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ARAB INDUSTRIAL DEVELOPMENT
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TRADE IN INDUSTRIAL STRATEGIC COMMODITIES

MAJOR MARKETING ISSUES RELATING TO TRADE IN PETROCHEMICALS AND FERTILIZERS IN THE ARAB WORLD AND THEIR IMPACT ON INVESTMENT

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AIDO GLOBAL AND SECTORAL
STUDIES DEPARTMENTS

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CONTENTS

		Page
Abbreviations		vii
Chapter		
1.	INTRODUCTION	1
	1.1 Objectives of the study	1
	1.2 Background and justification	1
	1.3 Methodology	1
	1.4 Scope of the study	3
	1.5 Organization of the study	3
2.	INTERNATIONAL TRADE IN PETROCHEMICALS AND FERTILIZERS	5
	2.1 Trade structure and potential in the world	5
	2.2 Forces and mechanism of the world market for petrochemicals and fertilizers	15
	2.3 Major problems facing newcomers and their consequences for Arab countries	19
	2.4 Direction of trade in the Arab world, including the dynamics of development of local and regional demand	23
3.	ANALYSIS OF MAJOR ISSUES OF MARKETING PETROCHEMICALS AND FERTILIZERS PRESENTLY BEING PRODUCED IN THE ARAB WORLD	52
	3.1 Size of the markets	53
	3.2 Trade barriers	53
	3.3 The increasing role of new forms of trade	63
	3.4 Lack of co-operation with developing countries	68
	3.5 Lack of marketing information systems	70
	3.6 Competition with international companies	72
	3.7 Transport of products	79
	3.8 Storage and distribution facilities and their effect on the security of supply	82

CONTENTS (continued)

Chapter		Page
	3.9 Technical support (after-sales services).....	84
4.	IMPACT OF MARKETING ISSUES ON INVESTMENT IN PETROCHEMICAL AND FERTILIZER PRODUCTS IN ARAB COUNTRIES.....	86
	4.1 Impact of marketing issues on past investment.....	86
	4.2 Impact of marketing issues on future investment.....	97
5.	CONCLUSION AND RECOMMENDATIONS.....	155
	5.1 Conclusions.....	155
	5.2 Recommendations.....	159

LIST OF TABLES

2.1	Structure of world trade by region for chemicals.....	5
2.2	Direction of world trade in chemicals by region, 1984.....	6
2.3	Trade in petrochemicals at 1975 prices.....	9
2.4	Ammonia - world consumption and trade.....	10
2.5	Urea - world consumption and trade.....	10
2.6	Production capacity of fertilizers in the Arab world, as at 1 January 1986.....	12
2.7	Production capacity of petrochemicals in the Arab world, as at 1 January 1986.....	13
2.8	World and Arab region petrochemical consumption and import demand.....	14
2.9	Petrochemical production capacities, actual production and consumption in the Arab region.....	15
2.10	Import of selected petrochemicals and fertilizers by country, 1983.....	16
2.11	Demand for final petrochemicals in the Arab world, 1990.....	20
2.12	Demand for final petrochemicals in the Arab world, 1995.....	21
2.13	Major export markets for the petrochemical industry, 1995....	22

LIST OF TABLES (continued)

		Page
2.14	Direction of trade - merchandise exports and imports: commodity structure of trade	24
2.15	Trade of Arab countries with major trading partners	25
2.16	Trade balance for chemical products between the European market and Arab countries in 1983	27
2.17	Trade in petrochemicals in the Arab region: average annual value of imports and exports in millions of US Dollars at 1975 prices for the years 1980-1983	29
2.18	Production and sales of petrochemicals and fertilizers in Algeria, 1985	30
2.19	Foreign trade - imports and exports of Bahrain by sections of commodities, 1985	31
2.20	Fertilizer production capacity in Egypt	32
2.21	Fertilizer production capacity in Iraq, 1986	33
2.22	Fertilizer production and sales in Kuwait	34
2.23	Foreign trade - imports and exports of Kuwait by sections of commodities, 1983	35
2.24	Libyan Arab Jamahiriya petrochemical and fertilizer production capacity, as of 1 January 1986	36
2.25	Production of petrochemicals and fertilizers in Qatar	37
2.26	Foreign trade - imports of Qatar by sections of commodities, 1985	38
2.27	Production capacity of petrochemicals and fertilizers in Saudi Arabia	39
2.28	Tariff structure for Saudi Arabian petrochemicals	40
2.29	SABICs joint venture companies	43
2.30	Petrochemical production in Saudi Arabia	44
2.31	SABICs first half 1987 sales by region	44
2.32	Foreign trade - imports and exports of the Syrian Arab Republic by sectors of commodities, 1985	46

LIST OF TABLES (continued)

		Page
2.33	Phosphatic fertilizer production in Tunisia.....	47
2.34	Fertilizer production capacity in the United Arab Emirates...	48
2.35	Foreign trade - imports and exports of the United Arab Emirates by sectors of commodities, 1982.....	49
2.36	Per capita consumption of petrochemicals in various regions..	50
2.37	Projected per capita consumption of plastics in the Arab world for the year 1985.....	51
3.1	Tariff rates for selected petrochemical products imposed by the developed countries, 1979.....	55
3.2	Effective protection rate of selected petrochemical products imposed by the industrialized countries, 1979.....	58
3.3	The net balance of the 1983 fertilizer counter-purchase agreements between Indonesia and producers from several other countries.....	67
3.4	Saudi Arabian export markets for petrochemicals, 1985.....	73
3.5	Export of some Arab petrochemical products to the three developed markets, January to October 1986.....	73
3.6	Capacity reductions of the Western European petrochemical and plastics industry.....	77
3.7	Freight costs for shipping petrochemicals to industrialized country markets in 1980.....	80
3.8	Cost of shipping petrochemicals from Qatar to industrialized country markets, 1980.....	81
3.9	Typical shipping costs for petrochemicals: Qatar to Northern Europe (1980).....	82
4.1	Oil companies share of total production capacity.....	88
4.2	Utilization rates for ethylene plants in Western Europe, Japan and the United States.....	90
4.3	Estimated capacities and production for basic olefins in Western Europe, Japan and the United States of America.....	91
4.4	Capacity reductions of Western European petrochemicals and plastics industry.....	91

LIST OF TABLES (continued)

		Page
4.5	Number of producers in Western Europe 1980/1986.....	92
4.6	Ethylene/ethylene derivatives/polymers European plant closures 1980-1986.....	93
4.7	Feedstock use for olefins (1985).....	101
4.8	Demand-capacity balances for the Arab petrochemical industry, 1990.....	106
4.9	Demand-capacity balances for the Arab petrochemical industry, 1995.....	107
4.10	World petrochemical consumption by region and product, 1985..	108
4.11	World petrochemical consumption by region and product, 2000..	109
4.12	Ratio of ethylene consumption in 1979 and 1980 in the three developed regions.....	112
4.13	Ethylene yield from different feedstocks by different processes.....	113
4.14	Consumption of ethylene oxide and ethylene glycol in Western Europe.....	119
4.15	Propylene consumption ratio in the United States, Western Europe and Japan.....	121
4.16	Propylene gas-phase processes-production cost comparison.....	123
4.17	Comparison of polypropylene homopolymer production costs.....	124
4.18	Some end-uses of C4-olefins.....	127
4.19	World butadiene balance.....	128
4.20	Butadiene production and demand in the United States.....	129
4.21	Butadiene production and demand in Western Europe.....	130
4.22	Butadiene production and demand in Japan.....	131
4.23	World benzene demand.....	135
4.24	World benzene capacity.....	136
4.25	Effective capacity, production and consumption of toluene, o-xylene and p-xylene in Western Europe.....	136

LIST OF TABLES (continued)

	Page
4.26 World polystyrene supply/demand	139
4.27 World methanol demand/supply	142
4.28 Fertilizer production in the Arab world and the percentage of world production	144
4.29 World fertilizer supply/demand balance	144
4.30 Changes in production/consumption levels of nitrogen fertilizers between 1984/1985 and 1985/1986	145
4.31 Nitrogen fertilizers trade balances	145

LIST OF FIGURES

2.1 Linkages in the petrochemical industry	8
2.2 SABIC Marketing Co., sales values and quantities, 1981-1987	41
2.3 SABIC Marketing Co., first half of 1987 sales by region	42
3.1 Relationship of crude oil price to chemical prices	76
4.1 Economies of scale in ethylene cracking	88
4.2 Development of the DM/$US exchange rate	95
4.3 Development of naphtha prices in Western Europe in nominal and real terms	95
4.4 World ethylene demand/supply through 1990	96
4.5 Production relationships in the petrochemical industry	99
4.6 Petrochemicals from ethylene	103
4.7 Petrochemicals from propylene and C4-hydrocarbons	104
4.8 Petrochemicals from aromatics	105
4.9 Schematic diagram of SOC process	114
4.10 Integrated LAB complex	141
4.11 Schematic diagram for petrochemical refinery	152
References	163

Abbreviations

ABS	Acrylonitrile butadiene styrene
AIDO	Arab Industrial Development Organization
AFCFP	Arab Federation of Chemical Fertilizer Producers
AN	Ammonium nitrate
APPE	Association of Petrochemical Producers in Europe
AS	Ammonium sulphate
CAN	Calcium ammonium nitrate
CEFIC	Conseil europeen des federations des industries petrochimiques
c.i.f.	Cost, insurance, freight
CN	Calcium nitrate
CPE	Centrally Planned Economies
DAP	Di-ammonium phosphate
DMT	Di-methyl terephthalate
ECU	European currency unit
EDC	Ethylene dichloride
EEC	European Economic Community
EG	Ethylene glycol
ESCWA	Economic and Social Commission for Western Asia
f.o.b.	Free on board
GOIC	Gulf Organization for Industrial Consulting
HDPE	High density polyethylene
JFI	Jordan Fertilizer Industries Co.
KISR	Kuwait Institute for Scientific Research
LAB	Linear alkyl benzene
LDPE	Low density polyethylene
LLDPE	Linear low density polyethylene
LPG	Liquefied petroleum gas
MAP	Mono-ammonium phosphate
MTBE	Methyl tertiary butyl ether
NPK	Nitrogen, phosphate, potassium compound fertilizer
OAPEC	Organization of Arab Petroleum Exporting Countries
OPEC	Organization of Petroleum Exporting Countries
PE	Polyethylene
PET	Polyethylene terephthalate
PIC	Petrochemical Industries Company
PP	Polypropylene
PS	Polystyrene
PU	Polyurethane
PVC	Polyvinyl chloride
QAPCO	Qatar Petrochemical Company
SABIC	Saudi Basic Industries Corporation
SAFCO	Saudi Arabian Fertilizer Company
SBR	Styrene butadiene rubber
TPA	Terephthalic acid
TSP	Triple super phosphate
UNCTAD	United Nations Conference on Trade and Development
UNIDO	United Nations Industrial Development Organization
USA	United States of America
USSR	Union of Soviet Socialist Republics
VCM	Vinyl chloride monomer

1. INTRODUCTION

1.1. Objectives of the study

This study aims at identifying the major issues relating to the marketing of petrochemicals and fertilizers produced in the Arab region, and assessing the impact of these issues on future investment in this industry.

The study analyses the direction of interregional and intraregional trade in the petrochemicals and fertilizers that are produced in the Arab region, and discusses the major marketing issues in the trade of these commodities. The study also examines the impact of these issues on future investment in the petrochemical and fertilizer industry.

Finally, the study proposes corrective measures that might help to enhance the marketability of existing petrochemical and fertilizer products.

1.2. Background and justification

Under its Medium-Term Plan 1984-1989, the Industry Division of the Economic and Social Commission for Western Asia (ESCWA) has been undertaking several studies dealing with trade in manufactured products. Consequently, during the biennium 1986/1987, the Industry Division implemented programme element 2.2 under the title: "Trade in industrial strategic commodities", that deals specifically with the trade in petrochemicals and fertilizers produced in ESCWA countries.

Preliminary discussions between ESCWA and officials in the region revealed great interest in this subject. Therefore, close co-operation with other regional and international organizations and institutions such as AIDO, OPEC, OAPEC, GOIC, KISR, UNIDO and UNCTAD was sought for the implementation of this programme. This eventually led to a co-operation agreement between AIDO and ESCWA to undertake this study jointly. As a consequence, the number of countries covered by the study was expanded to include non-ESCWA Arab countries, in line with the requirements and terms of reference of AIDO.

Within its programme of activities AIDO has the following:

(1) Technical preparation for the Seventh Arab Industrial Conference, to be held in Tunis in 1989;

(2) Preparation for a joint project on "the development and integration of petrochemical industries in Arab countries";

(3) A project for co-ordination between existing industries in Arab countries.

The present study will be utilized as an input for the above-mentioned programme.

1.3. Methodology

The activities under this programme element are divided into the following three phases. The first phase was desk-work research involving a survey of

the existing literature available at ESCWA and AIDO on the subject of this study. Reports prepared by other organizations and United Nations agencies such as UNIDO and UNCTAD on the subject of (trade in) petrochemicals and fertilizers, as well as forecasts up to the year 2000 for the demand and supply situation in the world and/or the Arab region, were reviewed. Statistical data compiled by the United Nations and its organizations, as well as by the Arab Industrial Development Organization and some other regional organizations on the production, consumption, import and export of the petrochemicals and fertilizers listed below, were used in the preparation of a background paper. This paper dealt with the status of the petrochemical and fertilizer industries in the region, their structure, the problems facing the "newcomers", and the direction of trade in the Arab world.

Petrochemicals

Basic	Intermediate	Final
Ethylene	Ethylene dichloride	LLDPE/LDPE
Propylene	Ethylene glycol	HDPE
Butadiene	Ethylene oxide	PVC
Benzene	Styrene	Melamine
Xylenes	Vinylchloride monomer	Polypropylene
Methanol	Formaldehyde	Polystyrene
Ethanol		Polyester
Toluene		SBR
		MTBE
		LAB
		Alkylate

Fertilizers

Nitrogeneous	Phosphatic	Acids	Compound
Ammonia	Phosphates	Sulphuric	MAP/DAP
Urea	TSP	Nitric	NPK
AS		Phosphoric	
AN/CN			

In addition, the study utilized a consultant's report which analysed the major marketing issues. The report drew upon work previously undertaken by UNIDO and other organizations on the subject, and on information gathered during the consultant's visits to a number of European and Arab companies and organizations.

The second phase consisted of organizing a workshop to discuss the main marketing issues relating to trade in petrochemicals and fertilizers. The workshop was held in Amman from 22-24 September 1987, and was jointly organized by ESCWA, AIDO and the Royal Scientific Society (RSS). Representatives from major companies (SABIC, SAFCO, PIC, QAPCO, JF1), as well as from the international and regional organizations concerned, participated in the workshop.

Papers were presented by major Arab petrochemical and fertilizer companies and other relevant organizations: SABIC, SAFCO, PIC, UNIDO, ESCWA/AIDO and the consultant.[1/]

In the third phase, the results of the desk-work research, the consultant's report and the outcome of the workshop were used as major inputs for the preparation of this joint ESCWA/AIDO technical publication.

1.4. Scope of the study

The present study discusses major marketing issues in the trade of petrochemicals and fertilizers in the Arab world. These issues are identified as follows:

- Size of the markets;
- Trade barriers and protectionist policies;
- New practices of trade;
- Lack of a marketing information system;
- Competition with international companies;
- Transport and storage of products;
- After-sales service;
- Continuity of supply;
- Lack of co-operation with developing countries.

In the last few years, several articles and studies have dealt with the subject of marketing the output of the newly established complexes in the Arab world, and a number of recent seminars have also discussed the subject. In order to avoid a duplication of effort and overlap in coverage, this study concentrates on a thorough discussion of the problems faced, followed by practical recommendations for improving the marketing of Arab petrochemicals and fertilizers. However, the study gives an overview of present capacities in petrochemicals and fertilizers in the Arab region, as well as the trade structure and direction of trade in the world.

The study covers the petrochemical products presently being produced in the region, as well as some of the products that are expected to be produced in the near future.

1.5. Organization of the study

The report consists of five chapters, as follows:

1. Introduction;
2. International trade in petrochemicals and fertilizers;
3. Analysis of major issues of marketing petrochemicals and fertilizers presently being produced in the Arab world;
4. Impact of marketing issues on future investment in petrochemicals and fertilizers in the Arab world;
5. Conclusions and recommendations.

1/ The proceedings of this workshop will be published separately.

Chapter 1 gives the objectives and background of the study, followed by the methodology of the research carried out, and defines the scope of the study.

Chapter 2 provides information on the status of the petrochemical and fertilizer industry in the Arab region, including data on installed capacities and production. This chapter gives also an overview of international and intraregional trade. It concludes with an estimation of the supply and demand situation of petrochemicals and fertilizers in the near future.

Chapter 3 discusses the major marketing issues, as outlined under 1.4 above.

Chapter 4 highlights the impact of marketing issues on future investment in the industry. It also suggests the production of new petrochemical and fertilizer products that could enhance the marketability of existing products.

Chapter 5 contains the conclusions of the study, and gives recommendations for further action, while examining the co-operation between Arab companies that produce petrochemicals and fertilizers.

2. INTERNATIONAL TRADE IN PETROCHEMICALS AND FERTILIZERS

2.1. Trade structure and potentials in the world

Chemicals

International trade in chemicals, Standard International Trade Classification (SITC) group 5, is largely dominated by the developed countries. The major producers are to be found there, and the trade in chemicals between the industrialized countries of the world constitutes the bulk of all trade. For example, the developed market economies accounted for approximately 85 per cent of total exports and about 65 per cent of the total imports of chemicals in 1984 (see also table 2.1). From this table, it follows also that the developing countries, including those in the Middle East, were net importers of chemicals in that year. Their share in world exports was only 7 per cent, while they imported almost 25 per cent of all chemicals traded. Trade between the industrialized countries is roughly in balance, and the same holds true for the centrally-planned economies (CPE).

Table 2.1. Structure of world trade by region for chemicals
(SITC group 5 - percentages)

	Origin of exports			Origin of imports		
	1975	1980	1984	1975	1980	1984
World	100.0	100.0	100.0	100.0	100.0	100.0
Developed market economies	86.9	87.4	84.5	62.4	64.2	65.7
Europe	62.5	62.3	59.8	47.9	49.6	46.9
United States	14.2	15.4	15.3	5.8	5.8	8.8
Japan	6.3	4.6	5.1	2.9	4.0	4.5
Developing countries	5.9	6.6	7.7	26.6	25.9	24.6
Africa	0.6	0.5	0.8	4.7	4.5	3.3
America	2.8	2.3	3.1	9.1	7.7	6.5
Middle East	1.1	1.0	0.7	3.8	4.1	4.5
Other Asia	1.4	2.7	3.1	8.9	9.4	10.1
Centrally planned economies	7.2	6.0	7.8	0.4	8.7	8.9
Soviet Union	1.4	1.2	1.9	3.8	3.3	3.1

Source: Statistical Yearbook, 1983/1984, thirty-fourth issue (United Nations publication, Sales No. E/F 85.XVII.1)

As can be seen from the above table, the role of the developed market economies as exporters diminished only slightly over the period 1975-1984, while the developing countries, including the centrally-planned economies, gradually increased their share in the world trade in chemicals . At the same

Table 2.2. Direction of world trade in chemicals by region, 1984

(Millions of US$ f.o.b., (SITC, revised)

Exports to / Exports from	World	Developed market economies				Developing countries					CPEs	
		Total	Europe	U.S.A.	Japan	Total	America	Africa	Middle East	Other Asia	Total	Soviet Union
World	146,421	96,265	68,702	12,843	6,647	36,227	9,603	4,974	6,645	14,788	13,007	4,518
Developed market economies	123,771	87,548	63,723	10,572	5,596	28,680	7,717	4,373	5,212	11,257	7,005	2,042
Europe	87,539	66,476	55,170	6,083	2,219	15,630	3,141	3,866	4,443	4,123	5,054	2,528
United States	22,388	13,238	6,373	..	2,974	8,229	4,135	254	539	3,294	921	208
Japan	7,447	2,744	983	13,461	.	3,779	201	63	177	3,326	923	227
Developing countries	11,267	4,692	1,732	1,831	769	5,500	1,392	417	804	2,869	901	157
Africa	1,230	471	460	10	1	640	19	153	177	292	117	34
America	4,531	2,567	843	1,352	205	1,774	1,331	78	159	206	188	47
Middle East	1,025	128	65	28	26	735	9	72	343	311	136	26
Asian others	4,476	1,524	364	430	537	2,348	34	115	125	2,061	460	50
CPEs	11,384	4,025	3,247	441	282	2,046	494	185	630	663	5,101	2,318
Soviet Union	2,710	1,061	811	195	50	488	149	37	108	119	1,161	..
Annual average rate of growth of the world trade in chemicals, by region												
Origin of exports												
1975/1983	10.7	10.5	10.5	11.0	7.5	13.3	11.8	13.8	3.5	20.2	11.8	13.1
1975/1980	19.2	19.4	19.2	21.2	11.6	21.7	15.0	17.1	16.2	35.9	15.0	15.8
1980/1984	0.9	0.0	-0.8	-1.9	3.0	6.1	7.2	11.7	-8.1	8.4	6.6	12.3
Destination of world exports												
1975/1983	10.7	11.5	10.8	15.4	16.7	9.7	5.7	7.1	14.6	12.0	7.9	7.7
1975/1980	19.9	20.0	19.2	27.3	18.5	15.4	18.2	20.9	20.5	15.0	16.3	-
1980/1984	0.9	1.2	-1.0	12.1	5.6	-0.2	-3.9	-7.2	2.3	4.7	0.9	-1.9

Source: 1984 International Trade Statistics Yearbook, vol. I (United Nations publication, Sales No. E/F. 86.XVII.7).

time the developing countries gradually imported fewer chemical products owing to their increasing domestic capacities. This trend is not yet in evidence in the Middle Eastern region, since its capacities only came on stream after 1984 and are therefore not reflected in table 2.1.

The production and trade of chemicals follows the general trend of world economic development, and its prospects are likewise influenced by the growth of the world economy. In the early 1980s, production and trade in chemicals fell back, although a recovery phase has been taking place since 1982. However, production and trade have shown a markedly higher growth rate than average industrial growth over the period 1975-1984; furthermore, since 1985, general economic growth is believed to have resulted in a rise in demand for many chemical products. This situation is illustrated in table 2.2, which gives the direction and annual average growth rate of the world trade in chemicals, by region, for the year 1984 (the latest available at this moment).

Petrochemicals and fertilizers

The situation with respect to trade in petrochemicals is similar to that outlined for chemicals as a whole. However, it should be borne in mind that international trade in petrochemicals is relatively limited compared to actual production. Less than 10 per cent of world petrochemical production is internationally traded. The remaining 90 per cent is traded either domestically or within regional blocks.

In this report, petrochemicals are roughly classified as being those that belong to SITC groups 51, 52, 56 and 58, since it is these that are of relevance to the Arab world.

Table 2.3 gives the value of the world trade in petrochemicals, at constant 1975 prices, for the years 1970, 1980 and 1983. As can be seen, the share of the developing countries in international trade increased, in particular the share of Middle Eastern and African countries - although they remained net importers during 1983.

In order to describe the trade structure of petrochemicals and fertilizers in the world, it is first necessary to define the production linkages of petrochemical products in general. This is presented in figure 2.1., in which the gas-based fertilizers, ammonia and urea, are considered as part of the petrochemical industry. It is important to note, that at present the region lacks an aromatics complex, although there is some production of benzene, toluene and xylenes and their derivatives: for example in Algeria (p-xylene, benzene, toluene and BTX-mix), Saudi Arabia (benzene and styrene) and Iraq (LAB, toluene and heavy alkylates). Therefore, further downstream development into synthetic rubbers and polyester and acrylic fibres is not feasible at this moment, unless aromatics can be produced for this purpose. Ethylene is the region's main product, and to a limited extent other basic petrochemicals such as propylene and butylene are produced.

The ethylene that is produced is used to produce ethylene oxide, ethylene dichloride and polyethylenes, which in turn are converted into VCM, PVC and ethylene glycol. The final petrochemicals produced are then marketed in domestic and international markets.

Figure 2.1. Linkages in the petrochemical industry

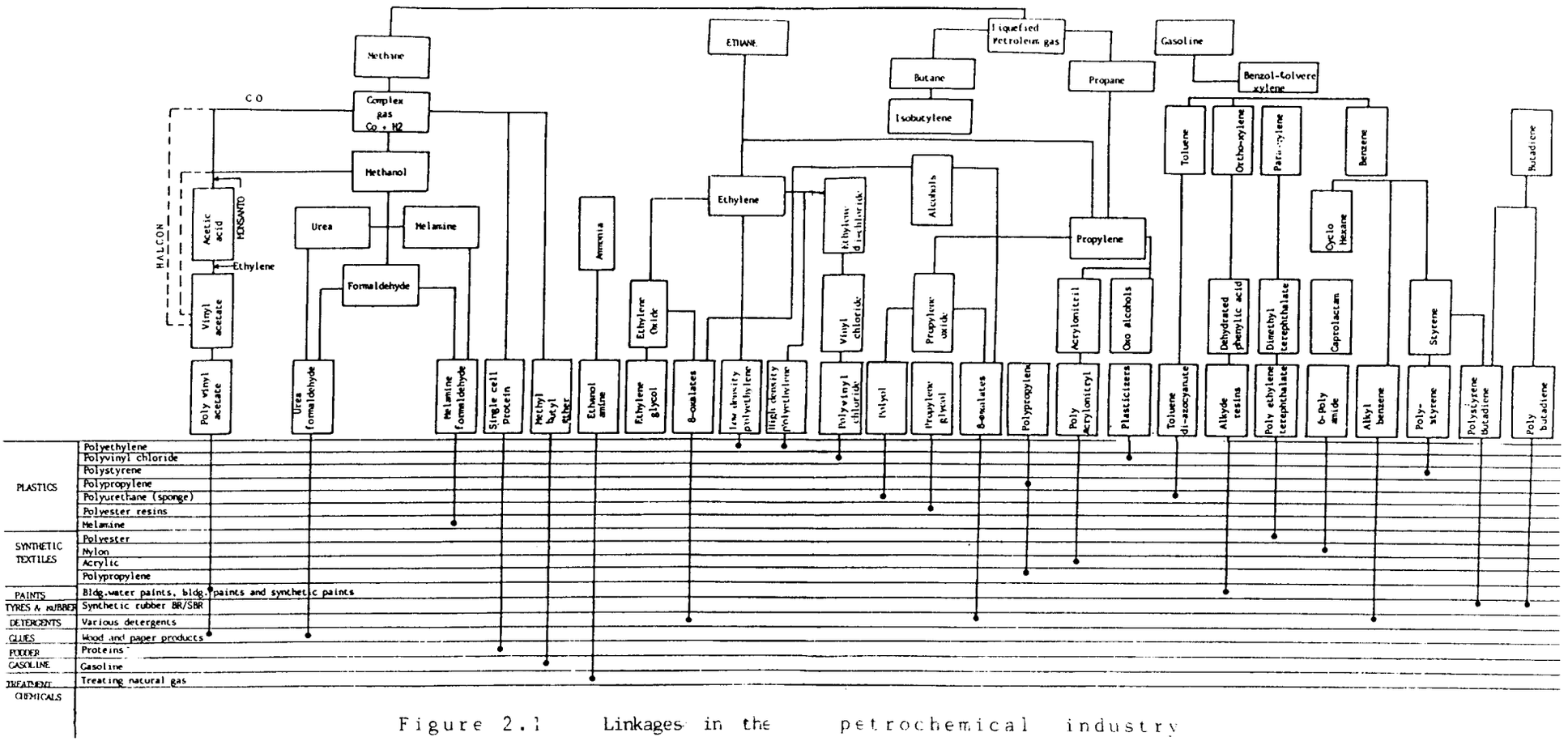


Figure 2.1 Linkages in the petrochemical industry

Table 2.3. Trade in petrochemicals at 1975 prices

Country	1970		1980		1983	
	Imports	Exports	Imports	Exports	Imports	Exports
Developed market	216,555	275,482	349,573	425,451	396,193	462,139
Centrally planned economies	21,461	7,063	31,736	11,357	27,051	12,662
Developing countries	68,616	6,384	104,407	14,381	115,393	20,501
Middle East and Africa[a/]	14,439	913	20,768	1,329	29,1 01	2,243

Source: Proceedings of the Seminar on the Integration of Petrochemical Industry in the Arab World, Manama, Bahrain, January 1986. (Kuwait, OAPEC, 1986).

a/ Including Arab countries, Turkey, Iran and Cyprus; these are also included in the figures for developing countries.

Up until now, international trade has been dominated by the petrochemical producing giants of the United States of America, Europe and Japan, though in recent years a growing share has been taken by the traditional oil-producing companies. These organizations have long-established marketing networks, service organizations and sophisticated transport systems, including pipeline grids between major producers and consumers.

The emergence of the new petrochemical-producing developing countries has had an impact on trading patterns, particularly with other developing countries. Long-term contracts have been concluded between governments and counter-trade has evolved. This became necessary particularly as the new producers lack the integrated marketing organizations of the developed world and because of their protectionist trade practices, which means that new markets have to be found in other developing countries.

In order to be able to look into the potential of the region's producers, an overview will first be given of where the petrochemical manufacturers in the region are located, where the major world markets exist and where they are likely to be found in the near future.

It is important to note that the amount of fertilizer products actually traded between countries is a relatively small percentage of total world consumption. The amount traded between regions is even less if intraregional sales are considered. Forecasting world trade can, therefore, be extremely hazardous, particularly as it represents a relatively small tonnage figure compared with the large figures that represent production and consumption. As the following tables 2.4 and 2.5 show, a 1 per cent difference in either figure could be equivalent to a 10 or even 20 per cent change in world trade!

Table 2.4. Ammonia -- world consumption and trade

(Thousands of metric tons)

	Total world consumption (1)	Total world trade (2)	Total world trade without intra-trade (3)	Percentage (2) of (1) (4)	Percentage (3) of (1) (5)
1980	93,831	6,946	4,801	7.4	5.1
1981	94,257	6,379	4,279	6.7	4.5
1982	93,068	6,479	4,377	6.9	4.7
1983	98,142	7,384	5,179	7.5	5.3
1984	104,287	8,691	5,808	8.3	5.7
1985	106,902	8,718	5,730	8.1	5.4
1986	105,640	8,010	5,697	7.6	5.4

Source: Paper presented by the Petrochemical Industries Company at a workshop on "Marketing issues relating to trade in petrochemicals and fertilizers in the Arab world and their impact on future investment", held in Amman, 22-24 September 1987.

Table 2.5. Urea -- world consumption and trade

(Thousands of metric tons)

	Total world consumption (1)	Total world trade (2)	Total world trade without intra-trade (3)	Percentage (2) of (1) (4)	Percentage (3) of (1) (5)
1980	47,797	13,313	4,680[a/]	27.8	9.8
1981	49,567	12,722	5,217[a/]	25.7	10.5
1982	49,879	12,038	8,172	24.1	16.4
1983	53,775	13,866	9,081	25.8	16.9
1984	60,140	15,960	9,811	26.5	16.3
1985	61,526	15,827	10,483	25.7	17.0
1986	63,000[b/]	17,400[b/]	12,000[b/]	27.6[b/]	5.4[b/]

Source: Paper presented by the Petrochemical Industries Company at a workshop on "Marketing issues relating to trade in petrochemicals and fertilizers in the Arab world and their impact on future investment", held in Amman, 22-24 September 1987.

a/ Excluding Eastern Europe.
b/ Estimated.

The first fertilizer complex in the Arab region came on stream in Kuwait in 1966. This was followed by basic fertilizer plants in other Arab countries. A complete list of fertilizer plants, as of 1986, is presented in table 2.6. Petrochemical products other than fertilizers were not produced in the region until 1975, and then only on a limited basis in terms of scale of production and product mix. Iraq and Qatar were the first countries to establish petrochemical plants based upon ethylene. Qatar built a complex at Umm Said to produce 280,000 tons per year of ethylene and 140,000 tons per year of LDPE. The Iraqi complex was completed at the end of the 1970s at Khor Al-Zubair to produce 130,000 tons per year of ethylene. Saudi Arabia entered the petrochemical field at a much later stage by establishing major complexes at Al-Jubail and Yanbu. Table 2.7 gives the total petrochemical production capacity as it existed at 1 January 1986.

As can be noted from these tables, the production of aromatics in the region is very limited. The only country actually producing benzene and p-xylene is Algeria, while a pan-Arab project for the production of benzene and linear alkyl benzene (LAB) was commissioned in June 1987 in Iraq. Kuwait has shelved its plans for an aromatics complex for the time being. This means that the Arab petrochemical industry is confined to the production of a very limited number of different basic, intermediate and final petrochemicals, until such time as projects for further downstream products materialize. The reason for this situation is clear. Olefin production in the region is based upon associated gas feedstock, which until recently was mostly flared. Aromatics are based mainly upon naphtha, which is derived from crude oil-refining and which, therefore, has a significant opportunity cost (i.e., the ongoing export price of crude oil).

Although the production capacities of the plants in the region are large compared with a world-scale plant, they are only equivalent to a small fraction of world consumption, even when considered in the long-term. This is shown in table 2.8, which puts into perspective Arab demand compared with world consumption for a number of petrochemical products, up to the year 2000. If all the existing plants in the region produce, at full capacity, the exportable balance would be small (sometimes even negative) compared to world demand levels, (see table 2.9).

The major markets for petrochemicals are now not only the industrialized countries: The United States of America, Japan and Western Europe, but also newly developing countries such as the Republic of Korea, Taiwan, Brazil and Mexico. The United States is both the world's largest producer and consumer of petrochemicals. This situation is not likely to change dramatically in coming years, even though the feedstocks and energy costs in the United States are relatively high in comparison with new producers in developing countries. However, significant imports into the United States of certain ethylene derivatives are still expected, without causing any change in its dominant position.

The reduction of the ethylene capacity in Japan over the last few years, together with the lack of indigenous feedstocks, mean that Japan is also likely to become a major market for the new export-oriented producers, especially those from the Gulf region, owing to their geographic proximity to this market.

Table 2.6. Production capacity of fertilizers in the Arab world, as at 1 January, 1986

(Thousands of tons/year)

	Nitrogeneous fertilizers				Phosphatic fertilizers		Acids			Compound fertilizers	
	Ammonia	Urea	AS	AN/CN	Phosphates	TSP	Sulphuric	Nitric	Phosphoric	MAP/DAP	NPK
Bahrain	330										
Egypt	1,390	1,075	95	1,455	...	...	450	...	65		
Iraq	900[a/]	1,398[a/]	129[a/]		...	600	...		416	250	272
Jordan					...		1,188		410	740[b/]	330
Kuwait	990	792	165				132				
Qatar	590	660									
Saudi Arabia	330	830					100				
Syrian Arab Republic	300	330		...	...	420	...	...	160		
United Arab Emirates	330	500									
ESCWA region	4,260	4,187	260	1,455		1,020	1,870		1,051	990	272
Algeria	660	130		465	550	490	...	130	165	550	225
Libyan Arab Jamahiriya	660	908		213[c/]			165[c/]	165[c/]	..		
Morocco			132	200[c/]	...	400	1,485		1,492	1,396[c/]	
Tunisia				300	...	936	...	...	960	880[b/]	495
Arab region	5,580	5 225	392	2,250	...	2,846	3,355	130	3,668	2,420	497
World total	110,834	...	...			...	...	...	33,085	...	...

Source: Arab Industrial Development Organization/ESCWA compilation from various sources.

a/ Not operational owing to Gulf War.
b/ Planned.
c/ Under construction or being expanded.

Note: ... means information not available.

Table 2.7. Production capacity of petrochemicals in the Arab world, as at 1 January 1986

(Thousands of metric tons)

	Ethylene	Propylene	Butadiene	Benzene	Xylenes	Styrene	VCM	Methanol	EG
Bahrain								330	
Egypt	200[a]			10[a]			100		
Iraq	130[b]			22			65[b]		
Kuwait	60[a]								
Qatar	280	5							
Saudi Arabia	1,611		125[a]	245[c]		295	300	1,300	520
ESCWA total	1,891			277		295	400	1,630	520
Algeria	120			90	285		40	100	
Libyan Arab Jamahiriya	330	170[a]	45[a]				60	660	
Morocco							25		
Tunisia									
Grand Total	2,341	5		367	285	295	525	2,390	520

	Ethanol	LLDPE/LDPE	HDPE	PS	PVC	Butene-1	LAB	PP	MTBE
Bahrain					80		40[a]		
Egypt		60[b]	30[b]		60[b]		50		
Iraq								80[a]	
Kuwait		140	70[a]						
Qatar		595	91	100[a]	200	50[a]			500[a]
Saudi Arabia	281								
ESCWA total	281	735	91		280		50	-	-
Algeria		48			35	15[a/d]			
Lybian Arab Jamahiriya		80[a]	80[a]		60[a]	17[a]		70[a]	47[a]
Morocco					25				
Tunisia									
Grand total	281	783	91	-	340	-	50	-	-

Source: Arab Industrial Development Organization/ESCWA compilation from various sources.

a/ Planned or under construction.
b/ Not operational due to Gulf war.
c/ For captive use.
d/ Including butene mix.

Table 2.8. World and Arab region petrochemical consumption and import demand

(Thousands of metric tons)

Product	1975		1980		1985	
	World	Arab	World	Arab	World	Arab
ABS	690	5	1,096	3	1,838	6
Acetic acid	1,831	19	2,877	25	3,434	20
Acrylonitrile	1,845		2,552		3,446	
Ammonia	53,700	870	70,530	1,200	90,393	2,655
Butadiene	3,166		3,807		5,672	
Ethyl benzene	6,395		9,219		13,009	
Ethylene	24,025	51	35,018	210	39,806	350
Ethylene dichloride	11,400	70	17,202	44	19,364	57
Ethylene glycol	2,883		3,761	20	4,380	24
Ethylene oxide	3,886		4,788		5,561	
Formaldehyde	4,022	21	9,206	74	13,145	80
HDPE	2,846	70	5,286	100	6,903	111
LDPE	7,860	220	11,365	370	14,080	550
Methanol	7,837	23	11,298	40	12,423	50
PET	3,229	19	4,496	28	5,826	29
PVC	7,742	230	11,335	150	13,261	505
Polypropylene	2,379	40	4,775	60	6,233	175
Polystyrene	3,565	80	5,124	95	6,891	150
Propylene	12,177	15	18,197	3	23,639	13
SBR	4,130		4,705	12	6,357	13
Styrene	5,553		7,994	2	11,099	
VCM	7,600		11,578	25	13,704	33
Vinyl acetate	1,432	11	1,743	19	1,973	18
Total	180,193	1,744	257,952	2,680	322,538	3,839

Source: UNIDO World Demand for Petrochemical Products and the Arab Petrochemical Industry. (24 July 1984). (UNIDO/IS.480).

Table 2.9. Petrochemical production capacities, actual production and consumption in the Arab region

(Thousands of metric tons/year)

Product	Existing Capacity in 1986	Actual Production 1985	Consumption 1985	Potential Export (Import)
Ethylene	2,341	1,113	1,832	(719)
Propylene	5	-	-	-
Methanol	2,390	1,400	14	1,386
Ethanol	281	200	48	152
EDC	918	190	158	32
EG	520	310	36	274
Styrene	295	125	2	123
VCM	525	..	..	..
LDPE/LLDPE	783	538	301	137
HDPE	91	190	135	55
PVC	340	..	305	(305)
Polystyrene	100[a/]	-	81	(81)
MTBE	500[a/]	-	..	..
Ammonia	5,580	1,495	3,350	(1,855)
Urea	5,225	2,700	1,395	1,305

Source: Arab Industrial Development Organization/ESCWA compilation from various sources.

a/ Under construction.

The recent overcapacity situation in Western Europe has improved greatly and the European market has been penetrated by the new producers. However, owing to the fragmented structure of its market and trade policies (they are, after all, still 12 different countries), the new producers are facing all kinds of obstacles.

2.2. Forces and mechanism of the world market for petrochemicals and fertilizers

Trade in petrochemicals in the developed market economies is characterized by the high degree of integration between producers and consumers. For example, a typical feature of the European market is the intra-trade between European countries, which depends on the need for a particular product at a given time. Since most countries are connected with each other through a pipeline grid, the intra-trade of products to cover temporary shortages in one plant, with those of another is relatively easy. This leads to a situation as exemplified in table 2.10, where countries with a self-sufficient production capacity in a particular product are still able to import this product in a given year.

Table 2.10. Import of selected petrochemicals and fertilizers by country, 1983

(Thousands of metric tons)

SITC code:	511.11	511.12	511.13	511.22	511.24	511.25	511.31	512.11	512.15	512.16	522.22	522.24	522.51	562.16	583.11	583.31	583.41
Austria				8	49			72			19	13	8	32			
Belgium/Luxembourg					..			-32		16[d]	21	18		104	--	-104	52
Bulgaria					10	4					18[a]	129[a]	-71[a]	113[a]	.....	4	7
Canada															45	14	82
Cyprus								-24	2	22	16	73	364	18			
Czechoslovakia				2[a]		34[a]	42	-77	10	6	5	11	-249	14	.....	60[a]	
Denmark					5	1	124	-105	51	29	136	191	-212	-278	118	-35	54[e]
Finland(b)			54[c]			35											26
France	16	25	175[c]	182	50	113	149	-804	110	72	73	186[f]	140	65	------	368	177
Federal Republic of Germany	123	-516	22[c]	84	141	100	17	-65		105	-	8	4	183	549	171	355
German Democratic Republic							18	-11	2	1	-	-	-146				
Greece[b]					1	19				-	1				----	73	----
Hungary					2	6											
Iceland							103	-265	45		44	340	-469	38			
Ireland																	
Italy	-106	21	16	167	23	71		144	45	34[d]	423	110[c]	134	2	-327	-108	192
Japan														14			
Malta							125	40	5		-	2	91	4			
Netherlands	71	82	49[b]	297	119	62			9		-		-88				
Norway		3			5										38	26	29[c]
Poland			3	4	5										----	16	31
Portugal								-135	22	3	22	15	-547	-14			
Romania					9		9	-102	7	11	2	4	-213	-7			
Soviet Union																	
Spain	-36	3	1	9		38		-31		19	3	3	-18		22	16	41
Sweden	-31		13[c]		72	43	18	-61	34	--	74	564	-364	-210	-----	156	
Switzerland	----------		8[c]	----------	20												
Turkey	39				65	25	120	27[b]	20	38		101		-59	-46	--	27
United Kingdom	10	-144	33[c]	94		126	100			9	134	16	-91		-263	-155	
United States	-80	-216	-395	-3,943	153	33	57	313	27	157	491	9	-2,000	-813			
Yugoslavia[b]						28											

Source: Economic Commission for Europe, Annual Review of the Chemical Industry, 1983.

Table 2.10. (continued)

Note: (-) sign indicates a net importer.
a/ Thousands of crowns, free frontier of delivering country.
b) Data for 1982.
c/ Including propylene, butadienes, butylenes and other acyclic hydrocarbons.
d/ Thousands of litres.
e/ Including 583.51.
f/ Thousands of tons of phosphorus pentoxyde (P2O5).

SITC, Rev.2	Name
511.11	ethylene
.12	propylene
.13	butylenes,butadienes and methylbutadienes
511.22	benzene
.23	toluene
.24	xylenes
.25	styrene
.31	vinylcloride
512.11	methanol
.15	ethylene glycol
.16	ethanol
522.22	sulphuric acid
.24	phosphoric acid
.51	ammonia
562.16	urea, tons of N
583.11	polyethylene
.31	polystyrene
.41	polyvinylchloride

(a) Fertilizers

Trade in fertilizers has grown steadily over the last decade at a rate of approximately 2 per cent annually, although decreases have occurred in some years. This growth rate is also expected to continue in the near future.

Until recently, ammonia was mainly supplied to the world market by east European countries, but Arab Gulf producers are fast becoming major suppliers too. The importers of the ammonia are Western Europe and North America. The European countries accounted for approximately 63 per cent (1.6 million tons) of total imports in 1974, and 48 per cent in 1980 (2.8 million tons); this figure is likely to fall to 40 per cent by 1995. The United States imported 11 per cent of the total in 1974, and it is expected to take up 30 per cent of world trade by 1995. Asian countries are also expected to be major importers by 1995, accounting for about 20 per cent of world trade.

The trade in phosphoric acid is also increasing at a fast rate. The new plants in North Africa, principally Morocco, are responsible for the increase in total world exports. The importing countries are in Western and Eastern Europe and Asia, mainly India and China, which use phosphoric acid to produce DAP.

For trade in urea, Eastern Europe, in particular the Soviet Union, has become a major supplier. The share of Arab Gulf producers has not yet become substantial. On the other hand, Asian countries, again principally India and China are major importers of urea. At present they take about 60 per cent of total world trade and will, therefore, become important markets for Arab producers. Although the United States is also expected to become a net importer in future, it is thought that its main supplier will be Canada.

The total phosphate fertilizer trade is approximately 15 million tons at present,and this will increase to more than 20 million tons by 1995. The major exporter will continue to be the United States which accounts for 40 per cent of total trade. Morocco will also become a major supplier in future, possibly producing 5 million tons per year in 1995. For the imports of phosphate fertilizers, as with other fertilizers, the most important market will be Asia. It could be importing 9 million tons by 1995, compared to the 5 million tons at present. The major market here is again China. Western Europe was a major importer, but is also a large producer itself. Total imports are expected to decrease in future, which will not make it an easy market for exports from the Arab region.

(b) Petrochemicals

The main petrochemicals produced in the region, are methanol, ethylene and their derivatives. These are olefins that are produced from the available associated natural gas in the region, which has a high ethane and methane content. Furthermore, they require only relatively simple technology for their production.

Since the early 1980s, a restructuring of the petrochemical industry has taken place in Western Europe, Japan and the United States of America. In most cases this has meant the closure of obsolete plants, and of units that produced on uneconomically small scales. This reduction in capacity, together with the increased demand following the years of recession, has led to an improvement in capacity utilization in, these countries. There is now very little overcapacity in Western Europe and, to a lesser extent, in the United States and Japan, as will be shown later in 4.1.1(b). This, coupled with the relative decline in the competitiveness of the Arab Gulf producers (see 2.3), does nothing to improve the chances of the Arab region of entering the world markets with their basic petrochemicals.

In the case of ethylene, the Arab world is expected to export 1.2 million tons per year by 1990. Western European countries and Japan will be net importers of around 0.5 million tons; other importers will be the United States and the Eastern European countries. By that time, the other main exporters besides the Arab countries, will be Canada and Mexico.

Methanol demand is expected to grow at an annual rate of 2 per cent, and Western Europe, North America and Eastern Europe are the largest groups of consumers. However, the fastest growing market is to be found in South-East Asia, although the quantity imported is relatively small.

With regard to the regional Arab demand for petrochemicals, a detailed forecast for various products for the years 1990 and 1995 is presented in tables 2.11 and 2.12 below. From these it can be concluded that a substantial increase in regional demand is expected in the next decade. However, except for polyethylenes and PVC, no regional production capacity exists at present, and this situation is likely to continue also in the near future. This indicates that a large amount of the final petrochemical products will have to be imported from outside the region in order to cover domestic consumption.

2.3. Major problems facing newcomers and their consequences for Arab countries

It is only since the late 1960s that countries of the Arab world have begun to establish fertilizer plants, and petrochemical production units from the late 1970s. The main producers are Saudi Arabia, Iraq, Qatar, Egypt, Kuwait and Bahrain in the ESCWA region and the Libyan Arab Jamahiriya, Algeria, Morocco and Tunisia for the north African Arab countries.

The main reason for this development was the need felt by countries of the region to diversify their industrial economic base, and by oil exporting countries to reduce their heavy reliance on the oil and gas sector, coupled with the availability of cheap petrochemical feedstocks (ethane and methane), and the financial resources available after the adjustments of oil prices in 1973 and 1979.

Almost all projects are based on facilities that produce ethylene and its derivatives, ammonia and methanol. In north Africa, Iraq, Jordan and the Syrian Arab Republic, development has also centred around phosphate rock as a raw material.

Table 2.11. Demand for final petrochemicals in the Arab world, 1990

(Thousands of metric tons)

Products	Algeria	Libyan Arab Jamahiriya	Tunisia	Morocco	Bahrain	Egypt	Iraq	Jordan	Kuwait	Qatar	Saudi Arabia	Syrian Arab Republic	United Arab Emirates	Other	Total
Plastics															
PE	133	12	47	56	4	206	92	22	29	8	148	30	18	59	864
PP	11	0	8	7	0	80	139	1	5	2	18	11	1	8	291
PVC	36	19	23	32	6	203	90	19	15	7	177	13	36	29	705
PS	23	..	7	3	1	22	133	1	4	1	31	5	2	3	236
PU	9	1	4	-	1	7	14	1	10	0	38	3	3	5	96
Paints															
Polyvinyl acetate	23	2	3	4	..	4	5	2	2	..	8	1	2	4	60
Synthetic fibres															
Polyester	50	...	16	23	a/	96	a/	...	a/	...	a/	...	a/	...	320
Acrylic	15	...	10	12	a/	20	a/	...	a/	...	a/	...	a/	...	92
Nylon	20	...	7	6	a/	8	a/	...	a/	...	a/	...	a/	...	131
Synthetic rubber															
Styrene butadiene	13	3	5	10	3	10	11	2	4	1	17	7	..	2	88
Poly butadiene	4	1	1	1	1	4	2	1	2	0	5	1	..	-	23
Butyl rubber	6	1	1	2	0	2	2	1	3	1	9	2	..	1	31
Synthetic detergents															
Linear alkyl benzene	18	13	4	13	1	20	20	5	5	1	23	3	3	12	141

Source: Gulf Organization for Industrial Consulting, estimates Petrochemical Refinery Study, (November 1985).

a/ Total demand for fibres of GOIC member states is estimated as follows: Polyester (135), Acrylic (35), Nylon (90).

Note: ... Data not available.

Table 2.12. Demand for final petrochemicals in the Arab world, 1995

(Thousands of metric tons)

Products	Algeria	Libyan Arab Jamahiriya	Tunisia	Morocco	Bahrain	Egypt	Iraq	Jordan	Kuwait	Qatar	Saudi Arabia	Syrian Arab Republic	United Arab Emirates	Other	Total
Plastics															
PE	196	29	60	78	6	342	135	28	41	11	207	39	26	71	1,269
PP	20	1	9	9	1	129	160	12	7	2	29	14	1	12	406
PVC	48	37	30	41	7	203	120	26	23	10	225	20	45	40	875
PS	33	..	8	4	1	30	150	2	5	1	38	6	2	4	204
PU	15	4	5	1	1	10	23	2	15	..	56	6	5	6	149
Paints															
Polyvinyl acetate	33	4	4	6	-1	6	7	2	3	...	11	2	2	6	87
Synthetic fibres															
Polyester	64	...	25	26	a/	123	a/	...	a/	a/	a/	...	a/	...	427
Acrylic	19	...	15	15	a/	26	a/	...	a/	a/	a/	...	a/	...	124
Nylon	26	...	10	6	a/	12	a/	...	a/	a/	a/	...	a/	...	180
Synthetic rubber															
Styrene butadiene	20	3	6	11	4	15	13	2	6	2	24	8	...	2	116
Poly butadiene	5	1	1	1	1	6	2	1	2	1	7	2	...	...	30
Butyl rubber	8	1	1	2	...	3	3	2	4	1	12	3	...	2	42
Synthetic detergents															
Linear alkyl benzene	22	13	5	15	1	26	23	5	7	2	29	5	4	14	171

Source: Gulf Organization for Industrial Consulting, Petrochemical Refinery Study, (November 1985).

a/ Total demand for fibres of GOIC member states is estimated as follows: Polyester (135), Acrylic (35), Nylon (90).

Note: ... Data not available.

The first products of this Arab petrochemical industry came on the world market at a time when there was a surplus capacity in some of the commodities produced. At the same time, they entered a world market in which trading, until then, had been dominated by relatively few, but large, international corporations. Consequently, these countries have faced resistance in entering the markets originally envisaged.

The new capacity coming on stream in the Arab world enables this region to become a net exporter of petrochemicals such as LLDPE, HDPE, ethylene glycol, diethylene glycol and methanol. Table 2.13 summarizes the major export markets by the year 1995.

Table 2.13. Major export markets for the petrochemical industry, 1995

(Thousands of metric tons)

Product	Importing region	Net trade, 1995 (export-import)
EDC	North America	-315
	Far East	-870
VCM	North America	-255
	South America	-120
	Far East	-357
	Oceania	-122
Benzene	North America	-160
Butadiene	North America	-285
LDPE	Far East	-110
Ethylene glycol	Far East	-458
PVC	Far East	-120
Vinylacetate	Far East	-185
P-xylene	Far East	-220
Polypropylene	Far East	-165

Source: Compiled from data supplied by the Gulf Organization for Industrial Consulting/Stanford Research Institute.

The above table indicates that prospective markets are more likely to be in the Far East, rather than in Europe or the United States of America. Also, the latter two markets are producers themselves, and are geographically located close to different producing areas such as Mexico and Canada, which give them a strategic advantage in selecting their sources. Add to this the drastically changed (read: diminished) competitiveness of the Arab Gulf petrochemical-producing countries owing to the fall in crude oil prices, and it becomes clear that the situation of the region's producers is not as promising as was forecasted at the beginning of 1980s.

It was assumed then, for example, that the cost advantage of feedstocks and power for the Saudi Arabian plants was such that their prices would be 30 per cent lower than those of their European competitors. Even when higher marketing and transport costs were taken into account, it was still believed that prices would be 15 per cent lower. However, the application of customs duties in the range of 11-13 per cent considerably reduced this advantage. These calculations all assumed a price for crude oil of approximately US$ 27 per barrel, and therefore the present (February 1987), much lower price established by OPEC of $US 18 per barrel has once again put the naphtha-based European producers in a strong position against Arab Gulf producers.

Other difficulties encountered by the newly established producers in the Arab world, such as trade barriers and protectionist policies, counter-trade, the lack of a comprehensive market information system, transport and storage problems, etc., are discussed in detail in chapter three.

Despite the present difficulties that are faced by the region's petrochemical plants, the more important fact is that many countries have established modern, world-scale plants that in the future will give the region a higher value added for their natural resources than the continuing exportation of crude oil would have given them.

During the past 10 years, the Arab world has installed an ethylene production capacity of 2.5 million tons/year and a methanol capacity of almost two million tons/year. However, further development is needed, particularly in filling "gaps" in the existing product range, in order to achieve full integration of the petrochemical industry in the Arab world.

2.4. Direction of trade in the Arab world, including the dynamics of development of local and regional demand

The trade of petrochemicals in the Arab world was characterized until the mid-1980s by the import of almost all the products needed by the chemical industry. This picture has changed only in recent years with the establishment of basic petrochemical-producing units in the region. As is shown in table 2.14, the trade in (petro-)chemicals constitutes only a fraction of total trade in most of the countries of the region. The table also shows that the import of chemicals far exceeds the export of these products, thus indicating a heavy reliance on supplies from outside the region in order to satisfy local consumption of these products. Although official statistics after 1983 are not yet available, the preliminary data for 1984 and 1985 show a marked increase in the export of chemicals, basically owing due to the commencement of exports of petrochemicals.

Table 2.15 shows the trade of Arab countries, including the trade in chemicals, with some of their major trading partners, such as the United States, the Federal Republic of Germany, Italy, France, Japan, the United Kingdom, the Netherlands and Singapore. All of these data indicate that the trade-balance for chemicals for the above-mentioned developed countries with countries of the Arab region has been in favour of the former. This fact is also clearly demonstrated by the data of table 2.16, which is based upon 1983 data on trade between Arab and European countries.

Table 2.14. Direction of trade – merchandise exports and imports: commodity structure of trade

(Millions of US Dollars)

Country	Year	Bahrain	Egypt	Iraq	Jordan	Kuwait	Lebanon	Oman	Democratic Yemen	Qatar	Saudi Arabia	Syrian Arab Republic	United Arab Emirates	Yemen Arab Republic
Exports														
Total merchandise	1980	3,601.0	3,046.0	26,551.0	574.0	19,641.0	849.0	3,294.0	502.0	5,684.0	102,012.0	2,108.0	20,522.0	22.6
Exports	1981	4,374.0	3,233.0	10,446.0	734.0	16,251.0	827.0	4,448.0	337.0	5,844.0	113,230.0	2,103.0	20,025.0	47.5
(to all countries)	1982	3,789.0	3,120.0	10,148.0	750.0	10,866.0	709.0	4,115.0	381.0	4,507.0	75,839.0	2,026.0	16,837.0	39.5
	1983	3,200.0	3,214.0	9,784.0	583.0	11,504.0	488.0	3,600.0	262.0	3,338.0	45,616.0	1,923.0	14,530.0	28.0
Mineral fuels														
(including crude oil)	1980	3,202.0	1,957.0	26,328.0	1.0	14,237.0	..	3,603.0	2.5	5,372.0	107,985.0	1,662.0	19,460.0	0.0
	1981	3,883.0	2,087.0	10,589.0	1.2	14,237.0	-	4,419.0	2.4	5,496.0	118,995.0	1,662.0	18,761.0	0.0
	1982	3,145.0	2,069.0	10,069.0	0.7	9,071.0	.	4,081.0	3.2	4,214.0	78,204.0	1,513.0	15,464.0	0.0
	1983	2,586.0	..	6,949.0	0.2	10,061.0	..	3,899.0	..	3,039.0	..	1,324.0	12,577.0	..
Chemicals														
	1980	9.8	18.6	138.2	36.7	170.0	..	...	..	..	112.0	3.0	47.0	0.6
	1981	9.3	18.6	9.1	54.2	134.0	..	..	..	..	88.0	5.0	58.0	0.7
	1982	6.6	38.6	0.7	65.6	63.0	..	..	..	..	166.0	22.0	64.0	0.0
	1983	9.0	-	..	101.3	..	..	-	..	..	..	30.0	84.0	..
Imports														
Total merchandise	1980	3,482.0	4,860.0	7,478.0	2,402.0	6,529.0	3,660.0	1,782.0	1,649.0	1,441.0	30,166.0	4,119.0	8,746.0	1,853.0
Imports	1981	4,124.0	8,840.0	7,903.0	3,170.0	6,978.0	3,645.0	2,288.0	1,317.0	1,518.0	35,268.0	5,040.0	9,646.0	1,758.0
(from all world countries)	1982	3,614.0	9,079.0	9,857.0	3,241.0	8,317.0	3,336.0	2,683.0	829.0	1,947.0	40,653.0	4,014.0	9,419.0	1,521.0
	1983	3,342.0	10,275.0	9,140.0	3,039.0	7,319.0	3,423.0	2,492.0	626.0	1,456.0	39,198.0	4,542.0	8,294.0	1,263.0
Mineral fuels														
(including crude oil)	1980	2,054.0	53.0	5.1	410.0	50.0	..	237.0	150.0	17.0	191.0	1,070.0	999.0	135.5
	1981	2,536.0	266.0	5.8	552.0	40.0	.	299.0	157.0	16.0	257.0	1,745.0	1,262.0	133.3
	1982	1,881.0	371.0	19.8	683.0	49.0	-	280.0	155.0	13.0	888.0	1,511.0	710.0	181.6
	1983	1,455.0	..	-	586.0	..	..	41.0	..	13.0	1,006.0	1,371.0	587.0	..
Chemicals														
	1980	132.9	458.6	567.6	132.0	275.0	..	60.0	23.0	77.0	1,425.0	338.0	407.0	94.7
	1981	1,606.0	787.1	313.9	153.0	270.0	..	79.0	32.0	73.0	1,374.0	339.0	478.0	90.4
	1982	153.5	710.0	353.1	154.0	298.0	.	84.0	31.0	91.0	2,415.0	355.0	503.0	99.6
	1983	142.8	..	-	159.0	..	..	92.0	..	72.0	2,484.0	353.0	489.0	..

Source: ESCWA compilation, based upon data from Arab Monetary Fund, Trade Statistics of Arab States, 1973-1983.

Note: ... Data not available.

Table 2.15. Trade of Arab countries with major trading partners

(Monthly averages in millions of US Dollars)

Country	Total 1982	Total 1983	U.S.A 1983	U.S.A 1984	Federal Republic of Germany 1983	Federal Republic of Germany 1984	Italy 1984	Italy 1985	France 1983	France 1984	Japan 1984	Japan 1985	United Kingdom 1985	United Kingdom 1986	Netherlands 1985	Netherlands 1986	Singapore 1985	Singapore 1986
Algeria																		
Exports to Algeria																		
Total			42.5	43.9	78.3	74.5	69.7	93.1	199.2	209.2	33.1	25.0	19.8	17.7	18.4	17.7		
Imports from Algeria																		
Total			236.8	166.8	110.1	86.9	206.8	183.1	210.4	182.7	13.0	16.5	30.2	14.5	84.7	55.1		
Egypt																		
Exports to Egypt																		
Total	756.5	856.3	199.2	148.8	96.5	94.0	80.5	80.5	92.2	79.0	81.0	60.8						
Petroleum and products	31.0	48.7	0.1	0.2	0.2		5.3	2.3	3.8	1.0	0.0	0.0						
Chemicals	69.0	67.3	6.4	6.8	11.0	12.	8.0	8.0	8.7	9.1	1.7	2.0						
Imports from Egypt																		
Total	260.0	267.9			25.3	40.0	126.3	133.5	43.3	50.9	21.2	45.0	15.9	44.7				
Petroleum and products	172.4	167.1			12.9	24.	115.5	122.6	38.4	45.6	12.1	36.5	9.4	36.8				
Iraq																		
Exports to Iraq																		
Total					122.2	71.0	52.2	57.1	67.1	57.1	67.1	107.8	48.1	62.7				
Chemicals					5.6	8.0	5.4	5.2	3.1	3.2	1.8	2.4	6.6	8.9				
Imports from Iraq																		
Petroleum and products			37.9	33.7		29.0	84.9	94.5	41.0	64.7					9.5	26.5		
Jordan																		
Exports to Jordan																		
Total[a/]	1,071.3	1,074.4	128.0			67.0	62.7	73.4			79.1	67.8	63.3					
Petroleum	204.0	192.6																
Chemicals	79.9	67.6																
Imports from Jordan																		
Total	261.1	255.3									5.5	5.8						
Chemicals	67.6	51.0																
Kuwait																		
Exports to Kuwait																		
Total			46.0	62.3	57.7	53.0	43.8	35.5			118.8	129.1	63.7	37.7				
Chemicals			2.8	2.0	2.5	2.0	1.2	1.1			1.4	1.5	5.7	5.0				
Imports from Kuwait																		
Total			11.6	25.6			96.8	118.9				98.0			86.8	58.7	37.3	73.5
Crude petroleum			5.2	8.6			0.9	22.9				53.8			54.7	37.9	18.7	48.8
Petroleum products			5.8	16.0			94.7	91.8				26.5			32.0	20.5	18.6	24.6
Lebanon																		
Exports to Lebanon																		
Total			14.4	8.8	19.2	14.0	34.1	23.5	30.1	20.3			5.7	7.0				
Chemicals			0.6	0.6	2.3	2.0	2.7	1.6	3.6	3.8			1.4	1.5				

Table 2.15. (continued)

Country	Total 1982	Total 1983	U.S.A 1983	U.S.A 1984	Federal Republic of Germany 1983	Federal Republic of Germany 1984	Italy 1984	Italy 1985	France 1983	France 1984	Japan 1984	Japan 1985	United Kingdom 1985	United Kingdom 1986	Netherlands 1985	Netherlands 1986	Singapore 1985	Singapore 1986
Libyan Arab Jamahiriya																		
Exports to Libyan Arab Jamahiriya																		
Total	690.5	597.9			67.0	43.0	138.5	104.8	17.5	20.4	34.9	21.7	34.6	32.9				
Petroleum and products	6.8	8.6				27.3	17.7	0.6	1.1			0.1	0.3					
Chemicals	31.4	23.3			3.5	1.8	4.9	4.3	2.3	1.7	0.3	0.2	4.3	5.8				
Imports from Libyan Arab Jamahiriya																		
Total	928.0	910.8			183.0	176.9	230.2	297.3	67.9	64.3			15.2	15.4	37.7	11.5		
Morocco																		
Exports to Morocco																		
Total			24.7	34.7	15.5	24.7	12.2	16.8	86.6	92.3			9.2	10.8				
Imports from Morocco																		
Total					18.1	23.0	12.0	12.6	59.1	73.4	10.0	12.4	8.5	9.2	8.6	6.7		
Saudia Arabia																		
Exports to Saudi Arabia																		
Total			378.3	284.0	249.2	186.0	198.8	153.0	150.2	189.8	466.3	328.2	139.8	192.4				
Petroleum products			0.7	0.5	0.2		5.4	1.7	0.3	0.3	0.0	0.0	2.6	0.3				
Chemicals			17.3	14.8	12.0	13.0	8.3	7.7	11.6	12.2	4.4	4.1	25.3	28.0				
Imports from Saudi Arabia																		
Total			105.0	330.0		83.0	160.1	121.5	291.4	178.8		1,043.7	49.9	29.8				
Crude petroleum			60.4	275.2		76.0	143.8	80.8	280.9	160.3		8,889.0	26.4	-				
Syrian Arab Republic																		
Exports to Syrian Arab Republic																		
Total			8.5	5.5	26.9	19.0	17.2	21.2	16.9	18.1	9.6	10.5	8.5	8.3				
Chemicals			0.8	0.3	2.9	3.0	2.3	3.0	2.4	3.0	0.1	0.2	2.3	1.5				
United Arab Emirates																		
Exports to United Arab Emirates																		
Total			48.8	43.2	42.9	35.0	48.7	38.0			93.5	97.3	66.0	74.5				
Petroleum and products			1.1	1.5	0.1		0.4	0.4			0.2	0.3	1.3	2.3				
Chemicals			4.0	3.2	2.8	2.0	1.4	1.4			1.4	1.5	7.2	8.8				
Imports from United Arab Emirates																		
Petroleum products			16.8	4.3			1.3	1.2	0.8	..		29.5						

Source: Data compiled from country reports by the Economic Intelligence Unit (EIU).

a/ Figures in millions of Jordanian dinars for 1984 and 1985.

Note: Exports to are based upon prices f.o.b.
Imports from are based upon prices c.i.f.

Table 2.16. Trade balance for chemical products between the European market and Arab countries in 1983

(Millions of US dollars)

Country	European market imports	European market exports
Algeria	27.446	458.099
Bahrain	1.366	47.396
Egypt	7.899	507.391
Iraq	..	251.568
Jordan	17.720	92.087
Kuwait	1.748	156.194
Lebanon	..	158.967
Libyan Arab Jamahiriya	45.156	310.348
Morocco	140.726	166.835
Oman	-	52.183
Qatar	5.455	..
Saudi Arabia	2.309	904.492
Sudan	-	132.617
Syrian Arab Republic	-	169.751
Tunisia	175.191	169.432
United Arab Emirates	-	225.486
Total	425.016	3,802.846

Source: Compiled by Arab Industrial Development Organization/ESCWA.

At the same time, the inter-Arab trade in petrochemical products is negligible when compared with the trade with developed countries (see table 2.17). All this points to a one-sided trade in petrochemicals from the developed to the developing countries, including Arab countries.

As was mentioned earlier, products that are presently being produced in the region are mostly based on the abundantly available (associated) gas from crude oil exploration in Arab countries. Therefore, only a limited number of basic petrochemicals are produced in the region, and these only satisfy domestic and, to a limited extent, regional demand. The bulk of products, however, is destined for the world export market.

Tables 2.6 and 2.7 presented the total production capacity for petrochemicals and fertilizers that exists in the region, while table 2.9 showed the expected surpluses available for export, based upon production and consumption figures for 1985. Actual statistics on exports are difficult to obtain, partly because these data are too recent to be included in official trade statistics, and partly because they are not published by the exporting countries, and can only be identified if reported by importing countries.

The following information was compiled from national trade statistics and other available sources on a country-by-country basis. Although export figures are almost non-existent, the import data for SITC group 5 (chemicals) are presented. A discussion of the production and trade in petrochemicals and fertilizers in various Arab countries is given in the following paragraphs.

Algeria

Algeria established its first fertilizer plant in 1967 at Arzew, which began operations in 1970 with a designed capacity of 1,000 tons/day of ammonia, 400 tons/day of urea, 400 tons/day of nitric acid and 500 tons/day of ammonium nitrate. About half the ammonia output is exported, while the fertilizers are sold on the domestic market. The Arzew complex has since been expanded with the addition of another 1,000 tons/day ammonia unit, and plans already exist for upgrading the latter.

Another fertilizer complex is located at Annaba. It comprises a 550,000 tons/year ammonium phosphate plant, a 40,000 tons/day sodium tripoly phosphate (STPP) unit, a 300,000 tons/year ammonium nitrate unit, and a 300,000 tons/year ammonium manufacturing unit.

A methanol and synthetic resins complex was also built at Arzew, and 96 per cent of the output of this 100,000 tons/year methanol plant is exported. Small units for the production of phenol resin (6,000 tons/year), melamine resin (500 tons/year) and urea resin (800 tons/year) are part of this complex.

Ethylene and its derivatives are produced at Skikda. The 120,000 tons/year ethylene unit came on stream in 1978, followed in 1979 by VCM (40,000 tons/year) and PVC (35,000 tons/year) units. A year later the production of LDPE started (capacity: 48,000 tons/year). An aromatics unit has been also constructed at Skikda; it has an annual capacity of 90,000 tons of benzene, 5,000 tons of toluene, 247,000 tons of xylene mix plus 38,000 tons of p-xylene. The production and sales of petrochemicals and fertilizers in 1985 is shown in table 2.18.

Table 2.17. Trade in petrochemicals in the Arab region: average annual value of imports and exports in millions of US Dollars at 1975 prices for the years 1980-1983

Product		Developed market economies	CPE	Countries	Other developing countries	Total
Plastic resins	Import	758.0	9.6	20.9	19.3	807.8
	Export	3.2	0.2	19.7	12.6	35.7
Detergents	Import	109.4	2.9	21.9	10.5	144.7
	Export	0.1	..	21.1	0.3	21.5
Carbon ashes	Import	25.0	0.5	..	0.2	25.7
	Export	..	-	..	..	..
Synthetic rubber	Import	22.5	0.6	..	1.0	24.1
	Export	..	..	..	..	..
Above total	Import	914.9	13.6	92.8	31.0	1,002.3
	Export	3.3	0.2	40.8	12.9	57.2
Synthetic fibres	Import	...	...	...	...	...
	Export	1.1	-	-	..	1.3
Organic petrochemicals	Import	462.2	6.2	3.7	6.8	479.6
	Export	55.4	0.2	3.3	11.9	70.8

Source: Compiled by Arab Industrial Development Organization/ESCWA.

Note: ... Data not available.

Table 2.18. Production and sales of petrochemicals and fertilizers in Algeria, 1985

Product	Capacity	Production	Domestic sales	Exports
Nitrogenous fertilizers	465	364	135	)
Phosphatic fertilizers	550	188		) 87
LDPE	48	12	268	)
HDPE			)	
PVC	–	–	) 64	
Methanol	35	5	)	
Ethylene	100	61	25	
	120	28	-	56
			–	10

Source: ESCWA, compiled from various sources.

Bahrain

Bahrain's petrochemical complex is located at Sitra, where two basic petrochemicals, ammonia and methanol, are produced by the Gulf Petrochemical Industries Co., (GPIC). The design capacity of both units is 330,000 tons per year. However, in the first year of production (1985) only 96,000 tons of ammonia and 113,000 tons of methanol were produced. Nevertheless, it is reported that the average capacity utilization in 1986 was 111 per cent.

By the end of 1986, the Company attained a total accumulated production of one million tons of methanol and ammonia. Fifty two per cent of production consisted of methanol while the rest was ammonia. The Company marketed its entire output world-wide.

GPIC is expanding its capacity to reach 115-120 per cent of design capacity by the end of 1988.

Bahrain (thousands of metric tons)

	Design capacity	Production 1985
Ammonia	330	96
Methanol	330	113

The complex was set up as a tripartite joint venture between PIC of Kuwait, and SABIC of Saudi Arabia and the Government of Bahrain. The latter two partners are responsible for the marketing of the products; PIC will

ə ammonia exports for the first five years of operation, while SABIC is ɔnsible for marketing the methanol. The main destinations of exports in ɔ were Western Europe, the Arab countries (mainly Jordan and Tunisia) and .e Far East. Table 2.19 shows the amount and value of trade in a number of petrochemicals, grouped according to the SITC, Rev. 2 for 1985.

Table 2.19. Foreign trade -- imports and exports of Bahrain by sections of commodities, 1985

(Thousands of tons and millions of Bahrain dinars)

	SITC Code	Imports Quantity	Imports Value	Exports Quantity	Exports Value
	27	1,203.6	4.6		
	33	85.8	9.2	0.0	0.0
	51	354.6	24.0	28.1	0.5
	53	10.0	5.2	0.0	0.0
	54	0.8	4.1		
	55	9.8	8.8	0.4	0.1
	56	2.5	0.4		
	57	0.7	0.3		
	58	1.1	0.4		
	59	18.2	11.5		
Total	(5)	379.6	54.8	28.5	0.6
Grand total (0-100)		2,982.6	487.5	200.3	61.9

Source: ESCWA, compiled from various sources.

Egypt

The petrochemical complex of the Egyptian General Petroleum Company (EGPC) in Ameriyah, was completed in 1986, but is presently moth-balled awaiting the completion of the terminal. This is necessary since the feedstock for this complex has to be imported during the period in which the ethylene complex, based upon indigenous associated gas feedstock, still awaits construction.

The imported ethylene is piped to the plant from a 5,000 ton/capacity offshore storage depot near Alexandria, which is presently under construction. It is expected that the output of the Ameriyah plant will be used to satisfy the local demand for PVC. This also applies to the various fertilizer-producing plants in Egypt, whose total production is consumed in the local market. Table 2.20 presents a detailed view of the Egyptian production capacity for a number of fertilizers.

Table 2.20. Fertilizer production capacity in Egypt

(Thousands of tons)

	Ammonia	Urea	Calcium nitrate	Ammonium sulphate	Ammonium nitrate	Nitric acid	Phosphoric acid	Sulphuric acid
Suez	60[a/] 140 132[b/]		245 605	95			65	450
Talkha	520 130	565	605					
Aswan	150[a/]				150			
Helwan	60[a/] 330[c/]				150			
Dekheila	330 330[b/]	510			760[b/]	594[b/]		
Existing	1,390	1,075	1,455	95	300	-	65	450
Under construction or planned	792	--	--	--	760	594	-	-
Total	2,182	1,075	1,455	95	1,060	594	65	450

Source: Arab Oil and Gas Directory 1986.

a/ Naphtha-based feedstock.
b/ Under construction.
c/ Planned.

Iraq

Owing to the Gulf war, Iraq's petrochemical complexes in the south of the country are not operational. Only the fertilizer plant at Al Qaim in the west, is currently producing. New plants are under construction at Baiji and Shwerah in the north of the country. Iraqi fertilizer plants have the capacities shown in the table 2.21 below, but up-to-date information on trade is not available for Iraq at present.

Table 2.21. Fertilizer production capacity in Iraq, 1986

(Thousands of tons/year)

Location	On-stream	Ammonia	Urea	AS	MAP	NPK	TSP
Abu Al Khassib	1971	290[a/]	475[a/]	165[a/]			
Khor Al Zubair	1976	1,022[a/]	475[a/]				
Al Qaim	1980	50			250	272	440

Source: ESCWA, compiled from various sources.

a/ Not operational owing to Gulf war.

Jordan

The fertilizer industry is based upon phosphate rock and potash, and therefore falls outside the scope of this report. Petrochemical products are not produced in Jordan at present, although there are some small plastic processing units that import their raw materials.

The mining and marketing of phosphate is handled by the Jordan Phosphate Mining Company (JPMC), which operates the country's three mines at Rusaifa,Al-Hasa and Wadi Al-Abyad. The production of various grades of phosphate was 6.07 million tons in 1985, of which 4.61 million tons were directly exported. The Jordan Fertilizer Industry Company (JFIC) has, however, an agreement with Mitsubishi of Japan and Woodward and Dickerson of the United States, to market 75 per cent of the production of di-ammonium phosphate (DAP).

Kuwait

Kuwait has the oldest established ammonia plant in the Arab world, and has constantly modernized and expanded its production facilities. The present nominal capacities of the ammonia and urea plants of PIC are 990,000 tons and 792,000 tons per year respectively. In total, PIC has an export potential in ammonia of over 400,000 tons/year. In addition to this production, PIC

markets the ammonia production of GPIC in Bahrain. It has a share in this tripartite joint venture between PIC of Kuwait SABIC of Saudi Arabia and the Government of Bahrain.

Understandably, the demand for fertilizers in Kuwait is very limited and this situation is unlikely to change. PIC is therefore obliged to export virtually all of its products. Domestic sales represent only about 1,000 tons per year.

Although the production of PIC plants has been well below designed capacity, Kuwait fertilizer capacity sales have failed to match even this reduced production level. This was partly owing to a continuing shortage of gas feedstock, as a result of the strongly cut back crude oil output under a new OPEC production quota system introduced in December 1986.

Table 2.22. Fertilizer production and sales in Kuwait

(Thousands of metric tons)

	Design capacity	Production 1984/1985	Sales 1984/1985
Ammonia	990	416	71
Urea	792	595	580
Ammonium sulphate	165	-	-
Sulphuric acid	132	4	5
Caustic soda		10	8
Chlorine		9	9

Source: ESCWA estimates.

Although almost all of the ammonia produced is used in the production of urea, some of it is shipped to Turkey to be utilized as feedstock in a fertilizer complex producing calcium ammonium nitrate (CAN) and di-ammonium phosphate (DAP), once this project comes on stream. The latter company is a joint venture between Turkey and the Kuwait Petroleum Company (KPC). This plant also uses phosphoric acid from another KPC joint venture in Tunisia. A third joint venture of KPC is a fertilizer plant in China, which also receives its feedstock from Tunisia.

Another investment of PIC has been its 25 per cent stake in the West German chemicals company Hoechst. This company provides a marketing outlet for Kuwait's ammonia and urea production. The sale of 580,000 tons of

(liquid) urea in 1984/1985 was mostly to China (200,000 tons), as well as to the local Kuwait Melamine Industries Company (15,000 tons). However, with the closure of this latter plant, other outlets for the urea produced will have to be found outside the country. Recently, however, it was reported that an agreement had been concluded with China to export 400,000 tons of urea during 1987. At the same time, PIC exports urea to India under a three-way agreement with the Union of Soviet Socialist Republics.

Though Kuwait previously had plans to construct an aromatics complex, it now looks as if the project will fail to materialize in the near future, given the uncertainty of the price of oil. Only a 80,000 tons a year PP-plant is being planned. No other petrochemical products are produced at this moment, except for relatively small amounts of alkyd and polyvinyl resins and unsaturated polyesters at the Kuwait Chemical Manufacturing Company. Table 2.23 gives the total value of imports and exports of chemicals in 1983.

Table 2.23. Foreign trade -- imports and exports of Kuwait by sections of commodities, 1983

(Millions of Kuwaiti dinars)

	SITC Code	Imports Quantity	Imports Value	Exports Quantity	Exports Value
	27				
	33				
	51				
	52				
	53				
	54				
	55				
	56				
	57				
	58				
	59				
Total	(5)	-	93.88	-	50.39
Grand total (0-100)			2,149.06		3,363.76

Source: ESCWA estimates.

Libyan Arab Jamahiriya

The country established two petrochemical complexes, one at Marsa El-Brega and another (near to being commissioned) at Ras Lanuf, together with a fertilizer complex at Sirte. These are fed by natural gas and the local refineries at Ras Lanuf. The refinery capacity stands at 350,000 barrels/day (bbl/day), after the start up of the major refinery at Ras Lanuf in 1985, but

more refining capacity will be coming on stream in the next two years, raising total capacity to 550,000 bbl/day.

Associated-gas mainly feeds the three petrochemical complexes. The production capacity of the Marsa El-Brega complex consists of a 1,000 tons/day urea plant, a 1,000 tons/day methanol plant as well as a 1,000 tons/day ammonia plant. Expansion already constructed includes another 1,000 tons/day methanol plant, a 1,750 tons/day urea and a 1,000 tons/day ammonia plant. The second major petrochemical complex is under construction at Ras Lanuf. The first phase encompasses the construction of a 330,000 tons/year ethylene unit based upon naphtha, a 170,000 tons year propylene unit, an 80,000 tons/year LDPE unit, a 80,000 tons/year HDPE unit, a 60,000 tons/year VCM unit, a 7,000 tons/year polypropylene unit, a 47,000 tons/year ethylene glycol and a 45,000 tons/year butadiene unit.

Table 2.24. Libyan Arab Jamahiriya petrochemical and fertilizer production capacity as of 1 January 1986

(Thousands of tons)

Location	Product	Existing capacity	Under construction	Planned
Marsa El-Brega	Methanol	660	-	330
	Ammonia	660	660	-
	Urea	907	990	-
	Nitric acid		165	-
	Sulphuric acid		165	
	Ammonium nitrate		231	
Ras Lanuf	Ethylene		330	
	Propylene		170	
	LDPE	-	80	
	HDPE	-	80	
	PP	-	70	
	EG	-	47	
	VCM/PVC	-	60	
	Butadiene	-	45	
	Butene-1	-	17	
Sirte	Ammonia	-	-	660
	Urea	-	-	990
	Sulphuric acid	-	-	165
	Nitric acid	-	-	165
	Ammonium nitrate	-	-	150

Source: Arab Industrial Development Organization/ESCWA compilation from various sources.

Morocco

Morocco has only limited oil and gas resources, and relies on imported oil for 98 per cent of its needs. It has two refineries with a combined capacity of 7.85 million tons/year. In 1984 they processed a total of 4.7 million tons of crude oil, of which 4.6 million tons were imported.

The country is the world's second largest producer of phosphates (after the United States of America), and the largest exporter of phosphates and phosphoric acid. They account for around 83 per cent of total mineral exports. Morocco's phosphoric acid plants are all located in SAFI. In 1983 they produced 1.2 million tons of phosphoric acid and 1.04 million tons of phosphate fertilizers. Exports of phosphoric acid, mainly to India and Turkey, reached 858,000 tons in 1983, while fertilizer exports totalled 802,000 tons.

A new, large fertilizer complex is being constructed at Jorf Lasfar. It will have the capacity to produce 1 million tons/year of DAP, 400,000 tons/year of TSP and 200,000 tons/year of ammonium sulphate phosphate.

Qatar

Qatar has a fertilizer complex at Umm Said, where the production of ammonia and urea came on stream in 1975. The Qatar Fertilizer Company (QAFCO) is jointly owned by the Qatar General Petroleum Corporation (QGPC -- 70 per cent) and the Norwegian Norsk Hydro (30 per cent). Present capacities and recent production are given in table 2.25 below. Gas feedstock for the complex comes from the onshore (associated) gas gathering system, but feedstock shortages for this plant have occurred in the past. Therefore, the gas feedstock is now also supplied from the offshore Khuff gasfield.

Table 2.25. Production of petrochemicals and fertilizers in Qatar

(Thousands of metric tons)

	Capacity	Production 1985	Production 1984	Sales 1985	Sales 1984	Production 1986 (Jan. to June)	Exports 1985
Ammonia	590	640	632	895	202	311	192
Urea	660	744	734		717	355	701
Ethylene	280	185	205	31	57		31
LDPE	140	159	149	138	153		137
Sulphur		28	33	29	28		..

Source: ESCWA compilation from various sources.

QGPC has also established a petrochemical venture with the French Company CdF Chimie, which holds a 16 per cent share in QAPCO. The plant consists of ethylene and LDPE units that came on stream in 1984. Their production has been below capacity owing to the unavailability of ethane feedstock, caused by the cut-back in Qatari oil production. The marketing of the products is handled by the French partner CdF Chimie. Table 2.26 gives the imports of Qatar for a number of petrochemical commodities.

Table 2.26. Foreign trade -- imports of Qatar by sections of commodities 1985

(Millions of Qatar riyals and tons)

	SITC Code	Imports	
		Quantity	Value
	27		
	33		
	51	1,169	6.2
	52	5,807	14.3
	53	6,407	27.3
	54	1,102	39.4
	55	5,763	53.1
	56	1,084	1.3
	57	236	2.4
	58	3,037	12.8
	59	10,997	57.2
Total	(5)	35,593	214.0
Grand total	(0-100)	--	4,146.5

Source: ESCWA estimates.

Saudi Arabia

Saudi Arabia began producing petrochemicals only recently, but with its up-to-date plants and its cheap and abundant feedstock resources, the belief is that it will have a strong impact on the trade in certain petrochemicals in the future. With most plants producing at world-scale levels, and at the same time in the absence of an important domestic market - even at the regional level - it is expected that new markets will have to be found outside the region. Table 2.27 presents an overview of the petrochemical and fertilizer plants in Saudi Arabia.

Table 2.27. Production capacity of petrochemicals and fertilizers in Saudi Arabia

(Thousands of metric tons)

Products	Ar-Razi	YANPET	KEMYA	SADAF	Ibn Sina	PETROKEMYA	SHARQ	Ibn Hayyan	Ibn Zahr	SAFCO	SAMAD	Ibn al Baytar
Ethylene		455		656		500						
Butadiene									125[a/]			
Butene-1						50[a/]						
Xylenes												
Methanol	600				700							
Ethanol				281								
EG		220					300					
EDC				454								
VCM								300				
PVC								200				
LDPE/LLDPE		205	260				130					
HDPE		91										
Styrene				295						20		
Melamine												
Caustic soda/ chlorine				377					500[a/]			
MTBE												
Ammonia												500[a/]
Urea										330	500	

Source: ESCWA compilation from various sources.

a/ Under construction.

It was SABICs stated objective that it would enter the world markets in an orderly and non-disruptive way that led to the establishment of two marketing organizations, namely SABIC Marketing Ltd., and SABIC Marketing Services Ltd., in order to achieve this aim. It also led SABIC to acquire storage facilities for liquid and solid products near prospective customers, e.g. in Rotterdam and Singapore, and it has set up sales offices, for example, in London, Houston and Hong Kong. In total, it has a network of 11 depots in five countries, including sales offices and distribution centres. At the same time, the newly established joint ventures have agreements for marketing products with their respective partners (see table 2.29). Essentially, SABICs production aims at satisfying export markets - in addition, of course, to satisfying local markets. In order of priority, SABIC views important markets for its products, first in the Arab region, the developing Asian markets, then in the traditional industrial markets of Japan, Western Europe and the United States of America. However SABIC has faced resistance in locating and entering traditional markets, especially in Western Europe. In particular, the imposition of tariffs on a number of products by the European Economic Community has resulted in a much reduced price competitiveness for SABIC in the European market. Table 2.28 presents an overview of these tariff measures.

Table 2.28. Tariff structure for Saudi Arabian petrochemicals

Product	Rate of duty (Percentage)	Duty-free quota (Millions of ECU)
LLDPE	12.5	6.600
HDPE	12.5	8.000
Methanol	13.0	3.300
Urea	11.0	0.375
EG	13.0	1.090
Di-ethylene glycol	8.0	0.340

Source: Figures supplied by the United Nations Conference on Trade and Development secretariat.

The production of Saudi petrochemicals started on a large scale only in 1985 (see table 2.30) and, consequently, sales of its products have increased since then. Total sales for SABIC in 1986 amounted to $US 624 million, and this is expected to grow to approximately $US 868 million in 1987(43). Figure 2.2 presents SABIC Marketing Co., sales values and quantities for the years 1981-1987. The figures cover SABICs 13 plants, including the non-petrochemical plants. Profits for the first six months of 1987 were $US 93 million from sales of $US 586 million, compared with profits of $US 15 million from sales of $US 395 million in 1986. Figure 2.3 and table 2.31 show the breakdown of the first half of 1987 sales, by region and quantity respectively.

Figure 2.2. SABIC Marketing Company: sales values and quantities, 1981-1987

(Thousands of US dollars)

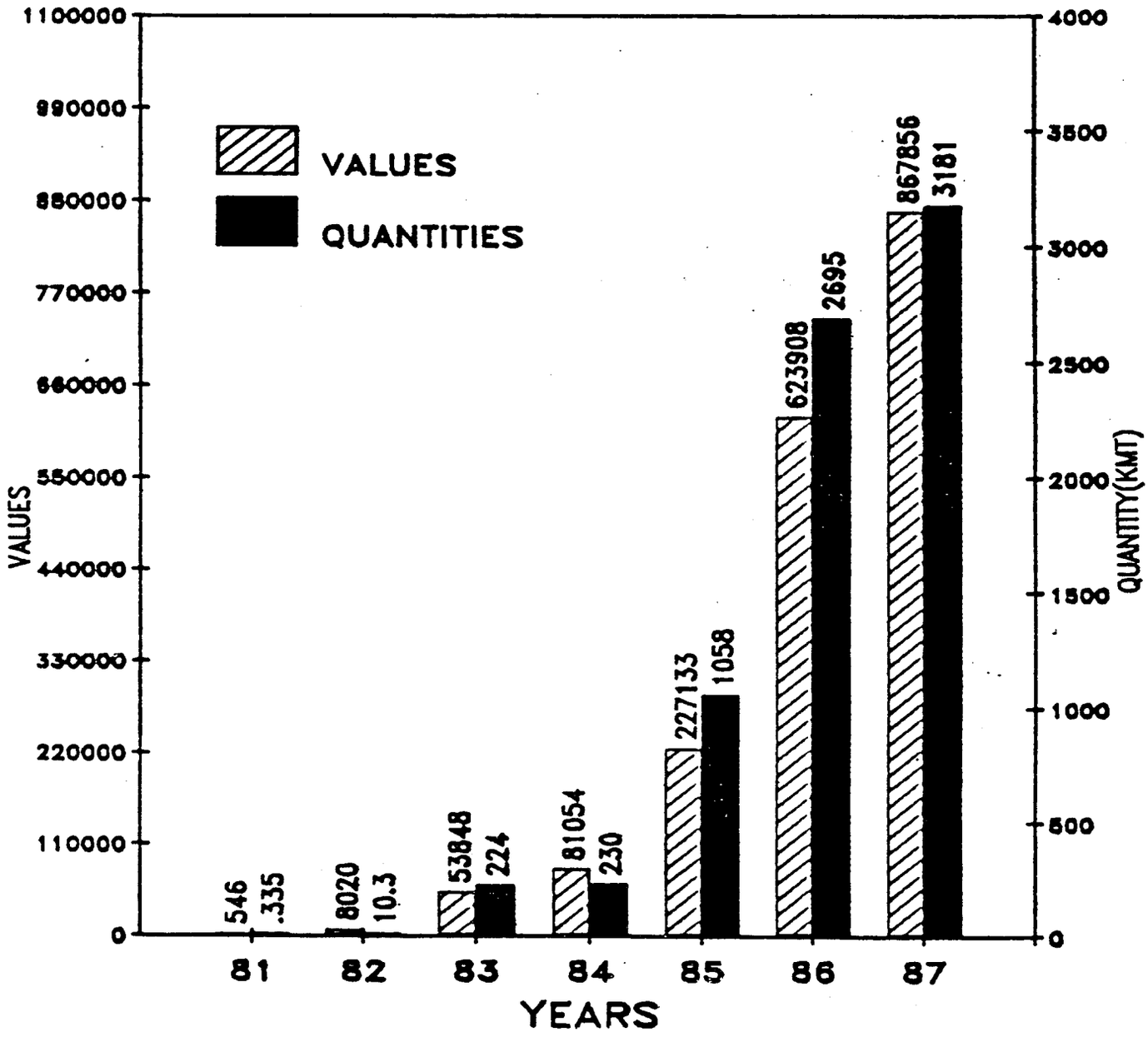
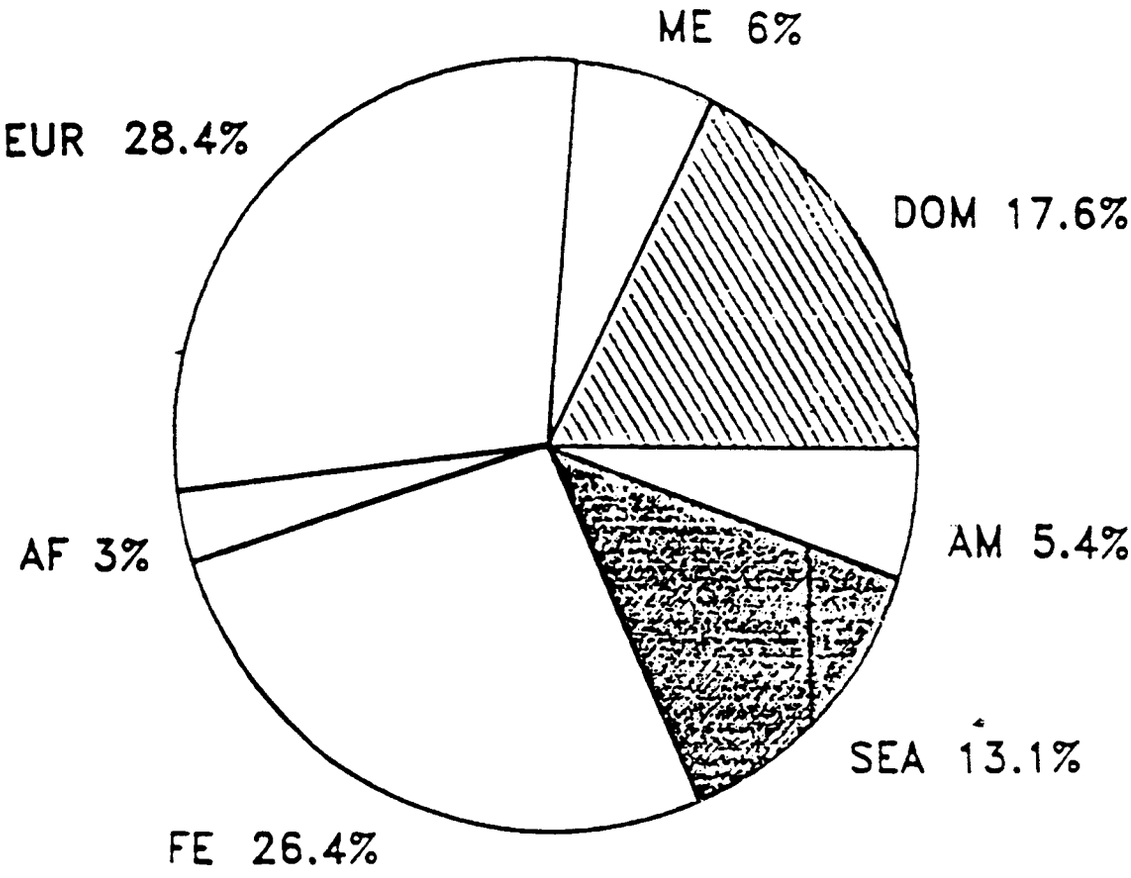


Figure 2.3. **SABIC Marketing Company: first half 1987 sales by region**



DOM = domestic
AM = America
SEA = South-East Asia
FE = Far East
AF = Africa
EUR = Europe
ME = Middle East

Sales quantities

Table 2.29. SABICs joint venture companies

Name of Company	Joint venture partner	Foreign partners' marketing commitments
Ar-Razi (Methanol)	Mitsubishi (Japan) 50%	Marketing 86%
Ibn-Sina (Methanol)	Celanese/Texas Eastern (USA) 50%	Marketing 60-70%
SADAF (various petrochemicals)	Pecten Arabia (Shell) (USA) 50%	Total marketing of ethanol, a contract with Mitsui (Japan) for buying 100,000 tons of EDC
KEMYA (various petrochemicals)	Exxon (USA) 50%	
YANPET (various petrochemicals)	Mobil Oil (U.S.A) 50%	Total marketing of products
SHARQ (various petrochemicals)	Mitsubishi (Japan) 50%	Marketing of 40% of project's products in Japan
SAMAD (Fertilizer)	Taiwan Fertilizer Co. 50%	Marketing of 60% of company's products
SAFCO (Fertilizer)	None	SABIC is responsible for marketing its share of products
Ibn-Hayyan (Plastics)	Lucky Group/Republic of Korea 15%	Marketing its share in the Republic of Korea
Ibn-Zahr (var.Petrochem)	10% APICORP 70% SABIC 10% Enichem (Italy) 10% Neste Oy (Finland)	
Arab Chemicals	Dow Chemicals 50%	Domestic markets
PETROKEMYA	None	

Source: Arab Industrial Development Organization/ESCWA compilation from various sources.

Table 2.30. Petrochemical production in Saudi Arabia

(Thousands of metric tons)

	Designed capacity	Production 1985	Sales 1985	Exports 1985 to EEC
Ethanol	281	200		
Ethylene	1,161	928		
EDC	454	190		
EG	520	310		30
HDPE	91	190		
				150
LDPE/LLDPE	595	379		
Melamine	20	14	5	
Methanol	1,300	1,287		400
Caustic soda	377	120		
Styrene	295	125		8
Sulphuric acid	100	84	82	
Urea	830	865	718	

Source: SABIC and ESCWA.

Table 2.31. Sabic Marketing Co. first half of 1987 sales by region

(Thousands of metric tons)

Domestic	356
Middle East	121
Europe	573
America	110
Far East	534
South-East Asia	265
Africa	60
Total	2,019

Markets for Ar-Razi methanol were Japan -- under the agreement with its joint venture partner, JSAMC takes 50 per cent of the output and will market another 30 per cent in the international market -- India, Singapore, Republic of Korea and Australia. The first methanol exports from the Ibn-Sina plant went to India (12,000 tons) and Spain (2,500 tons). The joint venture partner Celanese (United States of America) effectively markets about 75 per cent of output through its own marketing channels. Altogether, Saudi Arabia exported 400,000 tons of methanol to the EEC during 1985, leading to the imposition of protective duties on a number of petrochemical products from Saudi Arabia, as was outlined above.

The output of the Saudi Petrochemical Company (SADAF), petrochemical complex is marketed as follows; all ethanol produced is lifted by Pecten Arabia (Shell), which has in turn an agreement with Union Carbide to take half of production. The ethanol output was 200.000 tons in 1985.

Thirty-eight per cent of ethylene output (that is, 250,000 tons) constitutes feedstock for the KEMYA plant nearby, for conversion into LLDPE and HDPE. The rest is utilized as feedstock for the production of other derivatives. Half of the output from SADAF 454,000 tons per year EDC unit, goes to feed the VCM/PVC plant. The other half is exported to the Far East (particularly Japan). Output of the 295,000 tons styrene plant goes mainly to Japan (100,000 tons/year) and the Republic of Korea, while smaller quantities have been supplied to Europe and India.

The second petrochemical complex in Al-Jubail, that of KEMYA, produces LLDPE and HDPE. The only exports to be reported during 1985 were 1,400 tons of LLDPE for Mitsubishi (Japan).

The Yanbu-based petrochemical complex of YANPET produces ethylene, which is to be utilized for the production of ethylene glycol, LLDPE and HDPE. Its joint venture partner, Mobil Oil (United States of America), was mainly responsible for marketing their products. Some EG (30,000 tons) was exported to the EEC, and consequently this product was also included in the list of products falling under the newly imposed import duties.

The SABIC-Mitsubishi-led Japanese consortium (SPDC), partners in the SHARQ petrochemical plant, has a complicated agreement for the marketing of its products (LLDPE and EG). SHARQ takes its 330,000 tons/year feedstock from the PETROKEMYA plant in Jubail, while the latter owns and exports 50 per cent of SHARQs 300,000 tons/year EG plant. However, the first exports in 1985 were handled by the Japanese partner and were destined for markets in the Far East, Africa and the Middle East. SPDC is responsible for marketing 112,500 tons/year of EG and 97,000 tons/year of LLDPE, mainly in Japan, China, Australia and other Far East countries.

PETROKEMYA, as a 100 per cent SABIC-owned plant, has no joint venture partners, and is thus fully responsible for marketing its ethylene. Part of the ethylene produced (330,000 tons/year) is supplied to SHARQ (see above), while the Ibn Hayyan plant takes 70,000 tons/year of its output as feedstock to produce 300,000 tons/year of VCM and 200,000 tons/year of PVC. The Lucky Group of the Republic of Korea has a 15 per cent stake in this joint venture and handles the marketing of its share.

The Ibn Zahr petrochemical complex is scheduled to come on stream in 1988, and will use the butane and methanol produced by other SABIC units.

The two fertilizer plants in Saudi Arabia have different arrangements for exporting their output. SAFCO is solely responsible for marketing its product, both at home and abroad. In 1985 it produced 353,000 tons of urea, 216,000 tons of ammonia, besides 84,000 tons of sulphuric acid and 7,200 tons of melamine. The sulphuric acid is being used by the country's sea-water desalination plants, while the melamine was mainly exported to the Federal Republic of Germany and Spain.

The SAMAD complex is a joint venture between SABIC (50 per cent) and the Taiwan Fertilizer Corporation (50 per cent). The latter partner markets approximately 60 per cent of total output, primarily in South-East Asian markets. Of the combined urea production of both plants, which amounted to 865,000 tons in 1985, 213,000 tons were absorbed by the Saudi Arabian market, while the rest was exported to India (150,000 tons), China, Sudan, Iraq, Jordan, and others.

Syrian Arab Republic

Although the Syrian Arab Republic has only recently begun to exploit its limited resources of crude oil, it has no plans to set up a petrochemical industry. However, it is in the process of converting its existing naphtha-based fertilizer plants into gas-based ones, owing to the availability of this resource.

The major fertilizer complex is located in Homs, which produces ammonia, urea, TSP as well as nitrogenous and phosphatic fertilizers.

Domestic consumption took most of the production of the above fertilizers, although there are plans to export some of the surplus TSP, once the plant begins to is produce at full capacity.

Table 2.32. Foreign trade -- imports and exports of the Syrian Arab Republic by sectors of commodities, 1985

(Millions of Syrian pounds)

	SITC code	Imports value	Exports value
	27	71.3	601.6
	33	4,443.7	4,759.1
	51	62.4	0.3
	52	130.4	0.0
	53	82.4	14.4
	54	523.8	0.5
	55	57.6	181.2
	56	64.5	-
	57	2.3	..
	58	333.0	0.0
	59	216.8	1.4
Total	(5)	1,473.2	197.8
Grand total (0-100)		..	..

Source: ESCWA estimates.

Tunisia

At present, Tunisia is still an oil-exporting country, but it is widely assumed that it will become a net oil importer in the next decade, when its known oil and gas reserves are finally exhausted.

A refinery is located at Bizerti (capacity 34,000 bbl/d), and several plans have been developed to increase its capacity, although construction has not yet started.

Tunisia is an important producer of phosphates, and has sufficient reserves to last for 200 years at its 1985 rate of output, which was 5.4 million tons. Its phosphate-based fertilizer facilities are located in the Gabes industrial zone, where four phosphatic fertilizer companies operate. Their combined output is listed in table 2.33. Another fertilizer complex can be found at Gafsa.

Table 2.33. Phosphatic fertilizer production in Tunisia

(Thousands of metric tons)

Product	Production		Exports	
	1983	1984	1983	1984
Triple super phosphates	633	627	591	549
Phosphoric acid	620	550	783	599
Di-ammonium phosphate	406	368		
Mono-ammonium phosphate	81	62		
Simple super phosphates	43	49		
Hyper phosphates	15	33		
Aluminium fluoride	21	21		
Other compound fertilizers	10	8		
Ammoniate	5	132		

Source: ESCWA estimates.

United Arab Emirates

Abu Dhabi is the only emirate of the seven that form the United Arab Emirates to have constructed a fertilizer plant based upon natural gas feedstock. For that purpose, the Abu Dhabi National Oil Company (ADNOC) has set up a joint venture with the French Compagnie des Petroles (CFP), in order to construct and operate the Ruwais Fertilizer Industry Company (Fertil).

The Company has a nameplate capacity of 330,000 tons/year of ammonia and 500,000 tons/year of urea. Fertil has concluded marketing agreements with Japan's Mitsubishi and India's Mineral Trading Corporation, by which the two market more than 50 per cent of the urea produced. Other long-term contracts

Table 2.34. Fertilizer production capacity in the United Arab Emirates

(Thousands of metric tons)

	Design Capacity	Production 1984	Sales 1984	Production 1985	Sales 1985
Ammonia	330	275	79	343	129
Urea	500	343	322	354	343

Source: ESCWA compilation from various sources.

involve the Republic of Korea and China. Of the 1984 urea sales, India accounted for 61 per cent (196,000 tons), while China took 23 per cent (74,000 tons) and the domestic market bought 3 per cent of total urea sales of 322,000 tons.

As is clear from the above, the United Arab Emirates, together with other Gulf countries, mostly have trade deals with countries with governmental buying organizations and a centralized agricultural sector. This is because it is easier for small producers like Fertil to sell in bulk than through several small orders, for which the company lacks a sophisticated marketing capacity.

The petrochemical industry sector encompasses only plastic processing plants that face problems similar to those in the cement industry in the United Arab Emirates, that is, the industry has a surplus production capacity, while at the same time it suffers from competition through cheap imports from countries such as India, Greece, Taiwan, Japan and the Republic of Korea. This is also confirmed by trade statistics (table 2.35), which show substantial imports of certain locally produced commodities.

The Arab world

It is clear from the above that the Arab world has so far only established a limited industry for producing certain petrochemicals. However, the Arab world lacks an integrated industry to produce a wide range of products. This situation is likely to continue in coming years, since most plans for further downstream production have been postponed or cancelled in view of Arab investors.

At the same time, the marketing of present products has started slowly and is developing, although at a slow pace and with many more difficulties than were originally envisaged at the inception of the plans. There is a need to develop new markets, particularly in the Far East where the demand is likely to rise further. However, in the distant future some of these Asian countries will also develop their own petrochemical industries. A more secure and lasting market, therefore is the Arab market itself.

Table 2.35. Foreign trade -- imports and exports of the United Arab Emirates by sectors of commodities, 1982

(Millions of United Arab Emirates dirhams)

	SITC code	Imports value	Exports value
	27	150.3	3.9
	33	2,602.3	161.9
	51	367.7	14.1
	52	1.4	..
	53	138.5	20.1
	54	216.3	6.0
	55	377.5	47.8
	56	23.0	0.0
	57	25.5	4.0
	58	272.7	58.6
	59	458.5	83.2
Total	(5)	1,880.9	234.0
Grand total	(0-100)	34,708.9	1,656.4

Source: ESCWA compilation.

Tables 2.36 and 2.37 reveal that the per capita consumption of petrochemicals is much lower in the Middle East -- albeit still higher than in most other developing countries - but that it lags far behind the developed countries. Even within the region, there are big differences, as for instance, those that exist in plastics consumption between different countries. Therefore, it is believed that a potential exists for further downstream development, as well as the integration of the petrochemical industry, particularly if demand in the Arab world is to be taken as a guiding principle.

Table 2.36. Per capita consumption of petrochemicals in various regions

Region	Plastics (1979)	Rubbers (1975)	Synthetic fibres (1975)
North America	49.0	11.9	12.0
Western Europe	36.0	7.2	6.5
Japan	46.0	7.8	8.0
Eastern Europe	13.5	6.5	5.0
Middle East	5.2	1.8	2.6
Other developing countries	2.5	0.8	1.2

Source: Proceedings of the seminar on the Integration of Petrochemical Industry in the Arab World, Manama, Bahrain, January 1986 (Kuwait, OAPEC, 1986).

Table 2.37. Projected per capita consumption of plastics in the Arab world for the year 1985

Country	Population 1985 (Millions)	Total plastic consumption 1985 (Tons)	Per Capita 1985
Algeria	22.111	144,400	6.53
Bahrain	0.578	7,400	12.8
Egypt	47.445	92,700	1.95
Iraq	14.949	133,900	8.95
Jordan	3.841	32,700	8.51
Kuwait	1.832	46,800	25.54
Libyan Arab Jamahiriya	3.603	8,225	2.28
Morocco	23.397	74,800	3.19
Qatar	0.464	10,550	22.73
Saudi Arabia	13.711	274,400	20.01
Sudan	21.397	35,181	1.64
Syrian Arab Republic	10.692	48,000	4.49
Tunisia	7.102	69,900	9.84
United Arab Emirates	1.961	45,600	23.25
Others[a/]	21.050	46,500	2.97
Total	149.133	1,068,056	5.50

Source: Saudi Consulting House, Petrochemicals Industry in the Arab Region till the year 2000.

a/ Including Lebanon, Mauritania, Somalia, Yemen, Djibouti and Oman.

3. ANALYSIS OF MAJOR ISSUES OF MARKETING PETROCHEMICALS AND FERTILIZERS PRESENTLY BEING PRODUCED IN THE ARAB WORLD

As was indicated previously, the developed regions, mainly Western Europe, the United States of America and Japan and their multinationals have managed to control and, basically, to dominate the bulk of production of all petrochemical products. This came about as a result of certain advantages that were available to them such as technology, financing capabilities and, of course, access to reasonably-priced raw materials and cheap energy. In addition, they operated in the absence of competition as they had a monopoly and, basically, an unchallenged position in the world market.

After the 1973 increase in crude oil prices, some of the above-mentioned advantages began to shift in favour of a number of the developing countries, especially those producing oil. As such, some of these countries started planning to establish their own petrochemical plants, which were mostly geared for export to international markets, especially to those of the developed countries.

The new petrochemical producers, who had a lack of appropriate marketing experience faced strong resistance from the developed countries to open their markets to the new products. In fact, new obstacles in the form of tariffs and non-tariff barriers were created, which added further to the marketing complexities encountered in the developing countries by the new producers.

In this chapter, the major issues that affect the marketing of petrochemicals and fertilizers are analysed and discussed. These issues include:

- The size of the markets;

- Trade barriers and protectionist policies;

- The increasing role of new forms of trade (barter arrangements and other compensatory forms of trade, and joint ventures with other developing countries);

- Lack of co-operation with developing countries;

- Lack of a marketing information system (production statistics, market trends, competitors);

- Competition with international companies;

- Transport of products;

- Storage and distribution facilities and their effect on the security of supply;

- Technical support (after sales services).

3.1 Size of the markets

This issue pertains to the demand/supply of the various petrochemical and fertilizer products in each region of the world.

The data for the present consumption and production capacities of petrochemical and fertilizer products in the Arab region are presented in table 2.6, 2.7, 2.8 and 2.9. The demand forecasts are listed in tables 2.11 and 2.12. In addition, import data for most countries of the world and the major expected petrochemical markets are shown in tables 2.10 and 2.13 respectively.

In addition to the above, more extensive demand/supply estimates for petrochemicals in the Arab region are presented in tables 4.6 (for 1990) and 4.7 (for 1995). International and Arab world petrochemical consumption data are tabulated in tables 4.8 and 4.9 for the years 1985 and 2000 respectively. The data in table 4.9 seem to be on the optimistic side, and should therefore, be considered with care. Besides these four tables, figures relating to important individual products are also listed and discussed under the heading of each product in section 4.2.2.

A summary of the Arab production of nitrogen, phosphate and potash fertilizers is presented in table 4.26. In addition, changes in nitrogen fertilizer production/consumption levels are presented in table 4.28, while the nitrogen fertilizer trade balance is presented in table 4.29. The world nitrogen, phosphate and potash fertilizers supply/demand balance, as well as the trade balance, are tabulated in table 4.27.

From the data presented in the above-mentioned tables, it is clear that a demand exists in the world for each of the petrochemical and fertilizer products presently being produced in the Arab world. Moreover, there is a substantial demand in domestic markets, as well as in the region itself, although exact data about the size of these markets are difficult to estimate and vary according to the assumptions that are made concerning the future growth of the consumption of these products in the region.

For products such as LLDPE/LDPE and EG, markets exist in the Far East, as well as in Europe, while for other products such as methanol, styrene, HDPE and urea, only a limited market exists (owing to the tariff structure) in Europe. For some petrochemical products, domestic markets could absorb a large part of production, while for fertilizers such as urea, prospective markets lie mostly in the Far East and in other developing countries.

With the proven availability of (world) markets, the question that remains is how to enter these markets, what obstacles have to be overcome, and what marketing strategies are needed, especially in view of the competition faced and the investment needed to set up a marketing network. The following pages address these issues in greater detail.

3.2 Trade barriers

The emergence of relatively new petrochemical and fertilizer export-oriented plants in the Arab world, as well as in some of the other developing countries coincided with the following:

(a) The international economic recession;

(b) Low growth rates in petrochemical;

(c) Overall surplus and overcapacities;

(d) High unemployment rates, especially in Western Europe and the United States of America.

In view of the above, the industrialized countries became much more protective towards their own local industrial activities and, as such, they started resisting the importation of the petrochemical products of the developing countries. This resistance was displayed in several forms that included the adoption of various protective measures and policies that encompassed tariff and non-tariff barriers, as is indicated below:

3.2.1 Tariff barriers

A tariff is normally defined as an additional tax imposed on a product by the importing country as a precondition to its entering its market. The value of this tax is determined either as a percentage of the value of the product, as assessed at the port of entry, or as a monetary amount estimated in relation to the volume of the imported product. Table 3.1 indicates the tariff rates that the major industrialized countries impose on imports of selected petrochemical products.

The purpose of imposing a tariff tax is to give the local producer a competitive edge over the foreign producer in the product-selling price. In other words, it allows the local producers to operate less efficiently, yet still be able to market their products profitably, at competitive prices. This places a heavy burden on the newcomers from the developing countries who acquire their processing licence, technology, machinery and equipment from the developed countries, all at high costs.

An examination of table 3.1 reveals that the listed tariff rates do vary somewhat from one country to another, and that they are rather low for basic building blocks petrochemicals as compared with intermediate products. In other words, tariff rates tend to increase proportionally to the processing stage of the products.

At a first glance, one might get the impression that the relatively low level of tariff rates would not prevent new producers who display a reasonable degree of cost efficiency from gaining entry into the markets of the three main industrialized regions. This is normally not the case because, in any attempt to quantify the effect of the tariffs on a new producer, one must consider the extent of protection enjoyed by producers in the developed countries, and this is not necessarily limited to the nominal amount of the tariff rate. In fact, quantification of the competitive advantage or the efficiency differential provided by the tariffs to local producers at each stage of processing, is normally achieved by the theory of effective protection.

Table 3.1. Tariff rates for selected petrochemical products(1) imposed by the developed countries, 1979

Product[a]	Tariff rate[b] percentage		
	EEC	Japan	USA
A. Packaging			
Ethylene	6.3*	6.0*	F
Polyethylene	12.5*	11.0*	4.2*
Propylene	6.3*	6.0*	F
Polypropylene	12.5*	22.0*	4.2*
B. Disinfectant			
Methanol	13.0*	5.0*	18.0*
Formaldehyde	7.6*	5.0*	0.2*
C. Fertilizer			
Ammonia	11.0*	4.0*	F
Urea	11.0*	F	F
D. Antifreeze			
Ethylene	6.3*	6.0*	F
Ethylene oxide	12.0*	6.0*	9.0*
Ethylene glycol[c]	13.0*	12.0*	12.0*
E. Packaging			
Benzene	F	4.0*	F
Ethylene	6.3*	6.0*	F
Ethylbenzene	6.4*	2.0*	18.0
Styrene	6.0*	8.0*	7.4*
Polystyrene	12.5*	14.0*	F
F. Pipe, conduit, flooring			
Chlorine	11.0*	4.0*	F
Ethylene	6.3*	6.0*	F
Vinyl chloride	12.0*	6.0*	12.0*
Polyvinyl chloride (PVC)	12.5*	6.0*	4.2*

Table 3.1. (continued)

Product[a/]	Tariff rate[b/] percentage		
	EEC	Japan	USA
G. Synthetic rubber tyres			
Benzene	F	4.0*	F
Ethylene	6.3*	6.0*	F
Ethylbenzene	6.4*	2.0*	18.0
Styrene	6.0*	8.0*	7.4*
Butadiene	6.3*	6.0*	F
Styrene-butadiene Rubber (SBR)	3.2*	F	F
H. Polyester fabrics, etc.			
Methanol	13.0*	5.0*	18.0
Paraxylene	F	2.0	F
Di-methyol terephthalate	10.0*	8.0*	13.0
Ethylene glycol	13.0*	12.0*	12.0*
Polyester fibers	8.0*	10.0*	5.0
Polyester yarns	8.0*	10.0*	9.0

Source: Data supplied by the United Nations Conference on Trade and Development.

a/ Products are organized by end-use products (which are underlined) and stage of processing, starting with the basic feedstock products. Successive stages of processing are indicated by indentations; e.g. polyethylene is produced from ethylene (in product A. Joint inputs are left juxtaposed, e.g. benzene and ethylene are combined to produce ethylbenzene (in product E).

b/ Specific duties have been converted into ad valorem equivalents using 1977 trade weights. "F" indicates duty-free. All tariffs are post-multilateral trade negotiation (MTN) rates which will apply after the eight-year phase-in period. An asterisk * denotes that the product qualifies for duty-free treatment under the general system of preference (GSP), subject to the "competitive need formula" under the United States scheme and/or ceiling type limits under the schemes of the EEC and Japan. In some cases, the product is partly covered by the GSP and partly excluded; whenever possible the GSP designation is based on actual imports from developing countries.

c/ Ethylene glycol is produced from ethylene oxide, which in turn is produced from ethylene; see product E for intermediate stage effective protection and imports.

The efficiency differential in operation costs is normally termed as the effective rate of protection (ERP) which can be calculated by using the following equation:

$$ERP = T/VA$$

where ERP = effective rate of protection;
T = tariff rate on product;
VA = value added during the local processing.

The validity of this equation is based on the assumption that the cost of the feedstock required to produce the intermediate product is the same for both foreign and local producers, or in other words, that the feedstocks are duty-free.

In cases where the cost of the feedstock is not the same for both producers, then ERP can be calculated using the following expanded equation:

$$ERP = \frac{T - \sum_{i=1}^{n} a_i t_i}{1 - \sum_{i=1}^{n} a_i}$$

where ERP = effective rate of protection;
T = tariff rate on the product;
t_i = tariff rate on feedstock i;
a_i = fractional cost share of the feedstock i out of the total cost.

It is obvious from this that the value $1 - \sum a_i$ is the processing share of the total cost of the product.

Table 3.2 presents the effective rate of protection in the main three developed regions for the same petrochemical products that are indicated in table 3.1. ERP figures were computed for each stage of processing using the above equations, both for the current market prices at the time and the full cost prices of the products if produced by newly-constructed plants.

It should be emphasized that these effective rates of protection are only estimates and are not necessarily exact. Nevertheless, they are of the right order of magnitude, and do give a realistic picture regarding the added operation cost efficiency that must be accounted for by the foreign petrochemicals producer, in order that he can compete with domestic producers in marketing his products in the three main developed regions.

The rates that are presented in table 3.2 imply that a new producer wishing to market his polyethylene products in the EEC region must be 23-25 per cent more efficient in his manufacturing operations than his competitors from EEC countries. This, when compared with the effect of the apparent nominal tariff rate of 12.5 per cent for the polyethylenes, signifies the real impact of imposed tariffs on foreign producers and the positive competitive advantage gained by the local producer. This is especially true as

Table 3.2. Effective protection rate of selected petrochemical products (1) imposed by the industrialized countries, 1979

Product[a]	Effective protection rate [b] percentage (Market prices - full cost prices)					
	EEC		Japan		USA	
A. Packaging						
Ethylene	26	20	6	6	0	0
Polyethylene	25	23	24	21	8	7
Propylene	7	7	6	6	0	0
Polypropylene	18	18	37	42	10	9
B. Disinfectant						
Methanol	22	19	6	8	30	28
Formaldehyde	...	0	5	5	...	-25
C. Fertilizer						
Ammonia	19	15	5	4	0	0
Urea	11	11	-8[c]	-14	0	0
D. Antifreeze						
Ethylene	26	20	6	6	0	0
Ethylene oxide	30	23	6	6	22	22
Ethylene glycol	33	18	98	49	23	26
E. Packaging						
Benzene	0	0	...	...	0	0
Ethylene	26	20	6	6	0	0
Ethylbenzene	27	47	...	-30	80	202
Styrene	4	4	33	37	-43	-30
Polystyrene	28	31	45	36	-29	-20
F. Pipe, conduit, flooring						
Chlorine	12	12	4	5	0	0
Ethylene	26	20	6	6	0	0
Vinyl chloride	27	20	6	6	42	29
Polyvinyl chloride (PVC)	14	13	6	6	-11	-6

Table 3.2. (continued)

Product[a/]	Effective protection rate [b/] percentage (Market prices - full cost prices)					
	EEC		Japan		USA	
G. Synthetic rubber tyres						
Benzene	0	0	...	...	0	0
Ethylene	26	20	6	6	0	0
Ethylbenzene	27	47	...	-30	80	202
Styrene	4	4	33	37	-43	-30
Butadiene	...	...	...	...	0	0
Styrene-butadiene Rubber (SBR)	-1.2	-0.2	-1	-1	-4	-2
H. Polyester fabrics, etc.						
Methanol	22	19	6	8	30	28
Paraxylene	0	0	3	3	0	0
Di-methyol terephthalate	40	18	20	15	33	22
Ethylene glycol[d/]	33	18	98	49	23	26
Polyester fibres	5	3	12	13	-21	-10
Polyester yarns	8	8	10	10	...	...

Source: United Nations Conference on Trade and Development secretariat calculations; production coefficients used to calculate effective protection were obtained with the assistance of the United Nations Industrial Development Organization.

a/ Products are organized by end-use products (which are underlined) and stage of processing, starting with the basic feedstock products. Successive stages of processing are indicated by indentations, e.g. polyethylene is produced from ethylene (in product A). Joint inputs are left juxtaposed, e.g. benzene and ethylene are combined to produce ethylbenzene (in product E).

b/ Effective rates of protection are calculated for each stage of processing using the formula given earlier, and for two pricing situations: (i) current market prices and (ii) full cost prices which would prevail in newly constructed plants operating at full capacity. Newly constructed plants have the advantage of being more efficient technically, but face the disadvantage of high construction costs, higher debt-servicing costs, and higher return on investment requirements.

c/ Calculated negative protection rate is theoretically possible when the tariff rate on the required intermediate feedstock is higher than the tariff rate on the product itself.

d/ Ethylene glycol is produced from ethylene oxide, which in turn is produced from ethylene; see product D for intermediate stage effective protection and imports.

Note: ... Data not available.

competitors, both local and foreign producers, attempt to sell the same product in the same market, and as such their ability to compete is directly related to the efficiency of their processing operation.

For economical as well as political reasons, and in order to decrease the effects of tariff rates and the consequent high effective rate of protection, the developed countries started to give preferential treatment to other countries belonging to the same trading block. This preferential treatment entitles exporting countries to the unrestricted, duty-free entry of some of their industrial products. At present, a number of Arab countries, for example Saudi Arabia, are developing into major producers of basic and intermediate petrochemicals and as such, with the proper negotiations, they could obtain custom tax concessions from the developed countries. Presently, few developing countries have been granted the status of most favoured nation (MFN), which entitles them to duty-free concessions from some developed countries.

In addition to the aspect of the tariff rates and their impact, one must also consider the preferential access of the exports of developing countries in general, to the markets of the industrialized regions under the generalized system of tariff preferences (GSP).

Under GSP, the European Economic Community, the United States and Japan permit the imports of some intermediate petrochemical products on a duty-free basis. In other words, the exports of a developing country, if granted GSP, are not subject to any duty that results from normal tariff regulations. The petrochemical products which might qualify for this treatment are identified by an asterisk (*) in table 3.1. Unfortunately, the GSP method is governed by certain restrictions that in many cases lead to the denial of this duty-free treatment. Consequently, products are treated in accordance with the normal tariff regulations. These restrictions include the following:

(a) Each developed region designates the countries which can be granted beneficiary status under the GSP scheme. For example, the United States of America does not grant this beneficiary status to most OPEC member States, including Saudi Arabia, Kuwait, the Libyan Arab Jamahiriya, etc.

(b) Each developed region has the option of deciding on an upper ceiling to limit the imports from beneficiary countries that receive GSP treatment to pre-determined maximum quantities. Any trade exceeding the ceiling is subject to the normal tariff duties. These ceilings are normally fixed on a product-by-product basis. In addition, the major suppliers of each product are limited to a certain fraction of this maximum-allowable ceiling. This option is exercised by all the developed regions. The United States normally denies the GSP scheme under the so-called "competitive need formula" whenever the import of any product from a particular developing country during the previous year exceeds 50 per cent of total United States imports of that product.

Simply translated, this means that whenever a developing country becomes a major supplier of a particular petrochemical product, it stands a good chance of losing the benefits of duty-free treatment under GSP, whereupon its exports

will face the normal tariff duties and the consequent efficiency-differential requirements, as represented in table 3.2. For example, in 1980, a customs duty of 14.4 per cent was imposed on methanol imports from the Libyan Arab Jamahiriya to the EEC, whereas this product has previously been imported on a duty-free basis.

(c) The requirement that each exporting country must present special documentation in order to certify the origin of the products. It should be stated, however, that this was introduced to ensure that the benefits of GSP would reach the beneficiary developing countries. In other words, the enactment of this requirement would eliminate the initiation of trading activities that involved the exporting of a product from a developed country through a developing country under the duty-free GSP treatment.

In addition, the concept of minimal processing requirements was introduced so as to ensure that the exporting developing countries have actually contributed significant value-added to the exported products. Even though the idea of a certificate of origin has its own positive merits, it can still place a heavy burden on those developing countries that import feedstocks for further processing, because import requirements have only limited scope for the improvement of value-added.

Another important issue that must be mentioned and discussed briefly is the so-called multilateral trade negotiations (MTN) that can offer some of the developing countries a good opportunity to negotiate and achieve an improved, and possibly more secured term of access to the markets of the developed countries. When compared with GSP, which is considered to be a unilateral system normally applied on a non-reciprocal basis, the concessions resulting from the multilateral trade negotiations can be duty-free and relatively stable. The degree of success is normally related to the bargaining power of the countries involved.

3.2.2 Non-tariff barriers

As was mentioned earlier, Arab petrochemical plants started their production at a time when the developed countries, which basically controlled the bulk of the petrochemical industry, were in the midst of an economic recession, with its consequently high unemployment, surplus capacities and low petrochemical growth rate. This recession, coupled with a change in comparative international advantage and a slackness in the demand for petrochemical products, put heavy pressure on the governments of the developed countries to enact additional measures over and above normal tariffs in order to protect and safeguard their own domestic industries. The pressure was exerted by labour unions and industrial firms that were experiencing difficulties in coping with the new developments.

As a result of various international negotiations that took place under the auspices of the General Agreement on Tariffs and Trade (GATT), normal tariffs have become less of a barrier to trade.

The two underlying principles of GATT are non-discrimination and the mutual benefit of the concerned parties (reciprocity). Many of the international negotiations conducted under these principles have resulted in a

general lowering of tariffs and a binding of rates. This implies that, after being agreed on, negotiated tariff rates will not be increased. Therefore, in response to the demands of their labour unions and industrial firms, the governments of developed countries have enacted, in addition to existing tariffs, other protective measures that are commonly referred to as non-tariff barriers.

These governmental non-tariff barriers vary from one country to another, but basically they all form different obstacles to the importation of foreign petrochemical products. Some of the main non-tariff barriers are listed below(2):

- Arbitrary customs valuations based on the different criteria in assigning a home market value to determine the tariff;

- Explicit import quotas on certain products from specific regions, or in general;

- The imposition of special import fees and/or border taxes;

- A discretionary import licensing programme that affects most intermediate products;

- The administrative discouragement of local importers through the requirement of tedious licensing procedures and exchange controls;

- The introduction of specifications and standard requirements in order to qualify imported products for utilization in home markets;

- The application of stringent rules of origin in order to qualify imported products for reductions in duty on entry to the local market;

- Subsidies and other government aid to local manufacturers, including the provision of credit and marketing infrastructure facilities, conducting bilateral negotiations in order to qualify local production for exports, etc.;

- Government preference in selecting suppliers for its own, and for public welfare procurement;

- The limitation of exemption of companies from the anti-trust laws imposed by their governments;

- Anti-dumping procedures.

There is no doubt that the application of the above mentioned measures contributes significantly to increasing the cost of imported goods, and thus to decreasing the competitivity of foreign producers with local manufacturers. In other words, these measures constitute major obstacles to new petrochemicals producers who attempt to enter the markets of the developed countries where these measures are applied.

Many attempts have been made to quantify the restrictive effects of non-tariff barriers on the flow of trade. The reported results, which may not

ıy be accurate, do give a clear indication regarding the impact and ınce of these non-tariff barriers on the direction of trade flow.

3.3. The increasing role of new forms of trade

ıere are many forms of trade other than the goods for cash transactions that are presently utilized by the international market. The form under which most trade transactions with different terms and conditions are carried out is commonly referred to as counter-trade. The origins of this international counter-trade in its modern form go back to East-West deals agreed on after the Second World War when the COMECON block was short of hard cash. Counter-trade (barter) was considered to be rather primitive in many developing countries until recently when it started gaining respectability at least among traders and bankers.

The prominence of counter-trading has re-emerged, mainly because of the international economic recession and the third world debt crisis. Barter trading, once viewed as a short-term expedient for countries short of cash, is becoming a permanent feature of third world trade. This is owing to the following reasons (5).

(a) The realization that the debt crisis and the resulting foreign exchange constraints are more than just temporary problems;

(b) The realization that counter-trade can help third world exporters to circumvent protectionist trade barriers and promote industrial development;

(c) The growth of a financial superstructure to service barter trade.

At present, at least 100 nations (6) have counter-trade policies. Current expectations are that counter-trade will continue to grow because the developing countries affected will remain short of cash, while in the industrial regions, a surplus of manufacturing capacity means that business still has to find extra outlets for their manufactured goods. Yet institutions such as the International Monetary Fund (IMF) and the Organization, for Economic Co-operation and Development (OECD) have long frowned upon this process, which, it is argued, acts like grit in the machinery of the world trading system. Ideally, this system should operate on open multilateral lines, with products being paid for by money or credit if it is to flourish and grow. Counter-trade is basically a closed, bilateral operation that distorts prices and competition, and is ultimately inflationary because exporters from industrial countries seem to increase their prices sharply in order to offset the losses they expect to make on the goods they receive in return.

Counter-trade transactions are normally complex, even for the experienced, taking in different parts of the globe and various trading sectors. Such transactions are kept strictly secret, and only the most spectacular deals become openly known. As such, accurate statistics regarding the volume of counter-trade are hard to come by. GATT (5) estimated the 1984 volume to be 8 per cent of world trade, or $US 155 billion, compared with 2 per cent in 1976. Other estimations put this figure at around 30 per cent of world trade, or approximately $US 600 billion. MOst agree that it is steadily growing, and

even the conservative estimates of the United States Department of Commerce suggest that counter-trade will reach 10-20 per cent of world trade by the end of the decade.

There is, however, considerable variation, both among countries and over time, in the way that counter-trade is carried out. Normally, requests for this type of trade are not regular or standardized, nor are they always accepted in their entirety by the supplier, except in those, as yet rare, cases where the procedure is imposed by official regulations. It is apparent that, not only may the method be different, but also that counter-trade terminology is not standardized between or even within countries. Many counter-trade forms are commonly practised in the international trading market, among which the most important are:

(i) Classical barter: this form involves an exchange of goods without the use of money. It is relatively rare and invariably takes place between governments. Such arrangements or deals usually involve mineral or agricultural commodities where quality and volume can be verified. In general, it is rather difficult to match, by value, the requirements of potential partners under this form of counter-trade;

(ii) Counter-purchase: this is considered to be the most common form of counter-trade for the developing countries. Under such deals, specific import orders are placed with suppliers who agree to purchase export products, sometimes of equivalent value. The obligations of such transactions are transferable, and can often be assigned to third parties. The following generalizations can be made about counter-purchase (9):

a. The timing sequence for counter-purchase is that the developing country usually imports first and exports second. The export period can extend over a number of years.

b. There will usually be two (or more) contracts;

c. The method is most appropriate for creditworthy countries or for countries with foreign exchange reserves, because the imports are normally financed by conventional means such as credits. The exports from the developing country do not actually finance the imports; they simply help to balance the expenditure on the import at a later date;

d. Many developing countries give permission for counter-purchase obligations to be assigned to third parties. Some countries such as Indonesia have standard letters of assignment. Typically, the obligation to export the products from the developing country will be undertaken by a trading company. The actual products to be exported will be agreed on either in advance, or at a later date with the government of the developing country;

e. The trading company or other assignee will be paid an amount equal to the discount (often called disagio), by the western exporter plus other agreed expenses.

f. A discount on the price of the export product is usually required in order to provide a purchasing incentive for the final buyer. The same holds true for most counter-traded exports;

g. The extra counter-purchase costs incurred by the western exporter are usually added to his price, i.e. the developing country pays the extra costs.

(iii) Offset: This is basically similar to counter-purchase, but it applies mainly to the government purchase of aircraft and military equipment. The private manufacturer or supplier who makes the initial sale agrees to offset part of the cost by purchasing or producing components - sometimes for related products - locally. Alternatively, he may agree to buy or market local products. Jones (9) cites the following two types of offset:

a. Direct offset occurs where there is an arrangement whereby the components to be used by the western exporter are to be produced within the developing country. In addition to agreeing to purchase the components, the western exporter can also provide technical assistance as part of the deal. The actual goods procured do not need to be components as such, but can be any products to be used in-house by the exporting company;

b. Indirect offset occurs where the western exporter agrees to export unrelated products from the developing country. For example, an aeroplane manufacturer can extract tropical products over a period of years. In a number of cases, the western exporter's obligation will be expressed in terms of "best efforts". There is often a close similarity between indirect offset and counter-purchase.

(iv) Buy-back: in conceptual terms, the buy-back form of counter-trade is probably the easiest to visualize, although it can become complicated in certain instances. In general, this form of counter-trade involves industrial projects such as steel and aluminium mills or truck plants. Under such agreements, the supplier is paid by agreeing to receive/market an output such as steel bars, aluminium ingots or trucks. These deals, which are normally based on a long-term agreement (10 to 20 years), guarantee the transfer of technology and an export market. As Jones (9) reported, the buy-back arrangement as a model is attractive because of its simplicity, but a number of practical problems have to be overcome in real-world situations. First and foremost is the problem of finance. The interval between the shipment of the western machinery and payment can be as long as several years, and conventional forms of financing are often not available. There is a risk that the project will not be successfully concluded. Further

problems, particularly in the manufacturing sector, involve the danger of establishing an operation whose resultant products will compete on world markets with western companies' own exports.

From the point of view of developing countries, although buy-back could offer benefits such as technology transfer and assured export markets, it can, nevertheless, rank below alternative methods of organizing capital investment like aid financing, the establishment of subsidiaries by overseas companies or joint ventures. Certain types of buy-back deals are also referred to as being counter-investment, as is indicated below:

a. Counter-investment: this is relatively a new form of counter-trade where a company seeking to export its products to a developing country agrees to help in setting up some local export projects. Earnings from such projects are specifically allocated to pay back the company/supplier. It is anticipated that this type of counter-trade will become more common in future;

b. Compensation: this term has a variety of meanings. It is used as a generic term for all types of counter-trade, as an alternative to buy-back or barter-style counter-trade, and where it takes the form of partial compensation for deals that are paid partly in cash, with the balance being settled through product counter-trade;

c. Swap: this form of trade is usually reserved for the simple exchange of bulk commodities such as oil, where the same or similar commodity is used on both sides. In general, this is mainly used to save on transportation costs, and as such it can be considered to fall outside the definition of counter-trade;

d. Switch-trading: this involves operations that are concerned with resolving imbalances in bilateral payment agreements, particularly where a third country/party supplies goods to the creditor nation within the bilateral agreement. The manipulation of clearing credits and debts, and the trading of the associated goods often involve several parties/countries in a web of complex arrangements. It is not unusual to include a switch-trading deal component within a broader counter-trade transaction. In general, substantial discounts can be involved in the switch-trading or conversion processes;

e. Disagio: this is the discount required by final buyers of counter-trade goods in order to provide a purchasing incentive.

It is clear from the above that counter-trade is now achieving a prominent role in international trade.

This is evident from the above-mentioned trade volume estimates and from the fact that, even though industrial countries frown on this form of trade, many of their major firms and banks have established counter-trade departments. Of the developing countries, Indonesia and Yugoslavia have

enacted mandatory counter-trade rules. A few other countries such as Mexico, Colombia, Ecuador and Malaysia have issued non-mandatory counter-trade regulations, together with the criteria for their application. Most other developing countries are thought to have issued informal directives to government departments in an effort to encourage counter-trade whenever possible. Indonesia, in its attempt to acquire fertilizers in 1983, made several counter-purchase agreements with various suppliers, as is indicated in table 3.3.

Table 3.3. The net balance of the 1983 fertilizer counter-purchase agreements between Indonesia and the producers from several other countries

Companies supplying	Commodities exchanged
Amitrex (USA)	Aluminium ingots
Chemie Export/Import (German Democratic Republic)	Black
Danubiana (Romania)	Cacao
Fred. Lekker (Federal Republic of Germany)	Clothing
Hart Tindo (Singapore)	Coal
ICEC (USA)	Coffee
Kali Bergbau (German Democratic Republic)	Nickel
Kuok (Singapore)	Palm stearin
Mitsubishi (Japan)	Plywood
Transcontinental (USA)	Rubber
Woodward and Dickerson (USA)	Timber
	Veneer
Value of fertilizers:	$126.4 million
Value of commodities:	$87.9 million
Net counter-trade balance:	$38.5 million

Source: Data compiled by ESCWA.

Arab petrochemical companies have also had some experience in counter-trade, and PIC of Kuwait reported that the industrialized countries have begun to implement counter-trade through assistance programmes, e.g. Europe dispatched over 700,000 tons of urea as aid to India, and the United States of America dispatched more than 800,000 tons as aid to South America. Japan continuously provides fertilizers as aid to China and other countries.

Some countries prefer payment in soft currency, e.g. India managed to purchase about 50 per cent of its fertilizer imports in Indian rupees during 1986-1987. It was also mentioned that counter-trade and reciprocal trade now constitutes a recognizable share of trade between developing countries.

3.4. Lack of co-operation with developing countries

As was indicated previously, Arab petrochemical plants were designed basically as export-oriented industries. At present, and for some time to come, the developed regions, namely Western Europe, Japan and the United States of America constitute the major consuming markets.

The United States in addition to its own local petrochemical production, will be supplied by its new neighbouring producers from Canada and the Latin American countries. Assuming all cost factors, excluding transportation, to be about equal, it would appear that transport costs will give a distinct advantage to Mexican and Canadian producers over those from Arab countries in most products.

The Western European region, given its geographic proximity to the Arab world and its very large and reasonably accessible market, becomes, by de facto, the natural market for Arab petrochemical products. A close analysis of the EEC market reveals that, when the crude oil price exceeded $US 30/bbl, the mainly ethane gas-based Arab petrochemical plants were able to charge less to produce and deliver to Western Europe on a variable/marginal cost-basis, than did the European naphtha/LPG-based plants. It should be stated however, that on a full cost basis, the difference was somewhat less. In order to protect their local industries, EEC countries responded by introducing certain restrictions, including tariff barriers and export ceilings, in an effort to minimize the importation of petrochemicals from Arab and other developing countries.

At present, with the fall of the price of crude oil to $US 18/bbl or below, which is expected to last through the 1980s, the gas-based variable/marginal competitive advantages have been minimized and almost eroded. This, in addition to existing restrictions, places a great deal of pressure on the Arab petrochemical companies to seek and establish other markets that can absorb their products.

The search for these additional markets could be directed towards developing countries, where at present only minimum co-operation in this field has been achieved (10). These markets could be tapped through agreements either on a regional or bilateral basis for the establishment of joint industrial ventures, or simply in order to achieve an economic and trade understanding with the least possible restrictions on these countries.

Many attempts to achieve such co-operation have been made especially in the area of establishing joint projects, but unfortunately they have resulted in only limited success. This can be attributed to the following obstacles:

(a) The non-availability of funds sufficient enough to finance the establishment of industrial projects in many developing countries;

(b) The lack of technical and marketing expertise;

(c) The lack of experience in similar co-operation activities;

(d) The failure to realize and foresee potential economic mutual benefits;

(e) The differences in the political and economic structure that exist between the developing countries. Yet while it should be pointed out that, even though such differences also exist between some developed countries, they are often overlooked in attempts to achieve economic co-operation or even integration.

A survey by UNIDO (10), and another one carried out jointly by the Arab League and the Organization of Arab Petroleum Exporting Countries (OAPEC) (11) indicated the existence of some encouraging co-operative actions and agreements between the developing countries in various fields, however, there were very few in the area of petrochemicals and fertilizers. Therefore, it is suggested that there should be more serious endeavour on the part of certain developing countries/regions to reach co-operation agreements, especially in the following areas:

(i) The establishment of intermediate and downstream petrochemical processing plants in the developing countries that do not possess basic and/or intermediate petrochemical plants;

(ii) Regional/bilateral marketing agreements.

Such activities, if successfully achieved, would ensure unrestricted marketing outlets, without trade barriers, for basic/intermediate petrochemical products from Arab countries.

One could envisage the possibility of enlarging the scope and sphere of such co-operation to include some developed countries in order to achieve what may be termed a "triangular co-operation agreement". This could be based on:

a. Technology, management and finance, to be supplied by the developed country;

b. Raw materials (basic/intermediate petrochemicals), management and finance, to be supplied by the developing country that is a petrochemical producer;

c. Land, labour and infrastructure, to be supplied by the host developing country.

This type of co-operative arrangements would no doubt lead to a minimization of the effects of the above-mentioned obstacles, as well as to the realization of the mutual economic benefits of the three concerned parties. The value added from these joint projects in a populated developing country that could be financially poor, will increase purchasing power and thus create a stable outlet for Arab petrochemical products. In addition, this could help to ease the severe international competition in favour of the traditional as well as new petrochemical producers.

The success of such triangular co-operation agreements will, no doubt, depend on the realistic identification of appropriate feasible joint venture projects. This could be accomplished by the establishment of qualified committees representing the three parties who would study, evaluate and recommend these projects.

3.5. Lack of marketing information systems

There is no doubt that appropriate marketing activities play an extremely important role in assuring the success of any industrial establishment. In order to succeed in the marketing of any industrial product, it is essential to keep abreast of the market by ensuring that the following information is available at all times:

- Production statistics;
- Competitors and their capabilities;
- Market trends, including demand/supply, types of products, quality of products and market prices.

The availability of this information will guide the management of the industrial enterprise to co-ordinate production levels and marketing activities at the right markets incurring minimal competition and cost whenever possible. Arab petrochemical companies are basically new producers who need to strengthen their capabilities in the various marketing activities and, of course, to know their competitors. Many attempts aimed at strengthening petrochemical marketing methods have been made over the last few years. One of the first of these attempts was the Regional Seminar on Petrochemical Marketing Strategies for the Arab Gulf States in the 1980s, which was organized by GOIC in Doha, Qatar between 19 and 21 May 1979. Some of the conclusions and recommendations of that seminar are listed below(12):

(a) Since petrochemical companies in the developed countries intend to maintain their local and foreign markets, the States of the region should prepare an aggressive and responsible strategy for each market so that basic goals and required policies are established in order to penetrate these markets;

(b) Regarding the European and North American markets, it is suggested that consultation and co-operation be started with Arab petrochemical-producing countries in North Africa, in order to co-ordinate the strategies and to share in the costs and required infrastructure, as those ports are closest to these markets.

(c) In order to penetrate product markets during the period 1982-1987, it is necessary to start the preparation and implementation of appropriate marketing strategies as soon as possible.

(d) It is suggested that the possibility of establishing and co-ordinating various marketing activities should be studied and, that these activities should be implemented jointly in order to avoid unnecessary duplication and competition and to share in the required cost and investment. Examples of such activities are as follows:

(i) The establishment of an organization or working group to carry out marketing research with the aim of acquiring information on markets and performing and preparing marketing studies, strategies and policies with regard to international producers, as well as petrochemical supply/demand predictions for important geographical regions;

(ii) The attainment of optimum shipping costs and share in the terminal and distribution costs;

(iii) The co-operation of sales and development in integrated business areas such as VCM/EDC/PVC;

(iv) The establishment of a back-up system for certain selected products in Gulf States, in order to ensure the security of supply such as the establishment of a common pipeline for ethylene plants in the region;

(v) The establishment of a joint technical organization to provide the required services;

(vi) Participation in research and development;

(vii) The encouragement of co-operation in the establishment of downstream industries that will lead to a fully-integrated petrochemical industry.

(e) In order to prepare and implement the required marketing strategies and policies for member States, it is suggested that priority be given to the preparation of a feasibility study for the establishment of a Gulf organization for petrochemical marketing with the following terms of reference:

(i) Future basic research:

a. To perform marketing research activities and to prepare studies regarding the strategies and policies for the various international producers;

b. To evaluate the alternatives ways of penetrating the European and North American markets, and to prepare and develop marketing plans in these areas;

c. To prepare studies regarding co-ordination between intermediate or long-term marketing strategies and plans for production, and their required investment;

d. To evaluate the economies and procedures for exporting ethylene to foreign markets.

(ii) Establishment procedures:

a. To establish liaison offices in the main market areas, namely Western Europe, North America and South-East Asia/Japan in order to collect commercial data and to establish industrial contacts;

b. To establish relations with international producers and distributors in order to create co-operation in international markets, and also to prepare and develop marketing plans;

c. To strengthen mutual relationships with other Arab petrochemical companies for joint marketing, and to agree on sales policies and the ways and means of implementing them.

(iii) Basic back-up structure:

a. Estimation of the requirements regarding the regulations and employment for petrochemical sales and distribution, in order to provide technical services for polymers in the Gulf region and in other Arab markets;

b. To prepare specific requirements for shipping and to develop optimum procedures in accordance with marketing plans;

c. To prepare and calculate specific plans for overall production that can be compared with actual sales figures.

d. In order to achieve co-ordination in the area of marketing development operations, it is necessary to hold yearly consultation meetings at the regional level.

Some concrete steps in this direction were taken on an individual country basis, but not collectively, by the Arab petrochemical producers. Examples include the sales offices opened by SABIC in the developed regions. It should be pointed out, however, that many difficulties in organizing collective action have to be anticipated because many petrochemical projects, mainly in Saudi Arabia and Qatar, were implemented as joint ventures with foreign partners. In most cases, these joint-venture agreements offer the advantages that are needed to ensure the successful and beneficial operation of an individual plant, but they stop short or may even become an obstacle to achieving collective marketing and operational agreements between the Arab petrochemical companies.

Naturally, every foreign partner plans its marketing activities in accordance with the plans drawn up by its mother company in the respective countries, and these may prove to be contrary to the interests of Arab producers.

3.6. Competition with international companies

During the rapid growth period of the petrochemical industry, which lasted for more than two decades, the three main consuming areas of the world, namely Western Europe, Japan and the United States were also the main producers, and thus exporters, of petrochemical products. But the recent increase in the number of petrochemical-producing plants in other regions of the world, including the Arab countries, has led to a new trend by which these three traditional exporting regions no longer constitute the main source for the supply of petrochemical products to the rest of the world. Essentially in fact, they have been forced to restructure their petrochemical plants, and even to shut down some uneconomical ones, as will be indicated later in this section of the report.

A number of the main new producers whose manufacturing plants are based on reasonably-priced ethane feedstock include the Arab oil-producing countries, Mexico, Brazil and Canada. The natural export markets for the new Latin

American and Canadian producers are neighbouring countries, including the United States of America; for Arab petrochemical companies, the nearest very large and reasonably accessible market for the Arab petrochemical companies is Western Europe. Therefore, an analysis of the competitiveness of Arab petrochemical producers with international companies must be centred mainly on Western European producers. This is realistic because, all other factors being equal, the cost, of transportation of most products to the United States will constitute a further disadvantage for Arab producers, as compared with those in Mexico and Canada. However, certain products subject to other controlling cost factors and market supply/demand will still find their way to the other two main developed regions, namely Japan and the United States as is shown in table 3.4.

Table 3.4. Saudi Arabian export markets for petrochemicals (13), 1985
(Thousands of metric tons)

Product range	Total EEC market	Markets of Saudi Arabian export destination				
		EEC	Japan	USA	Others	Total
Methanol	4,070	400	600	70	130	1,200
Ethylene	12,365	30	negligible	negligible	negligible	30
LLDPE/LDPE	4,230	150	30	20	180	380
HDPE	1,740	20	10	10	25	65
EG	825	30	80	60	15	185
EDC	7,600	20	90	80	10	200
Styrene	2,920	25	40	40	15	120
Percentage (based on total tonnage)		31	39	13	17	100

Source: Compiled from data supplied by the Organization for Economic Co-operation and Development.

The share of Arab petrochemicals exports to the West European region increased in 1986, as is indicated in table 3.5. This increase gives a strong indication of the importance of the EEC market for Arab products.

Table 3.5. Exports of some Arab petrochemical products to the three developed markets (14) January to October 1986
(Thousands of tons)

Product	EEC	Japan	USA
Styrene	33	100	0
Methanol	532	298	189
Ethylene glycol	51	120	26
Polyethylenes	248	22	23
Percentage	53	33	14

Owing to the high degree of price competition in Western Europe, domestic prices of the four products listed in table 3.5 are lower in the EEC region than in the two other developed markets. Because of this, and despite the geographic proximity of the EEC market to the Arab region, the most profitable outlets for Arab petrochemicals seem theoretically, to be Japan and the Far East, while the United States and the EEC are about equal in terms of profitability (14). Nevertheless, Western Europe will remain a major outlet for Arab petrochemical products, as is indicated in table 3.5 above.

If Arab petrochemical/fertilizer producers are to compete successfully in international markets, their maximum landing price must be equal to, or preferably less than, the prevailing selling price in that market. This landing price is normally computed as the sum of the following items:

- Total production cost;

- Transportation cost to the market's port of entry - it is assumed that the distribution costs within the country are the same for all producers. The effect of transport costs will be discussed later in section 3.7;

- Tariffs and custom duties;

- Expected rate of return on investment;

- Other related costs - sales expenses, etc.

The total production cost is influenced by:

- Total investment;

- Total capital cost - installed machinery and equipment, etc.;

- Required working capital;

- Plant size and production capacity;

- Manufacturing technology and process;

- Feedstock and energy requirements;

- By-products credits, if any.

An analysis of these factors and their effects on the competitiveness of the Arab petrochemical industry in world markets, reveal:

(a) The designed plant sizes and the corresponding production capacities, as well as manufacturing technologies, are basically in line with the existing international standards used by other producers. As such, there will be no competitive effect resulting from these factors, either in favour of or against Arab petrochemical producers.

(b) Under normal circumstances, one would expect the total capital cost of an Arab petrochemical plant to be much higher than a similar one in Western

Europe. This expectation has been confirmed by GOIC (15) which estimated the location factor for the Arab Gulf States to be around 1.57 relative to the industrial regions. However, during the early 1980s, when the Arab petrochemical plants were being built, the machinery, equipment and construction markets were severely depressed at a time when the US dollar was very strong relative to other international currencies. Both of these factors worked somewhat to the advantage of the new producers in the Arab world. Not only were the Saudi Arabian petrochemical projects completed ahead of time, they were also under the budgeted capital. However, it should be pointed out that these plants will have to compete with older plants that have already been depreciated, which only adds to the disadvantages of Arab petrochemical competitiveness.

(c) The availability of reasonably priced feedstocks and energy in the form of associated natural gas was the prime mover behind the establishment of the gas-based Arab petrochemical and fertilizer plants. Feedstocks and energy costs are the main items that can be effectively controlled by Arab producers in terms of availability and pricing.

At the time when the crude oil price exceeded $US 35/bbl, the share of feedstocks and energy costs, especially for the European naphtha-based petrochemical plants, exceeded 70 per cent of the total production cost. This has been confirmed by different sources (2), (16), (17), (18).

During the late 1970s, when gas-based petrochemical plants were being built in many developing and developed countries, including the Arab States, the naphtha-based petrochemical industry was confronted with the following conditions (19):

(i) The high cost of raw materials and energy;

(ii) An economic recession which curtailed the demand for petrochemical products. The demand for ethylene fell by over 10 per cent during the period 1978-1982;

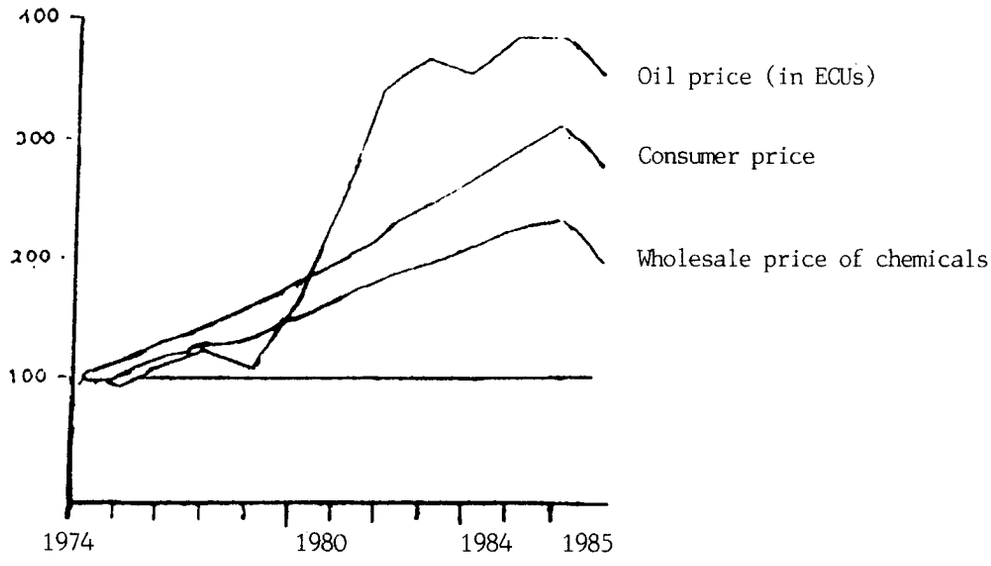
(iii) Governmental controls on oil and gas prices in Western Europe, which gave the North American producers a significant competitive advantage in international export markets;

(iv) More powerful competition from new gas-based petrochemical producers was in prospect;

(v) Feedstocks ceased to be sold on (hitherto advantageous) fixed quarterly terms, which has created an increasingly volatile spot market. The effect of the increase in the price of crude oil on chemical prices is presented graphically in figure 3.1.

As a result of the high costs of feedstocks and energy, in addition to the huge capacity surplus and their competitive disadvantages, West European producers were forced to restructure by closing down older and uneconomical plants, as is indicated in table 3.6 below:

Figure 3.1. Relationship of crude oil price to chemical prices



Source: Data supplied by Conseil européen des federations des industries petrochimiques.

Table 3.6. Capacity reductions of the West European petrochemical and plastics industry

	Capacity closed since 1980 (Thousands of tons)	Percentage achieved	Number of producers 1979	Number of producers 1985
Ethylene	4,440	67	32	28
LDPE	1,600	76	25	19
HDPE	790	73	22	17
ED/MEB	505	68	13	12
PVC	1,335	87	29	17
PP	345	-	19	16
PS	560	77		22

Source: Data supplied by the Conseil européen des fédérations des industries petrochimiques.

In addition to the restructuring process, the heavy naphtha-based petrochemical industry embarked on serious efforts to conserve energy and to use feedstock efficiently. Companies established the flexibility of being able to use other alternatives to fuel oil such as coal. This placed them in a better position to respond effectively to any unforeseen rise in oil prices. Gas-based industries, on the other hand, experienced less acute problems during this period as gas prices rose less and more slowly than oil prices. However, the recent reaction to the over-production of food has affected urea consumption, which in turn has depressed the European demand for ammonia.

The recent drop in crude oil prices to $US 10-18/bbl caused the naphtha and LPG dollar cost to fall by over 50 per cent on a free supply basis. This situation has greatly diminished the competitive advantage previously enjoyed by the gas-based petrochemical industry. This trend of low crude oil prices is expected to last for some time. Few analyses believe that prices will recover substantially in the next few years. In fact, independent consultants seem to agree that prices will be volatile, within the range of $US 10-20/bbl, at least up to 1990. The EEC Commission is reported to believe that the present trend suggests a $US 15/bbl up to 1990, while the World Bank, in making energy loans, assumes that the present price in real terms will persist into the 1990s.

Based on the above, it can be concluded that with the relatively low oil prices that prevail and the weakness of the US dollar relative to major European currencies, the previously anticipated competitive advantage of Arab petrochemicals has diminished owing to reasonably priced feedstocks, instead of increasing as expected. However, in view of present and future prices of crude oil, Arab Gulf and North African companies are likely to remain competitive, albeit with a lower profit margin, but only if no additional trade restrictions in the international markets are imposed.

It is a well-known fact that the Arab Gulf States have been negotiating with Western Europe in an effort to achieve a free trade area (FTA) agreement that would regulate the flow of Arab petrochemicals into EEC countries. Certain difficulties were foreseen and are still expected to be encountered, before an acceptable mutual agreement can be reached. The views of the Association of Petrochemical Producers in Europe (APPE/CEFIC) as reflected in MCC/UN/20 - APPE 28C, April 1987, are as follows:

(a) Petrochemicals in Europe represent a strategic industry onto which is woven the whole fabric of downstream chemical, fibre, plastic, pharmaceutical, agro-chemical and other high value/high technology industries;

(b) Petrochemicals in Europe have already been restructured in order to take into account the first phase of the Gulf States' investments. The difficult process of restructuring the highly integrated petrochemicals industry in Europe still needs a few more years before it is completed;

(c) This ongoing restructuring process could be exacerbated by the unnecessary opening of the EEC market, by changing the tariff regime to favour competitors operating on cheap feedstocks;

(d) The stated key objective of the Gulf States is to secure duty-free entry into the EEC for their petrochemicals. Such access to Europe could well lead to a second phase of investment in the Gulf States, in expectation of obtaining tariff advantages in the Community for a range of products, and this would have knock-on effects which would undermine the essential European manufacturing base still further;

(e) As has been stated elsewhere, the reduction of tariffs on a multilateral basis - for example in the Uruguay GATT round - would be acceptable to the European petrochemicals industry. However, a unilateral reduction, if this was achieved, would lead to a further distortion of Europe's world competitive situation by putting the EEC in the position of a "magnet" for Middle East products;

(f) Technology is unlikely to be developed in Saudi Arabia, and all their processes and plants have been imported. Thus, in order to be able to afford the substantial research and development programmes that would enable it to remain competitive with the United States of America and Japan, the European petrochemicals industry has to maintain its position as a major, profitable industry sector;

(g) In the view of the European petrochemicals industry, it is extremely doubtful that security of oil supply would be guaranteed by the suggested bilateral deal: the duty-free access of EEC products to GCC countries is not thought likely to bring any major benefit to European sales in the area, since the local infrastructure is largely complete;

(h) Arguments are made within the Commission to the effect that the FTA issue is a "political" matter, and not an "industry or business" matter. This seems to be a question of semantics, since whatever it is called, such a move in our view, would have dramatic and damaging effects on the petrochemicals sector in Europe;

(i) As it is, compared to the United States and Japan, Europe imports the major share of the production of the Gulf States. Why should the Gulf obtain additional help? Their petrochemicals industry ought to face the same commercial and competitive pressures as the petrochemical industries in the rest of the world, and should meet the obligations of GATT.

European protective measures were aimed, therefore, not just at hampering the importation of Arab petrochemicals, but also at discouraging Arab countries from further investment in petrochemical plants.

The view that the local infrastructure (in Arab countries) is largely complete is a superfluous statement, since Arab countries still need to invest millions of dollars to improve their infrastructure.

The above highlights some of the anticipated negotiating difficulties. Petrochemicals are only one of the products traded between these two regions. As such, the collective bargaining power of the Arab producers is the only way of achieving a realistic but mutually beneficial agreement which will, in turn, help the export activities of petrochemicals.

3.7. Transport of products

As was indicated in section 3.6, the transport costs of Arab petrochemicals and fertilizers to international markets has a direct effect on the competitiveness of these products. For example, assuming the existence of similar tariff rates and other protectionist policies, Mexican and/or the Canadian petrochemicals will have a built-in competitive advantage in the United States market, mainly because of the proximity of the market and, consequently, the difference in transportation costs, as is indicated in table 3.7.

In general, transportation is one of the most transparent and less variable when compared with other cost factors. On the other hand, as was indicated previously, other cost factors such as tariffs, marketing and commercial costs are much more variable and, as such, their true effect on competitiveness cannot be easily assessed.

As was reported by UNIDO (20), transport costs and/or their ratio to selling prices have not varied substantially since the Second World-wide Study (ID/WG.336/3), published in May 1981 was undertaken. For intermediate petrochemical products, this ratio is still less than 10 per cent, while it ranges between 10 to 15 per cent for end- and most basic-products. For fertilizers and ammonia, the ratio is between 20 to 30 per cent. As reported by UNIDO (2), the freight costs for shipping certain petrochemicals and fertilizers from three developing countries in different regions are presented in table 3.7.

The figures presented in this table clearly indicate the effect on the transport cost of the geographic proximity of producers to the desired market and, consequently, on the competitiveness of their products in these international markets. In addition to the above, UNIDO (21) has reported the 1980 Qatari petrochemical products shipping costs to markets in the three developed regions, as is indicated in table 3.8.

Table 3.7. Freight costs for shipping petrochemicals to industrialized country markets in 1980
(1980 dollars)

Destination market		Japan	Northern Europe	Southern Europe	United States
Producer (exporter)	Product	$/ton	$/ton	$/ton	$/ton
Qatar	LPG	41.1	45.5	34.4	59.0
	Ammonia	35.4	39.1	29.6	50.1
	Ethylene	43.2	47.8	36.1	61.2
	Propylene	40.3	44.6	48.2	78.4
	Methanol	19.2	21.8	16.6	29.0
	Urea (bulk)	39.2	41.6	33.1	54.2
	Urea (bagged)	67.0	69.2	58.4	84.6
	PVC (bagged)	85.1	88.2	72.5	110.7
	LDPE (bagged)	92.3	95.7	78.7	120.0
Mexico	LPG	59.1	33.3	56.1	9.0
	Ammonia	50.8	28.6	48.2	7.7
	Ethylene	62.1	35.0	58.9	9.4
	Propylene	67.4	38.0	63.9	10.3
	Methanol	27.9	15.6	16.6	4.0
	Urea (bulk)	54.1	31.9	34.8	11.5
	Urea (bagged)	85.1	58.0	66.1	31.7
	PVC (bagged)	109.9	72.0	83.7	34.4
	LDPE (bagged)	119.3	78.1	90.8	37.3
Indonesia	LPG	24.3	53.1	42.3	68.8
	Ammonia	20.9	45.7	36.4	59.1
	Ethylene	25.5	55.7	44.4	72.2
	Propylene	27.7	60.5	48.2	78.4
	Methanol	11.4	25.2	20.2	35.5
	Urea (bulk)	24.9	48.1	39.6	61.1
	Urea (bagged)	49.2	77.2	66.6	93.2
	PVC (bagged)	59.4	99.8	84.4	123.0
	LDPE (bagged)	64.4	108.2	91.6	133.5

Source: UNIDO, Second World-wide Study on the Petrochemical Industry, 19 May 1981, (ID/WG.336/3) p. 153.

Table 3.8. Cost of shipping petrochemicals from Qatar to industrialized country markets, 1980

Product	Production cost $/ton[a/]	Japan		Northern Europe		Southern Europe		United States	
		$/ton	Percentage production cost	$/ton	Percentage production cost	$/ton	Percentage production cost	$/ton	Percentage production cost
Ammonia b/	151	35.4	23.5	39.1	25.9	29.6	19.6	50.1	33.2
DMT	928	19.2	2.1	21.8	2.3	16.6	1.8	29.0	3.1
Ethyl benzene	618	19.2	3.1	21.8	3.5	16.6	2.7	29.0	4.7
Ethylene c/	290	43.2	14.9	47.8	16.5	36.1	12.5	61.2	21.1
Ethylene glycol	845	19.2	2.3	21.8	2.6	16.6	1.9	29.0	3.4
Ethylene oxide	695	19.2	2.7	21.8	3.1	16.6	2.4	29.0	2.4
HDPE	737	92.3	12.5	95.7	13.0	78.7	10.7	120.0	16.3
LDPE	638	92.3	14.5	95.7	15.0	78.7	12.3	120.0	18.8
LLDPE	710	92.3	13.0	95.7	13.5	78.7	11.1	120.0	16.9
Methanol b/	110	19.2	17.3	21.8	19.7	16.6	15.0	29.0	26.2
PET	1,874	92.3	9.9	95.7	5.7	78.7	4.2	120.0	6.4
PP	944	92.3	9.8	95.7	10.1	78.7	8.3	120.0	12.7
PS	1,051	92.3	8.7	95.7	9.1	78.7	7.5	120.0	11.4
PVC	1,344	85.1	6.3	88.2	6.5	72.5	5.4	110.7	8.2
SBR	1,671	92.3	5.5	95.7	5.7	78.7	4.7	120.0	7.2
Styrene	831	19.2	2.3	21.8	2.6	16.6	2.0	29.0	3.5
TPA	972	19.2	1.2	21.8	2.2	16.6	1.7	29.0	3.0
Urea (bulk)		39.2	29.2	41.6	31.0	33.1	24.7	54.2	40.4
VCM		43.2	6.7	47.8	7.5	36.1	5.6	61.2	9.6

Source: UNIDO, Second World-wide Study on the Petrochemical Industry, 19 May 1981, (ID/WG.336/3) p. 154.

a/ 125,000-130,000 cu m.

b/ 75,000 cu m.

c/ 55,000 d.w.t.

In addition to the above, it is essential for Arab petrochemical producers to ensure the availability of adequate, suitable and reliable shipping capacities for many of their petrochemical products. Not only would this minimize shipping costs (as is shown in table 3.9), and thus improve their competitiveness, but it would also establish the confidence required by consumers regarding the continuity of supply of these products. This is particularly true for the majority of basic petrochemical products such as ethylene, etc. This, in turn, would help to secure long marketing agreements with consumers (i.e. presumably with processing plants) in international markets, with regard to the sale of Arab petrochemical and fertilizer products. The importance of the continuity of supply is reflected in the increasing practice of concluding such long-term contracts for the sale/purchase of chemicals, in recognition of the advantages offered by stable supply relationships, as compared with short-term supply operations.

In connection with table 3.9, it should be noted that:

- Using standard vessel sizes dedicated to particular materials can reduce shipping costs by 10 to 25 per cent;

- In the LPG group, the lower specific gravity of anhydrous ammonia reduces transportation costs by 86 to 87 per cent of those for LPG;

- Conversely, ethylene will cost more to ship than LPG owing to its lower refrigeration temperature: a 5 per cent premium is assumed;

- Propylene's lower specific gravity would increase shipping costs by 14 per cent, as compared with LPG.

3.8. Storage and distribution facilities and their effect on the security of supply

The successful marketing of any product can only be achieved through the realistic implementation of the necessary elements involved. If a new producer is to enter a new distant market, he must be able to compete in terms of quality and price, as well as being able to demonstrate his ability to secure the continuity of supply to the consumer.

Security of the continuity of supply must be demonstrated by the Arab producer, not only in terms of providing secure shipping arrangements and the ability to preserve the quality of products in accordance with internationally-recognized production standards, but also in being able to establish storage, terminal and distribution facilities.

Storage, terminal and distribution facilities generally differ from one product to another. It is clear that the movement of ethylene by sea necessitates special appropriate shipping, terminal and storage facilities that differ drastically from those for polymer products. It is the combination of these elements that presents a limitation on the present/future potential for the export of ethylene by Arab petrochemical companies. Ethylene is normally transported in specially designed ships, but is restricted to regions where terminal and storage facilities are well established, as is the case in Western Europe. But even in this region, there

Table 3.9. Typical shipping costs for petrochemicals: Qatar to Northern Europe, 1980
(Dollars per ton)

Product	Vessel type	Transportation costs	
		Variable vessel size	Standard vessel size
Methane (as LNG)	Refrigerated	-	70,34 a/
LPG	Pressurized and semi- or fully-refrigerated	50.22	45.50 b/
Ethylene	Fully-refrigerated	52.73	47.77 b/
Methanol	Products carrier	26.39	21.76 c/
	Chemical tanker type III	-	42.08
Urea (bulk)	Bulk carrier	41.63	-
Urea (bagged)	Bulk carrier	69.23	-
PVC (bagged)	Bulk carrier	88.23	-
LDPE (bagged)	Bulk carrier	95.75	-

Source: UNIDO, Second World-wide Study on the Petrochemical Industry, (19 May 1981) (ID/WG.336/3) p. 154.

a/ 125-130,000 cu m.

b/ 75,000 cu m.

c/ 55,000 d.w.t.

may be a need for pipeline expansion, which is very costly to enable bulk ethylene contracts to be negotiated. On the other hand, terminal and storage requirements for polymer products are quite different from those for ethylene. This is owing to the physical nature of polymers, which do not require cryogenic shipping and storage conditions. In other words, terminal and storage facilities must be established so as to accommodate the various products.

If an individual Arab petrochemical company is to achieve all of the above, it would be a very expensive task that could affect its competitiveness in international markets. It is obvious that every effort must be made to minimize costs, and this can be achieved through collective action on the part of Arab companies that produce the products under consideration. SABIC has already established storage facilities in some of the developed regions, and these could offer a good starting point for co-operation agreements with other Arab producers. In the case of ethylene, joint Arab terminal and pipeline facilities would definitely be advantageous to Arab producers, especially if they co-ordinated with the North African Arab States, namely the Libyan Arab Jamahiriya and Algeria.

3.9. Technical support (after-sales services)

The importance of providing technical support for after-sales services to customers cannot be over-emphasized. This has been an integral element of the entire marketing operation of successful producers. This is even truer for new producers such as the Arab petrochemicals and fertilizers companies, in their attempts to minimize or even eliminate any doubts that could arise regarding the quality of the products. At present, there is no doubt that certain groups circulate rumours with the intention of discrediting the quality and even the reliability of supply of products manufactured in the developing countries. Therefore, even though the provision of an after-sales service is rather costly and also technically difficult, especially at the start of marketing activities, it is of paramount importance for the new Arab petrochemical producers to initiate such a service in every market in which they become involved, especially in the polymer product area. Product name and quality and the reliability of the supply source need to be established quickly for the large number of small volume consumers that make up the polymer markets in each country.

Normally, operations related to the technical back-up of after-sales require:

(a) The availability of technically qualified distributors/salesmen is necessary in order to be successful in selling the products. The staff of the sales department are required to know the markets, the technical requirements of consumers and, above all, must have the ability to convince clients to use the new products through financial, as well as technical incentives that arise from the new products;

(b) The establishment of reputable chemical analysis facilities, which are essential elements in the marketing of petrochemical products, particularly polymers.

Some specialized Arab experts believe in going one step further with the establishment of technical trouble-shooting units to assist petrochemical consumers in pin-pointing the causes of any operating problems, that could conceivably be attributed to the use of petrochemical polymers. This, of course requires the availability of technically qualified personnel able to maintain, repair and operate the specialized machinery and equipment of the plant.

It would be an expensive task for a new supplier to achieve the above. Therefore, the prime strategic objective of the new polymer producer is, perhaps, to minimize the cost of the entry into the market and to ensure that the basis is laid for an effective longer-term strategic approach.

One strategic approach through a long-term plan consisting of two phases could be as follows:

First, in an attempt to enter a new market, the new producer could start with the joint venture approach for a fixed period, either with a trading company or with an established producer. It would be preferable to locate a producer who already has an established market in the area, as well as in other regions closer to the new producer. This would enable swap operations to take place that would be in the interests of both. In addition to providing the benefits of a trading organization, and/or an established producer in non-local markets, the foreign joint venture partner could also bring specific polymer technology sales and service expertise, most probably in relation to the petrochemical type actually being produced. It would also minimize the need for technical service facilities in the short-term through the use of the partner's existing technical staff team, in order to begin a phased build-up of servicing facilities for local sales that would be the responsibility of the Arab petrochemical producer. In addition, during this phase, plans to train local staff to handle marketing activities in the international markets should be made. It should be pointed out that the Arab petrochemical producer would probably have to pay dearly for a partnership such as this, in return, his local staff would be properly trained and, at the same time, he would be guaranteed entry to a market.

Secondly, with the availability of fully-trained local personnel after the planned first phase period, the Arab producer should be able to switch and handle all the marketing activities in both the local and the foreign export markets. These activities would include the technical support of after-sales services. The extent of these services, and whether or not they should include trouble-shooting would be decided by the management of the Arab company.

In the short-term, the background and assistance provided by the foreign partner could well enable a greater proportion of the marketing functions to be taken over by the Arab producer in the longer-term. However, the effect that this might have on the overall market share and returns from these markets would then need to be studied carefully, before any shift in strategic approach is decided upon.

4. IMPACT OF MARKETING ISSUES ON INVESTMENT IN PETROCHEMICAL AND FERTILIZER PRODUCTS IN ARAB COUNTRIES

4.1. Impact of marketing issues on past investment

As was stated previously, one of the major factors which is likely to have a direct impact on the success of Arab petrochemical and fertilizer companies is the establishment and implementation of effective marketing strategies, in order to obtain realistic market shares and, accordingly, to maximize sales revenues. It has been stated that, during the next decade or so, an efficient marketing policy will override all other factors, including technology, in determining the success of industrial petrochemical plants.

The above is evident from the fact that, as soon as Arab plants went into production, alternative but stiff protectionist policies, including high tariffs, were imposed by the three industrial regions, namely Western Europe, the United States and Japan. The obvious purpose of these policies was to protect their own industries by creating obstacles and, as such, to minimize the importation of foreign, and especially, Arab petrochemical products into their respective regions. Therefore, it is essential that attempts at all levels should be pursued in an effort to overcome these difficulties and obstacles in order that the flow of Arab petrochemicals and fertilizers can continue to these regions.

Concurrently with these attempts, other avenues should be explored in order to guarantee additional outlets for Arab products. One such avenue is to plan for additional investment so as to build other industrial plants to process the available basic/intermediate petrochemicals further and to produce intermediate/end-products for local, as well as for export consumption. This is commonly referred to as industrial integration. It should be realized, however, that the marketing of end-products is much more complicated than that of basic petrochemicals, mainly because the number of end-product consumers is far greater than those of basic ones, and there are many different variations in their feedstock quality requirements.

The process of petrochemical industrial integration has been operated by multinational petrochemical companies since the 1960s. The intention behind the integration is not only to minimize costs and to improve profitability, but also to continue capturing the market. Petrochemical giants have frequently engaged in joint ventures, by which one partner integrates forward in order to capture a market for his end-products, while the other partner integrates backwards so as to ensure the availability of his required raw materials at reasonable prices. It goes without saying that such integration creates a captive outlet for basic petrochemicals. These joint ventures have had a direct impact by limiting the opportunities in world markets for the new suppliers from developing countries who have been searching for outlets for their new producing plants.

It is of interest to briefly review petrochemical industry behaviour starting from 1973/1974, just after the first crude oil price increase, through to the present time, when prices fell drastically and on a spot basis, reached less than $US 10/bbl in 1986.

4.1.1. Petrochemical industry 1973-1984

The 1973 and subsequent 1978/1979 crude oil price increases had a massive impact on the world economy as a whole, and in particular on the petrochemical industry. The world hit a deep economic recession, particularly in 1981-1982, that greatly affected the demand for petrochemicals, especially in the major consuming regions of the developed countries. After more than 20 years of continuous growth, world-wide demand for many petrochemicals actually declined. In the case of ethylene, demand fell by over 10 per cent between 1978 and 1982. It is now believed that for many of the principal established petrochemical products, future demand growth rates will be significantly lower than was previously anticipated.

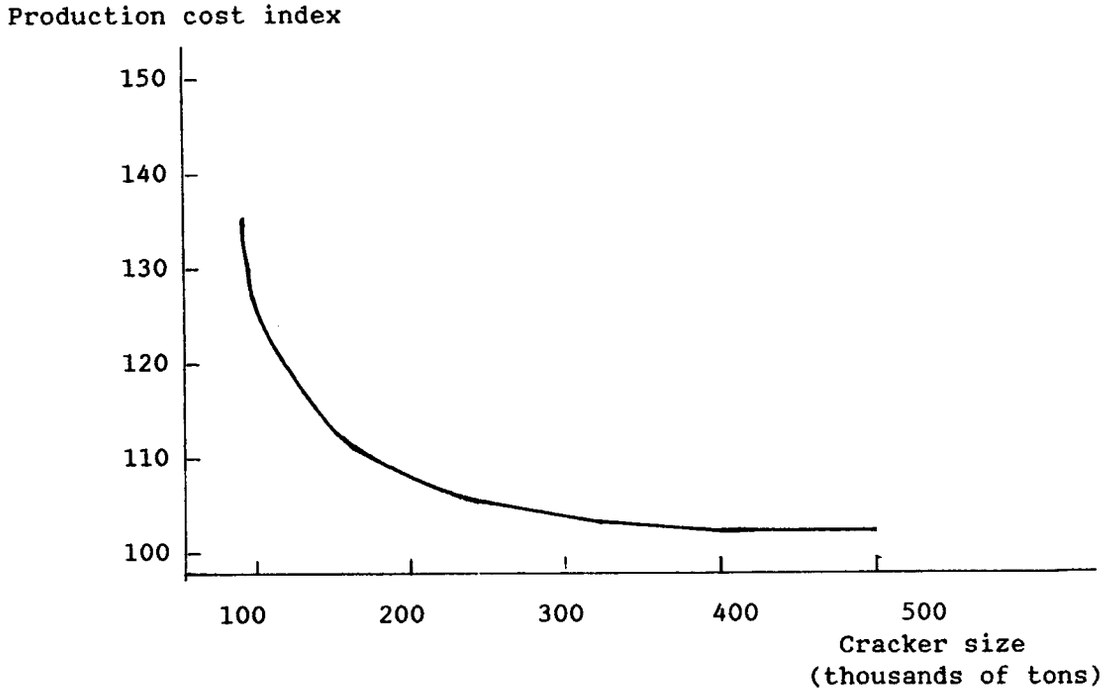
The decline in the demand growth rate for both basic and intermediate petrochemicals has resulted in overcapacity and, consequently, in the need for rationalization and restructuring in some established producing areas. This process began during the early 1980s, and in spite of the strong economic recovery in the United States at that time, and the growth of exports in Japan that boosted demand slightly in 1984, the basic underlying trend is towards the continuation of structural reorganization. The necessity for such a move by traditional producers was given added impetus by the establishment of new petrochemical plants in developing countries.

During this period, the petrochemical industry has witnessed a continued trend of downstream integration. The vertical build-up of producers was mainly caused by their desire to economize on production costs (see figure 4.1) by facilitating the transfer of raw materials and by-products and, at the same time, minimizing transportation costs. This, of course, has led to an increase in captive production, which presently accounts for much of the market. Through integration there is no doubt that captive production led to a situation where these producers gained market power, especially in basic petrochemicals such as ethylene. Owing to its known techno-economic factors, international trade in this product is extremely limited. UNIDO (4) reported that in 1981 trade in ethylene reached 10 per cent in the United States, 9.1 per cent in the EEC and 4.2 per cent in Japan.

Vertical integration in the petrochemical industry was accelerated during the late 1970s and early 1980s by the increased cost of necessary materials, a decrease in demand and the consequent losses encountered, as well as the anticipation of a decrease in the competitive advantage of traditional producers compared with that of the new producers in the developing oil-producing countries. This was evident in the case of the major oil companies, especially in Western Europe and the United States which, by taking full advantage of their control over feedstocks and energy supply, and of their surplus cash-flow situation, intensified their integration activities in the downstream production of petrochemicals. The percentages of the share of the total petrochemical production capacity of major Western European oil companies, as reported by the OECD(22), are presented in table 4.1.

During the late 1970s and early 1980s, the strong competition between traditional producers, high production costs, the decrease in the demand for petrochemicals, combined with overcapacity at a time when the plants of new producers were coming on stream, led traditional producers to adopt the following:

Figure 4.1. Economies of scale in ethylene cracking



Source: Data supplied by the Economic Commission for Europe.

Table 4.1. Oil companies share of total production capacity

(Percentage)

	Ethylene	Ethylene oxide	Styrene	VCM	PVC	Polypro-pylene	LDPE	HDPE	Poly-styrene
1970	50	23	24	9	16	29	28	20	-
1975	53	31	49	12	21	34	28	26	10
1980	60	42	51	19	21	39	41	29	18

Source: Data compiled by the Organization for Economic Co-operation and Development.

(a) Production of specialty chemicals

There was a need to decrease the production of basic petrochemicals and to move into the production of specialty chemicals, where the value added to primary chemicals is greatly enhanced. This process increases overall profitability. The production of such specialty chemicals normally requires a technologically advanced manufacturing process, often associated with proprietary technology, which is not normally available in developing countries.

The process of producing specialty chemicals (25) involves developing products that have an improved performance, or that possess enhanced properties that distinguish them from similar products that perform the same task. In some cases, entirely new products are created, while in others, existing standard products are replaced by tailor-made alternatives. Examples include:

(i) Materials to improve performance and efficiency in a range of engineering applications. In the automotive industry, plastics are progressively replacing other materials. The mechanical properties of resins can be improved by reinforcing them with fibres such as glass or carbon in 'composite' materials. This enables the high strength of fibres to be used in a material that can be formed into a variety of shapes. The combination of high strength and low weight are attractive in many applications and industries as, for example, in automobiles and aerospace. Engineering plastics have a good potential for investment in projects in Arab countries that lack iron, steel and wood.

(ii) The rapid development of the electronics/computer industry has also opened up new markets. Epoxy resins used in the manufacture of printed circuit boards are just one example of the need for high quality products that meet stringent specifications.

(iii) In the food industry, blow-moulded polyethylene terephthalate (PET) bottles have provided an alternative to the traditional glass bottle, while the familiar tin-can could well be challenged by polypropylene laminates capable of withstanding sterilization temperatures.

This increasing emphasis on pushing back the frontiers of technology presents a challenge to the petrochemical industry, which in the past two decades has been geared primarily to producing bulk products to standard specifications. The development of highly sophisticated products involves considerable investment in research and development, with no guarantee of success. In addition, different operational, marketing and sales strategies are often required to produce and promote such products.

Strong world-wide links and a reputation for reliability established over a number of years, integration with the oil industry to give access to a wide range of potential feedstocks, the availability of high investment and

resources for research and development, all backed by marketing expertise, will enable the petrochemical industry to respond to these challenges and to create new market opportunities for the future.

(b) Petrochemical restructuring

The restructuring measures that were referred to earlier were undertaken by the major petrochemical producers, with the aim of shutting down the uneconomical and less efficient plants. This was planned and carried out in order to eliminate the losses encountered during 1979-1984, and in anticipation of the future competitive effect of the new procedures from the developing countries, especially the Arab plants.

In the United States, as elsewhere, the level of economic activity is the key determining factor that affects underlying local demand and utilization rates. But the business environment of the United States is more accustomed to adapting to changing needs than that of many developing countries. Therefore, much necessary rationalization has already been undertaken, and utilization rates have improved significantly. Table 4.2 indicates that utilization rates were raised to over 90 per cent in 1986. The anticipated growth in overall petrochemical demand is such that, in the period ending in 1990, ethylene capacity is expected to remain virtually unchanged, with higher production permitting improved utilization levels (see table 4.3). Detailed reduction figures for the United States are, unfortunately, not available.

In Japan, the reduction of capacity in the Japanese petrochemical industry since 1979 resulted from rationalization plans that were co-ordinated by the Ministry of International Trade and Industry. Ethylene capacity was reduced from a nominal 6.2 million tons per year in 1980, to 5.3 million tons in 1982 and 4.7 million tons in 1984. Because of the non-availability of local feedstocks, further reduction must be envisaged, particularly of some old and less efficient plants that will effectively be replaced by competitively-priced derivative imports from the new export-oriented producers in the developing countries, particularly those in the Arab world. Up-to-date reduction figures of major petrochemical products in Japan are not available.

Table 4.2. Utilization rates for ethylene plants in Western Europe, Japan and the United States of America

(Percentages)

	Western Europe	Japan	United States
1974	86	80	100
1978	76	75	78
1982	64	60	63
1984	84	98	85
1986	91	98	93

Source: Data compiled by the Stanford Research Institute.

Table 4.3. Estimated capacities and production for basic olefins in Western Europe, Japan and the United States

(Millions of tons/year)

	1986	1988	1990
Western Europe			
Capacity	13.5	13.8	14.0
Actual production	12.7	12.9	13.0
Japan			
Capacity	5.8	6.0	6.9
Actual production	5.7	5.9	6.7
United States			
Capacity	15.7	15.8	15.8
Actual production	14.8	15.1	15.4

Source: Data compiled by the Stanford Research Institute.

Capacity reductions of the Western European petrochemicals and plastics industry (23) are tabulated in table 4.4 below.

Table 4.4. Capacity reductions of Western European petrochemicals and plastics industry

	Plant closures since 1980						
	Ethylene	LDPE	HDPE	EO/MEG	PVC	PP	PS
United Kingdom	910	210	50	140	460	140	80
Benelux[a/]	470	300	50	80	45	-	135
France	590	285	90	130	150	-	45
Germany	1,640	320	450	70	160	45	100
Italy	590	420	130	60	410	160	170
Others	240	65	20	25	110	-	30
Total	4,440	1,600	790	505	1,335	345	560
Percentage achieved	87	76	73	68	87	-	77

Source: Data compiled by the Conseil Européen des federations petrochimiques.

a/ Belgium, the Netherlands and Luxembourg in association as a regional economic group.

These cut-backs have had an effect on employment in various regions of Europe.

During the restructuring process, the number of producers in Western Europe was reduced considerably for most products, as is indicated in table 4.5.

Table 4.5. Number of producers in Western Europe, 1980/1986

	1980	1986
LDPE	21	15
LLDPE	-	8
HDPE	20	15
Polypropylene	18	16
Polyvinyl chloride	24	17
Polystyrene	15	15
ABS	13	10

Source: Data compiled by the Conseil Européen des federations de petrochimiques.

It should be pointed out that a reduction in the number of producers for the various products leads to the idea of more specialization in products production process, which in turn will almost certainly result in their gaining an even greater grip on marketing activities. This type of specialization can be considered to be a sure way towards monopolization. Even though this can be viewed as an economic necessity, the fact that this is an indication of the forms of co-operation between traditional producers in their attempts to continue to control markets cannot be ignored. In addition to pursuing a process of full integration, these producers have co-operated in the establishment of joint production facilities, joint transportation grids and terminals, as well as joint sales organizations with a profit equalization plan for partners. Recent examples of closures/joint ventures/portfolio swaps include (24) the following:

(i) BP/Atochem-polypropylene joint venture (Appryl);
(ii) Phillips withdrawal from Petrochim and polyolefins;
(iii) ICI/Enichem PVC into EVC (European Vinyls Corporation);
(iv) Atochem withdrawal from PO manufacture in favour of Acro;
(v) Proposed Enichem/Montedison deal;
(vi) EC/BP rationalization.

There were also a number of well-known portfolio exchanges of the early 1980s (e.g. BP/ICI - PVC/LDPE: the merging of the PVC interests of Shell/Akzo into Rovin and those of DSM/EMC into LVM).

Moreover, intensive trade activities in petrochemicals among the developed countries was basically promoted by the petrochemical producers. There is no doubt that these trading activities form a series of blocks against the new

petrochemical/fertilizer contenders who have attempted to infiltrate international markets, especially in the developed regions. It should be stated, however, that while less efficient plants were shut down, plans were also made to establish new plants as was indicated by the Association of Petrochemical Producers in Europe (26). Table 4.6 shows the plants that were shut down, opened and planned.

Table 4.6.. Ethylene/ethylene derivatives/polymers European plant closures 1980-1986

(Thousands of tons)

	Ethylene	LLDPE	LDPE	HDPE	EO	PVC	PP	PS
Capacity end 1980	18,185	-	2,707	2,758	2,200	5,954	2,521	2,363
Plant closed	5,780	--	1,638	460	490	1,179	230	317
Percentage of capacity	32	-	24	17	22	20	9	13
Plant opened	1,255	800	--	-	-	150	630	230
Net closed (percentage)	25	-	24	17	22	17	(15)	4
Proposed additions	200	600	-	-	-	200	325	90

Source: Data compiled by the Association of Petrochemical Producers in Europe.

The restructuring process is not yet complete. It seems that the remaining overcapacity, particularly in downstream ethylene derivatives will be reduced further in the future.

At the same time as traditional producers were undertaking restructuring measures, all oil-importing countries were making serious attempts to reduce their energy consumption, with the aim of becoming less dependent on the imports of OPEC crude oil. These attempts were a definite success: from 1980, the loading of West European refineries (20) has oscillated at around the 60 per cent level, although refining capacities were drastically reduced in order to cope with the lower demand. The volume of oil traded in 1984, as compared with that of 1973, has changed relatively little, as can be seen from the fact that the volume of global exports shrunk by 23 per cent.

To sum up, the petrochemical industry during the period 1973-1985 can be characterized as follows:

(a) Prior to 1973, crude oil and feedstocks were abundant and available at very low prices;

(b) After the price correction of 1973 by which prices of crude oil rose from about $US 3 to 10/bbl, there were temporary shortages and restrictions on feedstocks, and prices were much higher;

(c) The petrochemical industry went through a period of adjustment, during which stabilization was achieved once again. During this period, feedstock prices were higher, while the demand for petrochemicals was lower than that prior to 1973. These factors forced the industry to curtail its production, and as such to create a surplus capacity that affected the overall profitability of the petrochemical industry;

(d) The second increase in crude oil prices hit the international economy, including the petrochemical industry, much more severely. The world economy entered into recession during 1981 to 1982, causing huge losses for practically all the industrial sectors related to crude oil such as refining, petrochemicals and energy-intensive industries;

(e) The recession, coupled with the low demand for petrochemicals and the high price of both feedstocks and products, forced traditional suppliers to start the restructuring process;

(f) Oil-importing countries began to make serious efforts to conserve energy. These efforts were successful, as the production of OPEC crude oil was out by about 40 per cent. This led to an over-supply situation and, consequently, to a drastic decrease in crude oil prices.

4.1.2. The petrochemical industry 1985-1987

As was stated above, the drastic decline in the demand for crude oil, combined with excessive global production led to an increasing over-supply situation. As a result, in 1986 crude oil prices fell to less than $US 10/bbl on a spot basis, their lowest level since 1973. This fall in prices took place at the same time as the United States exchange rate also fell to its lowest level against the major international currencies. Figure 4.2 indicates the deutsche mark (DM)/$US exchange rates during the period 1981 to 1987.

The combined effect of the decline in both crude oil prices and the US dollar exchange rate has resulted in noticeable improvements in the profitability of the petrochemical industry. This is particularly so in the oil-importing countries such as Western Europe, where oil producer prices are now below the average levels of the period 1974-1978. This, of course, has resulted in a drastic decrease of petrochemical feedstock prices, as is reported (23) in figure 4.3 below.

Figure 4.3 clearly indicates that in 1985/1986 the prices of naphtha, which constitutes the main feedstock for European petrochemical crackers, were lower than those those in 1973/1974.

These new conditions have created an optimistic and encouraging outlook for the petrochemical industry; they are characterized by the following;

Figure 4.2. Development of the DM/$US exchange rate

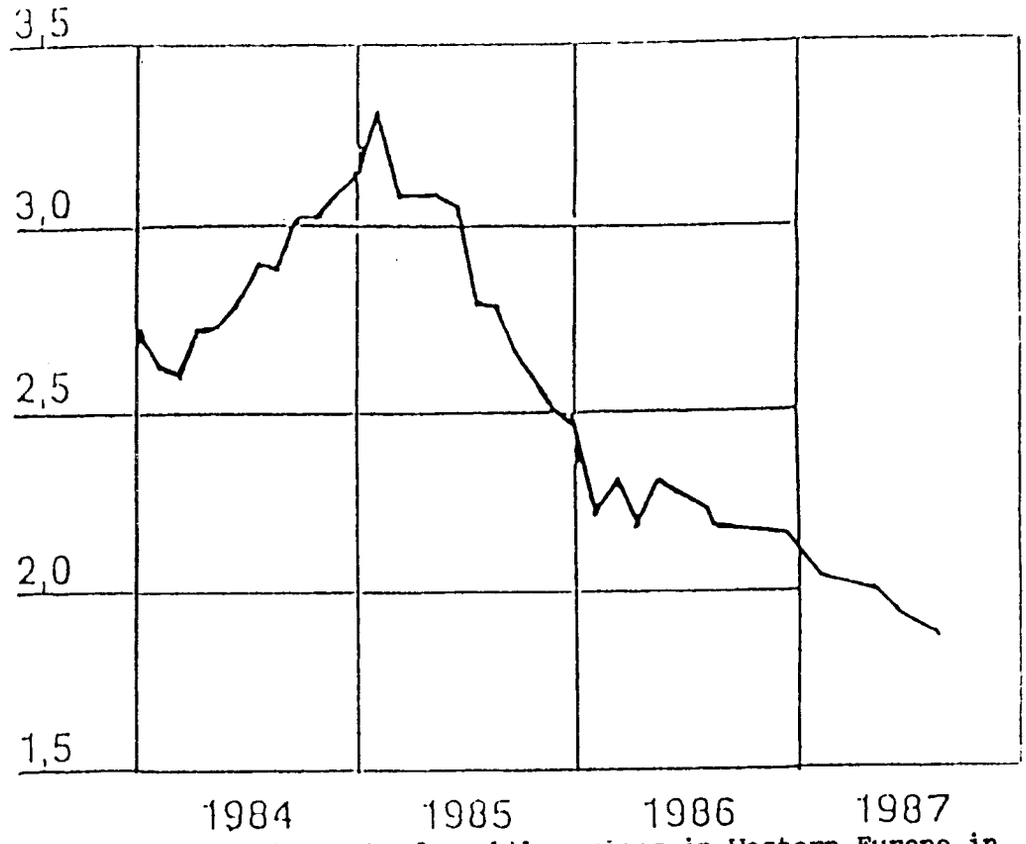
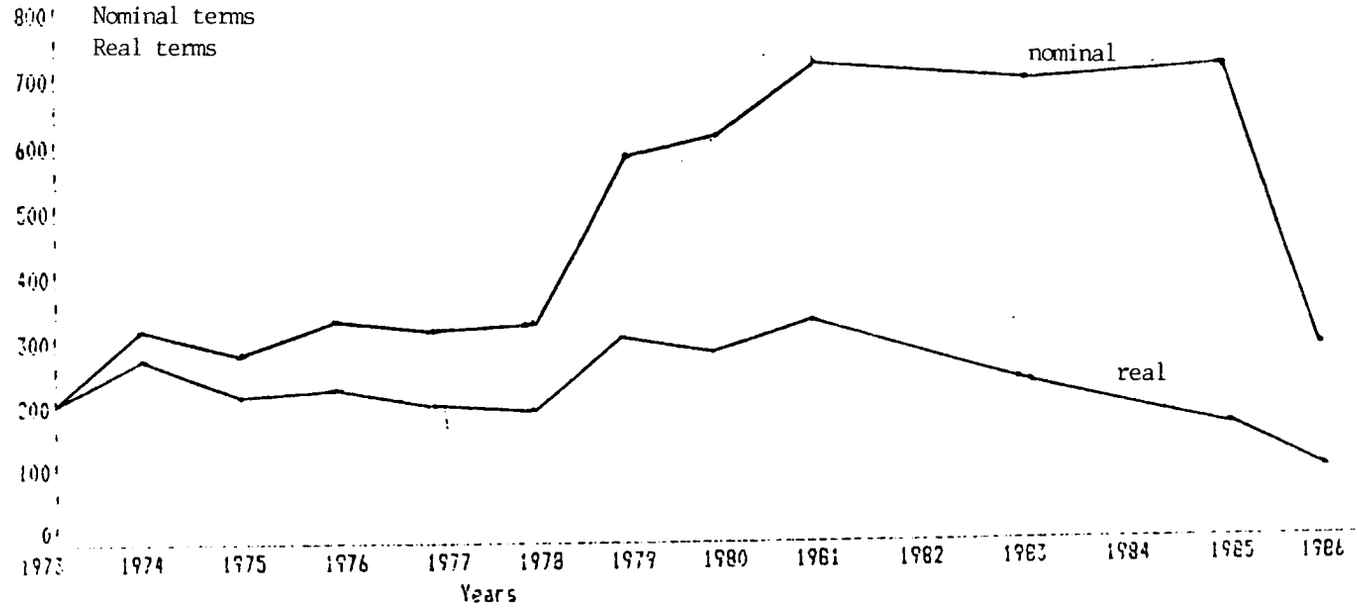


Figure 4.3. Development of naphtha prices in Western Europe in nominal and real terms



Source: Data compiled by the Conseil européen des federations des petrochimiques.

(a) An abundance of different varieties of raw materials, without restrictions, at relatively low prices as compared with the previous 13 year period. It has been pointed out that the advantage of the variable costs of manufacture, hitherto enjoyed by the new producers, as compared with most European producers, has been reduced drastically. Furthermore, in European markets, the new producers' margin over variable costs (which include freight are now lower than those of West European naphtha-based producers;

(b) The impact upon the United States of America is not necessarily the same as that in Europe, as ethylene production in the latter is primarily based on ethane, and not naphtha. An assessment of this impact can only be made when ethane prices are settled.

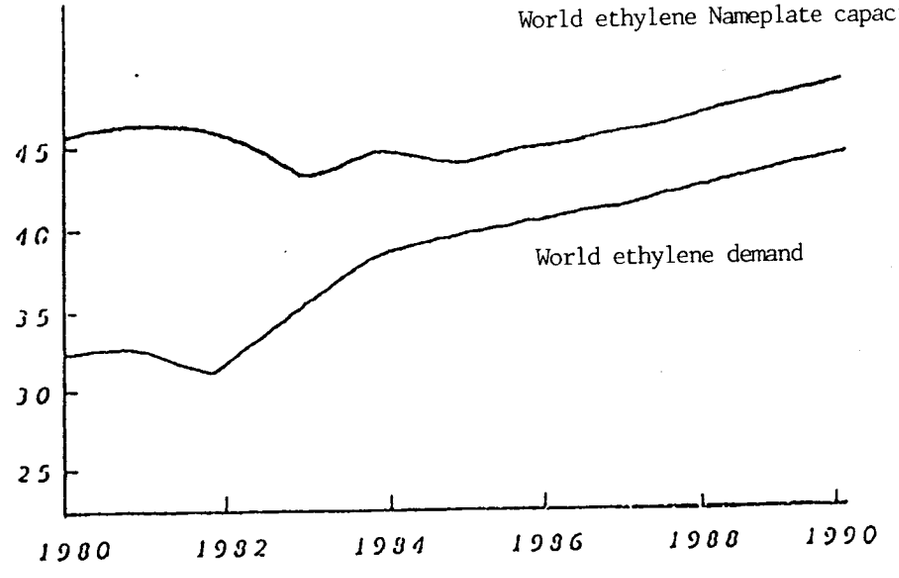
In Japan, however, there appears to be a tendency to reactivate the use of naphtha from the country's own refineries, possible at the expense of imported products from new producers;

(c) Modest increase in the demand for international petrochemicals in Western Europe. The overall volume of petrochemicals increased by 2 per cent in 1986 over figures for 1985.

(d) Petrochemical restructuring has been undertaken as was indicated previously in this report;

(e) The high level of production capacity utilization. Figure 4.4 presents ethylene demand/supply through 1990. It is clear that the demand/supply relationship has greatly improved in the 1980s, owing to restructuring, lower cost feedstocks and a corresponding increase in demand. The situation, as predicted in figure 4.4, is expected to remain stable, possibly through the 1990s, barring any unexpected upheavals in the world economy;

Figure 4.4. World ethylene demand/supply through 1990



Source: Data compiled by the Stanford Research Institute.

(f) The decrease in the US dollar exchange rate will, in theory, promote United States petrochemical exports to international markets at the expense of both European and Japanese producers, as well as the newcomers from the developing countries, including Arab petrochemical companies.

It should be noted, however, that though the petrochemical industry appears to be in a much better condition than in the early 1970s, it is still far from reaching safe ground and stability. This is because, in addition to the arrival of new producers on the scene, capacity surplus in a few petrochemical products still exists. As such, further restructuring and adjustment is still needed by traditional producers, especially for those plants that have been operating longer than their theoretical useful life. The Association of Petrochemical Producers in Europe reported that, although the major part of necessary capacity adjustment for European petrochemicals and bulk plastics has been achieved, a 10 to 20 per cent overcapacity still exists and must be eliminated before a stabilized market can be achieved.

It is clear from the above that traditional producers have successfully utilized the chain process of basic petrochemicals (creating the captive market for these products), following the process all the way through in order to produce the end-product. This process of integration was employed not only to upgrade value-added, but also to guarantee a stable and continuous outlet for the marketing of their products. In the next section, attempts will be made to discuss the need for Arab petrochemical companies to invest further in the downstream area and to identify suitable projects, thus creating the desired marketing outlets for the different Arab products.

4.2. Impact of marketing issues on future investment

As can be deduced from the previous sections, skillful marketing activities will determine the success of Arab petrochemicals plants. In the light of the marketing difficulties and obstacles that have been encountered by Arab petrochemical products in the international markets this would definitely appear to be the case. In future, it is anticipated that the obstacles involving all types of protectionist policies that face Arab petrochemicals will grow bigger and stronger in the markets of developed regions. It has already been stated that it is axiomatically accepted that capability in marketing and selling is more important than the cost factor, because any commodity, however expensive, can be marketed provided that the right methods in the art of marketing are employed.

The restructuring of the petrochemical industry in the developed regions started a few years ago, and successful results have been achieved. This is because the present progress towards a supply/demand balance across a range of petrochemical products, gives traditional producers grounds for having more confidence and optimism in the industry than they have had for many years. Nevertheless, much remains to be accomplished. The Association of Petrochemical Producers in Europe (24) has declared that:

"For most products, there are still too many producers and the asset base is aging. Rationalization and restructuring must therefore move to a new emphasis on consolidation and refurbishment, in addition to capacity closure where this remains appropriate."

Regarding the useful life or age of a plant, there is always an economical time-limit beyond which a profitable operation becomes doubtful. For example, the normal life of an ethylene cracker is usually calculated at around 10 years, but, with constant upgrading and regular maintenance, the life span can be extended. Nevertheless, the economic time-limit that involves the number of times an old plant can be stretched, renovated and have improved technology introduced must be considered and observed.

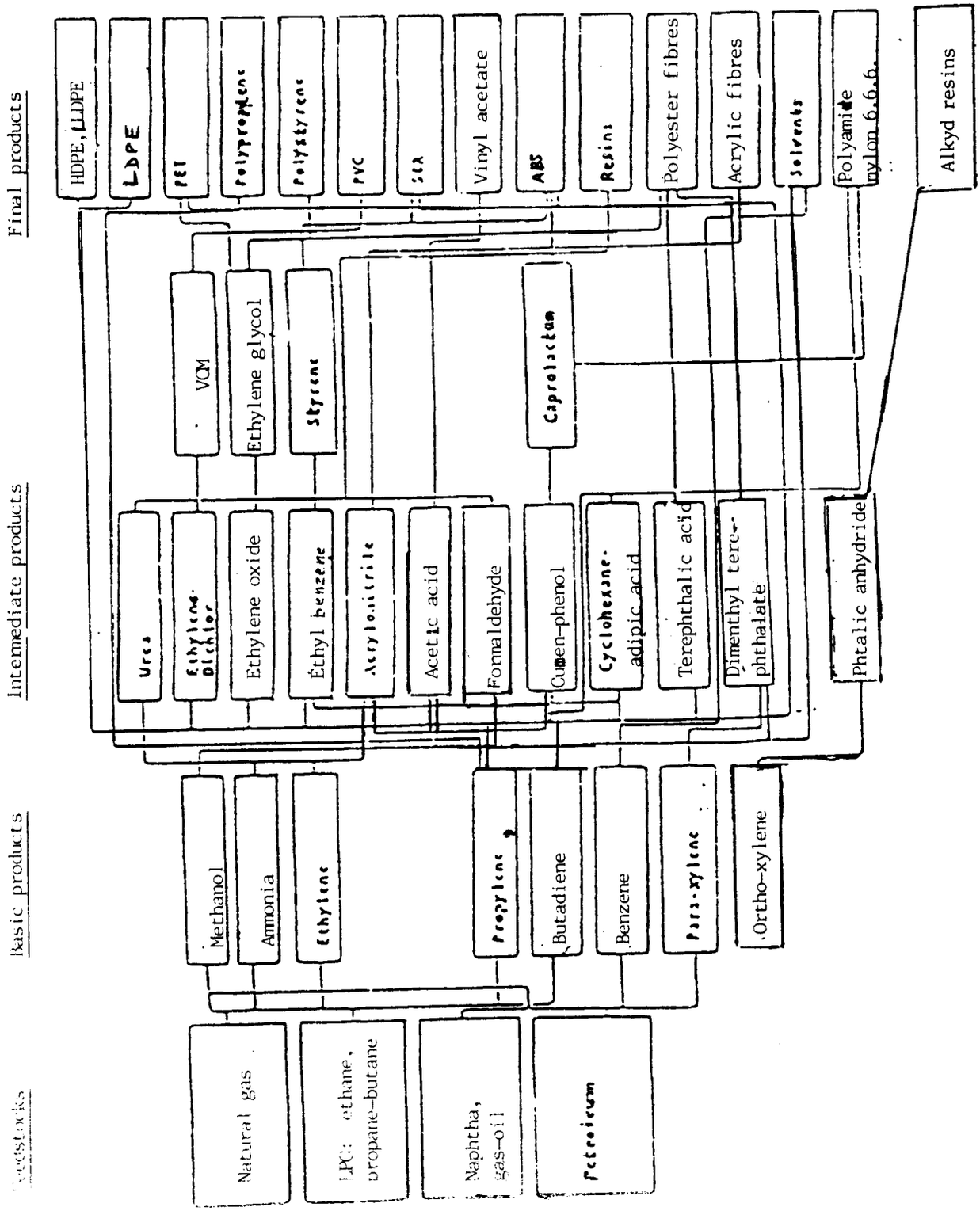
In Europe, petrochemical plants are aging as 95 per cent of ethylene capacity is already more than five years old, 65 per cent is more than 10 years old and 50 per cent is more than 15 years old. Basically, the same applies to Japan and the United States. Ichikawa and Koike (27) reported in 1980 that 23 per cent of ethylene capacity in Japan was built before 1966, and about 70 per cent was constructed during or before 1970.

It must be assumed that similar aging conditions exist for most of the other petrochemical products. Therefore, there seems little doubt that main producers will be planning to renew or establish replacement plants in industrialized countries, or perhaps in countries where raw materials are available to guarantee the continuity of supply. This is unless other producers can pre-empt them by establishing sufficient plants to provide the anticipated deficit in the various products.

As was stated previously, major producers have embarked on integrating their petrochemicals horizontally, as well as vertically. They have established additional petrochemical plants to process their basic materials further in order to produce intermediate and/or end-products. This is normally carried out to create a stable outlet for basic and intermediate products, as well as to upgrade the value-added of the chemicals involved. Figure 4.5 presents production relationships in the petrochemical industry that indicate various possibilities for the integration process.

With Arab petrochemical plants already on stream and already encountering major difficulties in marketing manufactured products in international markets, it is of paramount importance to consider integrating this petrochemical industry. As is the case with other producers, this will create some appropriate stable outlets for Arab products, and therefore enhance their marketability. An integration process such as this should be geared so that the end-products produced will satisfy local demand, and/or will be exported to international markets. The production of end-products to meet local demand will no doubt minimize imports from foreign markets. However, the direction of the integration process needs to be carefully selected to avoid the situation whereby new outlets for basic/intermediate petrochemicals are established, but the producer finds he has no market for his end-products. This is where co-operation to achieve a single Arab market becomes vital.

Figure 4.5. Production relationships in the petrochemical industry



4.2.1. Criteria for identifying future products to enhance the marketability of existing products

The process of identifying products and/or a group of products for investment purposes, with the aim of enhancing the marketability of existing products is not a simple one. A rigorous identification scheme requires:

(i) Accurate analysis of the currently produced products in order to determine their quantities, types and, of course, the availability of each one;

(ii) Identification of products that could be produced by utilizing the existing one as the main feedstock, or as one of the required raw materials. In the latter case the other feedstocks, required should also be identified and their availability should be established;

(iii) A detailed market study should be carried out to determine local Arab consumption as well as international demand/supply. Such a survey will help in reaching a decision as to whether the project will be geared to satisfy the Arab market only, or if it will be export-oriented. If it is to be the export-oriented type, the possible difficulties that could be encountered on entering international markets must be carefully considered, as is the case with products produced currently.

The above-mentioned steps are both time- and effort-consuming and, indeed, very costly to implement. Therefore, in view of the nature and scope of the present study, other preliminary methods that only depend on available information, will be utilized in order to achieve the sound guidelines needed to identify certain suitable products which could enhance the marketability of existing products, as will be indicated later. This implies that only products that require a number of available products as raw materials should be considered. But the inter-linkage nature of petrochemical products, as well as the variety of the required feedstocks needed to produce certain products, make it necessary to examine the possibility of establishing certain products mainly for use as raw materials. The methods used are:

(a) An examination of general production relationships in the petrochemical industry or, more specifically, the main petrochemical building blocks and their derivatives. This will clearly indicate the intermediate and/or end-products that could be produced from each of the building blocks.

(b) A review of the available Arab petrochemical demand/supply data and international petrochemical consumption estimates. These two steps will give a clear indication as to the types and nature of the product, and/or group of products that could be considered for investment purposes with the aim of enhancing the marketability of existing petrochemical products, as is outlined below:

(a) Petrochemical building blocks

Petrochemicals are generally classified in terms of basic products, intermediates and finished or end-products. Unfortunately, even with the long

history of the petrochemical industry, confusion and disagreement between authors still arise with regard to identifying certain products in relation to this classification.

One of the characteristics of petrochemicals is the well known fact that, although the total number of products is very large, they are all derived from a relatively small number of basic building blocks. Many petrochemicals can be made from two or more building blocks through the use of alternative processes. On the other hand, a single product can be produced from more than one basic feedstock, but production costs may be different.

Regardless of the existence of odd classifications and a number of basic products that different authors consider to be building blocks, it is generally agreed that the following four products and/or groups of products constitute the basis for the synthesis of the great majority of petrochemicals:

-Ethylene;
-Propylene;
-C4-olefins;
-Aromatics.

These building blocks and the importance of their derivatives to the Arab world economy will be discussed. In addition, the development of these products and their future prospects, as well as the constraints on them will be reviewed.

(i) Ethylene and derivatives

The two main major sources used to produce ethylene were the ethane fraction of natural gas and naphtha from crude oil refineries. After the 1973 crude oil price increase, research and development efforts by the major producers resulted in other feedstock alternatives with suitable process flexibilities being added to produce ethylene, as is indicated (29) in table 4.7.

Table 4.7. Feedstock use for olefins (1985) (29)

(Percentage)

	Naphtha	Propane	Ethane	Other	Total
Western Europe	86	9	5	0	100
United States	23	22	55	0	100
Latin America/ Canada	38	2	57	2	100
Middle East/ Africa	11	0	72	17	100
Asia/Pacific	86	14	0	0	100
Japan	93	7	0	0	100
Total	55	13	31	0	100

The ethylene industry developed in the Arab world is based mainly on the ethane separated in natural gas liquid plants. Figure 4.6 shows the ethylene-based products chart.

(ii) Propylene, C4-olefins and aromatics

Figures 4.7 and 4.8 indicate the derivatives of propylene, C4-olefins and aromatics. It is important to note that at present the Arab world has no aromatics or butadiene complexes that could provide the main raw materials required to produce end-products such as synthetic rubbers, polyesters and acrylic fibres. Therefore, the production of these end-products in any downstream development scheme is not feasible at the present time.

Many previous plans were drawn up to produce aromatics and to establish naphtha-based olefin plants, but as yet these plants have not been implemented. It is reported that a 170,000 metric tons/year propylene plant is under construction in the Libyan Arab Jamahiriya, and an 80,000 metric tons/year polypropylene plant is being planned in Kuwait.

Recently, attempts were made by some specialized organizations in the Arab world, e.g. AIDO, GOIC and OAPEC to reactivate the establishment of an aromatics complex and some naphtha-based olefin plants. Among these attempts are the study on a petrochemical refinery and the one currently being undertaken by AIDO on aromatics. The petrochemical refinery study was based on the utilization of crude oil as the main raw material. The aim is to provide the feedstocks, including naphtha cracker by-products for the production of polypropylene, butadiene, synthetic rubbers and aromatics and their derivatives.

(b) Petrochemicals supply/demand data

The estimated supply/demand data for the Arab petrochemical industry (12) are tabulated for 1990 and 1995 respectively in tables 4.8 and 4.9. In addition, tables 4.10 and 4.11 show the estimated world petrochemicals consumption by region and by product for 1985 and 2000, respectively. These last two tables are basically an extension to table 2.8, as they include aromatics products and their derivatives, as well as the petrochemicals consumption forecast for all products through the year 2000. These figures are only estimates and, therefore, their accuracy limits cannot easily be defined. In fact, variations of figures for a single product in these tables do exist. Nevertheless, they give quite a realistic picture of the petrochemical products that are invaluable in helping to plan the future activities of this industry.

Figure 4.6. Petrochemicals from ethylene

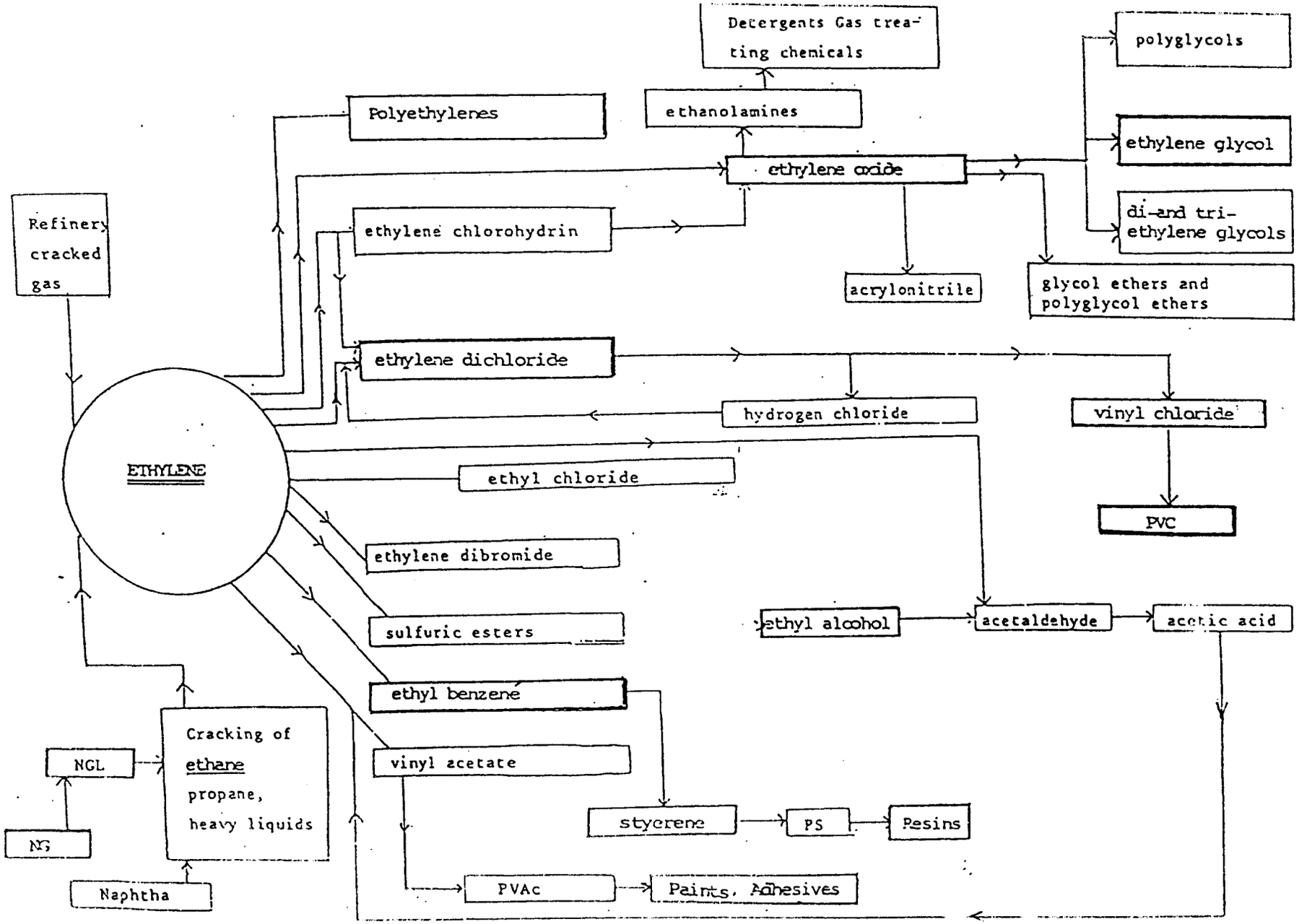


Figure 4.7. Petrochemicals from propylene and C4 hydrocarbons

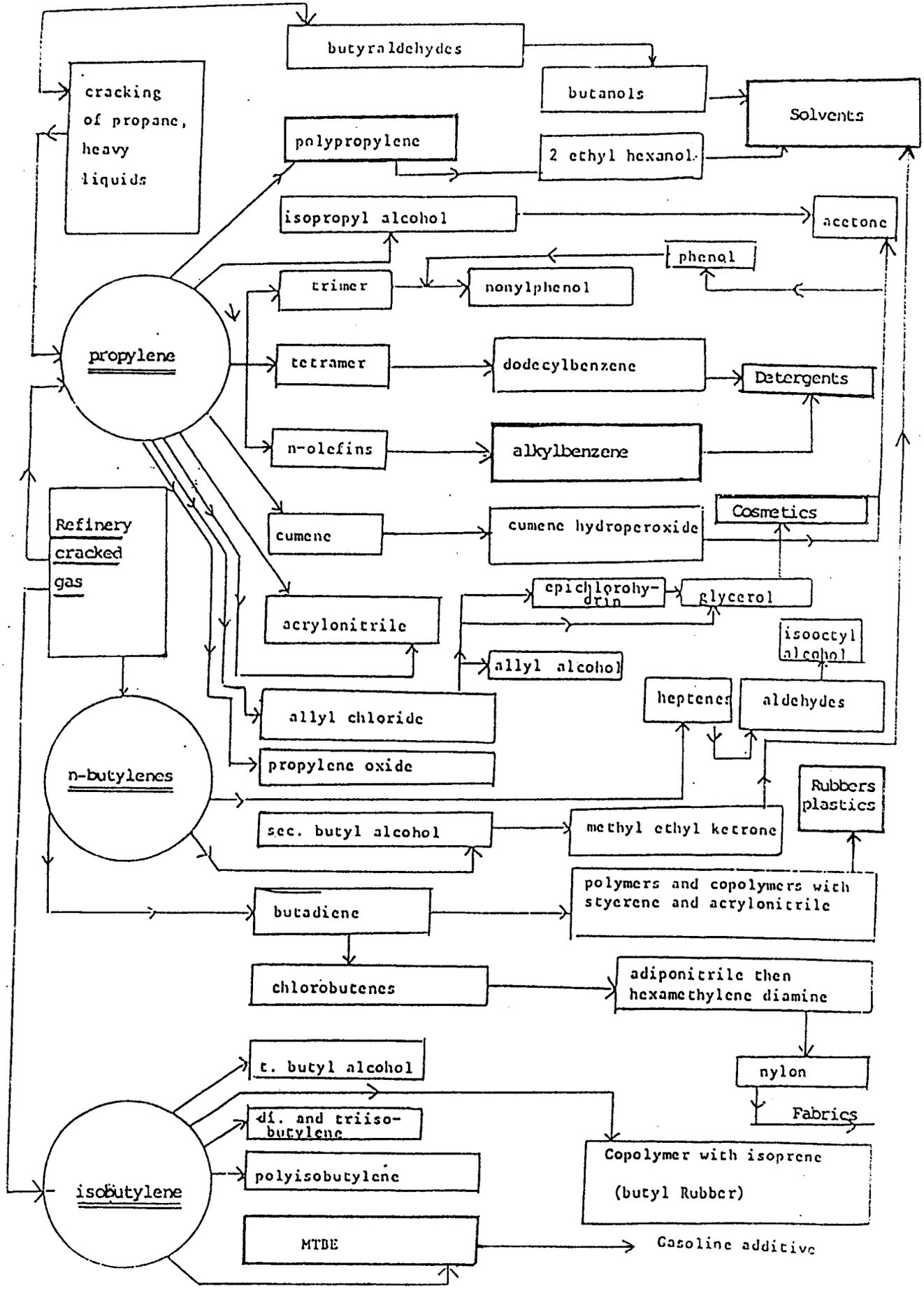


Figure 4.8. Petrochemicals from aromatics

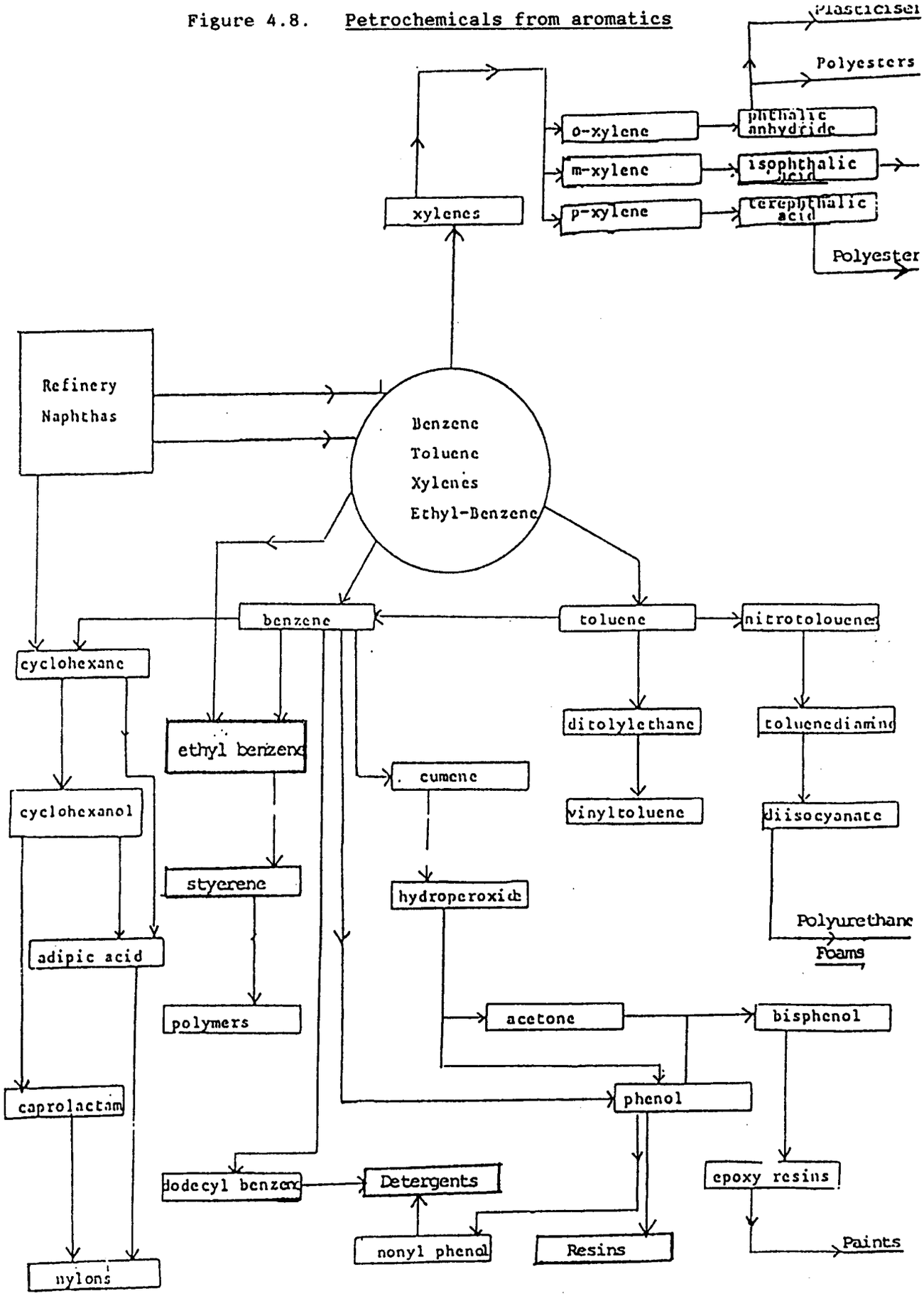


Table 4.8. Demand-capacity balances for the Arab petrochemical industry, 1990
(Thousands of metric tons)

Product coverage	Demand	Design capacity	Surplus (deficit)
Basic products			
Ethylene	2,118	2,471	353
Propylene	163	220	57
Butadiene	89	255	166
Butene-1	80	104	24
Benzene	56	494	438
O-xylene	18	0	(18)
P-xylene	127	38	(89)
Methanol	359	2,340	1,981
Intermediate products			
EDC	0	729	729
EG	46	550	504
Styrene	71	395	324
VCM	525	525	0
Maleic anhydride	0	0	0
DMT	202	50	(152)
Phthalic anhydride	15	0	(15)
Ethyl benzene	453	453	0
Vinyl acetate	61	0	(61)
Acetic acid	32	0	(32)
Propylene glycol	0	0	0
Ethylene oxide	410	390	(20)
Cyclo hexane	0	0	0
Propylene Oxide	65	65	0
2. Ethyl hexanol	27	0	(27)
Caprolactam	0	0	0
Final products			
PE	864	1,243	379
PP	291	160	(131)
PVC	705	520	(185)
PS	236	70	(166)
PU (raw materials)	96	..	(96)
PV acetate	60	6	(54)
Polyester	320	129	(191)
Acrylic	92	0	(92)
Nylon	131	0	(131)
SBR	88	0	(88)
PBR	23	0	(23)
Butyl rubber	31	0	(31)
LAB	141	130	(11)
Unsaturated polyester	61	0	(61)
MTBE	...	500	...

Source: Data compiled by the Gulf Organization for Industrial Consulting.

Note: Design capacity figures are based on the assumption that owing to the recent rescheduling of implementation plans by a number of Arab countries, total expected capacity will not be achieved by 1990.

... Data unavailable.

Table 4.9. Demand-capacity balances for the Arab petrochemical industry, 1995
(Thousands of metric tons)

Product coverage	Demand	Design capacity	Surplus (deficit)
Basic products			
Ethylene	2,642	2,722	80
Propylene	284	320	36
Butadiene	117	295	178
Butene-1	80	104	24
Benzene	994	519	(475)
O-xylene	18	0	(18)
P-xylene	170	78	(92)
Methanol	366	3,165	2,799
Intermediate products			
EDC	0	839	839
EG	76	602	526
Styrene	81	720	639
VCM	525	595	70
Maleic anhydride	0	0	0
DMT	270	100	(170)
Phthalic anhydride	15	0	(15)
Ethyl benzene	827	827	0
Vinyl acetate	89	12	(77)
Acetic acid	45	0	(45)
Propylene glycol	0	0	0
Ethylene oxide	449	430	(19)
Cyclo hexane	0	0	0
Propylene Oxide	110	110	0
2. Ethyl hexanol	27	0	(27)
Caprolactam	24	0	(24)
Final products			
PE	1,269	1,589	320
PP	396	278	(118)
PVC	874	520	(354)
PS	284	70	(214)
PU (raw materials)	148	0	(148)
PV acetate	87	6	(81)
Polyester	428	212	(216)
Acrylic	124	37	(87)
Nylon	180	22	(158)
SBR	116	45	(71)
PBR	30	25	(5)
Butyl rubber	42	0	(42)
LAB	171	130	(41)
Unsaturated polyester	95	0	(95)
MTBE	...	546	...

Source: Data compiled by the Gulf Organization for Industrial Consulting.

Note: ... Data unavailable.

Table 4.10. World petrochemical consumption by region and product, 1985
(Old trend, thousand of metric tons/year)

Product	North America	Western Europe	CPE Europe	Japan	Other Developed	Latin America	N. Africa + Middle East	South Asia	South East Asia	AFRICA (South Sahara)	World Total
OLEFINS											
ABS	1035.7	306.6	.0	441.2	22.4	65.1	9.3	24.2	220.6	.0	2125.2
Acetic Acid	1422.6	845.7	.0	469.8	22.5	3579.2	41.7	371.1	325.5	.0	7078.0
Acrylonitrile	1209.5	939.8	88.4	1105.9	5.6	263.1	.0	33.7	462.2	.0	4108.2
Ammonia	35653.6	12972.4	23114.9	.0	1706.5	8517.4	2496.5	29060.2	.0	331.8	113853.3
Butadiene	3079.5	1127.5	135.0	1156.2	257.1	366.6	.0	64.4	446.0	.0	6633.9
Ethyl Benzene	2888.3	2859.2	911.6	2468.8	193.8	563.5	.0	48.8	435.1	.0	10368.9
Ethylene	20420.9	10655.0	1380.8	4798.2	5527.1	5452.2	185.8	385.2	2043.1	.0	50848.1
Ehtylene Dichloride	7361.9	6230.7	499.9	2757.2	275.3	835.9	167.4	125.6	483.4	.0	18737.1
Ethylene Glycol	3703.2	719.8	66.2	1114.3	361.9	224.7	8.8	41.2	767.0	.0	7006.9
Ethylene Oxide	4573.4	1315.8	145.0	1494.8	373.9	223.5	.0	46.5	248.6	.0	8421.5
Formaldehyde	6313.7	3515.7	471.8	2216.3	149.5	721.6	47.9	260.4	1794.9	.0	15491.7
HDPE	2767.0	1349.7	400.4	615.0	242.2	591.0	299.9	127.2	864.6	.0	7256.8
LDPE	4010.0	3834.0	1670.0	1113.0	416.0	1325.0	473.0	217.0	1235.0	.0	14293.0
Methanol	4583.0	3064.0	3034.0	2802.0	77.0	4626.0	51.0	521.0	1379.0	.0	20137.0
PET	2898.5	721.7	667.4	1192.1	1373.9	546.3	49.5	124.1	1909.8	8.1	9491.3
PVC	3221.2	3724.7	1375.8	1394.8	423.3	1033.3	402.8	168.2	2145.6	.0	13809.7
Polypropylene	14468.2	1143.5	295.0	815.4	212.8	477.2	82.2	47.0	1318.8	2.1	18862.2
polystyrene	1204.0	1631.2	586.9	772.8	112.2	513.0	112.2	27.9	879.3	.0	5839.6
Propylene	37831.8	5750.7	381.8	5601.2	308.4	966.0	22.8	102.2	1248.6	.0	52213.5
SBR	2768.7	1150.1	1466.9	860.9	569.0	461.6	40.0	45.1	923.2	.0	8294.4
Styrene	2089.9	2592.2	879.9	2190.6	194.1	730.8	.0	42.4	831.1	.0	9551.1
VCM	3536.9	4126.3	1949.5	1609.6	363.9	859.4	96.9	121.4	2145.6	.0	14809.3
Vinyl Acetate	662.6	478.3	.0	441.7	18.3	2527.7	36.9	19.5	499.7	.0	4684.6
Aromatics											
Acrylic Fibres	409.3	433.0	235.5	654.2	.0	52.8	89.2	24.2	317.5	.0	2215.7
Benzene	5076.8	4426.9	1612.1	4718.1	.0	850.5	150.5	294.6	708.2	.0	17837.6
Caprolactum	485.2	165.2	805.9	1166.7	.0	188.8	21.2	.0	418.9	.0	3252.9
Cumene - Phenol	1353.9	577.5	646.0	727.9	.0	.0	.0	.0	.0	.0	3505.2
Dimethyl Teraphtalate /Teraphtalic Acid	5986.0	66.3	.0	1988.7	.0	514.6	50.9	.0	1119.3	.0	9725.9
Para - Xylene	6715.6	723.0	844.3	3138.6	.0	504.8	25.6	.0	403.0	.0	12354.8
Polyamids (Nylon)	447.6	122.7	391.1	53.3	78.8	130.5	37.8	67.5	291.3	.0	1620.5
Polyester Fibres	2049.6	165.9	266.8	524.1	36.6	182.0	113.7	102.1	712.8	.0	4153.6
Regional Total	190227.8	77742.9	44532.5	50403.1	13322.0	37902.0	5113.3	32513.7	26578.2	342.0	478677.4

Source : Econometric Research Data Files.

Table 4.11. World petrochemical consumption by region and product, 2000
(Old trend, thousand of metric tons/year)

Product	North America	Western Europe	CPE Europe	Japan	Other Developed	Latin America	N. Africa + Middle East	South Asia	South East Asia	AFRICA (South Sahara)	World Total
OLEFINS											
ABS	2077.6	712.2	.0	1294.3	37.9	184.9	16.6	62.6	1010.4	.0	5396.5
Acetic Acid	1938.0	1520.0	.0	672.6	32.8	7626.3	68.5	650.2	676.7	.0	13518.7
Acrylonitrile	2117.7	2131.1	140.9	3303.0	9.5	747.1	.0	62.2	1715.9	.0	10247.3
Ammonia	62426.8	29497.1	36837.6	.0	2884.1	24181.8	5193.5	74547.5	.0	481.3	236049.2
Butadiene	5060.3	1926.0	210.2	3153.1	391.7	824.8	.0	140.8	1437.8	.0	13147.6
Ethyl Benzene	8825.7	4758.3	1732.4	6916.5	362.7	1533.3	.0	90.7	1964.4	.0	24184.0
Ethylene	37357.2	15810.6	3146.2	8947.6	8039.5	12614.8	436.5	849.0	6973.8	.0	94183.2
Ethylene Dichloride	14041.8	9244.1	1046.3	5170.0	510.3	2168.0	409.2	258.6	1365.1	.0	34153.3
Ethylene Glycol	6048.9	1106.6	141.9	3536.8	523.3	546.6	17.0	91.8	3167.2	.0	15178.0
Ethylene Oxide	7457.9	2022.9	311.0	4744.6	540.6	543.7	.0	103.6	1026.5	.0	16760.7
Formaldehyde	12665.4	8165.2	751.8	6502.1	252.7	2048.6	85.2	674.4	8220.0	.0	39365.3
HDPE	6568.8	2530.3	1074.2	1575.6	477.5	1693.3	717.4	269.9	3715.3	.0	18562.4
LDPE	7497.0	6347.0	3443.0	2350.0	769.0	3428.0	1106.0	481.0	4762.0	.0	30183.0
Methanol	7029.0	6226.0	4935.0	8721.0	127.0	9307.0	102.0	1191.0	5326.0	.0	43544.0
PET	4607.1	1110.6	1431.0	3763.9	1986.1	1328.8	95.9	281.0	7881.8	11.7	22517.7
PVC	6144.1	5526.2	2879.9	2615.5	734.6	2680.1	934.6	345.1	9037.1	.0	30997.9
Polypropylene	24453.5	8234.5	705.7	1787.2	445.6	1409.5	196.1	113.8	5678.0	0.0	38067.6
Polystyrene	2922.4	2500.8	1153.1	1745.7	212.0	1384.1	272.2	51.8	3713.8	.0	13955.9
Propylene	64459.2	13065.9	791.4	17343.1	642.2	2779.6	47.3	227.9	5376.4	.0	105038.1
SBR	4277.6	1390.1	2270.2	2331.3	651.2	953.6	98.7	84.0	2560.6	.0	14797.9
Styrene	4939.0	4313.9	1672.2	6137.1	363.4	1983.7	.0	78.8	3752.6	.0	23245.8
VCM	6745.2	6122.0	4060.6	3018.1	674.4	2229.0	236.8	249.7	9037.1	.0	32393.9
Vinyl Acetate	902.6	864.7	.0	632.4	26.7	5385.8	78.4	44.8	1348.9	.0	9284.3
Aromatics											
Acrylic Fibres	613.1	654.0	375.4	2155.0	0.	110.5	180.4	53.4	1155.7	.0	5303.5
Benzene	11010.0	7575.9	3003.0	15130.6	.0	2193.5	369.7	598.5	2972.5	.0	42911.3
Caprolactum	836.5	249.5	1225.9	4057.9	.0	395.0	35.6	.0	1693.9	.0	8614.3
Cumene - Phenol	2473.8	872.1	1348.2	2537.9	.0	.0	.0	.0	.0	.0	7232.0
Dimethyl Terephtalate	10435.9	100.1	.0	6312.3	.0	1076.7	98.4	.0	4648.0	.0	22671.4
/Terephtalic Acid											
Para - Xylene	11707.9	1091.9	1345.6	9962.2	.0	1056.0	49.5	.0	1673.3	.0	26886.3
Polyamids (Nylon)	817.9	185.3	620.3	185.9	115.1	289.7	63.3	153.3	1177.9	.0	3598.5
Polyester Fibers	3573.2	250.6	425.2	1663.5	53.4	330.8	240.6	219.9	2959.8	.0	9707.0
Regional Total	340069.3	181422.1	77121.6	138307.0	21093.3	93766.3	11225.3	82187.2	106171.4	496.1	1011854.5

Source : Econometric Research Data Files.

(c) Review of the petrochemical building blocks and their demand/supply

A review of the charts of the petrochemicals building blocks (figures 4.6 to 4.8), Arab petrochemicals demand/capacity balances (tables 4.8 and 4.9), together with the world petrochemical consumption reveals:

(i) Many products that are not currently produced by Arab petrochemical companies are clearly identified. But, of course, it is not logical or economical to consider a complete vertical and horizontal integration for the industry. Nevertheless, some form of integration should be considered and carefully planned, so as to minimize the competition between Arab plants while increasing their ability to provide a wide variety of different products (e.g. different LDPE or PVC grades). In turn, this would enable more customers to be reached, and at the same time it would project an image of the supply-continuity of Arab petrochemicals. This is an important factor that, if implemented, will enhance the marketability of present products both domestically and internationally.

(ii) As was stated previously, the petrochemical demand/capacity balances indicate the non-availability of an international-size aromatics complex in the Arab world. This has been the main stumbling block for petrochemical diversification in the region. Many plans have been made to establish an aromatics complex in various Arab States, but unfortunately these plans were never implemented.

The most widely-used feedstocks for aromatics and the other products required are produced as by-products of ethylene naphtha crackers. With the exception of the plant in the Libyan Arab Jamahiriya there is no other production in the Arab world. Therefore, the availability of a naphtha cracker is an extremely important factor in aiding the required petrochemicals integration.

(iii) At present, many petrochemical products need to be produced locally in order to meet Arab world demand and, therefore, to replace imported materials. In order to establish projects for these products, the feedstocks and processing technology must first be secured at a reasonable cost. Therefore, it would seem appropriate at this stage to review the main building blocks, the products that can be produced and their related processing technologies.

4.2.2. Main petrochemical and fertilizer products and their process technologies

One of the main sources for this section is the study prepared by the Saudi Consulting House (31) for the Arab Industrial Development Organization, on the Arab petrochemical industry and the prospects for its development, which was completed in April 1983. In addition, various papers (32), (33), (34), (35), (36), (37) and (38) that were presented at the Petkim Seminar, in Aliaga, Izmir, Turkey between 6 and 10 July 1987, were also utilized.

Petrochemical products

The main products, their uses and production technologies are reviewed below.

Ethylene

- Ethylene, which is considered to be the heart of the petrochemical industry, is used as a feedstock to produce:

- Low density polyethylene (LDPE), linear low density polyethylene (LLDPE) and high density polyethylene (HDPE), which are considered to be the most important plastic materials;

- Ethylene di-chloride (EDC), which is used in the production of vinyl chloride monomer (VCM), and which in turn is used for the production of polyvinyl chloride (PVC). PVC is considered to be the second most important plastic material;

- Ethylbenzene, which is produced from ethylene and benzene. It constitutes the main feedstock for the production of styrene, which is mainly used for:

  - The production of polystyrene;

  - The production of synthetic rubber, mainly styrene butadiene (one of the most important synthetic rubbers);

  - The production of unsaturated polyester thermosetting resins. In this operation, other raw materials are also required;

- Ethylene oxide, which is used as a feedstock to produce ethylene glycol and other important chemicals. Ethylene glycol, together with terephthalic acid (TPA) or di-methyl terephthalate (DMT), constitute the main feedstocks required to produce polyethylene terephthalate (PET), which is used for:

  - Polyester fibres;
  - Polyester bottles;
  - Tyre chord made from fibres;

- Acetaldehyde for the production of acetic acid. This is utilized to produce vinyl acetate monomer (VAM) and polyvinyl acetate for the paint industry;

- Ethanol, which is presently produced by SABIC, which has an annual capacity of 281,000 tons;

- Other chemicals. The percentage ratios of ethylene consumption (31) in the main three developed regions in 1979, together with anticipated consumption in 1990, are listed in table 4.12 below.

Table 4.12. Ratio of ethylene consumption in 1979 and 1990 in the three developed regions.

Product	USA		Western Europe		Japan
	1979	1990	1979	1990	1979
LDPE	44.0	50.0	37.8	37.0	26.7
HDPE			13.7	15.2	14.6
PS	7.5	7.4	5.8	5.8	8.7
PVC	12.5	10.7	17.6	17.3	15.7
ED	16.4	17.8	6.1	5.5	13.5
EG			6.1	5.8	9.3
Others	19.6	14.1	12.9	13.4	11.5
Total	100.0	100.0	100.0	100.0	100.0

Source: Data compiled by the Saudi Consulting House.

The available technological processes for the production of ethylene depend on the cracking at high temperatures of saturated hydrocarbons such as ethane, propane, naphtha, gas oil, etc. The different cracking processes are classified as:

- Catalytic cracking, which requires a suitable catalyst;
- Hydrocracking, which requires the availability of hydrogen;
- Steam-cracking, which requires the presence of steam.

Cracking is normally achieved with either low severity, where the operating temperature is less than 800° C or with high severity with a temperature of around 900° C. The different technological processes are characterized by the following:

(i) High flexibility regarding the type of hydrocarbon feedstock used in the process;

(ii) The ability to control the types and quantity of products in the steam cracking operation;

(iii) The production of by-products consisting of high purity materials.

The main ethylene production processes are those of:

- C.E. Lummus - which accounts for approximately 50 per cent of the ethylene production;

- M.W. Kellogg - has 40 plants to its credit, with around 8 million tons per year production capacity;

- Linde uses liquid feedstocks only, and has over 100 plants to its credit with a total production capacity of around 7 million tons per year.

The ethylene yields from some feedstocks by these processes are tabulated in table 4.13 below.

Table 4.13. Ethylene yield from different feedstocks by different processes

Process	Ethane	Pro-pane	n-butane	Full range naphtha	Light naphtha	Atmospheric gas-oil	Vacuum gas-oil
E.C.Lummus	84.0	45.0	44.4	34.4	28.7	25.9	22.0
M.W.Kellogg				35.0		30.0	
Linde				33.1	40.4	27.6	30.3

Source: Compiled from data supplied by the Saudi Consulting House; and Hydrocarbon processing. (November, 1981).

- Other available but older technologies (and/or licensors) include Stone and Webster, C.F. Braun, Humphries and Glasgow, Foster Wheeler and KIT/Technip.

- The new technologies that have been reported are as follows:

  - Super oil cracking SOC technology (32) is a newly developed hydrocracking process that uses fine particles of a catalyst, which are suspended in cracked vacuum oil (see figure 4.9). This process is based on:

    - Conversion as high as 90 per cent;

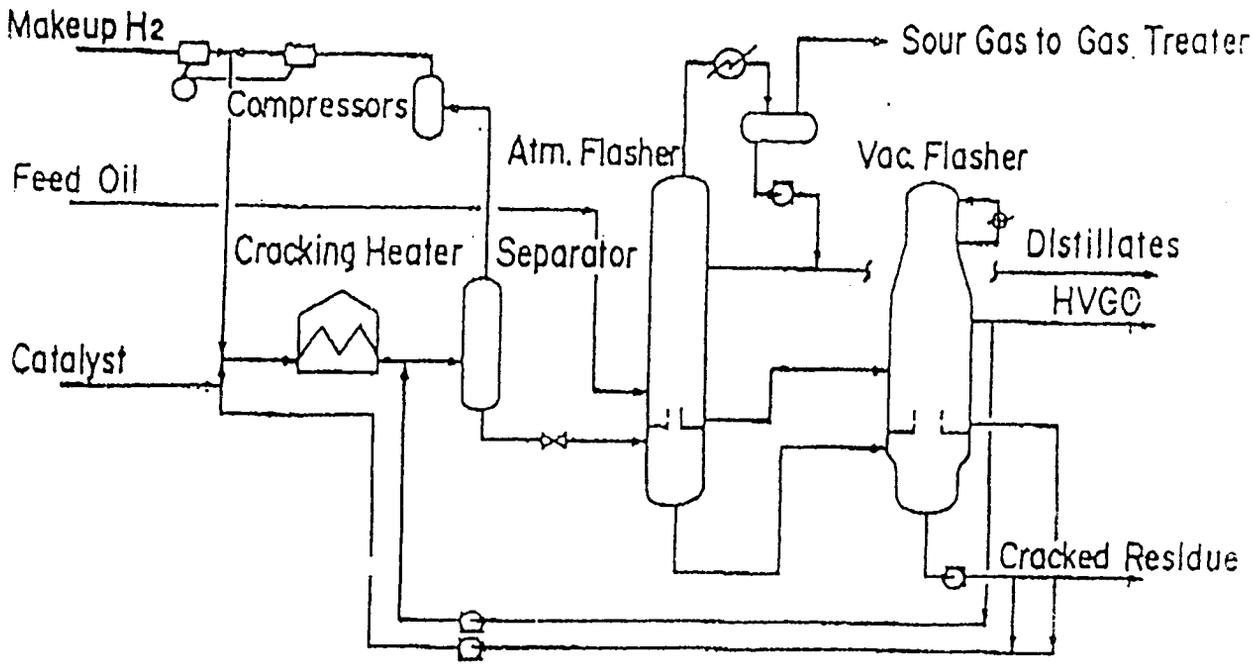
    - A highly active catalyst to prevent coke deposits;

    - A tubular-type reactor to accommodate reaction conditions under high temperatures and pressure.

The hydrotreated vacuum gas oil (HVGO) is one of the most preferable feedstocks for ethylene production by this process. The Mizushima refinery of the Nippon Mining Co. started a commercial demonstration plant in June 1987.

As is indicated in the 1995 ethylene demand/capacity balance, it is anticipated that ethylene will be balanced with no expected deficit. Nevertheless, any possible integration through the establishment of a petrochemical refinery will lead to the erection of an ethylene cracker. This will be so because of the nature of such a refinery, as well as the possible need for more ethylene as a raw material for other products.

Figure 4.9. Schematic diagram of SOC process



(a) Polyethylene

Polyethylenes are considered to be major plastic materials and their production utilizes more ethylene than any of the other derivatives. Polyethylenes are classified into low density polyethylene (LDPE), high density polyethylene (HDPE) and linear low density polyethylene (LLDPE). This classification is related to chemical structure, specific gravity, melting point and flexibility.

Traditionally, low density polyethylene was produced by a high pressure process, while high density polyethylene was formed by the normal pressure process. Recently, Union Carbide patented its low pressure Unipol gas-phase process for the production of LDPE and LLDPE. The importance of this, as compared with the traditional high pressure processes can be seen in its added operating safety factor, together with the substantial savings of energy (25 per cent) and in the cost of equipment and machinery (almost 50 per cent). Jones (34) has reported that the UNIPOL process has been developed further so as to produce high density resins in addition to low density polyethylenes. The products are used for a broad spectrum of consumer and industrial end-use applications, including film, blow-moulding and injection-moulding, pipe- and rotational-moulding. These varieties of resins cover a wide range of melt indices and densities.

Since the introduction of LLDPE a few years ago, consumers have shown greater interest in this product than in other polyethylene resins because:

- The films produced from LLDPE are much stronger and, therefore, require fewer raw materials;

- Moulded products are harder and stronger and therefore last much longer than those produced from LDPE.

Many international producers such as DuPont of Canada, Union Carbide and Dow Chemical have their own processing technologies for the production of polyethylenes. Eight companies, including SABIC have acquired the rights of the UNIPOL process from Union Carbide.

The demand/supply data for polyethylenes indicate that there will be a surplus situation in the 1990s in the Arab world, as well as in the international market. Because of the different varieties of polyethylene grades, co-operation between Arab companies to produce the various grades will help promote polyethylene marketing activities.

(b) Vinyl chloride monomer (VCM)

This product is an intermediate petrochemical manufactured from chlorine and ethylene in the presence of oxygen. The importance of this

product is derived from the fact that it is the main raw material used in the production of polyvinyl chloride (PVC).

VCM is produced by the following process:

(i) The reaction of ethylene, chlorine, hydrogen chloride and oxygen in order to produce ethylene dichloride (EDC);

(ii) The purification of EDC;

(iii) The transformation of EDC into VCM;

(iv) The purification of VCM.

The current technologies for the production of VCM are:

- B. F. Goodrich - which has over 36 plants with production capacities ranging from 15,000-480,000 tons/year. Badger Company Incorporated is the most experienced engineering firm in the construction of these plants;

- Stauffer Chemicals Co. - which has over 33 plants with an estimated total production capacity of 3.6 million tons/year;

- Mitsui Toatsu Chemicals Incorporated - which has nine plants with an estimated annual production capacity of 1.3 million tons;

- Other companies including ICI, Solvay and Toya also have their own processes.

As stated above, vinyl chloride monomer is mainly consumed in the production of polyvinyl chloride, which is considered to be the second most important plastic material after polyethylene resins.

(c) Polyvinyl chloride (PVC)

Polyvinyl chloride has been widely accepted by international consumers, mainly because of its properties that include the following:

- Resistance to other chemical materials;

- Resistance to atmospheric conditions and decay;

- Fire resistance;

- Electrical insulating characteristics;

- Production health safety;

- Availability of PVC in rigid and flexible forms.

Polyvinyl chloride is used to produce various end-products by the following methods:

- Injection-moulding;
- Extrusion;
- Calendering;
- Blow-moulding;
- Coating.

The main end-uses include:

- Building and construction: water and sewage pipes, pipe fittings, hoses, profiles, flooring, false ceilings and wall coverings;

- Consumer products: toys, kitchen utensils, shoes and suitcases;

- Packaging: plastic bottles, rigid and flexible film;

- Electrical insulation: wire and cable covering;

- Furniture: homes, airports and bus stop furniture.

Polyvinyl chloride is produced by the polymerization of vinyl chloride using one of the following methods:

(i) Suspension polymerization. This is the most widely used process where polymerization takes place in a water atmosphere with the vinyl chloride suspended in the water. Approximately 75-80 per cent of PVC is produced by this method. Producers with their own processing technologies include Huls AG, Solvay-ICI, Goodrich, Mitsui Toatsu, Stauffer, Diamond Shamrock, Hoechst AG and Chiyoda Chemicals;

(ii) Emulsion polymerization. An emulsifying agent is added to help distribute the vinyl chloride evenly in the water. Difficulties are encountered in separating the emulsifying agent from the PVC, and this affects its purity which, as such, limits its uses. Ten to fifteen per cent of polyvinyl chloride is produced by this method. Producers with their own processing technologies include Huls AG, Diamond Shamrock, Borden, Sumitomo and Hoechst AG;

(iii) Bulk or mass polymerization. This process does not require water or any other liquids, therefore the PVC produced is pure. Only about 10 per cent of PVC is produced by this operation.

The polymerization method used has a direct effect on the properties of PVC, and this leads to the availability of different grades. It is normally difficult for a company to produce all the available grades. Therefore, agreements are reached between producers to complement their products in order

to satisfy end-users' requirements and, as such, to control markets. It seems logical, then, to suggest that co-operation between Arab PVC producers would help in the marketing of PVC products through the provision of access to a variety of different grades and more support for technical consultation with customers.

(d) Ethylene glycol

Ethylene glycol is classified either as an intermediate petrochemical when it is used as a feedstock in the production of other chemicals, or as a finished product when it is used directly by the consumer.

Some of the products that require ethylene glycol as a feedstock for their production are:

(i) Polyethylene terephthalate (PET), which is needed for the production of polyester fibres. At present, these are considered to be the most important synthetic fibres available. In addition, PET is increasingly used in the manufacture of polyester bottles;

(ii) Polybutylene terephthalate;

(iii) Glycol dinitrate, which is used in the manufacture of explosives. Because the freezing point of glycol dinitrate is lower than that of nitro-glycerine, both materials are normally mixed in order to produce a safe operating freezing point;

(iv) Propylene glycol;

(v) Polypropylene glycol;

(vi) Ethylene glycol diacitate.

In addition to the above, ethylene glycol is used directly in:

- The prevention of freezing of cooling water - antifreeze;
- The drying of gases;
- The production of cosmetics;
- Cement grinding/milling;
- Paint and adhesive material, as a solvent.

(e) Ethylene oxide

Ethylene oxide is used as the main feedstock in the production of ethylene glycol. Therefore, these two materials are normally produced in one chemical complex. Ethylene oxide is converted into ethylene glycol through its reaction with water. This produces diethylene glycol (DEG) and triethylene glycol (TEG) as by-products. Control of the quantities of these by-products is accomplished by varying the ethylene oxide/water ratio.

Some of the important processes employed in the production of ethylene glycol and ethylene oxide are the ones by:

- Halcon/Scientific Design Groups;

- Shell Development Co.

Some companies such as Halcon, Atlantic Richfield, ICI, DuPont and Teijin are attempting to produce ethylene glycol directly through ethylene oxidation in the presence of acetic acid and water. Several other methods are also being tried out by other manufacturers.

More than 50 per cent of ethylene oxide production is used in the manufacture of ethylene glycol. In addition, it is also used in the manufacture of other industrial chemicals such as:

(i) Non-ionic surfactants used in industrial liquid and powder detergents;

(ii) Monoethanolamine, diethanolamine and triethanolamine which are used for sweetening and industrial detergents;

(iii) Glycolether, which is used in the preparation of cosmetics, sponge, detergents and shampoo, textiles and rubber. Huls AG is a well-known producer of this product.

The main areas of consumption for ethylene oxide and ethylene glycol in Western Europe are indicated in table 4.14.

Table 4.14. Consumption of ethylene oxide and ethylene glycol in Western Europe

Product	Used for	Percentage
Ethylene oxide	Ethylene glycol	52
	Industrial detergents	16
	Diethylene glycol and triethylene glycol	8
	Glycolether	8
	Ethanolamine	7
	Polyethylene glycol	3
	Others	6
	Total	100
Ethylene glycol	Polyester	49
	Antifreeze	41
	Others	10
	Total	100

Source: Compiled from data supplied by the Saudi Consulting House. Arthur D. Little (1983).

The present demand for ethylene glycol in the Arab world is still limited, and a sizeable amount is available (see table 4.9) for export to international markets.

2. Propylene

Propylene is an important basic petrochemical. It was produced mainly as an ethylene liquid cracker by-product, and as such its balance is influenced by ethylene production. The growth rates of propylene derivatives have been higher than those of ethylene derivatives. Therefore, the supply of propylene originating from ethylene crackers became insufficient to meet demand. At present, most of the required balance is supplied by fluid catalytic cracking (FCC) refinery streams.

In Western Europe, where the supply of ethylene comes mainly from liquid crackers, while attempts have been made to obtain additional requirements of propylene from FCC refinery streams, about 300,000 metric tons (38) was imported from international markets during 1985/1986 (Eastern Europe 58 per cent, Latin America 23 per cent, North America 17 per cent and the Middle East 2 per cent). The supply from Eastern Europe is expected to decrease because of the start-up of C3-derivatives, so that the United States will become the main supplier unless investment is made to increase the supply of propylene from refinery streams. Experts have forecast a decrease in the propylene/ethylene ratio because of the anticipated increase in LPG consumption. In Japan and the United States the propylene ratio is expected to be almost balanced.

Propylene is consumed in the production of a wide variety of petrochemical products, some of which are listed below, together with their end-uses.

Petrochemical	End-uses
Acrylic acid	Lacquers, enamels, paints, plastics
Acrylonitrile	Acrylic fibres
Cumene	Phenol, acetone
EP rubber	Synthetic rubber
Isopropanol	Solvents, octane booster
Oxo aldehydes/alc.	Plasticizers
Polypropylene	Fabrics, carpets, ropes
Propylene oxide	Detergents, shampoo, polyester resins, polyurethane
Acetone	Methyl methacrylates, solvent
Polymer gasoline	Transportation fuel
Diesel fuel	

The percentage consumption of propylene used in the production of some of the products listed above in the three main developed regions is tabulated in table 4.15.

Table 4.15. Propylene consumption ratio in the United States, Western Europe and Japan

	USA		Western Europe		Japan	
	1986	1990	1986	1990	1986	1990
Acrylonitrile	15	15	15	13	24	23
Cumene	8	9	8	8	...	...
Isopropanol	6	5	...	...	...	...
Oxo aldehydes/alc.	8	8	12	11	10	9
Polypropylene	36	38	38	40	44	47
Propylene oxide	11	11	13	10	...	...
Others	16	14	14	18	22	21
Total	100	100	100	100	100	100

Source: N. Mitani, Mitsubishi International, 7 July 1987.

Note: ... Data unavailable.

The supply of propylene originates from the following sources:

(i) A by-product of ethylene steam crackers, considered to be the main source, especially in Western Europe and Japan;

(ii) Refinery fluid catalytic cracking streams, which are gaining more importance as the growth rate for propylene derivatives is higher than for ethylene derivatives;

(iii) De-hydrogenation of propane to produce propylene. De-hydrogenation can be carried out in the presence of oxygen (oxidative de-hydrogenation) in order to produce propylene and benzene, which improves the economies of this operation owing to the value of benzene.

In the Arab world, there are many LPG plants, that produce sizeable amounts of propane and butane, which is mainly exported to international markets. The utilization of propane and butane as feedstocks for the production of basic petrochemicals must be given serious consideration. At present, there are no major difficulties in the marketing of propane and butane in international markets. However, detailed studies should be carried out in order to compare the economies of exporting these products with their use as petrochemicals feedstocks.

The availability of propylene in the Arab world is limited to the extent that the production of polypropylene, which is greatly needed, cannot be justified economically. At present, there is only one polypropylene project in the Arab region in the Libyan Arab Jamahiriya. In addition, another project

is being planned in Kuwait. Therefore, there is a definite need to provide propylene, either through a steam cracker as part of the proposed petrochemical refinery, FCC refinery streams or the de hydrogenation of propane, The final decision must be based on the results of detailed studies for the respective areas.

(a) Polypropylene

The industrial importance of polypropylene stems from its versatility as a plastic material, its use as a feedstock for the production of synthetic fibres (used for carpets, ropes and fishing), and in polymerization with ethylene in the manufacture of synthetic rubber (ethylene-propylene-diene monomer (EPDM) rubber). The properties of polypropylene have helped to increase its wide acceptance by consumers, as compared with other plastic products. Among its main properties are the following:

- Low specific gravity;
- Good heat resistance and high rigidity;
- High melting point;
- Good chemical resistance, used for vessels and medical equipment;
- Good mouldability, used in injection moulding, extrusion, blow moulding, etc.;
- Good drawing and spinning properties, used for fibres, yarns;
- Good electrical resistance, used in capacitors, films, battery cases, cables;
- High impact at low temperature;
- Good transparency and flexibility.

Polypropylene is produced by polymerizing propylene using the following methods:

(i) Polymerization of propylene in the gas-phase. This has been developed further by BASF in their Novolen process, which uses a stirred, vertical bed. Amoco uses a stirred, horizontal bed, while Union Carbide (UCC) uses a fluid bed. Jaggard (36) reported that the Stanford Research Institute compared these three processes and concluded that the production costs and net selling prices required for a 25 per cent return on investment, are similar, as is indicated in table 4.16.

Table 4.16. Polypropylene gas-phase processes-production cost comparison

Gas-phase process	Fluid bed (UCC)	Stirred bed Vertical (BASF)	Stirred bed Horizontal (AMOCO)
Design basis capacity (tons/year)	100,000	100,000	100,000
Reactor lb/hour	6	8	6
Investment (millions of dollars, 1984)			
Battery limits	26.0	22.1	22.8
Off-sites	15.2	15.4	15.5
Total	41.2	37.5	38.3
Production costs (cents/lb)			
Raw materials	21.60	21.53	21.53
Utilities	1.79	1.47	1.72
Variable costs (total)	23.39	23.00	23.25
Variable and other costs[a/]	25.23	25.22	25.32
Required selling price[b/]	34.78	34.18	34.41

Source: Data supplied by the Stanford Research Institute International.

a/ "Other" including labour and overhead costs.

b/ Indicates a 10 per cent depreciation is required for a 25 per cent return on investment.

This suggests that the selection of a gas-phase process is determined by product quality, product flexibility and by the range of products that the process is capable of producing.

(ii) Slurry/bulk polymerization of propylene whereby slurry polymerization takes place in suspension, and the latter is polymerization in liquid propylene. Hercules, a big American producer, developed its well-known process for the production of over half a million tons per year. The Solvay process is another well-known process. Recently, Montedison and Mitsui developed a catalyst that made great improvements on the quality of the polypropylene. Again, as in the case of gas-phase polymerization, the selection of a process depends on its capability of producing the different polypropylene grades required by consumers.

As was reported by Jaggard (36), Chem. Systems made a comparison of polypropylene homopolymer production costs, as is shown in table 4.17.

Table 4.17. Comparison of polypropylene homopolymer production costs*

	Raw materials	Utilities	Depreciation	Cash cost including finance
Gas-phase	100	100	100	100
Bulk (loop reactor)	101	109	122	103
Simplified slurry	104	201	216	116

* The data are taken from a study by Chem. Systems, entitled West European PP Strategies for further survival, June 1984, and converted by BASF into figures based on an index of 100 for BASF gas-phase. (Basis 80,000 tons/year plant).

One should emphasize that improvement through research and development is being achieved year after year. Therefore, any new interested party must carefully review the latest developments made in each process and compare them before making a final decision regarding the selection of the process.

Polyropylene is one of the propylene derivatives where capacities in the past have not increased internationally in line with demand growth. Therefore, the demand for polypropylene came near to matching the available supply, reaching more than 90 per cent. This led to the generation of high profits, even in 1986 when the price of all petrochemical products dropped sharply. Under these circumstances, rumours about new expansion plans or the removal of bottle-necks in the production of polypropylene have spread throughout the world.

In the Arab world, as is indicated in table 4.9, demand is forecast to approach 400,000 tons per year in 1995. At present, only one 70,000 ton plant is under construction in the Libyan Arab Jamahiriya. Therefore, serious efforts should be made for the construction of plants to produce enough polypropylene to satisfy Arab demand, as well as to export to international markets. This, in turn, will require the availability of propylene in the Arab region, as was mentioned previously.

(b) Acrylonitrile

Acrylonitrile is an intermediate petrochemical produced from propylene. It is used mainly in the production of polyacrylonitrile, as a feedstock for acrylic synthetic fibres, and with butadiene for the production of synthetic rubber.

The Sohio process was developed by Standard Oil of Ohio to produce acrylonitrile through the oxidation of propylene in the presence of ammonia (the ammoxidation of propylene). In this process, acetonitrile and hydrogen cyanide are produced as by-products.

Acrylonitrile is also used as a feedstock in the production of nylon 66, an important consumer product.

The international demand/supply for acrylonitrile is balanced. The average annual growth rate is less than 1 per cent.

In the Arab region, no manufacturing plants exist for the production of acrylonitrile. There are only three small plants for the production of acrylic fibres that presently operate in Tunisia, Algeria and Morocco, and which have an annual capacity totalling 37,000 tons, while demand is estimated at more than 120,000 tons.

(c) Plasticizers

Propylene is used in the production of a variety of plasticizers in order to improve the processing of polymers. These polymers include flexible PVC, which is produced by adding 30 per cent plasticizers to PVC. In addition, these plasticizers are used in the production of certain special paints, and also as a rubber softener.

In Arab countries, no plasticizers plants exist. Owing to the high consumption of polyvinyl chloride, it would be of interest to consider establishing a plant to produce suitable plasticizers such as the dioctyl phthalate (DOP) and dibutylphthalate (DBP).

At present, Western Europe is the world's main producer of plasticizers. Production in the developing countries is very limited. As such, it is not difficult to see that such a project in the Arab world would compliment local PVC production and consumption, as well as in the export markets.

(d) Propylene oxide

Propylene oxide is an intermediate petrochemical used as a feedstock in the production of the following:

(i) Propylene glycol, which is used in cooling systems as an antifreeze. In addition, it is used as one of the required materials for the production of polyester resins;

(ii) Polypropylene glycol, which is used in the production of detergents and emulsifiers and as a feedstock for the production of polyurethane.

Two technological processes that are currently used in the production of propylene oxide are:

- The chlorhydrin process, which is an old process but one that is still used. One of its disadvantages is the production of calcium chloride (thus entailing a loss of chlorine), and undesirable water solutions;

- The oxirane process that is used to produce propylene oxide by direct oxidation. One of its main disadvantages is the production of larger quantities of by-products compared with propylene oxide.

In the Arab world, no plants exist at present to produce either propylene oxide or propylene glycol. Interest is being generated in the production of polyol, which is needed to produce polyurethane, as there will be an expected deficit of 150,000 tons per year by 1995. On the other hand, propylene glycol will be needed to produce polyester resins for which forecasts indicate a deficit of more than 200,000 tons per year by 1995.

(e) Isopropanol

Isopropanol is normally used as a solvent or as feedstock in the production of acetone, which is used also as a solvent and feedstock to produce other chemicals. Isopropanol is produced by propylene reaction with steam.

3. C4-olefins

C4-olefins represent a large variety of products with different chemical structures, production methods and uses. In this study, emphasis will be placed on butadiene, but for references purposes a list of some of the end uses of C4-olefins are listed below in table 4.18.

(a) Butadiene

It has been stated (38) that among olefin products, butadiene is very difficult to forecast because its balance is influenced by various factors, not just physical constraints (such as production), but economic constraints (such as price). These difficulties result in the following:

(i) Butadiene is produced mainly as a by-product of ethylene liquid crackers. This means that production quantities are not necessarily related to demand. In addition, as MTBE is gaining in importance as an octane booster, butadiene is becoming less important than isobutylene as a feedstock for MTBE production;

(ii) The main butadiene derivatives are used in the production of synthetic rubber for the tyre industry. If this industry were to shift more to the radial type, the consumption of derivatives per tyre would decrease and the demand for butadiene would also decline;

(iii) The availability of natural rubber with which synthetic rubber competes to some extent, basically controls the price of the latter.

Western Europe seems to remain a traditional exporter (with surplus of 260,000-270,000 tons/year), while the United States and the Far East will remain net importers towards 1990. The United States is expected to import 200,000-220,000 tons/year and the Far East 50,000-60,000 tons/year by 1990.

Table 4.18. Some end uses of C4-olefins (35)

Petrochemical	End-uses
Isobutylene	
Miscellaneous chemicals	Alkyl-substituted phenols, cresols, amines
Methacrolein	Acrylic resins, thermoplastic materials
Methacrylic acid	Methyl methacrylate (plexiglas(R) or perspex(r))
MTBE	Transportation fuel, high purity isobutylene
Polyisobutylene Butyl rubber	Binders, sealing compounds, tyre tubes
TBA	Methacrolein, methacrylic acid, methyl-methacrylate, octane booster high purity isobutylene
Butene-1	
HDPE	Co-monomer with ethylene for LDPE and
LLDPE	HDPE (10 per cent C4=1)
Polybutene-1	Pipe, specialty films, polymer alloys
Butene-2 (also mixed butene-1 and butene-2)	
Sec-butanol	MEK, solvent, butyl acetate
Octene	Plasticizers (DINP), alkylphenols, (wetting agents)
Mixed butenes	
Alkylate	Transportation fuel
Polymer gasoline	Transportation fuel
Maleic anhydride	Insecticide, unsaturated polyesters

In 1986, because the American ethylene feedstock changed from a lighter to heavier variety and there was an improvement in the demand for ethylene, world production of butadiene increased. Consequently, the flow of butadiene from Europe to the United States was not constant. As a result, the surplus from one area was passed to another, and prices dropped drastically. Butadiene manufacturers, with the consequent drop in oil prices, began to crack butadienes and other C4 products further. If prices begin to drop towards 1990 manufacturers will once again crack butadiene further in order to produce ethylene and other products.

Mitani (38) has reported the world balance of butadiene through 1990, as is presented in table 4.19.

Table 4.19. World butadiene balance

(Thousands of metric tons)

	1986	1987	1988	1989	1990
Asia and Pacific					
Production	879	887	899	926	972
Demand	875	901	938	974	1,003
Balance	4	-14	-39	-48	-31
Europe					
Production	1,600	1,613	1,625	1,638	1,638
Demand	1,333	1,345	1,354	1,364	1,376
Balance	267	268	271	274	262
USA					
Production	1,264	1,246	1,258	1,270	1,297
Demand	1,465	1,471	1,480	1,489	1,498
Balance	-201	-225	-222	219	-201

Source: Data supplied by the Mitsubishi Corporation.

Butadiene production sources and its uses by product basis in the United States, Western Europe and Japan are listed in tables 4.20, 4.21 and 4.22 respectively.

Table 4.20. Butadiene production and demand (38) in the United States

(Thousands of metric tons)

	1986	1987	1988	1989	1990
C2 production	14,800	14,950	15,100	15,250	15,400
B/E ratio	0.080	0.077	0.079	0.079	0.080
Butadiene production					
Steam cracker	1,184	1,151	1,193	1,205	1,232
Dehydro unit	15	30	0	0	0
Imported crude	65	65	65	65	65
Total production	1,264	1,246	1,258	1,270	1,297
Butadiene demand					
ABS	66	67	69	70	71
Adiponitrile	165	167	168	170	172
Chloroprene	103	105	105	105	106
Nitrile rubber	38	38	38	38	39
Polybutadiene	341	342	343	344	344
SB latex	143	145	149	152	155
SB rubber	486	487	488	490	491
Others	73	70	70	70	70
Domestic demand	1,415	1,421	1,430	1,439	1,448
Exports	50	50	50	50	50
Net S/D balance = import (export is considered as US demand)	-201	-225	-222	-219	-201

Source: Data compiled by the Mitsubishi Corporation.

Table 4.21. Butadiene production and demand (38) in Europe

(Thousands of metric tons)

	1986	1987	1988	1989	1990
C2 production	12,700	12,800	12,900	13,000	13,000
B/E ratio	0.126	0.126	0.126	0.126	0.126
Butadiene production	1,600	1,613	1,625	1,638	1,638
Butadiene demand					
ABS	110	112	114	117	120
Adiponitrile	92	94	95	96	97
Chloroprene	85	86	86	86	87
Nitrile rubber	61	62	62	62	63
Polybutadiene	300	301	302	302	303
SB rubber	360	361	362	363	364
SB latex	210	214	218	223	227
Others	55	55	55	55	55
Domestic demand	1,273	1,285	1,294	1,304	1,316
Net S/D balance (Export to others' is considered as euro-demand)	267	268	271	274	262
Exports	285	295	323	326	291
USA	201	225	222	219	201
Japan/Far East	24	10	41	47	30
Others	60	60	60	60	60
Material balance	42	33	8	8	31

Source: Data compiled by the Mitsubishi Corporation.

Table 4.22. Butadiene production and demand (38) in Japan
(Thousands of metric tons)

	1986	1987	1988	1989	1990
C2 production	4,290	4,330	4,400	4,420	4,380
B/E ratio	0.15	0.15	0.15	0.15	0.15
Butadiene production					
Steam crackers	644	650	660	663	657
Imported crude	10	8	8	8	8
Total production	654	658	668	671	665
Butadiene demand					
SB rubber	220	220	220	225	230
Polybutadiene	195	195	200	205	210
Nitrile rubber	38	38	40	41	42
Chloroprene	30	30	30	30	30
Latex	75	77	79	82	84
ABS and others	93	96	99	102	105
Domestic demand	651	656	668	685	701
Net S/D balance (Imported crude is not counted)	-8	-7	-8	-22	-44
Butadiene exports					
Taiwan	3	10	22	29	10
Republic of Korea	7	18	27	12	0
Australia	6	6	6	6	6
USA	3	0	0	0	0
Total exports	19	34	55	47	16
Butadiene imports					
Europe	24	10	41	47	30
Singapore	14	14	14	14	14
Republic of Korea	0	0	0	0	8
Total imports	38	24	55	61	52
Material balance	22	-9	0	0	0

Source: Data compiled by the Mitsubishi Corporation.

As is indicated in tables 4.20, 4.21 and 4.22, polystyrene butadiene rubber (SBR) and polybutadiene rubber (PR) are the most important petrochemical end-products from butadiene as they are used in the tyre and other related rubber industries. At present, more than 60 per cent of total demand is for synthetic rubber.

The production of petrochemical end-products used in the rubber industry is carried out by the polymerization of olefins, including the following:

- Polymerization of butadiene to produce polybutadiene;

- Polymerization of isobutylene to produce polyisobutylene;

- Polymerization of styrene and butadiene to produce polystyrene butadiene;

- Polymerization of ethylene and propylene, or together with butadiene, to produce EPM and EPDM;

- Production of these synthetic rubber products is achieved through the use of special catalysts known as Ziegler-Natta (lithium, nickle and cobalt compounds, etc).

The technological processes used to produce synthetic rubber are:

- Polybutadiene is produced by:

  - B. F. Goodrich — which uses cobalt as a catalyst
  - Bridgestone — which uses nickle as a catalyst
  - Philips Petroleum — which uses titanium as a catalyst
  - Firestone — which uses lithium as a catalyst

- Polystyrene butadiene is produced by:

  - Philips Petroleum
  - Firestone
  - B. F. Goodrich
  - Japanese Synthetic Rubber Company.

At present, only one Arab project in the Libyan Arab Jamahiriya is designed to produce butadiene, with feedstocks that are provided by an ethylene naphtha cracker. As is well known, other Arab ethylene crackers utilize an ethane feedstock, and such butadiene is not produced as a by-product.

Other Arab companies, for example SABIC, plan to produce butadiene by the de-hydrogenation of butanes. In addition, the Arab Petroleum Investments Corporation (APICORP) and the Libyan Arab Jamahiriya studied the possibility of establishing a joint venture to produce polybutadiene and polystyrene butadiene.

4. Aromatic petrochemicals

The aromatic family, as is indicated in figure 4.8, consists of benzene, toluene and xylenes, all of which play an important role in the development and growth of some basic industrial sectors, as can be seen from the following:

Aromatic product	Main derivative	Downstream market
Benzene	Cyclohexane/caprolactam/ adipicacid	Nylon, fibres, plastics, plasticizers, resins
	Maleic anhydride	Polyester resins, pesticides
	Aniline/isocyanates	Polyurethane foams, rubbers, dyes
	Alkylbenzene (LAB)	Polystyrene plastics, rubbers, latex
	Cumene/phenol	Phenolic resins
Toluene	Benzene	As above
	Toluene di-isocyanate	Polyurethane foams, surface coatings
	Phenol	Phenolic resins
	Caprolactam	As above
	Solvents and chemicals	Surface coatings, explosives
Orthoxylene	Phthalic anhydride	Plasticizers, polyesters, alkylresins
Paraxylene	Dimethyl terephthalate	Polyester fibres chip film
	Terephthalic acid	Polyester fibres chip film, PBT

Note: PBT = polybutylene terephthalate

Because of increased international demand for the above-mentioned downstream products, it has been necessary to secure reliable sources at reasonable prices of these aromatics.

At present, the main sources or feedstocks for the production of these aromatics are:

- Pyrolysis gasoline, produced as a by-product of ethylene liquid crackers, which is processed in order to produce these aromatic products. The olefins present in this gasoline must first be removed to allow the aromatics to be separated.

- Naphtha from crude oil refineries, which is further treated by catalytic reforming so as to convert its paraffinic and cycloparaffinic contents into aromatics. The final products containing the aromatics are further treated to produce either reformate gasoline for cars or basic aromatics for the petrochemical industry.

The production of aromatics products is normally accomplished as follows:

(i) Separation of the benzene, toluene and xylene (BTX) fraction from the mixture. Several technological processes that differ according to the type of solvent utilized are in use presently:

- Udex process by UOP-Dow;
- Sulfolane process by Shell-UOP;
- Arosolvan process by Lurgi;
- Formex process by Snamprogetti;
- Aromex process by Krupp-Koppers

(ii) Separation of BTX components. The separation is normally achieved by distillation, and in some cases by using hydrocarbon solvents with low boiling points before distillation. In this operation, the benzene and toluene are easily separated, while it is difficult to separate the different xylenes and ethyl-benzene due to the similarities in their boiling points;

(iii) Separation of xylenes: In order to separate xylenes, it is necessary to use either the Atlantic Richfield process, which depends on crystallizing the components in the mixture, or the adsorption UOP-Parex process.

M-xylenes are separated by forming a HF/BF_3 m-xylene mixture by using the distillation (Japan Gas Chemical Co.) process to separate the o-xylene.

As was indicated above, p-xylene is used to produce dimethyl terephthalate (DMT) and terephthalic acid (TPA), both of which are used to produce polyester fibres.

The Parex process produces 90 per cent purity p-xylene compared with 60 per cent purity through the use of crystallization. In addition, the Parex process uses less energy and requires only minimum maintenance, and has a large production capacity that results in a more economic operation.

At present the aromatics industry faces an international capacity surplus. Current trends in aromatics, represented here by benzene, indicate some of the difficulties of achieving accurate forecasting for the future demand/supply of benzene. This is the case both for oil refineries and petrochemical products. The refineries reform naphtha in BTX units, which in most industrialized countries account for over half of the aromatics capacity (39). In addition, aromatics are also produced by oil refineries as a by-product of petroleum coke plants and pyrolysis gasoline operations. In developed countries, the main outlets for benzene and its derivatives are the mature industries like housing, textiles and infrastructural development. Only areas such as engineering thermoplastics are likely to show a tendency towards rapid growth, but as their volume is expected to remain limited the impact will be rather limited.

On the other hand, in developing countries outlets cannot be found yet in mature industries, therefore an enormous potential still exists. At present, many developing countries are attempting to build BTX plants, either to satisfy their own needs or also to export to international markets. This, of course, will result in a continuation of the overcapacity situation, unless restructuring similar to that which has taken place for other petrochemicals commences soon. Tables 4.23 and 4.24 indicate the estimated world capacity and demand for benzene. The figures in these two tables should be taken only as a guide of the expected benzene situation in 1990. Table 4.25 presents the effective capacity, production and consumption of toluene, o-xylene and p-xylene in Western Europe (41).

In the United States, the major derivatives of benzene (40) are currently ethyl benzene (50 per cent), cumene (20 per cent), cyclohexane (15 per cent), aniline (5 per cent) and others (10 per cent). The major petrochemical end-products for benzene are styrenic resins (35 per cent), phenolic resins (20 per cent), polyamids (nylon 15 per cent) and others (30 per cent).

In Arab countries, a BTX project is being planned/constructed in Algeria for the production of:

Benzene	90,000 tons/year
Toluene	5,000 tons/year
P-xylene	38,000 tons/year
Mixed xylene	247,000 tons/year

In Saudi Arabia, a project for the production of 242,000 tons/year of benzene, which will be used wholly locally to produce styrene, is now on stream. Plans to build aromatics complexes in Iraq, Kuwait and the United Arab Emirates have been shelved for the present.

Table 4.23. World benzene demand (39)
(Thousands of tons/year)

Region	1982	1983	1984	1985(b)	1990(b)
Developed countries	12,000	13,500	14,200	14,700	17,700
North America	4,400	5,000	5,200	5,300	6,200
Western Europe	3,200	3,900	4,000	4,200	5,000
Eastern Europe	2,700	2,800	2,900	3,000	3,700
Japan	1,700	1,800	2,100	2,200	2,800
Developing countries	1,560	1,720	1,890	2,270	3,900
Asia	900	1,000	1,100	1,300	2,200
Middle East	70	80	90	200	500
Africa	30	40	50	100	200
Latin America	560	600	650	870	1,000
World total	13,560	15,220	16,090	16,970	21,600
Share of developing countries (percentage)	11.5	11.3	11.7	13.4	18.1

Source: UNIDO, Current World Situation in Petrochemicals, (November 1985). (UNIDO/PC.126).

Table 4.24. World benzene capacity (39)

(Thousands of tons/year)

Region	1982	1983	1984	1985(b)	1990(b)
Developed countries	22,600	22,000	22,200	22,700	23,400
North America	9,200	8,700	8,600	8,800	9,200
Western Europe	7,100	7,100	7,200	7,200	7,200
Eastern Europe	3,300	3,200	3,400	3,700	4,000
Japan	3,000	3,000	3,000	3,000	3,000
Developing countries	1,590	2,100	2,300	3,240	5,220
Asia	920	1,070	1,200	1,520	2,290
Middle East	20	20	20	380	1,040
Africa	90	90	90	130	130
Latin America	920	990	990	1,210	1,760
World total	24,190	24,100	24,500	25,940	28,620
Share of developing countries (percentage)	6.6	8.7	9.4	12.5	18.2

Source: UNIDO, Current World Situation in Petrochemicals, (November 1985). (UNIDO/PC.126).

Table 4.25. Effective capacity, production and consumption of toluene, o-xylene and p-xylene in Western Europe (41)

(Thousands of tons/year)

	Toluene	
	1984	1985
Production	1,199	1,490
Consumption	1,207	1,363

	O-xylene	
	1984	1995
Effective capacity	748	711
Production	520	489
Consumption	566	547

	P-xylene	
	1984	1985
Effective capacity	1,155	1,160
Production	1,004	1,015
Consumption	...	1,136

Source: Data compiled by the Conseil européen des federations des industries chimiques.

Note: ... Data unavailable.

It is obvious from the above that, at the moment, Arab countries do not possess the aromatics feedstocks required to establish projects in several industrial sectors that are needed to satisfy local requirements. Some of these industries include the following:

(a) Synthetic fibres

The manufacture of synthetic fibres depends on the availability of aromatics for use as feedstocks. During the last 30 years, the growth rate for synthetic fibres has steadily increased, so that in 1980 they constituted 36 per cent of total world fibre production.

Synthetic fibres consist mainly of polyester fibres, nylon and polyacrylonitrile, of which polyester fibre is the most widely used.

Polyester fibres are produced from polyethylene terephthalate or di-methyl terephthalate, both of which require p-xylene for their production. Polyethylene terephthalate requires ethylene glycol and terephthalate acid in its production.

Terephthalate acid is produced by the Amoco process from p-xylene through oxidation in air in the presence of cobalt or manganese catalysts. In addition, acetic acid is used as a solvent in this process.

Di-methyl terephthalate is normally produced from p-xylene and methanol. This is achieved by oxidizing p-xylenes in air, and is followed by the subsequent reaction of the acid produced with methanol, which produces di-methyl terephthalate. The Dinamit Nobel process is used for this purpose. Krupp-Koppers is an engineering company which has extensive experience in this process.

Estimated Arab demand and international consumption of synthetic fibres and their related petrochemicals are respectively listed in tables 4.9 (for 1995) and 4.11 (for 2000). Table 4.9 indicates the expected deficits of these products in the Arab world.

(b) Plastic materials

Two of the main related products are polystyrene and styrene butadiene rubber, both of which require styrene in their production. In addition, styrene is also utilized in the production of unsaturated polyester resins.

(c) Styrene

Styrene is produced from benzene by converting it to ethyl benzene, considered to be the most important benzene derivative. Ethyl benzene is then transformed into styrene.

The alkylation reaction between benzene and ethylene that produces ethyl benzene requires a catalyst which has acidic properties, e.g. aluminium chloride. Ethyl benzene can be produced in a liquid-phase by the Monsanto, Dow, BASF and UCC processes. It can also be produced in the gaseous phase by the following processes:

- Koppers, Philips, UCC (H_3PO_4/alsilicate catalyst);
- Mobil-Badger (molecular sieve catalyst);
- UOP (BF_3/Al_2O_3 catalyst);

Ethyl benzene is converted into styrene by several technological processes:

- Monsanto/Lummus;
- UCC/Cosden/Badger.

A 295,000 tons/year styrene project is presently on stream in Saudi Arabia. It is an export-oriented project, as most of the production will be sold on the international market. Both ethylene and benzene are available from within SABIC companies. Other plans have been made in Arab countries, such as Kuwait and the Libyan Arab Jamahiriya to establish styrene projects. The Libyan Arab Jamahiriya project was supposed to go on stream in 1984/1985, while the Kuwaiti plan has apparently been postponed.

(d) Polystyrene

Polystyrene is produced by polymerizing styrene in order to produce both general purpose polystyrene (GPPS) and high impact polystyrene (HIPS), as well as thermal insulating materials.

The polystyrene is produced by:

- Solution polymerization
- Suspension polymerization
- Emulsion polymerization
- Bulk or mass polymerization

The problems that are normally encountered are related to producing a pure product with the desired properties. The preferred processes are bulk or mass polymerization and suspension polymerization, as they produce better quality products.

High impact polystyrene is produced through styrene polymerization with rubber in order to improve its properties.

Available processes related to bulk polymerization are offered by: DOW, Shell, UCC, Foster Grant, Hoechst and CdF/Badger.

Available processes related to suspension polymerization are offered by: BASF, Cosden, Hoechst, Huls and Koppers.

At present there are no polystyrene projects in Arab countries. Polystyrene world supply/demand data are presented in table 4.26.

As is indicated in table 4.26, the polystyrene industrial sector is over-supplied, and this situation is expected to continue, possibly through the early 1990s. Therefore, restructuring is needed in order to achieve a higher demand/supply ratio.

Table 4.26. World polystyrene supply/demand

(Thousands of tons/year)

Region	1983		1984		1985	
	Demand	Supply	Demand	Supply	Demand	Supply
Developed countries	4,800	7,540	5,050	7,650	6,600	8,500
North America	1,900	2,950	2,000	2,800	2,500	3,100
Western Europe	1,700	2,300	1,750	2,500	2,200	3,000
Eastern Europe	570	900	650	950	900	1,000
Japan	600	1,390	650	1,390	1,000	1,420
Developing countries	920	990	1,170	1,290	1,800	1,900
Asia	450	500	550	700	800	800
Middle East	90	20	120	20	150	250
Africa	80	--	100	--	150	150
Latin America	300	470	400	570	700	700
World total	5,700	8,500	6,200	8,900	8,400	10,400

Source: UNIDO, Current World Situation in Petrochemicals, (November 1985), (UNIDO/PC.126).

Polystyrene production is a project that could conceivably be suggested for implementation in Arab countries in view of the availability of styrene. Because of international overcapacity in polystyrene, any such project should be planned with the intention of satisfying the Arab market where a deficit is expected, as is indicated in tables 4.8 and 4.9.

(e) Unsaturated polyester resins (UP-resin)

The importance of unsaturated polyester resins lies in the fact that, when reinforced with fibre glass, they have properties that enable them to replace wood, steel and glass. As such, these resins are considered to have significant industrial importance.

The production of these resins requires the following raw materials, which are derived from aromatics:

- Maleic anhydride;
- Phthalic anhydride;
- Isophthalic anhydride;
- Styrene.

Other raw materials that are not derived from aromatics such as propylene glycol, as well as certain other chemicals, are also needed for the production of unsaturated polystyrene.

At present, only a relatively small Saudi Arabian project exists to produce polyester resins. There are no other Arab projects in this field. However, forecasts indicate an expected deficit in the Arab world of about 100,00 tons per year in 1995, as is indicated in table 4.9.

(f) Polyurethane

The production of polyurethane represents an important outlet for basic aromatics products. Polyurethane has many different uses such as adhesives, plastics used for furniture, synthetic rubber, artificial leather, flexible and insulating foam, etc.

Polyurethane is produced mainly from toluene di-isocyanate (TDI), which is produced from toluene and methylene di-isocyanate (MDI); benzene is the main feedstock. The Arab region is expected to have a deficit of about 150,000 tons per year in 1995, as is shown in table 4.9.

(g) Toluene di-isocyanate (TDI)

TDI and polyol are important raw materials needed for the production of polyurethane.

The manufacture of TDI calls for the supply of toluene, an aromatic product, and a host of other chemicals. TDI is also used in other industrial sectors to provide products that are needed in the Arab region.

(h) Linear alkyl benzene (LAB)

Concern about the environment in the early 1960s has led to the development of new biodegradable raw materials. The introduction of linear alkylbenzene sulphonate (LABS or LAS) signalled the beginning of the modern biodegradable detergent industry.

Over the past four decades, a number of biodegradable petroleum-derived synthetic detergents have been developed with properties that have enabled them to capture specific sections of the market. However, linear alkylbenzene sulphonate today remains the most important biodegradable synthetic detergent because of the suitability of its properties and its cost-effectiveness. Some of the synthetic detergent raw materials that are produced from petroleum fractions (37) are:

- (Branched) dodecylbenzene sulphonates (DDBS, BABS or ABS);
- Linear alkylbenzene sulphonates (LABS or LAS);
- Linear alcohol sulphates (AS);
- Linear alcohol ethoxylates (AE);
- Linear alcohol ether sulphates (alcohol ethoxysulphates) (AES);
- Alpha-olefin sulphonates (AOS);
- Secondary alkane sulphonates (SAS).

UOP introduced their Molex process for the production of linear alkylbenzene, which operates according to the following reaction:

$$\underline{n}\text{-paraffins} \xrightarrow{\text{(catalyst)}} \underline{n}\text{-olefins} + H_2$$

$$\underline{n}\text{-olefins} + \text{benzene} \xrightarrow{HF} \text{linear alkylbenzene}$$

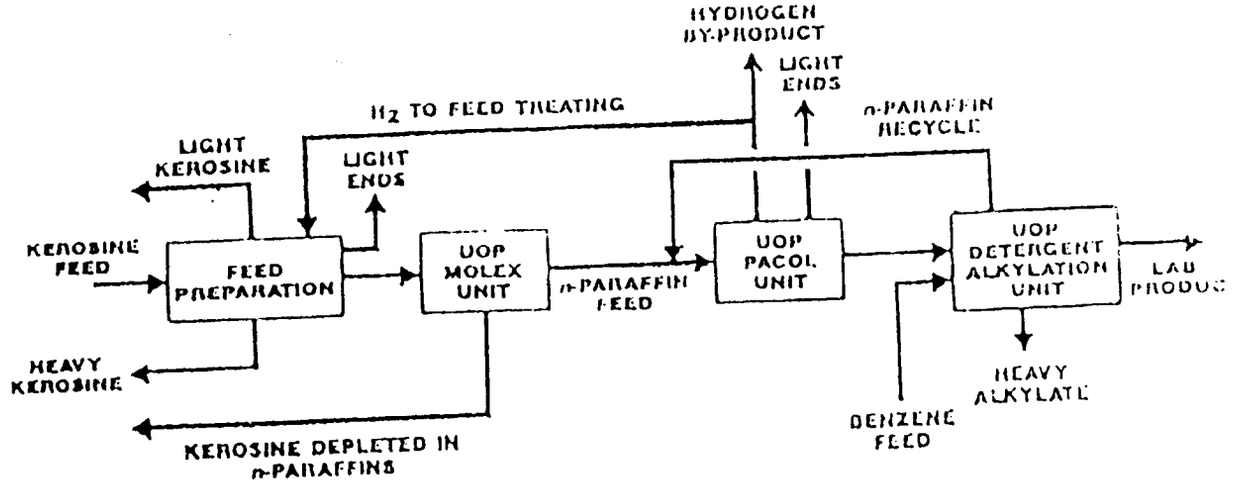
The main advantages of the Molex process over older technologies include the minimization of corrosion problems, yield improvement and the production of hydrogen as a by-product (37). The production of LAB consists of two main sections (as is also indicated in figure 4.9): n-paraffin separation and de-hydrogenation and alkylation.

World production capacity of linear alkylbenzene in 1988 is estimated (37) at around 1.6 million metric tons per year. The forecasted deficit in Arab countries is 120,000 metric tons per year by 1995. This forecast only takes into consideration a 50,000 tons/year project in Iraq.

5. Methanol

Methanol is one of the basic petrochemicals whose international overcapacity (39) has grown from around 3 million tons/year in 1980, to 7.3 million tons/year in 1985; it is expected to reach 10 million tons in 1990, as is indicated in table 4.27. Its present chemical markets, mostly in the industrialized countries, are growing at no more than 4 per cent annually, and its long-expected fuel applications have still to materialize. In oil- and gas-producing countries, methanol constitutes an attractive industrial application for associated and/or dry natural gas. This is because methanol is a relatively easy to produce product that can also be easily transported to international markets. Unless fuel uses develop more rapidly than now seems likely, methanol producers world-wide face a period of major restructuring and a sharp reduction in prices. The main potential and present uses of methanol are presented below.

Figure 4.10. Integrated LAB complex



Source: Data compiled by Universal Oil Products Co. (UOP).

Table 4.27. World methanol demand/supply

(Thousands of metric tons)

Region	1980		1985		1990	
	Demand	Supply	Demand	Supply	Demand	Supply
Developed countries	10,200	13,250	13,350	17,800	16,500	19,400
North America	3,600	4,300	4,700	7,700	6,000	8,400
Western Europe	3,100	4,100	3,900	4,000	4,800	4,000
Eastern Europe	2,400	3,600	3,300	5,700	4,000	6,600
Japan	1,100	1,250	1,450	400	1,700	400
Developing countries	1,080	1,220	1,710	4,460	2,430	9,720
Asia	650	750	1,000	1,650	1,500	2,350
Middle East	50	-	150	1,600	200	2,400
Africa	50	110	80	440	100	770
Latin America	330	360	480	770	630	4,200
World total	11,300	14,500	15,000	22,300	19,000	29,100

Source: UNIDO, Current World Situation in Petrochemicals, (November 1985), (UNIDO/PC.126).

(a) Fuel uses of methanol

Potential fuel uses for methanol include gasoline blending, MTBE and synthetic gasoline, amongst others.

(i) Methyl tertiary butyl ether (MTBE)

The demand for MTBE as an octane booster is increasing rapidly as it is used to replace tetraethyl lead in attempts to protect the environment. It is produced from methanol and iso-butylene.

The main technological processes used for the production of MTBE are:

- The Huls MTBE process, which uses methanol and the ready-produced isobutylene as a by-product from steam or catalytic cracking operations as part of the C4 fraction;

- The Snamprogetti process;

- The Davy McKee process, which converts the butanes into isobutanes by isomerization, and which are further converted by de-hydrogenation into isobutylene. The latter is then reacted with methanol in order to produce MTBE.

At present, international production of MTBE reaches approximately 3 million tons/year, of which 500,000 tons per year are produced in Saudi Arabia. Forecasts are that MTBE demand will increase rapidly in conjunction with the gradual elimination of tetraethyl lead from gasoline in Europe and in other regions of the world.

(ii) Synthetic gasoline

Mobil Oil Company has successfully managed to produce gasoline directly from methanol in the presence of a zeolite catalyst. This gasoline has a relatively high octane count, and is free of sulphur and nitrogen.

(b) Production of chemicals from methanol

Methanol is considered to be an important raw material in the production of a variety of petrochemicals such as formaldehyde, di-methyl terephthalate, acetic acid, methylamine, methyl chloride, etc. In addition, methanol is also used in the production of single cell protein (SCP), whose consumption is expected to be on the rise in the Arab world owing to the process of securing future food sources.

Through their research and development activities, many specialized petrochemical companies are attempting to produce olefins (ethylene and propylene), ethylene glycol, phenol resins, ethyl-benzene, styrene, ethanol, etc. from methanol. Some of the main technological processes for the production of methanol include the ICI and Lurgi processes. In view of the various potential uses of methanol, forecasting its demand is a very difficult task. Table 4.27 presents the UNIDO demand/supply forecast. Other specialized groups believe that these figures are rather optimistic, and that actual 1990 capacities and demand will be less than those predicted by UNIDO.

The production of methanol in the Arab world includes 1,300,000 tons in Saudi Arabia, 330,000 tons in Bahrain, 100,000 tons in Algeria and 660,000 tons in the Libyan Arab Jamahiriya, giving a total of 2.39 million tons per year.

(b) Fertilizer products

The available information indicates that the types and quantities of fertilizers and their related products (see table 2.6) presently produced in the Arab world are as listed in table 4.28.

The world fertilizer supply/demand balance data are tabulated in table 4.29.

Changes in nitrogen production and consumption levels in certain world regions and major countries are presented in table 4.30.

As is indicated in table 4.30, major reductions in the nitrogen(N) fertilizer production levels were recorded in North America, Western Europe and China while increased output was largely centred in the Soviet Union and India. Consumption statistics are dominated by the reductions in the United States and China, while continued growth was in evidence in most other regions and, in particular, in the Soviet Union.

Nitrogen fertilizer trade by regions and major countries in the period 1983/1984 to 1985/1986 is shown in table 4.31.

Table 4.28. Fertilizer production in the Arab world and their percentage of world production

(Thousands of metric tons)

Product	Production	Percentage of world production
Ammonia	5,580	5
Nitrogenous fertilizers	7,835	11
Urea	5,225	
Ammonium sulphate	95	
Ammonium nitrate	1,060	
Calcium nitrate	1,455	
Phosphatic fertilizers	3,396	10
Phosphates	550	
Triple super phosphate	2,846	
Compound fertilizer	2,917	...
MAP/DAP	2,420	
NPK	497	

Note: Total world production is based on the British Sulphur Corporation database.

... Data unavailable.

Table 4.29. World fertilizer supply/demand balance

(Thousands of tons)

	1983/1984	1984/1985	1985/1986 (Preliminary)
Nitrogen			
Production	60,030	74,723	73,094
Available supply[a/]	66,959	72,481	70,901
Consumption	67,184	70,587	70,380
Trade	13,594	15,834	14,536
Phosphate			
Production	33,816	35,586	33,850
Available supply[a/]	32,800	34,517	32,834
Consumption	32,718	34,158	33,301
Trade	7,407	8,833	7,155
Potash			
Production	27,834	28,922	28,515
Available supply[b/]	26,450	27,477	27,090
Consumption	25,493	25,947	25,747
Available supply for fertilizers	25,760	26,103	25,736
Trade	17,567	18,416	17,955

Source: Data compiled from the British Sulphur Corporation database.

a/ Available supply equals production, minus losses incurred by transport, bagging and handling operations, estimated at 3 per cent for nitrogen and phosphate, and 5 per cent for potash.

b/ Available supply less industrial sales.

Table 4.30. Changes in production/consumption levels of nitrogen fertilizers between 1984/1985 and 1985/1986

(Thousands of tons of N)

	Production	Consumption
Western Europe	-735	+94
Eastern Europe	+917	+845
Soviet Union	+867	+671
North America	-2,129	-965
Asia	-27	-659
China	-772	-1,181
India	+406	+325
World	-1,629	-207

Source: Data compiled from the British Sulphur Corporation database.

Table 4.31. Nitrogen fertilizer trade balances

(Thousands of tons of nitrogen)

	1983/1984	1984/1985	(1985/1986)
Western Europe	+580	+841	+17
Eastern Europe	+3,143	+3,744	+4,019
Africa	-293	-103	-446
North America	+772	+1,479	+427
Central America	-429	-387	-339
South America	-154	-352	-453
Asia	-3,502	-4,841	-2,929
Oceania	-100	-146	-86

Source: Data compiled from the British Sulphur Corporation database.

It can be deduced from table 4.31 that the 1985/1986 level of trade was 6.9 per cent higher than that for 1983/1984, and that it was the second highest on record. The combined reduction in imports of China (-1.0 million tons N) and India (-0.66 million tons N) was greater than the reduction world-wide. Major regional increases in imports took place in Africa (+0.28 million tons N) and Western Europe (+0.19 million tons N). This increase in Western European imports was accompanied by a reduction in exports of 0.6 million tons N, resulting in the regional balance barely being in surplus. Eastern Europe's exports continued to increase, and its regional export surplus accounted for 27.6 per cent of world trade. A further major factor in trading patterns was the reduction in the exports of the United States. The figures presented in Table 4.29 indicate the following:

(i) Nitrogen fertilizer

Nitrogen fertilizer in 1985/1986 showed an overall reduction in supply, demand and trade. Compared with the record levels of 1984/1985, production fell by 2.2 per cent, consumption declined by the marginal level of 0.3 per cent, while trade levels dropped by 8.2 per cent.

(ii) Phosphate fertilizer

Phosphate fertilizer for 1985/1986 showed a 5 per cent reduction in world production, while consumption fell back by about half this rate. World consumption was the second highest on record, surpassed only by the 1984/1985 level of 34.1 million tons of phosphate.

Trade in finished phosphate fertilizers in 1985/1986 amounted to 7.155 million tons of phosphate, a reduction of some 19 per cent on the 1984/1985 level of 8.83 million tons. The major factor behind the reduction in world trade was the decrease in the imports of China, which fell from 1.7 million tons in 1984/1985 to 0.4 million tons in 1985/1986.

(iii) Potash fertilizer

As is indicated in table 4.29, potash fertilizer production declined to 28.52 million tons in 1985/1986, a reduction of 1.4 per cent on the 1984/1985 record level of 28.9 million tons. Consumption of potash fertilizers also fell by 0.7 per cent compared with 1984/1985 levels.

The increase in potash output was caused by higher production in the Soviet Union and Asia; in all other regions, however, production declined. Consumption levels on a regional basis were mostly unchanged or reduced; the major exception was Eastern Europe and the Soviet Union, where demand increased by 7 per cent. World potash trade fell by 2.1 per cent in 1985/1986, but still remained 3 per cent higher than in 1983/1984.

The major technological processes for urea have become almost standard recognized operations. Further developments and any possible future technological break-throughs are not expected to produce any drastic changes in current operations.

4.2.3. Identification of future products

This study is concerned with the identification of the products and/or groups of related products that will aid the marketing of existing products. In other words, the proposed projects are such that they depend for their production, either on currently-produced petrochemicals in the Arab world, or on other products for which production can be integrated with present products. At the same time, marketing of the proposed products should not be

more difficult than the present products. In other words, the integration required to achieve further processing of intermediate/ end-products is the key to this problem.

The identification of industrial projects in accordance with the terms of reference of this study have been influenced by the following:

1. The nature of possible markets;

   - Local Arab market;
   - Arab and export markets;
   - Export markets;

2. Main raw materials should come from the products currently produced;

3. The availability of suitable technology.

The objective behind the investment in new projects is to enhance marketability and also to increase the value-added. Therefore, the demand/supply data of Arab petrochemicals, as presented in tables 2.7, 2.8, 2.9 and 4.7 form the basis for selecting projects for the local Arab market. For export and mixed-market projects, care must be exercised to avoid ending up with projects whose products would be subject to higher tariff rates on international markets and, as such, possibly present more marketing obstacles and difficulties. When projects form part of a wider petrochemical integration process, emphasis needs to be placed on overall operation, rather than on the individual project.

As was stated before and indicated previously in the above-mentioned supply/demand tables, the bulk of the present Arab petrochemical industry, with the exception of the Libyan liquid ethylene cracker, depends mainly on the production of ethylene from ethane. Therefore, no significant quantities of valuable by-products (propylene, butadiene, pyrolysis gasoline, etc.), are produced at present by Arab companies. This, in fact, has been and will continue to be, a significant handicap in the diversification and integration of the Arab petrochemical industry. In addition to ethylene and its derivative industry, Arab companies produce methanol, urea and melamine.

In order to achieve some degree of petrochemical integration, which is essential in order to achieve successful diversification, as well as helpful in minimizing a number of marketing obstacles, ideas and suggestions regarding the establishment of new projects, and/or groups of projects, will be presented and discussed briefly. All the suggestions made here should be investigated further with regard to their market consumption/supply data, before any serious studies are carried out. Some of the suggestions regarding project investment will now be discussed.

(a) Projects based on available feedstocks

(i) Polyethylene terephthalate project (PET)

The production of PET requires ethylene glycol (presently produced by SABIC - 500,000 tons/year and the Libyan Arab Jamahiriya - 50,000 tons/year), as the main feedstock, together

with either terephthalic acid (TPA) or di-methyl terephthalate (DMT). Both TPA and DMT require p-xylenes, neither of which are produced at present by Arab companies. Currently, TPA is the preferred raw material because of its purity, especially when produced by the Amoco PTA process. PET is needed as a raw material for the production of polyester fibres, threads and bottles, as well as for tyre reinforcing. As is indicated in table 4.9, forecasts suggest that the Arab market will have a polyester deficit of about 200,000 tons per year.

The estimated investment to produce 90,000 tons/year of PET from TPA is $US 115 million, at 1985 prices.

(ii) Formaldehyde and its derivatives

Formaldehyde is produced by several similar technological processes which allows the selection of the most suitable process to meet the required production capacity, the availability of energy and other operational requirements. This product could be produced economically with a small capacity ranging from 10,000 to 20,000 tons per year.

Methanol is the main raw material. It is used in the presence of a catalyst (mainly silver) in the following processes: Bordon, ICI, Meisner, BASF, Karl Fischer, Mitsui Toatsu, Davy McKee and Degussa. More than 50 per cent of formaldehyde is produced by these processes. It has been reported that the BASF process is probably the most economical for the production of large annual capacities. The total cost for a 125,000 ton formaldehyde plant in the United States was 15 million dollars in 1980. For small production capacities, processes including Reichhold-Perstorp, Haig-Lurgi, Lummus, IFB-CdF and Montedison, which use a molybdenum-iron oxide catalyst, are more suitable than the ones mentioned previously.

Formaldehyde is consumed mainly as a raw material in the production of urea formaldehyde resins, melamine formaldehyde resins and phenol formaldehyde resins. All of these are used widely in the adhesive and plastics sectors. In addition, formaldehyde is used in the production of several other chemical products.

As is indicated in table 2.8, in 1985 Arab consumption was about 80,000 tons. It should be pointed out that an international overcapacity exists at present, therefore this project should be designed with the aim of satisfying local Arab demand.

At present, a project in Algeria produces 6,500 tons of formaldehyde per year, together with 14,000 tons of different resins. Another project with a capacity of 10,000 tons of formaldehyde is reported to be operating in Egypt. The Algerian plant imports the required melamine and phenol from international markets.

Resins are produced in batch operations with catalysts by various processes, including those of: Allied Chemicals, American Cyanamid, Gulf Oil. Monsanto Co., Reichhold Chemicals and Westinghouse Electrical Co. Besides formaldehyde the production of resins requires the following:

- Melamine for the production of melamine formaldehyde resin;
- Urea for the production of urea formaldehyde resin;
- Phenol for the production of phenol formaldehyde resin.

It is therefore suggested that either one or both of the existing formaldehyde projects be expanded and supplied with melamine from the Saudi Arabian SABIC (SAFCO) project. Depending on actual Arab market requirements, the possibility of establishing a project in the eastern Arab countries should also be investigated.

(iii) The acetic acid-PVA project

This project was thoroughly studied with the preparation of a detailed techno-economic feasibility study by the Gulf Organization for Industrial Consulting.

The raw materials for the production of acetic acid are either methanol or ethylene, both of which are readily available. The unused Qatar ethylene could be a suitable feedstock. Otherwise, methanol is available in many Arab countries. The location of such a project could be determined by selecting where the greatest demand lies in order to minimize transportation costs.

Acetic acid is produced either by the oxidation of liquid hydrocarbons (the Wacker-Hoechst process for ethylene oxidation, plus others for the oxidation of other hydrocarbons), or through the use of methanol and carbon monoxide in the Monsanto or BASF processes, which were designed for high-pressure operation. Both the Monsanto and BASF processes utilize catalysts in their operations.

Some acetic acid is processed further in order to obtain vinyl acetate monomer from which the polyvinyl acetate (PVA) is finally produced. PVA is used extensively in the paint industry, and it has many other uses such as adhesives, paper, textiles and other chemicals.

The total estimated investment cost for these acetic acid (80,000 tons/year) and polyvinyl acetate (40,000 tons/year) plants is about $US 85 million.

(iv) Freon project

Freon is used as a cooling liquid for use in air conditioning. Methanol is the main feedstock, which is used as follows:

- The production of methyl chloride by reacting methanol with hydrogen chloride, either in the gaseous or liquid phase;

- The production of chloroform and methylene chloride;

- The production of freon from chloroform and methylene chloride.

Previous discussions have taken place about the production of freon in Arab States, and a detailed market study is already being undertaken to decide on the best location for such a project.

Other possible investment opportunities exist for the following products and petrochemicals:

- TDI and polyurethane;
- Styrene butadiene rubber;
- Polypropylene;
- Acrylic fibres;
- Soda carbonates;
- Alkyd resins;
- Nylon;
- Pipe production and plastic derivatives used in the food and construction industries and in agriculture;
- Single cell protein production from methanol or paraffins.

(v) Petrochemicals integration projects

The Arab petrochemical industry has made remarkable progress since its inception in the late 1970s and has become a recognized source for international markets. Nevertheless, because of the lack of availability of important feedstocks such as aromatic products, propylene and butadiene, and the severe international competition that inhibits the importation of these raw materials, a number of important projects failed to be established owing to economic considerations.

The non-availability of these major raw materials creates a series of insurmountable economical obstacles to the manufacture of many end-products in the various industrial sectors that require these feedstocks. Some of the industrial sectors that are affected include the following:

- Aromatics: synthetic fibres, plastics, synthetic rubber, plasticizers and industrial detergents;

- Propylene: plastics, textiles, synthetic rubber, detergents, coolants and solvents;

- Butadiene: synthetic rubber, plastics and other chemicals.

The interlinkage needed in the production operations of many products is extensive, as many intermediate and/or end-products require more than one feedstock. These feedstocks could come from one of more basic petrochemicals and/or their derivatives, or a mixture thereof. A simple example is the

production of polystyrene, which is considered to be the third most important plastic material after polyethylenes and polyvinyl chloride. Polystyrene is produced through the polymerization of styrene (alkylation in the presence of a catalyst). On the other hand, the production of styrene requires benzene and ethylene as its main feedstocks. At present only ethylene is produced by Arab companies. Basically, therefore, there are no polystyrene plants in the Arab region mainly because benzene is not available. This indicates that in order to have a successful petrochemical industry it is necessary to have a wider variety of feedstocks that will help to integrate the industry.

One of the most important production sources for these raw materials is naphtha steam cracking for the production of ethylene (this is the case with much of the Western European petrochemical industry), where these products, and/or their important feedstocks (pyrolysis gasoline, a raw material for aromatics), constitute by-products. Other ways of producing these materials are, of course, available. Again, as was stated previously, in Arab countries, only the Libyan ethylene project depends on naphtha cracking, while others utilize ethane when these by-products are not produced in significant quantities. Therefore, in view of the prevailing severe international competition, and in order to have a fully independent operation, serious thought should be given to integration in the Arab petrochemical industry.

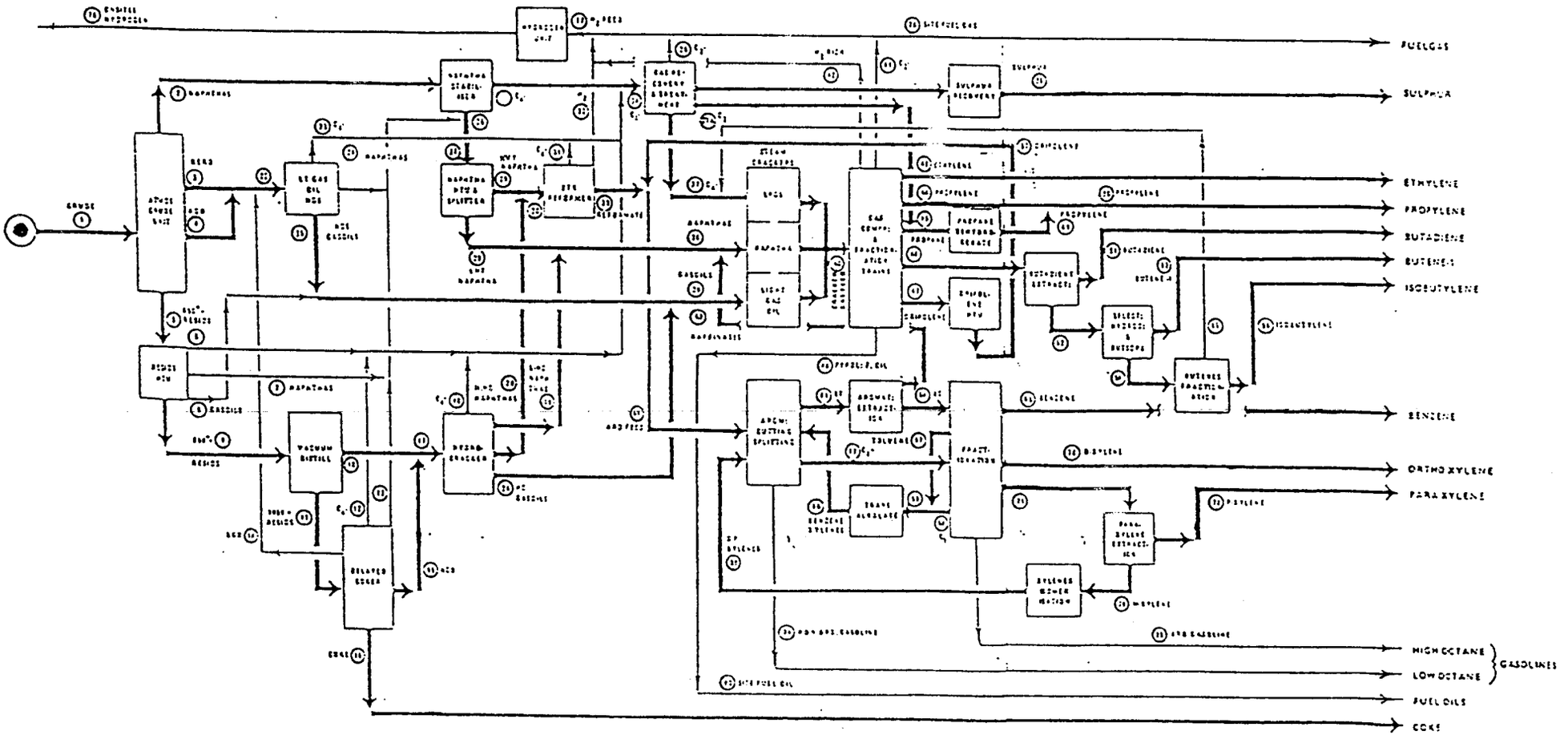
In order to secure the important feedstocks needed for integration such as this the establishment of a petrochemical refinery, based on either light or heavy crude oil should be considered. A schematic diagram (42) of one such petrochemical refinery is presented in figure 4.10. It is worth mentioning that GOIC and OAPEC have carried out a preliminary study on this, and that results suggested that the matter should be pursued further.

The aim of the proposed refinery is that, with the right design, the production of petrochemical feedstocks will be maximized, while the production of gasolines will be minimized. As is clear from figure 4.10, the feedstocks would include ethylene, propylene, butadiene, butene-1, isobutylene, benzene, orthoxylene and paraxylene.

With the availability of these raw materials, a wide range of petrochemical products could be developed so that most of the basic/intermediate products would be in captive use in the process of producing the end-products. In other words, depending on the financing schemes that are available, projects could be established to produce most of end-products listed in this report (see section 4.2.2) under the subtitles: ethylene, propylene, butadiene, aromatics, methanol and fertilizers.

With the present low price of crude oil, which some experts believe will prevail for some time to come, investment in such a petrochemical refinery would lead to a higher value-added for the crude oil and its products and, possibly, to the resolution of some of the marketing obstacles faced by petrochemicals.

Figure 4.11. Schematic diagram for a petrochemical refinery



It is suggested that consideration should be given to the establishment of a petrochemical refinery in one of the Arab States. The estimated cost of building this refinery to the stage of only producing petrochemical feedstocks is around $US 2,000 million. Alternatively, existing downstream refineries could be utilized to produce such feedstocks. The cost of establishing associated projects for further processing in the production of intermediate/end-products will, of course, depend on the number and nature of these products.

The construction of a refinery such as this would give Arab petrochemical companies flexibility to achieve the desired vertical and horizontal integration. However, it is of vital importance that these activities be planned in co-operation with all Arab petrochemical companies, with regard to the type and nature of projects. This would help to avoid local and international competition and would assist the achievement of a continuity of supply. A detailed marketing and techno-economic feasibility study should be carried out in order to verify and ascertain the practicality of this approach.

(vi) Joint ventures between Arab States

There is no doubt that joint ventures between Arab States, if properly conceived, would minimize marketing obstacles by at least securing a bigger local market, creating new ones, and/or utilizing present marketing expertise.

Good examples of these joint ventures are:

a. Gulf Petrochemical Industries Company (GPIC), which was established in Bahrain as a joint venture between Saudi Arabia, Kuwait and Bahrain for the production of ammonia and methanol. At present, SABIC of Saudi Arabia markets the methanol while PIC of Kuwait takes responsibility for the ammonia. Both SABIC and PIC have their own marketing organizations and have wide experience with the respective products. Therefore, it is expected that the cost of marketing ammonia and methanol would be less than if marketed by GPIC itself. This would improve competitiveness and, as such, would minimize some of the marketing obstacles;

b. The joint fertilizer venture between Kuwait and Tunisia is another good example of co-operation. The availability of raw materials and finance in Kuwait, and of the other needed feedstocks, related infrastructure and manpower in Tunisia, has led to a sound agreement and to a profitable project. Some of the Tunisian products will be sent to Turkey as a feedstock for another joint venture project.

In addition to the above, some Arab countries do not have the petrochemical raw materials or the financial resources to start projects on their own. Nevertheless, these countries possess large populations, and new markets for some of the petrochemical end-products could easily be found if projects were established there.

The proposal is for existing Arab petrochemical companies to provide raw materials and some financial support, while the host countries would provide the land, other needed infrastructure and the required labour.

Conceivably, the joint venture could be expanded to include some developed countries which could provide the technology and the required machinery and equipment. This idea is generally welcomed by the European Economic Community, provided that adequate preparation (including realistic market information and project and country identification) has been carried out.

Unfortunately it is not possible in the present study to give concrete suggestions regarding the nature of the projects and/or specification of the countries. However, one exception will be made.

It has been reported that VCM/PVC production facilities have been built in Egypt. At present, they do not have ready access to ethylene feedstocks. It is possible that an arrangement could be made with QAFCO in Qatar to provide the ethylene under a joint-venture agreement that could benefit both countries. This could offer a simple solution for the marketing of the ethylene, provided that adequate and reasonable compensation can be agreed upon.

There is no doubt that joint ventures such as this could secure a number of outlets for some petrochemical products, and that it could help to minimize the various marketing obstacles that are encountered in industrialized markets.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

The petrochemical industry witnessed a phenomenal growth during the 1950s and 1960s. After the 1973 adjustment of oil prices, the growth of the industry started to slow down. This was further magnified following the second oil price adjustment in 1978/1979. With the growth rate decreasing during this period, traditional producers in the developed countries continued their investment momentum, and this resulted in an over capacity situation for the industry.

At the same time, oil producing countries, with their good financial resources and the flaring of their associated natural gas, started to establish petrochemical plants. This added further to the petrochemical capacity surplus.

As a result of the above, competition became fierce at a time when demand was slowing down. This led to plants being loaded at about 60 to 70 per cent of their designed capacities, and this caused substantial losses for producers and forced them to begin restructuring, which favoured the oil-producing countries.

When the Arab petrochemical plants came on stream in the early 1980s, the developed countries, the major consumer markets, started to impose additional tariffs and protectionist policies on Arab products. Therefore, different marketing obstacles were created. This prompted Arab petrochemical and fertilizer producers and other organizations concerned with this subject to search for a solution to these problems. Among these efforts was the joint undertaking of this study by ESCWA and AIDO.

The marketing issues that have been identified in this study are not exhaustive, but it is believed that they are the major ones to affect the Arab petrochemical industry. Based upon the findings of this study, the following conclusions can be drawn.

(a) Trade barriers and protectionist policies

The developed countries, where the major petrochemical consumer markets are to be found, have enacted various trade barriers and policies in an effort to project their local industries from others in the developing countries, especially the Arab States. Higher tariff rates, ceilings on the quantities imported, as well as other regulations were imposed and have helped to diminish the competitive advantage of the Arab petrochemical products in these markets.

(b) The increasing role of new forms of trade

The role of new forms of trade (e.g. counter trade, barter, etc.) has significantly increased. It is thought that this factor does not have a noticeable effect on the marketing of Arab products. Depending on the situation, this factor can either be an advantage or a disadvantage to marketing activities.

(c) Lack of co-operation with developing countries

Per capita consumption of petrochemical products in the developing countries is much less than that in industrial countries, as is indicated in table 2.36. Therefore, there is great potential for the opening of new markets in developing countries especially in the more populated States. Such markets could be created through co-operation in joint ventures between petrochemical producers and the populated States. In addition, co-operation can also help to establish an Arab market (in line with the EEC market), where the custom duties in any Arab country on Arab products was completely abolished.

(d) Lack of marketing information system

Successful marketing can only be achieved through well-established organizations with experience in sales and full knowledge of markets, including the competitor's policies, prices, plans, etc., and with access to realistic forecasts for the demand/supply of each product, together with the requirements of the consumer (type, grade, etc.).

This factor has been a handicap for new Arab producers. Therefore, serious efforts, even though costly, must be made by Arab companies in order to establish the appropriate methods and procedures needed to acquire vital market information.

(e) Competition with international companies

During the early planning stages in the establishment of Arab petrochemical plants, feedstock prices varied from one plant to another but ranged between $US 0.2 to 1 per million British thermal units (Btu) (1,000 cu ft of natural gas). At that time, the average international value was about $US 6 per million Btus. This gave a future competitive advantage to Arab products compared with those from Europe and Japan, and slightly less against United States producers.

Unfortunately, with the drastic 1985/1986 decrease in oil prices and the imposition of trade barriers and protectionist policies in the major markets, the Arab advantage has been eroded. This, no doubt, has added serious marketing difficulties that must be resolved.

(f) Transport of products

Transport costs no doubt add to the landing price of any exported product. This was, of course, considered in the feasibility studies related to the establishment of Arab petrochemical plants. Yet, because of the decrease in oil prices, the consequent minimization of the anticipated production advantages and the present severe competition, it is of definite interest to attempt to lower transport costs and thus increase Arab ability to compete on international markets.

(g) Continuity of supply/storage facilities

Adequate storage facilities at the receiving end in export markets are a basic element needed to guarantee the continuity of supply of products.

Customers need to be assured of the continuity of supply of products before they are willing to sign long-term supply contacts. If a "continuity of supply" status is not achieved, major difficulties in the marketing of many products will arise.

In addition to the above identified issues, the possibilities of identifying new outlets for products other than in existing markets must also be considered.

One possibility is to invest in the manufacture of new products by the further processing of presently available petrochemicals. In this way new products could either have readily available local/export markets and/or fewer marketing obstacles.

This is considered to be part of an integration scheme where existing exportable products can be captively used in Arab plants. In order to be a success, this integration scheme needs the close co-operation of existing Arab companies. A more detailed discussion follows under subsection (i).

Another important possibility is to plan a wide petrochemical integration scheme so as to acquire the flexibility to economically produce local Arab petrochemical requirements (see tables 2.8, 2.11, 4.8 and 4.9), and, therefore, to minimize imports. As has already been mentioned several times, production of the required products is not economically feasible at this time because of the lack of vital raw materials such as propylene, butadiene and aromatic products. Therefore, a way must be found to make these products available at reasonable and economical prices.

Other outlets could be found through economic co-operation with other developing countries to establish new markets (see subsection (c) above).

Another important issue is the fact that, at present, no co-operation exists between Arab producers, either on technical or on marketing issues. This, of course, creates a duplication of efforts and, as such, adds additional costs to products.

(h) Technical support (after-sales services)

Again, as in the case of marketing information, Arab petrochemical producers are new to this field. This activity is vital to the success of marketing operations and, therefore, problems and difficulties will emerge if the technical support for after-sales services are not provided for consumers. It should be realized that the provision of these services is costly, but unfortunately they are needed in order to achieve success in marketing the various products.

(i) Co-operation between existing Arab companies producing petrochemicals and fertilizers

- A minimization of local and international competition;
- The affirmation of security and continuity in the supply of products;
- The securing of a higher share in international markets if negotiations are carried out collectively;
- The minimization of costs through possible swap agreements, as well as a decrease in transportation and marketing costs, etc.

A review of the status of the existing Arab petrochemical industry reveals that many Arab projects were established as joint ventures with a foreign partner, who is responsible for marketing a large share of the products. Therefore, it could be expected that the marketing of these products by the foreign partners would be co-ordinated with the overall marketing activities of the mother company. But, when it is realized that the same foreign partners are also competitors in their home countries, as well as on international markets, the difficulties of achieving collective co-operation between the two in order to market Arab products become evident. In fact, as has been stated by a European producer who is also a partner in an Arab company, some European producers object to importing Arab products marketed by American companies, when the latter makes no attempt to open the American market to these products.

In many ways, the establishment of Arab projects as joint ventures with a foreign partner has its merits and advantages. The foreign partner helps with the technology, finance, construction and erection, marketing and management (possibly for a limited time). On the other hand, resistance by the foreign partner to full co-operation with other Arab projects, similar to the co-operation that exists between European producers under the umbrella of CEFIC (APPE) is only to be expected.

Despite the above, co-operation between Arab companies is needed and, therefore, serious endeavours should be made to achieve it. The nature of this co-operation, and the ways and means of applying it, should be negotiated and agreed on. Co-operation could be started by the formation of a Federation of Arab Petrochemical Industries, in line with the Arab Federation of Chemical Fertilizer Producers. This petrochemical federation could be charged with co-ordinating activities and collecting suitable production and marketing information (including prices and the nature of international markets), and other similar activities. This information would be of great importance to Arab companies.

AIDO has attempted to pave the way for the establishment of such a federation, or to expand the activities of AFCFP to include petrochemicals. However, in October 1986 AIDOs Board of Arab Ministers of Industry decided to leave this subject to the producers themselves. During the 1986 Petrochemical

Seminar in Bahrain, an Action Group was formed to co-ordinate the various petrochemical activities. At present, AIDO, GOIC and OAPEC are attempting to establish a joint data base, which is a definite step in the right direction.

The above gives an indication of the interest in and importance of establishing a Federation of Arab Petrochemical Industries.

5.2. Recommendations

Based on the findings of this study, the following action, related to resolving marketing issues is recommended.

(a) Trade barriers and protectionist policies

It is natural for any country/region to do whatever is possible to protect local industry by enacting suitable policies to achieve this. Trade barriers are imposed not only on petrochemicals, but rather, if needed, on all industrial outputs. Recently, the United States imposed more than 200 per cent custom duties on microchips from Japan. In addition, when Spain joined the Common Market, the United States threatened to impose high tarrifs on European agricultural products, unless compensation was paid for the loss arising from the inability to export American products to Western Europe. Both issues have since been resolved.

The best way for Arab countries to achieve access to major markets is to negotiate collectively with the governments concerned, on policies aimed at regulating all exports/imports from/to all Arab countries. By so doing, petrochemicals would only from a part of these negotiations.

At present, negotiations between the Arab Gulf States and the European Community is continuing without any conclusive results being achieved so far. It is therefore suggested that:

(i) All Arab countries affected by the protective measures join in these negotiations;

(ii) The range of negotiations should be expanded to include most import/export commodities.

(b) Co-operation with developing countries

The potential for opening new markets to Arab petrochemicals in the developing countries, if properly planned, is very promising. The goal would be to increase per capita consumption and to eliminate all trade barriers between these countries. This would create new and additional outlets other than the major markets in developed countries.

It is therefore recommended that common markets, either on a bilateral and/or regional basis, should be established. This could be achieved through:

(i) The elimination of all trade barriers, including customs duties, between the countries of the parties concerned. As a good starting point, an agreement between all Arab countries should be considered, with preference being granted to Arab products over those of their competitors;

(ii) The establishment of joint industrial projects in populous Arab countries whose financial resources are relatively limited. Arab petrochemical producers could supply raw materials and financial support, while the recipient country would provide labour, land and some of the required infrastructure.

These joint ventures could be expanded to include some developed countries (triangular co-operation), who would particulate by providing the technology, equipment and machinery, as well as some financial support. As a prerequisite for success, it is essential that adequate preparation by an appointed specialized committee should be made, regarding the identification of projects and overall requirements, including finances and raw materials, the market, etc.

(c) Competition with international companies

As was stated before, the initially anticipated competitive advantage of Arab petrochemicals was drastically eroded by the recent decline in oil prices. Because major markets are still located in developed regions whose competitiveness was greatly enhanced, not only because of the decline in oil prices, but also as a result of the sharp decrease in the US dollar exchange rate against their currencies. The latter has resulted in the buying power of the Federal Republic of Germany and Japan being increased by almost 200 per cent.

To summarize, feedstock prices in Western Europe and Japan have declined to the point where their petrochemical industry has become competitive with Arab petrochemicals in terms of production costs.

It is recommended, therefore, that the basis for establishing the prices of Arab petrochemical/fertilizer feedstocks should be reconsidered in order to bring them into line with changes in feedstock prices in Europe and/or Japan.

It is also recommended that Arab countries utilize their raw materials as feedstocks for new projects, on the basis of their socio-economic viability and the benefit to be gained from the value added through processing them.

(d) Transport of products

Discussion related to product transport costs can only be carried out logically in terms of lowering, but never eliminating them. Costs could be lowered through co-operation efforts between all Arab producers, in order to have appropriate ships for the different products (see table 3.9 for the variations in transport costs).

Therefore, it is recommended that all Arab petrochemical producers join together under an agreement to organize and, possibly acquire, transport facilities, specifically, standard ships that are designed for specific products. This would ensure the availability of adequate, reliable, yet reasonable, shipping capacities.

It is also recommended that Arab producers co-operate in setting up joint storage and distribution facilities, particularly in geographically suitable Arab countries such as Algeria, Morocco and Tunisia.

(e) Continuity of supply

A guarantee of continuity of supply is vital to the consumer, if the supplier is to reach the successful conclusion of convincing the customer to sign a long-term agreement to buy his products. Several elements are involved.

(i) Reliable transportation means (common ships for Arab producers);

(ii) Common storage and terminal facilities at the receiving and producing ends;

(iii) Agreement between Arab suppliers to provide customers with the products in case of any shut-down;

(iv) Contingency agreements between Arab producers to exchange feedstocks essential for the running of their plants, when needed.

Therefore, it is recommended that Arab producers co-operate to provide and ensure the continuity of supply. Studies by experts should be carried out in order to determine the optimum economical condition for this activity.

(f) Technical support (after-sales services)

As was stated before, vital technical support can only be minimized through meaningful co-operation between Arab petrochemical producers who export to the same market. Overall costs would be reduced by the elimination of all duplications of manpower, laboratories, offices, etc.

Therefore, it is recommended that serious efforts should be made so as to achieve the desired co-operation in providing technical support activities. A committee could be set up to study the details of this co-operation.

(g) Petrochemical integration

The integration of the petrochemical industry is a scheme that was successfully followed by the traditional producers in an attempt to capture markets and improve the overall profitability of their operations. The Arab world could use this experience to its advantage.

In order to achieve successful integration, the availability of the most important raw materials must be assured at reasonable prices. The great majority of these raw materials could be made available through the establishment of a petrochemical refinery using crude oil as the starting feedstock.

This refinery could be designed (see figure 4.11) so as to maximize the production of petrochemical feedstocks, and at the same time minimize gasoline

production. The cost of such a refinery is estimated at around 2 billion dollars. GOIC and OAPEC have carried out a preliminary study for the establishment of such a refinery, and it was suggested that techno-economic feasibility studies for specific projects be carried out in order to determine those that could utilize petrochemical raw materials produced as by-products in Arab refineries. It is strongly recommended that a petrochemical refinery be established, and/or that existing downstream refineries be utilized to produce feedstocks such as aromatics, C3- and C4-olefins for the Arab region.

(h) Recommended individual projects

Based on available products and expected future deficits in the Arab world, the following projects were recommended for implementation:

(i) Polyethylene terephthalate project (PET);
(ii) Formaldehyde and its derivatives project. It is suggested that the present project in Algeria be expanded and that the possibility of establishing a new one in the ESCWA region be considered;

(iii) Acetic acid-PVA project. A feasibility study has already been completed by GOIC. This should be updated and the project promoted;

(iv) Freon project.

(i) Co-operation between existing Arab petrochemical and fertilizer companies

There is a definite need to establish a Federation of Arab Petrochemical Industries, similar to the European Federation CEFIC/APPE.

At present, there is the Arab Federation of Chemical Fertilizer Producers, which has been operating for many years. It is believed to have been a great success in providing useful information related to production statistics and technology.

Therefore, it is recommended that Arab petrochemical producers should establish a practical mechanism to achieve co-operation and co-ordination among them, either in the form of a federation or otherwise.

Information sharing is one of the useful mechanisms for co-operation, and existing data banks in some Arab companies, e.g. SABIC, could assist a great deal in improving the marketing capabilities of other Arab companies.

Also, the sharing of existing storage facilities among Arab producers, as well as participation in the activities of international sales offices already established by some Arab companies, e.g. in London, Hongkong and the United States, could benefit other Arab producers, thereby avoiding the need of setting-up similar facilities by them.

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