

## *Chapter-4*

# **GCC Petrochemical Industry**

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## Chapter-4

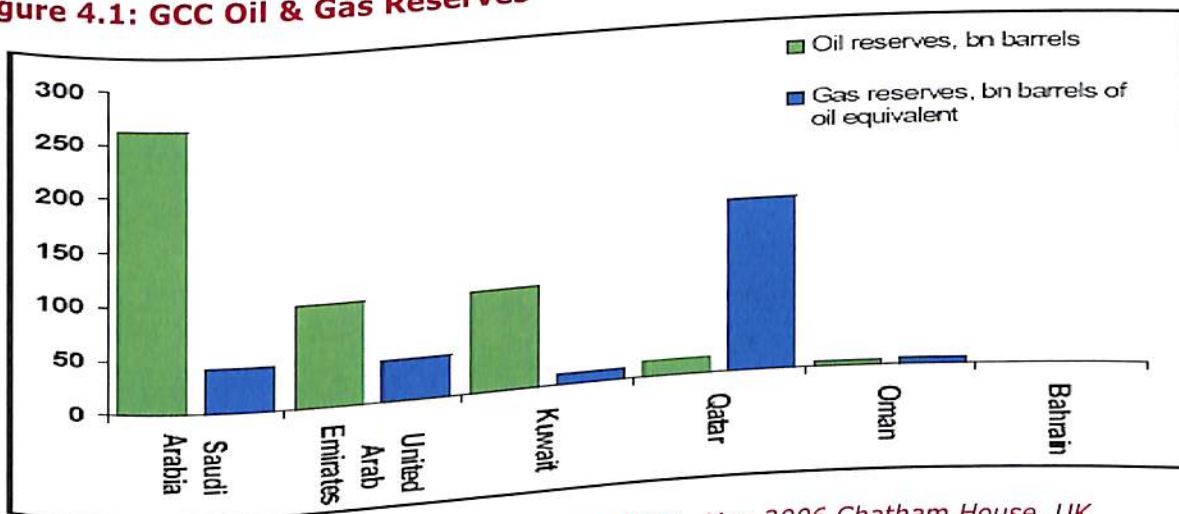
# GCC Petrochemical Industry

### 4.1 OVERVIEW OF GCC ECONOMY

Gulf Corporation Council (GCC) was established in May 1981 by six Middle Eastern countries Saudi Arabia, Kuwait, Bahrain, Qatar, UAE and Oman. In 1982, the United Economic Agreement (UEA) was signed to introduce unified tariffs and to carry out economic and technical cooperation among member countries. The complete implementation of common tariffs was initially scheduled by the end of 2005 which is now extended till 2007. In addition, goods produced within the region are considered domestically produced and tariffs have been repealed.

The combined GDP of the GCC is US\$595bn, with a population of 35m and average per capita incomes of US\$17,000. The GCC possesses 40% of the world oil reserves and 20% of world's known gas reserves. GCC total crude oil production is around 17 million barrel /day. The region's economic growth is estimated at 7.3% in real terms in 2005.

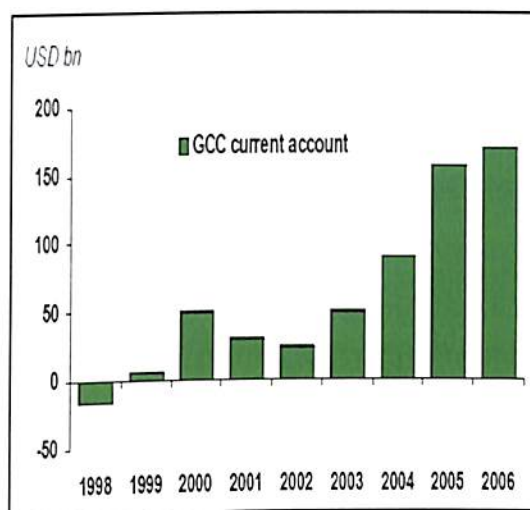
**Figure 4.1: GCC Oil & Gas Reserves**



Source: International Economics Program (IEP), May 2006 Chatham House, UK

**Figure 4.2: GCC Current Account Surplus**

The region's macro-economic position has been transformed in recent years. In 2005, GCC posted a current account surplus of over US\$157bn, equivalent to 26% of the region's GDP. Indeed, from 2000 to 2005, Gulf state governments generated surpluses exceeding US\$230bn.



Source: IEP, May 2006 Chatham House, UK

Since its formation in 1981, the GCC has pursued a slow path towards greater economic integration. Each GCC country is promoting the diversification of industry, introduction of foreign investments and privatization utilizing oil and gas resources. Trade among six GCC members is currently only \$15 billion.

Although a common economic agreement was passed in June 1981, real progress towards integration has only been made in the last six years. A customs union was established in 2003 and GCC citizens can now travel, work and own property in all member states. In 2005, the GCC Committee for Financial and Economic Cooperation set out a timetable for the region's most ambitious goal, the establishment of a single currency by 2010.

Foreign direct investment (FDI) into the GCC rose from just under \$ 2 billion in 2001 to more than \$ 20 billion in 2005. This trend will help integrate the GCC' economy into the global economy. Roughly \$ 1trillion in infrastructure investments are currently in pipeline and by the decade's end these could total \$ 3 trillion.

### 4.1.1 GCC Country Risk Analysis and Investment Environments

GCC countries are trying to reduce their dependence on the oil economy of the past and implementing policies for introducing foreign capital and technology with the aim of diversifying their industries. The access to abundant low cost oil and gas resources as feedstock and with strong cost competitiveness the potential for development of the petrochemical industry has been extremely high. This allows GCC countries to build world-scale, state-of-the-art petrochemical complexes.

Preliminary data from GCC countries revealed that there remarkable rise is attributed to opening up of new sectors for foreign investment. These sectors include: oil and gas, mining, infrastructure, telecommunications, electric generation, and service sectors (banking, insurance, media, health and education). Further more, most of them succeeded in simplifying and streamlining their investment systems and procedures, as well as strengthening investment promotion efforts, developing focused investment promotion techniques, and establishing internal and external networks with the aim of attracting new investors from regions such as Russia, China, India, Turkey, Iran, Central and Eastern Europe.

In 2004, WTO list of the major (30) merchandise exporting countries in the World included two GCC countries: Saudi Arabia, 20<sup>th</sup> rank with a share of 1.3% of World total merchandise exports another is U.A.E. which ranked 28<sup>th</sup> with 0.9% share.

GCC countries strengthened their international trade relations with other Arab countries (Algeria, Sudan, Lebanon, Libya and Yemen). All six GCC countries are the members of World Trade Organization (WTO). Bahrain and Kuwait became its members in 1995, while Qatar and UAE joined in 1996

and Oman in 2000. Saudi Arabia has been an observer of GATT since 1985, but its admission became effective in December 2005.

The GCC countries continued introducing favorable changes in the legislative and regulatory measure to improve overall investment environment. They are also closely following the emerging developments in global markets. New FDI investment laws are issued, and other existing ones were amended. A number of multilateral arrangements have been concluded between GCC countries with other Arab, European, and Asian countries, and USA. These arrangements included bilateral agreements for encouragement and protection of investment and avoidance of double taxation, memoranda of understanding, and joint committees.

During 2004, all six GCC countries maintained their Sovereign Composite Rating (SCR) prepared by the Financial Times (FT), which is a weighted average of the individual ratings by the renowned international credit rating agencies. 4 GCC countries (Kuwait, U.A.E., Qatar and Saudi Arabia) had high investment grade, very low risk, and strong payment record whereas 2 GCC countries (Bahrain, and Oman) had investment grade, low risk, and reasonable payment record.

In *Euromoney Country Risk Index* (September 2004), 20 Arab countries were ranked. Qatar, Kuwait and U.A.E. have been classified as low risk countries where as Bahrain, Saudi Arabia and Oman as moderate risk countries.

According to *DUN & Bradstreet Country Risk Index 2004*, U.A.E. has been considered as very low risk, Kuwait and Qatar as low risk whereas Bahrain, Oman, Saudi Arabia are moderate risk countries.

The *WEF Competitiveness Index*, composed of two indices: the Growth Competitiveness Index (covers 104) countries, and the Business

Competitiveness Index (covers (103) countries. In *Growth Competitiveness Index*, U.A.E. ranked (16) followed by Bahrain (28), and in the *Business Competitiveness Index*, U.A.E ranked (28), followed by Bahrain (40).

## 4.2 GCC HYDROCARBON RESOURCES

### 4.2.1 Oil Reserves & Production

It is believed that oil and natural gas will be the main source of energy and chemical raw material for at least next 50 years. Oil resources are concentrated in the Middle East (ME). ME reserves account for 62% of the world's reserves and reserve- production ratio is also a long 82 years. The top five oil producing countries (Saudi Arabia, Iran, Iraq, Kuwait and UAE) are in ME and despite of 2% share of world population, their reserves are large 59%.The reserves of Saudi Arabia (population ratio 0.35%) at 264 billion barrels (22%) are the largest.

**Table4.1: Proved Oil Reserves & Production**

Country	Proved Reserve		Production		R/P year*
	Billion barrels	Share (%)	Thousand barrels daily	Share (%)	69
			11,035	13.5	69
<b>Saudi Arabia</b>	264.2	22.10	2,643	3.3	<b>109</b>
<b>Kuwait</b>	101.5	8.33	2,750	3.3	<b>103</b>
<b>UAE</b>	97.8	8.23	1,097	1.2	<b>45</b>
<b>Qatar</b>	15	1.28	780	1	<b>19</b>
<b>Oman</b>	5.6	0.47	0.19	NA	NA
<b>Bahrain</b>	0.13	NA			
<b>Total GCC</b>	<b>484.3</b>	<b>40.33</b>	<b>18,305</b>	<b>22</b>	<b>76</b>
<b>Total Middle East</b>	<b>743</b>	<b>62</b>	<b>25,119</b>	<b>31</b>	<b>82</b>
<b>Total OPEC</b>	<b>902.4</b>	<b>75.2</b>	<b>33,836</b>	<b>42</b>	<b>74</b>
<b>Total World</b>	<b>1200.7</b>	<b>100</b>	<b>81,017</b>	<b>100</b>	<b>41</b>

\*R/P = year end proved reserve/production of the year  
Source: BP Statistical Review of World Energy, June 2006

At present there are 47 massive oil fields in the world with proved reserves of 5 billion barrels or more and majority of them (29) are in located in Middle East (11 are in Saudi Arabia). Saudi Arabia's Ghawar oilfield (reserves of 86.3 billion barrels) is the largest. Saudi Arabia also has the world's largest offshore oilfield in Safaniya field (41.4 billion barrels).

Oil and gas production in the Middle East is operated and managed by national oil/gas corporations. Among top 10 global oil companies, in terms of proved reserves of oil & gas, current production of oil & gas, refinery capacity and quantity of oil & gas sold, are five multinational oil enterprises and five state owned oil corporations of oil producing countries. The top ranking enterprise is Saudi Aramco followed by ExxonMobil, National Iranian Oil Corporation and PDVSA of Venezuela. Table 4.2 lists the major state own oil companies in GCC countries.

**Table 4.2: Major state own oil companies in GCC countries**

Country	Major Oil Companies	Start up	Proved reserves (Billion Barrels)	Production Million barrels
Saudi Arabia	Saudi Arabian Oil Company (Saudi Aramco)	1988	259	9.0
Kuwait	Kuwait Petroleum Corporation	1980	99	1.2
UAE, Abu Dhabi	Abu Dhabi National Oil Co.	1971	55	1.2
UAE, Dubai	Dubai Petroleum Co.	1975	4	0.4
Qatar	Qatar Petroleum	1974	11	0.7
Oman	Petroleum Development Oman	1974	3	0.7
Bahrain	Bahrain Petroleum Co.	1929	0	0.0

Source: IEP, May 2006 Chatham House, UK

### 4.2.2 Natural Gas Reserves & Production

Natural gas is attracting attention as a clean energy source. The world's proven reserves of natural gas are estimated as 180 trillion cubic metres in 2005. Middle East accounts for 72 trillion cubic metres (40% of total world reserves). Russia (27%), Iran (15%) and Qatar (14%) are three major producers of natural gas. Among GCC countries Qatar has made a substantial progress in Natural Gas production and export.

**Table 4.3: Proved Natural Gas Reserves**

Country	Proved Reserve	
	Trillion cubic meters	Share (%)
Saudi Arabia	6.9	4
Kuwait	1.6	0.01
UAE	6	3
Qatar	26	14
Oman	0.99	NA
Bahrain	0.09	NA
<b>Total GCC</b>	<b>41.58</b>	<b>23</b>
<b>Total ME</b>	<b>72.126</b>	<b>40</b>
<b>Total World</b>	<b>179.831</b>	<b>100</b>

*Source: BP Statistical Review of World Energy, June 2006*

### 4.2.3 Liquefied Natural Gas (LNG) Projects in GCC

In Middle East, Qatar is one of the most LNG intensive countries. Qatar is promoting five LNG projects, the total capacity of which will amount to 56.2 million ton per year by 2011, with aim to exporting large quantities to US and UK.



**Table 4.4: Major LNG Projects in GCC countries**

Country	Major LNG Project	Start up	Liquefaction capacity 1000t/yr	Participants
Qatar	Qatar Gas II Qatar Gas III Qatar Gas IV	2007, 2009 2010 2010-2012	7,800 7,800 7,800	QP, ExxonMobil, Total QP, ConocoPhillips QP, Shell
	Ras Gas II Ras Gas III	2005, 2007 2009,2011	4,700 7,800	QP, ExxonMobil, QP, ExxonMobil,
Oman	Qalhat LNG	2006	3,700	Oman Govt, Oman LNG, Union Fenosa

*Source: Qatar Petroleum Annual Report, 2005, Petroleum Economist, July 2006, Oil & Gas Journal, January 2007*

#### 4.2.4 Gas to Liquids (GTL) Projects in GCC

Oil reserves are sparse in Qatar, but because it possesses the mammoth North Field, the world's largest gas field, its natural gas reserves rank third in the world.

GTL projects to produce liquid fuel from natural gas have started to reach the full fledged commercialization stage. GTL entails making syngas (hydrogen and carbon monoxide) from natural gas, and then producing synthetic gasoline or diesel or various types of petrochemical feedstock (FT oil) such as naphtha via Fischer Tropsch (FT) reaction. Sasol is producing FT oil from coal in South Africa, while PetroSA is synthesizing FT oil from natural gas feedstock. Sasol in process of completing its Ft oil production plant in a venture (Oryx GTL) jointly established with Qatar Petroleum. Table 4.5 lists existing GTL projects in GCC countries.

**Table 4.5: Major GTL Projects in GCC countries**

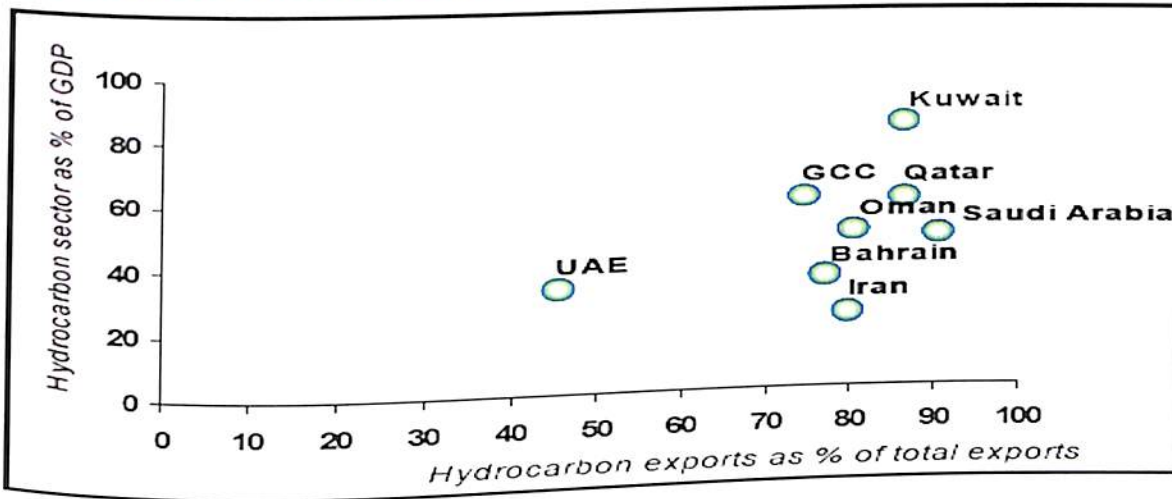
Country	Major GTL Project	Start up	capacity 1000barrels/day	Participation
Qatar  Location: Ras Laffan	Oryx GTL	2006	34	QP, Sasol
		2009	(+65) 100	QP, Sasol, Chevron
		2013	130	QP, Sasol, Chevron
	ExxonMobil	2011	154	
	Pearl GTL	2009	70	Qatar Shell
		2011	(+70) 140	Qatar Shell
Conocco Phillips	2012	80+80		
Marathon	2013	60+60	Petro Canada, Mitsui & CO./UAE	

Source: Qatar Petroleum Annual Report, 2005, Petroleum Economist, July 2006, Oil & Gas Journal, January 2007

The major gas field in GCC countries are North Field, Qatar with proven reserve of 900 trillion cubic feet(TCF), followed by Ghawar and Shaybah in Saudi Arabia with combined gas reserves of 105 TCF, Greater Burgan in Kuwait with gas reserves of 43 TCF, Umm Sharif and Bab in Abu Dhabi (UAE) with combined gas reserves of 62 TCF. Saudi Arabia has the world's fourth largest proven reserves of gas but remain ranked 12<sup>th</sup> in terms of production. It has not been capable to satisfy a large domestic gas demand and as such has no plan to export gas.

Although GCC countries are trying to reduce their dependence on the oil economy but it always revolve around their rich hydrocarbon resources. Oil and gas accounts for about a third of the GCC's GDP, three-quarters of GCC government revenues and three-quarters of exports This dominance naturally makes the economies of the GCC relatively synchronized.

**Figure 4.1: GCC Oil & Gas Economic**



Source: IEP, May 2006 Chatham House, UK

### 4.3 GCC PETROCHEMICAL INDUSTRY

Currently, the Middle East petrochemical sector growth rate is 4% per year and margins are high. These conditions are expected to last until 2009, when a significant amount of new capacity comes on-line. The prosperity of the sector will then depend on whether demand growth can balance supply increases. The Middle East petrochemical industry stands on verge of yet another period of massive expansion, the largest so far. The region's indigenous competitive advantage of access to hydrocarbon coupled with the inherent economies of scale associated with large petrochemical investments; create a compelling story for the Middle East to take the lion's share of new global capacity. Feedstock competitive advantage, especially ethane, in the Middle East is a key factor in regional development of the petrochemical industry.

Ethylene is the fundamental building block for the large-volume plastics and petrochemicals industry. Global ethylene demand has typically grown at an average rate of 5% per year. World ethylene capacity in 2006 is 121.4 million metric tons and the largest global producers of ethylene are DOW

(8%), ExxonMobil (7%), SABIC (6%) and Shell (5%). By 2010, global ethylene capacity is expected to reach almost 150 million metric tons. Most of the new capacity additions will be in Middle East (50%). As a result, the Middle East's ethylene capacity is expected to reach to 27 million metric tons in 2010 (see Table 4.6).

The US and Europe, in contrast, are projected to become net importers of chemicals. North America's share of the world ethylene market is slated to drop from 30 to 24 percent, while Western Europe's share should slip from 21 to 17 percent and Middle East share will reach to 20 percent of global capacity during by 2011. Asia's share will remain at 26 percent. It signals an eastward shift of the global economy, population and petrochemical sector.

In 2006, Saudi Arabia announced the major industrial projects totaled \$283 billion. Petrochemicals industry is undertaking projects worth of \$ 45 billion out of which projects worth more than \$28 billion is announced by SABIC. The government, aided by the country's accession to the WTO, aims to obtain \$162 billion of foreign direct investment in refining and petrochemical projects over the next 14 years.

As far as plastic's production is concern the petrochemical producers in Iran and GCC are rapidly stepping up their operations and will bring on stream an additional 10.4 million tons of polyethylene between now and 2010. Annual exports of all petrochemical products from the GCC have crossed the 30 million ton mark in 2005.

As of June 2006, the GCC countries are promoting more than \$ 85 billion petrochemical projects. This will lead to a start up rush, when these plans are materialized between 2008-2011, details are listed in Table 4.7

**Table 4.6 GCC- Ethylene Capacities (Thousand metric tons /year)**

COMPANY	LOCATION	2001	2005	2010
<b>KUWAIT</b>				
Equate	Shuaiba	850	920	920
PIC	Shuaiba	----	----	----
TKOC	Shuaiba	----	----	850
<b>TOTAL - Kuwait</b>		850	920	1,770
<b>OMAN</b>				
OPIC	Sohar	----	----	----
<b>TOTAL - Oman</b>		----	----	----
<b>QATAR</b>				
Q-Chem	Mesaieed	----	500	500
QAPCO	Umm Said	525	525	720
QP/ExxonMobil	Ras Laffan	----	----	----
QP/Shell	Ras Laffan	----	----	1,300
Ras Laffan Ethylene Co.	Ras Laffan	----	----	2,520
<b>TOTAL - Qatar</b>		525	1,025	300
<b>SAUDI ARABIA</b>				
Jubail ChevPhill	Al Jubail	----	1,000	1,350
JUPC	Al Jubail	----	----	1,325
Kayan	Al Jubail	----	700	810
KEMYA	Al Jubail	700	----	----
Nat'l Chev/Phil	Al Jubail	----	----	1,300
Petro-Rabigh	Rabigh	800	800	800
Petrokemya	Al Jubail	800	1,000	1,250
	Al Jubail	850	850	850
	Al Jubail	850	1,280	1,280
SADAF	Al Jubail	1,150	----	----
Saudi Aramco/Dow	Ras Tanura	----	----	1,200
SHARQ	Al Jubail	----	----	----
SIPCHEM	Al Jubail	----	----	1,000
Tasnee/Sahara	Al Jubail	----	875	875
YANPET	Yanbu	875	830	980
	Yanbu	800	----	1,300
Yansab	Yanbu	----	7,335	14,620
<b>TOTAL - Saudi Arabia</b>		6,025	7,335	600
<b>UNITED ARAB EMIRATES</b>				
Borouge	Abu Dhabi, Ruwais	----	600	1,050
	Abu Dhabi, Ruwais	----	600	1,650
<b>TOTAL - United Arab Emirates</b>		----	9,880	20,560
<b>TOTAL - GCC</b>		7,400	11,803	27,638
<b>TOTAL - Middle East</b>		8,880		

Source: CMAI Petrochemical Databank 2006 and Dewitt 2006 Ethylene Annual.

**Table 4.7: Petrochemical Projects underway in GCC (\$million) as on June 2006**

Country	Planned	Feasibility study	Outline design	ITB* released	Main contract awarded	Total
Saudi Arabia	23,860	12,950	3,840	4,400	13,602	<b>58,652</b>
Kuwait	1,200	-		-	3,070	<b>4,270</b>
UAE	100	1,500	2,950	800	200	<b>5,550</b>
Qatar	2,250	3,750	-	670	1,870	<b>8,540</b>
Oman	450	250	4,500	350	1,700	<b>7,250</b>
Bahrain	-	300	-	700	-	<b>1,000</b>
<b>TOTAL</b>	<b>27860</b>	<b>18,750</b>	<b>11290</b>	<b>6920</b>	<b>20442</b>	<b>85262</b>

\* Invitation to bid (ITB)

Source: MEED Petrochemicals Report, 2006

#### 4.4 GCC PETROCHEMICAL FEEDSTOCK ANALYSIS

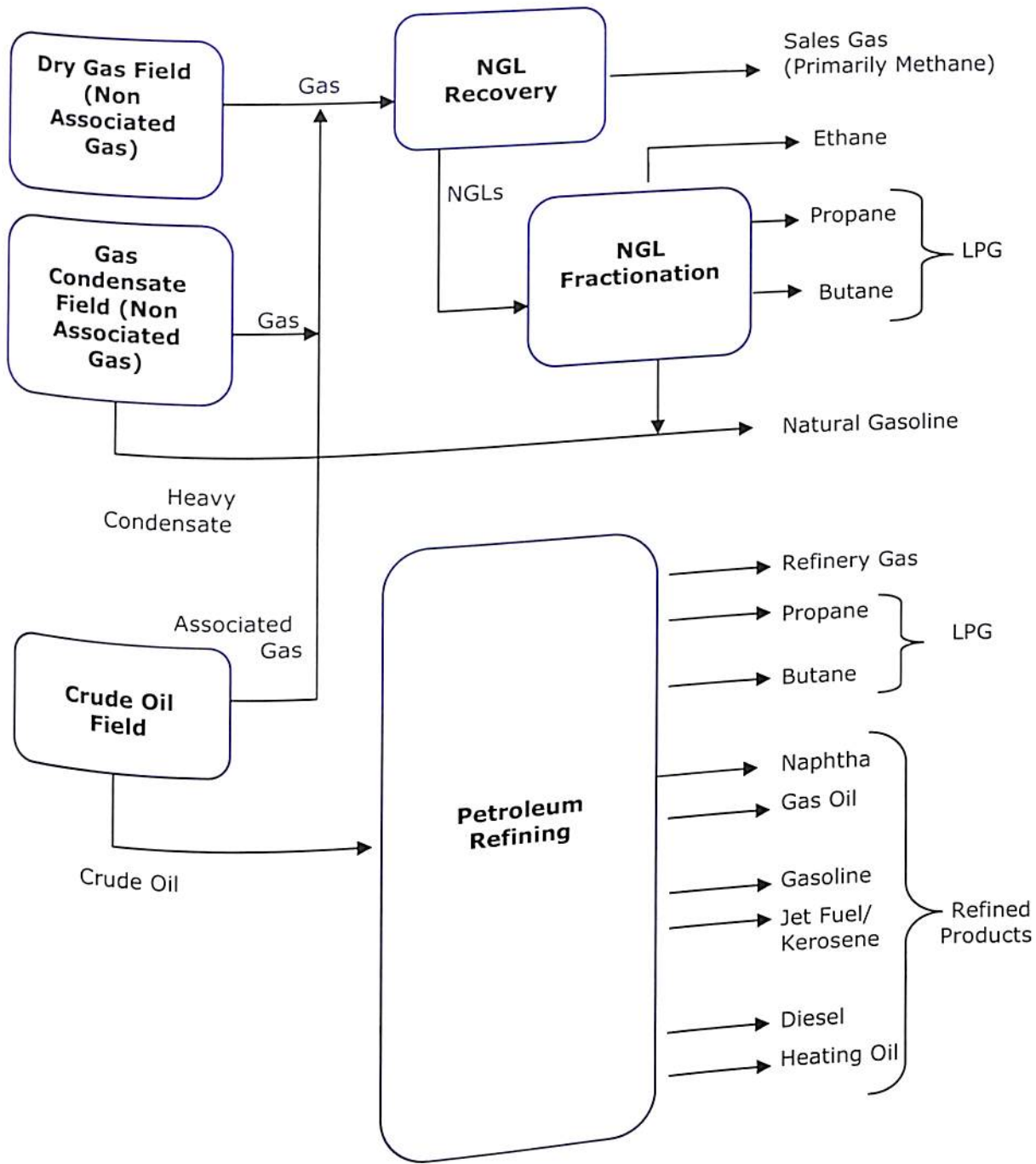
The petrochemical industries in United States started their business of producing ethylene by thermal cracking of ethane (C<sub>2</sub>) and propane (C<sub>3</sub>). The industries also utilised propylene and BTX recovered from secondary units in refineries (reformers or FCC). The integrated oil refinery and petrochemical complexes provided a comprehensive advantageous feedstock supply structure. Petrochemical producers in Europe, Japan and Asia commenced their businesses co-producing basic chemicals such as ethylene, propylene and aromatics using naphtha as feedstock. As a result, the petrochemical complexes are composed in each region having their own unique line-up of derivatives.

From the 1980, the Middle East actively started producing ethylene and its derivatives using ethane recovered from oil associated gases that had until then been flared off. Saudi Arabia and Qatar made a head start, and other

GCC countries Kuwait and UAE soon followed. Saudi Arabia then started to recover ethane from structural gas fields to supplement the shortage of ethane by its rapidly over expanded petrochemical businesses.

In Section 4.2 GCC hydrocarbon resources has been discussed in detail. This section explores feedstock availability of ethane, LPG and naphtha in GCC countries. *Ethane* is recovered from either non-associated gas field or associated gas fields where production is linked to the production of crude oil. The ethane content is typically much lower in non-associated gas fields. *LPG* is typically produced as a by product of gas separation processes or from refining of crude oil. *Naphtha* is usually produced from crude oil refining or in the form of condensate via gas separation from non-associated gas production. Figure 4.2 shows the typical key source of these materials.

**Figure 4.2 Sources of Ethane, LPG and Naptha**



Source: *Petroleum Economics*, Jean (1990) & *Chemicals for Beginners*, Johnson et al (2004)



#### 4.4.1 GCC Ethane Demand and Supply Outlook

The ethane content of natural gas varies depending upon the production location. Depending upon the quantities present, it may or may not be economical to undertake ethane extraction and supply the ethane as a petrochemical feedstock for the production of ethylene and derivatives.

The Middle East has around 40% of the world's gas reserves including a significant volume of recoverable ethane. There is a drive for many countries in this region to increase recovery and consumption of gas reserves due to a need to satisfy both the incremental demand of domestic and global gas consumers including local industry sectors such as petrochemicals. In Table-4.8, GCC Ethane demand for petrochemicals is given.

**Table 4.8: GCC Ethane Demand (thousand tons)**

Country	ACTUAL		FORECAST		Average Annual Growth Rate (%)	
	2000	2005	2010	2015	2000- 2005	2005- 2015
Saudi Arabia	5,840	6,840	13,950	13,950	3.2	7.4
Iran	694	1,356	7,220	9015	14.3	20.9
Qatar	525	1,123	2,520	2520	16.4	8.4
Kuwait	748	748	1,598	1598	0.0	7.9
Oman	-	-	504	1000	-	-
UAE	-	600	1,306	2000	-	12.8
<b>GCC Total</b>	<b>7,113</b>	<b>9,311</b>	<b>19,878</b>	<b>21,068</b>	<b>6.4</b>	<b>10.9</b>
<b>ME Total</b>	<b>7,807</b>	<b>10,667</b>	<b>27,098</b>	<b>30,083</b>		

Source: CMAI Petrochemical Databank 2006 and Dewitt 2006 Ethylene Annual

In *Saudi Arabia*, available ethane supply to Jubail petrochemical complexes account for about 75% of total current demand. Increased volumes from both associated and non-associated gas developments are planned in the next few years and will be supplied to new petrochemical facilities to be operated by Jubail Chevron, Sharq, PMD/SABIC, Yansab, Rabigh and Tasnee Petrochemical.

**Qatar** has significant non-associated gas reserves which have relatively high ethane content. Qatar has developed a number of NLG fractionating plants located in Messaid, processing and non associated gas from North Field. Qatar plans to recover sufficient ethane to support three new ethane crackers by 2010.

In **Kuwait**, ethane is currently extracted to supply Equate's ethylene cracker. Additional quantities of ethane will also be recovered in order to supply the new Equate II cracker when it is operational in 2008.

**Oman** does not currently extract ethane for petrochemical use. However, DOW and Oman Oil are planning to develop an ethane cracker at Sohar due online in year 2010.

In **UAE**, the main ethane supply is from Ruwais and Habshan fractionation plants. The sole user of ethane is Borouge's ethylene cracker which is planning an expansion by 2010.

#### **4.4.2 GCC LPG Demand and Supply Outlook**

Liquefied Petroleum Gas (LPG) is produced from refining of crude oil or processing natural gas. It comprised of propane and butane, both of which are mainly used as fuel but can also be used in several petrochemical applications:

- Both propane and butane can be used to produce olefins by steam cracking or converted to aromatics via CYCLAR process
- Propane may be converted to propylene via propane dehydrogenation
- Iso-butane can be converted to isobutylene by dehydrogenation, alkylate or methyl tertiary butyl ether (MTBE) for gasoline blending

The Middle East is the world's largest LPG exporting region, with most LPG recovered from associated gas. This applied particularly to major producers

Saudi Arabia and UAE. Future LPG production is heavily dependent on level of crude oil production.

Demand for LPG in the Middle East is forecast to grow primarily as a result of continuing growth arising from petrochemical projects. Export of LPG will continue to increase as well given current gas field developments, notably associated with Qatari North field and Iran's South Pars field.

#### 4.4.2.1 GCC LPG Demand

LPG demand from fuel sector in this region is relatively small due to the hot climate and relatively low population. Middle East LPG demands for petrochemicals uses are focused in three countries- Saudi Arabia, Iran and Qatar – where it is typically used as feedstock to steam crackers. GCC LPG demand is shown in Table 4.9.

**Table 4.9: GCC LPG Demand (million tons)**

Country	ACTUAL		2005		FORECAST		2015	
	2000 Total	2000 Petchem.	Total	Petchem.	2010 Total	2010 Petchem.	Total	Petchem.
Saudi Arabia	5.6	5.5	8.8	8.6	9.4	9.2	10.2	9.9
Iran	2.8	2.7	3.7	3.6	4.4	4.2	4.5	4.2
Qatar	0.5	0.3	0.7	0.3	0.7	0.3	0.8	0.3
Kuwait	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4
Kuwait	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4
Oman	0.1	0.3	0.1	0.3	0.1	0.7	0.1	0.7
Oman	0.1	0.3	0.1	0.3	0.1	0.7	0.1	0.7
UAE	0.7	0.3	0.9	0.3	1.0	0.3	1.2	0.3
UAE	0.7	0.3	0.9	0.3	1.0	0.3	1.2	0.3
others	2.5	-	3.1	-	3.8	-	5.0	-
others	2.5	-	3.1	-	3.8	-	5.0	-
GCC Total	7	6.3	10.7	9.6	11.6	10.7	12.5	11.7
GCC Total	7	6.3	10.7	9.6	11.6	10.7	12.5	11.7
ME Total	12.3	9	17.5	13.2	19.8	14.9	22.1	15.9

\*Petchem: LPG demand for Petrochemicals production  
Source: CMAI Petrochemical Databank 2006 and SRI Database, 2006

In *Saudi Arabia*, industrial development based on LPG as a feedstock was promoted by providing a pricing incentive for companies to start considering petrochemical projects based on propane and butane feedstock. For example, Yabsab and Tasnee flexi-cracker designs which allow a broad range of natural gas liquids feedstock including LPG. The Ibn Rishd aromatics

project was also developed based on the CYCLAR technology, which converts LPG to benzene, toluene, and xylenes. To a smaller extent, butane is used to produce MTBE for export but this sector is not expected to offer significant growth potential due to usage restrictions being implemented in the US. Most new crackers are expected to include other feeds beyond ethane, as ethane supply is limited.

LPG has limited petrochemical uses in *Qatar* where it is supplied to Qafac's MTBE facilities. The only use of LPG in *Kuwait* is to produce small volume of MTBE in KNPC's Mina-Al-Armadi Refinery.

#### 4.4.2.2 GCC LPG Supply

Unlike other commodity hydrocarbons, LPG is usually not produced "on purpose" but it is produced as co-product from oil and gas production and as a by-product from crude oil refining. Table 4.9 lists the supply of LPG by country in GCC.

**Table 4.9 GCC LPG Supply & Trade\* (million tons)**

Country	ACTUAL				FORECAST			
	2000		2005		2010		2015	
	Supply	Trade	Supply	Trade	Supply	Trade	Supply	Trade
<b>Saudi Arabia</b>	18.1	12.5	20.1	11.3	22.8	13.4	28.7	18.5
<b>Iran</b>	3.1	0.3	4.5	0.7	8.8	4.5	8.8	4.3
<b>Qatar</b>	0.8	0.3	3.0	2.3	4.4	3.6	5.4	4.7
<b>Kuwait</b>	3.3	3.2	3.9	3.6	4.7	4.4	5.3	4.9
<b>Oman</b>	0.3	0.2	0.3	0.2	0.7	0.5	0.7	0.6
<b>UAE</b>	6.2	5.5	7.3	6.4	8.1	7.0	8.3	7.2
<b>others</b>	3.9	1.4	6.2	3.1	5.9	1.4	2.0	0.1
<b>GCC Total</b>	<b>28.7</b>	<b>21.2</b>	<b>34.6</b>	<b>23.4</b>	<b>40.7</b>	<b>28.9</b>	<b>48.4</b>	<b>35.9</b>
<b>ME Total</b>	<b>35.7</b>	<b>23.4</b>	<b>45.2</b>	<b>27.7</b>	<b>56</b>	<b>36.2</b>	<b>62.3</b>	<b>40.1</b>

\*Trade= Total Supply -total Demand= Export  
Source: CMAI Petrochemical Databank 2006 and SRI Database,2006

Over 90% of LPG in the GCC countries is from gas plants with remainder supplied from the refineries. Growth in supply in this region had been driven by improvements in LPG recovery associated with oil and gas production, notably in Saudi Arabia, UAE and Kuwait. *Saudi Arabia* produces vast amount of LPG as co-product of oil production. The capacity will increase given current oil field development activities in the forecast period.

*Qatar* and *Kuwait* will also be increasing LPG supply with the increasing oil & gas production. *Oman* LPG supply will increase by 0.3 million tons per year with the start up of new refinery in Sohar which has LPG sweetening unit.

#### **4.4.2.3 GCC LPG Trade**

The Middle East is the world's major exporting region of LPG supplying significant deficits in Asia particularly China and Japan. Saudi Arabia, Kuwait and UAE account for over 30% of global trade. Saudi Arabia is largest exporter of LPG with its current export volume at 11.3 million tons in 2005 and expected to increase to 18 million tons in next 10 years with current oil and gas developments. Export volumes are largely destined for Asia and Western Europe. Table 4.9 lists the trade (export) of LPG by country in GCC.

#### **4.4.3 GCC Naphtha Demand and Supply Outlook**

Naphtha is widely traded petrochemical feedstock, primarily used in ethylene cracking and reforming. Quality is key factor in determining the end use of naphtha, in terms of both boiling range and type of hydrocarbons that it contains- paraffins, naphthenes, and aromatics. Naphthas with high paraffin content are preferred for steam cracking while high naphthenic and aromatic content are preferred for catalytic reforming.

The Middle East has been the largest exporter of naphtha in the past and is expected to retain its dominant role in the future. Gas related investment in

the region has also contributed to the increase in naphtha production from condensates. Demand for naphtha in the ME petrochemical sector is limited as compare to Asia but it is forecasted to increase with new cracker projects and aromatic plants capacity additions in the region. Middle East Naphtha exports serve deficits in Asian and Western Europe markets.

#### 4.4.3.1 GCC Naphtha Demand

In Saudi Arabia, there are currently two mixed crackers are operating Petrokemya and Yanpet- and two more mixed feedstock crackers are planned to be brought on stream, Jubail Chevron Phillips in 2007 and PMD/SABIC in 2010. There are five benzene plants using naphtha as feedstock in Saudi Arabia with total capacity of 1.3 million tons per year and capacity is expected to triple by 2015. As such, the demand of naphtha and natural gasoline will increase at an average rate of 7.6% per year during 2005-2015. In Qatar, there are plants to build a new condensate splitter with capacity of 140,000 barrels per day which will produce naphtha by 2010. A world class aromatics plants is planned to be built in Kuwait by PIC in 2009, which will consume around one million tons of naphtha per year. GCC naphtha demand for petrochemicals is shown in Table 4.10

**Table 4.10 GCC Naphtha Demand (million tons)**

Country	ACTUAL		FORECAST		Average Annual Growth Rate (%)	
	2000	2005	2010	2015	2000- 2005	2005- 2015
Saudi Arabia	3.1	4.2	7.2	8.8	6.8	7.6
Iran	1.5	2.9	6.2	9.4	13.6	12.5
Qatar	-	-	5.3	5.3	-	-
Kuwait	-	-	1.0	0.9	-	-
Oman	-	-	-	-	-	-
UAE	-	-	-	-	6.3	2.1
Others	1.5	1.4	1.5	1.7		
<b>GCC Total</b>	<b>4.6</b>	<b>5.7</b>	<b>15</b>	<b>16.8</b>		
<b>ME Total</b>	<b>6.1</b>	<b>8.6</b>	<b>21.2</b>	<b>26.2</b>	<b>7.1</b>	<b>11.8</b>

Source: CMAI Petrochemical Databank 2006 and SRI Database, 2006

#### 4.4.3.2 GCC Naphtha Supply

Saudi Arabia is the only nation in the Middle East where supply of naphtha is broadly balanced with 50% supplied from refinery and 50% from gas plants. Production from gas facilities dominates in other GCC countries with refineries typically consuming naphtha to meet local gasoline requirements. The trend expected to continue in future with number of new refineries are planned over next decade across the region. GCC naphtha supply by county is shown in Table 4.11

**Table 4.11 GCC Naphtha Supply & Trade\* (million tons)**

Country	ACTUAL				FORECAST			
	2000		2005		2010		2015	
	Supply	Trade	Supply	Trade	Supply	Trade	Supply	Trade
<b>Saudi Arabia</b>	8.5	5.4	11.1	6.9	11.5	4.2	13.0	4.1
<b>Iran</b>	2.1	0.6	5.5	2.6	9.5	3.2	11.9	2.6
<b>Qatar</b>	1.9	1.9	3.9	3.9	7.1	1.8	7.9	2.7
<b>Kuwait</b>	1.9	1.9	8.2	8.2	8.6	7.7	8.8	7.8
<b>Kuwait</b>	8.1	8.1	1.7	1.7	1.7	1.7	1.7	1.7
<b>Oman</b>	0.8	0.8	6.1	6.1	8.1	8.1	11.1	11.1
<b>UAE</b>	3.6	3.6	14.2	12.8	15.1	13.5	16.2	14.5
<b>others</b>	10.9	9.4	<b>31.1</b>	<b>26.8</b>	<b>37</b>	<b>23.6</b>	<b>66.1</b>	<b>27.3</b>
<b>GCC Total</b>	<b>22.9</b>	<b>19.7</b>						
<b>ME Total</b>	<b>35.8</b>	<b>29.7</b>	<b>50.8</b>	<b>42.2</b>	<b>61.5</b>	<b>40.3</b>	<b>70.6</b>	<b>44.4</b>

\*Trade= Total Supply -total Demand= Export  
Source: CMAI Petrochemical Databank 2006 and SRI Database,2006

#### 4.4.3.3 GCC Naphtha Trade

The Middle East will continue to export naphtha, with volumes targeting Asia. The region is forecast to export around 27 million tons of naphtha by 2015. GCC naphtha supply by county is shown in Table 4.11

## **4.5 GCC PETROCHEMICAL FEEDSTOCK PRICE ANALYSIS**

Historically, market price of ethane, naphtha and LPG as petrochemical feedstock fluctuate together with slight deviations from that of crude oil prices under a market mechanism of supply/demand balance particular to each hydrocarbon.

### **4.5.1 Price of Natural Gas and Ethane in GCC Countries**

Unlike LPG and Naphtha, ethane is not a commonly traded commodity. Price setting thus varies widely from region to region depending on availability, extraction cost, delivery cost and the prevailing price of natural gas. In some countries the cost of ethane to petrochemical producers is linked to the price of derivative products. The supply price of natural gas in the GCC countries is artificially set by respective governments to a level substantially lower than in the US, for example, to encourage industrialization. The reasons for such mechanism were:

- GCC economies were striving to find ways to better use flared –off oil associated gas containing ethane.
- There was no prevailing international market price for methane and ethane in that era and region. GCC was using recovered oil associated gas only as fuel, with the exception of a limited quantity of methane exported as LNG, and there was no other output of massive amounts of methane and ethane in the region.
- Saudi Arabia and Qatar, which strongly promoted the petrochemical industry in the 1980s, wanted to use cheap ethane as an incentive to encourage industrialization of their countries, to create employment opportunities for the younger generation and to explore industrial energy output on their soil.



#### 4.5.1.1 Saudi Arabia

In early 1980s, by Royal decree, the Saudi Arabian government declared it would supply its ethane at solidly fixed price of \$0.50 /MMBtu to any consumer in any region of the country. The price was changed in January 1998 to \$0.75 /MMBtu (or \$37 per ton), the number is still firmly fixed and does not fluctuate in any manner with price of crude oil or natural gas on the open market.

#### 4.5.1.2 Qatar

Although Qatar has not announced it public, the price of natural gas and ethane currently it is estimated at \$ 0.70MMBtu and \$1.60MMBtu respectively. In the course of developing a gas trading market for exporting natural gas from Qatar to UAE and Oman (referred as the Dolphin Project) in the coming years, GCC regional market price of natural gas is expected to emerge at around \$1.3/MMBtu (CIF price). Considering that level, it is estimated that domestic price of natural gas in Qatar will be around \$1/MMBtu. The pricing scheme Qatar is likely to follow will be, different from Saudi Arabia, negotiated natural Gas and ethane prices case by case.

#### 4.5.1.3 UAE, Kuwait and Oman

The current natural gas price is estimated to be \$0.75/MMBtu. As transfer pipeline projects in the GCC countries (Dolphin Project) go ahead, the domestic price may be fixed based on the CIF price from Qatar of around \$1.30/MMBtu.

### 4.5.2 Price of LPG (Propane & Butane) in GCC Countries

LPG is traded as a commodity across the world. The market is more complex than for other refined products because, on the *supply side*:

- The production economics of LPG are not like other products as it typically produced as a by product of natural gas and crude oil refining, hence its market tend to be supply driven. It is not produced "on purpose" particularly in natural gas processing operations, where it usually must be removed from "wet" gas to meet operating specifications.
- Storage and handling are more expensive for LPG than other refined products, which mean that storage capacity is generally limited.

On the *demand side*:

- Each of the different end uses (gasoline blending, automotive, fuels and petrochemical feedstock) involves competition with different fuels, and hence different price drivers.
- LPG demand for fuels use is very sensitive to weather, with demand rapidly increasing during cold spells.

These factors mean that LPG markets are generally not as efficient (in economic terms) as those for other refined products. Massive quantities of LPG in the GCC countries have been exported to Asia, particularly to Japan. The contract price posted by Saudi Aramco (CP) for LPG has led the market price in Asia. The market price of LPG in the US has long been formed by considering the CP of LPG. The price of LPG as a petrochemical feedstock in regions importing LPG (Europe, USA and Asia) has been formed in accordance with an identical pricing mechanism.

Saudi Arabia, UAE, Kuwait and Qatar are major LPG exporting countries in the Middle East. For more than a decade Saudi Arabia has been the key in establishing the Middle East LPG export pricing:

- In the late 1980s, the formula linkage was naphtha related but this increasingly under valued LPG and /or did not take into account of its seasonality.
- This was revised and pricing was set monthly in mid 1990s, based on market factors, but included a retrospective adjustment linked to spot pricing.
- More recently, a monthly three stage tendering process was introduced where negotiations take place between major off-takers and Saudi Aramco, to establish a Contract Price (CP) to reflect the prevailing conditions.

Other Middle East exporters are also adopted Saudi CP reference to their term sales. Saudi CP has now for several years closely tracked the reported LPG spot price.

Propane and butane employed as petrochemical feedstock used to enjoy a 30% discount over the lowest Saudi export price in the preceding quarter. This provides an advantage to domestic LPG consumers for petrochemicals use and also eliminates the issue seasonality in prices during the year, which can be substantial. It is important to mention here the size and availability of this discount was a major point of contention in WTO accession talks, as the WTO felt that this was an "undue" benefit been provided by the State to the industry in Saudi Arabia. The Saudi position on this issue was that this discount is not discriminatory and is available to all ventures in Saudi Arabia. The basis/ justification for this has been cited as the cost saving of not investing in additional infrastructure and logistics ( ships and storage tanks necessary for LPG exports). This is considered as the "alternative value" of LPG in Saudi Arabia.

### 4.5.3 Price of Naphtha in GCC Countries

Naphtha prices are influenced by a variety of the factors, with the major one being: international crude oil price level, gasoline market fundamentals (supply/ demand balance in the region), underline refining margins in the region, the price differential between light and heavy products and supply/ demand balance for naphtha in the region. Like LPG, none of the other countries in GCC except Saudi Arabia offer an advantage (discount) over international price for use of natural gasoline/naphtha as a petrochemical feedstock in the country.

Using natural gasoline for cracking feedstock in Saudi Arabia carries a slight disadvantage versus naphtha cracking operations in other regions. A major impact on the overall economics is the utilization of by-product streams from the cracker. Integrated crackers in Europe in Asia usually have downstream plants that add value by converting the olefins (ethylene, propylene and butadiene) into derivatives. In Saudi Arabia, the olefins industry is based heavily around ethylene. For the by-products, there are two polypropylene plants, while there is no major butadiene consumer. Therefore, other than propylene, there is limited value addition opportunity for other co-product streams.

Price for naphtha in Singapore, Japan and the Middle East are quoted for naphtha streams whose quality confirms the specification in the "open-spec" naphtha contracts utilized by Japanese traders and other in the region. Open-spec, by definition, incorporates a wide range of naphtha quality, but generally can be characterized by lighter (specific gravity of 0.69 or lower), paraffinic (greater than 65% paraffins) naphtha which is suitable for ethylene plant feedstock.

Japanese and Singapore naphtha pricing reflects international crude oil prices, Singapore refinery margin developments and variation in the differentials between price of major refined products, particularly gasoline.

These factors are expected to establish Singapore naphtha price over the long term. CIF Japan prices have historically been above FOB Singapore prices, reflecting Japan's import position and freight cost associated with supplying Japan with product from Middle East or Singapore refineries.

Most Asian and Middle Eastern naphtha streams have a higher quality than the "open-spec" naphtha specifications and generally command a premium above the quoted prices of "open-spec" naphtha. This premium is in the range of \$2-10 per ton (\$0.2-\$1 per barrel) and varies with market conditions for naphtha and ethylene.