Petroleum Federation of India

Report on Domestic Petrochemical Market

Capacity Assessment

December 30, 2005

Acknowledgment

PetroFed acknowledges the contribution of its member company and knowledge partner M/s PricewaterhouseCoopers who have carried out this study.

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1 Background

1.1 Background and Assumptions

1.1.1 Petroleum Federation of India (PetroFed) assigned to PricewaterhouseCoopers (PwC) the task of undertaking a high end study to review emerging supply and demand market conditions for the petrochemicals industry.

1.1.2 This study undertakes review of demand-supply situation in India for basic petrochemicals and their derivatives for milestone years 2009-10 and 2014-15 alongwith perspective of global trends. The study draws upon a broad spectrum of secondary research data to project demand for polymers and monomers based on growth rate forecasts made by credible agencies.

1.1.3 The 2009-10 supply analysis takes into account ethylene capacity additions planned by GAIL (140,000 tonne), HPL (140,000 tonne), IPCL Baroda (35,000 tonne), IPCL Gandhar (40,000 tonne), IPCL Nagothane (25,000 tonne), RIL Hazira (100,000 tonne), RIL Jamnagar (181,500 tonne) and IndianOIl Panipat (800,000 tonne).

1.1.4 The planned propylene capacity additions considered for the 2009-10 supply analysis include HPL (65,000 tonne), IPCL Baroda (25,000 tonne), IPCL Gandhar (25,000 tonne), IPCL Nagothane (15,000 tonne), RIL Hazira (35,000 tonne), RIL Jamnagar (200,000 tonne) and IndianOil Panipat (600,000 tonne)

1.1.5 For the purpose of this study, given the limited extent of research possible, the growth rates as projected by reports of the following credible agencies, were relied upon -

- CRIS INFAC's Annual Review of the Petrochemical Industry, May 2005
- ICRA's Sector Analysis of the Petrochemical Industry, June 2005
- The Report of the Task Force on Petrochemicals, 2003# (GVR Committee Report)

1.1.6 For the purpose of regional and global demand and supply scenarios, reliance has been laid on reports of credible agencies like Chemical Markets Associates, Inc. (CMAI), Oil & Gas Journal, Nexant ChemSystems, PCI Xylene and Manufacturing Industries Bureau, Ministry of Economy, Trade & Industries, Japan.

1.1.7 The study is intended to become an input for capacity planning by the industry.

The Task Force has estimated the growth rates of polymers on two levels. Under Level I, it is projected that the demand for polymers will grow at 13 per cent & 12 per cent during the X and XI Plan, respectively. Under Level II, it is projected that the demand for polymers will grow at 12 per cent & 11 per cent during the X and XI Plan, respectively

2 Executive Summary

2.1 The Petrochemical Industry

2.1.1 Indian petrochemical industry is a relatively new entrant in the industrial sector, which after making a modest beginning in the early 1960s grew rapidly and is now an established industry. Today, petrochemicals business has evolved into commodity industry and like most other commodity industries, its profitability is driven by the cyclicality in demand and capacity augmentation.

2.1.2 The average per capita consumption of polymers in India in 2004 was 3.4 kg which is much below the world average of 25 kg. Given the economic growth rate forecasts for India, the petrochemical industry is expected to have the opportunity to grow at an even higher rate, specially since penetration level of polymers is expected to grow.

2.1.3 To support the burgeoning demand for petrochemical products and their derivatives in the domestic market as also to service the neighbouring deficit markets, Indian petrochemical players, both private companies and Public Sector Undertakings (PSUs) have plans to expand existing capacities and add new capacities. New refinery projects, availability of new gas sources are some of the important triggers for capacity expansions/additions.

2.1.4 Today, Asia including China accounts for the lion's share of the incremental global petrochemicals demand while the Middle East is fast emerging as a major production hub advantaged by low cost feedstock.

2.2 Polyethylene (PE): Surplus/ Deficit Estimation

2.2.1 Taking into consideration the currently planned capacities, domestic polyethylene (PE) demand in 2009-10 is expected to be serviced at around 92 per cent operating rate with most conservative growth rate while a deficit of 328,000 tonne is expected under the most optimistic growth scenario. PE capacities in 2009-10, therefore, will be insufficient to service exports as well as domestic demand.

2.2.2 In 2014-15 the deficit is estimated to range from 865,000 tonne to 3,053,000 tonne for servicing domestic demand alone. These deficits indicate requirement of additional production capacity to those extents, only to serve the domestic demand. Production capacities for exports would be over and above these volumes. Additional capacities by 2014-15, therefore, will need to be planned accordingly.

2.2.3 The above PE analysis includes HDPE, LDPE and LLDPE data. In 2009-10, surplus/ deficit analysis for ethylene derivatives at 100 per cent operating rate suggests a

surplus of 288,000 tonne of HDPE under conservative market demand growth rate while a deficit of 159,000 tonne results with a higher Task Force growth rate. LLDPE, with 10 per cent growth rate is expected to be serviced at 100 per cent operating rate while LDPE deficit is expected to range between 43,000 to 68,000 tonne.

2.2.4 In 2014-15, at 100 per cent operating rate, the deficit for HDPE under all the three growth rates is expected to range between a 293,000 tonne to 1,743,000 tonne. LLDPE deficit is expected to range between 511,000 tonne to 927,000 tonne while LDPE deficit is in the range of 69,000 to 148,000 tonnes.

2.3 Polypropylene (PP): Surplus/ Deficit Estimation

2.3.1 In 2009-10 the surplus/ deficit analysis at 100 per cent operating rate suggest a surplus of around 652,000 tonnes at conservative growth rates and a deficit at most optimistic growth rates.

2.3.2 In 2014-15 market capacity scenario analysis at 100 per cent operating rate throws up a deficit in the range from 114,000 tonnes to 3,178,000 tonnes. The actual deficit would be higher depending upon export companies resort to and operating rates they achieve. These deficit scenarios indicate necessity of installation of additional plants coming on-stream before 2014-15.

2.4 Ethylene Monomer: Surplus/ Deficit Estimation

2.4.1 In 2009-10, at operating rate of 100 per cent of planned capacity, a surplus of 47,000 tonne is estimated in the most conservative scenario of ethylene demand growth rate. A deficit of 619,000 tonne results in case of relatively optimistic growth rate. Any exports or imports would increase or decrease the deficit, respectively.

2.4.2 Surplus/deficit analysis for ethylene suggests, based on the assumption of no capacity additions/expansions between 2010 and 2015, a deficit in the domestic market by 2014-2015. At an operating rate of 100 per cent the deficit is estimated to range from 1,786,000 tonne to 3,825,000 tonne under the demand growth rates between 8 per cent and 11.8 per cent. This analysis reaffirms the observations made in the surplus/ deficit analysis of PE, thereby highlighting the necessity of adding new or expanding existing capacities.

2.5 Propylene Monomer: Surplus/ Deficit Estimation

2.5.1 In the year 2009-10, the domestic demand for propylene is expected to be serviced at 90 per cent operating rate under the most conservative growth rate while at operating rate of 100 per cent a surplus of 284,000 tonne is estimated. A deficit of 807,000 tonne is, however, estimated in case of relatively optimistic growth rate.

2.5.2 Surplus/ deficit analysis of propylene suggests a deficit in capacity to service domestic market by 2014-2015. The deficit under 100 per cent operating rate could range from 720,000 to 4,492,000 tonne.

2.6 PX/PTA: Surplus/ Deficit Estimation

2.6.1 In 2009-10, the domestic paraxylene (PX) market is expected to be in deficit of around 763,000 tonne. The domestic Purified Terephthalic Acid (PTA) market also indicates a deficit of around 746,000 tonne in 2009-10. The deficit for PX and PTA is expected to increase in 2014-15.

2.7 Feedstock Availability in India

2.7.1 The availability and choice of feedstock and its relative cost would be an important factor impacting the competitiveness of Indian producers. Naphtha is projected to be in surplus due to expected increase in domestic refining capacity and declining off-take expected from the fertilizer and power sectors. Despite the increase in supply of natural gas, largely on account of expected increase in LNG imports and recent gas finds expected to come on stream in the medium term, there shall still be a deficit in the natural gas market.

2.7.2 The world class gas find by Reliance Industries Ltd (RIL) in the Krishna-Godavari (KG) basin is learnt to be unsuitable for the C_2/C_3 extraction. Until recently, gas prices were capped which ensured a significant spread between naphtha and gas based cracker margins. The shift towards market determined prices for natural gas is expected to significantly impact the advantage enjoyed by gas based producers. In recent years, the spread between naphtha and natural gas margins have also declined due to greater by-product netbacks from naphtha resulting in increased attractiveness of naphtha as a feedstock for the petrochemical industry.

2.8 Monomers: Global & Regional Scenario

2.8.1 Polyethylene, currently the largest consumer of ethylene, will continue to consume the most ethylene due to continued high demand growth rates for HDPE and LLDPE. By 2010, global ethylene supply is expected to reach 133 million tonnes. Most of the new capacity additions will be in Asia (36 per cent) and the Middle East (51 per cent).

2.8.2 Significant ethylene capacity additions are expected to be seen in Asia over the next 5 years. Capacity additions in China and Taiwan are estimated to exceed 10.2 million tonne by 2010. In 2009, Asia is expected to import around 12 million tonne of ethylene based derivatives, driven largely by Chinese imports. The Middle East is expected to be a net exporter of around 16.9 million tonne per annum.

2.8.3 Polypropylene, currently the largest propylene derivative, will to continue to consume the most propylene due to continued high demand-growth rates in the injection moulding and fibre segments.

2.8.4 By 2010, global propylene supplies will reach 83.7 million tonne. Most of the new capacity additions will be in Asia (38 per cent), the Middle East (30 per cent), and North America (10 per cent). Propylene monomer trade will remain stable as North America maintains a dominant export position. Additional exports will also come from the Middle East, Africa, the countries of the former Soviet Union, and the Baltic States. West Europe and Asia will remain the dominant importing regions of propylene monomer.

2.9 The Middle East Challenge

2.9.1 Saudi Arabia and Iran have major plans of installing ethane feedstock based mega projects which are expected to be commissioned by 2010. The Middle East enjoys tremendous advantage by virtue of access to low cost feedstock. According to a report by McKinsey, with the Middle East ethane costing US$ 0.75 to 1.0 per MMBtu, the cost of crude oil would need to drop below US$ 15 per barrel for western producers and US$ 20 per barrel for China to be competitive for LLDPE in Asia. Exactly the reason why companies are forced to drop West from their agenda to set up petrochemical plants in the East.

2.9.2 Debate is on over whether the Middle East would resort to price undercutting. to capture the market resulting in production facilities in high cost centres to be pushed out of the market. It may be argued given the high demand growth for petrochemicals, the Middle East would sell at prices set by their western counterparts. Also, the Middle East producers will look to recover capital cost as soon as possible by maintaining higher operating margins. The West producers, however, would continue to be active since the market provides operating margin. They do not have room to reduce production costs since all the avenues available were exhausted in the 1980s and early 1990s.

2.10 Conclusions

2.10.1 Currently planned capacity expansions and new additions are expected to be just sufficient for servicing the domestic market. By 2015, even under the most conservative growth in polymer consumption, the expected domestic PE and PP deficits justify setting up of new crackers.

2.10.2 High plant operating rates are expected if Indian producers are able to capture the lucrative Asian market, particularly China, which is expected to be a net importer of petrochemical products.

2.10.3 China would continue to drive the global polymer trade and is expected to remain a net importer of significant quantities of petrochemicals even in 2014-15 despite domestic capacity additions through foreign investments and joint ventures.

2.10.4 The Middle East gas based capacities being added possess feedstock cost advantage. Indian propylene based polymers, however, may still enjoy price and offtake comfort considering the inability of the Middle East to service propylene demand.

2.10.5 Indian petrochemical players, in order to take advantage of low feedstock cost, must evaluate the option of partnering with companies desirous of setting up plants in the Middle East. Similarly investments in China, the consumer, would provide Indian companies an opportunity to grow.

2.10.6 Currently, Government of India is evaluating the possibility of promoting India as a refining hub. It goes unsaid that if and when such refineries are commissioned, integrating petrochemical plants would be necessary for economic viability of such projects.

3 Indian Petrochemicals Industry

3.1 Brief History

3.1.1 As downstream hydrocarbons, petrochemicals are a valuable resource and constitute vital raw material for industrial development. The Indian petrochemical industry is relatively a new entrant in the industrial sector. Petrochemical production in India began with the commissioning of Union Carbide's naphtha cracker in 1961. Among the first producers of polymers in India were Imperial Chemical Industries (ICI) and Chemicals & Plastics Ltd., which were in the business of manufacturing Low Density Polyethylene (LDPE), and Polyvinyl Chloride (PVC) respectively. Next was the Shell, Hoechst and Mafatlal joint venture christened National Organic Chemical Industries Ltd. (NOCIL).

3.1.2 With capital deficiency in the domestic private sector, the federal government took the first step to establish India on the petrochemicals map by incorporating Indian Petrochemical Corporation Ltd. (IPCL) in 1969 and the first olefins plant was commissioned in 1978 at Vadodara (Baroda), Gujarat. In the 1980s, the industry grew rapidly, with IPCL setting up plants at Nagothane in Maharashtra and at Gandhar in Gujarat. The Nagothane plant stabilized in 1992. At Gandhar various products' plants came on stream from 1996 with the ethylene cracker getting commissioned in 2000. In mid 2002, Reliance group took over the control of IPCL as the process of disinvestment by Government of India culminated in the sale of 26 per cent holding.

3.1.3 In the 1980s and 1990s, the domestic production of hydrocarbons increased significantly, resulting in excess availability of naphtha. Petrochemicals like plastics were perceived as cost effective and superior alternatives for conventional materials such as glass, wood and metals. Synthetic fibres, which were perceived to be a luxury, became critical to supplement cotton production. Low crude oil prices resulted in decrease in the price of imported petrochemicals. As a result, the demand for petrochemicals rose significantly and many capacities were set up to meet increasing domestic demand. These trends have defined the existing structure of the domestic petrochemicals industry.

3.1.4 In the early 1990s, RIL commissioned three downstream plants in the first phase of its cracker complex. It commissioned its 800,000 tonne per annum capacity mother cracker and other downstream units in 1997 at Hazira, Gujarat.

3.1.5 Competition increased with the commissioning of new capacities by Gas Authority of India Limited, now renamed as "GAIL India Limited" (GAIL) and Haldia

Petrochemicals Limited (HPL). In April 1999, GAIL set up a 300,000 tonne cracker at Auraiya, Uttar Pradesh, as a part of its forward integration plan. In April 2000, HPL set up its 420,000 tonne cracker at Mednipur, West Bengal.

3.1.6 At present, RIL and IPCL dominate the industry with combined capacity share of about 65 per cent.

3.2 Consumption Levels – Polymers

3.2.1 *Ceteris paribus*, ethylene and polymer consumption have strong correlations with the GDP growth. Polymer consumption has strong backward and forward linkages and an increase in the GDP growth rate has a multiplier effect on the polymer consumption. The Common Minimum Programme of the United Progressive Alliance (UPA) running the Government in India wants to ensure that the growth of Indian economy is in the range of 7 to 8 per cent per year in a sustained manner over the next decade and more. If such growth rates are achieved then the petrochemical industry would have the opportunity to grow at even higher rate, given the current low penetration of polymers.

3.2.2 The growth in the polymer industry dropped to less than 10 per cent between 2000 and 2003 from a high of above 20 per cent growth during the 1990s. Despite the high growth in the 1990s, the per capita consumption of polymers in India is still much below not only the consumption levels of the developed world but even the world average. The average per capita consumption of polymers in India in 2004 was 3.4 kg against world average of 25 kg.

3.2.3 The consumption pattern of the polymers in India also differs from that of the world. This can be attributed to the evolution of the Indian petrochemical industry and the Indian lifestyle, which is different form that in other high polymer consuming countries. India's late entry into the petrochemical industry, when the importance of LDPE was already on a decline, could be one of the reasons.

4 Approach and Methodology of Study

4.1 Approach

4.1.1 In order to analyse the basic petrochemicals and derivative product market surplus/deficit scenario in foreseeable future, this study has considered 2009-10 and 2014-15 as milestone years. In order to ensure that the projections are based on the latest information, base year was considered as 2004-05.

4.1.2 For the purpose of estimating demand for basic petrochemicals and derivatives, in the milestone years it was necessary to know the following-

- Consumption of derivatives in year 2004-05;
- Projected derivatives' demand growth rates upto the milestone years and;
- Projected production capacities in milestone years.

4.1.3 For the purpose of this study, given the limited extent of research possible, the growth rates as projected by reports of the following credible agencies, were relied upon -

- CRIS INFAC's Annual Review of the Petrochemical Industry, May 2005
- ICRA's Sector Analysis of the Petrochemical Industry, June 2005
- The Report of the Task Force on Petrochemicals, 2003# (GVR Committee Report)

4.1.4 Consumptions of derivatives in year 2004-05 were studied as estimated by "CRIS INFAC's Annual Review of the Petrochemical Industry, May 2005". This information was, however, superceded by actual consumption data to the extent made available by industry sources during the course of study.

4.1.5 Production capacities projected to be available in 2009-10, as indicated by "CRIS INFAC's Annual Review of the Petrochemical Industry, May 2005" have been corrected to the extent of limited inputs available from industry.

4.1.6 For the purpose of regional and global demand and supply scenarios, reliance has been laid on reports of credible agencies like Chemical Markets Associates, Inc. (CMAI), Oil & Gas Journal, Nexant ChemSystems, PCI Xylene and Manufacturing Industries Bureau, Ministry of Economy, Trade & Industries, Japan.

The Task Force has estimated the growth rates of polymers on two levels. Under Level I, it is projected that the demand for polymers will grow at 13 per cent & 12 per cent during the X and XI Plan, respectively. Under Level II, it is projected that the demand for polymers will grow at 12 per cent & 11 per cent during the X and XI Plan, respectively

4.2 Surplus/Deficit Estimation Methodology

4.2.1 As stated above, for the purpose of estimating demand of derivatives, in the milestone years 2009-10 and 2014-15, demand growth rates as projected by CRIS INFAC, ICRA and GVR Committee Report were applied to base demand in year 2004-05. The growth rates projected by these three agencies are varying and hence different surplus/deficit scenarios have emerged by using outlook of these agencies.

4.2.2 Operating rates of 100 per cent and 90 per cent have been applied to production capacities projected to be available in year 2009-10, to estimate scenarios of supply potential of derivatives.

4.2.3 Derivatives demand and supply volumes thus arrived at under different scenarios have been compared to estimate surplus/deficit situations for the year 2009-10. For analysis of situation in the year 2014-15, capacities projected to be available in year 2009-10 were used but demand projections for year 2014-15 were compared with that. In effect, such an analysis will enable understanding the market space available for new projects or expansions to be commissioned between 2009-10 and 2014-15.

4.2.4 The demand for basic petrochemicals has been calculated by applying operating rates and input/output ratios to the projected production capacities in milestone years. Whereas, the supply of basic petrochemicals in milestone years is estimated by applying operating rates under likely range under two scenarios (of 90 per cent and 100 per cent) to the projected capacity forecast. The surplus or deficit scenario for basic petrochemicals has thus been arrived at and analysed.

4.3 Assumptions

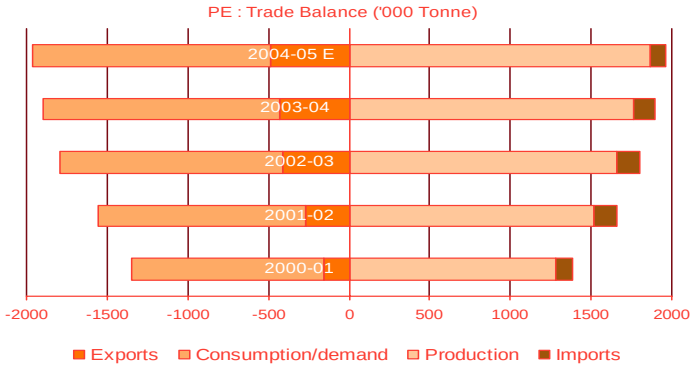
4.3.1 The following major assumptions have been made while analysing data available from various agencies to arrive at conclusions of this study for milestone years 2009-10 and 2014-15-

- Operating rates would range between 100 per cent and 90 per cent;
- Petrochemicals domestic consumption in year 2004-05 as estimated by CRIS INFAC's Annual Review of the Petrochemical Industry, May 2005 and as corrected with inputs from industry are correct;
- Production capacities in year 2009-10 as estimated by CRIS INFAC's Annual Review of the Petrochemical Industry, May 2005 and as corrected with inputs from industry are correct;
- Input/Output ratios for derivatives and basic petrochemicals are as per industry estimates and/or as derived from CRIS INFAC's Annual Review of the Petrochemical Industry, May 2005.

5 Polyethylene Demand and Supply Estimation

5.1 Polyethylene (PE) Trade Balance

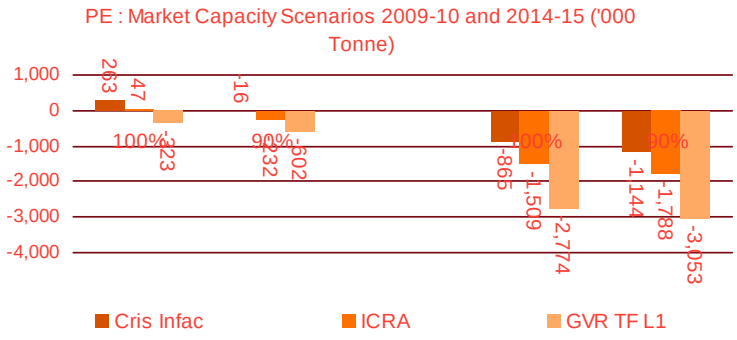
5.1.1 PE analysis in this section includes HDPE, LDPE and LLDPE data. Analysis of the last five years shows that while the domestic consumption of PEs has grown, there has also been an increasing trend in exports. There has been a steady rise in PE exports from around 12 per cent in 2000-01 to more than 25 per cent in 2004-05.



Source: CRIS INFAC, Industry Inputs

5.2 PE Market Capacity Scenarios

5.2.1 Domestic PE demand in 2009-10 is expected to be serviced at around 92 per cent operating rate with most conservative growth rate. In the most optimistic growth scenario, in 2009-10, a deficit of 328,000 tonne is expected even with 100 per cent operating rates. Given that this is the case while servicing only domestic demand, the PE capacities in 2009-10 will be insufficient for producers to service exports as well as domestic demand. In 2014-15 the deficit is estimated to range from 865,000 tonne to 3,053,000 tonne for servicing domestic demand alone. Capacity additions by 2014-15 will need to be planned accordingly.



6 HDPE Demand and Supply Estimation

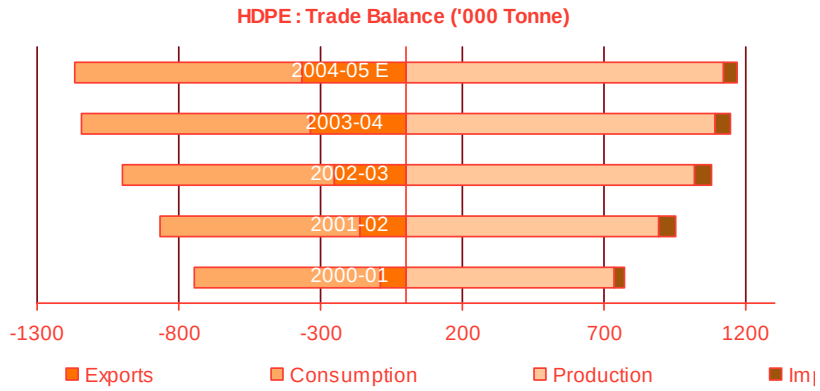
6.1 HDPE Usage

6.1.1 The most important applications of HDPE are lamination and multi-layer films (27 per cent of HDPE demand in 2004-05), raffia (20 per cent), blow-moulded articles (21 per cent) and injection moulding (15 per cent). HDPE is also used in pipes, cables and monofilaments.

6.1.2 Sales of HDPE are conducted through a network of distributors. In addition, all producers have direct and consignment sales. Sales are usually on an ex-factory basis wherein transportation costs are borne by the customers.

6.2 HDPE Trade Balance

6.2.1 Domestic demand for HDPE in 2004-05 is estimated at around 0.8 million tonne by CRIS INFAC. According to industry sources the demand for HDPE in 2004-05 is placed at around 1.02 million tonne. The producers of HDPE in India are RIL, IPCL, GAIL and HPL with a combined capacity of 1.07 million tonne.

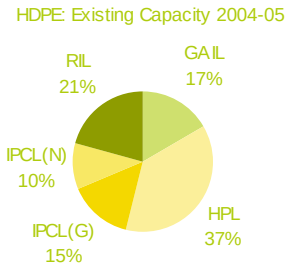


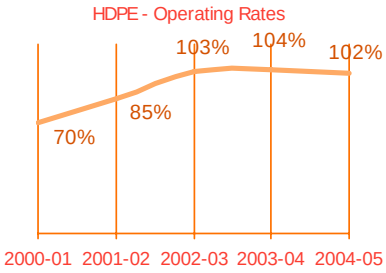
Source: CRIS INFAC, Industry Inputs

6.2.2 During the period from 2000-01 to 2003-04, domestic HDPE demand increased at a CAGR of 5 per cent to around 0.8 million tonne, while production increased at a CAGR of around 11 per cent, and contributed to growing exports.

6.3 Existing Capacities and Operating Rates

6.3.1 In 2004-05, HPL was the market leader, with a capacity share of 37 per cent in the total domestic HDPE capacity. RIL had a market share of 21 per cent, IPCL had a share of 25 per cent and GAIL had a share of 17 per cent.





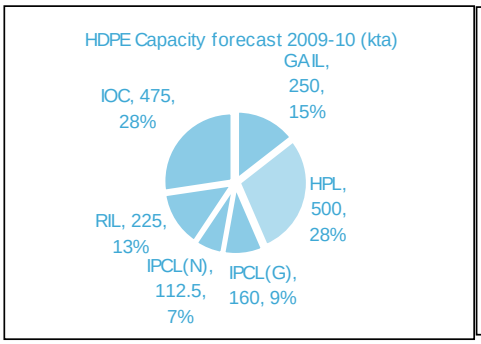
Source: CRIS INFAC, Industry Inputs

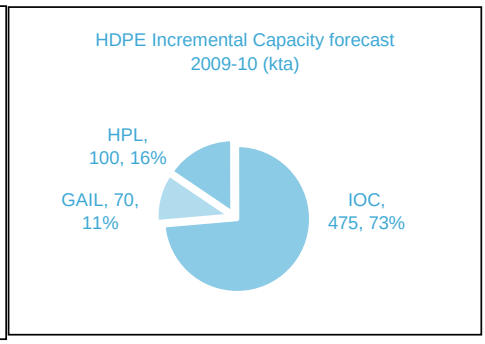
6.3.2 Over the years, the size of the average HDPE plant has increased from around 0.2 million tones per annum to 0.4-0.5 million tonne per annum owing to larger ethylene crackers.

6.3.3 Despite NOCIL shutting down production in 2002-03, total HDPE production for 2002-03 increased by 14 per cent over 2001-02 on account of better operating rates achieved due to increased exports.

6.4 Capacity Forecasts

6.4.1 By 2009-10, a total of 650,000 tonne of HDPE capacity is expected to be added thus taking the total domestic capacity to 1.72 million tones. Out of the above incremental capacity addition, majority is due to the proposed Panipat petrochemical plant of IndianOil (73 per cent). Apart from IndianOil, HPL (16 per cent) and GAIL (11 per cent) capacity expansion due to de-bottlenecking have been considered while estimating supplies.





Source: Industry Sources

6.5 HDPE: Domestic Demand Estimation

6.5.1 The demand for HDPE in the milestone years 2009-10 and 2014-15 has been projected based on the expected consumption growth rates in the various industry segments in which HDPE finds application. It is expected that high consumption growth rates in the films and pipes segments would be the major driver for growth in consumption of HDPE in the domestic market.

6.5.2 Based on the market analysis and future industry segment outlook, the HDPE demand growth rates estimated by CRIS INFAC, ICRA and the Task Force Level I and Level II are 7.04 per cent, 10 per cent and 13 per cent & 11 per cent, respectively.

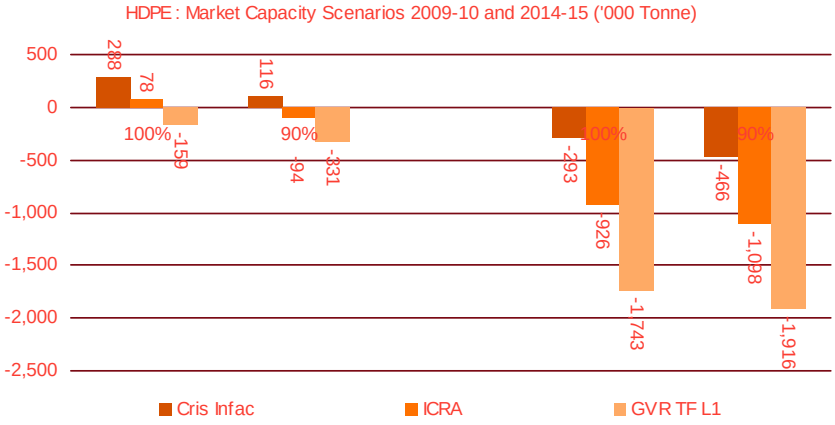
HDPE Sectoral Consumption Growth Rates

	Process	CAGR (2009-10 over 2004-05) (%)
Raffia	Extrusion	5
Monofilaments	Extrusion	4.69
hm-HDPE and HDPE blow moulding	Blow moulding	5.72
- HDPE blow moulding		*5.38*
- hm-HDPE blow moulding		*6.38*
Injection moulding	Injection moulding	5
hm-HDPE films	Extrusion	8.59
Pipe grade	Extrusion	14.79
Sheathing grade	Extrusion	-12.36
Sheathing grade	Extrusion	0.5
Total		**7.04**

E:Estimate F:Forecast Note: CAGR for the period 2004-05 to 2009-10
Source: CRIS INFAC

6.6 HDPE: Market Capacity Scenarios

6.6.1 Our analysis of 2009-10 surplus/ deficit situation under 100 per cent operating rate suggests a maximum surplus of 288,000 tonne over the domestic demand of HDPE under the conservative market demand growth rate of 7.04 per cent projected by CRIS INFAC. However, applying the Level I growth rate of Task Force (13 per cent) suggests a deficit of 159,000 tonne. Under 90 per cent operating rate, however, both ICRA and Task Force L-I growth rates result in a deficit.



Source: PwC Analysis

6.6.2 In 2014-15, the deficit under all the three growth rates of domestic market demand is expected to range between a minimum of 293,000 tonne to a maximum of 1,743,000 tonne of HDPE under 100 per cent operating rate. The deficit is expected to range between 466,000 tonne to 1,916,000 tonne under 90 per cent operating rate. These deficits indicate production capacity addition requirement to those extents, only to serve the domestic demand. The producing capacities for exports would be over and above these volumes.

7 LLDPE/LDPE Demand and Supply Estimation

7.1 LLDPE/LDPE Usage

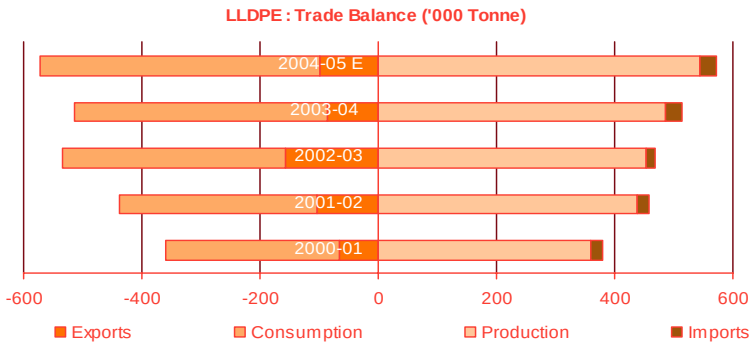
7.1.1 LDPE and LLDPE are largely used in similar applications such as construction, pipes conduits, and injection-moulded articles. LDPE and LLDPE are largely used in general purpose packaging applications.

7.1.2 LDPE is available in two major grades; General purpose and Roto-moulding grades. General purpose (GP) grade LDPE is used in a variety of processes, such as extrusion moulding, extrusion coating, laminate coating and injection moulding. The roto-moulding process of LDPE is used to manufacture overhead and storage tanks.

7.1.3 LLDPE is available in three grades; octene, butene and hexene. The octene grade can be blended with LDPE, and is used for down-gauging LDPE. At present, LLDPE is blended with LDPE in roto-moulding and films for drip irrigation. The extent of blending depends on the price differential. Given the higher production of LLDPE by swing plants, demand for LDPE is restricted, and the market share of LLDPE has increased at the cost of LDPE.

7.2 LLDPE Trade Balance

7.2.1 The demand for LDPE and LLDPE in 2004-05 is estimated at 679,352 tonne (473,162 tonne for LLDPE and 206,190 tonne for LDPE) by CRIS INFAC. Industry sources place the demand for LDPE and LLDPE in 2004-05 at 745,000 tonne (520,000 tonne for LLDPE and 225,000 tonne for LDPE).



Source: CRIS INFAC, Industry Inputs

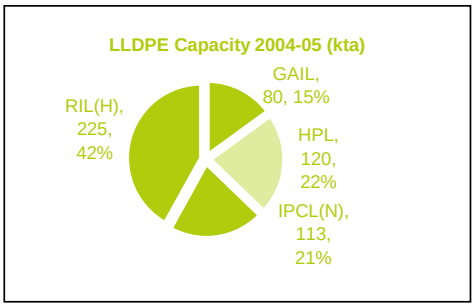
7.2.2 LDPE growth registered a decline of around 12 per cent, while LLDPE witnessed a positive growth of around 10 per cent in 2004-05 over 2003-04. LDPE is produced by

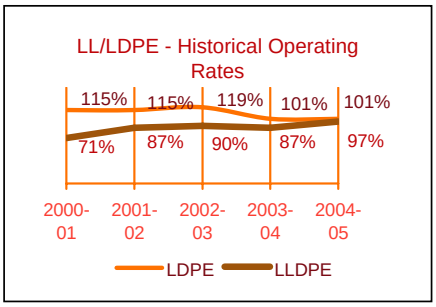
IPCL Baroda and IPCL Nagothane. The major producers of LLDPE in India are RIL, IPCL, HPL and GAIL.

7.3 Existing Capacities and Operating Rates

7.3.1 RIL remains the market leader, with a market share of 41 per cent in the LLDPE market. In year 2004-05, IPCL, HPL and GAIL had a market share of 20 per cent, 24 per cent and 15 per cent respectively. In case of swing plants, it is assumed that LLDPE capacity is 50 per cent.

7.3.2 Historically, the operating rates for LDPE have remained high on account of steady growth and limited domestic capacity. LLDPE operating rates have ranged from 70 per cent to 90 per cent.

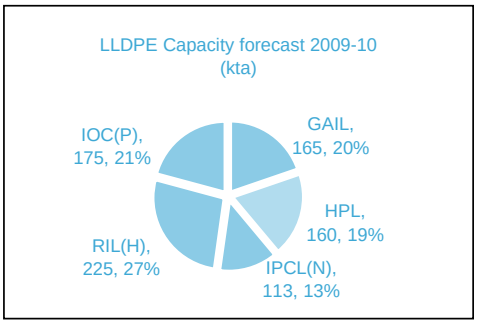


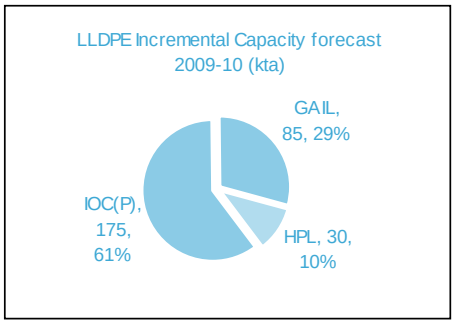


Source: CRIS INFAC, Industry Inputs

7.4 Capacity Forecast

7.4.1 Additional capacities of around 42,500 tonne of LLDPE are expected to commence production by 2005-06. No major capacity expansion is expected for LDPE. All the capacity augmentation will be in the form of de-bottlenecking.





Source: CRIS INFAC, Industry Inputs

7.4.2 During the period from 2004-05 to 2009-10, LDPE production capacity is expected to increase marginally to 205,000 tonne, and LLDPE production capacity is expected to

increase to 766,250 tonne, the combined capacity therefore to grow at a CAGR of 7.1 per cent.

7.5 Domestic Demand Estimation

7.5.1 The demand for LL/LDPE in the milestone years 2009-10 and 2014-15 has been projected based on the expected consumption growth rates in the various industry segments in which LL/LDPE finds application. It is expected that high consumption growth rates in the general purpose packaging, liquid packaging and plasticulture segments would be the major driver for growth in consumption of LL/LDPE in the domestic market.

LL/LDPE: Sectoral Consumption Growth Rates					
Process	**Major application**	**CAGR (%)**	**Process**	**Major application**	**CAGR (%)**
Extrusion	**General purpose packaging**	10.71	**Extrusion**	**Heavy duty applications**	**4.84**
	-Industrial packaging	9.7		-Cereal/ salt packaging	5.48
	-Textiles and garments	15		-Detergent packaging	4.39
	-Consumer products	8.4		-Others	3.79
	-Processed foods	11	**Extrusion**	**Extrusion coating**	7.59
	-Carrier bags	8.5	**Extrusion**	**Wire and cables**	1.1
	-Others	5.95		- Telecom	-17.83
Extrusion	**Liquid packaging**	**8.5**		- Power	22.38
Extrusion	**Plasticulture**	9.47	**Roto moulding**	**Roto moulding**	4.5
	-Drip laterals	12.19	IM and masterbatches	IM and masterbatches	7.3
	-Nursery bags	7.57	Extrusion	Special techniques	5.19
	-Canal linings	10.59			
Total					**7.94**
LDPE					**2.44**
LLDPE					**10.03**

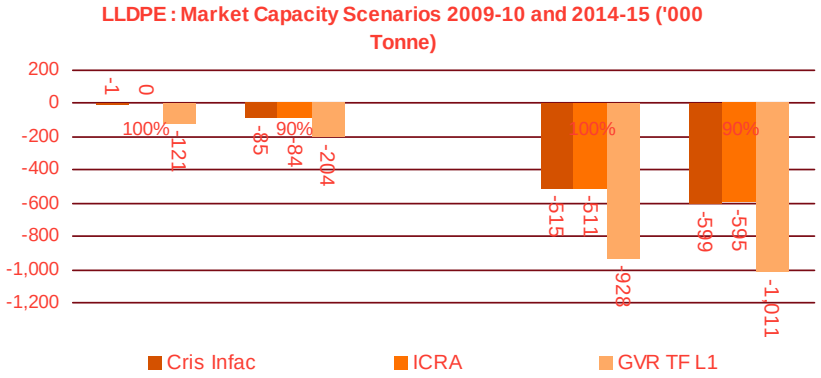
Source: CRIS INFAC

7.5.2 Based on the market analysis and individual market segment outlook CRIS INFAC, ICRA and the Task Force on Petrochemicals have suggested different LL/LDPE growth rates. The LDPE demand growth rates estimated by CRIS INFAC, ICRA and the Task Force are 2.44 per cent, 3.0 per cent and 4.0 per cent (Level I) & 2 per cent (Level II), respectively. The LLDPE demand growth rates estimated by CRIS INFAC, ICRA and the Task Force are 10.03 per cent, 10.0 per cent and 13.0 per cent (Level I) & 11.0 per cent (Level II), respectively.

7.6 LL/LDPE Market Capacity Scenarios

7.6.1 The consumption growth rate for LDPE is expected to be low due to substitution of LDPE by LLDPE in many end use applications. LLDPE scores over LDPE on account of its advantages of low cost and processing ease. It is expected that the LDPE growth rate will range from anywhere between 2 per cent to 4 per cent.

7.6.2 LLDPE is expected to witness a sharp increase in consumption over the coming years, primarily on account of the shift from LDPE to LLDPE.



7.6.3 Given the production estimates in 2009-10 the projected domestic demand for LLDPE, with 10 per cent growth rate is expected to be serviced at 100 per cent operating rate. The domestic LLDPE market under all growth rates suggests a deficit in milestone years 2009-10 and 2014-15 even under 100 per cent operating rates, leaving no room for exports if the capacities serve only the domestic market. The deficit for the year 2009-10 is expected to range between nil to 204,000 tonne. The deficit for the year 2014-15 is expected to range between 511,000 tonne to 1,011,000 tonne.

7.6.4 LDPE deficit is expected to range between 43,000 to 89,000 tonnes in 2009-10 while the deficit in milestone year 2014-15 is expected to be in the range of 69,000 to 148,000 tonnes.

8 Polypropylene Demand and Supply Estimation

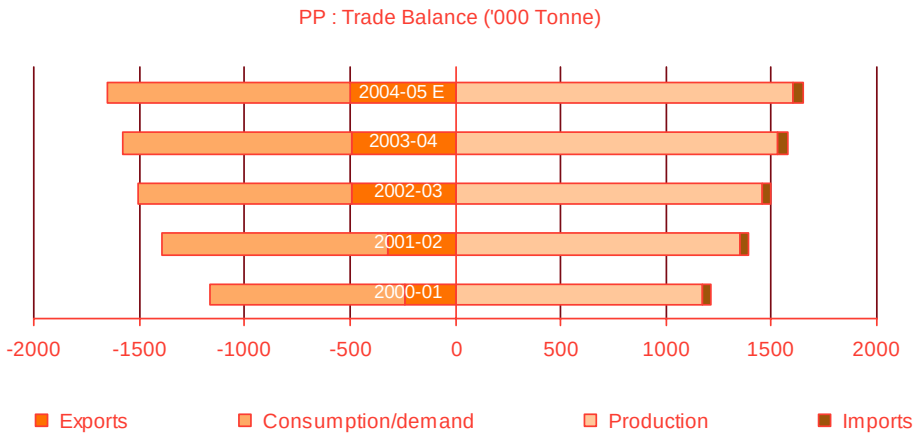
8.1 Polypropylene (PP) Usage

8.1.1 The 2004-05 sectoral consumption figures show that the important PP applications include woven sacks, tarpaulins (28 per cent), household applications (20 per cent) and TQ/BOPP films (27 per cent).

8.1.2 RIL, which has a market share of 68 per cent in domestic production, produces all grades of PP, largely raffia, IM and co-polymer grades. IPCL, which has a market share of 16 per cent, largely produces IM grades. HPL has the flexibility to produce all grades, including co-polymer.

8.2 PP Trade Balance

8.2.1 In India, the PP demand is estimated at 1.15 million tonne in 2004-05 by CRIS INFAC. In 2004-05, PP demand is estimated to have increased by 5.5 per cent. According to industry sources, 2004-05 consumption of PP in India is estimated to be around 1.3 million tonne.

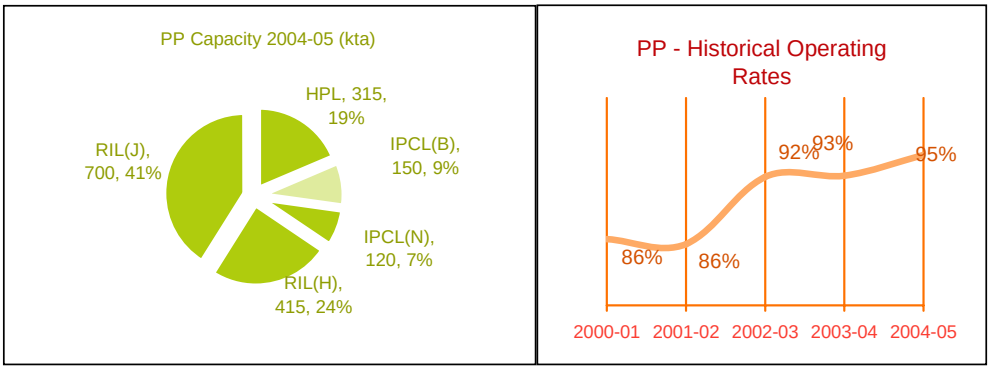


Source: CRIS INFAC, Industry Inputs

8.2.2 In 2004-05, PP production increased by around 5 per cent to 1.6 million tonne. Exports as a percentage of production increased from around 20 per cent in 2000-01 to more than 31 per cent in 2004-05

8.3 Existing Capacities and Operating Rates

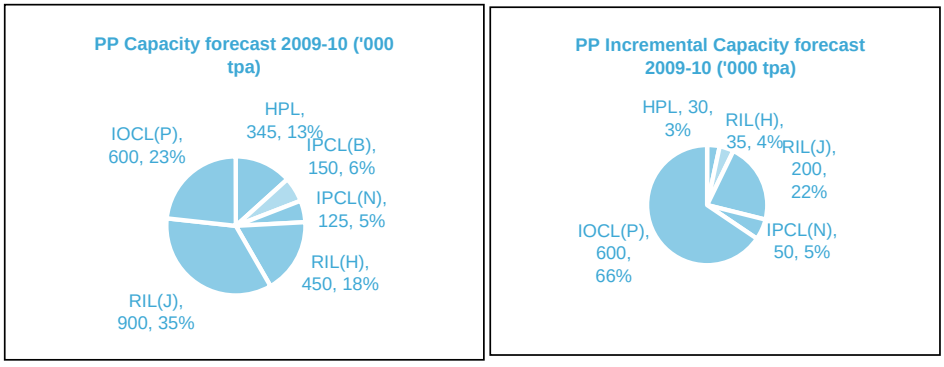
8.3.1 RIL is the market leader in this segment with a capacity share of 66 per cent, followed by HPL with 19 per cent. IPCL has the balance capacity share of 15 per cent. Propylene can also be produced in a refinery through a fluidised catalytic cracker unit (FCCU) extraction route.



Source: CRIS INFAC, Industry Inputs

8.4 Capacity Forecast

8.4.1 RIL is expected to increase the PP capacity at both of its plants. Supply from its Jamnagar plant is expected to increase from around 685,000 tonne to around 910,000 tonne by 2009-10. This expansion is expected to be secured by feedstock (propylene) from its Jamnagar refinery. The supply from RIL's Hazira plant is expected to increase from around 415,000 tonne to around 450,000 tonne by 2007-08. HPL also has plans to increase its PP capacity from around 315,000 tonne to around 345,000 tonne by 2006-07. IOC is expected to set up a 600,000 tonne PP plant at Panipat. CRIS INFAC has estimated that IOC's PP production will be around 390,000 tonne in 2008-09 and around 450,000 tonne in 2009-10.



Source: CRIS INFAC, Industry Inputs

8.4.2 Growing exports and domestic demand have enabled improvement in operating rates to the levels of 95 per cent in 2004-05. This has been achieved despite marginal additions in PP production capacities in last five years. From 2004-05 to 2009-10, PP production is expected to grow at a CAGR of 8.2 per cent to 2.4 million tonne.

8.5 Domestic Demand Estimation

8.5.1 The demand for PP in the milestone years 2009-10 and 2014-15 has been projected based on the expected consumption growth rates in downstream industry segments. It is expected that high consumption growth in the food packaging, fibres & filaments, injection moulding used for applications such as automobiles, appliances, furniture & luggage and blow moulding used for household articles will be the major driver for growth in consumption of PP in the domestic market.

8.5.2 Based on the market analysis and individual market segment outlook CRIS INFAC, ICRA and the Task Force on Petrochemicals have projected PP demand growth rates of 8.04 per cent, 7.0 per cent and 15.5 per cent (Level I) & 14.0 per cent (Level II).

PP: Sectoral Consumption Growth Rates (2009-10 over 2004-05)

(tonne)	Process	Major applications	CAGR (per cent)
PPHP			**7.28**
Raffia – fibres	Extrusion	Woven sacks, tarpaulins	5.7
	Extrusion	Others	7.8
Injection moulding	IM	Household applications,	5.8
		Furniture, and others	
TQPP films	Extrusion	Textile packaging and multi-layer films	7.8
BOPP films	Extrusion	Food packaging	12.97
Fibres and Filaments	Extrusion	Ropes, multi-filaments	10.38
PPCP			**11.83**
Injection moulding	IM	Various applications	11.84
		- Automobiles	13.38
		- Luggage	10.7
		- Furniture	9.46
		- Appliances and others	13.98
Blow moulding	BM	Household articles	11.68
Total			**8.04**

Source: CRIS INFAC

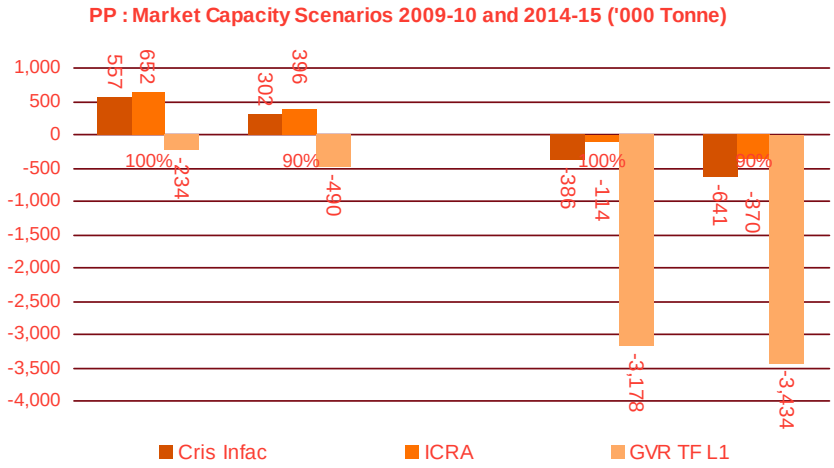
8.6 PP Market Capacity Scenarios

8.6.1 The demand of PP is expected to register a strong growth due to the following factors:

- Dilution of the Jute Packaging Materials Act
- Decline in import duties on polymers

- Significant capacity additions in the domestic market leading to lower prices and hence greater demand.
- Shift from HDPE to PP for certain application on account of greater percentage increases in prices of HDPE as compared to PP.

8.6.2 The 2009-10 surplus/ deficit situation, with CRIS INFAC and ICRA growth rates, suggests a surplus ranging between 302,000 tonnes to 652,000 tonnes. However, if demand grows at 15.5 per cent as projected by the Task Force in Level I, a deficit would result.



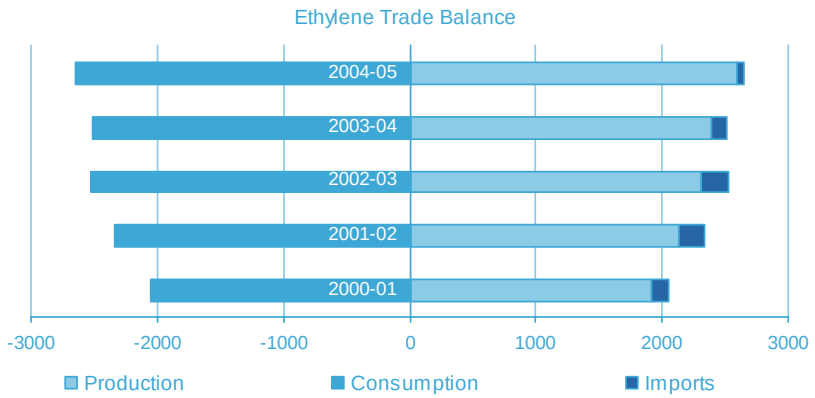
8.6.3 The 2014-15 market capacity scenario analysis throws up a deficit in the range from 114,000 tonnes to 3,434,000 tonnes. The actual deficit would be higher depending upon export companies resort to. These deficit scenarios indicate potential for installation of additional plants coming on-stream before 2014-15.

9 Ethylene Demand and Supply Estimation

9.1 Ethylene Trade Balance

9.1.1 International trade of ethylene monomer is quite limited due to the expense associated with the transportation of highly pressurised or refrigerated liquids. The domestic ethylene market witnessed a deficit, eventually met through imports, of 135,000 tonne in 2003-2004 despite availability of 2,395,000 tonnes of production capacity . In 2004-05 the deficit is estimated to have been 62,000 tonne.

9.1.2 The demand for ethylene is derived from the demand for its various end products, the most important of which are polyethylene (PE) and mono-ethylene glycol (MEG), which in 2004-05 was approximately 70 per cent and 15 per cent respectively.



Source: CRIS INFAC, Industry Inputs

9.1.3 PE production is expected to increase significantly due the expected capacity expansions by GAIL and HPL and the new capacity being set up by IOC at Panipat. Also, with RIL planning India's first styrene plant, the ethylene demand is expected to increase. Increased MEG production on account of likely capacity expansions planned by IPCL and RIL would raise ethylene demand.

9.2 Existing Capacities and Operating Rates

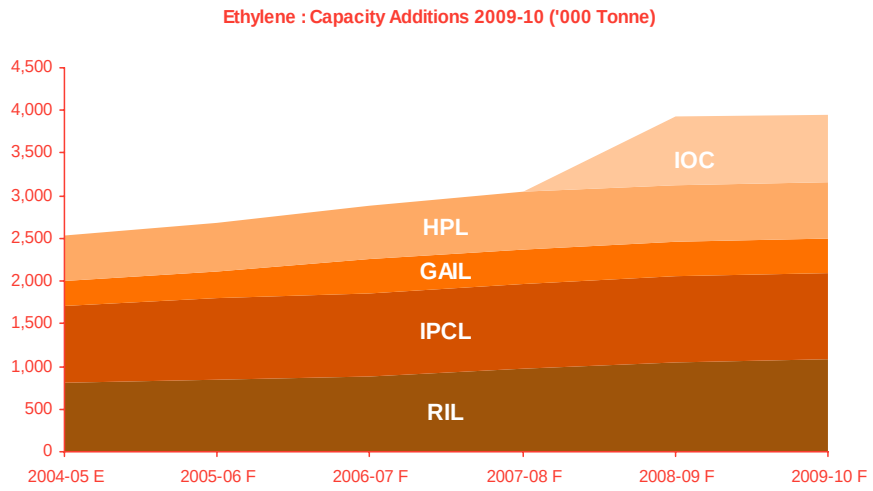
9.2.1 The total installed capacity of ethylene in 2004-05 was 2.53 million tonne. RIL (Hazira), IPCL (Baroda, Gandhar and Nagothane), GAIL (Auraiya) and HPL (Mednipur) are India's major ethylene producers. IPCL and RIL are the largest producers of ethylene and account for nearly 34.6 and 30.4 per cent of the total capacity, respectively.

9.2.2 Ethylene produced by using ethyl alcohol as a feedstock by companies like India Glycol, Jubilant Organosys and Chemplast Sanmar have not been taken into account while calculating supply estimates. During the last four years the operating rates for ethylene have ranged between 81 per cent and 99 per cent.

9.3 Capacity Additions

9.3.1 HPL, GAIL, IPCL and RIL are expected to make capacity additions in the next few years. IOC has progressed on the naphtha cracker at Panipat. RIL is expected to obtain dilute ethylene stream from FCC alkylated with benzene to produce styrene. Supply is estimated to increase at a CAGR of 7.7 per cent between 2004-05 and 2009-10.

9.3.2 ONGC has also sought permission for setting up new cracker capacities.



Source: CRIS INFAC, Industry Inputs

9.4 Feedstock Tie-up

9.4.1 Among the gas-based plants, IPCL Gandhar and Nagothane are faced with feedstock availability problems. As a result, these plants import propane to meet their feedstock requirements.

9.4.2 The projected capacity expansions of GAIL and IPCL might encounter delays due to lack of availability of feedstock. The Ministry of Petroleum and Natural Gas (MoPNG) has awarded to ONGC the right to extract C2/C3 and LPG fractions from the LNG imported by Petronet LNG Limited at Dahej. ONGC has plans of constructing a petrochemical complex using the extracted C2/C3 fractions from the imported LNG

and by pooling of feedstock from Uran and Hazira. This may pose feedstock constraint for the expansion plans of GAIL and IPCL.

Ethylene: Capacity Additions & Feedstock Tie-ups up to 2009-10					
Company	**Location**	**State**	**Capacity ('000 tonne)**	**Year**	**Possible Feedstock tie-ups**
IPCL	Baroda	Gujarat	35	'07-08	Naphtha – Group Refinery
IPCL	Gandhar	Gujarat	40	'06-07	NG – ONGC
IPCL	Nagothane	Maharashtra	25	'08-09	NG – ONGC
RIL	Hazira	Gujarat	100	'07-08	Naphtha - Group Refinery
RIL	Jamnagar	Gujarat	181.5	'08-09	Naphtha - Group Refinery
HPL	Mednipur	West Bengal	150	'07-08	Naphtha - IOCL Haldia refinery and import
GAIL	Auraiya	Uttar Pradesh	40	'07-08	C2/C3 mix from HBJ
IOC	Panipat	Haryana	750	'08-09	Naphtha – Group Refineries

Source : Industry Inputs, PwC Analysis

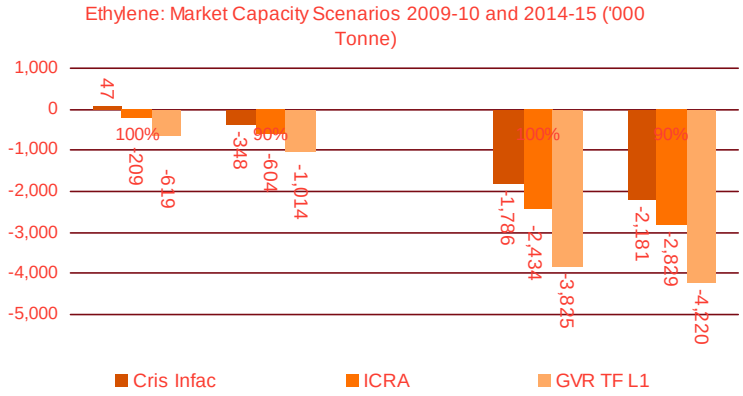
9.5 Ethylene Market Capacity Estimation

9.5.1 Demand of ethylene arising for derivative production needs to be analysed under different scenarios arising from projections made by various agencies. CRIS INFAC has projected 8.1 per cent growth in ethylene monomer production upto 2009-10 over 2004-05 base.

9.5.2 Ethylene based derivatives demand growth rates projected by ICRA and GVR Committee (Level I and Level II) were used as inputs for analysis of monomer demand by PwC. By applying some assumptions, growth rates in ethylene monomer demand work out to about 9.7 per cent, 11.8 per cent and 10.4 per cent respectively. In order to project surplus/ deficit scenarios, these demands are compared with capacities expected to be available in 2009-10 under 100 per cent and 90 per cent operating rates.

9.5.3 At operating rate of 100 per cent of projected capacities in respective years, a surplus of 47,000 tonne is estimated in the most conservative scenario of 8.1 per cent ethylene demand growth rate in 2009-2010. In case of ambitious growth rate of 11.8 per cent, a deficit of 619,000 tonne is estimated. At a lower operating rate, say 90 per cent, the deficit would range between 348,000 tonne and 1,014,000 tonne in 2009-2010. This scenario is drawn without taking exports/ imports into account.

9.5.4 An analysis of the demand-supply summary for ethylene, based on the assumption of no capacity additions/expansions between 2010 and 2015, suggests a deficit in the domestic market by 2014-2015 under all three scenarios given the varying rates of demand growth. At an operating rate of 100 per cent the deficit is estimated to range from 1,786,000 tonne to 3,825,000 tonne under the demand growth rates between 8 per cent and 11.8 per cent.

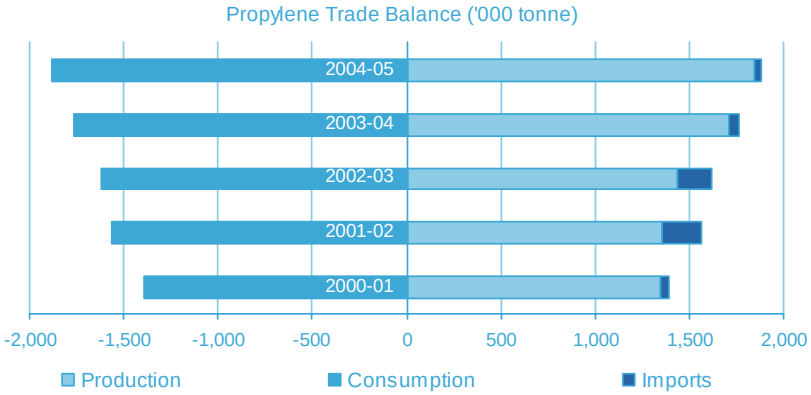


9.5.5 This analysis reaffirms the observations made in the surplus/ deficit analysis of PE in earlier chapters, thereby highlighting the necessity of adding capacities.

10 Propylene Demand and Supply Estimation

10.1 Propylene Trade Balance

10.1.1 Propylene demand is largely driven by the production of polypropylene (PP). PP accounted for around 90 per cent of the total demand for propylene in 2004-05. From 2000-01 to 2004-05 propylene demand increased at a CAGR of 7.8 per cent.



Source: CRIS INFAC, Industry Inputs

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10.1.2 In the period between 2000-01 and 2003-04, there was deficit in the domestic supply situation for propylene, driven by robust growth rates in polypropylene demand. In the year 2003-04, the deficit of 48,000 tonne remained despite capacity additions undertaken by RIL at Jamnagar (100,000 tonne per annum) and at Hazira (35,000 tonne per annum) and that by IPCL at Gandhar (40,000 tonne per annum) in addition to improvement in plant operating rates.

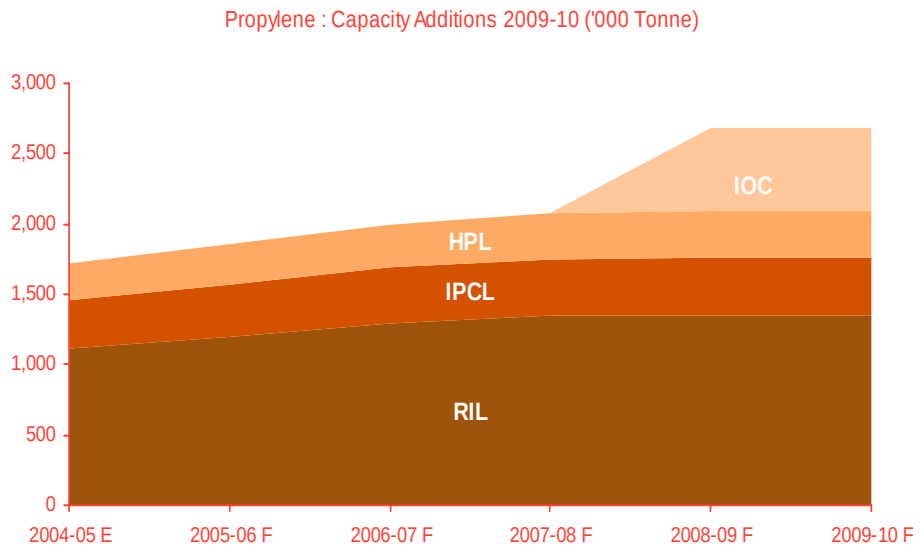
10.2 Existing Capacities and Operating Rates

10.2.1 In 2004-05, production capacity of propylene was estimated to be 1.9 million tonne. Bulk of the domestic propylene capacity is accounted for by RIL's Jamnagar FCC unit (37 per cent) and RIL's Hazira cracker complex (22 per cent). HPL accounted for 14 per cent of the total propylene capacity.

10.2.2 NOCIL shut down its operations in 2002-03 leading to a drop in propylene capacity by 40,000 tonne per annum. However, this drop in capacity levels was covered up on account of improved operating rates. Operating rates of most of the plants improved considerably in the period between 2000-01 and 2003-04 for propylene plants. The combined improvement was from around 86 per cent to 97 per cent.

10.3 Capacity Additions

10.3.1 Based on the capacity additions expected to come on-stream, as announced by various companies, propylene supply is expected to increase to around 2.74 million tonne by 2009-10 at a CAGR of 8.3 per cent during the period from 2004-05 to 2009-2010.



Source: CRIS INFAC, Industry Inputs

Propylene: Capacity Additions by 2009-10				
(tonne)	**Location**	**Capacity (tonne)**	**Type**	**Start-up date**
RIL	Hazira	35,000	Expansion	2006-07
RIL	Jamnagar	200,000	Expansion	2007-08
HPL	Mednipur	65,000	Expansion	2007-08
IPCL	Baroda	25,000	Expansion	2007-08
IPCL	Gandhar	25,000	Expansion	2008-09
IPCL	Nagothane	15,000	Expansion	2008-09
IOC	Panipat	600,000	New	2008-09
Total		**977,000**		

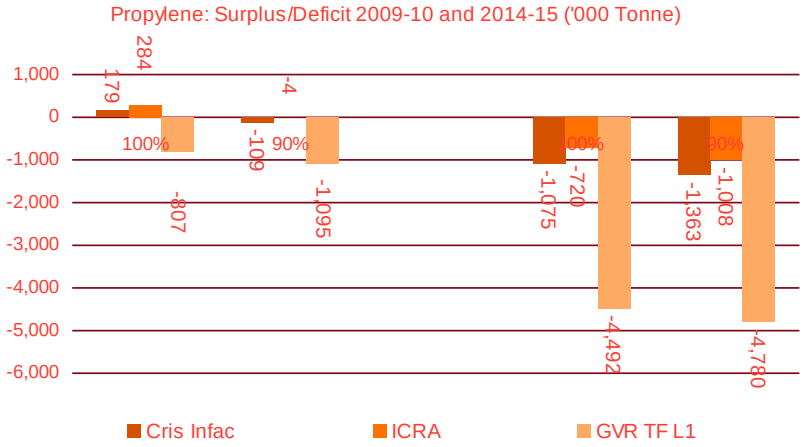
Source: Industry Inputs, CRIS INFAC

10.4 Propylene Market Capacity Estimation

10.4.1 Demand of propylene arising for derivative production needs to be analysed under different scenarios arising from projections made by various agencies. CRIS INFAC projected 7.8 per cent growth in propylene production upto 2009-10 over 2004-05 base.

10.4.2 Propylene based derivatives demand growth rates projected by ICRA and GVR Committee (Level I and Level II) were used as inputs for analysis of monomer demand by PwC. By applying some assumptions, growth rates in propylene monomer demand work out to about 6.7 per cent, 14.5 per cent and 13.1 per cent respectively. Supply projections are with operating rates of 100 per cent and 90 per cent of production capacity of propylene. The result of surplus/deficit analysis is presented below.

10.4.3 In the year 2009-10, the domestic demand for propylene is expected to be serviced at 90 per cent under conservative growth rate. At operating rate of 100 per cent of projected capacities in respective years, a surplus of 284,000 tonne is estimated in the most conservative growth rate scenario of 6.7 per cent in 2009-2010. In case of ambitious growth rate of 14.5 per cent, a deficit of 807,000 tonne is estimated.



10.4.4 An analysis of the demand-supply summary for propylene and its derivatives suggests a deficit in capacity to service domestic market by 2014-2015 under all three scenarios of demand growth. The deficit under 100 per cent operating rate could range from 720,000 to 4,492,000 tonne. The deficit under 90 per cent operating rate could range from 1,008,000 tonne to 4,780,000 tonne.

11 PX & PTA Demand and Supply Estimation

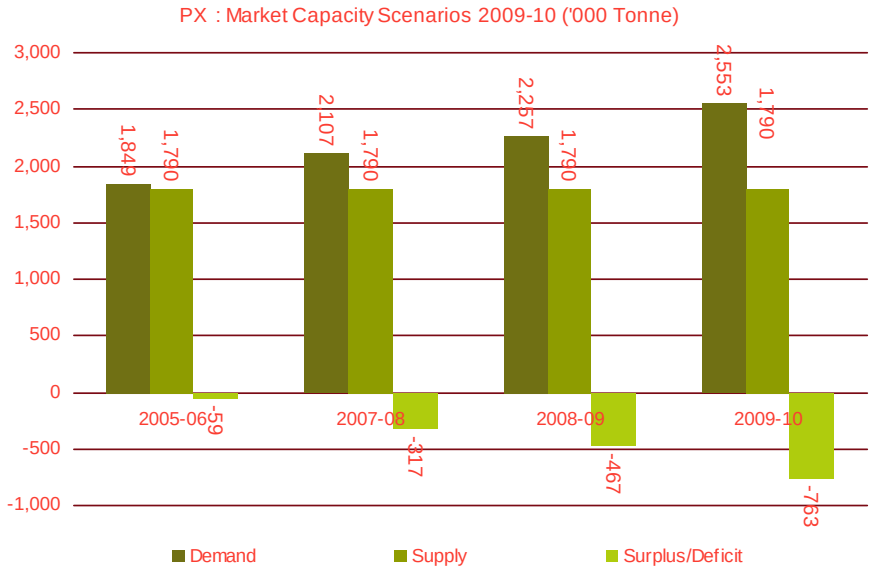
11.1 Introduction

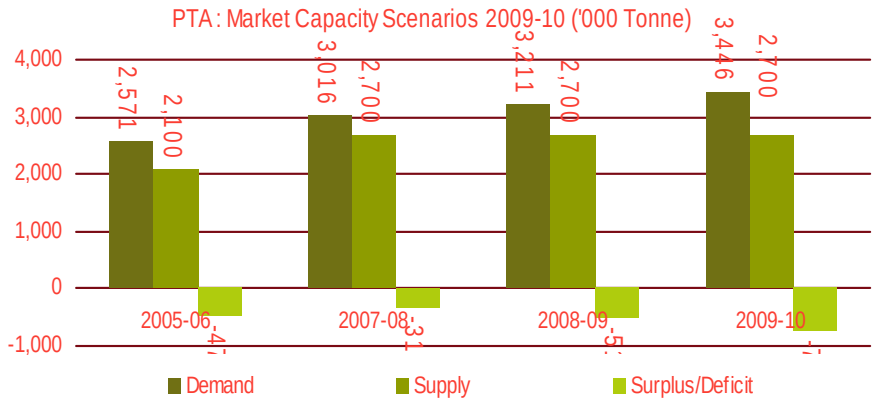
11.1.1 China and India are fast emerging as the major hubs for the manufacture of textiles in the world market. PX & PTA, unlike olefin basic petrochemical, can be traded with ease. Producers of PTA in the North East countries such as South Korea are largely dependent upon imports. The planned capacities should, therefore, try to capture the local demand and also that of the neighbouring markets.

11.1.2 In India RIL is the leader in the aromatic based derivative market with an annual PX capacity of approximately 1.6 million tonne and annual PTA capacity of 975,000 tonne per annum. Presently, RIL exports paraxylene while Mitsubishi imports paraxylene for its PTA plant at Haldia. IndianOil is expected to commission its PX/PTA plant by March 2006. The PX plant is designed to produce about 360,000 tonne per annum of PX. The PTA unit will produce 553,000 tonne per annum of PTA from PX.

11.2 PX & PTA Demand-Supply Estimation

11.2.1 According to the estimates of PCI Xylenes the deficit in the domestic paraxylene market is expected to be around 763,000 tonne in 2009-10. The situation in the domestic PTA market also shows a deficit of around 746,000 tonne in 2009-10. The deficit for PX and PTA is expected to increase in 2014-15.





11.2.2 Global growth in PX/PTA demand will be driven by the Asian market. The global growth rate for PX and PTA is expected to be around 7.8 per cent.

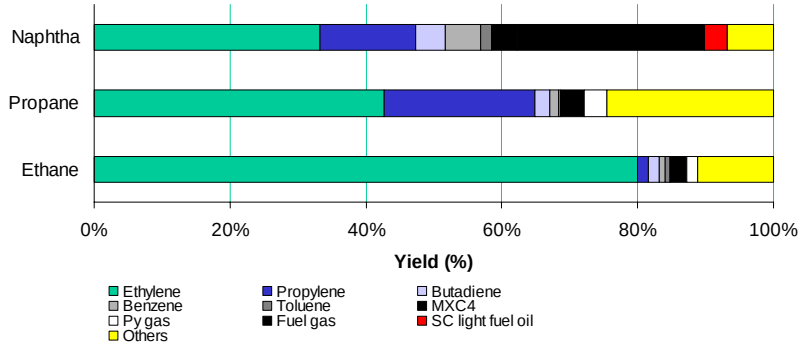
12 Domestic Feedstock Situation

12.1 Olefin Yield Pattern

12.1.1 Feed-stocks used in a petrochemical complex are naphtha, ethane, propane, ethane-propane mix, natural gas liquids (NGL), gas oil, butane and liquefied petroleum gas (LPG). Global ethylene is produced mostly from naphtha feedstocks because they are easy to transport into regions of high ethylene demand. Naphtha feedstocks particularly dominate ethylene supply in Europe and Asia.

12.1.2 The proportion of ethylene and propylene produced varies with the type of feedstock used. Naphtha yields around 33 per cent ethylene and by-products like propylene, butadiene, benzene, toluene and fuel gas. Ethane and propane yield around 80 per cent and 43 per cent ethylene respectively. Propylene production is highest (around 22 per cent) using propane as the feedstock while naphtha and ethane yield around 14 and 2 per cent respectively.

Olefin Yield by Feedstock



12.2 Feedstock Availability

12.2.1 India has six major ethylene cracker plants, three of which (RIL, IPCL Baroda and HPL) use naphtha as a feedstock, while the rest (IPCL Gandhar, IPCL Nagothane and GAIL) use natural gas fractions (C2/C3) as feedstock. Around 56 per cent of the total ethylene-cracking capacity in the domestic market is based on naphtha.

Naphtha

12.2.2 Supply of naphtha depends on the refining capacity, the crude mix and the refinery product mix. The refining capacity in India as on April 1, 2005 was 127 MMTPA, which is expected to increase to around 152 MMTPA by 2009-2010, as a result of expansions and new capacity additions.

12.2.3 Refinery product mix in India is largely driven by the demand for middle distillates, mainly high speed diesel (HSD) and kerosene. Hence the production of naphtha is dependent on the production levels of middle distillates. Roughly, naphtha accounts for about 10-11 per cent of the total petroleum production of a refinery.

12.2.4 Naphtha is used as a fuel in the power sector and as a feedstock for fertilizer and petrochemical plants. In 2003-04, the demand from the petrochemical sector accounted for around 58 per cent of the total naphtha demand. The value addition for naphtha is the highest when it is used as a petrochemical feedstock as compared with its usage in the fertilizer and power sectors. It is expected that natural gas will gradually replace naphtha in the power and fertilizer sectors thus making naphtha available to the petrochemical sector.

12.2.5 Naphtha is surplus in India currently allowing scope to export quantities. New refineries and expansions would also be potential sources for naphtha production. The availability of naphtha feedstock for petrochemical projects is therefore not in question.

Natural Gas

12.2.6 Petrochemical sector in India consumed about 5 per cent of the country's natural gas production in 2003-04. The fertilizers and power sectors accounted for 23 per cent and 37 per cent respectively.

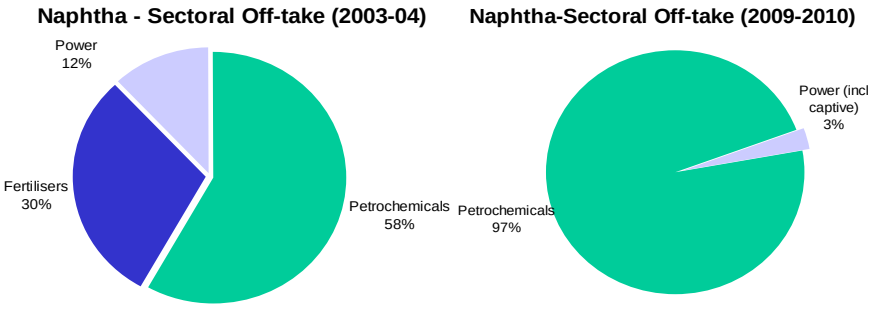
12.2.7 By 2009-2010, the domestic supply of natural gas is expected to increase to 169 MMSCMD largely due to higher LNG imports and gas from the Krishna-Godavari basin. By 2009-2010, gas demand from domestic installed capacity is estimated to be around 188 MMSCMD in a base case scenario. In an optimistic scenario, the same is projected to be 200 MMSCMD driven by an increase in demand from the power sector. The demand for natural gas being sensitive to availability and price as compared to that of alternate fuels, with additional gas supply sources being available, the demand is expected to rise.

12.2.8 Natural gas demand from the fertilizer sector is expected to increase due to the Government's policy of encouraging de-bottlenecking/brown-field expansion of capacities based on natural gas. It is expected that 20-25 per cent of the fertilizer

plants, currently based on naphtha/fuel oil, will shift to gas. Similarly the naphtha based power capacities including those which are idling, would attempt to utilise gas if available.

12.2.9 An analysis of the demand-supply situation of the natural gas market over the medium term reveals that despite the increase in supply of natural gas, largely on account of expected increase in LNG imports, there shall still be a deficit in the natural gas market.

12.2.10 For the purpose of petrochemical production, ethane feedstock is made available by extraction from natural gas. The gas discovered in KG basin by RIL is learnt to be dry with no practical possibility of providing ethane feedstock for petrochemical plants. LNG imported from Qatar is expected to be supplied in wet condition and therefore, ONGC has been granted permission to install a C2/C3 extraction plant at Dahej near Petronet LNG regasification plant.



12.2.11 In addition, companies are studying the possibility of extracting gas from sources of gas like in Assam and also putting up similar extraction projects near proposed LNG terminals like in Kochi. These projects will make new ethane streams available.

12.2.12 The situation, however, is not expected to significantly change allowing major or multiple ethylene projects to be planned.

12.3 Economics of Naphtha and Natural Gas Based Petrochemical Plants

12.3.1 Domestic naphtha prices move in line with international prices, which are highly volatile as they are correlated with the crude oil prices. Natural gas prices (the C2/C3 cost in the case of IPCL Gandhar) are regulated. Hence the domestic production cost for a gas-based cracker, due to capped natural gas prices, is currently lesser than that of naphtha based cracker.

12.3.2 Apart from the feedstock cost, cracker production economics and its overall profitability is linked to the value received on various by-products. The higher

margins enjoyed by natural gas based crackers due to lower feedstock cost is however offset to a large extent, by higher by-product net-backs from naphtha-based crackers. Higher by-product yields and strong by-product prices have led to robust by-product netbacks for naphtha-based crackers.

12.3.3 The government is currently contemplating an increase in domestic natural gas prices as also allowing free market pricing of gas produced from new fields and the gas regasified from LNG. If the domestic regulated natural gas prices for the petrochemical sector are brought on par with the basket of fuel oils, the spread between natural gas and naphtha-based cracker margins will decline further.

13 Basic Petrochemicals – Global & Regional Scenario

13.1 Ethylene Demand

13.1.1 Global ethylene demand growth typically averages 4 to 5per cent per year. In 2005, global demand for ethylene increased to 107 million tonne, or about 3.1per cent. The lesser growth was due to a slight slowdown in the current economic expansion and a recovery in the manufacturing sector. Because of their large economic bases, the largest producing and consuming regions are North America, West Europe, and Northeast Asia.

13.1.2 Global ethylene is produced mostly from naphtha feedstocks because they are easy to transport into regions of high ethylene demand. Naphtha feedstocks particularly dominate ethylene supply in Europe and Asia. Ethane feedstocks are popular in regions with associated natural gas production, including North America and the Middle East. The ethane feedstocks in the Middle East are based on fixed natural gas prices ($0.75-1.50/MMbtu) and produce the lowest-cost ethylene in the world. Recent high natural gas prices in North America (often more than $10/MMbtu) have made ethylene production from ethane feedstocks in this region much less competitive as compared to historical relationships.

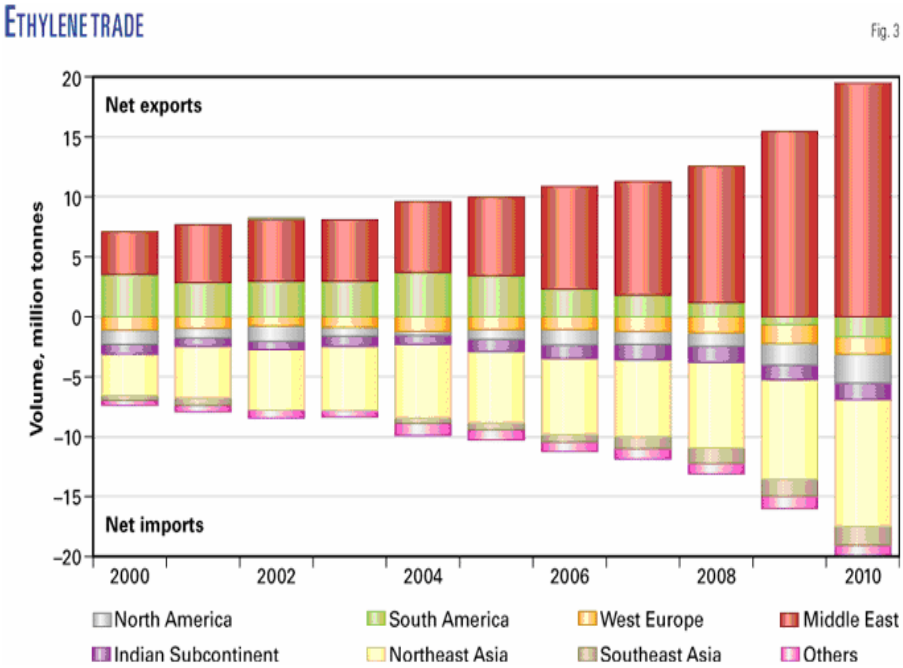
13.1.3 Global ethylene demand is dominated by polyethylene production for films, containers, and mechanical parts. Ethylene oxide, ethylene dichloride, and ethylbenzene are also significant ethylene consumers.

13.1.4 Ethylene demand typically grows at about 1.5 times GDP. The relationship between ethylene growth and general economic growth is becoming less clear, however, because more and more ethylene derivatives are being used for nondurable applications, resulting in lower multiples to GDP. Also, global GDP numbers are becoming more influenced by “service” sectors and less influenced by “manufacturing” sectors, which further dilutes the relationship between ethylene demand and overall economic growth.

13.1.5 Polyethylene, currently the largest consumer of ethylene, will continue to consume the most ethylene due to continued high demand growth rates for HDPE and LLDPE. Strong growth rates for these two resins are primarily a result of their end-use substitution for non-synthetic, non-durable applications such as grocery and garbage bags, food packaging, and shipping containers.

13.2 Ethylene Capacity addition

13.2.1 By 2010, global ethylene supply is expected to reach 133 million tonnes. Most of the new capacity additions will be in Asia (36 per cent) and the Middle East (51 per cent). The Middle East will, therefore, increase its share of total ethylene capacity to about



20 per cent. During 2005-10, supplies of ethylene from ethane feedstock will increase about 7.1 per cent year.

13.2.2 Significant ethylene capacity additions are expected to be seen in Asia over the next 5 years. Capacity additions in China/Taiwan are estimated to exceed 10.2 million tonne by 2010.

13.2.3 The capacity additions in Saudi Arabia are expected to come on stream as scheduled. This is due to their strong operational experience and competence of their chemical operators. In contrast, the Iran has limited operational experience in setting up and operating large-scale petrochemical projects. The delay in commencement of these plants might lead to a severe demand-supply imbalance.

13.3 Ethylene Regional Outlook

13.3.1 Asia has emerged as a major manufacturer of petrochemicals in recent years. In 2004, Asia accounted for around 28 per cent of the global ethylene capacity and 29.6

Source: Nexant Chem Systems

per cent of the global ethylene demand. In 2004, Asia accounted for around 37 per cent of global polyolefin capacity (around 60 million tonne) and around 40 per cent (57 million tonne) of global polyolefin demand.

13.3.2 China, South Korea and Japan are the region's major polymer manufacturers. However, China also has a large deficit of polymers which it meets through imports from South Korea, Taiwan and Japan.

13.3.3 In 2003, Asia imported 5 million tonne of ethylene derivatives, driven primarily by imports from China. In the medium term, the demand for polymers in Asia is expected to increase at a CAGR of 7-8 per cent, mainly due to the high growth rates in India and China. Asia, especially China, is expected to remain a net importer of petrochemicals, despite significant domestic capacity additions.

13.3.4 In 2009, Asia is expected to import around 12 million tonne of ethylene based derivatives, driven largely by Chinese imports. The Middle East is expected to be a net exporter of around 16.9 million tonne per annum.

13.4 Propylene Demand

13.4.1 Global propylene demand typically grows at about 5 per cent/year. The size of the total world propylene market grew at slightly less than typical rates in 2005 to 67.1 million tonnes (4.1per cent). Due to their large economic bases, North America, West Europe, and Northeast Asia are the largest producing and consuming regions. Propylene is produced mostly from steam crackers as an ethylene by-product. Regions that use mostly high-propylene-yielding naphtha feedstocks for steam crackers, such as West Europe and Northeast Asia, have the largest proportions of propylene produced from steam crackers.

13.4.2 Refinery FCC units are the other dominant global supplier of propylene, as a by-product of motor gasoline and distillates production. Regions that have high levels of demand for motor gasoline, such as North America, have the largest proportions of propylene sourced from FCC units.

13.4.3 Propylene from other sources (propane dehydrogenation and metathesis) currently supplies about 5 per cent of the global market. These sources are usually less cost-competitive relative to steam cracker and FCC sourced by-product propylene supplies, particularly when the technologies use feedstocks that are not stranded but based on free market pricing. Polypropylene production for mechanical parts, containers, fibres, and films is the primary consumer of propylene. Other important propylene consumers include acrylonitrile, propylene oxide, oxo-alcohols, cumene, and acrylic acid.

13.4.4 Polypropylene, currently the largest propylene derivative, will to continue to consume the most propylene due to continued high demand-growth rates in the injection moulding and fibre segments. Polypropylene's demand growth is also supported by its ability as a low-cost substitute for non-plastic materials (paper, concrete, steel) and other plastic materials (polyethylene, polystyrene).

13.5 Propylene Supply

13.5.1 By 2010, global propylene supplies will reach 83.7 million tonnes. Most of the new capacity additions will be in Asia (38 per cent), the Middle East (30 per cent), and North America (10 per cent).

13.5.2 Propylene production from steam crackers depends upon the operating rates of the steam cracker and the type of feedstock. Historically, propylene production from steam crackers has grown at rates almost identical to ethylene production. In the future, propylene production growth from steam crackers will be slightly lower than the corresponding ethylene production growth due to the addition of large amounts of low propylene yielding, ethane-based steam cracking capacity in the Middle East near 2010.

13.5.3 Propylene production from FCC units has grown more quickly than production from steam crackers. This trend will continue. New propylene supplies from FCC sources will result from a few new FCC units and expansions (due to slow relative demand growth for motor gasoline), the recovery of propylene from nonchemical end uses (alkylation and LPG), and the use of higher propylene yielding catalyst additives. Propylene production from other sources will be the fastest growing segment of propylene supply, increasing to more than 10 per cent of global supplies by 2010. The production from other sources will remain relatively low compared to steam cracker and FCC supply on an absolute basis.

13.5.4 During 2005-10, investments in other propylene technologies will be predominantly the established technologies of metathesis and propane dehydrogenation, but some investments are also planned using technologies such as olefin cracking, gas-to-olefins, and deep catalytic cracking.

13.6 Propylene Trade

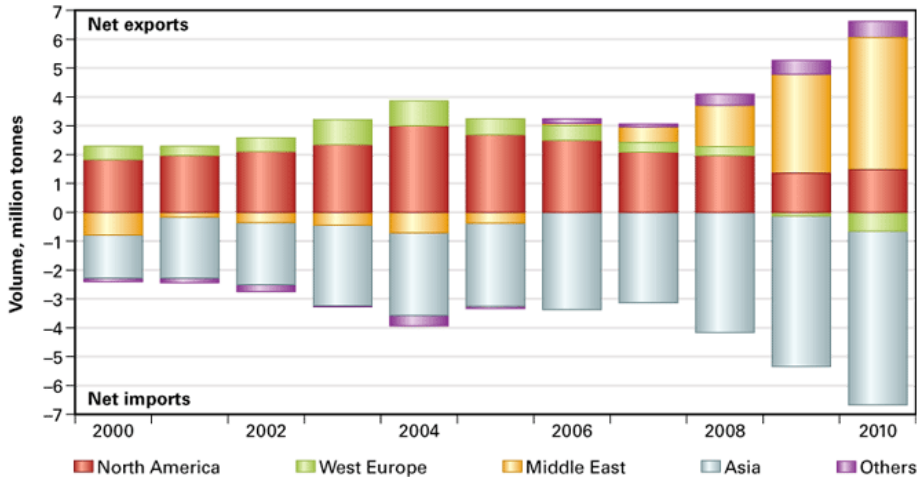
13.6.1 International trade of propylene is quite limited due to the expense associated with transportation of highly pressurized or refrigerated liquids. Japan, South Korea, Taiwan, Malaysia, Canada, the US, and Libya export most of the world's propylene monomer. The largest propylene importing areas are the US, Colombia, West Europe, Egypt, China, South Korea, Taiwan, Indonesia, and the Philippines.

13.6.2 Due to the costs associated with shipping propylene most global trade of propylene monomer, therefore, occurs to cover planned and unplanned production outages. Several countries (Philippines, Colombia, Indonesia, Egypt, and China) continue to consistently import propylene, however, until they can find or build alternative, more cost-effective sources.

13.6.3 Propylene monomer trade will remain stable as North America maintains a dominant export position. Additional exports will also come from the Middle East, Africa, the countries of the former Soviet Union, and the Baltic States. West Europe and Asia will remain the dominant importing regions of propylene monomer.

PROPYLENE TRADE

Fig. 8



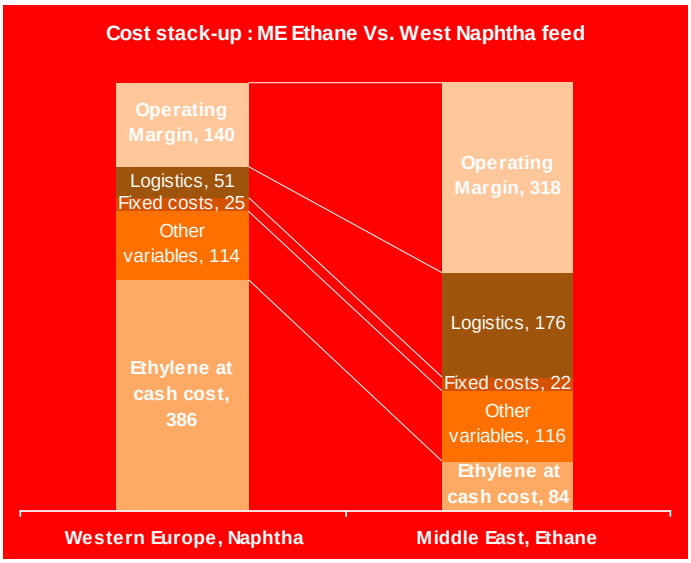
13.6.4 Much more propylene is traded regionally in its primary derivative form (polypropylene, acrylonitrile, cumene, oxo-alcohols, etc.) than as pure monomer. These chemicals are easily transported as a liquid or bulk solid, which are much less expensive to transport than propylene. Of all the propylene traded (as monomer or derivative form) between countries, most is traded in the form of polypropylene or acrylonitrile.

13.7 The Middle East Challenge

13.7.1 Low feedstock cost in the Middle East and low labour cost along with fast growing demand in Asia has prompted companies to drop West from their agenda to set up petrochemical plants in the East. Production in the US and Europe is almost flat or declining, especially for the C_2 value chain such as ethylene and polyethylene.

13.7.2 According to a McKinsey report, with the Middle East ethane costing US$ 0.75 to 1.0 per MMBtu, the cost of crude oil would need to drop below US$ 15 per barrel for western producers and US$ 20 per barrel for China to be competitive in Asia.

13.7.3 With the Middle East capacities expected to come on-stream by 2010, the argument that Middle East will resort to lower prices to capture the market resulting in production facilities with high cost centres to be pushed out of the market, seems weaker. Middle East would sell at prices set by their western counterparts. Even with capacity additions planned by the Middle East, the demand for petrochemicals in the medium term is expected to outstrip supply. Also, the Middle East producers will look to recover capital cost as soon as possible by maintaining higher operating margins.



Source : McKinsey

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13.7.4 The possibility of shutting down of production facilities in the West is not envisaged since the prices ruling in the market still offer them margins. The West, however, would be strained on margins since all their cost optimization avenues were exploited in the last decade.

13.7.5 In view of the above, it would be reasonable to conclude that in mid term the Middle East capacities would not directly affect the domestic capacity building plan of India.

13.7.6 Given the limited availability of natural gas in India along with high prices as compared to the Middle East, Indian petrochemical companies should look for forging alliances with companies in the Middle East to set up gas based petrochemical plants specially in countries like Saudi Arabia, Qatar and Kuwait.

14 ANNEXURE

14.1 Abbreviations

Abbreviations	Expansions
Units	
BCM	Billion Cubic Metre
MMBtu	Million British Thermal Unit
MMSCMD	Million Standard Cubic Metre per Day
MMTPA	Million Tonne per Annum

Abbreviations	Expansions
AFTA	ASEAN Free Trade Agreement
C_2/C_3	Ethane/ Propane
CAGR	Compounded Annual Growth Rate
CMAI	Chemical Markets Associates, Inc.
FCCU	Fluidised Catalytic Cracker Unit
GAIL	GAIL (India) Limited
GDP	Gross Domestic Product
GVR Committee Report	GV Ramakrishna Committee Report
HDPE	High Density Polyethylene
HPL	Haldia Petrochemical Limited
HSD	High Speed Diesel
ICI	Imperial Chemical Industries
IM	Injection Moulding
IOCL	Indian Oil Corporation Limited
IPCL	Indian Petrochemicals Corporation Limited
LDPE	Low density Polyethylene
LLDPE	Linear Low Density Polyethylene
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MEG	Mono Ethylene Glycol
MoPNG	Ministry of Petroleum and Natural Gas
NGL	Natural Gas Liquid
NOCIL	National Organic Chemical Industries Limited
ONGC	Oil and Natural Gas Corporation
PE	Polyethylene
PP	Polypropylene
PTA	Purified Terephthalic Acid
PVC	Polyvinyl Chloride
PX	Paraxylene
RIL	Reliance Industries Limited
TQ/BOPP	Tubular Quenched/ Biaxially Oriented Polypropylene
UPA	United Progressive Alliance