THE POLYMER INDUSTRY IN ISRAEL AND THE WORLD

PRESENT STATUS AND FUTURE PROSPECTIVES

Dr. Henrique David Frenkel

Technion - Israel Institute of Technology
The Samuel Neaman Institute
for Advanced Studies in Science
and Technology

Society of Israel Plastics Industry
Ministry of Industry and Trade
Chief Scientist Office
MATIMOP - Israeli Industry
Center for R&D

הטכניון - מכון טכנולוגי לישראל
TECHNION - ISRAEL INSTITUTE OF TECHNOLOGY

THE S. NEAMAN INSTITUTE
FOR ADVANCED STUDIES IN SCIENCE & TECHNOLOGY

מוסד שמואל נאמן
למחקר מתקדם במדע ובטכנולוגיה

THE POLYMER INDUSTRY

IN ISRAEL AND THE WORLD:

PRESENT STATUS AND FUTURE PROSPECTIVES

Dr. Henrique David Frenkel

This publication is part of the study on
Future Policy Alternatives for the Israeli Polymer and Plastics Industry
carried out by the S. Neaman Institute for Advanced Studies in
Science and Technology for the Society of Israel Plastics Industry *
Ministry of Industry and Trade * Chief Scientist Office *
MATIMOP - Israel Industry Center for R & D

November 1990

Technion City, Haifa 32000, Israel, Tel. 237145 / 292329.קרית הטכניון, חיפה 32000,טל
Telex 471170 SNI IL FAX 4231889

תעשית הפלסטיקה בישראל ובעולם:
תמונת מצב והתפתחויות עתידיות

ד״ר הנריק דוד פרנקל

פורסם בנובמבר 1990
מוסד שמואל נאמן למחקר מתקדם
קרית הטכניון חיפה 32000

THE POLYMER INDUSTRIES IN ISRAEL AND THE WORLD:
PRESENT STATUS AND FUTURE PROSPECTIVES

TABLE OF CONTENTS

ADDENDUM
EFFECT OF THE GULF CRISIS ON THE INTERNATIONAL PETROCHEMICAL INDUSTRY

The first half of 1990 had been a relatively bad year for the international petrochemical and polymer industries. There were unexpected decreases in consumption and polymer prices were decreasing to mid 1980 normal price levels.

Due to the above the first-half petrochemical industry results - in the world- were generally worse than expectations. Although the fall in basic chemicals and polymer prices was the main reasons for the decline in profits, in the second quarter the benefits of lower feedstock costs were more than offset by several adverse factors. These included : poor demand, further destocking, unfavorable currency movements, weak pricing and rising costs.

The Persian Gulf Crisis certainly became the strongest negative impact in an already deteriorating profit outlook trend. Feedstock costs have now increased significantly - due to the increased crude oil prices- and although producers are trying to recover the effects of this through higher selling prices, operating margins will come under further pressure.

As a result of the wider economic consequences of higher oil prices, demand - which was already soft - will weaken further. At the same time, pricing will be restrained by additional capacity - now probably unnecessary due to decreasing demands- coming on stream within the next two years.

The poor outlook for the chemical industry will impact all sectors of the business. The more basic petrochemical and polymer producers will obviously be worst affected.

However, the specialties and engineering sectors of the polymer industry are bound to be also affected by the slowdown in global growth. Initial estimates consider that if the current oil prices are sustained, global growth will be reduced by at least 0.5 % per year. The damage to certain sectors of the economy will be even worse. For example, oil prices of $ 30/barrel or more will strongly hit the vehicle industry, a key market for specialty and engineering polymers. This is not good news for the US auto industry, which even before the Iraqi invasion of Kuwait, was having a very hard time in boosting sales, having to heavily discount prices in order to promote sales.

The above example is true for consumption patterns of consumer goods and appliances in general and many polymer producers will have to reassess their portfolios and planned expansion programs.

At first sight, it appears that we are once again at the beginning of a recession directed period similar to the one that the World faced in the early 1980`s, rather than at the threshold of prosperity, progress, innovation and increased consumption patterns, as originally forecasted in this study.
October 10, 1990.

THE POLYMER INDUSTRIES IN ISRAEL AND THE WORLD PRESENT STATUS AND FUTURE PROSPECTIVES.

SECTION 1 - INTRODUCTION.

This study is part of an overall study, carried out at the Neaman Institute, on the Future Alternatives of the Plastics and Polymers in Israel.

The objectives of the present study are :

1. To review the status of the monomer and polymer manufacturing industries in Israel at the beginning of the 1990s; their interrelation with the plastics manufacturing industry. To present an analysis of the potential of this industrial sector.

2. To review the monomer and polymer manufacturing industries in the world, at the beginning of the 1990s. To discuss global trends of the industry and to present forecasts of supply and demand of polymers in the various geographical regions over the next decade.

3. To discuss products innovation stemming from changes in polymer and polymer characteristics. Technological changes that are taking place in the worldwide polymer industry.

4. To evaluate how will the existing/potentially expanded Israeli monomer/polymer industries influence plastics manufacturing.

5. To analyze the present direction and interrelation of the petrochemical industry in Israel with respect to the local plastics industry; consequently to propose directional change if necessary.

The information and analyses presented in this study have been prepared by using extensive information from :

* Various reports on the Israeli Petrochemical Industry, prepared by H.D.Frenkel, the Committee for the Petrochemical Industry and by Tahal.
* Discussions, visits to the industry and other information available to the writer in respect to the Petrochemical Industry in Israel. Information from the Plastics Division of the Ministry of Industry and Trade.
* Information on the world-wide status and global trends of polymers have been prepared based on :
** SRI`s Chemical Economics Handbook and other SRI reports
** Modern Plastics
** Chem Systems reports
** Chem Intell specific products reports
** The New Face of the World Petrochemical Sector - Implications for Development Countries. World Bank Technical Paper 84 - 1988.
** International Status Report on Plastics for 1988 ; The British Plastics Federation, on behalf of International Plastics Associations Directors -IPAD-, issued in August 1989.
** Extensive literature survey of European Chemical News 1987-1990, and other technical periodicals.

FIGURE 1.1

OBJECTIVES OF THE STUDY

1. **OVERVIEW OF STATUS OF MONOMER AND POLYMER MANUFACTURING IN ISRAEL**

2. **OVERVIEW OF STATUS OF MONOMER AND POLYMER MANUFACTURING IN THE WORLD**

3. **DISCUSS PRODUCTS INNOVATION - CHANGES IN PRODUCTS**
   - CHANGES IN TECHNOLOGY

4. **EVALUATE HOW WILL POTENTIALLY EXPANDED ISRAELI POLYMER INDUSTRY INFLUENCE PLASTICS MANUFACTURING**

5. **EVALUATION IF DIRECTION OF THE PETROCHEMICAL INDUSTRY IN ISRAEL IS BENEFICIAL TO PLASTICS MANUFACTURING SHOULD THERE BE DIRECTIONAL CHANGES ?**

SECTION 2 - STATUS OF THE PETROCHEMICAL INDUSTRY IN ISRAEL AT THE BEGINNING OF THE 1990s.

2.1 Existing plants and products.

The petrochemical industrial sector - defined as those industries that produce chemicals from petroleum fractions - consists in Israel of six operating enterprises, which operate fifteen plants:

* Oil Refineries Ltd. - Ethylene Plant
* Israel Petrochemicals Ltd. - Polyethylene and Polystyrene Plants
* Gadot Petrochemical Industries - Aromatics Extraction and Upgrading plants, Phthalic Anhydride, Fumaric Acid and Aliphatic Solvent plants
* Israel Electrochemicals Frutarom Ltd.- VCM and PVC plant
* Dor Chemicals Ltd.-Methanol, MTBE, Formalin and Para-formaldehyde
* Fertilizer and Chemicals - Ammonia

One new enterprise - Carmel Olefins Ltd. has recently been set-up and is currently in the planning stages for the implementation of a Polypropylene Plant.

2.2 Industry Background.

The total turnover of the petrochemical industry for the year 1988 was almost 250 millions dollars, 54 % of this amount was earned from export sales and the rest from local market sales of polymers and intermediates.
The Israel plastics industry was, without doubt the major consumer of the petrochemical products locally produced, accounting for 89 % of total local market sales volume; i.e. slightly over 100 million dollars.

In 1988 the industry upgraded some 550,000 tons of petroleum gases and naphtha into a total of 391 thousand tons salable (non-fuel) products; selling in the local market some 151 thousand tons products, including almost 100 thousand tons polymers to over 200 local customers.
Petrochemical exports reached some 240 thousand tons, including some 79 thousand tons of polymers to some 200 customers in over 30 countries.

The total historical investment in the petrochemical industry in Israel was about 345 million dollars; the current replacement value of the various operating plants is about 420 million dollars.

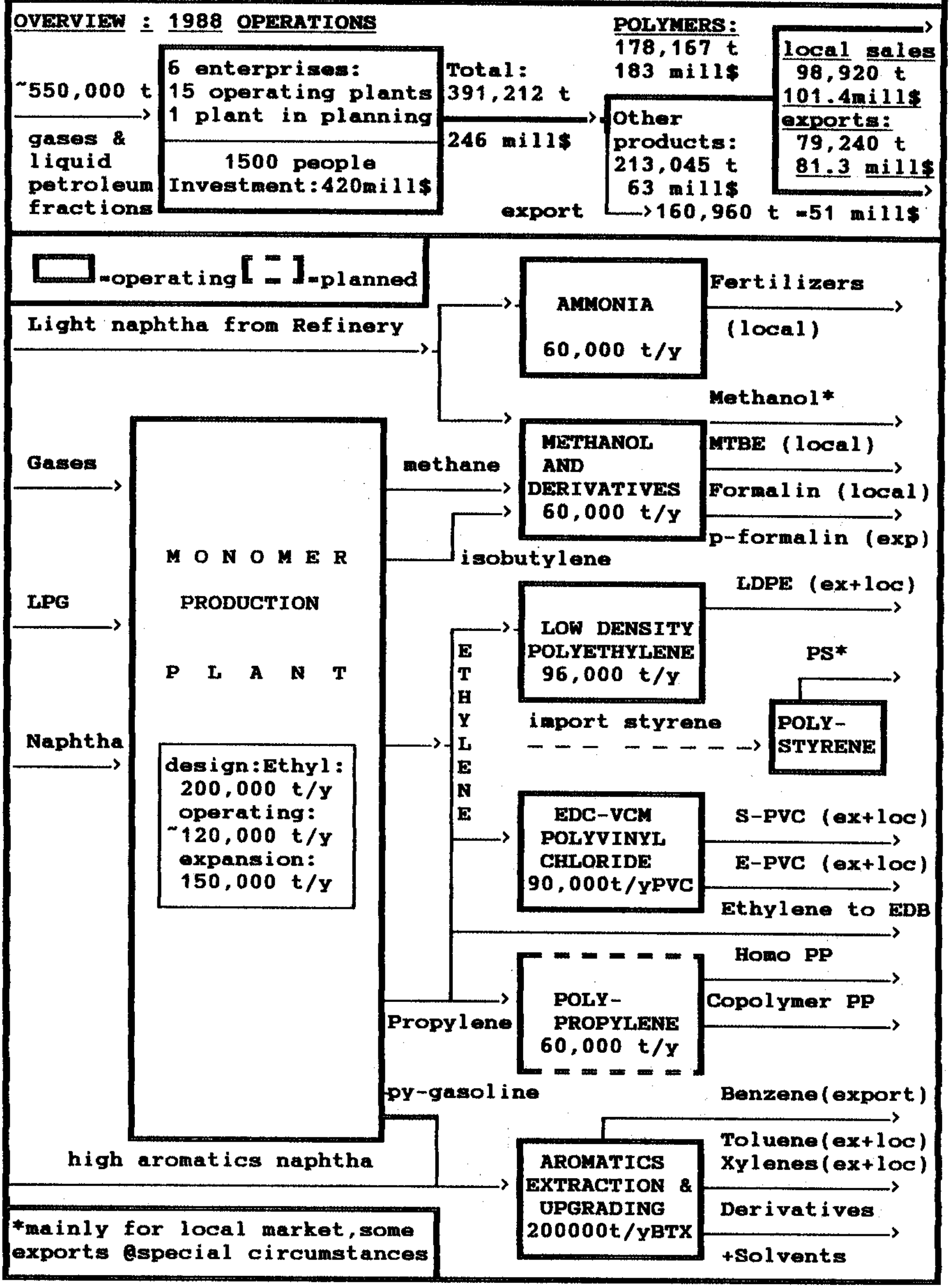
The petrochemical industrial sector provides a direct permanent job occupancy to about 1,500 people, about one third of them in direct operations, and the rest in maintenance, engineering, technical services, administrative, sales and managerial activities.

Table 2.1 presents summary production, sales and turnover information for the petrochemical industry for 1988.
Figure 2.1 presents a schematic overview of the industry's 1988 operations and a schematic flow chart showing the interrelation of the various plants.

TABLE 2.1 PETROCHEMICAL INDUSTRY IN ISRAEL - 1988 OPERATIONS DETAILS

PRODUCT	PRODUCTION	DESTINY AND VALUE OF PRODUCTS LOCAL MARKET			EXPORT MARKETS			TOTAL SALES		PROCESSING	POLYMERS LOCAL MARKET		EXPORT MARKETS	
	MT/year	Mt/year	$/MT	000'$/year	Mt/year	$/MT	000'$/year	Mtons/year	000'$/year	Mt/year	Mt/year	000$/year	Mt/year	000$/year
ETHYLENE	115,399	2,235	$371	$829				2,235	$829	113,164				
BTX														
BENZENE	32,480				32,480	$340	$11,043	32,480	$11,043					
TOLUENE	29,400	6,000	$285	$1,710	23,400	$263	$6,154	29,400	$7,864					
ORTHO-XYLENE	14,630				14,630	$380	$5,559	14,630	$5,559					
PARA-XYLENE	12,600				12,600	$630	$7,938	12,600	$7,938					
SOLVENT XYLENE	47,600	7,000	$325	$2,275	40,600	$300	$12,180	47,600	$14,455					
POLYETHYLENE	87,367	60,000	$1,050	$63,000	27,367	$1,075	$29,420	87,367	$92,420		60,000	$63,000	27,367	$29,420
POLYSTYRENE	11,000	11,000	$1,080	$11,880				11,000	$11,880		11,000	$11,880		
VCM	80,100									80,100				
PVC	79,800	27,920	$950	$26,524	51,880	$1,000	$51,880	79,800	$78,404		27,920	$26,524	51,880	$51,880
METHANOL	58,500	16,000	$250	$4,000	24,700	$180	$4,446	40,700	$8,446	17,800				
MTBE	11,250	300	$270	$81	10,950	$246	$2,694	11,250	$2,775					
FORMALIN	25,000	20,550	$170	$3,494				20,550	$3,494	4,450				
P-FORMALDEHYDE	1,600				1,600	$620	$992	1,600	$992					
TOTAL	606,726	151,005	4,751	113,793	240,207	5,034	132,306	391,212	246,099	215,514	98,920	101,404	79,247	81,300

FIGURE 2.1 THE PETROCHEMICAL INDUSTRY IN ISRAEL - FLOW CHART



2.3 Plastics related Petrochemical Plants in the Country.

2.3.1 MONOMERS (OLEFINS).

Location : At the Refinery; Haifa Bay. Owner :Oil Refineries Ltd.

General :

Normally referred to as the Ethylene Plant, this plant upgrades gas and liquid fraction from the refinery producing ethylene and also a number of co-products :

* Hydrogen - partly sold as such
* Methane - sold and used as fuel only
* Propylene - which presently is used in gasoline production and in the LPG (cooking gas) pool, will be upgraded to polypropylene
* a C_4 butadiene/butenes rich stream; only the isobutylene is upgraded in synthesis with methanol for the production of MTBE. The other components-in the remaining stream- are used either as fuel; or hydrogenated and recycled as feedstock to the same plant. This stream includes a potential source for monomers for elastomers and polymers production.
* pyrolisis gasoline -a high aromatic stream, used as raw material for BTX (Aromatics) extraction.

Capacity :

Design : 200,000 tons ethylene/year. Built: for 130,000 tons/year
Operating : 115-125,000 tons ethylene/year.
Currently being expanded to 150,000 tons/year.
This expanded capacity corresponds to: 0.3 % of world-wide capacity
Minimum economic commercial capacity is 500,000 tons/year Ethylene.

Feedstocks:

* Flue gases from the refinery, otherwise used as fuel
* LPG, whenever in excess-over home cooking market requirements; would otherwise be used as fuel.
* C_4 stream -plant`s own co-product- hydrogenated, after extraction of isobutylene; would otherwise be used as fuel, until new upgrading facilities are installed.
* light naphtha, which otherwise would have to be exported. (since this plant requires more naphtha than locally available, certain quantities have to be imported)

Investment:

Historical : 112 million $. Replacement Value: 170 million $.

Manpower : Direct : 86 people

Brief Process Description :

Refinery gases are fractionated into it`s components in a distillation train; ethane, propane, butane and naphtha are steam cracked at high temperatures in separate furnaces. The ethane, propane, butane and the longer aliphatic molecules of the naphtha, are so converted to olefins and aromatics.The cracked effluent is then quenched, the lighter fraction is separated from the heavy ends, compressed and the various components are separated at low temperatures in the superfractionation train. The fraction of ethane/ethylene is first separated from the lighter gases (Hydrogen and methane);then from the heavier C_3+fraction.Ethylene is split-off from ethane by superfractionation,treated and piped to consumers. The heavier by-products are separated in additional distillation columns.Fig. 2.3.1 presents an Overview of this plant.

FIGURE 2.3.1

MONOMERS PRODUCTION PLANT : MARKETS, ECONOMICS AND OVERVIEW

Sales :(Basis: 1988 operations)

Local Market-Ethylene		
Met.Ton	$/total	000 $
115,400	100.0%	73,000

DISTRIBUTION OF LOCAL MARKET CONSUMPTION

IPE -Low Density Polyethyl.: 85,510 tons
Frutarom - PVC : 27,650 tons
Dead Sea Bromine - EDB : 2,240 tons

Basic Upgrading Economics: Comparison with other plants $/ton

1988 operations,Note p2.16	UnitedStates	West Europe	ISRAEL
Income: Ethylene	445	532	515
Costs : Raw Materials-net	(22)	(58)	(215)
Other Variable	(47)	(87)	(80)
Fixed Costs	(76)	(65)	(93)
Working Captl.Interst	(5)	(6)	(2)
Contribution (Cash Margin)	295	316	125

COMPETITIVENESS:

IMPAIRED BY FOLLOWING MAJOR TECHNOLOGICAL AND ECONOMIC FACTORS:

* VERY LOW PLANT CAPACITY; LARGE CAPACITY ONLY POSSIBLE THROUGH NEW LARGE ETHYLENE CONSUMER MINIMUM ECONOMIC COMMERCIAL UNIT: 500,000 T/Y
* INSUFFICIENT CO-PRODUCTS VALORIZATION
* LOW TURN-DOWN RATIO CAUSES INCREASED STEAM, POWER AND FUEL REQUIREMENTS
* HIGH MANPOWER AND OTHER FIXED COSTS
* OUTDATED FURNACE DESIGN

MONOMERS PRODUCING PLANT- OVERVIEW 1988 OPERATIONS

gases,LPG,naphtha → ~ 370,000 tons

Capcty:120,000tEt
Product:115400tEt
Investment: 170M$
Manpower:86people
Turnover:73 M$/yr

→ H2+Methane
ethylene → LDPE :85,510 tons
→ PVC :27,650 tons
propylene → EDC : 2,310 tons
→ PP*
→ C4 to MTBE/recycle
→ py-gasoline to BTX

2.3.2 LOW DENSITY POLYETHYLENE PLANT
Location: Next to Refinery;Haifa Bay. Owner:Israel Petrochemicals
General :
The plant consists of three older smaller units, each one of 12,000 tons per year and one larger 60,000 tons/year unit.
The plant produces over 30 different grades of low density polyethylene, ranging between 0.915-0.924 density, with flow indices ranging between 0.2 up to 50. It produces some 13 types of film grade, 7 injection molding, 7 blow molding and various pipe, extrusion coating and cable sheething grades. Some infra-red thermic film grades are produced, as well as types with ultra-violet protection. Carbon black blended polyethylenes for film, pipes and blow molding are also available.

Capacity :
Present: 96,000 tons LDPE/year.
Currently being expanded by 20,000 tons LDPE/year.
The expanded capacity corresponds to about 0.7 % of worldwide capacity.

Feedstocks:
* Polymer grade Ethylene.

Investment:
Historical : 63 million $. Replacement Value: 80 million $.

Manpower : Direct : 150 people.

Brief Process Description :
Ethylene, transferred by pipeline from the ethylene plant at the Haifa refinery is compressed to 200-300 atmospheres by a multistage compressor; after mixing with oxygen and with ethylene being recycled from the system, the gaseous mixture is compressed to a final operating pressure above 2000 atmospheres. The high pressure compressed gas is fed into a jacketed tubular type reactor together with peroxide, which is used as a reaction initiator.
The polymer -ethylene mixture is then expanded through a special rotary valve in order to separate the polymer from unreacted ethylene. The latter is cooled, purified from low-molecular weight polymers (waxes) and recycled to the high pressure compressor suction. The polyethylene is further expanded to a lower pressure to release the ethylene still dissolved.
The degassed polyethylene is washed, pelletized in a conventional pelletizing extruder where antioxidant and slip agent are added by proportioning pumps. The polymer pellets are then dried and collected in a sampling silo, where the product is analyzed. After the analysis the polymer is blended in a gravity blender and pneumatically conveyed to the storage and bagging section.

The process-licensed by the leading licensor in the LD polyethylene field - allows to cover the complete LDPE applications. Each specific grade is obtained by selecting the proper polymerization conditions and by a suitable proportioning of catalysts.
Figures 2.3.2 and 2.3.2.A present an Overview for this plant.

FIGURE 2.3.2

LOW DENSITY POLYETHYLENE PLANT : MARKETS

Sales :(Basis: 1988 operations)							
Local Market			Export Markets			Total	
Met.Ton	%/total	000 $	Met.Ton	%/total	000 $	Met.Ton	000 $
60,000	68.7%	63,000	27,367	31.3%	29,420	87,367	92,420

Local Market Growth (1983-1988)						
Year	Local Market		Export Markets**		Total**	
	Met. Tons	%Change*	Met. Tons	%Change*	Met. Tons	%Change*
1983	34,000		20,700		54,700	
1984	41,000	20.6%	32,900	58.9%	73,900	35.1%
1985	46,000	12.2%	29,100	-11.6%	75,100	1.6%
1986	54,000	17.4%	22,800	-21.6%	76,800	2.3%
1987	58,000	7.4%	31,700	39.0%	89,700	16.8%
1988	60,000	3.4%	27,367	-13.7%	87,367	-2.6%
average 1983-88	12.0% per year		5.75% per year**		9.8% per year**	
	*Change /previous year.**limited by ethylene available.					

DISTRIBUTION OF LOCAL MARKET CONSUMPTION
(includes indirect exports)

BY END - USERS			BY CONVERSION PROCESSES		
End Use Market	Tons/y	%total	Conversion Process	Tons/y	%total
Agriculture	27,000	45	Film for packaging	26,000	43.3
			Film for agriculture	12,500	20.8
Packaging	20,000	33.3	Film -other uses	4,250	7.1
			Piping extrusion	7,700	12.8
Piping	7,700	12.8	Injection molding	3,500	5.8
			Blow molding	1,400	2.3
Home uses and Others	5,300	8.8	Other processes	4.650	7.8

FIGURE 2.3.2.A

LOW DENSITY POLYETHYLENE PLANT : ECONOMICS

Basic Upgrading Economics: Comparison with other plants $/ton

1988 Operations, Note p2.16	UnitedStates	West Europe	ISRAEL
Income: LDPE	980	1,030	1,058
Costs : Raw Materials	(459)	(548)	(530)
Other Variable	(35)	(48)	(120)
Fixed Costs	(65)	(80)	(160)
Working Captl.Interst	(10)	(10)	(20)
Contribution (Cash Margin)	411	344	218

COMPETITIVENESS:

IMPAIRED BY FOLLOWING MAJOR TECHNOLOGICAL AND ECONOMIC FACTORS:

* ETHYLENE - LACK OF ASSURED AVAILABILITY
HIGH PRICES -COMPARED TO OIL/GAS COUNTRIES
LIMITED PRODUCTION CAPACITY

* WIDE-RANGE PRODUCT DISTRIBUTION DUE TO SOPHISTICATED DIVERSIFIED END - USE MANUFACTURE

* RELATIVELY LOW CAPACITY IN FOUR SMALL UNITS CAUSES INCREASED MANPOWER, UTILITY AND CATALYSTS

* VERY HIGH COST OF PERBORATES INITIATOR DUE TO COMPLICATED AND COSTLY FORM OF SHIPMENT

LOW DENSITY POLYETHYLENE - OVERVIEW 1988 OPERATIONS

ETHYLENE → ~ 89,110 tons
Inc. 3,600 Tons imports

Capcty: 96,000t
Product: 87,367
Investment: 80M$
Manpower: 150 peop
Turnover: 92 M$/yr

60,000 t Local Market

LDPE
Agricult: 27,000
Packagin: 20,000
Piping : 7,700
Other* : 5,300

Export : 27,637

* includes injection, blow molding; household goods, etc.

2.3.3. POLYSTYRENE

Location: Next to Refinery;Haifa Bay. Owner:Israel Petrochemicals

General :

The plant, built in the early 1970's, using Monsanto's batch process. The plant produces General Purpose (GP), High Impact (HI), and Foamed Expandable Polystyrenes. The capacity of the plant is between 15-16,000 tons/year. The raw material - Styrene- is imported.

Four grades of Crystal (GP) Polystyrenes are produced; their Melt Flow Index (MFI) ranging from 4-16 and their Izod impact strength being 0.30-0.35 ft.llbs/inch of notch. Three of these grades are for vacuum injection molding conversion to packages, housewares, toys, kitchenware. The fourth grade is for extrusion of sheets, and is used as a diluent with High Impact in various thermoforming and extrusion applications.

Three grades of High Impact (HI) Polystyrenes are manufactured; one is a standard high impact grade for injection and thermoforming of thin walled containers, housewares, toys, etc. ; the other two grades are for extrusion and injection molding of very thin containers, tableware, small appliances. refrigerator parts, drinking cups, shoe heels, etc. The Melt Flow Index (MFI) of these grades ranges between 2.5-5.5, and the impact strength is in the order of 1.1-1.4 ft.lbs/inch of notch.

There are two basic grades of Foamed Expandable Polystyrenes. Both grades are also available as fire-retardant grades. Foamed polystyrene is primarily used for packaging, building crates and building and insulation blocks.

Capacity :

Present: 15,000 to 16,000 tons Polystyrene /year, depending on grade distribution..

This capacity corresponds to about 0.3 % of worldwide capacity. There was a program to increase the plant capacity to 24,000 tons/year; however lack of styrene availability and roaring prices of this monomer since 1988 have paralyzed such expansion interest.

Feedstocks:

* Styrene from imports.

Investment:

Historical : 4 million \$. Replacement Value: 8 million \$.

Manpower : Direct : 45 people, included allocated maintenance.

Brief Process Description :

Styrene is polymerized in a water medium containing the necessary initiators, dispersion and suspension agents. The styrene is polymerized in a batch reactor until the desired degree of polymerization is reached. Total volatiles are reduced to below 50 ppm. The polymer is then moved to a wash kettle where acid is added and the water is removed by centrifuging and drying.

High impact grades are manufactured by adding to the virgin material elastomers and mineral oils.Expandable grades are manufactured by adding blowing agents during the polymerization. Figure 2.3.3 presents an Overview for this plant.

FIGURE 2.3.3.

POLYSTYRENE PLANT OVERVIEW

Sales :(Basis: 1988 operations)

Local Market (only)			DISTRIBUTION OF LOCAL MARKET CONSUMPTION
Met.Ton	%/total	000 $	Crystal General Purpose PS : 40 %
11,000	100.0%	12,000	High Impact Polystyrene : 30 % Expandable Polystyrenes : 30 %

Basic Upgrading Economics: Comparison with other plants $/ton

1988 operations,Note p2.16	UnitedStates	West Europe	ISRAEL
Income: Polystyrene	1,100	1,100	1,158
Costs : Raw Materials	(659)	(600)	(900)
Other Variable	(85)	(100)	(155)
Fixed Costs	(45)	(65)	(130)
Working Captl.Interst	(11)	(10)	(12)
Contribution (Cash Margin)	300	325	(47)

PLANT WORKED AT A LOSS IN 1988/1989 ; i.e. POLYETHYLENE PROFITS SUBSIDIZES POLYSTYRENE; TAX DECREASES MAKE OPERATIONS WORTHWHILE BREAKEVEN OPERATIONS REQUIRE $ 300 DIFFERENTIAL BETWEEN STYRENE AND POLYSTYRENE PRICES.

COMPETITIVENESS:

IMPAIRED BY FOLLOWING MAJOR TECHNOLOGICAL AND ECONOMIC FACTORS:

* PLANT NOT COMPETITIVE TECHNOLOGICAL, QUALITYWISE AND FROM ECONOMIC STANDPOINT LIMITED PRODUCTION CAPACITY

* TECHNOLOGICAL PROBLEM: BADGE PROCESS QUALITY : OUTDATED, OBSOLETE CONTROLS POLYSTYRENE OPERATION NOT VIABLE WITHOUT STYRENE

POLYSTYRENE OVERVIEW OF OPERATIONS

STYRENE-imported ~11,520 tons ——>
various rubbers, ——>
chem+solvents

Capcty: 15,000 t
Product:12,000 t
Investment: 8 M$
Manpower:45people
Turnover:13 M$/yr

12,000 t
Local Market

——> GP:40%
——> HI:30%
——> Exp:30%

2.3.4 POLYVINYL CHLORIDE PLANT.

Location : Acre -South industrial area.
Owner: Electrochemical Industries-Frutarom Ltd.
General:

The complex - for the manufacture of polyvinyl chloride - consists of three steps :

a. Synthesis of EDC,from ethylene with chlorine, and ethylene with hydrochloric acid.

In addition, EDC is also imported from overseas shipment, and direct off-loading through a line located at jetty across from the plant. EDC imports constitute 36-40% of total EDC consumed (i.e ~46,000 tons/year.

b. Production of VCM through cracking of the EDC.

c. Polymerization of the VCM into PVC.

The VCM plant is designed for a capacity of 100,000 tons per year; the plant was built in the mid 1970s, but had many start-up and initial operating difficulties, and never reached full capacity. PVC manufacture is in a 90,000 tons per year suspension PVC (SPVC) plant and in an old 6,000 tons per year emulsion PVC (EPV) plant. The SPVC plant also had many initial difficulties and only in the last years the plant has been operating more or less smoothly at a capacity of up to 80,000 tons/year.

The company produces eight types of SPVC , free-flowing powder having a particle size between 100-150 microns, with K values ranging from 57 to 74; relative velocity (1% Cyclohexanone @ 25°C) Four grades of EPVC are produced, as fine white powder with K values ranging between 67 and 79, specific gravity of 1.4, average particle size ranging from 1-2 microns.

Feedstocks:

* Polymer grade ethylene
* Chlorine from Frutarom`s chloro-soda plant
* EDC - imported

Investment: Historical:69 million $. Replacement Value:100 million$
Manpower: Total workers in Frutarom : 540 people
Special Problems : Frutarom has had severe technical and financial problems since the implementation of their new plant in the late 1970s, due primarily to the fact that the plants were built without proper technology and know-how; this caused late start-up at below design capacity. This factor coupled with decreased PVC markets and prices, very high overheads and overall costs brought the company into severe financial difficulties. The heavy financial burden has now been wiped-out, and as of 1987 the plant is operating at capacity and at a profit.

*Process Scheme

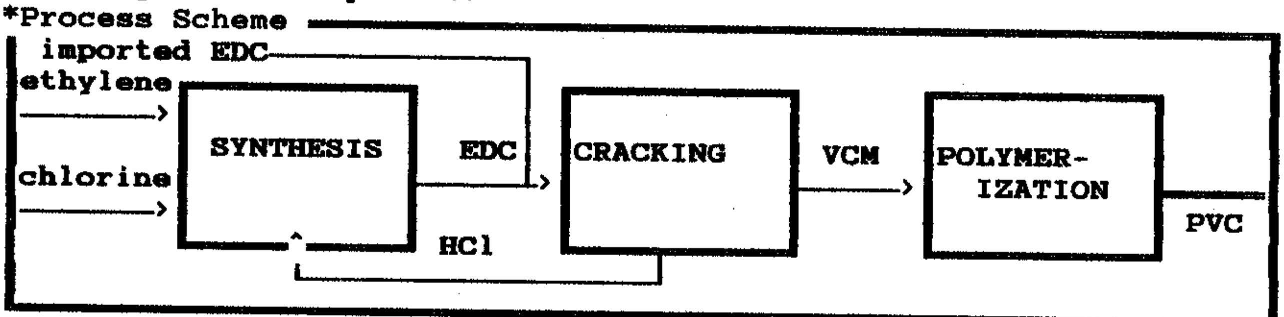


Figure 2.3.4 presents an Overview of the EDC/VCM/PVC complex.

FIGURE 2.3.4

POLYVINYL CHLORIDE (PVC): MARKETS, ECONOMICS AND OVERVIEW

SALES TO LOCAL AND EXPORT MARKETS (1984-1988)

Year	Local Market		Export Markets**		Total**	
	Met. Tons	%Change*	Met. Tons	%Change*	Met. Tons	%Change*
1984	22,700		51,600		74,300	
1985	22,100	- 2.6%	47,600	- 7.8%	69,700	- 6.2%
1986	27,500	24.4%	47,400	- 0.4%	74,900	7.5%
1987	31,700	15.2%	51,800	9.3%	83,500	11.5%
1988	27,900	12.0%	43,700	-15.6%	71,600	-14.3%
average 1984-88	4.3% per year		- 2.8% per year			
	*Change /previous year.					

Basic Upgrading Economics: Comparison with other plants $/ton

1988 operations,Note p2.16	UnitedStates	West Europe	ISRAEL
Income: PVC	879	956	982
Costs : Raw Materials	(424)	(405)	(476)
Other Variable	(21)	(54)	(117)
Fixed Costs	(83)	(212)	(227)
Working Captl.Interst	(9)	(10)	(31)
Contribution (Cash Margin)	342	275	131

COMPETITIVENESS:

IMPAIRED BY FOLLOWING MAJOR TECHNOLOGICAL AND ECONOMIC FACTORS:

* ETHYLENE - LACK OF ASSURED AVAILABILITY
HIGH PRICES -COMPARED TO OIL/GAS COUNTRIES
LIMITED PRODUCTION CAPACITY

* TECHNOLOGICAL AND QUALITY PROBLEMS DUE
TO UNAVAILABILITY OF PROPER KNOWHOW ASSISTANCE
AS NO PROPER TECHNOLOGY & KNOW HOW WAS PURCHASED

* INCREASED MANPOWER AND VERY HIGH OVERHEAD

* BURDENED BY FINANCIAL PROBLEMS IN PAST

2.4 POLYPROPYLENE PLANT.

Location : Next to the Refinery; Haifa Bay.
Owner : Carmel Olefins Ltd. a joined company, owned 50% by ORL and 50% by IPE.

General :

Carmel Olefins Ltd. was set-up so as to integrate the operations of the ethylene plant and its derivatives; thus it is expected that ethylene, polyethylene existing operations would be transferred to this entity from their respective present owners;i.e. ORL and IPE, respectively.
As a first step the company is engaged in planning and construction of a 60,000 tons/year polypropylene plant, upgrading the propylene co-product from ethylene production.
Although the Israeli market for polypropylene has increased considerably, and is already over 40,000 tons per year, the pace of project implementation is very slow.
Although the project has been fully justified and recommended for implementation ever since 1981 (at the time the Israeli polypropylene market was less than 16,000 tons/year), the new company was only set-up in 1988, and due to the continuous difficulties between ORL and IPE, no actual implementation activity has taken place to present.
It is understood that a licensing agreement has been finalized with Himont, still in 1989, and that at present -late May 1990, the company`s directors are evaluating and selecting potential engineering companies. Since the pace has been -to present -very slow and erratic, no start-up date can be projected at this time. Furthermore, since Carmel Olefins is already distributing their licensors product, earning a commission profit, their incentive to proceed implementation of a polypropylene plant in Israel, may be decreasing, especially so in view of the many new polypropylene plants which are being built currently world-wide.

The following are some of the major features of the new project:
Capacity: 60,000 tons/year. It is expected that co-polymer capacity will be about 2/3 of the over-all capacity. Production of homo and co-polymers (with ethylene)
Feedstock: C_3 stream from the ethylene plant
Manpower : Estimated to be about 100 people, out of which some 36 people in operations.
Process Scheme:

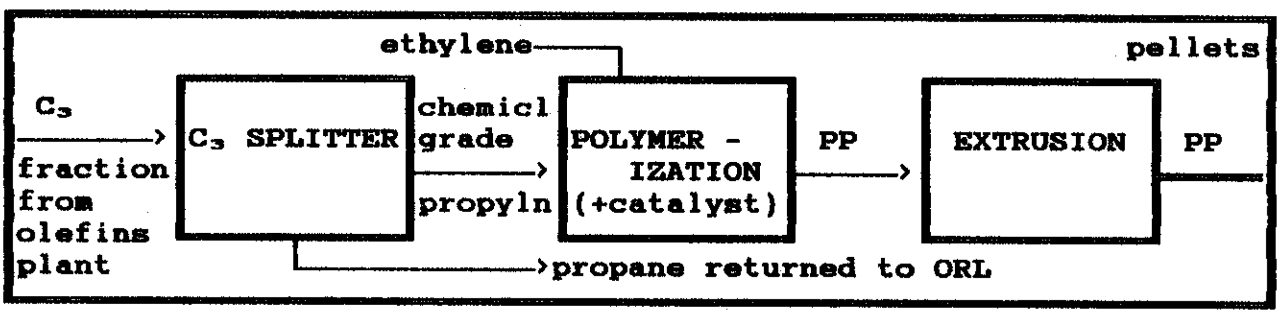


Figure 2.4.1 presents an expected Overview of the PP plant.

FIGURE 2.4.1
POLYPROPYLENE PLANT - OVERVIEW

LOCAL MARKET GROWTH (imports) and ASSUMED MARKET DISTRIBUTION

Year	Local Market	
	Met. Tons	%Change*
1982	16,500	
1983	17,800	7.9%
1984	19,500	9.6%
1985	20,200	3.6%
1986	33,500	65.8%
1987	40,400	20.6%
1988	32,900	-18.6%
1989	39,300	19.5%
average 1983-88	13.2% per year	

MAJOR USES AND APPLICATIONS IN ISRAEL	
1.Furniture, large parts	35 %
2.Injection molding**	18 %
3.Fibers and fabrics	17 %
4.Films for packaging, bags	12 %
5.Blow molded containers	3 %
6.Trays, medical parts, batteries, specialties,	3 %
7.Strappings, cords, nets	3 %
8.Vacuum forming, extrusion coatings, other processes	4 %
9.Imported by distributors	5 %

*Change /previous year.**includes irrigation fittings .

Basic Upgrading Economics: Comparison with other plants $/ton

(Basis 1990 estimates)	UnitedStates	West Europe	ISRAEL
Income: Polypropylene	880	915	915*
Costs : Raw Materials(net)	(296)	(295)	(206) **
Other Variable	(119)	(131)	(128)
Fixed Costs	(67)	(92)	(96)
Working Captl.Interst	(10)	(10)	(20)
Contribution (Cash Margin)	388	387	465

* West European price in April 1990.
**Taken at Naphtha + 1.15 premium for propylene + 3% ethylene

BASED ON LOW PROPYLENE FEEDSTOCK PRICE POLICY, THE ISRAELI PROPOSED POLYPROPYLENE PLANT SHOULD BE HIGHLY PROFITABLE.

POLYPROPYLENE- OVERVIEW OF EXPECTED 199? OPERATIONS

ethylene: ~1,800 t →
propylene: 60,000 tons net →

Capcty: 60,000t
Investment: 65M$
Manpower: 100 peop
Turnover: ~55M$/yr

→ 40,000 t Local Market:
- Furniture 12,000
- Injecti.: 9,000
- Fibers* : 8,000
- Film : 6,000
- Other** : 5,000

→ Export :20,000

* includes cordage,straps.**includes vacuum,blow molding,coating

2.5 THE PETROCHEMICAL INDUSTRY IN ISRAEL IN RELATION TO POLYMER SUPPLIES.

Figure 2.5.1 presents a summarized overview of the operations of the petrochemical industrial sector for 1988, showing production and sales in quantities and values. Polymer production is segregated out to show the heavy proportion of revenue from polymer sales.

Although polymer production represents less than half of total petrochemical products, the total income stemming from polymers accounts for almost 3/4 of total revenues from petrochemical products.

While other petrochemical intermediates - mainly aromatics and solvents- are exported, polymers are routed almost equally (54%) to the local and export markets.

FIGURE 2.5.1

SALES FIGURES FOR PETROCHEMICALS AND POLYMERS -1988

PRODUCTION AND SALES

	PRODUCTION		LOCAL MARKET			EXPORT MARKET		
	MTons	MM $	MTons	MM$	%$	MTons	MM$	%$
Petrochemicals	391.2	246.1	151	113.8	46	240.2	132.3	54
Polymers	178.2	182.7	98.9	101.4	56	79.3	81.3	44
%Polymers on Total Petrochemicals	45.6	74.2	65.5	89.1		33.0	61.4	

It is clear that with local consumption increasing, the ratio of polymers being exported will decrease.

Figure 2.6 presents very interesting information regarding upgrading factors; the average cost of raw materials for petrochemicals in 1988 was $ 165/ton. The average sales price of all petrochemicals sold during 1988 - for local market and export was $ 629 per ton product, representing an upgrading factor of 3.8 of product sold or an average of $ 464/ton.
The average sales price for polymers, during 1988, was $ 1025/ton, for local and export market sales, resulting an upgrading factor for polymers for 1988 of 6.2 (naphtha + gases); this is equivalent to almost $900/ton of product sold.

FIGURE 2.5.2

UPGRADING FACTORS FOR PETROCHEMICAL INDUSTRY AND RELATION TO POLYMERS -1988

UNIT PRODUCT VALUE $/Ton -AND UPGRADING FACTOR ON RAW MATERIAL*			
	TOTAL	LOCAL MARKET	EXPORT MARKET
Petrochemicals $/t Upgrading Factor *	$ 629/t 3.8	$ 754/t 4.6	$ 551/t 3.3
Polymers $/t Upgrading Factor *	$1025/T 6.2	$1025/T 6.2	$1025/T 6.2

* Based on $ 165/ton average feedstock cost (gas+naphtha)- 1988

GENERAL NOTE TO SECTION 2

It is important to point out that all the cost comparisons presented in this section are for 1988 operations; this year is representative of proper profitable operations and constitutes a proper basis for cost comparisons between Israeli, USA and West Europe operations.The period 1982-1986, was a period of excessive losses in the industry, with dumping practices and severe difficulties in even meeting cash costs,thus it is not proper for comparative purposes.

SECTION 3 - ISRAEL'S POLYMER REQUIREMENTS AND SOURCES OF SUPPLY

3.1 POLYMER REQUIREMENTS 1982 TO 1989.

Low Density Polyethylene (LDPE), Polyvinyl Chloride (PVC) and Polystyrene (PS) have been and are being supplied primarily from local manufacture, while all other polymers and plastic materials have been and are imported.

3.1.1 Quantities Consumed.

Figure 3.1 summarizes quantities consumed from 1982 to 1989, showing average yearly growth. This table is composed from the following basic data:

* **POLYMERS CONSUMED LOCALLY FROM LOCAL MANUFACTURE.**

This subject has been extensively discussed in Section 2. The various figures in Section 2 present local supplies of LDPE, PVC and PS for local market requirements; included are polymers used as raw materials for manufacturing plastic products for exports; i.e. indirect exports.

* **POLYMERS IMPORTED.**

Customs information are presented by value of imports in Dollars; estimates of tons imported have been calculated based on the customs import values, divided by average yearly prices in West Europe plus freight to Israel. Figure 3.1 also includes import of commodity polymers to Israel between 1982 and 1989. Figure 3.1.1 presents summaries of imports of polymers into Israel in 1989.

3.1.2 Rate of Growth of Polymers in Israel 1982-89.

From Figure 3.1 it can be seen that the growth of polyolefins in Israel during the 1980s has been way above the growth in GNP, and on the whole is very impressive; the exception to the above has been the demand for PVC, which has been erratic. This will be discussed in more detail later on.

The overall growth rate of polymers in Israel, averaged almost 8 % per annum during the period 1982-1989; the peak was reached during 1986-1987, decreasing considerably in 1988. There was a slight improvement during 1989.

Polypropylene showed the highest rate of growth for the period 1981-1989 -over 13 % average per year-; however, while the growth between 1982-1985 was normal -at an average rate of 7.2 % per year- there was a sizeable jump in 1986/87, when apparently a number of new polypropylene consuming projects went on stream and there was a sporadic increase of 20,000 tons. After a considerable decrease during 1988, probably due to increased price and stock availability considerations,the consumption in 1989 returned to close to the 40,000 tons/year level - as in 1987.

Low Density Polyethylene has had a consistent growth every year ; between 1982 and 1987 the rate averaged over 12.5 % per annum; in 1988 there was an increase of less than 1 %, with a moderate recovery of 3 % in 1989. Over the whole period, LDPE shows an average growth of about 10% per year.

FIGURE 3.1

ISRAEL'S POLYMER REQUIREMENTS 1982 TO 1989.

POLYMERS PRODUCED IN ISRAEL

LOW DENSITY POLYETHYLENE - LDPE - -Thousand Tons

	1982	1983	1984	1985	1986	1987	1988	1989
LOCAL	32	34	41	46	54	58	60	60
IMPORTED	7	8.5	8.5	7.8	9.5	13.4	12	14.3
TOTAL	39	42.5	49.5	53.8	63.5	71.4	72	74.3
% growth pr.year		9.0%	16.5%	8.7%	18.0%	12.4%	0.8%	3.2%
Avg.%/yr 1982-89	> 9.7%							

POLYSTYRENE - PS - -Thousand Tons

	1982	1983	1984	1985	1986	1987	1988	1989
LOCAL	11.1	12.0	12.4	13.7	11.6	12.0	11.0	10.0
IMPORTED	3.1	4.3	4.1	2.9	5.3	10.2	13.6	11.7
TOTAL	14.2	16.3	16.5	16.6	16.9	22.2	24.6	21.7
% growth pr.year		14.8%	1.2%	0.6%	1.8%	31.4%	10.8%	-11.8%
Avg.%/yr 1982-89	6.3%							

POLYVINYL CHLORIDE - PVC - -Thousand Tons

	1982	1983	1984	1985	1986	1987	1988	1989
LOCAL	20.0	24.7	23.3	22.9	27.5	31.7	27.9	32.0
IMPORTED	11.2	12.3	14.4	13.4	12.2	13.3	9.3	4.7
TOTAL	31.2	37.0	37.7	36.3	40.7	45.0	37.2	36.7
% growth pr.year		18.6%	1.9%	-3.7%	12.1%	10.6%	-17.3%	-1.3%
						-9.6% (1987-89)		
Avg.%/yr 1982-89	2.3%							

FIGURE 3.1
ISRAEL`S POLYMER REQUIREMENTS 1982 TO 1989.

IMPORTED POLYMERS

HIGH DENSITY POLYETHYLENE - HDPE- -Thousand Tons

	1982	1983	1984	1985	1986	1987	1988	1989
IMPORTED	21.2	24.1	24.8	27.1	28.5	31.9	33.3	33.9
% growth pr.year		13.7%	2.9%	9.3%	5.1%	11.4%	4.4%	1.9%
Avg.%/yr 1982-89	<7.0%							

POLYPROPYLENE - PP - -Thousand Tons

	1982	1983	1984	1985	1986	1987	1988	1989
IMPORTED	16.5	17.8	19.5	20.2	33.5	40.4	32.9	39.3
% growth pr.year		7.9%	9.6%	3.6%	65.8%	20.6%	-18.6%	19.5%
Avg.%/yr 1982-89	13.2%							

TOTAL MAYOR (COMMODITIES) POLYMERS -Thousand Tons

	1982	1983	1984	1985	1986	1987	1988	1989
LOCAL	63.1	70.7	76.7	82.6	93.1	101.7	98.9	102.0
IMPORTED	59.0	67.0	71.3	71.4	89.0	109.2	101.1	103.9
TOTAL	122.1	137.7	148.0	154.0	182.1	210.9	200.0	205.9
% gr./yr		12.8%	7.5%	4.1%	18.2%	15.8%	-5.2%	3.0%
Avg.%/yr 1982-89	7.75%							
% Local								

DISTRIBUTION OF POLYMER CONSUMPTION - by grades -percentages

YEAR	1982		1983		1984		1985		1986		1987		1988		1989	
	MTY	%	MTY	%	MTY	%	MTY	%	MTY	%	MTY	%	MTY	%	MTY	%
LDPE	39	32	43	31	49	33	54	35	63	35	71	34	72	36	74	36
PS	14	12	16	12	17	11	17	11	17	9	22	11	25	12	23	11
PVC	31	25	37	27	37	25	36	23	41	23	45	21	37	19	37	18
HDPE	21	17	24	17	25	17	27	18	28	15	32	15	33	17	34	16
PP	17	14	18	13	20	14	20	13	33	18	40	19	33	16	39	19

FIGURE 3.1.1

POLYMER IMPORTS TO ISRAEL IN 1988 AND 1989 in MTons and MM$**						
	1988			1989		
	M Ton *	MM $	$/ton	M Ton *	MM $	$/ton
Produced in Israel	34.9	41.0	1,175	30.7	36.3	1,182
Not Produced Israel						
Commodities	66.2	76.1	1,149	73.2	80.0	1,093
Specialties	80.3	103.9	1,294	96.1	107.6	1,120
Total Imports	181.4	221.0	1,218	200.0	223.9	1,195

*Tons are calculated from import values (Customs)+ Average prices
** Imports by grades are shown as part of Figure 3.1

High Density Polyethylene showed a steady growth throughout the period averaging somewhat less than 7 % per annum. It is interesting to point out that while HDPE consumption in 1982 was considerably higher than polypropylene (by about 5 thousand tons per year, equivalent to about 20%), the opposite is true at present. In 1989, polyproylene consumption was over 39 thousand tons, while HDPE consumption was about 35 thousand tons. This is primarily due to the decreased prices of polypropylene, its many new and diversified applications, while there have not been drastic new innovations in HDPE product innovations and/or price changes.

Consumption of polystyrene has been erratic; an average yearly increase of about 7-8 % in the 1970s, followed by a relatively large jump in 1983 of close to 15 % , after which there were yearly increases ranging between 0.6 to 1.8 % per year during 1984-1986. In 1987 there was a dramatic increase of over 5 thousand tons (representing over 30% growth) to reach 22 thousand tons per year. In 1988 there was an additional increase of over 10 %, but there was a correspondent decrease by about 8 % in 1989. Present consumption is slightly above the 1987 requirements of 22 thousand tons per year. The resulting average increase between 1982-1989 is somewhat less than 7 % per year.

Consumption of PVC is usually strongly influenced by the construction activities in the country; the growth for the 1982-1989 period averaged a relatively low 2.3 % per year, primarily due to a slump between 1987-1989 of close to 10% average per year. The height was in 1987, when 45 thousand tons were consumed, while at present the yearly consumption decreased to less than 37thousand tons. What is interesting to note, is that there has been a strong decrease in imports of PVC during 1989, and a consequential increase in supply from local production.

3.1.3 Polymer Consumption - By Grades

Figure 3.1 also shows distribution by grades - in percentages - between 1982 and 1989.
While in 1982, LDPE accounted for 32 % of the consumption of major polymers, PVC for 25 %, HDPE for 17 %, and PP for 14 %, there has been a considerable swing toward increased LDPE (36 %) and PP (19%) share of the market at the expense of primarily PVC (which decreased to 18%), and HDPE and PS to a lesser extent.

3.2 Sources of Imported Polymers to Israel.

Imports of polymers into Israel stem primarily from the EEC members; accounting in 1989 for 78 % of all imports. Figure 3.2 presents the sources of supply of imported polymers for 1990, split into major polymer imported and source of supply.

Surprisingly, in 1989 Japan and other South East Asian suppliers accounted for less tan 1 % of total imports, and the United States for only about 6 %.
Also surprisingly, 7.7 % of imports stem from Switzerland - due primarily to PET imports (46 % of total PET imports were from Switzerland). It is believed that the financial transaction may have been handled through Switzerland, while the actual origin of the PET polymer may be a different country.

The largest supplier of polymers to Israel - in 1989 - was the United Kingdom (20 % of total imports), followed by Germany (14 %) the Netherlands (13 %), Italy (11 %) and Belgium (10 %).

Himont in Italy - is by far the major share of polypropylene supplies (about 27 %), followed by suppliers from the United Kingdom (>15 %), France(~11 %), Germany (~11 %)and Belgium (10 %).

High Density Polyethylene - the other large volume polymer imported - stems from the United Kingdom (~18 %), Belgium (~14 %), the Netherlands (~11 %) and Germany (>10 %).

Of the polymers manufactured in Israel, LDPE is primarily imported from the Netherlands (>34 %), and United Kingdom (15 %); polystyrene about evenly from the United Kingdom (>28 %), the Netherlands (>26 %) and Germany (>25 %); PVC imports were from Germany (39 %) and France (~37 %).

The distribution pattern of import sources shown in this section is for the last year, i.e. 1989. A similar pattern has prevailed over the last five years, while in the earlier part of the decade the imports from the USA and Canada were considerably higher.

FIGURE 3.2
ISRAEL'S IMPORTED POLYMER -SOURCES OF SUPPLY-1989

in percentage of total imports (%)								
AREA/COUNTRY	LDPE	PS	PVC	HDPE	PP	ABS	PET	TOTAL
Imports, Tons	14300	11700	4700	33900	39300	4000	12500	120,400

in percentage of total imports (%)								
EUROPEAN ECONOMIC COMMUNITY								
Belgium	8.1	8.7	2.7	13.7	10.0	19.7		9.8
Denmark					0.1			
France	6.8	2.5	36.7	1.5	11.6	0.9		5.6
Germany F.R.	8.8	25.5	39.1	10.4	11.6	5.6	23.0	14.3
Ireland						0.4		
Italy	3.1	0.4	4.7	9.8	26.9	1.7	1.2	11.1
Netherlands	34.3	26.4	0.8	10.6	5.4	19.7	2.8	13.0
Portugal	1.4			2.2	1.1			1.5
Spain	2.0			6.6	1.1			2.6
United Kingdom	15.1	28.5	0.8	17.9	15.3	42.2	25.4	20.1
Total EEC	79.6	92.0	84.8	72.7	83.1	90.2	52.4	78.0
OTHER WEST EUROPEAN COUNTRIES								
Austria				0.2				
Finland	0.3	0.1		0.4	8.2			0.5
Norway				0.4				0.1
Sweden	3.2			2.2	0.1			1.1
Switzerland	1.4	1.3	0.3	0.9	6.3		44.6	7.7
Total other WE	4.9	1.4	0.3	4.1	14.6		44.6	9.4
Total W.Europe	84.5	93.4	85.1	76.8	97.7		97.0	87.4
EASTERN EUROPE				0.4	0.2			0.2
UNITED STATES	10.8	6.0	8.6	11.3	0.8	2.3	3.0	6.3
Canada	2.9	0.4		2.7	0.2	0.9		1.3
Japan	1.2			8.2				0.5
Other Far East				0.4		6.5		0.5
Other	0.6	0.2	6.3	0.2	1.1	0.1		3.8

SECTION 4 - THE PETROCHEMICAL INDUSTRY AS RAW MATERIALS SUPPLIER TO THE PLASTICS INDUSTRY IN THE WORLD

4.1 Introduction and Background

After many years of market depression in the early and mid 1980s, consumption of all traditional thermoplastic resins increased considerably over the last years, and prices reached in 1988 unknown high peaks, due to shortages of raw materials as well as insufficient polymer production capacities. Many new polymer production plants were approved during 1988, as inflated high prices enhanced petrochemical production profits and encouraged the planning and implementation of new plants.
Additional capacity was immediately required for monomers - mainly ethylene- so as to permit prices to decrease to more comfortable levels, to allow further growth and development.

Last year, 1989 was certainly quite different than 1988 which was a record growth year. There was still growth, but at a much lower rate, especially in the United States. However new projects have been announced and many have started active implementation stage.

It should be borne in mind that the polymer production industry, as the whole petrochemical sector is in the aftermath of an extensive restructuring due to changes in raw materials prices as of 1986, broad technology improvements, investment decreases, emergence of non-traditional producers as major players in world trade.

The above changes have altered extensively the current situation of the industry and its outlook; forcing producers, end-users and financial institutions to formulate new strategies to adapt to these situations and to prepare for the future.

The polymer manufacturing sector is furthering the production of specialized materials which will displace conventional ones in the construction, transportation, electronics and engineering fields for further substitutions of steel, aluminum, wood, glass, paper, natural fibers and rubbers, etc.

It is important to briefly review the background of the industry and what it went through in the 1980s so as to have a better understanding about the industry at present and to be able to identify the global trends in the polymer manufacturing sector and their relevance to further development.
Section 4 presents an Overview of the industry at present, including some background reasoning; it reviews the current world situation; and analyzes regional supply/demand for the current situation.
Section 5 discusses the foreseen global trends of the petrochemical and polymer industries, presents world-wide forecasts of major polymers demand for the years 1995 and 2000 for the main geographical regions, and discusses innovations and expected reasons for growth of the various polymers.
An outline of new projects for polymers expansion -announced or in various stages of implementation-for the next years is included.

4.1.2. Overview of Present Scenario

As companies contemplate their strategies for the 1990s, one of the key factors influencing their plans is their prospects for trade. A major consideration is that the regional perspective of the 1970s has been replaced by the international perspective of the 1980s.

During the 1960s and the 1970s, the petrochemical industry was concentrated in the United States, Western Europe and Japan. Petrochemical trade among these three areas was virtually nonexistent and each region had its sphere of influence.

The United States was practically the exclusive supplier to Latin America; Western European manufacturers maintained a privileged position in the Middle East and African markets and Japan dominated trade in East Asia. Although some alterations in this pattern of global trade began to occur after the 1973 escalation in oil prices, significant changes did not take place until after the higher price escalation in 1978/79. At that time, petrochemical producers in the United States found themselves with a competitive feedstock position in olefins with respect to their counterparts in Western Europe and Japan, and this combined with surplus production capacity provided an incentive to increase exports.
While some polymer quantities were moved to the European markets, higher proportions were shipped to East Asia. Although the subsequent global recession had a significant impact on the global demand for petrochemicals, producers in the United States continued to increase their global market share, primarily at the expense of Japanese manufacturers.

Throughout most of the 1980s, essentially all polymers - as the rest of petrochemical products- were in surplus supply. Production capacity built in the late 1970s in anticipation of continued strong growth in most regions of the world resulted in global overcapacity as demand stagnated in the 1980-1982 recession. West European and Japanese producers were particularly hard hit because of their dependency on naphtha as a feedstock, and in the case of Western Europe, the large number of underutilized country oriented plants. Although experiencing an advantageous feedstock position because of the availability of natural gas liquids, the United States industry still operated at reduced levels because of the overbuilding in the 1970s and recession limiting demand growth.

While the United States petrochemical industry experienced a surge in polymer export sales in the early 1980s, the highly competitive nature of these sales resulted in prices 15-25 percent below those for domestic sales.

As the global economy recovered from the recession, operating rates began to improve. However, recovery was sluggish and product prices tended to remain at levels that barely covered out of pocket costs.

The pressure of highly competitive global markets, continued high feedstock costs, and the startup of three large petrochemical complexes producing primarily large quantities of polyethylene in Saudi Arabia based on low cost feedstock, eventually led to a restructuring of the petrochemical industries of the United States, Western Europe and Japan.
As of the early-mid 1980s, various European governments and multinational producers undertook active rationalization programs combined with the closing-down of obsolete capacities.
As various companies were in the process of revamping their operations and shutting down unprofitable plants, a significant reversal in crude oil prices occurred during the first quarter of 1986 and has continued to the present.

This drop in crude oil prices -from 32 dollars to as low as 10 dollars in 1986, and $ 18 per barrel at present- has had a significant impact on the global petrochemical industry.

* In the developed nations of the world, operating rates have improved, but the real positive impact has been associated with profitability. Feedstock prices have fallen and product prices have increased considerably, with rising demand for petrochemicals and generally tight supply. As a consequence, Japan and Western Europe have benefited from much lower naphtha prices.

* The favorable feedstock cost associated with the plants in Saudi Arabia no longer represents such a significant advantage.

*Lower revenues and the prospects for continuing low crude oil prices have a negative impact on the plans of the energy-rich countries to further their interest in petrochemical projects.

Even with improved prospects for growth and profitability, most petrochemical companies were wary of future prospects. As a result, investments in new plants did initially not go forward. As global supply and demand came into balance in 1987, surpluses disappeared and prices began to rise both in domestic and export markets. With requirements for additional capacity, companies undertook capacity debottlenecking projects and began to review and even approve plans for grass-roots expansions.

Over the last decade, Asia has become an increasingly important market for polymers and petrochemicals in general. South Korea and Taiwan have emerged as major consumers and producers of such products; China has substantially increased its commitment to the development of a domestic polymer industry; and the newly industrialized nations of Asia have an ever increasing demand for thermoplastic resins.

Trade of major polymers to this region has increased almost 30 percent annually since the mid 1970s, and the demand of major polymers is currently in excess of nine million metric tons.

The emergence of South Korea, Taiwan and Saudi Arabia as major participants in the global polymer manufacturing industry is indicative of the changeover from what was a regional industry in the 1960s and 1970s to one that became an international industry in the 1980s. Thus the pattern of worldwide trade prevalent in 1990 is distinctly different from what it was a decade ago.

The United States is now a substantial supplier of petrochemicals to East Asia as well as to Latin America; however, imports to the United States are more frequent, as capacity for various polymers has become scarce. Western Europe exports polymers to East Asia as well as to the Middle East and Africa. However, for many polymers, the Western Europe region is rapidly becoming a net importer.
Canada and Saudi Arabia have now emerged as major participants in trade. Canada has now a positive trade balance in petrochemicals with the United States, and ships significant quantities of petrochemical materials- including EDC and polymers- to East Asia. Saudi Arabia is also a major supplier of polyethylene to East Asia and ships large quantities of polyethylene to Western Europe.

In addition, other countries have developed new advantageous trade positions in specific product areas.Brazil is shipping polyethylene and EDC to East Asia, and Singapore is taking advantage of its geographic position in Southeast Asia to move polyolefins to most of the other countries in the region.

A recent factor in trade has been a swing in prices as supply and demand have come into balance. For most of the 1980s, consumers of polymers in East Asia have been able to obtain, on a CIF basis, material that was priced competitively with product available in the U.S.Gulf Coast. This situation changed in 1987 and consumers in East Asia now find themselves paying a premium for most plastics and intermediates. This situation will probably persist until either supply increases or a recession develops and demand decreases as a result.

The polyolefins represent the most important products of global trade in both volume and value. Styrene, ethylene-dichloride, vinyl chloride monomer and therephthalic acid - all raw materials for polymer manufacture are next in importance, and increasing interest is developing in moving ethylene and propylene to specific locations to supplement local supplies. Such movements will become increasingly important in the 1990s.

4.2. Current Situation of the World Monomers Availability

The supply/demand and capacity utilization situation for basic olefins - ethylene and propylene- is the prime factor in the availability and pricing of polyolefins - Low Density Polyethylene (LDPE), High Density Polyethylene (HDPE), Linear Low Density Polyethylene (LLDPE) and Polypropylene (PP) - as well as for Polystyrene (PS) and to a somewhat lesser extent for ethylene dichloride (EDC) required for PVC production.
The current situation on these olefins is therefore included in this discussion.

4.2.1. Ethylene

Ethylene is clearly the main building block of the petrochemical industry and as such is the focus of attention of most countries with petrochemical interests.
Ethylene past development typifies the fast rate of development of the petrochemical industry. On a worldwide basis, ethylene demand grew at the rate of 16 % per annum between 1965 and 1974. More recently, however, consumption grew at slightly above 4 % per annum between 1975 and 1987.

The worldwide demand for ethylene in 1987 was about 50 million metric tons per year, the global industry operated at 93 percent of nameplate capacity in 1987, a level already indicative of extremely tight supply. Severe shortages of ethylene developed during 1988 and 1989. Most producers started urgent debottlenecking of their plants, as effective capacity reached over 100 % of the 54 thousand metric tons nameplate capacity.*(1).
But it became, very apparent already in 1987, that grass-roots expansions were urgently required if sufficient ethylene is to be available to meet the expected demand. This is especially true, as a good part of the operating capacity - especially in Western Europe and Japan is over 20 years old and therefore may soon have to be replaced or overhauled.

The demand for ethylene is primarily impacted by developments in polyethylene and to a lesser extent by styrene, ethylene glycol and vinyl chloride monomer. Polyethylene accounts for 55 percent of global ethylene demand and should continue to hold or increase this share for the next decade. Polyethylene will also have a marked influence on the construction of ethylene plants in developing regions of the world.
In petrochemical complexes built in countries outside of the developed markets, a polyethylene plant is the key downstream derivative facility, and a domestic market must be available to absorb a substantial amount of the output of such a polyethylene unit.

---

*World Bank Technical Information shows world capacity of ethylene in 1987 at 48 million tons, while Industry reports show 53 to 54 million tons; the higher figure is used in this report.

If not, the polyethylene facility either operates below design capacity or has to compete in the global export market, a prospect that few developing countries enjoy. The exception is a country with a substantial amount of light hydrocarbon feedstock, such as Saudi Arabia, that utilizes this position to become a major supplier of polyethylene to other regions of the world.

Ethylene historical growth as well as 1987, 1988 and 1989 actual demand and estimated demand for 1990 are shown in Figure 4.2.1. divided in major geographical regions.

Trade in Ethylene

While ethylene has been moved relatively short distances by barges in Western Europe and Japan for some time, it was generally conceded in the past that shipments over longer distances were uneconomical. Although some ocean movements took place in the early 1980s between Japan and Australia and between Mexico, Brazil and Venezuela -as suppliers to Western Europe, the amount of ethylene shipped on a regular basis was relatively minor - in the range of some 30 - 40 thousand metric tons annually. Thai Petrochemicals, however, commenced production in 1982 of a 65 thousand ton low density polyethylene plant which was brought on stream several years prior to the operation of the upstream ethylene plant (completed in 1989), based on imported ethylene, which was shipped successfully. The same company started operations in 1987 of a 60 thousand ton per year high density polyethylene plant on the same basis. Since then, the idea of moving ethylene a considerable distance by sea has been accepted and has become economically viable. Besides Thailand several polyethylene companies in South Korea, Taiwan, Argentina and several countries in Western Europe have been importing large quantities of ethylene on which their operations are fully dependent. Israel has been importing ethylene from Turkey since 1988, increasing considerably its import in 1989.
Exxon and Chevron are constructing a terminal in the Houston area to store imported ethylene at Mont Belvieu as a means of offsetting shortages in the Gulf Coast.

The concept of moving ethylene long distances by sea has been now fully accepted as a conventional form of ethylene supply and will undoubtedly become an integral part of the global petrochemical trade picture in the 1990s and beyond. The expected trade of ethylene is also presented in Figure 4.2.1.

East Asia and Western Europe were the primary net importers of ethylene in 1987 and should continue to be so throughout the 1990s. Much of the ethylene imported by these regions were supplied by the Middle East (Saudi Arabia and Qatar), and this region, jointly with Latin America, are expected to be the principal sources of ethylene exports in the future.

4.2.2. Propylene

By volume, propylene is the second largest tonnage monomer. Its production is to a large extent tied to the operation of ethylene plants where it is obtained as a coproduct from naphtha cracking. Production from catalytic and thermal crackers in oil refineries provides an incremental source of propylene.

Between 1970 and 1980 world consumption of propylene grew at an annual rate of 7.4% but growth was dampened to 4.6 % between 1980 and 1987. As of 1987 to present,consumption has grown well over 5 % as new polypropylene facilities have come on stream. Present demand is over 29 million tons per year, corresponding to about 97 % of capacity utilization.
However propylene production capacity is a rather vague term, as propylene can be produced either from refinery operations, or as a coproduct with ethylene. Propylene availability is impacted by a number of factors, which include propylene alternative pricing, feedstocks used for ethylene operations, other uses for propylene, etc. Thus, propylene effective production capacity is difficult to determine and will depend to a large extent on the slate of feedstocks used in the future for ethylene production. In the short term and while petroleum prices remain low, propylene availability should increase as a result of the shift toward use of naphtha feedstock for ethylene production,especially in the United States.

Current chemical propylene demand is primarily for polypropylene- 40%-and acrylonitrile -15%- . Non-chemical demand is for gasoline alkylation and dimerization.
Actual propylene demands for 1987, 1988 and 1989 and estimated demand for 1990 are presented in Figure 4.2.2.

Trade in Propylene

Much more so than ethylene, trade of propylene has been quite common for many years and is expected to continue.
* The United States imports all of Canada`s surplus propylene and will continue to do so in the coming years. However, the expected increase in naphtha cracking in the United States should provide an increasing supply of propylene.
* South Korea is currently the world`s largest propylene importer; current massive cracking expansion should decrease considerably the import requirements of this country.
* Taiwan is currently short of propylene and should continue to be an importer for some time to come; as with South Korea the substantial increase in naphtha cracking being installed in this country should also decrease it`s dependency on imports.
* Japan is currently an exporter of propylene, but is expected to become a net importer in the near future.
* Western Europe is a large importer of propylene and is expected to continue imports at the same rate than at present.
* China appears to have a surplus of propylene, but it is uncertain if it has the infrastructure capable of storing and shipping it.

Figure 4.2.2. also presents actual trade of propylene for 1987, 1988 and 1989 and forecasts for 1990.

Figure 4.2.1 GLOBAL ETHYLENE DEMAND AND TRADE -Thousands Tons						
Region	GLOBAL ETHYLENE DEMAND			GLOBAL ETHYLENE TRADE		
Year	1988	1989	est1990	in 1987	in 1990	est1990
United States	15,766	16,352	18,000	(4)	(25)	(130)
Western Europe	13,667	14,115	14,600	(97)	(220)	(230)
Japan	4,479	4,610	4,800	107	225	260
Other East Asia	3,249	3,618	4,800	(263)	(358)	(260)
Rest of World	12,748	13,388	14,600	257	378	360*
World- Total	49,909	52,083	56,800			
*Major regional exports: Middle East :165; (Saudia,Qatar) Africa:155 (Algeria);Latin America:55;Oceania:35;Canada:25.						

Figure 4.2.2 GLOBAL PROPYLENE DEMAND AND TRADE -Thousands Tons						
Region	GLOBAL PROPYLENE DEMAND			GLOBAL PROPYLENE TRADE		
Year	1988	1989	est1990	in 1987	in 1990	est1990
United States	8,543	8,905	9,300	(149)	(113)	(18)
Western Europe	7,817	8,132	8,600	(250)	(250)	(250)
Japan	3,234	3,415	3,700	123	135	110
Other East Asia	1,693	1,913	2,500	(194)	(232)	(280)
Rest of World	4,130	4,366	5,000	470	460	438*
World- Total	25,417	26,731	29,100			
*Major regional exports: Eastern Europe: 250; Canada : 188						

4.3. Current World Capacity, Supply and Demand of Plastics.

4.3.1 Annual Rate of Growth

Plastics are the most versatile and the highest tonnage group of all petrochemicals and are generally characterized by the continuous introduction of new products and improved applications. World consumption for low density polyethylene (LDPE), high density polyethylene (HDPE), polypropylene (PP), polystyrene (PS) and polyvinylchloride (PVC) - the so called commodity plastics -grew at an annual rate of about 9 % for the period 1975 to 1980, decreasing to an estimated rate of 6 % per year for the period 1980 to 1987. 1988 was the record growth year for the decade for consumption of commodity plastics, averaging 8.6 % over the previous year; there was a considerable decrease in 1989 to below 5 %, while somewhat more than 5 % growth on 1989 consumption figures is expected for the present year, for a total expected world-wide consumption of almost 86 million tons for thermoplastic materials in 1990.

Polypropylene is by far the fastest growing polymer of the commodity plastics group; it`s growth in the 1980s was over 10 %; Polyethylene Terephthalate (PET) and Reinforced Plastics as well as other engineering plastics also grew at yearly rates averaging close to 10 % during the last decade.

Figure 4.3.1 presents average annual growth history for commodity plastics; conservative estimates for 1990 are also included.

Figure 4.3.1 AVERAGE ANNUAL GROWTH FOR COMMODITY PLASTICS

Commodity	Average Annual World-wide Growth %/yr				EstDemand for 1990 Thous.Ton
Polymer	1980-1987	1988	1989	est. 1990	
Low Density Polyethylene	5.3	6.1	2.8	4.8	18,866
High Density Polyethylene	7.2	6.8	3.7	4.4	11,510
Polypropylene	10.1	10.1	8.1	7.6	12,488
Polystyrene	4.7	6.7	3.9	3.8	7,506
Polyvinyl-chloride	5.3	8.6	5.6	4.9	19,014
Commodity Plastics Total	~ 6	8.9	4.8	5.1	69,384

Figure 4.3.1 A presents the annual growth of the combined group of Commodity Plastics, divided by major geographical regions for the years 1988 and 1989 as well as forecasted growth for 1990. The estimated demand for 1990 for each major region is also presented, as well as the split of consumption (in percentages) region by region in 1987 as well as in 1990.

Figure 4.3.1.A ANNUAL GROWTH FOR COMMODITY PLASTICS BY REGIONS

Region	Average % Growth during			%World Consumpt		EstDemand for 1990 Thous.Ton
Year	1988	1989	est1990	in 1987	in 1990	
United States	7.0	1.0	4.3	27.0	24.4	17,651
Western Europe	8.1	3.6	3.9	27.8	27.3	18,945
Japan	10.0	7.7	6.1	9.7	10.2	7,107
Other East Asia	9.2	9.4	8.2	12.1	13.3	9,205
Rest of World	5.9	6.7	6.5	23.4	23.7	16,477
World- Total	7.6	4.7	5.1			69,384

From Figure 4.3.1.A the following interesting conclusions can be drawn :

* 1988 was a record growth year for plastics consumption in all regions of the world; such high growth came after a relatively low growth during the early-mid 1980s. Quite unexpected, Japan showed the highest growth factors for practically all commodity plastics (excepting LDPE) for all the regions, in spite of expected market saturation. Western Europe - which had continuously shown a low 2-3% annual growth factor for commodity plastics -due to market saturation- increased its demand for commodity plastics by over 8%.

* 1989, on the other hand was a slow growth year for the United States and Western Europe, as there was much stock-building in 1988, due to increasing product prices. Japan and East Asia`s consumption growth continued to be high, although somewhat lower than for 1990.

* East Asia is the regional area of fastest growth of the group of Commodity Plastics; the growth is steady in all the polymers, and is expected to continue to be so.

* There is a change in the market share of commodity plastics between the various regions. The United States and Western Europe are decreasing their relative market share, while East Asia and Japan are increasing their proportion.

4.3.2 Supply and Demand of Major Polymers

Figure 4.3.2 presents actual consumption for major plastics by major regions for the years 1987, 1988 and 1989 as well as estimates for 1990. Section A is for Commodity Plastics ; i.e.- LDPE/LLDPE, HDPE, PP, PS, and PVC. Section B is for other plastics -ABS, Reinforced Plastics and PET; all other thermoplastics are included in "Other Plastics". Thermosetting materials are not included.

The information in this Figure has been compiled, primarily from the yearly consumption information appearing in Modern Plastics, supplemented by studies and reports from SRI, Chem Systems, The World Bank and the International Status Report on Plastics, published by IPAD.

Rates of growth for 1990 are based primarily on literature surveys of information appearing during January to March 1990.

A brief discussion on each Commodity Plastics and on PET (which in the future may well enter into this category) follows. Emphasis is also placed on regional trade of the various polymers.

4.3.2.1 Low Density/Linear Low Density Polyethylene

Global demand for LDPE/LLDPE is expected to be almost 19 million tons in 1990. East Asia (including Japan) has shown the largest regional increase in its share of global market, increasing from 19.8 in 1987 to almost 22 percent in 1990.

The global LDPE/LLDPE industry operated at 90 percent capacity in 1987 increasing to almost 100 % in 1989. Some areas of the world, most notably the United States, Canada and Japan have been operating at over 100% nameplate capacity for the last years. Furthermore operations in certain countries have been curtailed due to lack of sufficient ethylene.

It should be pointed out that there is considerable swing-capacity between LLDPE and HDPE especially in Canada, and that part of the LLDPE capacity has been used for HDPE production. It is estimated that some 1.2 million tons of LLDPE/HDPE swing capacity will be utilized for HDPE production in 1990.

The market share per region for 1990 LDPE/LLDPE consumption is estimated as shown in Figure 4.3.2.1

Figure 4.3.2.1 ESTIMATED 1990 LDPE/LLDPE CONSUMPTION BY REGIONS

Region	est.1990-Thous.Tons	% of World
United States	4,500	23.9
Western Europe	5,252	27.8
Japan	1,378	7.3
Other East Asia	2,758	14.6
Rest of World	4,979	26.4
Total	18,866	

THOUSANDS METRIC TONS		DEMAND 1987	1988	INCREASE %per year 88/87	1989	INCREASE %per year 89/88	Forecasted Increase % 90/89	Est.1990	REGIONAL % SHARE OF WORLD MARKET
LDPE/LLDPE	US	4,257	4,569	7.3%	4,412	-3.4%	2.0%	4,500	23.9%
	WEST EUROPE	4,765	4,979	4.5%	5,074	1.9%	3.5%	5,252	27.8%
	JAPAN	1,143	1,216	6.4%	1,294	6.4%	6.5%	1,378	7.3%
	OTHER E.ASIA	2,128	2,318	8.9%	2,530	9.1%	9.0%	2,758	14.6%
	REST OF WORLD	4,220	4,431	5.0%	4,697	6.0%	6.0%	4,979	26.4%
	TOTAL	16,513	17,513	6.1%	18,007	2.8%	4.8%	18,866	
HDPE	US	3,341	3,416	2.2%	3,348	-2.0%	2.0%	3,415	29.7%
	WEST EUROPE	2,312	2,566	11.0%	2,649	3.2%	3.2%	2,734	23.8%
	JAPAN	732	809	10.5%	881	8.9%	5.5%	929	8.1%
	OTHER E.ASIA	1,307	1,440	10.2%	1,598	11.0%	9.0%	1,742	15.1%
	REST OF WORLD	2,270	2,405	5.9%	2,550	6.0%	5.5%	2,690	23.4%
	TOTAL	9,962	10,636	6.8%	11,026	3.7%	4.4%	11,510	
POLYSTYRENE	US	2,187	2,224	1.7%	2,292	3.1%	2.5%	2,349	31.3%
	WEST EUROPE	1,979	2,160	9.1%	2,185	1.2%	3.0%	2,251	30.0%
	JAPAN	811	914	12.7%	995	8.9%	5.0%	1,045	13.9%
	OTHER E.ASIA	n.a.	n.a.		n.a.			n.a.	
	REST OF WORLD	1,544	1,660	7.5%	1,756	5.8%	6.0%	1,861	24.8%
	TOTAL	6,521	6,958	6.7%	7,228	3.9%	3.8%	7,506	
VINYLS	US	3,540	4,019	13.5%	4,219	5.0%	3.8%	4,379	23.0%
	WEST EUROPE	4,609	4,912	6.6%	5,068	3.2%	2.8%	5,207	27.4%
	JAPAN	1,563	1,732	10.8%	1,847	6.6%	5.0%	1,939	10.2%
	OTHER E.ASIA	2,125	2,303	8.4%	2,475	7.5%	6.2%	2,629	13.8%
	REST OF WORLD	3,964	4,194	5.8%	4,520	7.8%	7.5%	4,859	25.6%
	TOTAL	15,801	17,160	8.6%	18,129	5.6%	4.9%	19,014	
POLYPROPYLENE	US	2,499	2,703	8.2%	2,824	4.5%	6.5%	3,008	24.1%
	WEST EUROPE	2,610	2,979	14.1%	3,257	9.3%	7.5%	3,501	28.0%
	JAPAN	1,401	1,546	10.3%	1,681	8.7%	8.0%	1,815	14.5%
	OTHER E.ASIA	1,562	1,713	9.7%	1,905	11.2%	9.0%	2,076	16.6%
	REST OF WORLD	1,684	1,801	6.9%	1,942	7.8%	7.5%	2,088	16.7%
	TOTAL	9,756	10,742	10.1%	11,609	8.1%	7.6%	12,488	
COMMODITY PLASTICS	US	15,824	16,931	7.0%	17,095	1.0%	3.3%	17,651	25.4%
	WEST EUROPE	16,275	17,596	8.1%	18,233	3.6%	3.9%	18,945	27.3%
	JAPAN	5,650	6,217	10.0%	6,698	7.7%	6.1%	7,107	10.2%
	OTHER E.ASIA	7,122	7,774	9.2%	8,508	9.4%	8.2%	9,205	13.3%
	REST OF WORLD	13,682	14,491	5.9%	15,465	6.7%	6.5%	16,477	23.7%
	TOTAL	58,553	63,009	7.6%	65,999	4.7%	5.1%	69,386	100.0%

THOUSANDS METRIC TONS		DEMAND 1987	1988	INCREASE %per year 88/87	1989	INCREASE %per year 89/88	Forecasted Increase % 90/89	Est.1990	REGIONAL % SHARE OF WORLD MARKET
ABS	US	510	492	-3.5%	534	8.5%	5.0%	561	28.3%
	WEST EUROPE	452	465	2.9%	485	4.3%	5.0%	509	25.7%
	JAPAN	406	444	9.4%	462	4.1%	4.0%	480	24.2%
	OTHER E.ASIA	n.a.	n.a.		n.a.				
	REST OF WORLD	370	396	7.0%	415	4.8%	4.0%	432	21.8%
	TOTAL	1,738	1,797	3.4%	1,896	5.5%	4.5%	1,982	
REINFORCED PLASTICS	US	995	1,077	8.2%	1,108	2.9%	2.8%	1,139	31.2%
	WEST EUROPE	941	1,079	14.7%	1,173	8.7%	5.5%	1,238	33.9%
	JAPAN	322	379	17.7%	421	11.1%	8.0%	455	12.4%
	OTHER E. ASIA	n.a.	n.a.		n.a.			n.a.	
	REST OF WORLD *	690	725	5.1%	769	6.1%	6.8%	821	22.5%
	TOTAL	2,948	3,260	10.6%	3,471	6.5%	5.2%	3,653	
PET	US	652	740	13.5%	770	4.1%	7.0%	824	50.1%
	WEST EUROPE	205	220	7.3%	242	10.0%	10.5%	267	16.3%
	JAPAN	379	400	5.5%	425	6.3%	5.0%	446	27.1%
	OTHER E. ASIA	60	67	11.7%	75	11.9%	10.0%	83	5.0%
	REST OF WORLD	15	18	20.0%	21	16.7%	19.0%	25	1.5%
	TOTAL DEMAND	1,311	1,445	10.2%	1,533	6.1%	7.3%	1,645	
OTHER PLASTICS	US	3,760	4,488	19.4%	4,595	2.4%	4.5%	4,802	51.7%
	WEST EUROPE	1,724	1,915	11.1%	2,034	6.2%	6.0%	2,156	23.2%
	JAPAN	494	676	36.8%	763	12.9%	10.0%	839	9.0%
	OTHER E. ASIA	n.a.	n.a.		n.a.				
	REST OF WORLD *	1,125	1,249	11.0%	1,350	8.1%	11.0%	1,499	16.1%
	TOTAL DEMAND	7,103	8,328	17.2%	8,742	5.0%	6.3%	9,296	
TOTAL	US	21,741	23,728	9.1%	24,102	1.6%	3.6%	24,977	29.1%
	WEST EUROPE	19,597	21,275	8.6%	22,167	4.2%	4.3%	23,115	26.9%
	JAPAN	7,251	8,116	11.9%	8,769	8.0%	6.4%	9,328	10.9%
	OTHER E.ASIA**	7,182	7,841	9.2%	8,583	9.5%	8.2%	9,288	10.8%
	REST OF WORLD	15,882	16,879	6.3%	18,020	6.8%	6.8%	19,253	22.4%
	TOTAL DEMAND	71,653	77,839	8.6%	81,641	4.9%	5.3%	85,961	

* REST OF THE WORLD (including Other E. Asia) estimated by assuming USA + West Europe + Japan at 80-85 % of total World Consumption.

** Total for OTHER E. ASIA is not complete, as several polymers are included in Rest of World.

March 1-2, 1990
H. D. Frenkel

Sources of Information : Chem Systems and SRI reports
Updated actual 1989-1990 from Modern Plastics and ECN
Estimated growth for 1990 from Jan.-Feb. 1990 literature reviews.

Trade in LDPE/LLDPE

The global trade of LDPE/LLDPE amounted to 1.4 million metric tons in 1987, and is expected to be between 1.8-2 million tons in 1990. Asia is the principal target for exports, however with the commencement of new ethylene and polyethylene plants to commence operations in South Korea and Taiwan in the early 1990s, this target market is expected to decrease. The increase in volume of trade in the 1987 to 1990 period has been the result of the current imbalance between supply and demand in the developing regions in the world, particularly East Asia, and will persist until plants now in the planning stage are built and brought on stream in these areas in the early 1990`s.

Figure 4.3.2.1.A. shows the actual trade of LDPE/LLDPE for the various regions during 1987,1988 and 1989 - as well as estimates for 1990.

Figure 4.3.2.1.A - TRADE OF LDPE/LLDPE in Thousand Tons

Region/Year	1987	1988	1989	est. 1990
United States	167	122	350	411
Canada	547	580	550	485
Latin America	(76)	(130)	(200)	(267)
Japan	13	20	10	(15)
Other East Asia	(1,018)	(1,117)	(1,115)	(1,112)
Oceania	(29)	(42)	(50)	(57)
Middle East	425	477	455	560
Africa	(279)	(286)	(300)	(315)
Western Europe	160	146	100	100
Eastern Europe	130	200	200	210

( )= import. positive figures= export.

4.3.2.2 High Density Polyethylene

The global demand for High Density Polyethylene amounted to almost 10 million tons in 1987, and is estimated to be 11.5 million tons. While there is little increase in the United States, due to market saturation, there have been massive increases in Western Europe, Japan and other Asian countries. As for LDPE, the major increase has been in East Asia,(including Japan), which increased it`s market share from 20.5 % in 1987, to 23.2% in 1990.
1990 estimated demands for HDPE by major regions are shown in Figure 4.3.2.2.

Figure 4.3.2.2 ESTIMATED 1990 HDPE CONSUMPTION BY REGIONS

Region	est.1990-Thous.Tons	% of World
United States	3,415	29.7
Western Europe	2,734	23.8
Japan	929	8.1
Other East Asia	1,742	15.1
Rest of World	2,690	23.4
Total	11,510	

The global HDPE industry operated at 92 percent capacity in 1987, with producers in the United States and Japan running their facilities above 95 %. Since 1987, the industry as a whole has been operating at close to 100 % capacity. Supply has been very tight in the last two years even with HDPE being produced in a number of swing LLDPE facilities around the world, especially in the United States, Canada, Western Europe and Saudi Arabia.

Trade in HDPE

Global trade of HDPE is considerably lower than for LDPE. The major importer has been the East Asian Region, with United States and Saudi Arabia being the major exporters. Trade was about 900 thousand tons in 1987, and is expected to have remained about the same by 1990. Trade of HDPE for 1987,1988 and 1989 and estimates for 1990 are shown in Figure 4.3.2.2.A.
The Asian market is the most important target for HDPE exports, accounting for slightly 40 percent of the world trade. However, the volume of exports to Latin America is expected to surpass that of East Asia, during the present year.

Figure 4.3.2.2.A - TRADE OF HDPE in Thousand Tons				
Region/Year	1987	1988	1989	est. 1990
United States	437	315	360	359
Canada	(3)	0	0	20
Latin America	(252)	(303)	(340)	(379)
Japan	186	200	200	200
Other East Asia	(478)	(425)	(385)	(358)
Oceania	(20)	(25)	(25)	(27)
Middle East	220	268	265	280
Africa	(150)	(152)	(120)	(130)
Western Europe	70	50	15	0
Eastern Europe	(10)	27	30	35
( )= import. positive figures= export.				

4.3.2.3 Polypropylene

The 1987 global demand for polypropylene was 9.8 million tons, somewhat below the HDPE demand (of nearly 10 million tons). During 1990, it is expected that polypropylene demand will be about 12.5 million tons, about 1 million above the expected HDPE demand. Consumption of polypropylene is increasing all over the world, and supply has been rather scarce. East Asia (including Japan) is the major consuming region for polypropylene, accounting for 31 %. Estimates of 1990 polypropylene demand by region are shown in Figure 4.3.2.3.

Figure 4.3.2.3 ESTIMATED 1990 PP CONSUMPTION BY REGIONS		
Region	est.1990-Thous.Tons	% of World
United States	3,008	24.1
Western Europe	3,501	28.0
Japan	1,815	14.5
Other East Asia	2,076	16.6
Rest of World	2,088	16.7
Total	12,488	

The global polypropylene industry has operated at 97 percent of capacity in 1987, with the result that global supply has been extremely tight. However, new capacity has come on stream in the last year and additional capacity is coming on stream during this year which ought to relieve the supply situation with consequential lowering in prices.

Trade in Polypropylene

The global trade for polypropylene amounted to 1.1 million tons in 1987, decreasing in 1989 and expected to decrease further to less than 900 thousand tons in 1990, as new plants come on stream in various regions.

Figure 4.3.2.1.A - TRADE OF PP in Thousand Tons

Region/Year	1987	1988	1989	est. 1990
United States	644	588	540	407
Canada	16	22	10	4
Latin America	(237)	(242)	(250)	(95)
Japan	152	145	145	145
Other East Asia	(650)	(625)	(560)	(508)
Oceania	19	38	42	52
Middle East	(112)	(116)	(125)	(130)
Africa	(105)	(100)	(80)	(80)
Western Europe	280	300	300	250
Eastern Europe	(25)	(10)	(22)	(45)

( )= import. positive figures= export.

4.3.2.4 Polystyrene

The 1987 global demand of polystyrene was 6.5 million tons; worldwide increase of polystyrene from 1987 to 1990 has been at an average rate of slightly below 5 % per year. The rate of increase has been the highest in Japan. Estimates for 1990 polystyrene requirements in various areas of the world are presented in Table 4.3.2.4.

Figure 4.3.2.4 ESTIMATED 1990 POLYSTYRENE CONSUMPTION BY REGIONS

Region	est.1990-Thous.Tons	% of World
United States	2,349	31.3
Western Europe	2,251	30.0
Japan	1,045	13.9
Other East Asia	n.a.	
Rest of World	1,861	24.8
Total	7,506	

Trade in Styrene

There is no reliable information available on polystyrene trade, split by regions. There is however information on global Styrene trade. The global trade of Styrene amounted to 1.0 million metric tons in 1987, and is expected to be at this level during 1990. Exports to East Asia account for a large part of this trade; but, with new capacity planned for South Korea, Taiwan, China and Thailand, East Asia`s importance will diminish somewhat in the future years. Nevertheless, it will continue to be a major target market for styrene exports. Western Europe is expected to increase it`s imports; Canada, the United States and Saudi Arabia are the major exporters of styrene in the world; their joint export accounts for almost 97 percent; the only other exporting country is Australia.

Figure 4.3.2.4.A. shows the actual trade of Styrene for the various regions during 1987,1988 and 1989 - as well as estimates for 1990.

Figure 4.3.2.4.A - TRADE OF STYRENE in Thousand Tons				
Region/Year	1987	1988	1989	est. 1990
United States	320	435	412	379
Canada	420	416	480	500
Latin America	(167)	(165)	(140)	(120)
Japan	(148)	(130)	(120)	(100)
Other East Asia	(518)	(645)	(665)	(661)
Oceania	26	24	24	22
Middle East	234	258	220	190
Africa	(37)	(38)	(38)	(40)
Western Europe	(115)	(125)	(143)	(145)
Eastern Europe	(30)	(30)	(30)	(25)
( )= import. positive figures= export.				

4.3.2.5 Polyvinyl Chloride

The 1987 global demand of polyvinyl chloride was 15.8 million tons; 1990 estimates are in the order of 19 million tons ; corresponding to an average rate of almost 6.5 % per year.
Estimates for 1990 polyvinyl chloride consumption in various regions of the world are presented in Table 4.3.2.5.

Figure 4.3.2.5 ESTIMATED 1990 PVC CONSUMPTION BY REGIONS		
Region	est.1990-Thous.Tons	% of World
United States	4,379	23.0
Western Europe	5,207	27.4
Japan	1,939	10.2
Other East Asia	2,629	13.8
Rest of World	4,859	25.6
Total	19,014	

Trade in Ethylene Dichloride (EDC), Vinyl Chloride Monomer (VCM) and Polyvinyl Chloride (PVC).

Large quantities of EDC and VC monomer (much more than PVC) are traded in the international markets. Some 1.4 million tons of EDC and over 1.1 million tons of VCM are being traded per year from region to region, compared to less than 500 thousand tons of PVC. Japan and Taiwan are the largest importers of EDC and they will be joined shortly by South Korea. Eastern Europe is also a net importer. The United States, Saudi Arabia and Canada supply almost 90 percent of the EDC to Asia; other exporters are Brazil and Western Europe.

Exports of VCM are primarily to East Asia, Japan, Latin America and Oceania; the major exporters are the United States, Western Europe, Saudi Arabia and Canada. However, exports to East Asia (at present some 800 thousand tons per year), are expected to decrease with no capacity due to come on stream in this area.

East Asia is also the major importer of PVC, which is being exported mainly from Western Europe.
Table 4.3.2.5.A. presents the Trade picture for EDC, VCM and PVC between 1987 and 1990.

Figure 4.3.2.5.A - TRADE OF EDC, VCM, PVC in Thousand Tons

PRODUCT	E D C			V C M			P V C		
Region/Year	1987	1988	1990*	1987	1988	1990*	1987	1988	1990*
United States	415	455	650	252	230	375	122	99	68
Canada	205	200	200	130	120	100	not available		
Latin America	155	160	195	-297	-343	-282	not available		
Japan	-583	-640	-700	2	-	- 5	- 29	- 30	- 30
Other East Asia	-556	-520	-610	-621	-689	-811	-208	-218	-184
Oceania	- 2	0	0	-102	-107	-119	not available		
Middle East	305	295	265	180	200	180	not available		
Africa	-	-	-	-	-	-	not available		
Western Europe	160	150	100	480	400	300	220	200	200
Eastern Europe	-100	-100	-100	- 50	- 25	-	not available		
Rest of the World							- 88	- 51	- 44

*1990 estimates; negative figures = import; positive = export.

4.3.2.6 Polyethylene Terephthalate -PET -
This is the most dynamic polymer for the 1990s, not only in it`s growth in existing markets, but also in realizing its potential in a wide variety of new and developing applications.

Global consumption of PET for 1990 is estimated at over 1.6 million tons ; Table 4.3.2.6 presents the regional breakdown of this estimated consumption.

Figure 4.3.2.6 ESTIMATED 1990 P E T CONSUMPTION BY REGIONS

Region	est.1990-Thous.Tons	% of World
United States	824	50.1
Western Europe	267	16.3
Japan	446	27.1
Other East Asia	83	5.0
Rest of World	25	1.5
Total	1,625	

SECTION 5 - GLOBAL TRENDS AND FORECASTS FOR THE NEXT DECADE

5.1. Factors Influencing Global Trends in Polymer Manufacture

The complexity of the petrochemical industry - and therefore of polymer manufacture - is continuously guided by a number of major factors which influence products availability and prices.
The following have been identified as the major factors influencing global trends in polymer manufacturing :

1). Feedstock Availability
2). Market Growth, Penetration and Saturation
3). Vertical Integration
4). Changes in International Trade Patterns

Figure 5.1 presents the major factors influencing global trends.

5.1.1. Feedstock Availability

The availability of low cost monomers-mainly ethylene and propylene-has been the key factor in polymer manufacturing profitability and competitive prices. Availability of low cost monomers is dependent on gas and oil prices; and on plant capacity availability. Actually the interplay of these two factors has caused, in the last years, drastic changes of monomer prices from one extreme to another.
As a direct consequence of the fast pace of oil exploration in the last 15 years, world natural gas reserves have increased dramatically. The world`s gas reserves/production ratio has consequentially steadily increased and significant gas reserves are now distributed among 100 odd countries. During 1985 world gas reserves increased 2.4% compared with an increase in oil reserves of only 0.2%. Boosted by reserves availability, world gas consumption has also increased and is now estimated at close to 2×10^{15} cubic meters. Regional requirements have also increased with the notable exception of the United States where lower petroleum prices and gas to gas competition have prevented a higher growth. In Latin America, Asia and Africa, gas use is increasing at rates ranging between 5 to 7 % per annum.

However, for many gas rich developing countries, the requirements for oil production and the lack of transport and distribution infrastructure have also forced a high degree of flaring, venting and re-injection of associated natural gas. Therefore, in the short range, many of these countries will continue to have large amounts of gas reserves associated with very low marginal costs of production but lacking the infrastructure for storage, transportation and marketing required. The polymer industry has no use for the methane contained in the gas -which constitutes the major part (usually 90-99%) of natural gas, and is upgraded only to ammonia and methanol-and therefore the availability of gas based feedstocks for polymers is closely tied to the fraction of condensates (ethane (C_2) and propane (C_3)) available in the natural gas.

Natural gas condensates and naphtha have been the preferred feedstocks for ethylene manufacture. Naphtha, although still the main feedstock should continue a long term declining trend in favor of new-ethane based ethylene capacity in gas rich areas, and to a lesser degree to unbalanced refinery streams, ranging from refinery gases to heating oils.

FIGURE 5.1 GLOBAL TRENDS AND FORECASTS FOR THE NEXT DECADE

INFLUENCING FACTORS

1). Feedstock Availability

2). Market Growth, Penetration and Saturation

3). Vertical Integration

4). Changes in International Trade Patterns

1). Feedstock Availability

VERY LOW GAS PRICES IN ENERGY RICH COUNTRIES ARE TAKING OVER ETHYLENE/PROPYLENE PRODUCTION INSTEAD OF NAPHTHA FEED BASIS

YEAR FEEDSTOCK	BASIS/AREA/COUNTRY	1987	1990	1995
NAPHTHA-Major Analyst`s Forecasts		155	200	250
NATURAL GAS US$/MMBtu Prices for Feedstocks	Wellhead USA-GulfCoast	1.40	1.75	2.00
	FOB Factory-WestEurope	2.30	2.80	3.20
	Middle East	0.50	0.50	0.50
	OtherEnergyRich Areas	0.60-1.20	0.40-1.25	0.50-1.00

2). Market Growth, Penetration and Saturation

PER CAPITA CONSUMPTION OF POLYMERS -Kg./person-

	INDUSTRIALIZED REGIONS						REGIONS IN DEVELOPMENT					
Area	US+CANADA		JAPAN		WEST.EURO		LAT.AMER.		ASIA		ISRAEL	
Year	1987	1990	1987	1990	1987	1990	1987	1990	1987	1990	1987	1990
COMMD	63.1	71.5	48.2	57.9	44.6	51.6	8.6	10.6	2.6	3.4	46.6	47.2
POLYM	88	101	65	81	54	63	9.2	11.3	3.00	4.00	61.4	64.1

3). Downstream Integration

*VERTICAL INTEGRATION: for economy of scale
to assure continuous raw materials supply
to create and control captive markets

* GAS/OIL PRODUCING COUNTRIES BUILDING LARGE INTEGRATED NATIONAL OWNED PETROCHEMICAL COMPLEXES

4). CHANGING TRENDS IN INTERNATIONAL TRADE

* IMPACT OF CHANGING LOCATIONS FROM MARKETING CENTERS TO LOW GAS/OIL PRODUCTION AREAS: > TRADE

1970:15 B$	1980: 50 B$	1990: 70 B$	2000:~100 B$

Naphtha prices are critical to the continuation of this trend. In the short term, the shift in feedstocks has been slowed by the drop in naphtha prices from around US$ 300 per ton in 1983 to the prices of US$ 150 in 1987 and current price of US$ 170. The softening of crude oil prices has taken away some of the incentives from natural gas as a low cost alternative feedstock. While crude oil and therefore naphtha prices remain low, naphtha based producers- located near the markets- will be able to compete with new plants -located in development areas based on natural gas. Furthermore, it should also be borne in mind that ethylene and propylene production from naphtha cracking yields a series of valuable co-products -butadiene, isobutylene and high aromatics content pyrolisis gasoline-which have interesting upgrading value. This means that choice of feedstock depends not only on the base cost of the feedstock, but also on the upgrading potential of all the co-products, and on market proximity/logistics conjecture of the polymers against the monomers.

Analysts project crude-oil prices to increase to the extent that naphtha should come back to the US$ 200-250/ton price range by 1995. The writer is in disagreement with such increasing naphtha price projections; believing that crude-oil prices will increase in US$ by not more than the inflation of this currency, and naphtha prices will be strongly influenced by it`s supply and demand as a petrochemical feedstock. World-wide over availability of natural gas should have a direct effect on reduced naphtha prices. The writer considers US$ 200 as the top level price for naphtha during the 1990s, with a figure of $ 150-180 as more likely to prevail.

Natural gas prices will be tied to its opportunity cost and will vary considerably from region to region, expected to range from very low in the Middle East, Latin America and the Pacific Basin, to very high in Western Europe, where it is scarce and premiums are granted for cleanliness, easiness of utilization and high opportunity values.

Overall, condensate rich natural gas is expected to be the preferred feedstock for new ethylene plants. Gas rich developing countries with existing and/or developing substantial domestic markets are bound to gain the most from the trends in feedstock prices. Gas rich countries with large populations -such as Canada, India, Indonesia, Malaysia, Thailand, Mexico, Venezuela, Argentina, Brazil, Algeria and Nigeria are expected to benefit the most -as these countries already have extensive natural resources and are developing their consuming domestic markets. Many of these countries are adding new gas based petrochemical plants currently.

Figure 5.1.1 presents a comparison of past, current and projected naphtha prices; as well as natural gas prevailing and forecast prices in various regions in the world.

Figure 5.1.1 NAPHTHA PRICES FOR ETHYLENE/PROPYLENE PRODUCTION COMPARED TO NATURAL GAS PRICES IN VARIOUS REGIONS IN THE WORLD

YEAR FEEDSTOCK	BASIS/AREA/COUNTRY	1987	1990	1995
NAPHTHA-Major Analyst`s Forecasts US$/ton - H.D.Frenkel`s forecast		155 150	200 165	250 190
NATURAL GAS US$/MMBtu	Wellhead USA-GulfCoast FOB Factory-WestEurope	1.40 2.30	1.75 2.80	2.00 3.20
Prices for Petrochem. Feedstocks	Middle East	0.50	0.50	0.50
	East Asia China India Indonesia Malaysia	 1.80 3.00 1.00 0.75	 1.80 2.00 1.25 1.00	 2.00 1.60 0.85 1.05
	Africa Algeria Nigeria	 1.00 1.50	 1.00 1.50	 0.75 0.75
	Latin America Argentina Brazil Mexico Venezuela	 0.75 1.50 2.25* 0.60	 0.75 1.00 2.00 0.40	 0.75 1.00 2.00 0.50

* Mexico-as Canada- quotes high gas prices, because of sales of gas to the United States; however petrochemical projects are justified at prices much lower than the one shown in the Figure

Lower feedstock costs in gas rich countries translate into low ethylene and propylene costs, with consequential savings in the production costs of polymers. This is the major reason why Canada and Saudi Arabia have become world scale polymer producers in recent years.

It is expected that in the 1990s gas rich countries with access to natural gas at prices below $ 1/MMBtu will play a leading world-wide role in the production and supply of monomers and polymers. This means that Saudi Arabia, and the other Middle East producers, shall find competition from monomers/polymers producers now building plants in Venezuela, Argentina, Indonesia, Malaysia, Nigeria and Algeria.

5.1.2 Market Growth, Penetration and Saturation.
The world market for primary monomers and commodity polymers has been strongly influenced in the past by the market size and growth in the developed western economies - i.e. United States, Western Europe and Japan. These traditional marketing regions accounted -in the early 1980s- for 75% to 80% of global consumption.
The rate of growth of most plastic materials, and their respective raw materials dropped considerably in the early to mid eighties, as the economies of the western developed countries were facing recessions and sharp economic downturn, and at the same time many of the polymers had in the meanwhile become mature products approaching market saturation. These factors caused decreased overall demand and severe over-capacity.

Forecasts made in the mid 1970s and early 1980s for the world demand of primary olefins and commodity polymers had been over-optimistic. For example, demand forecasts for ethylene made in 1975, 1980 and 1982 failed to predict the slowdown of the market and caused extensive over-capacity, which resulted in rationalization in capacity, including mothballing and closure of large petrochemical complexes in Japan, Western Europe and North America. Since 1982 about a quarter of the developed world`s bulk or basic chemicals plant capacity has been closed down and during the period 1982 to 1987 not a single olefins producing plant had been planned nor constructed in the developed western economies.

In summary and in retrospect the severe overcapacity in monomer and polymer production developed during the early 1980s resulted from:

* sharp economic downturn and recessional trends which caused decreased polymer demand.
* failure of manufacturers to recognize the implications of the 1982 recession on projected polymers demand.
* market maturity of many of the polymers, resulting in slower growth rates.
* new gas rich developing countries became new producers and influenced global market patterns.

The 1987/1988 surge in ethylene demand stems primarily from :

* the high growth rates for polyolefins in new non-saturated markets.
* overall improvement of the world economy, which spearheaded construction, transportation and domestic consumption, thus increasing consumption of polymers in these areas.
* surging economies of large population countries in development, with relative low base per capita consumption, which have shown a high growth rate of market penetration. While the 1980-1987 growth rates of ethylene/propylene and their derivatives averaged 2-4% per annum in the western industrialized countries (USA, Western Europe and Japan), the same products have grown 11-14% in Latin America and 15-18% in the Far East. However, as the share of the developing areas has been relatively low their high growth impact has not yet been strongly felt on the overall global growth.

Hence, while primary olefins and their derivatives have generally reached maturity in conventional uses in the industrialized countries, market development is very promising -indeed- even in conventional applications in the developing countries. This change in regional marketing arena ought to have a marked influential effect in polymer market penetration in the 1990s.

For all commodity plastics the per-capita consumption in developing countries is generally an order of magnitude lower than in the industrialized regions of the world. This can best be seen in Figure 5.1.2. which compares per capita polymer consumption in the various geographical regions, between 1987 actual consumption against expected 1990 per capita consumption.

Figure 5.1.2 PER CAPITA CONSUMPTION OF POLYMERS -Kg./person-

	INDUSTRIALIZED REGIONS						REGIONS IN DEVELOPMENT					
Area	US+CANADA		JAPAN		WEST.EURO		LAT.AMER.		ASIA		AFRICA	
Year	1987	1990	1987	1990	1987	1990	1987	1990	1987	1990	1987	1990
LDPE*	17.5	19.6	9.9	11.2	13.0	14.3	3.4	4.0	0.59	0.78	0.67	0.83
HDPE	12.8	13.6	7.0	7.6	6.4	7.4	1.3	1.7	0.39	0.59	0.32	0.40
PP	9.5	11.6	11.6	14.8	7.2	9.5	0.9	1.4	0.51	0.69	0.41	0.57
PS	8.8	9.3	7.1	8.5	5.4	6.1	0.8	1.1	0.27	0.36	0.21	0.28
PVC	14.5	17.4	12.6	15.8	12.6	14.2	2.1	2.4	0.83	0.97	0.83	1.25
TOTAL COMMD	63.1	71.5	48.2	57.9	44.6	51.6	8.6	10.6	2.6	3.4	2.4	3.3
ABS	1.9	2.3	3.3	4.6	1.1	1.5	0.1	0.1	0.13	0.15	-	0.1
PET	1.5	3.1	0.7	0.9	0.6	0.7	0.1	0.1	0.08	0.12	-	0.1
OTHER	21.1	23.9	12.8	17.5	7.6	9.3	0.4	0.5	0.22	0.32	0.1	0.2
TOTAL POLYM	88	101	65	81	54	63	9.2	11.3	3.00	4.00	2.5	3.7

* Includes LLDPE.

From this Figure it can be seen that there is an enormous difference between the per capita consumption in the regions in development and the industrialized regions. Thus in can be concluded, that even at a relatively slow pace of development, there is still a great potential market for the polymers especially in countries-now in development- which have their own natural gas resources and only allow consumption of polymers at the present.

Considering that Asia -the fastest development area- accounts for some 3 billion people, and Latin America and Africa for some 400 million and 600 million people respectively, it can be forecasted that the regions in development will add over 12 million tons polymer requirements in the next 5 years.

Such new requirements from the regions in development -over the next five years- compares well to the expected increase of the same amount (12 million tons) from the natural growth in the industrialized areas for the same period. In total this amounts to an additional 24 million tons of polymer (over the present) for some 109 million tons, equivalent to an average global annual growth of about 5 %.

5.1.3 Vertical Integration.

During the last decade the petrochemical industry -as a whole- and the polymer industry specifically- have gone through a continuous trend of downstream integration of the major producers. Vertical integration is motivated by the desire to gain in economy of scale value added and to reduce production and transportation costs. Furthermore, such integration also assures continuous availability of raw materials for outlet markets and permits improved inter-relation planning.
The emergence of non-traditional petrochemical producers in the export markets -Saudi Arabia, Canada, Brazil- has also lead producers in industrialized regions to move faster into downstream and specialty products where the value added is greater and the quality of the products requires the use of more advanced sophisticated technologies. Likewise, chemical specialty companies have moved into upstream integration so as to assure the availability of their feedstocks. Both directions have moved toward vertical integration; furthermore, new petrochemical projects in the regions in development, usually are set-up with a combined infrastructure which enhances vertical integration.

Simultaneously, the degree of concentration of the commodity markets appears to have become more fragmented and therefore more competitive. A recent analysis concludes that by the year 2000 no major chemical company will be a pure manufacturer of basic chemicals; i.e. monomers. On the contrary, major chemical companies will offer a whole range of products oriented toward specialized end uses.

One of the directions that polymer manufacturers have taken is to provide a more active and dynamic approach to the converters, in understanding the converters problems; in addition to actual vertical integration and setting-up joint ventures between polymer manufacturers and converters, the polymer producing companies have provided compounding services, engineering and many times even financial assistance in new product development. The trend will be stronger in these directions, as more "in-reactor" compounding will prevail and more sophisticated relationships will be required between polymer producers,converters and the final end-use markets.

5.1.4 Trends in International Trade.

The growth rate of world chemical trade has been very high. World trade of polymers grew from some US$ 15 billion in 1970 to over some US$ 50 billion in 1980 and are estimated to become over US$ 70 billion in 1990. International trade in polymers continues to be dominated by industrial nations, although new producers have started to become a significant factor in the trading markets.

As a major consequence of the oil price increases, gas and oil rich developing nations saw an improvement in their competitiveness of their petrochemical trade. During the last fifteen years, the developing countries share of polymer exports increased from less than 2 % to close to 20%.

The new petrochemical producers from the developing regions - notably from the Middle East and South Pacific - impacted world trade in two different ways : first, the new petrochemical manufacturers substituted -through local production- polymers imports for their domestic demand -previously exported from the industrialized countries- and secondly, the new producers entered with some success into the world market and compete for market share in the industrialized regions. However, for the time being the larger industrialized countries are still the ones achieving the lion`s share of the trading market.

The growth in polymer trade with developing countries - especially exports from industrialized regions- faces a series of obstacles based on the deteriorating balance of payments, deficits and foreign debts situations, sharp inflation rates and difficulties in obtaining hard currencies to permit imports. To bypass some of these difficulties, world trade with developing nations tends to grow on a barter trade basis; i.e. linkage between imports and exports, which makes it possible to pay for purchases of polymers with goods - in many instances agricultural produce. It is expected that the share of global barter trade will continue to increase at a rapid rate. Increased polymer production in and barter trade with developing countries have the potential to ease the burden on balance of payments and increase the domestic consumption of polymers in areas with low per-capita consumption.

On the other hand, restrictions to trade and in particular increased levels of tariff protection and setting-up import quotas, being established in industrialized and developing countries are also a severe obstacle to increased global trade in polymers. Current trends in trade legislation in the United States, West Europe and Japan indicate that developing countries will face increased difficulties in exporting polymers to the traditional large markets in these industrialized regions. Tariff rates in developing countries are also generally high and reflect a high degree of protectionism for local producers.

5.2 Improvements and Innovations.

As a direct consequence of world-wide competition, high raw material prices, capital intensiveness of industrial development and polymer maturity in conventional applications, there have been -in the last years- many production technology improvements, innovations, and new applications for polymers. The trends in the two major areas are discussed hereinafter.

5.2.1 Trends in Production Technology.

Technology progress has been a key factor in the production economies of polymers so as to overcome the increased feedstock costs of the 1970s. Improvements in production technologies resulted in increased product yields, decreased investments and considerable reductions in energy requirements. All these factors strongly counter weighted the increased raw materials costs, permitting overall lower production costs. Furthermore, since 1986, when raw material prices decreased sharply, such production technology improvements were an important factor in turning the petrochemical industry as a whole, from a losing or marginally profitable sector, into a highly profitable one.

Likewise, the gradual maturity of a number of polymers, especially in conventional uses has sparked a new generation of products and has created diversified new applications. New plastics have appeared in the world markets with substantial advantages in production costs, improved performance and technical characteristics.

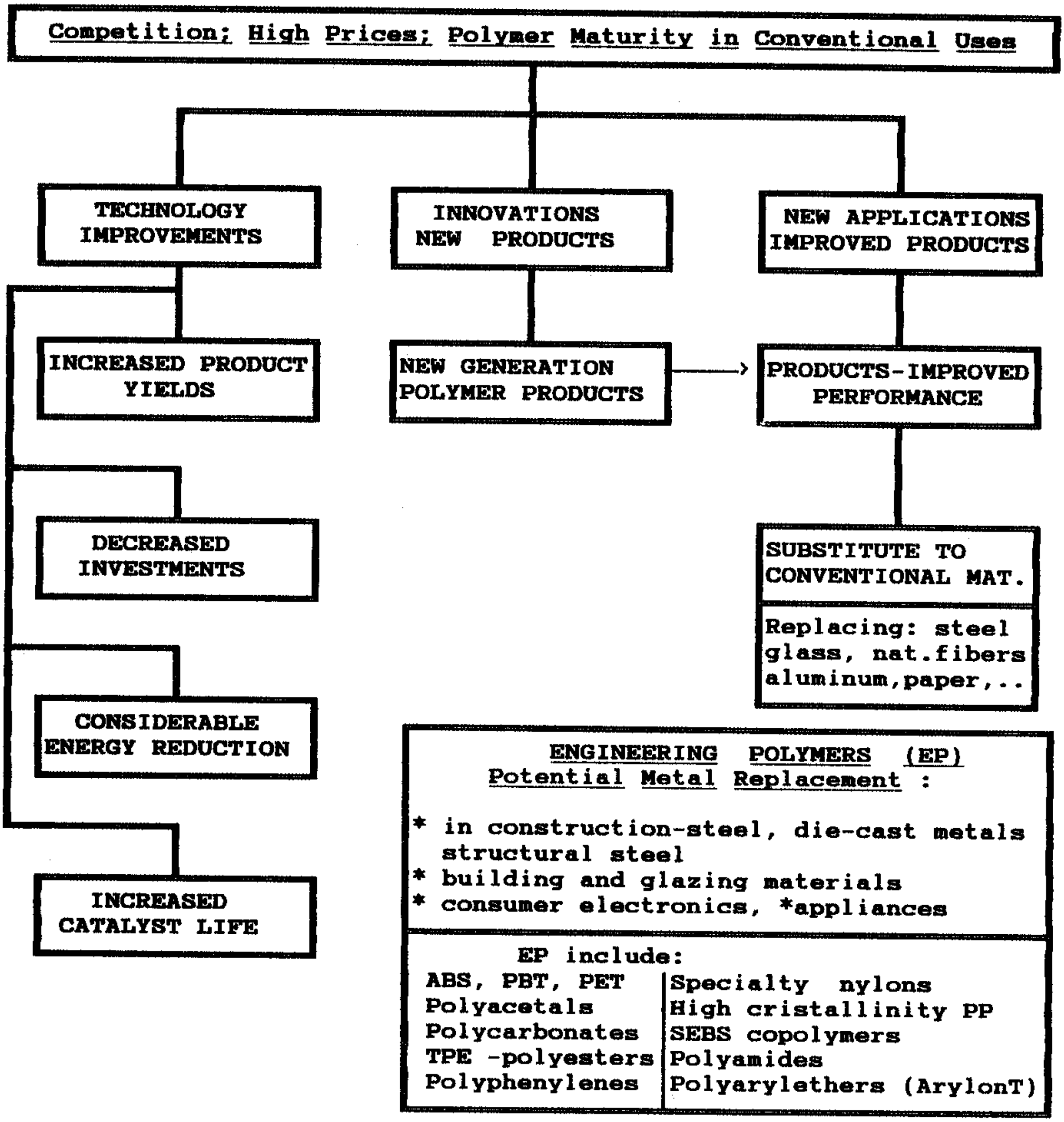
The new products reaching the market in industrialized countries have the potential to become substitutes of long standing traditional materials in many sectors of economic activity. Hence, the lower per capita demand for some of the traditional materials like steel, glass, paper, etc. in developing countries offer an excellent opportunity and challenge to those economies to capitalize on polymer technology improvements and innovations, at an early stage of their industrial development. A major innovation is constituted by the introduction of engineering plastics which will be discussed in more detail in the next sub-section. In the production of polyolefins, much of the latest and current activity in technology development is directed toward the introduction of more versatile technologies. For example, processes capable of producing a wider variety of polymer grades. Other technology improvement priorities are : (a) increase in catalyst activity and life span (b) further use of common monomers such as butane to develop additional products and (c) process retrofits.

Further examples of modifications in production technology are typified by the quality and costs improvements in the production of polypropylene and the advent of LLDPE as a supplement to LDPE, permitting down-gauging and improved conversion economy.

Figure5.2 presents an Overview of such Improvements and Innovation.

FIGURE 5.2

IMPROVEMENTS AND INNOVATIONS



5.2.2 Engineering Plastics.

As commodity plastics face maturity in many applications, the next phase of the world`s polymer industry, especially in the industrialized countries, appears to be accelerated commercialization of the high technology, high performance engineering plastics. The term engineering plastics (EP) includes a number of polymers and encompasses a variety of applications. Most of these materials` demand has resulted from their potential as metal replacements. The combination of structural engineering properties with the economics of thermoplastic processing makes these plastics excellent substitutes for metals and other materials in a wide range of markets.

The group of engineering plastics includes ABS, polyacetals (POM), polycarbonates (PC), thermoplastics polyesters (TPE), polyphenylene sulphides and oxides, polybutylene and polyethylene terephthalates (PBT and PET), specialty nylon and others. Much research and development work is being invested on Polypropylene, which is the commodity polymer with the most suitable engineering features.

New high-crystallinity polypropylene (HCPP) grades are being produced through a new catalyst system; such high-crystallinity polymers are a completely new family, with properties very different from previously known grades. Especially block copolymers of HCPP show an extraordinary balance of impact strength, tensile strength and stiffness, even at higher melt flow rates. Blends of HCPP with styrene-grafted chlorinated polyethylene (CPES), as impact modifier, surpass the performance of ABS as an engineering plastic. It is most likely that the HCPP/CPES blends will have a high application in automotive parts, replacing the more expensive ABS as well as metal parts.

Styrene-ethylene-butene-styrene (SEBS) block copolymers are used in blends with polyolefins, to impart them elastomer properties. SEBS copolymers are being utilized as compatibilizing blends of a wide range of commercially available polymers having glass transition temperatures or apparent crystalline melting points between 150 and 350°C such as :

* Polyamides -such as nylon 6, 6/6, 11, 12, 6/3, 6/12
* Thermoplastic polyesters such as PET and PBT
* Polyarylethers
* Polarylsulfones
* Polycarbonates
* Polyacetals
* Polyamide-imides
* Thermoplatic polyurethanes
* Halogenated thermoplastics such as PTFE, PCTFE and PVDF
* Nitrile barrier resins

The SEBS block copolymers can be used to improve the balance of physical properties compared to individual component polymers by blending a large amount of a relatively inexpensive polyolefin (mainly used with PP) with a small amount of engineering thermoplastic. The blends retain much of the properties of the engineering thermoplastic, with considerable price decrease, as 40 to 68 % of the blend is lower cost polypropylene.

The development pace of engineering plastics is very intense and resembles some of the characteristics exhibited originally by commodity plastics when first introduced: very high growth rates, a very large degree of of research and development activity and a continuous strive for new and improved applications.

In the United States engineering plastics demand has been growing at a combined rate of over 12% per year for the last five years, and is estimated to be over 1.7 million tons . An average yearly growth rate of over 10% is expected to continue throughout the decade. Japan`s growth rate has been over 12%, and is expected to continue growing at the same pace. Japanese demand is estimated to be about 1.5 million tons. West Europe`s demand is about 800 thousand tons, growing at an average annual rate of 6%. Total global demand for engineering plastics for 1990 is estimated at about 5.25 million tons, which represents only some 6 % of total polymer consumption. By 1995, it is expected that engineering plastics will be close to 10% of total polymer demand.

Major markets for engineering plastics are:
* metal replacement in construction - sheet, die-cast metals and structural steel-
* building and glazing materials
* component parts and body panels in transportation equipment
* consumer electronics
* component parts in appliances

Estimates of the future scope of engineering plastics markets vary considerably; most analysts seem to agree, however, that global growth rates for established and new applications in industrialized countries will continue to be three to four times the GDP rates for the next decade. Some analysts, even expect that engineering plastics may replace by the year 2000 up to 50% of die-cast metals, hot rolled steel and structural steel in the United States. That substitution level alone represents an 8 to 10 million ton market potential.
Another market development potential is the application of engineering plastics in the transport industry.The first prototypes of all-plastic body vehicles are expected to be ready within the next two years at lower costs (some $ 2000 reduction for passenger cars), lower weight, improved mechanical characteristics,and attractive aesthetics. The plastic share of all passenger cars is expected to increase to 150 kg/unit in 1992, from the current 100 kg/unit.

But potential applications are not limited to passenger cars or transportation hardware. Polycarbonates and polyacetals have a bright future in irrigation hardware, pump housings, potable water distribution systems, construction materials and durable goods. Such applications are not limited to the industrialized regions only; in fact, demand for engineering plastics in developing countries is also growing at a fast pace with some early starters such as Korea, Taiwan and Brazil showing increasing demands in an established and ever growing market.

The potential for product substitution, in developing countries is also enormous, with metal replacement as a potential and very economically attractive area, in particular for those countries without an established steel or metal industry.

Figure 5.2.2 presents estimates of past, and present global consumption of engineering plastics, by different polymers and expected growth rates over the next five years. It also shows a consumption forecast for 1995.

Figure 5.2.2 GLOBAL DEMAND FOR ENGINEERING PLASTICS

	Consumption-MM Tons		Growth	Cons-MMTon
RESIN	1985	1990	Avg. %/yr	forcst1995
ABS	1.66	1.98	6	2.65
Polyacetals	0.24	0.33	7	0.46
Polycarbonates	0.35	0.64	13	1.20
Nylon 66	0.26	0.42	10	0.67
Polyphenylenes	0.15	0.28	13	0.51
PBT and PET	0.13	0.29	22	0.80
Others	0.35	1.32		3.28
Total	3.14	5.26	12.5	9.57

5.3 Forecasts for the Next Decade.

Figure 5.3 presents forecasts for polymer consumption in the various regions of the world for the years 1995 and 2000, based on the expected 1990 consumption.
Section A presents the consumption forecasts for commodity polymers, Section B presents the consumption of other plastics.
Projected average annual growths for the 1990-1995 period and for the 1995-2000 period, for each major region, are also shown in Figure 5.3, as well as the relative share of world market for each region for each polymer.

Following is a brief summary polymer by polymer.

5.3.1 Low Density Polyethylene (including Linear) (LDPE/LLDPE)

Average annual growth of LDPE/LLDPE is expected to be about 4% world-wide between 1990 and the year 2000. East Asia, Japan and Latin America are expected to show the highest growth factors, while for the United States and West Europe LDPE is considered as a relatively mature product which market will grow at 3.0-3.5 % up to 1995, and below 3 % thereafter.
At present, the industrialized economies (U.S., West Europe and Japan) account for 59% of the total world-wide consumption, S.E. Asia for 14.6% and the rest of the world for 26.4%.By the beginning of next century the industrialized economies are expected to decrease their share to 54%, while S.E.Asia will increase consumption to account for 17.4% and the rest of the world for 28.6%.

5.3.2 High Density Polyethylene (HDPE).

HDPE is expected to grow at an average annual rate of 5.4% world-wide between 1990 and 1995, decreasing to 5 % thereafter. While the S.E. Asian countries and Latin America are expected to show the highest growth, all regions in the world are expected to show an average growth above 4.5 % throughout the decade.
The industrialized economies presently consume 61.6% of total world consumption; with S.E. Asia consuming 15.1 % and the rest of the world 23.4 % of total world consumption. By the year 2000, the industrialized nations are expected to decrease their share only to about 59 %. This forecast can be translated to mean that HDPE is a polymer with much wider potential growth than LDPE all throughout the world, and not only in the development regions.

5.3.3 Polystyrene (PS).

Although in the United States and West Europe polystyrene requirements are not expected to grow above an annual average rate of 3-3.5 % average over the next decade, consumption in the Far East and rest of the world is on the increase, so that world-wide consumption is expected to show an average annual growth of 4.6 % between 1990 and 1995, and 4.1 % per annum thereafter.
The United States and West Europe presently consume about 61 % of the world requirements, but will reduce their share to about 54 % by the year 2000. Japan presently is responsible for 14 % of the world wide consumption, and is expected to increase their share to about 18% by the end of the century.

F I G U R E 5.3

GLOBAL FORECAST OF POLYMERS TO YEAR 2000
COMMODITY POLYMERS

section A

THOUSANDS METRIC TONS		Est.1990	REGIONAL % SHARE OF WORLD MARKET	Projected Growth Avg. %/Yr. 1990-1995	Forecast Demand 1995 Thousand Ton	Projected Growth Avg. %/Yr. 1995-2000	Forecast Demand 2000 Thousand Ton	REGIONAL % SHARE OF WORLD MARKET
LDPE/LLDPE	US	4,500	23.9%	3.5%	5,345	2.9%	6,166	21.8%
	WEST EUROPE	5,252	27.8%	3.0%	6,089	2.5%	6,889	24.3%
	JAPAN	1,378	7.3%	5.5%	1,801	4.5%	2,244	7.9%
	OTHER E.ASIA	2,758	14.6%	6.5%	3,779	5.5%	4,939	17.4%
	REST OF WORLD	4,979	26.4%	5.0%	6,355	5.0%	8,110	28.6%
	TOTAL	18,867			23,367		28,348	
HDPE	US	3,415	29.7%	5.0%	4,359	4.7%	5,484	28.5%
	WEST EUROPE	2,734	23.8%	4.5%	3,407	4.7%	4,287	22.3%
	JAPAN	929	8.1%	5.5%	1,214	5.0%	1,550	8.1%
	OTHER E.ASIA	1,742	15.1%	6.5%	2,387	6.0%	3,194	16.6%
	REST OF WORLD	2,690	23.4%	6.0%	3,600	5.5%	4,705	24.5%
	TOTAL	11,510			14,966		19,219	
POLYSTYRENE	US	2,349	31.3%	3.0%	2,723	2.5%	3,081	26.6%
	WEST EUROPE	2,251	30.0%	3.5%	2,673	3.5%	3,175	27.5%
	JAPAN	1,045	13.9%	7.5%	1,500	6.5%	2,055	17.8%
	OTHER E.ASIA	n.a.						
	REST OF WORLD	1,861	24.8%	6.0%	2,490	5.5%	3,255	28.1%
	TOTAL	7,506			9,387		11,567	
VINYLS	US	4,379	23.0%	3.5%	5,201	3.0%	6,029	21.2%
	WEST EUROPE	5,207	27.4%	2.5%	5,891	2.0%	6,504	22.9%
	JAPAN	1,939	10.2%	5.0%	2,475	4.0%	3,011	10.6%
	OTHER E.ASIA	2,629	13.8%	7.0%	3,687	6.0%	4,934	17.4%
	REST OF WORLD	4,859	25.6%	5.0%	6,201	5.0%	7,915	27.9%
	TOTAL	19,013			23,456		28,394	
POLYPROPYLENE	US	3,008	24.1%	6.5%	4,121	5.5%	5,386	23.6%
	WEST EUROPE	3,501	28.0%	7.0%	4,910	5.5%	6,418	28.1%
	JAPAN	1,815	14.5%	6.0%	2,429	5.0%	3,100	13.6%
	OTHER E.ASIA	2,076	16.6%	7.5%	2,980	6.0%	3,988	17.5%
	REST OF WORLD	2,088	16.7%	7.0%	2,929	6.0%	3,919	17.2%
	TOTAL	12,488			17,369		22,811	
COMMODITY PLASTICS	US	17,651	25.4%	4.4%	21,748	3.9%	26,146	23.7%
	WEST EUROPE	18,945	27.3%	4.4%	22,971	3.5%	27,272	24.7%
	JAPAN	7,106	10.2%	5.8%	9,419	4.9%	11,960	10.8%
	OTHER E.ASIA	9,205	13.3%	6.8%	12,833	5.7%	17,055	15.5%
	REST OF WORLD	16,477	23.7%	5.5%	21,575	5.2%	27,904	25.3%
	TOTAL	69,384	100.0%	5.0%	88,546	4.5%	110,338	100.0%

F I G U R E 5.3

GLOBAL FORECAST OF POLYMERS TO YEAR 2000
NON-COMMODITY POLYMERS

THOUSANDS METRIC TONS		Est.1990	REGIONAL % SHARE OF WORLD MARKET	Projected Growth Avg. %/Yr. 1990-1995	Forecast Demand 1995 Thousand Ton	Projected Growth Avg. %/Yr. 1995-2000	Forecast Demand 2000 Thousand Ton	REGIONAL % SHARE OF WORLD MARKET
ABS					0		0	
	US	561	28.3%	3.8%	676	3.0%	784	26.9%
	WEST EUROPE	509	25.7%	4.5%	634	3.0%	735	25.2%
	JAPAN	480	24.2%	4.0%	584	4.0%	711	24.4%
	OTHER E.ASIA	n.a.			0		0	
	REST OF WORLD	432	21.8%	4.5%	538	5.0%	687	23.6%
	TOTAL	1,982		4.3%	2,433	3.8%	2,917	
REINFORCED PLASTICS	US	1,139	31.2%	2.5%	1,289	2.0%	1,423	25.2%
	WEST EUROPE	1,238	33.9%	5.0%	1,580	3.8%	1,904	33.7%
	JAPAN	455	12.5%	7.0%	638	6.0%	854	15.1%
	OTHER E. ASIA	n.a.			0		0	
	REST OF WORLD *	821	22.5%	6.0%	1,099	6.0%	1,470	26.0%
	TOTAL	3,653		4.8%	4,606	4.2%	5,651	
PET	US	824	50.1%	5.5%	1,077	4.5%	1,342	46.4%
	WEST EUROPE	267	16.2%	10.0%	430	8.0%	632	21.8%
	JAPAN	446	27.1%	3.4%	527	3.0%	611	21.1%
	OTHER E. ASIA	83	5.0%	11.0%	140	10.0%	225	7.8%
	REST OF WORLD	25	1.5%	14.0%	48	12.0%	85	2.9%
	TOTAL DEMAND	1,645		6.3%	2,222	5.5%	2,895	
OTHER PLASTICS	US	4,802	51.7%	4.0%	5,842	3.5%	6,939	43.9%
	WEST EUROPE	2,156	23.2%	5.0%	2,752	4.0%	3,348	21.2%
	JAPAN	839	9.0%	10.0%	1,351	8.0%	1,985	12.6%
	OTHER E. ASIA				0		0	
	REST OF WORLD *	1,499	16.1%	10.0%	2,414	8.0%	3,547	22.4%
	TOTAL DEMAND	9,296		5.9%	12,359	5.3%	15,819	
TOTAL	US	24,977	29.1%	4.3%	30,632	3.7%	36,633	26.6%
	WEST EUROPE	23,115	26.9%	4.3%	28,367	3.7%	33,891	24.6%
	JAPAN	9,326	10.8%	6.3%	12,520	5.4%	16,121	11.7%
	OTHER E.ASIA**	9,288	10.8%	6.8%	12,973	5.9%	17,281	12.6%
	REST OF WORLD	19,254	22.4%	6.1%	25,674	5.6%	33,693	24.5%
	TOTAL DEMAND	85,960		5.3%	110,166	4.5%	137,620	

* REST OF THE WORLD (including Other E. Asia) estimat
** Total for OTHER E. ASIA is not complete, as several polymer quantities are missing for this region.
H. D. Frenkel May 12,1990

5.3.4 Polyvinyl Chloride (PVC)

PVC expected growth will be handicapped by environmental considerations in the United States and west Europe; thus, the yearly average growth rate is expected to be between 2-3.5 % in these regions, while in the Far East and the rest of the world, rate of consumption growth is expected to be 5-7 % average per year. The worldwide average annual growth of PVC is forecast at about 4.3 % between 1990-1995, and 3.9 % thereafter.
The industrialized economies consume at present 60.6 % of total PVC worldwide consumption, but are expected to have a 55 % share in the year 2000; S.E.Asia share is expected to increase from 13.8% to 17.4 % of world market.

5.3.5 Polypropylene (PP)

PP is expected to continue to be the fastest growing commodity polymer throughout the next decade, in all the regions. Annual average growth is forecast to range from 6 % - 7.5 % (worldwide average of 6.8 % per year) between 1990 and 1995 and from 5 % to 6 % (worldwide average of 5.6 % per year) thereafter.
World-wide market distribution will not change too much, as this polymer is expected to grow likewise in all areas. Presently the industrialized economies account for 2/3 of world-wide consumption, by the year 2000 their consumption share will decrease to 65.3 %.

5.3.6 Acrylo-Butyl-Styrene (ABS).

The expected growth of ABS is expected to be at an annual average rate of 4.3 % between 1990-1995, and 3.8 % per year thereafter. Rate of growth is fairly even throughout the world.

5.3.7 Polyethylene Terephthalate (PET).

PET expected world-wide growth over the next decade is close to expected Polypropylene growth; i.e 6.3 % between 1990-1995 and 5.5% thereafter. The major growth is expected to be in S.E. Asia, Latin America and West Europe, with Japan strongly lagging behind. The United States and Japan currently account for over 77 % of total consumption, while West Europe only has 16.2 % of the total market; by the year 2000 it is expected that the United States and Japan will jointly have a share of 67.5 % of the world market, while West Europe will have close to 22% and S.E. Asia close to 8%.

The following table presents an overall summary of world-wide polymer consumption and growth over the next decade.

Polymer	Year 1990 MMTons Consum	Year 1990 %	1990-95 Av.%/y growth	Year 1995 MMTons Consum	Year 1995 %	95-2000 Av.%/y growth	Year 2000 MMTons Consum	Year 2000 %	Decade Av.%/y growth
LD/LLDPE	18.9	22	4.3	23.4	21	4.0	28.4	21	4.2
HDPE	11.5	13	5.4	15.0	14	5.0	19.2	14	5.3
PS	7.5	9	4.6	9.4	9	4.1	11.6	8	4.4
PVC	19.0	22	4.3	23.5	21	3.9	28.4	21	4.1
PP	12.5	15	6.8	17.4	16	5.6	22.8	17	6.2
PET	1.6	2	6.3	2.2	2	5.5	2.9	2	6.0
POLYMERS	86.0	100	5.3	110.2	100	4.5	137.6	100	4.8

5.4 Current Monomer and Polymer Capacity Expansion.
It has been stated previously that monomer and polymer capacity is being actively expanded since 1988. Many new olefins producing plants are being built all over the world, especially in S.E. Asia. Many polymer producing plants, especially polypropylene are being built, and are being announced all over.

Tables 5.4.1-5.4.7 present projects which have been announced since 1988, and which have been either started up already, or under construction or engineering stages. Most likely some of these projects will not materialize, but on the whole the Project Planning lists presented in Figures 5.4.1 - 5.4.7 translate the "building euphoria" prevailing since 1988, after the very quiet "non-expansion" period between 1980-1987.

The following table presents a summary overview of announced expansion projects.

PLANT	U.S.A.	WEUROPE	EEUROPE	JAPAN	SE.ASIA	REST	WORLD
MONOMER PLANTS - ETHYLENE AND PROPYLENE							
	5,304	4,670	2,685	4,193	5,720	7,250	22,571
POLYMER PLANTS							
LDPE	1,093	1,365	940	227	1,690	1,876	6,191
HDPE	1,232	470	300	-	580	370	2,952
PS	377	489	668	120	605	455	2,713
PVC	1,050	787	210		325	1,448	3,820
PP	350	2,528	1,000	40	1,525	2,687	4,077
PET	187	71		8	194	133	399

SECTION 6
FORECASTS OF ISRAEL`S POLYMER REQUIREMENTS OVER THE NEXT DECADE

6.1. FACTORS EXPECTED TO INFLUENCE ISRAEL`S POLYMER REQUIREMENTS OVER THE NEXT DECADE.

Section 5 discusses in detail the factors influencing global trends in polymer manufacturing. The parameters identified as major factors influencing global trends in polymer manufacturing are :
1. Feedstock Availability
2. Market Growth, Penetration and Saturation
3. Vertical Integration
4. Changes in International Trade Patterns

A brief evaluation of these factors related to Israel`s expected growth in polymer consumption is pertinent.

6.1.1 Feedstock Availability

Israel does not have access to natural gas nor to low cost naphtha as feedstock for competitive monomer manufacturing.
This is, undoubtedly, the biggest handicap of the Israeli petrochemical industry; the naphtha, although produced at the local refineries is based on imported crude oil.
Furthermore, while in the past fuel oil requirements were large enough to permit a certain degree of crude processing deals - which permitted advantageous exports of heating oils and other middle distillates, while keeping locally the naphtha (in addition to the fuel oil locally), the Israeli fuel economy has changed, as fuel oil requirements decrease with increasing coal based electric energy, creating the incentive of lower refining throughputs ; thus additional naphtha for petrochemicals has to be imported as such.

In summary it can be said that there will be no large amounts of feedstocks available - over present consumption - and any increased feedstock requirements will have to be imported at a premium.
Thus there is no incentive in petrochemical expansion from a feedstock availability standpoint.

6.1.2. Market Growth.

It is considered that market growth of polymers in Israel -over the next decade- will be influenced by the following factors :

* Degree of Saturation
* Direct and Indirect Effect of Increasing Immigration
* New and Wider Application of Polymers
* Changes in Pattern of Exports of Plastic Products
* Effect of Local Production

6.1.2.1 Degree of Saturation

Figure 6.1.1 presents per-capita consumption of polymers in Israel compared to the Industrializes Regions;i.e. North America (U.S. and Canada), West Europe and Japan. In addition to showing the per-capita consumption in these areas in 1987 and expected in 1990, the average yearly rate of growth per capita is also presented.

FIGURE 6.1.1
PER CAPITA CONSUMPTION OF POLYMERS -Kg./person-
CONSUMPTION COMPARISON :
ISRAEL'S COMPARED TO INDUSTRIALIZED REGIONS

	INDUSTRIALIZED REGIONS									ISRAEL		
Area	U.S. & CANAD.			WEST EUROPE			JAPAN					
Year	1987	1990	%yr^	1987	1990	%yr^	1987	1990	%yr^	1987	1990	%yr^
LDPE*	17.5	19.6	3.8%	13.0	14.3	3.4%	9.0	11.2	7.6%	15.9	16.8	1.9%
HDPE	12.8	13.6	2.1%	6.4	7.4	5.0%	7.0	7.6	2.8%	7.1	7.8	3.2%
PP	9.5	11.6	6.9%	7.2	9.5	9.7%	11.6	14.8	8.5%	9.0	9.2	<1 %
PS	8.8	9.3	1.9%	5.4	6.1	4.1%	7.1	8.5	6.2%	4.7	4.7	-
PVC	14.5	17.4	6.3%	12.6	14.2	4.1%	12.6	15.8	7.8%	10.0	8.7	-5.%
TOTAL COMMD	63.1	71.5	4.3%	44.6	51.6	5.0%	48.2	57.9	6.3%	46.6	47.2	0.4%
ABS	1.9	2.3	6.6%	1.1	1.5	11 %	3.3	4.6	12 %	1.3	1.1	-5.%
PET	1.5	3.1	27 %	0.6	0.7	5.5%	0.7	0.9	8.8%	0.7	2.9	60 %
OTHER	21.1	23.9	4.2%	7.6	9.3	7.0%	12.8	17.5	11 %	12.8	12.9	<1%
TOTAL	88	101	4.7%	54	63	5.3%	65	81	7.6%	61.4	64.1	1.5%

^ Average % growth per year during 1987-1990 period.
* Includes Linear Low Density Polyethylene.

FROM THE ABOVE TABLE THE FOLLOWING CAN BE CONCLUDED:

1. Israel`s per capita total polymer consumption is very high - even above the average West European consumption.This is especially true for LDPE, HDPE ,PP and PET; less so for PVC and PS. Basically, it would appear that consumption of the polyolefins in conventional applications nears saturation.
2. In the period from 1987-1990 there was hardly any growth in polymer consumption; the exception being PET, which showed a considerable increase during this period.
3. One of the major uses of LDPE has been in agricultural film applications; this application is practically saturated.
4. From the above it would appear that if population increase would only be based on natural growth, there would be only a very marginal increase in polymers consumption over the next decade.

6.1.2 Effect of Increasing Immigration.
Israel is currently at the threshold of a new immigration wave, which ought to increase polymer use considerably; it is very difficult to make any forecast evaluations.
However, so as to show the potential growth an exercise has been made, assuming a rate of immigration of 150,000 new immigrants per year over the next three years, dropping to 100,000 new immigrants per year over the following three years and decreasing to 20,000 new immigrants per year in a stage-wise manner.
Such new immigrants will increase the consumption of polymers in a direct and indirect manner; they will consume more packaging materials, more plastics components in household goods, more plastic toys, certainly much more plastic components in furniture and many more direct plastic uses can be expected. New immigrants shall increase considerably construction requirements with associated plastic utilization in this sector.
A step by step utilization of plastic products is forecasted for such new population, assuming that in the first year such new immigrants would consume some 25% of the present per-capita consumption, increasing step-wise until they achieve the present per-capita consumption of each polymer after 10 years. The results of this exercise are shown in Figure 6.1.2 .
There is little doubt that the new wave of immigration will have a strong positive effect on Israeli`s polymer requirements during the next decade.

6.1.3 New Applications of Polymers.
It is expected that newer and wider applications of polymers in Israel will contribute to growth over and above the expected marginal growth of the presently prevailing uses.

The following areas should provide new and wider application for plastics, increasing polymer consumption :

a.Building and Construction
The building and construction industry is world-wide the second largest consumer of plastics. Most applications are for pipe and nonstructural applications, such as sidings, window frames and glazing. These are generally large-volume applications with performance requirements that can adequately be met by commodity plastics, at costs much lower than engineering plastics.
Engineering plastics are also used in building and construction for small functional parts such as casters, pulleys and latches or for the more demanding applications such as plumbing (pipe fittings, fixtures and components) and protective glazing.
The largest building and construction uses for thermoplastics are for pipe and conduit applications.In particular PVC,HDPE,LDPE/LLDPE and PP are used for water pipe, irrigation pipe, drainage pipe, gas pipe and various other pipe constructions. PVC is often used because of its high-pressure capability and ability to be extruded for large diameter applications, whereas polyolefins prevail in flexible, collable pipe which can reduce installation costs. Due to environmental problems there is a tendency to replace PVC by PP.

SECTION 6 - FORECASTS OF ISRAEL'S POLYMER REQUIREMENTS OVER THE NEXT DECADE

FIGURE 6.1.2 DIRECT AND INDIRECT EFFECT OF INCREASING IMMIGRATION ON POLYMER CONSUMPTION

YEAR		TONS PER YEAR										
		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
New Immigration in year		150,000	150,000	150,000	100,000	100,000	100,000	40,000	30,000	30,000	20,000	20,000
	Present Percapita Consumption Kg/per/yr	ADDITIONAL CONSUMPTION OVER AND ABOVE NATURAL INCREASE FROM PRESENT POPULATION TONS/YR										
LOW DENSITY POLYETHYLENE	16.8	630	1,638	2,898	4,200	5,628	7,098	8,358	9,467	10,534	11,122	12,457
HIGH DENSITY POLYETHYLENE	7.8	293	761	1,346	1,950	2,613	3,296	3,881	4,395	4,891	5,312	5,846
POLYPROPYLENE	9.2	345	897	1,587	2,300	3,082	3,887	4,577	5,184	5,768	6,266	6,895
POLYSTYRENE	4.7	176	458	811	1,175	1,575	1,986	2,338	2,648	2,947	3,201	3,523
POLYVYNIL CHLORIDE	6.7	251	653	1,156	1,675	2,245	2,831	3,333	3,775	4,201	4,563	5,022
TOTAL COMMODITY POLYMERS	47.2	1,695	4,407	7,797	11,300	15,142	19,097	22,487	25,470	28,340	30,463	33,743
ACRYLO-BUTYL-NITRIL	1.0	38	98	173	250	335	423	498	564	627	681	750
POLYETHYLENE TEREPHTHALAT	2.9	109	283	500	725	972	1,225	1,443	1,634	1,818	1,975	2,174
OTHER POLYMERS	12.9	484	1,258	2,225	3,225	4,322	5,450	6,418	7,269	8,088	8,786	9,669
TOTAL	64.0	2,325	6,045	10,695	15,500	20,770	26,195	30,845	34,937	38,874	41,905	46,335

Polystyrene is used in various building and construction applications for products such as light fixtures and ornamental profiles. Expanded polystyrene beads are used for insulation and foam core designs.
In addition to pipes, polyolefins include film and sheet for on-site construction applications- moisture-proofing-and various decorative profiles.
PVC is used in applications such as window profiles, flooring, gutters, foam moldings,etc. Acrylic resins -polymethylmethacrylate- are selected to impart a high level of clarity for glazing in windows, light fixtures, sun-roofs and panels.
Engineering polymers are used for plumbing fixtures (sanitaryware), window hardware and a variety of other uses such as lock mechanisms decorative moldings and specialized mechanical devices.
Multicolored bathroom and kitchen fixtures, rolling shutters, whirlpool baths (jacuzis), windows, built-in furniture and shelving and energy conservation features will in the near future all avail themselves of the versatility in performance and decorating options of various plastics materials.

In addition to the previously described building and construction applications, polymers offer future product design economies for insulation, decorative moldings, wall coverings, roofing materials and even structural applications.

Especially so in Israel, performance polymers will be useful in replacing wood and metal for certain weight-supporting structural applications.

In summary, the increase in new building and construction activities - due to a large extent to increased immigration- should lead to larger and wider polymer application in this sector in Israel.

<u>b). Consumers and Institutional Products</u>
Consumer products encompass a wide variety of applications such as toys, housewares, sporting goods, health care devices, serviceware and luggage. Improved economics, through performance improvements and parts consolidation, are the driving force for the use of plastics in this category, replacing glass, metal and wood.

The medical market, in particular, -so far barely tapped in Israel- is projected to exhibit high growth due to the replacement of glass and metals, with both disposable and sterilizable plastics.
Disposable medical gowns, operating table covers and other fabrics that currently have to be laundered will be increasingly replaced by single use plastic films and fibers. For instrumentation and surgical products, however, trends to reduce costs may favor multiple use products, requiring plastic products to withstand radiation and/or autoclave sterilizations for five or more cycles.
Dual ovenable, (for regular ovens and microwave use) disposable and reusable food trays will become an increasingly important segment of the household market. The major application for liquid crystal polymers is currently for dual ovenable, freezer-to-oven trays and casseroles.

Much of this cookware demand will be totally new, as the number of households with microwaves is expected to increase dramatically in Israel during the next five years. Some of the growth in plastics consumption for cookware will come at the expense of ceramics and glass.

Office supplies - tape dispensers, stapler bodies, desk organizers, in/out trays, etc.- represent good growth opportunity for plastics to replace metal.

Other emerging consumer goods applications include the use of polypropylene for apparel and footwear - replacing canvas on sneakers and other leisure/work shoes), polystyrene "clam shell" packages and "hot cups" for fast food and convenience food outlets. This latter application may, however, be adversely affected by environmental concerns regarding disposal of solid wastes.

<u>c). Electrical/Electronics Market</u>

The electrical/electronics market is expected to be worldwide one of the most dynamic markets for plastics usage. This market includes home and industrial appliances, electrical and industrial equipment, components, computers and perispherals, records and batteries. The appliance, computer and peripheral market segments will be the fastest growing applications for plastics.

The opportunities in small appliances -for which there is a significant growth factor- will most likely be captured by ABS, polypropylene, polystyrene, nylon and modified PPO/PPE resins.

The major appliance industry offers substantial potential for metal replacement by plastics. This is a segment which has hardly been penetrated on a world-wide scale, and is bound to create great potential opportunities for Israeli manufacturers for the home market, as well as sub-contractors for overseas works.

The electrical and industrial equipment market segment will also be a good source of growth for plastics through the year 2000, in response to the growing trend toward automated production.

Generally, the net increase in the use of plastics for this market segment will be for transitional and engineering plastics.

The wire and cable market segment will be declining in its demand growth for plastics through the year 2000, since all but power cables stand to be replaced by fiber optics.

The communication equipment market in Israel is bound to remain fairly stable, or to show a slight decline, with consequential results for plastics.

The electronic component market will most likely show a net decrease in the use of plastics through the year 2000, due to miniaturization of electronic equipment in general. There will be a trend toward the use of thermoplastics instead of thermosets, over the next decade.

The computer and peripheral market should be a very interesting one for plastics. Although the business segment could be saturated by the early 1990s, there has been very limited penetration in the home market. As a result, there is a potential for a large net increase in the use of plastics in this market segment.

It is expected that the market for traditional long-playing records -currently made out of PVC- will be replaced by compact discs and mini-cassettes by the year 2000. Compact discs are currently made out of polycarbonate,with the display cases made out of polystyrene The use of compact discs for institutional and industrial data storage also promises dynamic growth for these plastic materials. The battery market, is another area of potential high growth for plastics - mainly polypropylene. Some production of batteries from polypropylene has started in Israel, but the potential for increase is very high over the next decade.
In summary, the electrical/electronics market is one of great interest and potential for plastics - over the next decade- especially in Israel, since additional electronic devices will become produced in the country, and it is expected that there will be a greater penetration of plastic components in this ever-growing sector.

d). Furniture
This market consists of residential, office, commercial and institutional furniture as well as carpets, wall coverings, bedding curtains and blinds. The market is dominated by polyurethane foams and polypropylene. The use of PVC declined during the early 1980s, reflecting a decline in synthetic flooring in preference to carpet or parquet tile; however polypropylene carpeting has strongly penetrated in this market and is expected to do so in Israel in the next years.

The two key growth applications foreseen will be injection molded seating for commercial/institutional/garden furniture and carpets - backing and face yarn-. Growth in demand of polypropylene in these two newer applications is bound to increase considerably in view of improved economics replacing wood and metal for furniture, and natural yarn and jute for carpet bagging.

Significant demand growth for plastics in the furniture and furnishings market will result from the need to furnish new dwellings.
In Israel the polypropylene application in the furniture market has already made an inroad, and no doubt that the necessity of furnishing new dwellings for incoming immigrants will impact this application considerably over the next decade.
It is further expected that the eventual local production of polypropylene should have a positive effect on such furniture and carpet applications.

e).Industrial/Machinery
This market segment encompasses all types of construction, farm and industrial machinery, engines, machine tools, chemical process and other equipment. This market sector is and will continue to be dominated by metal due to strength and durability, as well as structural and safety requirements. Although this situation will continue to prevail throughout the world, and is not expected to change drastically, Israel may become the leader in developing a new plastics based equipment and machinery industry for local use and for export.

Plastic equipment and machinery will be an effective replacement for metal in hostile environments (e.g.corrosive liquid application) and in bearing and wear applications. Opportunities for plastics replacement of metals include parts consolidation in complex industrial assemblies such as meters and pumps. Continued demand for plastics in corrosion resistant environments will include applications in piping, waste treatment facilities and pollution control devices.
Again, it is thought that Israel, with its technological-engineering capabilities, should be a fore-runner in this interesting field which would permit the setting-up of high added value industries and at the same time create a new polymer application field.

<u>f). Transportation Industry Components</u>
The demand for plastics in the transportation industry has been on the increase worldwide and is considered as a major potential growth factor.
Plastics in the transportation industry consists of the following sub-sectors:

* Automotive -cars and light trucks-
* Other land-based vehicles (including trailers)
* Mass Transit
* Airplanes/Aerospace
* Marine
* Military

Worldwide, approximately 90 percent of plastics consumption in this overall sector is for cars and light trucks; almost 6 percent is for marine - primarily unsaturated polyester - and the remaining 4 percent for the other sub-segments. By virtue of its size - worldwide- the automotive industry offers the greatest potential for plastics use.
However, since this sub-sector is practically non -existent in Israel, plastic demand in this overall sector is primarily for the marine, airplane and military applications. It is expected that there will also be certain increases and additional uses for polymers in such applications; however, no dramatic changes are expected in this field.

No significant growth for polymers are expected in the agricultural and packaging fields in Israel, as plastics consumption in these sectors has practically reached saturation. The exception is new developments in packaging in the direction of multi-layers and other new developments.

6.1.4 Changes in Pattern of Exports of Plastic Products

Exports of plastics products (excluding exports of polymers per se) during 1988 amounted to 230 million dollars, out of a total plastics products manufacture amounting to 1.1 billion dollars; thus export represented over 20% by value of total production. While exports of plastics products were continuously on the increase from 1982 until 1987, there was a drastic decrease of almost 15 % between 1987 and 1988.

Exports of polymers in 1988 were 79 thousand tons, at a value of 81 million dollars. Total exports of polymers in previous years were also somewhat higher than in 1988, ranging between 80-84 thousand tons per year.

Thus, there has been a downward trend in polymers and plastics products exports from Israel, as world-wide competition has become fiercer.

The writer cannot identify any special reasons for a significant upward change in the expected pattern of exports of plastic products and in polymers (except that as soon as polypropylene production will commence, there will be export of this polyolefin).

Unless the changes in Europe toward 1992 will have a dramatically negative effect on Israeli exports to Europe, there is no identifiable reason for a significant downward trend.

On the whole, the forecasts in this study for the next decade contemplate that export of plastic products from Israel will range between 10 to 15% of the plastics industry output, and that about 40-45 % of polymer output will continue to be exported.

6.1.5 Effect of Local Production

Local production of any specific polymer enhances local consumption This can best be seen by the continuous growth of LDPE in Israel. It is fact that -on the whole- all polymers can be imported at competitive world-wide prices; however, when there is a shortage in supplies - as there was in 1988 - it is an evident that the existence of a local manufacturer assures continuity of supplies. Local manufacturing provides closer technical-customer service, and in general prices are somewhat lower than imported polymers. Unless special interest-free terms are obtained for imported polymers, which is only the case whenever there are large world-wide surpluses, there is a certain working capital advantage to local supplies, as stocks can be reduced.

While local production has had a definite positive effect on local consumption - especially on the growth of LLDPE- the influence could be much stronger if:

* there would be greater inter-action between polymer manufacturers and converters.
* there would be a more aggressive technical service assistance/development policy on the part of polymer manufacturers.

The above would encourage existing and new converters to enter new applications, with the technical and development assistance of the polymer manufacturers.

6.1.3. Vertical Integration.

It has been stated that over the last decade the polymer industry throughout the world has undergone a continuous trend of downstream integration, with major chemical companies offering a whole range of products oriented toward specialized end uses. This has however, not been the case in Israel.

There has been an intent -unsuccessful so far- to integrate the monomer manufacturing operations with polymer manufacture, through the establishment of Carmel Olefins Ltd. However, to present the integration of ethylene/polyethylene operation has not taken place, and the polypropylene project to be implemented by this new jointly owned (by Oil Refineries Ltd and Israel Petrochemicals Ltd) company is not being implemented at a reasonable fast pace.

Intents of horizontal and/or vertical integration have not worked in Israel so far. Horizontal integration between the various petrochemical companies, -so common in West Europe and the United States - in the early-mid 1980s - has not been acceptable to the individual owners of the various petrochemical companies in Israel, although this step was recommended and encouraged by the Government in an effort of improved sector economics.

Vertical integration including polymer production and conversion has been considered as non-feasible as the Israeli polymer producers have a monopolistic market supply situation, and they feel that any conversion manufacturing on their part would be considered as a competitive activity vis-a-vis their own customers. While the argument is certainly valid, the lack of vertical integration decreases Israel`s polymer conversion industry ability to participate in the world markets, especially in competition in the industrialized region markets. An alternative, which has been recommended by consultants, but so far has not been implemented, is that the Israel polymer manufacturing industry should buy into existing manufacturing polymer-conversion ventures, and/or establish new ones, in the European Common Market so as to establish foreign based captive market outlets. This could be an excellent joint inter-activity between Israeli polymer producers and converters to the benefit of both parties, without conflict of interest, which may assure continuous export market outlets. This subject will be discussed further in the forthcoming sections of this study.

There has been practically no attempt nor effort on the part of the polymer producers to integrate into nor offer polymer compounding services.

One attempt of some integration has been made in the polymer conversion field in the manufacture of irrigation components for agriculture, as joint coordinated operations and marketing activities have been set-up by a number of kibbutz industries in this field.

As export markets become more difficult and competitive throughout the world, and as the polymer production industry develops further in Israel, vertical integration should become a more important factor in preventing imports of foreign produced polymers and in enhancing exports of polymers, as such and as converted components.

6.1.4 Changes in International Trade Patterns.
As international trade of monomers and polymers grows, Israel is bound to be influenced by such changing patterns.
The effects are expected to be in a number of opposing directions, some of them are stated hereinunder :
* Fiercer competition of polymer trade from the energy rich producing countries, especially in the field of polyethylene.
* Increased levels of tariff protection and setting-up of import quotas being established in industrialized and developed countries, may curtail imports from Israel.
* Wider market inter-activity with East Europe may have an effect of competitive import of polymers from this area into Israel, and into markets to which the Israeli polymer manufacturers presently export, to the detriment of the local industry. On the other hand, expanded trade with eastern European countries may permit barter deals facilitating export of polymers.
* Increased competitive international trade -especially from the new aggressive South East Asia manufacturers - which may result in imports of polymers to Israel, even with due consideration to protective customs tariff.
* Increased international trade of monomers - especially ethylene- will most likely have a positive effect on the local polymer manufacturing industry, as this may permit continuous importing of ethylene supplies on a decreased price level, as Thailand and Korea had done in the past.

6.2 FORECASTS OF ISRAEL`S POLYMER REQUIREMENTS.
Considering all the factors discussed in Section 6.1 forecasts have been prepared as to expected local market consumption for the major polymers over the next decade. Table 6.2 presents expected growth of polymers in Israel over the next decade. Forecasts have been prepared assuming certain rates of increase of each of the polymers to be consumed by the present population plus the additional consumption expected to be generated by the increase in population, due to new immigration.
The reasoning for the growth factors for each polymer are discussed hereinunder.

6.2.1 Low Density Polyethylene (LDPE):
A 4.4 % increase is assumed for the present year, with an average 3 % annual growth in between 1990-1995 and an average of 2.4 % annual growth from 1995 to 2000, for the consumption of the present population (without the anticipated immigration influx). LDPE growth expectations are low considering that the agricultural film application is practically saturated and that exports of LDPE film are expected to decrease. New applications in construction and consumer goods will cause slight increases in LDPE consumption. Total consumptions - as shown in Figure 6.2 - include some 7,100 tons in 1995 and 12,457 tons in the year 2000 requirements by new immigrants, which boost the annual average rate of growth to 4.6 % for the 1990-1995 period and 3.3 % for the 1995-2000 period.

SECTION 6 - FORECASTS OF ISRAEL'S POLYMER REQUIREMENTS OVER THE NEXT DECADE.

FIGURE 6.2 FORECAST OF POLYMERS CONSUMPTION IN ISRAEL TO YEAR 2000

THOUSAND METRIC TONS POLYMER	Actual 1989 Consumption Local Production + import	Per Capita Consumpt. Kg/per/yr 1989*	Forecast Demand 1990	% of World Consumption	Projected Growth Avg. %/yr 1990-1995	Forecast Demand 1995	Per Capit Consumpt. Kg/per/yr 1995**	Projected Growth Avg. %/yr 1995-2000	Forecast Demand 2000	Per Capi Consumpt Kg/per/y 2000***
LDPE/LLDPE	74.3	16.8	77.6	0.41%	4.6%	97.3	17.4	3.3%	114.2	17.8
HDPE	33.9	7.8	35.6	0.31%	5.5%	45.3	8.1	4.0%	55.3	8.6
POLYSTYRENE	22.7	4.7	23.2	0.31%	2.5%	27.7	4.9	2.9%	32.0	5.0
PVC	36.7	8.7	37.4	0.20%	4.0%	45.1	8.1	2.8%	51.7	8.1
POLYPROPYLENE	39.3	9.2	41.7	0.33%	6.0%	55.6	9.9	4.5%	69.2	10.8
COMMODITY PLASTICS	206.9	47.2	215.5	0.31%	4.7%	271.0	48.4	3.5%	322.4	50.4
ABS	5.1	1.0	5.3	0.26%	4.0%	6.4	1.2	4.0%	7.8	1.2
PET	12.7	2.9	13.7	0.77%	7.8%	19.9	3.6	4.6%	24.9	3.9
OTHER PLASTICS	78.3	12.9	81.8	0.84%	4.8%	103.6	18.5	3.3%	121.5	19.0
TOTAL POLYMERS	303.0	64.0	316.3	0.35%	4.8%	401.0	71.6	3.5%	476.6	74.5

Population estimate : * 1989 = 4.5 million; ** 1995 = 5.6 million; *** 2000 = 6.4 million

6.2.2 High Density Polyethylene (HDPE)
A 5 % increase has been assumed during the current year, with an average expected yearly growth of about 3.3 % for the period 1990-2000; including the additional consumption by new immigrants, as detailed in Figure 6.1.2 the rate of growth corresponds to 5.5% annual average over the 1990-1995 period and to 4 % from 1995 onwards. No particular areas of decrease are envisaged in HDPE consumption in Israel.

6.2.3 Polystyrene (PS)
The annual growth is expected to be relatively low, as polystyrene is being replaced by polypropylene in many applications. An average growth of 2.5 % per year (including new immigrants added requirements), increasing to 2.9 % annual average growth from 1995 to the year 2000.

6.2.4 Polyvinyl Chloride (PVC).
PVC is bound to increase on the one hand, considering that construction is on the increase and new PVC consuming projects - such as PVC window frames- are expected to be implemented sooner or later; on the other hand - environmental considerations will rule out PVC manufactured products in food and drugs packaging. In view of this situation PVC increase between 1990 and 1995 is assumed to remain lower than the polyolefins; i.e. 4 % average growth per year -including the requirements for the new immigrants-from 1990 to 1995 decreasing to 2.8% thereafter.

6.2.5 Polypropylene (PP)
PP is expected to continue to be the leader in the commodity polymers field, mainly because of its new and varied applications as a carpet material on the one hand, and as the low-priced commodity polymer which can be utilized instead of engineering polymers in mechanical, medical electrical and other industrial uses. An average growth of 6 % per year is expected in Israel for the period 1990 to 1995, decreasing to 4.5 % average per annum for the rest of the decade.

6.2.6 Acrylo-Butyl-Styrene (ABS)
ABS requirements are expected to grow, as this polymer is used more and more in engineering applications. A 4 % per annum average growth is assumed throughout the decade.

6.2.7 Polyethylene Terephthalate (PET)
The consumption of this polymer, which showed a meteoric rise in the last years in Israel, is expected to continue to increase; a 7.8 % average yearly growth is expected over the next five years, declining to 4.6 % per year average thereafter.

6.2.8 Other Plastics
Are expected to increase at rates as predicted for West Europe, corrected for the imminent immigration that Israel will have to face over the next years;this translates to less than 5% yearly average- over the next five years, decreasing to 3.3 % thereafter.

SECTION 7
TOWARD THE NEXT CENTURY - OUTLOOK FOR THE PETROCHEMICAL AND POLYMER INDUSTRY IN ISRAEL

7.1 General Discussion

Section 5 of this study presents the global trends and forecasts of the polymer industry over the next decade. Section 6 evaluates the influence of some of the factors affecting global trends on the Israeli scenario and attempts to forecast polymer requirements in Israel for the next decade.

This section presents a summarized analysis of the directions foreseen for the Israeli petrochemical and polymer industry over the next decade, toward the 21th. Century. An overview is presented with respect to new polymers, innovations, new projects in the plastics field, local manufacture and supply of polymers and other petrochemical raw materials, feasibility of local production and export of polymers, competition from imports especially due to the European Community as of 1992.

7.2 Factors Influencing the Industry`s Working Pattern.

It is considered that the Israeli petrochemical and polymer producing industrial sector should take into consideration that they are bound to be affected by global trends and developments, as well as by a number of various specific local trends and factors which ought to influence it`s outlook, direction, planning and market strategies.

Some of the major factors are outlined hereinafter.

7.2.1. Developments and Innovations.

* Worldwide effect of new polymers, engineering plastics and very specialized polymers
* Development of new applications for polymers
* Innovations due to new copolymers, "in reactor" compounding; integration between commodities polymer production and compounding by the polymer manufacturer, rather than by independent compounders.

The Israeli polymer and plastics industry should take into account that the international industry is at the threshold of a new polymer era; the local industry cannot ignore this important fact, and the new trend directions followed worldwide, especially in the industrialized economies. The orientation should therefore be in the direction of new polymer production, manufacture of engineering and specialities polymers, compounding and alloys.
This is practically a new field for the Israeli polymer industry, in which very little work has so far been done.

While the Israeli industry should continue expanding in production of polyolefins, and probably in polystyrene, so as to cater to the local plastics market it will become imperative to enter the fast-developing engineering polymer specialties areas, to be able to become export competitive.

Israeli's technological advancement and ingenuity - clearly shown in the electronics, optics, communication, fine mechanics, solar energy and other high technology fields- should prove a valuable asset in the development and implementation of such engineering and specialty polymer directions.

It is also very important for Israeli polymer manufacturers to start concentrating on market oriented product applications, innovations and new uses for polymers presently and/or eventually to be locally produced. Neither IPE, nor Frutarom have invested much though and effort nor resources in the past in new product application and wider local market range development. But, as export possibilities for commodity polymers become scarcer and highly competitive -mainly from the gas rich countries- local market increased applications and diversification becomes a critically imperative function.

The polymer producing industry in Israel, will also have to change around so as to become a tailor-made oriented industry; Dupont, General Electric and other large-volume commodities producers have realized such end-user oriented approach as they offer compounded and special tailor-made polymer resins to their customers. European producers are rapidly following suit, and the local polymer manufacturers will have to do likewise if they want to protect their internal "preferential" market position in the future. Such local market should certainly not be treated as a "captive market"-as it was in the past- and should not be taken for granted. If a foreign manufacturer offers compounded commodity-based polymers, the local manufacturers will have no choice but to do likewise; and it is preferable to do so on it's own volition, rather than to be forced through competitive imports.

This would involve two major new steps by local polymer manufacturers,:

* Setting-up own compounding facilities

* Ascertaining that any new technology to be used in new polymer manufacturing plants in Israel includes "in-reactor" compounding

The "in-reactor" compounding technology concept should still be applied to the Polypropylene plant, which is still in planning and engineering stage; in polypropylene this concept is especially very important, as it increases considerably the variations and diversification of potential grades that can be produced.

7.2.2. Changes in the Raw Materials Scenario.

* Competition in monomer production from energy rich -mainly gas-producing countries.
* Oil industry reform in Israel.
* Economy of scale in monomer production.

There is no doubt that the availability of low cost raw material is a major factor influencing monomer production and petrochemical development. Unless there is a very drastic change for the better in Israel's oil and gas local availability situation, there will be no indigenous fossil fuel in Israel; and the petrochemical industry would have to continue to be based on imported crude oil and naphtha. Such situation constitutes an economic burden for monomer production, and will eventually make polymer production non-competitive; especially when compared to gas-based produced polymers.

Since the local market import par price is in the order of $100/ton above the FOB (ex-Israel) export net-back, production of polymers based on imported naphtha may be viable for local market sales, but it is doubtful that commodities polymer export competitiveness will be feasible in the long range scenarios.

Oil industry reform may be potentially be beneficial for the petrochemical industry, as naphtha and other feedstocks may be purchased advantageously in the open spot markets; however this is a rather uncertain conjecture oriented path, which can not assure continuous supply.

Economy of scale is also an important factor in monomers production; world-wide commercial plants are in the order of 500-600 thousand tons of ethylene per year. There is no potential ethylene derivatives market for such large quantities in Israel; thus ethylene requirements -over and above those to be supplied by the existing plant- would be in the order of not more than 150-200 thousand tons per year; certainly insufficient to permit the installation of a new world-wide scale ethylene plant.

Based on the above discussion, it would appear that the establishment of an additional olefins-monomer plant in Israel in the near future is rather farfetched.

Since market demands for polyethylenes will be on the increase - as discussed in Section 6 - it is hereby considered that the most viable way to justify increased polyethylene manufacture is based on imported ethylene.

There are at present drastic changes in concepts and patterns in ethylene international trade, which will make imports of ethylene to Israel potentially viable.

7.2.3. Changes in Local Market Requirements and new Local Industries Development.

Section 6 discusses in detail trends affecting Israel`s market growth and development patterns and present forecasts of consumption based on degrees of saturation for the various conventional polymers, direct and indirect effect of increasing immigration and new and wider application of polymers.

On the whole, all the above factors ought to encourage diversification, establishment of new polymer consuming projects increasing emphasis of plastics replacing metals, wood, glass and other materials not readily available in Israel.

It is believed that such development directions are bound to be positively influenced especially coupled to increased immigration; and the imperative necessity for creating new job opportunities.

7.2.4 Effect of Changes in International Trade Patterns.

The changes in international trade patterns will, most likely, have mixed effects on the future of the Israeli polymer industrial sector.
The following factors should have a bearing on the development of the local polymer industry:

** The European Community as of 1992 - will probably have an over-all negative effect on the development and production of polymers in Israel.
It is expected that it will be more difficult to export polymers to the countries in the European Community, and in parallel there will be more imports of polymers into Israel. Both of these factors will, undoubtedly have a negative effect on the development of the polymer industrial sector.

** Opening frontiers in Eastern Europe- will, most likely have a more positive than negative effect on the development of the Israeli polymer industry. There is expected to be increased commercial interchange between Israel and the Eastern European countries, including the U.S.S.R.. On the one hand, this could mean large polymer imports from these countries, but more likely there is an excellent chance for improved export -of polymers and plastic products -to the East European countries, including barter arrangements, joint ventures in agricultural field (and the consequential utilization of plastics for agriculture. Several of the Eastern European countries and several of the USSR Republics have already approached Israeli Government and private concerns with a view to creating joint ventures in their countries using Israeli technology and capital. It is not at all farfetched that joint venture polymer compounding and plastics conversion enterprises could be established, based on imports of polymers from Israel.

** The meteoric rise of the new petrochemical industries in South - East Asia and eventually in China should have a mixed effect on the development of the polymer industry in Israel.
Larger quantities of polymers from this relatively new producing area are expected to compete against locally produced polymers, and against imports from European and Northamerican suppliers.
Such new aggressive suppliers will probably hurt expansion and development potentials of the local polymer industries.
On the other hand, countries such as South Korea, Taiwan, Singapore and Thailand may be potential suppliers of olefins to Israel (see section 7.2.2)

** The continuing trends of setting up new large sized industries in the gas and oil producing countries will undoubtedly have a strong competitive effect in the market place.
Many of these countries - such as Mexico, Trinidad, Venezuela, Argentina and Brazil- in an eagerness to earn hard foreign currency tend to subsidize exports, absorbing freight differentials and permitting dumping practices.

While such dumping competition effect may well be to the overall advantage of the plastics manufacturers as it will permit conjectural price decreases, it is bound to have an adverse effect on the expansion and development of Israeli polymer industry.

** The petrochemical industry in the Arab countries is in continuous stages of development; while it is certainly very unlikely -for the time being and in the conceivable short and medium range future-that polymers produced in Arab countries may find their way into Israel, there will be ever increasing competition in the international market place, in the United States and Western Europe, and especially so in the Mediterranean countries.

From a long range standpoint and with a highly wishful optimism that one day in the future there will be peace in the region, it is conceivable to consider possibilities of economic cooperation between the Arab countries in the Persian Gulf Region - say Saudi Arabia for example - and Israel by which the gas/oil rich country/ies would supply low cost ethylene for processing and marketing by Israel`s polymer industries.

All the above factors - direct and indirect consequences- of changing international trade patterns should influence the eventual expansion and development programs of the Israeli polymer industry.

7.2 Forecast of Polymer Production in Israel by the year 2000.

In addition to the plants operating and being implemented at present, it is expected that there will be a number of additional plants expected to be in operation by the year 2000.

Figure 7.3 presents a foreseen flow-chart of the Petrochemical Industry in Israel by the year 2000.

While it is certainly not within the scope of this study to present feasibility or pre-feasibility studies for the various expanded and/or new plants, brief discussions and profiles for each of such new plants are included. Economic calculations are based on low scenario prices for the year 2000, as presented by SRI in their 1990 studies.

The flow chart presented in Figure 7.3 is based on the forecast growth of the Israeli market requirements, coupled with views on potential international trade scenarios for the various polymers.

Note regarding Ethylene availability:
Consistent with the discussion in section 7.2, it is assumed hereinafter that the existing ethylene plant will not be expanded, and that it`s output will be entirely for LDPE production. Additional ethylene requirements for EDC/VCM/PVC and other ethylene based projects would have to be imported.

7.3.1 Low Density Polyethylene (LDPE)

After the 1990 expansion program, it is expected that the four plants will be operating at a total of 120 - 125,000 tons/year capacity. Since local market requirements are expected to reach some 114 thousand tons by the year 2000, out of which some 10% are expected to be imported, it is considered that local production could be expanded to 150,000 tons/year, of which some 50,000 tons per year would be exported. Ethylene for this plant is expected to be supplied entirely from the existing ethylene plant.

A forecast economic profile for this plant in the year 2000 is presented on the next page.

7.3.2 High Density Polyethylene (HDPE)

It is expected that the local HDPE market by the year 2000 should reach some 55 thousand tons per year. Such a local market consumption certainly justifies the establishment of a HDPE plant in Israel. Conservatively, a 60,000 ton/year plant is contemplated. It is expected that due to the diversity of grades some 40,000 tons/year would be supplied to the local market consumers and some 20,000 tons/year would be exported. Ethylene for this plant will have to be based entirely on imported ethylene.

7.3.1 PROFILE OF OPERATIONS FOR THE YEAR 2000
LOW DENSITY POLYETHYLENE PLANT

Plant Capacity : 150,000 tons/y. Local Sales: 100,000 t/y
Export Sales: 50,000 t/y

Plant Expansion by : 25,000 tons/year
Investment estimate : 25 million $, including improvements in existing plants.
Manpower: no increase in shift operators + 4 packers

	Per Unit $/ton	Per Year MM$/yr
Income :	1162 *	174.3
Raw Materials:	(643) **	(96.5)
Variable Costs:	(100)	(15)
Fixed Costs:	(120)	(18)
Working Captl.Interest	(15)	(2.3)
Contribution (Cash Margin)	284	42.6

* LDPE low case forecast for year 2000, in USA; (W.Europe higher)
** Ethylene low case forecast in year 2000 in W. Europe + $ 50/t differential. (Ref: SRI studies -1990)

A forecast economic profile for the new HDPE plant in the year 2000 is presented hereinafter.

7.3.2 PROFILE OF OPERATIONS FOR THE YEAR 2000
HIGH DENSITY POLYETHYLENE PLANT

Plant Capacity : 60,000 tons/y. Local Sales: 40,000 t/y
Export Sales: 20,000 t/y

Investment estimate : 50 million $.
Manpower:20 shift operators;30 non-shift and 20 indirect= 70

	Per Unit $/ton	Per Year MM$/yr
Income :	1162 *	69.7
Raw Materials:	(693) **	(41.6)
Variable Costs:	(60)	(3.6)
Fixed Costs:	(85)	(5.1)
Working Captl.Interest	(15)	(0.9)
Contribution (Cash Margin)	309	18.5

* HDPE low case forecast for year 2000, in USA; (W.Europe higher)
** Ethylene low case forecast for year 2000 in W.Europe +$ 100/t differential for imported ethylene. (Ref: SRI studies -1990)

7.3.3 Polypropylene Plant (PP)

Polypropylene consumption is expected to be close to 70,000 tons/year by the year 2000; it is expected that about 80% or 56,000 tons per year would be supplied from local production, while the rest would be imported. It is expected that the polypropylene plant, presently in initial stages of implementation would be expanded to 120,000 tons/year, thus exports are expected to be about 64,000 tons per year.
Propylene raw material would be from the olefins plant and from the FCC.
A forecast economic profile for this plant in the year 2000 is presented hereinafter.

7.3.3 PROFILE OF OPERATIONS FOR THE YEAR 2000 POLYPROPYLENE PLANT		
Plant Capacity : 120,000 tons/y.	Local Sales: 56,000 t/y Export Sales: 64,000 t/y	
Plant Expansion by : 60,000 tons/year Investment estimate : 40 million $ Manpower: +2/ shift increase; + 12 non shift + 4 indirect= 24		
	Per Unit $/ton	Per Year MM$/y.
Income :	1076 *	129.1
Raw Materials:	(527) **	(63.2)
Variable Costs:	(130)	(15.6)
Fixed Costs:	(75)	(9.0)
Working Captl.Interest	(17)	(2.0)
Contribution (Cash Margin)	327	39.3

* PP low case forecast for year 2000,in USA; less freight
** Propylene low case forecast for year 2000 in W. Europe
(Ref: SRI studies -1990)

7.3.4. Styrene and Polystyrene Plants

Polystyrene consumption in Israel is expected to be some 32,000 tons per year by the year 2000. As a first planning approach it is considered logical to plan for the installation of an 80,000 tons per year Styrene plant; 50,000 tons of styrene would be upgraded to polystyrene, and 30,000 tons per year to be exported as such.
The new polystyrene plant would supply about 80 % of the local requirements, or about 26,000 tons per year; the rest would be exported.
Ethylene -as raw material for this plant-would also have to be imported, but benzene would be locally available at very attractive prices; i.e. USA prices less freight and handling.
This program considers that the existing 16,000 tons/year polystyrene plant, owned and operated by Israel Petrochemical Enterprises Ltd. would be closed down.

A forecast economic profile for this plant in the year 2000 is presented hereinafter.

7.3.4 PROFILE OF OPERATIONS FOR THE YEAR 2000
STYRENE AND POLYSTYRENE PLANTS

	STYRENE	POLYSTYRENE
Plant Capacities:	80,000 tons/year	50,000 tons/year
Local Sales :	50,000 tons/year	26,000 tons/year
Export Sales :	30,000 tons/year	24,000 tons/year

Investment estimate :Styrene : 40 MM$; Polystyrene: 35 MM$
Total investment estimate : 75 MM$.
Manpower: 5 persons/shift+ 25 non shift+ 30 indirect= 75 people

	Per Unit $/ton		Per Year MM$/y.
	STYRENE	POLYSTY.	COMBINED
Income :	* 844	1170 *	83.8
Raw Materials:	**(563)	(844)	(45.0)
Variable Costs:	(30)	(105)	(7.7)
Fixed Costs:	(45)	(65)	(6.8)
Working Captl.Interest	(8)	(15)	(1.4)
Contribution (Cash Margin)	198	141	22.9

* PS and styrene, low case forecast for year 2000 in W.Europe
** Ethylene low case forecast for year 2000 in W.Europe + $100/t import differential. Benzene, low case forecast for year 2000 in USA less freight differential -$ 50/t. (Ref:SRI 1990)

7.3.5 Terephthalic Acid (TAP) and Polyethylene Terephthalate (PET) Plants.

The inclusion of a TAP/PET complex in the overall structure of the Israeli petrochemical sector by the year 2000 appears of interest, considering the global growth of PET.

Local consumption of PET by the year 2000 is expected to reach about 25,000 tons/year. It is expected that a 50,000 ton/year PET plant, exporting half and supplying the other half to the Israeli local market should be a viable project.

The TAP plant should have a capacity of 70,000 tons/year, which would permit some 26,000 tons/year of export of TAP, above the 44,000 tons/year required captive for PET production.

A forecast economic profile for this plant in the year 2000 is presented hereinafter.

7.3.5 PROFILE OF OPERATIONS FOR THE YEAR 2000
TEREPHTALIC ACID AND POLYETHYLENE TEREPHTHALATE PLANTS

	TEREPHTHALIC ACID	POLYETHYLENE TEREPHTALATE
Plant Capacities:	70,000 tons/year	50,000 tons/year
Local Sales :	44,000 tons/year	25,000 tons/year
Export Sales :	30,000 tons/year	25,000 tons/year

Investment estimate : TPA : 45 MM$; PET : 40 MM$
Total investment estimate : 85 MM$.
Manpower: 6 persons/shift+ 30 non shift+ 60 indirect= 114 people

	Per Unit $/ton		Per Year MM$/y.
	TAP	PET	COMBINED
Income :	* 600	1250 *	80.5
Raw Materials:	**(320)	(833)	(37.4)
Variable Costs:	(45)	(60)	(6.2)
Fixed Costs:	(65)	(110)	(10.0)
Working Captl.Interest	(5)	(20)	(1.4)
Contribution (Cash Margin)	165	227	25.5

* TPA and PET low case forecast for year 2000 in W.Europe
** Ethylene glycol low case forecast for the year 2000 + $ 50/t freight differential. Para-xylene,low case forecast for 2000 in USA less freight differential -$ 50/t. (Ref:SRI 1990)

TABLES 5.4.1 - 5.4.9

PETROCHEMICAL EXPANSION PLANTS ANNOUNCED DURING 1988/1989/1990

PETROCHEMICAL PLANTS EXPANSION PROJECTS ANNOUNCED DURING 1988/1989/1990

TABLE #5.4.1 11-exp-1 PLANT: ETHYLENE + PROPYLENE FIGURES IN TONS

AREA	COUNTRY	COMPANY	LOCATION	EXISTING CAPACITY	EXPANDED CAPACITY	ADDITIONAL NEW/EXP.BY:	STATUS	EXPECTED START-UP	Expansion or NEW	
UNITED STATES	STATE									
	Texas	Phillips Petroleum	Sweeny		680,000	680,000	Construction	1990	NEW	Already operating @ 454,000 tons
	Texas	Quantum	Deer Park		680,000	680,000	Construction	1991	NEW	
	Texas	Texaco	Port Neches		158,000	158,000	Refurbishing		Restart	
	Texas	Texaco	Port Arthur		470,000	470,000	Refurbishing	1989	Restart	
	Louisiana	Occidental	Lake Charles		320,000	320,000	Construction		expansion	
	Texas	Dow	Freeport		680,000	680,000	Construction	1992	NEW	
	"	"	"		270,000	270,000	Construction	1992	NEW	
	Louisiana	Chevron	Cedar Bayou		280,000	280,000	Construction		expansion	
	Louisiana	West Lake Polymers	Lake Charles		450,000	450,000	Construction	1991	NEW	
	Texas	Formosa Plastics	Point confort		680,000	680,000	Construction	1991	NEW	
	Louisiana	Union Texas	Baton Rouge		500,000	500,000	Construction	1990	expansion	
	Louisiana	Vista Chemicals	Lake Charles	318,000	454,000	136,000	Construction	1990	expansion	
	Texas	Lyondell Petroch.	Channelview		270,000	270,000	Complete	1989	expansion	
	Texas	Occidental			450,000	450,000	Planning			
UNITED STATES	TOTAL			318,000	5,622,000	5,304,000				
WESTERN EUROPE										
	Netherlands	DSM	Geleen	750,000	1,025,000	275,000	Construction	1991	expansion	already operating at 925,000 tons
	Belgium	Finaneste	Antwerp		450,000	450,000	Construction	1991	NEW	
	Scotland	Exxon	Mossmorran	550,000	900,000	350,000	Construction		expansion	already operating at 650000 tons
	France	Exxon	Grovenchon	300,000	320,000	20,000			expansion	
	France	BP Chimie	Lavera	450,000	670,000	220,000	Construction	1991	expansion	
	France	Atochem	Gonfrevill	385,000	470,000	85,000	Construction	1990	expansion	
	Netherland	Shell	Moerdijk	350,000	600,000	250,000	Completed	1989	expansion	
	West Germany	ROW	Wesserling		230,000	230,000	Completed	1989	NEW	
		Veba Oil	Manchmunster	200,000	280,000	80,000	Construction		expansion	
		Veba Oil	Gelsenkirchen		350,000	350,000	Construction		NEW	
	Belgium	BASF	Antwerp		600,000	600,000	Construction	1992	NEW	
	France	Ato/Elf	Douges							85,000 Propylene
	Sweden	Statoil Petch	Stenungsund	375,000	420,000	45,000	Construction	1990	expansion	200,000 Propylene expansion
	West Germany	OMW	Karslruhe		100,000	100,000	Construction		NEW	
	West Germany	Exxon	Ingolstadt				construction	1990	NEW	70,000 Propylene
	Italy	Enimont	Brindisi		400,000	400,000	Construction		NEW	
	Italy	Enichem	Brindisi		350,000	350,000	Construction	1990	NEW	
	Spain	Dow	Tarragona	385,000	465,000	80,000	Construction	1990	expansion	part already operating
	Spain	Shell IQA	Tarragona		70,000	70,000	Refurbishing	1990	restart	
	Scotland	BP Chemicals	Grangemouth	400,000	540,000	140,000	Construction	1992	expansion	
	United Kingdom	ICI	Wilton		400,000	400,000			Restart	
		ICI/BP	Wilton	600,000	775,000	175,000	Construction		expansion	
	Belgium	Himont	Antwerp				Construction	1991	NEW	250,000 propylene
WESTERN EUROPE	TOTAL			4,745,000	9,415,000	4,670,000				

PETROCHEMICAL PLANTS EXPANSION PROJECTS ANNOUNCED DURING 1988/1989/1990

TABLE #5.4.1. 11-exp-1 Page # 2 PLANT: ETHYLENE + PROPYLENE FIGURES IN TONS

AREA	COUNTRY	COMPANY	LOCATION	EXISTING CAPACITY	EXPANDED CAPACITY	ADDITIONAL NEW/EXP.BY:	STATUS	EXPECTED START-UP	Expansion or NEW
EASTERN EUROPE	USSR	Government	Nizhuevartovsk		500,000	500,000	Construction		NEW
	USSR	Tenghizpolymer	Kulsari		600,000	600,000	Construction	1993	NEW
	Chekoslovakia	Slovnaft	Bratislava		200,000	200,000	Construction	1993	expansion
	USSR	Shell	Nizhnekansk		500,000	500,000	Construction		expansion
	USSR	Asetco	Vudyennovsk	100,000	350,000	250,000	Construction		expansion
	USSR	USSR	Surgut		300,000	300,000	Construction		NEW
	USSR	USSR/Dow	Shevchenko		215,000	215,000	Construction		NEW
	Hungary	Tiszai Vegyi	Leninvarost		300,000	300,000	Construction		NEW
EASTERN EUROPE	TOTAL			100,000	2,965,000	2,865,000			
JAPAN	Expansions completed in 1988				462,700	462,700			
	Expansions which were due for completion 1989				305,000	305,000			
	Expansions due for completion in 1990				225,000	225,000			
		Mitsubishi	Chiba		400,000	400,000			
		Mitsui/Uhbe	Uhbe		500,000	500,000	Construction	1992	NEW
		Maruzen,Sumitomo	Chibe		500,000	500,000	Construction	1993/1994	NEW
		Mitsubishi	Kashima		500,000	500,000	Planned		NEW
		Asai Chemicals	Yokohama		500,000	500,000	Planned		NEW
		Showa Denko	Oita	500,000	800,000	300,000	Construction		expansion
		Tosoh	Yokkaichi		500,000	500,000	Planned		NEW
JAPAN	TOTAL			500,000	4,692,700	4,192,700			
OTHER EAST ASIA	Indonesia	Shell/Mitsubishi/I	Cilicap		375,000	375,000	planned		NEW
	Thailand	PTT + Downstream	Map Ta Phut		280,000	280,000	completed	1989	NEW
	China	Fushun Petrochemic	Fushun		130,000	130,000	construction	1991	NEW
	China	Zhong Yuan	Zhong Yuan		140,000	140,000	construction		NEW
	China	China Petch	Dushanzi		140,000	140,000	construction		NEW
		China Petrochemica	Lanzhou		80,000	80,000	completed	1989	restart
	Malaysia	Petronas			400,000	400,000	construction	1992	NEW
	South Korea	Daelim Industrial	Yeochen	350,000	600,000	250,000	completed	1989	expansion
		Yukong	Ulsan	155,000	550,000	395,000	completed	1989	expansion
		Lucky Goldstar	Yeochen		350,000	350,000	construction	1991	NEW
		Korea Petrochem	Onsan		250,000	250,000	construction	1991	NEW
		Samsung Petrochem	Seosan		350,000	350,000	construction	1992	NEW
		Hanyang Chem Co.	Yeochon		350,000	350,000	construction	1992	NEW
		Hyundai Chem Co.	Seosan		350,000	350,000	construction	1992	NEW
		Honam Petrochem Co	Yeochen		350,000	350,000	construction	1992	NEW
		K.K.P.C.	????		350,000	350,000	construction	1994	NEW
		???????????	?????		500,000	500,000	construction	1992	NEW
	South Korea	Sub-Total		505,000	4,000,000	3,495,000			
	Taiwan	Formosa Plastics	Toayuan		450,000	450,000	PENDING envi	1991??	Pending
	Philipines	Bataan	Bataan		230,000	230,000	Construction		NEW
OTHER EAST ASIA	TOTAL			505,000	6,225,000	5,720,000			

PETROCHEMICAL PLANTS EXPANSION PROJECTS ANNOUNCED DURING 1988/1989/1990

TABLE #5.4.1. 11-exp-1 Page # 3 PLANT: ETHYLENE + PROPYLENE FIGURES IN TONS

AREA	COUNTRY	COMPANY	LOCATION	EXISTING CAPACITY	EXPANDED CAPACITY	ADDITIONAL NEW/EXP.BY:	STATUS	EXPECTED START-UP	Expansion or NEW	
REST OF WORLD	Canada	WCE/USI/FarEast	Taylor B.C.		300,000	300,000	Construction		NEW	
	Canada	Petromont	Montreal	220,000	265,000	45,000	Construction		expansion	
	Canada	Novacorp	Read Dear, Albe		540,000	540,000	Planning		NEW	
REST OF WORLD	Canada	Dow	Fort Saskatch.	500,000	820,000	320,000	Construction			
	Canada	Polysar Nova	Corunna, Ont	234,000	544,000	310,000	Construction	1990	expansion	
	Nigeria	NNPC	Port Harcourt		280,000	280,000	Construction		NEW	
	Iran	NPC	Areik		240,000	240,000	Construction		NEW	
		NPC/S.Kore	Bandar Khomeini		300,000	300,000	Construction		NEW	
	Saudia	Petrokemya	Al Jubail	500,000	700,000	200,000	Construction		expansion	
		Petrokemya	Al Jubail		500,000	500,000	Construction		NEW	
	Saudia	Yanpet	Yanbu	600,000	680,000	80,000	Construction	1991	expansion	
	Saudia	Yanpet	Yanbu		500,000	500,000	Construction	1991	NEW	
	Bahrain	Bahr.Gov. Inv	Sitra Island							100,000 propylene
	Iraq	Iraq Government	Musayad		420,000	420,000	Construction	1991	NEW	
	India	Reliance Petchem	Hazira		300,000	300,000	Construction		NEW	
		RPG	Madras		500,000	500,000	Planning		NEW	
	Mexico	PEMEX	La Cangrejera		500,000	500,000	Completed	1989	NEW	
	Argentina	Petr. Bahia Blanca	Bahia Blanca		200,000	200,000	Construction	1992	NEW	
	Venezuela	Pequiven	Jose(Pto.LaCruz)		350,000	350,000	Construction	1994	New	
	Venezuela	Pequiven	El Tablazo		350,000	350,000	Construction	1991		
	Venezuela	Pequiven/Veba	Jose(Pto.LaCruz)							250,000 propylene only
	Brazil	Copene	Sergipe		200,000	200,000	Construction		NEW	
	Brazil	PQU	Sa Paolo	360,000	460,000	100,000	Construction	1990	expansion	
	Brazil	Government	Itagua		545,000	545,000	Planned	1996	NEW	
	South Africa	Sasol	Secunda		150,000	150,000	Construction		NEW	
	Israel	Carmel/ORL ??	Haifa	130,000	150,000	20,000	Construction	1990	expansion	
REST OF WORLD	TOTAL			2,544,000	9,794,000	7,250,000				
WORLDWIDE	TOTAL			6,168,000	28,919,700	22,751,700				

March 7, 1990 H.D.Frenkel

PETROCHEMICAL PLANTS EXPANSION PROJECTS ANNOUNCED DURING 1988/1989/1990

TABLE #5.4.2 11-EXP-2 PLANT: HIGH DENSITY POLYETHYLENE FIGURES IN TONS

AREA	COUNTRY	COMPANY	LOCATION	EXISTING CAPACITY	EXPANDED CAPACITY	EXPANSION BY	STATUS	EXPECTED START-UP	
UNITED STATES	State								
	Texas	Cain Chemicals	Bay City	195,000	450,000	255,000	Construction	1990	expansion
		Exxon	Gulf Coast		120,000	120,000	Construction	1990	NEW
	Texas	Quantum	Houston		90,000	90,000	Construction	1990	NEW
		Quantum	Clinton		70,000	70,000	Completed	1989	expansion
		Union Carbide	Seadrift		230,000	230,000	Completed	1989	NEW
		Union Carbide	"	230,000	460,000	230,000	Construction	1990	expansion
		Formosa Plastics	Point Comfort		120,000	120,000	Construction		NEW
		Eastman Kodak	Longview		117,000	117,000	Construction	1992	NEW
UNITED STATES	TOTAL			425,000	1,657,000	1,232,000			
WESTERN EUROPE	France	Solvay	Sarralbe	60,000	120,000	60,000	Complete	1989	expansion
	Greece	Eko/Elevne	Thessaloniki		50,000	50,000	Construction		NEW
	West Germany	OMW	Burahansen		80,000	80,000	Construction	1991	NEW
	Norway	Statoil	Bamble	90,000	120,000	30,000	Construction		expansion
	Belgium	Dow	Tessenderlo		100,000	100,000	Construction		NEW
	Spain	Repsol Quimica	Tarragona	80,000	165,000	85,000	Construction	1991	expansion
	Spain	Repsol Quimica	Puerto LLano	80,000	145,000	65,000	Construction		expansion
WESTERN EUROPE	TOTAL			310,000	780,000	470,000			
EASTERN EUROPE	USSR	Asetco	Budyennovsk	300,000	400,000	100,000	Completed	1988	
	USSR	Asetco	Kazan	200,000	400,000	200,000	Completed	1988	
EASTERN EUROPE	TOTAL			500,000	800,000	300,000			
JAPAN	TOTAL								
OTHER EAST ASIA	South Korea	Honam Petroch	Yechon	130,000	180,000	50,000	Construction	1990	expansion
		Daelin Ind	Yechon		120,000	120,000	Complete	1989	NEW
		Yukon Pet	Ulsan		40,000	40,000	Complete	1989	NEW
		Samsung	Seosan		120,000	120,000	Construction	1992	NEW
		KKPC	????		150,000	150,000	Construction	1994	NEW
	Indonesia	Petrokimia Nusanta	Cilacap		100,000	100,000	Construction		NEW
OTHER EAST ASIA	TOTAL			130,000	710,000	580,000			
REST OF WORLD	India	Reliance Petch	Hazira		50,000	50,000	Construction		NEW
	Brazil	Polysul		100,000	160,000	60,000	Construction		Expansion
	Iran	NPC/SKorea	B.Khomeini		60,000	60,000	Construction		NEW
	Canada	Petromont	Montreal		200,000	200,000	Refurbishing		Restart
REST OF WORLD	TOTAL			100,000	470,000	370,000			
WORLDWIDE	TOTAL			1,465,000	4,417,000	2,952,000			

March 8, 1990 H.D.Frenkel

PETROCHEMICAL PLANTS EXPANSION PROJECTS ANNOUNCED DURING 1988/1989/1990

TABLE #5.4.3 — PLANT: LOW DENSITY POLYETHYLENE — FIGURES IN TONS

AREA	COUNTRY	COMPANY	LOCATION	EXISTING CAPACITY	EXPANDED CAPACITY	EXPANSION BY	STATUS	EXPECTED START-UP	
UNITED STATES									
	Texas	Chevron	Cedar Bayon		200,000	200,000	Construction	1991	NEW
	Illinois	Quantum Chem.	Morris		136,000	136,000	Construction	1990	NEW
	Texas	Union Carbide	Seadrift		230,000	230,000	Construction	1990	NEW
	Texas	Quantum Chem	Houston		90,000	90,000	Construction	1990	NEW
	Texas	Mobil Chem.	Beanmont		320,000	320,000	Construction	1990	NEW
	Texas	Eastman Kodak	Longview		117,000	117,000	Construction	1992	NEW
UNITED STATES	TOTAL			0	1,093,000	1,093,000			
WESTERN EUROPE									
	Scotland	BP Chemicals	Grangemouth		125,000		Completed	1989	expansion
	Netherland	Dow Chemicals	Ternenzen	100,000	220,000	120,000	Completed	1988	expansion
	United Kingdom	BP Chemicals	Wilton		85,000		Construction		expansion
	France	BP Chemicals	Lavera		130,000		Construction		expansion
	Findland	Neste	Porvoo	180,000	210,000	30,000	Completed	1989	expansion
	Sweden	Neste	Stenungsund	400,000	450,000	50,000	Completed	1989	expansion
	Spain	Dow Chemicals	tarragona		150,000	150,000	Construction	1991	NEW
	W.Germany	Erdolchemie	Worringen		125,000	125,000	Construction	1991	NEW
	Greece	Eko/Elevme	Thessaloniki		70,000	70,000	Construction		NEW
	France	Exxon	Notre Dame De Grav.		220,000	220,000	Construction	1991	NEW
	France	Atochem	Gonfreville L'Orcher		110,000	110,000	Construction	1990	NEW
	Belgium	Neste	Beringen		240,000	240,000	Construction	1990	NEW
	Norway	Statoil	Bamble	140,000	190,000	50,000	Construction		expansion
	W.Germany	BASF/Shell	Wesseling		100,000	100,000	Construction		NEW
	United Kingdom	Shell	Carrington		100,000	100,000	Construction	1992	NEW
	Turkey	Petkim	Alpet		190,000		Construction		expansion
WESTERN EUROPE	TOTAL			820,000	2,715,000	1,365,000			
EASTERN EUROPE									
	USSR	Asetco	Kazan		100,000	100,000	Completed	1988	NEW
	USSR	Asetco	Budyennovsk	200,000	400,000	200,000	Planned		expansion
	USSR	Asetco	Kazan		400,000		Planned		expansion
	Hungaria	Tiszai Veggi Ko	Leninvaros		60,000	60,000	Construction	1991	NEW
	USSR	Dow Chemicals	Shevchenko		130,000	130,000	Construction		NEW
	Bulgaria	Bulgaria	Burgas		50,000	50,000	Construction	1992	NEW
EASTERN EUROPE	TOTAL			200,000	1,140,000	540,000			

PETROCHEMICAL PLANTS EXPANSION PROJECTS ANNOUNCED DURING 1988/1989/1990

PETROCHEMICAL PLANTS EXPANSION PROJECTS ANNOUNCED DURING 1988/1989/1990

TABLE #5.4.3 Page #2 PLANT: LOW DENSITY POLYETHYLENE FIGURES IN TONS

AREA	COUNTRY	COMPANY	LOCATION	EXISTING CAPACITY	EXPANDED CAPACITY	EXPANSION BY	STATUS	EXPECTED START-UP	
JAPAN									
		Asahi Chem.	???		100,000	100,000	Planned		NEW
		Asahi Chem.	Mizushima		7,300	7,300	Completed	1988	Restart
		Nippon Unicar	Kawasaki		28,000	28,000	Completed	1988	Restart
		Tosoh	Yokkajchi		23,500	23,500	Completed	1988	Restart
		Ube Ind.	Goi		50,000	50,000	Completed	1988	Restart
		Showa Denko	Qhuita		18,000	18,000	Completed	1988	Restart
OTHER EAST ASIA	TOTAL			0	226,800	226,800			
OTHER EAST ASIA									
	India	IPCL	Nagothane		160,000	160,000	Construction		NEW
	Taiwan	Asia Polymer	Lin Yuan		100,000	100,000	Construction		NEW
	China	Zhong Yuan Pet.	Zhong Yuan		140,000	140,000	Construction		NEW
	China	China	Shanghai	60,000	140,000	80,000	Construction		NEW
	Indonesia	Pet.Nusantara	Cilacap.java		100,000	100,000	Construction		NEW
	Indonesia	Shell/Mitsubish	Cilicap		300,000	300,000	Construction		NEW
	Malaysia	Exxon	Kerteh		450,000	450,000	Construction	1994	NEW
	China	China	Xinjiaing		140,000	140,000	Construction		NEW
	Korea	Hyndai Petroche	Daesan		60,000	60,000	Construction	1991	NEW
	S.Korea	Hyundai	Seoul		100,000	100,000	Construction	1991	NEW
OTHER EAST ASIA	TOTAL			60,000	1,690,000	1,630,000			
REST OF WORLD									
	Canada	Novacor	Alberta		180,000	180,000	Construction		NEW
	Iran	Technipetrol	Arak		60,000	60,000	Construction		NEW
	Venezuela	Pequiven/Zulian	El Tablazo		150,000	150,000	Construction	1991	NEW
	NIgeria	Eleme Petrochem	Port Harcourt		270,000	270,000	Construction	1992	NEW
	Iraq	BP Chemicals	Mussayed		160,000	160,000	Construction		NEW
	Brazil	Politeno	Itaguai		140,000	140,000	Construction		NEW
	Brazil	Politeno	Camacari		130,000	130,000	Construction	1991	NEW
	Iraq	Techcorp	Mussayed		160,000	160,000	Construction	1991	NEW
	Brazil	Pollolefinas	Camcari		130,000	130,000	Construction	1991	NEW
	Saudi Arabia	Yanpet 1	Yanbu	430,000	480,000	50,000	Construction		expansion
	Canada	China-Canada	???		120,000	120,000	Planned		NEW
	Qatar	BASF	Umm Said		140,000	140,000	Construction		NEW
	Australia	ICI	Botany		86,000	86,000	Construction		NEW
	Iran	National Pet.	Bandar Khomeini		100,000	100,000	Construction		NEW
REST OF WORLD	TOTAL			430,000	2,306,000	1,876,000			
WORLDWIDE	TOTAL			1,510,000	9,170,800	6,730,800			

PETROCHEMICAL PLANTS EXPANSION PROJECTS ANNOUNCED DURING 1988/1989 8/1989/1990

TABLE #5.4.4 PLANT: POLYPROPYLENE FIGURES IN TONS

AREA	COUNTRY	COMPANY	LOCATION	EXISTING CAPACITY	EXPANDED CAPACITY	EXPANSION BY	STATUS	EXPECTED START-UP		
UNITED STATES										
	Texas	Exxon	Baytown		454,000		Conctruction	1990	expansion	
	New Jursey	Huntsman	Woodbury		330,000		Conctruction		expansion	
	Texas	Amoco chem.	Cedar Bayon		136,200		Completed	1989	expansion	*includes expantion in Belgium
			Chocolate Bayon						expansion	
	Pennsylvania	Epsilon	Marcus Hook		120,000	120,000	Conctruction	1990	NEW	
	Texas	Formosa plastics	Point confort		130,000	130,000	Construction	1991	NEW	
	Texas	Eastman Kodak	Longview			100,000	Conctruction	1991	expansion	
UNITED STATES	TOTAL				1,170,200	350,000				
WESTERN EUROPE										
	Spain	Himont/Hoechst	Tarragona		100,000	100,000	Completed	1989	NEW	
	France	Himont/Hoechst	Lillebonne		120,000	120,000	Completed	1989	NEW	
	W.Germany	Shell	Wesseling		120,000	120,000	Completed	1989	NEW	
	Belgium	Neste	Beringen		240,000		Completed	1989	expansion	
	W.Germany	Hoechst	Nennkirchen			45,000	Completed	1989	expansion	
	Findland	Neste	Kulloo		360,000	360,000	Completed	1988	NEW	
	Belgium	Exxon	Meerhout	245,000	365,000	120,000	Completed	1988	expansion	
	Belgium	UCB group	Wigton			26,000	Completed	1989	expansion	
	Italy	Himont	Ferrara		80,000	80,000	Completed	1989	NEW	
	France	Polychem	Dunkirk		120,000	120,000	Completed	1989	NEW	
	Netherland	DMS	Geleen		140,000	140,000	Conctruction	1990	NEW	
	Turkey	Polypet	Gaziantep		120,000	120,000	Conctruction	1991	NEW	
	Turkey	Mitsubishi	Aliaga			60,000	Construction		expansion	
	France	Exxon	NotreDame-de-G.		140,000	140,000	Construction		NEW	
	United Kingdom	Shell	Carrington		140,000	140,000	Construction	1991	NEW	
	W.Germany	Hoechst	Knapsack		160,000	160,000	Construction	1990	NEW	
	W.Germany	Huls(Veba)	Gelsenkirchen		100,000	100,000	Conctruction	1991	NEW	
	Belgium	Statoil/Himont	Antwerp		180,000	180,000	Completed	1989	NEW	
	Norway	Statoil/Himont	Bamble	70,000	90,000	20,000	Completed	1989	expansion	
	Belgium	Mobile	Virton		7,000	7,000	Construction	1990	NEW	
	Spain	Repsol	Bilbao		100,000	100,000	Conctruction	1991	NEW	
	Spain	BASF	Tarragona	30,000	80,000	50,000	Construction		expansion	
	United Kingdom	ICI	Wilton	40,000			Closure		Closure	
	France	Solvay	Sarralbe	150,000	170,000	20,000	Conctruction	1990	expansion	
	Belgium	Solvay	Antwerp			80,000	Construction	1991	expansion	
	Austria	Marathon	Burghhausen		120,000	120,000	completed	1989	NEW	
WESTERN EUROPE	TOTAL			535,000	3,052,000	2,528,000				

PETROCHEMICAL PLANTS EXPANSION PROJECTS ANNOUNCED DURING 1988/1989 8/1989/1990

TABLE #5.4.4 Page #2 PLANT: POLYPROPYLENE FIGURES IN TONS

AREA	COUNTRY	COMPANY	LOCATION	EXISTING CAPACITY	EXPANDED CAPACITY	EXPANSION BY	STATUS	EXPECTED START-UP	
EASTERN EUROPE									
	USSR	Tenghizpolymer	Kulsari		400,000	400,000	Construction	1993	NEW
	USSR	USSR	Nizhuevartovsk		150,000	150,000	Construction		NEW
	USSR	USSR	Tobolsk		350,000	350,000	Construction		NEW
	USSR	Tecnimont	Tomsk	100,000	200,000	100,000	Construction	1992	expansion
EASTERN EUROPE	TOTAL			100,000	1,100,000	1,000,000			
JAPAN									
		Asahi Chem	Mizushima		40,000	40,000	Planned		NEW
JAPAN	TOTAL				40,000	40,000			
OTHER EAST ASIA									
	Malaysia	Petronas/Neste	Kuantau		80,000	80,000	Construction		NEW
	Indonesia	Sumitomo Corp	Java		100,000	100,000	Construction	1990	NEW
	Thailand	Thai Petrochem.	???		80,000	80,000	Planned	1992	NEW
	Thailand	UHDE/BASF	Rayong		80,000	80,000	Construction	1990	NEW
	Indonesia	Shell/Itoh	Plaju S.Sumatra		125,000	125,000	Construction		NEW
	China	Guangzhon Works	Guangzhon		40,000	40,000	Construction		NEW
	Philippines	Bataan Petrochem	Bataan		110,000	110,000	Construction		NEW
	China	Panjin Gas/Himont	Panjin-Liaoning		80,000	80,000	Construction		NEW
	Malaysia	Himont/Chao	Pasir Gudang		100,000	100,000	Construction	1991	NEW
	China	China	Xinjiang		180,000	180,000	Planned		NEW
	Indonesia	Shell/Mitsubishi	Cilicap		180,000	180,000	Construction		NEW
	Malaysia	PP Malaysia	Pahang State		80,000	80,000	Construction	1992	NEW
	India	Reliance Ind.	Hazira		120,000	120,000	Construction		NEW
	Philippines	Luzon Petrochem.	???		110,000	110,000	Planned		NEW
	Israel	Carmel Olefins	Haifa		60,000	60,000	Construction		NEW
OTHER EAST ASIA	TOTAL			0	1,525,000	1,525,000			

PETROCHEMICAL PLANTS EXPANSION PROJECTS ANNOUNCED DURING 1988/1989 8/1989/1990

TABLE #5.4.4 Page #3 PLANT: POLYPROPYLENE FIGURES IN TONS

AREA	COUNTRY	COMPANY	LOCATION	EXISTING CAPACITY	EXPANDED CAPACITY	EXPANSION BY	STATUS	EXPECTED START-UP	
REST OF WORLD									
	Australia	Hoechst	Altona			10,000	Completed	1989	expansion
	South Africa	Hoechst	???	35,000	52,000	17,000	Completed	1988	expansion
	Argentina	Shell/Ipako	Ensenada		100,000	100,000	Construction	1990	NEW
	South Korea	Yukong Ltd	Ulsan		80,000	80,000	Completed	1989	NEW
	Venezuela	Technipetrol	El Tablazo		70,000	70,000	Construction	1990	NEW
	South Africa	Sasol	Secunda		120,000	120,000	Construction	1990	NEW
	South Africa	Safripol	Sasolburg		52,000		Completed	1988	expansion
	South Korea	ISU Chemicals	Ulsan		200,000	200,000	Construction	1990	NEW
	Baharain	Bechtel	Sitra Island		100,000	100,000	Construction		NEW
	Iran	Tecnimont	Arak		50,000	50,000	Construction		NEW
	Nigeria	Chioda/Itoh/Kellog	???		280,000	280,000	Planned	1990	NEW
	Nigeria	Himont/Tecnimont	Port Harcourt		80,000	80,000	Construction		NEW
	Kuwaite	Kuwaite Petrochem.	Shuaiba	60,000	80,000	20,000	Completed	1988	expansion
	Brazil	PPH	Triunto	95,000	160,000	65,000	Construction	1990	expansion
	Brazil	Braspol(Shell)	Rio de Janeiro		100,000	100,000	Construction	1991	NEW
	Argentina	Prteoquimica	Mendoza		100,000	100,000	Construction		NEW
	Brazil	Mitsubishi	Camacari		100,000	100,000	Construction	1991	NEW
	Mexico	Himont/Mexican fir	Tampico		100,000	100,000	Construction		NEW
	Australia	Shell australia	Sydney		80,000	80,000	Construction	1991	NEW
	Kuwaite	Petrochem.Ind.Co.	Shuaiba		80,000	80,000	construction	1992	NEW
	Iraq	Techorp	Mussayed		100,000	100,000	Construction	1991	NEW
	Brazil	Pollolefinas	Sao Paulo		100,000	100,000	Construction		NEW
	Canada	Himont	Varennes		65,000	65,000	Construction		NEW
	Venezuela	Pequiven/Veba	Jose		70,000	70,000	Construction		NEW
	Kuwaite	Petrochem.Ind.Co	Shuaiba	80,000	100,000	20,000	Construction	1992	expansion
	Brazil	PollaidenPet.	???		100,000	100,000	Planned		NEW
	Mexico	Indelpro	Tampico		80,000	80,000	Construction		NEW
	Saudi Arabia	Himont/Kenel	Riyal		350,000	350,000	Construction		NEW
	Iran	National Petrochem	Bandar Khomeini		50,000	50,000	Construction		
REST OF WORLD	TOTAL			270,000	2,999,000	2,687,000			
WORLDWIDE	TOTAL			905,000	9,886,200	8,130,000			

PETROCHEMICAL PLANTS EXPANSION PROJECTS ANNOUNCED DURING 1988/198/1989/1990

TABLE #5.4.5. PLANT: PVC - VCM - EDC FIGURES IN TONS

AREA	COUNTRY	COMPANY	LOCATION	EXISTING CAPACITY	EXPANDED CAPACITY	EXPANSION BY	STATUS	EXPECTED START-UP		PVC CAPACITY	
UNITED STATES											
	Texas	OxyChem.	Corpus Christi		360,000	360,000	Construction		NEW		EDC
	Texas	Shintech	Freeport		680,000		Construction	1990	expansion	680,000	PVC
	Los-Angles	Georgia Gulf Co	Plaquemine	320,000	370,000	50,000	Completed	1989	expansion	370,000	PVC
	Texas	OxyChem	Corpus Christi		500,000	500,000	Construction		NEW		VCM
	Texas	OxyChem	Ingleseside		450,000	450,000	Construction	1990	NEW		VCM
UNITED STATES	TOTAL			320,000	2,360,000	1,360,000				1,050,000	
WESTERN EUROPE											
	Italy	Solvay	Rosignano		80,000	80,000	Construction		NEW	80,000	PVC
	Belgium	DMS/Tessederlo	Tessenderlo		100,000	100,000	Construction	1991	NEW	100,000	PVC
	Spain	Atochem	???		120,000	120,000	Construction		NEW	120,000	PVC
	Netherland	Rovin	Pernis	215,000	295,000	80,000	Construction	1991	expansion	295,000	PVC
	Norway	Norsk Hydro	Heroya			80,000	Construction		expansion		PVC
	Turkey	Petkim	Alpet		130,000		Construction		expansion	130,000	PVC
	Turkey	Petkim	Alpet		132,000		Construction		expansion		VCM
	Turkey	Petkim	Yarpet		62,000		Construction		expansion	62,000	PVC
WESTERN EUROPE	TOTAL			215,000	919,000	460,000				787,000	
EASTERN EUROPE											
	Bulgaria	Bulgaria	Devnia		150,000	150,000	Construction	1991	NEW		VCM
	Bulgaria	Bulgaria	Devnia		120,000	120,000	Construction	1991	NEW	120,000	PVC
	Bulgaria	Bulgaria	Devnia		120,000	120,000	Construction	1991	NEW		EDC
	USSR	OxyChem	Kalush		90,000	90,000	Construction	1991	NEW	90,000	PVC
EASTERN EUROPE	TOTAL			0	480,000	480,000				210,000	
JAPAN											
JAPAN	TOTAL			0	0	0				420,000	
OTHER EAST ASIA											
	China	Wujing Chem.	Wujing		20,000	20,000	Construction		NEW	20,000	PVC
	India	Uhde	Ratnagiri		100,000	100,000	Construction	1992	NEW	100,000	PVC
	Thailand	Solvay&Cie	Mab ta Pud		140,000	140,000	Construction	1992	NEW		VCM
	Thailand	Solvay&Cie	Mab Ta Pud		135,000	135,000	Construction	1992	NEW	135,000	PVC
	Indonesia	Indonesia Petro	W.Java		30,000	30,000	Completed	1989	NEW		EDC
	Indonesia	Indonesia Petro	W.Java		150,000	150,000	Completed	1989	NEW		VCM
	Indonesia	Indonesia Petro	W.Java		70,000	70,000	Completed	1989	NEW	70,000	PVC
	India	Uhde	Ratnagiri		100,000	100,000	Construction	1992	NEW		VCM
OTHER EAST ASIA	TOTAL			0	745,000	745,000				325,000	

PETROCHEMICAL PLANTS EXPANSION PROJECTS ANNOUNCED DURING 1988/198/1989/1990

TABLE #5.4.5. Page #2 PLANT: PVC - VCM - EDC FIGURES IN TONS

AREA	COUNTRY	COMPANY	LOCATION	EXISTING CAPACITY	EXPANDED CAPACITY	EXPANSION BY	STATUS	EXPECTED START-UP		PVC CAPACITY	
REST OF WORLD											
	Australia	Petrolinm Ind.C	Kwinana		100,000	100,000	Construction		NEW		EDC
	Australia	Petrolinm Ind.C	Kwinana		240,000	240,000	Construction		NEW		VCM
	Canada	BF Goodrich	Fort Saskatchewan		110,000		Completed	1988	expansion	110,000	PVC
	Canada	BF Goodrich	Niagara Falls		180,000		Construction	1990	expansion	180,000	PVC
	Canada	Exxon	Sarnia		110,000		Completed	1989	expansion	110,000	PVC
	Israel	Frutarom	Akko	95,000	120,000	25,000	Construction		expansion		VCM
	Israel	Frutarom	Akko	92,000	98,000	6,000	Construction		expansion	98,000	PVC
	Saudi Arabia	Ibn Hayyam	Al Jubail	200,000	300,000	100,000	Completed	1988	expansion	300,000	PVC
	Brazil	CPC	Maceio		180,000	180,000	Construction		NEW		VCM
	Brazil	CPC	Maceio		100,000	100,000	Construction		NEW	100,000	PVC
	Venezuela	Pequiven	Jose		260,000	260,000	Construction	1994	NEW		EDC
	Venezuela	Pequiven	Jose		415,000	415,000	Construction	1994	NEW		VCM(100,000 at
	Venezuela	Pequiven	Jose		80,000	80,000	Construction	1991	NEW	80,000	PVC
	S.Korea	Han Yang Chem.	Ulsan		150,000	150,000	Construction	1990	NEW		VCM
	Brazil	Votorantin	Triunfo		180,000	180,000	Construction		NEW		VCM
	Brazil	Votorantin	Triunfo		180,000	180,000	Construction		NEW	180,000	PVC
	Iraq	Techcorp	Mussayed		91,000	91,000	Construction	1993	NEW		VCM
	Iraq	Techcorp	Mussayed		90,000	90,000	Construction	1993	NEW	90,000	PVC
	Saudi Arabia	Sadaf	Al Jubail		840,000		Construction		expansion		EDC
	Venezuela	Pequiven	El Tablazo		130,000	130,000	Construction	1991	NEW		VCM
	Iran	National Pet./S	Bandar Khomeini		294,000	294,000	Construction		NEW		EDC
	Iran	National Pet./S	Bandar Khomeini		150,000	150,000	Construction		NEW		VCM
	Brazil	Hansen	Alagoas		200,000	200,000	Construction		NEW	200,000	VCM/PVC
REST OF WORLD	TOTAL			387,000	4,598,000	2,971,000				1,448,000	
WORLDWIDE	TOTAL			922,000	9,102,000	6,016,000				4,240,000	

PETROCHEMICAL PLANTS EXPANSION PROJECTS ANNOUNCED DURING 1988/1989/1990

TABLE #5.4.6 PLANT: POLYSTYRENE-STYRENE FIGURES IN TONS

AREA	COUNTRY	COMPANY	LOCATION	EXISTING CAPACITY	EXPANDED CAPACITY	EXPANSION BY	STATUS	EXPECTED START-UP		PS CAPACITY	
UNITED STATES											
	Pennysylvania	Arco	Monaca		95,000	95,000	Completed	1988	Restart		Styrene
	Texas	Arco	Chnnalview		595,000		Completed	1988	expansion		Styrene
	Louisiana	Chevron	St.James Parish	270,000	680,000	410,000	Construction	1990	expansion		Styrene
	Los-Angles	Chevron	Baton Rouge		400,000	400,000	Completed	1989	NEW		Styrene
	Louisiana	Cosmar	Carville	681,000	863,000	182,000	Construction		expansion		Styrene
	Louisiana	Fina Oil&Chem.	Carville	154,000	290,000	136,000	Completed	1989	expansion	290,000	PS
	Ohio	Huntsman	Belpre		32,000	32,000	Construction		expansion	32,000	PS
	Texas	Dow	Free Port		450,000	450,000	Completed	1989	NEW		Styrene
	Los Angles	Dexico Polymer	Plaquemina		32,000	32,000	Construction		NEW		Styrene Bloc Copolymer
	Los-Angles	Deltech Corp.	Baton Rouge	270,000	400,000	130,000	Construction		expansion		Styrene+45,400 Paramethylstyrene
		Dow	Gulf Coast		450,000	450,000	Construction		NEW		Styrene
	Illinoi	Mobil Chemical	Juliet		55,000	55,000	Construction	1991	NEW	55,000	PS
UNITED STATES	TOTAL			1,375,000	4,342,000	2,372,000				377,000	
WESTERN EUROPE											
	Belgium	Finamont	Feluy		100,000	100,000	Completed	1989	NEW	100,000	PS
	France	CdF	Carling		50,000	50,000	Construction	1990	NEW	50,000	PS
	Turkey	Penta dis Ticar	Aliaga		100,000	100,000	Construction	1991	NEW		Styrene
	Turkey	Penta dis Ticar	Aliaga		60,000	60,000	Construction	1991	NEW	60,000	PS
	France	Norsolor	Carling	210,000	250,000	40,000	Completed	1989	expansion		Styrene
	United Kingdom	Huntsman	Carrington		50,000	50,000	Completed	1989	NEW	50,000	PS
	Netherland	Shell	Moerdijk			310,000	Construction	1991	expansion		Styrene
	Netherland	Dow	Tenenzen		450,000	450,000	Construction	1990	NEW		Styrene
	France	Norsolor	Carling		50,000	50,000	Construction		NEW	50,000	PS
	United Kingdom	Huntsman	Carrington	50,000	125,000	75,000	Construction	1990	expansion	125,000	PS
	United Kingdom	Enichem	Hythe	150,000			Construction	1990	expansion		PS
	Belgium	Dow	Tessenderlo		90,000	90,000	Construction	1992	NEW		Styrene
	Belgium	BASF	Antwerp		300,000	300,000	Construction	1991	NEW		Styrene
	Spain	Atochem	Prat de Llobregat		30,000	30,000	Construction		NEW	30,000	PS
	United Kingdom	Enichem	Hythe		60,000	60,000	Construction		NEW		Styrene
	Turkey	Petkim	Yarpet		24,000		Construction		expansion	24,000	PS
WESTERN EUROPE	TOTAL			410,000	1,739,000	1,765,000				489,000	

PETROCHEMICAL PLANTS EXPANSION PROJECTS ANNOUNCED DURING 1988/1989/1990

TABLE #5.4.6	Page #2			PLANT:	POLYSTYRENE-STYRENE			FIGURES IN TONS			
AREA	COUNTRY	COMPANY	LOCATION	EXISTING CAPACITY	EXPANDED CAPACITY	EXPANSION BY	STATUS	EXPECTED START-UP		PS CAPACITY	
EASTERN EUROPE											
	Hungary	Dunamont	S.Budapest		45,000	45,000	Construction	1991	NEW	45,000	PS+20,000 XPS
	USSR	USSR	Tobolsk		300,000	300,000	Construction		NEW		Styrene
	Czechoslovokia	Chemopetrol	Kralupy		22,500	22,500	Construction		Replace	22,500	PS
	USSR	USSR	Surgut		600,000	600,000	Construction		NEW	600,000	PS
EASTERN EUROPE	TOTAL			0	967,500	967,500					
JAPAN											
		Mitsubishi	Yokkaichi		90,000	90,000	Completed	1988	Restart		Styrene
		Idemitsu	Tokuyama		90,000	90,000	Completed	1989	Restart		Styrene
		Asahi Chemicals	Mizushima		50,000	50,000	Refurbishing		Restart		Styrene
		Nippon Steel Ch	Kimitsu Chiba		120,000		Constraction	1991	expansion	120,000	PS
JAPAN	TOTAL			0	350,000	230,000				120,000	
OTHER EAST ASIA											
	Siam Cement/Dow	Thailand	Mub Ta Pud		135,000	135,000	Construction		NEW		Styrene
	Huntsman/Mitsub	Thailand	Mub Ta Pud		55,000	55,000	Construction	1991	NEW	55,000	PS
	Hong-Kong	Kader/Montedipe	Yuen Long		100,000	100,000	Construction	1990	NEW	100,000	PS
	Malaysia	Petrochem.Malay	Johore		20,000	20,000	Completed	1989	NEW	20,000	PS
	Taiwan	Formosa Plastic	Lin Yuan			100,000	Construction	1990	expansion		Styrene
	China	Yansham Petroch	Beijing		60,000	60,000	Construction		NEW		Styrene
	China	Yansham Petroch	Beijing		60,000	60,000	Construction		NEW	60,000	PS
	Taiwan	China Gen.Plast	???		100,000	100,000	Construction	1991	NEW		Styrene
	Indonesia	Dow/PT	Cilacap		20,000	20,000	Construction	1991	NEW	20,000	PS
	Hong-Kong	Montedipe/CITIC	???		75,000	75,000	Construction		NEW		Styrene
	Taiwan	Chi Mei	Tainan		350,000	350,000	Construction	1990	NEW	350,000	PS
OTHER EAST ASIA	TOTAL			0	975,000	1,075,000				605,000	

PETROCHEMICAL PLANTS EXPANSION PROJECTS ANNOUNCED DURING 1988/1989/1990

TABLE #5.4.6 Page #3 PLANT: POLYSTYRENE-STYRENE FIGURES IN TONS

AREA	COUNTRY	COMPANY	LOCATION	EXISTING CAPACITY	EXPANDED CAPACITY	EXPANSION BY	STATUS	EXPECTED START-UP		PS CAPACITY	
REST OF WORLD											
	Saudi Arabia	Petrokemia	Al Jubail		80,000	80,000	Construction		NEW	80,000	PS
	Canada	Polysar	Sarnia		110,000	110,000	Refurbishing		Restart		Styrene
	Peru	Conosorcio Ind.	Callao(Lima)		15,000	15,000	Completed	1989	NEW	15,000	PS
	S.Korea	Arco	Ulsan		225,000	225,000	Construction	1990	NEW		Styrene
	Israel	Gadot	Haifa		60,000	60,000	Construction		NEW		Styrene
	Canada	Polysar-Nova	Decatur		110,000		Completed	1989	expansion	110,000	PS
	Canada	Polysar	Sarnia	110,000	360,000	250,000	Completed	1989	expansion		Styrene
	Korea	Lucky Polychem.	Yeochon		80,000	80,000	Completed	1989	NEW		Styrene
	Venezuela	Pequiven	El Tablazo		150,000	150,000	Construction	1992	NEW		Styrene
	Argentina	Pasa	San Lorenzo		120,000		Construction		expansion		Styrene
	Argentina	pasa	Santa Fe		30,000	30,000	Construction		NEW	30,000	PS
	Iraq	Techcorp	Mussayed		145,000	145,000	Construction	1991	NEW		Styrene
	Iraq	Techcorp	Mussayed		80,000	80,000	Construction	1991	NEW	80,000	PS
	Tunisia	Montedipe	Tunis		50,000	50,000	Construction	1992	NEW		Styrene
	Korea	Samsung Gen.Che	Deasan		180,000	180,000	Construction	1990	NEW		Styrene
	Brazil	Estireno do N.	Itaguai		150,000	150,000	Construction		NEW		Styrene
	Brazil	Estireno do N.	Itaguai		50,000	50,000	Construction		NEW	50,000	PS
	Saudi Arabia	Petrokemia	Al Jubail		200,000	200,000	Construction		NEW		Styrene
	Korea	Hyundai	Daesan		100,000	100,000	Construction		NEW		Styrene
	Tunisia	Enimont	Tunis		50,000	50,000	Construction	1991	NEW	50,000	PS
	India	Reliance Ind.	Hazira		80,000	80,000	Construction		NEW		Styrene

PETROCHEMICAL PLANTS EXPANSION PROJECTS ANNOUNCED DURRING 1988/1989/1990

TABLE #5.4.7 — PLANT: PET-PEI-PBT & POLYESTERS — FIGURES IN TONS

AREA	COUNTRY	COMPANY	LOCATION	EXISTING CAPACITY	EXPANDED CAPACITY	EXPANSION BY	STATUS	EXPECTED START-UP		PLANT	PET CAPACITY
UNITED STATES											
	S.Carolina	Formosa	Lake city		187,000	187,000	Construction		NEW	Polyester	
UNITED STATES	TOTAL			0	187,000	187,000					
WESTERN EUROPE											
	Belgium	Amoco Fina	Antwerp		38,000		Construction		expansion	Polybutene	
	Spain	GEP	Cartagena		66,000	66,000	Construction	1,992	NEW	PBT	
	Sweden	Neste	Nol		20,000		Completed	1,988	closure	Polyester	
	Spain	Brillen	Barbastro		5,000	5,000	Completed	1,988	NEW	PET	5,000
	United Kingdom	Blagdend	Harterhill				Completed	1,989	expansion	Polyester	
WESTERN EUROPE	TOTAL			0	129,000	71,000					
EASTERN EUROPE	TOTAL			0	0	0					
JAPAN											
		ICI	Tamatsukuri		7,500	7,500	Construction	1,990	NEW	Polyester	
JAPAN	TOTAL			0	7,500	7,500					
OTHER EAST ASIA											
	Indonesia	PT Yasinta	???		40,000	40,000	Construction		NEW	PE Polycond.	
	India	EMS Inventa	Maharashtra		38,000	38,000	Construction		NEW	Polyester	
	Taiwan	Dow	Taithung		15,000		Construction	1,990	expansion	Voranol Polyether	
	China	Xinhui Synth	Guangzhon		4,000	4,000	Construction	1,990	NEW	Polyester	
	China	Xiamen Lihen	Fujian-Xiamen		4,500	4,500	Construction	1,990	NEW	Polyester	
	Thailand	EMS Inventa	Bangkok		50,000	50,000	Construction	1,991	NEW	Polyester	
	China	Technip/Maru	Urumchi		47,000	47,000	Construction		NEW	Polyester	
	China	BASF/Sinopec	Nanjing		10,000	10,000	Construction	1,991	NEW	Polyester	
OTHER EAST ASIA	TOTAL			0	208,500	193,500					

PETROCHEMICAL PLANTS EXPANSION PROJECTS ANNOUNCED DURRING 1988/1989/1990

TABLE #5.4.7 Page #2 PLANT: PET-PEI-PBT & POLYESTERS FIGURES IN TONS

AREA	COUNTRY	COMPANY	LOCATION	EXISTING CAPACITY	EXPANDED CAPACITY	EXPANSION BY	STATUS	EXPECTED START-UP		PLANT	PET CAPACITY
REST OF WORLD											
	Iraq	Techcorp	Mussayed		45,000	45,000	Construction	1,993	NEW	Polybutadiene Rubber	
	Saudi Arabia	Anchem	Jubail		10,000	10,000	Construction	1,991	NEW	Polyester	
	Colombia	Eastman	???		363,000		Construction	1,990	expansion	PEI	
	Brazil	Celbras	Rio de Janeiro		60,000		Construction	1,992	expansion	Polyester	
	Bahia	ICI	Aratu		5,000	5,000	Completed	1,989	NEW	Polyester	
	Canada	Istman Kodak	Toronto		45,000	45,000	Construction	1,990	NEW	PET	45,000
	Colombia	Dow	???		15,000		Construction	1,990	expansion	Voranol Polyester	
	Brazil	Dow	???		10,000		Construction	1,990	expansion	PET	10,000
	Brazil	Rhodia Norde	Cabo	27,000	55,000	28,000	Construction	1,993	expansion	Polyester	
REST OF WORLD	TOTAL			27,000	608,000	133,000					
WORLDWIDE	TOTAL			27,000	1,140,000	592,000					60,000

PETROCHEMICAL PLANTS EXPANSION PROJECTS ANNOUNCE 1988/1989/1990

TABLE #5.4.8 — PLANT: ACRYLO-BUTYL-STYRENE — FIGURES IN TONS

AREA	COUNTRY	COMPANY	LOCATION	EXISTING CAPACITY	EXPANDED CAPACITY	EXPANSION BY	STATUS	EXPECTED START-UP	
UNITED STATES									
	Texas	BP Chemicals	Green Lake		7,300	7,300	Construction	1991	NEW
UNITED STATE	TOTAL			0	7,300	7,300			
WESTERN EUROPE									
	Spain	GE Plastic	Cartagena		100,000	100,000	Construction	1992	NEW
WESTERN EURO	TOTAL			0	100,000	100,000			
EASTERN EUROPE									
EASTERN EURO	TOTAL			0	0	0			
JAPAN									
		Mitzubishi/	???			30,000	Construction		expansion
		Ube Cycon	???			30,000	Construction		expansion
JAPAN	TOTAL			0	0	60,000			
OTHER EAST ASIA									
	Thailand	Thailand	Mab Ta Pud		8,000	8,000	Construction		NEW
	India	Bhansell Eng	Bombay		6,000	6,000	Construction		NEW
	China	Shanghi Goaq	Shanghi		450	450	Construction		NEW
OTHER EAST A	TOTAL			0	14,450	14,450			
REST OF WORLD									
	Iraq	Techcorp	Mussayed		15,000	15,000	Construction	1991	NEW
	Mexico	Polimar	Altamira		20,000	20,000	Construction		NEW
REST OF WORL	TOTAL			0	35,000	35,000			
WORLDWIDE	TOTAL			0	156,750	216,750			

PETROCHEMICAL PLANTS EXPANSION PROJECTS ANNOUNCED DURING 1988/1989/1990

TABLE #5.4.9 — PLANT: NON COMMODITY PLASTICS — FIGURES IN TONS

AREA	COUNTRY	COMPANY	LOCATION	EXISTING CAPACITY	EXPANDED CAPACITY	EXPANSION BY	STATUS	EXPECTED START-UP		
UNITED STATES										
	Texas	Mobay Corp.	Bayport		100,000		Construction	1990	expansion	Polycarbonat
	Texas	BASF	Freeport	272,000	290,000	18,000	Construction	1991	expansion	Nylon 6
	W.Virginia	Du Pont	Parkersburg			45,000	Construction		expansion	Nylon 6
	Texas	Du Pont	Gulf Coast		57,000	57,000	Construction	1991	NEW	MMA
UNITED STATES	TOTAL			272,000	447,000	120,000				
WESTERN EUROPE										
	Belgium	Bayer	Antwerp		70,000	70,000	Construction	1994	NEW	Polycarbonat
	Spain	GEP	Cartagena		325,000	325,000	Construction	1994	NEW	Polycarbonat
	United Kindom	American Col	Wallasey		10,000	10,000	Completed	1989	NEW	Polyacrylate
	France	RohmδHaas/Or	Viller-Saint-Paul		40,000	40,000	Construction		NEW	Polyacrylate
	Belgium	Neste	???		25,000	25,000	Construction	1990	NEW	Polyalphaolefins
	France	Orkem	Carling		60,000		Construction		expansion	MMA
	W.Germany	BASF	Ludwigshafen		40,000	40,000	Construction		NEW	MMA
WESTERN EUROPE	TOTAL			0	570,000	510,000				
EASTERN EUROPE	TOTAL			0	0	0				
JAPAN	TOTAL			0	0	0				
OTHER EAST ASIA										
	Taiwan	Taiwan Eng.P	Chang Chun		20,000	20,000	Construction	1990	NEW	Polyacetal
	Indonesia	BP Chemicals	Jakarta		20,000	20,000	Construction		NEW	Nylon 6
	Thailand	Thai Taffeta	Bangkok		12,000	12,000	Construction	1991	NEW	Nylon 6
	Taiwan	ICI	???		65,000		Construction	1990	NEW	MMA
	Taiwan	ICI	???		35,000		completed		Closure	MMA
OTHER EAST ASIA	TOTAL			0	152,000	52,000				
REST OF WORLD										
	Korea	Enichem	???		20,000	20,000	Construction	1991	NEW	Polycarbonat
	Brazil	Colpen	Alagoas		10,000	10,000	Construction	1992	NEW	Polycarbonat
	Canada	Du Pont	Maitland		23,000	23,000	Completed	1988	NEW	Nylon 12/12
	Brazil	BASF	???		15,000	15,000	Construction	1992	NEW	Nylon 6
	Brazil	Rhodia	Sao Paulo		15,000	15,000	Construction	1990	NEW	Nylon 6
	Brazil	Metacril	Bahia			10,000	Construction		expansion	Methyl Acrylate
REST OF WORLD	TOTAL			0	83,000	93,000				
WORLDWIDE	TOTAL			272,000	1,252,000	775,000				

תעשית הפלסטיקה בישראל ובעולם:
תמונת מצב והתפתחויות עתידיות

ד"ר הנריק דוד פרנקל

פרסום זה מהווה חלק מהמחקר על

חלופות לקידום תעשית הפלסטיקה והפולימרים בישראל

הנערך ע"י מוסד ש. נאמן עבור איגוד יצרני הפלסטיקה •

משרד התמ"ס - המדען הראשי • מתימו"פ

נובמבר 1990

תעשיית הפולימרים בעולם ובישראל - תמונת מצב והתפתחויות עתידיות

ד"ר דוד פרנקל, ד"ר שמואל קניג

תקציר מנהלים

1. רקע

מוסד נאמן למחקר מתקדם במדע וטכנולוגיה עורך מחקר מקיף על "חלופות לקידום תעשיית הפלסטיקה והפולימרים בישראל". העבודה כוללת שלושה שלבים עיקריים:

א. איסוף נתונים על מצב תעשיית הפולימרים והפלסטיקה בישראל ובעולם מבחינה טכנולוגית, כלכלית ושווקית.

ב. ניתוח משולב - טכנולוגי, כלכלי ושווקי, אודות מצבה העתידי של תעשיית הפולימרים והפלסטיקה בישראל.

ג. ניתוח חלופות לתעשיית הפולימרים והפלסטיקה בישראל והשלכותיהן על כח-אדם, ארגון התעשיה, מחקר ופיתוח, ציוד ומיכון, השקעות וחומרי גלם.

דו"ח זה עוסק בתעשיית חומרי הגלם המונומרים והפולימרים בישראל ובעולם, הן מבחינת מצבה הנוכחי והן מבחינת התפתחותה העתידית.

2. מצבה הנוכחי של תעשיית המונומרים והפולימרים בישראל

מכלל המכירות של התעשייה הפטרוכימית בישראל, שהגיעו בשנת 1988 ל-250 מליון דולר, מחזור המכירות של תעשיית הפולימרים בארץ הגיע ל-183 מליון דולר, בנפח ייצור של 178 אלף טון. ההשקעה בתעשיית המונומרים והפולימרים בישראל מסתכמת ב-420 מליון דולר. בתעשיה מועסקים בה כ-1500 איש.

מקורות המונומרים בישראל מצויים במפעלים הבאים:
אתילן - בבתי הזקוק, ויניל כלוריד (בנוסף ליבוא) - בפרוטרום, מונומרים ליצור מלמין ופנול פלסטיים בכרמל כימיקלים, ומונומרים מתקדמים - במפעלי הברום.

יצרני הפולימרים הם: מפעלים פטרוכימיים - פוליאתילן צפיפות נמוכה, פוליסטירן (מונומר מיובא), פרוטרום-פולי-

ויניל-כלוריד (PVC), כרמל כימיקלים - מלמין ופנול פלסטיים, נילית - ניילון 6/6, מכתשים - פוליאסטרים ואפוקסי. בנוסף מתוכננת הקמת מפעל ליצור פוליפרופילן בחברה משולבת בין בתי זיקוק ופטרוכימיים בשם כרמל אולפינים.

מכלל ייצור הפולימרים בישראל כ-2/3 הם לשוק המקומי ו-1/3 מכוון לייצוא. יש לציין שהיחס בין מחיר הפולימר הסופי לערך חומרי המוצא מגיע בישראל ל-6.2. ערך מוסף זה פרושו חסכון במטבע חוץ.

סך כל התצרוכת של פולימרים לצריכה (commodities) הגיעה בשנת 1989 ל-200 אלף טון. מכלל הצריכה של כ-74 אלף טון פוליאתילן צפיפות נמוכה כ-20% מיובא, מכלל צריכה של כ-22 אלף טון פוליסטירן כ-54% מיובא, מכלל צריכה של כ-37 אלף טון PVC כ-13% מיובא. בנוסף מיובאים לארץ כ-34 אלף טון פוליאתילן צפיפות גבוהה, כ-40 אלף טון פוליפרופילן וכ-96 אלף טון חומרים פולימריים שונים.

רוב היבוא של חומרים פלסטיים בשנת 1989 מקורו בשוק המשותף - 78%, 6% מארה״ב, כאשר יפן וייצרניות אסיאתיות אחרות תרמו רק 1% מכלל היבוא.

3. תעשיית המונומרים והפולימרים בעולם - תמונת מצב

התעשייה הפטרוכימית היתה מרוכזת במשך שנות השישים והשבעים בארה"ב, אירופה המערבית ויפן. מסחר פטרוכימי בין שלושה אזורים אלו לא היה קיים. ארה"ב סיפקה את צרכי אמריקה הלטינית, מערב אירופה סיפקה פולימרים למזרח התיכון ולאפריקה ויפן שלטה על מזרח אסיה. עם העלאות המחירים של הנפט הגולמי, במיוחד בשנת 78/9' החלה התעשייה הפטרוכימית בארה"ב להגדיל את חלקה בייצוא ע"ח היצרנים היפנים. במשך שנות ה-80' רוב הפולימרים, כמו כל המוצרים הפטרוכימיים, היו בעודף היצע. עם יציאת הכלכלה העולמית מהשפל של ראשית שנות ה-80' והפעלתן של שלוש מערכות פטרוכימיות גדולות בערב הסעודית, החל שינוי במבנה התעשיות הפטרוכימיות בארה"ב, מערב אירופה ויפן. בנוסף לכך חל שינוי במחירי הנפט הגולמי ב-1986 שהביאו לירידתם מ-32 דולר לחבית ל-18 דולר בראשית שנת 1990. מחיר הנפטא הנמוך השפיע לטובה על יפן ומערב אירופה והיתרון היחסי של המפעלים בערב הסעודית ירד. בשנת 1987 חל איזון בין ביקוש והיצע.

בעשור האחרון, אסיה הפכה לשוק חשוב לפולימרים ומוצרים פטרוכימיים. קוריאה הדרומית וטאיוון הפכו לצרכניות ויצרניות גדולות. סין פיתחה תעשית פולימרים עצמאית, והמדינות המתפתחות באסיה הפכו לצרכניות פולימרים. כתוצאה מכך החל מסחר בפולימרים שהיקפו מגיע כיום ל-9 מליון טון. השוק הפך משוק מקומי לשוק בינלאומי. ארה"ב מספקת מוצרים פטרוכימיים למזרח אסיה ואמריקה הלטינית, אך קיים גם יבוא של פולימרים לארה"ב. אירופה מייצאת למזרח אסיה, לאפריקה ולמזרח התיכון, אך גם מייבאת פולימרים רבים. קנדה וערב הסעודית הפכו ליצואניות לארה"ב, מזרח אסיה ואירופה המערבית. ברזיל מייצאת פוליאתילן ואתילן די-כלורי למזרח אסיה, וסינגפור מספקת פוליאולפינים למדינות אחרות באזור. פוליאולפינים מהווים חלק גדול מהמוצרים בסחר הבינלאומי. סטירן, אתילן די-כלורי, ויניל כלוריד וחומצה טרפתלית (TPA) גם הם חלק מסחר בינלאומי, כאשר קיימת התפתחות בסחר באתילן ופרופילן. התצרוכת העולמית באתילן מגיעה ל-57 מליון טון וזו של פרופילן ל-29 מליון טון בשנה. סך כל התצרוכת בפולימרים הגיע בשנת 1989 ל-70 מליון טון, כשפוליאתילן צפיפות נמוכה מגיע ל-19 מליון טון, פוליאתילן צפיפות גבוהה ל-11.5 מליון טון, פוליפרופילן ל-12.5 מליון טון, פוליסטירן ל-7.5 מליון טון ו-PVC ל-19 מליון טון. תצרוכת ABS כ-2 מליון טון, חומרים מרוכבים 3.6 מליון טון, PET 1.6 מליון טון וחומרים אחרים כ-9.3 מליון טון.

4. תעשיית המונומרים והפולימרים בעולם - תחזית לעשור הבא

הגורמים העיקריים המשפיעים על יצור פולימרים הם: חומרי המוצא, תנאי שוק הצריכה, המגמה לאינטגרציה אנכית ושינויים בסחר הבינלאומי במונומרים ופולימרים.

קיום מונומרים זולים, בעיקר אתילן ופרופילן, הוא המפתח לייצור פולימרים. עם זאת, קיום מונומרים זולים תלוי במחירי נפט גולמי וגז ותפוקת המתקנים. השימוש בגז לתעשיית הפולימרים תלוי בחלק המעובה (condensate - אתאן ופרופאן) של הגז הטבעי. הנפטא הוא המקור העיקרי לאתילן ומחירו הגיע בתחילת 1990 ל-170 דולר לטון. מחיר הנפטא ימשיך לעלות בהתאם לקצב האינפלציה.

השוק העולמי למונומרים ופולימרים לצריכה (commodities) מושפע מגודל השוק והגידול בארצות המערב. בתחילת שנות ה-80' רפיון כלכלי ורווית השוק הביאו להיצע יתר, בשנים 87' ו-88' חלה התאוששות עקב גידול בכלכלה העולמית, וגידול השימוש בפולימרים באמריקה הלטינית ואסיה. השווקים הללו הם בעלי פוטנציאל הגידול העיקרי בשנות ה-90'. לפיכך, התחזית היא לגידול של כ-12 מליון טון פולימרים בעולם המתפתח וכמות דומה בכלכלה המערבית בחמש השנים הקרובות.

בעשור האחרון ניתן להבחין, בתעשיה הפטרוכימית ובתעשית הפולימרים, במגמה לאינטגרציה אנכית (במורד הזרם) כתוצאה מהיתרון הכלכלי לגודל, החסכון בהוצאות יצור והובלה והבטחון לאספקה רציפה של חומרי גלם ליצור. הכניסה של היצרנים הפטרוכימיים כמו ערב הסעודית, קנדה וברזיל לשוק הפולימרים הביאה את היצרנים בארצות המפותחות לשנות מגמה לכוון של מוצרים מיוחדים בהם הערך המוסף גבוה והטכנולוגיה מתוחכמת יותר. באופן מקביל החברות המתמחות במוצרים מיוחדים עברו לאינטגרציה אנכית (במעלה הזרם) בכדי להבטיח את מקור חומרי הגלם. כמו כן, יצרני הפולימרים פונים יותר למעבדים תוך תשומת לב לבעיותיהם הטכניות.

ניתן להבחין במגמה של פרויקטים משותפים בין יצרני הפולימרים, המעבדים ומפתחי המוצרים. יש לציין את ההתפתחות לכוון שינויים "בתוך הריאקטור".

הסחר הבינלאומי בפולימרים גדל מ-15 מיליארד דולר בשנת 1970 ל-70 מיליארד דולר ב-1990. המסחר נשלט ע"י המדינות המתועשות, כאשר המגמה היא לגידול חלקם של המדינות המתפתחות. יש לצפות למכסי הגנה כך שמגמה זו תיבלם בחלקה.

כתוצאה ישירה מהתחרות במחירי חומר הגלם, הצורך בהשקעות ורווית השוק בשימושים הקונבנציונליים, חלו שיפורים וחידושים טכנולוגיים הן בחומרי הגלם והן בשימושים הסופיים. התפתחות זו הביאה בעקבותיה גידול ברווחי החברות המייצרות. ביצור הפוליאוליפינים, הוכנסו תהליכים המגדילים את הגמישות ליצור סוגים שונים, הוגדלה הפעילות של הקטליזטורים ואורך חייהם, פותחו חומרים חדשים וחלו שיפורים במתקנים קיימים. לדוגמה פיתוח LLDPE, הנותן אפשרות להקטנת עוביים ושיפור בעבידות ושיפורים ביצור פוליפרופילן העלו את הרווחיות.

הרוויה בשימוש בחומרי צריכה הביאה להאצת השימוש בפולימרים הנדסיים, תוך פיתוח תעשיית התרכוב עם סיבים

והכנת תערובות בין פולימרים, לקבלת תכונות משופרות. קצב הגידול השנתי הקיים בפולימרים הנדסיים הוא גבוה במיוחד - מעל 10% לשנה. התצרוכת העולמית ב-1990 תהיה מעל מליון טון עם תחזית לגידול עד כ-10 מליון טון בשנת 1995 לרמה כוללת של 10% מכמות הפולימרים הנצרכת.

שוק הרכב הוא המוביל מבחינת השימוש הקיים והפוטנציאל לשימוש עתידי. כמו כן שוק ההשקייה, שוק הבניה והמכונות הם בעלי פוטנציאל עתידי לגידול. סה״כ יגיע השימוש בפולימרים לצריכה ל-138 מליון טון ופולימרים הנדסיים לכ-16 מיליון טון עד שנת 2000.

5. תעשיית המונומרים והפולימרים בישראל - מבט לעתיד

לישראל אין מקורות עצמיים של גז טבעי ונפטא ליצור מונומרים. הנפטא המיוצרת בישראל מקורה בנפט גולמי מיובא. עם הרחבת השימוש בפחם ירד הצורך בזיקוק נפט גולמי ולפיכך כמויות נפטא נוספות מיובאות, ואין כח דוחף להרחבת התעשיה הפטרוכימית מנקודת מבט מקורות חומרי גלם לתעשית הפולימרים.

השימוש בפולימרים לגולגולת בישראל הוא גבוה - 64 ק״ג לנפש, בהשוואה למדינות מתועשות אחרות - 100 ק״ג בארה״ב ו- 63 ק״ג באירופה. הדבר מצביע על רויון בשימושים קונבנציונליים (גידול שנתי של 1.5% בלבד). שינוי בכיוון יתרחש רק בעקבות גידול באוכלוסית המדינה. גלי העליה ממזרח אירופה יביאו בתחזית שמרנית לגידול של יותר מ-26 אלף טון פולימרים עד שנת 1995, מעבר לצריכה הקיימת. במיוחד יש לצפות לגידול השימוש בבניה, במוצרי צריכה כמחליפים לזכוכית ומתכת, מוצרים רפואיים חד ורב-שימושיים, מוצרים חשמליים ואלקטרוניים. כמו כן צפוי גידול משמעותי בצריכת פולימרים בשוק הרהיטים המבוסס על פוליפרופילן ופוליאוריתן תוך ירידה בשימוש ב-PVC. שוק התעשיה והמיכון בו חלקים מתכתיים מוחלפים בחומרים פלסטיים הנדסיים גם הוא בעל פוטנציאל לגידול. אין לצפות לשינויים גדולים באריזה ובחקלאות בישראל היות והגיעו לרוויה, להוציא פיתוחים חדשים באריזה המבוססת על יריעות רב שכבתיות.

יצוא הפולימרים הגיע בשנת 1988 ל-79 אלף טון, בערך כספי של 81 מליון דולר, כאשר המגמה היא לירידה, ככל שהתחרות העולמית גדלה. יש לצפות שיצוא תעשיית הפולימרים יגיע ל-40-45% מכלל התפוקה המקומית.

יצור מקומי של פולימרים מביא בעקבותיו הגדלת השימוש המקומי, דבר המבטיח המשכיות באספקה מקומית גם בזמן משבר. יצרן מקומי מבטיח גם שירות טכני צמוד. בהתאם למגמות העולמיות, יש להגביר את שיתוף הפעולה בין יצרן ח״ג, המעבד ויצרן המוצר הסופי.

כאמור, תעשיית הפולימרים עוברת תהליך של אינטגרציה אנכית, מצב שכמעט ואינו קיים בישראל. עם הקמת התשלובת ״כרמל אולפינים״ נעשה הצעד הראשון לכוון אינטגרציה בין יצרני המונומרים והפולימרים, ובין יצרני הפולימרים והמתרכבים. עם התחזקות התחרות בשווקים העולמיים, אינטגרציה אנכית לכוון מוצרים תהיה מחויבת המציאות. סה״כ יש לצפות לצריכה של כ-270 אלף טון פולימרים לצריכה וכ-100 אלף טון פולימרים אחרים בשנת 1995.

התעשייה הישראלית תהיה מושפעת מהתפתחויות בעולם בתוספת מגמות מקומיות - פיתוח של פולימרים חדשים ומיוחדים ואיתם פיתוח של שימושים מיוחדים וחידושים כמו קופולימרים ותרכוב בריאקטור או לחילופין תרכוב ע״י

יצרן ח"ג עצמו. לפיכך, על התעשייה הישראלית לאמץ ייצור של פולימרים חדשים, במיוחד פולימרים הנדסיים ומיוחדים בנוסף לתרכוב וערבוב. חשוב ליצרני ח"ג הישראליים להתרכז באספקת ח"ג לשימושים המובילים את השוק, בשעה שיצוא של פולימרים לצריכה ילך ויצטמצם עקב כניסת המדינות עשירות הגז. תעשית הפולימרים בישראל תהיה חייבת להשתנות ולהפוך לתעשייה המייצרת פולימרים לפי תכונות מוזמנות, כפי שגם חברות גדולות כמו דו-פונט וגנרל אלקטריק מציעות היום. בהתאם יש צורך בהקמת מתקנים וציוד לתרכוב לאחר הריאקטור ובתוך הריאקטור. במיוחד יש להדגיש את הצורך לכך במתקן הפוליפרופילן הנמצא בשלבי תכנון.

אין ספק שהיצע של ח"ג זולים ע"י המדינות העשירות בגז תשפיע ישירות על יצור המונומרים, במיוחד לאור העובדה שהתעשייה הישראלית צורכת נפט גולמי ונפטא מיובאים. דבר זה יביא לקושי בתחרותיות ביצוא הפולימר המוגמר, במיוחד לאור תנודות הצפויות במחירי הנפט הגולמי בעולם.

"כלכלה של גודל" גם היא פקטור חשוב ביצור מונומרים. מתקני יצור בעולם הם בגודל של כ-500 אלף טון אתילן לשנה. מתקן מגודל זה הוא גדול על מדינת ישראל שתצרוך בעתיד כ-150 עד 200 אלף טון בלבד בשנה. לפיכך אין לצפות הקמת מתקן אתילן נוסף בישראל בעתיד. כל תוספת לתצרוכת הצפויה לפוליאתילן תבוא מיבוא של אתילן, במיוחד לאור הדפוסים המשתנים של הסחר הבינלאומי באתילן. האחדת השוק האירופי בשנת 1992 תביא להשפעה שלילית על פיתוח ויצור של פולימרים בישראל. יהיה קשה ליצא פולימרים לשוק המשותף ובמקביל היבוא לישראל יגבר.

לפתיחת השווקים במזרח אירופה תהיה השפעה חיובית על תעשיית הפולימרים בישראל. תהיה הזדמנות להרחיב את היצוא של פולימרים ומוצרים הן ע"י הסכמי ברטר והן ע"י פרויקטים משותפים המבוססים על ידע ישראלי.

הגידול המטאורי של התעשיות הפטרוכימיות בדרום מזרח אסיה ובסין ישפיע בצורה מעורבת על תעשיית הפולימרים בישראל. מצד אחד תחרות מצד מדינות אלו נגד התוצרת המקומית ויבוא אירופי ואמריקאי, מצד שני מדינות אלו יכולות לשמש מקור למונומרים אולפינים. המגמות הנמשכות להקמה של מתקנים פטרוכימיים גדולים בארצות העשירות בגז ונפט, תבאנה לתחרות קשה בשווקי העולם והורדת מחירים של פולימרים, דבר שימנע הרחבה של ייצור הפולימרים המקומי. התעשיה הפטרוכימית בארצות ערב תגדיל את התחרות בשוק הבינלאומי. בראיה אופטימית לטווח ארוך עם כינון שלום, יפתחו אפשרויות לשיתוף פעולה ורכישה ישירה של מונומרים לתעשיית הפולימרים.

התצרוכת החזויה של ישראל ב-LDPE לשנת 2000 מצדיקה הרחבת כושר יצור ל-150 אלף טון לשנה, בהשקעה של 25 מליון דולר, כאשר 1/3 מכמות זו ייועד ליצוא. תצרוכת HDPE תגיע ל-55 אלף טון לשנה, דבר המצדיק הקמת מתקן יצור בקיבול של 60 אלף טון לשנה בהשקעה של 50 מליון דולר. תצרוכת פוליפרופילן תגיע עד שנת 2000 ל-70 אלף טון לשנה. כ-80% מכמות זו תסופק ע"י המתקן המתוכנן והשאר יסופק ע"י יבוא. עם הרחבתו ל-120 אלף טון בהשקעה מוערכת של 40 מליון דולר, ייפתח השוק ליצוא. תצרוכת פוליסטירן תגיע ל-32 אלף טון. כצעד ראשון סביר להקים

מתקן מקומי ל-80 אלף טון סטירן בהשקעה של כ-40 מליון דולר, ש-50 אלף טון יפולמרו לפוליסטירן והשאר יכוון ליצוא. ההשקעה המוערכת במתקן פוליסטירן היא כ-35 מליון דולר. תכנון מתקן משולב של חומצה טרפתלית, בהשקעה של 45 מליון דולר, ופוליאתילן טרפתלט (PET) בהשקעה נוספת של 40 מליון דולר, תראה כלכלית במיוחד לאור תצרוכת חזויה של PET בהיקף של 25 אלף טון בשנת 2000. מתקן בהיקף של 50 אלף טון לשנה המייצא חצי מתפוקתו מוערך כצירוף כלכלי.

סה"כ התוספת בכח-האדם עקב ההשקעות הנ"ל מוערכת ב-240 עובדים.

6. התפתחויות נוספות

למשבר הבינלאומי במפרץ הפרסי, תוצאות שליליות מרחיקות לכת על תעשיית המונומרים והפולימרים בעולם ובארץ. עליית מחירי הנפטא מ-170 דולר לטון (בתחילת 1990) ל-330 דולר לטון (אוקטובר 1990), הביאה להורדת הרווחים של התעשייה. בנוסף יש למשבר תוצאות כלכליות רחבות יותר, כתוצאה מירידת הביקוש. גם המגזר של הפולימרים ההנדסיים והמיוחדים יושפעו ע״י העצירה בגידול הכלכלי ועליית מחירי הדלק, למשל, דרך השפעתם על שוק המכוניות ושוק מוצרי הצריכה. במבט ראשון נראה שאנו נמצאים בתחילתו של משבר כלכלי בדומה לזה של תחילת שנות ה-80', בניגוד למגמה של עליה בצריכה שנחזתה בתחילה בעבודה הנוכחית.