Chapter 3
World Oil Markets

In the IEO2006 reference case, world oil demand increases by 47 percent from 2003 to 2030. Non-OECD Asia, including China and India, accounts for 43 percent of the increase.

In the *IEO2006* reference case, world oil demand grows from 80 million barrels per day in 2003 to 98 million barrels per day in 2015 and 118 million barrels per day in 2030. Demand increases strongly despite world oil prices that are 35 percent higher in 2025 than in last year's outlook. Much of the growth in oil consumption is projected for the nations of non-OECD Asia, where strong economic growth is expected. Non-OECD Asia (including China and India) accounts for 43 percent of the total increase in world oil use over the projection period.

To meet the projected increase in world oil demand in the *IEO2006* reference case, total petroleum supply in 2030 will need to increase by 38 million barrels per day, to 118 million barrels per day, from the 2003 level of 80 million barrels per day. OPEC producers are expected to provide 14.6 million barrels per day of the increase. Higher oil prices cause a substantial increase in non-OPEC oil production—23.7 million barrels per day, which represents 62 percent of the increase in total world oil supplies over the projection period. The estimates of production increases are based on current proved reserves and a country-by-country assessment of ultimately recoverable petroleum.

The oil price path in the *IEO2006* reference case reflects a reassessment of the willingness of oil-rich countries to expand production capacity as aggressively as envisioned in last year's projection. It does not represent a change in the assessment of the ultimate size of the world's petroleum resources but rather a lower level of investment in oil development in key resource-rich regions than was projected in *IEO2005*. Several factors contribute to the expectation of lower investment and oil production in key oil-rich producing regions, including continued strong worldwide economic growth despite high oil prices, and various restrictions on access and contracting that affect oil exploration and production companies' costs.

In *IEO2005*, OPEC production was projected to increase by 24.0 million barrels per day between 2002 and 2025. *IEO2006* projects an increase in OPEC supply of only 11.8 million barrel per day over the same period. The resulting increase in world oil prices dampens world demand in the mid-term and makes previously uneconomical resources in non-OPEC regions more likely to be produced. Non-OPEC supplies of both conventional and unconventional resources (including biofuels, coal-to-liquids, and gas-to-liquids) are expected to increase as a result. In 2003, world production of unconventional resources totaled only 1.8 million barrels per day; in the *IEO2006* reference case, unconventional resource supplies rise to 11.5 million barrels per day and account for nearly 10 percent of total world petroleum supply in 2030.

To assess uncertainties in the reference case projections, *IEO2006* includes a high world oil price case and a low world price case in addition to the reference case. In all the cases, world oil prices are expressed as the average price of imported low-sulfur, light crude oil to U.S. refiners (see box on page 26). In the reference case, world oil prices increase from $41 per barrel in 2004 to $57 per barrel in 2030 (all prices in real 2004 dollars unless otherwise noted), and oil demand rises to 118 million barrels per day in 2030. In the low and high world oil price cases, prices in 2030 are $34 per barrel and $96 per barrel, respectively, accounting for the substantial range of uncertainty in the world's future oil markets. In 2030, oil demand in the two alternative price cases ranges from 102 million barrels per day in the high price case to 128 million barrels per day in the low price case.

World oil trading patterns change substantially over the projection horizon, as China and the other countries of non-OECD Asia fuel their growth in oil demand by taking an increasing share of the world's oil imports. China's petroleum imports are expected to grow fourfold from 2003 to 2030, with much of the increase coming from Persian Gulf suppliers. In 2003, China imported 0.9 million barrels per day of oil from Persian Gulf OPEC members, and in 2030 its Persian Gulf imports total 5.8 million barrels per day. The rising dependence of China on Middle Eastern oil supplies has geopolitical implications both for relations between the two regions and for the oil-consuming world as a whole.

World Oil Demand

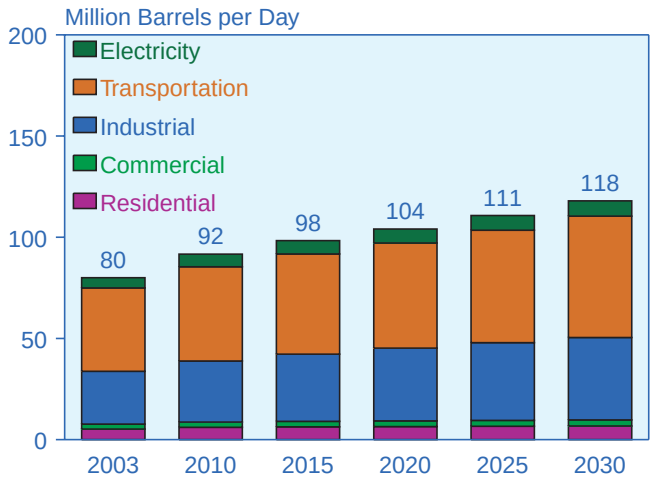
World oil consumption rose by about 1.2 million barrels per day in 2005, after an increase of 2.6 million barrels per day in 2004. The non-OECD countries accounted for 1.1 million barrels per day of the 2005 increase, and the OECD as a whole accounted for 0.1 million barrels per

day. Unlike in 2004, when China's oil use increased by 0.9 million barrels per day, its demand rose by only 0.4 million barrels per day in 2005, despite continued strong economic growth. In the United States, a 0.4-percent decline in oil demand in 2005 resulted from a combination of high prices, hurricane-related disruptions, and a mild winter [*1*]. It was the first decline in U.S. demand since 2001.

In the *IEO2006* reference case, growth in world oil demand averages 1.4 percent per year over the 2003 to 2030 period, as the world continues to experience strong economic growth. World oil prices in 2025 are 35 percent higher than projected in *IEO2005*, and as a result world oil demand grows more slowly in this year's reference case, to 111 million barrels per day in 2025, as compared with 119 million barrels per day in the *IEO2005* reference case. In *IEO2006*, total demand for petroleum liquids rises to 118 million barrels per day in 2030.

Much of the world's incremental oil demand is projected for use in the transportation sector, where there are few competitive alternatives to petroleum; however, several of the technologies associated with unconventional liquids (gas-to-liquids, coal-to-liquids, and ethanol and biodiesel produced from energy crops) are expected to meet a growing share of demand for petroleum liquids during the projection period. Of the projected increase in oil use in the reference case over the 2003 to 2030 period, one-half occurs in the transportation sector (Figure 26). The industrial sector accounts for a 39-percent share of the projected increase in world oil consumption, mostly for chemical and petrochemical processes.

Figure 26. World Oil Consumption by Sector, 2003-2030



Sources: **2003:** Derived from Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, System for the Analysis of Global Energy Markets (2006).

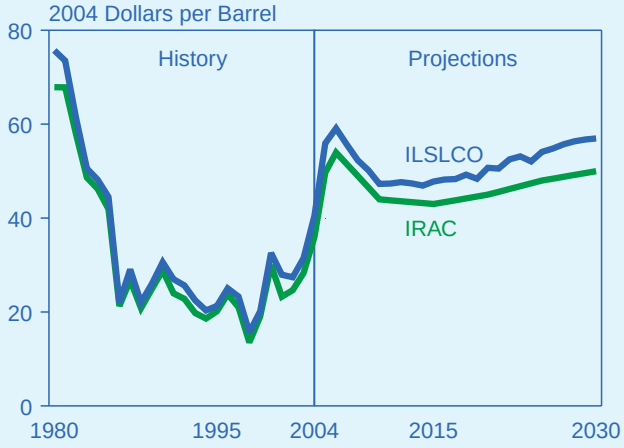
On a regional basis, two parts of the world lead the projected growth in world oil demand: non-OECD Asia and OECD North America (Figure 27). Outside North America, oil consumption in the OECD regions grows much more slowly (by 0.2 percent and 0.5 percent per year in Europe and Asia, respectively), reflecting expectations of slow growth or declines in population and slow economic growth over the next 25 years.

In the non-OECD countries, strong expansion of oil use is fueled by robust economic growth, burgeoning industrial activity, and rapidly expanding transportation use.

World Oil Prices in *IEO2006*

In previous *IEO*s, the world crude oil price was defined on the basis of the average imported refiner acquisition cost of crude oil to the United States (IRAC), which represented the weighted average of all imported crude oil. Historically, the IRAC price has tended to be a few dollars less than the widely cited prices of premium crudes (see figure below), such as West Texas Intermediate (WTI) and Brent, which refiners generally prefer for their low viscosity and sulfur content. In the past 2 years, the price difference between premium crudes and IRAC has widened—in particular, the price spread between premium crudes and heavier, high-sulfur crudes. In an effort to provide a crude oil price that is more consistent with those generally reported in the media, *IEO2006* uses the average price of imported low-sulfur, light crude oil to U.S. refiners.

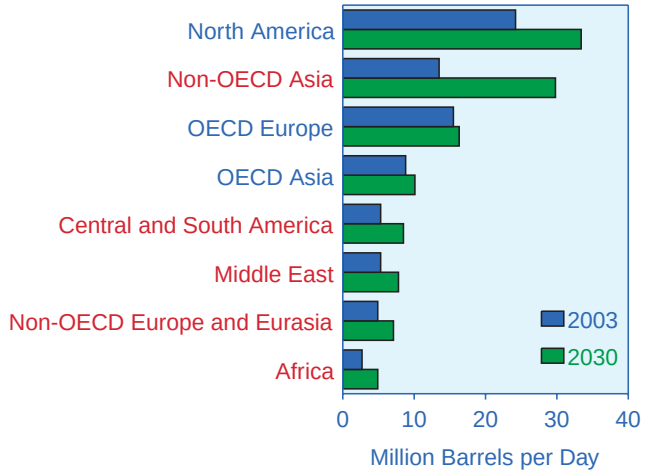
World Oil Prices, 1980-2030: Comparison of IRAC and Average Price of Imported Low-Sulfur, Light Crude Oil (ILSLCO) to U.S. Refiners



Sources: **History:** Derived from Energy Information Administration (EIA), *Annual Energy Review 2004*, DOE/EIA-0384(2004) (Washington, DC, August 2005). **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383 (2006) (Washington, DC, February 2006).

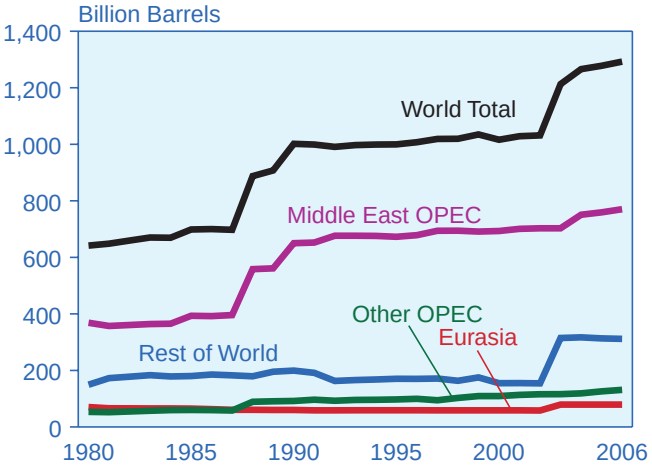
The fastest growth in oil demand is projected for the economies of non-OECD Asia, averaging 3.0 percent per year from 2003 to 2030. Fast-paced increases are also expected for the other non-OECD regions, including annual growth of oil use that averages 1.4 percent in non-OECD Europe and Eurasia, 1.5 percent in the Middle East, 1.8 percent in Central and South America, and 2.3 percent in Africa.

Figure 27. World Oil Consumption by Region and Country Group, 2003 and 2030



Sources: **2003:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **2030:** EIA, System for the Analysis of Global Energy Markets (2006).

Figure 28. World Crude Oil Reserves, 1980-2006



Note: Reserves include crude oil (including lease condensates) and natural gas plant liquids.

Sources: **1980-1993:** "Worldwide Oil and Gas at a Glance," *International Petroleum Encyclopedia* (Tulsa, OK: PennWell Publishing, various issues). **1994-2006:** *Oil & Gas Journal* (various issues).

Economic development in Asia will be crucial to long-term growth in oil markets. China, India, and the other nations of non-OECD Asia are expected to experience combined economic growth of 5.5 percent per year between 2003 and 2030, the highest rate of growth in the world. This robust expansion in gross domestic product (GDP) contributes to a 3.0-percent annual increase in regional oil use.

Oil Reserves and Resources

Historically, estimates of world oil reserves have generally trended upward (Figure 28). As of January 1, 2006, proved world oil reserves, as reported by *Oil & Gas Journal*,[3] were estimated at 1,293 billion barrels—15 billion barrels (about 1 percent) higher than the estimate for 2005 [**2**].

The largest increase in proved oil reserve estimates was made in Iran. Iranian oil reserves increased by 5 percent, from 125.8 billion barrels in 2005 to 132.5 billion barrels in 2006. Higher reserve estimates were also reported by Saudi Arabia, where reserves increased by 4.9 billion barrels (2 percent) in 2006, and Kuwait, where reserves increased by 2.5 billion barrels (3 percent). Venezuela also showed a substantive increase in reserves, with a gain of 2.5 billion barrels (3 percent). Chad, a country that previously had not been included in the *Oil & Gas Journal* survey, reported 1.5 billion barrels of proved oil reserves in 2006. Declining oil reserves were reported in Mexico (down by 1.7 billion barrels), with smaller losses in Norway (0.8 billion barrels), the United States (0.5 billion barrels), and the United Kingdom (0.5 billion barrels), among others.

Of the world's total proved oil reserves (Figure 29), 71 percent is located in the Middle East or Canada (where the Canadian Association of Petroleum Producers includes 174.1 billion barrels of Canadian oil sands as a conventional reserve). Among the top 20 oil reserve holders, 8 are OPEC member countries that together account for 65 percent of the world's total reserves (Table 3). It should be noted that there are sources of petroleum reserve estimates other than those offered in the *Oil & Gas Journal*, including *World Energy* [**3**], the OPEC Secretariat [**4**], and BP's *Statistical Review of World Energy* [**5**].

Table 4 shows estimates of the conventional oil resource base by region out to the year 2025. Reserve growth and undiscovered estimates are based on the *World Petroleum Assessment 2000* by the U.S. Geological Survey (USGS). The oil resource base is defined by three categories: remaining reserves (oil that has been discovered but not produced); reserve growth (increases in reserves

[3]Proved reserves, as reported by the *Oil & Gas Journal*, are estimated quantities that can be recovered under present technology and prices. Oil reserves reported by the *Oil & Gas Journal* are compiled from voluntary survey responses and do not always reflect the most recent changes. Changes made to individual countries' reserves during 2005 are not likely to be reflected in the reserves reported here.

resulting mainly from technological factors that enhance a field's recovery rate); and undiscovered (oil that remains to be found through exploration). The reserve growth and undiscovered volumes in Table 4 are derived from the USGS mean estimate, which is an average assessment over a wide range of uncertainty for reserve growth and undiscovered resources. The USGS provides three point estimates of undiscovered and inferred resources: the mean, a 5-percent lower bound, and a 95-percent upper bound with no price relationship. The *IEO2006* projections for oil production are based on the USGS mean estimate, which is derived from historical data on growth in oil and gas reserves for fields of similar size, without consideration of economic or political events [***6***].

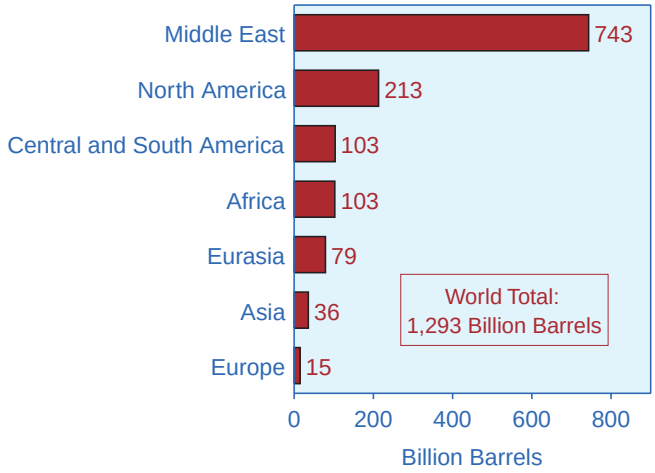
The Composition of World Oil Supply

An iterative approach was used to determine the composition of world oil supply in each of the three *IEO2006* oil price cases. For example, to develop the reference case an initial world oil price path was assumed for the 2010 to 2030 period. Future total world oil demand was then estimated on the basis of that price path and assumptions about future economic growth. The assumed price path was also used to estimate future non-OPEC production of conventional oil and production of unconventional liquids from both OPEC and non-OPEC countries, based on estimates of the total petroleum resource base. Finally, the level of OPEC conventional production that would be needed to balance world oil markets for the assumed reference case price path was calculated by subtracting non-OPEC conventional supplies and total unconventional supplies from total world oil demand. The likelihood that OPEC producers would supply this residual demand at the assumed price path was then evaluated, based on estimates of total OPEC oil resources and the apparent preferred production levels of key OPEC members.

If the OPEC production level required to balance the global market appeared too high, the assumed oil price path was adjusted upward, and a new iteration of demand and supply estimates was derived. Conversely, if the required OPEC production level appeared too low, the oil price path was adjusted downward for the next iteration. The reference case oil price path and associated composition of world oil supply represent a trajectory consistent with the *IEO2006* reference case assumptions about economic growth, supply and demand elasticities, the ultimate size of global oil resources, and preferred production levels for OPEC members.

Once the reference case oil price path and composition of world oil supply were determined, the same iterative approach was used to develop high and low world oil price cases. In the high world oil price case, worldwide crude oil resources were assumed to be 15 percent

Figure 29. World Proved Oil Reserves by Geographic Region as of January 1, 2006



Source: "Worldwide Look at Reserves and Production," *Oil & Gas Journal*, Vol. 103, No. 47 (December 19, 2005), pp. 24-25.

Table 3. World Oil Reserves by Country as of January 1, 2006
(Billion Barrels)

Country	Oil Reserves
Saudi Arabia	264.3
Canada	178.8
Iran	132.5
Iraq	115.0
Kuwait	101.5
UAE	97.8
Venezuela	79.7
Russia	60.0
Libya	39.1
Nigeria	35.9
United States	21.4
China	18.3
Qatar	15.2
Mexico	12.9
Algeria	11.4
Brazil	11.2
Kazakhstan	9.0
Norway	7.7
Azerbaijan	7.0
India	5.8
Rest of World	68.1
World Total	**1,292.5**

Source: "Worldwide Look at Reserves and Production," *Oil & Gas Journal*, Vol. 103, No. 47 (December 19, 2005), pp. 24-25.

smaller, and thus more expensive to produce, than in the reference case, and the preferred production levels of OPEC producers were reduced. In the low price case, the worldwide petroleum resource was assumed to be 15 percent larger and therefore cheaper to produce than in the reference case, and OPEC preferred production levels were increased.

It is important to note what this approach did and did not assume. A business-as-usual oil market environment was assumed. Disruptions in oil supply for any reason (war, terror, weather, geopolitics) were not assumed. It was assumed that all non-OPEC oil projects that show a favorable rate of return on investment would be funded. For the period out to 2030, there is sufficient oil to meet worldwide demand. Peaking of world oil production is not anticipated until after 2030.

In the *IEO2006* reference case, world oil supply in 2030 exceeds the 2003 level by 38 million barrels per day. Increases in production are expected for both OPEC and non-OPEC producers; however, only 38 percent of the total increase is expected to come from OPEC areas. In 2030, OPEC is expected to produce 45.3 million barrels per day and non-OPEC producers 72.6 million barrels per day in the *IEO2006* reference case. Over the past two decades, the growth in non-OPEC oil supply has resulted in an OPEC market share substantially under its high of 52 percent in 1973. In 2003, OPEC produced 39 percent of the world's oil supplies. High oil prices, new exploration and production technologies, aggressive cost-reduction programs by industry, and the emergence of unconventional resources contribute to the outlook for continued growth in non-OPEC oil production.

The reference case projects that about 62 percent of the increase in petroleum demand over the next 25 years will be met by increased production from non-OPEC suppliers. Non-OPEC production in 2030 is projected to be almost 24 million barrels per day higher than it was in 2003 (Figure 30). The *IEO2006* estimates of OPEC production capacity in 2010 are slightly less than those projected in *IEO2005*, reflecting a shift toward non-OPEC supply projects as a result of the higher prices assumed in *IEO2006*. The high world oil price case assumes that OPEC members might pursue significant price escalation through conservative capacity expansion decisions rather than undertake major production expansion programs. Such behavior would tend to raise world oil prices, and in this scenario OPEC suppliers increase their production capacity by only 4 million barrels per day between 2003 and 2030, in contrast to the reference case, where OPEC increases production capacity by 18 million barrels per day.

Table 4. Estimated World Oil Resources, 1995-2025[a]
(Billion Barrels)

Region	Proved Reserves	Reserve Growth	Undiscovered	Total
OECD				
United States	21.4	76.0	83.0	**180.4**
Canada	178.8	12.5	32.6	**223.9**
Mexico	12.9	25.6	45.8	**84.3**
OECD Europe	15.1	20.0	35.9	**71.0**
Japan	0.1	0.1	0.3	**0.5**
Australia/New Zealand	1.5	2.7	5.9	**10.1**
Non-OECD				
Russia	60.0	106.2	115.3	**281.5**
Other Non-OECD Europe/Eurasia	19.1	32.3	55.6	**107.0**
China	18.3	19.6	14.6	**52.5**
India	5.8	3.8	6.8	**16.4**
Other Non-OECD Asia	10.3	14.6	23.9	**48.8**
Middle East	743.4	252.5	269.2	**1,265.1**
Africa	102.6	73.5	124.7	**300.8**
Central and South America	103.4	90.8	125.3	**319.5**
Total World	**1,292.5**	**730.2**	**938.9**	**2,961.6**
OPEC	901.7	395.6	400.5	**1,697.8**
Non-OPEC	390.9	334.6	538.4	**1,263.9**

[a]The U.S. Geological Survey's assessment extends only to 2025.

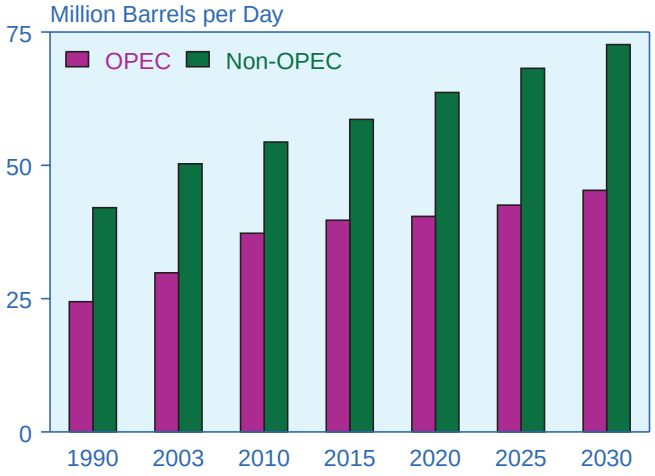
Note: Reserves include crude oil (including lease condensates) and natural gas plant liquids.

Sources: **Proved Reserves as of January 1, 2006:** *Oil & Gas Journal*, Vol. 103, No. 47 (December 19, 2005), pp. 24-25. **Reserve Growth (Total) and Undiscovered:** U.S. Geological Survey, *World Petroleum Assessment 2000*, web site http://pubs.usgs.gov/dds/dds-060/. **Estimates of Regional Reserve Growth:** Energy Information Administration, Office of Integrated Analysis and Forecasting.

Expansion of OPEC Production Capacity

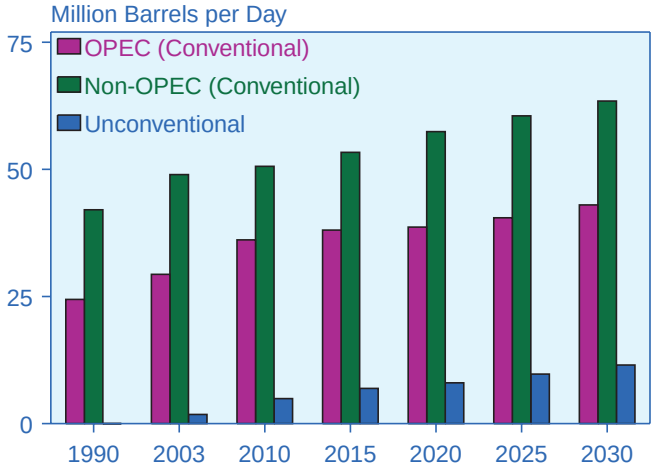
It is generally acknowledged that OPEC members with large reserves and relatively low costs for expanding production capacity can accommodate sizable increases in petroleum demand. In the *IEO2006* reference case, the production call on OPEC suppliers grows at an annual rate of 1.5 percent through 2030 (Figure 31 and Table 5). OPEC capacity utilization ranges between 90 and 93 percent for the duration of the projection period.

Figure 30. OPEC and Non-OPEC Total Petroleum Liquids Production, 1990, 2003, and 2010-2030



Sources: **1990 and 2003:** Energy Information Administration (EIA), Energy Markets and Contingency Information Division. **2010-2030:** EIA, System for the Analysis of Global Energy Markets (2006).

Figure 31. OPEC, Non-OPEC, and Unconventional Oil Production, 1990, 2003, and 2010-2030



Sources: **1990 and 2003:** Energy Information Administration (EIA), Energy Markets and Contingency Information Division. **2010-2030:** EIA, System for the Analysis of Global Energy Markets (2006).

Amidst enormous uncertainty, Iraq's role in OPEC in the next several years will be of particular interest. In 1999, Iraq expanded its production capacity to 2.8 million barrels per day in order to reach the slightly more than $5.2 billion in oil exports allowed by United Nations Security Council resolutions. In the *IEO2006* reference case, Iraq is assumed to maintain its current oil production capacity of about 2.5 million barrels per day into 2006 [7]. Iraq has indicated a desire to expand its production capacity aggressively, to more than 6 million barrels per day, once the security and political situation in the country has stabilized. Preliminary discussions of exploration projects have already been held with a number of potential outside investors. Such a significant increase in Iraqi oil exports would ease market tightness. Iraq's oil production reaches 5.5 million barrels per day in 2030 in the reference case.

In the *IEO2006* reference case, OPEC members outside the Persian Gulf increase their production capacity moderately, in part because of their higher capacity expansion costs. There is some optimism regarding Nigeria's offshore production potential, although it is unlikely to be developed until the later part of this decade. Except for modest near-term increments to supply, Algeria and Libya are expected to experience flat production throughout the projections; Indonesia's production capacity is expected to decline over the projection period. Venezuela is expected to see some increases in production, especially toward the end of the projection period. The lackluster increases in OPEC supply outside the Persian Gulf suggest that the organization's supply will rely even more on Persian Gulf members, whose current 71-percent share of total OPEC supply increases to nearly 73 percent in 2030. Tables E1-E6 in Appendix E

Table 5. OPEC Oil Production, 1990-2030
(Million Barrels per Day)

Year	Reference Case	High Oil Price	Low Oil Price
History			
1990	24.5	—	—
2003	30.7	—	—
Projections			
2010	37.3	32.9	37.9
2015	39.7	28.7	41.0
2020	40.4	29.3	43.3
2025	42.5	29.8	46.9
2030	45.3	30.9	51.0

Note: Includes the production of crude oil, natural gas plant liquids, refinery gain, and other liquid fuels.

Sources: **1990 and 2003:** Energy Information Administration (EIA), Energy Markets and Contingency Information Division. **2010-2030:** EIA, System for the Analysis of Global Energy Markets (2006).

show the ranges of production potential for both OPEC and non-OPEC producers.

Non-OPEC Supply

The expectation in the late 1980s and early 1990s was that non-OPEC production in the longer term would stagnate or decline gradually in response to resource constraints. The relatively low cost of developing oil resources within OPEC countries (especially those in the Persian Gulf region) was considered such an overwhelming advantage that non-OPEC production potential was viewed with considerable pessimism. In actuality, however, despite several periods of relatively low prices, non-OPEC production has risen every year since 1993, adding more than 6.9 million barrels per day between 1993 and 2003 [*8*].

Non-OPEC supply has become increasingly diverse over the past three decades, and growth in non-OPEC oil production has played a significant role in the erosion of OPEC's market share, which has fallen from 52 percent in 1973 to 39 percent in 2003. North America dominated non-OPEC supply in the early 1970s, the North Sea and Mexico evolved as major producers in the 1980s, and much of the new production in the 1990s came from the economies of South America, West Africa, the non-OPEC Middle East, and China.

Higher world oil prices in the *IEO2006* reference case allow non-OPEC suppliers to retain market share of world oil supplies through 2030. Non-OPEC supply from proven reserves increases steadily, from 48.9 million barrels per day in 2003 to 72.6 million barrels per day in 2030 (Table 6), as high prices attract investment in areas previously considered uneconomical. As a result, the non-OPEC market share in 2030, at 62 percent of the world's oil supply, is slightly higher than its 2003 share of 61 percent.

In addition, the reference case outlook for production of unconventional liquids (especially from oil sands and ultra-heavy oils) is twice as optimistic in *IEO2006* as it was in *IEO2005*, reflecting the impact of a much higher price path. In the *IEO2005* reference case, unconventional production rose to 5.7 million barrels per day in 2025; in *IEO2006*, unconventional supplies reach 9.7 million barrels per day in 2025 and 11.5 million barrels per day in 2030. In the *IEO2006* high world oil price case, unconventional liquids production rises to 16.3 million barrels per day in 2025 and 21.1 million barrels per day in 2030.

In the *IEO2006* reference case, the decline in North Sea production is slowed slightly relative to past outlooks, based on the implementation of strategies for redeveloping mature fields. Production from Norway, OECD Europe's largest producer, is expected to peak at about 3.6 million barrels per day in 2006 and then decline gradually to about 2.5 million barrels per day in 2030 with the maturing of some of its larger and older fields. The United Kingdom sector is expected to produce about 2.2 million barrels per day in 2010, followed by a decline to 1.4 million barrels per day in 2030.

With higher oil prices assumed to continue, oil production in the non-OECD Europe and Eurasian region exceeds 14.0 million barrels per day in 2015, based in large part on the potential investment outlook for the Caspian Basin region, where long-term production potential still is regarded with considerable optimism. Caspian output more than doubles, to 4.2 million barrels per day, in 2015 and increases steadily thereafter, although there still is considerable uncertainty about export routes from the Caspian Basin region.

North African producers Egypt and Tunisia produce mainly from mature fields and show little promise of adding to their reserve posture. As a result, their production volumes decline gradually in the projections. In East Africa, Sudan is expected to produce significant volumes by the end of this decade and could exceed 500,000 barrels per day in 2030. Eritrea, Somalia, and South Africa also have some resource potential, but they are not expected to produce significant volumes until late in the projections.

Several West African producers—Angola, Cameroon, Chad, Congo (Brazzaville), Equatorial Guinea, Gabon, Mauritania, Niger, Sao Tome and Principe, and Ivory Coast—are expected to reap the benefits of substantial exploration activity, especially if current high oil prices persist. Angola became a million barrel per day producer in 2004; and given the excellent deepwater exploration results, it could produce up to 3.4 million barrels per day in the later years of the projections. The other

Table 6. Non-OPEC Oil Production, 1990-2030
(Million Barrels per Day)

Year	Reference Case	High Oil Price	Low Oil Price
History			
1990	42.1	—	—
2003	48.9	—	—
Projections			
2010	54.4	54.1	54.6
2015	58.6	61.9	60.4
2020	63.7	64.9	67.1
2025	68.2	68.2	72.6
2030	72.6	71.0	76.7

Note: Includes the production of crude oil, natural gas plant liquids, refinery gain, and other liquid fuels.

Sources: **1990 and 2003:** Energy Information Administration (EIA), Energy Markets and Contingency Information Division. **2010-2030:** EIA, System for the Analysis of Global Energy Markets (2006).

West African producers with offshore tracts are expected to increase output by up to 1.1 million barrels per day by the end of the projection period.

Oil producers in the Pacific Rim are expected to increase their production volumes as a result of enhanced exploration and extraction technologies. India's deepwater prospects are expected to show some encouraging production increases in this decade, with the potential for significant increases near the end of the projection period. Vietnam's long-term production potential still is viewed with considerable optimism, although exploration activity has been slower than originally hoped. Output from Vietnamese fields is projected to exceed 375,000 barrels per day in 2015. In China, conventional oil production declines slightly, to about 3.2 million barrels per day in 2030.

Australia has continued to make additions to its proved reserves, and its oil production is expected to reach 900,000 barrels per day by the end of this decade. Malaysia shows little potential for any significant new finds, and its output is expected to peak at around 750,000 barrels per day in this decade and then decline gradually to less than 700,000 barrels per day in 2030. Papua New Guinea continues to add to its reserve posture and is expected to achieve production volumes approaching 110,000 barrels per day by the end of this decade, followed by only a modest decline over the remainder of the projection period. Exploration and test-well activity have pointed to some production potential for Bangladesh and Myanmar (formerly, Burma), but significant output is not expected until after 2010.

In North America, moderately declining U.S. output is expected to be supplemented by significant production increases in Canada and Mexico. Canada's conventional oil output contracts steadily in the reference case, by about 1.0 million barrels per day over the next 25 years, but an additional 2.8 million barrels per day of unconventional output from oil sands projects is added. The *IEO2006* reference case assumes in the sustained higher world oil price environment, Mexico's state oil company, Pemex will successfully lobby to use a larger portion of its profits to fund exploration and production investments and thereby increase production in the long-term. Production in Mexico exceeds 4.0 million barrels per day by the end of the decade and continues increasing to 5.0 million barrels per day by 2030, despite the anticipated decline in production of Mexico's largest oil field at Cantarell [***9***].

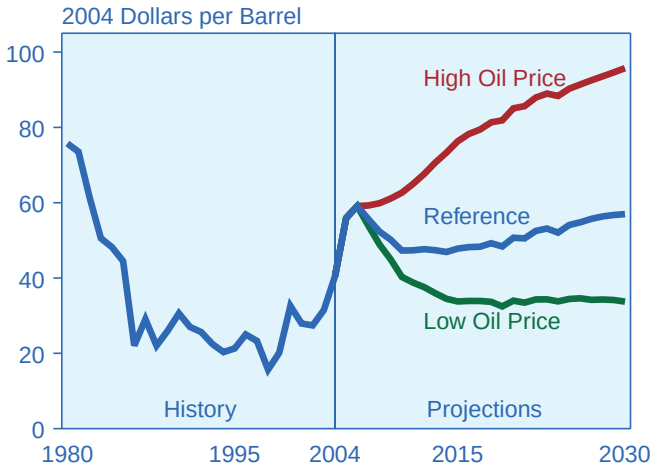
Oil producers in South America have significant potential for increasing output over the next decade. Brazil became a million barrel per day producer of crude oil in 1999, with considerable production potential waiting to be tapped. Brazil's production rises throughout the projection period, topping 3.9 million barrels per day of conventional supply and 0.6 million barrels per day of unconventional supply in 2030. Colombia's current economic downturn and civil unrest have delayed development of its oil production infrastructure, but its output is expected to exceed 610,000 barrels per day within the decade, with continued modest increases over the remainder of the projection period. In both Brazil and Colombia, the oil sector would benefit significantly from the creation of favorable climates for foreign investment. Argentina is expected to increase its production volumes by at least 65,000 barrels per day over the next 3 years, and by the end of the decade it could possibly become a million barrel per day producer. Although the current political situation in Ecuador is in transition, there is still optimism that Ecuador will double production volumes over the projection period.

World Oil Prices

The world oil price in *IEO2006* is defined as the annual average price of imported low-sulfur, light crude oil to U.S. refiners (see box on page 26). In the low world oil price, reference, and high world oil price cases, average world oil prices in 2030 are $34, $57, and $96 per barrel, respectively (Figure 32). (All prices are in real 2004 dollars—i.e., inflation-adjusted dollars—unless otherwise noted.)

The *IEO2006* oil price paths reflect a reassessment of the willingness of oil-rich countries to expand production capacity as aggressively as envisioned last year. It does not represent a change in the assessment of the ultimate size of the world's petroleum resources but rather a lower level of investment in oil development in key

Figure 32. World Oil Prices in Three Cases, 1980-2030



Sources: **History:** Energy Information Administration (EIA), *Annual Energy Review 2004*, DOE/EIA-0384(2004) (Washington, DC, August 2005), web site www.eia.doe.gov/emeu/ aer/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006).

resource-rich regions than was projected in *IEO2005* [***10***]. Resources are not expected to be a key constraint on world demand to 2030. Rather more important are the political, economic, and environmental circumstances that could shape developments in oil supply and demand.

The *IEO2006* high and low oil price cases are based on different assumptions about world oil supply. The reference case uses the USGS mean oil and natural gas resource estimate.[4] The high price case assumes that the worldwide crude oil resource is 15 percent smaller and is more costly to produce than assumed in the reference case. The low price case assumes that the worldwide resource is 15 percent more plentiful and is cheaper to produce than assumed in the reference case. Thus, the major price differences across the three cases reflect uncertainty with regard to both the supply of resources (primarily undiscovered and inferred) and the cost of producing them [***11***].

Although oil prices rose by more than $9 per barrel over the course of 2004 and an additional $15 per barrel in 2005, these developments are not indicative of the long-term trend in the *IEO2006* reference case. From record nominal high levels throughout 2006, oil prices in the reference case decline gradually to $47 per barrel in 2014, then rise by about 1.2 percent per year to $57 per barrel in 2030. In all the *IEO2006* oil price cases, oil demand rises significantly over the projection period. In the high and low price cases, the increases in oil consumption from 2003 to 2030 are 22 million barrels per day and 48 million barrels per day, respectively.

Oil prices have been highly volatile over the past 25 years, and periods of price volatility can be expected in the future principally because of unforeseen political and economic circumstances. It is widely recognized that tensions in the Middle East, for example, could give rise to serious disruptions of normal oil production and trading patterns. On the other hand, market forces can play a significant role in restoring balance over an extended period. High real prices deter consumption and encourage the emergence of significant competition from large marginal sources of oil, which currently are uneconomical to produce, and other energy supplies. Persistently low prices have the opposite effects.

Limits to long-term oil price escalation include substitution of other fuels (such as natural gas) for oil, marginal sources of conventional oil that become reserves (i.e., economically viable) when prices rise, and unconventional sources of oil that become reserves at still higher prices. Advances in exploration and production technologies are likely to bring prices down when such additional oil resources become part of the reserve base.

Worldwide Petroleum Trade

Because oil is fungible and traded in world commodities markets, there is much uncertainty associated with projections of future patterns of oil trade; however, anticipated changes in the world's oil trading patterns—particularly, the shifting regional dependence of importing regions on producing regions—may have important geopolitical ramifications. In 2003, the OECD economies imported 17.9 million barrels of oil per day from OPEC producers. Of that total, 11.3 million barrels per day came from the Persian Gulf region. Oil movements to OECD economies represented 57 percent of the total petroleum exported by OPEC member nations and 50 percent of all Persian Gulf exports (Table 7). By the end of the projection period, OPEC exports to OECD economies in the reference case are estimated to be about 3.2 million barrels per day higher than their 2003 level, and almost 42 percent of the increase is expected to come from the Persian Gulf region.

Despite such a substantial increase, the share of total petroleum exports that goes to OECD member nations in 2030 is more than 9 percentage points below their 2003 share in the reference case, and their share of Persian Gulf exports falls by more than 13 percent. The significant shift expected in the balance of OPEC export shares between the OECD and non-OECD economies is a direct result of the economic growth anticipated for the non-OECD nations, especially non-OECD Asia. OPEC petroleum exports to non-OECD economies increase by 13.6 million barrels per day over the projection period, with more than 85 percent of the increase going to the non-OECD economies of Asia. China, alone, is likely to import about 8.4 million barrels per day from OPEC in 2030, 69 percent of which is expected to come from Persian Gulf producers.

North America's petroleum imports from the Persian Gulf in the reference case increase by more than 40 percent from 2003 to 2030 (Figure 33). At the same time, more than 40 percent of North America's total imports in 2030 is expected to come from Atlantic Basin producers and refiners, with significant increases anticipated in crude oil imports from Latin American producers, including Venezuela, Brazil, Colombia, and Mexico. West African producers, including Nigeria and Angola, are also expected to increase their export volumes to North America. Caribbean Basin refiners are expected to account for most of the increase in North America's imports of refined products.

With a moderate decline in North Sea production, OECD Europe is expected to import increasing amounts from Persian Gulf producers and from OPEC member nations in western Africa. Substantial imports from the

[4]The USGS provides three point estimates of undiscovered and inferred resources: the mean, a 5-percent lower bound, and a 95-percent upper bound with no price relationship.

Caspian Basin are also expected. OECD Asian nations are expected to increase their already heavy dependence on OPEC oil. The non-OECD economies of Asia are expected to more than double their total petroleum imports between 2003 and 2030.

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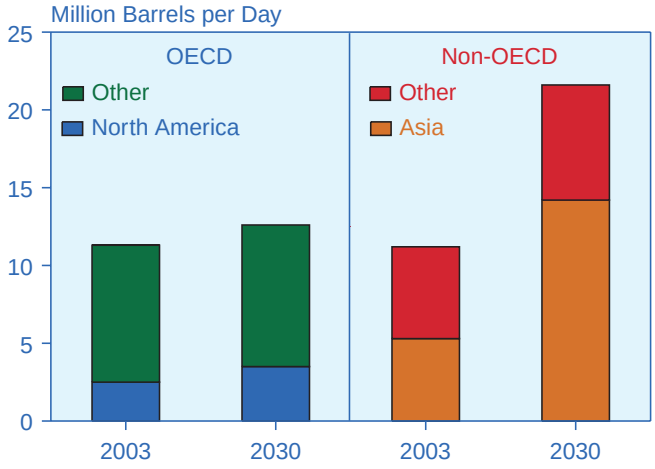
Table 7. Worldwide Petroleum Trade in the Reference Case, 2003 and 2030
(Million Barrels per Day)

Exporting Region	Importing Region: OECD: North America	OECD: Europe	OECD: Asia	OECD: Total	Non-OECD: China	Non-OECD: Other Asia	Non-OECD: Rest of World	Non-OECD: Total	Total Exports
				2003					
OPEC									
Persian Gulf	2.5	2.7	6.1	**11.3**	0.9	4.4	5.9	**11.2**	**22.5**
North Africa	0.6	1.9	0.0	**2.6**	0.1	0.0	0.3	**0.4**	**3.0**
West Africa	1.1	0.3	0.2	**1.6**	0.2	0.0	0.2	**0.4**	**1.9**
South America	1.7	0.1	0.2	**2.0**	0.1	0.0	1.0	**1.1**	**3.1**
Asia	0.0	0.0	0.4	**0.5**	0.3	0.4	0.0	**0.8**	**1.2**
Total OPEC	**5.9**	**5.1**	**6.9**	**17.9**	**1.6**	**4.8**	**7.4**	**13.8**	**31.7**
Non-OPEC									
OECD Europe	0.5	0.0	0.0	**0.5**	0.0	0.0	0.1	**0.1**	**0.7**
Brazil and Caribbean Basin	0.7	0.3	0.0	**1.0**	0.1	0.0	0.1	**0.1**	**1.2**
Russia and Caspian Area	0.4	2.9	0.2	**3.5**	0.4	1.2	0.8	**2.4**	**5.8**
Other Non-OPEC	5.9	2.5	1.0	**9.4**	0.7	1.1	2.2	**4.0**	**13.4**
Total Non-OPEC	**7.5**	**5.7**	**1.2**	**14.5**	**1.2**	**2.3**	**3.1**	**6.7**	**21.1**
Total Petroleum Imports	**13.5**	**10.8**	**8.1**	**32.4**	**2.8**	**7.1**	**10.6**	**20.4**	**52.8**
				2030					
OPEC									
Persian Gulf	3.5	3.3	5.8	**12.6**	5.8	8.4	7.4	**21.6**	**34.3**
North Africa	0.6	1.9	0.2	**2.6**	0.4	0.5	0.6	**1.5**	**4.1**
West Africa	1.1	0.7	0.4	**2.2**	1.2	0.2	0.4	**1.8**	**4.0**
South America	2.3	0.3	0.5	**3.0**	0.4	0.3	0.6	**1.4**	**4.4**
Asia	0.1	0.1	0.5	**0.7**	0.5	0.1	0.3	**1.0**	**1.7**
Total OPEC	**7.5**	**6.3**	**7.3**	**21.1**	**8.4**	**9.5**	**9.4**	**27.4**	**48.5**
Non-OPEC									
OECD Europe	1.3	0.0	0.1	**1.4**	0.1	0.1	0.1	**0.3**	**1.7**
Brazil and Caribbean Basin	1.6	0.9	0.4	**2.9**	0.2	0.3	1.0	**1.5**	**4.4**
Russia and Caspian Area	0.5	2.4	0.8	**3.6**	0.4	0.9	1.7	**2.9**	**6.6**
Other Non-OPEC	8.5	1.9	0.6	**10.9**	1.9	0.6	2.7	**5.1**	**16.1**
Total Non-OPEC	**11.9**	**5.2**	**1.9**	**18.9**	**2.5**	**1.9**	**5.5**	**9.9**	**28.8**
Total Petroleum Imports	**19.4**	**11.5**	**9.2**	**40.1**	**10.9**	**11.4**	**15.0**	**37.3**	**77.3**

Notes: Trade includes both crude oils and refined products. Totals may not equal sum of components due to independent rounding.

Sources: **2003:** Energy Information Administration (EIA), Energy Markets and Contingency Information Division. **2030:** EIA, Office of Integrated Analysis and Forecasting, IEO2006 WORLD Model run IEO2006.B30 (2006).

Figure 33. Imports of Persian Gulf Oil by Importing Region, 2003 and 2030



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