

CHAPTER-3

INTERNATIONAL SCENARIO OF NATURAL GAS

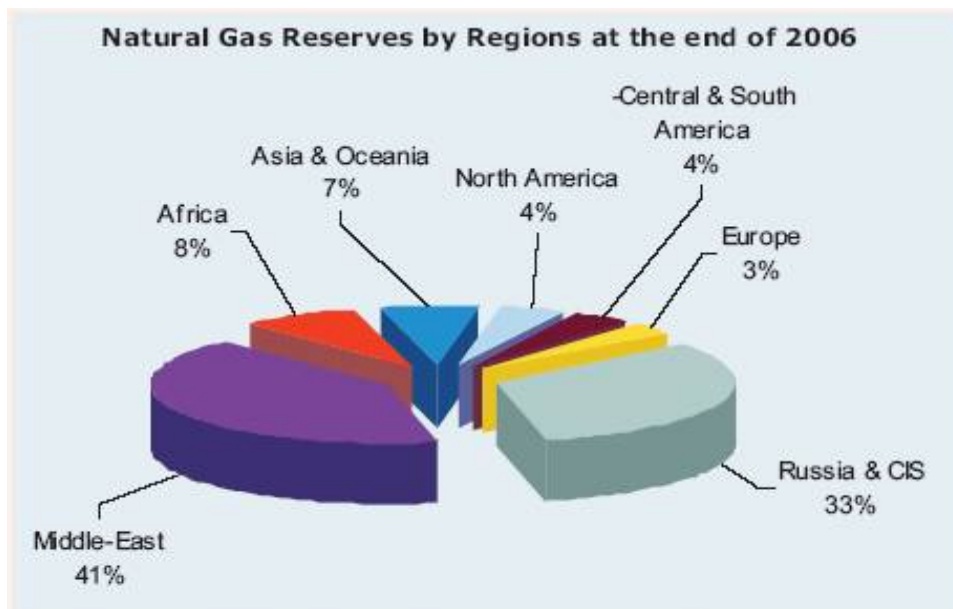
3.1 INTRODUCTION

The annual world demand for natural gas is 282.7 trillion cubic feet, and it is rising. The global market for gas is much smaller than for oil because gas transport is costly and difficult. Out of 103,843 BCF gas produced every year, only 19,404 BCF gas is traded by pipeline. This is about 18.5 percent of global gas production. Out of the rest of the gas, 7.7 percent, i.e. 7992.2 BCF is traded as LNG, with more than 10.8 percent of the trade accounted for by liquefied natural gas. However, in spite of the high cost of gas transportation and remote location of potential future supply regions, increasing international trade in natural gas is expected. Global gas reserves are abundant, but unevenly distributed. Industrialized countries are the major importers, but major gas supplies are located in the former Soviet Union and the Middle East. *[BP Statistics Review 2007]*

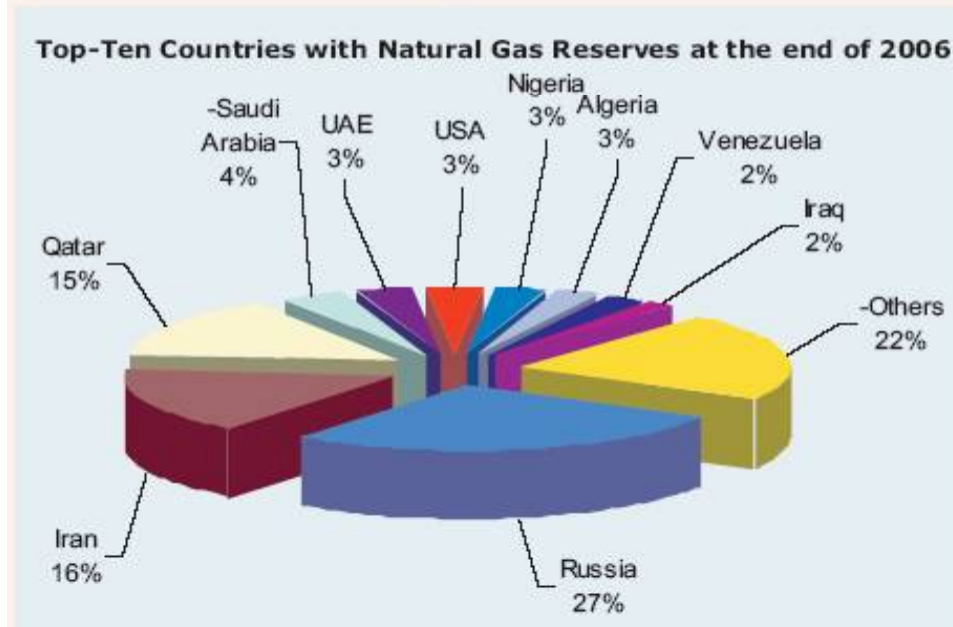
3.2 GLOBAL DISTRIBUTION AND PRODUCTION

As in the case of oil, natural gas is unevenly distributed throughout the world. More than one-third of the world's original gas endowment was in the territory of the former Soviet Union. The second largest gas resource, located in the Middle East, comprised about 22 percent of the world total. About 17 percent of the world's original recoverable gas was located in North America, and accounted for more than one-half of the world's gas production. Currently North America contains only 11 percent of the world's remaining gas resources. About 38 percent of the world's remaining gas is in the Former Soviet Union and 25 percent is located in the Middle East. South America, Europe, Africa, and Asia/Oceania are each projected to contain less than 10 percent of the world's remaining natural gas.

The world distribution of natural gas mirrors that of oil, which is as expected, since oil and gas are often generated and stored together. However, the Middle East which contains a very significant amount of gas, does not dominate world gas as it does world oil. The former USSR holds the dominant natural gas resource. It is also the world's leading gas producer, although its output is only slightly higher than that of North America. North America produces a large amount of gas from a relatively small reserve. Its reserves/production (RPR)¹ ratio of 12/1 contrasts with the 80/1 RPR of the former USSR.



Source: EIA, International Energy Outlook, Jan 2007



Source: EIA, International Energy Outlook, Jan 2007

Exhibit: 3.1

The world Natural Gas reserves by region and countries is shown in Exhibit.3.1

¹ Note: The Reserves-to-production ratio (RPR) is the remaining amount of a depleting natural resource, expressed in years. The RPR is commonly

applied to fossil fuels. The reserve portion (numerator) of the ratio is the amount of a resource known to exist in a specific location and which can be economically recoverable (proved reserves). The production portion (denominator) of the ratio is the amount of resource used in one year at the current rate.

Production quantities of natural resources can be readily measured; reserves can only be estimated. Optimism or pessimism can influence such estimates. Further, reserves are resources that are economically recoverable under existing conditions. Reserves may change as a result of new discoveries, technological advances, political change, or manipulation. Consumption of many resources is not constant, but typically increases as the population grows and becomes more prosperous. Non-constant values for both the numerator and denominator of the ratio imply it may either overestimate or underestimate the remaining life of the resource. (Ref: www.en.wikipedia.org)

The RPR is a measure of the rate of production of a proved gas reserve. Associated gas is produced along with oil, which can be efficiently recovered at a maximum RPR of about 10/1. Non-associated gas, which is more volatile than oil, can be produced at faster rates, sometimes as fast as an RPR of 5/1. Average regional RPR for intensively and efficiently developed natural gas provinces may range between 7/1 and 10/1. In general, the average RPR of a gas province or country is indicative of its development maturity. It will consist of a combination of low RPR in older depleting fields and higher RPR in more newly developed fields. Larger fields are usually discovered early in the exploration cycle (due to their large size and anomalous geology) and they will dominate. However, with depletion, they tend to decrease the average RPR. Any gas reserve that is undeveloped or not tapped efficiently increases the average RPR. An average RPR above 12/1 usually indicates a gas province or country in which significant new discoveries are being made, and/or one in which gas development is not intensive or production is not optimized.

North America, and particularly the United States (with an RPR of 9/1), is an intensively developed and mature gas producing region. Russia, with an RPR of 82/1, contains significantly larger gas reserves than the United States, but its gas output is only 10 percent higher. The United Kingdom is also intensively developed, producing gas at an RPR of 9/1. Average European gas production is at an RPR of 24/1, indicating that substantial reserves remain. In Asia/Oceania, South America, and Africa gas reserves are underdeveloped with average RPR ranging from 54/1 to 131/1. The Middle East, with its moderate gas output and enormous gas reserves, has an RPR of 409/1.

3.3 GLOBAL NATURAL GAS CONSUMPTION AND TRADE

The United States consumes about 2.4 TCF more natural gas per year than it produces. Germany imports even more gas than the United States (2.6 TCF per year) and Japan slightly less (2.3 TCF per year). North America is the leading consumer of natural gas, but is also a leading producer. The former USSR region leads the world in gas production, and is second in consumption. Europe ranks third in natural gas consumption, but has to import 4.1 TCF every year. Asia/Oceania has also to import natural gas to satisfy demand. Other regions are relatively minor producers and consumers of gas.

As compared to oil, only moderate amounts of natural gas are traded in world markets. Currently, only 16 percent of the produced gas is traded internationally. LNG accounts for less than 4 percent of this trade. The low density of gas makes it more expensive to transport than oil. A section of pipe transporting oil contains 15 times more energy than when used to transport high pressure gas. Thus, gas pipelines must be of larger diameter for the same energy movement. Compression adds to the disparity between the transportation costs of the two fuels. An oil pumping station uses energy to overcome frictional losses, but a gas line requires a large amount of energy to compress the gas before pipeline friction is encountered.

Pipeline transportation is not always feasible because of the growing geographic distance between gas reserves and markets. Further, since potential political instabilities could affect long pipeline routes, importing countries may like to diversify supply sources. While natural gas can be piped in a gaseous state, it needs to be condensed (liquefied) so that sufficient energy is packaged to be economically transported by ship. A full liquefied natural gas (LNG) chain consists of a liquefaction plant; low temperature, pressurized, transport ships; and a regasification terminal. World LNG trade is currently about 60 million metric tons per year, some 65 percent of which is imported by Japan. Other importers include France, Spain, Korea, Belgium, Taiwan, and Italy. Indonesia accounts for 39 percent of LNG exports, with Algeria in second place with 24 percent. Other exporters include Malaysia, Brunei, Australia, Abu Dhabi, and Libya. The United States imports and exports about 1 million metric tons of LNG per year.

The North American market is self sufficient in natural gas, although gas is traded within the region. Canada is expected to remain a net exporter of gas to the United States. Substantial natural gas reserves are located in Europe. Gas trade within Europe is extensive, with Norway and the Netherlands

being the main sources. Europe, however, is and will increasingly become more dependent on gas imported from other regions. Its traditional foreign suppliers, the former Soviet Union (meeting 20 percent of demand) and Algeria at (10 percent), are expected to increase their share of the European gas market. Important gas exporters in the Asia-Pacific region are Indonesia, Malaysia, Brunei, and Australia. The gas is shipped as LNG to Japan, Taiwan, and South Korea. The Middle East is another important supply center for natural gas. Abu Dhabi and Qatar deliver significant volumes of LNG to the Asia-Pacific region and future exports could be sent to Europe and South Asia. Gas demand in Africa, South Asia, and China are met by domestic or regional supplies. Some gas is being traded within South America. With industrialized countries as major gas importers, and the major gas supplies located in the former Soviet Union and the Middle East, the expanded use of natural gas by Europe and Japan will (like world oil utilization) become increasingly dependent on the world's most unstable regions. While Canada provides most of the natural gas imports to the United States and Mexico could become a significant gas source, the U.S. also imports LNG from Algeria.

In terms of export, the major exporters of natural gas at the end of 2006 were Russia and CIS nations, Canada, Norway, Algeria, the Netherlands and Indonesia. Russia and the CIS countries exported 162,900 million m³ of natural gas in 2006, while Canadian exports amounted to 99,750 million m³, while Norway exported 84,000 million m³. In terms of imports, the US along with Germany, Japan, Italy, France and Spain are among the leading importers. At the end of 2006, the US imported 116,390 million m³, followed by Germany's 90,800 million m³ and Japanese imports of 81,852 million m³. Earlier till 1993, Germany was the leading importer of natural gas after which the US became the leading importer. Region wise, it is mainly West Europe and East Europe that have driven the export markets. In terms of imports, it is the US that is the largest importer at 3.52 TCF, followed by Germany at 3.20 TCF of imports and Italy at 2.62 TCF. As far as liquefied natural gas (LNG) is concerned, Qatar is the largest exporter of LNG and exports around 1.09 TCF followed by Indonesia at 1.04 TCF. The third and fourth largest exporters of LNG are Malaysia and Algeria, at 0.99 TCF and 0.87 TCF, respectively. Japan is the largest importer of LNG, (2.89 TCF) followed by South Korea (1.20 TCF), Spain (0.86 TCF), the US (0.58 TCF) and France (0.49 TCF).

North America and a combined Europe, particularly Russia, produce and consume most of the natural gas in the world. The share of Middle East has been increasing through LNG exports but the region's future significance in natural gas cannot be ignored as they command the largest proved reserves. Iran, Saudi Arabia and Qatar will thus be key players in natural gas production. A major quantum of trade in natural gas takes place in the Eurasian region, i.e. between Western Europe and Eastern Europe, with additional demand and supply chains in Caucasus and Central Asia. In North America, the trade in

natural gas takes place mainly between the US and Canada. Historically, west Europe used to lead in overall natural gas consumption and production, but other regions, including North America and Asia-Pacific, are catching up fast. The emerging economies of Asia-Pacific, especially China and India, are also seeking to diversify and switch to natural gas for their energy requirements. In the future, the natural gas market is likely to be driven by demand in these emerging economies and their proximity to producing regions will make the market more competitive.

The World Natural Gas Imports/ Exports-2005 are shown in Exhibit 3.2.

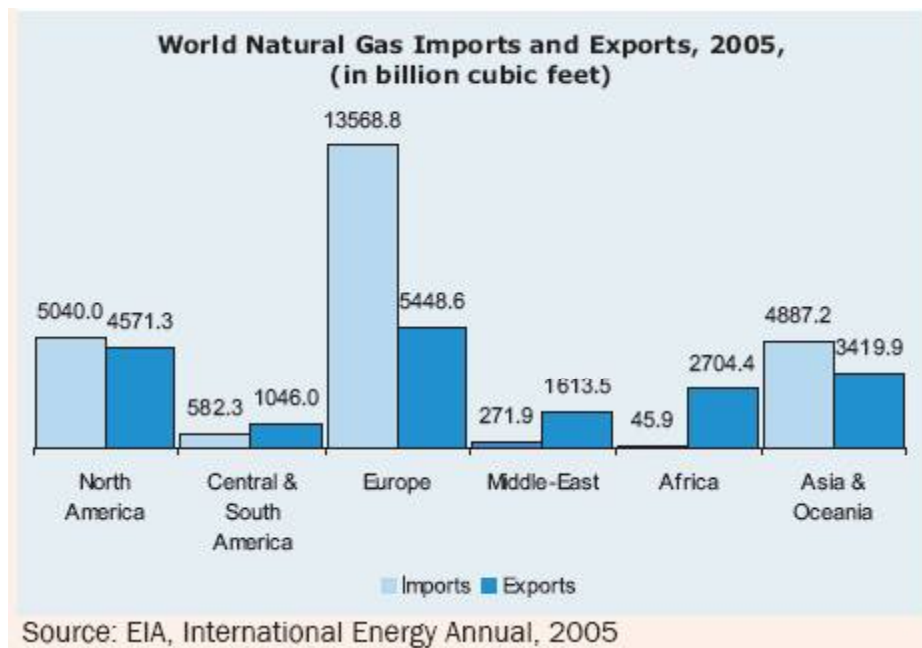


Exhibit: 3.2 World Natural Gas Imports/ Exports-2005

3.4 WORLD NATURAL GAS PRODUCTION VS CONSUMPTION

Referring to Exhibit 3.3, the top natural gas consumers are the US, Russia, Iran, Canada, the UK, Germany, Japan, Italy and Saudi Arabia. As for region-wise consumption, North America is the largest, consuming 27.1 trillion cubic feet (TCF) of natural gas followed by Russia and CIS nations. Europe is not very far behind, with its consumption at 20.3 TCF. Asia and Oceania regions consume 15.3 TCF, while the Middle East consumes 10.1 TCF followed by Central and South America and Africa at 4 TCF and 3.1 TCF, respectively.

Preliminary estimates at the end of 2007 show total world production of natural gas at 104.849 TCF. At the beginning of 2007, Russia and CIS countries were leading producers at 29.7 TCF, followed closely by North America with 26.8

TCF. Asia-Oceania region produced 13.3 TCF followed by Middle East with 11.8 TCF, while Europe and Africa produced 11.2 TCF and 6.8 TCF, respectively. As far as reserves are concerned, proven world natural gas reserves at the beginning of 2007 stood at 6,182.692 TCF. The term 'proven reserves of natural gas' implies quantities that can be recovered, as indicated by current geological and engineering information. The Middle East region along with Russia and the CIS countries possess over three-quarters or 70 per cent of the proven global natural gas reserves. The Middle East's share stands at 41 per cent while Russia and CIS countries follow closely with 33 per cent. Collectively, the top 10 countries, i.e. Russia, Iran, Qatar, Saudi Arabia, UAE, US, Nigeria, Algeria, Venezuela and Iraq possess around 4831.3 TCF of natural gas reserves while other countries hold 1351.4 TCF of the world total of 6182.7 TCF.

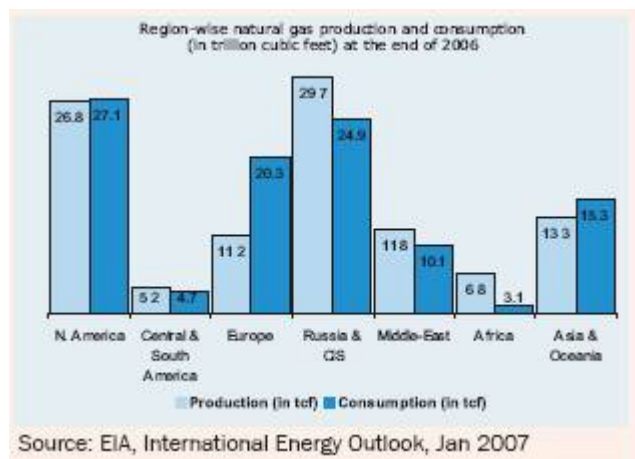


Exhibit: 3.3

3.5 WORLD PRIMARY ENERGY CONSUMPTION

World primary energy consumption increased by 2.4 percent in 2007. This was down from 2.7 percent in 2006, but still the fifth consecutive year of above-average growth. The Asia-Pacific region accounted for two-thirds of global energy consumption growth, rising by an above-average 5 percent even though consumption in Japan declined by 0.9 percent. North American consumption rebounded after a weak year in 2006, rising by 1.6 percent – double the 10-year average. Chinese growth of 7.7 percent was the weakest since 2002, although still above the 10-year average (as was China's economic growth). China again accounted for half of global energy consumption growth. Indian consumption grew by 6.8 percent, the third-largest volumetric increment after China and the US. Energy consumption in the European Union declined 2.2 percent, with Germany registering the world's largest decline.

The trend in world's primary energy demand in million tonnes oil equivalent (MTOE) is shown in Exhibit 3.4 and Table 3.1.

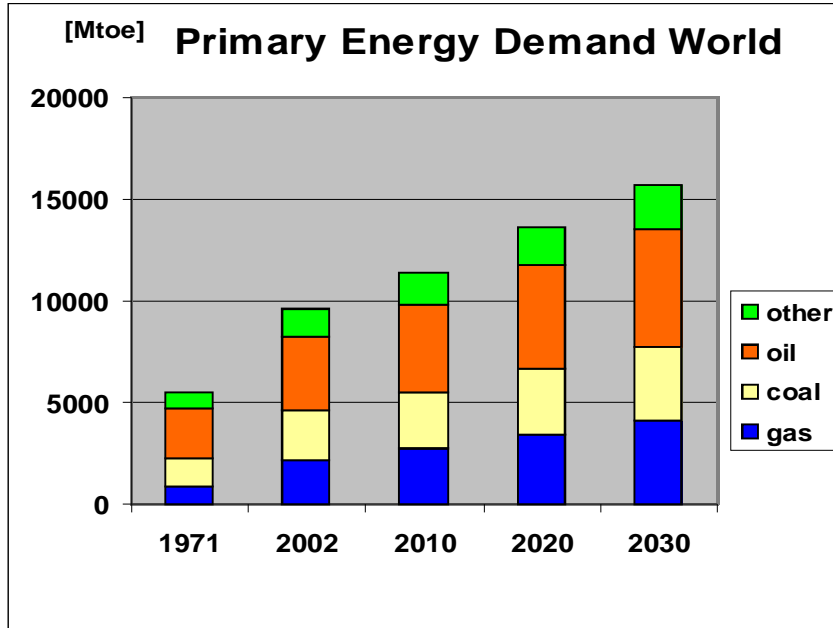


Exhibit:3.4

[MTOE]	1971	2002	2010	2020	2030
Gas	892	2190	2703	3451	4130
Coal	1407	2389	2763	3193	3601
Oil	2413	3676	4308	5074	5766
Other	795	1398	1641	1911	2226
Nuclear	29	692	778	776	764
Total	5536	10345	12193	14405	16487

Table: 3.1 Primary Energy Demand - World

Natural gas consumption (some 282.7 trillion cubic feet in 2007), is rising faster than that of any other fossil fuel. About two-thirds of the increase in gas demand is in the industrial and power generation sectors, while the remaining one-third is in space heating of buildings and homes. Recent technological improvements in the design, efficiency, and operation of combined cycle gas turbines have tilted the economics of power generation

in favor of natural gas. Gas fuelled power plants have lower capital costs, may be built faster, are more efficient, and emit less air pollutants than other fossil fuel based power plants. Consequently, a major share of new power generation capacity is based on natural gas. *[BP Statistics Review 2007]*

3.6 RISING UTILITY OF NATURAL GAS

In recent years, the need to meet the world's growing energy demand has been eclipsed by rising oil prices and the perils of climate change. In this scenario, the role of natural gas – a relatively abundant and clean fuel has attained new significance. In isolation, the sheer volume of gas reserves and resources is sufficient to meet the global growth in consumption. Based on 2006 estimates, gas has a reserve-to-production ratio of 61 years and a resource-to-production ratio of 133 years. In contrast, oil has a reserve-to-production ratio of 40 years and a resource-to-production ratio of 60 years.

Between 2005 and 2020, global consumption of natural gas is expected to grow at a compounded annual growth rate of about 2.7 per cent, that is, from about 2600 BCM in 2005 to around 3900 BCM in 2020. Rapid economic growth will make Asia the fastest growing region in the world as consumption accelerates by 5.8 percent year-on-year during this period. However, adoption of renewable energy resources and the resulting energy efficiency could impact gas consumption significantly.

As regional demand and supply imbalances increase, need for LNG and an international pipeline become even more important. If supply constraints do not exist LNG and international pipelines are likely to account for 23 to 24 percent or approximately 955 BCM of natural gas flows by 2020, as compared to 15 percent in 2005.

In the short to medium term, flow constraints will create a mismatch between demand and supply of natural gas.

Gas flows will be constrained by the following key factors in the short to medium term:

- Uncertainty about availability of gas for export from key producing centers:

Gas exporting countries in the Middle East and Asia are using additional quantity of indigenous gas to meet growing domestic demand. The political unrest in Nigeria affected the availability of gas for exports. Even Qatar which is a large producer of gas will not be able to step-up supplies due to liquefaction capacity constraints and the moratorium of additional exploration activities till 2010. There could also be delay in availability of

Russian supplies to Europe. Some of the LNG contracted to Europe may not be diverted to Asia or North America to meet their needs.

- Delays in the build-outs of additional LNG and pipeline infrastructure:

By 2020, an additional 320 to 325 BCM of liquefaction capacity will be needed in addition to the existing 225 BCM. Further, another 140 to 145 BCM of international pipeline capacity will be required over the existing 220 BCM. Executing such large scale projects would not be an easy task.

- Significant uncertainty clouds the implementation of liquefaction projects:

Australia, Iran, Nigeria and Qatar delay build-outs of their liquefaction capacities due to several factors. Overheated engineering, procurement and construction (EPC) markets, technical issues, uncertainty in achieving financial closure as a result of rising costs, delays in project execution and geopolitical issues are notable reasons. Further, in the last two to three years, the cost and time of building liquefaction terminals has risen by 20 to 50 percent. Closing deals with the National Oil Companies (NOCs) has also become increasingly difficult. Across regions, most liquefaction capacities have about 90 percent utilization rate. Such high cumulative utilization rates provide limited flexibility for managing seasonal variations, or to conduct preventive maintenance. Therefore, liquefaction capacity is likely to remain a bottleneck in the short to medium term

- Setbacks in pipeline construction resulting from geopolitical tensions are also likely to slow down pipeline build-outs, as witnessed in the Iran-Pakistan-India pipeline project and South Stream pipeline project.

Flow constraints will become increasingly evident in the next three to seven years, highlighting the urgency to complete pipeline and liquefaction projects.

3.7 FUTURE PROSPECTS

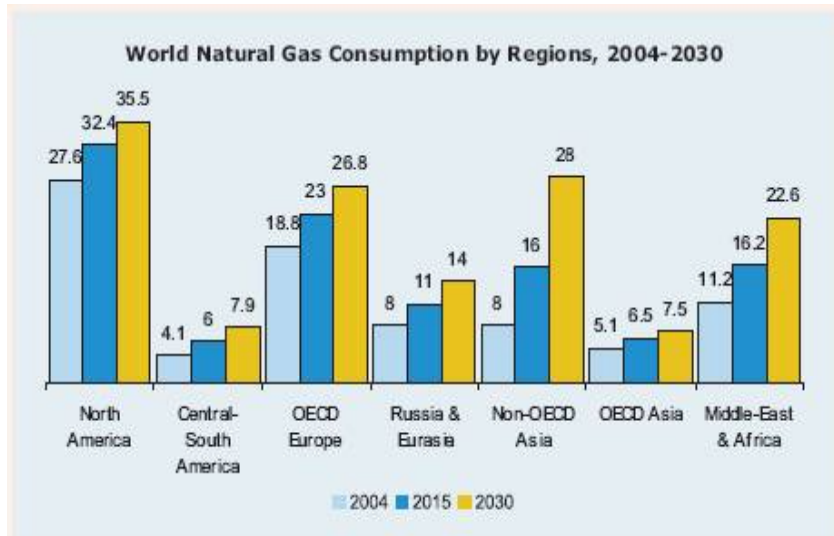
Referring to Table 3.2, the world produced 99 TCF of natural gas in 2004. It is estimated that the total world production will rise to 117 TCF by the year 2010 and 141 TCF by 2020. By 2030, global natural gas production is projected to be 164 TCF.

World Natural Gas Production Projections by Region, 2004-2030 (in trillion cubic feet)					
Years	OECD	Russia	Middle-East	Other Non-OECD	Total
2004	40	22	10	27	99
2010	42	26	14	35	117
2015	42	29	16	42	129
2020	44	31	18	48	141
2025	44	34	20	53	151
2030	45	37	23	59	164

Source: EIA, International Energy Outlook, Jan 2007

Table: 3.2

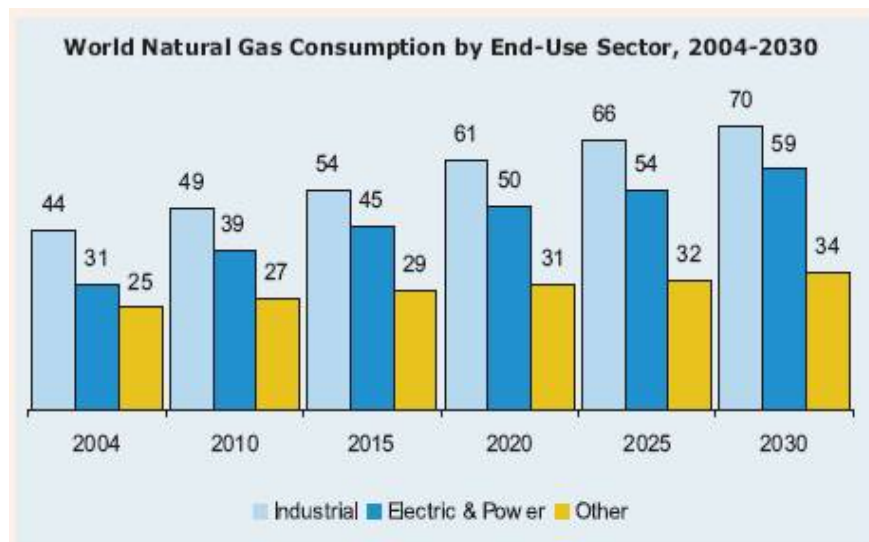
Referring to Exhibit 3.5, the projections for consumption in natural gas suggest a gradual increase to 7.5 TCF by 2030 in OECD countries in Asia. This includes Japan, the New Zealand and South Korea. Consumption in North America is projected to reach 35.5 TCF in 2030. The US, which consumed around 22.4 TCF in 2004, will utilize 26.1 TCF by 2030. OECD members in Europe, which consumed 18.8 TCF in 2004, will see a projected increase in consumption to 26.8 TCF by 2030. The projected consumption for Russia and other non-OECD Europe stands at 22.0 TCF and 14.0 TCF respectively. Projections for non-OECD Asia will see a huge increase in consumption from 8 TCF in 2004 to 28 TCF by 2030. The two fastest emerging economies, India and China, will see an increase in natural gas consumption at 4 and 7 TCF, respectively by 2030 against consumption of just 1 TCF in 2004. Other non-OECD Asian countries will also see a substantial increase in their natural gas consumption from 6 TCF to 17 TCF by 2030. The other regions - Middle East, Africa and Central and South America - will also witness positive increase in the consumption of natural gas. The Middle East would in fact double its consumption from 8.6 TCF in 2004 to 16.4 TCF by 2030. Africa will consume about 6.2 TCF by 2030 while Central and South America will consume 7.9 TCF by that year.



Source: EIA, International Energy Outlook, 2007

Exhibit: 3.5

There would not be much difference in global consumption pattern of natural gas in 2030. The US and OECD Europe will be consuming more natural gas than any other region. Consumption in non-OECD Europe will increase nominally. Sector-wise consumption estimates point that more and more natural gas will be used as feedstock in industries besides its wide use in power generation. Exhibit 3.6 shows the forecast usage of Natural Gas in various sectors.



Source: EIA, International Energy Outlook, 2007

Exhibit.3.6