted prices to their pre-August 1960 levels with the ultimate objective of controlling both the supply and the pricing of its members' petroleum. 7/ In so doing, OPEC endeavored to bring a degree of stability and predictability to the "posted prices" which were very important in determining

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1/ "World Petrochemicals: What's Ahead and Where," Chemical Engineering, Mar. 8, 1982, pp. 48-49.

2/ Chem Systems "The Impact of Petrochemical Developments in Southeast Asia on Global Planning," presented before American Chemical Society's Chemical Marketing and Economics Group, February 1982.

3/ Ibid.

4/ "Developing Nation's Petrochemical Role Debated," Chemical and Engineering News, July 20, 1981, p. 20.

5/ Richard F. Nyrop, ed., Iran: A Country Study, Washington, D. C., 3rd ed., 1978, p. 446.

6/ Kenneth W. Clarfield, et al, Eight Mineral Cartels: The New Challenge to Industrialized Nations, New York, 1975, p. 9.

7/ James P. Roscow, 800 Miles to Valdez: The Building of the Alaska Pipeline, Englewood Cliffs, N.J., 1977, p. 50.

the level of income of Middle East petroleum-producing countries. 1/ By the end of 1975 OPEC had reached its current 13-member status with the addition of Algeria, Ecuador, Gabon, Indonesia, Libya, Nigeria, Qatar, and the United Arab Emirates (UAE). 2/

Following the June 1967 war, another petroleum-exporting organization, Organization of Arab Petroleum Exporting Countries (OAPEC), was formed. The founding members of OAPEC. Kuwait, Libya, and Saudi Arabia, are also member of OPEC. 3/ The other OPEC members of OAPEC are: Algeria, Iraq, Qatar, and the UAE; Bahrain, Egypt, and Syria are the non-OPEC members. 4/ The economic objectives of OAPEC include the promotion of Arab interests and cooperation in the world and the encouragment of joint ventures among the member nations. 5/ OAPEC differs from OPEC in that it is a political organization which is dedicated to using its petroleum as a leverage with the West to encourage Israel to comply with certain United Nations resolutions. 6/ For example, OAPEC members agreed to either reduce or eliminate petroleum exports to those countries which failed to support the Arab viewpoint during the Arab's hostilities with Israel in the fall of 1973. 7/ The embargo was eventually discontinued. The creation of OAPEC satisfied the demands of some of the more radical Arab nations, which long had been displeased with the attitude of OPEC on this issue. 8/

Many of the OPEC nations have developed, or are in the process of developing, petrochemical industries to utilize natural gas, which was previously flared, as well as diversify their exports. Saudi Arabia, Indonesia, and Kuwait, discussed individually later in this section, have the most advanced petrochemical industry development plans and are likely to be world-scale producers by 1990.

Algeria, Ecuador, Iran, Iraq, Libya, Nigeria, Qatar, the United Arab Emirates, and Venezuela have plans for new or expanded petrochemical production. 9/ Industry sources report that Gabon has no petrochemical industry but may become a marginal petrochemical producer; as such, it would be unable to satisfy Gabon's domestic demand for most products, thus making the export of significant quantities of petrochemicals improbable. 10/

1/ Marwan Iskandar, The Arab Oil Question, 2nd ed., 1974, p. 9.
2/ Richard F. Nyrop, et al., Area Handbook for the Persian Gulf States, Washington, D. C., 1st ed., 1977, p. 84.
3/ Marwan Iskandar, The Arab Oil Question, 2nd ed., 1974, p. 13.
4/ U.S. Central Intelligence Agency, Internatinal Energy Statistical Review, May 25, 1982, p. 4. The non-OPEC members of OAPEC will be covered separately in this report if their petrochemical industry warrants it.
5/ Richard F. Nyrop, et al., Area Handbook for the Persian Gulf States, Washington, D.C., 1st ed., 1977, p. 90.
6/ Wilbur Crane Eveland, Ropes of Sand: America's Future in the Middle East, New York, 1980, p. 346.
7/ Trade, Inflation and Ethics: Critical Choices for Americans, Lexington, Mass., vol. V, 1976, pp. 203 and 204.
8/ Joe Stork, Middle East Oil and the Energy Crisis, New York, 1975, pp. 143 and 144.
9/ "Chemical Boom in the Middle East Oilfields," Manufacturing Chemist, January 1982, p. 15.
10/ This is based on information developed during fieldwork.

Industry sources believe it is highly unlikely that Gabon could find it economical to plan, design, and construct world-scale petrochemical facilities and the necessary infrastructure by 1990.

The other members of OPEC, Algeria, Ecuador, Iran, Iraq, Libya, Nigeria, Qatar, Venezuela, and the United Arab Emirates, have the natural resources necessary for the development of world-scale petrochemical industries but lack much of the necessary infrastructure and markets to support world-scale petrochemical plants despite the large revenues associated with their production and exports of crude petroleum. Although these nations have development plans for petrochemical industries, it is unlikely that they could be world-scale producers by 1990. It is their intention, nonetheless, to eventually develop petrochemical industries in an effort to decrease dependence on crude petroleum exports as their main source of income, as well as to serve such social goals as providing skills for the domestic labor force.

The estimated proved reserves of crude petroleum and natural gas for these nations are as follows: 1/

Country	Estimated proved reserves, as of Jan. 1, 1983	
	Crude petroleum	Natural gas
	Million barrels	Billion cubic feet
Algeria	9,440	111,250
Ecuador	1,400	4,100
Iran	55,308	482,600
Iraq	41,000	28,800
Libya	21,500	21,500
Nigeria	16,750	32,400
Qatar	3,425	62,000
United Arab Emirates	32,176	23,250
Venezuela	21,500	54,079

By the mid-1980's, Algeria hopes to increase its production of ammonia from 1 million metric tons per year in 1980 to 2 million metric tons per year by 1985. Algeria also has plans for about 26,000 metric tons per year of urea capacity which could come on-stream by 1985. 2/

A petrochemical complex, currently under construction in Ecuador, could come on-stream by 1985. The complex could have annual capacities of 140,000 metric tons of ethylene, 366,000 metric tons of ammonia, and 545,000 metric tons of urea. 3/

1/ "Worldwide Report," Oil & Gas Journal, Dec. 27, 1982, pp. 79-80.
2/ "Arab Industrialization," Financial Times, Dec. 17, 1981, p. v.
3/ "Petrochemicals," Oil & Gas Journal, Oct. 25, 1982, p. 118.

Iran and Iraq are not covered separately in this report since the war between the two nations is likely to result in the postponement of the startup dates for Iran's and Iraq's petrochemical complexes until the 1990's. Many of the existing petrochemical facilities, as well as the construction sites for facilities have been severly damaged by the war. 1/

Iran's petrochemical production expansion plans include 300,000 metric tons per year of ethylene capacity which was projected to come on-stream by 1987. 2/ This complex, when completed could also include capacities for the production of aromatics, cyclic intermediates, and fertilizers. 3/

Iraq's petrochemical expansion plans include 160,000 metric tons per year of ethylene capacity which could come on-stream by 1984. 4/ Iraq's petrochemical plans also call for ammonia capacity of 1.5 million metric tons per year and 2.5 million metric tons per year of urea which could come on-stream by 1987. 5/

In 1981, Libya had eight petrochemical projects under construction. 6/ These plants include annual capacity for the production of 1.6 million metric tons of ammonia and 2.3 million metric tons of urea, both of which could come on-stream by 1985, 7/ and 332,000 metric tons of ethylene which could come on-stream by 1984. 8/

Nigeria's petrochemical plants, which could come on-stream between 1985 and 1987, include annual capacity for 35,000 metric tons of polypropylene. 9/ Qatar's only announced petrochemical expansion is for 70,000 metric tons per year of HDPE which could come on-stream by 1984. 10/ The United Arab Emirates' expansion plans call for annual capacities of 366,000 metric tons of ammonia and 540,000 metric tons of urea, and could come on-stream by 1985. 11/ Venezuela's plans could include 60,000 metric tons of HDPE capacity to come on-stream by 1983. 12/

1/ "Chemical Boom in the Middle East Oilfields," Manufacturing Chemist, January 1982, p. 15.

2/ "Developing Nation's Petrochemical Role Debated," Chemical & Engineering News, July 20, 1981, p. 20.

3/ U.S. Department of Commerce, Iran: Country Market Sectional Study, October 1977, p. 49.

4/ "Developing Nation's Petrochemical Role Debated," Chemical & Engineering News, July 20, 1981, p. 20.

5/ "Picture Brightens for Petrochemicals," Oil & Gas Journal, Mar. 29, 1982, p. 82.

6/ Ibid.

7/ "Arab Industrialization," Financial Times, Dec. 17, 1981, p. v.

8/ European Chemical News, Sept. 7, 1981, p. 35; OAPEC: Organization of Arab Petroleum Exporting Countries, vol. 8, No. 1, January 1982, pp. 9 and 10; Journal of Commerce, Sept. 9, 1981, p. 14a; Chemical Engineering, May 3, 1982, pp. 30 and 33; also, "Petrochemicals," Middle East Construction, December 1981, pp. 57 and 58.

9/ "Petrochemicals," Oil & Gas Journal, Oct. 25, 1982, p. 124.

10/ Ibid., p. 125.

11/ Ibid., p. 115.

12/ Ibid., p. 131.

SAUDI ARABIA

Background

The Kingdom of Saudi Arabia, with an area of 830,000 square miles, occupies about 80 percent of the Arabian peninsula; 1/ the Arabian peninsula is about the size of the United States east of the Mississippi river. 2/ The population in 1982 was estimated at 10 million of which more than 1.6 million were foreign workers. 3/ Saudi Arabia is largely a desert country with a hot and humid fertile area that fringes the east coast; a cooler and drier climate is found in the mountainous regions of the west and south 4/ Saudi Arabia's natural resources include large deposits of crude petroleum containing associated natural gas. Viable deposits of several minerals, including gold, have been found. There are also reports of uranium deposits. The per capita income in 1980 was $9,500. 5/

Current petrochemical industry status

Market.--In 1980, Saudi Arabia's per capita consumption of plastics was 15 pounds 6/ compared with 107 pounds in the United States. 7/ These data indicate a good growth potential for plastics; similar potentials probably exist for other petrochemicals.

Domestic demand for petrochemicals used in the production of finished products increased from 50,000 tons in 1975 to 300,000 tons in 1980. 8/ A major portion of Saudi's domestic demand for chemicals has been satisfied by imports. Although domestic demand for petrochemicals is currently low, it is anticipated to increase rapidly as products become more readily available from domestic production. The development of local markets for petrochemical products such as paints, detergents, and pharmaceuticals is within the purview of the private sector.

Domestic petrochemical feedstocks in the mid-1980's could cost less and be more available than imported petrochemicals, and should supplant most, if not all, imported feedstock. Saudi planners hope this development may trigger a self-perpetuating industrial diversification by providing a secure supply of low-priced raw materials.

1/ The Europa Yearbook 1982: A World Survey, London, vol. II, p. 1319.
2/ U.S. Department of State, Background notes-Saudi Arabia, September 1979, p. 1.
3/ U.S. Central Intelligence Agency, The World Factbook-1982, April 1982, p. 204.
4/ Economic Handbook of the World: 1981, New York, 1981, p. 380.
5/ U.S. Central Intelligence Agency, The World Factbook-1982, April 1982, p. 205.
6/ "The Middle East and Africa: The New Frontier," Materieiv, Plastiche Ed Elastomeir, September 1981, pp. 470-471.
7/ U.S. data estimated by staff from readily available official sources.
8/ U.S. Department of Commerce, "Market Survey: Saudi Arabia's Petroleum, Gas, Petrochemical, and Chemical Equipment and Products Market," International Marketing Events, p. 15.

In 1981, approximately 100 privately owned chemical plants were in operation in Saudi Arabia. These plants rely primarily on imported raw materials which are used to produce finished products such as plastics, paints, and pharmaceuticals, for domestic consumption.

In 1981, 20 plastics-producing factories consumed 80,000 tons of imported raw materials that were used in the manufacture of polyvinyl chloride (PVC). One of these factories, a producer of PVC pipe, produced 22,000 tons of pipe and fittings in 1978 for domestic consumption.

Industry.--SABIC is the state-owned corporation responsible for establishing capital-intensive basic industry projects (other than in the petroleum industry). In the mid-1970's, SABIC launched a world-scale hydrocarbon-based industrialization plan in an effort to make the nation less dependent on crude petroleum as a source of revenue. 1/ SABIC placed the greatest emphasis on the development of a world-scale petrochemical industry based on natural gas most of which had previously been flared at the well-head. 2/

The development of a petrochemical industry was also intended to provide the Saudi with technical and managerial skills, and to create domestic private sector investment opportunities. With the crude petroleum industry in Government hands, there had been few other opportunities for private sector industrial investment. It was thought that completion of a petrochemical industry could result in private investment in secondary and support industries which need not be under Government control. Also, emphasis on training in each petrochemical venture should ensure the creation of a skilled domestic labor force and reduce the need for expatriate labor. 3/

The Saudi strategy to promote petrochemical industrialization has five major elements: (1) selection of the latest and most energy- and capital-intensive technology; (2) large plants with substantial economies of scale; (3) initial concentration on primary petrochemical production rather than downstream or secondary products; (4) concentration on joint ventures between SABIC and foreign firms with recognized expertise and experience in petrochemical production and marketing; and (5) generous financing and incentives to encourage foreign participation and enhance economic viability. 4/

The Saudi Industrial Development Fund (SIDF) was established in 1974 to promote private sector participation in Saudi industry. This Government agency provides interest-free loans for industrial projects with more than 25 percent Saudi participation. 5/ These loans may cover up to 50 percent of project costs.

1/ U.S. Department of State, "Saudi Arabia's Emerging Petrochemical Industry--Implications for the West," airgram, Reference No. A-011, Oct. 31, 1982, p. 2.

2/ Ibid., p. 2-3.

3/ Ibid., p. 3.

4/ Ibid.

5/ The Europa Yearbook 1982: A World Survey, London, vol. II, 1982, p. 1332.

The Saudi Arabian Fertilizer Co. (SAFCO), an ammonia and urea fertilizer producer, was the first major nonpetroleum industrial company in Saudi Arabia. 1/ SAFCO was established in 1965 with 51 percent of its capital originally held by the General Petroleum and Minerals Organization (PETROMIN), a Government agency, and the balance owned by Saudi private investors. 2/ The plant was completed in 1969, and urea production began in 1970. Since 1970, SAFCO's annual production of urea increased, as follows:

Year 1/ 2/	Urea production (1,000 metric tons)
1970	17
1972	94
1974	197
1978	260
1979	299
1980	330
1981	340

1/ Production from 1970 to 1979 derived from Kingdom of Saudi Arabia Ministry of Planning, Third Development Plan: 1980-1985 A.D., Riyadh, June 19, 1980, p. 221.
2/ Production for 1980 and 1981 derived from Chimie Actualities, Jan. 29, 1982, p. 18.

In 1975, the control of SAFCO was transferred from PETROMIN to the Ministry of Industry and Electricity. In 1980, as part of the Government's policy to allow public participation in successful public sector industries, 10 percent of SAFCO's shares were sold to the corporation's Saudi employees.

Trade.--Saudi Arabia had positive trade balances of $17 billion in 1978, $72.5 billion in 1980, and $77.8 billion in 1981. 3/ During the same period, the balance of trade in chemicals was negative.

Imports.--Saudi Arabia's total value of imports increased from about $4 billion in 1974 to more than $28 billion in 1980; 4/ it increased further from $35.2 billion in 1981 to approximately $39.4 billion in 1982, or by 12 percent. Saudi's major import sources are the United States, which in 1981 accounted for 21 percent of total imports, and Japan with 18 percent. 5/

The value of Saudi's chemical imports increased from $647 million in 1978 to approximately $963 million in 1980. The United States accounted for 15 percent of Saudi's chemical imports during this period.

1/ U.S. Department of Commerce, International Marketing Events, p. 14.
2/ Kingdom of Saudi Arabia, Ministry of Planning, Third Development Plan: 1980-1985 A.D., Riyadh, June 19, 1980, p. 220.
3/ The Europa Yearbook 1982, vol. II, 1982, pp. 1324-1325, and U.S. Department of Commerce, "Saudi Arabia," Foreign Economic Trends and Their Implications for the United States, FET: 82-005, January 1982, p. 2.
4/ The Europa Yearbook 1982, vol. II, 1982, p. 1324.
5/ U.S. Department of Commerce, "Saudi Arabia: Market Expands Despite Reduced Oil Production," Business America, Aug. 9, 1982, p. 30.

The following tabulation shows the value of Saudi Arabia's imports from the United States for selected chemical products in 1979 and 1980: 1/

Products	Imports in 1979 (million dollars)	Imports in 1980 (million dollars)
Plastic materials and resins	17.1	41.1
Agricultural chemicals	.6	1.8
Industrial organic chemicals	20.2	30.2
Paints and varnishes	16.2	24.3
Cosmetics and toiletries	21.6	23.6
Total	75.7	121.0

The Saudi Government generally does not emphasize import restrictions or protective tariffs for petrochemicals, and hopes to encourage the development of a strong private sector. The Government aids local industry through "Buy Saudi" programs. As part of this program, the Commerce Ministry requires foreign contractors and consultants to sign documents which commit them to purchase locally produced goods before turning to imports. 2/

Exports.--Crude and refined petroleum as well as natural gas liquids are Saudi Arabia's primary exports. 3/ Revenues derived from these exports, which dominate the Saudi economy, increased from $33 billion in 1974 to $101 billion in 1980. 4/ In 1981 export revenues were $113 billion, 5/ but sharply decreased to about $70 billion in 1982. Saudi's major markets for petroleum are the United States, Western Europe, and Japan. 6/ Petrochemical exports from Saudi Arabia were not significant during 1982.

Energy base

Petroleum.--Saudi Arabia had estimated proved reserves of crude petroleum of 162.4 billion barrels, or about 24 percent of the world's total, as of January 1, 1983. 7/ As of this date, Saudi also has proved reserves of 3 billion barrels in the neutral zone which is shared equally by Saudi Arabia and Kuwait.

In 1982, Saudi Arabia's 555 producing wells had a combined output of approximately 6.5 million barrels per day, representing a 32-percent decrease from the 1981 production of approximately 9.6 million barrels per day. 8/

1/ U.S. Department of Commerce, International Marketing Events, p. 20.

2/ U.S. Department of Commerce, "Saudi Arabia: Market Expands Despite Reduced Oil Production," Business America, Aug. 9, 1982, p. 31.

3/ Economic Handbook of the World: 1981, New York, 1981, p. 382.

4/ The Europa Yearbook 1982, vol. II, p. 1324.

5/ U.S. Department of Commerce, Foreign Economic Trends and Their Implications for the United States, FET: 82-005, January 1982, p. 2.

6/ U.S. Central Intelligence Agency, The World Factbook-1982, April 1982, p. 205.

7/ "Worldwide Report," Oil & Gas Journal, Dec. 28, 1981, p. 86.

8/ Ibid.

In April 1982, Saudi Arabia imposed a 7 million barrels per day production ceiling on crude petroleum in response to OPEC's desire to maintain a price of approximately $34 per barrel in the world market. 1/ In early 1983, Saudi Arabia imposed a production ceiling of 5 million barrels per day at a price of $29 per barrel in order to maintain OPEC's share of the world crude petroleum market. 2/ Recent economic conditions in the industrialized nations of the world, coupled with increases in conservation by these nations, were the primary reasons for the recent oversupply of crude petroleum on the world market. 3/

Saudi Arabia has effective crude petroleum production capacity of 10 million barrels per day, 4/ and Saudi Arabia's three crude petroleum refineries have a combined capacity to process 705,000 barrels per day. 5/ Construction of new refineries, valued at $10 billion, should increase the amounts of crude petroleum processed. This could result in sufficient products being produced to satisfy domestic demand as well as increase Saudi's potential to export refined products.

In 1981, Saudi Arabia's domestic consumption of crude petroleum was estimated at 585,000 barrels per day, or 6 percent of total crude petroleum production. In 1980 it was 535,000 barrels per day. 6/ Most of the crude petroleum consumed domestically has been refined into fuel or feedstocks. Petroleum supplies about 70 percent of Saudi Arabia's total energy demand. 7/

Saudi Arabia exported more than 3 billion barrels of crude petroleum in both 1980 and 1981. The principal market for Saudi Arabia's petroleum exports in 1981 was Western Europe which accounted for approximately 36 percent of Saudi Arabia's total exports. The United States accounted for about 11 percent, and Japan, 15 percent of Saudi Arabia's total petroleum exports in 1981. 8/

Natural gas.--Saudi Arabia's estimated proved reserves of natural gas were 117 trillion cubic feet, as of January 1, 1983. 9/ Most of Saudi's natural gas is associated with crude petroleum. Between 500 and 600 million cubic feet of natural gas is usually produced with each one million barrels of crude petroleum. 10/

Natural gas was flared at the wellheads prior to the completion of the first phase of a vast natural gas gathering system which could collect about

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1/ "Economy Vulnerable to Shifts in Oil Market," Financial Times, Apr. 26, 1982, p. II.
2/ "OPEC Cuts Oil to $29, Sets Production Quotas," Washington Post, Mar. 15, 1983, p. A-1.
3/ "Worldwide Report," Oil & Gas Journal, Dec. 27, 1982, p. 78.
4/ U.S. Central Intelligence Agency, The World Factbook-1982, p. 20.
5/ "Worldwide Report," Oil & Gas Journal, Dec. 27, 1982, p. 78.
6/ U.S. Central Intelligence Agency, The World Factbook-1982, p. 4.
7/ The British Petroleum Co., BP Statistical Review of World Energy, 1981, p. 8.
8/ U.S. Central Intelligence Agency, The World Factbook-1982, p. 4.
9/ "Worldwide Report," Oil & Gas Journal, Dec. 27, 1982, p. 78.
10/ U.S. Department of Commerce, International Marketing Events, p. 4.

3 billion cubic feet per day of associated natural gas. 1/ The methane and ethane now derived from the collected natural gas is expected to be used primarily as fuel and petrochemical feedstock. 2/ Saudi Arabia's natural gas production was 515 billion cubic feet in 1981 and in 1980, 3/ representing a 36-percent increase from 415 billion cubic feet in 1979. 4/ These natural gas production figures are for marketed production only; vented, flared, or reinjected natural gas is excluded.

A 730-mile cross-country natural gas liquids (NGL's) pipeline from the Abqaig and Ghawar petroleum fields in the Eastern Province to Yanbu on the West Coast has recently been completed. This pipeline, which is 26 to 30 inches in diameter, should be able to provide 270,000 barrels per day of NGL for use in the new petrochemical complexes at Yanbu. 5/

Other energy sources.--Saudi Arabia has no known reserves of coal and only negligible known reserves of uranium ore. Like most other nations of the world, however, Saudi Arabia is considering the use of nuclear power as an alternative source of energy in the future.

Another alternative energy source being considered by Saudi Arabia is solar energy, which because of its wide availability throughout the nation, could be used to provide electricity to remote villages. In 1977, a solar energy cooperative research program was established between the U.S. Department of Energy and the Saudi Arabian National Center for Science and Technology. As a result, a photovoltaic power system providing 50 kilowatts of power with expansion plans to 350 kilowatts could begin operations by 1985. 6/ Other solar energy projects include a heating system to provide space heat as well as telephone systems to remote villages which could begin operating by 1985. 7/

Petrochemical plans

Products.--The Saudi Arabian Government, in an effort to lessen its dependence on exports of crude petroleum as a source of revenue, has begun a program which, when completed, could supply approximately 5 percent of the world's demand for petrochemicals. 8/ The Saudi Arabian Government hopes that

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1/ "Vast Saudi Gas-Gathering System Moves Into Final Phase," Oil & Gas Journal, Apr. 12, 1982, p. 76.
2/ "First Phase of Vast Gas System Near Completion," Financial Times, Apr. 26, 1982, p. III.
3/ The British Petroleum Co., BP Statistical Review of World Energy, 1981, p. 10.
4/ U.S. Central Intelligence Agency, International Energy Statistical Review, May 25, 1982, p. 21.
5/ U.S. Department of Commerce, International Marketing Events, p. 8.
6/ Kingdom of Saudi Arabia, Ministry of Planning, Third Development Plan: 1980-1985 A.D.,p. 196.
7/ Ibid., p. 195.
8/ U.S. Department of State, Saudi Arabia's Emerging Petrochemical Industry--Implications for the West, airgram, Reference No. A-011, Oct. 31, 1982, p. 1.

the expansion into petrochemicals could increase the value of their natural resources and provide opportunities for the development of a skilled Saudi labor force. 1/

The Government of Saudi Arabia has entered into joint ventures with some of the world's largest petroleum and chemical companies in order to produce and market petrochemicals. The major petrochemical projects are expected to be based on natural gas which would otherwise be flared. 2/ The raw material feedstocks for these projects are expected to be readily available at a substantial cost advantage when compared with world-scale petrochemical plants located in the traditional petrochemical producing nations. 3/

According to the managing director of SABIC, there could be an economic advantage inherent in locating new petrochemical centers close to the source of the raw material. The petrochemical facilities are being built in the industrial areas of Jubail and Yanbu, where infrastructure such as utilities, housing, offices, telecommunications, and port facilities are also being completed. 4/

The majority of Saudi Arabia's major petrochemical projects are reportedly on schedule. A methanol and fertilizer project is scheduled to come on-stream in early 1983. Projects involving production of ethylene derivatives are scheduled to come on-stream in 1985 and 1986. 5/

Table 8 shows Saudi Arabia's planned petrochemical projects, capacities, and estimated startup dates.

1/ "Move Over," Forbes, Apr. 12, 1982, p. 81.

2/ "Comparative Economics of Basic Industries in the Arabian Gulf Region," OAPEC Bulletin, July 1981, pp. 5, 6.

3/ U.S. Department of State, Saudi Arabia's Emerging Petrochemical Industry, airgram, Reference No. A-011, Oct. 31, 1982.

4/ Mr. Abdulaziz al-Zamil, Vice Chairman and Managing Director of SABIC, Middle East Economic Survey, Feb. 8, 1982, p. 2.

5/ "Saudi Arabia Will Press For Low Tariff Chemicals Access to Europe," European Chemical News, Oct. 4, 1982, p. 8.

Table 8.--Saudi Arabia's planned petrochemical projects, capacity, and estimated startup dates

Firm	Foreign partner	Petrochemical and projected capacity	Estimated startup date
		1000 metric tons per year	
Saudi Methanol Co.	A Japanese consortium.	Methanol------600	May 1983
Al-Jubail Fertilizer Co. (SAMAD)	A Taiwan company.	Urea----------500 Ammonia-------300	May 1983
Saudi Yanbu Petrochemical Co. (YANPET)	A major U.S. petroleum company.	Ethylene------450 Ethylene Glycol------220 LDPE-----------200 HDPE------------90	January-March 1985
Al-Jubail Petrochemical Co. (KEMYA)	A second major U.S. petroleum company.	Linear low-density polyethylene (LLDPE)-----260	January-March 1985
Saudi Petrochemical Co. (SADAF)	A third major U.S. petroleum company.	Ethylene------656 Styrene-------295 Ethylene dichloride--456 Industrial Ethanol-----281	January-March 1985
National Methanol Co.	Two major U.S. chemical companies.	Methanol------650	January-March 1985
Arabian Petrochemical Co. (PETROKEMYA) 1/	A major multinational chemical company.	Ethylene------500 LDPE-----------80 HDPE------------70	April-June 1985
Eastern Petrochemical Co. (SHARQ)	A Japanese consortium.	Ethylene Glycol------300 LDPE----------130	April-June 1985

1/ The foreign partner has withdrawn from this project. The fate of the LDPE plant is, as of January 1983 unknown; however, the ethylene plant is expected to be completed.

Source: U.S. Department of State, Saudi Arabia's Emerging Petrochemical Industry--Implication for the West, airgram, Reference No. A-011, Oct. 31, 1982 p. 14; "Saudi Chemicals Make up for Lost Time," Chemical Week, May 19, 1982, pp. 24-27; "Dow Chemical to Drop Project in Saudi Arabia," Wall Street Journal, p. 4; "Dow Withdrawing from Ventures with SABIC, INA," Oil & Gas Journal, Dec. 6, 1982, pp. 114-116.

The $350 million joint-venture fertilizer plant, which is being built in Jubail on the East Coast, could produce 500,000 metric tons per year of urea and 300,000 metric tons per year of ammonia, and could come on-stream by 1983. 1/ Another Jubail joint-venture project scheduled to begin production in 1983 is a 600,000 metric tons per year methanol plant estimated to cost $300 million. 2/ A second methanol joint-venture plant with a 650,000 metric tons per year capacity is also expected to come on-stream at Jubail in 1985 at an estimated cost of $400 million. 3/

Also under construction in Jubail is a 656,000 metric tons per year joint-venture ethylene complex which is expected to produce 295,000 metric tons per year of styrene, 456,000 metric tons per year of ethylene dichloride, and 281,000 metric tons per year of industrial ethanol, at a cost of $3.0 billion. A joint-venture plant producing 260,000 metric tons per year of linear low-density polyethylene (LLDPE) with an estimated cost of $1.3 billion could come on-stream in 1985 or 1986. 4/ Also under construction is a joint-venture complex which could produce 300,000 metric tons per year of ethylene glycol and 130,000 metric tons per year of LDPE. Saudi Arabia's petrochemical expansion plans include a joint venture ethylene complex being built in Yanbu with a 450,000 metric tons per year capacity. The plant is also expected to produce 220,000 metric tons per year of ethylene glycol, 200,000 metric tons per year of LDPE, and 90,000 metric tons per year HDPE. The estimated cost of this joint venture is $1.6 billion. Industry sources estimate that Saudi petrochemicals could represent about 5 percent of total world capacity in 1985.

A summary of the planned petrochemical capacity with on-stream target dates between 1983-90 is shown in the following tabulation: 5/

Product	Capacity (1,000 metric tons)
Ethylene	1,606
Methanol	1,250
LDPE and LLDPE	670
Ethylene glycol	520
HDPE	160
Industrial ethanol	281
Urea	500
Ammonia	300
Styrene	295
Ethylene dichloride	456

1/ "Vast Saudi Gas-Gathering System Moves Into Final Phase," Oil & Gas Journal, Apr. 12, 1982, p. 78, and U.S. Department of Commerce, "Market Survey, Saudi Arabia's Petroleum, Gas, Petrochemical Equipment and Products Market," International Marketing Events, p. 13.

2/ Ibid.

3/ Ibid.

4/ "Saudi Chemicals Make Up For Lost Time," Chemical Week, May 19, 1982, p. 24, and U.S. Department of Commerce, "Market Survey, Saudi Arabia's Petroleum, Gas, Petrochemical Equipment and Products Market," International Marketing Events, pp. 12, 13.

5/ U.S. Department of State, Saudi Arabia's Emerging Petrochemical Industry, airgram, Reference No. A-011, Oct. 31, 1982, p. 5.

Potential projects under consideration which could come on-stream by 1988 to 1990 are as follows: (1) a plant manufacturing vinyl chloride monomer (VCM) and PVC with a capacity of 100,000 to 200,000 metric tons per year using locally produced ethylene dichloride; (2) a 300,000 to 500,000 metric tons per year methyl tertiary butyl ether (MTBE) plant using locally produced methyl alcohol and butane; (3) a polystyrene plant with a capacity to produce about 95,000 metric tons per year; and (4) a formaldehyde plant with a possible capacity of 100,000 metric tons per year. 1/ These plants may be joint ventures with European, Japanese, and U.S. firms. 2/ It is unlikely that crude petroleum entitlements would be offered foreign partners in any of these potential petrochemical ventures, but the other incentives such as low interest loans and low-cost raw materials, could be available. 3/

According to SABIC, the projected market distribution for petrochemical production from plants expected on-stream by 1990 could be 10 percent for local consumption, 20 percent destined for the United States, 22 percent for Europe, 20 percent for Japan, and 28 percent for the rest of the world. 4/ The methanol and fertilizer production could enter the world market by 1983 and production from the ethylene projects as early as 1985.

The Saudi joint-venture agreements are structured so that the foreign partner is usually involved in the marketing of the petrochemicals produced; the foreign partner generally supplies the technology and management as well as the marketing expertise. According to SABIC, one of the principal criteria for selecting foreign partners was the size of their global marketing networks. 5/ Some industry experts think SABIC may not be able to market products beyond what the foreign partners market or captively use. SABIC concedes that its lack of marketing expertise could be a problem but insists that it will sell only at market prices. 6/

Saudi Arabia's entry into world petrochemical markets may be orderly if the rationalization process which is underway in Europe and Japan continues to a logical conclusion. 7/ In the rationalization process petrochemical plants which are not world-scale and/or are obsolete technologically are closed. Whereas Saudi petrochemicals capacity would represent only about 3 to 5 percent of total world capacity in 1985-86, they could impact and affect markets in various areas of the world differently. 8/

1/ "Saudi Arabia Will Press For Low Tariff Chemicals Access to Europe," European Chemical News, Oct. 4, 1982, p. 8., and U.S. Department of State, Saudi Arabia's Emerging Petrochemical Industry, airgram, Reference No. A-011, Oct. 31, 1982, pp. 11-12.

2/ Ibid.

3/ "Saudi Chemicals Make Up For Lost Time," Chemical Week, May 19, 1982, p. 27.

4/ Mr. Abdulaziz al-Zamil, Middle East Economic Survey, Feb. 8, 1982, p. 4.

5/ "War Fails To Stop Mideast Buildup," Chemical Week, Nov. 5, 1980, p. 46.

6/ Ibid.

7/ Mr. Abdulaziz al-Zamil, op. cit., p. 3.

8/ "Saudi Arabia Will Press For Low Tariff Chemicals Access To Europe," European Chemical News, Oct. 4, 1982, p. 8.

Potential industry status by 1990.--Saudi Arabia has announced projects for 6 million metric tons of petrochemical capacity which could come on-stream by 1985. If this scenario occurs, Saudi Arabia would be able to satisfy domestic demand and become an important exporter of petrochemicals. The following tabulation shows production capacity for Saudi Arabia for ethylene, ammonia, and methanol in 1980 and the base scenario for 1990:

Product	1980	1990	Percentage increase between 1980 and 1990
	----1,000 metric tons----		
Ethylene	205	1,606	683
Ammonia	300	600	100
Methanol	230	1,250	443

The increase in petrochemical capacity could impact the world market. Since domestic demand is limited, most of the excess petrochemical production could be exported. The following tabulation shows the data for ethylene, ammonia, and methanol expressed in shares of total world production in 1980 and the base scenario for 1990 (in percent):

Product	1980	1990
Ethylene	1/	2
Ammonia	1/	1/
Methanol	2	4
Total	2	6

1/ Less than 0.5 percent.

Saudi Arabia's petrochemical industry expansion plans are hinged upon revenues generated by the export of crude petroleum. As a result of the world's current oversupply, Saudi Arabia has decreased the production of crude petroleum. Also, the OPEC price of crude petroleum has decreased substantially, thus decreasing revenues derived from exports. Another factor which already has affected the petrochemical expansion plans is the withdrawal of a major U.S. chemical company from a Saudi joint venture. These factors could result in delays in the petrochemical industry expansion plans.

Goals.--Most of Saudi Arabia's petrochemical plans are closely associated with its other goals, including the general welfare of its citizens. Saudi Arabia's previous 5-year development plans have provided a basis for industrialization by improving infrastructure; this in turn should help assure the success of the petrochemical industry.

Infrastructure.--Saudi Arabia began to improve its infrastructure in the 1970's through its first and second 5-year development plans. These plans included the construction of roads, ports, a power system, and a telecommunications network. There are at least 20,000 kilometers of paved roads and 23,000 kilometers of rural roads in Saudi Arabia. Saudi hopes to increase the amount of paved roads by 33 percent, and by 1985, the entire road system by 75 percent. In 1982, Saudi opened the world's largest airport in Jeddah and hopes to complete a similar airport in Riyadh by 1985. Two new ports were opened in 1976 in Yanbu and Jeddah, and by 1985, the port system could be further expanded by 50 percent. 1/ Saudi Arabia also hopes to complete projects which would bring telecommunication networks, sewage facilities, and power services to the rural areas of the country.

Energy.--Saudi's extensive natural gas gathering system was designed to provide previously flared natural gas to the petrochemical complexes at Jubail and Yanbu. 2/ By utilizing the natural gas, Saudi hopes to lessen its dependence on crude petroleum as a source of revenue while increasing exports of petrochemicals.

Social needs.--Saudi's commitment to building a modern industrial economy also includes improving the living conditions of its people, particularly those in remote areas of the country. The Saudi 5-year development plans include social welfare programs and the training of people for employment in petrochemical plants and other industrial facilities in an attempt to reduce dependence on foreign labor. 3/ Expanded employment of local personnel should help Saudi to maintain stable political and social bases which should increase the attractiveness of investment in Saudi Arabia to both foreign and local interests.

Political framework.--Saudi Arabia has a monarchial form of Government based on Islamic tradition; therefore, strong ties exist between the Government, family, and economic well-being. In the development of its petrochemical industry, the Saudi Government invited foreign companies to form joint ventures with SABIC. Saudi authorities hope to gain operational, technical, and marketing experience from their foreign partners in the petrochemical industry in an effort to increase the role of domestic private firms in future industrial projects. It has been suggested that once Saudi gains this experience, future prospects for foreign investment could be reduced in favor of domestic participation. 4/

1/ "Saudi Arabia-Survey," The Economist, Feb. 13, 1982, p. 30.

2/ "Slaking the Saudi Thirst," The Economist, Feb. 6, 1982, pp. 76-77.

3/ U.S. Department of Commerce, Foreign Economic Trends and Their Implications for the United States, August 1981, p. 4, and U.S. Department of Commerce, Business America, June 28, 1982, p. 18.

4/ U.S. Department of State, "Saudi Arabia's Emerging Petrochemical Industry--Implications for the West," airgram, Reference No. A-011, Oct. 31, 1982, p. 12.

Indonesia

Background

Indonesia is an archipelago nation which lies along the equator and is composed of more than 13,600 islands, 6,000 of which are inhabited. Many of these islands are small, covering only a few acres. The nation covers an area of 735,000 square miles, which is slightly smaller than Alaska and California combined. Indonesia has a warm, tropical climate, averaging about 80°F in the lowlands. From December to March, monsoons cover Indonesia with a rainfall that ranges from 70 to 145 inches throughout most of the country; as a result, about 70 percent of the country is covered with tropical rain forest. 1/

Indonesia is the fifth most populous nation in the world with a population approaching 160 million. 2/ The average adult illiteracy rate in 1979 was about 35 percent. 3/ It has abundant, readily available, low-cost labor (about $40 per month). 4/ Indonesia is predominantly a farming nation with agriculture accounting for more than 30 percent of Indonesia's gross national product and employing about 60 percent of the labor force. 5/ The per capita income of Indonesia was $415 in 1981.

Current petrochemical industry status

Market.--The petrochemical market in Indonesia is limited in scope, mainly to basic products or essential items, since 30 to 50 percent of the Indonesian population lives below the poverty line and approximately 30 percent of the population is unemployed. 6/

The annual per capita consumption of nitrogen fertilizers in Indonesia increased about one-fourth to one-third from the mid-1970's through 1979-80. In 1975, per capita consumption of nitrogen fertilizers is estimated to have

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1/ "Amid Indonesia's Bounty, Much Poverty," The New York Times, International Economic Survey, sec. 12, Feb. 8, 1981, p. 44.

2/ U.S. Department of State, "Indonesia," Background notes, May 1981, p. 1; and the U.S. Department of Commerce, Statistical Abstract of the United States, 1981, 102d ed., 1981, pp. 868 and 870.

3/ The Europa Year Book 1982: A World Survey, London, vol. II, 1982, pp. 521 and 522.

4/ "Amid Indonesia's Bounty, Much Poverty," The New York Times: International Economic Survey, sec. 12, Feb. 8, 1981, p. 44.

5/ U.S. Department of State, "Indonesia," Background notes, p. 4.

6/ "Indonesia," Financial Times, Dec. 21, 1981, pp. I, II, and VI; and, "Amid Indonesia's Bounty Much Poverty," The New York Times, International Economic Survey, Feb. 8, 1981, p. 46; Nena Vreeland and others, Area Handbook for Indonesia, Washington, 3d ed., 1975, pp. 354-355; and, U.S. Department of Commerce, Indonesia: A Survey of U.S. Business Opportunities, May 1977, p. 49.

been less than 6 pounds and increased to about 8 pounds by 1979-80. 1/ Per capita consumption of nitrogen fertilizers in the United States, by contrast, increased from about 80 pounds to about 97 pounds during this period. 2/ The annual per capita consumption of the five major plastics 3/ in Indonesia has reportedly been between 1 and 4 pounds in recent years. 4/ In contrast, annual per capita consumption of these five key thermoplastic resins in the United States during 1980 was estimated to have been about 107 pounds.

During the early 1980's, the growth in the petrochemicals industry in Indonesia was primarily limited to increases in capacity for ammonia and urea, about 90 percent of which in recent years entered the domestic fertilizers market. The growth in demand for fertilizers was motivated by a desire to be self-sufficient in food production.

Industry.--The Government of Indonesia is actively engaged in the development of its basic petrochemical industry through Pertamina, the national oil company, but allows for private participation in the production of downstream products. Indonesia does not appear to have the fine line distinguishing between products that may be produced by the public and private sectors. During 1981-82, petrochemical production in Indonesia was limited to polypropylene resins, used to manufacture synthetic fiber and household goods, ammonia, and urea. 5/

Pertamina reportedly has two major goals for petrochemical production: (1) to ensure an adequate supply of domestic monomers, such as ethylene, in order to supply the raw materials for the local plastics and synthetic fibers market; and (2) to ensure that primary petrochemicals, such as the olefins and aromatics, are produced from domestic crude petroleum and natural gas. 6/

1/ United Nations, 1978 Statistical Yearbook, New York, 13th issue, 1979, pp. 302 and 664. Population statistics from several sources including U.S. Department of Commerce, Statistical Abstract of the United States, 1980, 101st ed., 1980, p. 898; and, U.S. Department of Commerce, Statistical Abstract of the United States, 1981, pp. 868 and 870.

2/ U.S. Department of Agriculture, Commercial Fertilizers: Consumption by Class for Year Ended June 30, 1981, Sp Cr 7(81), December 1981, p. 14; the population from U.S. Department of Commerce, Statistical Abstract of the United States, 1980, p. 6; and, from U.S. Department of Commerce, Statistical Abstract of the United States, 1981, p. 9.

3/ These leading plastics are the thermoplastic resins: high-density polyethylene, low-density polyethylene, polypropylene, polystyrene, and polyvinyl chloride.

4/ "World Plastics Capacity-The Buildup Continues," Chemical Engineering, Aug. 10, 1981, p. 49; also, a speech by Carl A. Steinbaum, V.P., Chem Systems, Tarrytown, N.Y., "The Impact of Petrochemical Developments in Southeast Asia on Global Training," presented before American Chemical Society's Chemical Marketing and Economics Group in New York, February 1982.

5/ "Indonesia." Financial Times, Dec. 21, 1981, p. VII.

6/ U.S. Department of Commerce, Indonesia: Survey of U.S. Business Opportunities, May 1977, pp. 46-47.

Since 1980, foreign firms have been restricted to, at most, 80 percent ownership and are required to have an Indonesian partner accounting for at least 20 percent ownership. 1/ The Indonesian Government encourages foreign investment in most industries; however, areas vital to the national defense, such as munitions, public welfare, harbors, electric power, and aviation are reserved for the Government. 2/ Foreign firms may participate in the petroleum and natural gas industry only under a production-sharing contract with Pertamina.

The Indonesian Government, in order to encourage foreign investment in its petrochemical industry, decided at the end of 1980 to commit $10 billion to increase Indonesia's output of liquefied natural gas (LNG) and to expand its fertilizer industry. Further, to facilitate development of a world-class petrochemical industry, Pertamina has recently entered a joint venture with private firms for the construction of a $1 billion olefins complex in North Sumatra. 3/ Foreign investment in the chemical industry for January-June 1981 amounted to $186 million, representing a 26-percent increase compared with the corresponding period of 1980. One reason for the increase in foreign investment in Indonesia is the potential for substantial after-tax profit which may be totally repatriated. 4/ Along with encouraging foreign investment, however, Indonesia is also attempting to increase the role of local groups in business. 5/ The Indonesian Government offers preference to local firms employing native Indonesians for Government contract work.

Both foreign and Indonesian firms participate in the production of downstream petrochemical products such as pharmaceuticals. The largest pharmaceutical producer is a Government-owned firm; the remaining 150 or more pharmaceutical producers are privately owned. 6/ Most of these private firms are owned, wholly or in part, by leading foreign pharmaceutical firms whose headquarters are located in Japan, the United States, or Western Europe. There is little original formulation done in Indonesia and most pharmaceutical firms import the products in bulk form and package them for the local market.

Indonesia also has a detergent and surfactant industry, as well as a paint and varnish industry. Most of the firms in these areas are also either wholly or partially owned by foreign concerns. Indonesia's plastics industry is limited, for the most part, to fabricating basic articles, such as film and sheet, from imported plastics materials.

1/ "A Pint of Blood? Or $20?," Forbes, Oct. 12, 1981, p. 96.

2/ U.S. Department of Commerce, A Survey of U.S. Business Opportunities, pp. 312 and 313.

3/ "Indonesia," Financial Times, Dec. 21, 1981, pp. VII and VIII; and "Oil and Chemicals Do Not Mix at Exxon," Chemical Marketing Reporter, Feb. 8, 1982, p. 14.

4/ "A Pint of Blood? Or $20?," Forbes, Oct. 12, 1981, p. 96.

5/ U.S. Department of Commerce, "Indonesia," World Trade Outlook for 64 Countries," OBR81-24, September 1981, p. 28; and, U.S. Department of State, American Embassy, Jakarta, Indonesia, Indonesia's Petroleum Sector: 1982, pp. 16 and 17.

6/ U.S. Department of Commerce, Indonesia: A Survey of U.S. Business Opportunities, pp. 44, 186, and 313.

From 1965 to 1979 total annual urea capacity in Indonesia increased from 100,000 metric tons to about 1.7 million metric tons, or at an average annual growth rate of about 22 percent. Indonesia's first fertilizer unit, a 100,000 metric tons per year urea plant located in Palembang, South Sumatra, was completed in 1963 and became operational in 1965. This plant received natural gas feedstock from the Pertamina gas fields located in Perabumulih, South Sumatra. 1/ Although this plant was able to satisfy domestic demand, it was not a world-scale plant. A second unit with annual capacities of 366,000 metric tons of ammonia and 382,000 metric tons of urea came on-stream at this same location in 1974. In 1977, yet another unit came on-stream in Palemburg, with annual capacities of 366,000 metric tons of ammonia and 590,000 metric tons of urea. A fourth urea plant, near Cikompek on Java, was completed in 1979 and has an ammonia capacity of 366,000 metric tons per year and a urea capacity of 590,000 metric tons per year, and utilizes natural gas from the offshore Arjuna field as its feedstock. 2/

Although not a world-scale producer, Indonesia has production capacity for polypropylene. The polypropylene plant, located at Pladju in South Sumatra, has a capacity of only 20,000 metric tons a year.

Trade.--Indonesia has duty rates on imported products ranging from free to 100 percent ad valorem, and are levied on the cost-insurance-freight (c.i.f.) valuation. 3/ In addition to duties, there are also import surcharges levied on some goods which range from 50 percent to 400 percent, with 100 percent being most common. 4/ Products are grouped into two lists for import purposes. The first list contains items which may be imported and provides duties ranging from free to 10 percent, 20 to 40 percent, 50 to 70 percent, and up to 100 percent, depending on whether an item is classified as most essential, essential, less essential, or luxury. The second list contains approximately 30 items which are banned from entry.

The import duties on certain large-volume plastics in basic forms, such as polyethylene and polyvinyl chloride, are generally either 10 percent or 30 percent, with such imports in block form at 60 percent. 5/ These high-volume plastics are also subject to import sales taxes of 5 percent and 10 percent, depending on the basic form.

1/ Based on information obtained from industry sources; Vreeland, and others, op. cit., p. 355; and from U.S. Department of Commerce, Indonesia: A Survey of U.S. Business Opportunities, pp. 42 and 43.

2/ "Kellogg Confirms Indonesian Contract," European Chemical News, Apr. 5, 1982, p. 26; and from the U.S. Department of Commerce, Indonesia: A Survey of U.S. Business Opportunities, p. 43.

3/ U.S. Department of Commerce, Indonesia: A Survey of U.S. Business Opportunities, pp. 297-299.

4/ Ibid., pp. 297-299.

5/ International Customs Tariffs Bureau, Douanes: Republic of Indonesia 1976-1977, Brussels, No. 63, 7th ed., pp. i, ii, iii, and 53; and, also 1st supplement to No. 63, 7th ed., pp. i, ii, 52, and 53.

Indonesia has established some trade impediments to either encourage or protect local operations. In addition, Indonesia has a prior imports deposit system and requires the use of Indonesian agents in selling to Government agencies. 1/

In 1982 Indonesia instituted a policy of counterpurchase for contracts in excess of $750,000, in order to bolster its foreign exchange which declined in 1982 because of falling crude petroleum revenues. 2/ The counterpurchase arrangement requires a firm selling products to Indonesia to agree to purchase an equivalent amount in terms of value of certain Indonesian goods. The Indonesian Government requires that the foreign firms not sell the counterpurchased goods in Third World markets. The list of counterpurchase goods does not currently include petrochemicals.

Imports.--Indonesia's total value of imports increased from about $5.7 billion in 1976 to about $17.8 billion in 1980-81. 3/ In recent years the industrialized nations have annually accounted for two-thirds of Indonesia's total imports. Japan has been the principal source of Indonesia's imports, accounting for 30 to 40 percent annually, followed by the United States, which accounts for about 12 to 14 percent annually. About 50 percent of Indonesia's imports have been raw material and food; about 25 percent or more have been plant and capital equipment.

The value of Indonesia's imports of chemicals increased from $619 million in 1977 to $1.0 billion in 1979, or by 55 percent. 4/ During 1977-79, chemicals represented an increasing share of Indonesia's imports, increasing from about 10 percent of the total value of imports in 1977 to about 14 percent of the total value of imports in 1979. Imports are purchased mainly with the revenues generated by the export of crude petroleum and natural gas. 5/

Exports.--Indonesia's exports (not including exports of crude petroleum) during January-September 1981 amounted to $3.1 billion, or 34 percent below the $4.6 billion exported during the corresponding period of 1980. As a result of this decline, in late 1981, Indonesia began a series of measures designed to encourage exports. These measures include elimination of

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1/ U.S. Department of Commerce, Indonesia: A Survey of U.S. Business Opportunities, pp. 297 and 298; Economic Handbook of the World: 1981, New York, 1981, pp. 202 and 203; and, U.S. Department of Commerce, World Trade Outlook for 64 Countries, OBR81-24, September 1981, p. 28.

2/ "Indonesian Tender Tries Counterpurchase," European Chemical News, Mar. 15, 1982, p. 13; U.S. Department of Commerce, "Indonesians Persist on Counter-Purchasing," incoming telegram, 04147, Mar. 17, 1982, p. 1; and, U.S. Department of Commerce, "Indonesia," Business America, Aug. 9, 1982, p. 41.

3/ International Monetary Fund, Direction of Trade Statistics: Yearbook 1981, Washington, 1981, pp. 206 and 207; and, Financial Times, Dec. 21, 1981, p. V. The latter statistic is for Indonesia's fiscal year which runs from Apr. 1 to Mar. 31.

4/ The Europa Yearbook 1982, vol. II, 1982, p. 531.

5/ U.S. Department of State, Background notes, p. 4; and, Financial Times, Dec. 21, 1981, pp. II and IV.

the requirement that foreign exchange received from exports must be surrendered to Bank Indonesia, expansion of export credit facilities, lowering interest rates on export credits, and institution of a system of export credit guarantees and export insurance. 1/ Indonesia is also attempting to increase its exports of value-added products, instead of raw materials.

Virtually all of Indonesia's petrochemical exports are fertilizers which are sold in nearby countries, such as India, Pakistan, Thailand, and Malaysia, in order to minimize transportation costs. 2/ Indonesian exports of nitrogenous fertilizers decreased from about 710 million pounds, valued at more than $34 million in 1977, to 508 million pounds, valued at nearly $35 million in 1980. 3/

Indonesia hopes to increase and diversify its petrochemicals export base in order to become less dependent on crude petroleum exports for its revenue. 4/ Petrochemical exports could permit Indonesia to maximize the economic utilization of the country's vast reserves of natural gas, which are forecast to last at least a quarter of a century after the depletion of Indonesia's crude petroleum reserves. 5/

Energy base

Petroleum.--Indonesia, with estimated proved reserves of crude petroleum of 9.6 billion barrels, as of January 1, 1983, represents approximately 2 percent of OPEC's estimated proved reserves of crude petroleum. 6/ Indonesia's estimated proved reserves were 9.8 billion barrels in 1981, and 10.5 billion barrels in 1980.

In 1982, Indonesia which accounted for about 45 percent of OPEC's population, accounted for about 7 percent of OPEC's crude petroleum production. Indonesia's production of crude petroleum in 1982 averaged approximately 1.3 million barrels per day 7/ and in 1981, approximately 1.2 million barrels per day. In early 1983, Indonesia's production ceiling remained at the 1982 level of 1.3 million barrels per day. 8/

1/ U.S. Department of Commerce, "Indonesia," Business America, July 26, 1982, p. 15; Financial Times, Dec. 21, 1981, p. V; and, "A Ban on Logs That Bothers Nobody," Business Week, May 3, 1982, p. 46.

2/ "World Petrochemicals: What's Ahead and Where?," Chemical Engineering, Mar. 8, 1982, p. 49; and, United Nations, 1980 Yearbook of International Trade Statistics, New York, vol. II, 1981, p. 1009.

3/ United Nations, 1980 Yearbook of International Trade Statistics, New York vol. 1, p. 481.

4/ Financial Times, Dec. 21, 1981, p. II and V.

5/ Ibid., p. IV.

6/ "Worldwide Report," Oil & Gas Journal, Dec. 27, 1982, p. 78.

7/ Ibid.

8/ "OPEC Cuts Oil to $29, Sets Production Quotas," Washington Post, Mar. 15, 1983, p. A-1.

Indonesia's domestic consumption of crude petroleum increased to approximately 450,000 barrels per day in 1981, representing an increase of 14 percent from 395,000 barrels per day in 1980. 1/ In recent years, domestic consumption of crude petroleum has climbed steadily at an annual rate of 13 to 15 percent. 2/ This increase in domestic consumption is in part attributed to the growth of domestic industries that are dependent on crude and refined petroleum for use as a feedstock and as a source of energy.

About 70 percent of Indonesia's income comes from petroleum exports; such exports account for about 65 percent of Indonesia's total value of exports. 3/ In recent years, Indonesia has accounted for between 4 and 5 percent of both the volume and the value of OPEC's exports of crude petroleum and petroleum products. 4/ Indonesia's exports of petroleum and LNG make up about 75 percent of Indonesia's total value of exports, and amounted to $16.4 billion in 1980-81, representing an increase of 45 percent from the $11.3 billion in 1979-80. 5/ Even though the export earnings have been increasing, the volume of crude petroleum exports declined in recent years. Exports of crude petroleum declined steadily from about 1.4 million barrels a day in 1977-78 to about 1.2 million barrels per day in 1981, or by about 14 percent. 6/ This decline is attributable to increasing domestic demand, a lull in exploration during 1977-80, conservation methods adopted by the industrialized world, and worldwide economic conditions.

Industry sources report that by 1990, the number of OPEC nations exporting petroleum could decline, either because of dwindling reserves or increasing domestic demand. Indonesia is one of the OPEC nations which by 1990 could be exporting less crude petroleum. Indonesia's exportable surplus of crude petroleum could start to decline by 1985, as domestic consumption continues to increase. By the mid-1990's, Indonesia could even become a net importer of crude petroleum. 7/

1/ U.S. Central Intelligence Agency, International Energy Statistical Review, Nov. 30, 1982, p. 4. The source reports that statistics includes domestic refined product consumption, refinery fuels and losses, and bunkers. Liquified petroleum gas consumption is excluded.

2/ "Indonesia," ASIA 1980 Yearbook, Hong Kong, 1980, p. 189; and, Financial Times, Dec. 18, 1981, p. IV.

3/ U.S. Department of State, Background notes, p. 4; Financial Times, Dec. 21, 1981, pp. I, IV, and VIII; U.S. Central Intelligence Agency, The World Factbook--1982, April 1982, p. 107; and, "Low Liftings Hold Lid on OPEC Crude Prices," Oil & Gas Journal, July 20, 1981, p. 20.

4/ "Low Liftings Hold Lid on OPEC Crude Prices," Oil & Gas Journal, July 20, 1981, p. 20; and, Petroleum, June 1981, p. 232.

5/ Financial Times, Dec. 21, 1981, p. V. This source, pp. IV and V, reports that liquid natural gas now accounts for about 14 percent of Indonesia's aggregated exports of crude petroleum and natural gas.

6/ U.S Central Intelligence Agency, International Energy Statistical Review, pp. 1 and 4.

7/ "Chance for Oil Price Shock in Mid-1980's Seen," Oil & Gas Journal, Jan. 4, 1982, p. 51; and, Financial Times, Dec. 21, 1981, pp. I and IV.

Natural gas.--Indonesia's estimated proved reserves of natural gas increased from 27.4 trillion cubic feet in 1981 to 29.6 trillion cubic feet as of January 1, 1983, but still represents nearly 3 percent of OPEC's estimated proved reserves. 1/ Estimated additional reserves of at least 20 trillion cubic feet are reported to exist in the newly discovered Natuna field. 2/ Only about 10 percent of Indonesia's land mass has been mapped for exploration in petroleum and natural gas. 3/

In 1980, Indonesia accounted for nearly 2 percent of the non-Communist world's production of natural gas. Indonesia's natural gas production has increased steadily from about 85 billion cubic feet in 1976, to 815 billion cubic feet in 1980, and further to 1,124 billion cubic feet in 1981. 4/ An industry source has forecast that by 1990, Indonesia could be the fourth largest producer of natural gas in the world, after Mexico, Algeria, and China. 5/

In an effort to decrease the amounts of natural gas flared, the Indonesian Government has stressed its increased utilization. In 1981, 80 percent of total natural gas production was utilized compared with 33 percent in the mid-1970's. 6/ Indonesia consumes very little natural gas as an energy source; the only major domestic use at present is in the production of urea and ammonia fertilizers. 7/

Indonesia has become a major exporter of LNG, with about 50 percent of these exports going to Japan. Industry sources project that by 1990, Indonesia could supply 33 percent of Japan's annual LNG requirements. Indonesia recently committed itself to long-term export obligations with both The Republic of Korea (Korea) and Japan. Indonesia reportedly has agreed to supply Korea with 73 billion pounds of LNG between 1985 and 2005, and Japan with 14.3 billion pounds annually between 1983 and 2003. 8/ Three LNG

1/ "Worldwide Report," Oil & Gas Journal, Dec. 27, 1982, pp. 78; and, "A Strange Situation is Growing Stranger," World Oil, Aug. 15, 1981, p. 64.

2/ Financial Times, Dec. 21, 1981, p. IV; and, Nena Vreeland, and others, op. cit. p. 353.

3/ The New York Times, Feb. 8, 1981, p. 44.

4/ U.S. Central Intelligence Agency, International Energy Statistical Review, p. 21. This source reports marketed production. It excludes gas vented, flared, or reinjected. Also from U.S. State Department, American Embassy, Indonesia's Petroleum Sector: 1982, Jakarta, Indonesia, June 1982, p. 41. This source reports total production.

5/ "The Utilization of Gas in Developing Countries: Summary and Conclusion," Chemical Economy & Engineering Review, November 1981, p. 17; "Japanese Market to Keep Top LNG Role," Oil & Gas Journal, July 21, 1980, p. 22; Journal of Commerce, Mar. 22, 1982, p. 13A; "Worldwide Gas Processing Grows in Plant's, Products, and Thoughput," Oil & Gas Journal, July 13, 1981, p. 70; and, Chemical Marketing Reporter, Aug. 17, 1981, p. 4.

6/ U.S. State Department, American Embassy, Indonesia's Petroleum Sector: 1982, Jakarta, Indonesia, June 1982, p. 41.

7/ U.S. Department of Commerce, Indonesia: A Survey of U.S. Business Opportunities, May 1977, p. 201.

8/ Chemical Marketing Reporter, Aug. 17, 1981, p. 4.

production units are now operational in Indonesia, and three more units, all dedicated to exports (two for Japan and one for Korea) could double LNG capacity by 1983. 1/

Indonesia's gross receipts from LNG exports rose from $1.2 billion in 1979 to $2.8 billion in 1980. 2/ Industry sources estimate that Indonesia could export 1.7 billion cubic feet of LNG per day by 1985, and 2.54 billion cubic feet per day by 1990.3/ It is reported that by 1990, LNG may replace crude petroleum as Indonesia's largest source of foreign exchange; a total of 18 LNG production units are projected to be operational by that time. 4/

Other energy sources.--Indonesia has about 2.9 billion metric tons of recoverable coal deposits, mainly on Sumatra and East Kalimantan. 5/ A state-owned firm has entered into a joint venture with United States and British firms to develop coal deposits in Kalimantan and Borneo. 6/

Coal production in Indonesia increased from about 166,000 metric tons in 1976 to about 276,000 metric tons in 1980, or by more than 66 percent, and could reach 2.2 million metric tons by 1985. 7/

At present, coal, geothermal, and hydroelectric energy account for less than 10 percent of the country's electricity-generating capacity of 2,700 megawatts (MW). 8/ Indonesia dedicated its first geothermal plant, with 30 MW capacity in 1982, and could expand this source to realize a potential of more than 10,000 MW from geothermal energy. In recent years, however, electricity has represented less than one-half of 1 percent of Indonesia's annual gross domestic product. 9/

1/ Financial Times, Dec. 21, 1981, p. IV; The Journal of Commerce, Mar. 22, 1982, p. 13A; and, U.S. Department of State, Background notes, p. 5.

2/ U.S. Department of Commerce, Business America, July 26, 1982, p. 12.

3/ "LNG Grows as World Energy Source," Hydrocarbon Processing, April 1980, p. 131; Financial Times, Dec. 21, 1981, p. IV; and, Oil & Gas Journal, July 21, 1980, p. 22.

4/ "Oil Is Seen Vital to Development of Economies of Southeast Asia," The Journal of Commerce, Mar. 22, 1982, p. 14A; The Europa Yearbook 1982: vol. II, 1982, p. 522; and, U.S. Department of State, American Embassy, Jakarta, Indonesia, Indonesia's Petroleum Sector: 1982, Jakarta, Indonesia, pp. 42, and 52 to 56.

5/ U.S. Department of Commerce, Indonesia: A Survey of U.S. Business Opportunities, pp. 187 and 188; and, Financial Times, Dec. 21, 1981, p. IV.

6/ Metal Bulletin, London, England, Aug. 11, 1981. p. 29.

7/ National Coal Association, International Coal: 1979, Washington, D.C., 1980, p. I-4; and, The Europa Yearbook 1982, vol. II, 1982, p. 526 and U.S. Department of Commerce, A Survey of Business Opportunities p. 187.

8/ Financial Times, December 1981, p. IV.

9/ United Nations, Yearbook of National Account Statistics, 1979, New York, vol. 1, 1980, pp. 576 and 577; and, U.S. Department of Commerce, Statistical Abstract of the United States, 1981, p. 586.

Petrochemical plans

Products.--Trade sources report that of all the ethylene projects planned by members of ASEAN, those of Indonesia may be the most feasible because of the magnitude of Indonesia's proved reserves of crude petroleum and natural gas. Certain industry sources believe that the Indonesian world-scale ethylene project is the only one of the ASEAN projects which could come on-stream during the 1980's. 1/

In 1981, approximately 30 to 50 percent of Indonesia's population lived below the poverty level; sources disagree as to whether the population could sustain a world-scale petrochemical industry. Some sources venture that even a modest increase in per capita income could lead to much of Indonesia's additional production from the planned petrochemical expansion being consumed domestically. 2/ Other sources believe that a substantial increase in domestic petrochemical consumption is unlikely, thus earmarking production from the additional petrochemical capacity for export. 3/ A third group believes that the increased production from the planned petrochemical expansion probably could be shared about evenly between the domestic market and exports. 4/

In 1981, there were five petrochemical projects either under construction or proposed in Indonesia. These projects include the petrochemical complex at Aceh, North Sumatra; the methanol unit on Bunyu Island; the urea resin and formaldehyde plant at Medan; and several fertilizer units located in Northern Sumatra and in East Kalimantan. 5/ Tables 9 shows Indonesia's planned petrochemical industry expansion.

1/ "Problems Threaten Asian Petrochem Survival," Oil and Gas Journal, Oct. 19, 1981, p. 130; and, speech by Mike Hyde, ed., Chemical Insight, "Petrochemicals Changing Perspectives," before the National Petroleum Refiners' Association, at the Seventh International Petrochemical Conference, San Antonio, Tex., Mar. 28-30, 1982.

2/ Based on information obtained during fieldwork and also from subsequent telephone calls for this study. Also from Financial Times, Dec. 21, 1981, pp. VII and VIII; Chemical Insight, 240: February 1982, p. 4; and, speech by Hyde, op. cit.

3/ Gustav F. Papanek, The Indonesian Economy, New York, 1980, pp. 383, 385; and The New York Times, Feb. 8, 1981, p. 44. Also obtained from industry sources during fieldwork and from subsequent telephone calls for this study.

4/ Speech by Steinbaum, op. cit., also based on information obtained during fieldwork and from subsequent telephone calls for this study. It is evident that there are quite divergent views on the markets for Indonesias new petrochemical capacity.

5/ "Picture Brightens for Petrochemicals," Oil & Gas Journal, Mar. 29, 1982, p. 82; and, "Petrochemicals," Oil & Gas Journal, Apr. 19, 1982, p. 153.

Table 9.--Indonesia's petrochemical industry expansion plans

Location	Product	Capacity	On-stream date
		1,000 metric tons	
Aceh, North Sumatra	Ethylene	300	1987
	LDPE	107	1987
	HDPE	59	1987
	Ethylene glycol	71	1987
	Ammonia	364	1984-85
	Urea	636	1984-85
	Ammonia	364	1984-85
	Urea	636	1984-85
Bunyu Island	Methanol	330	1984
Plaju, South Sumatra	Benzene	375	1986-87
	Para-xylene	107	1986-87
	Ortho-xylene	41	1986-87
	Terephthalic acid	225	1986-87
Sumatra	Phenolic and/or urea resins	25	1983

Source: "Worldwide Construction Report", Oil & Gas Journal, Apr. 19, 1982, p. 153; Chemische Industrie, West Germany, November 1981, p. 698.

Industry sources report that the complex at Aceh could be the basis of Indonesia's petrochemical industry. In order to build this complex, Pertamina entered into a joint venture with a major U.S. petroleum company and a Japanese petrochemical company. 1/ Pertamina is a minor shareholder, controlling just 40 percent of the project; the U.S. firm controls 45-percent interest. However, guidelines decreed by the Indonesian Government in 1974 required that all new investments be joint ventures with initial Indonesian participation of at least 20 percent, and that within a period of 10 years, after the operations have begun, local participation should account for at least 51 percent. 2/

Although most of the materials from the olefins plant at Aceh could be consumed domestically, the excess production could be exported. 3/ These exports could be competitive in the Southeast Asian region for at least three reasons: (1) Indonesia has a major U.S. petroleum firm lending its

1/ "Oil and Chemicals Do Not Mix at Exxon," Chemical Marketing Reporter, Feb. 8, 1982, p. 14.

2/ U.S. Department of Commerce, Indonesia: A Survey of U.S. Business Opportunities, p. 312.

3/ Speech by Steinbaum, "The Impact of Petrochemical Developments," February 1982.

managerial, marketing, and technical expertise as a joint-venture partner; (2) Indonesia has a favorable feedstock position vis-a-vis most of its Southeast Asian neighbors; and (3) Indonesia has a transportation cost advantage compared with most other CERN's.

The $300 million, 330,000 metric tons per year methanol plant on Bunyu Island, off the coast of East Kalimantan, which could come on-stream in 1984, is being built by the French and West German subsidiaries of a European construction and engineering firm. 1/ The bulk of the plant's methanol output could be exported to Japan, Korea, or Taiwan and the remainder of the output is expected to be consumed domestically in the production of formaldehyde, which in turn could be used to produce adhesives for Indonesia's plywood industry. 2/

In early 1982, Indonesia signed a contract for an aromatics plant to be located at Plaju, South Sumatra. 3/ Nearly 40 percent of the output could be used to meet the domestic demand of the textile industry in the production of polyester, and the remaining 60 percent is expected to be exported to the neighboring ASEAN nations. 4/ The resins plant to be built on Sumatra is reported to be a joint venture between a private Indonesian firm, with 40 percent control, and a Norwegian firm, with 60 percent control. 5/ The resins produced are expected to be destined for use in the Indonesian fiber industry. The facility could become operational late in 1983.

Potential industry status by 1990.--Indonesia has petrochemical industry expansion plans for more than 3 million metric tons of petrochemical capacity which could come on-stream by 1990. The following tabulation shows production capacity for Indonesia for ethylene, ammonia, and methanol in 1980 and the base scenario for 1990:

Product	1980	1990	Percentage increase between 1980 and 1990
	----1,000 metric tons----		
Ethylene	400	750	88
Ammonia	1,098	2,007	83
Methanol	100	432	332

1/ Oil and Gas Journal, Dec. 21, 1981, p. 50; and "Petrochemicals," Oil & Gas Journal, Apr. 19, 1982, p. 153.

2/ European Chemical News, Nov. 16, 1981, p. 42; and Journal of Commerce, Nov. 9, 1981, p. 8a.

3/ Speech by Steinbaum, op. cit.

4/ "Thyssen, Kellogg Sign Contract for Indonesian Aromatics Projects," European Chemical News, Mar. 1, 1982, p. 25; "Exxon and Tonen Sign Indonesian Contract," European Chemical News, Apr. 26, 1982, p. 34; "Indonesian Olefins Set by Pertamina and Exxon," Chemical Marketing Reporter, Apr. 26, 1982, pp. 3 and 30; and Chemical & Engineering News, May 24, 1982, p. 23.

5/ "Dyno Indonesian Venture," European Chemical News, Apr. 26, 1982, p. 34.

The increase in petrochemical capacity could enable Indonesia to export more petrochemicals to the ASEAN nations, which are major consumers as well as net importers, of petrochemical derivatives. The following tabulation shows the data for ethylene, ammonia, and methanol expressed in shares of total world production in 1980 and the base scenario for 1990 (in percent):

Product	1980	1990
Ethylene	1	1
Ammonia	1	2
Methanol	1	1
Total	3	4

Indonesia's development plans build upon trade experience gained from exporting fertilizers. Pertamina's major goals for future petrochemical industry development include the export of additional natural gas-based petrochemicals to various Asian markets since it enjoys a transportation cost advantage vis-a-vis other CERN's.

Goals.--Indonesia's petrochemical expansion plans are based on the nation's hydrocarbon reserves. Indonesia's infrastructure development, energy plans, and political stability could be important to the success of its petrochemical industry.

Infrastructure.--In order to become an important source of petrochemicals in the Southeast Asian area, the Indonesian Government hopes to upgrade its infrastructure. For example, although there are approximately 57,700 miles of highway in Indonesia, only about 29 percent, or about 16,500 miles are paved. 1/ Furthermore, most of this paved highway is located on Java. One consequence of Indonesia being an archipelago nation is the difficulty in designing an effective transportation system. The Indonesian Government reportedly has devoted about 15 percent of the nation's development budget to this purpose under each of its three 5-year plans; the third plan, Repelita III, began in 1978. 2/ Indonesia has spent more than 50 percent of the total infrastructure budget on building and upgrading roads. Indonesia and the World Bank are jointly spending $1.5 billion on road building, shipping, ports, power supply, and urban development. There are over 4,260 miles of railroad track in Indonesia, nearly three-fourths of which is located on Java. 3/ Indonesia has over 13,370 miles of inland water ways, and is served by 15-ocean ports; 4/ the two major ports are Tanjung Priok near Jakarta, and Tanjung Perak near Surabaya. 5/

1/ Financial Times, Dec. 21, 1981, p. IV; and, U.S. Central Intelligence Agency, The World Factbook-1982, April 1982, p. 107.

2/ Financial Times, Dec. 21, 1981, p. IV.

3/ John Paxton, The Stateman's Year-Book: For the Year 1981-1982, New York, 118th ed., p. 678.

4/ U.S. Central Intelligence Agency, The World Factbook-1982, Apr. 1982, p. 107.

5/ The Europa Yearbook 1982, London, vol. II, 1982, p. 543.

In terms of transportation equipment, Indonesia hopes to replace steam engines with diesels by 1990, and in 1982, the Government committed about $675 million for railway improvement in Java and Sumatra. 1/ Domestic air service links the major Indonesian cities, and international service is provided by the State airline as well as by about 23 major airlines. 2/

Energy.--In order to economically utilize its natural gas reserves, Indonesia hopes to develop a viable petrochemical industry which could supply the basic domestic petrochemical needs. Indonesia also hopes to export these basic petrochemicals and petrochemical derivatives to other nations of the region. 3/ A viable petrochemical industry could provide Indonesia with an alternative to crude petroleum as a source of foreign revenue.

Social needs.--Indonesia could create employment by developing downstream, labor-intensive, finished-products industries which would use the products of the capital-intensive petrochemical industries as feedstocks. This could serve the social needs of Indonesia by helping to reduce the nation's unemployment, which is estimated to be as high as 30 percent. 4/

Political framework.--In order to create jobs for its 60 million unemployed, the Government is seeking to attract overseas technology and welcomes joint ventures and licensing agreements in certain areas. Many of Indonesia's crude petroleum and petrochemical projects, for example, have relied on foreign technical, managerial, and financial resources. The Government of Indonesia realizes that, for a time, expatriates may be required for certain tasks in these industries, particularly in the early years, but the Government expects foreign firms to replace expatriates with Indonesians as rapidly as possible. 5/

1/ Financial Times, Dec. 21, 1981, p. IV.

2/ The Europa Yearbook 1982, London, vol. II, 1982, pp. 522, 543, and 544.

3/ Based on information developed during fieldwork for this study, and also from subsequent telephone contacts.

4/ The New York Times, International Economic Survey, sec. 12, Feb. 8, 1981, p. 44.

5/ Economic Handbook of the World: 1981, New York, 1981, p. 202; U.S. Department of Commerce, Business America, Aug. 9, 1982, p. 6; and, U.S. Department of State, American Embassy, Indonesia's Petroleum Sector: 1982, Jakarta, Indonesia, June 1982, p. 20.

Kuwait

Background

Kuwait has a population of more than 1.5 million, of which only approximately two-fifths are Kuwaiti citizens, within an area of 7,900 square miles, about the size of Massachusetts. 1/ The country is primarily desert, but does have one of the best natural ports in the area, the Bay of Kuwait.

This nation is the eighth largest producer of crude petroleum in the world and has a per capita income of more than $20,000. 2/ Since 1974, Kuwait's revenues have annually exceeded expenditures by 50 percent. Kuwait had accumulated more than $65 billion in financial reserves by the end of 1982.

Current petrochemical industry status

Market.--Kuwait's market for petrochemicals is small as a result of the size of its population; the petrochemical market which does exist is supplied mainly through imports. These petrochemical imports have increased in terms of value from about $83 million in 1976 to about $155 million in 1979, or at an average annual rate of 24 percent. 3/ Much of this growth in demand has been for plastics, which are used in the construction of homes, hospitals, and water systems.

Kuwait's per capita consumption of fertilizers is negligible, since the nation's terrain is almost entirely desert. In 1979, Kuwait's per capita consumption of urea was calculated at only one-tenth of a pound; per capita consumption of ammonia was eight-tenths of a pound. 4/ By comparison, the U.S. 1979 per capita consumption of urea for fertilizer use was more than 45 pounds and of anhydrous ammonia for fertilizer use was more than 177 pounds. 5/

Kuwait's per capita consumption of the five leading thermoplastics resins in 1980 was reported to be no more than 27 pounds. 6/ By comparison, U.S. per capita consumption of these five resins in 1980 was about 107 pounds.

1/ Exxon Background Series, Middle East Oil, 2d ed., September 1980, p. 39; Economic Handbook of the World: 1981, New York, 1981, p. 247; and, An Almanack 1981, London, October 1980, p. 893.

2/ U.S. Department of Commerce, "Kuwait," Business America, Feb. 8, 1982, p. 33; John Paxton, The Statesman's Year-Book: For the Year 1981-1982, New York, 118th ed, p. 778; Gilda Berger, Kuwait and the Rim of Arabia, New York, 1978, p. 19; and, Central Bank of Kuwait, Central Bank of Kuwait: Economic Report for 1977, pp. 28, 35 to 40, and 99 to 102.

3/ Drawn from United Nations, 1980 Yearbook of International Trade Statistics, New York, vol. 1, 1981, p. 567.

4/ Staff estimations determined from available data.

5/ From various sources, including U.S. International Trade Commission, Anhydrous Ammonia from the U.S.S.R., Publication 1051, April 1980, pp. A-17 and A-40.

6/ These resins are high-density polyethylene, low-density polyethylene, polypropylene, polystyrene, and polyvinyl choride.

Industry.--Kuwait's petrochemical industry is controlled by the state-owned company, PIC, which was formed in 1963. Petrochemical Industries Co. (PIC) is a wholly-owned subsidiary of the 100-percent state-owned Kuwait Petroleum Corp. (KPC). 1/ PIC is divided into two divisions, one for fertilizers and other petrochemicals, and the other for inorganic compounds. The petrochemical industry is Kuwait's second most important industrial sector, following crude petroleum production and refining.

PIC's current two major petrochemical facilities are located at Shuaiba, and primarily produce ammonia and urea. Kuwait was the first country in the Middle East to use natural gas for the production of ammonia and urea, and is currently one of the largest producers of fertilizer in the world. 2/ PIC has three ammonia plants with combined capacity in excess of 636,000 metric tons per year. The three urea plants have a total annual capacity of about 682,000 to 773,000 metric tons, with the largest of the urea plants having an annual capacity of nearly 348,000 metric tons. 3/ The following tabulation shows production for ammonia and urea in 1975, 1979, and 1980:

Product	Production		
	1975	1979	1980
	1,000 metric tons		
Ammonia	546	500	330
Urea	546	682	445

Between 80 and 90 percent of Kuwait's annual production of ammonia is converted to urea; therefore, when ammonia production declined in 1980 as a result of the shutdown of a plant for safety reasons during the initial phase of the Iran/ Iraq war, urea production also decreased. PIC has plans for the expansion of its petrochemical industry to include the production of ethylene and a variety of ethylene derivatives, such as polyethylene resins, as well as certain aromatics, such as benzene. 4/ Since more than three-fourths of Kuwait's labor force consists of expatriates, the Government does not encourage labor-intensive products which might require additional expatriate labor. 5/

1/ U.S. Department of State, "Kuwait," Background notes.

2/ "Kuwait," Financial Times, Feb. 24, 1982, pp. VI and XV.

3/ Richard Nyrop, Area Handbook for the Persian Gulf States, Washington, 1st ed., 1977, pp. 156 and 157; and Central Bank of Kuwait: Economic Report for 1977, pp. 33 and 34.

4/ U.S. Department of State, "Kuwait Petrochemical Industry," airgram, A-10, April 1980, p. 1.

5/ U.S. Department of Commerce, Marketing in Kuwait, OBR79-18, June 1979, pp. 6 and 7; Richard F. Nyrop, and others, Area Handbook for the Persian Gulf States; Washington, D.C., 1st ed., 1977, pp. 156 and 157; U.S. Department of State, "Kuwait's Petrochemical Industry," airgram, A-10, Apr. 8, 1980, pp. 1-3; The Arab World Weekly, Beirut, Nov. 15, 1980, p. 17; and, Oil & Gas Journal, Apr. 19, 1982, p. 17.

The private sector, or joint ventures between the public and private sectors may participate in the production of downstream chemicals, such as surfactants, synthetic rubber, polyvinyl chloride resins, and products of plastics, such as film and sheet. Firms producing downstream petrochemicals rely on PIC for their feedstocks. At present, there is only one privately owned petrochemical firm which began production in 1980. This firm, which has a capacity of about 15,000 metric tons per year of melamine, exports most of its production to Western Europe. Eventually, Kuwait hopes to produce melamine-formaldehyde resins, primarily for export. 1/

Foreign investment in Kuwait's petrochemical industry is welcomed, but is limited to 49-percent equity ownership. 2/ In order to encourage foreign investors, the Government, under the National Industries Law, offers incentives to foreign firms, including free industry sites, exemption from certain taxes and customs duties, low-cost and long-term loans for industrial development, repatriation of capital, and financial assistance for research; the firm's employees also may be exempted from personal income taxes. 3/

Trade.--Kuwait manufactures few of the industrial and consumer goods it needs, and imports nearly 100 percent of its food requirements. In recent years, Kuwait's principal imports have been machinery and transport equipment, basic manufactures, and food and live animals, which together account for 68 to 83 percent of the value of Kuwait's total imports. 4/

Imports.--Japan, the principal source of Kuwait's imports, has accounted for about 20 percent of the value of Kuwait's total annual imports in recent years. The United States, Kuwait's second leading source of imports, has accounted for about 13 to 14 percent of the value of Kuwait's imports. 5/ Other important sources of imports in recent years have been the United Kingdom, West Germany, Italy, Australia, and France.

Petrochemical products, such as medicinals, perfumes, and cosmetics, annually account for about 50 percent of the value of Kuwait's chemical

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1/ U.S. Department of State, "Kuwait Petrochemical Industry," airgram, A-10, Apr. 8, 1980, p. 2; Chemicals Industries, August 1981, p. 494; "Kuwait," Financial Times, Feb. 24, 1982, 1982, p. VI; and, Ragaei El Mallakh, Kuwait: Trade and Investment, Boulder, 1979, p. 47.

2/ U.S. Department of Commerce, Marketing in Kuwait, OBR 77-18, June 1979, p. 23.

3/ Richard Nyrop, Area Handbook for the Persian Gulf States, Washington, D.C., 1977, p. 157 and, Economic Handbook of the World: 1981, New York, 1981, p. 249.

4/ The Europa Yearbook 1982: A World Survey, London, vol. II, 1982, p. 765; and, U.S. Department of Commerce, World Trade Outlook for 64 Countries, OBR 81-24, September 1981, p. 37.

5/ U.S. Department of Commerce, Highlights of U.S. Export and Import Trade, FT990, December 1981, pp. 36 and 37; International Monetary Fund, Direction of Trade Statistics: Yearbook 1981, Washington, D.C., 1981, pp 236 and 237; and, "Kuwait," Financial Times, Feb. 24, 1982, p. XIII.

imports. The principal sources of these imports are Western Europe, Japan, and the United States. 1/

Kuwait's duty rates on imports are about 4 percent ad valorem, and goods transshipped through Kuwait are dutiable at 2 percent ad valorem. 2/ Imports by petrochemical companies for use as raw materials in production facilities are duty free. 3/ Certain products which have recently begun to be manufactured domestically, such as industrial paints, chemical detergents and shampoos, aerosol products, and certain plastics products, have rates of duty which range from 10 to 15 percent ad valorem.

Exports.--Kuwait's principal export is crude petroleum, which has accounted for about 75 percent of the total annual value of exports; exports of refined products have annually accounted for 10 to 20 percent of the value of Kuwait's total export trade. 4/ In 1980, revenues from crude petroleum exports were $19 billion. Revenues from such exports declined in 1981 to $15 billion, and further decreased to between $6 billion and $8 billion in 1982. 5/ One possible reason for the decline was a market surplus of better grades of crude petroleum than normally supplied by Kuwait. 6/ It is reported that by 1990, Kuwait could export as much as 2 million barrels per day of crude petroleum. 7/

Japan has been the principal market for Kuwait's exports of crude petroleum, annually accounting for 20 to 25 percent of the value of these exports. Japan's refineries are able to process the relatively "heavy" Kuwait crude petroleum. Other important markets for Kuwait's exports of crude petroleum include Korea, Singapore, the Netherlands, the United Kingdom, and France. The United States is not a major market for Kuwait's crude petroleum, since most U.S. refineries are better able to process lighter grade crude petroleum.

1/ United Nations, 1980 Yearbook of International Trade Statistics, New York, vol. 1, 1981, p. 567.

2/ U.S. Department of Commerce, Marketing in Kuwait, OBR 79-18, June 1979, pp. 10 and 23; and, John Paxton, The Statesman's Year-Book: For the Year 1981-1982, New York, 118th ed., p. 778.

3/ Ragaei El Mallakh, op cit., pp. 207 and 208, app. F.

4/ U.S. Department of Commerce, Marketing in Kuwait, OBR 79-81, June 1979, p. 5. and United Nations, 1980 Yearbook of International Trade Statistics, New York, vol. 1, Trade by Country, 1981, p. 570; Central Bank of Kuwait: Economic Report for 1977, p. 84; and Economic Handbook of the World: 1981, p. 248.

5/ "Kuwait," Financial Times, Feb. 24, 1982, pp. II, IV and VI; U.S. Department of Commerce, "Kuwait," World Trade Outlook for 64 Countries, OBR81-24, September 1981, p. 36; and U.S. Department of Commerce, "Kuwait," Business America, Aug. 9, 1982, p. 32.

6/ "Kuwait's Drive to be Oil's 'Eighth Sister,'" Business Week, Jan. 11, 1982, pp. 36 and 37.

7/ "Chance for Oil Price Shock in Mid-1980's Seen," Oil & Gas Journal, Jan. 4, 1982, p. 51.

Kuwait's annual chemical exports have not exceeded 5 percent of the total value of exports in recent years. 1/ Kuwait's annual exports of fertilizers, have not exceeded 1 percent of the total value of its exports in recent years, but have accounted for about 20 percent of the value of Kuwait's total value of chemical exports. Kuwait has been one of the world's leaders in exports of nitrogenous fertilizers, accounting for 3 to 6 percent of the total value of world trade of nitrogenous fertilizers. 2/

The principal market for urea fertilizer has been the People's Republic of China. Other major markets for both urea and ammonia fertilizers include India, Vietnam, Pakistan, the Sudan, Sri Lanka, and Thailand. 3/

Energy base

Petroleum.--Kuwait's estimated proved crude petroleum reserves were 64 billion barrels, or about 15 percent of OPEC's estimated proved reserves in 1982 as of January 1, 1983. 4/ Kuwait has crude petroleum production capacity of 2.9 million barrels per day, and a maximum sustainable capacity of 2.5 million barrels per day. 5/ As of August 1982, Kuwait's actual production rate was only 650,000 barrels per day. 6/ The Neutral Zone, whose output is shared equally by Kuwait and Saudi Arabia, has an installed nameplate capacity of 680,000 barrels per day; its maximum sustainable capacity is 600,000 barrels per day; and its production rate as of August 1982, was 238,000 barrels per day. 7/ As of March 14, 1983, Kuwait's production ceiling was set at 1.05 million barrels per day. 8/

Kuwait has 13 crude petroleum fields of which the leading three, Ahmandi, Bahra, and Burgan Kuwait, produce most of Kuwait's crude petroleum production. Kuwait's crude petroleum production declined steadily from an average of 2.3 million barrels per day in 1979, to an average of 675,000 barrels per day in 1982. 9/

1/ United Nations, 1980 Yearbook of International Trade Statistics, New York, vol. I, 1981, p. 570; International Monetary Fund, Direction of Trade Statistics: Yearbook 1981, Washington, D.C., 1981 pp.236 and 237; and Economic Handbook of the World: 1981, New York, 1981 p. 267.

2/ United Nations, 1980 Yearbook of International Trade Statistics, New York, vol. II, 1981, p. 446; "Kuwait," Financial Times, Feb. 24, 1982, pp. VI and XIII; and, The Europa Yearbook 1982: A World Survey, London, vol. II, 1982, p. 766.

3/ U.S. Department of State, "Kuwait Petrochemical Industry," airgram, A-10, Apr. 8, 1980, pp. 1 and 2; also developed from information obtained during fieldwork for this study.

4/ "Worldwide Report," Oil & Gas Journal, Dec. 27, 1982, pp. 78-79.

5/ U.S. Central Intelligence Agency, International Energy Statistical Review, Nov. 30, 1982, pp. 1 and 3.

6/ Ibid.

7/ Ibid.

8/ "OPEC Cuts Oil to $29, Sets Production Quotas," Washington Post, Mar. 15, 1983, p. A-1.

9/ The British Petroleum Co., BP Statistical Review of World Energy, 1981, p. 19; and "Worldwide Report," Oil & Gas Journal, Dec. 27, 1982, pp. 78-79.

Kuwait's crude petroleum consumption, including the Neutral Zone, rose from 125,000 barrels per day in both 1979 and 1980 to an estimated 155,000 barrels per day in 1981. 1/ Most domestic consumption is in the form of refined products, such as gasoline.

The value of Kuwait's petroleum exports increased from $17.0 billion in 1979 to $19.1 billion in 1980, but decreased to $15 billion in 1981. In 1982, export revenues from crude petroleum had been projected to have declined between $6 billion and $8 billion. 2/ Kuwait hopes to export 50 percent of its crude petroleum output as refined products, such as gasoline, heating oil, or jet fuel, by the mid-1980's. 3/

Natural gas.--Kuwait's estimated proved natural gas reserves were 30 trillion cubic feet, as of January 1, 1983, or more than 1 percent of the world's total estimated proved natural gas reserves and about 3 percent of OPEC's total estimated proved natural gas reserves. Kuwait's share of the Neutral Zone's estimated proved natural gas reserves was 4 trillion cubic feet in 1982. 4/ Trade sources report that at the 1979 and 1980 levels of domestic consumption, Kuwait's natural gas reserves could last more than 280 years. 5/

Kuwait's marketed production of natural gas increased from 220 billion cubic feet in 1978 to 305 billion cubic feet in both 1979 and 1980, or by 39 percent. 6/ Since most of Kuwait's natural gas is associated with crude petroleum, the decline in production of crude petroleum resulted in a decline in natural gas production in 1981 and 1982.

Kuwait consumed about 67 percent of its total natural gas production in 1981. About 37 percent of the natural gas was consumed by state-owned facilities, such as power plants and desalination plants. 7/ Approximately 5 to 6 percent of the natural gas produced is reinjected into the producing wells during crude petroleum field operations in order to enhance recovery of crude petroleum.

Other energy sources.--Kuwait has no proved reserves of coal or uranium ore. Coal and nuclear power account for little of Kuwait's primary energy consumption.

1/ U.S. Central Intelligence Agency, International Energy Statistical Review, Nov. 30, 1982, p. 4.

2/ "Kuwait," Financial Times, Feb. 24, 1982, pp. II, IV, and VI; and, U.S. Department of Commerce, "Kuwait," Business America, Aug. 9, 1982, p. 32.

3/ Industry estimates obtained during fieldwork for this study; Central Bank of Kuwait: Economic Report for 1977, p. 84, and Economic Handbook of the World: 1981, p. 248.

4/ "Worldwide Report," Oil & Gas Journal, Dec. 27, 1982, p. 78; and, "A Strange Situation is Growing Stranger," World Oil, Aug. 15, 1981, p. 64.

5/ Petroleum, August 1981, p. 336; and, "Worldwide Gas Processing Grows in Plants, Products, and Throughput," Oil & Gas Journal, July 13, 1981, p. 71.

6/ U.S. Central Intelligence Agency, International Energy Statistical Review, Nov. 30, 1982, p. 21.

7/ U.S. Department of Commerce, Marketing in Kuwait, OBR 79-81, June 1979, p. 6; The Europa Yearbook 1982: A World Survey, London, England, Vol. II, 1982, p. 763; and, Economic Handbook of the World, New York, N.Y., 1981, p. 248.

By the mid-1970's, Kuwait had installed electrical capacity of 1,364 MW's and production of 4.1 billion kilowatts-hours (kWh). 1/ The Government further expanded electrical capacity to 1,718 MW's by the late 1970's and up to 2,578 MW's at the start of the 1980's. In 1980, Kuwait produced 9.05 billion kWh. Work has begun on a 2400 MW power plant at Ras Al Zour, and studies have begun on construction of another power facility at Sobhiya. 2/ Kuwait's demand for power rose 20 to 25 percent annually in the early 1970's but slowed to an annual growth rate of 7 to 8 percent a year by 1980.

Petrochemical plans

Products.--Olefins and aromatics plants had been scheduled to be built in the Shuaiba Industrial Zone to produce petrochemicals for domestic consumption; however, Kuwait recently cancelled the projects in an effort to establish an intermediates industry intended to upgrade local resources. 3/ In place of the Shuaiba project, Kuwait has formed a new petrochemical company which is 45 percent owned by PIC, 25 percent by a bank in Kuwait, 15 percent by a Kuwait chemical company, and 15 percent by a privately owned Kuwait company. The new company is studying the feasibility of producing petrochemical intermediates for the manufacture of alkyd and polyester resins, plasticizers for PVC, and chemicals for the paints and varnish industry. 3/ The feedstocks for the projects could come from existing refineries or imports. The production from the complex is expected to be earmarked for the domestic market and the markets of Kuwait's neighboring nations; the complex could come on-stream by 1990. 4/

Some industry observers believe that the cancelled petrochemical expansions at Shuaiba could be rescheduled with new joint-venture partners and be on-stream by 1990, since the facilities planned for Shuaiba could produce the feedstocks needed for the planned production of petrochemical intermediates. The following tabulation shows the possible 1990 petrochemical capacity, if the Shuaiba complex is built: 5/

1/ Richard Nyrop, op. cit., p. 155.
2/ U.S. Department of Commerce, Marketing in Kuwait, OBR79-81, June 1979, pp. 4 and 9; U.S. Department of Commerce, "Kuwait," Business America, Feb. 8, 1982, p. 33; and, U.S. Central Intelligence Agency, The World Factbook - 1982, April 1982, p. 129.
3/ "Kuwait Forms Company to Make Petrochemical Intermediates," European Chemical News, Nov. 8, 1982, p. 30.
4/ "Kuwait Forms Company To Make Petrochemical Intermediates," European Chemical News, Nov. 8, 1982, p. 30.
5/ "Petrochemicals," Oil & Gas Journal, Apr. 19, 1982, p. 159.

Product	Capacity (1,000 metric tons)
Ethylene----------------	395
Ethylene glycol---------	130
Polyethylene------------	130
Benzene-----------------	284
Styrene-----------------	330
ortho-Xylene------------	60
para-Xylene-------------	90
Ammonia-----------------	1,296
Methanol----------------	250

Kuwait also plans to expand its interest in petrochemicals in other countries. For example, Kuwait, Saudi Arabia, and the United Arab Emirates have a joint plan to develop a pharmaceutical industry. 1/ PIC also is involved in a separate joint venture with the Bahrain National Oil Co. and plans to invest about $300 million in a plant, scheduled to be on-stream by 1984, which may produce both ammonia and methanol at the rate of about 1,000 metric tons per day each. Kuwait also retains approximately 25 percent interest in one of the world's major chemical companies headquartered in West Germany. 2/

A privately owned firm reportedly could build a synthetic resins plant with a capacity of about 16,000 metric tons per year, and this plant could come on-stream in late 1983. The plant could have annual capacities of 11,000 metric tons of alkyd resins, 4,000 metric tons of polyvinyl esters, and around 1,000 metric tons of unsaturated polyester resins. 3/

Most of the planned potential increases in petrochemical output could be for export, since Kuwait has a small population which is not likely to be capable of sustaining a world-scale petrochemical industry. It has been reported that Kuwaiti fertilizers may continue to be exported mainly to developing countries, and petrochemical products from the potential olefins and aromatics complexes could be directed to the markets of Japan, other Far East nations, and Western Europe. 4/

Potential industry status by 1990.--Kuwait, the first Middle Eastern nation to utilize its natural gas as a feedstock in the production of ammonia and urea, is one of the world's largest ferilizer producers. PIC's expansion plans for petrochemical production could utilize nearly one-third of the

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1/ "Chemicals Boom in the Middle East Oilfields," Manufacturing Chemist, January 1982, p. 15.

2/ "Worldwide Construction Report," Oil & Gas Journal, Apr. 19, 1982, p. 147.

3/ Based on information supplied by a country specialist at the U.S. Department of Commerce. Also from Petroleum, February 1981, p. 81; Chemical Age, Apr. 24, 1981, p. 17; and, Chemische Industrie, West Germany September 1981, p. 570.

4/ "Chemicals Boom in the Middle East Oilfields," Manufacturing Chemist, January 1982, p. 15; and, Ragaei El Mallakh, op. cit., p. 61.

natural gas now flared. The following tabulation shows production capacity for ethylene, ammonia, and methanol in 1980 and the base scenario for 1990:

Product	1980	1990	Percentage increase between 1980 and 1990
	------1,000 metric tons------		
Ethylene	45	395	777
Ammonia	636	1,296	104
Methanol	45	250	455

Kuwait has interests in petrochemicals in other nations, via joint ventures in the Persian Gulf region. Kuwait has joint plans with Saudi Arabia and the UAE to develop a pharmaceutical industry, and with Bahrain to produce ammonia and methanol. Also, Kuwait owns substantial interest, which could be expanded, in a large chemical company headquartered in West Germany. The following tabulation shows the data for ethylene, ammonia, and methanol expressed in shares of total world production in 1980 and the base scenario for 1990 (in percent):

Product	1980	1990
Ethylene	1/	1
Ammonia	1	1
Methanol	1/	1
Total	1	3

1/ Less than 0.5 percent.

Goals.--Since the production of many petrochemicals is capital intensive, the planned expansion of the petrochemical industry fits in well with Kuwait's plan to direct local investments away from labor-intensive goods. Kuwait hopes to utilize revenue from petrochemical production to achieve its many social goals.

Infrastructrure.--It is reported that Kuwait already has much of the infrastucture necessary for its planned petrochemical expansion. Although no formalized plans for upgrading infrastructure exist, Kuwait could spend more than $13 billion in infrastructure development during the 1980's. 1/ Kuwait has no railroads, but has nearly 1,200 miles of roads, including major highways connecting Kuwait with both Iraq and Saudi Arabia. 2/ Kuwait has

1/ U.S. Department of Commerce, Business Guide to the Near East and North Africa, February 1980, p. 8.

2/ The Europa Yearbook 1982: A World Survey, London, England, vol. II, 1982, p. 761.

three major seaports and four minor ones. Special terminals expedite crude petroleum shipments, the main one being Mina Al-Ahmadi. Kuwait has six usable airfields, four with permanent-surface runways. 1/ Kuwait is serviced by a number of international airlines in addition to its own airline.

Energy.--Expansion into the production of a wide range of petrochemicals could also benefit Kuwait by providing revenue from previously flared natural gas. Kuwait hopes to export less crude petroleum, thus conserving its reserves, and instead derive more of its export revenue from the export of petrochemicals, LNG, and LPG.

Social needs.--Kuwait's goals include improving education, public health care, and housing for its citizens. The additional revenues generated by the production and sales of petrochemicals could enable the Government of Kuwait to achieve these goals as well as increase the per capita consumption of petrochemicals.

Political framework.--PIC's petrochemical expansion plans, which call for the production of capital-intentsive products since the Government does not encourage additional expartriate labor, could provide the opportunity for joint ventures with Western nations. In order to encourage such projects, Kuwait offers various incentives for foreign firms to bring their technology and marketing expertise to Kuwait. Kuwait has also entered into joint ventures to produce chemicals outside its borders.

1/ U.S. Central Intelligence Agency, The World Factbook - 1982, April 1982, p. 130.

Canada

Background

Canada is the second largest country in the world with an area of 3.8 million square miles. Canada's population in 1980 was 23.9 million of which 45 percent were of British descent and 29 percent of French descent. The terrain varies from flatland to mountainous, with climates ranging from temperate to arctic. Canada's natural resources include natural gas and crude petroleum, metals, minerals, fish, and forests. The 1981 per capita income was $10,296. 1/

Current Petrochemical Industry Status

Market

Canada began commercial petrochemical production in 1942 but did not become a world leader in petrochemicals, at least in part, because of its small population which did not consume enough petrochemicals to support world-scale plants. 2/ As a result, the petrochemical industry was not price competitive with imports or in the world export market.

Canadian investment in world-scale petrochemical plants started in the mid-1970's. These plants have been coming on-stream and, combined with the prices and availability of feedstocks, have made Canadian production of certain petrochemicals competitive in the world market. Canada currently does not export large volumes of petrochemicals, but still imports large volumes of certain petrochemicals and petrochemical products not produced locally or in sufficient quantities to satisfy domestic consumption.

Two of the first of a series of major world-scale plants came on-stream in the late 1970's, one in Alberta and one in Sarnia. The locations, in addition to providing products for the Canadian domestic market, also offer easy access to the United States and other export markets.

In 1980, Canadian per capita consumption of ethylene derivatives was about 45 pounds, or one-half of that in the United States. Approximately 50 percent of the Canadian consumption of ethylene derivatives was supplied by imports.

Canadian petrochemical consumption is increasing and based on the preceding comparison would appear to offer good growth potential. Many of the factors operating in the U.S. market to increase demand are also operating in the Canadian market. In addition, as mentioned earlier, many petrochemicals and petrochemical products are imported into Canada at present and, over time, many products could be made in Canada.

1/ U.S. Department of State, "Canada," Background notes, March 1981.
2/ Clifford L. Mort, "Challenges from the North; Canada," Report of the Chemical Marketing Research Association, New York, 1980, p. 110.

Industry

The role of the Government in the petrochemical industry appears greater in Canada than in the United States. For example, the Canadian Development Corp. (CDC), established in 1972, is a holding company of which the Government owns 68 percent, and private domestic or foreign-owned enterprises own the other 32 percent. CDC is a privately managed corporation whose mission includes the maintenance and management of the production of petrochemicals, pipelines, and refining operations, among other duties.

In addition, a national petroleum company, Petro-Canada, was established in 1976. It was the logical result of a Government move toward greater involvement in resource development. Petro-Canada obtained the operations of two major privately owned producers in 1978 1/ and could increase in importance in the future as a result of the Canadian Government's decision to increase Canadian ownership in the petroleum and natural gas industry. 2/

Canada's two world-scale olefins facilities are based on feedstocks available in Canada and located so that export markets are easily accessible. One plant, located in Alberta, is based on natural gas to primarily produce ethylene. The other plant, located in Sarnia uses petroleum-derived feedstocks to produce a wider variety of products, including the aromatics.

Canada's other petrochemical facilities, located in Sarnia and Montreal, are petroleum based. The Sarnia facilities were expanded during the 1970's and, with low petroleum prices, are modern enough to be competitive in Ontario and along the Great Lakes. 3/ The industry in Montreal is older and smaller than that in Sarnia but plants are located near 5 petroleum refineries and 600 plastics processing facilities. 4/

Ethylene capacity in Canada has increased from less than 667,000 million metric tons in 1974 5/ to 1.3 million metric tons in 1981, but decreased to 960,000 metric tons in 1982. 6/. As the ethylene capacity has increased so has the production of ethylene derivatives and other petrochemicals. The following tabulation shows production for selected petrochemicals: 7/

1/ Dean Rusk Center, Comparative Facts on Canada, Mexico, and the United States, 1979, pp. 94-95.

2/ Wall Street Journal, Oct. 29, 1980, p. 6.

3/ "Canadian Chemical Producers Go Conservative," Chemical Marketing Reporter, Oct. 18, 1982, p. 15.

4/ Ibid., p. 16.

5/ "Canadian Petrochemicals Set for Big Growth," Chemical & Engineering News, May 25, 1981, p. 17.

6/ "Chemical Companies Seek Relief from the Burden of Feedstock Cost," Chemical & Engineering News, Dec. 20, 1982, p. 61.

7/ Ibid.

Product	1979	1980	1981	1982
	---------------	-1,000 metric	tons---	-------
Ethylene	1,014	1,197	1,330	11.1
Polyethylene	628	641	674	610
Benzene	493	604	566	480
Ammonia	2,405	2,555	2,654	2,570
Urea	1,212	1,274	1,302	1,220
Polystyrene	124	110	123	135
PVC	145	190	222	200

The largest producer of olefins in Canada utilizes ethane extracted from natural gas. Sufficient supplies of ethane are available from this additional natural gas to provide the feedstock for at least two or three more world-scale olefins plants. 1/

Whereas Canada has some advantages in the production of petrochemicals, there are also some disadvantages, such as construction costs which are generally 20 to 30 percent higher in certain parts of Canada than on the U.S. gulf coast because of the usually harsher Canadian climate and the less experienced construction workers. 2/ Further, there are higher costs involved in shipping chemicals long distances; for example, transportation costs from Alberta to Chicago are 50 percent higher than they are from the U.S. gulf coast to Chicago. 3/

U.S. firms are the leading foreign investors in the Canadian petrochemical industry. Of the top eight firms in Canada producing petrochemicals in 1980, five were majority owned by U.S. parent companies and two of the largest producers were subsidiaries of U.S. firms. Two of the Canadian-owned firms in the top eight have at least partial Government ownership as both are partially owned by the CDC of which the Government owns 68.1 percent.

Historically, Canada has welcomed foreign investment and has placed few limits on the activities of these investors. Currently, foreign investors control 55 to 60 percent of all manufacturing, 80 percent of pharmaceutical manufacturing, 75 to 80 percent of food processing, and, until recently, 70 percent of the petroleum industry. 4/

There has, in recent years, reportedly been an increase in Canada of economic nationalism which has led successive Governments to be more critical of foreign investment and more prepared to take action to control foreign investment. As a result, the Foreign Investment Review Agency (FIRA) was created in 1975 with the mandate to screen (1) new foreign ventures in Canada;

1/ "Petrochem Units Will Have Firm Base," Canadian Chemical Processing, vol. 61, No. 9, September 1977.

2/ "Canadian Chemical Producers Go Conservative," Chemical Marketing Reporter, Oct. 18, 1982, p. 10.

3/ "Pressure on Ethylene from the North," Chemical Week, Dec. 9, 1981, p. 32.

4/ "Business Outlook Abroad," Business America, Apr. 5, 1982, p. 22.

(2) foreign acquisitions of existing domestic corporations, whether or not they currently are domestically controlled; and (3) expansion of existing ventures "controlled" by foreigners into new business areas. The Canadian Government may authorize these new ventures if it is determined that "significant benefit to Canada" will result. Since 1980, FIRA has taken a much more restrictive view of "significant benefit." 1/

The National Energy Policy (NEP) is a Canadian Government program primarily formulated to decrease foreign control of the domestic crude petroleum industry. The NEP's essential goals are to (1) reduce foreign ownership of the energy sector from over 70 percent in 1980 to 50 percent by 1990; (2) give Canadian-owned and controlled companies incentives for future petroleum and gas exploration in Canada and its coastal waters; (3) maintain domestic energy prices at below world levels at least until 1986, which will provide Canadian firms an advantage in the export of energy-intensive products such as petrochemicals; (4) create a strong public sector presence (Petro-Canada) in petroleum exploration, production and marketing; and (5) provide greater opportunities for Canadian industrial suppliers to the energy sector. 2/

Trade

The world-scale facilities which came on-stream in the late 1970's aided Canada's shift from a negative to a positive trade balance in chemicals in 1979 compared with 1978. The positive trade balance increased from $509 million in 1979 to $636 million in 1980 3/ and to $712 million in 1981; 4/ but it decreased to $530 million in 1982. 5/

The Canadian tariff system may be called multipreferential. Tariff preferences are afforded to incoming goods first, on the basis of the membership of the exporting country in the British Commonwealth; these British preferential countries are generally levied duties that are less than non-Commonwealth nations. The United States receives MFN tariff status in the Canadian tariff system. These tariffs are less lenient than the British Preferential Tariff yet more lenient than Canada's General Tariff, which applies to most nonpreferred nations.

Imports.--The difference between production and demand for olefins was filled by imports until 1978. Imports of ethylene increased from 18,000 metric tons in 1975 to 53,550 metric tons in 1977, but decreased to 4,950 metric tons in 1978, as a result of the new olefins plants coming on-stream. 6/ Canada's imports of ethylene decreased further to 4,350 metric tons in 1980, and 4,400 metric tons in 1981.

1/ Ibid.

2/ "Canadian Petrochemicals Set for Big Growth," Chemical & Engineering News, May 25, 1981, p. 17.

3/ Ibid

4/ Ibid., p. 20.

5/ "Chemical Companies Seek Relief from the Burden of Feedstock Costs," Chemical & Engineering News. Dec. 20, 1982, p. 62.

6/ Ministry of Industry, Trade and Commerce, Statistic Canada, Ottawa, Canada, 1975-81.

Canada, however, remains a net importer of ethylene derivatives, such as LDPE and HDPE, primarily from the United States. Canadian imports of plastics increased from 294,090 metric tons in 1975 to 426,363 metric tons in 1980, or at an average annual growth rate of 10 percent. 1/

Canada is self-sufficient in the production of fertilizers and imports only a minimal amount to serve a limited area where there is a freight or delivered cost advantage associated with imports vis-a-vis local production. Canadian imports of ammonia increased from 54,900 metric tons in 1978 to 55,800 metric tons in 1980. Urea imports increased from 90,900 metric tons in 1978 to 92,700 metric tons in 1980. The increase in imports of both ammonia and urea are the combined result of increased domestic demand and larger exports. 2/

Exports.--Chemical exports from Canada increased from $3.2 billion in 1980 to $4 billion in 1981, or by 20 percent. 3/ Canada has as a goal the reversal of its historical role as an exporter of natural resources and an importer of finished products. The petrochemical industry's expansion plans are intended not only to make Canada self-sufficient in petrochemicals, thus alleviating the need for imports, but also to increase the potential to export. 4/

Canada is looking toward nations other than the United States as markets for its exports. Among the most likely markets for excess production capacity besides the United States are Mexico, Japan, and the other Pacific Rim nations.

Prior to 1978, Canada exported ethylene and imported ethylene derivatives; however, in 1978, several ethylene-derivative plants came on-stream. One result is that exports of plastics increased from 128,636 metric tons in 1975 to 379,091 metric tons in 1980, or by 31 percent per year. The increased capacity to produce other natural gas-based petrochemicals has also resulted in export growth. For example, exports of ammonia increased from 115,200 metric tons in 1975 to 480,000 metric tons in 1980; exports of urea increased from 101,700 metric tons in 1975 to 750,000 metric tons in 1980. 5/

Pricing.--The provisions of the NEP affect petrochemical feedstock price and availability to the petrochemical industry. The petrochemical industry in the Western Provinces uses natural gas whose price is controlled by the NEP as its feedstock. At the same time, petrochemical companies that rely on crude petroleum as a feedstock (about 35 percent of total petrochemical production) cannot expand since the NEP sets limits on their use of crude petroleum. 6/

1/ Ibid.
2/ Ibid.
3/ "Canadian Petrochemicals Set for Big Growth," Chemical & Engineering News, May 25, 1981, p. 17.
4/ Ibid.
5/ Ministry of Industry, Trade and Commerce, Statistic Canada, Ottawa, Canada, 1975-81.
6/ "Canadian Petrochemicals Set for Big Growth," Chemical & Engineering News, May 25, 1981, p. 21.

The NEP established a Federal petroleum and natural gas revenue tax (8% initially) applied to net producer revenues from Canadian petroleum and natural gas production. This tax is not deductible from federal income taxes, nor are deductions allowed from net revenues for exploration and development expenses. 1/ According to Federal calculations, Ottawa's share of petroleum and natural gas revenues could increase from 10 percent to 24 percent. The amount retained by the producing Provinces could decrease from 45 percent to 43 percent, and the producer is expected to keep only 33 percent of revenues, compared with 45 percent before the NEP became effective. 2/ Such revenue changes could affect investment in the petrochemical industry.

The NEP, signed in September 1981, established a two-tier pricing system for old petroleum (discovered prior to Jan. 1, 1981) and new petroleum (discovered after Dec. 31, 1980). It provided for a schedule of price increases that intended to bring old petroleum prices to $58 per barrel on July 1, 1986, with a ceiling of 75 percent of the international price at Montreal. The price for new petroleum, including synthetic crude, was estimated at $46 per barrel on January 1, 1982 and is expected to reach $77 per barrel by July 1986 with a 100-percent ceiling of the international price. 3/

The continuing decline in world petroleum prices was not anticipated when the agreement was designed. As a result, Canadian industry sources have stated that unless the world price of petroleum returns to the levels anticipated by the NEP, the price for Canadian petroleum could exceed 85 percent of the international price before 1986. 4/

Under the agreement, the Natural Gas and Natural Gas Liquids (NGGLT) Excise Tax, which is levied on propane and butane, but not ethane, established that natural gas prices would increase steadily reaching 65 percent of the Toronto gate price of crude petroleum by 1986. 5/ The discount price of natural gas compared with petroleum reflects the relative price position of both energy sources if the market had remained unregulated. The NGGLT Excise Tax, which was 67 cents per thousand cubic feet in 1982, is added to the cost of producing petrochemicals in an effort to reduce the comparative feedstock advantage which Alberta producers would have enjoyed in an unregulated energy market; 6/ however, it has also resulted in higher prices for LPG for the Eastern producers of petrochemicals. 7/

1/ Ibid., p. 18.

2/ "Canadian Petrochemicals Set for Big Growth." Chemical & Engineering News, May 25, 1981, p. 18, and John H. Dinsmore, "The Cost and Availability of Oil-Based Feedstocks," a speech delivered at the Financial Post Conference, Edmonton, Apr. 21, 1982, p. 23.

3/ "Alberta Seeks Changes in Energy Facts," Chemical Week, Apr. 14, 1982, p. 55.

4/ John H. Dinsmore, "The Cost and Availability of Oil-Based Feedstocks," a speech delivered at the Financial Post Conference, Edmonton, Apr. 21-22, 1982, p. 23.

5/ Robert L. Pierce, "Alberta Petrochemical Prospects," a speech delivered at the Financial Post Conference, Edmonton, Apr. 21-22, 1982, P. 175-176.

6/ Ibid.

7/ "Canadian Petrochemicals: Great Opportunity Has Turned Sour," Chemical & Engineering News, Mar. 7, 1983, p. 11.

Energy Base

Petroleum

Reserves.--A large portion of Canada's crude petroleum reserves are located in the Western Provinces and are estimated to be 7 billion barrels, as of January 1, 1983. Proved reserves of light crude petroleum, more desirable for the production of light petroleum products such as motor gasoline, are estimated to be approximately 5 billion barrels, or approximately 71 percent of the total. 1/

There are also extensive deposits of about 1 billion barrels of crude petroleum in Alberta and Saskatchewan, however, these reserves are difficult and expensive to recover because of climate, terrain, and location in relation to markets. 2/ Also, crude bitumen in oil sands is estimated at more than 1 trillion barrels, but the technological and logistical problems associated with its recovery are formidable, and thus the capital costs would be high. 3/ The following tabulation shows estimated crude petroleum reserves by region: 4/

Region	Crude petroleum proved reserves
	Million barrels
Western Canada	19,200
Mackenzie-Beaufort	9,400
Artic Islands	4,300
East coast	7,400

Production.--Canadian crude petroleum production in 1982 totaled approximately 486 million barrels, or 1.2 million barrels per day. As shown in the following tabulation, Alberta accounted for about 87 percent of Canada's 1982 crude petroleum production: 5/

1/ "Worldwide Report," Oil & Gas Journal, Dec. 27, 1982, p. 79.
2/ Ibid.
3/ "Chemical Cooperation in Resources of the North American Continent," Chemical & Engineering News, Sept. 22, 1980, p. 35.
4/ Geological Survey of Canada.
5/ "Worldwide Report," Oil & Gas Journal, Dec. 27, 1982, pp. 105-107.

Province	Average production	Percent of total products
	1,000 barrels per day	
Alberta	1,068	87
British Columbia	35	3
Manitoba	9	1
Saskatchewan	116	9
Ontario	2	1/
Northwest Territories	3	1/
Total	1,233	100

1/ Less than 0.5 percent.

In 1981, production of light crude petroleum was 450 million barrels and that of heavy crude petroleum was about 75 million barrels. 1/ Canadian production capacity for crude petroleum from oil sands was about 60 million barrels in 1981. 2/ More than 87 percent of Canada's total production of petroleum comes from Alberta, 13 percent from Saskatchewan, and 4 percent from the Northern Territories, Manitoba, Ontario, and New Brunswick.

Consumption.--Canadian consumption of petroleum was estimated to be 700 million barrels per year in the late 1970's and in 1980. 3/ Petroleum supplies about 37 percent of Canada's total energy requirements. 4/ Domestic petroleum production supplies approximately 70 percent of domestic demand for petroleum, with imports accounting for the remaining 30 percent. 5/

Exports.--Canada exported 164 million barrels of crude petroleum in 1981, of which the United States accounted for 94 percent. Canadian crude petroleum exports to the United States were 425,000 barrels per day, or approximately 150 million barrels in 1981. Canada's other markets in 1981 were Western Europe, Africa, and Latin America.

Natural gas

Reserves.--Estimated proved reserves of Canadian natural gas were 97 trillion cubic feet, as of January 1, 1983, including reserves in the frontier areas. 6/ Western Canada accounts for approximately 37 percent of total natural gas reserves; the Mackenzie-Beaufort Delta, 26 percent; the Artic Islands, 20 percent; and the east coast, 17 percent.

1/ "Chemical Cooperation in Resources of the North America Continent," Chemical & Engineering News, Sept. 22, 1980, p. 35.
2/ "Newsletter," Oil & Gas Journal, May 25, 1981.
3/ "Chemical Cooperation in Resources of the North American, Continent," Chemical & Engineering News, Sept. 22, 1980, p. 35.
4/ The British Petroleum Co., p.l.c., BP Statistical Review of World Energy, 1981, p. 12.
5/ "Newsletter," Oil & Gas Journal, May 25, 1981.
6/ "Worldwide Report," Oil & Gas Journal, Dec. 27, 1982, p. 77.

Production.--Canadian production of natural gas reached approximately 2.6 trillion cubic feet in 1981. 1/ Alberta accounted for 2.5 trillion cubic feet, or 98 percent of total Canadian natural gas production in 1981.

Canada produced approximately 16.8 million gallons per day of NGL's in 1981, of which ethane accounted for 19 percent, and propane accounted for 16 percent. The following tabulation lists the average daily production of selected NGL's by product and Province: 2/

Province	Ethane	Propane	Butane	NGL mix	Natural gasoline
	1,000 gallons				
Alberta	3,110.5	2,365.0	1,567.0	3,592.4	3,624.2
British Columbia	-	58.2	59.0	-	107.7
Saskatchewan	63.0	45.6	16.9	0.5	-
Northwest Territories	-	-	-	-	1.2

Consumption.--In 1981, approximately 68 percent of Canada's natural gas production was consumed domestically, 31 percent was exported to the United States, and 1 percent was used as fuel in transmission networks or reinjected into production reservoirs. 3/ Natural gas is estimated to provide about 22 percent of Canada's total energy requirements. 4/ Natural gas produced in the Western Provinces supplies all of Canada's natural gas requirements.

Exports.--Canada supplied 840 billion cubic feet, or 12 percent of the world natural gas export market in 1980 and 1981. 5/ Future increases in exports of natural gas to the United States, which account for about one-third of total Canadian production of natural gas, are dependent, among other factors, on the completion of the Alaskan pipeline. The Canadian Government authorized the exportation of nearly 14 trillion cubic feet of natural gas to the United States through 1987, entering into markets in Chicago and California.

Other energy sources

Canada, whose coal reserves are estimated at 40 billion metric tons, produced about 40 million metric tons of coal in 1980. 6/ Coal accounted for

1/ International Petroleum Encyclopedia, vol. 15, 1982, p. 354.
2/ Ibid., p. 440.
3/ International Petroleum Encyclopedia, vol. 13, 1982, p. 440.
4/ The British Petroleum Co., p.l.c., BP Statistical Review of World Energy, 1981, p. 100.
5/ International Petroleum Encyclopedia, vol. 13, 1982, p. 83.
6/"Chemical Cooperation in Resources of the North American Continent," Chemical & Engineering News, Sept. 22, 1980 p. 35.

about 10 percent of Canada's total energy requirements in 1981. 1/ Approximately 20 million metric tons of production are metallurgical coals, which are used for the production of steel and exported to Japan. At the same time, Canada imports about 17.7 million metric tons of steam coal, which is used for the generation of power, from the United States. 2/

Another major source of Canada's energy requirements is waterpower. Waterpower accounted for nearly 27 percent of Canada's total energy requirements in 1981. 3/

Petrochemical Plans

Products

The principal basis of Canada's world scale petrochemical industry is the availability of feedstocks from natural gas. A large portion of Canada's crude petroleum and natural gas reserves are located in the Western Province away from the major consuming areas in the East. Therefore, since Canada's world-scale petrochemical complexes are located in the Provinces of Alberta, the export markets of the United States and the Pacific Rim are attractive and easily accessible. By 1990 Canada could become a net exporter of petrochemical derivatives.

Efforts are currently underway in Canada to assess the potential for the petrochemical industry in the Eastern Provinces. Existing petrochemical facilities in Montreal and Sarnia are faced with high feedstock prices which make it difficult to compete in the world market. 4/ In Alberta, petrochemical producers are also faced with high feedstock prices as a result of the provisions of the NEP. The NEP has forced feedstock prices to increase at a time when world prices for these feedstocks have been decreasing. In 1982, prices for petroleum-based feedstocks used in the Eartern Provinces had increased by 15 percent from the 1981 prices; and prices for natural gas-based feedstocks (ethane) increased by 18 percent compared with a 30-percent decrease in the price of ethane on the U.S. gulf coast. 5/ In 1982, the Alberta price for ethane was $10.50 per barrel versus a U.S. gulf coast price of $8.50 per barrel. 6/

As a result of these high feedstock prices, Canadian petrochemical producers petitioned the Federal Government for relief from high prices for petrochemical producers in Sarnia and Montreal in order to allow them to be

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1/ The British Petroleum Co., p.l.c., BP Statistical Review of World Energy, 1981, p. 100.
2/ Official statistics of the U.S. Department of Commerce.
3/ The British Petroleum Co., p.l.c., BP Statistical Review of World Energy, 1981, p. 10.
4/ "Eastern Canada Eyed for Petrochemicals," Chemical & Engineering News, Jan. 3, 1983, p. 24.
5/ "Canadian Petrochemical Officials Seek Government Relief from High Feedstock Prices," Platt's Oilgram News, Nov. 17, 1982, p. 14.
6/ "Uncertainty Hits Several Major Canadian Petrochemical Projects," European Chemical News----Petrochemical '82 Supplement, Dec. 20, 1982, p. 10.

able to compete effectively with petrochemical producers in the western Provinces as well as on the U.S. gulf coast. 1/ The petroleum-based petrochemical producers were seeking relief from some of the NEP taxes which were levied on petroleum upgraded into petrochemicals, as well as changes in the pricing policy for other petrochemical feedstocks, in order to provide flexibility if world prices fluctuate. The Canadian Federal Government recently responded by offering loans to two of the eastern producers; however the loans are contingent upon matching funds from the Provinces. 2/

Many of the petrochemical producers in Canada are large multinational companies, many of which are based in the United States. Table 10 shows the location, capacity, and proposed startup date of the announced Canadian petrochemical projects:

1/ "Canadian Petrochemical Officials Seek Government Relief from High Feedstocks Prices," Platt's Oilgram News, Nov. 17, 1982, p. 14.
2/ "Canadian Government to Aid Petrochemical Firms," Chemical & Engineering News, Mar. 14, 1983, p. 7.

Table 10.-- Canada's planned petrochemical projects

Product	Location	Capacity	Startup date
		1,000 metric tons	
Methanol	Medicine Hat, Alberta	360	1982
Ethylene	Red Deer, Alberta	680	1985
Ethylene	Red Deer, Alberta	680	1986
LLDPE	Red Deer, Alberta	270	1984
Methanol	Edmonton, Alberta	715	1/
Acetic acid	Edmonton, Alberta	365	2/
Vinyl acetate	Edmonton, Alberta	400	2/
LDPE	Edmonton, Alberta	35	1/
HDPE	Edmonton, Alberta	100	2/
Ammonia	Courtright, Ontario	375	1984
Urea	Courtright, Ontario	225	2/
LLDPE	Ft. Saskatchewan, Alberta	180	1985
Ethylene gycol/ethylene oxide	Ft. Saskatchewan, Alberta	3/	1985
EDC	Ft. Saskatchewan, Alberta	4/ 460	1985
Vinyl chloride monomer	Ft. Saskatchewan, Alberta	4/ 365	1985
LLDPE and HDPE	Edmonton, Alberta	250	1984
Ammonia	Redwater, Alberta	262	1983
Urea	Redwater, Alberta	492	1983
LLDPE	Sarnia, Ontario	175	1983
PVC	Sarnia, Ontario	40	1983
Benzene	Bruderheim, Alberta	323	1984
Styrene	Bruderheim, Alberta	408	1984
Ethylene	Redwater, Alberta	700	1986-87
Benzene	Edmonton, Alberta	220	2/
Methanol	Kitimat, British Columbia	420	1/
Benzene	Scotford, Alberta	235	1984
Styrene	Scotford, Alberta	300	1984
Linear olefins	Scotford, Alberta	3/	2/
Ammonia	Ft. Saskatchewan, Alberta	340	1983
Urea	Ft. Saskatchewan, Alberta	310	1983
LLDPE	Sarnia, Ontario	23	1/
Ethylene glycol	Prentiss, Alberta	225	1984

1/ Plant in operation.
2/ Indefinite.
3/ Not available.
4/ Includes current capacity.

Source: "Canadian Chemical Producers Go Conservative," Chemical Marketing Reporter Oct. 18, 1982, p. 14.

By the end of the 1980's, it is expected that $6 billion in new petrochemical projects will be in Alberta as compared with approximately $2 billion in the eastern Provinces. 1/ Whereas plants in the western Province's should primarily be based on natural gas and ethane, the eastern Province's plants may continue to be based on crude petroleum, much of which may continue to be imported. The esentially higher cost eastern producers are closer to the country's major markets than the western producers and can offset some of these costs with lower shipping costs.

Although the announced petrochemical projects in Alberta have not changed, their startup dates may be delayed. By the mid-1980's, however, enough ethylene capacity should be on-stream to support most of the planned derivatives plants.

Potential industry status by 1990

Canada has announced petrochemical industry expansion plans for nearly 10 billion metric tons of additional capacity which could come on-stream by 1990. If this scenario occurs, Canada could be an important exporter of petrochemical derivatives by 1990. The following tabulation shows production capacity for Canada for ethylene, ammonia, and methanol in 1980 and the base scenario for 1990:

Product	1980	1990	Percentage increase between 1980-90
	1,000 metric tons		
Ethylene	1,600	3,700	131
Ammonia	2,065	4,105	99
Methanol	450	2,000	344

This increase in petrochemical capacity could impact the world market. Since Canada has a limited domestic demand, excess capacity has been earmarked for export. The following tabulation shows the data for ethylene, ammonia, and methanol expressed in shares of total world production in 1980 and the base scenario for 1990 (in percent):

1/ "Pressure on Ethylene from the North," Chemical Week, Dec. 9, 1981, p. 32.

Product	1980	1990
Ethylene	3	6
Ammonia	2	3
Methanol	3	7
Total	8	16

Canada's petrochemical industry expansion plans are associated with the price of feedstock and energy which are regulated by the NEP. Reportedly, below-world-level prices are needed in world-scale facilities, particularly in the Western Provinces, if investment is to continue. 1/

Goals

Canada's petrochemical plans are dependent, in part, on its natural resources and its goal of "Canadianization" of the petroleum and natural gas industry. Canada's political stability, energy plans, and transportation infrastructure development could be important to the success of the petrochemical industry. And the petrochemical industry should help Canada meet some of its social goals, such as increasing employment.

Infrastructure.--The infrastructure of Canada is similar to that in the United States. Canada has a good system of transportation as well as a sophisticated communications network. There are approximately 60,000 miles of rails and 690,000 miles of highway, as well as 25 large deep-water ports and 600 smaller port facilities. 2/ In addition to its coastal ports, Canada borders the St. Lawrence Seaway and the Great Lakes which allow for easy access to world petrochemical markets.

Canada's petroleum and natural gas are shipped via a network of pipelines to petrochemical plants. There are plans to expand its pipeline system in response to petrochemical expansions by an additional 9,768 miles of pipe. Canada's section of the Alaskan pipeline was to include more than 527 miles of pipe. Other pipeline projects could carry natural gas from the Artic Islands, the Beaufort Sea, and the Mackenzie Delta to the petrochemical facilities further south. 3/

Energy.--The NEP includes a goal of reducing foreign control of Canada's energy industry by 1990 in an effort to decrease crude petroleum imports and to largely Canadianize the petroleum industry. 4/ To achieve this end, the NEP established a goal of 35 percent Canadian ownership of the petroleum

1/ "Canadian Petrochemicals: Great Opportunity Has Turned Sour," Chemical & Engineering New, Mar. 7, 1983, p. 11.
2/ Statistic Canada, Canada Yearbook, p. 742,762 and 765-766.
3/ Statistic Canada, Canada Yearbook, pp. 742, 762 and 765-766.
4/ "The Canadian Economy," Business Week, June 28, 1982, p. 81.

industry by 1982; in actuality, only 7 percent Canadian ownership, or 20 percent of the goals was achieved by this date.

Social needs.--Currently, Canada, like many other nations is beset with high inflation, increased unemployment, and weak energy prices. Although per capita income in Canada is relatively high, per capita consumption of petrochemicals is below that of some nations at comparable stages of economic development, such as the United States. Canada's petrochemical expansion plans are intended to supply an increasing domestic demand for downstream products which had, in the past, been imported. These expansions should increase employment and per capita income, and thus also help foster the development of domestic demand for petrochemicals and petrochemical products.

Political framework.--Canada has historically welcomed foreign investment to fund projects for the development of its resources; however, the NEP's recent move to Canadianize the petroleum and natural gas industries has dampened foreign participation. While the policy of Canadianization continues, the target date of 1990 is expected to be postponed, with foreign investment in the nation's petroleum and natural gas industries perhaps becoming more acceptable. 1/

Since the majority of Canada's petrochemical expansion plans are dependent upon natural gas feedstock, these plans could be affected by changes in foreign investment in the petroleum and natural gas industries or changes in the Canadian Government's energy policy. Allowance for increased exploitation of Canada's natural resources could result in increases in petrochemical production.

1/ Ibid.

Mexico

Background

Mexico is a country of 764,000 square miles with a population in 1981 of approximately 69 million, of which approximately 60 percent are mestizo (Indian-Spanish). The terrain varies from coastal lowlands to high mountains. Mexico's natural resources include large deposits of crude petroleum, natural gas, silver, copper, and gold. The per capita income in Mexico is about $1,800. 1/

Current Petrochemical Industry Status

Market

PEMEX is the Mexican state-owned petroleum company formed in 1938 to maintain petroleum industry productivity after Mexico nationalized the industry and expropriated foreign investments. PEMEX was also designed to achieve such social goals as full employment of the Mexican population; the stabilization of petrochemical and petroleum prices; and the satisfaction of domestic demand for petrochemicals.

PEMEX operated 72 plants in 15 petrochemical centers in 1982, producing 38 different petrochemicals, 28 of which were available for export and 10 of which were solely for domestic consumption. Approximately 40 percent of the domestic demand for petrochemicals was met by domestic production. Petrochemical imports accounted for the remaining 60 percent of domestic demand and have traditionally exceeded petrochemical exports, causing a negative trade balance.

In the past, small chemical plants produced for domestic consumption and Mexico relied heavily on imports to satisfy demand for petrochemicals which were not domestically produced. Very little petrochemical production was exported since it was needed to supply domestic demand and because the small plants could not produce petrochemicals that were price competitive in the world market.

The plastics industry in Mexico has been one of the most dynamic segments of the nation's chemical industry during the past decade with total consumption of all plastics increasing from 200,000 metric tons in 1970 to 847,000 metric tons in 1980, or by an average annual growth rate of 16 percent. 2/ Per capita consumption of plastics in 1980 reached 27 pounds, but, in spite of the high growth rates, was still below the United States with per capita consumption in 1980 of 107 pounds. This would appear to indicate a good future growth potential.

1/ "Mexico," Background Notes, U.S. Department of State, April 1981 and U.S. Central Intelligence Agency, The World Factbook - 1981, April 1981, pp. 132-133.

2/ "Plastics Industry Report," Made in Mexico, vol. IV, No. 4, p. 34.

There currently are about 50 plastics producers in Mexico and approximately 300 companies engaged in the conversion of these plastics to finished products. 1/ Despite the number of plastics producers, the industry is not considered mature, since production does not meet domestic demand.

Mexico's 1982 production of ammonia could reach about 7,200 metric tons per day, or approximately 2.9 million metric tons per year, at the PEMEX Cosoleacaque petrochemical complex at Veracruz. The complex includes six plants which produce ammonia and fertilizers, of which 65 percent is for domestic use and 35 percent for export. The fertilizers produced include urea, ammonia sulphate, phosphate, ammonia superphosphate, and anhydrous ammonia. 2/

Industry

The ownership of Mexico's petrochemical industry is divided between PEMEX and private companies; however, by law, only PEMEX can produce "basic" petrochemicals. Basic petrochemicals are defined as the basic building blocks, such as olefins and aromatics as well as certain first-order derivatives. Thus, resins such as polyethylene and polypropylene are considered basic petrochemicals and fall under the sole purview of PEMEX.

Private ownership in the "secondary" petrochemical (all petrochemicals not classified as basic petrochemicals) industry requires a Government permit which is issued based upon favorable findings of a project feasibility review. Such projects must be controlled by Mexican interests and foreign ownership is limited to a maximum of 40 percent. 3/

There appears to be little incentive for foreign-owned, or even domestic Mexican firms, to develop new processes, or for foreign corporations to bring new processes to Mexico. Patent and trademark laws do not guarantee any rights or payment of royalties to the originator of the process as in most of the industrialized world. 4/

In 1974, the National Industrial Development Plan (NIDP) was instituted to provide private industry with a number of incentives to increase the nameplate capacity for certain chemicals. The incentives included 30-percent discounts on energy and feedstocks supplied by PEMEX to plants located in

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1/ Ibid.

2/ "Mexico World's Top Ammonia Producer," Manufacturing Chemist, September 1982, p. 30.

3/ Carlos Pani, "Major Developments in the Mexican Petrochemical Industry in the '80's," as printed by Shearson/American Express, Chemical Notes, Apr. 2, 1982, p. 5.

4/ The reader is referred to "U.S./Mexico Relations and Potentials Regarding Energy, Immigration, Scientific Cooperation and Technology Transfer," a document prepared by the Committee on Science and Technology, U.S. House of Representatives, 96th Cong., 1st Sess., July 1979, pp. 6-7.

"high priority zones" 1/ in return for agreeing to export at least 25 percent of their production for 3 years. 2/

Mexico's NIDP for 1979-90 includes goals such as increasing domestic production of petrochemicals by building world-scale plants in order to supplant imports and increase exports. 3/ Rather than increasing exports of crude petroleum and natural gas, it appears Mexico seeks to utilize its raw materials internally and export downstream products to take advantage of the greater profits inherent in value-added merchandise.

Mexico's petrochemical industry has continually been one of the most dynamic industries in Mexico, only topped by the petroleum industry itself. The Mexican petrochemical industry has experienced production growth rates of about 27 percent per year since the early 1960's when several units came on-stream producing urea. 4/ The value of Mexico's chemical production increased from $1.5 billion in 1975 to $6 billion in 1981 (at 1981 exchange rates). 5/ However, in 1982, the petrochemical industry did not achieve the anticipated continuation of high growth rates because of high interest rates, shortages of hard currency, lack of raw materials, and decreased domestic consumption. 6/

Mexico's ethylene capacity increased from 435,000 metric tons in both 1980 and 1981 to 935,000 metric tons in 1982 as a result of La Cangrejera's ethylene plant which came on-stream in early 1982. The following tabulation shows Mexico's reported installed ethylene capacity, by location, as of July 1, 1982: 7/

1/ The high-priority zones are Coatzacoalcos, Veracruz; Lazaro Cardenas, Michoacan; Salina Cruz, Oaxaca; and Altamira, Tamaulipas.

2/ U.S. Department of State, "Update on Secondary Petrochemical Industry: Northeastern, Mexico," airgram, Reference No. A-16, Dec. 13, 1982, p. 2.

3/ Business International Corp., Investing, Licensing, and Trading Conditions Abroad-Mexico, 1980, pp. 3-22.

4/ Fernando Gutierrez Saldivar, "Competitiveness of the Mexican Chemical and Petrochemical Industry," as presented at the Second Annual Congress of the North American Continent, Las Vegas, Nev., 1980, pp. 10-14.

5/ "The Mexican Report," Oil & Gas Journal, Sept. 6, 1982, p. 76.

6/ U.S. Department of State, "Update on Secondary Petrochemical Industry: Northeastern Mexico," airgram, Reference No. A-16, Dec. 13, 1982, p. 2.

7/ "The Mexican Report," Oil & Gas Journal, Sept. 6, 1982, p. 76.

Company	Location	Capacity	Feedstock
		--1,000 metric--- tons	
PEMEX	La Cangrejera	500	Ethane
	Pajarito	209	Ethane
	Posa Rica	182	Refinery streams
	Reynosa	27	Light hydrocarbons
	Ciudad Madero	14	Refinery streams
	Minatitlan	3	Refinery streams
Total	-	935	-

PEMEX produced 7.2 million metric tons of basic petrochemicals in 1980 and approximately 8.3 million metric tons in 1981. 1/ Total production of all basic petrochemicals probably ranged from 9.6 million metric tons to 11.2 million metric tons in 1982, depending on the number of derivatives plants that actually went on-stream at La Cangrejera. 2/

Mexico's petrochemicals mix changed between 1980 and 1981 as a result of changing domestic demand and exports. Table 11 shows the annual petrochemical production in 1981.

1/ "Mexican Buildup Aims for Self-Sufficiency," Chemical & Engineering News, Dec. 21, 1981, p. 52.

2/ Ibid, and "Mexico's Petrochemical Slowdown," Chemical Week, Nov. 10, 1982, p. 34.

Table 11.--Mexican petrochemical production, by type, 1981

Product	Production	Percentage change, 1981 from 1980
	1,000 metric tons per year	Percent
Acetaldehyde	122	157
Acrylonitrile	54	-1
Ammonia	2,183	16
Benzene	77	-4
Butadiene	12	-28
Cumene	2	1/
Cyclohexane	44	11
Dodecylbenzene	60	7
Ethane	1,337	112
Ethyl benzene	29	-1
Ethylene	378	3
Ethylene oxide	48	63
Methanol	180	3
Nitrogen	30	1/
HDPE	78	17
LDPE	91	0
Propylene	156	14
Styrene	33	5
Sulfur	426	5
Toluene	132	5
Vinyl chloride	57	-9
Xylenes	142	7

1/ A new product in 1981.
Source: "The Mexican Report," Oil & Gas Journal, Aug. 30, 1982, p. 111.

Trade

Historically, Mexico has had a negative chemical trade balance, with imports exceeding exports by about a 3 to 1 margin. Mexico had negative trade balances of $880 million in 1979, $1.3 billion in 1980, 1/ and $1.4 billion in 1981. 2/ It appears likely that there was a negative trade balance of over $2 billion in 1982.

Imports.--In 1980, about 60 percent of Mexico's total chemical imports came from the United States. While Mexico's petrochemical industry can now satisfy domestic demand for certain natural-gas-based petrochemicals, it has been deficient in the production of propylene and butadiene derivatives. Part of the reason has been the use of lighter feedstocks for the olefins plants which results in lower yields of propylene and butadiene than obtained with naphtha and other petroleum-based feedstocks. Industry sources believe that

1/ "Mexican Buildup Aims for Self-Sufficiency," Chemical & Engineering News, Dec. 21, 1981, p.36.
2/ "Mexico's Petrochemical Slowdown," Chemical Week, Nov. 10, 1982, p. 34.

Mexico will most likely continue to make imports, particularly of such petrochemicals well into the late 1980's. 1/

Only two products, LDPE and para-Xylene, accounted for 40 percent of Mexico's total imports of basic petrochemicals in 1981; imports of LDPE, para-Xylene, styrene, butadiene, and vinyl chloride accounted for 67 percent. The following tabulation shows Mexico's imports of basic petrochemicals in 1981, by products: 2/

Product	Imports in 1981
	(1,000 metric tons)
LDPE	126
para-Xylene	148
Styrene	88
Butadiene	54
Vinyl chloride	84
Dodecylbenzene	33
Ethylene oxide	31
Acrylonitrile	20
Propylene	24
Propylene tetramer	23
Benzene	21
Toluene	23
HDPE	10
Ethylene	15
Isopropyl alcohol	15
ortho-Xylene	12
Xylenes	15
Ethylbenzene	11
Perchloroethylene	17
Cyclohexane	8
Acetaldehyde	6

Mexico is not a member of the GATT and maintains relatively high tariffs and nontariff barriers (NTB's). Rates of duty on imports of olefins and aromatics, the sole purview of PEMEX, average around 5 percent ad valorem. However, Mexico relies more on the use of NTB's than duty restrictions to minimize imports. 3/

The most significant of the NTB's imposed by the Mexican Government is its system of import licenses which are used to control imports and promote the development of domestic industries. Most domestic petrochemicals production is protected by the use of these licenses. Often when a license requirement is removed, the duty rate is reevalutated and frequently raised. 4/

1/ Ibid., p. 36.

2/ "Slump Hits Mexican Chemical Industry," Chemical & Engineering News, Oct. 11, 1982, p. 18.

3/ U.S. Department of Commerce, "Questions and Answers From Mexican Workshops," Business America, June 1980, p. 12.

4/ Ibid.

Incentives to buy domestic products can also be considered impediments to trade. For example, companies, including petrochemical producers, are eligible for a 5-percent tax credit on the purchase of domestically manufactured equipment and machinery. 1/ Another example is the 30-percent price discount on PEMEX's basic petrochemicals which is provided to companies that agree in turn to grant a 10-percent discount on their product prices to other domestic secondary petrochemical producers. 2/

Exports.--Approximately one-half of Mexico's chemical exports go to the United States. Since Mexico is eligible for GSP treatment, exports to the United States incur little or no duty.

Mexico's petrochemical exports have been relatively modest with the exception of ammonia. 3/ Of a total of approximately 775,000 metric tons of petrochemicals exported in 1980, ammonia accounted for 710,000 metric tons, or 92 percent, with ethylene and methanol making up the remainder.

In 1980, Mexico introduced a value-added tax (VAT). Mexican exports are exempt from the VAT and exporters are given credit for VAT charges on their purchases of raw materials. 4/

In addition to exemption from VAT, exporters can receive tax rebates on the indirect taxes on production that is exported. To qualify, exported products must have at least 30-percent local content. Unless a producer can prove that he actually pays indirect taxes at a higher rate, the amount of the rebate is a flat 5 percent. 5/

Producers of secondary petrochemicals may receive 30-percent discounts on feedstocks from PEMEX for a period of 10 years, provided they locate new facilities in priority zones, which are located away from the congested Mexico City area. In order to receive these discounts, expansion must increase capacity by at least 40 percent and firms must commit at least 25 percent of their increased production to exports for a 3 year period without adversely affecting supplies for internal consumption. 6/

Energy Base

Petroleum

Reserves.--Mexico, with estimated crude petroleum proved reserves of 48.3 billion barrels, as of January 1, 1983, ranks fifth in the world behind

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1/ Business International Corp., Investing, Licensing, and Trading Conditions Abroad-Mexico, p. 22.

2/ Prices Waterhouse, Doing Business in Mexico, 1979, pp. 44-45.

3/ In November 1982, U.S. producers of fertilizers petitioned both the U.S. Department of Commerce and the U.S. International Trade Commission alleging that Mexican exports of ammonia to the United States are being sold at less than fair value.

4/ Price Waterhouse, op.cit., pp. 158-160.

5/ Business International Corp., Investing, Licensing, and Trading Conditions Abroad-Mexico, p. 30.

6/ Prices Waterhouse, op. cit., pp. 44 and 45.

Saudi Arabia, Kuwait, the U.S.S.R., and Iran. 1/ Mexico's estimated proved reserves of crude petroleum have decreased by 15 percent since 1982. As a result of financial problems in 1982, PEMEX shifted its resources from exploration to production of crude petroleum.

Production.--With estimated production of 2.7 billion barrels per day, Mexico is the fourth largest producer of crude petroleum in the world behind the U.S.S.R., Saudi Arabia, and the United States. 2/ The major crude-petroleum-producing areas in Mexico are shown in the following tabulation: 3/

Zone	Average production	Percent of total production
	1,000 barrels per day	Percent
North Zone	128	5
Central Zone:		
Poza Rica	108	4
N. Falade Oro	7	1/
Veracruz	11	1/
Southern Zone	716	27
Gulf of Campeche	1,730	63
Total	2,700	100

1/ Less than 0.5 percent.

The current production mix consists of Isthmus (lighter) and Maya (heavier) crude petroleum, and it was about 70 percent light and 30 percent heavy crude petroleum in 1981. 4/ The mix could change in the future as drilling produces more light crude petroleum and as refineries become better able to process heavy Maya crude petroleum.

The total production of crude petroleum increased from 2.4 million barrels per day in 1981 to 2.7 million barrels per day in 1982, or by 9 percent. The Gulf of Campeche, which accounted for 63 percent of Mexico's total daily production of crude petroleum in 1981, had 4 producing fields with 69 wells in 1982. 5/

Consumption.--Most domestic consumption of crude petroleum is in the form of gasoline and other refined products. Domestic consumption of these refined products has increased with population growth and increases in the gross national product. Gasoline consumption increased at an estimated rate of 15 percent per year from 1979 to 1981. 6/ Domestic consumption of kerosene increased at rate of 12 percent per year, and consumption of diesel fuel

1/ "Worldwide Report, Oil & Gas Journal, Dec. 27, 1982, pp. 78-79.
2/ Ibid., p. 77.
3/ Ibid., pp. 110-112.
4/ "Mexican Report," Oil & Gas Journal, Aug. 30, 1982, p. 92.
5/ "Worldwide Report," Oil & Gas Journal, Dec. 27, 1982, p. 112.
6/ "Oil Exports Buck the World Trend," Financial Times, Mar. 22, 1982, p. IV and "Mexico's Oil and Gas Policy: Implications for the U.S." Congressionnal Research Service, Issue Brief #IB79015.

increased at a rate of 8 percent per year. 1/ The average 1981 price for gasoline was $0.56 per gallon and automotive diesel fuel was $0.14 per gallon. 2/

Exports.--In 1981, as the world became oversupplied with crude petroleum, Mexico continued to increase its output. Mexico's refineries have the capacity to process about 1.5 million barrels per day of crude petroleum; thus, making it the eleventh largest refiner in the world. 3/

Mexico's exports of crude petroleum amounted to approximately 1 million barrels per day in 1981 as compared with 448,000 barrels per day in 1979. 4/ In 1982, PEMEX planned to export an average of 1.5 million barrels per day which is the ceiling on crude petroleum exports set by the Government.

The United States was Mexico's major market for crude petroleum in 1981, 5/ and accounted for 44 percent of Mexican exports, whereas Western Europe (including France, Italy, Portugal, Spain, and the United Kingdom) accounted for approximately 30 percent. Japan accounted for approximately 8 percent of Mexico's crude petroleum exports and has been steadily increasing the amount of Mexican crude purchased in response to its desire to diversify its sources of supply.

Since Mexico's trade is dominated by the United States, Mexico limited crude petroleum exports to the United States to 50 percent of total exports in 1982. In an effort to diversify its trading partners, 6/ Mexico has signed contracts with both Japan and Korea, calling for increased sales of crude petroleum in an effort to achieve this diversification. 7/

In early 1982, Mexico sold its top grade (Isthmus) crude for $32.50 per barrel (which was approximately $1.50 less than the OPEC price) and the heavier (Maya) crude sold for $25 per barrel. In 1981, Isthmus crude sold for $36.50 per barrel and the heavier Maya crude sold for $30 per barrel. 8/ In an effort to gain more buyers for its crude in a time when petroleum prices declined because of an oversupply of the product, Mexico offered incentives to purchasers, such as allowing 60 rather than 30 days for payment, thus essentially decreasing by about $0.40 per barrel the price of crude petroleum based on 1982 interest rates. 9/

1/ Ibid.

2/ "Worldwide Report," Oil & Gas Journal, Dec. 28, 1981., p. 87.

3/ "Oil Exports Buck the World Trend," Financial Times, Mar. 22, 1982, p. IV.

4/ Ibid.

5/ "Search Proves Abundance of Hydrocarbons," Financial Times, Mar. 22, 1982, pp. IV and V.

6/ "Why Mexicans are Pumping More Oil, Business Week, June 28, 1982, p. 43.

7/ "Mexican Report, Oil & Gas Journal, Aug. 30, 1982., p. 88.

8/ Ibid.

9/ "Why Mexicans are Pumping More Oil, Business Week, June 28, 1982, p. 43.

PEMEX contracted to export 1.5 million barrels per day of crude petroleum in 1982. The following tabulation shows the crude petroleum Mexico contracted to supply in 1982, by country: 1/

Country	Contracted crude petroleum exports	
	1,000 barrels per day	Percent of total export
Brazil	61.2	3.6
Canada	51.0	3.0
Central America and Caribbean	73.1	4.3
France	103.7	6.1
Israel	78.2	4.6
Italy	81.6	4.8
Japan	139.4	8.2
Philippines	10.2	0.6
Portugal	10.2	0.6
Korea	20.4	1.2
Spain	215.9	12.7
United Kingdom	91.8	5.4
Uruguay	10.2	0.6
United States	753.1	44.3
Total	1,700.0	100

Natural gas

Reserves.--As Mexico's crude petroleum production has increased, so has the output of associated natural gas. Mexico had estimated proved reserves of 76 quadrillion cubic feet of natural gas, as of January 1, 1983. 2/ Approximately 70 percent of its natural gas reserves are associated with crude petroleum, with large deposits in the areas of Reforma, Chicontepec, and the Gulf of Campeche. 3/

The northern section of the country contains large finds of nonassociated natural gas. In the area of Sabinas, over 7 trillion cubic feet of dry natural gas have been categorized as proved. 4/ Other areas containing nonassociated natural gas include Reynosa and the Gulf of Cortes.

Production.--Mexico's natural gas deposits are relatively concentrated; therefore, with the installation of a pipeline system, the amounts of gas flared during the production of crude petroleum has decreased. Mexico produced approximately 3.6 billion cubic feet per day in 1980 and 4 billion

1/ "Oil Exports Buck the World Trend" and "Search Proves Abundance of Hydrocarbons," Financial Times, Mar. 22, 1982, pp. IV and V.
2/ "Worldwide Report," Oil & Gas Journal, Dec. 27, 1982, p. 78.
3/ "Oil Exports Buck the World Trend," Financial Times, March 22, 1982, p. IV.
4/ Ibid.

Other energy sources

Mexico has the largest coal reserves of any Latin American country and imports less than 10 percent of its domestic coal requirements. Approximately 90 percent of the coal mined in Mexico is used in the production of coke for the steel industry. 1/ Mexico, with only one coal-field electric generating plant, Rio Escondido, relies more on petroleum than coal for its energy needs.

Approximately 10 percent of Mexico has been explored for reserves of uranium. URAMEX, the State-owned and operated uranium mining and milling company, has found that Mexico has economically recoverable reserves of approximately 15,000 metric tons of uranium ore. 2/ The first uranium milling operation, at Los Amoles in the State of Sonora, was expected to start-up in late 1982 with the capacity to produce 50 metric tons per year of uranium oxide 3/. Mining operations could begin during 1982-85 in three other Mexican states. 4/

Petrochemical Plans

Products

Primarily based on an abundance of inexpensive hydrocarbons which can be used as petrochemical feedstocks, Mexico has started the construction of a world-scale petrochemical industry, with a goal of 31 million metric tons of petrochemical capacity by 1990. 5/. Some of Mexico's projected plant on-stream dates, have, in the past, been overly optimistic.

Originally, PEMEX's expansion plans called for about $8 billion worth of petrochemical projects, doubling the number of plants from 82 in 1980 to 161 by 1985. The petrochemical complex at La Cangrejera could add 3.5 million metric tons to Mexico's primary petrochemical capacity by 1990. 6/ PEMEX announced plans to increase its nameplate capacity for primary petrochemicals from 2.3 million metric tons in 1980 to 6.7 million metric tons in 1985 and 12.4 million metric tons in 1990. 7/ The following tabulation shows nameplate capacity estimates for certain basic petrochemicals for 1985 and 1990, by product: 8/

1/ U.S. Department of State, "Update of Mexican Coal Developments," airgram, Reference No. A-06, Feb. 7, 1983, p. 1.

2/ "Search Proves Abundance of Hydrocarbons," Financial Times, Mar. 22, 1982, p. V.

3/ Uranium oxides are those chemicals which are used to fuel nuclear reactors.

4/ "Search Proves Abundance of Hydrocarbons," Financial Times, Mar. 22, 1982, p. V.

5/ "Mexico's Petrochemical Slowdown," Chemical Week, Nov. 10, 1982, pp.37-38.

6/ "Mexican Petrochemicals: The Big Buildup," Chemical Week, May 27, 1981, p. 30.

7/ "Mexico Increasing Petrochemical Capacity," Chemical & Engineering News, Sept. 14, 1981, p. 15.

8/ Ibid.

Product	Nameplate capacity	
	1985	1990
	---1,000 metric tons---	
Acetaldehyde	144	294
Acrylic acid	30	30
Acrylonitrile	174	224
Ammonia	4,770	-
Benzene	420	720
Butadiene	55	155
Cumene	40	80
Ethylbenzene	257	447
Ethylene	1,438	2,338
Ethylene dichloride	482	977
Ethylene oxide	128	328
HDPE	100	300
LDPE	299	540
Methanol	997	1,822
Polypropylene	-	200
Propylene	351	828
Styrene	183	333
Toluene	489	859
Vinyl chloride	270	570
Xylenes	350	645

As a result of declining crude petroleum export revenues and the devaluation of the peso in 1981-82, Mexico postponed some of these projects. PEMEX was authorized a budget of $16 billion for all operations for 1982. With the peso devalued, and a 3 percent across-the-board decrease in public spending, the 1982 petrochemical budget decreased from its original $800 million to $600 million. 1/

Although no project has officially been cancelled, many will not be on-stream until much later than planned, if at all. PEMEX's priorities currently include exploration for and production of more light crude petroleum, construction of refineries, and completion of 2 natural-gas treatment plants with a capacity of 1 billion cubic feet per day. 2/

In terms of petrochemicals, PEMEX has officially postponed the Laguna del Ostion and Dos Bocas complexes. PEMEX plans to bring the La Cangrejera complex completely on-stream by 1983 and the Morelos complex on-stream in two stages in 1987 and 1989.

Table 12 shows the production capacity, by products at La Cangrejera and Morelos, and the on-stream dates.

1/ "Mexico Takes a Harder Look at Petrochemicals," Chemical Week, Mar. 31, 1982, p. 14.
2/ Ibid.

Table 12.--Mexican petrochemical complexes estimated to come on-stream, by products, and capacity

Location	Product	Capacity	On-stream date
		1,000 metric tons	
La Cangrejera	Acetaldehyde	100	1980
	Benzene	299	1982
	Cumene	40	1981
	Cyclohexane	120	1983
	Ethylbenzene	188	1983
	Ethylene	500	1982
	Ethylene oxide	100	1982
	Heavy aromatics	50	1983
	Heptane	11	1983
	Hexane	35	1983
	LDPE	240	1983
	Xylenes	665	1982
	Nitrogen	20	1980
	Oxygen	200	1980
	Styrene	150	1983
	Toluene	371	1982
Morelos	Acetaldehyde	150	1989
	Acrylonitrile	50	1989
	Butadiene	100	1989
	Ethane	705	1987
	Ethylene	500	1987
	Ethylene oxide	200	1987
	HDPE	100	1987
	Hydrogen cyanide	75	1989
	Isopropyl alcohol	75	1989
	MIBE	60	1989
	Nitrogen	60	1989
	Oxygen	350	1989
	Polypropylene	100	1989
	Propylene	377	1989

Source: "Slump Hits Mexican Chemical Industry," Chemical & Engineering News, Oct. 11, 1982, p. 18.

Secondary petrochemicals, the domain of the private sector, are also expected to have increased capacity. In 1980, Mexico's capacity for 20 leading secondary petrochemicals was 1.9 million metric tons and it could reach 3.6 million metric tons by 1985 and 4.8 million metric tons by 1990. 1/ Unlike basic petrochemical production, secondary petrochemicals are often reliant on costly imports, in addition to which are usually produced in small and rather expensive-to-operate plants which results in high-unit-production costs.

1/ "Mexico Inceasing Petrochemical Capacity," Chemical & Engineering News, Sept. 14, 1981, p. 16.

The following tabulation shows the expected nameplate capacity estimates for certain secondary petrochemicals for 1985 and 1990, by product: 1/

Product	Nameplate capacity	
	1985	1990
	---1,000 metric tons---	
Acetic acid	175	200
Acetic anhydride	58	115
Acetone	44	60
Formaldehyde	40	60
Phenol	35	60
Phthalic anhydride	52	80
Urea	1,260	1,760
Vinyl acetate	40	80
Polyvinyl chloride	310	410
Polystyrene	135	205
Styrene-butadiene rubber	115	160
Polystyrene	245	355
Nylon	90	120

Mexico's secondary petrochemicals industry is often more adversely affected by factors in the banking industry than is the basic petrochemical industry. As a result of foreign exchange controls, for example, there may be a shortage of capital to cover current accounts and there may be no mechanism for buying imports of raw materials or receiving payments. 2/ Unable to obtain foreign exchange, some secondary petrochemical companies are turning increasingly to bartering in an effort to balance their imports into Mexico with their exports from Mexico. 3/

It is possible, that by the end of 1983, PEMEX could have an additional 3.3 million metric tons of capacity to produce such petrochemicals as ethane, ethylene, LDPE, vinyl chloride monomer, benzene, toluene, xylenes, ethylbenzene, styrene, propylene, dodecylbenzene, and acrylonitrile. 4/ By the late 1980's there could be even further additions to capacity of 7.8 million metric tons per year for such products as methanol, ammonia, ethylene, LDPE, propylene, polypropylene, acrylic acid, acrylonitrile, isopropanol, butadiene, and cyclohexane, bringing total installed petrochemical capacity to 31 million metric tons by 1990. 5/

1/ Ibid.

2/ "Mexico's Chemical Industry is Disarmed," Chemical Week, Sept. 22, 1982, p. 20.

3/ "Mexico Rattles the Multinationals," Business Week, Oct. 4, 1982, p. 87.

4/ "Mexico's Petrochemical Slowdown," Chemical Week, Nov. 10, 1982, pp. 37-38.

5/ Ibid.

Potential industry status by 1990

Mexico has announced projects for the construction of 31 million metric tons of basic petrochemical capacity and 4.8 million metric tons of secondary petrochemical which could come on-stream by 1990. If this scenario occurs, PEMEX would be able to satisfy domestic demand and become an important exporter of basic and/or secondary petrochemicals by 1990. The following tabulation shows production capacity for Mexico for ethylene, ammonia, and methanol in 1980 and the base scenario for 1990:

Product	1980	1990	Percentage increase between 1980 and 1990
	1,000 metric tons		
Ethylene	435	1,450	233
Ammonia	1,680	5,280	214
Methanol	170	1,200	606

The increases in petrochemical capacity could impact the world market. By 1990, Mexico could shift from a negative to a positive trade balance in chemicals since much of the production from the additional petrochemical capacity could be exported. The following tabulation shows the capacity data for ethylene, ammonia, and methanol expressed in shares of total world capacity in 1980 and the base scenario for 1990 (in percent):

Product	1980	1990
Ethylene	1	2
Ammonia	2	4
Methanol	1	4
Total	4	10

Mexico's petrochemical industry expansion plans are at least partially dependent upon revenues generated by the export of crude petroleum, petroleum products, and natural gas. With the current low world prices for crude petroleum and the devaluation of the peso, Mexico's expansions could be further delayed.

As a result of the imposition of foreign exchange controls, Mexico's secondary petrochemical industry has not had access to hard currencies, and therefore has been unable to purchase raw materials not available domestically. The secondary petrochemical industry expansions are dependent upon the completion of long delayed PEMEX projects such as the La Cangrejera complex to produce basic petrochemicals for downstream petrochemical production and alleviate the need for imported feedstocks.

Goals

Most of Mexico's petrochemical plans are dependent on or otherwise closely tied to its other goals. Political stability and an improved transportation infrastructure would help assure the success of the petrochemical plans. On the other hand, success in petrochemicals should help Mexico achieve its goals in energy and other areas.

Infrastructure.--Although the transportation infrastructure of Mexico expanded during the 1970's, inadequacies still exist. Between 1970 and 1980, the highway system increased from 72,000 kilometers to 212,000 kilometers, and the railroad system increased from 50 million kilometers to 55 million kilometers, but both systems are still considered to need further modernization. 1/

Approximately 75 percent of the crude petroleum and natural gas distributed within Mexico is shipped via pipelines. 2/ The national pipeline network consists of approximately 43,000 kilometers with 19,000 kilometers of pipelines that transport petroleum and natural gas from the fields; 1,000 kilometers to carry off-shore deposits; and 23,000 kilometers to transport and distribute the crude petroleum and natural gas to refineries and industrial plants. 3/ Mexico hopes to construct an additional 3,300 kilometers of natural gas pipelines and 700 kilometers of crude petroleum pipelines by the mid-1980's. 4/

Energy.--In an effort to diminish its dependence on crude petroleum exports for revenue, Mexico has embarked on a plan to expand its petrochemical industry utilizing natural gas as feedstocks. Mexico hopes to decrease the amounts of natural gas flared, develop its petrochemical industry, decrease petrochemical imports, and increase petrochemical exports.

Social needs.--Mexico is a nation with high unemployment, devalued currency, and high inflation, with much of the population outside the money market. In addition, the buying power of many workers declined because of concessions made in the past by labor unions in order to achieve the creation of more and better jobs. 5/ Such conditions have contributed to the low per capita consumption of petrochemicals in Mexico. Expanded employment in the petrochemical and allied industries should aid Mexico in its efforts to increase the number of jobs and GNP per capita. This, in turn, may increase Mexico's per capita consumption of petrochemcals.

1/ "Mexico's Petrochemical Slowdown," Chemical Week, Nov. 10, 1982, pp. 37-38.
2/ Jose Lopez Portillo, Fourth State of the Nation Report, Sept. 1, 1981, p. 3.
3/ "Pipelines to Move Nations Oil, Gas, " R. & D. in Mexico, Sept. 12, 1982, p. 11.
4/ Ibid.
5/ "Mexico's Petrochemical Slowdown," Chemical Week, Nov. 10, 1982, pp. 34-38.

Political framework.--On September 1, 1982, Mexico nationalized private banks and imposed general exchange controls 1/ in an effort to avert the collapse of the nation's banking structure and prevent complete national bankruptcy. 2/ Under the nationalization plan, Banco de Mexico, the central bank, announced that Mexican banks can no longer extend loans or maintain deposits in foreign currencies. The bank also established a preferential exchange rate of 50 pesos per U.S. dollar (the open market was 70 pesos per U.S. dollar) for priority imports and interest payments on loans that were incurred by private industry prior to the nationalization of the banks. 3/

As a result of this action, the short-term future is unclear for petrochemical projects announced by PEMEX. The future petrochemical development plans may be dependent upon the amount of capital that will be available, rather than the amount required; 4/ however, some projects may not be affected by this move, including the 21-plant complex that PEMEX is planning to bring on-stream by 1985 at La Cangrejera. Construction of natural gas-treatment plants is reportedly proceeding as is international negotiations for the ethylene and methanol plants to be part of the petrochemical complex at Laguna del Ostion. 5/

1/ Exchange controls are designed to ration a limited supply of foreign exchange and aim to prevent private citizens and businesses from buying foreign currency freely, and limit their ability to take money out of the country, or to hold on to foreign exchange earned from selling goods abroad.

2/ "The Threat of Turmoil in Mexico," Business Week, Sept. 13, 1982, p. 31.

3/ "Mexico's Chemical Industry is Disarmed," Chemical Week, Sept. 22 1982, p. 20.

4/ "Mexico Rattles the Multinationals," Business Week, Oct. 4, 1982, p. 87.

5/ "Mexico's Chemical Industry is Disarmed," Chemical Week, Sept. 22 1982, p. 20.

Nonmarket Economies

The nonmarket economies that may be important to the world's petrochemical industry during the 1980's are the U.S.S.R., other Comecon 1/ countries--particularly Bulgaria, East Germany, Hungary, Czechoslovakia, Poland, and Romania, the People's Republic of China (China), and Yugoslavia. 2/ Information concerning these countries is difficult to obtain and often when data become available from one source, it may conflict with data from other sources. However, all of the above countries produce chemicals, and most trade chemicals, principally among themselves. Almost all Comecon planning and cooperation efforts have been inward looking and if these countries are to become important to the world's petrochemical industry in the 1980's this orientation will be difficult to maintain.

Starting in 1956, the standing Comecon Commission for the Chemical Industry began its effort to organize cooperation between Comecon members as these members began establishing petrochemical industries. One of the most important achievments was a pipeline which assured a simultaneous continuous supply of petroleum to petrochemical complexes in Czechoslovakia, Hungary, East Germany, and Poland. There have also been a number of other agencies formed whose primary task has been to rationalize the petrochemical industry within the Comecon countries. A result is that within the bloc the following specialization is taking place in specified areas: 3/

Country	Description of specialty
Bulgaria-----------	Soda ash, certain inorganics, certain fibers, certain pharmaceuticals, cosmetics, certain synthetic rubbers, certain pesticides, bleaches, dyes, and certain intermediates.
Czechoslovakia-----	Textile, leather, and rubber additives; certain dyes; reagents; polypropylene fibers.

1/ Council for Mutual Economic Assistance. It was established in the 1949 to 1951 period with the primary mission of coordinating the development of its members from headquarters in Moscow. Member countries account for 20 percent of the world's land mass and have a combined population of 433 million. Natasha Alperowicz, and Tony Cox, A Time of Transition: The East European Chemical Industry, 1981-1985, London, December 1981, p. 9.

2/ Original members were U.S.S.R., Bulgaria, Czechoslovakia, Hungary, Poland, and Romania. Albania was a temporary member, while other current full members are the German Democratic Republic, Mongolian People's Republic, Cuba, and Vietnam. Yugoslavia is an associate member and North Korea takes part in certain Comecon activities. The People's Republic of Yemen, Angola, Laos and Afghanistan attend, as observers, certain Comecon meetings. Nato Directorate of Economic Affairs, Comecon: Progress and Prospects, 1977, pp. 25-25.

3/ Council for Mutual Economic Assistance. It was established in the 1949 to 1951 period with the primary mission of coordinating the development of its members from headquarters in Moscow. Member countries account for 20 percent of the world's land mass and have a combined population of 433 million. Natasha Alperowicz, and Tony Cox, A Time of Transition: The East European Chemical Industry, 1981-1985, London, December 1981, p. 9.

East Germany-------	Certain dyes, photochemicals, and plant protection agents.
Hungary------------	Certain pharmaceuticals.
Poland-------------	Sulfuric acid, phthalic anhydride, and maleic anhydride.
Romania------------	Caustic soda, primary petrochemicals, and polyisoprene rubber.

The future appears to be outlined by a series of agreements signed in June 1979. Increasingly products such as ammonia, fertilizers, plastics, synthetic rubber, and methanol should be produced in the U.S.S.R. and the East European countries should produce and supply the U.S.S.R. specialty small-volume, high-value products such as dyes, agrichemicals, pharmaceuticals, and additives. 1/

U.S.S.R.

Background

The U.S.S.R. is the world's largest country covering more than 8.6 million square miles, or one-sixth of the world's land areas, making it almost 2.5 times the size of the United States. The U.S.S.R. has most every type of climate and has all types of topography.

The U.S.S.R. possesses large mineral deposits and other natural resources, including coal, natural gas, and crude petroleum. In addition to its energy resources, which are covered elsewhere in the report, the U.S.S.R., has 41 percent of the world's iron reserves, 80 percent of the manganese reserves, 30 percent of the phosphates reserves, and 54 percent of the potassium salts reserves. 2/

Its wealth of mineral and energy resources, diversified climate and topography, and high literacy rate of 99 percent have all been important factors in the U.S.S.R.'s rise in world prominence. Its per capita income was $2,600 in 1976 and its population reached 267 million in 1980. 3/

In 1980 the U.S.S.R. had a favorable balance of trade of $7 billion, the difference between imports of $59 billion and exports of $66 billion. One-half of all trade was with Comecon nations, with East Germany being both the leading source of imports and the leading market for exports. The leading

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1/ Council for Mutual Economic Assistance. It was established in the 1949 to 1951 period with the primary mission of coordinating the development of its members from headquarters in Moscow. Member countries account for 20 percent of the world's land mass and have a combined population of 433 million. Natasha Alperowicz, and Tony Cox, A Time of Transition: The East European Chemical Industry, 1981-1985, London, December 1981, p. 9.

2/ Newspaper Enterprise Association, Inc., The World Almanac and Book of Facts: 1982, 1981, p. 587.

3/ Ibid.

industries in the U.S.S.R. are steel, machinery, machine tools, vehicles, chemicals, cement, textiles, appliances, and paper; its chief crops are grain, cotton, sugar beets, potatoes, vegetables, and sunflowers. 1/

Current petrochemical industry status

It is estimated that the U.S.S.R.'s chemical industry is the fourth largest in the world, and in 1981 it employed 2.2 million, or 5.5 percent of the total industrial workforce. 2/ From 1976 to 1980, the period of the 10th Five-Year Plan, production of chemicals increased by 31 percent, as $33 billion or, 24 billion rubles, were invested in 1,000 production units and 900 new products were introduced; worker productivity increased by about 3.3 percent per year during the period. 3/ However, the industry did not meet its overall goals primarily because of 4/--

1. delays in commissioning new plants, sometimes because of the unavailability of certain machine parts;

2. lack of feedstock because of poorly coordinated construction of interdependent units; and/or

3. poor coordination between various Government ministeries that must work together to get a plant constructed and assure its continued operation.

The poor performance by the U.S.S.R.'s chemical industry has been recognized by the Government. Recently, a Soviet chemical minister admitted that some of the problem was attributable to Government officials, who indifferent to their tasks, have permitted planning deficiencies, poor organization, and inefficient management to exist. 5/ The following tabulations shows the performance of the industry during the period from 1975 to 1980 in terms of production index numbers (wherein 1970=100): 6/

1/ Ibid.

2/ Ibid, p. 21.

3/ Ibid.

4/ Ibid, p. 22. U.S. Congress, Joint Economic Committee, Soviet Economy on a Time of Change, vol. 1, Oct. 10, 1979, p. 412.

5/ "Soviet Chemical Makers Miss the Target," Chemical Week, July 30, 1980, p. 36.

6/ Alperowicz and Cox, op. cit., p. 22.

Item	1975	1976	1977	1978	1979	1980
Chemical and petrochemical industry	165	178	190	200	207	218
Chemical industry	169	182	195	206	214	225
Petrochemical industry	155	166	178	187	191	201
Basic chemicals	175	189	200	211	219	232
Manmade fibers	167	182	200	213	220	236
Plastics and resins	162	175	186	193	194	199
Varnishes and paints	137	142	148	155	150	150
Synthetic dyes	184	198	208	218	222	231
Pharmaceuticals	173	192	210	229	248	270

Energy Base

Petroleum.--Estimates of crude petroleum reserves vary widely; the U.S.S.R.'s official estimates have been classified as State secrets since 1941, in addition to which the estimation method used by the U.S.S.R. differs from that used in the West. Western estimates made between 1975 and 1980 of the U.S.S.R.'s proved reserves vary from 4.1 billion metric tons to 15.1 billion metric tons. 1/

A Swedish consultant's estimate indicates U.S.S.R. proved crude petroleum reserves are on a par with those of Saudi Arabia. Both pessimistic and optimistic estimates are viewed skeptically by most Western European and U.S. industry observers. 2/ Often used figures range from 8.6 billion metric tons to 10.3 billion metric tons. 3/

Crude petroleum production has increased during the period from 1960 to 1980 period from 148 million metric tons to 603 million metric tons. Although production increased each year from 1975 to 1980, it did not in any of the years reach the planned production level, as the following tabulation indicates: 4/

1/ U.S. Congress, Joint Economic Committee, Subcommittee on International Trade, Finance, and Security Economics, Energy in Soviet Policy, June 11, 1981, p. 27.

2/ Ibid

3/ Alperowicz and Cox, op. cit., p. 26.

4/ U.S. Congress, Joint Economic Committee, Energy in Soviet Policy, June 11, 1981, p. 26.

Year	Production		Annual share increase
	Actual	Planned	
	----Million metric tons----		
1975	491.0	496	8.6
1976	519.7	520	5.8
1977	546.0	550	5.1
1978	571.4	575	4.7
1979	586.0	593	2.6
1980	603.0	620-640	2.9

The U.S.S.R. has been a net exporter of crude petroleum; in 1979 net exports reached more than 3.1 million barrels per day. During the period 1970-79, imports averaged 150,000 barrels per day, while exports averaged 2.7 million barrels per day. 1/

During 1970-79 period, the largest annual imports from any one nation were from Iraq and averaged 114,000 barrels per day between 1972 and 1979, after rising from zero in 1971 to 80,000 barrels per day in 1972. From 1971 to 1978, the other Communist countries imported more than 55 percent of the Soviet's total exports. 2/ Western Europe was the largest free-world market for exports, accounting for most of the remainder.

Published forecasts of the U.S.S.R.'s 1985 petroleum balance vary greatly. It is generally accepted by the experts on the U.S.S.R. that forecasts for periods more than 5 years in the future cannot be made with any degree of accuracy. 3/ However, some observers, using certain assumptions about the "energy intensiveness" of the Soviet economy, project a potential 1985 surplus available for export of between 50 to 100 million metric tons. 4/ However, if attained, this level would still represent a decrease from the levels in the late 1970's and early 1980's; therefore, the U.S.S.R. may have to seek new hard-currency-generating exports. 5/

Natural gas.--Estimates of the U.S.S.R.'s proved natural gas reserves are in general agreement. Unlike crude petroleum reserves figures, Soviet natural gas reserves data are not classified as secret.

More than one-third of the world's proved reserves, totaling 28 trillion cubic meters, lie within the U.S.S.R. borders, and provide the Soviets with

1/ U.S. Central Intelligence Agency, International Energy Statistical Review, May 25, 1982, pp. 23 and 24.
2/ Ibid.
3/ U.S. Congress, Joint Economic Committee, Energy in Soviet Policy, June 11, 1982, p. 30.
4/ Ibid., p. 32.
5/ "More Soviet Hard Currency Ills Seen," Oil & Gas Journal, Oct. 5, 1982, p. 84.

about a 70-year supply at current production rates. Since it has only been since the end of the last decade that attention has been focused on Soviet natural gas, only minimal effort has been expended quantifying total Soviet natural gas resources. It is believed, however, that many times current proved reserves are ultimately recoverable even though they lie offshore and in the severe climatic locations, such as Northern Siberia. 1/

The natural gas industry has made progress in dealing with transportation problems. Imports of large diameter pipe and compressor stations helped the industry meet its 1980 production goal of 15 trillion cubic feet. Soviet production and trade data for 1973-81 indicate steadily increasing production and exports and diminishing imports, as seen in the following tabulation (in billions of cubic feet per day): 2/

Year	Production	Exports	Imports
1973	22.9	0.7	1.1
1974	25.2	1.4	1.2
1975	28.0	1.9	1.2
1976	31.1	2.5	1.1
1977	33.5	3.2	1.3
1978	36.0	3.6	0.9
1979	39.4	4.7	0.2
1980	42.1	5.4	0.2
1981	45.0	5.8	0.4

The Orenburg pipeline, recently completed, was instrumental in increasing Soviet exports to the East European Comecon members. The U.S.S.R. also exports to West Germany, France, Italy, Austria, Finland, and Yugoslavia.

Most observers expect continued increases in production and exports, at least through 1985 by which year production could reach 61 billion cubic feet per day. A large share of this increased production is expected to move through the Yamal pipeline, commencing in the autumn of 1984. Western Europe could receive 3.9 billion cubic feet per day. U.S.S.R. revenues could increase to levels that would enable Comecon to start the next century with no debts. 3/

The future growth of the Soviet industry could be impacted by the rate of development of the infrastructure, particularly in the more severe climatic regions, and the degree of availability of equipment from the West. 4/ It has been postulated that the U.S.S.R. will increasingly rely on natural gas to

1/ U.S. Congress, Joint Economic Committee, Energy in Soviet Policy, June 11, 1982, p. 32.

2/ U.S. Central Intelligence Agency, International Energy Statistical Review, May 25, 1982, p. 25.

3/ "U.S. Opposition Won't Delay Yamal Line," World Oil, October 1982, p. 224.

4/ U.S. Congress, Joint Economic Committee, Energy in Soviet Policy, June 11, 1981, p. 33

fill the difference between total energy demand and supply because of decreasing rates of growth in production of both crude petroleum and coal. 1/

Other energy sources.--The U.S.S.R. has large coal reserves of around 240 billion metric tons and possible ultimately recoverable resources of 6 trillion metric tons. 2/ In spite of this resource base, however, production since the late 1970's has been almost level. The factors most often cited for this poor performance relative to the previous 5 years are related to investment problems, equipment problems, and poor mine conditions, including the decreasing depth and thickness of coal seams. 3/ It is not expected that coal production should increase rapidly through 1985 4/

Petrochemical plans

The goals of the eleventh 5-year plan for 1981-85 have been set using the experience gained from the previous plan in which goals were set unrealistically high. 5/ However, some observers believe there are no quick solutions on the horizon for the problems of the Soviet chemical industry. 6/ Overall, the new plan projects investment of $14 billion, or 10 billion rubles which should result in additional production valued at $12 billion, or 9 billion rubles. 7/ The target of 30 to 33 percent growth during the period for chemicals and petrochemical production is about half the target rate of the previous plan. 8/

Sectors chosen for increased emphasis include fertilizers, plastics and resins, manmade fibers, small tonnage chemicals, polymer additives, textile additives, catalysts, synthetic dyes, varnish, detergents, thin polymer film, and consumer chemicals. 9/ To support these plans, at least two world-scale olefins units with a combined ethylene capacity of about 900,000 metric tons per year are expected to be on-stream at Tomsk in Siberia by 1990. 10/ A 600,000 metric tons per year unit is expected to be based on heavy fuel oil residues and Soviet officials are working with Western contractors to obtain their technology; the Soviets are interested in financing the plant by means of a compensation agreement. 11/ In addition, the Soviets have brought an ethane cracker on-stream at the Shevchenko complex in Kazakhstan. This cracker (to produce ethylene) is expected to be just the first in a sucession

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1/ Ibid., p. 37.
2/ Ibid., p. 35.
3/ Ibid.
4/ Ibid., p. 36.
5/ Alperowicz and Cox, op. cit., p. 39.
6/ "Soviet Chemical Makers Miss the Target," Chemical Week, July 30, 1980, p. 37.
7/ Alperowicz and Cox, op. cit., p. 39.
8/ "Soviet Chemical Growth Targets Reduced in on New Five Year Plan," European Chemical News, Dec. 15, 1980, p. 4.
9/ Ibid.
10/ "Soviet Union Presses Ahead With Petrochemicals Build-up at Tomsk," European Chemical News, June 22, 1981, p. 6.
11/ Ibid.

of crackers to be based on ethane which is extracted from natural gas. As natural gas production from the ethane-rich deposits in the Urengoi and Yamal fields in Siberia increases in the future, the availability of ethane should also rise. 1/

The deputy minister of the Soviet chemical industry has stated that the Western European chemical industry should not fear future large exports of plastics from the U.S.S.R. since most of the new production is expected to be required to meet demand in the U.S.S.R. Although Soviet plastics are now entering Western Europe, most of the volume is related to compensation agreements agreed upon in the late 1970's. However, part of any compensation agreements related to the future ethylene production facilities previously discussed could conceivably be in the form of additional plastics or petrochemical exports to Western Europe. Further, the U.S.S.R. has been seeking technology to produce polycarbonates, polyamides, and polytetrafluoroethylene, and wishes to enter into compensation agreements for it. Depending upon the terms, such agreements could increase the volume of Soviet petrochemicals to be sold in the world market, including Western Europe. 2/

It is expected that petrochemical trade within the Comecon bloc should increase in the future. Part of this trade increase could result from the centering of future plastics production in the U.S.S.R. near feedstock sources, and, for example, the common olefins production program agreed to by the U.S.S.R. and Hungary. The production of a new 250,000 metric tons per year ethylene plant at Kalush in the Western Ukraine is expected to be divided between use at Kalush and shipment to Hungary for upgrading. 3/

The general consensus is that the U.S.S.R. is technologically behind the United States, particularly in the areas of chemical processes and plastics, in part because materials such as fibers, plastics and synthetic rubber have not been high priority items in the U.S.S.R. This lack of chemical expertise in certain areas is at least partly attributable for the current poor competitiveness of the Soviet chemical industry in some international markets for certain chemicals. 4/

The Soviets, however, do place emphasis on fertilizers. Observers believe the U.S.S.R. has some of the biggest and best ammonia production facilities in the world. They further believe the U.S.S.R. could become one of the world's leading exporters of ammonia over the next decade. 5/

The Soviets are also investigating many aspects of methanol production, including the use of brown coal available from large reserves at Kansk-Achinsk. Both fuel and chemical grades of methanol could be produced. However, a principal objective is expected to be to produce liquid fuel--synthetic gasoline--for export to Western Europe. 6/

1/ Ibid.

2/ Ibid.

3/ Ibid.

4/ "Soviets Strive to Catch the U.S. in Technology And Make Some Gains," Wall Street Journal, Mar. 21, 1980, p. 1.

5/ Ibid.

6/ Soviet Ministers Outline Plans for Chemical Industry," European Chemical News, June 21, 1982, p. 25.

Increasing R. & D. emphasis on other areas or products could increase future Soviet competitiveness in the world market. Reports state that some of the currently planned expansions in plastics could be based on Soviet technology, such as a "block" process for polystrene. 1/ Overall plastics production is expected to receive special attention under the current 5-year plan and total production by 1985 could reach 6 million metric tons. 2/ If these new plans are successful, the free-world nations may have to contend with increasing Soviet petrochemical exports, particularly during the post-1985 period. This would be particularly true should the U.S.S.R. plan to use petrochemical exports as a vehicle to supply at least part of its future hard currency requirements.

Potential industry status by 1990

The U.S.S.R. is already the world's fourth largest petrochemical producer and the eleventh 5-year plan includes expansion in the production capacities for many petrochemicals. The following tabulation shows the 1980 and base scenario for 1990 capacities for ethylene, ammonia, and methanol:

Product	1980	1990	Percentage increase between 1980 and 1990
	1,000 metric tons		
Ethylene	2,700	4,400	63
Ammonia	19,545	34,540	77
Methanol	2,200	5,000	127

Some of the production from those expansions may be used to satisfy future internal Comecon demand. However, the magnitude of the expansions makes it most likely that sufficient product will be available to impact the world market. The following tabulation shows the ethylene, ammonia, and methanol data expressed as a share of the world's capacity in 1980 and for the base scenario for 1990 (in percent):

Product	1980	1990
Ethylene	5	7
Ammonia	22	28
Methanol	15	17
Total	42	52

1/ "Soviet Union Presses Ahead With Petrochemicals Build-up at Tomsk," European Chemical News, June 22, 1981, p. 60.

2/ Soviet Ministers Outline Plans for Chemical Industry," European Chemical News, June 21, 1982, p. 25.

While past problems have prevented the U.S.S.R. from achieving its goals, and there appear to be no quick solutions, the future goals, which have been set based on experience, may be reached. Compensation agreements for Western technology and plants involving other than hard currencies have been consumated in the past and are likely to occur in the future. Additional future agreements could increase product flows from the U.S.S.R. to the free world. Future hard-currency requirements may also be increasingly satisfied by petrochemical exports to the free world, particularly if U.S.S.R. exports of petroleum and natural gas should not continue to provide adequate resources.

The People's Republic of China

Background

The People's Republic of China has a land area of approximately 3.7 million square miles, which is slightly larger than that of the United States. However, its population was estimated at over 1 billion in 1980, giving it a population density of 278 per square mile versus 62 per square mile for the United States, and 31 per square mile for the U.S.S.R.

A large part of the labor force in China, estimated at 85 percent, is involved in agriculture, as one of the prime necessities for China is to feed its large population. Although China has mineral and energy resources it is not highly industrialized, with a literacy rate of 70 percent in 1977, and a 1980 per capita income estimated at $566. 1/

China's leading industries are textiles, steel, chemicals, cement, plastics, agricultural equipment, and trucks; chief crops are grain, corn, peas, soybeans, rice, sugar, hemp, jute, ramie, flax, cotton, and tea. China's trade has been roughly in balance and for 1978 imports are estimated to have been $11 billion and exports are estimated to have been $10 billion. 2/ In 1978, China's principal export partners were Hong Kong, Japan, and the People's Republic of Korea, and its principal import partners were Japan, West Germany, the United States, and Australia. 3/

China has long had a chemical industry based on natural materials and coal. The natural products include plant extracts, and food and fiber production byproducts. Some of the more important exports representative of these categories are beeswax, gum rosin and turpentine, starches, and essential oils; the United States has been an important market for Chinese exports of menthol and cassia and other natural oils.

Until the 1960's, when significant development of China's crude petroleum resources started, most synthetic organic chemicals were made from coal; the production facilities were small and widely scattered. 4/ Initial

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1/ Newspaper Enterprise Association, Inc., The World Almanac and Book of Facts: 1983, 1982, p. 509-510.

2/ Ibid.

3/ Ibid.

4/ Sy Yuan, "China's Chemicals," U.S.-China Business Review, November-December 1975, p. 38.

petrochemical plants were based on Chinese technology although Japan and Western Europe were the technology sources for most of the larger plants, particularly between 1960 and 1965. 1/ Chinese overseas purchases, which began in 1972, included not only individual plants but entire complexes composed of several individual plants designed to be interdependent. 2/

Current petrochemical industry status

The main emphasis of China's petrochemical development has been to obtain facilities to produce the major plastics, elastomers, fibers, and fertilizers. 3/ A principal building block, ethylene, is made by cracking petroleum fractions such as gas oil; the use of natural gas liquids as ethylene plant feedstocks is very small. 4/ Natural gas is used as the feedstock for several methanol and ammonia facilities.

China's petrochemical facilities are primarily located in the eastern and northeastern regions, areas of high population, usually near a petroleum refinery. At these locations, the plants are close to markets as well as feedstock and energy supplies.

The petrochemical industry's core is reportedly composed of 10 complexes. The mid-1980 production capacities associated with the industry for certain petrochemicals are shown in the following tabulation (in thousands of metric tons per year): 5/

Item	Capacity	Item	Capacity
Benzene	160	Ethylene oxide	77
Butadiene	45	Phenol	13
Ethylene	460	Styrene	12
Methanol	95	Vinyl acetate	156
Propylene	267	Vinyl chloride	80
o-Xylene	20	Ammonia	10,000
p-Xylene	82	Urea	3,500
Acetaldehyde	30	LDPE	274
Acetic acid	30	Polypropylene	85
Acetone	7	Polystyrene	12
Acrylonitrile	60	Polyvinyl chloride	300+
Alkybenzenes	15	Styrene-butadiene rubber	40
Cumene	18	Acrylic	56
cis-Polybutadiene	97	Nylon 6	10
Dimethyl terephthalate	115	Nylon 66	59
Ethanol	200	Polyester	105
Ethylene glycol	86	Vinylon	78

1/ Ibid., p. 43.
2/ Ibid.
3/ James J. L. Ma, "The Petrochemicals Challenge in the People's Republic of China," Reprints of the meeting of the Chemical Marketing and Economics Division of the American Chemical Society, Las Vegas, Nev., Aug. 26-28, 1980, p. 131.
4/ Ibid., p. 130.
5/ Ibid., pp. 135 and 136.

The items mentioned are produced as part of the effort to raise the standard of living by increasing the availability of food and clothing. 1/ In addition, the production of synthetic fibers frees additional land from the production of natural fibers for the production of food. 2/

In spite of the expanding Chinese petrochemical industry, the Chinese 1979 per capita consumption in kilograms of synthetic fibers, plastics, and synthetic elastomers was below that of other countries at comparable stages of development, as the following tabulation indicates: 3/

Item	China	Other countries 1/
Polyester fibers------------------	0.22	1.78
Vinylon, acrylic and nylon fibers-------------------------	.22	1.26
LDPE----------------------------	.29	2.75
HDPE, polyvinyl chloride, polypropylene, and polystyrene-------------------	.25	9.20
Synthetic elastomers-------------	.13	2.04

1/ Argentina, Brazil, Chile, Colombia, Mexico, Peru, and Venezuela.

These data would lead one to believe that a large part of the planned new capacity for various petrochemicals could be consumed domestically. Exports are not likely to increase rapidly during the first half of the 1990's unless the Chinese Government decides to use such exports to generate hard currency or to aid political allies. 4/

U.S. exports of chemicals and derivatives to China, particularly synthetic fibers, are expected to continue. 5/ In 1981, China's imports of synthetic fibers were sharply higher whereas total imports declined. In the future, China may also import petrochemicals used when processing polymers and elastomers into finished products, as well as some specialty products. 6/

Energy base

China is known to have resources of crude petroleum, natural gas, coal, and the potential for hydroelectric power from fast flowing rivers. However, relatively little definitive information is available as to the size of these resources. This lack of information can be at least particularly attributed to Government secrecy, although the historic general lack of exploration

1/ Ibid., p. 131.

2/ Ibid.

3/ Ibid., p. 138.

4/ "Little to Fear from China in the New Japan," European Chemical News, Nov. 12, 1979, p. 34.

5/ "Prospects for China Trade Through 1985," Business America, Aug. 11, 1980, p. 8.

6/ James J. L. Ma. op. cit., p. 133.

activity makes it difficult for anyone to make realistic assessments of Chinese resource potentials. 1/

Petroleum.--Although Chinese use of crude petroleum dates from around 3000 BC, it was only after 1949 that substantial crude petroleum deposits were discovered with the aid of the U.S.S.R., particularly during the period 1949 to 1958. 2/ The large transfer of Soviet technology to China, particularly during the period of the First Five-Year Plan (1953 to 1957), was one of the most important factors in the development of the Chinese petroleum industry. 3/ The Second Five-Year Plan (1958 to 1962) and "The Great Leap Forward" (1958), during which time Soviet technicians returned home, saw the development of a policy of Chinese self-reliance. 4/ However, the loss of Soviet refinery expertise adversely affected the development of the Chinese refinery industry to the present. 5/ Although the Third Five-Year Plan (1966-1970) was suspended by the Cultural Revolution (1966-1969), the petroleum industry appears to have suffered little. The period of the Fourth Five-Year Plan, or from 1971 to 1975, saw renewed emphasis on self-sufficiency and high technology; numerous technology exchanges were started with the West. 6/ The petroleum industry benefited through the discovery of new fields further east, nearer the population centers, and the development of offshore capabilities. 7/ The 1976-85 economic plan called for continued crude petroleum production; however, production has remained relatively stable since 1978, as it appears production from existing fields has ceased to increase as the following tabulation indicates (in millions of metric tons): 8/

Item	1976	1977	1978	1979	1980	1981
Crude petroleum production-------------	87.0	93.64	104.05	106.15	105.95	E 100.20

Conservation plans and 1.2 billion to 2.8 billion metric tons of recoverable proved reserves, combined with Chinese hard-currency needs, appear to insure continued exports. 9/ Present production rates applied to the above recoverable proved reserves estimates indicate depletion during the period from the early 1990's to around the year 2010.

Total potential crude petroleum reserves are estimated to be in the range of 13 billion to 16 billion metric tons. 10/ The development of this potential

1/ Jeffery Segal, "Need for More Oil Exploration," Petroleum Economist, November 1981, p. 495.
2/ "China's Oil and Energy Industries," Petroleum Economist, November 1981, p. 476.
3/ Ibid.
4/ Ibid., p. 477
5/ Ibid., p. 478.
6/ Ibid.
7/ Ibid.
8/ Ibid., p. 483.
9/ Ibid., p. 484.
10/ Ibid., p. 490.

is expected to require foreign participation in the forms of both expertise and funds. Uncertainties about China's position vis-a-vis joint ventures and wholly-owned operations have resulted in most foreign companies exhibiting extreme caution, although they do wish to become a part of the Chinese industry. 1/

Natural gas.--It is estimated that from 25 to 34 percent of the natural gas produced is associated with the production of crude petroleum. 2/ However, the only data released by the Chinese authorities are for nonassociated natural gas as indicated in the following tabulation (in billions of cubic feet): 3/

Item	1976	1977	1978	1979	1980	1981
Natural gas	357	437	481	508	499	429

Estimates place total (both associated and nonassociated) natural gas production in the 700 billion cubic feet range during the period 1976 to 1981. 4/ The nonassociated natural gas recovery potential could be probably 200,000 billion cubic feet from onshore areas and 100,000 billion cubic feet from offshore areas. 5/

Other energy sources.--China's coal deposits are the third largest in the world with proved reserves of 600 billion metric tons. 6/ The basic problems of the reserves are quality and location; the high grades of coal are located far from its markets, and the coal reserves close to the markets are of lower grades.

Projects with U.S., British, West German, and Japanese firms for developing future production capacity equal to about 10 percent of current Chinese coal production have been agreed upon; additional projects with Japanese firms are under discussion. Infrastructure is still a major obstacle to the development of some Chinese coal resources, particularly those in the more remote regions. The Government plans to invest in port facilities and railways. Expansion is also hampered by a scarcity of coal loading and transporting equipment, wood mine supports, and facilities to sort and upgrade coal as it comes from the mines. 7/

Coal production increased each year from 1976 to 1979, from 487 million metric tons to 635 million metric tons, but declined in 1980 as shown in the following tabulation (in millions of metric tons): 8/

1/ Ibid., p. 479.
2/ Ibid.
3/ Ibid., p. 484.
4/ Ibid.
5/ Ibid.
6/ Ibid.
7/ Ibid.
8/ Ibid., p. 478.

Item	1976	1977	1978	1979	1980
Coal production---------	487	550	618	635	620

Petrochemical plans

China plans capacity expansions by yearend 1983 in most of the previously listed petrochemicals and also plans to start production of some other petrochemicals as indicated in the following tabulation (in thousands of metric tons): 1/

Product	Capacity	Product	Capacity
Benzene------------------	375	Ethanol----------------	600
Butadiene----------------	139	Ethylene glycol--------	180
Ethylene-----------------	1,860	Ethylene oxide---------	152
Methanol-----------------	95	Epichlorohydrin 1/----	30
Propylene----------------	1,055	Hexamethylene diamine 1/------------	22
o-Xylene-----------------	20	Oxo alcohols 1/-------	200
p-Xylene-----------------	804	Phenol-----------------	63
Acetaldehyde-------------	210	Styrene----------------	12
Acetic acid--------------	30	Terephthalic acid 1/--	675
Acetone------------------	37	Vinyl acetate----------	156
Acrolein 1/--------------	3	Vinyl chloride---------	480
Acrylic acid 1/----------	30	HDPE-------------------	455
Acrylonitrile------------	60	LDPE-------------------	334
Adipic acid 1/-----------	55	Polypropylene----------	280
Alkybenzenes-------------	15	Polystyrene------------	12
Butylated m-cresol 1/----	12	Polyvinyl chloride----	700+
Cumene-------------------	98	cis-Polybutadiene-----	97
Cyclohexane 1/-----------	45	Styrene-butadiene rubber---------------	200
Dimethyl terephthalate---	203		

1/ New petrochemicals to be produced in China.

Overall, China's plant capacity for the items specified, excluding ammonia and urea, could increase from 2.8 million metric tons in mid-1980 to 9.8 million metric tons by yearend 1983; in addition, synthetic fiber capacity is forecast to increase from 308,000 metric tons per year to 1,164,000 metric tons per year during the same timespan.

China has been reassessing its investment program, including petrochemicals, a process which was expected to have lasted through 1982. 2/ Early in 1982, equipment contracts for almost $3 billion with Western nations were cancelled and controls were placed on foreign exchange expenditures. Emphasis has been placed on the production of daily consumer needs such as

1/ James M. L. Ma, op. cit., pp. 135-136.
2/ Washington Post, Feb. 12, 1981, p. B1.

housing, food, and clothing. Actual and planned investments in synthetic fibers and fertilizer facilities reflect this emphasis. 1/

Future expansion of the petrochemical industry most likely will involve the development of downstream processing facilities. 2/ Most of the current plant construction is in the areas of primary and intermediate petrochemicals. Planned future facilities are expected to be used to produce additional plastics, synthetic rubber, synthetic fibers, and so forth, and to process these materials into plastics products, automobile tires, and textiles. 3/ Because of a shortage of funds and exchange problems, China would probably be interested in obtaining Western equipment and technology on the basis of compensation trade rather than with hard currency. 4/ China is also in the process of promulgating joint-venture laws and regulations that would define and encourage foreign participation. 5/ China has the natural resources to support a large petrochemical industry and can be expected to proceed to develop such an industry should other factors fall into place. It has been said, for example, that the Cultural Revolution, which ended in the mid-1960's, set chemical technology back 20 years. 6/

Potential industry status by 1990

China's petrochemical industry expansion plans, designed with emphasis on consumer needs, are somewhat dependent upon China's ability to acquire the needed technology and equipment via compensation agreements. Like the U.S.S.R., China has a shortage of hard currencies. The following tabulation shows production capacity for China for ethylene, ammonia, and methanol in 1980 and the base scenario for 1990:

Product	1980	1990	Percentage increase between 1980 and 1990
	------1,000 metric tons-----		
Ethylene	675	2,055	204
Ammonia	10,820	11,820	9
Methanol	260	500	92

The main emphasis of China's petrochemical industry appears to be ethylene and ethylene derivatives; however, because of the small base from

1/ Ibid.
2/ George P. Koo, "Developing Long-Term Trade Strategies," Reprints of the meeting of the Chemical Society, Las Vegas, Nev., Aug. 26-28, 1980, p. 152.
3/ Ibid., p. 152.
4/ Ibid., p. 153.
5/ Ibid.
6/ Henry P. Shing, "China Trade-A Realistic Appraisal," Reprints of the meeting of the Chemical Marketing and Economics Division of the American Chemical Society, Las Vegas, Nev., Aug. 26-28, 1980, p. 140.

which it is starting, China's increased capacity is not likely to increase China's share of the world's capacity by 1990. The following tabulation shows ethylene, ammonia, and methanol expressed in shares of total world capacity in 1980 and the base scenario for 1990 (in percent):

Product	1980	1990
Ethylene	1	3
Ammonia	12	10
Methanol	2	2
Total	15	15

Although China's increased capacity may not make the nation a significant net exporter of petrochemicals by 1990, it could decrease imports.

The Comecon Nations

The petrochemical industries in six other Eastern European Comecon nations--Bulgaria, Czechoslovakia, East Germany, Hungary, Poland, and Romania--are small compared with those of the U.S.S.R. and many Free World nations. However, industries from these countries have been important to one another within the Comecon bloc, including the U.S.S.R. The respective countries' industries have developed, and are continuing to develop, in a manner so as to be complementary rather than competitive. Country specialization, as previously discussed, is being advocated and planned for the future. Under this scheme, the largest future share of the production of large-volume petrochemicals, particularly the primary petrochemicals, will occur in the U.S.S.R., which has the necessary natural gas and petroleum resources. The petroleum and natural gas supply positions of the other Eastern European Comecon nations are shown in the following tabulation: 1/

Country	Petroleum and natural gas supply position
Bulgaria	Essentially entirely reliant upon the U.S.S.R.
Czechoslovakia	Reliant upon the U.S.S.R. for 40 percent of its supplies.
East Germany	Larger part of supplies imported from the U.S.S.R.
Hungary	Although the third largest producer in Comecon, declining production will increase reliance upon supplies from the U.S.S.R.

1/ Alperowicz and Cox, op. cit., pp. 122, 143, 171, 194, 222, 252.

Country	Petroleum and natural gas supply position
Poland------------	Reliant upon imports from the U.S.S.R. of crude petroleum and products.
Romania-----------	Oil field production declining as imports supply 50 percent of consumption. Natural gas production increasing slowly--currently second largest producer in Comecon.

The new specialization agreements, along with domestic crude petroleum and natural gas resources and production deficiencies, will probably limit the petrochemical export potential of these nations. A slow start in 1982 for the Comecon petrochemical industries and projected shortages in plant target areas, such as agrochemicals and pharmaceuticals, are symptomatic of disappointing progress. 1/

1/ "East Bloc Chemicals Show Slow Start in 1982," European Chemical News, May 10, 1982, p. 10.

IMPLICATIONS FOR U.S. PETROCHEMICAL ACTIVITIES RESULTING FROM THE EXPANDING PETROCHEMICAL INDUSTRIES IN THE CONVENTIONAL-ENERGY-RICH NATIONS

Although some observers believe the long-term prospects for many of the petrochemical facilities which are either planned, under construction, or on-stream, and designed primarily to serve the export market, are tenuous at best, 1/ these facilities could have certain effects on the U.S. industry. Possible effects include changes in imports, exports, the U.S. balance of trade, production, employment, raw materials, feedstocks, product mix, and profitability, as well as changes in company and industry structure. This section presents and discusses these possible changes.

The first part of this section examines multiple 1990 supply-demand scenarios for ethylene, ammonia, and methanol. All of the information developed during this study indicates that possible changes in the production, demand, and trade of these petrochemicals and their derivatives could be instrumental in shaping U.S. and world petrochemical industries during the 1980's.

The second part of this section assesses the possible quantitative impacts these scenarios could have on the United States' net trade, domestic production, and domestic employment in petrochemicals. The U.S. Department of Labor's input/output model was used for this assessment. 2/

The last part of this section contains a qualitative discussion of the other possible affects of the buildup of petrochemical facilities in the CERN's. The items discussed, such as industry structure and raw materials, are less amenable to quantitative analysis but are important to an understanding of what is happening, or could happen, to the petrochemical industries in the United States and the world.

It is assumed that actions and reactions by nations and companies are primarily motivated by economic factors in general, and, more specifically, by the profit motive. Where other factors are, or could be, overriding they are included in the discussion. These other factors, such as societal development and national priorities, could be particularly important during periods of excess capacity, when competition for markets would be particularly intense.

Future Supply-Demand Scenarios

This section quantifies possible future supply-demand scenarios. The information used in this section has been obtained from field visits, company submissions, consultants' reports, industry journals, books, and telephone conversations. Although the scenario bases that are discussed are logical and consistent with historic facts, the reader may change any of the variables and

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1/ Anantha K. S. Raman, "An Analysis of International Profitability and the Strategy Behind the Explosion of World Scale Project Proposals for Western Canada," presentation at the Canadian Oil and Gas Seminar, Calgary, Alberta, 1982, p. 3.

2/ U.S. Department of Commerce, Bureau of Economic Analysis, Definitions and Conventions of the 1972 Input-Output Study, July 1980.

construct alternate scenarios; the scenarios presented are in no way to be construed as forecasts.

In assessing future supply and demand, many assumptions must be made. In general, the underlying assumptions most often used by companies and consultants, as well as in this report, include continued peace, the absence of the use of petroleum energy supply as a weapon, the continuation of OPEC and OAPEC, a minimum of U.S. Government regulation of energy production, use, and price, or in general, a continuation of the current status, or "business-as-usual." Of course, we all know from past experience that there is a likelihood of some unexpected event. However, without a clear view of the future, an assessment based on the continuation of the current situation provides a better planning base; other scenarios may then be constructed by superimposing on this base some extraordinary event, such as a crude petroleum embargo. Such alternate scenarios may be useful for contingency planning by companies and governments.

Scenarios could be constructed for any number of items; the petrochemicals chosen for this report are ethylene, ammonia and methanol. All of these items can be made from natural gas and its components, and, indeed, these petrochemicals are expected to be produced by nations such as Canada, Mexico, and Saudi Arabia, which have indicated plans for world-scale petrochemical development over the next decade. These nations have natural gas resources and little or no current commercial natural gas consumption. In addition, these three petrochemicals can be produced in large world-scale plants, for which the technology can be purchased. Further, they are the raw materials for the production of many other petrochemicals. This fact works to the advantage of those nations installing ethylene, ammonia, and methanol production facilities. It allows them to produce those derivatives most in demand at any particular time and, if necessary, to produce other derivatives in the future to assure that their ethylene, ammonia, and methanol production capacities are fully utilized. Because of fixed expenses and overhead, production cost per unit of output increases as output decreases, which in turn decreases the margin between production cost and selling price. The large world-scale plants operate most efficiently at high rates of capacity utilization.

Table 13 contains the principal assumptions that account for the differences between the scenarios:

Table 13.--Principal assumptions that account for the differences between scenarios for ethylene, ammonia, and methanol

Petro-chemical	Base scenario	Scenario I	Scenario II
Ethylene	(1) "Business-as-usual."	(1) Lower future demand than base scenario.	(1) Higher future demand than base scenario.
	(2) Net addition to world capacity between 1980-90.		
	(3) Higher plant utilization rates in 1990 than 1980.		
	(4) Average annual growth in production of 4.6 percent during 1980-90.		
Ammonia	(1) "Business-as-usual."	(1) Same demand growth as base scenario.	(1) Demand growth more closely aligned with production growth.
	(2) Net addition to world capacity during 1980-90.	(2) Less planned capacity actually built as compared with that in the base scenario.	
	(3) Average annual growth in production of 4.4 percent during 1980-90.	(3) Continued trend to close certain plants.	
Methanol	(1) "Business-as-usual."	(1) Expanded use of methanol as a fuel compared with that in the base scenario.	(1) Wide use of methanol in in most all fuel appli-cations.
	(2) Emphasis on traditional uses of methanol.	(2) Use of metha-nol in low-level gaso-line blends.	(2) Includes fuel uses in-cluded in scenario I.
		(3) Use of metha-nol as a feedstock to make gaso-line additives.	(3) Use of metha-nol directly as a fuel, in high-level gaso-line blends, and possi-bly as a feedstock for gaso-line manu-facture.

The probability of the slower growth scenarios occurring, which are more pessimistic than the base scenario, may be greater than generally accepted based on a recent World Bank study. This study cites as reasons for their pessimism the likelihood of a continuing economic slowdown in the developed nations causing increasing pressure for trade protection and smaller export markets. Further, higher and more erratic interest rates would limit investment, repayment of debts, and other borrowing. These problems would decrease growth prospects for the developing nations by limiting official aid funds and prospects for borrowing. Smaller export markets in the developed nations would cause depressed world market prices, particularly for commodities. 1/

Ethylene

Under ambient conditions ethylene is a colorless gas; it boils at -103.9°C. It is usually moved as a gas by pipeline, because liquefaction and transport by railcar, truck, or ship is expensive. Because of transportation difficulties, ethylene is normally used proximate to where it is made, as a raw material to produce other petrochemicals. The derivatives that can be made from ethylene are numerous, and of themselves important; they include ethylene glycol and polyethylene, which can be transported more easily than ethylene. A flow diagram of ethylene and some of its derivatives can be found in figure 2.

Ethylene is usually made in olefins plants, although it may also be recovered in refineries, where it is produced during the processing of crude petroleum. Olefins plants are designed to use various feedstocks. Some feedstocks, such as ethane, give higher yields of ethylene. Other feedstocks, such as naphtha, give higher yields of other olefins, such as propylene and heavier products.

Almost all of the ethylene produced in the new large facilities just coming on-stream and expected on-stream later in the decade will be consumed in the country where it is made. Cursory examination of ethylene supply-demand forecasts may, therefore, lead one to believe that the new ethylene facilities will be principally used to satisfy local demand. Such is not the case, for the major portion of the production from these facilities will be used to make derivatives, most of which will be exported rather than consumed in the country. To reflect this fact in the ethylene data presented

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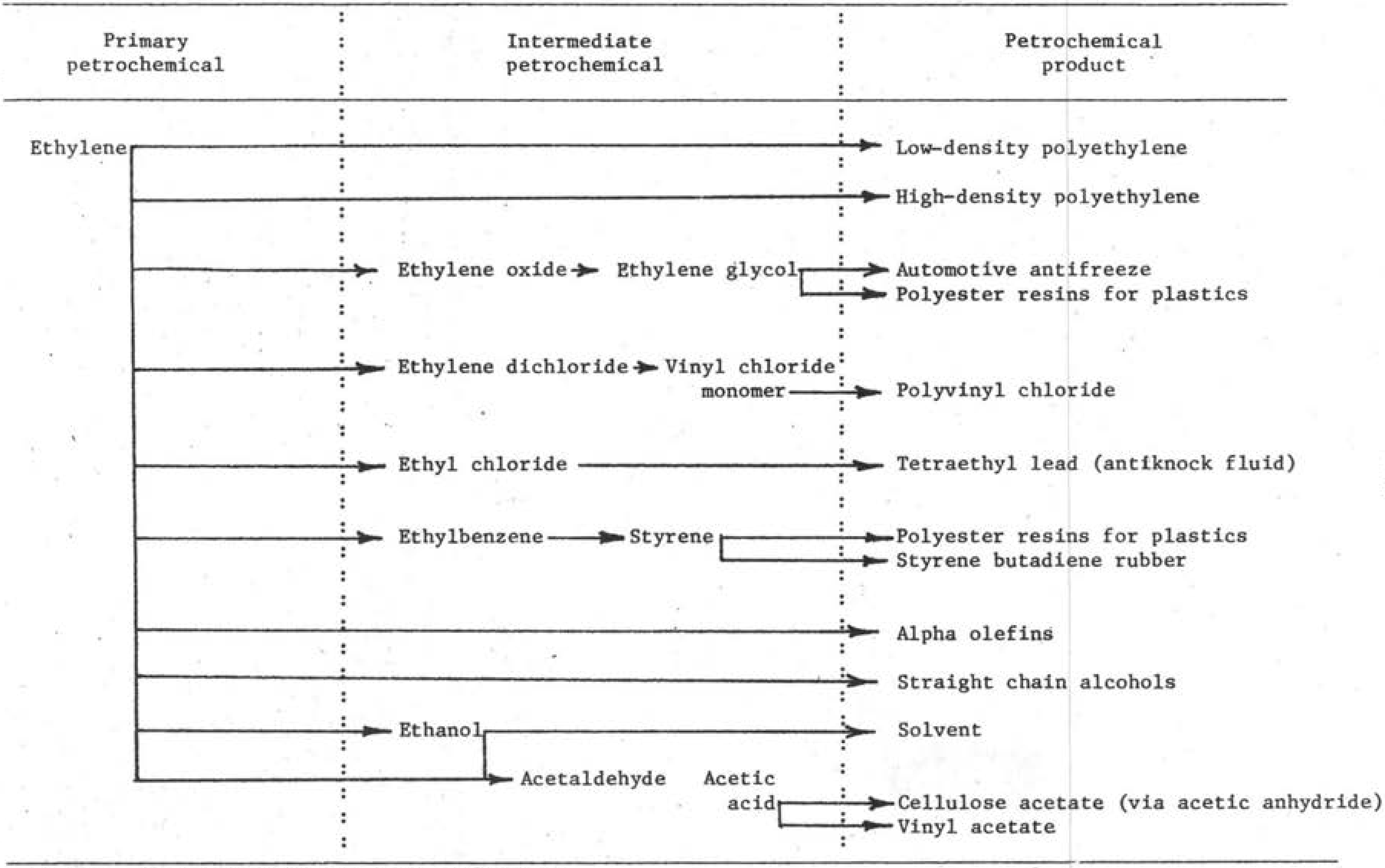
1/ "Annual World Bank Development Report Predicts Worsening Scenario For 1980's," U.S. Import Weekly, Aug. 18, 1982, p. 620.

Figure 2.--Principal products of ethylene.



Source: U.S. International Trade Commission

in tables 14 and 16, the ethylene equivalents 1/ of the ethylene derivatives imported and exported 2/ are included. Therefore, ethylene trade is not only discussed in terms of ethylene, but also in terms of the ethylene included in the ethylene derivatives. 3/

In 1980, the major net exporters of ethylene were the United States, Canada, Western Europe, and Japan (table 14). The trade flow was essentially between the developed nations, and from the developed nations to the developing nations.

1/ Ethylene equivalent is the number of pounds of ethylene used to make a pound of an ethylene derivative. For example, each pound of ethylene oxide produced requires 0.91 pounds of ethylene, and each pound of low-density polyethylene made requires 1.02 pounds of ethylene. The conversion equivalents are taken from the February 1982 issue of the National Petroleum Refiners Association's monthly publication entitled, Selected Petrochemical Statistics: U.S. Trade Production and Consumption.

2/ Ethylene equivalents enter trade in the following manner. Even if a country does not export or import ethylene as such, it is exporting or importing ethylene when it exports or imports ethylene derivatives. For example, for each pound of ethylene oxide traded, 0.91 pounds of ethylene are traded. Thus, if a nation produced 910 pounds of ethylene, used the 910 pounds in the country to produce 1000 pounds of ethylene oxide and then exported all the ethylene oxide, the country would essentially be exporting all of its ethylene production. The ultimate justification for the ethylene capacity would not be the domestic market, but rather the export market. A large portion of the ethylene capacity buildup in the CERN's is based on the movement of the ethylene produced into the world market.

3/ Other sections of the report discuss the ethylene derivatives for which capacities are expected on-stream during the 1980's in the CERN's. It is these derivatives that are expected to be traded; industry observers expect little ethylene, as such, to move in foreign trade, even when the new large ethylene plants come on-stream.

The data presented in the tables in this section may not be identical to data presented elsewhere in the report. The data in this section are usually an average achieved as the result of combining information from many sources and as such often do not match those from any one source. This is particularly true when estimates of future data are involved, but it is also sometimes true when past data are involved. Historic data for many nations vary depending upon the source.

To illustrate, the 1990 ethylene production capacity figure in this section for a nation or area may not be identical to the figure(s) presented in other sections. This would occur where the majority of the sources used in preparing this section do not believe that all of the reported planned capacity will be completed, or that it will all be on-stream by 1990. The degree of disagreement between knowledgeable sources on these points increases for facilities not already under construction, but announced as "planned," and "under study." In addition, nations with strong government involvement in the petrochemical industry, such as centrally planned economies, can use future capacity addition announcements to ward off potential competitors. Announced additions often occur, but they often come on-stream at a date later than originally announced.

Table 14.--Ethylene: Estimated world production, estimated domestic consumption, and apparent surplus or (deficit), by areas, 1980

(In thousands of metric tons)

Area	Estimated domestic production	Estimated domestic consumption	Apparent surplus or (deficit) 1/
United States	13,030	12,650	2/ 1,380
Canada	1,200	985	215
Mexico	365	630	(265)
Other Western Hemisphere	950	1,270	(320)
Western Europe	11,300	10,500	800
Japan	4,175	3,900	275
Middle East	30	405	(375)
Africa	30	225	(195)
Asia	1,305	2,210	(905)
Total, free world	32,385	32,775	610
U.S.S.R	1,800	1,900	(100)
China	500	620	(120)
Eastern Europe	1,140	1,215	(75)
Total, nonmarket economies	3,440	3,735	(295)
Grand total	35,825	36,510	315

1/ Estimated domestic production minus estimated domestic consumption.

2/ Does not equal estimated production minus estimated domestic consumption but is based on calculated ethylene equivalents of actual exports and imports.

Source: Compiled by the staff of the U.S. International Trade Commission with information obtained from industry, consultants, and publications.

World ethylene production capacity in 1980 was 52 million metric tons (table 15). Production was 36 million metric tons which indicates an average plant operating rate of approximately 70 percent. This rate is below the historic rate, which is nearer the 90 percent level, and is attributed to the depressed state of the world's economy and ethylene overcapacity.

Base scenario

The base scenario for 1990 assumes the net addition of 14 million metric tons of capacity, or an increase of approximately 25 percent above the 1980

Table 15.--Ethylene: Estimated world production capacities by areas, 1980 and 1990

(In thousands of metric tons)

Area	1980	1990	Increase, 1990 from 1980
United States	18,000	19,000	1,000
Canada	1,600	3,700	2,100
Mexico	435	1,450	1,015
Other Western Hemisphere	1,430	2,450	1,020
Western Europe	17,000	17,800	800
Japan	6,000	6,400	400
Middle East	330	2,630	2,300
Africa	270	1,050	780
Asia	1,565	2,915	1,350
Total, free world	46,630	57,395	10,765
U.S.S.R	2,700	4,400	1,700
China	675	2,055	1,380
Eastern Europe	1,900	2,200	300
Total, nonmarket economies	5,275	8,655	3,380
Grand total	51,905	66,050	14,145

Source: Compiled by the staff of the U.S. International Trade Commission with information obtained from industry, consultants, and publications.

capacity. All of the areas and nations (table 15) are expected to have net additions to capacity, with the leaders being the Middle East, Canada, the U.S.S.R., China, and Asia.

Base scenario ethylene production in 1990 is assumed to be 56 million metric tons which would indicate an 85-percent average plant-operating rate (table 16). This rate is more in line with historic operating rates than the average rate of approximately 70 percent achieved in 1980.

The growth in world ethylene production of approximately 20 million metric tons between 1980 and 1990 would result from an average annual growth in production for the period of approximately 4.6 percent. This world average rate of growth for ethylene production is expected to be exceeded by Canada, Mexico, other Western Hemisphere countries (not including the United States), the Middle East, Africa, Asia, the U.S.S.R., and China. Those areas and nations expected to have production growth rates below the world average are the United States, Western Europe, Japan, and Eastern Europe. The primary reasons for these projections are the differences in energy and feedstock prices and the policies practiced by various nations in such areas as investment incentives and energy and feedstock pricing.

These differences in growth rates between nations and areas would result in increased net ethylene trade in 1990. Trade will continue between developed nations, but the United States, Western Europe, Japan, and Eastern Europe are expected to become more dependent upon imports, particularly from the CERN's. Canada, Mexico, and the Middle East are expected to increase in importance as ethylene sources, and the favorable net balance of ethylene trade is expected to increase for each.

Free world.--In 1980, the free world is believed to have been essentially self-sufficient in terms of ethylene and to have had a positive ethylene trade balance with the nonmarket economy countries (NME's) (table 14). The net trade flow was from the United States, Canada, Western Europe, and Japan to Mexico and other Latin American countries, the Middle East, Africa, and Asia (excluding Japan). This does not mean that each of the nations and/or areas did not have both exports and imports, as the following tabulation shows (in thousands of metric tons of ethylene equivalents):

Area	Imports	Exports
United States	220	1,600
Canada	110	325
Mexico	265	0
Other Western Hemisphere	420	100
Western Europe	1,000	1,800
Japan	300	575
Middle East	380	5
Africa	220	25
Asia	1,135	230
U.S.S.R.	200	100
China	135	15
Eastern Europe	125	50

Table 18.--Ethylene: Estimated world production, estimated domestic demand, and apparent surplus or (deficit), by areas, 1990

(In thousands of metric tons)

Area	Estimated domestic production	Estimated domestic demand			Apparent surplus or (deficit) 1/		
		Scenario I	Base scenario	Scenario II	Scenario I	Base scenario	Scenario II
United States	16,720	15,420	18,000	18,725	1,300	(1,280)	(2,005)
Canada	3,145	1,200	1,330	1,460	1,945	1,815	1,685
Mexico	1,235	950	1,050	1,150	285	185	85
Other Western Hemisphere	1,960	1,850	2,600	2,750	110	(640)	(790)
Western Europe	15,650	12,800	14,170	15,540	2,850	1,480	110
Japan	5,760	5,240	6,112	6,985	520	(352)	(1,225)
Middle East	2,100	660	855	1,050	1,440	1,245	1,050
Africa	840	365	475	585	475	365	255
Asia	2,475	3,600	5,300	5,730	(1,125)	(2,825)	(3,255)
Total, free world	49,885	42,085	49,892	53,975	7,800	(7)	(4,090)
U.S.S.R	3,520	2,550	3,145	3,740	970	375	(220)
China	1,645	920	1,130	1,340	725	515	305
Eastern Europe	1,320	1,630	2,125	2,625	(310)	(805)	(1,305)
Total, nonmarket economies	6,485	5,100	6,400	7,705	1,385	85	(1,220)
Grand total	56,370	47,185	56,292	61,680	9,185	78	(5,310)

1/ Estimated domestic production minus estimated domestic demand.

Source: Compiled by the staff of the U.S. International Trade Commission with information obtained from industry, consultants, and publications.

Free world ethylene production capacity in 1980 was 47 million metric tons, or almost 90 percent of the world total. Production in 1980, at 32 million metric tons, indicated an average industry operating rate of only slightly above that for the world as a whole (69.5 versus 69.0 percent).

The base scenario for 1990 assumes the net addition of 11 million metric tons, or approximately 76 percent of the total world capacity addition (table 16). All areas or nations are expected to have net capacity increases, with the Middle East, Mexico, and possibly Canada among the leaders; the recent energy- and feedstock-pricing controversy has added additional uncertainty to Canada's plans. Their probable combined net additions of 5.4 million metric tons would be about one-half of total free-world net additions. Relatively smaller net capacity additions would occur in Japan, Western Europe, and the United States.

Base scenario production in 1990 is estimated at approximately 50 million metric tons, or 88 percent of world production. In 1980, the same figure was more than 90 percent, which indicates a loss of share in ethylene production by the free world. The average annual rates of growth for production during 1980-90 would be highest for the Middle Eastern and African nations because of new, efficient facilities and low 1980 production levels.

The combination of various free-world average annual growth rates for both capacity and production in the different nations and areas indicates that additional trade will be necessary to balance supply with demand during 1980-90. On the basis of transportation differences and assuming the absence of any overriding factors, it is generally thought that Middle Eastern and North African suppliers would preferentially move into European markets; Canadian material would move into the United States and the Pacific Rim nations, possibly including Japan; Mexican exports could be expected to enter the United States and the Latin American countries, particularly in the late 1980's.

The following tabulation lists the 1980 and 1990 net trade balances for ethylene, in terms of ethylene equivalents (in thousands of metric tons):

Nation or area	1980	1990
United States	1,380	-1,280
Canada	215	1,815
Mexico	-260	185
Other Western Hemisphere	-320	-640
Western Europe	800	1,480
Japan	275	-352
Middle East	-375	1,245
Africa	-195	365
Asia	-905	-2,825

The data indicate that the United States and Japan could become net importers of ethylene and ethylene derivatives in 1990 compared with being net exporters in 1980 (table 16). The figure for Western Europe is misleading, since it does not take into account the rationalization of the ethylene and ethylene derivatives industry currently taking place in Western Europe. 1/ Few, if any, industry observers believe Western Europe would be a net exporter in 1990 directly competing with Canada and the Middle East for markets. At best, in 1990, after rationalization, Western Europe may be in a position in which imports and exports are approximately equivalent; however, it is more likely to be, along with the United States and Japan, a net importer.

The tabulation does indicate the significant potential for favorable net trade growth for Canada and the Middle East. The increase in the net negative trade balance for Asia (not including Japan) appears reasonable between 1980 and 1990. Many of the facilities under discussion for Asia are not expected on-stream before the early 1990's.

NME's.--The NME's accounted for only 10 percent of world ethylene capacity in 1980; the U.S.S.R. had more than 50 percent of the NME's total (table 15). China, in spite of a large population, had little ethylene capacity. The Eastern European countries, with over 33 percent of the NME's total, had a relatively sophisticated ethylene industry in spite of the fact that much of the feedstocks had to be imported, principally from the U.S.S.R.

In 1980, the U.S.S.R., China, and Eastern Europe all were net importers of ethylene. Although net imports were of the same order of magnitude for the U.S.S.R. and China in 1980, they accounted for more than 19 percent of consumption in China compared with 5 percent for the U.S.S.R.; domestic consumption in the U.S.S.R. was more than triple that of China in 1980.

The base scenario reveals that between 1980 and 1990, the free world is expected to add 10.8 million metric tons per year of production capacity, but the NME's capacity is expected to grow at a faster rate (table 15). Most of the capacity additions are expected to take place in the U.S.S.R. and China, which, with low historic per capita consumption, could experience sufficient growth in local demand to consume the increased domestic production. However, since these centrally controlled economies operate under Government plans which can be changed or redirected, it is difficult to assess whether increased production will be used to satisfy local demand or designated for export. In the past, the centrally planned economies were relatively unimportant in the world's chemical trade. 2/ In 1980, Western European imports of NME's production accounted for but 4.2 percent of the acrylonitrile market, 3.2 percent of the polyvinyl chloride market, and 2.4 percent of the low-density polyethylene market. 3/

1/ "Ethylene Report," Oil & Gas Journal, Sept. 6, 1982, p. 73.
2/ "Developing Nations Boost Chemical Exports", Chemical & Engineering News, Aug. 23, 1982, p. 29.
3/ "Western Europe Worries About Comecon Chemicals," Chemical Business, July 26, 1982, p. 34.

In the base scenario, both the U.S.S.R. and China could have surplus ethylene production in 1990 that could be exported, compared with the situation in 1980, when both were net importers. This surplus material may be principally moved between the NME's, as has been the historical pattern. It is probable that Eastern Europe would be in a greater supply deficit position in 1990 compared with the situation in 1980. However, there have been indications that certain NME's are interested in exporting chemicals to the free world. 1/ Exports to the West could be parts of compensation agreements, or made to generate hard currency which could then be used by the NME's to pay for other necessary free-world imports.

Most of the concern over future NME's exports to the free world centers in Western Europe. 2/ The European Communities Commission has investigated alleged dumping of polyvinyl chloride, oxalic acid, trichloroethylene, and methyl amines by certain Eastern European producers. The centrally controlled economies, not particularly interested in profits, have considerable leeway in pricing exports and may compete in future world markets with all competitors. This ability to price at almost any level resulted in a statement by a (European) Council of Chemical Manufacturers' Federations (CEFIC) executive that current Eastern European exports to Western Europe were at "grossly unreasonable prices." 3/

Those observers who are less concerned about future NME's exports base their relative optimism on the fact that, historially, Comecon nations have achieved only about 50 percent of their planned production growth rates. The U.S.S.R. and the Eastern European nations have been prevented from achieving their production goals because of problems such as large national debts, energy and feedstock shortages, lack of transportation infrastructures, centralized planning inefficiencies and inflexibility, and low productivity. 4/ It is not expected that these and other problems will be entirely solved during 1980-90; however, the effect these problems will have on the NME's is uncertain and will depend upon the corrective efforts expended and the results achieved, as well as the development directions chosen by the governments of the centrally planned economies.

Future world market penetration by the NME's will be aided if they follow the example Hungary is setting with its national trading corporation, Chemolimpex. At present Chemolimpex is represented on 5 continents and in 43 countries. 5/ In addition, an official of a Chemolimpex London-based trading company has stated that some of the large international chemical companies with which Chemolimpex has a negative trade balance might in exchange help Chemolimpex to market petrochemicals in the Commonwealth countries. 6/

1/ "Czechoslovakia Aims to Increase Chemical Exports to the West," European Chemical News, July 2, 1982, p. 6.

2/ "Western Europe Worries About Comecon Chemicals," Chemical Business, July 26, 1982, p. 32.

3/ Ibid., p. 33.

4/ Ibid.

5/ Ibid., p. 34.

6/ Ibid., p. 35.

Alternative scenarios

The two ethylene alternative scenarios discussed in this section of the report retain the same production capacities and levels of production included in the base scenario (tables 16). However, one alternative scenario is a low future demand case (scenario I); the other alternative scenario is a high future demand case (scenario II). These alternate scenarios were selected because ethylene demand is often more susceptible to fluctuation, particularly in the short to medium term, than is production or production capacity. Available production facilities tend to be operated at optimum capacity both because of the investment involved and the usual desire of company management to maintain employment levels. However, comments will be made under both of these scenarios on possible capacity and production rate changes, including industry rationalization, particularly in Western Europe.

Scenario I.--In the base scenario, the world's average annual rate of increase in ethylene demand is 4.4 percent. In alternate scenario I, the rate is 2.6 percent. The growth rates of individual nations would not all be the same under scenario I, but all of the rates would be lower than the base scenario rates (table 16). As the nations of the world become more interdependent, trends are becoming increasingly global in nature. It is becoming progressively more difficult for any nation or group of nations to exhibit growth characteristics unaffected by general worldwide events. 1/

Under scenario I, a worldwide oversupply situation would cause a reduction in capacity utilization rates and/or a closing of production facilities, particularly those with high production costs. Price competition between surviving suppliers for available markets would increase, and the use of various devices, such as linking energy sales with petrochemical sales, could be expected to become more prevalent. In general, the potential for industry and market disruption would be greater in this scenario than in either of the other two scenarios. Protectionist pressures would also increase.

Free world.--The higher cost ethylene producers in the free world could be expected to reduce plant-operating rates and close facilities. Producers in Western Europe and Japan, with ethylene plants based on higher-priced naphtha or other petroleum feedstocks relative to natural gas based feedstocks, would be particularly vulnerable. U.S. producers could also be adversely affected because of natural gas price decontrol, the loss of export markets, and increased imports. The industries in Japan and Western Europe recognize possible problems and are studying and implementing petrochemical rationalization plans, some of which include the formation of "crisis cartels," 2/ swapping of production facilities, and the closing of plants. 3/ Judging by known current industry plans in Western Europe, Japan, and the United States, the future effect on investment would be limited in the base ethylene scenario. As indicated, large new expenditures for plants are not

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1/ "Annual World Bank Development Report Predicts Worsening Scenario for 1980's, U.S. Import Weekly, Aug. 18, 1982, p. 620.

2/ "Japanese Producers Discuss Possible Ethylene Crisis Cartel," European Chemical News, Aug. 2, 1982, p. 7.

3/ "Government Agreement Expected for Enoxy, Montedison Plans," European Chemical News, Aug. 2, 1982, p. 4.

expected in these areas during the 1980's. The total combined capacity addition in Western Europe, Japan, and the United States by 1990, in the base scenario, is 2.2 million metric tons, or a little more than 5 percent of the 1980 production capacity (table 15).

Producers in Western Europe, Japan, and the United States would all have more than enough capacity to supply their respective domestic markets under scenario I. At the same time, the movement of excess production to export markets would be limited by the lower cost producers in Canada, the Middle East, Africa, and Mexico. These same producers could also use lower prices to export into the higher cost producers' countries. Under such circumstances, there could be increasing pressure on the governments of higher cost producers to in some manner limit imports to protect their domestic ethylene industries.

The lowest cost producers located primarily in the CERN's, such as Mexico and the Middle East, would all be competing for a smaller total market. The trade flow would in general be from low-cost producing areas to high-cost producing areas. The competitive edge would go to those producers able to offer the lowest price and/or tie sales of ethylene to purchases of conventional energy materials, such as petroleum, or develop some other such linkage. Competition could become intense because few, if any, of the CERN's would want to reduce plant operating rates and/or close facilities. Income from ethylene exports could be required to help offset decreased income from petroleum exports, since world energy consumption would probably also be low in scenario I, compared with the situation in the base case.

Investment in new ethylene production facilities would decrease under scenario I relative to that in the base case. Many of the CERN's currently planning to expand, and already expanding, capacity would have sufficient feedstocks available in 1990 for additional ethylene facilities. However, investment in these facilities and others, possibly located in Thailand, Malaysia, and other Asian nations, would be postponed.

Under scenario I, about the only area of the free world that could benefit would be certain Asian, African, or other countries that would have insufficient or no ethylene capacity in 1990. Such nations could probably import ethylene at prices which may be below the prices described in the base scenario.

NME's.--Under scenario I, the NME's, because of a slower growth in domestic consumption, would be capable of supplying internal demand and of exporting larger quantities to the Western nations than they would in the base scenario (see table 16). This additional supply, added to the exports from other CERN's, could cause increased market disruption. Even if NME's exports cannot be linked with energy supplies because of unavailability, lower ethylene prices and/or attractive compensation agreements could make these exports difficult to refuse by certain Western nations and could provide stiff competition for exports from other CERN's.

The majority of exports from the NME's would be from the U.S.S.R. and China; the Eastern European nations would remain net importers. As such, the Eastern European nations could provide markets for free world as well as NME producers. Although this situation would be advantageous to Western producers, the displaced NME's supplies could reappear as additional supply in the free world. Therefore, the most probable scenario would be for the NME's to first satisfy internal demand and then attempt to market excess production in the free world.

Scenario II.--Alternate scenario II is predicated on a higher-than-base case average annual growth rate for ethylene demand of 5.4 percent. This overall world rate is the result of the combination of many individual rates which vary from a low of 4 percent in the United States and Western Europe to 8 to 10 percent in some of the developing areas, such as the Middle East, Africa, and certain parts of Asia (table 16).

The overall rate is sufficiently large to indicate a supply shortage in 1990. This shortage would probably not actually occur, however, because additional capacity would be built to satisfy the additional demand. Most of the additional facilities would be built in the CERN's, although some of the developed nations might also invest. In a tight market, price would not be the dominant factor, and higher cost producers might function profitably; there could be a resurgence of ethylene involvement in some developed nations.

Free world.--Although the free world would have a 1990 indicated ethylene shortfall of 4.1 million metric tons in 1990, the shortfall would not exist in all areas and nations (table 16). Those nations expected to experience net shortages would be the United States, Japan, and other Asian and Western Hemisphere nations, not including Canada and Mexico. Canada, the Middle East, Africa, Western Europe, and Mexico would be expected to have excess capacity.

The supply deficit of the free world could be alleviated by 8 ethylene plants each producing 0.5 million metric tons per year, plus additional ethylene derivatives capacity. The majority of new ethylene facilities and many of the derivative plants would probably be constructed in Canada, the Middle East, Northern Africa, and Australia/New Zealand. Higher cost energy and feedstocks could limit new ethylene plant construction in Japan and Western Europe, although the additional costs may be able to be recouped in a tight market. Capacity additions in the United States would be dependent upon the availability of competitively priced energy and feedstocks, trade policy, and the degree of overseas involvement of U.S. multinational companies; overall, the U.S. would probably not seek a self-sufficient position in ethylene if alternate lower priced supplies became available from capacity additions in other nations. This would be particularly true if the overseas facilities involved U.S. joint-venture partners, such as those projects currently part of the Saudi Arabian ethylene capacity buildup.

NME's.--NME's would be in a net supply deficit ethylene position in 1990 (table 16). However, China might have sufficient capacity to supply its domestic requirements and also export. Such exports would move to supply-short countries, particularly those in Asia, including Japan.

Because of payment problems and a shortage of hard currency, it would not be expected that the U.S.S.R. or Eastern Europe would look to the West for supplies. However, if they did, energy exports from the U.S.S.R. could be important. In 1981, U.S.S.R. petroleum exports reached a record level of

$29.4 billion, with more than 50 percent going to free-world countries; natural gas exports were $7.4 billion. 1/ Such exports could generate the hard currency needed to pay for supplies from the West, or alternatively, these energy exports could be bartered for or linked to required Western imports.

Most likely, however, the U.S.S.R. would strive to be self-sufficient and capable of supplying its allies in Eastern Europe, if historical precedent is followed. The U.S.S.R. has large resources of both crude petroleum and natural gas. Liquids extracted from the increasing quantities of natural gas sold to Eastern and Western Europe could be used as ethylene plant feedstock.

Ammonia

Ammonia, under ambient conditions, is a colorless gas that boils at -33.35° C. It can be moved as a gas by pipeline, or liquefied and shipped, usually by tank truck, tank car, or ship. Ammonia's chief use is as a fertilizer, although it is also used in industrial and military applications.

Ammonia may be made into numerous derivatives (figure 3). One of the most popular derivatives, particularly in the developing countries, is urea. Urea is a nontoxic solid, and thus relatively easily transported. In addition, it can be used directly as a high-nutrient fertilizer; urea can be spread in the fields by hand from bags, whereas the use of liquid ammonia in the fields necessitates mechanical injection equipment and pressure vessels.

Ammonia is made by chemically combining nitrogen and hydrogen. Since World War II, natural gas and petroleum have become the most common sources of the hydrogen; hence ammonia became known as a petrochemical. However, in some nations, such as the U.S.S.R., China, and those in Eastern Europe, coal (reacted with steam) remains an important source of the hydrogen. In China, some of the ammonia capacity expected on-stream during the 1980's could be based on coal. If natural gas and petroleum prices continue to increase, coal may increase in importance as a basis of hydrogen. Improved coal-to-ammonia processes are being developed in certain countries, including the United States. 2/

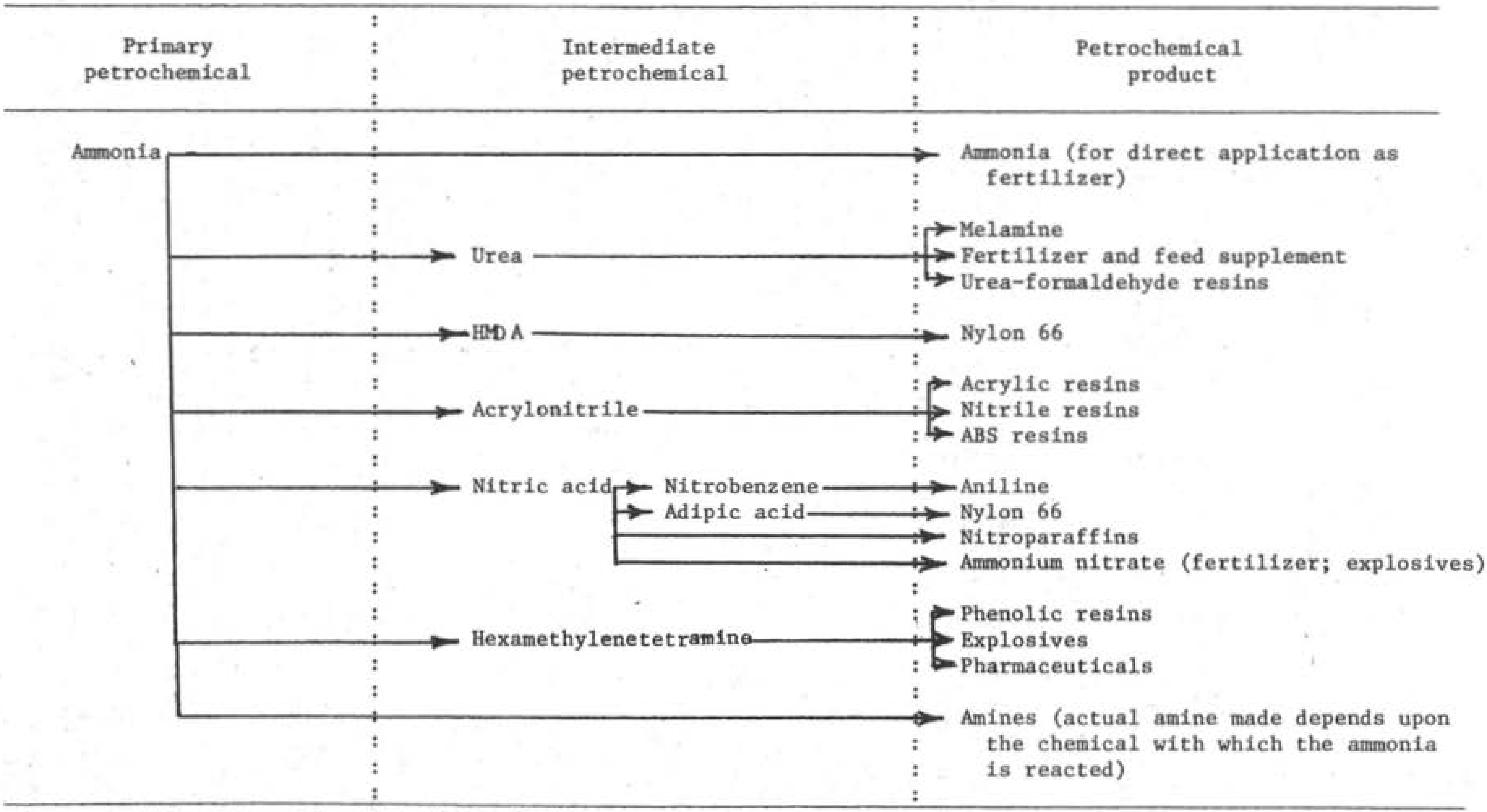
Since ammonia and all of its derivatives, such as urea, contain nitrogen, ammonia and all of its derivatives can be quantified in terms of nitrogen content. It has, therefore, become common industry practice to assess the supply and demand for ammonia and its derivatives in terms of nitrogen. Nitrogen trade may be in the form of ammonia or any of its derivatives, such as urea and ammonium nitrate.

In 1980, the general consensus was that a surplus of nitrogen production occurred (table 17). It is assumed that the surplus was added to the inventories of various countries to be used in succeeding years.

1/ "Value of Soviet Oil Exports Hits Record," Oil & Gas Journal, Aug. 23, 1982, p. 66.

2/ "TVA Has Successfully Started Up a 200 tpd" Coal Gasifier at its Coal-to-Ammonia Plant at Muscle Shoals, Alabama," Chemical Marketing Reporter, May 17, 1982, p. 5

Figure 3.--Principal products of ammonia.



Source: U.S. International Trade Commission

Table 17.--Ammonia: Estimated world production, estimated domestic consumption, and apparent surplus or (deficit), by areas, 1980

(In thousands of metric tons of nitrogen)

Area	Estimated domestic production	Estimated domestic consumption	Apparent surplus or (deficit) 1/
United States	15,045	14,420	625
Canada	1,990	1,115	875
Mexico	1,595	1,145	450
Trinidad	490	30	460
Other Western Hemisphere	1,635	1,455	180
Western Europe	11,360	9,635	1,725
Japan	1,590	1,820	(230)
Middle East	1,635	725	910
Africa	725	2,000	(1,275)
Asia	2,775	4,635	(1,860)
Total, free world	38,840	36,980	1,860
U.S.S.R	13,820	11,000	2,820
China	6,635	8,270	(1,635)
Eastern Europe	6,365	5,910	455
Total, nonmarket economies	26,820	25,180	1,640
Grand total	65,660	62,160	3,500

1/ Estimated domestic production minus estimated domestic consumption.

Source: Compiled by the staff of the U.S. International Trade Commission with information obtained from industry, consultants, and publications.

The U.S.S.R. and the United States were ranked first and second in terms of national ammonia production capacity in 1980, and ranked in the reverse order in terms of national ammonia consumption. As a group of nations, Western Europe ranked third in both categories.

The U.S.S.R. was the largest net exporter of nitrogen in 1980. Other large net exporters included Western Europe, Canada, Mexico, and the Middle East. Net importers were principally the developing nations in Asia, Africa, and China.

In 1980, world production of ammonia in terms of nitrogen was 65.7 million metric tons, of which free-world production accounted for almost 60 percent. The capacity utilization rate was about 75 percent. The rate was generally higher in the developed nations; some of the developing nations encounted various production difficulties which resulted in lower capacity utilization rates.

Base scenario

The base scenario for 1990 assumes, in terms of nitrogen, the addition of 37 million metric tons per year of ammonia production capacity compared with such capacity in 1980, representing an increase of 42 percent (table 18). Almost all nations and areas are expected to have capacity increases, with the leaders being the U.S.S.R., Asia (excluding Japan), Mexico, the Middle East, and probably Canada. The United States and Japan are assumed to maintain ammonia capacity during the 1980's. Overall, the relative capacity positions of the free world and the NME's are not expected to change. In 1980, the NME's held approximately 45 percent of world capacity, and this share is expected to remain essentially the same in 1990.

The ownership of the world's nitrogen capacity is expected to continue to change. It is expected that government-controlled facilities will account for a greater share of world capacity in 1990 than they did in 1980. In addition to the expansions in the NME's, the majority of the new facilities in the CERN's will probably be government controlled. Virtually all of the ammonia capacity in Mexico and the OPEC nations is expected to be government controlled in 1990. Very few developing nations allow private ownership of ammonia facilities. Reasons for this position include the ready availability of turnkey 1/ plants and the relative ease with which ammonia can be marketed vis-a-vis ethylene derivatives.

Base scenario world production in 1990 is more than 101 million metric tons (table 19) compared with 65.6 million metric tons in 1980. This increase represents an average annual growth rate of 4.4 percent during the 1980's. During this period, NME production would increase at a faster rate than free-world production, principally because of increased utilization rates.

The 3.8-percent average annual increase in the world's nitrogen demand during 1980-90 reflects a lower rate in many of the developed nations and areas and a somewhat higher rate for the developing nations and areas. For example, the demand growth rates for the United States, Western Europe, and

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1/ Turnkey plants are plants built by a contractor that are ready to go on-stream with a minimum of effort (i.e., a turn of the key) by the purchaser.

Table 18.--Ammonia: Estimated world production capacities, by areas, 1980 and 1990

(In thousands of metric tons of nitrogen)

Area	1980	1990		Increase or (decrease) 1990 over 1980	
		Scenario I	Base scenario and scenario II	Scenario I	Base scenario and scenario II
United States	15,725	13,545	15,725	(2,180)	0
Canada	2,065	3,180	4,105	1,115	2,040
Mexico	1,680	3,465	5,280	1,785	3,600
Trinidad	515	1,115	1,115	600	600
Other Western Hemisphere	1,910	2,725	3,635	815	1,725
Western Europe	14,000	14,545	15,455	545	1,455
Japan	2,275	2,275	2,275	0	0
Middle East	2,090	5,180	5,180	3,090	3,090
Africa	820	1,635	1,635	815	815
Asia	7,455	14,360	14,360	6,905	6,905
Total, free world	48,535	62,025	68,765	13,490	20,230
U.S.S.R	19,545	30,905	34,540	11,360	14,995
China	10,820	11,820	11,820	1,000	1,000
Eastern Europe	9,270	10,000	10,000	730	730
Total, nonmarket economies	39,635	52,725	56,360	13,090	16,725
Grand total	88,170	114,750	125,125	26,580	36,955

Source: Compiled by the staff of the U.S. International Trade Commission with information obtained from industry, consultants, and publications.

Japan are expected to average about 2.5 percent per year; those for Asia, and Africa are expected to average close to 5 percent per year.

In the base scenario, the difference between world production capacity and demand is expected to widen during 1980-90 (table 19). In 1990, demand could be almost 35 million metric tons as compared with about 26 million metric tons in 1980. This change could be expected to cause plant closings, deferrals and cancellations of new investments, increased trade, and intense marketing competition; protectionist pressures could also increase. Facilities located in CERN's have certain competitive advantages, including assured natural gas supplies at prices below world levels. The NME's could also be favorably situated. The net nitrogen trade flow would increasingly be from these advantaged areas to the developed nations and areas, particularly Japan, Western Europe, and the United States.

Free world.--In the base scenario, those nations and areas expected to benefit from their energy resources and build new ammonia facilities are also among the nations expected to have the faster rates of demand growth. However, because their current nitrogen consumption is low, even a faster rate of increase in demand will not enable these nations to consume all, or even major shares, of future production from their new facilities coming on-stream, under construction, or in the planning stage.

The CERN's are expected to account for about 80 percent of the free world's capacity additions in the base scenario between 1980 and 1990 (table 18). Almost all of this capacity is to be based on natural gas which had previously been flared, and in some cases is still being flared. Under such circumstances, it can be argued that the past economic value of the natural gas was essentially zero. Since a large part of the net production cost of ammonia is the cost of natural gas for energy and feedstock, the CERN's competitive advantage becomes obvious and is one of the primary reasons these nations are interested in ammonia production.

According to the base scenario, the United States and Japan are not expected to have a net change in production capacity between 1980 and 1990 (table 18). This does not mean that some smaller and/or less efficient facilities may not be closed and larger more efficient plants brought on-stream. Higher energy and feedstock costs in these two countries relative to such costs in the CERN's makes investment in significant expansions of production facilities unattractive, particularly when it appears lower cost imports will be readily available in the future.

According to the base scenario, Western Europe could expand capacity by around 10 percent during 1980-90. Availability of natural gas from North Sea fields would provide the basis for such an expansion.

The developing nations of the world held an estimated 15 million metric tons per year of ammonia production capacity in 1980; their consumption was about 10 million metric tons. By 1990 these two figures in the base scenario could be 31 million metric tons per year and 18 million metric tons, respectively. These data indicate that the developing nations, therefore, would advance from having a net export potential of 5 million metric tons in 1980 to 13 million metric tons in 1990.

Table 19.--Ammonia: Estimated world production, estimated domestic demand, and apparent surplus or (deficit), by areas, 1990

(In thousands of metric tons of nitrogen)

Area	Estimated domestic production	Estimated domestic demand			Apparent surplus or (deficit) 1/		
		Base scenario	Scenario I	Scenario II	Base scenario	Scenario I	Scenario II
United States	12,870	15,000	18,670	20,345	(5,800)	(3,670)	(5,345)
Canada	3,020	3,955	1,875	1,875	1,145	2,080	2,280
Mexico	3,290	5,020	2,480	2,480	810	2,540	2,540
Trinidad	1,055	1,055	70	70	985	985	985
Other Western Hemisphere	1,910	2,545	2,365	2,365	(455)	180	180
Western Europe	11,635	12,360	12,335	13,590	(700)	25	(1,230)
Japan	1,590	1,590	2,275	2,565	(685)	(685)	(975)
Middle East	3,635	3,635	2,455		1,180	1,180	
Africa	1,180	1,180	3,270	20,780	(2,090)	(2,090)	(5,965)
Asia	10,000	10 000	7,550		2,450	2,450	
Total, free world	50,185	56,345	53,345	64,070	(3,160)	2,995	(7,730)
U.S.S.R	24,725	27,635	18,360	18,360	6,365	9,275	9,275
China	8,270	8,270	10,000	10,000	(1,730)	(1,730)	(1,730)
Eastern Europe	8,500	8,910	8,725	8,725	(225)	185	185
Total, nonmarket economies	41,495	44,815	37,085	37,085	4,410	7,730	7,730
Grand total	91,680	101,155	90,430	101,155	1,250	10,725	0

1/ Estimated domestic production minus estimated domestic demand.

Source: Compiled by the staff of the U.S. International Trade Commission with information obtained from industry, consultants, and publications.

This expected capacity expansion in the developing nations, coupled with the expansion in the U.S.S.R., could be the bases of an expanded world nitrogen trade in 1990. The net trade flow from these CERN's to the developed nations could be greater in 1990 than in 1980, with the favorable net balance of nitrogen trade decreasing for the United States, Western Europe, and Japan, and increasing for Canada, Mexico, Asia, and the Middle East (table 19).

Industry sources foresee an increase in U.S. net nitrogen imports during 1980-90 as a result of the decontrol of natural gas prices by 1985, combined with the rapid overseas buildup of capacity and the ready availability of relatively lower cost imports. These sources speculate that the most likely major sources of U.S. nitrogen imports in 1990 would be Canada, Mexico, Trinidad, and the U.S.S.R., which became a major U.S. nitrogen supplier in 1980.

NME's.--In the base scenario, the U.S.S.R., China, and Eastern Europe are all expected to increase ammonia production capacity between 1980 and 1990. The largest increase, almost 90 percent of the total NME's increase, is expected to be in the U.S.S.R. (table 18). This is based on the construction of nine additional world-scale ammonia plants between 1985 and 1990 in the U.S.S.R. According to current industry and Government assessments and projections, providing energy and feestocks for these additional plants should present no problems for the U.S.S.R. Some of the coal-based ammonia capacity in the U.S.S.R. could be shut down and possibly replaced by natural-gas-based capacity during the 1980's.

The capacity expansions in both China and the Eastern European nations would account for 10 percent of all NME's additions during 1980-90. Each nation is expected to add approximately 1 million metric tons of capacity by 1990. Depending upon the natural gas supply situation, some or all of China's expansion may be coal based.

In the base scenario, demand in the NME's would increase at an average annual rate of almost 4 percent between 1980 and 1990 versus 3.7 percent for the free world (table 19). The U.S.S.R. could have the fastest rate of increase of demand in the NME; it seeks to become increasingly less dependent upon the imports of grains and other foodstuffs.

According to the base scenario, the U.S.S.R., may triple the size of its net surplus or export potential, which, at approximately 9 million metric tons per year, would be the largest of any single nation. Some of this potential could be used to make the NME's self-sufficient, but some industry observers believe a significant portion could be exported to the United States.

Alternative scenarios

Although demand for nitrogen could increase at higher rates between 1980 and 1990 and therefore reduce the base scenario's potential production surplus in 1990 to more manageable levels, most industry observers do not assign a great probability to this happening. Nitrogen demand, particularly as a fertilizer, is not generally expected to increase at rates faster than those shown in the base scenario for the developed nations because nitrogen is already widely used at optimum levels; such demand is not expected to increase at these rates in developing nations because of possible economic growth restrictions. The most often industry-cited alternate, scenario I, would be a case that assumed the same demand growth as in the base scenario, but included less capacity actually being built and other facilities being closed between 1980 and 1990 (tables 18 and 19).

Scenario II assumes demand growth will remain more abreast of production growth than in the base scenario, and that the projected 1990 base scenario production surplus will thus be smaller (see table 18). Since base scenario production is expected to increase at an average annual rate of 4.4 percent between 1980-90, demand would have to increase at approximately the same rate, or almost 0.6 percent per year faster than in the base scenario. Because the United States and Western Europe together currently account for between 55 and 60 percent of the free-world demand and already use optimum quantities of nitrogen as a fertilizer, a large portion of the increased growth rate would have to be attributed to the other nations of the free world. In the base scenario, these nations already are projected to experience a faster rate of increase in demand than the developed nations.

Scenario I.--This scenario differs from the base scenario in that it assumes a slower rate of capacity expansion, particularly during the period 1985 to 1990 (table 18). It also examines the possibility of continuing the trend, already established, to close plants in the United States.

Free world.--The higher cost production areas, such as the United States, Japan, and Western Europe, could undergo more severe nitrogen industry rationalization. Even under the base scenario, only Western Europe would be expected to add capacity; the United States and Japan would merely maintain 1980 capacity levels between 1980 and 1990, with no net additions (table 18).

There have already been plant closings in the United States. It has been reported by industry sources that 36 ammonia plants with a combined total of 4.8 million metric tons of capacity were closed during 1977-82. These sources see the possibility of this trend continuing and perhaps given additional impetus by the planned decontrol of natural gas prices by 1985. Plant closings during 1980-90 could remove an additional 2.2 million metric tons of capacity in the United States.

In Western Europe, the capacity additions between 1980 and 1990 are expected to be based on North Sea natural gas. However, depending upon the relative prices of North Sea natural gas in alternative applications, along with ammonia imports, these facilities could be postponed or canceled, which would reduce 1990 Western European capacity by approximately 1 million metric tons. Additional plant closings are also a possibility, because the majority of the Western European plants use even higher cost petroleum for feedstocks and energy.

Also, other cancellations or postponements of planned expansions could reduce total projected 1990 world capacity by 11 million metric tons. All of the developing nations, particularly those with expectations of weak economies in the 1980's because of large external debts or lower than expected petroleum revenues, would be likely to curtail expansion plans. Alternatively, a lower capacity utilization rate of the base scenario 1990 available capacity could also help alleviate the potential 1990 surplus. However, ammonia plants, especially the newer facilities in the capacity range of 1,000 metric tons per day are not designed for intermittent or sporadic use; production costs increase rapidly at less than optimum utilization rates, and mechanical difficulties are more likely to occur.

The cancellation and/or postponement of additional new free-world capacity and/or lower rates of capacity utilization totaling approximately 6 million metric tons could result in the free world becoming a net nitrogen importer in 1990. The net deficit position would be satisfied by imports from the NME's, particularly the U.S.S.R.

NME's.--In the base scenario, more than 70 percent of the 1990 potential surplus production would originate in the NME's (table 19). Since the U.S.S.R. is expected to have about 50 percent of the NME's 1990 total ammonia production capacity, the U.S.S.R. could act to moderate its capacity expansion and therefore reduce the magnitude of the potential production surplus. Alternate scenario I assumes the U.S.S.R. reduces its 1990 capacity buildup by approximately 4 million metric tons. The U.S.S.R. could achieve this goal by either of two or a combination of two actions. The U.S.S.R could postpone and/or cancel the nine planned new ammonia plants scheduled to come on-stream during 1985-90 and/or shut down one or more of its coal-based ammonia facilities.

In 1990, even with the capacity reduction, the U.S.S.R would remain the world's largest single net exporter (table 19). While some of these exports could be used to meet internal NME requirements, a significant portion, up to 50 percent, could be needed to balance free-world supply with demand. The United States, as a result of possible future plant closures, could be one of the world's largest net importers and a major market for U.S.S.R. exports in 1990.

Scenario II.--This scenario assumes that 1990 world ammonia production will remain as in the base scenario, but that demand will be sufficiently greater than that of the base scenario to significantly reduce the potential surplus (table 19). This scenario indicates that even with higher demand growth rates in many of the developed nations, the rate of growth of demand in the developing countries would need to be in the 8 to 9 percent per year range in order to reduce the potential surplus.

Free world.--With a more rapid growth in demand than under the base scenario, the free world could go from a net surplus to a net shortage status in 1990 (table 19). Only Canada, Mexico, and Trinidad would have significant surpluses, and thus be capable of being substantial exporters. The United States would became a larger net importer than under the base scenario, and almost all the developing nations would become net importers.

The growth in demand in the developing nations of the Middle East, Africa, and Asia would increase at a rate about 2.5 percent per year higher than in the base scenario rate. This faster rate would be required, because the developed nations' rates of growth of demand are limited by the fact that most of them already use optimium levels of nitrogen as a fertilizer and in other uses.

Under this scenario, the net shortage position of the free world in 1990 would be greater than in either of the other scenarios. This deficit would have to be alleviated by imports from the NME's, with the U.S.S.R. the major source of supply.

NME's.--Under scenario II, the U.S.S.R. assumes the position of the world net supplier of nitrogen; the U.S.S.R. would be in a position relative to nitrogen similar to that currently held by OPEC relative to petroleum (table 19). Without the assumed large capacity buildup in the U.S.S.R. during 1980-90, the world would be in a potential net shortage position in 1990, and either demand would be limited by supply or some other nations would have to increase their capacities.

Methanol

Methanol is a colorless liquid that boils at approximately 64.65° C. This property, among others, makes methanol easily transportable; it may be moved in drums, by tank truck, rail car, ship, or pipeline.

Methanol is made from carbon monoxide and hydrogen, which may be obtained from a variety of different raw materials. Those most commonly used today are natural gas and petroleum fractions; hence, methanol is a petrochemical.

The manufacture of methanol in the CERN's provides these nations with another way to upgrade and use natural gas which may once have been flared, and thus had essentially no economic value. In addition, the methanol facilities can use as raw materials the carbon monoxide or carbon dioxide made as byproducts during the manufacture of ammonia; many of the CERN's also have on-stream, under contruction, or are planning ammonia production facilities. Methanol and ammonia production facilities are often built simultaneously and close to one another.

Methanol is used as a solvent and as a feedstock for the manufacture of other chemicals, including formaldehyde and acetic acid. The production of formaldehyde now consumes the largest share of the methanol produced. However, feedstock for the manufacture of acetic acid is currently the fastest growing chemical use for methanol.

Although the solvent and chemical feedstock uses of methanol should continue to grow, it is the use of methanol or methanol derivatives as fuel or fuel additives that may have the greatest potential for future growth; 1/ a flow diagram of methanol and its derivatives can be found in figure 4. The extent to which this potential will be realized is dependent upon, among other factors, the future prices of petroleum-based fuels, such as gasoline and diesel fuel, and the construction of large methanol production facilities. 2/

Since the fuel market is highly price competitive, anything that helps lower the production cost of methanol vis-a-vis competing fuels increases methanol's chance for success in the fuel market. The availability of low-

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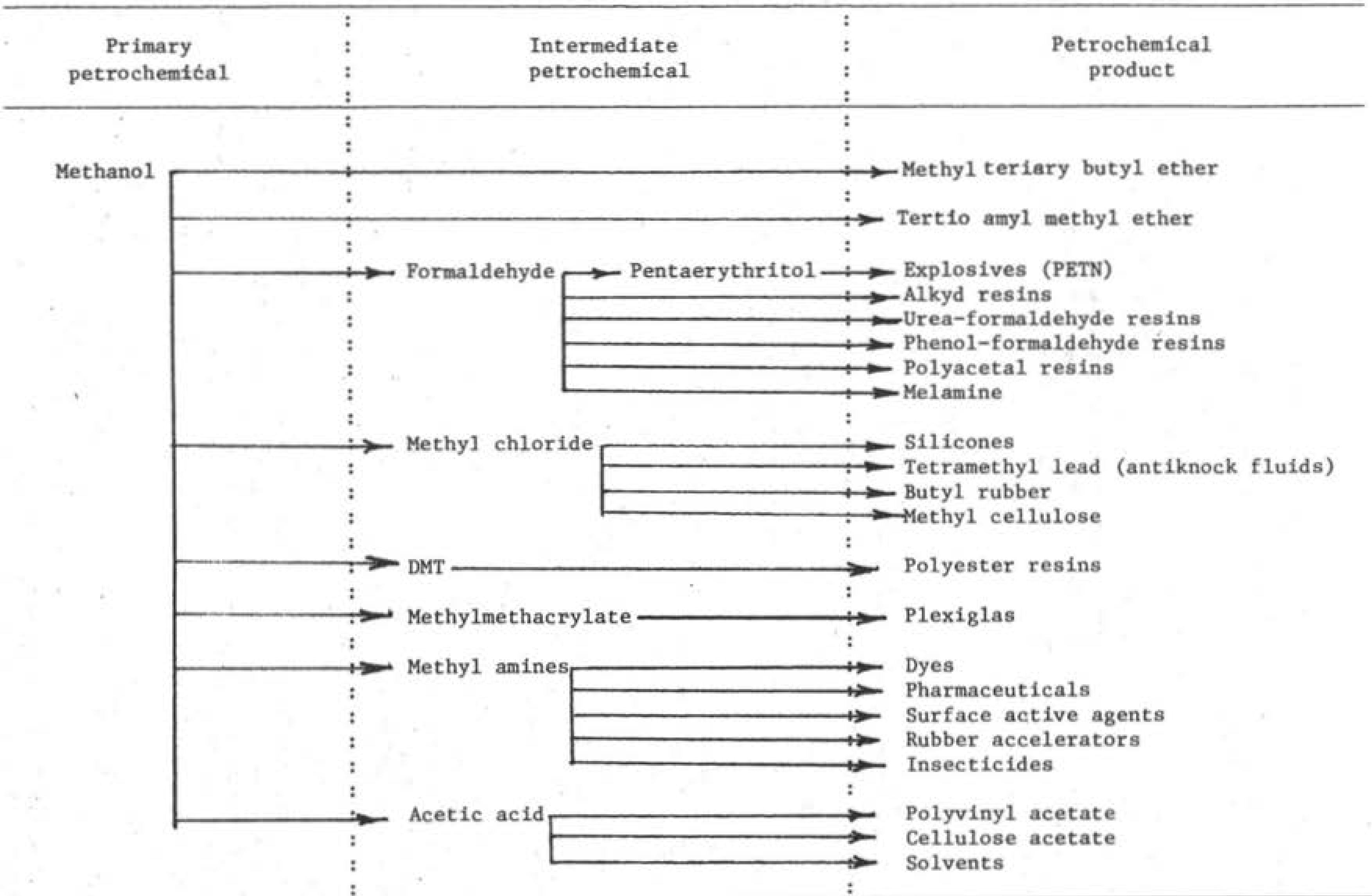
1/ World Bank, Emerging Energy and Chemical Applications of Methanol: Opportunities for Developing Countries, April 1982, p. ii.

2/ Ibid., pp. 57-59.

Figure 4.--Principal products of methanol.



1/ Motor gasoline octane improvers.

Source: U.S. International Trade Commission

cost, natural gas feedstock in the CERN's with sufficient capital to invest in expensive, large methanol facilities appears fortuitous for these nations. Many of these nations have under construction, planned, or under study, world-scale production capacity methanol plants. Further enhancing the price competitiveness of methanol in the fuel market is the fact that the methanol does not require purification at additional cost as when used as a chemical feedstock.

Methanol can potentially enter the fuel market during the 1980's in one or a combination of ways: (1) It can be used directly as a fuel; (2) it can be blended with gasoline in low level concentrations (up to 4 to 5 percent methanol) or in high-level concentrations (up to 15 to 20 percent methanol); or (3) it can be converted into derivatives which are then blended with gasoline.

Methanol theoretically costs less to produce and deliver as a carrier for natural gas than does liquefied natural gas; this is particularly true when the distances involved are more than several thousand miles by sea. 1/ Methanol can be used in power plant furnaces or reconverted into natural gas at its destination. There are no current commercial operations using methanol as a method of transporting natural gas. If larger quantities of methanol at attractive prices become available in the future, it could provide a new use for methanol.

Other potential uses for methanol, which may not be commercially important before the late 1980's or 1990's, include applications where methanol would be converted into ethanol, ethylene, and gasoline.

Many uses of methanol and its derivatives as fuel currently face technical and legal barriers. For example, in the United States the Environmental Protection Agency, as required under the Clean Air Act, must approve the use of gasoline additives; 2/ the use of methanol as a fuel, or extender for gasoline, is illegal in most States. 3/ Technical barriers to widespread use in the United States include the absence of a distribution system to sell methanol to the general public and the unavailability of vehicles designed to use methanol. 3/ Although methanol-gasoline blends are finding market acceptance in Europe, different laws in different European nations could hinder the development of blends. 2/

Some U.S. proponents have suggested the need for a U.S. floor price for methanol to assure its profitability if all other problems were to be solved and the use of methanol as a fuel became widespread. 4/ This mechanism might be necessary before the billion dollar investments in large methanol plants would be made by the private sector. 5/ A collapse of OPEC, and/or a large

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1/ "Producing Methanol for Fuels," <u>CEP</u>, August 1982, p. 30.

2/ "DuPont Seeks EPA Waiver for Use of Methanol in Gasoline," <u>European Chemical News</u>, Sept. 6, 1982, p. 22.

3/ "Bank of America Plans to Convert Entire Fleet to Methanol, Official Says," <u>Energy Users Report</u>, Aug. 19, 1982, p. 865.

4/ "Producing Methanol for Fuels," <u>CEP</u>, Aug. 1982, p. 33.

5/ Ibid.

decrease in crude petroleum prices, could quickly reduce the profitability of methanol for fuel investments.

Assuming methanol were to become established as a fuel, its growth potential could be large. In 1981, for example, free-world consumption of gasoline was more than 625 million metric tons; that of the United States alone was almost 300 million metric tons. 1/ Thus, in 1981, U.S. gasoline consumption was about 75 times greater than methanol production, and free-world consumption about 55 times greater than methanol production.

Should a large market for methanol as fuel develop, it could hasten the construction of coal-based methanol facilities, some of which could be on-stream before 1990. Coal-based methanol plants would use synthesis gas (hydrogen and carbon monoxide) made from the coal. In order to be economical, such gasification plants must be large; the methanol plants would also have to be large to use all of the synthesis gas produced. It is probable, therefore, that such large coal-based plants may not be built before the market for methanol as fuel is developed.

In 1980, both the free world and the NME's had methanol surpluses (table 20). Certain Asian and Western Hemisphere nations, including Japan, required net imports in order to maintain supplies equal to domestic consumptions. It is estimated that China was also a small net importer. Nations and areas with large net export potentials in 1980 were Canada, the Middle East, Africa, and Western Europe.

In 1980, the United States and Western Europe together accounted for 54 percent of the world's production, as well as 57 percent of the world's domestic consumption of methanol. Almost all of the methanol consumed was used in solvent applications and as raw material for chemical manufacture. Small quantities of methanol were used to produce gasoline additives and for low-level blending in gasoline.

The NME's were the third largest producers and consumers behind the United States and Western Europe, with 14 percent of both the world's production and domestic consumption. Within the NME's, the U.S.S.R. was both the production and domestic consumption leader, with 58 percent of the NME's total for each.

Base scenario

The base scenario for 1990 does not provide for any appreciable demand for methanol as a fuel; almost all of the methanol demand would be for the manufacture of chemicals (tables 21 and 22). This scenario would most probably occur if petroleum prices remained soft, reducing the attractiveness of methanol as a fuel substitute.

In the base scenario, world demand would increase at a rate of 4.2 percent per year during 1980-90, rising from 11.8 million metric tons in 1980

1/ The British Petroleum Co., BP Statistical Review of World Energy, 1981, 1982, p. 22.

Table 20.--Methanol: Estimated world production, estimated domestic consumption, and apparent surplus or (deficit), by areas, 1980

(In thousands of metric tons)

Area	Estimated production	Estimated domestic consumption	Apparent surplus or (deficit) 1/
United States	3,500	3,460	40
Canada	400	190	210
Mexico	150	100	50
Other Western Hemisphere	160	200	(40)
Western Europe	3,400	3,275	125
Japan	1,100	1,200	(100)
Middle East	200	50	150
Africa	200	50	150
Asia	450	500	(50)
Total, free world	9,560	9,025	535
U.S.S.R	1,800	1,600	200
China	210	250	(40)
Eastern Europe	1,100	900	200)
Total, nonmarket economies	3,110	2,750	360
Grand total	12,670	11,775	895

1/ Estimated domestic production minus estimated domestic consumption.

Source: Compiled by the staff of the U.S. International Trade Commission with information obtained from industry, consultants, and publications.

to 17.7 million metric tons in 1990. Anticipated 1990 production would be much greater than base scenario demand, and the potential for a large production surplus would be created. A large surplus would lead to increased competition, which would favor the newer, larger plants using lower priced feedstocks and energy.

Free world.--All of the countries or areas are expected to expand their methanol capacities during 1980-90 (table 21). The United States, Western Europe, and Canada could together account for 5.9 million metric tons, or almost 52 percent of the total free-world additions to capacity. Although most of these additions would go to satisfying 1990 domestic demand in the United States and Western Europe, the Canadian additions could produce large quantities of methanol for export (table 22). Some of the other nations or areas may also increase their potential for exports, as internal demand for chemical feedstocks will probably not rise as quickly as methanol production capabilities. This would be particularly true for some Middle Eastern and African countries.

The potential surplus in the CERN's could lead to increased price competition and result in reduced plant-operating rates, or plant closures, in some of the nations or areas with higher methanol production costs. Additional potential surpluses from the NME's could increase market pressures.

Alternatively, the potential surplus and lower prices could provide the impetus for the expanded use of methanol in fuel applications. These possibilities are discussed further in scenarios I and II which follow.

NME's.--The NME's, led by the U.S.S.R. with a potential capacity expansion of 5 million metric tons during 1980-90, should keep pace with the free world and retain the approximate 25 percent of the world's capacity it had in 1980 (table 21). The Eastern European nations are also expected to expand their methanol production capacity and their export potential. Industry sources, in general, expect only modest capacity expansion in China, with almost all of the increased capacity necessary to supply the anticipated internal use of methanol as a chemical feedstock in 1990.

Scenario I

Scenario I envisions, in addition to the base scenario's chemical applications, the expanded use of methanol as a fuel, but in a limited number of applications. The assumptions include the growing use of methanol in low-level gasoline blends, as well as in the manufacture of gasoline additives. These derivatives are oxygenated chemicals capable of increasing the octane rating of the gasoline to which they are added.

The currently dominant oxygenated methanol derivative used to improve octane rating is methyl tertiary butyl ether (MTBE). In addition, heavier oxygenated methanol derivatives can be used as octane boosters, including tertiary amyl methyl ether (TAME). Current world production capacity for MTBE is centered in the United States, Western and Eastern Europe, and Japan. 1/

1/ World Bank, Emerging Energy and Chemical Applications of Methanol: Opportunities for Developing Countries, April 1982, p. 27.

Table 21.--Methanol: Estimated world production capacities by areas, 1980 and 1990

(In thousands of metric tons)

Area	1980	1990	Increase, 1990 from 1980
United States	3,600	5,800	2,200
Canada	450	2,000	1,550
Mexico	170	1,200	1,030
Other Western Hemisphere	190	1,000	810
Western Europe	3,700	5,800	2,100
Japan	1,300	1,700	400
Middle East	275	1,500	1,225
Africa	275	1,100	825
Asia	600	1,800	1,200
Total, free world	10,560	21,900	11,340
U.S.S.R	2,200	5,000	2,800
China	260	500	240
Eastern Europe	1,300	2,400	1,100
Total, nonmarket economies	3,760	7,900	4,140
Grand total	14,320	29,800	15,480

Source: Compiled by the staff of the U.S. International Trade Commission with information obtained from industry, consultants, and publications.

Table 22.--Methanol: Estimated world production, estimated domestic demand, and apparent surplus or (deficit), by areas, 1990

(In thousands of metric tons)

Area	Estimated domestic production	Estimated domestic demand			Apparent surplus or (deficit) 1/		
		Base scenario	Scenario I	Scenario II	Base scenario	Scenario I	Scenario II
United States	5,220	5,100	7,800	10,000	120	(2,580)	(4,780)
Canada	1,760	275	530	530	1,485	1,230	1,230
Mexico	1,050	175	175	175	875	875	875
Other Western Hemisphere	1,000	385	485	1,500	615	515	(500)
Western Europe	5,300	5,300	6,300	9,000	0	(1,000)	(3,700)
Japan	1,450	1,700	2,100	2,100	(250)	(650)	(650)
Middle East	1,125	100	300	300	1,025	825	825
Africa	770	100	300	300	670	470	470
Asia	1,350	950	1,100	1,100	400	250	250)
Total, free world	19,025	14,085	19,090	25,005	4,940	(65)	(5,980)
U.S.S.R	4,000	2,000	2,500	2,500	2,000	1,500	1,500
China	400	400	400	400	0	0	0
Eastern Europe	2,000	1,200	1,400	2,100	800	600	(100)
Total, nonmarket economies	6,400	3,600	4,300	5,000	2,800	2,100	1,400
Grand total	25,425	17,685	23,390	30,005	7,740	2,035	(4,580)

1/ Estimated domestic production minus estimated domestic demand.

Source: Compiled by the staff of the U.S. International Trade Commission with information obtained from industry, consultants, and publications.

U.S. and European refiners have been using methanol as a gasoline extender, a deicer, or an additive to increase octane rating. Industry sources believe that a greater quantity of methanol is currently being used in these applications in Europe than in the United States.

The rate of world growth of methanol during 1980-90, including these limited fuel applications, could be 7.1 percent per year versus 4.2 percent per year in the base scenario. Demand would about double, increasing from 11.8 million metric tons in 1980 to 23.4 million metric tons in 1990 (table 22).

Free world.--Methanol demand in 1990 could be increased by about 5 million metric tons through the use of methanol in a limited number of fuel applications (table 22). Most of this increase would occur in the United States and Western Europe, which together could account for about 75 percent of the free world's use of methanol in certain fuel applications in 1990.

The development of the use of methanol in certain fuel applications would consume the 1990 free world's methanol surplus expected under the base scenario. Overall, the free world would be in a slight shortage position in 1990, which could be easily satisfied by excess production from the NME's and higher plant utilization rates and expanded capacity in the free world.

The United States and Western Europe could become net methanol importers under this scenario; Japan, which was a net importer under the base scenario, could increase its dependence upon external methanol sources. The principal free-world sources would be Canada, the Middle East, and Mexico.

NME's.--Some increased demand for methanol in certain fuel uses is expected in both the U.S.S.R. and Eastern Europe (table 22). The picture for China is less clear, and this scenario does not assume any increase in demand; this does not necessarily mean none will occur.

According to scenario I, the NME's, particularly the U.S.S.R., could become marginal methanol suppliers to the world. With its extensive natural gas deposits and centrally controlled economy, the U.S.S.R. would be capable of meeting most, if not all, competition from other suppliers for the available market.

Scenario II

This scenario assumes, in addition to the chemical and limited fuel uses of scenario I, the expanded use of methanol as a fuel. Specifically, it assumes the use of both high-level gasoline blends and the use of straight methanol as a fuel. Although the most optimistic of the three scenarios, it stands a probability of occurring, but it is often excluded from the more conservative industry forecasts. 1/ There is a reasonable chance that the use of straight methanol as a fuel could develop during 1985-90, although the probability, at least for widespread use in areas of large automobile populations, is greater for 1990-2000. The principal drawbacks to widespread

1/ Ibid., p. 10.

use of straight methanol as a fuel are the lack of a distribution infrastructure and the lead time necessary to develop and market automobiles capable of operating on methanol. Also, as previously mentioned, widespread use of methanol as a fuel assumes a price parity between methanol and gasoline.

As scenario II reveals, both the free world and the NME's could be in net deficit positions in 1990 (table 22). In actuality, it has been assumed by some industry observers that widespread use of straight methanol as a fuel would develop at the same time that large-scale, coal-based methanol facilities were built. 1/ Therefore, the potential deficit projected in scenario I for 1990 would not occur, because additional methanol could become available from coal-based plants.

Many areas of the world where the potential for consumption of straight methanol as a fuel exists, including both the United States and Western Europe, have extensive deposits of coal, including lignite and peat. It has been estimated that this coal could be delivered to coal-based methanol facilities adjacent to the mines at a cost estimated to range from $0.50 to $1.00 per million British thermal units. 2/ This price range is equivalent to that often cited for natural gas in the CERN's.

The primary reason coal-based methanol plants are not expected to be built in the absence of rapidly expanding methanol demand is that in order for such plants to be economical, they must be of world-scale capacity. The optimum capacity of such a plant is from a minimum of 5,000 metric tons per day to a maximum of 25,000 metric tons per day. 3/ In order to illustrate the required size, one plant would have the capacity to produce one-half to almost three times as much as 1980 total U.S. methanol capacity.

Free world.--Free-world methanol demand in 1990, according to scenario II, is almost double that of the base scenario, or 25 million metric tons versus 14 million metric tons (table 22). The United States and Western Europe would be the leading consumers of straight methanol as a fuel, and together would account for almost 5 million of the 6 million metric tons used in the free world. According to this scenario, both the United States and Western Europe would require net imports approaching 50 percent of consumption. However, before this point could be reached, it is believed that the coal-based facilities previously discussed would have been developed. The incentive for these facilities could be even greater if some of the other potential large-volume uses for methanol were to be commercially developed in the latter 1980's. These uses would include applications such as a raw material for single-cell protein, ethylene and other chemicals, gasoline, 4/ and as fuel for power generation, households, fuel cells, and industry. 5/

1/ World Bank, Emerging Energy and Chemical Applications of Methanol: Opportunities for Developing Countries, April 1982, pp. 40-41.

2/ "Producing Methanol for Fuels," CEP, p. 31.

3/ Ibid., p. 33.

4/ Making gasoline from methanol is attractive, because it circumvents the need to establish methanol fuel distribution networks and to produce special methanol engines for new cars or retrofit the engines of older cars to use methanol.

5/ World Bank, Emerging Energy and Chemical Applications of Methanol: Opportunities for Developing Countries, April 1982, p. 9.

All of these applications face various hurdles, but assumed availability of competitively priced methanol could increase the incentive to find solutions.

NME's.--No large increase is expected in methanol demand, because its use in expanded fuel applications in the NME's is expected to be limited, principally because of the ready availability of other energy sources and the limited number of automobiles therein. It is possible that expanded fuel applications would be sought if potential production surpluses could not be marketed outside the NME's. If the demand were developed, it would also be possible for most of the NME's, particularly the U.S.S.R. and China, to develop coal-based methanol plants because of large coal deposits. Only relatively recently have coal-based chemical operations been subject to displacement by petroleum-based plants in many NME's, and the trend could be reversed with sufficient incentive.

Possible Quantitative Impacts of These Scenarios on the United States

The preceding section discussed future world supply-demand scenarios for ethylene and ammonia and their derivatives, and methanol. Apparent 1990 surplus or deficit positions, equal to estimated domestic production minus estimated domestic demand, are given for various countries and areas. The apparent surplus or deficit is assumed to be equivalent to the net trade position. Those nations or areas with a surplus would presumably export the excess domestic production, whereas those nations with a deficit would presumably import to meet the domestic demand.

The following tabulation summarizes the 1990 trade positions of the United States for ethylene and ammonia and their derivatives, and methanol, taken from the scenarios in the previous section. A negative (parenthesis) net trade position indicates a net import status, and a positive net trade position indicates a net export status:

	Quantity 1,000 metric tons
Ethylene and derivatives (in terms of ethylene equivalents)	1,300 to (2,005)
Ammonia and derivatives (in terms of nitrogen equivalents)	(3,670) to (5,800)
Methanol	120 to (4,780)

Using 1982 average unit values for these items, 1/ the quantity data can be converted into U.S. net trade positions, which range from -$140 million to

1/ Ethylene and derivatives, $650 per metric ton; ammonia and derivatives, $275 per metric ton; methanol, $200 per metric ton.

-$3.8 billion. The base scenarios give a U.S. net trade position of -$1.8 billion. By way of comparison, it has been estimated by other sources that, hypothetically, $1 billion in U.S. chemical exports in 1980 could have been replaced by exports from but one specific new petrochemical-producing nation in the Middle East. 1/

Input/Output Model

The U.S. Department of Labor input/output model can be used to calculate the change in U.S. industry output and employment resulting from any given hypothetical change in final demand for a domestically produced commodity. The model is based on the input/output relations existing in the U.S. economy in 1977 and 1981 productivity factors (employment-output ratios). It should be noted that to the extent that the input/output relationships have changed since 1977, the model results will not reflect the current situation. Further, the supply-demand scenarios presented in the previous section relate to the 1990 period, and actual input/output relations and labor productivity in 1990 will most likely differ from those used in the model.

To calculate the possible effects of production from the new petrochemical-producing nations on the U.S. economy requires the forecasting of possible U.S. net trade positions resulting from imports and/or exports because of the new production, and the price elasticities of demand and supply. The demand elasticity for chemicals and allied products has been estimated to range from -0.7 to -0.9. 2/ A low elasticity is expected, because the largest sectors within the industry are producer goods. 3/ No published supply elasticity is available; it has been estimated to be 1.0. 4/ Once all these values are determined, estimates of petrochemical production changes caused by net trade changes can be made.

The estimates of the effect on production of the net trade can vary with different assumptions about the elasticities of demand and supply. For this study, a one-to-one ratio is assumed between net trade changes and production changes. This assumption implies an infinite supply elasticity or a zero demand elasticity, or that any increase in imports replaces domestic production; domestic prices, consumption, exchange rates, and other variables are assumed to be unaffected by changes in imports and exports. 5/

The changes in industry output and employment provided by the input/output model are upper limits. The model does not provide for continued or additional exports of derivatives made from the imported petrochemicals. A decrease in demand for a certain petrochemical will be reflected by the model

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1/ U.S. Department of State, Airgram, Saudi Arabia's Emerging Petrochemical Industry -- Implications for the West, Oct. 31, 1982, p. 13.

2/ U.S. International Trade Commission, The Impact of Foreign Trade-Related Performance Requirements on U.S. Industry and Foreign Investment Abroad, Sept. 30, 1982, (unpublished), p. A-126.

3/ Ibid., p. A-126.

4/ Ibid., p. A-127.

5/ Ibid. Also, U.S. Department of Commerce, Philip M. Ritz, "The Input-Output Structure of the U.S. Economy," Survey of Current Business, 1972, p. 43.

as a decrease in output for all of that certain petrochemical's derivatives and products, as well as in the employment in the industries that make these further advanced items. In actuality, this may not be an accurate reflection. When a certain petrochemical is imported, output and employment of the domestic manufacturers of that petrochemical would decrease. However, to the extent that the imported petrochemical is used to make those derivatives previously made from the domestically produced petrochemical, the output and employment in these derivatives would be unaffected. In this investigation, it has been found that some of the U.S. producers plan on importing petrochemicals and decreasing their U.S. production. However, many of these same producers claim they will continue to make the same derivatives from the imported petrochemicals as previously made from their domestic production. Lower prices for imported petrochemicals relative to domestic production, if passed through in the prices of the derivatives made from the imports, could potentially increase U.S. exports.

Changes in Industry Output

The input/output model indicates that for each hypothetical decrease of $1 billion in final demand for ethylene and ammonia and their derivatives, and methanol, the chemical and allied products industry would experience a decline in output of $1.35 billion. The difference between change in final demand and output is accounted for by the value added at each step in the further processing of a petrochemical, such as the progression from ethylene to ethylene oxide to ethylene glycol to antifreeze. As a result of the same $1 billion decrease in final demand for these petrochemicals, the U.S. petroleum-refining and related products industry output would decline $280 million, and all U.S. industry output throughout the economy would decline $2.6 billion.

Using the net trade figures obtained from the high and low scenarios of -$140 million and -$3.8 billion as input, the model would indicate a decline of $190 million to $5.1 billion in the output of the U.S. chemical and allied products industry. The U.S. petroleum refining and related products industry output would decline between $39 million and $1 billion, the U.S. crude petroleum and natural gas industry output would decline between $32 million and $0.9 billion, and the output of the entire economy, including the industries already mentioned, would decline between $365 million and about $10 billion. The base scenario net trade figure of -$1.8 billion would cause output declines of $2.4 billion in the chemical and allied products industry, $0.5 billion in the petroleum-refining and related products industry, $0.4 billion in the crude petroleum and natural gas industry, and $4.7 billion in total industry output.

Changes in Industry Employment

The input/output model indicates that for each hypothetical decrease of $1 billion in final demand for ethylene and ammonia and their derivatives, and methanol, the chemical and allied products industry would experience a decline in employment of 6,420. As a result of the same $1 billion decrease, the petroleum-refining and related products industry employment would decline by 245, and employment throughout the economy would decline by 17,270.

Using the net trade figures obtained from the high and low scenarios of -$140 million and -$3.8 billion as input, the model would indicate a decline of between 902 and 24,396 in chemical and allied products industry employment. The employment declines would range in the petroleum-refining and related products industry from 35 to 931, from 31 to 836 in the crude petroleum and natural gas industry, and in the economy as a whole, from 2,429 to 65,626. The base scenario net trade figure of -$1.8 billion would cause employment declines in the chemical and allied products industry of 11,556, in the petroleum-refining and related products industry of 441, in the crude petroleum and natural gas industry of 396, and in the economy as a whole of 31,086.

Other Possible Effects of Expanding Petrochemical Industries in the Conventional-Energy-Rich Nations

Other possible changes resulting from the development of petrochemical industries in the CERN's could occur to the petrochemical industries in any nation. However, those countries whose industries would most likely undergo some or all of these possible changes are the United States, Western European nations, and Japan; that is, those countries currently possessing relatively developed petrochemical industries would be the most susceptible to changes. Developing nations and centrally planned economies, in general, would be less susceptible because of number a of reasons. These reasons include newer facilities, more up-to-date technology, greater Government involvement in controlling prices and setting national priorities, as well as a less well-defined profit motive. It has been stated that Government enterprises are primarily concerned with employment and foreign exchange, compared with the interest in profits of private sector enterprises. 1/

Those possible changes to be addressed in the following sections can be categorized by industry structure and operation, raw materials and feedstocks, products, and profitability. The frequency with which these changes do actually occur may in some cases be directly linked to the level of competition for world markets; the more intense this competition becomes in the future, the greater the likelihood such changes could occur.

Industry Structure and Operation

As a result of the efforts of individual chemical companies to accomodate or counter the petrochemical buildup in CERN's, the structure of the U.S. chemical industry may itself change. By the end of the decade, there could be, among other factors, changes in the numbers and sizes of companies, as well as changes in the degree of involvement by petroleum companies. All of these actions have already been discussed in trade and Government publications, and some are currently being taken. No one action, or combination of actions, has been recommended by industry as a solution for its current and possible future problems. Industry observers believe the actions taken by any one

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1/ "Big Changes in Chemical Firms by 2000," Chemical & Engineering News, Oct. 11, 1982, p. 6.

should be specifically tailored to enhance that company's assets, whether they be marketing, R. & D., and natural resources.

Investment and Rationalization

Close facilities.--Companies may choose or be forced to close or sell facilities and withdraw from the market. This action may appeal to those companies that believe they should not remain as producers of certain products because of perceived inherent corporate deficiencies in areas such as natural resources and R. & D. ability. It may also be a useful tool for those companies that have redefined their business interests and find that certain current activities do not coincide with their new goals. For example, a large U.S. petroleum company, that until recently was diversifying, is now abandoning the production of chemicals, plastics, and metals; it has redefined its basic interests as finding, producing, upgrading, and marketing hydrocarbons. 1/

Companies may close older facilities, that are perhaps higher cost or lower efficiency units, and replace them with expansions at other facilities or with completely new facilities. This strategy is being followed by a leading U.S. petroleum company's petrochemical affiliate. It has gradually shut down two smaller ethylene plants after a new, larger ethylene facility came on-stream. 2/

Other companies may close U.S. facilities and replace the output with imports from wholly or partially owned overseas plants. One U.S. firm with investment in a petrochemical complex in the Persian Gulf has stated that it expects to import a large portion of the output for use as feedstock for its U.S. derivatives plants. 3/

In addition, some facilities, incapable of competing with lower priced petrochemicals in the domestic or export markets, could simply be forced to close. This approach to rationalization, however, may be necessary only in the case of certain petrochemicals. It has been suggested, for example, that a reduction in manufacturing capacities for raw-material-intensive and capital-intensive petrochemicals produced by a relatively large number of manufacturers, with complex feedstock and interrelated dependencies, may not be achievable in any planned, coordinated manner. 4/ If this statement is true, planned capacity reductions may be difficult or impossible in the olefins which are vulnerable to negative impact from the planned increases of olefin capacity in the CERN's. Planned capacity reduction is preferable, because it reduces the possibility of industry disruption.

Trade product interests.--Companies continue to explore for opportunities where "one company trades its total interests in a product (or group of

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1/ "A Craving for Chemicals Changes to Aversion," Chemical Week, Apr. 21, 1982, p. 32.

2/ "Oil and Chemicals Do Not Mix at Exxon," Chemical Business, Feb. 8, 1982, p. 10.

3/ "U.S. Firms Put Damper on Plans for O'seas Chemical Projects," Chemical Marketing Reporter, Mar. 29, 1982, p. 32.

4/ "Concerted Capacity Cut Will Not Work in Petrochemicals," European Chemical News, Oct. 11, 1982, p. 18.

products) for those of another company." 1/ In theory, this mechanism should result in each of the parties involved becoming stronger in their retained products, but the practical problem has been to find a situation which may be attractive to both companies. In spite of these inherent difficulties, opportunities to trade product interests are becoming more common, particularly in France, Italy, and the United Kingdom.

In 1982, several chemical companies in France were nationalized. 2/ One goal of this action was to improve the competitiveness of the French chemical industry. The nationalized companies have been divided into three groups, each of which is expected to concentrate on improvement in mutually exclusive, arbitrarily defined product(s) sectors. 3/

In Italy, plant transfers have occurred between two of the major chemical companies. 4/ This effort furthers the Italian Government's goal of establishing national production monopolies in primary and secondary chemicals, including specialties and fine chemicals. The objectives are reported to be the elimination of duplicate production facilities and excessively competitive marketing. 5/

In the United Kingdom, two major plastics producers exchanged their interests in LDPE and PVC production; one producer will now specialize in LDPE, and the other will concentrate in PVC. The arrangement also involved the closure of 7 plants and the elimination of 1,800 positions. The exchange does not affect the plastics facilities of either company in countries other than the United Kingdom. 6/

Cost reduction

The costs of doing business can be categorized in different ways, but many fall under the headings of personnel, maintenance, raw materials/feedstocks, and energy. Most of the structural changes the industry in the historic petrochemical-producing areas are now undergoing, and are expected to undergo in the future, are attractive because they may reduce one or more of those costs. Further, current R. & D. expenditures for the development of automation and streamlining processes, if successful, could also help reduce costs. A related area that holds promise of future cost reduction which is

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1/ "European Companies Begin to Act on Petrochemical Plant Closures," European Chemical New, Dec. 7, 1981, p. 19.

2/ "Restructuring Plans for a State-owned Industry," Chemical Week, May 26, 1982, p. 18.

3/ "French Chemicals Sector Split in Three in Nationalization Plan," European Chemical News, May 24, 1982, p. 4.

4/ "More Details Emerge on Proposed Italian Chemical Restructuring," European Chemical News, Aug. 9, 1982, p. 6.

5/ "Italy's New Plan to Revive Chemicals," Chemical Week, Sept. 8, 1982, p. 30.

6/ "ICI, BP Chemicals Exchange LDPE and PVC Businesses," European Chemical News, June 28, 1982, p. 4

receiving increasing attention is that of "energy management." Energy management includes the following stages: 1/

(1) Housekeeping and operational improvements;

(2) Improvements to existing equipment;

(3) New equipment, improved controls, and the use of alternate energy sources;

(4) Improved processes; and

(5) New technologies.

It has been estimated that, at present, the U.S. petrochemical industry is at stage 2. 2/ Most of the simpler, less costly steps to improving energy efficiency have already been taken, and further improvements involving capital investment, as well as the possible use of new energy materials are expected.

Energy and feedstocks are often derived from the same sources for use by the petrochemical industry. Therefore, as energy prices rise, the petrochemical industry is affected not only by increasing energy costs, but also by increasing feedstock costs. Since the Arab petroleum embargo in 1973-1974, it has been estimated that because of market resistance the chemical industry has seldom been able to increase chemical prices by the same ratio that energy and feedstock costs have increased, as the following tabulation indicates (in percent): 3/

Year	Yearly increase in chemical prices	Yearly increase in energy and feedstock prices
1973	3.0	16.6
1974	32.0	92.0
1975	12.5	13.2
1976	4.0	6.9
1977	3.0	5.9
1978	3.0	2.8
1980	12.8	24.8
1981	7.0	10.8
1982 1/	3.0	3.8

1/ Estimated.

1/ "Energy Management in the 1980's," Hydrocarbon Processing, May 1982, p. 165.

2/ Ibid.

3/ "Coping with Structural Change," Chemical Purchasing, July 1982, p. 42. Unit chemical price and energy and feedstock price changes were derived from a chemical industry income statement model by The First Boston Corp.

Since as much as 70-80 percent of the production costs of petrochemicals such as ethylene, methanol, and ammonia, are attributable to energy and feedstock costs, the cost potential for energy management becomes apparent. If less energy and feedstocks are required per unit of petrochemical produced, the product will be more competitive with products produced in CERN's. While these areas may also be interested in energy management, the potential cost, and thus incentive to invest in energy management, is considerably less. In addition, the funds that could be used for energy management projects in CERN's might often be better utilized in other projects that give greater benefits.

Joint Ventures, Mergers, and Foreign Subsidiaries

Some companies are themselves becoming involved in the buildup of overseas petrochemical capacity through joint ventures, mergers, and foreign subsidiaries. The joint ventures and mergers essentially build upon the strengths of two or more companies. The establishment of foreign subsidiaries is often primarily based, at least at present, on the availability of lower cost energy and feedstocks in the host nations. A number of U.S. firms have established such subsidiaries and invested in petrochemical facilities in Canada and Persian Gulf nations.

Joint ventures

Joint ventures, which are receiving renewed attention in the domestic market, allow companies interested in producing the same product, to combine resources in such areas as marketing, R. & D., and production. A product of a joint venture, under such circumstances, may be more competitive than either of the companies' products would have been separately. 1/

Mergers

Mergers often accomplish the same purposes as joint ventures. However, since mergers permanently combine two or more companies, they also tend to reduce competition in the market place. Mergers also make it easier to close facilities and may allow investment in modernization, expansion, or new facilities to be delayed. 2/

A recent update, by the U.S. Department of Justice of the 1968 merger guidelines should help many U.S. companies, including U.S. petrochemical companies, to gauge the probable response of U.S. antitrust institutions to their contemplated mergers or acquistions. This ability may increase the probability of petrochemical company managements' considering mergers or acquisitions, which could have a positive effect on the future competitiveness of individual companies, and possibly the entire U.S. petrochemical industry. 3/

1/ European Companies Begin to Act on Petrochemical Plant Closures," European Chemical News, Dec. 7, 1981, p. 19.

2/ Ibid.

3/ "Green Lights For More CPI Acquistions," Chemical Week, June 30, 1982, p. 23.

Foreign subsidiaries

Most of the petrochemical complexes planned, under construction, or on-stream in the CERN's are the result of joint ventures. In most instances, the CERN involved has an abundance of crude petroleum and/or natural gas and wishes to develop a petrochemical industry. However, these nations usually recognize their deficiencies in such areas as marketing, management, and technology, and promote joint ventures with experienced partners noted for their expertise in one or more of these areas. SABIC in Saudi Arabia is a leading proponent of this joint-venture approach and has entered into joint ventures with at least one Taiwan company, two Japanese companies, and five U.S. companies. 1/

Foreign investment by the U.S. chemical industry is not only limited to the CERN's, but also includes interests in Western Europe, Africa and South America. 2/ Part of the investment in Western Europe, Africa and South America could be for downstream petrochemical plants which could use, as feedstocks, the primary petrochemicals from the CERN's. It has been stated, for example, by a SABIC spokesman, that Saudi Arabia will probably not invest in downstream petrochemical facilities outside of Saudi Arabia which are based on Saudi feedstocks. 3/ Depending upon the nation in which the downstream petrochemicals facilities would be located, the producer may have the advantage of lower priced petrochemical raw materials as well as lower tariffs for exports to foreign nations. Investments may take place in such countries primarily because of these dual competitive advantages.

Industry-Government Interaction

The interactions among the chemical industries in various nations and governments are now changing, and may continue to change. At present, no one country is being used as a model by others, although in general, a trend to closer cooperation between industry and government appears to be occurring.

Western Europe

In Western Europe, there has been increasing government involvement on the part of many nations to aid the national chemical industries and decrease unemployment; these actions reflect an increased involvement when compared with past practices of partial or complete state ownership of certain chemical companies. The Italian Government now controls a large part of that country's chemical industry; the heavy chemicals industry in France is dominated by state corporations; in at least four EC countries, the synthetic fibers industries are recipients of Government incentives of various types. 4/

1/ Hugh G. Hambleton, "Saudi Arabia: The Emerging Petrochemical Industry," Universite Laval, 1982.

2/ "U.S. Chemical Spending Abroad to Rise 27%," Chemical & Engineering News, May 10, 1982, p. 25.

3/ "SABIC Director Sees Bright Future For Saudi Industries as Gulf Emerges as New World Petrochemical Center," Middle East Economic Survey, Feb. 8, 1982, p. 6.

4/ "The Tightening State Grip on Europe's Chemical Industry," Chemical Business, May 4, 1981, p. 41.

United States

Historically, the U.S. Government has become involved in the domestic chemical industry in areas concerning only national defense. During World War II, the U.S. Government was the driving force behind the development and production of synthetic rubber, primarily to replace imports of natural rubber, which had been disrupted by the war. At present, the U.S. Government is only minimally involved in a few privately managed plants which produce chemicals used in the production of munitions.

Future involvement.--It is not expected that the U.S. Government will significantly increase its direct industry participation during the 1980's, but there may be an increasing number of requests by the U.S. petrochemical industry for assistance. Although no specific action could be ruled out, industry observers believe most of the requests will be to support U.S. exports and/or limit U.S. imports. In Western Europe, for example, the chemical tariff issue is already under discussion, and the European Council of Chemical Manufacturers' Federations is demanding that the Common Market's GSP no longer apply to chemical imports from the Arab petroleum States. 1/ This action applies directly to the matter previously mentioned--low-price energy and feedstock nations which are also receiving reduced-tariff consideration.

Foreign investments.--Foreign investment in U.S. industries is also coming under increasing study by the Congress and the executive branch, primarily because foreign governments have more restrictions on U.S. investment in their domestic industries than the U.S. Government does on foreign investments in U.S. industries. 2/ Action in this area by the U.S. Government is of particular interest to the U.S. chemical industry, which is a prime candidate for foreign investment. A senior executive of a leading U.S. petroleum company with diverse petrochemical interests has stated that investment policy is a relatively recent issue and "will dominate international economic issues during the next decade, as trade policy did during the past three." 3/ He further stated that although the United States currently has invested about $19.5 billion overseas, new opportunities for investment are shrinking "not because of economic factors, but because of political obstacles imposed by foreign governments--the U.S. has the most open investment environment of any country." 4/

By the end of 1980, a consultant reports that more than 101 foreign firms had investments in over 186 U.S. chemical firms. 5/ The largest of these firms, which is 100 percent foreign owned, had 1980 chemical sales of almost $5 billion. 5/

1/ "How Do European Chemical Producers Spell 'Anxiety'? A-R-A-B-S," Chemical Business, Mar. 8, 1982, p. 14.

2/ "Plans to Curb Foreign Purchases of U.S. Firms," Chemical Week, Feb. 3, 1982, p. 26.

3/ "Trade Rules Threaten U.S. Chemical Industry," Hydrocarbon Processing, April 1982, p. 23.

4/ "Trade Rules Threaten U.S. Chemical Industry," Hydrocarbon Processing, April 1982, p. 23. Also, U.S. International Trade Commission, The Impact of Foreign Trade-Related Performance Requirements on U.S. Industry and Foreign Investments Abroad, Sept. 30, 1982, (unpublished), pp. vii-xiii.

5/ Alan S. Brown, "U.S. vs. Foreign Chemical Companies: Battling It Out on the Home Front," Chemical Business, July 27, 1981, p. 9.

Most of the foreign investments in the United States have been in smaller volume, technically sophisticated chemicals, such as dyestuffs. 1/ Competition could be intense in the future, because some U.S. chemical companies increasingly turn to the manufacture of such specialty chemicals to maintain their economic viability. Some U.S. firms find it increasingly unattractive to compete with overseas producers of high-volume petrochemicals, such as the olefins, because of the CERN's energy and feedstock price advantages.

Although trade policy has been important in the past, it could become even more so in the future. Sufficient future changes in the U.S. chemical balance of trade could renew an emphasis on import controls and export promotion. Trade journals are publishing an increasing number of articles concerning foreign government participation in domestic petrochemical production, nontariff barriers, the GSP, and the Domestic International Sales Corporation (DISC). 2/

The call for reciprocity is a relatively new movement in the United States that has many proponents. Reciprocity is often defined as the theory that equal access to each others markets should be afforded major trading partners. 3/ If reciprocity is not forthcoming, equity demands that the deprived trading partners decrease their home-market availabilty to their trading partners in an effort to have the trading partners change their policy. 3/ The Reciprocity Trade and Investment Act (S.2079) was introduced in the 97th Congress, and if passed, would have required the President to identify the major U.S. trading partners' barriers to U.S. products services and investment, attempt to negotiate an end to the practices, and failing that, to suggest retaliatory measures to Congress. 4/

New forces to be reckoned with by the U.S. petrochemical industry include foreign nations' energy policies, tax and other incentives, and direct U.S. Government involvement in petrochemical production. 5/ A growing feeling on the part of many U.S. petrochemical producers is that the U.S. Government may need to change its policies as a reaction to these changing global conditions. 6/ Some other petrochemical producers believe the industry has had only marginal impact on Government policies and advise the industry to

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1/ Ibid., p. 13.

2/ For example: Leslie A. Glich, "Charges of "Subsidies Trouble U.S.-Mexico Trade Relations," Made in Mexico, vol. IV, No. 4, 1982, pp. 36-40. The Japan Economic Institute of America, Inc., Japans' Import Barriers: An Analyses of Divergent Bilateral Views, 1982. Michael A. Sammuels, "Time for an Activist Export Policy," Busines America, Feb. 2, 1982, p. 1. Mr. Tower, U.S. Trade Posture," Congressional Record, Feb. 11, 1982, p. S. 891. Also various issues of Washington Tariff and Trade Letter.

3/ Christopher Madison, "Flirting with Reciprocity: New U.S. Trade Policy Makes Some People Nervous," National Journal, Feb. 20, 1982, p. 320.

4/ Ibid., p. 323.

5/ "U.S. Chemical Exports Face Sharp Decline," Chemical & Engineering News, May 24, 1982, p. 22.

6/ "U.S. Government Policy is Key to Competition in Chemicals," The Journal of Commerce, June 3, 1982, p. 1.

concentrate on those issues it can affect, such as products, customers, price, and restructuring. 1/

In summary, many U.S. petrochemical company officials believe world petrochemical competition is changing from a situation of trade between companies to trade directly between nations. 2/ To adequately deal with this problem, some petrochemical industry executives plan to request a new coalition of government, academia, and industry. 2/ There have been talks between the United States and several of its trading partners to discuss ways in which to strengthen the GATT in an atttempt to lessen barriers to trade. 3/

The excessive dependence of any nation upon imports may impact the degrees of freedom that the nation may exercise in international affairs. For example, the United States, in its effort to avoid possible constraints, has usually operated in a manner so as to limit its vulnerability to petroleum supply disruptions by promoting the use of alternate energy sources such as coal, aiding crude petroleum exploration and development, advocating conservation, diversifying its sources of petroleum imports, and by joining organizations which could offer alternatives during periods of supply shortages, such as the International Energy Agency. 4/

Raw Materials

If the product emphasis in the U.S. petrochemical industry changes during the next decade, the industry's interest in feedstocks, energy sources, and processes is expected to also change. This interest would be the result of (1) the emergence of new products, (2) seeking cheaper and/or more secure feedstock and energy sources, and (3) developing new production processes to improve established products. Thus, interest could extend into such areas as coal, acetylene chemistry, biotechnology, fermentation processes (based on agricultural products), and renewable biological materials, including molasses, starch, and cellulosic biomass. The extent that any of these areas is commercially exploited during the 1980's and 1990's could depend upon such factors as pollution controls, toxic substances laws, and price and availability of crude petroleum and natural gas.

Some industry observers believe that there may be sufficient world petroleum supplies to meet anticipated petrochemical feedstock demand until the year 2025, but it does not necessarily mean that there will be a reduced

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1/ "Big Changes in Chemical Firms by 2000," Chemical & Engineering News, Oct. 11, 1982, p. 6.

2/ John M. Henske, "The Changing Environment for International Trade: A Major Challenge for the Chemical Industry," Address before a Meeting of the Synthetic Organic Chemical Manufacturers Association, New York, Sept. 9, 1982, p. 3.

3/ "Basic Revisions in Trade Laws Sought by U.S.," Washingtion Post, Mar. 16, 1983, p. A-1.

4/ U.S. Congress, Senate Subcommittee on Energy, Nuclear Proliferation, and Government Processes, Committee on Governmental Affairs, International Energy Agency and Global Energy Security Matters, July 14, 1987, pp. 3-5, and 40-44.

focus on alternate feedstocks. 1/ The success or failure to achieve an alternate low-cost source of feedstocks and energy could mean the difference between the success or failure of the synthetic organic chemical industries of countries competing with production based on low-cost petroleum and natural gas from the CERN's. 2/

Coal

Synthetic organic chemicals derived from coal, such as certain dyes and pharmaceuticals, were important since before World War I. Coal remained the basis of the world's synthetic organic chemicals industry through the 1930's. It was not until around the beginning of World War II that the relative abundance and low prices of crude petroleum and natural gas helped these materials displace coal as the primary energy source and feedstock for the manufacture of synthetic organic chemicals (most of which are petrochemicals). The U.S. petrochemical industry underwent rapid expansion during World War II; it successfully replaced many natural products, unavailable because of the war, with petrochemicals derived from petroleum and natural gas.

Currently, coal is receiving renewed attention by the chemical industry, particularly in those countries with relatively large coal resources, such as the United States. These nations could, at least theoretically, develop chemical industries based on coal which would be capable of competing with petrochemicals from the CERN's.

Synthesis gas 3/ and methanol made from synthesis gas are likely to be the important coal-based chemicals; a large plant to make chemicals from coal is expected on-stream in 1983 in the United States. However, the production of such petrochemicals as olefins and aromatics directly from synthesis gas may not become commercially significant for some time, unless petroleum supplies should be drastically curtailed, or petroleum prices increase significantly. 4/ One of the more conservative forecasts states that 1990 crude petroleum prices would have to be in the range of $100 per barrel for the economics of producing chemicals from synthesis gas to be marginally attractive. 5/ Others have argued that coal may be more attractive if any coal gasification facility is associated with the generation of electricity. Many of the costs related to coal gasification facilities are also associated with the generation of electricity, and thus a combination of both facilities would have certain advantages. 6/

1/ "Chemical Feedstocks When the Oil Runs Out," Manufacturing Chemist, May 1982, p. 21.
2/ Ibid.
3/ Carbon monoxide and hydrogen mixtures.
4/ "New Routes to Petrochemicals-Coal Soon, Biotechnology Later," ECN Petrochemicals-81 Supplement, Dec. 14, 1981, p. 54.
5/ "Progress Slows in Chemicals From Synthetic Fuels," Chemical & Engineering News, Mar. 29, 1982, p. 28.
6/ "Chemical Feedstocks When the Oil Runs Out," Manufacturing Chemist, May 1982, p. 23.

Acetylene

Acetylene has been, and may again become, an important feedstock for the production of synthetic organic chemicals. Before petroleum and natural gas were accepted as feedstocks, many synthetic organic chemicals were produced from acetylene, which was made by the reaction between calcium carbide and water. The new interest in acetylene is, therefore, not in acetylene per se, but rather in its manufacture from sources other than calcium carbide and water.

Acetylene may be made from both natural gas and coal, but it is the use of coal that holds the most potential for the future. Recent advances in plasma arc technology have made it possible to produce acetylene directly from coal. 1/ In comparison, ethylene cannot be manufactured directly from coal in a one-step process. 2/ This savings of processing steps may give acetylene from coal a competitive cost advantage when compared with the production of olefins from coal.

Biotechnology

It has been stated by a senior management official of a large U.S. chemical company that "Biotechnology is not an opportunity for the chemical industry, it is the opportunity." 3/ Although not everyone may be of this persuasion, many of the world's chemical companies have committed significant capital to the research and development of biotechnology. One indication of the success of this research is that in 1981, 306 biotechnical pharmaceutical-licensing agreements were active.

Although biotechnology can include the fermentation processes of the types currently used in industrial-scale fermentation facilities to produce such chemicals as ethanol and acetic acid, it can also include those items that are potentially capable of being produced by recombinant DNA technology. A recent study suggests that clear concise definitions are needed to minimize uncertanity and to provide a base upon which the biotechnology field can develop. 4/

The first recombinant DNA technology product, a veterinary vaccine to treat a diarrheal disease of newborn cattle and pigs, has been licensed for commercialization in the near future.

Biotechnical techniques may become commercially significant in certain isolated instances, but general commercialization of the techniques is not expected until the end of the 1990's. 5/ Even after commercialization takes place, forecasts vary as to the future impact of biotechnology on the chemical industry. Biotechnology has the long-term potential for producing

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1/ "Progress Slows in Chemicals From Synthetic Fuels," Chemical & Engineering News, Mar. 29, 1982, p. 28.

2/ "Chemical Feedstocks When the Oil Runs Out," Manufacturing Chemist, May 1982, p. 23.

3/ "Explosive Growth Last Year in Biotechnology Licensing Deals," European Chemical News, May 17, 1982, p. 22.

4/ "OECD Report Probes Biotechnology Issues," Chemical & Engineering News, Oct. 18, 1982, p. 17.

5/ "Diversification-Key to Success for Biotechnology Companies," European Chemical News, Jan. 18, 1982, p. 16.

large-volume chemicals but is expected to be even more important in the production of smaller volume, high-value chemicals, such as amino acids. 1/

The Office of Technology Assessment of the U.S. Congress, after a survey of two leading organizations knowledgeable in biotechnology, has stated that of 57 different chemicals identified as being capable of being produced, only 8 were common to the lists of both organizations. 2/ These chemicals are acetic acid, acrylic acid, adipic acid, ethanol, ethylene glycol, ethylene oxide, glycerol, and propylene glycol. Processes are currently being studied to produce such items as high-purity fructose; veterinary vaccines, such as foot-and-mouth vaccine; human interferons, including leukocyte and fibroblast interferons; genetically engineered human insulin; and human, bovine, and porcine growth hormones. The worldwide market value estimate for these products is between $80 billion and $100 billion per year. 3/ The commercialization time scale for these products given by a leading biotechnology company is from 1 to 6 years. 4/

The Japanese have been vigorously pursuing the acquistion of a share of the biotechnology market; during 1977-81, about 60 percent of the 2,400 international biotechnical patents issued were to Japanese firms; U.S. firms accounted for about 10 percent. 5/

Renewable biological materials

The materials usually considered to be of more than passing interest under the renewable biological materials heading are molasses, starch, and cellulosic biomass, including wood and plants. All of these materials are readily available and can usually be obtained from more than one source. Cellulosic biomass, in addition to its potential as a source of feedstocks for chemical manufacture, is a potential future energy source.

The attractiveness of all of the materials previously mentioned is their continuing availablity if certain procedures, such as replacing trees that are harvested with seedlings, are followed. Crude petroleum, coal, lignite, and natural gas resources all have finite limits; new resources cannot be created, at least not in the same time spans as biological materials.

The low prices of crude petroleum and natural gas have caused disadvantages for all of the renewable biological materials. These materials may not, in general, become commerically significant in the routine production of most chemicals until the year 2000 unless the prices of crude petroleum or

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1/ Ibid.

2/ Ibid., p. 58.

3/ "Biotechnology's Drive for New Products," Chemical Week, Feb. 24, 1982, pp. 48 and 49.

4/ "Diversification-Key to Success for Biotechnology Companies," European Chemical News, Jan. 18, 1982, p. 16.

5/ "OECD Report Probes Biotechnology Issues", Chemical & Engineering News, Oct. 18, 1982, p. 18.

natural gas escalate more rapidly than currently expected. 1/ However, chemicals will continue to be produced from these materials; for example, ethanol from sugar cane molasses and corn is already a commercial reality in both Brazil and the United States. 2/

Products Manufactured

Olefins and aromatics

As the new petrochemical centers come on-stream during the 1980's, the product emphasis in the developed nations producing petrochemicals may change. Initially, a deemphasis could occur in ethylene and its derivatives, with the possibility that it may spread to the aromatics (benzene, toluene, and xylenes) and their derivatives later in the 1980's. It is expected that olefins and aromatics may continue to be made in many of the developed nations; their manufacture in the CERN's could increase. Most industry observers believe it will be difficult for other petrochemical-producing nations to compete with the CERN's.

United States

The United States has historically been the major producer and exporter of petrochemicals. Many industry observers believe that the impact on the U.S. petrochemical industry of the new petrochemical centers located in the CERN's will not initially be severe; however, without some action to offset production increases by the CERN's, the impact could become greater. 3/ It would appear that the impact could be the most serious for those firms that do not correctly evaluate and plan for the challenge from the new petrochemical centers.

The susceptability of individual firms to the buildup of CERN petrochemical capacity varies, depending upon such factors as products made, raw material and energy positions, and technical expertise. The multinational companies also have other considerations; the buildup overseas may threaten the multinational firm's U.S. operations, but it may also present the multinational firms the opportunity to invest in overseas petrochemical development. Therefore, it should come as no surprise that there does not appear to be a consensus of opinion among the U.S. firms related to the overseas buildup. The following sections discuss some of the changes in product orientation available to U.S. chemical producers to offset increases in petrochemical production from the CERN's.

Chemical specialties.--Increased emphasis on chemical specialties is one way in which some chemical companies may be able to minimize the impact of the

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1/ "Biomass Big Energy Resource, but Still Two Decades Away," Hydrocarbon Processing, October 1980, p. 17.

2/ "OECD Report Probes Biotechnology Issues", Chemical & Engineering News, Oct. 18, 1982, p. 18.

3/ Harvey N. Morris, communication of Mar. 17, 1982, with the U.S. International Trade Commission.

overseas petrochemical facilities on their U.S. operations as well as increase profitability. In 1980, chemical specialties accounted for between 45 and 85 percent of the activities of five large U.S.-based chemical companies. 1/ A recent study indicated that specialty chemical companies were major acquisition targets in 1981. 2/ This study stated that the attractiveness of the specialty chemical business is the high level and stability of profits. In 1980, 24 specialty chemical companies averaged 9.2 percent in after-tax sales margin and 17.4 percent in after-tax return on equity versus an average of 6.2 percent and 14.1 percent, respectively, for 39 large-volume chemical companies. 3/

Petroleum companies.--Some of the petroleum companies that have diversified into chemical production are now selling or closing some chemical operations, a trend some industry observers believe could increase. 4/ For example, one large multinational petroleum company is in the process of divesting itself from a company with a worldwide presence in many products to a company principally involved in primary petrochemicals and plastics in the United States. 5/ Another large petroleum company is abandoning the production of plastics. Such actions have prompted an industry consultant to observe that petroleum companies could increasingly resort to concentrating resources in areas familiar from the 1970's, since many of these companies have become involved in more production lines than can be properly managed. 6/

At the same time, a multinational chemical company that diversified into petroleum in order to assure available feedstocks during times of tight supplies, is now seeking to sell, or in some other way reduce, its involvement in petroleum production. This company believes that there is now a less likely prospect of feedstock shortages, and wishes to concentrate on expansion in specialty and high-value-added product lines. 7/

Imports.--Some larger companies hope to expand overseas operations for certain petrochemicals in the CERN's and thus obtain some, or all, of the competitive advantages discussed previously. At least one U.S. company, involved in overseas petrochemical production, plans to import into the United States a large portion of its overseas production. This company has stated that the overseas venture should assure it of a "competitive, secure, low-cost

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1/ "Chemical specialties" is the term often used to describe those chemicals usually produced and used in relatively small quantities which have a large benefit-to-cost ratio. They include such items as catalysts; dyes; pesticides; elastomers; floors; fragrances; oilfield chemicals; additives for oil field muds, paints, paper, petroleum, food and cosmetics; and photographic chemicals. From Alan S. Brown, "Will Chemical Specialties Measure Up?," Chemical Business, Apr. 5, 1982, p. 9.

2/ "Specialty Chemical Producers Major Targets of Acquisitions Involving U.S. Companies," Chemical Marketing Reporter, Mar. 2, 1982, p. 7.

3/ Ibid., p. 62.

4/ "Oil Firms Cut Back on Chemicals," Chemical Week, Feb. 17, 1982, p. 12.

5/ Ibid.

6/ "Petrochem's Future is Unpredictable, Execs Say," The Oil Daily, Mar. 29, 1982, p. B-6.

7/ Ibid., p. 13. Also, "Specialties, Value-added Products to Play Increasing Role at Dow Chemical Company," Chemical Purchasing, January 1982, p. 82.

supply." 1/ As a result, this company may change its U.S. product emphasis from domestic production of certain primary petrochemicals to domestic production of certain intermediate petrochemicals and petrochemical products using imported petrochemicals.

Industry Profitability

Background

Industry profits in the United States increased during the 1950's and 1960's, primarily as a result of the increased use of low-cost petroleum and natural gas feedstocks, the development and application of new technology which resulted in larger, more automated, and increasingly efficient plants, and increased labor productivity. During the 1970's, the U.S. petrochemical industry continued to develop as well as remain profitable; after-tax earnings as a share of sales in the 1970's were approximately 5 percent and increased to 8.5 percent in both 1974 and 1975 before beginning to decline. 2/ Price controls on crude petroleum and natural gas also contributed to the U.S. petrochemical industry's profitability during much of this period.

Since April-June 1980, profits in the U.S. petrochemical industry have been decreasing almost without exception. Petrochemical earnings have decreased by approximately 70 percent since January-March 1980, which was the most recent truly profitable quarter. 3/ The profit margin on sales for 1982 has been estimated to range from 3.4 percent 4/ to 5.6 percent. 5/ This performance has raised the often-discussed mature industry issue; it is generally accepted that the industry has long since passed through its initial development stage, and some observers believe it may have also completed its rapid growth stage.

Operating rates

In 1982, lower priced raw materials from readily available crude petroleum were not entirely able to offset the price decreases necessary to sell sufficient products to keep capacity utilization as high as possible. However, even with the lower prices, industry capacity utilization rates for many petrochemicals reached alltime lows. A survey indicated that nameplate plant capacity utilization rates in January-March 1982 were 60 percent in basic chemicals, 63 percent in plastics, and 67 percent in synthetic fibers. It should be noted that capacity utilization rates had not fallen below the 70 percent level since 1976. Furthermore, these figures stand in contrast to the 72 percent, 76 percent, and 86 percent, respectively, achieved during the

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1/ George Gale, "U.S. Firms Put Damper on Plans For O'seas Chemical Projects," Chemical Marketing Reporter, Mar. 29, 1982, p. 32.

2/ "Chemical Earnings Fall Drastically," Chemical & Engineering News, May 17, 1982, p. 9.

3/ Ibid., p. 13.

4/ "Chemical Earnings Fell Again in Fourth Quarter," Chemical & Engineering News, Feb. 14, 1982, p. 14.

5/ "Forecast 1983: Sales And Profits Will Be Up," Chemical Week, Jan. 5, 1983, p. 38.

summer of 1981. 1/ The industry's preferred rate of capacity utilization is approximately 85 percent; 2/ for 1982 it has been estimated at 68 percent. 3/

Capacity utilization rates are important because they directly impact production costs. Therefore, as demand falls and capacity utilization decreases, prices are reduced to maintain sales as high as possible, but profits decline. Increases in production cost at a time when the selling price is under downward pressure combine to exert a two-way downward pressure on profits.

The future profitability of the U.S. petrochemical industry is expected to be determined to a large extent by the manner in which individual companies react to the increase in petrochemical capacity in the CERN's as well as the degree of success the companies can achieve. For example, if some companies were to meet overseas, low-cost producers head on with U.S. production in the marketplace, the profitability of the U.S. industry would probably decrease regardless of the success of the U.S. companies in maintaining market share. On the other hand, U.S. companies that are joint-venture partners in overseas low-cost production ventures may find their profits enhanced. The probability of increased profitability could increase if the overseas production were to be used as feedstock by the U.S. partner's facilities.

Low-cost producers

As the rationalization of world petrochemical capacity proceeds, with the retirement of those facilities that are relatively old and high cost, it is possible that the world's low-cost producers could be able to increase prices and profitability. As long as these low-cost producers do not raise prices to a level high enough to attract new production, they could, and probably will, raise prices once excess world production capacity has been removed. For example, OPEC can theoretically raise prices to almost any level when crude petroleum supplies are tight, because of increased consumption or decreased production, or a combination of both. However, among the concerns that set practical limits on crude petroleum prices are the prices of alternate energy sources such as shale oil, and other high-cost conventional energy sources, such as geopressured natural gas and deep offshore crude petroleum. OPEC as a whole, and certain members in particular, are very aware of these issues and are therefore expected to remain careful not to allow prices to rise to levels that would make it economically attractive to develop such resources.

Small companies

Many of the previous comments are particularly relevant for the large chemical companies--both those companies currently involved in the CERN's, and

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1/ "Chemical Capacity Use Sinks to 60 Percent," Chemical & Engineering News, May 24, 1982, p. 16.
2/ "An Unbowed CPI Shows Strength in Spending," Chemical Week, May 19, 1982, p. 12.
3/ "Forecast 1983: Sales And Profits Will Be Up," Chemical Week, Jan. 5, 1983, p. 38.

those with sufficient capital and marketing expertise to be able to invest in the future, should the opportunity present itself. For smaller companies, perhaps the most obvious strategy to retain and possibly increase profitability may be to concentrate on high-value-added specialty chemicals such as pharmaceuticals, pesticides, and dyes.

However, it should be noted that even in the difficult low-profit years of 1980 and 1981, the smaller chemical companies, many of which were involved in the production of specialty chemicals, showed a higher level of profitability than the larger companies. Sales of the second 50 largest U.S. chemical companies, in terms of sales, increased 11 percent in 1981 compared with sales in 1980, whereas sales for the first 50 largest U.S. chemical companies increased by only 7 percent. More significantly, operating profits of the second 50 increased by 3 percent, and those of the first 50 decreased by 9 percent. 1/

Smaller companies often have less diverse product lines which allows them to be better able to adapt more easily and quickly to changes in demand and economic conditions. If indeed smaller is better, perhaps the U.S. chemical industry may be aided by the observation that in the year 2000, the United States may have only 4 of the world's top 20 chemical companies versus 7 in 1982. 2/

1/ "Medium-sized Chemical Firms Post Fair Year," Chemical & Engineering News, May 10, 1982, p. 21.

2/ "Overcapacity: It Could Last For a Decade," Chemical Week, Apr. 7, 1982, p. 44.