

Chapter 3

Natural Gas

In the IEO2008 reference case, natural gas consumption in the non-OECD countries grows more than twice as fast as in the OECD countries. Production increases in the non-OECD region account for more than 90 percent of the growth in world production from 2005 to 2030.

Worldwide, total natural gas consumption increases from 104 trillion cubic feet in 2005 to 158 trillion cubic feet in 2030 in the IEO2008 reference case (Figure 35). World oil prices are expected to remain high, and as a result natural gas replaces oil wherever possible. In addition, because natural gas produces less carbon dioxide when it is burned than does either coal or petroleum, governments implementing national or regional plans to reduce greenhouse gas emissions may encourage its use to displace other fossil fuels.

Natural gas remains a key energy source for industrial sector uses and electricity generation throughout the projection. The industrial sector, which is the world's largest consumer of natural gas, accounts for 43 percent of projected natural gas use in 2030. In the electric power sector, natural gas is an attractive choice for new generating plants because of its relative fuel efficiency and low carbon dioxide intensity. Electricity generation accounts for 35 percent of the world's total natural gas consumption in 2030.

In 2005, OECD member countries and non-OECD countries each consumed 52 trillion cubic feet of natural gas. Preliminary data for 2006 indicate that natural gas consumption in non-OECD countries has surpassed that in

OECD countries. In the IEO2008 reference case, natural gas consumption in the non-OECD countries grows more than twice as fast as consumption in the OECD countries, with 2.3-percent average annual growth from 2005 to 2030 for non-OECD countries, compared with an average of 1.0 percent for the OECD countries. Natural gas demand in the non-OECD countries accounts for 74 percent of the total world increment in natural gas consumption over the projection period. Natural gas use in the non-OECD countries increases from 50 percent of the world total in 2005 to 58 percent in 2030.

The OECD countries accounted for 38 percent of the world's total natural gas production and 50 percent of natural gas consumption in 2005; in 2030, they account for 27 percent of production and 42 percent of consumption. As a result, the OECD countries are projected to rely increasingly on imports to meet natural gas demand, with a growing percentage of natural gas imports coming in the form of liquefied natural gas (LNG). In 2030, more than one-third of the natural gas consumed in OECD countries is projected to come from non-OECD sources, up from one-quarter in 2005.

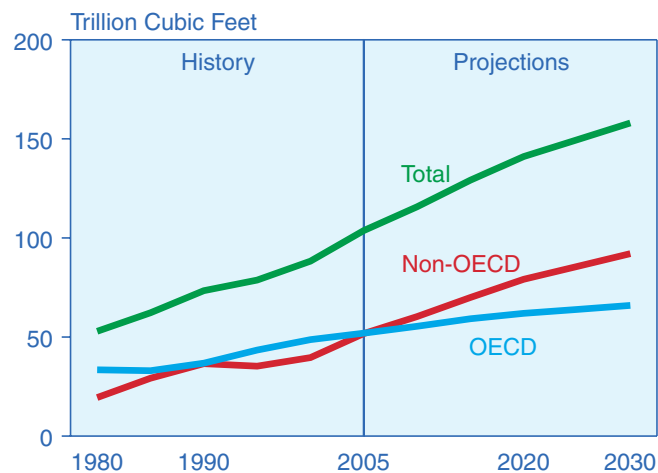
World Natural Gas Demand

OECD Countries

Natural gas consumption in OECD North America is projected to increase at an average annual rate of 0.6 percent from 2005 to 2030 (Figure 36). For the United States the average annual increase is 0.1 percent, significantly lower than for Canada and Mexico, largely because higher natural gas prices in the U.S. market are expected to dampen the use of natural gas for electricity generation. As North America's largest user of natural gas, the United States accounted for 81 percent of the 27.4 trillion cubic feet consumed in North America in 2005. In 2030 the U.S. share falls to 72 percent, reflecting relatively slow growth in U.S. demand and robust growth in Canada and Mexico.

In 2005, natural-gas-fired plants accounted for 19 percent of net electricity generation in the United States and coal-fired plants 50 percent. The natural gas share is projected to rise to 21 percent in 2010, after which higher natural gas prices discourage the construction of new natural-gas-fired plants. U.S. natural gas consumption for electricity generation increases in the near term, from

Figure 35. World Natural Gas Consumption, 1980-2030



Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2005* (June-October 2007), web site www.eia.doe.gov/iea. **Projections:** EIA, *World Energy Projections Plus* (2008).

5.9 trillion cubic feet in 2005 to 6.6 trillion cubic feet in 2015, then declines steadily to 5.0 trillion cubic feet in 2030. As more coal-fired plants are built after 2010, the natural gas share of generation falls to 14 percent and the coal share rises to 54 percent in 2030. Nuclear and renewables also gain market share at the expense of natural gas.

Canada's total natural gas consumption is projected to increase steadily, at a rate of 1.5 percent per year, from 3.4 trillion cubic feet in 2005 to 5.0 trillion cubic feet in 2030. In contrast to the decline in natural gas consumption for electricity generation in the United States, in Canada it increases by one-third from 2005 to 2030, growing at an average annual rate of 1.5 percent. Even more rapid growth is projected for Canada's industrial natural gas consumption, averaging 2.0 percent per year, and including vast quantities of natural gas consumed in the mining of the country's oil sands deposits.

By volume, the total increase in Canada's industrial use of natural gas from 2005 to 2030 equals 1.2 trillion cubic feet, compared with an increase of 0.2 trillion cubic feet for electricity generation. The growth in domestic consumption, coupled with a projected decline in Canada's natural gas production, leaves less Canadian natural gas available for export. Canada is projected to consume 93 percent of its own production in 2030, compared with 52 percent in 2005.

In Mexico, strong growth in natural gas consumption is expected in all sectors, with total consumption more than doubling from 2005 to 2030. Industrial natural gas consumption nearly doubles, and consumption for electricity generation nearly triples over the projection period. Consumption in the residential and commercial

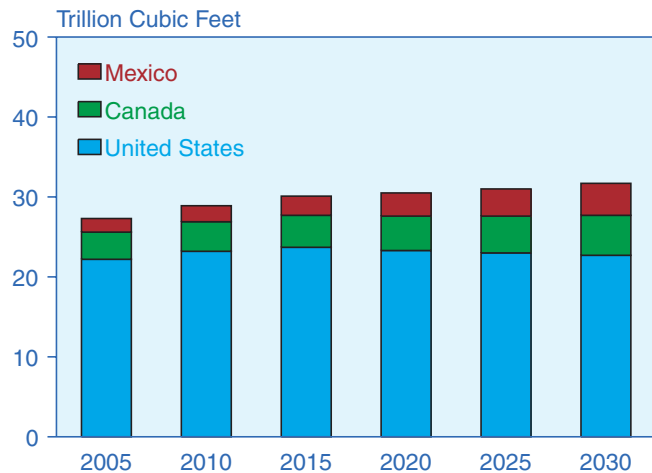
sectors also expands strongly (by 3.6 percent per year), although the absolute quantities are small.

Because the expected growth in Mexico's natural gas consumption over the period (an increase of 2.3 trillion cubic feet in 2030 compared with 2005) far exceeds its production growth, its dependence on pipeline imports from the United States and imports of LNG from overseas increases. Imports from the United States are offset somewhat by exports of regasified LNG to the United States, from a new facility in Baja California that is scheduled to begin operation in 2008; however, Mexico remains a net importer of U.S. natural gas throughout the projection.

In OECD Europe, natural gas consumption is projected to grow by an average of 1.4 percent per year—from 19.3 trillion cubic feet in 2005 to 22.8 trillion cubic feet in 2015 and 27.2 trillion cubic feet in 2030 (Figure 37)—mostly as a result of increasing use for power generation. Many of the OECD Europe nations have made commitments to reduce carbon dioxide emissions, bolstering the incentive for governments to encourage the use of natural gas in place of other fossil fuels. With renewable energy sources projected to remain more expensive than natural gas in OECD Europe, natural gas is expected to be the fuel of choice for new generating capacity. Natural-gas-fired generation in the region increases by 3.9 percent per year in the *IEO2008* reference case, from 0.7 trillion kilowatthours in 2005 to 1.2 trillion kilowatthours in 2015 and then to 1.9 trillion kilowatthours in 2030.

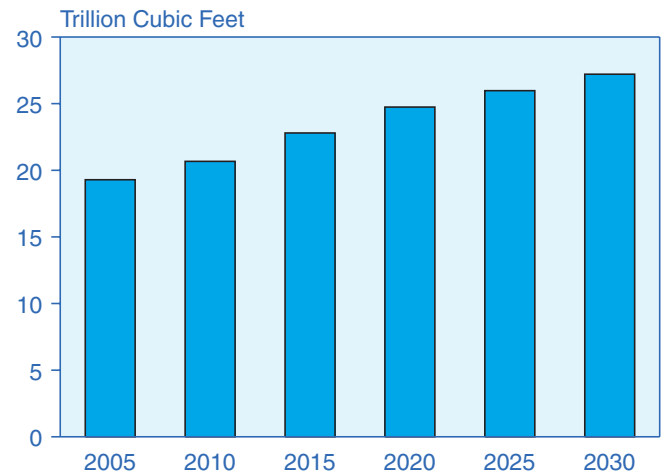
Natural gas consumption in Japan and South Korea is projected to grow on average by 0.7 percent and 2.2 percent per year, respectively, over the projection period, with each country adding less than 1 trillion cubic feet of

Figure 36. Natural Gas Consumption in North America by Country, 2005-2030



Sources: **2005:** Energy Information Administration (EIA), *International Energy Annual 2005* (June-October 2007), web site www.eia.doe.gov/iea. **Projections:** EIA, *World Energy Projections Plus* (2008).

Figure 37. Natural Gas Consumption in OECD Europe, 2005-2030



Sources: **2005:** Energy Information Administration (EIA), *International Energy Annual 2005* (June-October 2007), web site www.eia.doe.gov/iea. **Projections:** EIA, *World Energy Projections Plus* (2008).

gas consumption between 2005 and 2030 (Figure 38). Recent growth in natural gas consumption in both countries has been strong, with outages at nuclear power plants in Japan compounding the increase. LNG imports into Japan for 2007 reportedly totaled 3.1 trillion cubic feet of natural gas (66.8 million tons of LNG), up by 7.6 percent from 2006. The current nuclear issues are expected to be resolved before 2010, however [1], and continued growth in nuclear output, along with a modest GDP growth rate, is expected to slow the growth of Japan's natural gas consumption over the longer term.

In Australia and New Zealand, the industrial sector currently is the predominant consumer of natural gas and is projected to account for more than 50 percent of all natural gas consumption in the region throughout the projection period. Natural gas is the fastest growing fuel in Australia and New Zealand in the *IEO2008* reference case, accounting for just over 30 percent of the projected growth in the region's total energy consumption from 2005 to 2030. It is also the fastest growing fuel in the region's electric power sector. Australia's ratification of the Kyoto Protocol treaty in March 2008 is likely to increase the country's use of natural gas to displace more carbon-dioxide-intensive coal. In addition, several policies have been enacted by state governments in Australia to stimulate the use of natural gas for electric power generation and moderate the anticipated growth of generation using coal, of which Australia has large reserves.

Non-OECD Countries

In total, the countries of non-OECD Europe and Eurasia rely on natural gas for 51 percent of their energy needs—a larger share than for any other country grouping in the *IEO2008* projections. Russia is second only to the United

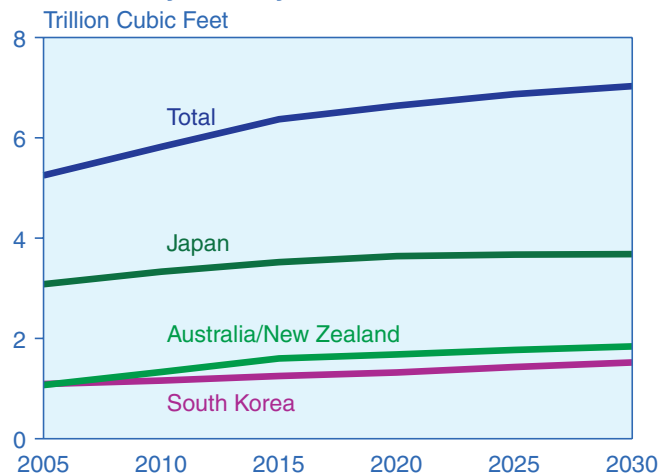
States in total natural gas consumption, with demand totaling 16.2 trillion cubic feet in 2005 and representing 55 percent of Russia's total energy consumption (Figure 39). The other countries of non-OECD Europe and Eurasia met 46 percent of their combined total energy needs with natural gas in 2005, consuming 9.1 trillion cubic feet. With ample natural gas resources, non-OECD Europe and Eurasia is expected to continue its reliance on natural gas in the future.

Natural gas consumption in non-OECD Europe and Eurasia grows at an average annual rate of 1.1 percent over the projection period, almost maintaining its share in the overall energy mix (although the growth rates for consumption of liquids and nuclear energy are slightly higher). The increase in natural gas consumption accounts for 45 percent of the total increase in energy consumption in non-OECD Europe and Eurasia from 2005 to 2030.

Non-OECD Asia, which accounted for only 9.0 percent of the world's total consumption of natural gas in 2005, shows the most rapid growth in natural gas use in the reference case and accounts for 33 percent of the total increase in world natural gas consumption from 2005 to 2030. Natural gas consumption in non-OECD Asia nearly triples, from 9.3 trillion cubic feet in 2005 to 27.4 trillion cubic feet in 2030, expanding by 4.4 percent per year on average over the projection period (Figure 40).

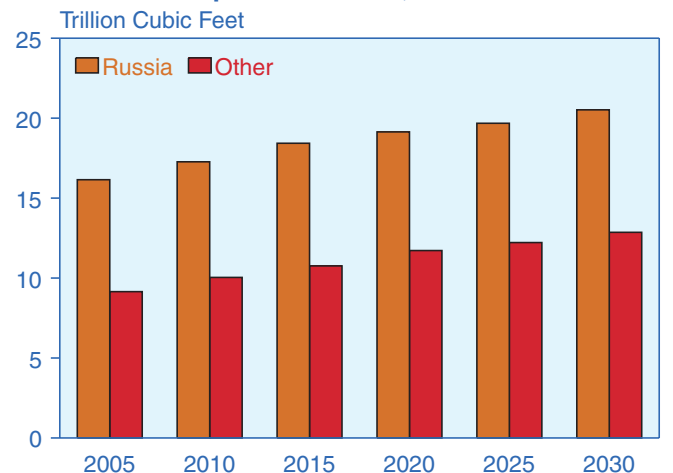
In both China and India, natural gas is currently a minor fuel in the overall energy mix, representing only 3 percent and 8 percent, respectively, of total primary energy consumption in 2005. In the *IEO2008* reference case, both countries' natural gas consumption rises rapidly, growing by 5.5 percent per year in China and 4.6 percent per

Figure 38. Natural Gas Consumption in OECD Asia by Country, 2005-2030



Sources: **2005:** Energy Information Administration (EIA), *International Energy Annual 2005* (June-October 2007), web site www.eia.doe.gov/iea. **Projections:** EIA, *World Energy Projections Plus* (2008).

Figure 39. Natural Gas Consumption in Non-OECD Europe and Eurasia, 2005-2030



Sources: **2005:** Energy Information Administration (EIA), *International Energy Annual 2005* (June-October 2007), web site www.eia.doe.gov/iea. **Projections:** EIA, *World Energy Projections Plus* (2008).

year in India on average from 2005 to 2030, as LNG imports and new domestic production help the two countries meet continued demand growth.

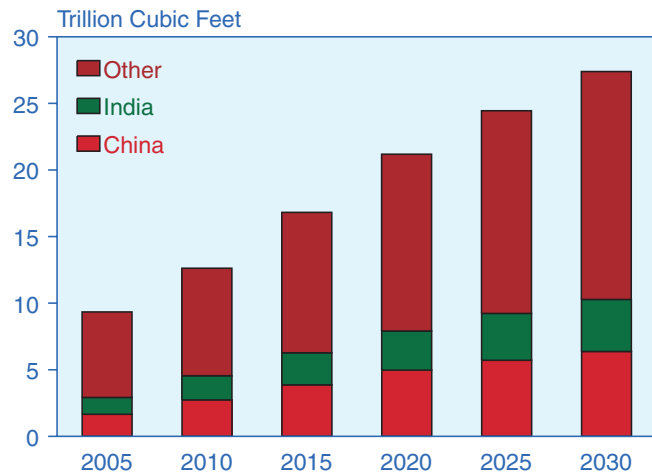
Natural gas consumption grows at average annual rates of 1.9 percent in the Middle East and 3.5 percent in Africa from 2005 to 2030 (Figure 41). Algeria, Nigeria, Egypt, and Libya, the major African producers, are also the major consumers, as there is very little infrastructure on the continent for intraregional trade of natural gas. The two notable exceptions are the Mozambique-South Africa pipeline, with a capacity of 0.1 trillion cubic feet per year, and the West African Gas Pipeline project of similar capacity. South Africa has been importing natural gas from its neighbor to feed the industrial complex at Sasolburg since completion of the pipeline from Mozambique in 2004. The West Africa pipeline, still under construction, is expected to bring natural gas from Nigeria to consumers in Benin, Ghana, and Ivory Coast.

In Central and South America, natural gas is the second-fastest-growing energy source after nuclear power (although nuclear generation is growing from a very small base and remains only a minor part of the region's total energy consumption). Natural gas demand increases on average by 2.8 percent per year, from 4.4 trillion cubic feet in 2005 to 8.7 trillion cubic feet in 2030. For Brazil, the region's largest economy, natural gas consumption nearly triples—from 0.7 trillion cubic feet in 2005 to 1.8 trillion cubic feet in 2030.

World Natural Gas Supply

The non-OECD nations are projected to account for 90 percent of the world's total increase in natural gas

Figure 40. Natural Gas Consumption in Non-OECD Asia, 2005-2030



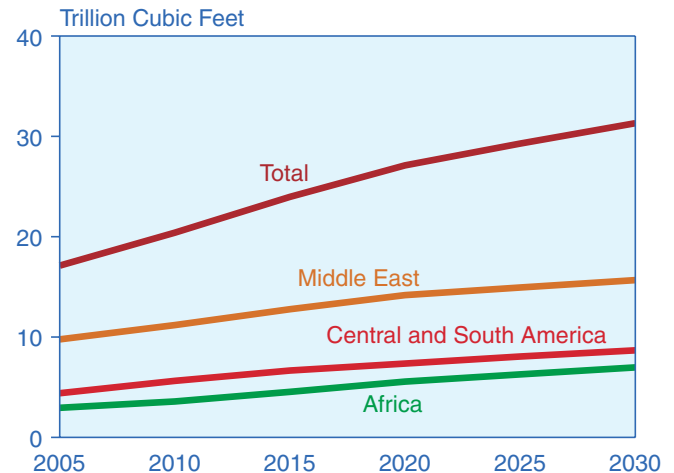
Sources: **2005:** Energy Information Administration (EIA), *International Energy Annual 2005* (June-October 2007), web site www.eia.doe.gov/iea. **Projections:** EIA, *World Energy Projections Plus* (2008).

production from 2005 to 2030. Non-OECD natural gas production grows by an average 2.5 percent per year in the reference case, from 63 trillion cubic feet in 2005 to 116 trillion cubic feet in 2030 (Table 5). Over the same period, production in the OECD countries grows by only 0.3 percent per year, from 39 trillion cubic feet to 42 trillion cubic feet.

A significant portion of non-OECD natural gas production (excluding Russia and the other nations of Eurasia) is expected to be for export projects. The Middle East and Africa are at the forefront of the trend to develop export projects—particularly, LNG exports. For the two regions combined, natural gas production increases by 21.0 trillion cubic feet from 2005 to 2030, while their combined demand for natural gas increases by only 9.9 trillion cubic feet. LNG projects are expected to account for a significant portion of natural gas exports from the Middle East and Africa. In Qatar, for instance, export facilities with a total capacity of approximately 3.6 trillion cubic feet of natural gas (77 million metric tons of LNG) are expected to be in operation by 2015, as compared with the country's 2005 LNG exports of 1 trillion cubic feet. The increase in exports from Qatar alone would account for 14 percent of the total projected increase in production from 2005 to 2015 for the non-OECD countries, excluding non-OECD Europe and Eurasia.

Significant increases in natural gas production are also projected for the countries of non-OECD Asia, but those supply increases are expected to be used largely for consumption in non-OECD Asia. China and India are projected to almost double their production volumes from 2005 to 2015, bringing production from India's Krishna

Figure 41. Natural Gas Consumption in Central and South America, Africa, and the Middle East, 2005-2030



Sources: **2005:** Energy Information Administration (EIA), *International Energy Annual 2005* (June-October 2007), web site www.eia.doe.gov/iea. **Projections:** EIA, *World Energy Projections Plus* (2008).

Godavari Basin and China's Sichuan province, as well as from smaller projects, to market. Some new export projects are expected to be brought on line in non-OECD Asia by 2015—most notably, the Tangguh LNG project in Indonesia—but production increases are aimed primarily at meeting rapid demand growth in the region. In 2005, net exports accounted for 17 percent of total production in non-OECD Asia, down from 30 percent in 1995. As rapid increases in production continue to be outpaced by consumption growth, non-OECD Asia is projected to become a net importer of natural gas after 2015.

In non-OECD Europe and Eurasia, natural gas production is projected to grow from 29.3 trillion cubic feet in 2005 to 36.1 trillion cubic feet in 2015 and 43.0 trillion cubic feet in 2030, although pricing and payment disputes currently are continuing to affect supplies. In

March 2008, Russia's Gazprom reduced supplies of natural gas to Ukraine in a dispute over payment for deliveries [2]. The reduction lasted for only 3 days, however, and did not affect supplies to downstream customers in OECD Europe. Production increases are projected to outpace growth in natural gas demand in non-OECD Europe and Eurasia, and the *IEO2008* reference case anticipates that Eurasian producers will remain important suppliers for their neighbors, especially in OECD Europe.

The expansion of natural gas trade between Eurasia and its western neighbors has not evolved without some difficulties. Exports of natural gas from Azerbaijan began to flow through the new South Caucasus pipeline to Georgia in March 2007 and to Turkey in July 2007 [3]. Turkey then began re-exporting Azeri gas to Greece after a new pipeline connecting Turkey and Greece

Table 5. World Natural Gas Production by Region and Country, 2005-2030
(Trillion Cubic Feet)

Region/Country	2005	Projections					Average Annual Percent Change, 2005-2030
		2010	2015	2020	2025	2030	
OECD North America	26.5	27.2	27.1	27.1	27.3	27.6	0.2
United States ^a	18.4	19.4	19.6	19.8	19.7	19.5	0.2
Canada	6.6	6.1	5.7	5.3	5.3	5.4	-0.8
Mexico	1.5	1.7	1.8	2.0	2.3	2.7	2.3
OECD Europe	10.9	11.3	11.2	10.7	10.5	10.3	-0.3
OECD Asia	1.8	2.2	2.9	3.7	4.0	4.3	3.7
Japan	0.2	0.2	0.2	0.2	0.2	0.2	0.2
South Korea	0.0	0.0	0.0	0.0	0.0	0.0	0.4
Australia/New Zealand	1.6	2.0	2.7	3.5	3.8	4.1	3.9
Total OECD	39.2	40.8	41.2	41.5	41.8	42.2	0.3
Non-OECD Europe and Eurasia	29.3	33.1	36.1	38.4	40.4	43.0	1.6
Russia	22.6	24.9	26.9	28.7	30.6	33.0	1.5
Other	6.6	8.2	9.3	9.6	9.8	10.0	1.7
Non-OECD Asia	11.2	13.7	17.2	20.6	23.5	25.6	3.3
China	1.8	2.5	3.2	3.8	4.2	4.3	3.6
India	1.1	1.5	2.0	2.4	2.7	2.9	4.1
Other non-OECD Asia	8.4	9.7	12.0	14.5	16.6	18.4	3.2
Middle East	11.2	14.6	16.9	19.3	20.7	22.5	2.8
Africa	6.1	7.9	10.7	13.5	14.8	15.8	3.9
Central and South America	4.9	6.2	7.3	7.9	8.8	9.5	2.7
Brazil	0.3	0.5	0.7	0.9	1.1	1.3	5.3
Other Central /South America	4.5	5.7	6.5	7.0	7.7	8.3	2.4
Total Non-OECD	62.7	75.5	88.3	99.7	108.1	116.4	2.5
Total World	101.9	116.2	129.5	141.2	149.9	158.6	1.8

^aIncludes supplemental production or forecast discrepancy. For details, see Energy Information Administration (EIA), *Annual Energy Outlook 2008*, p. 139, Table A13, "Natural Gas Supply, Disposition, and Prices."
Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** EIA, *International Energy Annual 2005* (June-October 2007), web site www.eia.doe.gov/iea. **Projections:** **United States:** EIA, *Annual Energy Outlook 2008*, DOE/EIA-0383(2008) (Washington, DC, June 2008), web site www.eia.doe.gov/oiaf/aer. **Others:** EIA, *World Energy Projections Plus* (2008).

opened in November 2007. In January 2008, Turkmenistan cut natural gas exports to Iran. Turkmenistan cited technical issues on the pipeline, later saying that Iran's failure to keep current on payments was hindering pipeline repairs [4]. The real reason for the halt in supplies, however, was widely believed to be a pricing dispute. Turkmenistan had proposed doubling the price Iran paid for imports, from \$1.91 per million Btu (\$70 per thousand cubic meters) to \$3.83 per million Btu, and Iran reacted by cutting exports to Turkey to make up for the lost imports from Turkmenistan. In turn, Turkey then cut re-exports of Azeri gas to Greece to make up for the lost imports from Iran. Subsequently, Russia's Gazprom increased its exports of natural gas to Turkey, diffusing the situation [5].

Brazil has the fastest-growing natural gas production in the *IEO2008* reference case, with average annual increases of 5.2 percent from 2005 to 2030; however, it starts from a very low level of 0.3 trillion cubic feet in 2005. As a whole, Central and South America's production increases by 2.7 percent per year, from 4.9 trillion cubic feet in 2005 to 9.5 trillion cubic feet in 2030. Despite adequate reserves that support healthy prospects for long-term production growth in South America, the region has begun importing LNG to supplement current domestic supplies, which have failed to keep up with demand (especially, peak seasonal demand). Argentina became the first country in South America to import LNG, receiving its first cargo in May 2008. Brazil and Chile are expected to follow: the arrival of Brazil's first LNG cargo is planned for late 2008, and Chile's first LNG import facility is expected to begin operating in 2009.

In the OECD, Australia/New Zealand is projected to have the strongest growth in natural gas production. Much of the growth in Australia's production is expected to support planned or proposed LNG export projects, however, and increasing costs for liquefaction projects have delayed project commitments in Australia and around the world. New projects in Western Australia face further hurdles. The first is a government policy requiring new export projects to reserve 15 percent of production for domestic use. The second is the intention of the state and federal governments to identify a single hub for liquefaction facilities serving the Browse Basin, in order to minimize environmental impacts from the separate facilities being proposed by various companies.

In contrast, development of coalbed methane (CBM) reserves in Queensland and New South Wales is progressing rapidly, with production from fiscal year 2000-2001⁹ to 2005-2006 growing by 30 percent per year on average [6] and accounting for roughly 5 percent of

production and 8 percent of consumption in 2005 and 2006. Production from CBM represents a higher percentage of total natural gas consumption than total production, because no CBM is being exported currently. That may change, however, as four LNG projects have been proposed with CBM as the feed gas [7].

In OECD North America, the United States has historically been both the largest producer and the largest consumer of natural gas, and Canada has been the primary source of U.S. natural gas imports. In 2005, Canada provided 86 percent of gross U.S. imports of natural gas. Although Canada's unconventional production is expected to increase over the projection period and LNG imports into Canada are projected to begin by the end of the decade, the combined increases in supply are not sufficient to offset a decline in conventional production in Canada's largest producing basin, the Western Canadian Sedimentary Basin. Increasing costs are expected to prevent the development of Canada's McKenzie Delta natural gas resource in the reference case, and Canada's production is projected to decline steadily, at an average annual rate of 0.8 percent. U.S. gross imports of LNG are projected to exceed gross pipeline imports from Canada after 2017, and Canada's share of U.S. gross imports is projected to decline to 32 percent in 2030.

In the United States, rising natural gas prices are expected to provide sufficient incentive for an Alaska natural gas pipeline, which has long been in the planning stages, to come on line. The pipeline is expected to begin transporting natural gas from Alaska to the lower 48 States in 2020, making a significant contribution to U.S. domestic supply. Alaska's natural gas production is expected to account for 100 percent of the projected growth in domestic U.S. conventional natural gas production.

A large portion of North America's remaining technically recoverable natural gas resource base consists of unconventional sources, which include tight sands, shale, and coalbed methane. With most of the large onshore conventional fields in the United States already having been discovered, the United States, like Canada, must look to these costlier sources of supply to make up for declines in conventional production. Unconventional production is expected to be a significant source of U.S. incremental supply, increasing from 7.9 trillion cubic feet (44 percent of total domestic production) in 2005 to 9.5 trillion cubic feet (49 percent) in 2030. With the increases in unconventional production and production from Alaska more than offsetting the decline in conventional production, U.S. production grows by an average of 0.2 percent per year.

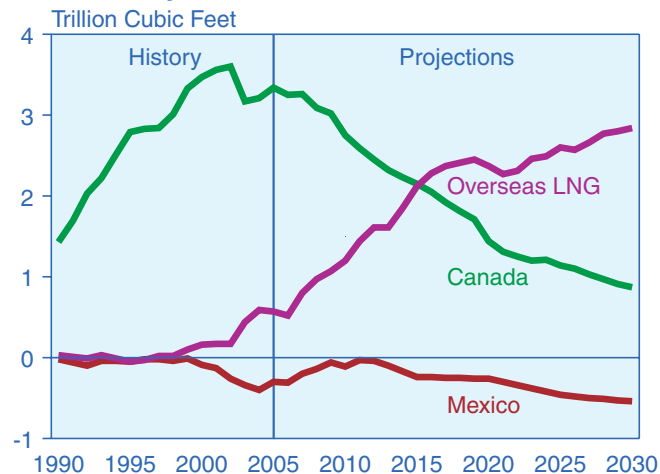
⁹The Australian Bureau of Agricultural and Resource Economics (ABARE) reports production on a fiscal year basis, which extends from July 1 through June 30 of the following year.

The largest source of incremental natural gas supply for the United States is expected to be LNG imports, which increase from 0.6 trillion cubic feet in 2005 to 2.8 trillion cubic feet in 2030. As of January 2008, five U.S. LNG import facilities were in operation, with a total peak capacity of slightly more than 5.8 billion cubic feet per day. Four additional facilities are under construction in the Gulf of Mexico and two in the offshore waters of New England. When completed, the new terminals will more than double U.S. LNG import capacity.

U.S. gross imports of LNG are expected to grow rapidly through 2015, increasing from 631 billion cubic feet in 2005 to 2.1 trillion cubic feet in 2015, as new domestic regasification capacity comes on line and new liquefaction projects are completed worldwide. The growth in LNG imports slows after 2015, however, as natural gas prices in general rise and demand declines. In the reference case projection, LNG imports reach 2.8 trillion cubic feet in 2030 (Figure 42). The emerging LNG markets in Canada and Mexico also show their strongest growth in the early years of the forecast.

There are significant untapped reserves of natural gas in Mexico; however, the state-owned oil company, PEMEX, does not have the resources needed to develop them fully, and the constitutional provision that prohibits foreign ownership of Mexico's oil and natural gas resources makes it difficult to attract foreign direct investment in the country's energy sector. Still, Mexico's

Figure 42. U.S. Net Imports of Natural Gas by Source, 1990-2030



Source: Energy Information Administration, *Annual Energy Outlook 2008*, DOE/EIA-0383(2008) (Washington, DC, June 2008), web site www.eia.doe.gov/oiaf/aeo.

¹⁰Proved reserves, as reported by the *Oil & Gas Journal*, are estimated quantities that can be recovered under present technology and prices. Natural gas reserves reported by the *Oil & Gas Journal* are compiled from voluntary survey responses and do not always reflect the most recent changes. U.S. proved reserves of natural gas are reported by the Energy Information Administration and are defined as the estimated quantities of natural gas reserves as of December 31, 2007, which analysis of geological and engineering data demonstrate with reasonable certainty to be recoverable in future years from known reservoirs under existing economic and operating conditions. Significant natural gas discoveries made in 2007 are not likely to be reflected in the reported reserves.

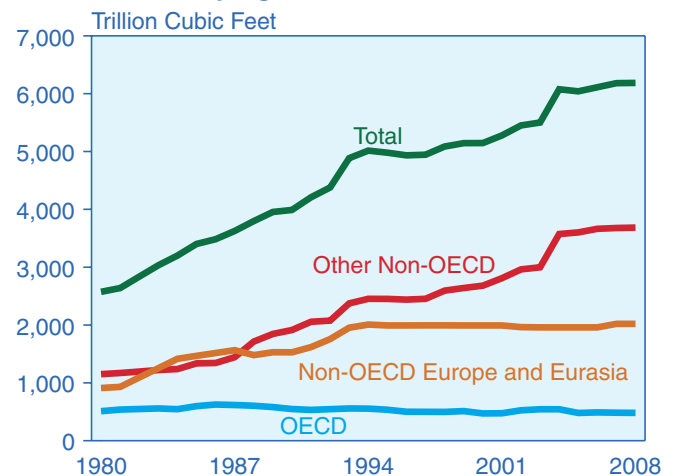
natural gas production is expected to increase significantly, from 1.5 trillion cubic feet in 2005 to 2.7 trillion cubic feet in 2030.

Reserves and Resources

Historically, world natural gas reserves have generally trended upward (Figure 43). As of January 1, 2008, proved world natural gas reserves, as reported by *Oil & Gas Journal*,¹⁰ were estimated at 6,186 trillion cubic feet—virtually unchanged from the estimate for 2007 of 6,168 trillion cubic feet [8]. Reserves have remained relatively flat since 2004, despite growing demand for natural gas, implying that, thus far, producers have been able to continue replenishing reserves successfully with new resources over time.

The largest additions to natural gas reserve estimates in 2008 were reported for Venezuela and Saudi Arabia. Venezuela added an estimated 14 trillion cubic feet (a 9-percent increase over 2007 proved reserves) and Saudi Arabia 13 trillion cubic feet (5 percent). There were smaller, but still substantial, reported increases in reserves in Malaysia and Angola—both of which added around 8 trillion cubic feet. The reserve addition in Malaysia represents an 11-percent increase in its proved reserves. The addition in Angola represents an increase of more than 300 percent. The United States also had a fairly substantial 6-percent increase in reserves, almost 7 trillion cubic feet over the 2007 estimate.

Figure 43. World Natural Gas Reserves by Country Grouping, 1980-2007



Sources: **1980-1993:** "Worldwide Oil and Gas at a Glance," *International Petroleum Encyclopedia* (Tulsa, OK: PennWell Publishing, various issues). **1994-2008:** *Oil & Gas Journal* (various issues).

The largest reported declines in natural gas reserves were reported for Iran (a decrease of 26 trillion cubic feet) and Qatar (5 trillion cubic feet); however, given the vast reserves in each of those countries, the declines represent relatively modest decreases of 3 percent and 1 percent, respectively. A more significant drop in reserves was reported for Papua New Guinea—just over 4 trillion cubic feet, or a 34-percent decrease in the country’s total natural gas reserves. Other decreases in proved natural gas reserves were reported for Indonesia (4 trillion cubic feet), Norway, Thailand, Algeria, and Libya (about 3 trillion cubic feet each).

Almost three-quarters of the world’s natural gas reserves are located in the Middle East and Eurasia (Figure 44). Russia, Iran, and Qatar together accounted for about 57 percent of the world’s natural gas reserves as of January 1, 2008 (Table 6).

Despite high rates of increase in natural gas consumption, particularly over the past decade, most regional reserves-to-production ratios are substantial. Worldwide, the reserves-to-production ratio is estimated at 63 years [9]. By region, the highest ratios are about 48 years for Central and South America, 78 years for Russia, 79 years for Africa, and more than 100 years for the Middle East.

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* and adjusted to reflect current proved reserves, a significant volume of natural gas remains to be discovered. Worldwide undiscovered natural gas is estimated at 4,133 trillion cubic feet (Figure 45). Of the new natural gas resources

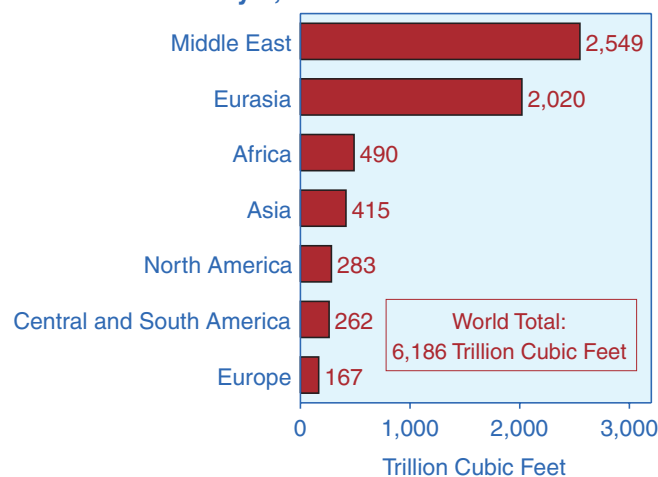
expected to be added through 2025, reserve growth accounts for 2,347 trillion cubic feet.

Table 6. World Natural Gas Reserves by Country as of January 1, 2008

Country	Reserves (Trillion Cubic Feet)	Percent of World Total
World	6,186	100.0
Top 20 Countries	5,606	90.6
Russia	1,680	27.2
Iran	948	15.3
Qatar	905	14.6
Saudi Arabia	253	4.1
United Arab Emirates	214	3.5
United States	211	3.4
Nigeria	184	3.0
Venezuela	166	2.7
Algeria	159	2.6
Iraq	112	1.8
Turkmenistan	100	1.6
Kazakhstan	100	1.6
Indonesia	94	1.5
Malaysia	83	1.3
China	80	1.3
Norway	79	1.3
Uzbekistan	65	1.1
Egypt	59	0.9
Canada	58	0.9
Kuwait	56	0.9
Rest of World	580	9.4

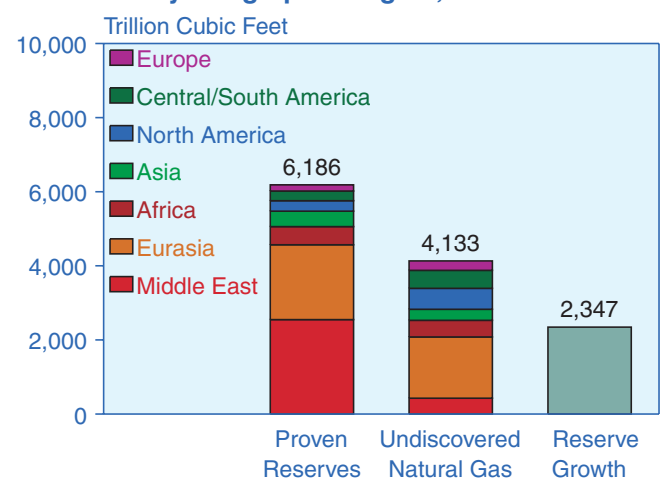
Source: “Worldwide Look at Reserves and Production,” *Oil & Gas Journal*, Vol. 105, No. 48 (December 24, 2007), pp. 24-25.

Figure 44. World Natural Gas Reserves by Geographic Region as of January 1, 2008



Source: “Worldwide Look at Reserves and Production,” *Oil & Gas Journal*, Vol. 105, No. 48 (December 24, 2007), pp. 24-25.

Figure 45. World Natural Gas Resources by Geographic Region, 2008-2025



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. 105, No. 48 (December 24, 2007), pp. 24-25; and Energy Information Administration estimates.

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