

Natural Gas

Natural gas is the fastest growing primary energy source in the IEO2005 forecast. Consumption of natural gas is projected to increase by nearly 70 percent between 2002 and 2025, with the most robust growth in demand expected among the emerging economies.

Natural gas is projected to be the fastest growing component of world primary energy consumption in the *International Energy Outlook 2005 (IEO2005)* reference case. Consumption of natural gas worldwide increases in the forecast by an average of 2.3 percent annually from 2002 to 2025, compared with projected annual growth rates of 1.9 percent for oil consumption and 2.0 percent for coal consumption. From 2002 to 2025, consumption of natural gas is projected to increase by almost 70 percent, from 92 trillion cubic feet to 156 trillion cubic feet (Figure 34), and its share of total energy consumption on a Btu basis is projected to grow from 23 percent to 25 percent. The electric power sector accounts for almost one-half of the total incremental growth in worldwide natural gas demand over the forecast period.

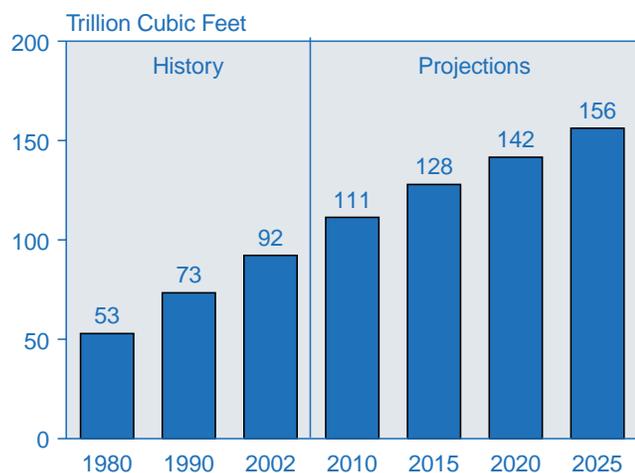
On a regional basis, the largest increases in natural gas consumption worldwide are projected for the transitional economies of Eastern Europe and the former Soviet Union (EE/FSU) and for emerging Asia (Figures 35 and 36). Natural gas use in the EE/FSU expands by 63 percent over the projection period; and in emerging Asia, gas use is expected to nearly triple from 2002 to 2025. In the mature market economies, where natural gas markets are more established, consumption of

natural gas is projected to increase by a more modest annual average of 1.6 percent from 2002 to 2025, with the largest incremental growth in the mature market economies projected for North America, at 11 trillion cubic feet.

The emerging economies are also expected to show the strongest growth in natural gas production, with a projected average increase of 4.1 percent per year from 2002 to 2025 in the reference case (Figure 37). In contrast, natural gas production in the transitional economies is projected to grow at an average annual rate of 2.3 percent, and production in the mature market economies is expected to increase by an average of only 0.6 percent per year from 2002 to 2025.

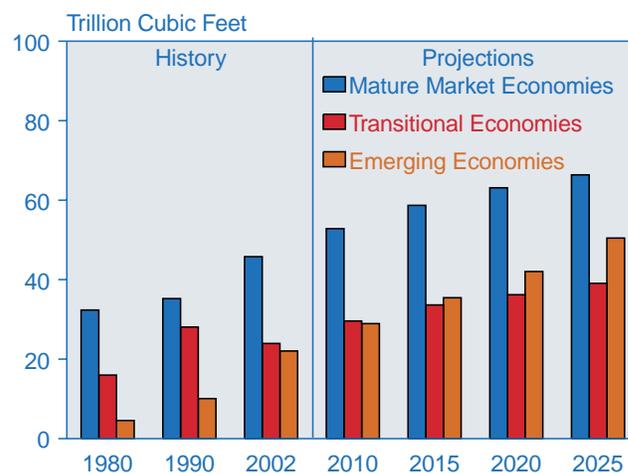
The disparity between the increase projected for natural gas consumption in the mature market economies and the much smaller increase projected for their gas production points to an increasing dependence on the transitional and emerging market economies for gas supplies (Figure 38). In 2002, the mature market economies accounted for 42 percent of the world's total natural gas production and 50 percent of the world's natural gas consumption; in 2025, they are projected to account

Figure 34. World Natural Gas Consumption, 1980-2025



Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2002*, DOE/EIA-0219(2002) (Washington, DC, March 2004), web site www.eia.doe.gov/iea/. **Projections:** EIA, System for the Analysis of Global Energy Markets (2005).

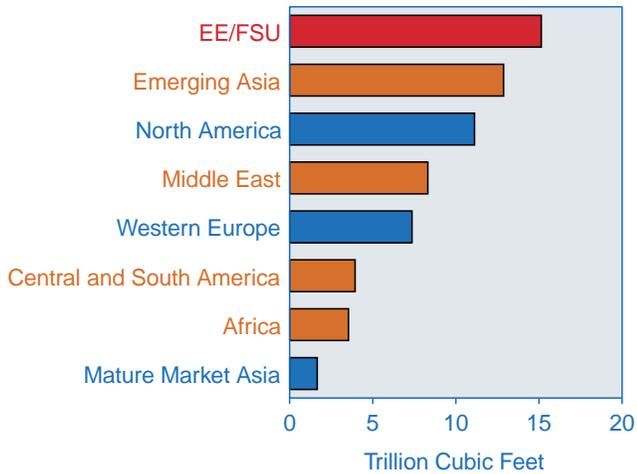
Figure 35. Natural Gas Consumption by Region, 1980-2025



Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2002*, DOE/EIA-0219(2002) (Washington, DC, March 2004), web site www.eia.doe.gov/iea/. **Projections:** EIA, System for the Analysis of Global Energy Markets (2005).

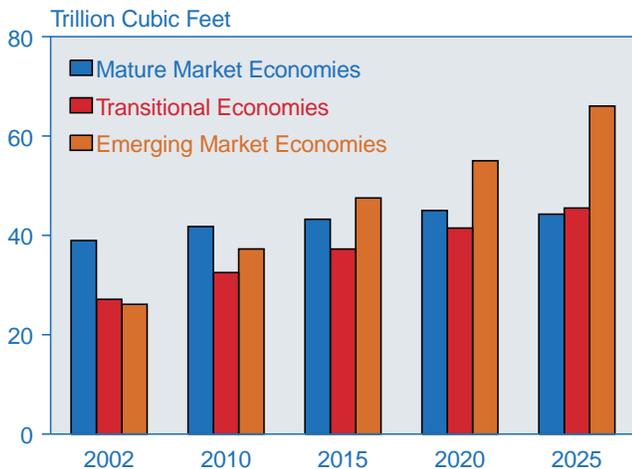
for only 29 percent of production and 43 percent of consumption. As a result, the mature market economies are expected to rely on imports of natural gas from other parts of the world to meet almost one-third of their natural gas consumption in 2025, up from 15 percent in 2002.

Figure 36. Increases in Natural Gas Consumption by Region and Country Group, 2002-2025



Sources: **2002:** Energy Information Administration (EIA), *International Energy Annual 2002*, DOE/EIA-0219(2002) (Washington, DC, March 2004), web site www.eia.doe.gov/iea/. **2025:** EIA, System for the Analysis of Global Energy Markets (2005).

Figure 37. Natural Gas Production by Region, 2002-2025



Sources: **2002:** Energy Information Administration (EIA), *International Energy Annual 2002*, DOE/EIA-0219(2002) (Washington, DC, March 2004), web site www.eia.doe.gov/iea/. **Projections:** EIA, System for the Analysis of Global Energy Markets (2005).

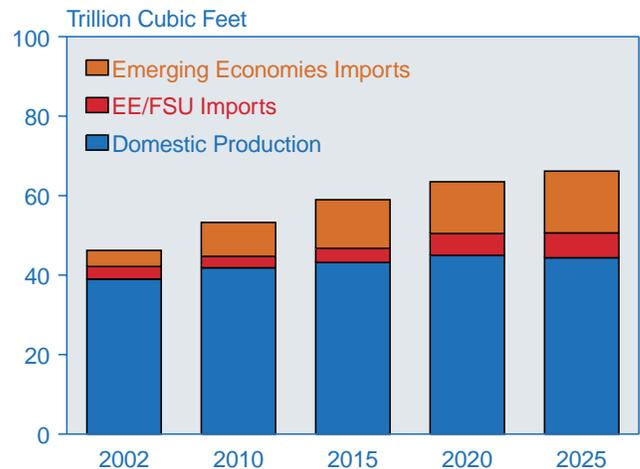
Reserves and Resources

As of January 1, 2005, proved world natural gas reserves, as reported by *Oil & Gas Journal*,³ were estimated at 6,040 trillion cubic feet—36 trillion cubic feet (less than 1 percent) lower than the estimate for 2004 [1]. In general, world natural gas reserves have trended upward since the mid-1970s (Figure 39).

The largest revision to natural gas reserve estimates was made in Australia. The Australian government reported a two-thirds cut in its estimate of natural gas reserves between 2004 and 2005, from 90 trillion cubic feet to 29 trillion cubic feet. Higher reserve estimates were recorded for the emerging economies, mostly in Africa and the Middle East. Nigeria alone accounted for most of the increment in Africa, with a gain of 17 trillion cubic feet (11 percent), and Libya reported a smaller increase of 6 trillion cubic feet (12 percent). In the Middle East, Saudi Arabia increased its estimate of reserves by 4 trillion cubic feet (2 percent), accounting for all of the region’s addition to reserves. Elsewhere, national estimates of natural gas reserves changed little over the 1-year period.

Almost three-quarters of the world’s natural gas reserves are located in the Middle East and in the transitional economies of the EE/FSU (Figure 40). Russia, Iran, and Qatar combined account for about 58 percent of the world’s natural gas reserves (Table 8). Reserves in

Figure 38. Natural Gas Consumption in Mature Market Economies by Source, 2002-2025



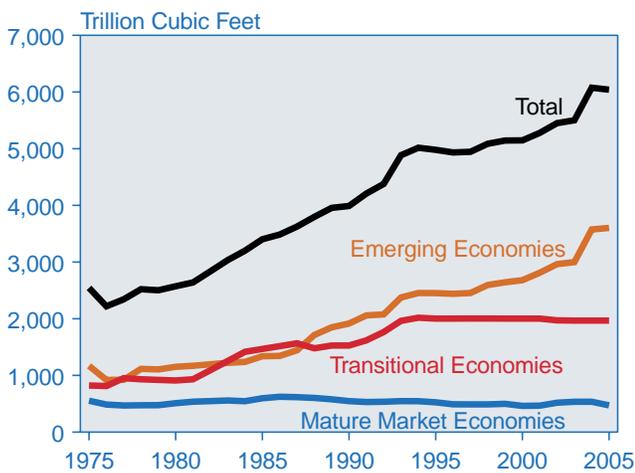
Sources: **2002:** Energy Information Administration (EIA), *International Energy Annual 2002*, DOE/EIA-0219(2002) (Washington, DC, March 2004), web site www.eia.doe.gov/iea/. **Projections:** EIA, System for the Analysis of Global Energy Markets (2005).

³Proved Reserves, as reported by the *Oil & Gas Journal*, are estimated quantities that can be recovered under present technology and prices. Figures reported for Canada and the former Soviet Union, however, include reserves in the probable category. Natural gas reserves reported by the *Oil & Gas Journal* are compiled from voluntary survey responses and do not always reflect the most recent changes. Significant natural gas discoveries made during 2004 are not likely to be reflected in the reported reserves.

the rest of the world are fairly evenly distributed on a regional basis.

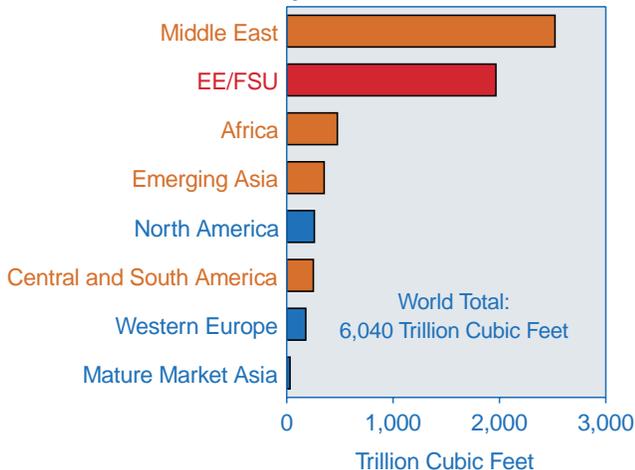
Despite high rates of increase in natural gas consumption, particularly over the past decade, most regional reserves-to-production ratios have remained high. Worldwide, the reserves-to-production ratio is estimated at 66.7 years [2]. Central and South America has a reserves-to-production ratio of 55.0 years, the FSU 77.4 years, and Africa 96.9 years. The Middle East's reserves-to-production ratio exceeds 100 years.

Figure 39. World Natural Gas Reserves by Region, 1975-2005



Sources: **1975-1993:** "Worldwide Oil and Gas at a Glance," *International Petroleum Encyclopedia* (Tulsa, OK: PennWell Publishing, various issues). **1994-2004:** *Oil & Gas Journal* (various issues).

Figure 40. World Natural Gas Reserves by Region as of January 1, 2005



Source: "Worldwide Look at Reserves and Production," *Oil & Gas Journal*, Vol. 102, No. 47 (December 20, 2004), pp. 22-23.

The U.S. Geological Survey (USGS) periodically assesses the long-term production potential of worldwide petroleum resources (oil, natural gas, and natural gas liquids). According to the most recent USGS estimates, released in the *World Petroleum Assessment 2000*, a significant volume of natural gas remains to be discovered. The mean estimate for worldwide undiscovered natural gas is 4,301 trillion cubic feet (Figure 41), which is approximately double the worldwide cumulative consumption forecast from 2002 to 2025 in *IEO2005*. Of the total natural gas resource base, an estimated 3,000 trillion cubic feet is in "stranded" reserves, usually located too far away from pipeline infrastructure or population centers to make transportation of the natural gas economical. Of the new natural gas resources expected to be added over the next 25 years, reserve growth accounts for 2,347 trillion cubic feet. More than one-half of the mean undiscovered natural gas estimate is expected to come from the FSU, the Middle East, and North Africa; and about one-fourth (1,065 trillion cubic feet) is expected to come from a combination of North, Central, and South America.

Table 8. World Natural Gas Reserves by Country as of January 1, 2005

Country	Reserves (Trillion Cubic Feet)	Percent of World Total
World	6,040	100.0
Top 20 Countries	5,391	89.3
Russia	1,680	27.8
Iran	940	15.6
Qatar	910	15.1
Saudi Arabia	235	3.9
United Arab Emirates	212	3.5
United States	189	3.1
Nigeria	176	2.9
Algeria	161	2.7
Venezuela	151	2.5
Iraq	110	1.8
Indonesia	90	1.5
Malaysia	29	0.5
Norway	75	1.2
Turkmenistan	74	1.2
Uzbekistan	71	1.2
Kazakhstan	66	1.1
Netherlands	65	1.1
Canada	62	1.0
Egypt	57	0.9
Ukraine	40	0.7
Rest of World	649	10.7

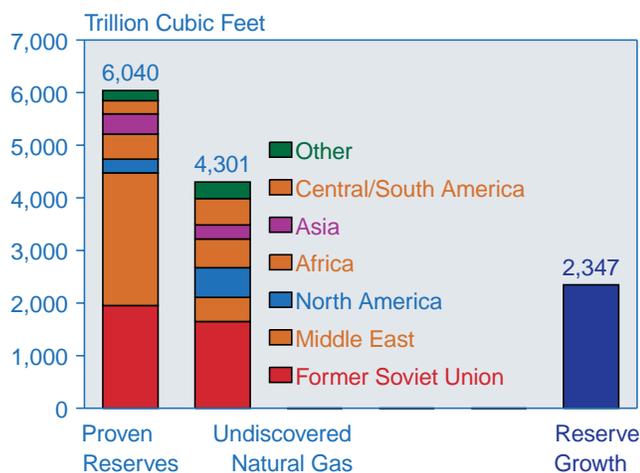
Source: "Worldwide Look at Reserves and Production," *Oil & Gas Journal*, Vol. 102, No. 47 (December 20, 2004), pp. 22-23.

Regional Forecasts

North America

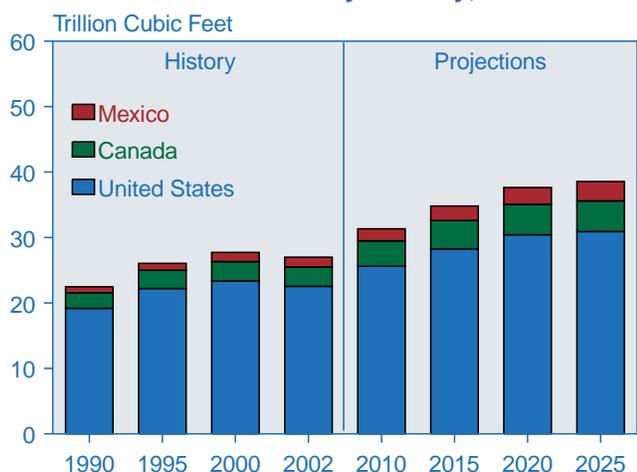
North America's natural gas production⁴ is expected to grow at an average annual rate of 0.5 percent between 2002 and 2025 in the *IEO2005* forecast, whereas its gas consumption (Figure 42) is expected to grow by 1.5

Figure 41. World Natural Gas Resources by Region, 2005-2025



Source: U.S. Geological Survey, *World Petroleum Assessment 2000*, web site <http://greenwood.cr.usgs.gov/energy/WorldEnergy/DDS-60>; "Worldwide Look at Reserves and Production," *Oil & Gas Journal*, Vol. 102, No. 47 (December 20, 2004), pp. 22-23; and Energy Information Administration estimates.

Figure 42. Natural Gas Consumption in North America by Country, 1990-2025



Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2002*, DOE/EIA-0219(2002) (Washington, DC, March 2004), web site www.eia.doe.gov/iea/. **Projections:** EIA, System for the Analysis of Global Energy Markets (2005).

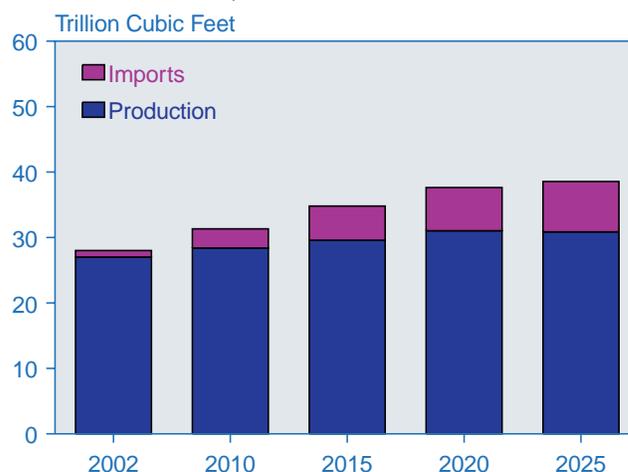
⁴U.S. domestic production does not include production from any areas that currently are off limits for oil and gas drilling or production from methane hydrates.

percent per year. In 2002, most of the natural gas consumed in North America was produced within the region (Figure 43). In 2015, however, North America is projected to consume 5.7 trillion cubic feet more than it produces, and in 2025 the gap between North America's natural gas production and consumption is projected to be 8.0 trillion cubic feet, illustrating the region's growing dependence on imports.

Currently, Canada supplies the bulk of U.S. imports of natural gas, the United States supplies most of Mexico's import needs, and less than 1 percent of North America's natural gas demand in 2002 was met by imports from outside the region (Figure 43). Imports from other regions are all in the form of liquefied natural gas (LNG) into the United States through one of five existing LNG regasification facilities. Four are onshore terminals that were built more than 20 years ago, located in Everett, Massachusetts, Cove Point, Maryland, Elba Island, Georgia, and Lake Charles, Louisiana. The fifth is the Gulf Gateway Energy Bridge, located in the offshore Gulf of Mexico. It is the first new U.S. LNG terminal to be constructed in more than 20 years, and it received its first cargo on March 17, 2005.

LNG imports are expected to increase substantially and play a prominent role in the future, with LNG imports into the United States surpassing pipeline imports from Canada by 2015. Although Mexico is expected to remain a net importer from the United States, LNG imports are expected to begin reducing Mexico's dependence on the United States in 2007.

Figure 43. Natural Gas Supply in North America by Source, 2002-2025



Sources: **2002:** Energy Information Administration (EIA), *International Energy Annual 2002*, DOE/EIA-0219(2002) (Washington, DC, March 2004), web site www.eia.doe.gov/iea/. **Projections:** EIA, System for the Analysis of Global Energy Markets (2005).

New LNG regasification facilities are expected to begin operating in Mexico, the United States, and Canada between 2005 and 2010. After 2010, the region's import capacity continues to expand throughout the remainder of the forecast period. More than 50 proposals to build new regasification facilities in North America have been put forth, and projects in all three countries have already received at least some of the needed regulatory approvals. If all the proposed facilities were constructed, they would add more than 20 trillion cubic feet to the region's import capacity, equivalent to almost 75 percent of the natural gas consumed in North America in 2002; however, the *IEO2005* reference case does not assume that all the proposed facilities will be built. Still, the level of activity is a clear indication that LNG is poised to play a much greater role in North American gas markets in the future.

According to EIA's *Annual Energy Outlook 2005 (AEO-2005)*, the share of total U.S. natural gas consumption met by net imports of LNG is expected to grow from about 1 percent in 2002 to 15 percent (4.3 trillion cubic feet) in 2015 and 21 percent (6.4 trillion cubic feet) in 2025. LNG terminals are expected to be built relatively early in the forecast, with new terminals receiving supplies on the Gulf Coast and in the Bahamas by 2010. A new terminal in Baja California, Mexico, is projected to begin operation in 2007 to serve Northern Mexico and Southern California, with additional capacity in Baja California added after 2020. Although new U.S. terminals are projected to be constructed along the East Coast after 2015, the Gulf Coast is expected to be the primary location for new LNG import capacity.

Most of the projected new U.S. LNG capacity is located in the Gulf of Mexico because of the locale's many advantages. There is spare capacity in the existing pipeline infrastructure to move natural gas to market, and deepwater ports are available to serve onshore facilities. In addition, offshore pipeline systems are in place to move natural gas to shore from offshore facilities. The extensive pipeline grid provides a ready ability to blend gases of varying heat content and thus, handle high-Btu LNG. Finally, the local environment appears to be favorable for the permitting of new facilities. Imports into new Gulf Coast terminals are expected to account for more than 70 percent of imports into new U.S. LNG terminals in 2025.

Canada is the only North American country that currently produces more natural gas than it consumes, and its domestic production is projected to continue to exceed its consumption through 2025. Most of Canada's natural gas production currently comes from the Western Sedimentary Basin. Although conventional production in the basin is in steady decline, the decreases are expected to be more than offset by increases in

unconventional production in western Canada, conventional production in the MacKenzie Delta and Eastern Canada, and LNG imports. Supply is also expected to be supplemented by natural gas from the MacKenzie Delta. A pipeline to bring natural gas from the MacKenzie Delta to market is expected to open in 2010. In spite of these supply additions, pipeline imports from Canada are expected to decline toward the end of the forecast because of strong growth in Canada's internal need for natural gas.

In the *IEO2005* reference case, Canada's natural gas production is projected to grow at an average annual rate of 0.1 percent. Whereas in 2002, production exceeded consumption in Canada by 3.6 trillion cubic feet, excess production available for export to the United States is expected to drop to 2.5 trillion cubic feet in 2015 and to 2.1 trillion cubic feet in 2025.

In Mexico, natural gas consumption is expected to far outstrip production. Mexico's demand for natural gas is projected to grow at an average annual rate of 3.0 percent between 2002 and 2025, while production grows at a rate of only 1.7 percent annually. Most of the growth in consumption is expected to fuel electricity generation. Although consumption in the residential and commercial sectors combined accounted for less than 3 percent of the country's total natural gas use in 2002, pipeline infrastructure to serve residential and commercial users is expected to continue growing, allowing their natural gas consumption to increase tenfold from 2002 to 2025.

Mexico's dependence on natural gas imports, like that of the United States, is projected to increase. In the *IEO2005* reference case, imports are expected to grow from 13 percent of Mexico's total natural gas consumption in 2002 to 37 percent in 2025. The Mexican government is attempting to attract foreign capital to help in developing the country's own abundant resources and supporting production increases, but to date little increase has been seen, and it appears that LNG will be the biggest contributor to additional supply in the near term. In addition to import facilities in Baja California, Mexico, that will serve both Mexican and U.S. markets, an LNG facility is under construction at Altamira on Mexico's Gulf Coast, and two facilities currently are under consideration on the Pacific Coast, primarily to serve the Mexican market.

Western Europe

Natural gas is expected to be the fastest growing fuel source in Western Europe, with demand projected to grow at an annual average rate of 1.8 percent, from 15.0 trillion cubic feet in 2002 to 22.4 trillion cubic feet in 2025. More than 60 percent of incremental gas consumption in Western Europe between 2002 and 2025 is expected to be used for electric power generation. Natural gas is the

fuel of choice for new electricity generation capacity in Western Europe, where many nations are looking to replace oil- and coal-fired plants that are more carbon intensive than natural gas. In addition, natural gas is expected to remain more cost competitive than renewable energy sources, and countries such as Germany and Belgium have government policies that discourage the expansion of nuclear power capacity and may result in the retirement of existing nuclear power plants over the forecast period.

Natural gas consumption for electricity generation in Western Europe is projected to increase on average by 3.6 percent per year from 2002 to 2025, surpassing the use of coal and renewables for electricity generation (on a Btu basis) by 2015 and the use of nuclear power by 2025. The share of total electricity sector energy demand met by natural gas is projected to increase from 14 percent in 2002 to 23 percent in 2015 and 28 percent in 2025.

With the notable exception of Norway, natural gas production is in decline in most areas of Western Europe. In the mid-term future, production from Norway is expected to stave off a decline in the region's overall production; however, total natural gas production in Western Europe is still far from keeping pace with demand (Figure 44). Western Europe received net imports of 4.9 trillion cubic feet of natural gas in 2002, accounting for one-third of total gas consumption. The region's reliance on imported gas is projected to grow to more than 40 percent of demand in 2015 and more than 50 percent in 2025. Currently there are 10 LNG regasification terminals operating in Western Europe, and LNG receiving capacity is being expanded aggressively. More than 20

new facilities have been proposed, including 4 that are under construction. Egypt, a new addition to the list of LNG suppliers to the world as well as to Europe, sent its first-ever LNG cargo to Spain in March 2005.

Mature Market Asia

In Japan, natural gas shows the largest incremental growth in demand among primary energy sources over the forecast period. Japan's natural gas consumption is projected to increase at an average annual rate of 1.5 percent, from 2.7 trillion cubic feet in 2002 to 3.8 trillion cubic feet in 2025. Natural gas use in the industrial sector is projected to grow by 3.4 percent per year on average from 2002 to 2025, and to claim an increasing share of the country's total gas consumption. Electricity generation remains by far the largest use for natural gas in Japan, however, despite an expected decline in its share of the total, from 71 percent in 2002 to 67 percent in 2025.

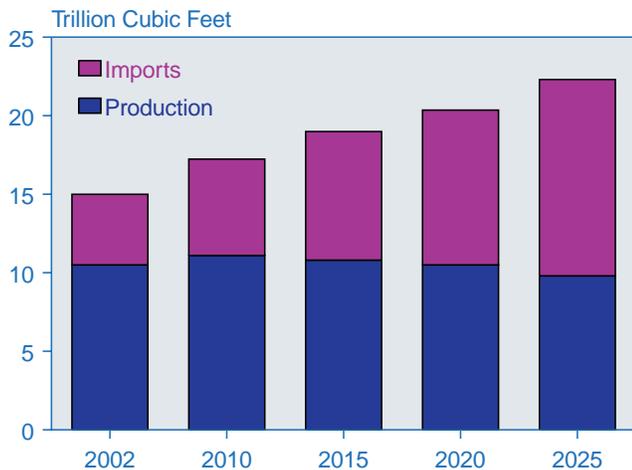
In Australia and New Zealand, the industrial sector currently is the predominant user of natural gas, and it is projected to account for more than one-half of all gas consumption in Australia and New Zealand throughout the forecast period. Natural gas is also the fastest growing fuel in the region's electricity sector. Natural gas consumption as a percentage of total energy use in the electric power sector is projected to grow from 11 percent in 2002 to nearly 13 percent in 2025, but this will have only a modest impact on the electric power sector fuel mix, which is dominated by coal. Even in 2025, coal is expected to account for almost 73 percent of energy consumption in Australia and New Zealand's electric power sector on a Btu basis.

Transitional Economies

In the EE/FSU countries, natural gas consumption in the electric power sector is expected to surpass consumption in the industrial sector by 2010, and to account for 44 percent and 43 percent of total gas consumption in 2025 in the FSU and Eastern Europe, respectively. Total natural gas demand in the EE/FSU region is projected to grow at an average annual rate of 2.2 percent from 2002 to 2025 (Figure 45). In both Eastern Europe and the FSU, the electric power sector is expected to account for nearly 60 percent of the total increment in natural gas use over the forecast period.

The FSU, which holds around 30 percent of the world's natural gas reserves, is much more dependent on natural gas for its energy supply than is Eastern Europe (51 percent of total energy consumption in the FSU was supplied by natural gas in 2002, compared with 23 percent in Eastern Europe). Natural gas production in the FSU is projected to grow at an average annual rate of just over 2 percent from 2002 to 2025, and exports are projected to increase to around one-quarter of total gas production in 2025 from 19 percent in 2002. Despite the Russian

Figure 44. Natural Gas Consumption in Western Europe by Source, 2002-2025



Sources: **2002:** Energy Information Administration (EIA), *International Energy Annual 2002*, DOE/EIA-0219(2002) (Washington, DC, March 2004), web site www.eia.doe.gov/iea/. **Projections:** EIA, *System for the Analysis of Global Energy Markets* (2005).

government's recent dismantling of the oil giant Yukos, foreign companies—especially Western European companies—have increasingly been pursuing investments in Russia's upstream gas sector. Gazprom, the majority state-owned Russian gas company, currently has a spate of suitors from which to choose its partners in the development of the giant Shtokmanovskoye field [3].

Emerging Asia

In China, natural gas is currently a minor fuel in the overall energy mix, representing only 3 percent of total primary energy consumption in 2002; however, China is rapidly expanding infrastructure to facilitate the consumption of gas throughout the country as well as imports of gas into the country. Overall natural gas consumption in China is projected to grow at an average annual rate of 7.8 percent, from 1.2 trillion cubic feet in 2002 to 6.5 trillion cubic feet in 2025 (Figure 46). Only nuclear power generation is projected to grow more rapidly, at a 9.9-percent average annual rate over the forecast period.

Natural gas consumption in China's residential sector, projected to more than double from 2002 to 2010, received a boost with the start of commercial operation of the West-East pipeline in December 2004. Most of the early natural gas coming off the pipeline has been going to residential consumers and the remainder to industrial consumers [4]. The pipeline is far from full utilization, because several natural-gas-fired electric power plants, which ultimately are to be the main consumers of West-East gas, are not yet complete and operational.

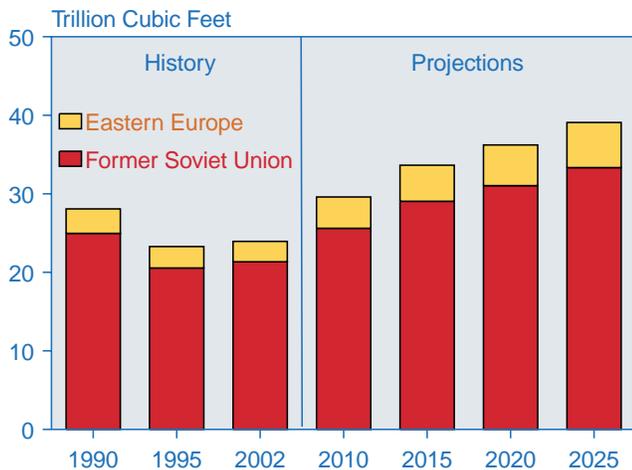
In the long term, the electric power sector is the main source of projected growth in China's natural gas

demand, accounting for fully two-thirds of the total increment in China's natural gas consumption from 2002 to 2025. In 2002, natural gas consumption in the electric power sector was 0.2 trillion cubic feet, accounting for only 1 percent of the country's total electricity generation. In 2010, natural gas consumption in the electricity sector is projected to surpass consumption in the industrial and residential sectors, and in 2025 it is projected to surpass their combined consumption, accounting for more than one-half of China's total natural gas use.

In India, as in China, natural gas is currently a minor fuel in the overall energy mix, representing only 6.5 percent of total primary energy consumption. Also like China, India is rapidly expanding infrastructure to facilitate consumption and imports of gas. Overall, India's gas consumption is projected to grow at an average annual rate of 5.1 percent, from 0.9 trillion cubic feet in 2002 to 2.8 trillion cubic feet in 2025. The electric power sector is projected to account for 71 percent of the total incremental growth in India's natural gas demand from 2002 to 2025.

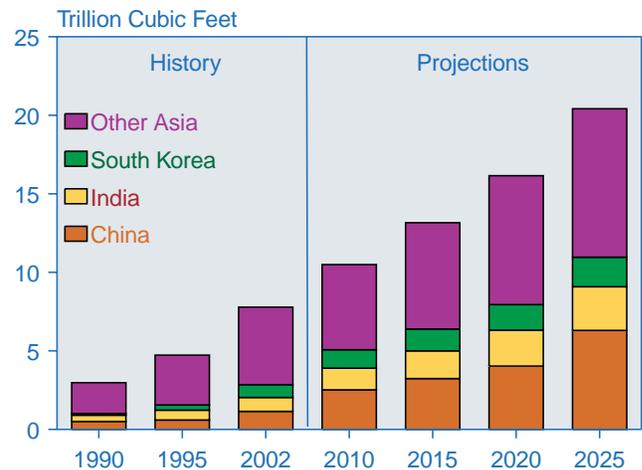
Total natural gas consumption in South Korea is projected to grow at an average annual rate of 3.7 percent from 2002 to 2025. In 2002, the residential sector was the country's predominant consumer of natural gas, accounting for 37 percent of the total, and the electric power sector was a close second, accounting for 34 percent of total gas use. In the forecast, natural gas use in South Korea's industrial sector increases on average by 7.0 percent per year from 2002 to 2025, compared with average annual growth of 1.7 percent in both the residential and electric power sectors. In 2015, more natural

Figure 45. Natural Gas Consumption in Transitional Economies, 1990-2025



Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2002*, DOE/EIA-0219(2002) (Washington, DC, March 2004), web site www.eia.doe.gov/iea/. **Projections:** EIA, *System for the Analysis of Global Energy Markets* (2005).

Figure 46. Natural Gas Consumption in Emerging Asia, 1990-2025



Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2002*, DOE/EIA-0219(2002) (Washington, DC, March 2004), web site www.eia.doe.gov/iea/. **Projections:** EIA, *System for the Analysis of Global Energy Markets* (2005).

gas consumption is expected in the country's industrial sector than in its residential or electric power sector. In 2025, industrial natural gas use is projected to account for more than 40 percent of all the natural gas consumed in South Korea.

High world oil prices, beginning in 1999, provided the impetus for the strong growth in gas use in South Korea's industrial sector, and it is partially at the expense of oil consumption that natural gas is expected to grow in this sector. On a Btu basis, the share of total industrial consumption attributable to natural gas is projected to grow from just 5 percent in 2002 to almost 16 percent in 2025, and the share attributable to oil is expected to shrink from 58 percent in 2002 to just under 50 percent in 2025.

In the other countries of emerging Asia, total natural gas consumption is projected to grow at an average annual rate of 2.9 percent from 2002 to 2025. Natural gas consumption in 2002 and throughout the forecast period is fairly evenly split between the industrial and electricity sectors, with each accounting for more than 40 percent of total gas consumption. Penetration of gas into the residential, commercial, and transportation sectors is projected to remain low with the three sectors combined continuing to account for less than 10 percent of total gas consumption in the other countries of emerging Asia throughout the forecast period. Natural gas infrastructure across the region is fragmented, with limited infrastructure outside producing areas, and extensive advances will be needed to meet growing demand in the long term.

Middle East

Natural gas consumption in the Middle East is projected to double between 2002 and 2025 (Figure 47). The overall share of natural gas in the Middle East's fuel consumption mix increases over the forecast period at the expense of oil, although oil will remain the region's predominant fuel source. The share of total Middle East energy demand met by natural gas is projected to increase from 39 percent in 2002 to 45 percent in 2025, while the share of total energy demand met by oil is projected to decline from 53 percent to 48 percent.

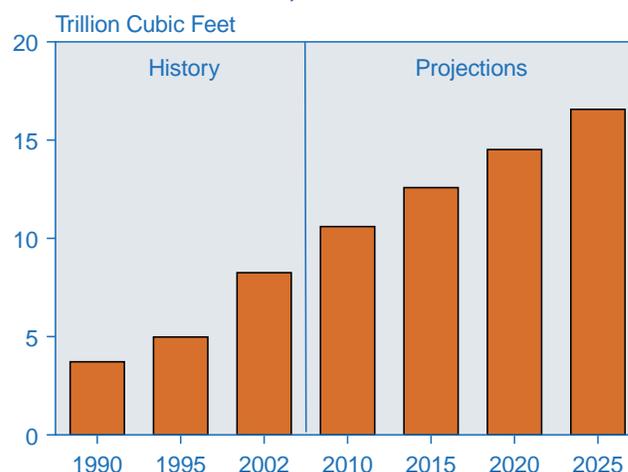
Natural gas is projected to retain its dominant position in the Middle East's power sector, with 1.9-percent average annual growth over the forecast period. In the industrial sector, however, natural gas use is projected to grow by 4.0 percent per year, accounting for more than two-thirds of the overall incremental growth in gas demand in the region from 2002 to 2025. The natural gas share of total energy consumed in the region's industrial sector is projected to grow from 46 percent in 2002 to 59 percent in 2025, and oil is expected to lose share in the sector (from 41 percent of industrial energy consumption in 2002 to just under 30 percent in 2025).

Oil-exporting countries in the region have deliberately sought to expand domestic gas use in order to make more oil available for export. Many gas-rich countries in the region are also developing projects to monetize their natural gas resources, in particular through LNG and, more recently, gas to liquids (GTL) projects (see box on page 46). Qatar has secured several high-profile deals that, when realized, will eventually boost its total LNG exports to 77 million metric tons per year. One such deal is for the construction of what will be the two largest liquefaction trains in the world, at 7.8 million metric tons per year each.

Africa

Natural gas consumption in Africa is projected to grow at an average annual rate of 4.0 percent from 2002 to 2025 (Figure 48), compared with average yearly growth rates of 2.7 percent for oil and 1.6 percent for coal. Gas consumption is expected to surpass coal consumption by 2025, with oil remaining the dominant fuel throughout the projection period. Incremental growth in Africa's gas demand from 2002 to 2025 is projected to be fairly even across sectors, with the industrial, residential, and electric sectors each accounting for around one-third of total growth. Significant flaring of associated gas is still common in Africa because of the remoteness of much of the production and a lack of infrastructure to use all the associated gas produced. Despite continuing instability in some countries of the region, the investment climate in Africa appears to be welcoming to foreigners, with massive investments planned for Egypt, Libya, Algeria, Nigeria, and other parts of West Africa.

Figure 47. Natural Gas Consumption in the Middle East, 1990-2025



Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2002*, DOE/EIA-0219(2002) (Washington, DC, March 2004), web site www.eia.doe.gov/iea/. **Projections:** EIA, *System for the Analysis of Global Energy Markets* (2005).

Central and South America

Natural gas is expected to be the fastest growing fuel source in Central and South America, with demand projected to increase on average by 3.3 percent per year, from 3.6 trillion cubic feet in 2002 to 7.5 trillion cubic feet in 2025 (Figure 49). By 2010, natural gas is expected to overtake oil as the second most prevalent fuel for electricity generation in the region, with renewables—particularly, hydropower—retaining their dominant share in the sector throughout the forecast period.

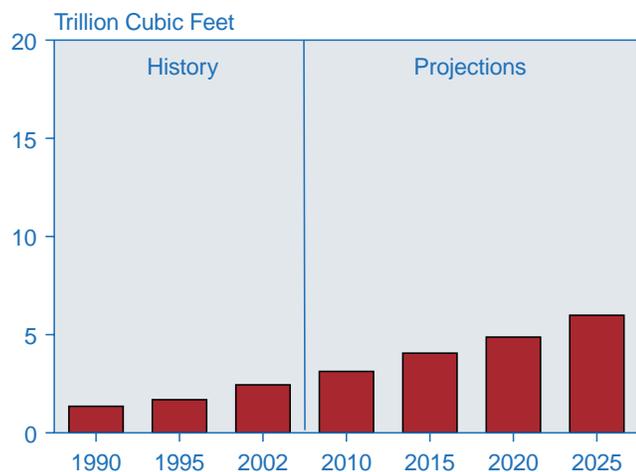
The investment climate for natural gas production projects in Central and South America has been less than ideal. Although Venezuela appears to be more welcoming to foreign investment in its natural gas sector than its oil sector, negotiations, especially on the Mariscal Sucre project, continue with no final decisions taken [5]. In Bolivia, two successive presidents were forced to resign by street protests over the handling of the nation's natural gas resources. (Gonzalo Sanchez de Lozada resigned in October 2003, and Carlos Mesa resigned in June 2005.) Protestors have called for increased government involvement in the natural gas sector, including possible

nationalization of the industry. On the other hand, Brazil is proceeding with natural gas exploration and hopes to become self-reliant in the gas sector in the future. Major investments in the natural gas sector are underway in Trinidad and Tobago and in Peru.

References

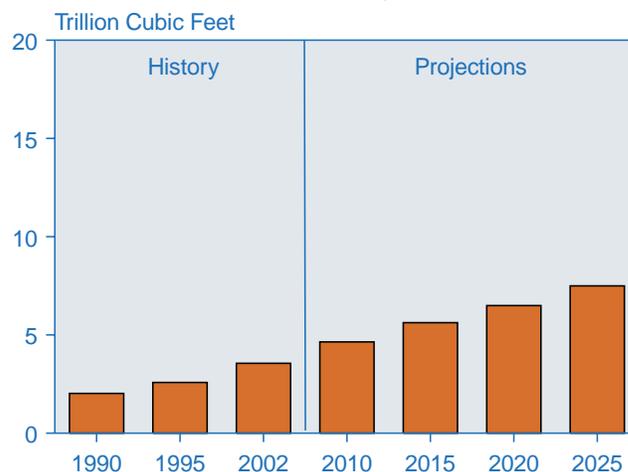
1. "Worldwide Look at Reserves and Production," *Oil & Gas Journal*, Vol. 102, No. 47 (December 20, 2004), pp. 22-23.
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4. FACTS Inc., "Natural Gas Pipelines and LNG Terminals in China: An Update," *Gas Insights*, No. 46 (March 2005), p. 4.
5. World Markets Research Centre, "Venezuela: Chevron Announces 'Significant' Gas Discovery in Deltana Platform," web site www.worldmarketsanalysis.com (June 21, 2005).

Figure 48. Natural Gas Consumption in Africa, 1990-2025



Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2002*, DOE/EIA-0219(2002) (Washington, DC, March 2004), web site www.eia.doe.gov/iea/. **Projections:** EIA, System for the Analysis of Global Energy Markets (2005).

Figure 49. Natural Gas Consumption in Central and South America, 1990-2025



Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2002*, DOE/EIA-0219(2002) (Washington, DC, March 2004), web site www.eia.doe.gov/iea/. **Projections:** EIA, System for the Analysis of Global Energy Markets (2005).

Gas to Liquids: A New Frontier for Natural Gas

The relatively high world crude oil prices of the past 3 years have drawn attention to the potential for developing previously uneconomical natural gas reserves, such as associated gas (gas found jointly with oil in an oil field) or stranded gas (gas that lies far from markets, thus requiring major investments to commercialize). Converting these resources to liquids—either to liquefied natural gas (LNG) or to petroleum liquid substitutes, such as diesel, naphtha, motor gasoline, or other products (such as lubricants and waxes) by employing “gas to liquids” (GTL) technology—could provide a way to bring these gas resources to market. GTL has recently become attractive as an option for monetizing stranded gas and complementing traditional commercialization opportunities such as LNG or pipeline transportation.

The economics of GTL continue to improve with advances in technology and scale. Capital costs have dropped significantly, from more than \$100,000 per barrel of total installed capacity for the original plants to a range of \$25,000 to \$30,000 per barrel of capacity today.^a Moreover, Royal/Dutch Shell has commented that it expects to be able to reduce the costs to below \$20,000 per barrel. By comparison, the costs associated with conventional petroleum refining are around \$15,000 per barrel per stream day after several decades of technology improvements. The high oil prices of recent years, moreover, have made transportation fuels produced through GTL technology more commercially viable. Few companies release the detailed costs of their GTL conversion technologies, but according to ConocoPhillips, assuming that the cost of natural gas is \$1.00 per million Btu, GTL fuel is cost

Cost to Produce a Barrel of Diesel Fuel: Grass Roots Gas to Liquids Plant vs. Refinery (2002 Dollars per Barrel)

Cost Component	GTL	Refinery
Natural Gas (at \$1.00 per Million Btu)	\$10.00	
Crude Oil (at \$20 per Barrel)		\$20.00
Operating Costs	\$ 4.00	\$ 2.50
Capital Recovery, Taxes . . .	\$14.00	\$ 6.50
Total	\$28.00	\$29.00

Source: M. Culligan, ConocoPhillips, Director of Business Development-Qatar GTL Project, “GTL: New Technology for a New Industry,” presentation at the Fifth Doha Gas Conference (March 1, 2005).

^aPersonal correspondence with Sylvia Williams, Business Development Manager, Global GTL Development, Shell International Gas Limited (May 3, 2005).

^bACTED Consultants, “Gas to Liquids,” Chemicals Australia Web Site, <http://www.chemlink.com.au/gtl.htm> (1999).

^cFACTS Inc., *Gas Databook I: Asia-Pacific Natural Gas & LNG* (Honolulu, HI, 2005), p. 87.

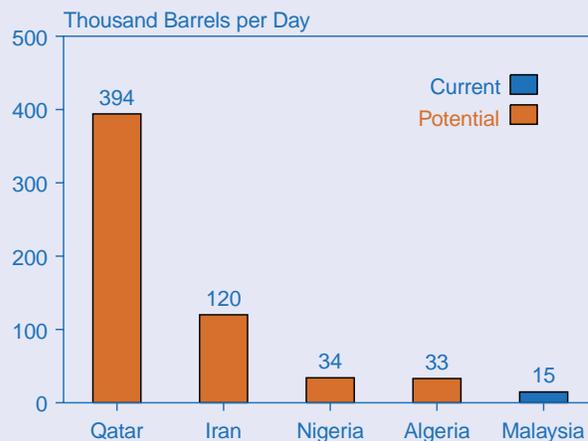
competitive with diesel fuel at world oil prices above \$20 per barrel (see table below).

Among the different GTL products, the diesel fraction, in particular, is highly valued in the downstream market because of its unique properties that meet environmental regulations aimed at tightening emissions standards for light- and heavy-duty diesel vehicles. The GTL fuel reduces emissions relative to conventional diesel, as it contains near-zero sulfur and aromatics. GTL fuel also exhibits a high cetane number that enhances engine combustion performance.^b Because they are compatible with existing vehicle engines and fuel distribution infrastructures, GTL fuels are the most cost-effective in reducing emissions among the nonconventional fuels.

At present, worldwide there are at least 9 commercial GTL projects at various stages of planning and development for the period 2009 to 2012 that could bring to market an additional capacity of 580 thousand barrels per day (see figure). More than 19 additional proposed projects could double that capacity beyond 2012.^c

(continued on page 47)

Current and Potential Gas to Liquids Capacity, 2005-2012



Note: In addition, a 45,000-barrel-per-day GTL plant in South Africa's Mossel Bay has been switched temporarily from processing coal to liquids to processing gas to liquids.

Sources: Interview with Abdullah Bin Hamad Al-Attiyah, Qatar Minister of Energy and Industry, at the Center for Strategic and International Studies in Washington, DC (May 9, 2005). Data from FACTS Inc., *Gas Databook I* (Honolulu, HI, 2005), p. 87; and “Algeria—International Tender for First Gas-to-Liquids Project,” *Cedigaz News Report*, Vol. 44, No. 15 (April 15, 2005), p. 4.

Gas to Liquids: A New Frontier for Natural Gas (Continued)

These projects are being initiated by companies operating in gas-rich countries such as Qatar, Iran, Russia, Nigeria, Australia, and Algeria, where natural gas can be developed at a cost of less than \$1.00 per million Btu.^d Qatar's North Field, with an estimated 900 trillion cubic feet of natural gas reserves, and the adjoining South Pars field in Iran with an estimated 500 trillion cubic feet of reserves, are the cheapest natural gas resources in the world.^e For other countries, such as Nigeria and Algeria, GTL complements their LNG industries. GTL offers promise for use in Nigeria to convert natural gas that would otherwise be flared. Huge capital investments are required for GTL, however, and project financing and the availability of qualified contractors and operators may limit the growth of GTL projects on a year-to-year basis.^f

Six of the nine confirmed GTL projects are located in the state of Qatar as joint ventures based on an integrated development and production sharing agreement (DPSA) with major international oil companies. Foreign companies have favored this approach, because it gives them an opportunity to book part of the gas reserves on their balance sheet and support their upstream and downstream activities.^g By 2011, Qatar is set to produce about 394,000 barrels of GTL products per day, the equivalent of 68 percent of the total confirmed new capacity.^h A list of Qatar's GTL ventures is shown in the table below.

Unlike many other gas-producing countries, Qatar has established a favorable climate in terms of transparent

business and investment policies. Foreign investors have also been encouraged to invest in Qatar's energy sector because of its stable tax regulations, enforcement of formal agreements, and the government's willingness to protect foreign investors through its legislature. In addition to the stable political climate, Qatar has invested substantially to develop infrastructure and services to support development of its natural gas resources. The country also provides guarantees for the safety of foreign employees and the potential for future development through expansion of existing facilities.ⁱ In the second quarter of 2005, Moody's Investor Service upgraded Qatar's rating for long-term foreign currency bonds and bank bonds from A3 to A1.^j

Qatar has been able to reach agreements with a group of financial institutions to fund their gas-related projects (which exceed \$60 billion) and has developed a master plan to expand its port and double the size of Ras Laffan Industrial city from 39 square miles to 77 square miles, in order to accommodate 7 GTL projects, 16 LNG trains, 5 gas processing plants, 6 to 7 ethylene plants, and a variety of other gas-related industries. By 2012, Qatar must produce nearly 25 billion cubic feet of natural gas per day to support its commitments. Some 10.3 billion cubic feet per day will be needed to produce 77 millions metric tons of LNG per year; 4 billion cubic feet per day for the 394,000 barrels per day of GTL; about 5 billion cubic feet per day for petrochemical, local power, and industrial projects; and about

(continued on page 48)

GTL Joint Venture Projects in Qatar (2002 Dollars per Barrel)

Project	Initial Capacity (Barrels per Day)	Start Date	Final Capacity (Barrels per Day)
Oryx (QP/Sasol Chevron) . . .	34,000	2005	100,000
Pearl (Shell)	70,000	2009	140,000
ExxonMobil	154,000	2011	154,000
QP/Sasol Chevron	130,000	Delayed	130,000
Marathon	60,000	Delayed	120,000
ConocoPhillips	80,000	Delayed	160,000
Total	528,000		804,000

Source: Middle East Economic Survey (MEES), March 2005.

^dEnergy Information Administration, *Model Documentation: Natural Gas Transmission and Distribution Module*, DOE/EIA-M062 (Washington, DC, May 2005), Appendix F-27.

^eFACTS Inc., "Iran's Gas Industry and Export Projects," *Gas Insights*, No. 45 (March 2005).

^fM. Culligan, ConocoPhillips, Director of Business Development-Qatar GTL Project, "GTL: New Technology for a New Industry," presentation at the Fifth Doha Gas Conference (March 1, 2005).

^gWorld Markets Research Centre, "Shell Holds Back on FID for Qatar GTL," web site www.worldmarketsanalysis.com (January 20, 2005).

^hFACTS Inc., *Gas Databook I* (Honolulu, HI, 2005), p. 87.

ⁱKeynote speech by Abdulla bin Hamad Al-Attiyah, Qatar Minister of Energy and Industry, at the Fifth Doha Gas Conference (February 28, 2005).

^j"Third Annual Finance, Investment in Qatar Set To Open in London," *Gulf Times (Qatar)* (May 24, 2005).

Gas to Liquids: A New Frontier for Natural Gas (Continued)

2 billion cubic feet per day for exports through the Dolphin pipeline. Over a 25-year period (the duration of a long-term LNG or GTL contract), Qatar would need to produce 225 trillion cubic feet, or one-fourth of its North Field reserve.^k Although the 900 trillion cubic feet of natural gas reserves from the North Field should be sufficient to support these projects on a sustainable basis, the quality of the gas and cost of development will vary from project to project. As a result, there could be delays in some of the plans.

In the *IEO2005* reference case, world demand for oil in the transportation sector is projected to grow by 2.1

percent per year, from 41.7 million barrels per day in 2002 to 67.3 million barrels per day in 2025. Even if all the proposed GTL projects worldwide materialized by 2025, assuming a 70-percent yield for diesel fuel from the natural gas stock, the expected GTL diesel supply of 1.2 million barrels per day in 2025 would represent only a fraction of total world transportation sector demand. Nevertheless, GTL diesel projects do provide gas-producing companies with an opportunity to add new value-added activities to their portfolios, as well as providing governments with an effective approach to meeting policy and environmental objectives.

^k"Qatar Seeks New Math From North Field," *World Gas Intelligence* (June 1, 2005), pp. 2-3.