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Preface

This report presents international energy projections through 2030, prepared by the Energy Information Administration, including outlooks for major energy fuels and associated carbon dioxide emissions.

The *International Energy Outlook 2006* (*IEO2006*) presents an assessment by the Energy Information Administration (EIA) of the outlook for international energy markets through 2030. U.S. projections appearing in *IEO2006* are consistent with those published in EIA's *Annual Energy Outlook 2006* (*AEO2006*), which was prepared using the National Energy Modeling System (NEMS). *IEO2006* is provided as a service to energy managers and analysts, both in government and in the private sector. The projections are used by international agencies, Federal and State governments, trade associations, and other planners and decisionmakers. They are published pursuant to the Department of Energy Organization Act of 1977 (Public Law 95-91), Section 205(c).

IEO2006 focuses exclusively on marketed energy. Nonmarketed energy sources, which continue to play an important role in some developing countries, are not included in the estimates. The *IEO2006* projections are based on U.S. and foreign government laws in effect on January 1, 2006. The potential impacts of pending or proposed legislation, regulations, and standards are not reflected in the projections, nor are the impacts of legislation where the mechanisms for implementing the legislation have not yet been announced. For example, the *IEO2006* reference case does not include the potential impacts of the Kyoto Protocol (which entered into force on February 16, 2005), because the treaty does not indicate the methods by which signatories will implement the Protocol. The Kyoto Protocol also does not address signatory obligations beyond 2012, making it impossible in the context of a reference case projection for EIA to assess the impacts of the Protocol through 2030, the end of the *IEO2006* projection period.

Projections in *IEO2006* are displayed according to two basic regions or country groupings: members of the Organization for Economic Cooperation and Development (OECD) and nonmembers (non-OECD) (see Appendix J for complete regional definitions). The regionalization has changed since last year's report. The OECD region includes three basic subgroups: North America (United States, Canada, and Mexico); OECD Europe; and OECD Asia (Japan, South Korea, and Australia/New Zealand). The non-OECD region is divided into five separate regional subgroups: non-OECD Europe and Eurasia, non-OECD Asia, Africa, Middle East, and Central and South America. Russia is included in non-OECD Europe and Eurasia; China and India are included in non-OECD Asia; and Brazil is included in Central and South America.

The report begins with a review of world trends in energy demand and the major macroeconomic assumptions used in deriving the *IEO2006* projections. The time frame for historical data begins with 1980 and extends to 2003, providing a 23-year historical view of energy demand. The projections extend to 2030. High economic growth and low economic growth cases were developed to depict a set of alternative growth paths for the energy forecast. The two cases consider higher and lower growth paths for regional gross domestic product (GDP) than assumed in the reference case. The resulting projections—and the uncertainty associated with international energy projections in general—are discussed in Chapter 1, "World Energy and Economic Outlook."

Worldwide and regional projections of end-use energy consumption in the residential, commercial, industrial, and transportation sectors are presented in Chapter 2. Projections for energy consumption by fuel—petroleum, natural gas, and coal—are presented in Chapters 3, 4, and 5, along with reviews of the current status of each fuel on a worldwide basis. Chapter 6 discusses the projections for world electricity markets—including nuclear power, hydropower, and other commercial renewable energy resources—and presents forecasts of world installed generating capacity. Finally, Chapter 7 discusses the outlook for global carbon dioxide emissions. With the entry into force of the Kyoto Protocol on February 16, 2005, this year's outlook includes a Kyoto Protocol scenario, which is also presented in Chapter 7.

Appendix A contains summary tables of the *IEO2006* reference case projections for world energy consumption, GDP, energy consumption by fuel, carbon dioxide emissions, and regional population growth. The reference case projections of total foreign energy consumption and consumption of oil, natural gas, coal, and renewable energy were prepared using EIA's System for the Analysis of Global Energy Markets (SAGE), as were projections of net electricity consumption, energy consumed by fuel and region and by end-use sector, and carbon dioxide emissions. In addition, the NEMS Coal Export Submodule was used to derive flows in international coal trade, presented in Chapter 5.

Summary tables of projections for the high and low economic growth cases are provided in Appendixes B and C, respectively. Appendix D contains reference case projections of delivered energy consumption by end-use sector and region. Appendix E contains summary tables of projections for world oil production capacity and oil production in the reference case and the high and low world oil price cases. The projections in Appendix E were derived from the International Energy Module of NEMS. Appendix F contains summary tables of reference case projections for installed electric power capacity by fuel, as well as regional electricity generation by fuel. Appendix G provides a summary of assumptions underlying the *IEO2006* Kyoto Protocol case. Appendix H includes a set of comparisons of alternative forecasts with the *IEO2006* projections, as well as comparisons of historical *IEO* forecasts with actual historical data. Comparisons of the *IEO2006* and *IEO2005* forecasts are also presented in Appendix H. Appendix I describes the SAGE model, and Appendix J defines the regional designations included in the report.

Objectives of the *IEO2006* Projections

The projections in *IEO2006* are not statements of what will happen, but what might happen given the specific assumptions and methodologies used. These projections provide an objective, policy-neutral reference case that can be used to analyze international energy markets. As a policy-neutral data and analysis organization, EIA does not propose, advocate, or speculate on future legislative and regulatory changes. The projections are based on U.S. and foreign government laws effective as of January 1, 2006. Assuming fixed laws, even knowing that changes will occur, will naturally result in projections that differ from the final data.

Models are abstractions of energy production and consumption activities, regulatory activities, and producer and consumer behavior. The forecasts are highly dependent on the data, analytical methodologies, model structures, and specific assumptions used in their development. Trends depicted in the analysis are indicative of tendencies in the real world rather than representations of specific real-world outcomes. Many events that shape energy markets are random and cannot be anticipated, and the content and timing of policy developments, as well as assumptions concerning future technology characteristics, demographics, and resource availability, are inherently uncertain.

Highlights

World energy consumption is projected to increase by 71 percent from 2003 to 2030. Fossil fuels continue to supply much of the energy used worldwide, and oil remains the dominant energy source.

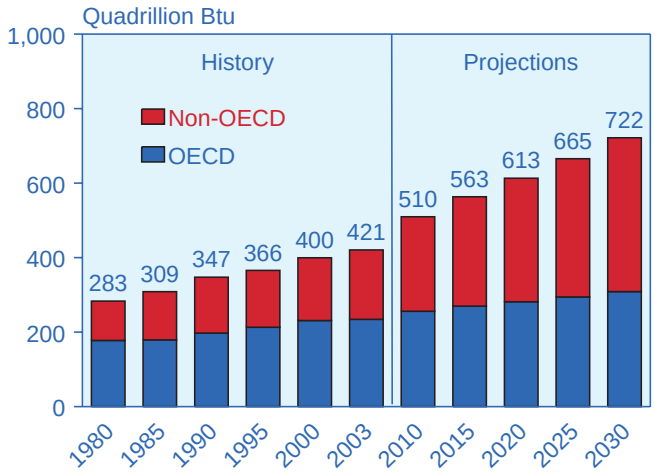
In the *International Energy Outlook 2006* (*IEO2006*) reference case, world marketed energy consumption increases on average by 2.0 percent per year from 2003 to 2030. Although world oil prices in the reference case, which remain between $47 and $59 per barrel (in real 2004 dollars), dampen the growth in demand for oil, total world energy use continues to increase as a result of robust economic growth. Worldwide, total energy use grows from 421 quadrillion British thermal units (Btu) in 2003 to 563 quadrillion Btu in 2015 and 722 quadrillion Btu in 2030 (Figure 1).

The most rapid growth in energy demand from 2003 to 2030 is projected for nations outside the Organization for Economic Cooperation and Development (non-OECD nations). Energy demand growth averages 3.7 percent per year for non-OECD Asia (which includes China and India), 2.8 percent per year for Central and South America, 2.6 percent per year for Africa, 2.4 percent per year for the Middle East, and 1.8 percent per year for non-OECD Europe and Eurasia. The increases result from projections of strong regional economic growth. For all the non-OECD regions combined, economic activity—as measured by gross domestic product (GDP) in purchasing power parity terms—expands by 5.0 percent per year on average, as compared with an average of 2.6 percent per year for the OECD economies.

The OECD nations, for the most part, are more mature energy consumers with well-established infrastructures, and their economies generally are moving away from energy-intensive industries toward services. Consequently, total OECD energy demand increases by an average of 1.0 percent per year over the projection period, as compared with an average increase of 3.0 percent per year for total non-OECD energy demand.

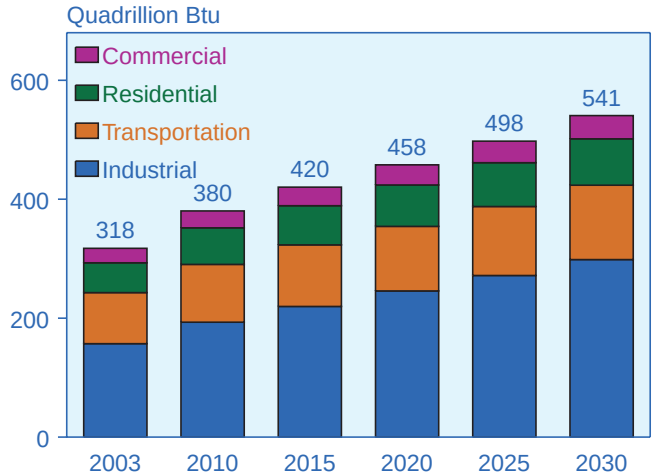
Trends in end-use sector energy consumption can vary widely, according to the level and pace of economic development in a given region. On a worldwide basis, energy demand in the industrial sector grows most rapidly, at an average rate of 2.4 percent per year (Figure 2). Slower growth is projected for the buildings sectors: residential energy use rises by an average of 1.7 percent per year and commercial energy use by 1.8 percent per year from 2003 to 2030 for the world as a whole. The slowest growth in energy demand among the end-use sectors is projected for transportation, at 1.4 percent per year. In contrast, the *International Energy Outlook 2005* (*IEO2005*) reference case showed transportation energy use growing at the same rate as industrial energy use and faster than energy use in the buildings sectors. The higher world oil prices in *IEO2006* are largely responsible for the slower growth in transportation sector energy

Figure 1. World Marketed Energy Consumption by Region, 1980-2030



Sources: **History:** 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).

Figure 2. World Delivered Energy Consumption by End-Use 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/. **2010-2030:** EIA, System for the Analysis of Global Energy Markets (2006).

demand, in that oil dominates transportation energy use, and there are currently no fuels that compete widely with oil in the transportation sector.

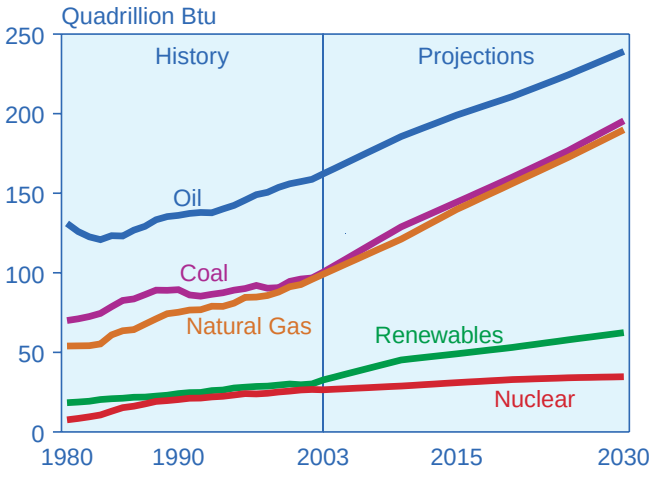
In the OECD, where population growth generally is slow or negative in many countries over the projection period, the slowest growth in energy use is projected for the residential sector, at 0.6 percent per year; and the fastest growth is in the industrial sector, averaging 1.2 percent annually. For the non-OECD regions as a whole, strong growth in demand for energy is projected for every end-use sector, ranging from 2.3 percent per year in the transportation sector to 3.2 percent per year in the commercial and industrial sectors.

In the *IEO2006* reference case, the use of all energy sources increases through 2030 (Figure 3). Fossil fuels (oil, natural gas, and coal) continue to supply much of the energy used worldwide. Oil remains the dominant energy source, given its importance in the transportation and industrial end-use sectors; however, higher world oil prices in this year's outlook mean that oil's share of the world energy market is lessened in the projection as other fuels replace oil where possible. In *IEO2005*, in contrast, the oil share of total energy demand was relatively stable from 2002 to 2025. Renewable energy sources become more economically competitive with fossil fuels in the reference case, and renewable energy use expands as rapidly as consumption of natural gas and coal. Higher fossil fuel prices also support renewed interest in expanding the use of nuclear power to generate electricity.

World oil use 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 in the reference case. The *IEO2006* projection for oil demand in 2025 is 8 million barrels per day lower than the 119 million barrels per day projected in *IEO2005*, which extended only to 2025. The slower growth in this year's projections is in large part explained by the substantially higher world oil prices in the *IEO2006* reference case. Indeed, world oil prices in 2025—expressed as the average price of imported low-sulfur, light crude oil to U.S. refiners (see box on page 3)—are 35 percent higher than in *IEO2005*. In the *IEO2006* reference case, world oil prices rise from $31 per barrel (in real 2004 dollars) in 2003 to $57 per barrel in 2030, and oil's share of total world energy use falls from 39 percent to 33 percent (Figure 4).

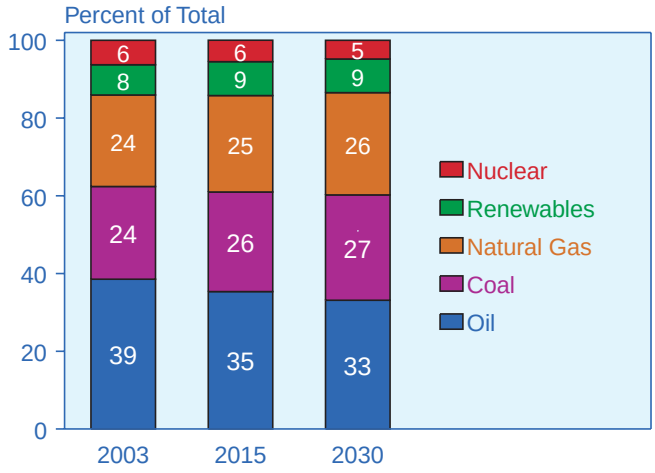
To meet the projected increase in world oil demand in the reference case, total petroleum supply in 2030 will need to be 38 million barrels per day higher than the 2003 level of 80 million barrels per day. OPEC producers are expected to provide 14.6 million barrels per day of the increase. Higher oil 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. In addition, unconventional resources (including biofuels, coal-to-liquids, and gas-to-liquids) are expected to become more competitive. 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.

Figure 3. World Marketed Energy Use by Energy Type, 1980-2030



Sources: **History:** 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).

Figure 4. Fuel Shares of World Marketed Energy Use, 2003, 2015, and 2030



Note: Fuel shares may not add to 100 percent due to independent rounding.

Sources: **2003:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **2015 and 2030:** EIA, System for the Analysis of Global Energy Markets (2006).

The higher oil prices in this year's reference case raise the projected demand for, and price of, natural gas. Natural gas consumption increases on average by 2.4 percent per year from 2003 to 2030. The higher natural gas prices also make coal more cost-competitive, especially in the electric power sector. As a result, for the first time since the Energy Information Administration (EIA) began publishing outlooks for worldwide energy use in 1990, demand for coal grows faster than demand for natural gas in the *IEO2006* projections, albeit only slightly faster, at 2.5 percent per year. Among the end-use sectors, the industrial sector remains the largest consumer of natural gas worldwide, accounting for 52 percent of the total increase in demand for natural gas between 2003 and 2030. Natural gas also is expected to remain an important energy source in the electric power sector, particularly for new generating capacity.

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, 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.

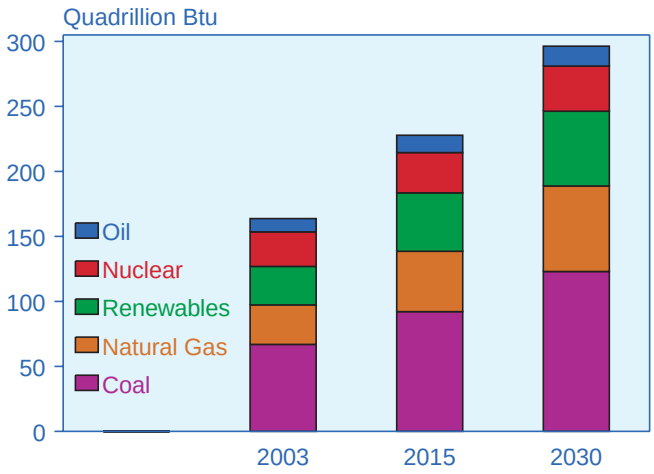
World coal consumption is projected to increase from 5,440 million short tons in 2003 to 7,792 million short tons in 2015, at an average annual rate of 3.0 percent. The rate of growth in world coal use slows after 2015 to 2.0 percent annually through 2030, when coal consumption totals 10,561 million short tons. Of the coal produced worldwide in 2003, 67 percent was shipped to electricity producers and 30 percent to industrial consumers, the two end-use sectors that account for virtually all the growth in coal use in the mid-term. On a worldwide basis coal's share of industrial sector energy use increases, mostly because of the substantial growth projected for coal consumption in China's industrial sector. In the *IEO2006* reference case, industrial energy use in China more than triples from 2003 to 2030 as a result of the country's abundant coal reserves, its limited reserves of oil and natural gas, and its leading position in world steel production.

World net electricity consumption more than doubles in the reference case, from 14,781 billion kilowatthours in 2003 to 21,699 billion kilowatthours in 2015 and 30,116 billion kilowatthours in 2030. Most of the growth in electricity demand occurs in the non-OECD nations, where electricity use increases on average by 3.9 percent per year from 2003 to 2030, as compared with 1.5 percent per year in the OECD nations. Worldwide, increases are projected for all primary energy sources in electricity generation (Figure 5). Coal and natural gas remain the most important fuels for electricity generation throughout the projection period, however, accounting for more than two-thirds of the total increment in energy use for electricity production in the reference case.

Consumption of electricity generated from nuclear power worldwide increases from 2,523 billion kilowatthours in 2003 to 3,299 billion kilowatthours in 2030 in the *IEO2006* reference case. Higher fossil fuel prices and concerns about security of energy supplies are expected to improve prospects for nuclear power capacity over the projection period, and many countries are expected to build new nuclear power plants. World nuclear capacity rises from 361 gigawatts in 2003 to 438 gigawatts in 2030, with significant declines in capacity projected only for Europe, where several countries have either plans or mandates to phase out nuclear power, or where old reactors are expected to be retired and not replaced.

Non-OECD Asia accounts for 69 percent of the increase in non-OECD nuclear capacity in the reference case and leads the growth in nuclear power generation with an average increase of 6.3 percent per year from 2003 to

Figure 5. World Energy Consumption for Electricity Generation by Fuel Type, 2003, 2015, and 2030



Sources: **2003:** Derived from Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **2010-2030:** EIA, System for the Analysis of Global Energy Markets (2006).

2030. The 51 gigawatts of additional installed nuclear generating capacity projected for non-OECD Asia includes 33 gigawatts in China and 12 gigawatts in India. Russia accounts for most of the remaining non-OECD additions, adding 22 gigawatts of nuclear capacity over the 2003 to 2030 period.

Rising fossil fuel prices also allow renewable energy sources to compete economically in the electric power sector. Consumption of hydroelectricity and other grid-connected renewable energy sources expands by 2.4 percent per year—approximately the same as the rates of growth projected for natural gas and coal—and the renewable energy share of the world's total energy consumption increases from 8 percent in 2003 to 9 percent in 2030.

Much of the projected growth in renewable electricity generation results from the expected completion of large hydroelectric facilities in non-OECD nations, especially in non-OECD Asia, where the need to expand electricity production with associated dams and reservoirs often outweighs concerns about environmental impacts and the relocation of populations. China, India, and Laos, among other non-OECD Asian economies, already are constructing or planning new large-scale hydroelectric facilities.

Apart from Turkey, where development of the 7.5-gigawatt Southeast Anatolia hydroelectric system is ongoing, most hydroelectric resources in the OECD nations already have been developed or lie far from population centers. As a result, nonhydroelectric marketed renewables, such as wind, solar, geothermal, and biomass, are expected to account for most of the growth in OECD renewable energy use, given government programs and policies to encourage their expansion.

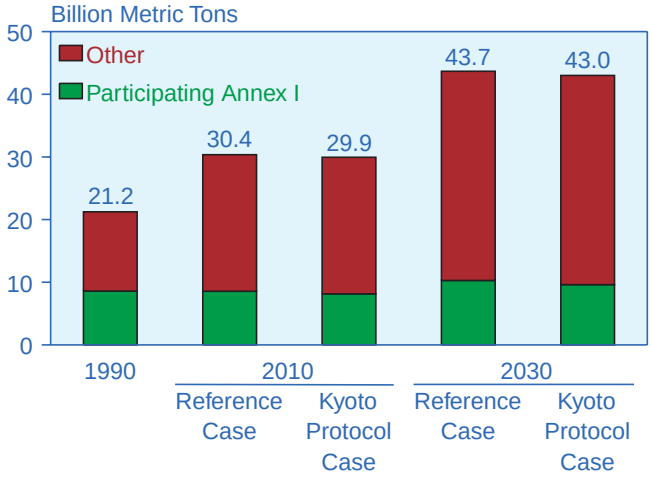
World carbon dioxide emissions continue to increase steadily in the *IEO2006* reference case, from 25.0 billion metric tons in 2003 to 33.7 billion metric tons in 2015 and 43.7 billion metric tons in 2030. Carbon dioxide is one of the most prevalent greenhouse gases in the atmosphere, and anthropogenic (human-caused) emissions of carbon dioxide result primarily from the combustion of fossil fuels for energy. Three-fourths of the projected increase in carbon dioxide emissions results from fossil fuel consumption in non-OECD countries.

The Kyoto Protocol, which requires participating "Annex I" countries[1] to reduce their carbon dioxide emissions collectively to an annual average of about 5 percent below their 1990 level over the 2008-2012 period, became a legally binding treaty on February 16, 2006, 90 days after it was ratified by Russia. The *IEO2006* reference case does not include the potential impacts of the Kyoto Protocol, because the treaty does not indicate the methods by which ratifying parties will implement their obligations either in the first commitment period or after 2012. To examine the implications of the treaty for energy use and carbon dioxide emissions, a Kyoto Protocol case was analyzed.

A number of assumptions were made in developing the *IEO2006* Kyoto Protocol case. First, it was assumed that energy use would not vary from the reference case projection for countries that are not undertaking emissions reduction commitments. In addition, assumptions were made about how the affected participating regions would achieve their reductions. In OECD Europe, stated intentions that "most" of the emissions reductions will be achieved domestically led to an assumption that 50 percent of the aggregate emissions reduction for OECD Europe would be met by domestic reductions. With no stated intentions about levels of domestic reductions in Japan or in Canada, an assumption was made that a 25-percent share of total reductions in both countries would be met domestically. Finally, it was assumed that the emissions commitments would remain in effect at their 2008-2012 level through 2030.

In the Kyoto Protocol case (Figure 6), energy-related carbon dioxide emissions in the participating nations are 673 million metric tons lower than in the reference case

Figure 6. World Carbon Dioxide Emissions in Two Cases, 1990, 2010, and 2030



Sources: **1990:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **2010 and 2030:** EIA, System for the Analysis of Global Energy Markets (2006).

[1]Austria, Belgium, Bulgaria, Canada, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Monaco, the Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine, and the United Kingdom. Australia, Belarus, Turkey, and the United States are Annex I nations that will not participate in the Protocol.

in 2030. In those countries required to make reductions in the Kyoto Protocol case (Canada, Japan, and OECD Europe), emissions decline from 6.1 billion metric tons in 2003 to 5.9 billion metric tons in 2010. After 2010, however, their emissions begin to rise again—to 6.5 billion metric tons in 2030—when participants find it less expensive to purchase permits than to make domestic reductions.

Continued heavy reliance on coal and other fossil fuels in many parts of the world suggests that even if nations that have ratified the Kyoto Protocol reduce their carbon dioxide emissions as required in the treaty, there still will be substantial increases in carbon dioxide emissions worldwide. In the *IEO2006* Kyoto Protocol case, worldwide carbon dioxide emissions rise to 29.9 billion metric tons in 2010 and 43.0 million metric tons in 2030.

Chapter 1

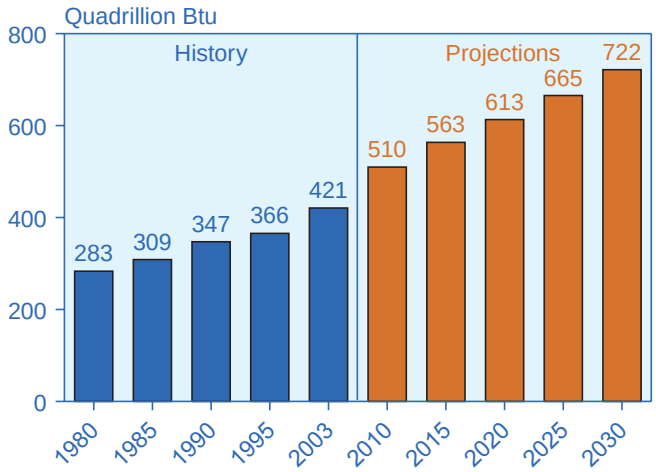
World Energy and Economic Outlook

The IEO2006 projections indicate continued growth in world energy use, despite world oil prices that are 35 percent higher in 2025 than projected in last year's outlook. Energy resources are thought to be adequate to support the growth expected through 2030.

The *International Energy Outlook 2006* (*IEO2006*) projects strong growth for worldwide energy demand over the 27-year projection period from 2003 to 2030. Despite world oil prices that are 35 percent higher in 2025 than projected in last year's outlook, world economic growth continues to increase at an average annual rate of 3.8 percent over the projection period, driving the robust increase in world energy use. Total world consumption of marketed energy expands from 421 quadrillion British thermal units (Btu) in 2003 to 563 quadrillion Btu in 2015 and then to 722 quadrillion Btu in 2030, or a 71-percent increase over the 2003 to 2030 period (Table 1 and Figure 7).

In the *IEO2006* mid-term outlook, countries outside the Organization for Economic Cooperation and Development (non-OECD countries)[2] account for three-fourths of the increase in world energy use. Non-OECD energy use surpasses OECD energy use by 2015 (Table 1 and Figure 8), and in 2030 total energy demand in non-OECD countries exceeds that in the OECD countries by 34 percent.

Figure 7. World Marketed Energy Consumption, 1980-2030



Sources: **History:** 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).

Table 1. World Marketed Energy Consumption by Country Grouping, 2003-2030
(Quadrillion Btu)

Region	2003	2010	2015	2020	2025	2030	Average Annual Percent Change, 2003-2030
OECD	**234.3**	**256.1**	**269.9**	**281.6**	**294.5**	**308.8**	**1.0**
North America	118.3	131.4	139.9	148.4	157.0	166.2	1.3
Europe	78.9	84.4	87.2	88.7	91.3	94.5	0.7
Asia	37.1	40.3	42.8	44.4	46.1	48.0	1.0
Non-OECD	**186.4**	**253.6**	**293.5**	**331.5**	**371.0**	**412.8**	**3.0**
Europe and Eurasia	48.5	56.5	62.8	68.7	74.0	79.0	1.8
Asia	83.1	126.2	149.4	172.8	197.1	223.6	3.7
Middle East	19.6	25.0	28.2	31.2	34.3	37.7	2.4
Africa	13.3	17.7	20.5	22.3	24.3	26.8	2.6
Central and South America	21.9	28.2	32.5	36.5	41.2	45.7	2.8
Total World	**420.7**	**509.7**	**563.4**	**613.0**	**665.4**	**721.6**	**2.0**

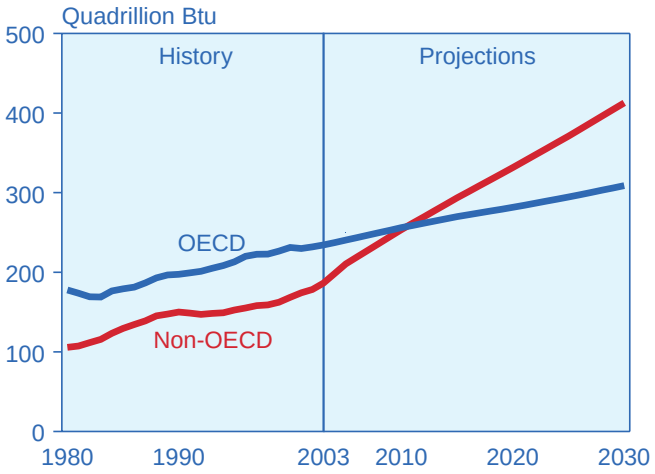
Note: Totals may not equal sum of components due to independent rounding.
Sources: **2003:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **2010-2030:** EIA, System for the Analysis of Global Energy Markets (2006).

[2]For consistency, OECD includes all members of the Organization for Economic Cooperation and Development as of February 1, 2006, throughout all time series presented in this publication.

Much of the growth in energy demand among the non-OECD economies occurs in non-OECD Asia, which includes China and India; demand in the region nearly triples over the projection period (Table 1 and Figure 9). Total primary energy consumption in the non-OECD countries grows at an average annual rate of 3.0 percent between 2003 and 2030. In contrast, for the OECD—with its more mature energy-consuming nations—energy use grows at a much slower average rate of 1.0 percent per year over the same period.

This chapter begins with an overview of the *IEO2006* outlook for energy consumption by primary energy source, followed by a discussion of the macroeconomic projections in the context of recent economic developments in key OECD and non-OECD regions. Macroeconomic growth and energy intensity are key factors underlying the projections of future energy demand, and different assumptions result in substantially different projections, underscoring the uncertainty associated with the *IEO2006* reference case. Alternative assumptions about economic growth and their impacts on the *IEO2006* projections are considered, as well as the possible effects of future trends in energy intensity on the reference case projections.

Figure 8. World Marketed Energy Use: OECD and Non-OECD, 1980-2030



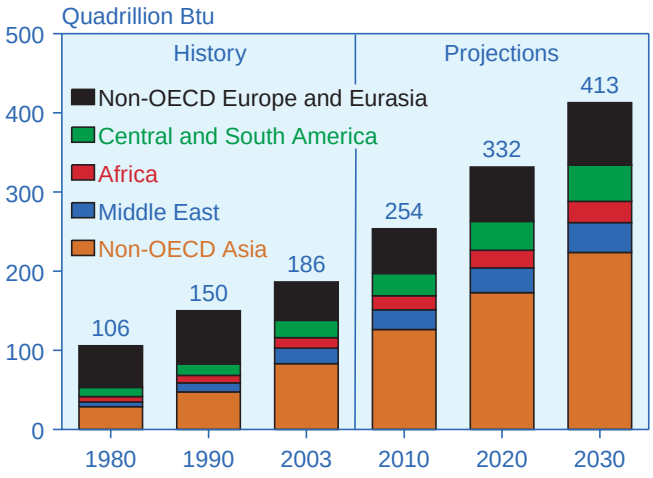
Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, System for the Analysis of Global Energy Markets (2006).

Outlook for World Energy Consumption

The *IEO2006* reference case projects increased world consumption of marketed energy from all sources over the next two and one-half decades. Fossil fuels continue to supply much of the increment in marketed energy use worldwide throughout the projections. Oil remains the dominant energy source over the projection period, but its share of total world energy consumption declines from 38 percent in 2003 to 33 percent in 2030 (Figure 10), largely in response to higher world oil prices in this year's outlook, which dampen oil demand in the mid-term.

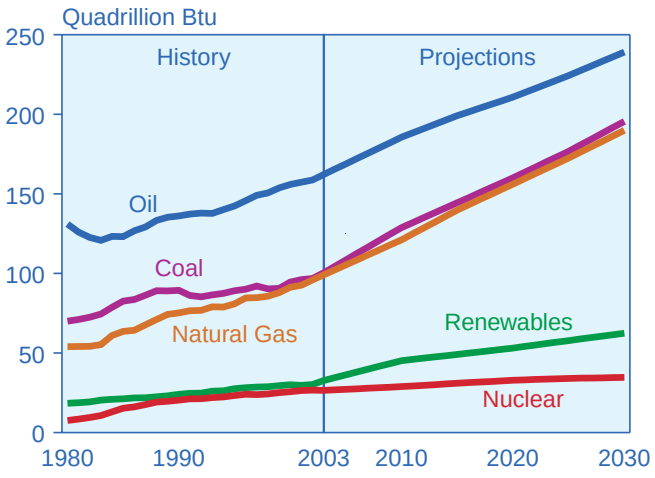
Worldwide oil consumption rises from 80 million barrels per day in 2003 to 98 million barrels per day in 2015 and then to 118 million barrels per day in 2030. The *IEO2006* projection for oil demand in 2025 is 8 million barrels lower than the 119 million barrels per day projected in last year's outlook, which extended only to 2025. The slower growth in world oil demand than was projected in the *International Energy Outlook 2005*

Figure 9. Marketed Energy Use in the Non-OECD Economies by Region, 1980-2030



Sources: **History:** 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).

Figure 10. World Marketed Energy Use by Fuel Type, 1980-2030



Sources: **History:** 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).

(*IEO2005*) is in large part explained by substantially higher projections for world oil prices in the *IEO2006* reference case, which in 2025 are 35 percent higher than projected in *IEO2005* (Figure 11).

Worldwide, transportation and industry are the major growth sectors for oil demand. On a global basis, the transportation sector—where there are currently no alternative fuels that compete widely with oil—accounts for about one-half of the total projected increase in oil use between 2003 and 2030, with the industrial sector accounting for another 39 percent of the incremental demand.

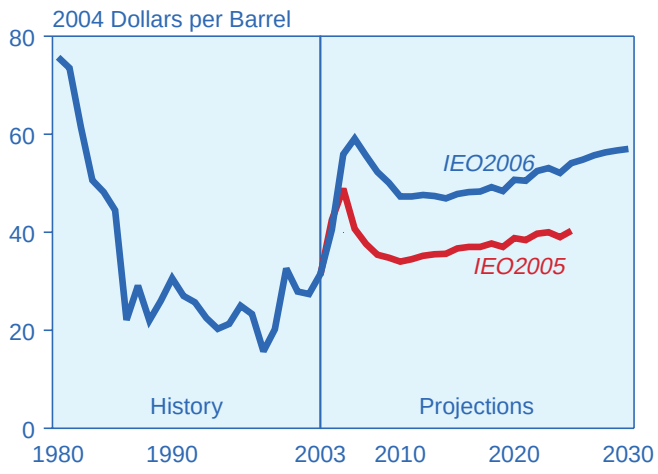
The higher world oil price path in the *IEO2006* also affects natural gas markets. For many years, the *IEO* has projected that natural gas would be the fastest growing energy source in the mid-term; however, higher natural gas prices in *IEO2006* make coal more cost-competitive, especially in the electric power sector, and as a result natural gas use and coal use increase at similar rates. Natural gas demand rises by an average of 2.4 percent per year over the 2003 to 2030 period and coal use by an average of 2.5 percent per year. Total world natural gas consumption rises from 95 trillion cubic feet in 2003 to 134 trillion cubic feet in 2015 and 182 trillion cubic feet in 2030.

The industrial sector remains the most important end-use consumer for natural gas worldwide, accounting for 52 percent of the total growth in natural gas use in the projections; however, natural gas also remains an important energy source in the electric power sector, particularly as a fuel for new generating capacity. The electric power sector accounts for 39 percent of the increase in global natural gas demand over the 2003 to 2030 period, although the higher price path in *IEO2006* leads to a slower growth rate for natural gas consumption in the electricity generation sector than was projected in *IEO2005*. Natural gas still is seen as a desirable option for electric power in many parts of the world, given its efficiency relative to other energy sources and its low carbon content relative to other fossil fuels, making it a more attractive choice for countries interested in reducing greenhouse gas emissions.

Coal use worldwide increases by 2.4 billion short tons between 2003 and 2015 and by another 2.7 billion short tons between 2015 and 2030. In this year's outlook for coal, nearly all regions of the world show some increase in coal use, except for Japan. In Japan, the electricity sector continues to be dominated by natural gas and nuclear power generation. In addition, with its population growing more slowly, Japan's electricity demand is likely to grow slowly, so that new coal-fired capacity additions are unlikely to be needed.

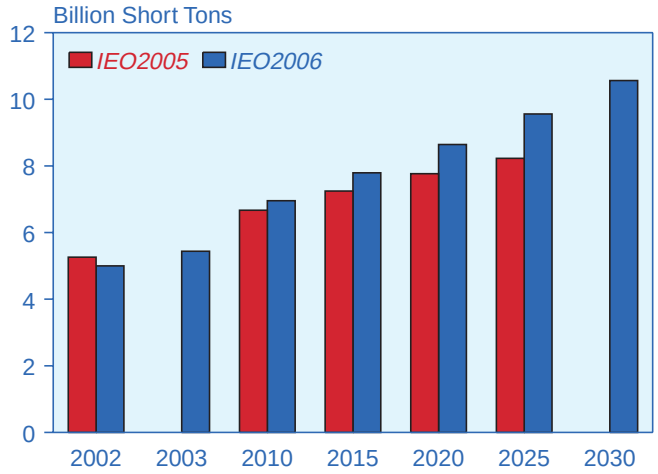
With higher prices for oil and natural gas making coal more competitive, the *IEO2006* projection for world coal use in 2025 is 16 percent higher (on a tonnage basis) than in *IEO2005* (Figure 12). Consequently, coal's share of total energy use rises from 24 percent in 2003 to 27 percent in 2030, and world coal consumption continues to exceed world natural gas consumption throughout the projections. The largest increases in coal use worldwide

Figure 11. Comparison of *IEO2005* and *IEO2006* World Oil Price Projections, 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/contents.html. ***IEO2005*:** EIA, *International Energy Outlook 2005*, DOE/EIA-0484(2005) (Washington, DC, July 2005), web site www.eia.doe.gov/oiaf/ieo/index.html. ***IEO2006*:** EIA, System for the Analysis of Global Energy Markets (2006).

Figure 12. Comparison of *IEO2005* and *IEO2006* Projections for World Coal Consumption, 2002-2030



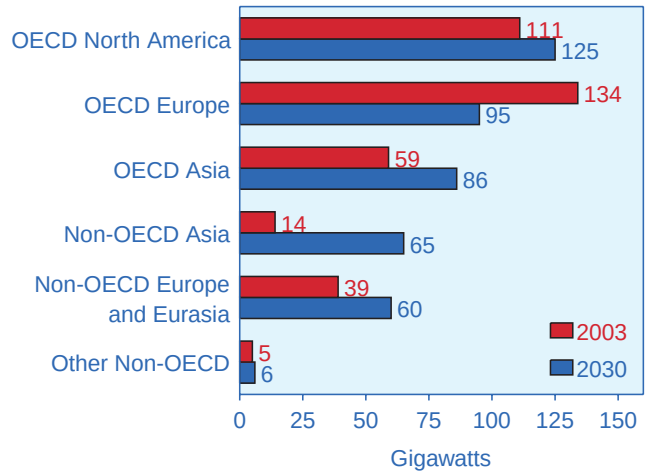
Sources: **2002 and 2003:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. ***IEO2005*:** EIA, *International Energy Outlook 2005*, DOE/EIA-0484(2005) (Washington, DC, July 2005), web site www.eia.doe.gov/oiaf/ieo/index.html. ***IEO2006*:** EIA, System for the Analysis of Global Energy Markets (2006).

are projected for China and India, where coal supplies are plentiful. Together, China and India account for 86 percent of the rise in non-OECD coal use and 70 percent of the total world increase in coal demand over the projection period.

Net electricity consumption more than doubles between 2003 and 2030, from 14,781 billion kilowatthours to 30,116 billion kilowatthours. The strongest growth in net electricity consumption is projected for the non-OECD economies, averaging 3.9 percent per year in the *IEO2006* reference case. Robust economic growth in many of the non-OECD countries is expected to boost demand for electricity to run newly purchased home appliances for air conditioning, cooking, space and water heating, and refrigeration. Although expanding use of home appliances and other electronic devices also results in increased demand for electricity in the OECD nations, their more mature infrastructures and slower rates of population expansion result in slower growth for total net electricity consumption, averaging 1.5 percent per year over the projection horizon.

Natural gas and renewable energy sources are the only fuels expected to increase their shares of total world electricity generation in the projections. The natural gas share of world electricity markets increases from 19 percent in 2003 to 22 percent in 2030, and the renewable share rises from 18 percent in 2003 to 20 percent in 2010 before declining slightly to 19 percent in 2030. The relative environmental benefits and efficiency of natural gas make the fuel an attractive alternative to oil- and coal-fired generation. Higher fossil fuel prices also allow renewable energy sources to compete more effectively in the electric power sector. In addition, coal is the regional economic choice in some power markets, like the United States and non-OECD Asia, where coal resources are ample and high natural gas prices lead to an increase in coal's share of the electricity market.

Figure 13. World Nuclear Generating Capacity by Region, 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).

Worldwide, consumption of electricity generated from nuclear power increases from 2,523 billion kilowatthours in 2003 to 2,940 billion kilowatthours in 2015 and 3,299 billion kilowatthours in 2030. Higher fossil fuel prices and the entry into force of the Kyoto Protocol are expected to improve prospects for new nuclear power capacity over the projection period, and the world nuclear generation projections include new construction of nuclear plants in several countries. In the *IEO2006* reference case, the world's total installed nuclear capacity rises from 361 gigawatts in 2003 to 438 gigawatts in 2030, with declines in capacity projected only for Europe—both non-OECD and OECD—where several countries have either plans or mandates to phase out nuclear power, or where old reactors are expected to be retire and not replaced.

Nuclear power generation in the non-OECD countries increases by 3.5 percent per year between 2003 and 2030. Non-OECD Asia, in particular, is expected to see the largest increment in installed nuclear generating capacity, accounting for 69 percent of the total increase in nuclear power capacity for the non-OECD countries (Figure 13). Of the 51 gigawatts of additional installed nuclear generating capacity projected for non-OECD Asia between 2003 and 2030, 33 gigawatts is projected for China and 12 gigawatts for India. Russia accounts for most of the remaining non-OECD additions of nuclear capacity, adding 22 gigawatts over the projection period.

The use of hydroelectricity and other grid-connected renewable energy sources continues to expand over the projection period, increasing by 2.4 percent per year—approximately the same as the growth rates for natural gas and coal demand in the reference case. Higher fossil fuel prices, particularly for natural gas in the electric power sector, allow renewable energy sources to compete economically. Renewables increase their share of total world energy consumption slightly in the projections, and the renewable share rises from 8 percent in 2003 to 9 percent in 2030. Much of the growth in renewable energy sources results from large-scale hydroelectric power projects in non-OECD regions, particularly among the nations of Asia. China, India, and Laos, among others, are already constructing or have plans to construct ambitious hydroelectric projects in the coming decades.

World Economic Outlook

Economic growth is among the most important factors to be considered in projecting changes in the world's energy consumption. In the *IEO2006* projections, assumptions about regional economic growth—measured in terms of gross domestic product (GDP) in real 2000 U.S. dollars at purchasing power parity rates—underlie the projections of regional energy demand.

The macroeconomic framework employed for the economic growth projections reflects the interaction of many economic variables and underlying relationships, both in the short term and in the medium to long term. In the short term, households and businesses make spending decisions (the demand side) based on their expectations of future movements in interest rates, prices, employment, incomes, wealth, fiscal and monetary policies, exchange rates, and world developments. In the long run, it is the ability to produce goods and services (the supply side) that ultimately determines the growth potential for any country's economy.

The outlook for medium- to long-term economic growth depends on the underlying demographic and expected productivity trends in each economy. These in turn depend on population growth, labor force participation rates, productivity growth, and national savings and capital accumulation. In addition, for the developing economies, progress in building human and physical capital infrastructures, establishing regulatory mechanisms to govern markets, and ensuring political stability play equal or perhaps more important roles in determining their medium- to long-term growth potential.

Over the 2003 to 2030 period, world real GDP growth averages 3.8 percent annually (Table 2), similar to the *IEO2005* projection. The projected growth in world GDP is higher than the growth rate over the past 30 years. The reason is that most of the countries expected to see more rapid growth are developing non-OECD nations that have undertaken significant reforms over the past several years. Improved macroeconomic policies, trade liberalization, more flexible exchange rate regimes, and lower fiscal deficits have lowered their national inflation rates, reduced uncertainty, and improved their overall investment climates. More microeconomic structural reforms, such as privatization and regulatory reform, have also played key roles. In general, such reforms have resulted in growth rates that are above historical trends in most of these economies over the past 5 to 10 years.

OECD Economies

In the United States, compared with the second half of the 1990s, GDP growth rates were lower from 2000 to 2002 but rebounded to 2.7 percent in 2003 and 4.2 percent in 2004. GDP growth in 2005 is estimated at 3.6 percent. Despite large increases in energy prices over the past 2 years and damage caused by major hurricanes in 2005, the U.S. economy is expected to continue growing at a robust pace in the short term, reacting to strong fiscal stimulus, the continued need of businesses to expand productive capacity, growth in household income and wealth, and the lagged effects of declines in the value of the dollar since 2002, which should boost exports relative to imports. In the projections, the U.S. economy stabilizes at its long-term growth path between 2005 and 2010 as rates of interest, inflation, and unemployment gradually revert toward their long-term averages. GDP is projected to grow by an average of 3.0 percent per year between 2006 and 2015, with somewhat slower growth—2.9 percent per year—expected between 2015 and 2030 as the baby boom generation retires and labor force growth slows.

Canada has the potential to maintain strong growth in productivity and its standard of living by increasing the labor force participation rate, focusing on immigration, strengthening policies on education and innovation, and reducing structural unemployment. Labor force growth is projected to slow in the medium to long term, however, and Canada's overall potential economic growth is expected to fall from the current 2.9 percent to 2.6 percent per year between 2006 and 2015 and 1.8 percent per year between 2015 and 2030.

Mexico's real GDP is projected to grow by an average of 4.1 percent per year from 2003 to 2030. Global financial markets remain friendly to Mexico in terms of the availability and cost of credit and the volume of foreign direct investment. In general, strong trade ties with the United States are expected to help cushion Mexico from deeper economic troubles. By the same token, Mexico's future growth is also more dependent on U.S. growth.

Over the long term, OECD Europe's GDP is projected to grow by 2.2 percent per year between 2003 and 2030 in the reference case. There are structural impediments to economic growth in many countries of OECD Europe, related to the region's labor markets, product markets, and costly social welfare systems. Reforms to improve the competitiveness of European labor and product markets could yield significant dividends in terms of increases in regional output.

After a decade of stagnation, the Japanese economy appears to have turned the corner, growing by 2.6 percent in 2004 and an estimated 2.4 percent in 2005. Japan's GDP growth is projected to average 1.7 percent per year from 2006 to 2015 and then to slow to 1.0 percent per year from 2015 to 2030. In the short term, Japan's highly skilled labor force and strong work ethic are expected to support the projected growth rate of 1.7 percent per

year, provided that more flexible labor policies allowing greater mobility for workers are adopted.

Economic growth in the rest of OECD Asia is expected to be somewhat stronger than in Japan. In the medium to long term, South Korea's growth is projected to taper off and be sustained by productivity growth as labor force growth slows. South Korea's economy is expected to expand by 3.6 percent annually over the 2003 to 2030 period, after growing by 6.7 percent per year between 1978 and 2003. Prospects in both Australia and New Zealand are healthy due to a consistent track record of fiscal prudence and structural reforms aimed at maintaining competitive product markets and flexible labor markets. The two countries are expected to see GDP rise by 2.5 percent per year on average from 2003 to 2030.

Non-OECD Economies

Over the 2003 to 2030 projection period, economic growth in non-OECD Europe and Eurasia as a whole is projected to average 4.4 percent annually. For the past several years, the non-OECD nations of Europe and Eurasia have largely been sheltered from global economic uncertainties, recording strong growth in each year since 2000, primarily as a result of robust domestic demand, the growth bonus associated with ascension of some countries (including Estonia, Latvia, Lithuania, and Slovenia) to the European Union, and the impacts of

Table 2. Average Annual Growth in World Gross Domestic Product by Selected Countries and Regions, 1978-2030
(Percent per Year)

Region	History				Projections		
	1978-2003	2003	2004	2005	2005-2015	2015-2030	2003-2030
OECD North America	**2.9**	**2.5**	**4.1**	**3.5**	**3.1**	**2.9**	**3.1**
United States	2.9	2.7	4.2	3.6	3.1	2.9	3.0
Canada	2.8	2.0	2.9	2.9	2.6	1.8	2.2
Mexico	2.9	1.4	4.4	3.1	4.0	4.1	4.1
OECD Europe	**2.4**	**1.4**	**2.6**	**1.9**	**2.3**	**2.1**	**2.2**
OECD Asia	**3.0**	**1.9**	**3.0**	**2.6**	**2.3**	**1.6**	**1.9**
Japan	2.5	1.4	2.6	2.4	1.7	1.0	1.4
South Korea	6.7	3.1	4.7	4.0	4.7	2.8	3.6
Australia/New Zealand	3.3	3.2	3.6	2.3	2.5	2.4	2.5
Total OECD	**2.7**	**2.0**	**3.4**	**2.7**	**2.7**	**2.4**	**2.6**
Non-OECD Europe and Eurasia	**-0.3**	**7.7**	**8.1**	**6.5**	**4.9**	**3.7**	**4.4**
Russia	-0.5	7.3	7.2	6.1	4.2	3.3	3.9
Other	0.2	8.0	9.5	7.0	5.9	4.0	5.1
Non-OECD Asia	**6.7**	**7.6**	**7.8**	**7.5**	**5.8**	**4.9**	**5.5**
China	9.4	9.1	9.5	9.2	6.6	5.2	6.0
India	5.3	8.5	6.9	6.8	5.5	5.1	5.4
Other	5.4	4.8	6.0	5.4	4.9	4.3	4.6
Middle East	**2.6**	**4.8**	**6.4**	**6.7**	**4.4**	**3.7**	**4.2**
Africa	**2.9**	**4.8**	**5.1**	**4.9**	**4.8**	**4.1**	**4.4**
Central and South America	**2.3**	**2.1**	**5.9**	**4.5**	**3.8**	**3.5**	**3.8**
Brazil	2.5	0.5	4.9	2.7	3.7	3.3	3.5
Total Non-OECD	**3.7**	**6.4**	**7.2**	**6.7**	**5.3**	**4.5**	**5.0**
Total World							
Purchasing Power Parity Rates	**3.1**	**4.0**	**5.1**	**4.6**	**4.0**	**3.6**	**3.8**
Market Exchange Rates	**2.8**	**3.5**	**4.1**	**3.1**	**3.1**	**2.6**	**3.0**

Note: All regional real GDP growth rates presented in this table are based on 2000 purchasing power parity weights for the individual countries in each region, except for the final line of the table, which presents world GDP growth rates based on 2000 market exchange rate weights for all countries.

Sources: **Historical Growth Rates:** Global Insight, Inc., *World Overview* (Lexington, MA, various issues). **Projected GDP Growth Rates:** Global Insight, Inc., *World Overview*, Fourth Quarter 2005 (Lexington, MA, January 2006); and Energy Information Administration, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington DC, February 2006). GDP growth rates for China and India were adjusted downward, based on the analyst's judgment.

rising oil prices on the oil-exporting nations of the region. High world oil prices have stimulated investment outlays, especially in the energy sector of the Caspian region; however, given the volatility of energy market prices, it is unlikely that the region's economies will be able to sustain the growth rates recently achieved until diversification from energy becomes more broadly based. The long-term growth prospects of the Eurasian, former Soviet Republic economies hinge on their success in economic diversification, as well as further improvements in domestic product and financial markets.

Much of the growth in world economic activity between 2003 and 2030 is expected to occur among the nations of non-OECD Asia, where regional GDP growth is projected to average 5.5 percent per year. China, non-OECD Asia's largest economy, is expected to continue playing a major role on both the supply and demand sides of the global economy. *IEO2006* projects an average annual growth rate of approximately 6.0 percent for China's economy over the 2003 to 2030 period. The country's economic growth is expected to be the highest in the world. In 2020, based on share of world GDP (in terms of purchasing power parity rates), China is expected to be the world's largest economy.

Structural issues that have implications for medium- to long-term growth in China include the pace of reform affecting inefficient state-owned companies and a banking system that is carrying a significant amount of nonperforming loans. The development of domestic capital markets to maintain macroeconomic stability and ensure that China's large savings are used efficiently support the medium-term growth projection.

Another Asian country with a rapidly emerging economy is India. The medium-term prospects for India's economy are positive, as it continues to privatize state enterprises and increasingly adopts free market policies. Average annual GDP growth in India over the 2003 to 2030 projection period is 5.4 percent. Accelerating structural reforms—including ending regulatory impediments to the consolidation of labor-intensive industries, labor market and bankruptcy reforms, and agricultural and trade liberalization—remain essential to stimulate potential growth and reduce poverty in the medium to long term. With its vast and relatively cheap labor force, India is well positioned to reap the benefits of globalization in the medium to long term. In the rest of non-OECD Asia, national economic growth rates are expected to be roughly constant over the 2006 to 2015 period, then taper off gradually, to 4.3 percent annually from 2015 to 2030, as their labor force growth rates decline and their economies mature.

Although the nations of Central and South America are on favorable economic growth paths, registering a combined 5.9-percent increase in GDP in 2004—the best performance in 20 years—the region's growth rate remains below potential. The weak international credit environment is a constraint, as are domestic economic and/or political problems in a number of countries. Growth in the region remains heavily dependent on the volume of foreign capital flows. Beyond macroeconomic stability and commitment to sound fiscal and monetary policies, the countries of Central and South America will face governance issues and severe economic disparities between the wealthy and the poor in the region's societies.

Rising oil production and prices have helped boost growth in the oil-exporting countries of the Middle East. Many of the oil-importing countries in the region have also benefited from spillover effects on trade, tourism, and financial flows from the region's oil exporters. Real GDP growth in the Middle East region was estimated at 6.7 percent in 2005. Medium-term prospects for the region remain favorable, given that a significant portion of the recent increase in the region's oil revenue is expected to be permanent.

For Africa as a whole, average annual real GDP growth of 4.4 percent is projected over the 2003 to 2030 period. This optimistic projection is supported by strong economic activity over the past 5 years, which has resulted from expansion of oil and non-oil primary exports and robust domestic demand in many of the region's national economies. Nevertheless, both economic and political factors—such as low savings and investment rates, lack of strong economic and political institutions, limited quantity and quality of infrastructure and human capital, negative perceptions on the part of international investors, and especially the impact of HIV/AIDS on population growth—present formidable obstacles to growth in many African countries.

Alternative Growth Cases

Expectations for the future rates of economic growth are a major source of uncertainty in the *IEO2006* projections. To account for the uncertainties associated with economic growth trends, *IEO2006* includes a high economic growth case and a low economic growth case in addition to the reference case. The reference case projections are based on a set of assumptions about regional economic growth paths—measured by GDP—and the energy-income elasticity (the relationship between percentage changes in energy consumption and GDP). The two alternative growth cases are based on alternative assumptions about possible economic growth paths; assumptions about the elasticity of energy demand are held constant, at reference case values.

For the high and low economic growth cases, different assumptions are made about the range of possible economic growth rates among the OECD and non-OECD

regions. For the OECD, 0.5 percentage point is added to the reference case GDP growth rates for the high economic growth case and 0.5 percentage point is subtracted from the reference case GDP growth rates for the low economic growth case. Outside the OECD (excluding Russia), reference case GDP growth rates are increased and decreased by 1.0 percentage point to provide the high and low economic growth case estimates.

Russia suffered a severe economic collapse in the early part of the 1990s and, until recently, has shown wide variation in its year-to-year economic growth. Between 1990 and 2003, its annual GDP growth rate varied from -15 percent in 1992 to +10 percent in 2000. Given this wide range, Russia can be characterized as having a considerably more uncertain economic future than many other nations of the world. As a result, 1.5 percentage points are added and subtracted from the reference case GDP assumptions to derive the high and low macroeconomic projections for Russia.

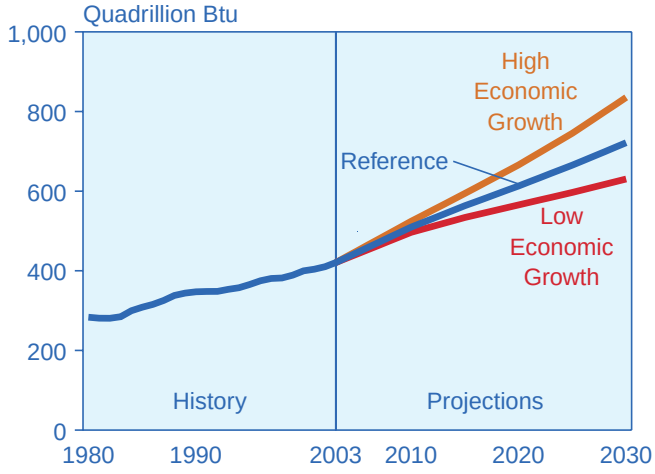
The *IEO2006* reference case shows total world energy consumption reaching 722 quadrillion Btu in 2030, with the OECD countries projected to consume 309 quadrillion Btu and the non-OECD countries 413 quadrillion Btu. In the high economic growth case, world energy use in 2030 totals 835 quadrillion Btu—113 quadrillion Btu (or 57 million barrels oil equivalent per day) higher than in the reference case. In the low economic growth case, worldwide energy consumption in 2030 totals is projected to be 91 quadrillion Btu (46 million barrels oil equivalent per day) lower than in the reference case, at 631 quadrillion Btu. Thus, there is a substantial range of 205 quadrillion Btu—nearly 30 percent of the total consumption projected for 2030 in the reference case—between the projections in the high and low economic growth cases (Figure 14).

Trends in Energy Intensity

Another major source of uncertainty in long-term projections is the relationship of energy use to GDP—or energy intensity—over time. Economic growth and energy demand are linked, but the strength of that link varies among regions over time. For the OECD countries, history shows the link to be a relatively weak one, with energy demand lagging behind economic growth (Figure 15). For the non-OECD countries (excluding non-OECD Europe and Eurasia), energy demand and economic growth have been closely correlated for much of the past two decades (Figure 16). Economic growth has only recently (that is, within the past decade or so) begun to outpace growth in energy use among the emerging economies of the world.

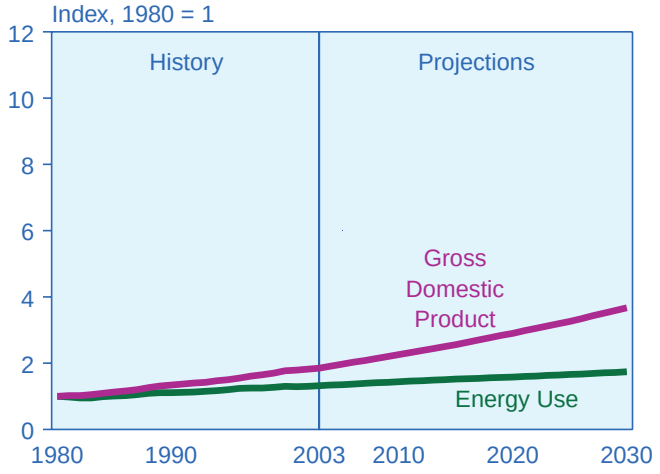
The historical behavior of energy intensity in non-OECD Europe and Eurasia is problematic. Since World War II, the economies of the region have had higher levels of energy intensity than either the OECD or the other non-OECD economies. In non-OECD Europe and Eurasia, however, energy consumption generally grew more quickly than GDP until 1990 (Figure 17), when the collapse of the Soviet Union created a situation in which both income and energy use declined, but GDP fell more quickly and, as a result, energy intensity increased. Only since the late 1990s, after the 1997 devaluation of the Russian ruble, have the Russian and Ukrainian industrial sectors begun to strengthen. As a result, economic growth in non-OECD Europe and Eurasia has begun to outpace growth in energy use significantly, and energy

Figure 14. World Marketed Energy Consumption in Three Economic Growth Cases, 1980-2030



Sources: **History:** 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).

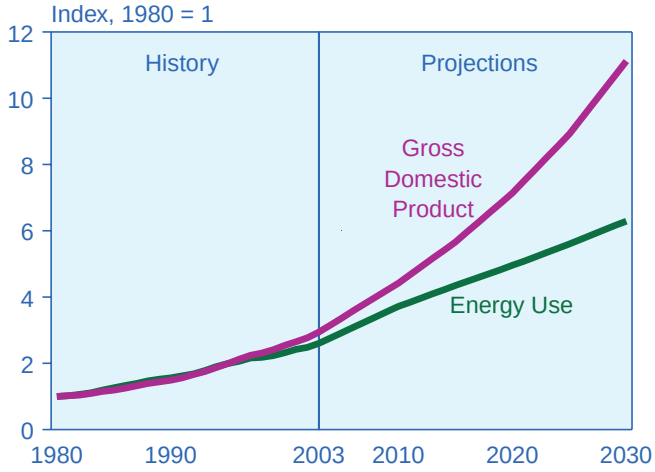
Figure 15. Growth in Energy Use and Gross Domestic Product for the OECD Economies, 1980-2030



Sources: **History:** 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).

intensity has begun to decline precipitously. Over the projection horizon, energy intensity in the region continues to decline but still remains higher than in any other region of the world (Figure 18).

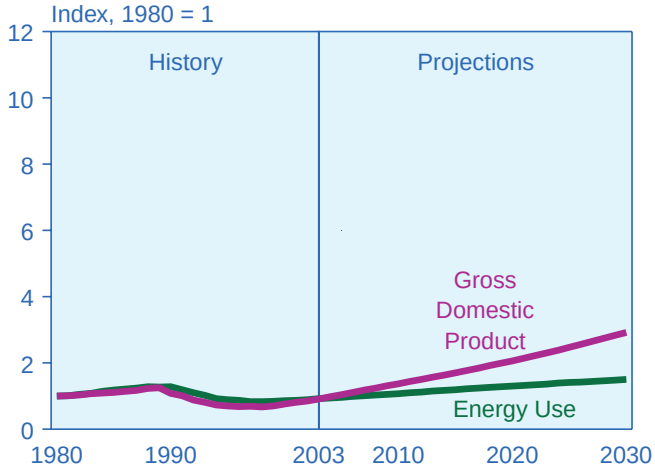
Figure 16. Growth in Energy Use and Gross Domestic Product for the Non-OECD Economies, 1980-2030



Note: Non-OECD economies in this figure exclude non-OECD Europe and Eurasia.

Sources: **History:** 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).

Figure 17. Growth in Energy Use and Gross Domestic Product for the Non-OECD Economies of Europe and Eurasia, 1980-2030

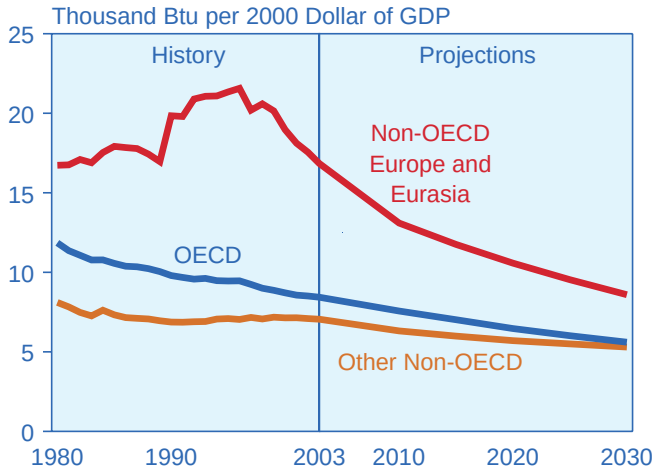


Sources: **History:** Derived from Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, System for the Analysis of Global Energy Markets (2006).

The stage of economic development and the standard of living of individuals in a given region strongly influence the link between economic growth and energy demand. Advanced economies with high living standards have a relatively high level of energy use per capita, but they also tend to be economies where per capita energy use is stable or changes very slowly. In the OECD economies, there is a high penetration rate of modern appliances and motorized personal transportation equipment. To the extent that spending is directed to energy-consuming goods, it involves more often than not purchases of new equipment to replace old capital stock. The new stock is often more efficient than the equipment it replaces, resulting in a weaker link between income and energy demand.

The pace of improvement in energy intensity may change, given different assumptions of macroeconomic growth over time. Faster growth in income leads to a faster rate of decline in energy intensity. Worldwide energy intensity in the *IEO2006* high economic growth case improves by 1.9 percent per year on average from 2003 to 2030, compared with 1.8 percent in the reference case. On the other hand, slower economic growth would result in a slower rate of decline in energy intensity. In the low macroeconomic growth case, world energy intensity declines by an average of 1.5 percent per year over the projection period.

Figure 18. Energy Intensity by Region, 1980-2030



Sources: **History:** 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).

Chapter 2

Energy Consumption by End-Use Sector

In the IEO2006 projections, end-use energy consumption in the residential, commercial, industrial, and transportation sectors varies widely among regions and from country to country.

One way of looking at the future of world energy markets is to consider trends in energy consumption at the end-use sector level. With the exception of the transportation sector, which is almost universally dominated by petroleum products at present, the mix of energy use in the residential, commercial, and industrial sectors varies widely by region, depending on a combination of regional factors, such as the availability of energy resources, the level of economic development, and political, social, and demographic factors. This chapter outlines the *IEO2006* projections for delivered energy consumption by end-use sector in the OECD and non-OECD regions.

Residential Sector

Residential sector energy use is defined as the energy consumed by households, excluding transportation uses. The physical sizes of residential structures, their locations, and their designs are key factors in determining the amounts of energy used by their occupants. All else being equal, larger homes require more energy to provide heating, air conditioning, and lighting, and they tend to include more energy-using appliances, such as televisions and laundry equipment.

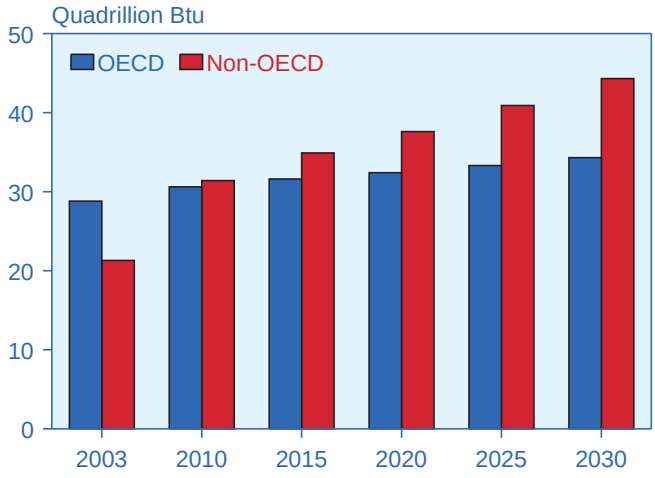
The type and amount of energy used by households vary from country to country, depending on income levels, natural resources, and available energy infrastructure. In general, typical households in the OECD countries use more energy than those in non-OECD nations, in part because they tend to include more energy-using appliances. Consequently, residential energy use per capita in 2003 was about 6 times higher in the OECD countries than in the non-OECD countries, averaging 24.9 million and 4.1 million Btu per person, respectively.

In the *IEO2006* reference case, the difference between OECD and non-OECD residential delivered energy consumption per capita narrows by about one-third from 2003 to 2030, as strong economic growth in the non-OECD countries results in improved standards of living and growing demand for household appliances, space heating and cooling equipment, and other energy-consuming devices. Even relatively small changes in per capita consumption will have a profound impact on total residential energy use in the non-OECD economies, which make up 80 percent of the world's population. Whereas the OECD nations in total used more energy in 2003 than did the non-OECD nations, more rapid growth of residential energy consumption is projected for the non-OECD than for the OECD nations (Figure 19). Total non-OECD residential energy use surpassed the OECD total in 2010 and is 29 percent higher than the OECD total in 2030.

OECD Countries

Households in OECD nations use energy more intensively than those in non-OECD nations, primarily because of their higher income levels. Total residential electricity use in the OECD region increases by an average of 1.4 percent per year from 2003 to 2030 (Figure 20), accounting for about 80 percent of the total projected growth in OECD residential energy demand. As a result, increases in power plant capacity and corresponding fuel use are needed. The most rapid growth in residential energy use among the OECD nations is in Mexico, where real GDP grows at a rate that is nearly 60 percent faster than the OECD average. In OECD Asia, however, where population growth is expected to be minimal over the projection period, growth in residential energy demand is relatively slow.

Figure 19. OECD and Non-OECD Residential Sector Delivered Energy Consumption, 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).

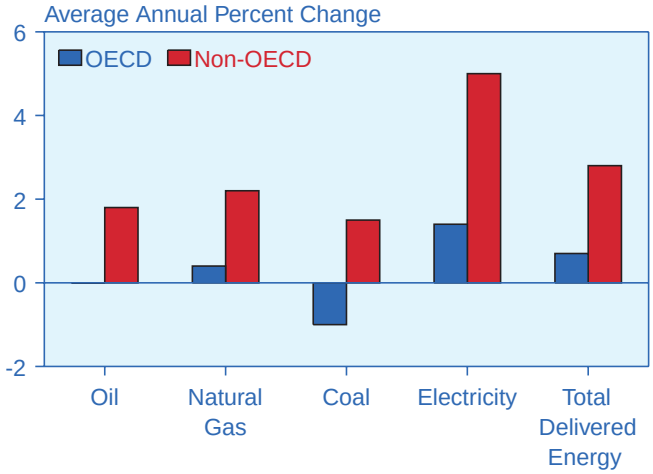
Currently, the United States is by far the largest residential energy consumer in the world. For example, in 2003, residential energy use in all of OECD Europe was only about 7 percent greater than that in the United States. Moreover, with the U.S. population projected to grow at nearly 4 times the rate of OECD Europe's population from 2003 to 2030, residential energy consumption in the United States in 2030 is 6 percent greater than in OECD Europe.

Non-OECD Countries

Household energy use increases more rapidly in the non-OECD countries than in the OECD countries (Figure 20). Driven by robust economic growth and expanding populations, residential energy consumption in the non-OECD nations exceeds that in the OECD nations by nearly one-third in 2030. Real GDP in the non-OECD region as a whole is projected to grow by nearly 5 percent per year through 2030, and population by more than 1 percent per year on average. As a result, household energy use grows at a robust rate of 2.7 percent per year on average through 2030.

In China and India, the two fastest growing economies among the non-OECD countries in the *IEO2006* reference case, urbanization and population growth are expected to result in large increases in demand for residential energy services. China and India account for nearly one-half of the total increase in residential energy use in the non-OECD countries through 2030, as their economies continue to grow strongly over the projection period. In 2003, GDP in China and India combined was about 91 percent the size of U.S. GDP on a purchasing power parity basis; in 2030, their combined GDP is projected to be almost double that of the United States.

Figure 20. Growth in OECD and Non-OECD Residential Sector Delivered Energy Consumption by Fuel, 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).

Commercial Sector

The commercial sector—often referred to as the services sector or the services and institutional sector—consists of businesses, institutions, and organizations that provide services, as opposed to those in manufacturing or agriculture. The sector encompasses many different types of buildings and a wide range of activities and energy-related services. Examples of commercial sector facilities include schools, stores, correctional institutions, restaurants, hotels, hospitals, museums, office buildings, banks, and even stadiums that hold sporting events. Most commercial energy use occurs in buildings or structures, including services such as space heating, water heating, lighting, cooking, and cooling. Energy consumed for services not associated with buildings, such as for traffic lights and city water and sewer services, is also categorized as commercial sector energy use.

Economic and population growth trends drive commercial sector activity and the resulting energy use. The need for services (health, education, financial, government) increases as populations increase. The degree to which these additional needs may be met depends in large measure on economic resources—whether from domestic or foreign sources—and economic growth. Economic growth also determines the degree to which additional commercial sector activities are offered and utilized. Higher levels of economic activity and disposable income lead to increased demand for hotels and restaurants to meet business and leisure requirements; for office and retail space to house and service new and expanding businesses; and for cultural and leisure space such as theaters, galleries, and arenas.

OECD Countries

Commercial sector energy consumption in the OECD nations increases in the reference case by an average of 1.1 percent per year from 2003 to 2030 (Figure 21). Slow population growth in most of the OECD nations—along with continued efficiency improvements as energy-using equipment wears out and is replaced with newer, more efficient stock—moderates the projected growth; however, these factors are offset by economic growth that is expected to include continued growth in business activity, with its associated energy use, in areas such as retail and wholesale trade and business, financial, and leisure services. Although the fastest growth in commercial energy demand among the OECD economies is expected to be in the countries with the fastest GDP growth (Mexico and South Korea), the United States remains the largest commercial sector energy consumer in the OECD, accounting for one-half of the 24.7

quadrillion Btu of commercial energy use in the OECD as a whole in 2030.

Commercial electricity demand in the OECD nations grows by 1.8 percent per year from 2003 to 2030, with continued advances in technology and the introduction of new electronic appliances and equipment (Figure 22). Electricity delivered to commercial consumers in OECD countries, which totaled 8.5 quadrillion Btu in 2003, is 11.0 quadrillion Btu in 2015 and 13.8 quadrillion Btu in 2030, surpassing projected OECD residential electricity use of 13.1 quadrillion Btu by the end of the projection period. Natural gas continues to displace petroleum products and coal as the preferred commercial heating fuel in the OECD region.

Non-OECD Countries

Economic growth and commerce are expected to increase rapidly in the non-OECD nations, fueling additional energy demand in the services sector. Faster population growth is also expected, relative to that in the OECD countries, portending increases in the need for education, health care, and social services and the energy required to provide them. Under these circumstances, commercial sector energy use in non-OECD countries nearly doubles between 2003 and 2020, to 11.6 quadrillion Btu, and continues growing to 14.3 quadrillion Btu in 2030. Over the 2003 to 2030 period, commercial energy use in the non-OECD region increases at an average annual rate of 3.2 percent.

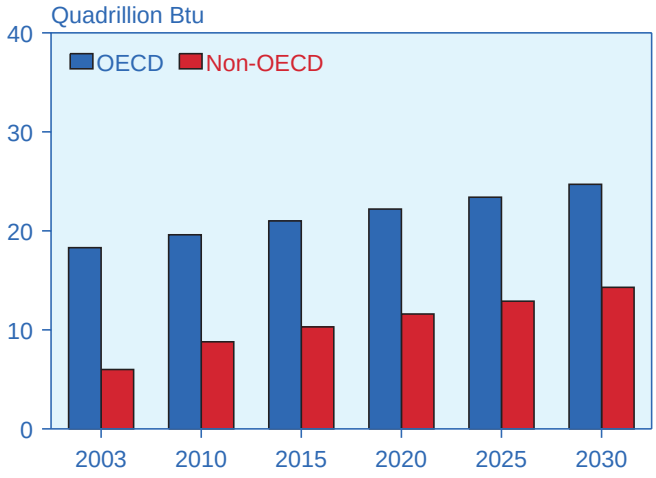
Electricity demand for commercial applications grows rapidly in the non-OECD nations as more clinics, schools, and business gain access to electricity. Annual growth in commercial delivered electricity use averages 4.3 percent through 2030 (Figure 22), with projected consumption of 5.6 quadrillion Btu in 2015 and 8.8 quadrillion Btu in 2030. The largest increases in commercial electricity demand are projected for the nations with rapidly growing economies, particularly China and India, as their burgeoning economies foster increases in demand for services.

Increasing commercial activity is expected to lead to growth in demand for fossil fuels in the non-OECD nations. In the projections, commercial demand for natural gas grows by 3.0 percent per year from 2003 to 2015 and by 2.2 percent from 2003 to 2030, as several countries focus on expanding the infrastructure necessary for delivery of this relatively clean fuel. Commercial sector oil consumption in the non-OECD region increases from 1.4 quadrillion Btu in 2003 to 1.9 quadrillion Btu in 2015 and 2.3 quadrillion Btu in 2030, with more rapid increases in areas where the availability of natural gas is limited. Commercial sector coal use nearly doubles over the projection period in the non-OECD region, to 0.8 quadrillion Btu in 2030, with most of the growth occurring between 2003 and 2015. Coal remains an economically attractive choice for commercial water heating, space heating, and cooking in non-OECD countries in the projections, especially in China and India, which together account for around 80 percent of non-OECD commercial coal use from 2003 through 2030.

Industrial Sector

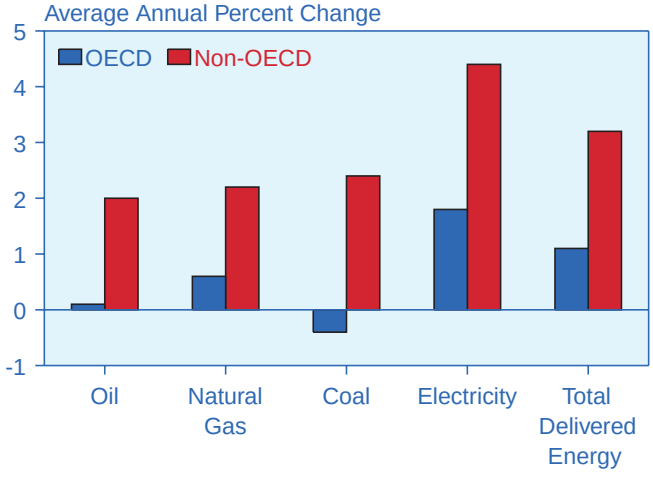
Energy is consumed in the industrial sector by a diverse group of industries—including manufacturing, agriculture, mining, and construction—and for a wide range of

Figure 21. OECD and Non-OECD Commercial Sector Delivered Energy Consumption, 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).

Figure 22. Growth in OECD and Non-OECD Commercial Sector Delivered Energy Consumption by Fuel, 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).

activities, such as process and assembly uses, space conditioning, and lighting. Industrial sector energy demand varies across regions and countries of the world, based on the level and mix of economic activity, technological development, and population growth, among other factors.

The industrial sector is the largest of the end-use sectors, consuming 50 percent of delivered energy worldwide in 2003, and industrial energy use is projected to grow more rapidly than energy use in the other end-use sectors. Worldwide, energy consumption in the industrial sector increases by an average of 2.4 percent per year from 2003 to 2030, as compared with 1.0-percent average annual growth in the world's population. Industrial energy consumption increases in all countries and regions; however, its growth rate in the OECD region—1.2 percent per year on average—is slower than the 3.2-percent average projected for the non-OECD region (Figure 23).

OECD Countries

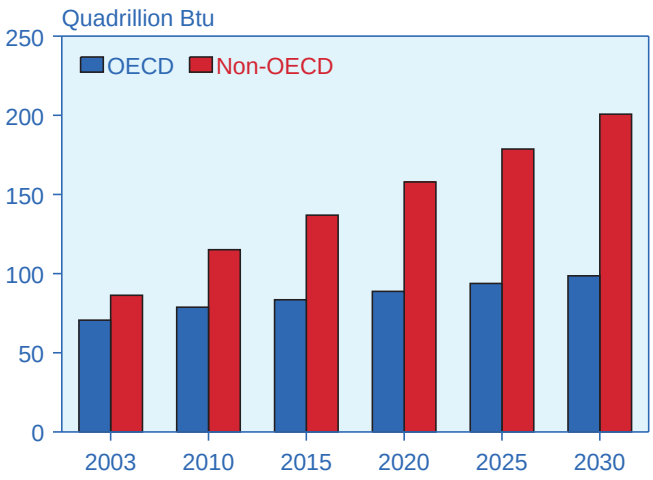
Industrial sector energy use among the OECD nations increases by 1.2 percent per year, from 70.6 quadrillion Btu in 2003 to 97.8 quadrillion Btu in 2030. The United States accounts for approximately one-third of the OECD's total industrial energy consumption in 2030, and OECD Europe accounts for another one-third of the region's total, just as they did in 2003.

The OECD economies generally have more energy-efficient industrial operations and a mix of industrial output that is more heavily weighted toward non-energy-intensive sectors than do the non-OECD countries. For example, in the United States, the manufacturing share of total economic output has declined steadily over the past two decades, while the output share for service industries (included in the commercial sector) has increased. Additionally, within the U.S. manufacturing sector, a smaller share of output has been produced by the heavy, energy-intensive industries (such as steelmaking). These general trends are projected to continue.

Similar developments are expected for the other OECD economies, as increasing international trade fosters a shift toward a less energy-intensive mix of industrial activity. For example, many of Japan's heavy industries are reducing their output as demand for energy-intensive materials increasingly is met by imports from China and other Asian countries. In the projections, the industrial sector in South Korea has the fastest energy consumption growth of the OECD countries, at nearly 2.5 percent per year. In Germany, a decline in industrial energy intensity in the early 1990s was largely the result of closures of heavy industries in the former East Germany after reunification. Much of the inefficient, energy-intensive eastern capacity in eastern Germany has already been shut down, but further improvements are projected as capital stock is replaced and modernized.

Electricity accounted for about 16 percent of OECD industrial sector energy use in 2003, and its share remains fairly stable throughout the projection period. Oil and natural gas were the most heavily used fuels in the OECD countries' industrial sectors in 2003, together accounting for two-thirds of the energy consumed in the sector. The two fuels maintain their overall share in 2030, but consumption of natural gas is grows almost twice as rapidly as that of oil (Figure 24). Coal makes up the bulk of the remaining industrial energy consumption, while renewables remain a minor energy source for the sector.

Figure 23. OECD and Non-OECD Industrial Sector Delivered Energy Consumption, 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).

Non-OECD Countries

Industrial sector energy consumption increases by 3.2 percent per year in the non-OECD countries between 2003 and 2030 (Figure 23). The non-OECD economies generally have higher industrial sector energy consumption relative to GDP than do the OECD countries. On average the ratio is 50 percent higher in the non-OECD countries. This is particularly true of Russia and the countries of non-OECD Europe and Eurasia, which still have energy-inefficient Soviet-era capital equipment. Per dollar of GDP, Russia's industrial sector consumes more than 9,000 Btu of delivered energy, and the non-OECD European and other Eurasian countries average more than 7,000 Btu, as compared with the overall non-OECD average of less than 4,000 Btu per dollar of GDP and the overall OECD average of around 2,500 Btu per dollar of GDP. As inefficient facilities in non-OECD

Europe and Eurasia are replaced with modern capacity, industrial energy intensities in the region are expected to decline more rapidly than in most of the rest of the world.

Of the non-OECD economies, China, the Middle East, and India have the most rapid increases in industrial sector energy consumption from 2003 to 2030. Whereas the economies of the OECD countries have largely moved away from heavy, energy-intensive industries (such as steel and cement) toward a greater emphasis on light manufacturing and service activities, the economies of many of the non-OECD countries and regions have growing energy-intensive, heavy manufacturing sectors.

Although electricity is expected to become an increasingly important component of industrial sector delivered energy demand in the non-OECD economies, oil, coal, and natural gas were the most heavily used fuels in 2003, and they are projected to remain so in 2030. Oil use in the non-OECD industrial sector increases at a slower rate than natural gas or coal use (Figure 24). The continued importance of coal in the non-OECD industrial sector is largely attributable to China, which accounts for two-thirds of industrial coal use in the non-OECD economies in 2030.

Transportation Sector

Transportation sector energy use includes fuels consumed for the purpose of moving people and goods by road, rail, and air. The road transport component consists of both light-duty vehicles (automobiles, sport utility vehicles, minivans, small trucks, and motorcycles, among other small vehicles) and heavy-duty vehicles (large trucks used for moving freight and buses for mass transit). Economic growth and population growth are key factors.

Petroleum products continue to dominate energy use in the transportation sector; and barring any widespread increase in the penetration of new technologies, the use of alternative fuels is expected to remain relatively modest through 2030. The *IEO2006* reference case projects a 1.4-percent average annual growth rate for transportation petroleum demand from 2003 to 2030. Much of the projected growth in demand for petroleum products in the transportation sector comes from the non-OECD economies (2.3 percent per year) as compared with the OECD countries (0.8 percent per year).

OECD Countries

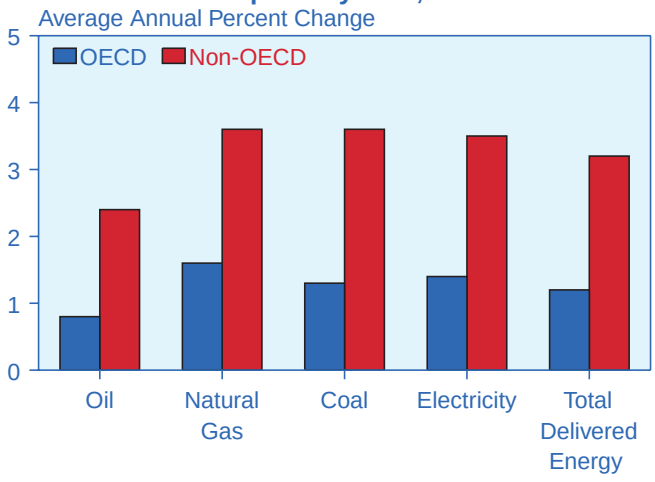
In general, the transportation sector of the OECD economies is fully established, with extensive infrastructure that includes highways, airport facilities, and rail systems. Transportation energy demand in the OECD region grows at an average annual rate of 0.9 percent, from 57.0 quadrillion Btu in 2003 to 64.1 quadrillion Btu in 2015 and 71.7 quadrillion Btu in 2030 (Figure 25).

In the United States, the transportation sector continues to account for more than one-fourth of the country's total energy consumption; and in the *IEO2006* reference case, U.S. transportation energy demand grows from 27.1 quadrillion Btu in 2003 to 33.1 quadrillion Btu in 2015 and 39.7 quadrillion Btu in 2030. The United States, currently the largest user of transportation energy among the OECD economies, accounts for 55 percent of total OECD transportation sector energy use in 2030.

Strong economic growth and a growing population are expected to increase the demand for larger, more powerful vehicles in the United States; however, advanced technologies and materials are expected to provide increased performance and size while improving new vehicle fuel economy. In the projections, the U.S. fuel economy standard for passenger cars is assumed to stay at the current level of 27.5 miles per gallon [***1***]. Not reflected in the projections is the new Corporate Average Fuel Economy (CAFE) rule, finalized in March 2006, which requires a higher fuel economy standard for light trucks, including the largest sport utility vehicles [**2**]. The new CAFE rule is expected to increase light truck fuel economy from an average of 20.7 miles per gallon in 2004 to an average of 24.1 miles per gallon for model years 2011 and beyond.

In contrast to the United States, transportation energy demand in OECD Europe is projected to remain fairly flat throughout the projection period. Low population growth, high taxes on transportation fuels, and environmental policies all contribute to the slow growth in the

Figure 24. Growth in OECD and Non-OECD Industrial Sector Delivered Energy Consumption by Fuel, 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).

OECD Europe transport sector. In fact, the transportation sector's share of total energy use in OECD Europe falls from 23 percent in 2003 to about 20 percent in 2030.

Petroleum products remain OECD Europe's largest source of energy for transportation. Although gasoline usage is expected to be higher than diesel fuel use in the OECD region as a whole, the product mix for road travel in OECD Europe is dominated by diesel fuel. In OECD Europe, the *IEO2006* projection assumes that most countries will keep taxes on diesel fuel lower than those for gasoline through 2030, encouraging a switch to diesel in the mid-term. Fast-paced growth in air travel is expected to translate to robust growth in demand for aviation fuels in the region.

In Japan, transportation energy use drops by an average of 0.4 percent per year, from 4.3 quadrillion Btu in 2003 to 4.2 quadrillion Btu in 2015 and 3.9 quadrillion Btu in 2030. The decrease is due mainly to Japan's aging population and low projected birth rate, in addition to the high taxes levied on motorists. Passenger cars in Japan are subject to numerous taxes imposed on acquisition, ownership, and operation, which are aimed at reducing oil imports and securing government funds for infrastructure projects.

In South Korea, transportation energy demand grows by 1.2 percent per year, from 1.8 quadrillion Btu in 2003 to 2.1 quadrillion Btu in 2015 and 2.4 quadrillion Btu in 2030. South Korea's total demand for oil grows at an average annual rate of 1.7 percent, from 4.5 quadrillion Btu in 2003 to 7.2 quadrillion Btu in 2030.

Non-OECD Countries

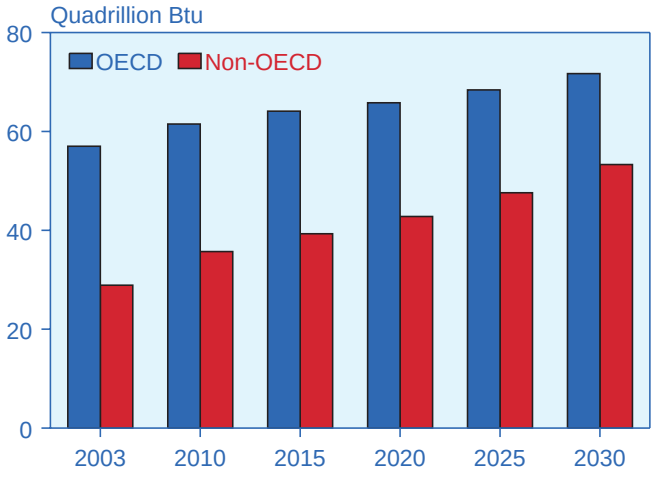
Energy demand in the non-OECD transportation sector as a whole grows at an average annual rate of 2.3 percent, from 28.9 quadrillion Btu in 2003 to 39.3 quadrillion Btu in 2015 and 53.3 quadrillion Btu in 2030 (Figure 25). As in the OECD economies, the growth in transportation energy is led by greater demand for air travel. Expanding ownership of private automobiles and an increasing role of trucking in freight transportation also play a significant role in the increase in energy demand. In 2003, the non-OECD economies accounted for about 34 percent of world energy use for transportation. In 2030, their share is 43 percent, as the gap between transportation energy consumption in the non-OECD and OECD economies narrows substantially over the projection period.

Non-OECD Asia is poised for strong and significant growth in transportation sector energy use, with China and India as the primary contributors to the growth. Strong growth is also projected for Asia's mid-sized markets, such as Thailand and Indonesia. In China and India combined, GDP expanded by an average annual 7.8 percent over the past decade, and their growth remains strong in the mid-term projections, increasing by an anuual average of 5.8 percent through 2030. The major hurdle facing China's and India's projected increases in the transportation energy demand is the need for increased infrastructure development. India has an effective and extensive rail system, but its highway system needs development. Work has started on a highway project to connect India's major cities, and it is expected to be completed in the next 5 years. Similar transportation infrastructure investments are occurring in China, as well. With these improvements, Asia's car ownership could exceed that of the United States by 2030 [***3***].

China's energy use for transportation grows by an average of 4.1 percent per year over the projection period, from 4.6 quadrillion Btu in 2003 to 7.8 quadrillion Btu in 2015 and 12.9 quadrillion Btu in 2030. Virtually all of the projected increase in transportation energy consumption is in the form of petroleum products. Road transport is the primary factor in China's growing demand for transportation fuels. There were 4.9 million automobiles in China in 2002, compared with 129.9 million automobiles in the United States [***4***]. Personal travel in China has soared in the past two decades, with passenger miles traveled increasing fivefold [***5***, ***6***]. Those trends continue in the projections.

In India, energy demand in the transportation sector grows at an average rate of 2.9 percent a year, from 1.4 quadrillion Btu in 2003 to 2.1 quadrillion Btu in 2015 and 3.0 quadrillion Btu in 2030. Transportation energy demand could grow even faster than anticipated in the *IEO2006* reference case, if all of the new highway projects currently under consideration in India are

Figure 25. OECD and Non-OECD Transportation Sector Delivered Energy Consumption, 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).

completed. Diesel usage in India is expected to be much higher than gasoline, in contrast to the United States. Diesel is often the preferred fuel for vehicles in developing economies. In the OECD countries, especially the United States and Europe, ultra-low-sulfur diesel is legislatively required for emission control purposes. Although there are similar regulations in many non-OECD countries, including in India, they are rarely enforced, and vehicles continue to burn less expensive, lower quality fuels. Transportation energy demand in the other non-OECD nations of Asia (the largest of which are Thailand, Indonesia, Malaysia, Singapore, Taiwan, and Hong Kong) grows by 2.3 percent per year, from 5.8 quadrillion Btu in 2003 to 7.7 quadrillion Btu in 2015 and 10.6 quadrillion Btu in 2030.

The Middle East region has a relatively small population and is not a major energy consumer but rather an exporter; however, rapid population growth is expected to result in more energy use for transportation in the future. The region's energy demand for transportation grows from 4.2 quadrillion Btu in 2003 to 5.2 quadrillion Btu in 2015 and 6.2 quadrillion Btu in 2030. Demand for transportation fuels in traditional exporting countries such as Saudi Arabia, Kuwait, Iraq, Oman, the United Arab Emirates, Yemen, and, most notably, Iran made the region a net importer of gasoline in 2003; however, that trend is expected to be reversed by 2010, when planned additions to refinery capacity come on line.

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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

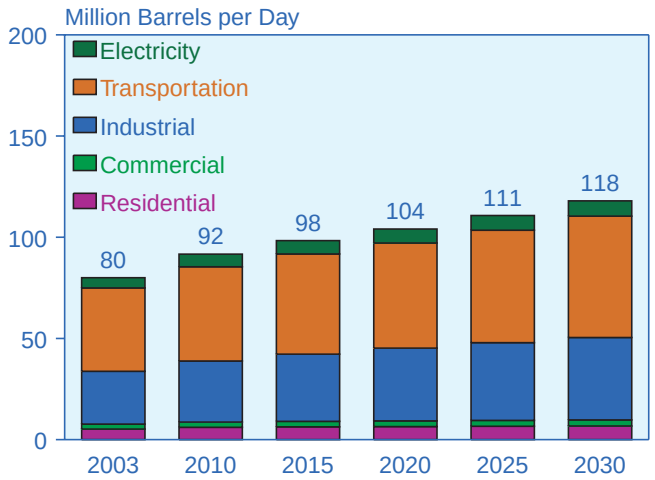
World oil consumption rose by about 1.2 million barrels per day in 2005, after an increase of 2.6 million barrels per day in 2004. The non-OECD countries accounted for 1.1 million barrels per day of the 2005 increase, and the OECD as a whole accounted for 0.1 million barrels per

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).

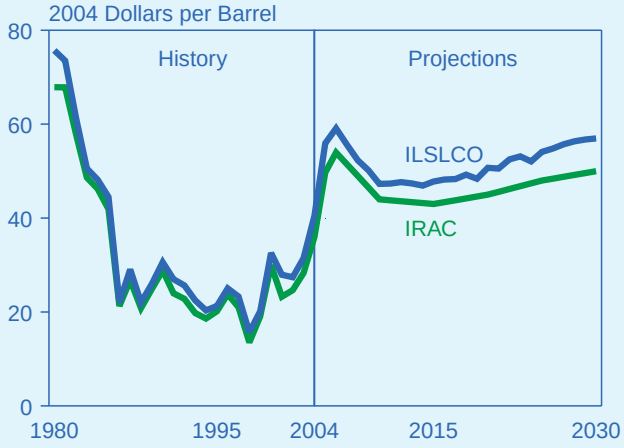
On a regional basis, two parts of the world lead the projected growth in world oil demand: non-OECD Asia and OECD North America (Figure 27). Outside North America, oil consumption in the OECD regions grows much more slowly (by 0.2 percent and 0.5 percent per year in Europe and Asia, respectively), reflecting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

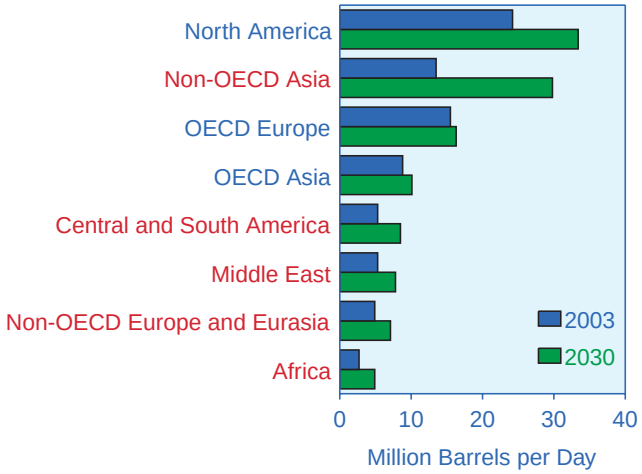
World Oil Prices, 1980-2030: Comparison of IRAC and Average Price of Imported Low-Sulfur, Light Crude Oil (ILSLCO) to U.S. Refiners



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).

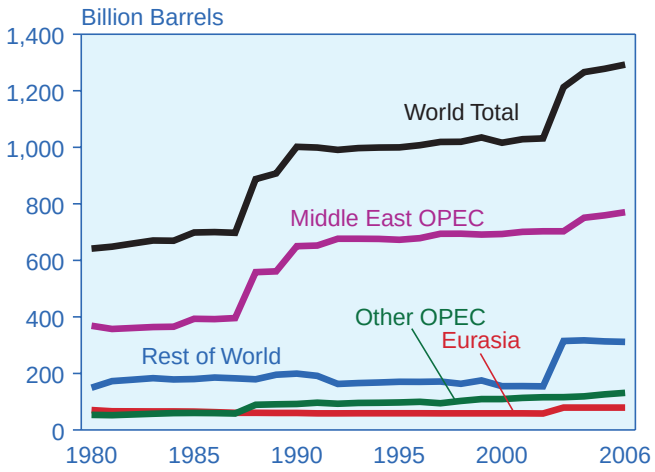
The fastest growth in oil demand is projected for the economies of non-OECD Asia, averaging 3.0 percent per year from 2003 to 2030. Fast-paced increases are also expected for the other non-OECD regions, including annual growth of oil use that averages 1.4 percent in non-OECD Europe and Eurasia, 1.5 percent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

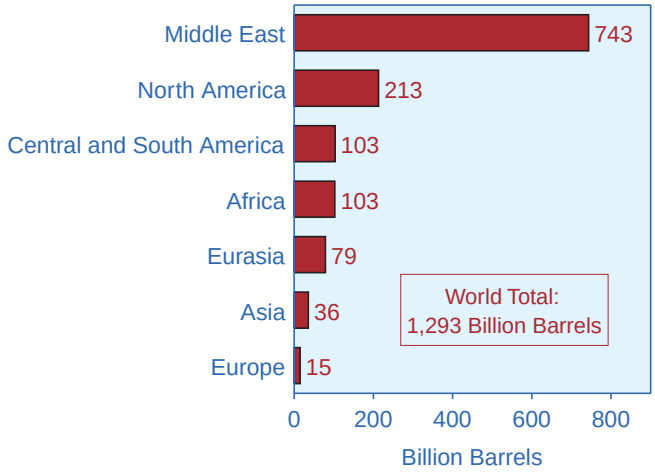
The Composition of World Oil Supply

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.

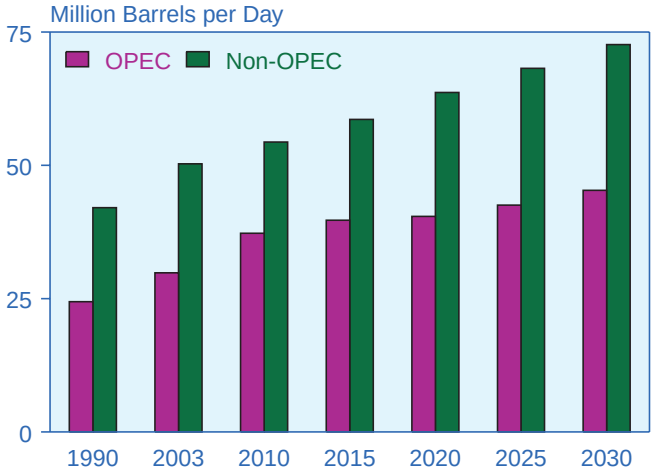
Note: Reserves include crude oil (including lease condensates) and natural gas plant liquids.

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

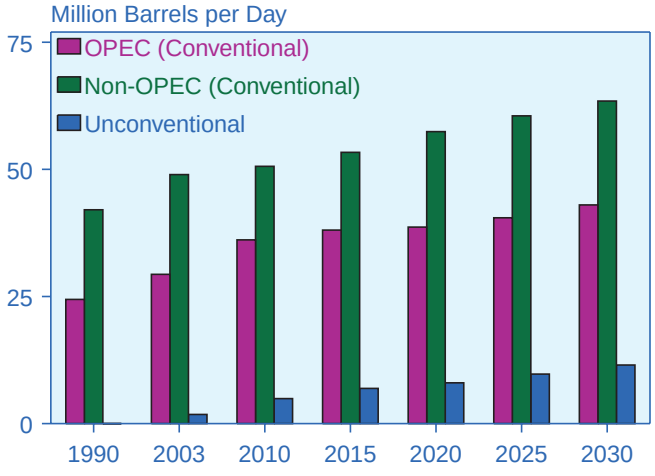
It is generally acknowledged that OPEC members with large reserves and relatively low costs for expanding production capacity can accommodate sizable increases in petroleum demand. In the *IEO2006* reference case, the production call on OPEC suppliers grows at an annual rate of 1.5 percent through 2030 (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***].

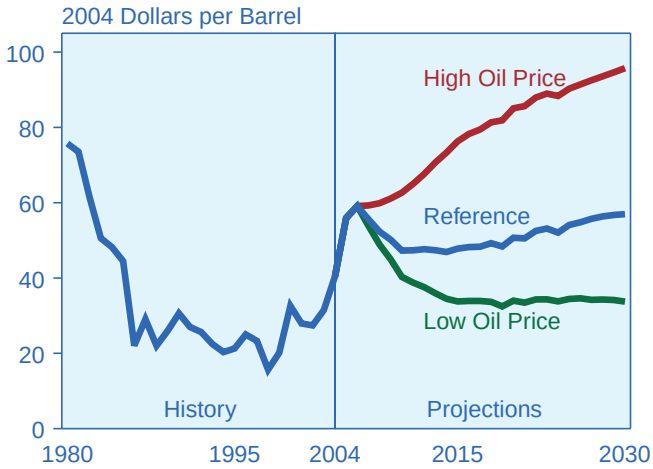
Oil producers in South America have significant potential for increasing output over the next decade. Brazil became a million barrel per day producer of crude oil in 1999, with considerable production potential waiting to be tapped. Brazil's production rises throughout the projection period, topping 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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4. Organization of Petroleum Exporting Countries, *Annual Statistical Bulletin 2004*, Table 10, "World Proven Crude Oil Reserves by Region, 1969-2004" (Vienna, Austria, 2005), p. 18.
5. BP, *Statistical Review of World Energy* (London, UK, June 2005), p. 4.

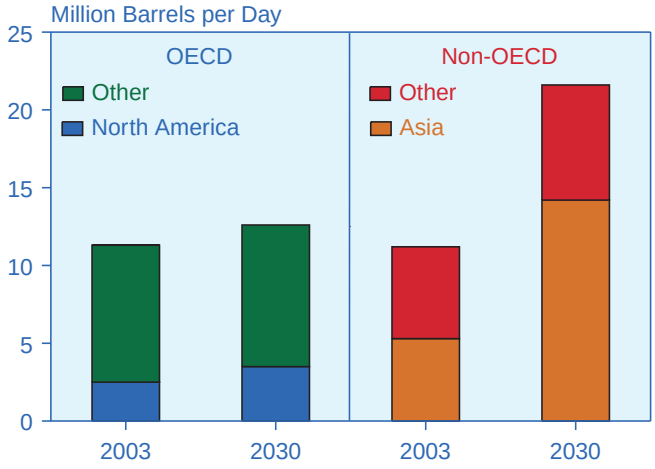
Table 7. Worldwide Petroleum Trade in the Reference Case, 2003 and 2030
(Million Barrels per Day)

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



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).

6. J.W. Schmoker and T.R. Klett, "Chapter RG: Estimating Potential Reserve Growth of Known (Discovered) Fields: A Component of the USGS World Petroleum Assessment 2000," in *U.S. Geological Survey Digital Data Series 60*, web site http://energy.cr.usgs.gov/WEcont/chaps/RG.pdf.
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10. Energy Information Administration, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), p. 33.
11. Energy Information Administration, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), p. 33.

Chapter 4

Natural Gas

Natural gas trails coal as the fastest growing primary energy source in IEO2006. The natural gas share of total world energy consumption increases from 24 percent in 2003 to 26 percent in 2030.

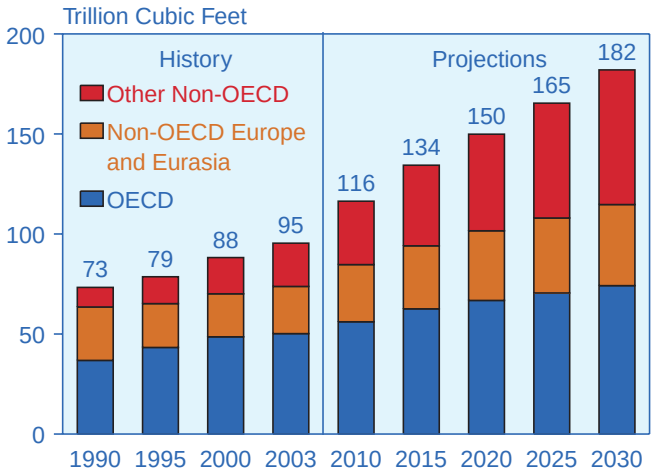
Consumption of natural gas worldwide increases from 95 trillion cubic feet in 2003 to 182 trillion cubic feet in 2030 in the *IEO2006* reference case (Figure 34). Although natural gas is expected to be an important fuel source in the electric power and industrial sectors, the annual growth rate for natural gas consumption in the projections is slightly lower than the growth rate for coal consumption—in contrast to past editions of the *IEO*. Higher world oil prices in *IEO2006* increase the demand for and price of natural gas, making coal a more economical fuel source in the projections.

Natural gas consumption worldwide increases at an average rate of 2.4 percent annually from 2003 to 2030, as compared with 2.5 percent per year for coal and 1.4 percent per year for oil. Nevertheless, natural gas remains a more environmentally attractive energy source and burns more efficiently than coal, and it still is expected to be the fuel of choice in many regions of the world. As a result, the natural gas share of total world energy consumption (on a Btu basis) grows from 24 percent in 2003 to 26 percent in 2030.

Worldwide, the industrial and electric power sectors are the largest consumers of natural gas (Figure 35). In 2003, the industrial sector accounted for 44 percent and the electric power sector 31 percent of the world's total natural gas consumption. In the projections, natural gas use grows by 2.8 percent per year in the industrial sector and 2.9 percent per year in the electric power sector from 2003 to 2030. In both sectors, the share of total energy demand met by natural gas grows over the projection period. In the industrial sector, natural gas overtakes oil as the dominant fuel by 2030. In the electric power sector, however, despite its rapid growth, natural gas remains a distant second to coal in terms of share of total energy use for electricity generation.

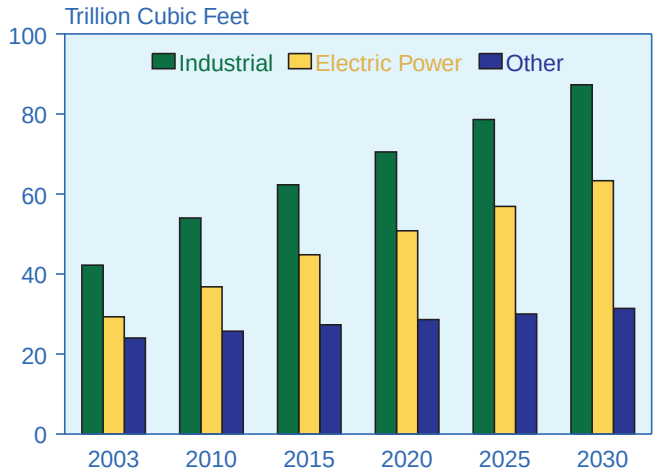
In 2003, OECD member countries accounted for just over one-half of the world's total natural gas use, non-OECD Europe and Eurasia accounted for one-quarter, and the other non-OECD countries accounted for the remainder. The OECD countries are, by and large, mature consumers of natural gas with well-established infrastructure and consuming patterns. In contrast, natural gas infrastructure in the non-OECD countries, outside of non-OECD Europe and Eurasia, is largely in its infancy, and natural gas demand is fairly small. The *IEO2006* reference case projects fast-paced growth in

Figure 34. World Natural Gas Consumption by Region, 1990-2030



Sources: **History:** 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).

Figure 35. World Natural Gas Consumption by End-Use 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).

demand for natural gas among those non-OECD countries, as their natural gas infrastructures expand.

In the reference case, natural gas consumption in the non-OECD countries grows more than twice as fast as consumption in the OECD countries, with 3.3 percent average annual growth from 2003 to 2030 for non-OECD countries, compared with an average of 1.5 percent for the OECD countries. Natural gas demand in the non-OECD countries accounts for 73 percent of the total world increment in natural gas consumption over the projection horizon. In the non-OECD countries (excluding non-OECD Europe and Eurasia) natural gas use increases from less than one-quarter of the world total in 2003 to 38 percent in 2030.

Reserves and Resources

Historically, world natural gas reserves have, for the most part, trended upward (Figure 36). As of January 1, 2006, proved world natural gas reserves, as reported by *Oil & Gas Journal*,[5] were estimated at 6,112 trillion cubic feet—70 trillion cubic feet (about 1 percent) higher than the estimate for 2005 [***1***].

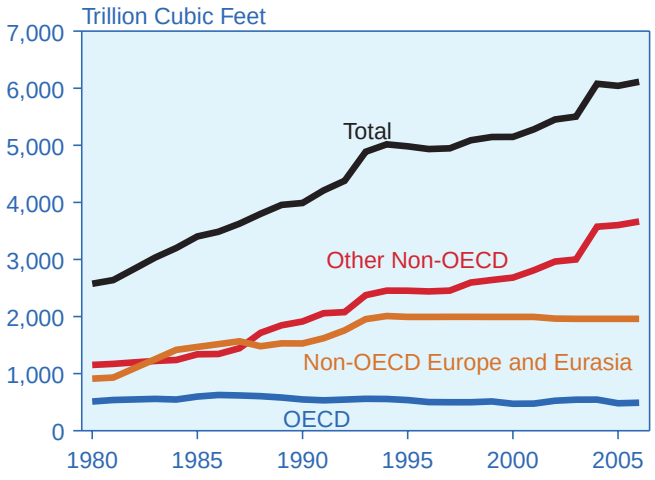
The largest revision to natural gas reserve estimates was made in Iran. Iran's natural gas reserves increased by 31 trillion cubic feet (3 percent) between 2005 and 2006, from 940 trillion cubic feet to 971 trillion cubic feet. Also in the Middle East, higher reserve estimates were reported by Saudi Arabia, with an increase of 7 trillion cubic feet (3 percent). Other countries with substantial increases in reserves include Norway with a gain of 11 trillion cubic feet (14 percent), Nigeria with an increase of 9 trillion cubic feet (5 percent), and Indonesia with an increase of 7 trillion cubic feet (8 percent). Declining natural gas reserves were reported for Bangladesh (a decrease of 6 trillion cubic feet), and smaller losses were reported for Argentina (3 trillion cubic feet), Taiwan (2 trillion cubic feet), Germany (1 trillion cubic feet), and the United Kingdom (1 trillion cubic feet).

Almost three-quarters of the world's natural gas reserves are located in the Middle East and Eurasia (Figure 37). Russia, Iran, and Qatar combined accounted for about 58 percent of the world's natural gas reserves as of January 1, 2006 (Table 8). Reserves in 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, Russia 81.5 years, and Africa 96.9 years. The Middle East's reserves-to-production ratio exceeds 100 years.

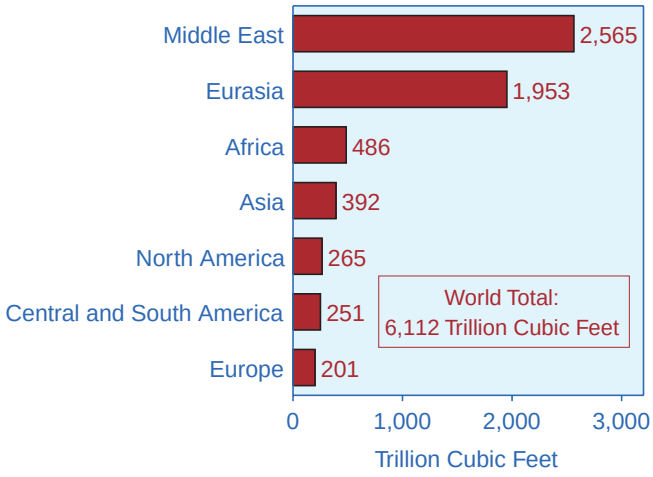
The U.S. Geological Survey (USGS) periodically assesses the long-term production potential of worldwide petroleum resources (oil, natural gas, and natural gas liquids). According to the most recent USGS estimates, released in the *World Petroleum Assessment 2000* and adjusted to reflect current proved reserves, a significant volume of natural gas remains to be discovered. Worldwide undiscovered natural gas is estimated at 4,221 trillion

Figure 36. World Natural Gas Reserves by Region, 1980-2006



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).

Figure 37. World Natural Gas 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.

[5]Proved 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. Significant natural gas discoveries made during 2005 are not likely to be reflected in the reported reserves.

cubic feet (Figure 38), slightly larger than the *IEO2006* projection for cumulative worldwide natural gas consumption from 2003 to 2030.

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 for its transportation to be economical. Of the new natural gas resources expected to be added through 2025, 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 Eurasia, 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.

World Natural Gas Supply

Non-OECD Europe and Eurasia and the Middle East account for almost three-quarters of the world's natural gas reserves, but in 2003 they accounted for only 39 percent of world production. Together, these two regions account for 47 percent of the projected increase in global natural gas production from 2003 to 2030 (Table 9), much of it for export to OECD countries.

Russia is already the world's single largest exporter of natural gas, with net exports of 6.3 trillion cubic feet in 2003, all of it by pipeline. There are also some plans to export natural gas from the Middle East, but much of the region's increase in production is projected to be used domestically—particularly in the electric power sector, where shifts from petroleum to natural gas allow the producing countries to monetize more of their oil assets through export.

Other non-OECD regions are also expected to increase their natural gas production strongly. Africa, with its rich and underdeveloped natural gas resources, has the fastest growth rate in natural gas production worldwide, with supply rising by 4.9 percent per year from 2003 to 2030. A considerable amount of the incremental production in Africa—from Algeria, Nigeria, Libya, and Egypt—is slated for export, both by pipeline and in the form of liquefied natural gas (LNG).

Natural gas production in non-OECD Asia also grows substantially over the projection period, but all the growth in supply is required for consumption within the region, and imports are needed to fill the shortfall. In Central and South America, natural gas production outpaces regional demand. As a result, Trinidad and Tobago continues to export LNG outside the region. Peru, and possibly Venezuela, may also begin to export LNG outside the region over the course of the projection.

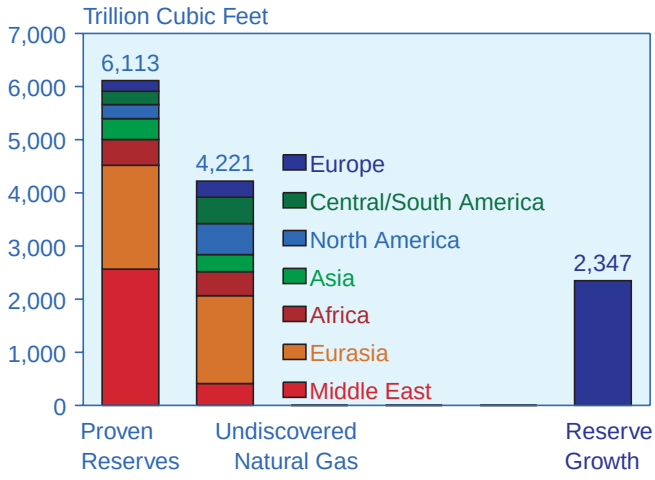
In 2003, the OECD countries accounted for 41 percent of the world's total natural gas production and 52 percent

Table 8. World Natural Gas Reserves by Country as of January 1, 2006

Country	Reserves (Trillion Cubic Feet)	Percent of World Total
World	**6,112**	**100.0**
Top 20 Countries	**5,510**	**90.2**
Russia	1,680	27.5
Iran	971	15.9
Qatar	911	14.9
Saudi Arabia	241	3.9
United Arab Emirates	214	3.5
United States	193	3.1
Nigeria	185	3.0
Algeria	161	2.6
Venezuela	151	2.5
Iraq	112	1.8
Indonesia	98	1.6
Norway	84	1.4
Malaysia	75	1.2
Turkmenistan	71	1.2
Uzbekistan	66	1.1
Kazakhstan	65	1.1
Netherlands	62	1.0
Egypt	59	1.0
Canada	57	0.9
Kuwait	56	0.9
Rest of World	**602**	**9.8**

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

Figure 38. World Natural Gas Resources by Geographic Region, 2006-2025



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. 103, No. 47 (December 19, 2005), pp. 24-25; and Energy Information Administration estimates.

of total natural gas consumption; in 2030, they are projected to account for only 25 percent of production and 40 percent of consumption. Natural gas supply from the OECD nations increases by an average of only 0.5 percent per year in the *IEO2006* reference case, whereas demand increases by 1.5 percent per year. As a result, the OECD countries rely increasingly on imports to meet natural gas demand (Figure 39), with a growing percentage of traded natural gas coming in the form of LNG. OECD countries rely on natural gas produced in other parts of the world to meet more than one-third of their natural gas consumption in 2030, up from 22 percent in 2003.

LNG is expected to become an increasingly important source of supply to meet the world's demand for natural gas. Although there were only 12 LNG-exporting countries in 2004,[6] the number is increasing. In 2005, Egypt joined the ranks of LNG-producing countries with the start of two separate liquefaction projects. Russia also entered the LNG business in 2005, not with LNG it produced but with LNG for which it traded pipeline natural gas [3]. Not until 2008, when the Sakhalin liquefaction project is expected to start operations, will Russia become an LNG-producing country. Norway and Equatorial Guinea also have their first liquefaction terminals under construction, and construction on the first liquefaction terminal in South America is scheduled to begin in 2006 in Peru.

The number of countries installing the infrastructure necessary to accept LNG imports is also increasing.

Table 9. World Natural Gas Production by Region and Country, 2003-2030
(Trillion Cubic Feet)

Region/Country	2003	2010	2015	2020	2025	2030	Average Annual Percent Change, 2003-2030
OECD North America	**27.1**	**26.4**	**28.1**	**29.3**	**29.9**	**30.4**	**0.4**
United States	19.0	18.6	20.4	21.6	21.4	21.2	0.4
Canada	6.5	6.1	5.8	5.5	5.8	6.2	-0.2
Mexico	1.5	1.7	1.9	2.2	2.6	3.0	2.6
OECD Europe	**10.7**	**10.9**	**11.0**	**10.7**	**10.7**	**10.3**	**-0.2**
OECD Asia	**1.5**	**2.4**	**3.2**	**3.9**	**4.4**	**4.8**	**4.3**
Japan	0.1	0.1	0.1	0.1	0.1	0.1	0.6
South Korea	0.0	0.0	0.0	0.0	0.0	0.0	—
Australia/New Zealand	1.4	2.3	3.1	3.8	4.2	4.6	4.5
Total OECD	**39.3**	**39.7**	**42.3**	**44.0**	**44.9**	**45.4**	**0.5**
Non-OECD Europe and Eurasia	**27.9**	**33.9**	**38.2**	**42.0**	**45.7**	**51.1**	**2.3**
Russia	21.8	26.8	30.4	33.5	36.6	41.5	2.4
Other	6.1	7.1	7.8	8.5	9.0	9.6	1.7
Non-OECD Asia	**9.7**	**12.9**	**16.5**	**19.9**	**23.7**	**27.4**	**3.9**
China	1.2	2.4	3.0	3.5	3.9	4.4	4.9
India	1.0	1.1	1.3	1.6	1.9	2.4	3.5
Other non-OECD Asia	7.5	9.3	12.2	14.8	17.8	20.6	3.8
Middle East	**9.1**	**14.2**	**17.1**	**19.8**	**23.1**	**26.2**	**4.0**
Africa	**5.1**	**8.7**	**11.4**	**14.3**	**16.3**	**18.5**	**4.9**
Central and South America	**4.2**	**6.7**	**8.4**	**9.6**	**11.4**	**13.0**	**4.3**
Brazil	0.3	0.6	0.7	0.8	0.9	1.1	4.8
Other Central /South America	3.9	6.2	7.7	8.8	10.5	11.9	4.2
Total Non-OECD	**55.9**	**76.4**	**91.7**	**105.6**	**120.2**	**136.2**	**3.4**
Total World	**95.2**	**116.1**	**134.0**	**149.6**	**165.1**	**181.6**	**2.4**

Note: Totals may not equal sum of components due to independent rounding.
Sources: **2003:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **2010-2030: United States:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383 (2006) (Washington, DC, February 2006), web site www.eia.doe.gov/oiaf/aeo/. **Others:** EIA, System for the Analysis of Global Energy Markets (2006).

[6]Algeria, United States, Libya, Brunei, United Arab Emirates, Indonesia, Malaysia, Australia, Qatar, Nigeria, Trinidad and Tobago, and Oman.

More than 30 years had passed since the United Kingdom imported LNG, but in 2005 it rejoined the ranks of LNG importers, with the startup of its Isle of Grain regasification terminal. China, Canada, and Mexico all have their first LNG import terminals under construction; and Germany, Poland, Croatia, Singapore, and Chile are among the other countries considering their first regasification terminals.

World Natural Gas Demand

OECD North America

North America's natural gas consumption (Figure 40) is projected to increase at an average annual rate of 1.1 percent between 2003 and 2030. The regional growth rate for natural gas demand is somewhat slower than in past *IEO*s, largely because of the impact of higher prices and supply concerns in natural gas markets of the United States, North America's largest consumer. The United States accounted for more than 80 percent of the 27.4 trillion cubic feet of natural gas consumed in the region in 2003, and its share of the total in 2030 is 73 percent, despite robust growth in demand for natural gas in Canada and Mexico, averaging 1.9 percent per year and 3.4 percent per year, respectively.

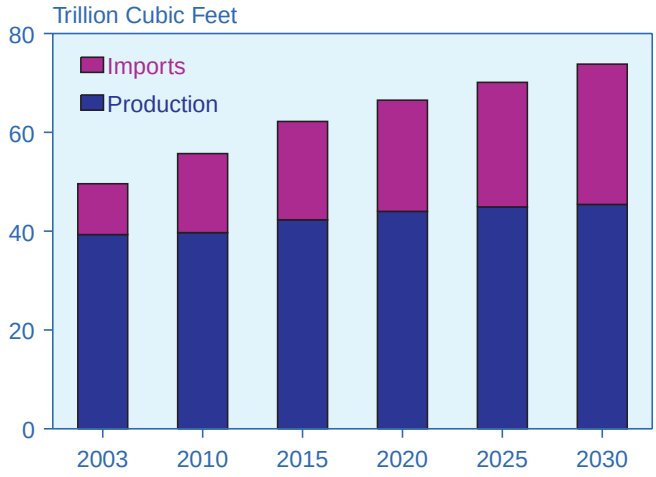
The current high levels of natural gas prices in the United States are expected to discourage the construction of new natural-gas-fired electricity generation plants in the mid-term. As a result, only 130 gigawatts of new natural-gas-fired capacity is added from 2003 through 2030 in the reference case, as compared with 154 gigawatts of new coal-fired capacity. U.S. natural gas consumption for electricity generation peaks in 2020 at 7.5 trillion cubic feet, followed by a decline to 6.4 trillion cubic feet in 2030.

Natural gas prices in the United States remain relatively high throughout the projection period; and as a result, consumption of natural gas in the U.S. industrial sector grows slowly, from 8.3 trillion cubic feet in 2003 to 10.0 trillion cubic feet in 2030. Natural gas consumption increases in all the major industrial sectors, with the exception of the refining industry. High prices also limit consumption increases in the U.S. buildings sector (residential and commercial), where natural gas use grows from 8.3 trillion cubic feet in 2003 to 9.6 trillion cubic feet in 2030. The net result of changes in energy use in the electric power, industrial, and other end-use sectors is that U.S. natural gas consumption is essentially flat between 2020 and 2030.

Canada, currently the source of almost 90 percent of U.S. net natural gas imports, remains the primary source of natural gas imported into the United States until 2010. After 2010, LNG imports replace Canadian imports as the primary source. The decline of Canada's largest producing basin, the Western Sedimentary Basin, coupled with 1.9-percent projected average annual growth in Canada's domestic consumption, leaves less Canadian natural gas available for export to the United States.

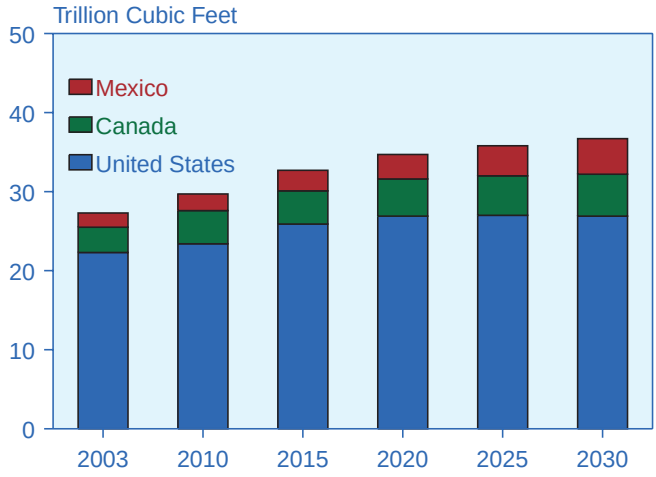
In EIA's *Annual Energy Outlook 2006* (*AEO2006*) reference case, rising natural gas prices make it economical for two major North American pipelines that have long been in the planning stages to come online. The first, a Canadian pipeline to transport natural gas from the MacKenzie Delta, is expected to become operational in 2011. The second, an Alaska pipeline, is expected to

Figure 39. OECD Natural Gas Supply by Source, 2003-2030



Sources: **2003:** 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).

Figure 40. Natural Gas Consumption in North America by Country, 2003-2030



Sources: **2003:** 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).

begin transporting natural gas from Alaska to the lower 48 States in 2015, contributing significantly to U.S. domestic supply. From 2003 to 2030, Alaska's natural gas production accounts for most of the growth in domestic U.S. conventional natural gas production, with flows on the pipeline exceeding 2 trillion cubic feet in 2030.

The other expected source of U.S. domestic incremental supply is unconventional natural gas production. More than one-third of the remaining U.S. technically recoverable 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.

Currently, the United States has five LNG import facilities in operation, with a combined peak annual capacity of 1.6 trillion cubic feet. Three additional terminals under construction in the Gulf of Mexico will add a combined peak annual regasification capacity of 2.0 trillion cubic feet, more than doubling U.S. LNG import capacity. *AEO2006* projects peak annual U.S. LNG import capacity in 2030 at 5.9 trillion cubic feet, with actual imports of 4.4 trillion cubic feet (Figure 41). The growth of U.S. LNG import capacity is expected to be strong through 2015 and then to slow as high natural gas prices begin to slow the growth of domestic consumption. LNG imports into Canada are also expected to contribute to the supply of Canadian natural gas available for export to the United States. LNG is expected to be a significant contributor to supply in the United States, indicative of the country's growing dependence on imports and the increasing globalization of natural gas markets.

In Canada, most of the projected increase in natural gas consumption is for industrial uses and electricity generation, with only moderate growth in the other consuming sectors. Although natural gas use in Canada's electric power sector more than doubles from 2003 to 2030, the largest absolute increase is projected for the industrial sector, largely because significant amounts of natural gas are expected to be used in the mining of Canada's expansive oil sands deposits.

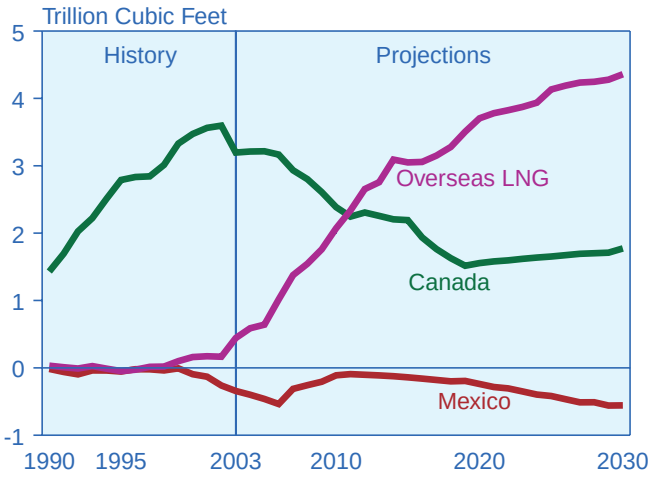
Canada produced more than twice as much natural gas as it consumed in 2003, and the balance was exported to the United States. In 2030, Canada is projected to consume 85 percent of its own production, leaving only 15 percent available for export. Increases in unconventional production in western Canada and conventional production in the MacKenzie Delta and Eastern Canada are expected to help reverse the decline in production after 2020, and net exports to the United States increase gradually from 2020 to 2030.

In Mexico, strong growth in natural gas consumption for industry and for electricity generation is expected, with industrial consumption doubling and consumption for electricity generation more than tripling between 2003 and 2030. Growth in Mexico's natural gas consumption is expected to far outpace growth in its production. Although Mexico has significant untapped natural gas reserves, the Mexican government does not have the resources needed to develop them and to date has been relatively unsuccessful in attracting foreign capital. Currently, only the state oil and natural gas company, Petroleos Mexicanos (PEMEX), is allowed to have any ownership interest in Mexico's oil and natural gas reserves. Mexico is thus expected to be dependent on pipeline imports from the United States and LNG imports to meet its growing supply deficit. In the reference case, imports grow from 17 percent of Mexico's total natural gas consumption in 2003 to 33 percent in 2030. Throughout the projections, Mexico remains a net importer of natural gas from the United States.

OECD Europe

Natural gas is expected to be the fastest growing fuel source in OECD Europe, with demand increasing at an annual average rate of 2.0 percent, from 17.8 trillion cubic feet in 2003 to 23.9 trillion cubic feet in 2015 and 30.8 trillion cubic feet in 2030. Almost 60 percent of incremental natural gas consumption in OECD Europe between 2003 and 2030 is expected to be used for electric power generation (Figure 42). Natural-gas-fired generation is less carbon-intensive than oil- or coal-fired generation and is expected to remain more cost-competitive

Figure 41. U.S. Natural Gas Supply by Source, 1990-2030



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), web site www.eia.doe.gov/oiaf/aeo/.

than renewable energy, making natural gas the fuel of choice for new generating capacity in OECD Europe.

Natural gas consumption for electricity generation in OECD Europe increases on average by 3.9 percent per year from 2003 to 2030, surpassing the use of renewables for electricity generation (on a Btu basis) by 2015 and the use of coal or nuclear power by 2020. The share of total electricity sector energy demand met by natural gas increases from 14 percent in 2003 to 24 percent in 2015 and 32 percent in 2030.

OECD Europe received net imports of around 7 trillion cubic feet of natural gas in 2003, accounting for more than one-third of the region's total natural gas consumption. With domestic production declining in most of the countries of OECD Europe, the region's reliance on imported natural gas grows to more than one-half of demand in 2015 and almost two-thirds in 2030. Russia, alone, currently provides around two-thirds of Europe's imports, and much of Europe was affected in January 2006 when Russia, in a dispute over contract prices, cut off natural gas supplies to Ukraine.

Security and diversity of natural gas supply are major concerns for OECD Europe now and going forward. Europe is aggressively expanding LNG receiving capacity, and several new pipelines have been proposed that would link Europe to supplies in Egypt, the Middle East, and the Caspian Basin, and would increase capacity from North Africa and add capacity from Russia via routes that bypass traditional transit states.

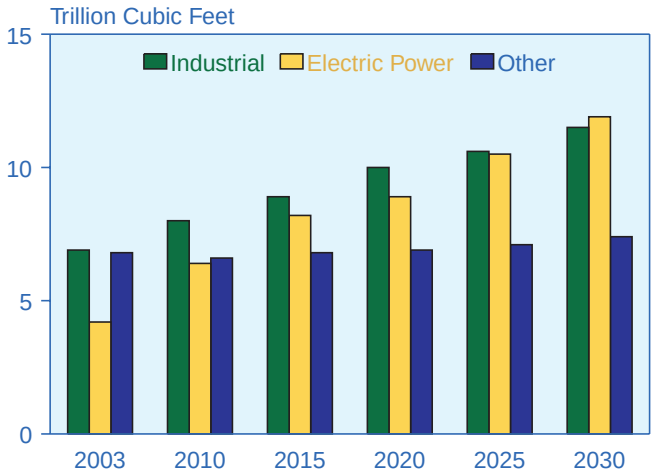
OECD Asia

In the *IEO2006* reference case, Japan has the lowest growth rate for natural gas consumption among the OECD countries outside North America (Figure 43), mainly because its population declines and its economic growth is relatively slow. Even with an average annual growth rate in consumption of only 0.8 percent, however, natural gas still is the second fastest growing primary energy source in Japan, behind nuclear power.

Total natural gas consumption in South Korea grows at an average annual rate of 1.7 percent from 2003 to 2030. In 2003, the residential sector was the country's predominant consumer of natural gas, accounting for 39 percent of the total, with the electric power sector a close second at 33 percent of total natural gas use. In the projections, natural gas use in South Korea's industrial sector increases on average by 4.9 percent per year from 2003 to 2030, compared with average annual growth of 0.7 percent in the residential sector. By 2020, natural gas consumption in the country's industrial sector surpasses that in its residential sector; and in 2030, industrial natural gas use accounts for more than 45 percent of all the natural gas consumed in South Korea.

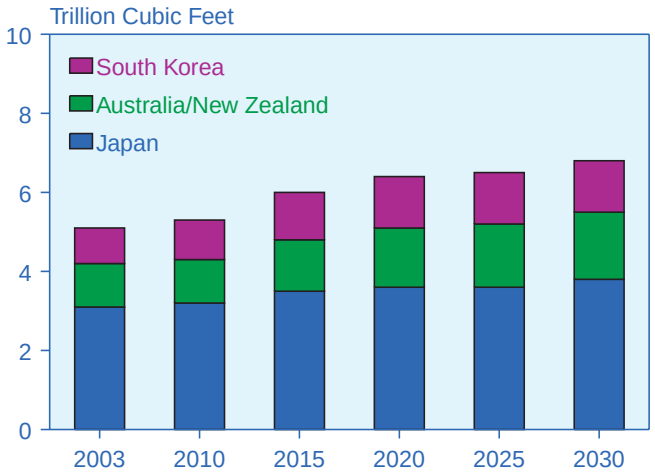
In Australia and New Zealand, the industrial sector currently is the predominant user of natural gas, and it accounts for more than one-half of all natural gas consumption in the region throughout the projection period. Natural gas is the fastest growing fuel in Australia and New Zealand in the reference case; however, with the region's abundance of coal reserves, and with

Figure 42. Natural Gas Consumption in OECD Europe by End-Use 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).

Figure 43. Natural Gas Consumption in OECD Asia by Country, 2003-2030



Sources: **2003:** 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).

its natural gas reserves located far from demand centers, its natural gas consumption in 2030 on a Btu basis is less than one-half of its coal consumption.

Non-OECD Europe and Eurasia

The non-OECD Europe and Eurasia region is more reliant on natural gas than any other region in the world. Russia is second only to the United States in total natural gas consumption, and it is the only country in the world where natural gas accounts for more than one-half of total primary energy consumption. In 2003, Russia consumed 15.3 trillion cubic feet of natural gas. The other countries of non-OECD Europe and Eurasia met 44 percent of their combined total energy needs with natural gas in 2003.

Growth in natural gas demand in non-OECD Europe and Eurasia remains strong throughout the projection period, with an average annual growth rate of 2.0 percent from 2003 to 2030. Natural gas consumption in both the electric power and industrial sectors increases by around 8 trillion cubic feet from 2003 to 2030 (Figure 44). Natural gas use in the electric power sector grows slightly faster, at 2.4 percent per year, from 8.4 trillion cubic feet in 2003 to 16.1 trillion cubic feet in 2030. Industrial natural gas consumption in the region grows by an average of 2.1 percent per year, from 11.0 trillion cubic feet in 2003 to 19.1 trillion cubic feet in 2030.

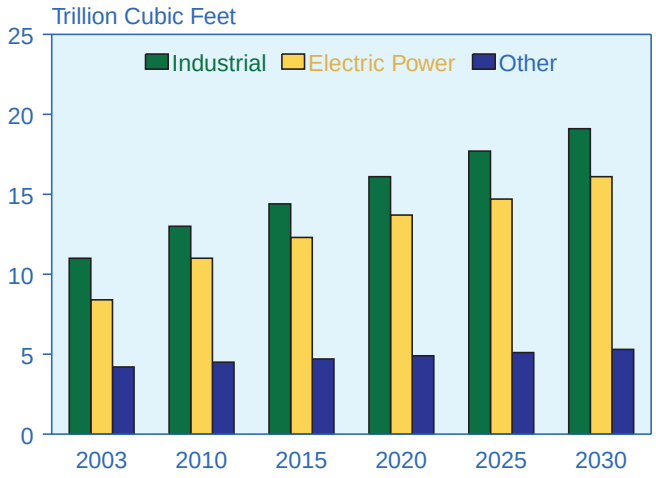
Other Non-OECD

In the rest of the non-OECD countries, significant growth in natural gas use is projected from 2003 to 2030, as strong economic growth and available resources encourage the development of natural gas infrastructure to support demand. In the other non-OECD countries (excluding non-OECD Europe and Eurasia), natural gas demand triples in the *IEO2006* reference case, from 21.7 trillion cubic feet in 2003 to 67.3 trillion cubic feet in 2030.

Non-OECD Asia accounts for much of the growth in natural gas demand projected for the non-OECD region. Led by demand in China and India, natural gas consumption in non-OECD Asia expands by 5.1 percent per year on average from 2003 to 2030. In both China and India, natural gas is currently a minor fuel in the overall energy mix, representing only 3 percent and 7 percent, respectively, of total primary energy consumption in 2003; however, both countries are rapidly expanding infrastructure to facilitate natural gas consumption, as well as natural gas imports. In the reference case, natural gas consumption grows at an average annual rate of 6.8 percent in China and 5.9 percent in India.

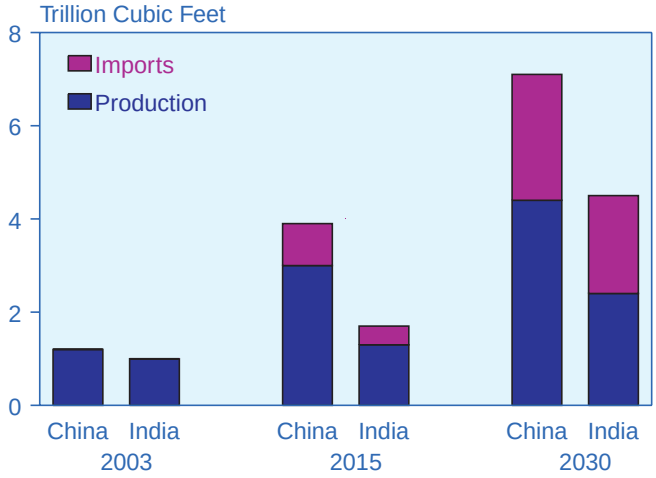
Both China and India have limited natural gas reserves and are projected to rely on imports to meet more than 40 percent of natural gas demand in 2030 (Figure 45). Both countries have been discussing possible import pipelines, but none is imminent. China and India have also been pursuing LNG imports. China has two regasification terminals under construction and a number of others approved or proposed (see box on page 45). India has two terminals operating and several more proposed. The supply contracts for China's Guandong and Fujian terminals, as well as India's Dahej terminal, were signed several years ago at historically favorable terms and prices; however, both countries are finding it difficult to secure additional long-term LNG supplies for any of their proposed regasification terminals at prices that local natural gas consumers would find acceptable [*4*].

Figure 44. Natural Gas Consumption in Non-OECD Europe and Eurasia by End-Use 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).

Figure 45. Natural Gas Supply in China and India by Source, 2003, 2015, and 2030



Sources: **2003:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **2015 and 2030:** EIA, System for the Analysis of Global Energy Markets (2006).

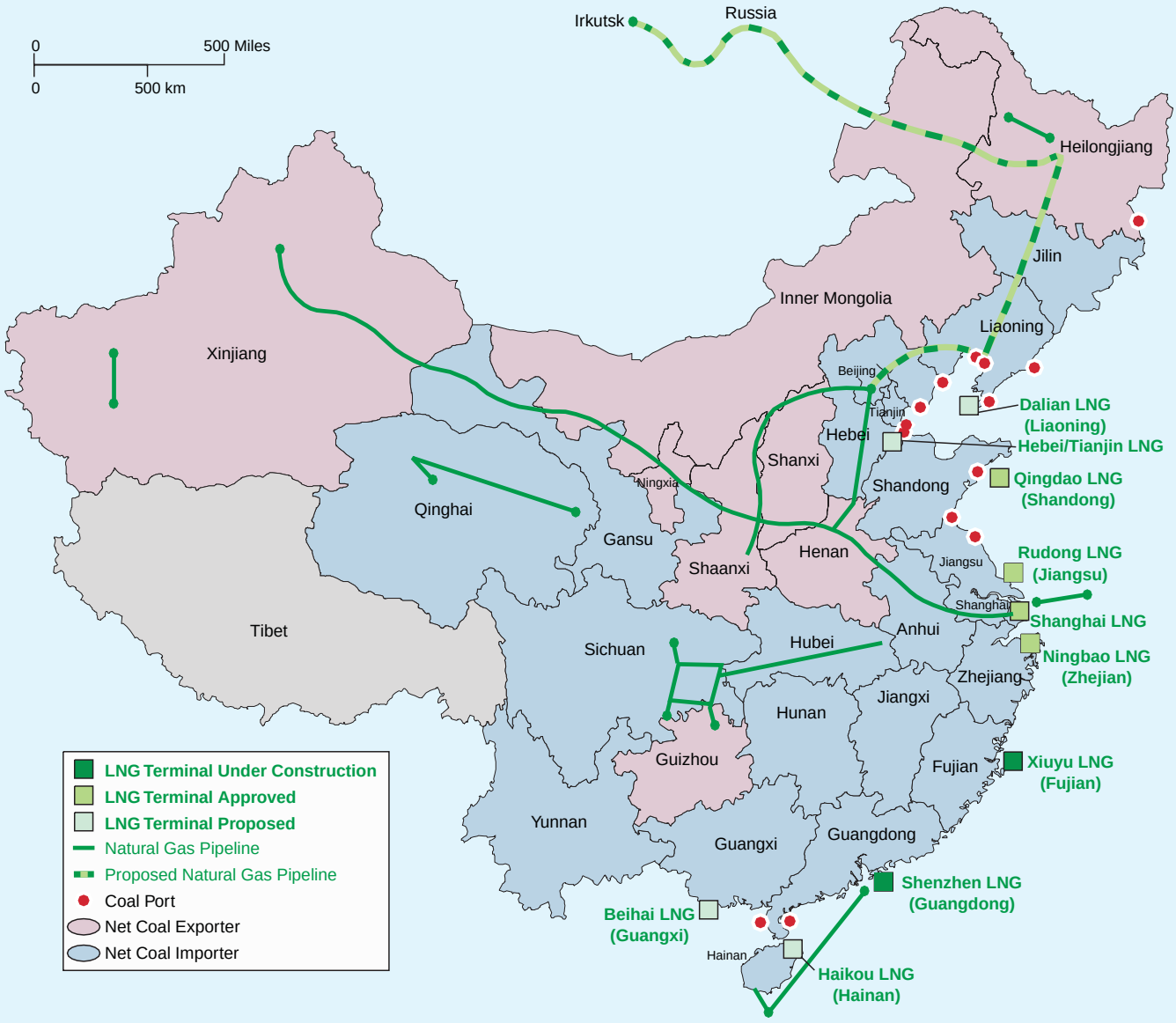
Liquefied Natural Gas: Market Developments in China

Pressed by shortages of peak-load capacity and growing concern about pollution from coal burning, China has begun to turn to cleaner burning fuels—in particular, LNG—for electricity generation. There is great potential for development of LNG within China, and a number of regasification facilities are currently under construction or planned, especially in the eastern part of the country, where access to coal resources is limited (see map below). In large part, however, the growth of China's LNG market may be limited by competition with coal.

Rapid growth in China's manufacturing output increased its electric power demand by about 15 percent

(continued on page 46)

China's Natural Gas Pipelines and Major LNG Terminals Under Construction, Approved, or Proposed



Sources: **Coal:** Barlow Jonker Pty. Ltd., *Major Coalfields of China* (Sydney, Australia, 2001). **Natural Gas:** Jeffrey Logan, Senior Energy Analyst and China Program Manager, International Energy Agency, "China Oil and Gas Outlook and Implications for Energy Markets," Testimony Before the U.S. Senate, Committee on Energy and Natural Resources, Hearing on EIA's Annual Energy Outlook for 2005 (Washington, DC, February 3, 2005), web site http://energy.senate.gov/public/.

Liquefied Natural Gas: Market Developments in China (Continued)

in 2004.[a] In summer 2004, China saw a 30-gigawatt nationwide power deficit, with 24 provincial grids forced to restrict power supplies,[b] prompting a sharp increase in demand for fuel oil (estimated at 170,000 barrels per day) to generate electricity, in addition to the existing 300,000 barrels per day used for electric power generation annually.[c] The power shortage is expected to continue through 2006, but demand for fuel oil in the power sector is expected to fall in the second half of 2006, when new LNG projects come online. China's LNG imports are expected to increase from 1 million metric tons in 2006 to between 20.9 and 25.9 million metric tons in 2015.[d]

Several LNG projects are underway in China. Construction of the country's first LNG regasification terminal, in Guangdong Province, has been completed, and the facility is scheduled to receive its first cargo in June 2006 from North West Shelf Australian LNG. A second LNG terminal, in the city of Xiuyu in Fujian Province, is scheduled for completion by 2008. At present, the Chinese government is reviewing more than 10 additional LNG proposals up and down China's coastline (see table below).

Plans to build LNG terminals on China's northeast coast developed quickly in 2004, accelerating when negotiations between China and Russia over a major proposed natural gas pipeline project that would bring natural gas from Irkutsk, Russia, to northern China were stalled. Lack of progress in the negotiation resulted mainly from China's insistence that the price of natural gas from Russia be indexed to domestic coal prices in China. LNG pricing in Asian contracts traditionally has been linked to the price of oil, not coal, but China has been attempting to index LNG and pipeline natural gas imports to the price of domestic coal.

The three LNG projects most likely to be built after the Guangdong and Fujian projects are in Shanghai, Ningbao (Zhejian Province), and Qingdao (Shandong Province). Economic growth and industrial output in the two provinces are the highest in China, making it possible for their regional governments to purchase relatively expensive imported natural gas. Shanghai is both China's largest city and its largest port, and it is one of the most prosperous cities in China. The municipal government of Shanghai is planning to phase out use of coal in the city over the course of the next 10 years. At present, Shanghai consumes more than 46 million short tons of coal per year, providing 70 percent of its energy needs.[e] Shandong is rich in coal, but the provincial power companies still have coal production and deliverability problems, and there is a serious lack of available peaking capacity.[f]

Most of the areas in China targeted for LNG developments have large coal-fired power plants, and the government is carefully considering the issue of natural gas and coal prices charged to the power plants. In 2004, the cost of coal from northern China was around $1.92 per million Btu, and the average cost of natural

(continued on page 47)

China's Proposed LNG Imports, 2005-2015
(Million Metric Tons per Year)

Year	Haikou LNG (Hainan)	Shenzhen LNG (Guangdong)	Xiuyu LNG (Fujian)	Ningbao LNG (Zhejian)	Shanghai LNG	Rudong LNG (Jiangsu)	Qingdao LNG (Shandong)	Hebei/ Tianjin LNG	Dalian LNG (Liaoning)	Beihai LNG (Guangxi)
2005	—	—	—	—	—	—	—	—	—	—
2006	—	3.9	—	—	—	—	—	—	—	—
2008	—	3.9	2.6	—	—	—	3.0	—	—	—
2010	1.0	9.9	2.6	4.0	4.0	3.0	5.0	—	—	—
2012	2.0	12.9	2.6	4.0	4.0	3.0	5.0	2.0	3.0	—
2015	3.0	12.9	5.0	10.0	10.0	5.0	5.0	3.0	6.0	3.0

Sources: *International Gas Report*, No. 522 (April 22, 2005); K. Wu and F. Fesharaki, "Natural Gas Pipelines and LNG Terminals in China: An Update," *FACTS Gas Insights*, No. 46 (March 2005), web site www.factsinc.net; and FACTS Inc., *China Oil & Gas Monthly* (May 2005).

[a]Cambridge Energy Research Associates, "China Market Commentary, Spring 2005: After the Peak" (April 15, 2005), web site www.cera.com.

[b]World Market Research Centre, "China: Urban Centers in China To Face Power Crunch" (April 7, 2005), web site www.worldmarketsanalysis.com.

[c]Personal correspondence with Fatih Birol, Chief Economist, International Energy Agency (April 26, 2005), web site www.iea.org.

[d]K. Wu, L. Wang, and F. Fesharaki, "China's LNG Imports: Delayed Terminal Projects and a Less Bullish Demand Outlook," *FACTS Gas Insights*, No. 4 (January 2006), web site www.factsinc.net.

[e]C. Bergersen, "Country Profile: China Electric Power Overview" (February 16, 2005), web site www.platts.com/coal/resources.

[f]A.J. Minchener, "Coal in China" (July 2004), web site www.iea-coal.org.uk.

Liquefied Natural Gas: Market Developments in China (Continued)

gas from China's west-to-east pipeline was $4.22 per million Btu. On average, coal-fired electricity generation in China costs $34 per megawatthour and natural-gas-fired generation $44 per megawatthour.[g] Potential users of natural gas in the electric power sector estimate that prices for natural gas must be in the range of $3.30 to $3.60 per million Btu to compete economically with coal.[h] The expected price of natural gas from the Guangdong LNG terminal is $2.80 per million Btu, including freight, plus $0.40 per million Btu for regasification.[i]

All the Chinese provinces have some coal resources; however, those in the east and southeast, which account for one-half of China's total GDP, contain only 17 percent of its coal resources.[j] As a result, more than 60 percent of the coal produced in China is transported by rail over an average distance of about 340 miles, under a coal pricing scheme that used to be determined by the central government.[k] The Chinese government has gradually relaxed its pricing control on coal since 1992, and coal prices for power generation have become negotiable. Currently, coal prices are determined by a mix of negotiated contracts between state-run producers and large end users, and the price of coal imports. Domestic coal prices are typically $5 to $7 per short ton higher than the international market price of high-quality steam coal, which makes imports more attractive.[l]

Concerns about pollution from electricity generation in China have also led to higher coal prices, as the government has incorporated a number of environmental controls to limit pollution from power generation. In October 2003, the State Environmental Protection Administration (SEPA) raised the fee assessed to generators for sulfur dioxide emissions by a factor of ten and applied the same fee for the first time to nitrogen oxide emissions, in addition to banning the construction or expansion of coal-fired plants in many large cities.

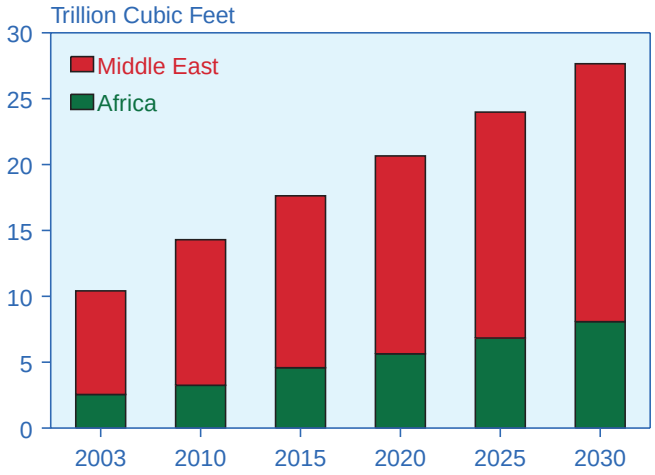
China's attempts to index its import contracts for LNG and pipeline natural gas to the price of domestically produced coal may or may not succeed. If they do, China will certainly be able to accommodate more imports of natural gas.

[g]D. Hurd, "Global LNG: Key Themes and Choices" (April 21, 2005), web site www.db.com.
[h]K. Wu and F. Fesharaki, "Natural Gas Pipelines and LNG Terminals in China: An Update," *FACTS Gas Insights*, No. 46 (March 2005), web site www.factsinc.net.
[i]*Petroleum Intelligence Weekly*, No. 5 (July 2004), web site www.EnergyIntel.com.
[j]FACTS Inc., Gas Databook I (Honolulu, HI, 2005).
[k]China National Bureau of Statistics.
[l]A.J. Minchener, "Coal in China" (July 2004), web site www.iea-coal.org.uk.

Natural gas use in the Middle East more than doubles between 2003 and 2030 (Figure 46). Oil-exporting countries in the region have deliberately sought to expand domestic natural gas use in order to make more oil available for export. In addition, natural-gas-rich countries in the region are developing projects to monetize their natural gas resources, in particular through LNG and, more recently, gas-to-liquids (GTL) projects, which have become an active area of interest (see box on page 48). As a result, the importance of natural gas as a source of supply for domestic energy demand in the Middle East grows over the projection period, with its share of regional energy use increasing from 42 percent in 2003 to 54 percent in 2030 while the oil share declines from 55 percent to 42 percent over the same period.

In Africa, natural gas consumption increases by an average of 4.4 percent per year over the projection period, making it the most rapidly growing primary energy source in the region. In comparison, Africa's oil demand increases by only 2.3 percent per year and its coal

Figure 46. Natural Gas Consumption in Africa and the Middle East, 2003-2030



Sources: **2003:** 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).

demand by only 1.7 percent per year. The incremental growth in Africa's natural gas demand occurs mostly in the industrial and electric power sectors. Despite continuing instability in some countries of the region, the investment climate in Africa remains fairly attractive, with massive investments planned, mostly in West Africa.

In Central and South America, natural gas is the fastest growing fuel source, with demand increasing on average by 3.9 percent per year, from 3.8 trillion cubic feet in 2003 to 10.8 trillion cubic feet in 2030 (Figure 47). By 2010, natural gas overtakes 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 projection period.

South America's southern cone area is already criss-crossed by pipelines linking Bolivia, Brazil, Argentina, Chile, and Uruguay. In addition, a number of new pipelines are under discussion, which would link Peru with Ecuador and Chile, Venezuela with Colombia and Brazil, and Colombia with Panama [5]. The new lines could later be linked with each other and with existing pipelines to create a South American natural gas grid—an idea that is being promoted by Venezuela. Even some of the more modest proposed pipelines, however, face substantial political hurdles.

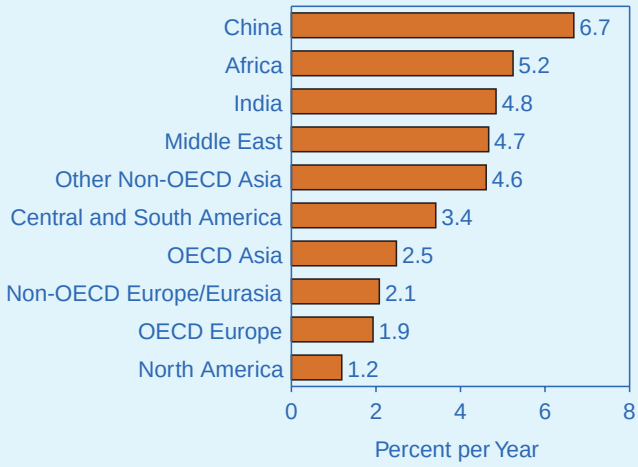
Current Developments in Gas-to-Liquids

The relatively high world oil prices of the past several years have made gas-to-liquids (GTL) a more attractive option for monetizing stranded natural gas reserves. Currently, only South Africa and Malaysia have commercial GTL operations; but new projects have been proposed for Algeria, Australia, Egypt, Iran, Nigeria, and Qatar. Proposed plant sizes range from 20 to 160 thousand barrels per day of liquids output. In addition, Russia has significant potential for GTL production because of its plentiful and often remote natural gas reserves.

Natural gas use as a feedstock for GTL operations is reflected in the *IEO2006* projections for industrial natural gas consumption. In regions where natural gas markets are less developed, GTL may represent a significant share of industrial or even total natural gas use. For example, in 2003, natural gas for the Bintulu GTL plant in Malaysia, with an original design capacity of only 12.5 thousand barrels per day, accounted for almost 2 percent of industrial sector natural gas use and 1 percent of total natural gas consumption in non-OECD Asia excluding China and India ("Other Non-OECD Asia"). In Africa, natural gas use for GTL operations in 2003 represented some 6 percent of industrial and 3 percent of total natural gas consumption.

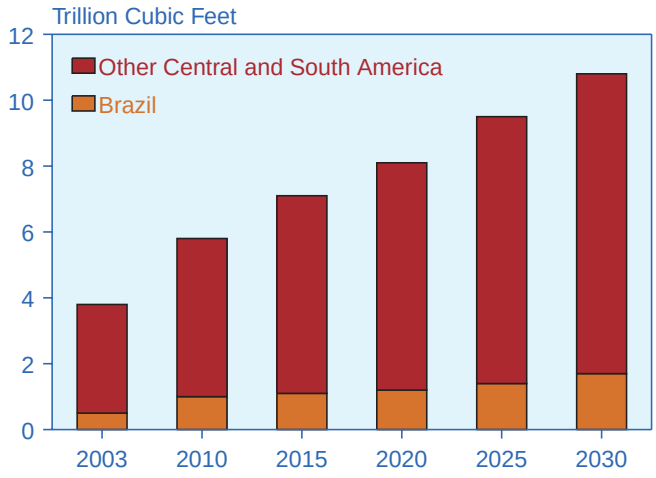
In *IEO2006*, significant quantities of GTL production by 2030 are projected only for Russia, Africa, the Middle East, and Other Non-OECD Asia. For all but Russia, which already consumes large amounts of natural gas in its industrial sector, natural gas use for GTL has potentially significant effects on industrial and total natural gas consumption. The addition of a single 140 thousand barrel per day GTL plant, consuming 0.5 trillion cubic feet of natural gas per year, would represent an increase in total natural gas consumption over 2003 levels: 3 percent in Russia, 6 percent in the Middle East, 9 percent in non-OECD Asia, and 18 percent in Africa. In all but Russia, projected GTL operations in large part drive industrial sector natural gas demand in the reference case. The projected growth rates for industrial natural gas use in the Middle East, non-OECD Asia, and Africa are among the highest in *IEO2006* (see figure below).

Average Annual Increases in Industrial Natural Gas Consumption, 2003-2030, by Region and Country



Sources: **2003:** Energy Information Administration (EIA), *International Energy Annual 2003*, DOE/EIA-0219(2003) (Washington, DC, July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, System for the Analysis of Global Energy Markets (2006).

Figure 47. Natural Gas Consumption in Brazil and Other Central and South America, 2003-2030



Sources: **2003:** 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).

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2. *BP Statistical Review of World Energy 2005* (London, UK, June 2005), p. 20.
3. "Gazprom, Gaz de France Swap Pipeline Gas for LNG Cargo," *LNG Express*, Vol. 15, No. 23 (December 1, 2005), p. 13.
4. FACTS Inc., "China's LNG Imports: Delayed Terminal Projects and a Less Bullish Demand Outlook," *China Energy Series: Gas Edition*, No. 4 (January 2006), pp. 1, 4; and "India Struggles with LNG Imports; Hazira, Ratnagiri Seek New Supplies," *LNG Express*, Vol. 16, No. 4 (February 15, 2006), pp. 3-4.
5. "Northern South America Takes First Step Towards Gas Pipeline Integration," *Platt's International Gas Report*, No. 535 (November 4, 2005), p. 17.

Chapter 5
World Coal Markets

In the IEO2006 reference case, world coal consumption nearly doubles from 2003 to 2030, with the non-OECD countries accounting for 81 percent of the increase. Coal's share of total world energy consumption increases from 24 percent in 2003 to 27 percent in 2030.

In the *IEO2006* reference case, world coal consumption nearly doubles, from 5.4 billion short tons[7] in 2003 to 10.6 billion tons in 2030 (Figure 48). Coal consumption increases by 3.0 percent per year on average from 2003 to 2015, then slows to an average annual increase of 2.0 percent annually from 2015 to 2030. World GDP and primary energy consumption also grow more rapidly in the first half than in the second half of the projections, reflecting a gradual slowdown of economic growth in non-OECD Asia. Regionally, increased use of coal in non-OECD countries accounts for 81 percent of the growth in world coal consumption projected over the entire *IEO2006* projection horizon.

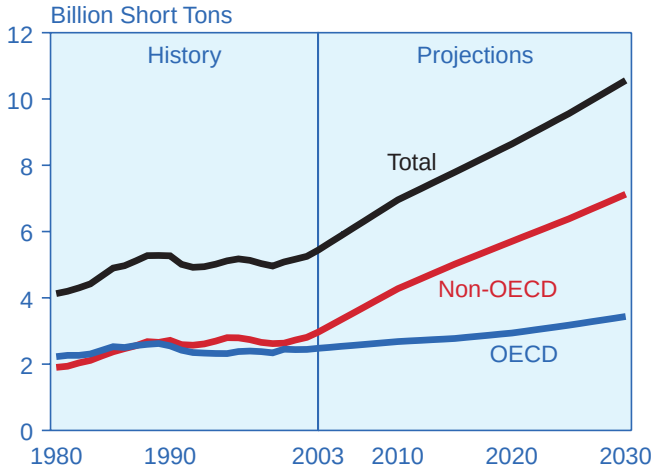
In 2003, coal accounted for 24 percent of total world energy consumption (Figure 49). Of the coal produced worldwide in 2003, 67 percent was shipped to electricity producers, 30 percent to industrial consumers, and most of the remaining 3 percent to coal consumers in the residential and commercial sectors. Coal's share of total world energy consumption increases to 27 percent in 2030, and in the electric power sector its share in 2030 remains at 41 percent, the same as in 2003.

International coal trade increases in the reference case from 764 million tons in 2004 to 1,122 million tons in 2030. Because the largest increase in coal consumption is projected for coal that is both produced and consumed domestically in China, the share of total world coal consumption accounted for by internationally traded coal falls from 13 percent in 2003 to 11 percent in 2030.

Reserves

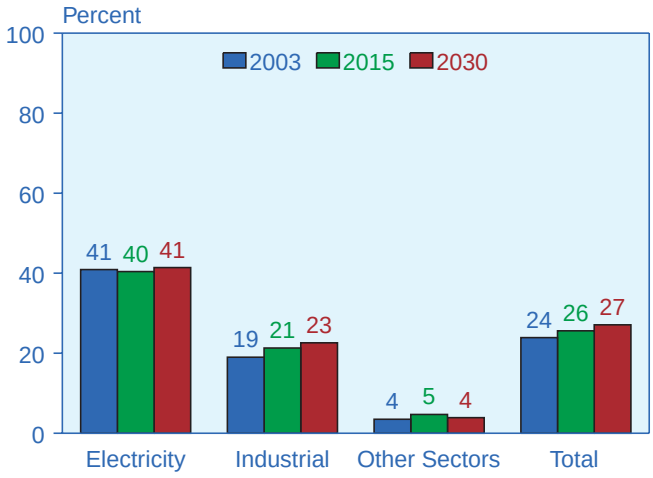
Total recoverable reserves of coal[8] around the world are estimated at 1,001 billion tons—enough to last approximately 180 years[9] at current consumption levels (Table 10). Historically, estimates of world recoverable coal reserves, although relatively stable, have declined gradually from 1,174 billion tons at the beginning of 1990 to 1,083 billion tons in 2000 and 1,001 billion tons in 2003

Figure 48. World Coal Consumption by Region, 1980-2030



Sources: **History:** 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).

Figure 49. Coal Share of World Energy Consumption by Sector, 2003, 2015, and 2030



Sources: **2003:** Derived from Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **2015 and 2030:** EIA, System for the Analysis of Global Energy Markets (2006).

[7]Throughout this chapter, tons refer to short tons (2,000 pounds).

[8]Recoverable reserves are those quantities of coal which geological and engineering information indicates with reasonable certainty can be extracted in the future under existing economic and operating conditions.

[9]Based on the *IEO2006* reference case forecast for coal consumption, and assuming that world coal consumption would continue to increase at a rate of 2.0 percent per year after 2030, current estimated recoverable world coal reserves would last for about 70 years.

[*1*]. The most recent assessment of world coal reserves includes a substantial downward adjustment for Germany, from 73 billion tons of recoverable coal reserves to 7 billion tons. The reassessment primarily reflects more restrictive criteria for the depth and thickness parameters associated with both underground and surface minable seams of coal [*2*].

Although coal deposits are widely distributed, 67 percent of the world's recoverable reserves are located in four countries: the United States (27 percent), Russia (17 percent), China (13 percent), and India (10 percent). In 2003, these four countries, taken together, accounted for 63 percent of total world coal production [*3*]. By rank, anthracite and bituminous coal account for 53 percent of the world's estimated recoverable coal reserves (on a tonnage basis), subbituminous coal accounts for 30 percent, and lignite accounts for 17 percent.

Quality and geological characteristics of coal deposits are important parameters for coal reserves. Coal is a heterogeneous source of energy, with quality (e.g., characteristics such as heat, sulfur, and ash content) varying significantly by region and even within individual coal seams. At the top end of the quality spectrum are premium-grade bituminous coals, or coking coal, used to manufacture coke for the steelmaking process. Coking coals produced in the United States have an estimated heat content of 27.4 million Btu per ton and relatively low sulfur content of approximately 0.8 percent by weight [*4*]. At the other end of the spectrum are reserves of low-Btu lignite. On a Btu basis, lignite reserves show considerable variation. Estimates published by the International Energy Agency for 2003 indicate that the average heat content of lignite in major producing countries varies from a low of 4.3 million Btu per ton in Greece to a high of 12.3 million Btu per ton in Canada [*5*].

Regional Demand Forecasts

OECD Countries

Coal consumption in the OECD countries rises at a relatively even pace in the reference case, from 2.5 billion tons in 2003 to 2.8 billion tons in 2015 and 3.4 billion tons in 2030 (Figure 50). The increases represent average growth of 1.2 percent per year over the entire period and a slightly higher rate of 1.4 percent per year from 2015 to 2030.

Much of the 0.9-billion-ton increase in coal consumption projected for the OECD countries from 2003 to 2030 is the result of expected strong growth in U.S. coal demand. With the exception of OECD Europe and Japan, where coal consumption is expected to be essentially constant, moderate increases in coal consumption are projected for the OECD countries, including South Korea, Canada, Australia/New Zealand, and Mexico. In OECD Europe, natural gas captures an increasing share of the region's total energy mix, displacing oil and, to a lesser extent, coal and nuclear energy. In Japan, slow

Table 10. World Recoverable Coal Reserves
(Billion Short Tons)

Region/Country	Bituminous and Anthracite	Subbituminous	Lignite	Total
World Total	**530.4**	**297.0**	**173.4**	**1,000.9**
United States	125.4	109.3	36.0	270.7
Russia	54.1	107.4	11.5	173.1
China	68.6	37.1	20.5	126.2
India	99.3	0.0	2.6	101.9
Other Non-OECD Europe and Eurasia	50.1	18.7	31.3	100.1
Australia and New Zealand	42.6	2.7	41.9	87.2
Africa	55.3	0.2	*	55.5
OECD Europe	19.5	5.0	18.8	43.3
Other Non-OECD Asia	1.4	2.0	8.1	11.5
Brazil	0.0	11.1	0.0	11.1
Other Central and South America	8.5	2.2	0.1	10.8
Canada	3.8	1.0	2.5	7.3
Other[a]	1.8	0.4	0.1	2.3

[a]Includes Mexico, Middle East, Japan, and South Korea.
*Less than 0.05 billion short tons.
Note: Data for the United States represent recoverable coal estimates as of January 1, 2004. Data for other countries are as of January 1, 2003.
Sources: **United States:** Energy Information Administration, unpublished data from the Coal Reserves Database (August 2004). **All Other Countries:** World Energy Council, *2004 Survey of Energy Resources*, Eds. J. Trinnaman and A. Clarke (London, UK: Elsevier, December 2004).

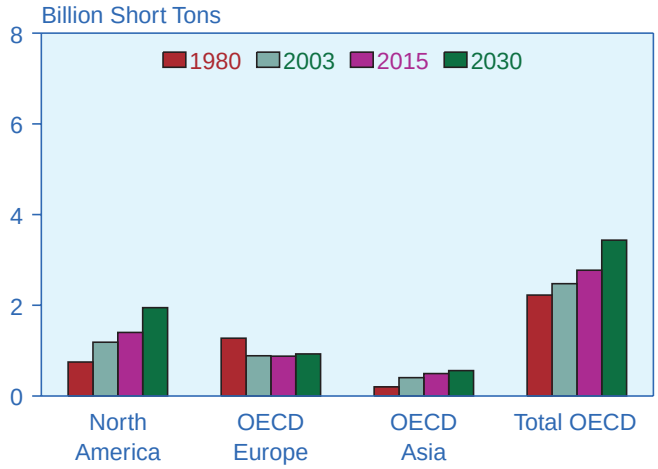
economic growth results in sluggish growth in overall energy demand in the *IEO2006* projections, keeping projected quantities of coal consumption near the 2003 level.

North America

In 2003, the United States consumed 1.1 billion tons of coal, accounting for 92 percent of total coal consumption in North America and 44 percent of the OECD total. U.S. coal consumption rises to 1.8 billion tons in 2030 in the reference case. The United States has substantial coal reserves and has come to rely heavily on coal for electricity generation, a trend that continues in the projections. Coal's share of total electricity generation in the United States (including electricity produced at combined heat and power plants in the industrial and commercial sectors) declines slightly, from 51 percent in 2003 to 48 percent in 2015, then rises to 57 percent in 2030.

Much of the projected growth in U.S. coal consumption occurs after 2015. Between 2005 and 2015, natural gas prices decline and remain competitive with coal prices for electricity generation. Although some new natural-gas-fired capacity comes on line during the period, much of the growth in electricity generation from natural gas is based on increasing utilization of the nearly 200 gigawatts of new natural-gas-fired capacity that was completed from 1999 through 2004. After 2015, rising natural gas prices gradually tilt economic decisions toward new coal-fired power plants. From 2015 to 2030, 155 gigawatts of new coal-fired capacity is built, representing 89 percent of the total coal builds from 2003 to 2030.

Figure 50. OECD Coal Consumption by Region, 1980, 2003, 2015, and 2030



Sources: **1980 and 2003:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **2015 and 2030:** EIA, System for the Analysis of Global Energy Markets (2006).

In Canada, coal consumption increases from 69 million tons in 2003 to 123 million tons in 2030. In the near term, Canada's coal consumption remains relatively flat as the Ontario government moves ahead with plans to shut down all of the Province's 7.6 gigawatts of coal-fired generating capacity by early 2009 [*6*]. The government has indicated, however, that the shutdown will not be completed until generation from alternative sources can be secured. The decision to close the plants was based primarily on the premise that the adverse health and environmental impacts of the plants' operation are unacceptable. In western Canada, where most of the country's coal resources are located, increasing demand for electricity is expected to result in the need for additional coal-fired generating capacity.

OECD Europe

Coal consumption in OECD Europe increases by only 40 million tons (5 percent) in the *IEO2006* reference case; however, the region is and will continue to be a major market for coal. Coal consumption in OECD Europe, at 887 million tons in 2003, represented 36 percent of total OECD coal use. The major coal-consuming countries of the region, all with consumption of 65 million tons or more in 2003, include Germany, Poland, Greece, Turkey, the United Kingdom, and the Czech Republic. Although OECD Europe relies heavily on imports of hard coal,[10] low-Btu lignite represents an important domestically produced source of energy. In 2003, lignite accounted for 47 percent of the region's total coal consumption on a tonnage basis and 23 percent on a Btu basis [*7*].

The stable outlook for coal consumption in OECD Europe represents a departure from the decline of 32 percent that occurred between 1990 and 2003. In addition to some planned and recently completed coal-fired capacity additions in Turkey and Greece, renewed interest in coal is evidenced in a number of other countries in the region, related to the replacement or refurbishment of existing capacity. Electricity producers in Germany, Spain, France, Italy, Poland, the Czech Republic, and Slovakia have announced plans to upgrade or replace existing coal-fired generating facilities over the next two decades. Power producers in Germany recently announced plans to build 11.5 gigawatts of new coal-fired generating capacity by 2011, primarily as a replacement for existing plants [*8*]. A key incentive for the new coal builds in Germany is a provision guaranteeing carbon dioxide emission rights for the new capacity during its first 14 years of operation.

Among the most important factors keeping OECD Europe's coal consumption from increasing more rapidly in the projections is the region's relatively slow growth in overall energy consumption (0.7 percent per

[10]Internationally, the term "hard coal" is used to describe anthracite and bituminous coal. In data published by the International Energy Agency, coal of subbituminous rank is classified as hard coal for some countries and as brown coal (with lignite) for others.

year). Contributing factors include continued penetration of natural gas in both the electricity and industrial sectors, growing use of renewable fuels in the region, and continuing pressure on member countries of the European Union to reduce subsidies that support domestic production of hard coal.

In 2003, the countries of OECD Asia (Australia, New Zealand, Japan, and South Korea) consumed 404 million tons of coal, representing 16 percent of total OECD coal consumption. In addition to being an important coal-consuming region, OECD Asia also plays an important role in the area of international coal trade. In 2003, Australia was the world's leading coal exporter, supplying 238 million tons of coal to the international market, while Japan and South Korea were the world's leading importers, receiving 181 and 77 million tons of coal, respectively, from other countries [***9***].

In the *IEO2006* reference case, coal consumption in OECD Asia increases by 156 million tons, to 560 million tons in 2030. With little change projected for Japan's coal consumption, South Korea and Australia/New Zealand account for virtually all of the increase in the region.

Coal consumption in Australia and New Zealand increases by an average of 1.4 percent per year, from 147 million tons in 2003 to 216 million tons in 2030. With substantial coal reserves, Australia/New Zealand continues to rely heavily on coal for electricity generation. Coal-fired power plants in the two countries supplied 73 percent of their total electricity generation in 2003, and they continue to supply more than 70 percent of generation through 2030.

Electricity generation also drives the 94-million-ton expansion in total coal consumption projected for South Korea between 2003 and 2030. South Korea's generating companies plan to add more than 8.0 gigawatts of coal-fired capacity from 2004 through 2010 [***10***], including two 800-megawatt units that came on line at Korea South-East Power Company's Yonghung plant in 2004.

Non-OECD Countries

Coal consumption in non-OECD countries increases by 140 percent in the *IEO2006* reference case, from 3.0 billion tons in 2003 to 7.1 billion tons in 2030, led by strong economic growth and rising demand for energy in China and India (Figure 51). The increase of 4.2 billion tons represents 81 percent of the projected increase in total world coal consumption. In the non-OECD countries, coal's share of total energy consumption increases slightly, from 29 percent in 2003 to 32 percent in 2030.

Coal consumption in non-OECD countries grows at an average annual rate of 4.5 percent from 2003 to 2015, then slows to 2.4 percent per year from 2015 to 2030. A gradual slowing of economic growth in non-OECD Asia, which currently is expanding at a rapid pace, underlies the declining growth rate for non-OECD coal consumption.

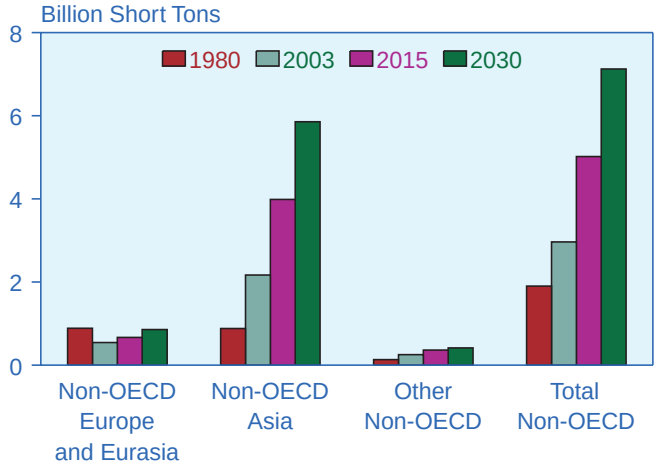
Tremendous growth in coal use is projected for China and India. In total, the two countries' coal consumption increases by 3.6 billion tons (3.9 percent per year) from 2003 to 2030, representing 86 percent of the increase for the non-OECD region. Coal consumption in the other non-OECD countries grows by an average of 1.7 percent per year, expanding by 0.6 billion tons from 2003 to 2030.

Non-OECD Asia

China and India are very large countries in terms of both population and land mass, and both have substantial quantities of remaining coal reserves. Together, they account for 70 percent of the projected increase in world coal consumption. Strong economic growth (averaging 6.0 percent per year in China and 5.4 percent per year in India from 2003 to 2030) is projected for both countries, and much of the increase in their demand for energy, particularly in the industrial and electricity sectors, is expected to be met by coal.

Coal use in China's electricity sector increases from 16.3 quadrillion Btu in 2003 to 50.1 quadrillion Btu in 2030, at an average rate of 4.2 percent per year (Figure 52). In comparison, coal consumption in the U.S. power sector grows by 1.6 percent annually, from 20.2 quadrillion Btu in 2003 to 30.7 quadrillion Btu in 2030. At the end of 2003, China had an estimated 239 gigawatts of coal-fired

Figure 51. Non-OECD Coal Consumption by Region, 1980, 2003, 2015, and 2030



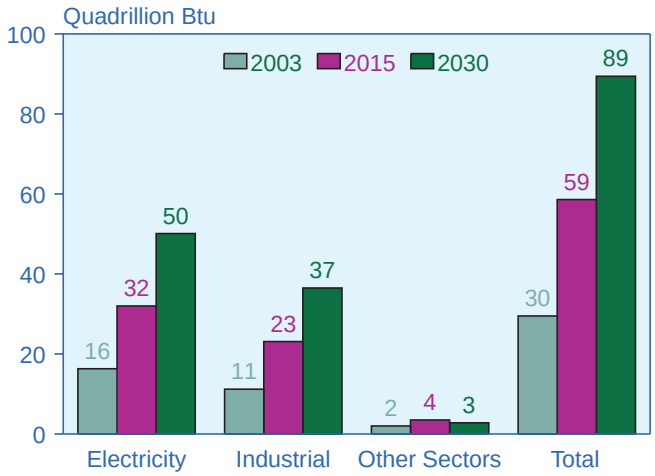
Sources: **1980 and 2003:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **2015 and 2030:** EIA, System for the Analysis of Global Energy Markets (2006).

capacity in operation. To meet the demand for electricity that is expected to accompany its rapid economic growth, an additional 546 gigawatts of coal-fired capacity (net of retirements) is projected to be brought on line in China by 2030, requiring large financial investments in new coal-fired power plants and associated transmission and distribution systems.

Nearly one-half (45 percent) of China's coal use in 2003 was in the non-electricity sectors, primarily in the industrial sector. China was the world's leading producer of both steel and pig iron in 2003 [***11***]. Over the projection period, coal demand in China's non-electricity sectors is expected nearly to triple, increasing by 26.1 quadrillion Btu. Despite such substantial growth, however, the non-electricity share of total coal demand remains close to the 2003 level. Coal remains the primary source of energy in China's industrial sector, primarily because the country has only limited reserves of oil and natural gas.

With a substantial portion of the increase in China's demand for both oil and natural gas projected to be met by imports, the Chinese government is actively promoting the development of a large coal-to-liquids industry. Initial production of coal-based synthetic liquids in China is scheduled to commence in mid-2007 with the completion of the country's first coal-to-liquids plant [***12***], located in the Inner Mongolia Autonomous Region. It is being built by the Shenhua Coal Liquefaction Corporation and will have an initial capacity of approximately 60,000 barrels per day. In another development, China's Shenhua and Ningxia Coal Groups have initiated a feasibility study regarding the construction of two 80,000 barrel per day plants to be sited in the Ningxia Autonomous Region and the Shaanxi Province.

Figure 52. Coal Consumption in China by Sector, 2003, 2015, and 2030



Sources: **2003:** Derived from Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **2015 and 2030:** EIA, System for the Analysis of Global Energy Markets (2006).

In India, almost 70 percent of the growth in coal consumption is expected to be in the electric power sector and most of the remainder in the industrial sector. In 2003, India's coal-fired power plants consumed 5.0 quadrillion Btu of coal, representing 69 percent of the country's total coal demand. Coal use for electricity generation in India is projected to grow by 2.7 percent per year, to 10.3 quadrillion Btu in 2030, as an additional 94 gigawatts of coal-fired capacity (net of retirements) is brought on line. As a result, India's coal-fired generating capacity more than doubles in the *IEO2006* projections, from 67 gigawatts in 2003 to 161 gigawatts in 2030. Currently, India's government indicates that 16.5 gigawatts of new coal-fired generating capacity will be completed during its tenth power plan period (a 5-year period ending in March 2007) and is targeting the completion of more than 50 gigawatts of new coal-fired capacity during its eleventh plan period (ending in March 2012) [***13***].

Like China, India relies heavily on imported oil to meet demand. In 2003, approximately 65 percent of India's total oil supply originated from foreign producers. Currently there are no coal-to-liquids projects under construction in India; however, a domestic coal-to-liquids industry would represent a viable means of increasing domestic oil supply. The country's Indian Oil Corporation is evaluating construction of an 80,000-barrel-per-day coal liquefaction facility, which would be based on the coal-to-liquids technology developed by the South African company Sasol and would use both domestic and imported coal as feedstock [***14***]. Elsewhere in non-OECD Asia, Indonesia also is investigating the startup of a coal-to-liquids industry, primarily as a strategy to offset declines in its petroleum production [***15***].

In other non-OECD Asia, coal consumption is projected to grow by an average of 1.7 percent per year, from 206 million tons in 2003 to 323 million tons in 2030, with increases in both the industrial and electric power sectors. In the electric power sector, significant growth in coal consumption is expected in Taiwan, Vietnam, Indonesia, and Malaysia, where considerable amounts of new coal-fired generating capacity are either planned or under construction.

Non-OECD Europe and Eurasia

Coal consumption in non-OECD Europe and Eurasia is projected to increase at an average rate of 1.7 percent per year, from 543 million tons in 2003 to 856 million tons in 2030. The region contains a substantial amount of coal reserves. Russia alone has an estimated 173 billion tons

of recoverable coal reserves (17 percent of the world total), and the other countries in the region have an additional 100 billion tons (10 percent of the world total).

Russia is the number one coal-consuming country in the region. Its 2003 coal consumption, at 251 million tons, corresponded to 46 percent of total coal consumption in non-OECD Europe and Eurasia. In 2030, Russia's coal use is projected to total 382 million tons.

In 2003, coal supplied 16 percent of Russia's total energy requirements, and coal-fired power plants provided 20 percent of its electricity. Although coal's share of the country's total energy consumption remains at about 16 percent in the *IEO2006* projections, its share of total electricity generation declines to 10 percent in 2030. In most cases, natural gas is expected to be the most economical option for new generating capacity in Russia. As a result, the natural gas share of Russia's total electricity generation rises from 40 percent in 2003 to 54 percent in 2030.

Although Russia's long-term energy strategy calls for considerable new nuclear generating capacity, the government maintains that fossil-fuel-fired plants will continue in their role as the primary source for electric power generation through 2020 [***16***]. For new fossil-fired generating capacity, Russia's energy strategy promotes the construction of advanced coal-fired capacity in the coal-rich Siberian region (central Russia) and recommends a focus on efficient natural-gas-fired capacity for the western and far eastern areas of the country.

In other non-OECD Europe and Eurasia, coal consumption is projected to increase from 292 million tons in 2003 to 474 million tons by 2030, growing by 1.8 percent per year on average. Plans for both new coal-fired capacity and the refurbishment of existing capacity in a number of countries, including Bosnia and Herzegovina, Serbia and Montenegro, Bulgaria, Romania, and Ukraine, is a significant indicator that coal will continue to be an important source of energy for the region [***17***].

Africa

Africa's coal consumption is projected to increase by 117 million tons from 2003 to 2030. South Africa currently accounts for 93 percent of the coal consumed in the continent and is expected to continue to account for much of the increase in Africa's total coal consumption over the projection period in both the electricity and industrial sectors.

In South Africa, increasing demand for electricity in recent years has led to the decision by Eskom, the country's state-owned electricity supplier, to restart three large coal-fired plants (Camden, Grootvlei, and Komati) that have been closed for more than a decade [***18***]. The individual units at the plants, with a combined generating capacity of 3.8 gigawatts, are scheduled to return to service during the years 2005 through 2011. Projections of power shortages for southern Africa in the latter half of this decade have led to increased interest in new coal-fired power projects not only in South Africa but also in Zimbabwe, Tanzania, Swaziland, and Botswana [***19***].

In the industrial sector, increasing use of coal in Africa is expected for several purposes, including the production of steam and process heat for industrial applications, production of coke for the steel industry, and production of coal-based synthetic liquids. Currently, two commercial-sized coal-to-liquids plants (Sasol II and Sasol III) in South Africa supply about 28 percent of the country's total liquid fuel requirements [***20***]. The two plants together are capable of producing 150,000 barrels of synthetic liquids per day.

Central and South America

The countries of Central and South America consumed 35 million tons of coal in 2003. Brazil, with the world's ninth largest steel industry in 2003, accounted for 68 percent of the region's coal demand, and much of the remainder occurred in Colombia, Chile, Puerto Rico, Peru, and Argentina [***21***].

In the projections, coal consumption in Central and South America increases by 39 million tons from 2003 to 2030, with 56 percent of the increase in Brazil, primarily for coke manufacture and electricity generation. Brazil's steel companies currently plan to expand production capacity by a substantial amount over the next few years to meet increasing domestic and international demand for steel [***22***]. Brazil's three southernmost states, Rio Grande do Sul, Santa Catarina, and Parana, which contain most of the country's coal reserves, are actively promoting the construction of several new coal-fired power plants [***23***]. The new coal projects being promoted by the government of Rio Grande do Sul represent a key component of its plan to become more self-sufficient in electricity supply.

Middle East

Countries of the Middle East consumed 16 million tons of coal in 2003. Israel accounted for 87 percent of the total and Iran most of the remainder. The region's coal consumption increases only slightly in the projections, to 19 million tons in 2030.

Trade

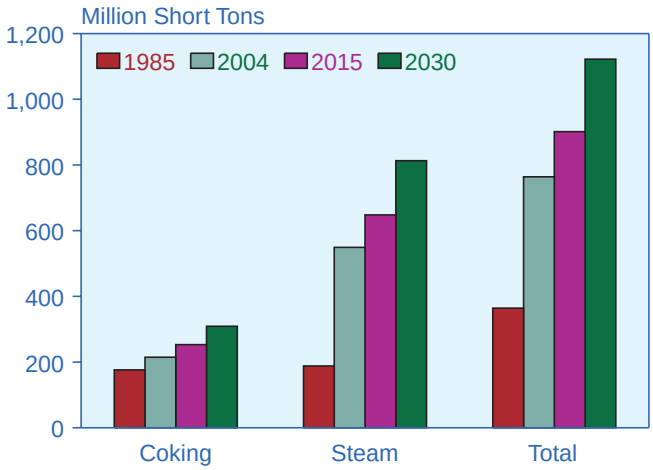
Most of the countries that consume significant amounts of coal have their own domestic coal resources. For that reason, the volume of world coal trade tends to be small relative to worldwide coal consumption. In 2003, only 13

percent of the coal consumed around the world was imported. In the *IEO2006* reference case, coal trade grows at an average rate of 1.5 percent per year, from 764 million tons in 2004 to 1,122 million tons in 2030 (Figure 53 and Table 11), and its share of total world coal consumption falls to 11 percent in 2030.

Although both steam coal and metallurgical (coking) coal are traded internationally, steam coal—used primarily for electricity generation but also for other industrial applications, including for direct heat and for pulverized coal injection in the steel industry—predominates, accounting for 72 percent of international coal trade in 2030. The largest increase in steam coal imports is projected for South Korea, where economic expansion and population growth are expected to stimulate an expansion of coal-fired electricity generation. The largest increase in imports of coking coal is projected for China, from 7 million tons in 2004 to 59 million tons in 2030.

Countries that import coal do so for a variety of reasons. For countries like Malaysia, which has a national fuel diversity goal, coal imports may be an important part of a secure energy supply strategy. Others, such as Japan, South Korea, and the countries of OECD Europe, may lack, or may have depleted, their own resources. Still others, like China and India, may require coal imports to supplement their own domestic supplies. Coal quality may also be a factor. For example, Indonesia's low-sulfur coal is in demand by electricity generators required to comply with environmental regulations in the United States. Coal-exporting countries typically have large reserves of high-quality coal and production capacity exceeding their own domestic demand requirements.

Figure 53. World Coal Trade, 1985, 2004, 2015, and 2030



Sources: **1985:** Energy Information Administration (EIA), *Annual Prospects for World Coal Trade 1987*, DOE/EIA-0363(87) (Washington, DC, May 1987). **2004:** SSY Consultancy and Research, Ltd., *SSY's Coal Trade Forecast*, Vol. 14, No. 3 (London, UK, September 2005); and Energy Information Administration, *Quarterly Coal Report*, October-December 2004, DOE/EIA-0121(2004/4Q) (Washington, DC, March 2005). **2015 and 2030:** Energy Information Administration, National Energy Modeling System, run IEO2006.D041306A.

The six largest exporters of coal in 2004 were Australia, Indonesia, China, South Africa, Colombia, and the United States. Australia has large reserves of high-quality coal that is suitable for both electricity generation and industrial applications. In the projections, Australia remains the world's foremost coal exporter through 2030, while Indonesia holds a distant second place. Australia and Indonesia both benefit from their highly productive mines and proximity to Asian markets. China continues to export some coal even as its imports increase to meet domestic demand. Colombia, a relative newcomer to maritime coal trade, is the third largest exporter of coal in 2030, and Vietnam increases its share of world coal trade to 5 percent in 2030.

In anticipation of future coal trade volumes, exporting countries are investing in their port, coal mining, and coal transportation infrastructures. Australia has plans to expand the total export capacity of its coal terminals at Abbot Point, Dalrymple Bay, Hay Point, R G Tanna, Barney Point, and Fisherman Islands by about 55 million tons by 2010. In addition, a feasibility study in Australia is underway for a terminal at Wiggins Island in Queensland, with a throughput capacity of 22 million tons. Australia also plans to expand rail transportation capacity in Queensland to 281 million tons [***24***]. Richards Bay Coal Terminal in South Africa aspires to reach 101 million tons of throughput capacity by 2008 [***25***]. Venezuela has cumulative coal export capacity expansion plans of 24 million tons by 2009 [***26***], and additional port expansions are also planned in Vietnam [***27***].

Asia

Primarily as a result of China's growing demand for coal, the largest increases in imports of both steam and metallurgical coal are projected for Asia. Currently a net exporter of coal, China is expected to import 22 million tons more than it exports in 2030. Lacking coal resources of its own, Japan is expected to remain the world's largest importer of coal in 2030, despite a decline of 10 million tons from its import total in 2004. South Korea produces a small amount of coal domestically, but in 2030 it still will import most of the coal it consumes. South Korea and Taiwan, with planned increases in coal-fired capacity, together are projected to increase their share of world steam coal imports from 22 percent in 2004 to 27 percent in 2030. In India, coal imports are expected to double from 2004 to 2030.

Australia remains the largest provider of steam coal exports to Asia in the projections. In addition, Vietnam,

Table 11. World Coal Flows by Importing and Exporting Regions, Reference Case, 2004, 2015, and 2030
(Million Short Tons)

Exporters	Importers											
	Steam				Coking				Total			
	Europe[a]	Asia	Americas	Total[b]	Europe[a]	Asia[c]	Americas	Total[b]	Europe[a]	Asia	Americas	Total[b]
2004												
Australia	6.3	109.8	3.3	**119.4**	30.6	88.5	9.1	**128.2**	36.9	198.3	12.4	**247.6**
United States	3.6	2.3	16.1	**22.0**	13.4	5.2	7.4	**26.0**	17.0	7.4	23.6	**48.0**
South Africa	68.6	2.4	0.7	**73.7**	0.8	0.0	0.4	**1.2**	69.3	2.4	1.1	**74.9**
Former Soviet Union	36.0	11.7	0.2	**47.9**	2.1	5.6	0.0	**7.8**	38.1	17.3	0.2	**55.7**
Poland	15.1	0.0	0.1	**15.2**	1.0	0.1	0.0	**1.1**	16.0	0.1	0.2	**16.3**
Canada	0.0	0.6	1.6	**2.2**	9.2	12.8	4.4	**26.6**	9.2	13.3	6.1	**28.8**
China	4.2	84.2	0.8	**89.2**	0.0	6.3	0.0	**6.3**	4.2	90.4	0.8	**95.5**
South America[d]	37.0	0.0	28.5	**65.9**	0.0	0.0	0.0	**0.0**	37.0	0.0	28.5	**65.9**
Vietnam	0.3	9.9	0.0	**10.3**	0.0	0.0	0.0	**0.0**	0.3	9.9	0.0	**10.3**
Indonesia/Other[e]	17.6	81.7	3.4	**103.5**	0.2	17.3	0.1	**17.6**	17.8	99.0	3.5	**121.2**
Total	**188.8**	**302.5**	**54.8**	**549.2**	**57.3**	**135.7**	**21.5**	**214.8**	**246.0**	**438.3**	**76.3**	**764.0**
2015												
Australia	5.0	112.0	0.0	**116.9**	30.3	124.1	10.9	**165.4**	35.3	236.1	10.9	**282.3**
United States	4.9	1.4	5.4	**11.7**	0.2	0.0	14.2	**14.4**	5.1	1.4	19.6	**26.1**
South Africa	62.8	19.8	6.3	**88.9**	0.9	0.0	0.7	**1.7**	63.8	19.8	7.0	**90.5**
Former Soviet Union	44.0	23.7	0.0	**67.7**	3.2	9.4	0.0	**12.5**	47.2	33.0	0.0	**80.2**
Poland	6.6	0.0	0.1	**6.7**	1.1	0.0	0.0	**1.1**	7.7	0.0	0.1	**7.8**
Canada	0.0	0.0	3.3	**3.3**	18.9	15.6	1.3	**35.8**	18.9	15.6	4.6	**39.1**
China	0.0	89.4	1.0	**90.4**	0.0	6.9	0.0	**6.9**	0.0	96.3	1.0	**97.3**
South America[d]	59.6	0.0	43.4	**103.0**	0.0	0.0	0.0	**0.0**	59.6	0.0	43.4	**103.0**
Vietnam	0.0	30.9	0.0	**30.9**	0.0	0.0	0.0	**0.0**	0.0	30.9	0.0	**30.9**
Indonesia/Other[e]	3.6	123.1	2.1	**128.7**	0.5	15.0	0.0	**15.4**	4.1	138.0	2.1	**144.2**
Total	**186.5**	**400.2**	**61.5**	**648.2**	**55.1**	**171.0**	**27.2**	**253.2**	**241.6**	**571.2**	**88.7**	**901.4**
2030												
Australia	7.3	170.2	0.0	**177.5**	36.1	155.5	15.3	**206.9**	43.4	325.7	15.3	**384.4**
United States	2.8	1.4	6.1	**10.3**	0.6	0.0	17.9	**18.6**	3.4	1.4	24.1	**28.9**
South Africa	64.3	23.8	11.0	**99.0**	0.0	0.0	0.8	**0.8**	64.3	23.8	11.8	**99.8**
Former Soviet Union	44.0	28.8	0.0	**72.8**	6.5	11.0	0.0	**17.5**	50.5	39.8	0.0	**90.3**
Poland	4.0	0.0	0.4	**4.4**	0.6	0.0	0.0	**0.6**	4.5	0.0	0.4	**5.0**
Canada	0.0	0.0	3.3	**3.3**	18.3	21.5	1.7	**41.6**	18.3	21.5	5.0	**44.9**
China	0.0	94.9	3.2	**98.1**	0.0	7.7	0.0	**7.7**	0.0	102.6	3.2	**105.8**
South America[d]	51.0	0.0	92.7	**143.7**	0.0	0.0	0.0	**0.0**	51.0	0.0	92.7	**143.7**
Vietnam	0.0	59.5	0.0	**59.5**	0.0	0.0	0.0	**0.0**	0.0	59.5	0.0	**59.5**
Indonesia/Other[e]	0.0	137.5	7.0	**144.5**	0.4	15.0	0.0	**15.4**	0.4	152.5	7.0	**159.9**
Total	**173.3**	**516.1**	**123.8**	**813.2**	**62.5**	**210.7**	**35.7**	**309.0**	**235.8**	**726.9**	**159.6**	**1,122.2**

[a]Europe/Mediterranean, including coal shipments to the Middle East and Africa.
[b]In 2004, total world coal flows include a balancing item used to reconcile discrepancies between reported exports and imports. The 2004 balancing items by coal type were 3.2 million tons (steam coal), 0.3 million tons (coking coal), and 3.4 million tons (total).
[c]Includes 15.4 million tons of coal for pulverized coal injection at blast furnaces shipped to Japanese steelmakers in 2004.
[d]Coal exports from South America are projected to originate from mines in Colombia and Venezuela.
[e]Includes shipments from other countries not modeled for the projection period. The 2004 exports from other countries by coal type were 3.1 million tons (steam coal), 2.2 million tons (coking coal), and 5.3 million tons (total).

Notes: Data exclude non-seaborne shipments of coal to Europe and Asia. Totals may not equal sum of components due to independent rounding.

Sources: **2004:** SSY Consultancy and Research, Ltd., *SSY's Coal Trade Forecast*, Vol. 14, No. 3 (London, UK, September 2005); and Energy Information Administration, *Quarterly Coal Report*, October-December 2004, DOE/EIA-0121(2004/4Q) (Washington, DC, March 2005). **2015 and 2030:** Energy Information Administration, National Energy Modeling System, run IEO2006.D041306A.

a relatively new competitor in international coal trade, competes strongly in the Asian market by 2030. Its proximity to China will be instrumental in the growth of Vietnam's coal export volume from 10 million tons in 2004 to nearly 60 million tons in 2030.

Europe, Middle East, and Africa

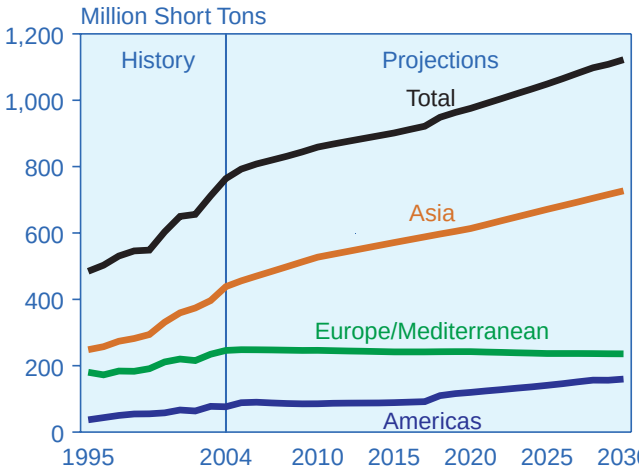
Total coal imports to the Europe/Mediterranean market (including the Middle East and Africa) decline in the projections (Figure 54). For most European countries, with increasing emphasis on natural gas in the power sector, coal becomes a less significant component of the fuel mix for electricity generation. In Turkey, however, economic expansion and steel industry growth partially offset the decline in Europe's coal imports. In addition, with the phaseout of mining subsidies in Europe, imports of coal from South America and Russia increase.

The Americas

The United States is projected to import 91 million tons of coal in 2030, 64 million tons more than in 2004. Although this is still a small share of overall U.S. consumption, at 5.0 percent, it represents a shift for the United States from being a net exporter to being a net importer. With declining productivity and mining difficulties in Central Appalachia and rising demand for coal in the Southeast, imports become increasingly competitive with domestic U.S. coal production. Already, plans are being made to expand U.S. ports to accommodate coal imports. For example, Dominion Terminal Associates has announced plans to add 7 million tons of coal import port capacity in Virginia by 2008 [*28*]. In recent years, Canada has been the largest importer of U.S. coal; however, Ontario's plans to close its five coal-fired generating plants by 2009 will reduce U.S. exports of steam coal by about 10 million tons between 2004 and 2030 [*29*].

Brazil, with rich reserves of iron ore but no coking grade coal, will fuel the planned expansion of its steel industry with imports from Australia, South Africa, and the United States. Coking coal imports to Brazil are projected to grow by 16 million tons from 2004 to 2030, at an average rate of 2.9 percent per year. Much of the coal imported by the countries of Central and South America is expected to come from Australia and from South American coal producers—in particular, Colombia. Colombia is also expected to increase its coal exports to the United States.

Figure 54. Coal Imports by Major Importing Region, 1995-2030



Sources: **History:** SSY Consultancy and Research, Ltd., *SSY's Coal Trade Forecast*, Vol. 14, No. 3 (London, UK, September 2005); International Energy Agency, *Coal Information 2001* (Paris, France, September 2001), and previous issues; and Energy Information Administration, *Quarterly Coal Report*, October-December 2004, DOE/EIA-0121(2004/4Q) (Washington, DC, March 2005), and previous issues. **Projections:** Energy Information Administration, National Energy Modeling System run IEO2006.D041306A.

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Chapter 6
Electricity

World electricity consumption doubles in the IEO2006 projections from 2003 to 2030. Non-OECD countries account for 71 percent of the projected growth, and OECD countries account for 29 percent.

In the *IEO2006* reference case, the world's total net electricity consumption[11] doubles, growing at an average rate of 2.7 percent per year, from 14,781 billion kilowatthours in 2003 to 21,699 billion kilowatthours in 2015 and 30,116 billion kilowatthours in 2030 (Figure 55). Non-OECD countries account for 71 percent of the projected growth and OECD countries 29 percent.

This chapter examines the future of electricity demand and supply, beginning with a discussion of regional demand and trends anticipated over the 27-year projection period. The remainder of the chapter discusses the projections for electricity generating capacity and electricity generation from competing fuel options. Detailed tables showing regional net electricity consumption, installed generating capacity, fuel use for electricity generation,[12] and generation are included in Appendix F.

Net Electricity Consumption

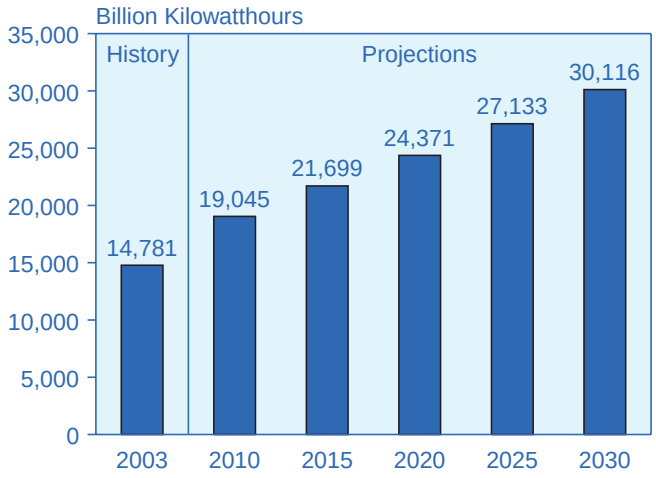
Projected growth in net electricity consumption is most rapid among the non-OECD economies of the world, with annual average growth of 3.9 percent from 2003 to 2030 (Figure 56), compared with 1.5 percent for OECD economies. China and the United States lead the growth in annual net electricity consumption with increases of 4,300 and 1,963 billion kilowatthours, respectively, over the projection period.

OECD Economies

In the OECD economies, the electricity sector is well established, and equipment efficiency gains are expected to temper growth in electricity demand. In addition, slower population growth is expected for the OECD economies than for the non-OECD economies; and some European countries, as well as Japan, are expected to see their populations decline. Electricity use in the OECD economies as a whole increases relatively slowly as a result, from 8,823 billion kilowatthours in 2003 to 10,885 billion kilowatthours in 2015 and 13,208 billion kilowatthours in 2030.

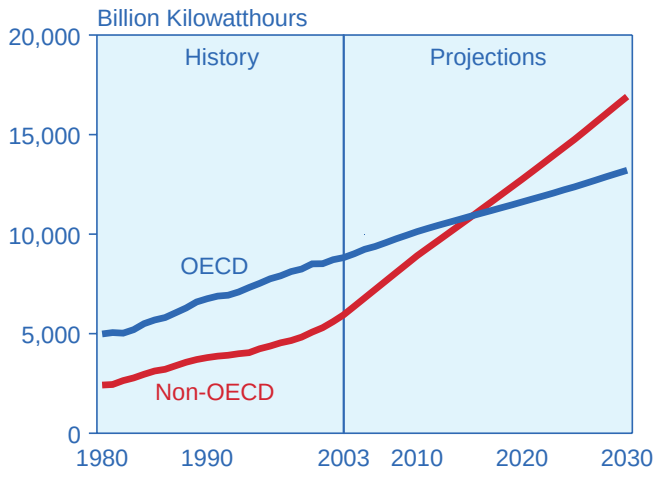
In 2003, nearly 60 percent of total net electricity consumption in the OECD economies was in the buildings

Figure 55. World Net Electricity Consumption, 2003-2030



Sources: **2003:** 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).

Figure 56. World Net Electricity Consumption by Region, 1980-2030



Sources: **History:** 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).

[11] In *IEO2006*, "net electricity consumption" equals total electricity generation, plus electricity imports, minus electricity exports, minus electricity used within the power station, minus electricity distribution losses as electricity flows from the power plant to the end user.

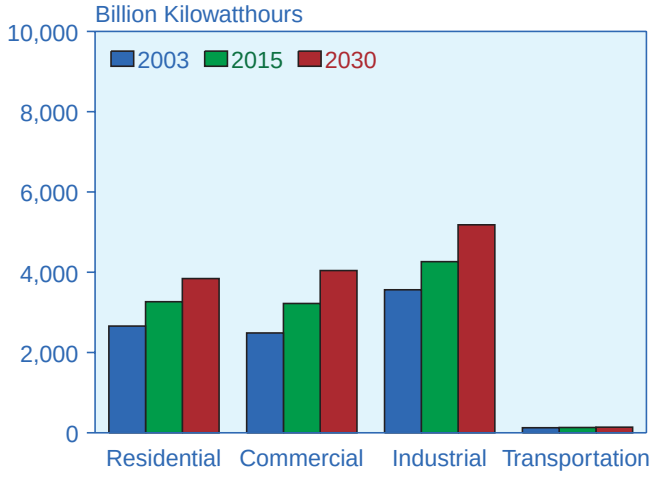
[12] In the SAGE model it is possible to distinguish between the electricity generated and heat produced by combined heat and power (CHP) plants; however, it is not possible to determine separately the quantities of each fuel used for electricity generation and for production of heat. Thus, "fuel for electricity generation" also includes fuel that more properly would be attributed to heat production.

sectors (residential and commercial). The remainder was consumed in the industrial sector, except for a small amount (1 percent) used by mass transit trains and buses. The relative shares of electricity consumption by sector do not change by more than 2 percent in the projections (Figure 57). Overall, net electricity consumption in OECD countries increases by 50 percent from 2003 to 2030, mostly as a result of increasing penetration and use of consumer electronics, office equipment, and telecommunications technologies.

In the United States, electricity demand increases from 3,669 billion kilowatthours in 2003 to 5,619 billion kilowatthours in 2030. Demand growth in the commercial sector is particularly strong, averaging 2.2 percent per year. Additions to commercial floorspace, the continuing penetration of new telecommunications technologies, and increased use of office equipment offset efficiency gains for electric equipment in the sector. Moderate increases are projected for electricity consumption in the industrial and residential sectors, averaging 0.8 percent per year and 1.5 percent per year, respectively. A similar pattern is projected for Canada, where net electricity consumption grows from 521 billion kilowatthours in 2003 to 660 billion kilowatthours in 2015 and 776 billion kilowatthours in 2030.

The most rapid growth in net electricity use among the OECD countries is projected for Mexico, averaging 4.1 percent per year overall and 5.8 percent per year in both the residential and commercial sectors. To date, popular opposition in Mexico's Congress and electricity unions to regulatory reform and incentives for private investment has slowed the development of the country's electricity sector [*1*]; however, such changes will be needed if growth in the demand for electricity is to be matched by adequate growth in electricity supply.

Figure 57. Net Electricity Consumption in OECD Countries by End-Use Sector, 2003, 2015, and 2030



Sources: **2003:** Derived from Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **2015 and 2030:** EIA, System for the Analysis of Global Energy Markets (2006).

In OECD Europe, net electricity consumption increases from 2,965 billion kilowatthours in 2003 to 4,107 billion kilowatthours in 2030. OECD Europe's drive to reduce cross-border barriers throughout the regional economy is expected to increase competition in its electricity and natural gas markets, offsetting some of the cost increases resulting from reduced reliance on coal-fired and nuclear power plants and increased reliance on natural gas and renewables for electricity production.

For OECD Asia, projected growth in net electricity consumption is slightly more rapid than it is for OECD Europe, averaging 1.3 percent per year. South Korea leads the increase, with average annual growth of 2.9 percent in industrial electricity consumption, 2.7 percent in residential electricity consumption, and 2.5 percent in commercial electricity consumption.

Non-OECD Economies

Electricity consumption in the non-OECD economies grows at an average annual rate of 3.9 percent from 2003 to 2030. Non-OECD Asia has the highest growth rate at 4.7 percent per year, followed by Central and South America at 3.7 percent, the Middle East at 3.0 percent, Africa at 2.9 percent, and non-OECD Europe and Eurasia at 2.8 percent. The average annual growth rates translate to a near tripling of net electricity consumption in the non-OECD nations over the projection period. In 2003, non-OECD economies consumed 40 percent of the world's electricity; in 2030 their share is projected to be 56 percent. Growth in net electricity consumption for the non-OECD economies is driven in large part by assumptions about GDP and population growth.

From 2003 to 2030, residential electricity consumption for the non-OECD economies as a whole grows from 23 percent to 30 percent of total net electricity consumption. In absolute terms, nearly four times as much electricity is consumed in the residential sector in 2030 than was consumed in 2003 (Figure 58), supporting a major transformation in living standards as electric lighting, appliances, and new technologies become available to an increasing share of the world's population. Electricity consumption growth in the non-OECD industrial sector is somewhat slower than in the buildings sectors, despite the rapid adoption of consumer electronics and computers for business use [*2*, *3*]. As a result, the industrial sector share of total non-OECD electricity demand declines from 61 percent in 2003 to 54 percent in 2030, even as industrial electricity use more than doubles.

In non-OECD Europe and Eurasia, electricity demand increases at an average annual rate of 2.8 percent from 2003 to 2030. Many countries in the region are attempting to reform or liberalize their electricity sectors—for the most part to attract much-needed private

and foreign investment to repair and expand aging and neglected infrastructure. Net electricity consumption in non-OECD Europe and Eurasia climbs from 1,350 billion kilowatthours in 2003 to 2,850 billion kilowatthours in 2030.

Residential electricity consumption growth in the non-OECD Asia region is by far the fastest in the world, at 6.5 percent per year, driven by population growth and rising living standards. In 2030, residential electricity consumption in the region totals 3,016 billion kilowatthours, or nearly four times its 2003 level. In the commercial and industrial sectors, electricity consumption grows strongly, at average annual rates of 4.8 and 4.0 percent to 1,291 and 5,653 billion kilowatthours, respectively, in 2030. The continuing challenge for the economies of non-OECD Asia will be to develop reliable electricity supplies steadily and avoid shortages or excess capacity.

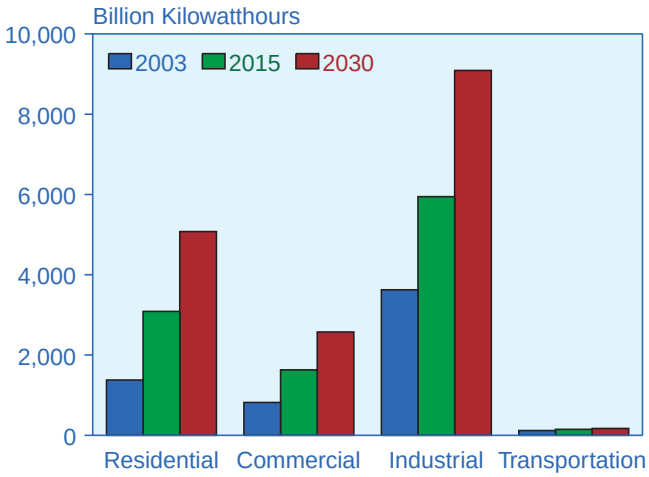
Other non-OECD regions also show robust growth in demand for electricity in the *IEO2006* reference case. In Africa and the Middle East, annual increases average about 3 percent from 2003 to 2030. Total electricity demand increases to 951 billion kilowatthours in Africa and 1,034 billion kilowatthours in the Middle East. In both regions, most of the demand growth is expected in the industrial and residential sectors. In Central and South America, net electricity consumption increases by 3.7 percent per year on average, to 2,047 billion kilowatthours in 2030, with the residential, commercial, and industrial sectors each accounting for approximately one-third of the total.

Electricity Supply

To meet the world's electricity demand over the 2003 to 2030 projection period, an extensive expansion of installed generating capacity will be required. In the reference case, worldwide installed electricity generating capacity grows from 3,710 gigawatts in 2003 to 6,349 gigawatts in 2030, at an average rate of 2.0 percent per year (Figure 59).

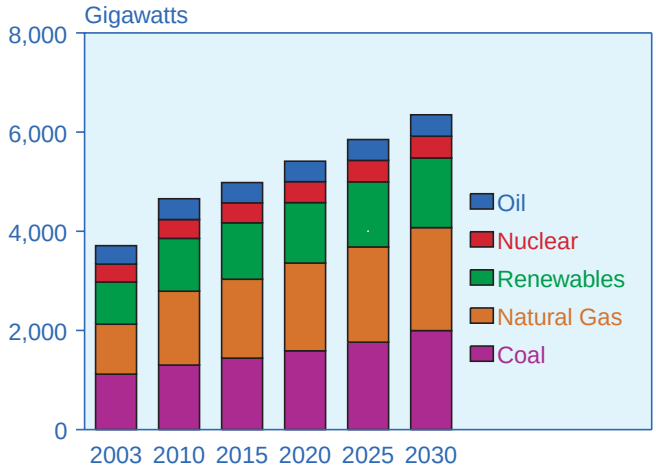
The fuels used in the additional generating capacity needed to meet the demand projection in *IEO2006* vary from region to region, as a function of available natural resources, energy security concerns, and market competition among fuel choices (see box on page 66), as well as other factors. Electricity suppliers must decide how much capacity of each generation technology to build, and then they must decide when to use the different types of capacity, balancing the costs and flexibility of the different technologies in their generation fleets. Baseload systems usually are operated over the longest periods and produce the most electricity per unit of installed capacity. For example, in the United States coal-fired steam plants represent 35 percent of the country's installed capacity but 52 percent of its total electricity production. In contrast, natural-gas- and oil-fired units[13] represent 43 percent of U.S. capacity but only 18 percent of electricity production.

Figure 58. Net Electricity Consumption in Non-OECD Countries by End-Use Sector, 2003, 2015, and 2030



Sources: **2003:** Derived from Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **2015 and 2030:** EIA, System for the Analysis of Global Energy Markets (2006).

Figure 59. World Electricity Generating Capacity by Fuel Type, 2003-2030



Sources: **2003:** Derived from Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **2010-2030:** EIA, System for the Analysis of Global Energy Markets (2006).

[13]Most technologies that generate electricity from natural gas are also capable (with some mechanical modification) of burning oil, with the exception of diesel-fired generators. Therefore, natural-gas- and oil-fired capacity are roughly interchangeable. SAGE model results are used for all regions except the United States, where natural gas and oil "capacities" have been assumed to equal their respective shares of electricity production. Distinctions between natural gas and oil are provided for fuel inputs and the electricity generated from the two fuels.

The mix of primary fuels used to generate electricity has changed a great deal over the past two decades on a worldwide basis. Coal has remained the dominant fuel, although electricity generation from nuclear power increased rapidly from the 1970s through the mid-1980s, and natural-gas-fired generation grew rapidly in the 1980s and 1990s. In contrast, in conjunction with the high world oil prices brought on by the oil price shocks after the oil embargo of 1973-1974 and the Iranian revolution in 1979, the use of oil for electricity generation has been slowing since the mid-1970s. High world oil prices encouraged switching from oil-fired generation to natural gas and nuclear power and reinforced coal's important role in world electric power generation. Similarly, the relatively high fossil fuel prices of recent years are raising renewed interest in nuclear power and making renewable energy sources more competitive economically.

Natural Gas

In the *IEO2006* reference case, natural-gas-fired generating capacity increases by approximately 2.7 percent per year from 2003 to 2030 (Figure 59), as compared with 2.2 percent per year for coal and 1.9 percent per year for renewables. Between 2003 and 2030, 1,070 gigawatts of natural gas capacity is added worldwide (net of total capacity additions minus capacity retirements), compared with 878 gigawatts of coal-fired generating capacity. As a result, the natural gas share of world installed generating capacity rises from 27 percent in 2003 to 33 percent in 2030. Natural-gas-fired combined-cycle capacity is an attractive choice for new power plants because of its fuel efficiency, operating flexibility (it can be brought on line in minutes rather than the hours it takes for other energy sources like coal), relatively short construction times (months instead of the years that coal or nuclear power plants typically require), and lower investment costs. The major drawback of natural gas capacity is the potential volatility of fuel costs.

At the world level, natural gas consumption increases from 19 percent of total fuel use for electricity generation in 2003 to 22 percent in 2030. Non-OECD economies, on the whole, relied on natural gas for 24 percent of fuel inputs in 2003 and OECD economies for 15 percent. No change is expected for the non-OECD economies, but in the OECD the natural gas share rises to 20 percent in 2030.

In the OECD economies, natural gas and coal each accounted for 28 percent of installed electricity

Technology Choices for New U.S. Generating Capacity: Levelized Cost Calculations

When decisionmakers are faced with the need for new capacity, several technology types can be considered. One of the tools used by decisionmakers is a levelized cost calculation, which incorporates all the expenses and revenues associated with a project over its lifetime. The costs include investment in plant construction, interest charges on funds borrowed to finance the construction, capital outlays after the plant has started operating, taxes, operations and maintenance costs, and fuel costs. The levelized cost calculation balances those expenses against estimates of revenues over the life of the plant, including proceeds from power sales and a desired rate of return on the investment. The streams of expenses and revenues are expressed as a real annuity, where the payments are assumed to be for the same dollar amount in every year of the plant's life.

Levelized cost comparisons give investors one basis for choosing a technology. In addition, other factors are considered, such as the operating characteristics of different technologies. For example, intermittent technologies like wind and solar produce less power over time than do coal, nuclear, or combined-cycle natural gas plants. There may also be tradeoffs between capital costs and fuel costs. Nuclear generators are expensive to build, but their fuel and operating costs are low; combined-cycle plants are far less expensive to build, but their fuel and operating costs are much higher.

An illustration of levelized cost calculations for a typical coal plant, an advanced combined-cycle natural gas plant, a wind plant, and a nuclear plant to be built in the United States is shown in the table below. The cost estimates are based on assumptions used in EIA's *Annual Energy Outlook 2006*, expressed in 2004 dollars per megawatthour. For U.S. plants that would begin operation in 2015, the combined-cycle plant is the least-cost option and the nuclear plant the most expensive.

Levelized Cost Comparison for New Generating Capacity in the United States
(2004 Dollars per Megawatthour)

Cost Element	Technology			
	Coal	Natural Gas	Wind	Nuclear
Capital . . .	30.4	11.4	40.7	42.7
O&M	4.7	1.4	8.3	7.8
Fuel	14.5	36.9	0.0	6.6
Total[a] . . .	**53.1**	**52.5**	**55.8**	**59.3**

[a]Includes transmission hookup costs.
O&M = operations and maintenance.
Source: Energy Information Administration, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington DC, February 2006).

generating capacity in 2003 (Figure 60). Over the projection period, natural gas capacity gains share (rising to 33 percent) at the expense of nuclear, renewables, and oil-fired capacity, while coal's share remains steady. Nearly one-half of the total increment in OECD natural-gas-fired generating capacity is attributed to the countries of Europe, where the natural gas share of electric power generation more than doubles, from 15 percent in 2003 to 39 percent in 2030. With planned phaseouts of nuclear generators in Belgium, Germany, and Sweden and disincentives for construction of new coal-fired capacity because of environmental restrictions, natural gas gains the largest share of the OECD Europe electricity market.

In the United States, both the share of natural gas capacity and the share of electricity generated from natural gas decline over the projection period. Natural-gas-fired plants, which provided 15 percent of total U.S. electricity supply in 2003, increase their share to 20 percent of supply in 2015 before dropping back to 15 percent in 2030. Natural-gas-fired generation (excluding generation in the industrial sector) increases initially as the recent wave of newer, more efficient plants come online, but it declines toward the end of the projection period as natural gas prices continue to rise [*4*]. A similar pattern of expanding natural gas capacity and generation shares, followed by declining shares relative to other fuels, is expected in OECD Asia. In both Canada and Mexico, natural gas capacity increases steadily, and natural-gas-fired generation increases by 4.5 percent per year in Canada and 6.9 percent per year in Mexico.

In the non-OECD nations, the natural gas share of total electricity generation rises as oil and renewables lose share. Natural-gas-fired capacity grows most rapidly in non-OECD Asia—especially China and India—and natural gas consumption in the electric power sector increases by an average of 7.0 percent per year in China and 7.1 percent per year in India from 2003 to 2030. For non-OECD Asia as a whole, natural-gas-fired electricity generation increases by an average of 7.2 percent per year, as compared with 4.7 percent per year worldwide.

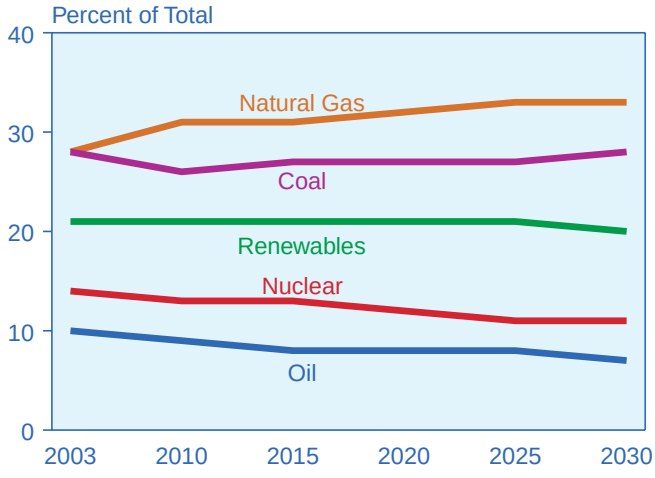
In non-OECD Europe and Eurasia, with access to rich natural gas resources, natural gas was used for 35 percent of total electricity generation in 2003. In 2030, its share of the region's electricity production is projected to be 60 percent. Africa, the Middle East, and Central and South America also rely increasingly on natural gas to produce electricity in the reference case.

Coal

Coal retains the largest market share of the world's electricity generation (roughly 40 percent) in the *IEO2006* reference case, despite losing some of its share to natural gas (Figure 61). Installed coal-fired capacity, as a share of total world capacity, remain at about 30 percent. Worldwide, coal-fired capacity grows by 2.2 percent per year, from 1,119 gigawatts in 2003 to 1,997 gigawatts in 2030 (Figure 62)—slightly faster than the 2.0-percent average annual increase for all electricity generation capacity. In 2003, non-OECD economies on the whole relied on coal for roughly 43 percent of generation, slightly more than the OECD economies.

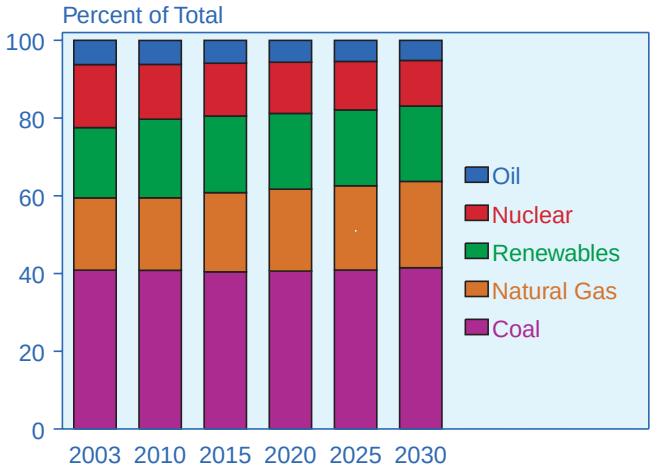
Regional differences in coal use for electricity generation arise primarily from differences in coal resources.

Figure 60. Shares of OECD Installed Electricity Capacity by Fuel Type, 2003-2030



Sources: **2003:** Derived from Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **2010-2030:** EIA, System for the Analysis of Global Energy Markets (2006).

Figure 61. Fuel Shares of World Electricity Generation, 2003-2030



Note: Fuel shares may not add to 100 percent due to independent rounding.

Sources: **2003:** Derived from Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **2010-2030:** EIA, System for the Analysis of Global Energy Markets (2006).

Regions with large coal resources are more likely to use coal for electricity generation, because coal has a lower energy density (energy per weight) and fewer alternative uses than oil or natural gas. These factors help keep coal prices, on an energy basis, lower than oil and natural gas prices. Coal reserves in the United States, China, India, and Australia are among the largest in the world, and those countries rely on coal to generate 50 to 80 percent of their electricity.

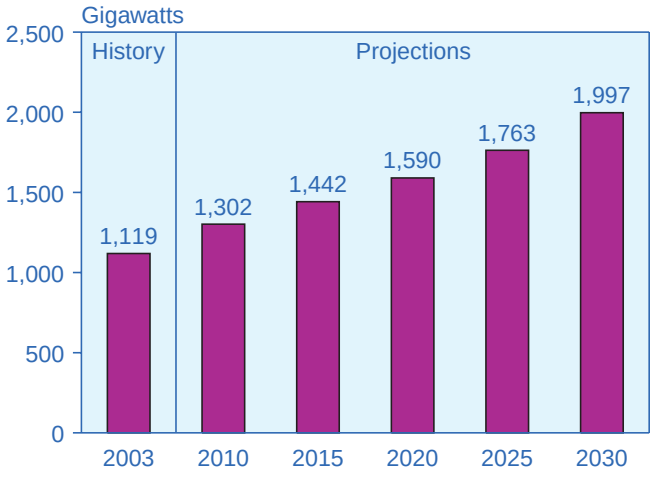
China and the United States lead the world in coal-fired capacity additions in the projections, adding 546 gigawatts and 154 gigawatts, respectively. In China, strong growth in natural-gas-fired capacity initially pushes coal's share of total capacity down to 63 percent in 2010, but it rebounds to 72 percent in 2030. In the United States, coal-fired power plants continue supplying the largest share of electricity generation through 2030 [*5*]. Sustained high world oil and natural gas prices in the *IEO2006* reference case lead to increased reliance on coal to produce electricity in the later years of the projection. The coal share of total electricity generation in the United States increases from 53 percent in 2003 to 57 percent in 2030. In non-OECD Asia excluding China, the share of electricity generated from coal-fired capacity declines, despite continuing additions to coal-fired capacity, because additions of natural-gas-fired capacity exceed additions to coal-fired capacity. In all other regions, the coal share of electricity generation remains stable or falls.

Oil

Although relatively little change in oil-fired generating capacity is expected, oil's share of world installed capacity declines over the projection period, from 10 percent in 2003 to 7 percent in 2030. Oil has more value in the transportation sector and in limited applications for distributed diesel-fired generators than in central power plant applications. Only the Middle East and China are expected to see sizable increases in oil-fired electric power capacity over the projection period, adding 24 and 22 gigawatts, respectively.

In recent years, China has shown fairly strong growth in oil-fired electricity generation, because peak electricity demand continues to outpace on-grid electricity generation, and Chinese industry has had to rely on diesel generators to cope with annual summer power shortages. That situation is expected to continue in the short term, but as planned capacity fueled by natural gas, coal, nuclear, and hydropower comes on line and the country's national electricity grid matures, the use of oil to generate electricity is expected to moderate.

Figure 62. World Installed Coal-Fired Generating Capacity, 2003-2030



Sources: **2003:** Derived from Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **2010-2030:** EIA, System for the Analysis of Global Energy Markets (2006).

Nuclear Power

The world's nuclear-powered generating capacity increases in the *IEO2006* reference case from 361 gigawatts in 2003 to 438 gigawatts in 2030, in contrast to projections of declines in nuclear power capacity in past *IEO*s. The reference case is based on existing laws and assumes that, for the OECD economies in the long term, retirements of existing nuclear power plants as they reach the end of their operating lives will nearly equal construction of new nuclear power capacity, resulting in a slight decline of installed nuclear capacity toward the end of the projection after peaking in 2020. Few new builds are expected in the OECD economies outside of Finland, France, Japan, South Korea, and the United States. In the United States, nuclear capacity is expected to increase by 3 gigawatts as a result of uprates at existing plants and by 6 gigawatts as a result of new construction [*6*].

In contrast, rapid growth in nuclear power capacity is projected for the non-OECD economies (Figure 63). The non-OECD economies are expected to add 33 gigawatts of nuclear capacity between 2003 and 2015 and another 42 gigawatts between 2015 and 2030. The largest additions are expected in China, India, and Russia.

Prospects for nuclear power have improved in recent years, with higher capacity utilization rates reported for many existing nuclear facilities and the expectation that most existing plants in the OECD nations and in non-OECD Europe and Eurasia will be granted extensions to their operating lives. Higher fossil fuel prices, concerns about energy supply security, and the possibility for new, lower cost nuclear reactor designs also may improve prospects for new nuclear power capacity. Nevertheless, nuclear power trends can be difficult to anticipate for a variety of political and social reasons, and considerable uncertainty is associated with nuclear power projections.

Nuclear power is an important source of electricity in many countries of the world. In 2005, 16 countries depended on nuclear power for at least 25 percent of their electricity generation (Figure 64). As of December 2005, there were 443 nuclear power reactors in operation around the world, and another 24 were under construction. Despite a declining share of global electricity production, nuclear power is projected to remain an important source of electric power through 2030. In the *IEO2006* reference case, electricity generation by nuclear power plants around the world increases from 2,523 billion kilowatthours in 2003 to 2,940 billion kilowatthours in 2015 and 3,299 billion kilowatthours in 2030.

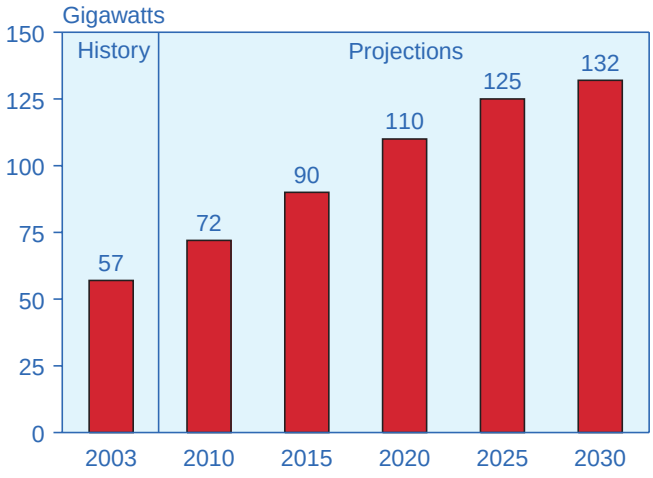
Hydroelectricity and Other Renewables

Grid-connected hydroelectric and other generating capacity fueled by renewable energy resources is projected to increase by 553 gigawatts from 2003 to 2030, at an average annual rate of 1.9 percent. High oil and natural gas prices, which are expected to persist in the mid-term projection, encourage the penetration of renewables. Renewable generating capacity in 2025 is 18 percent higher in *IEO2006* than was projected in the *IEO2005* reference case (the *IEO2005* projection period ended at 2025). Nonetheless, the renewable share of world installed capacity falls slightly, from 23 percent in 2003 to 22 percent in 2030, as natural gas continues to gain market share in many regions of the world.

Much of the projected growth in renewable generation results from the expected completion of large hydroelectric facilities in non-OECD Asia, where the need to expand electricity production with associated dams and reservoirs often outweighs concerns about environmental impacts and the relocation of populations. China has ambitious plans to increase hydroelectric capacity, including completion of the 5.4-gigawatt Longtan hydroelectric project by the end of 2007 and the 18.2-gigawatt Three Gorges Dam project in 2009 [*7*]. India and several other non-OECD Asian countries, including Laos and Vietnam, also have plans to increase hydroelectric capacity [*8*].

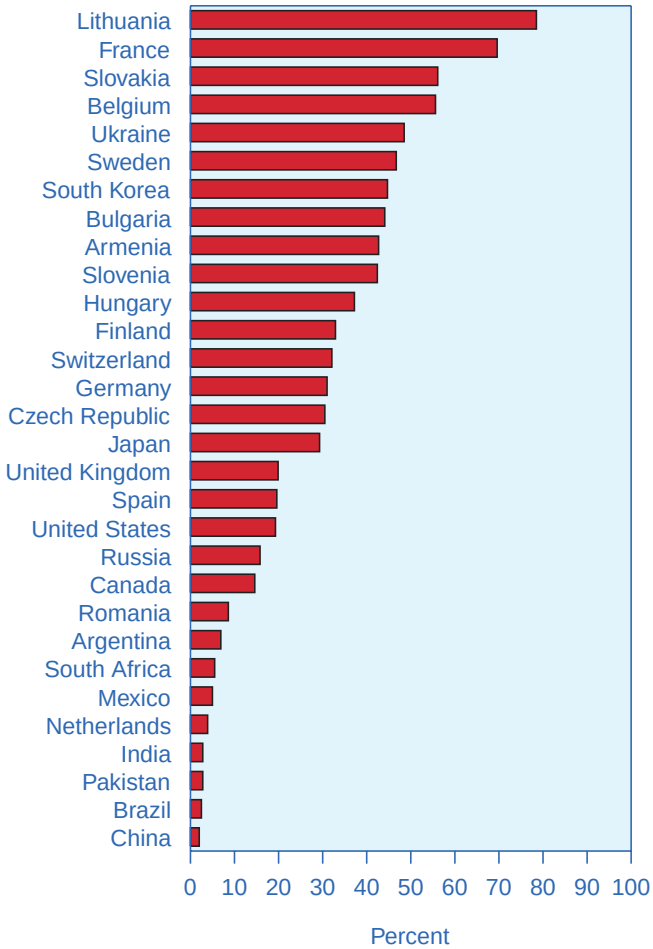
In Central and South America, many nations have plans to expand their already well-established hydroelectric resources. Brazil is the largest energy market in Central and South America, and more than 80 percent of its electricity generation comes from hydroelectric sources. As a result, Brazil is especially vulnerable to drought-induced shortages in electricity supply. In general, the nations of Central and South America are not expected to expand hydroelectric resources dramatically but instead are expected to invest in other sources of electricity—particularly natural-gas-fired capacity—that will allow them to diversify electricity supplies and reduce their reliance on hydropower.

Figure 63. Non-OECD Installed Nuclear Generating Capacity, 2003-2030



Sources: **2003:** Derived from Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **2010-2030:** EIA, System for the Analysis of Global Energy Markets (2006).

Figure 64. Nuclear Shares of National Electricity Generation, 2005



Source: International Atomic Energy Agency, Reference Data Series 2, "Power Reactor Information System," web site www.iaea.org/programmes/a2/ (April 2006).

In the OECD, grid-connected installed renewable capacity is projected to increase by 0.8 percent per year over the 2003 to 2030 period. Hydroelectric capacity in OECD economies is not expected to grow substantially, and only Canada is expected to complete any sizable hydroelectric projects over the projection. Nonhydropower renewables are instead expected to lead the growth in renewable generating capacity, especially wind in OECD Europe and the United States, where wind-powered generating capacity increased by 18 percent and 27 percent, respectively, in 2005 alone [***9***].

The *IEO2006* projections for hydroelectricity and other renewable energy resources include only on-grid renewables. Non-marketed (noncommercial) biofuels from plant and animal sources are an important source of energy, particularly in non-OECD economies, and the International Energy Agency has estimated that some 2.4 billion people in developing countries depend on traditional biomass for heating and cooking [***10***]. Because comprehensive data on the use of non-marketed fuels and dispersed renewables (renewable energy consumed on the site of its production, such as solar panels used to heat water) are not available, they are not included in the projections; however, both non-marketed fuels and dispersed renewables are considered in formulating end-use energy demands.

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Chapter 7

Energy-Related Carbon Dioxide Emissions

In the coming decades, actions to limit greenhouse gas emissions could affect patterns of energy use around the world and alter the level and composition of energy-related carbon dioxide emissions by energy source.

Carbon dioxide is one of the most prevalent greenhouse gases in the atmosphere. Anthropogenic (human-caused) emissions of carbon dioxide result primarily from the combustion of fossil fuels for energy, and as a result world energy use has emerged at the center of the climate change debate. In the *IEO2006* reference case, world carbon dioxide emissions increase from 25,028 million metric tons in 2003 to 33,663 million metric tons in 2015 and 43,676 million metric tons in 2030 (Figure 65).[14]

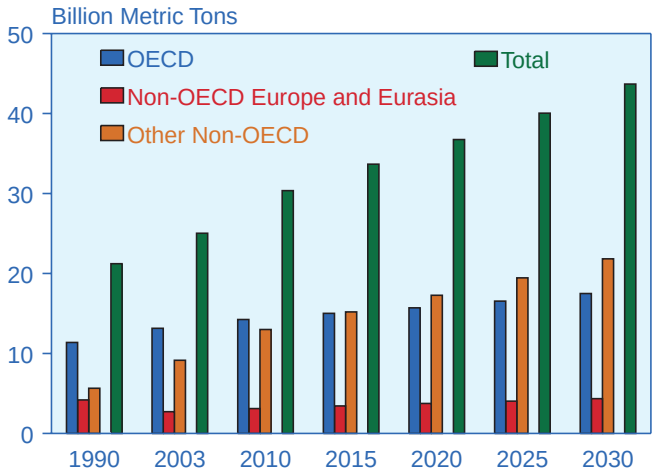
The Kyoto Protocol, which requires participating "Annex I" countries to reduce their greenhouse gas emissions collectively to an annual average of about 5 percent below their 1990 level over the 2008-2012 period, entered into force on February 16, 2005, 90 days after it was ratified by Russia. Russia's ratification satisfied the terms necessary to bring the treaty into force; that is, the total number of signatories had reached more than 55 countries, including Annex I signatories that accounted for more than 55 percent of Annex I carbon dioxide emissions in 1990. The Annex I countries include all the OECD countries except for Mexico and South Korea, along with the non-OECD countries Bulgaria, Estonia, Latvia, Lithuania, Monaco, Romania, Russia, Slovenia, and Ukraine.[15]

The *IEO2006* reference case projections are based on U.S. and foreign government laws in effect on January 1, 2006. The potential impacts of pending or proposed legislation, regulations, and standards are not reflected in the projections, nor are the impacts of legislation for which implementing mechanisms have not been announced. The *IEO2006* reference case does not include the potential impacts of the Kyoto Protocol, because the treaty does not indicate the methods by which ratifying parties will implement their obligations. Moreover, the Protocol does not address signatory obligations beyond 2012, making it impossible to assess its impacts on energy markets and carbon dioxide emissions through 2030 in the context of a reference case projection. In the year since the Kyoto Protocol entered into force, there has been little progress toward establishing goals for a second commitment period.

Another difficulty in projecting energy-related carbon dioxide emissions in the context of the Kyoto Protocol is that, in the 5-year increments of the SAGE model, upon which the *IEO2006* projections are based, 2010 is the only projection year that is part of the Protocol's first commitment period. While some participating countries have identified goals by energy-consuming sectors, not all have; and even for those that have done so, it is difficult to assess how the goals will be implemented with specific actions by the participants.

Despite the challenges, it is important to address the possible impacts of the Kyoto Protocol, because they could strongly influence future energy trends. Accordingly, this chapter begins with a presentation of the *IEO2006* reference case projections for regional carbon dioxide emissions, which can serve as an estimate against which future emissions reductions can be measured. The *IEO2006* Kyoto Protocol case assumes that the emissions goals of the Protocol will be met by the countries that have ratified the treaty and have

Figure 65. World Carbon Dioxide Emissions by Region, 1990-2030



Sources: **1990 and 2003:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **2010-2030:** EIA, System for the Analysis of Global Energy Markets (2006).

[14]In keeping with current international practice, *IEO2006* presents data on carbon dioxide emissions in million metric tons of carbon dioxide. The figures can be converted to carbon equivalent units by multiplying by 12/44.

[15]As of April 16, 2006, 162 countries and the European Community had ratified, accepted, acceded to, or approved the Kyoto Protocol. A list of the 162 countries is provided in Appendix J.

obligations to limit or reduce their greenhouse gas emissions, using a combination of domestic actions and purchases of international emissions permits. Further, although the current agreement extends only to 2012, the targets specified under the Protocol for the first commitment period are assumed to remain in place through 2030. Results from the Kyoto Protocol case are analyzed in the second part of the chapter.

Reference Case

Carbon Dioxide Emissions

In the *IEO2006* reference case, world carbon dioxide emissions from the consumption of fossil fuels grow at an average rate of 2.1 percent per year from 2003 to 2030. Emissions in 2030 total 43,676 million metric tons. Combustion of petroleum products contributes 5,028 million metric tons to the increase from 2003, coal 8,801 million metric tons, and natural gas 4,804 million metric tons (Figure 66). In the absence of carbon constraints, coal use is projected to grow at about the same rate as natural gas use, from 2003 consumption levels (in Btu) that are nearly identical; however, coal is a more carbon-intensive fuel than natural gas, and thus the increment in carbon dioxide emissions from coal combustion is larger than the increment in emissions from natural gas.

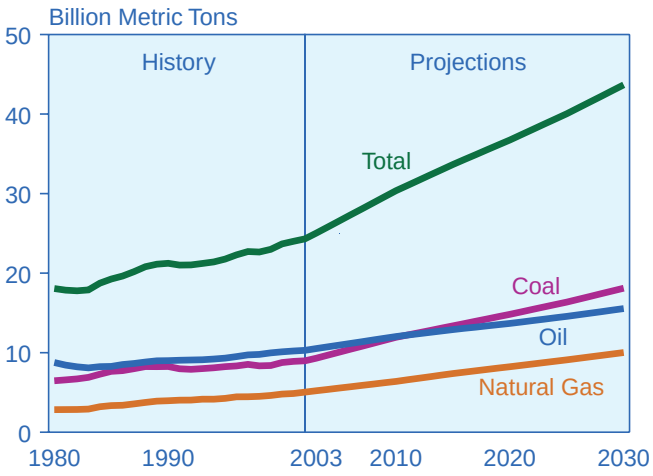
With oil prices in 2025 about 35 percent higher in the *IEO2006* reference case than projected in *IEO2005*, oil consumption and related emissions increase at a slower rate in the *IEO2006* projections (by an average of 1.5 percent per year, as compared with 1.9 percent per year in the *IEO2005* reference case), well below the growth rates for emissions related to natural gas and coal in this year's projections. As a result, coal combustion overtakes oil as the largest source of carbon dioxide emissions from 2015 to 2030 (Figure 66).

The OECD economies, for the most part, are growing more slowly than the non-OECD economies, and their growth tends to be in less energy-intensive sectors. As a result, carbon dioxide emissions from the OECD economies grow by 1.1 percent per year from 2003 to 2030 in the reference case, absent binding constraints (Figure 67 and Table 12). Emissions from North America grow the most rapidly among the OECD regions, by 1.3 percent per year. North America's average annual increase in GDP is 3.1 percent from 2003 to 2030, resulting from the combination of a 2.2-percent average increase in per capita income and population growth that averages 0.9 percent annually. That strong economic growth drives the demand for fossil fuels and thus the projected increase in the region's carbon dioxide emissions.

In contrast to North America, fairly modest growth in GDP is projected for OECD Europe and OECD Asia (2.2 and 1.9 percent per year, respectively), resulting from per capita income growth of 2.0 percent per year in OECD Europe and 1.9 percent per year in OECD Asia and population growth rates that average only 0.2 percent and 0.1 percent per year, respectively. Thus, only limited growth in demand for energy is projected for the two regions, leading to slower growth in emissions. Carbon dioxide emissions in OECD Europe grow by 0.7 percent per year on average from 2003 to 2030, and emissions in OECD Asia grow by an average of 0.9 percent per year.

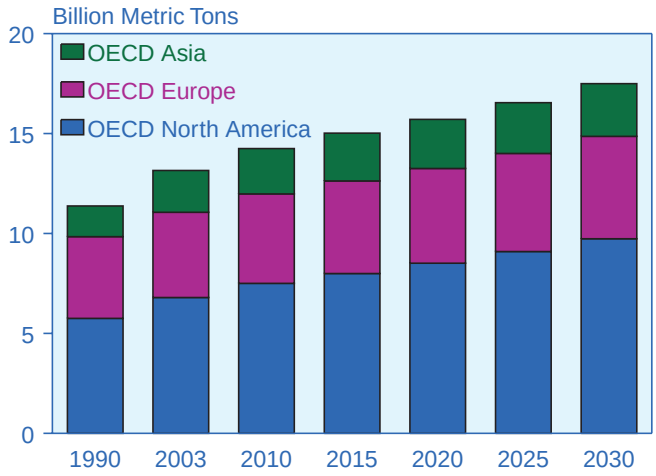
Carbon dioxide emissions in non-OECD Europe and Eurasia increase on average by 1.7 percent per year in

Figure 66. World Carbon Dioxide Emissions by Fuel Type, 1980-2030



Sources: **History:** 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).

Figure 67. Carbon Dioxide Emissions in the OECD Economies, 1990-2030

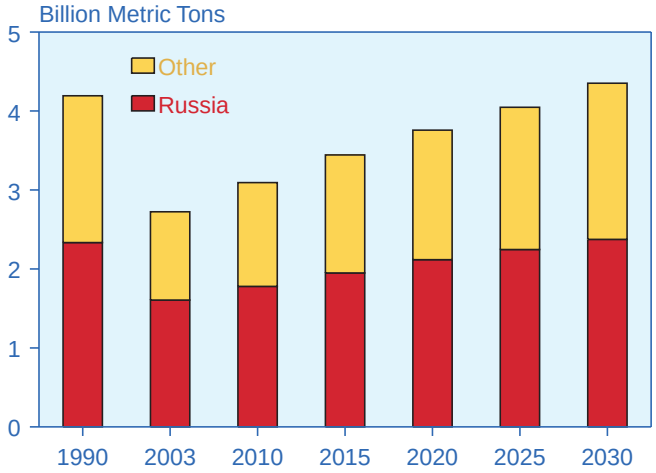


Sources: **1990 and 2003:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **2010-2030:** EIA, System for the Analysis of Global Energy Markets (2006).

the *IEO2006* reference case, from 2,725 million metric tons in 2003 to 3,444 million metric tons in 2015 and 4,352 million metric tons in 2030 (Figure 68 and Table 12). Russia, the region's largest economy, accounted for 60 percent of regional energy consumption and 59 percent of regional carbon dioxide emissions in 2003.

The economic collapse of the Soviet Union and the Eastern European countries in its sphere of influence—most of which are included in non-OECD Europe and Eurasia—slowed the growth of carbon dioxide emissions not only in the region but also on a worldwide basis for many years after the breakup of the Soviet Union in 1991. In 2003, total carbon dioxide emissions in the countries of non-OECD Europe and Eurasia were still 35 percent below their level in 1990, and in the reference case projection they do not return to 1990 levels until after 2025.

Figure 68. Carbon Dioxide Emissions in Non-OECD Europe and Eurasia, 1990-2030



Sources: **1990 and 2003:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **2010-2030:** EIA, System for the Analysis of Global Energy Markets (2006).

Although GDP growth in non-OECD Europe and Eurasia averages 4.4 percent per year from 2003 to 2030 in the reference case, improvements in energy infrastructure are expected to keep the growth in energy demand at an annual average of only 1.8 percent. In addition, an increase in the natural gas share of total energy consumption and a drop in coal's share are expected to lower the carbon intensity of energy supply in the region. Consequently, carbon dioxide emissions in non-OECD Europe and Eurasia in 2030 are only 159 million metric tons above the 1990 level.

For the other non-OECD economies, the reference case projects strong economic growth driven largely by the energy-intensive industrial and transportation sectors. Accordingly, their carbon dioxide emissions grow at twice the rate projected for non-OECD Europe and Eurasia (and three times the rate for the OECD economies), bringing the average annual increase in emissions for all non-OECD countries to 3.0 percent per year from 2003 to 2030. The most rapid increases are projected for the nations of non-OECD Asia (Figure 69).

Carbon Dioxide Intensity

World carbon dioxide intensity has improved (decreased) substantially over the past decade, falling from 629 metric tons per million 2000 U.S. dollars of GDP in 1990 to 493 metric tons per million dollars in 2003. Although the pace of improvement in emissions intensity is expected to be slower over the 2003-2030 period than it has been over the past decade, a continuing decline in intensity is projected in the reference case, to

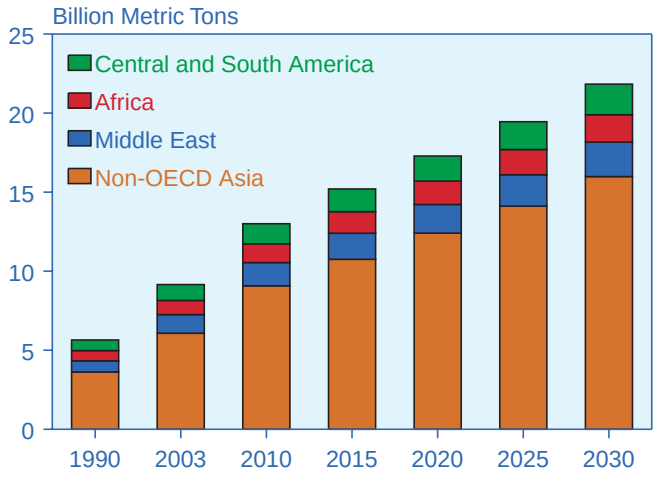
Table 12. World Carbon Dioxide Emissions by Region, 1990-2030
(Million Metric Tons)

Region	History		Projections					Average Annual Percent Change	
	1990	2003	2010	2015	2020	2025	2030	1990-2003	2003-2030
OECD	**11,378**	**13,150**	**14,249**	**15,020**	**15,709**	**16,545**	**17,496**	**1.1**	**1.1**
North America	5,753	6,797	7,505	7,997	8,513	9,096	9,735	1.3	1.3
Europe	4,089	4,264	4,474	4,632	4,741	4,909	5,123	0.3	0.7
Asia	1,536	2,090	2,269	2,390	2,455	2,540	2,638	2.4	0.9
Non-OECD	**9,846**	**11,878**	**16,113**	**18,643**	**21,039**	**23,500**	**26,180**	**1.5**	**3.0**
Europe and Eurasia	4,193	2,725	3,113	3,444	3,758	4,047	4,352	-3.3	1.7
Asia	3,626	6,072	9,079	10,753	12,407	14,113	15,984	4.0	3.6
Middle East	704	1,182	1,463	1,647	1,811	1,987	2,177	4.1	2.3
Africa	649	893	1,188	1,363	1,477	1,593	1,733	2.5	2.5
Central and South America	673	1,006	1,270	1,436	1,586	1,758	1,933	3.1	2.4
Total World	**21,223**	**25,028**	**30,362**	**33,663**	**36,748**	**40,045**	**43,676**	**1.3**	**2.1**

Sources: **1990 and 2003:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **2010-2030:** EIA, System for the Analysis of Global Energy Markets (2006).

408 metric tons per million dollars in 2015 and 311 metric tons per million dollars in 2030 (Table 13).

Figure 69. Carbon Dioxide Emissions in Other Non-OECD Economies, 1990-2030



Sources: **1990 and 2003:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **2010-2030:** EIA, System for the Analysis of Global Energy Markets (2006).

On a regional basis, the most rapid rates of improvement in carbon dioxide intensity are projected for the economies of non-OECD Europe and Eurasia and for the economies of India and other non-OECD Asia. In Eurasia, economic recovery from the upheaval of the 1990s following the breakup of the Soviet Union is expected to continue throughout the projections, and old, inefficient capital stock is expected to be replaced as the economic recovery progresses. Even with substantial improvement in efficiency, however, carbon dioxide intensity in non-OECD Europe and Eurasia is expected to be higher than in all other non-OECD countries except those of the Middle East.

Economic recovery has been slower in Russia than in the other nations of non-OECD Europe and Eurasia, where strong investment in improving the efficiency of energy use and a push to increase the use of natural gas have improved carbon dioxide intensity by an average of 3.5 percent annually from 1990 to 2003, as compared with an annual average of 1.1 percent for Russia. From 2003 to 2030, Russia's carbon dioxide intensity is projected to improve by 2.4 percent per year on average, while the rest of the region averages 2.8 percent per year.

Table 13. Carbon Dioxide Intensity by Region and Country, 1990-2030
(Metric Tons per Million 2000 U.S. Dollars of Gross Domestic Product)

Region	History		Projections					Average Annual Percent Change	
	1990	2003	2010	2015	2020	2025	2030	1990-2003	2003-2030
OECD	**565**	**473**	**421**	**391**	**361**	**338**	**318**	**-1.4**	**-1.5**
United States	701	562	488	445	406	377	351	-1.7	-1.7
Canada	693	611	574	561	538	520	498	-1.0	-0.8
Mexico	441	415	360	337	311	286	261	-0.5	-1.7
Europe	510	395	352	326	300	280	264	-1.9	-1.5
Japan	349	357	311	293	274	261	250	0.2	-1.3
South Korea	711	687	629	572	529	501	475	-0.3	-1.4
Australia/New Zealand	679	631	583	546	512	482	453	-0.6	-1.2
Non-OECD	**723**	**516**	**466**	**423**	**380**	**341**	**307**	**-2.6**	**-1.9**
Russia	1,042	903	711	637	579	522	474	-1.1	-2.4
Other Europe/Eurasia	1,622	1,018	737	654	578	521	473	-3.5	-2.8
Asia	627	449	430	390	350	314	282	-2.5	-1.7
China	1,240	591	579	517	463	414	372	-5.5	-1.7
India	343	299	265	238	208	182	156	-1.1	-2.4
Other	353	368	316	293	267	245	222	0.3	-1.9
Middle East	869	871	752	693	633	581	533	0.0	-1.8
Africa	444	411	386	357	315	279	249	-0.6	-1.8
Central and South America	310	327	307	290	269	251	232	0.4	-1.3
Brazil	215	252	235	220	203	189	176	1.2	-1.3
Other	393	388	362	342	317	295	272	-0.1	-1.3
Total World	**629**	**493**	**444**	**408**	**372**	**340**	**311**	**-1.9**	**-1.7**

Sources: **1990 and 2003:** Derived from Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **2010-2030:** EIA, System for the Analysis of Global Energy Markets (2006).

Fairly rapid improvement in carbon dioxide intensity in non-OECD Asia is expected to result primarily from rapid economic growth rather than a switch to less carbon-intensive fuels. Although China and India, in particular, are expected to remain heavily reliant on coal and other fossil fuels, their combined annual GDP growth averages 5.8 percent from 2003 to 2030, compared with a 4.0-percent annual increase in fossil fuel use. As a result, China's carbon dioxide intensity improves by 1.7 percent per year on average and India's by 2.4 percent per year from 2003 to 2030.

Overall, carbon intensity in the non-OECD countries in 2030 is projected to be slightly below that in the OECD countries. For the non-OECD region as a whole, GDP growth averages 5.0 percent per year while emissions grow by 3.0 percent per year, resulting in a 1.9-percent average annual improvement in carbon dioxide intensity. For the OECD region, GDP growth averages 2.6 percent per year while emissions grow by 1.1 percent per year, for an average annual improvement in carbon intensity of 1.5 percent per year.

Rates of improvement in carbon dioxide intensity could vary considerably in the future, based on technological advances, government policy initiatives, and economic growth rates. In the *IEO2006* reference case, world carbon dioxide intensity falls from 493 metric tons per million dollars of GDP in 2003 to 311 metric tons per million dollars in 2030. If world economic growth expanded to the levels projected in the *IEO2006* high economic growth case, carbon dioxide intensity could fall more quickly, to 298 metric tons per million dollars in 2030. In contrast, if the world economy expanded more slowly, as in the low economic growth case, carbon dioxide intensity could decline to 329 metric tons per million dollars in 2030.

Kyoto Protocol Case

Modeling Approach

Under the Kyoto Protocol, participating Annex I nations are required to reduce or limit emissions of carbon dioxide and other greenhouse gases over the first commitment period (January 2008 to December 2012) to a level that was determined as part of the negotiation process. The year 1990 was used as the base year for most countries, although some were allowed to use other years.[16] To fulfill their obligations under the treaty, the Annex I countries must limit their emissions over the 5-year commitment period to an annual average that is at or below their commitment goals. Because the SAGE model projections for *IEO2006* are in 5-year increments, 2010 is used as the basis year for achieving commitments in the first period.[17] The targets specified under the Protocol for the first commitment period are assumed to remain in place through 2030, although the current agreement extends only to 2012.

The SAGE model comprises 16 regions. In the Kyoto Protocol case, the model regions affected by the treaty are Canada, Japan, OECD Europe, and non-OECD Europe and Eurasia. Although New Zealand has ratified the Protocol and intends to honor the terms of the treaty, Australia has not. In SAGE, New Zealand and Australia are treated as a single entity; and Australia's energy use far exceeds New Zealand's. Therefore, projections for Australia/New Zealand are not included in the results of the Kyoto Protocol case. On the other hand, Turkey, which is included in OECD Europe, has not agreed to binding constraints. Because Turkey is not a participant in the Protocol, its emissions are allowed to grow in the Kyoto Protocol case, and the total goal for OECD Europe is adjusted accordingly.

For non-OECD Europe and Eurasia, countries other than Russia are split almost evenly between Kyoto participants and nonparticipants. The participants (such as Ukraine) have their emissions capped, whereas the nonparticipants have no emissions caps. Emissions in the participating countries of non-OECD Europe and Eurasia are expected to remain below the level of their emissions commitments through 2030; however, demand for credits by Kyoto participants in other regions are expected to absorb the difference between their projected emissions and commitments by the end of the projection period.

For the *IEO2006* Kyoto Protocol case, assumptions were made about how participating countries in the affected regions would achieve their reductions, based whenever possible on official government statements. For instance, the European Union (EU) has stated that "most" of its greenhouse gas emissions reductions must be achieved domestically. The Kyoto Protocol case therefore assumes that 50 percent of the aggregate emissions reduction for OECD Europe will be met by domestic reductions, as opposed to the use of international market mechanisms, such as permit trading. For Japan and Canada, which are expected to have higher domestic reduction costs than OECD Europe, both countries are assumed to achieve 25 percent of their total reductions domestically.

In the Kyoto Protocol case, a country or region is first required to achieve its domestic reduction goal. After the domestic requirement has been met, the country or region is free to seek other means of meeting its overall reduction goal—for example, by trading carbon permits

[16]The countries using a base year other than 1990 are Bulgaria (1988), Hungary (1985-1987), Poland (1988), and Romania (1989).
[17]For key assumptions in the Kyoto Protocol case, see Appendix G.

internationally. In SAGE, the marginal cost (also known as the "shadow price") of reducing carbon dioxide emissions by 1 metric ton in a given country or region is used to determine the price that the country or region will be willing to pay for the next additional reduction of 1 metric ton. If the price of a carbon permit traded internationally exceeds the shadow price of the domestic reduction, then the country or region will be better off achieving that reduction domestically. If the price of a purchased permit is less than the shadow price, then the country or region is expected to choose the trading option.

In order to find a "clearing price" for internationally traded emissions permits, various price levels were tested. It was determined that, at approximately $42 per metric ton, the supply of credits (2.1 billion metric tons) equaled the demand over the projection period. At a price higher than $42, countries could find additional domestic actions to reduce emissions, and some of the credits would not be purchased. At prices lower than $42, the demand for credits would be greater than the supply, and the available credits would be exhausted before the end of the projection period.

SAGE does not explicitly model Clean Development Mechanisms (credits purchased by Annex I countries of reductions made by non-Annex I countries), because they can involve factors such as carbon storage in trees that are outside the current model structure. Also, the generation of additional permits from non-OECD Europe and Eurasia or elsewhere was not allowed in determining the market clearing price for permits. Therefore, the $42 price probably represents an upper bound, assuming that the Kyoto Protocol goals remain in place until 2030. If the goals were relaxed, the permit price would be likely to fall; if they were made more stringent, the price would be likely to rise.

Summary

The Kyoto Protocol case assumes that energy use will not vary from the reference case projections for Annex I countries that are not expected to participate in the treaty (the United States and Australia, for example) or for countries that are not required to make reductions according to the terms of the treaty (China and India, for example). As a result, only the projections for energy use in the Annex I nations committed to participating are affected in the Kyoto Protocol case. For the participating Annex I group, total energy demand in the Kyoto Protocol case is about 3 quadrillion Btu lower than in the reference case in 2010 and 2 quadrillion Btu lower in 2030, assuming that the Kyoto targets remain constant over the entire projection period (Table 14). Energy-related carbon dioxide emissions in the participating nations are 422 million metric tons lower than in the reference case in 2010 and 675 million metric tons lower in 2030. Total coal use among the participating Annex I nations in 2030 is about 27 percent lower than in the reference case in 2030.

Total petroleum consumption in the participating nations is just under 1 quadrillion Btu lower in the Kyoto Protocol case than in the reference case in 2030, and the associated emissions are 58 million metric tons lower. In the short term, natural gas is expected to displace coal use among the participating Annex I nations, because natural gas is cleaner than coal and has an economic advantage over nuclear and renewable energy sources, which produce no net carbon dioxide emissions. In the longer term, as the marginal costs of carbon dioxide reductions increase, natural gas becomes less attractive than the non-fossil fuels (especially nuclear power), which begin to displace natural gas by 2030.

The projection for natural gas consumption in the Kyoto Protocol case is 1 quadrillion Btu higher than the reference case projection in 2010 but 2 quadrillion Btu lower in 2030, when non-fossil fuel use is almost 6 quadrillion Btu higher in the Kyoto Protocol case than in the reference case. Renewables account for about 1.6 quadrillion Btu of the increase and nuclear power 4.3 quadrillion Btu.

Table 14. Energy Consumption and Carbon Dioxide Emissions by Fuel in Participating Annex I Countries in Two Cases, 2010 and 2030

	Energy Consumption (Quadrillion Btu)				Carbon Dioxide Emissions (Million Metric Tons)			
	2010		2030		2010		2030	
Fuel	Reference Case	Kyoto Protocol Case	Reference Case	Kyoto Protocol Case	Reference Case	Kyoto Protocol Case	Reference Case	Kyoto Protocol Case
Oil	48.4	47.6	49.7	48.8	3,090	3,039	3,174	3,116
Natural Gas	29.3	30.5	41.0	38.9	1,548	1,610	2,167	2,054
Coal	18.5	14.2	20.2	15.5	1,719	1,285	1,874	1,370
Nuclear	13.4	13.7	12.5	16.8	—	—	—	—
Renewables	13.1	13.4	14.6	16.2	—	—	—	—
Total	**122.7**	**119.4**	**138.0**	**136.2**	**6,357**	**5,935**	**7,216**	**6,541**

Source: Energy Information Administration, System for the Analysis of Global Energy Markets (2006).

Regional Projections

Canada

In April 2005, Canada unveiled its plan for compliance with the Kyoto Protocol, based on multiple approaches. The plan includes binding constraints on the country's electric power sector and large-scale industrial emitters, subsidies for wind power, a "partnership fund" between government and industry, soil management goals, and programs in consumer awareness and voluntary reductions by automakers. The Canadian government also has budgeted $3.2 billion to $4.0 billion for purchases of carbon credits, depending on the permit price [*1*].

In January 2006, Canada elected Conservatives to 124 of 308 Parliament seats, versus 103 for the Liberal party, resulting in a change to a Conservative government. Although the new government may reevaluate and reinterpret Canada's Kyoto commitment, the Kyoto Protocol case nevertheless assumes that Canada will remain a participant in the Protocol, and that it will achieve its goals through a combination of domestic actions and purchases of emissions credits.

At the permit price of $42 per metric ton, Canada achieves some reductions domestically below that price in all years of the projection period. Canada's energy demand in 2010 is 0.4 quadrillion Btu (2.6 percent) lower in the Kyoto Protocol case than in the reference case, and its energy-related carbon dioxide emissions in 2010 are 63 million metric tons (9.2 percent) lower (Table 15).

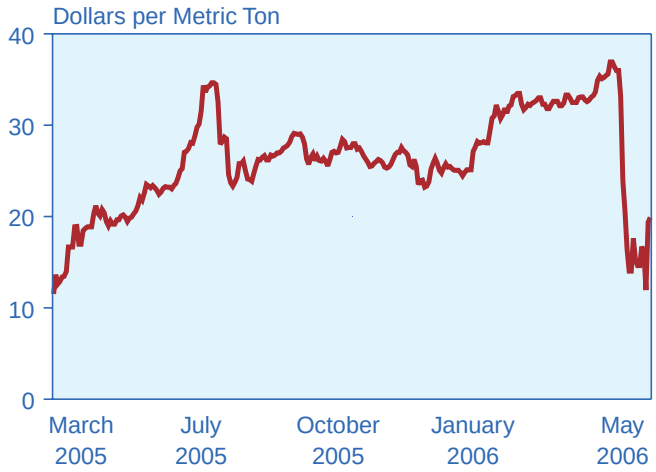
In 2010, Canada's coal consumption and associated carbon dioxide emissions both are about 43 percent lower in the Kyoto Protocol case than in the reference case. In 2030, its coal consumption is 32 percent lower than in the reference case, but emissions from coal are about 44 percent lower. The difference results from the introduction of technology that allows for the consumption of coal with 90 percent of the carbon dioxide sequestered. Emissions associated with oil consumption are about the same in the two cases in 2010 and 2030. Emissions from natural gas use are about the same in 2010 and 6 percent lower in the Kyoto Protocol case in 2030. Canada's consumption of non-fossil energy (nuclear and renewables) in 2030 is about 24 percent higher in the Kyoto Protocol case than in the reference case.

OECD Europe

The EU has developed its own plan for emissions trading in the 2005 to 2007 period, in preparation for the first Kyoto commitment period in 2008 [**2**]. The EU Greenhouse Gas Emission Trading Scheme (EU ETS) allocates emissions to more than 12,000 specific installations across 25 member countries and requires reductions or European Union Allowances (EUAs) to meet the allocated goals.

As of publication of this report, more than a year's worth of data has been accumulated since the EU ETS began trading in January 2005 (Figure 70). When trading began, the market price of an EUA for 1 metric ton of

Figure 70. Carbon Dioxide Allowance Price in the European Union, March 2005–May 2006



Sources: Deutsche Bank Commodities Research, e-mail dated May 17, 2006.

Table 15. Energy Consumption and Carbon Dioxide Emissions by Fuel in Canada in Two Cases, 2010 and 2030

Fuel	Energy Consumption (Quadrillion Btu)				Carbon Dioxide Emissions (Million Metric Tons)			
	2010		2030		2010		2030	
	Reference Case	Kyoto Protocol Case	Reference Case	Kyoto Protocol Case	Reference Case	Kyoto Protocol Case	Reference Case	Kyoto Protocol Case
Oil	4.8	4.8	5.1	5.1	305	306	327	325
Natural Gas	4.2	4.2	5.4	5.1	224	222	286	269
Coal	1.7	1.0	2.8	1.9	154	92	260	146
Nuclear	1.2	1.2	1.2	1.6	—	—	—	—
Renewables	3.8	4.0	4.6	5.6	—	—	—	—
Total	**15.6**	**15.2**	**19.2**	**19.3**	**683**	**620**	**873**	**741**

Source: Energy Information Administration, System for the Analysis of Global Energy Markets (2006).

carbon dioxide was around $12,[18] with prices fluctuating between $25 and $35 for most of 2005 and into the early part of 2006. The market did, however, experience marked volatility with the release of official estimates of industry emissions by country—which initially indicated that in 2005 Europe's major industries emitted 44 million metric tons less carbon dioxide than permitted. As a result, in late April 2006 the EUA price dropped precipitously, from about $36 per metric ton to record low of $11 per ton on May 12, 2006, but then recovered to nearly $20 per metric ton on May 16, one day after the United Kingdom and Spain were among the countries that reported exceeding their emissions limits [*3*].

The next trading period will begin in 2008, coinciding with the Kyoto Protocol's first commitment period. In the 2008-2012 commitment period, the price of EUAs will depend on the availability of credits from Russia and elsewhere, on the rules that ultimately apply to European domestic reductions by country, and on the rules governing European actions in total. As the SAGE model is currently configured, OECD Europe includes the Czech Republic, Hungary, Poland, and Slovakia—countries that in last year's report were part of the separate "Eastern Europe" region. This inclusion helps to mitigate the cost of achieving Kyoto goals for the OECD Europe region. To the extent that sharing of emissions reduction obligations across OECD Europe is restricted by provisions included in the Kyoto Protocol, the results of the Kyoto Protocol case may understate the challenges faced by countries of OECD Europe that were not included in the old "Eastern Europe" region.

OECD Europe's total projected energy demand is 2.2 quadrillion Btu lower in the Kyoto Protocol case than in the reference case in 2010 and 1.7 quadrillion Btu lower in 2030, and its energy-related carbon dioxide emissions are 284 million metric tons lower in 2010 and 446 million metric tons lower in 2030 (Table 16). Its coal consumption and associated emissions are 27 percent lower in 2010 in the Kyoto Protocol case than in the reference case and 25 percent lower in 2030. Oil consumption and related emissions are about 2.4 percent lower in the Kyoto Protocol case in 2030, natural gas consumption and associated emissions are 4.4 percent lower, and consumption of non-fossil fuels is 24 percent higher than in the reference case in 2030.

Japan

Japan's plan for compliance relies heavily on carbon sinks and Clean Development Mechanisms for most of the required emissions reductions to meet its Kyoto goal [*4*]. In 2010, Japan's energy demand is 0.7 quadrillion Btu lower in the Kyoto Protocol case than in the reference case, and emissions are 72 million metric tons lower (Table 17). Assuming that the country's goals for the first commitment period remain in place at the same level through 2030, its total energy demand in 2030 is 0.2 quadrillion Btu lower than in the reference case, and its energy-related carbon dioxide emissions are 94 million metric tons lower in 2030.

Japan's coal consumption in 2030 is 10 percent lower in the Kyoto Protocol case than in the reference case, and its oil consumption is 1 percent lower. Electricity generation from its nuclear power plants in 2030 is almost 0.7 quadrillion Btu higher than in the reference case, and with lower total energy demand, its natural gas consumption is 10 percent lower in the Kyoto Protocol case than in the reference case.

References

1. C. Holly, "Canada Unveils Kyoto Compliance Plan," *The Energy Daily*, Vol. 33, No. 74 (April 20, 2005), pp. 1 and 4; and Government of Canada, *Project Green: Moving Forward on Climate Change* (Ottawa, Canada, April 2005), web site www.climatechange.gc.ca/kyoto_commitments/report_e.pdf.

Table 16. Energy Consumption and Carbon Dioxide Emissions by Fuel in OECD Europe in Two Cases, 2010 and 2030

	Energy Consumption (Quadrillion Btu)				Carbon Dioxide Emissions (Million Metric Tons)			
	2010		2030		2010		2030	
Fuel	Reference Case	Kyoto Protocol Case	Reference Case	Kyoto Protocol Case	Reference Case	Kyoto Protocol Case	Reference Case	Kyoto Protocol Case
Oil	32.6	32.0	33.5	32.7	2,135	2,096	2,194	2,142
Natural Gas	21.7	23.1	31.6	30.2	1,146	1,220	1,668	1,595
Coal	12.7	9.3	13.4	10.0	1,191	872	1,257	938
Nuclear	9.5	9.7	7.5	10.7	—	—	—	—
Renewables	7.9	8.1	8.5	9.2	—	—	—	—
Total	**84.4**	**82.2**	**94.5**	**92.8**	**4,472**	**4,188**	**5,120**	**4,674**

Source: Energy Information Administration, System for the Analysis of Global Energy Markets (2006).

[18]Credits are traded in Euros. The conversion rate used here is 1.19 U.S. dollars per Euro.

Table 17. Energy Consumption and Carbon Dioxide Emissions by Fuel in Japan in Two Cases, 2010 and 2030

Fuel	Energy Consumption (Quadrillion Btu)				Carbon Dioxide Emissions (Million Metric Tons)			
	2010		2030		2010		2030	
	Reference Case	Kyoto Protocol Case	Reference Case	Kyoto Protocol Case	Reference Case	Kyoto Protocol Case	Reference Case	Kyoto Protocol Case
Oil	11.0	10.8	11.1	11.0	648	637	652	649
Natural Gas . . .	3.4	3.2	4.0	3.6	179	169	211	190
Coal	4.1	3.9	4.0	3.6	373	321	356	286
Nuclear	2.8	2.8	3.8	4.5	—	—	—	—
Renewables . . .	1.4	1.3	1.6	1.4	—	—	—	—
Total	**22.7**	**22.0**	**24.3**	**24.1**	**1,200**	**1,128**	**1,219**	**1,125**

Source: Energy Information Administration, System for the Analysis of Global Energy Markets (2006).

2. European Commission, "Emissions Trading: Commission Sets Out Guidance on National Allocations for 2008-2012," Press Release (January 9, 2006), web site http://europa.eu.int/press_room/index_en.htm, Reference Number IP/06/9.
3. Q. Schiermeier, "Europe Fails on Carbon Limits: Industry Emitted Less Than Allowed in 2005; But That Isn't Good News," news@nature.com (May 15, 2006), web site www.nature.com/news/.
4. H. Yamagata, "Japan's Climate Change Policy and Kyoto Mechanisms." Presentation at the Climate Policy in the U.S. and Japan: Prospects in 2005 and Beyond workshop (Tokyo, Japan, May 11-12, 2005), sponsored by Resources for the Future, web site www.rff.org/rff/Events/conferences.

Appendix A

Reference Case Projections:

- World Energy Consumption
- Gross Domestic Product
- Carbon Dioxide Emissions
- World Population

Table A1. World Total Energy Consumption by Region, Reference Case, 1990-2030
(Quadrillion Btu)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**100.8**	**117.5**	**118.3**	**131.4**	**139.9**	**148.4**	**157.0**	**166.2**	**1.3**
United States[a]	84.6	98.1	98.1	107.9	114.2	120.6	127.0	133.9	1.2
Canada	11.1	13.1	13.5	15.6	16.6	17.5	18.4	19.2	1.3
Mexico	5.0	6.2	6.8	7.9	9.1	10.3	11.7	13.2	2.5
OECD Europe	**69.9**	**77.9**	**78.9**	**84.4**	**87.2**	**88.7**	**91.3**	**94.5**	**0.7**
OECD Asia	**26.7**	**36.5**	**37.1**	**40.3**	**42.8**	**44.4**	**46.1**	**48.0**	**1.0**
Japan	18.4	22.2	22.4	22.7	23.4	23.6	24.0	24.3	0.3
South Korea	3.8	8.4	8.6	10.9	12.3	13.3	14.4	15.5	2.2
Australia/New Zealand	4.4	6.0	6.0	6.6	7.0	7.4	7.8	8.2	1.2
Total OECD	**197.4**	**231.9**	**234.3**	**256.1**	**269.9**	**281.6**	**294.5**	**308.8**	**1.0**
Non-OECD									
Non-OECD Europe and Eurasia	**67.2**	**46.9**	**48.5**	**56.5**	**62.8**	**68.7**	**74.0**	**79.0**	**1.8**
Russia	39.0	28.1	29.1	33.3	36.5	39.6	42.4	44.8	1.6
Other	28.3	18.8	19.4	23.2	26.3	29.1	31.6	34.1	2.1
Non-OECD Asia	**47.5**	**78.4**	**83.1**	**126.2**	**149.4**	**172.8**	**197.1**	**223.6**	**3.7**
China	27.0	42.1	45.5	77.0	91.8	106.6	121.7	139.1	4.2
India	8.0	13.8	14.0	19.4	22.5	25.7	29.0	32.5	3.2
Other Non-OECD Asia	12.5	22.5	23.6	29.8	35.1	40.6	46.4	52.0	3.0
Middle East	**11.3**	**19.1**	**19.6**	**25.0**	**28.2**	**31.2**	**34.3**	**37.7**	**2.4**
Africa	**9.5**	**12.8**	**13.3**	**17.7**	**20.5**	**22.3**	**24.3**	**26.8**	**2.6**
Central and South America	**14.5**	**21.3**	**21.9**	**28.2**	**32.5**	**36.5**	**41.2**	**45.7**	**2.8**
Brazil	5.8	8.6	8.8	10.8	12.4	13.8	15.5	17.2	2.5
Other Central and South America	8.8	12.7	13.1	17.4	20.1	22.7	25.7	28.5	2.9
Total Non-OECD	**150.0**	**178.4**	**186.4**	**253.6**	**293.5**	**331.5**	**371.0**	**412.8**	**3.0**
Total World	**347.3**	**410.3**	**420.7**	**509.7**	**563.4**	**613.0**	**665.4**	**721.6**	**2.0**

[a]Includes the 50 States and the District of Columbia.

Notes: Energy totals include net imports of coal coke and electricity generated from biomass in the United States. Totals may not equal sum of components due to independent rounding. The electricity portion of the national fuel consumption values consists of generation for domestic use plus an adjustment for electricity trade based on a fuel's share of total generation in the exporting country.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run AEO2006.D111905A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table A2. World Total Energy Consumption by Region and Fuel, Reference Case, 1990-2030
(Quadrillion Btu)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America									
Oil	40.5	46.3	47.2	52.3	55.5	58.3	61.4	65.0	1.2
Natural Gas	23.2	28.4	28.3	30.6	33.8	35.8	37.0	37.9	1.1
Coal	20.7	24.0	24.4	27.3	28.5	31.0	34.4	38.2	1.7
Nuclear	6.9	9.0	8.9	9.7	10.0	10.5	10.4	10.4	0.6
Other	9.5	9.8	9.5	11.5	12.0	12.8	13.9	14.7	1.6
Total	**100.8**	**117.5**	**118.3**	**131.4**	**139.9**	**148.4**	**157.0**	**166.2**	**1.3**
OECD Europe									
Oil	28.4	31.6	32.0	32.6	32.8	32.5	33.0	33.5	0.2
Natural Gas	11.2	17.7	18.3	21.7	24.5	26.6	29.0	31.6	2.0
Coal	17.6	12.8	12.8	12.7	12.7	12.9	12.9	13.4	0.2
Nuclear	7.9	9.7	9.8	9.5	9.3	8.5	7.9	7.5	-1.0
Other	4.8	6.1	6.0	7.9	8.0	8.3	8.4	8.5	1.3
Total	**69.9**	**77.9**	**78.9**	**84.4**	**87.2**	**88.7**	**91.3**	**94.5**	**0.7**
OECD Asia									
Oil	14.5	17.5	17.8	18.5	19.2	19.6	20.1	20.6	0.5
Natural Gas	2.9	5.1	5.3	5.7	6.3	6.7	6.9	7.2	1.2
Coal	5.2	8.2	8.4	9.7	10.2	10.5	10.9	11.5	1.2
Nuclear	2.5	4.0	3.7	4.2	4.7	5.3	5.8	6.2	2.0
Other	1.6	1.7	1.9	2.2	2.3	2.4	2.4	2.5	0.9
Total	**26.7**	**36.5**	**37.1**	**40.3**	**42.8**	**44.4**	**46.1**	**48.0**	**1.0**
Total OECD									
Oil	83.4	95.4	97.0	103.3	107.5	110.3	114.5	119.1	0.8
Natural Gas	37.2	51.2	51.9	58.0	64.7	69.1	72.9	76.8	1.5
Coal	43.5	44.9	45.6	49.7	51.4	54.3	58.3	63.1	1.2
Nuclear	17.3	22.7	22.3	23.4	24.0	24.3	24.1	24.1	0.3
Other	15.9	17.6	17.4	21.7	22.3	23.5	24.7	25.7	1.5
Total	**197.4**	**231.9**	**234.3**	**256.1**	**269.9**	**281.6**	**294.5**	**308.8**	**1.0**
Non-OECD									
Non-OECD Europe and Eurasia									
Oil	19.5	9.9	10.1	11.4	12.4	13.0	14.0	14.8	1.4
Natural Gas	27.5	23.0	24.3	29.4	32.4	35.8	38.6	41.7	2.0
Coal	15.1	8.3	8.4	8.7	9.8	10.8	11.7	12.6	1.5
Nuclear	2.5	2.8	2.8	3.1	3.5	4.3	4.8	4.9	2.0
Other	2.8	3.0	3.0	4.0	4.6	4.7	4.9	5.0	1.9
Total	**67.2**	**46.9**	**48.5**	**56.5**	**62.8**	**68.7**	**74.0**	**79.0**	**1.8**
Non-OECD Asia									
Oil	13.9	26.7	27.9	38.3	43.5	49.3	55.2	61.7	3.0
Natural Gas	3.0	7.3	7.9	12.4	16.6	20.8	25.5	30.6	5.2
Coal	27.2	38.7	41.2	63.7	75.7	87.0	98.6	111.3	3.8
Nuclear	0.4	0.9	1.0	2.0	2.9	3.8	4.6	5.3	6.3
Other	3.0	4.9	5.1	9.8	10.8	11.9	13.2	14.8	4.0
Total	**47.5**	**78.4**	**83.1**	**126.2**	**149.4**	**172.8**	**197.1**	**223.6**	**3.7**

See notes at end of table.

Table A2. World Total Energy Consumption by Region and Fuel, Reference Case, 1990-2030 (Continued)
(Quadrillion Btu)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
Non-OECD (Continued)									
Middle East									
Oil	7.2	10.5	10.8	12.4	13.5	14.3	15.2	16.0	1.5
Natural Gas	3.8	8.0	8.2	11.6	13.7	15.7	18.0	20.5	3.4
Coal	0.1	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.8
Nuclear	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	—
Other	0.1	0.2	0.2	0.6	0.6	0.7	0.7	0.8	4.5
Total	**11.3**	**19.1**	**19.6**	**25.0**	**28.2**	**31.2**	**34.3**	**37.7**	**2.4**
Africa									
Oil	4.3	5.4	5.5	7.6	8.3	8.8	9.3	10.1	2.3
Natural Gas	1.5	2.6	2.7	3.5	4.9	6.1	7.4	8.7	4.4
Coal	3.0	3.7	4.1	5.3	5.9	6.1	6.2	6.4	1.7
Nuclear	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.7
Other	0.6	0.9	0.9	1.2	1.3	1.3	1.3	1.5	1.9
Total	**9.5**	**12.8**	**13.3**	**17.7**	**20.5**	**22.3**	**24.3**	**26.8**	**2.6**
Central and South America									
Oil	7.7	10.8	10.8	12.6	13.9	15.0	16.2	17.5	1.8
Natural Gas	2.2	3.8	4.1	6.3	7.6	8.7	10.2	11.6	3.9
Coal	0.6	0.7	0.8	1.0	1.1	1.4	1.5	1.6	2.9
Nuclear	0.1	0.2	0.2	0.2	0.4	0.3	0.4	0.3	0.5
Other	3.9	5.7	6.0	8.1	9.5	11.1	12.9	14.7	3.3
Total	**14.5**	**21.3**	**21.9**	**28.2**	**32.5**	**36.5**	**41.2**	**45.7**	**2.8**
Total Non-OECD									
Oil	52.7	63.3	65.1	82.3	91.6	100.4	109.8	120.0	2.3
Natural Gas	38.0	44.7	47.2	63.1	75.1	87.0	99.6	113.1	3.3
Coal	45.9	51.8	54.8	79.1	92.9	105.7	118.4	132.4	3.3
Nuclear	3.1	4.0	4.2	5.5	7.0	8.7	10.0	10.6	3.5
Other	10.3	14.6	15.2	23.6	26.8	29.6	33.1	36.7	3.3
Total	**150.0**	**178.4**	**186.4**	**253.6**	**293.5**	**331.5**	**371.0**	**412.8**	**3.0**
Total World									
Oil	136.1	158.7	162.1	185.6	199.1	210.8	224.3	239.1	1.4
Natural Gas	75.2	95.9	99.1	121.1	139.8	156.1	172.5	189.9	2.4
Coal	89.4	96.8	100.4	128.8	144.4	160.1	176.7	195.5	2.5
Nuclear	20.4	26.7	26.5	28.9	31.0	32.9	34.0	34.7	1.0
Other	26.3	32.2	32.7	45.2	49.1	53.1	57.8	62.4	2.4
Total	**347.3**	**410.3**	**420.7**	**509.7**	**563.4**	**613.0**	**665.4**	**721.6**	**2.0**

Notes: Energy totals include net imports of coal coke and electricity generated from biomass in the United States. Totals may not equal sum of components due to independent rounding. The electricity portion of the national fuel consumption values consists of generation for domestic use plus an adjustment for electricity trade based on a fuel's share of total generation in the exporting country.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run AEO2006.D111905A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table A3. World Gross Domestic Product (GDP) by Region Using Purchasing Power Parity, Reference Case, 1990-2030
(Billion 2000 Dollars)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**8,477**	**11,968**	**12,273**	**15,503**	**17,986**	**20,940**	**24,083**	**27,733**	**3.1**
United States[a]	7,113	10,049	10,321	13,043	15,082	17,541	20,123	23,112	3.0
Canada	684	957	977	1,190	1,343	1,484	1,614	1,753	2.2
Mexico	680	962	976	1,271	1,561	1,916	2,346	2,868	4.1
OECD Europe	**8,017**	**10,647**	**10,799**	**12,713**	**14,194**	**15,799**	**17,508**	**19,394**	**2.2**
OECD Asia	**3,655**	**4,628**	**4,716**	**5,615**	**6,265**	**6,811**	**7,343**	**7,924**	**1.9**
Japan	2,898	3,329	3,375	3,858	4,192	4,438	4,653	4,878	1.4
South Korea	330	663	683	966	1,180	1,368	1,560	1,776	3.6
Australia/New Zealand	428	637	657	791	893	1,005	1,130	1,270	2.5
Total OECD	**20,150**	**27,243**	**27,788**	**33,832**	**38,445**	**43,550**	**48,934**	**55,051**	**2.6**
Non-OECD									
Non-OECD Europe and Eurasia	**3,387**	**2,672**	**2,878**	**4,315**	**5,345**	**6,494**	**7,759**	**9,190**	**4.4**
Russia	2,241	1,658	1,780	2,531	3,059	3,656	4,304	5,005	3.9
Other	1,146	1,013	1,099	1,784	2,286	2,837	3,455	4,185	5.1
Non-OECD Asia	**5,780**	**12,559**	**13,516**	**21,134**	**27,606**	**35,422**	**44,905**	**56,707**	**5.5**
China	1,807	5,494	5,994	10,116	13,538	17,615	22,592	28,833	6.0
India	1,684	3,160	3,429	5,162	6,694	8,644	11,059	14,102	5.4
Other Non-OECD Asia	2,289	3,905	4,093	5,856	7,374	9,162	11,255	13,772	4.6
Middle East	**810**	**1,295**	**1,357**	**1,946**	**2,376**	**2,863**	**3,423**	**4,085**	**4.2**
Africa	**1,461**	**2,074**	**2,173**	**3,073**	**3,815**	**4,684**	**5,717**	**6,970**	**4.4**
Central and South America	**2,174**	**3,011**	**3,075**	**4,136**	**4,956**	**5,904**	**7,015**	**8,328**	**3.8**
Brazil	1,022	1,370	1,378	1,796	2,127	2,510	2,951	3,462	3.5
Other Central and South America	1,153	1,641	1,697	2,340	2,828	3,395	4,064	4,866	4.0
Total Non-OECD	**13,612**	**21,611**	**22,999**	**34,603**	**44,098**	**55,366**	**68,820**	**85,281**	**5.0**
Total World	**33,761**	**48,854**	**50,786**	**68,435**	**82,544**	**98,917**	**117,754**	**140,331**	**3.8**

[a]Includes the 50 States and the District of Columbia.

Notes: Totals may not equal sum of components due to independent rounding. GDP growth rates for China and India were adjusted, based on the analyst's judgment.

Sources: **History:** Global Insight, Inc., *World Overview* (Lexington, MA, various issues). **Projections:** Global Insight, Inc., *World Overview*, Fourth Quarter 2005 (Lexington, MA, January 2006); and Energy Information Administration, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington DC, February 2006), Table A19.

Table A4. World Oil Consumption by Region, Reference Case, 1990-2030
(Million Barrels per Day)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**20.5**	**23.8**	**24.3**	**26.8**	**28.5**	**30.0**	**31.5**	**33.4**	**1.2**
United States[a]	17.0	19.8	20.1	22.2	23.5	24.8	26.1	27.6	1.2
Canada	1.7	2.1	2.2	2.4	2.5	2.5	2.6	2.6	0.6
Mexico	1.8	1.9	2.0	2.2	2.5	2.7	2.9	3.2	1.7
OECD Europe	**13.7**	**15.3**	**15.5**	**15.8**	**15.9**	**15.8**	**16.0**	**16.3**	**0.2**
OECD Asia	**7.1**	**8.6**	**8.8**	**9.1**	**9.4**	**9.6**	**9.9**	**10.1**	**0.5**
Japan	5.2	5.5	5.6	5.4	5.5	5.4	5.5	5.4	-0.1
South Korea	1.0	2.1	2.2	2.6	2.9	3.0	3.2	3.5	1.7
Australia/New Zealand	0.8	1.0	1.0	1.1	1.1	1.1	1.2	1.2	0.6
Total OECD	**41.3**	**47.7**	**48.5**	**51.7**	**53.9**	**55.3**	**57.4**	**59.7**	**0.8**
Non-OECD									
Non-OECD Europe and Eurasia	**9.3**	**4.8**	**4.9**	**5.5**	**6.0**	**6.3**	**6.7**	**7.1**	**1.4**
Russia	5.4	2.6	2.7	2.8	3.1	3.1	3.3	3.4	0.9
Other	3.9	2.1	2.2	2.6	2.9	3.2	3.5	3.8	2.0
Non-OECD Asia	**6.6**	**12.9**	**13.5**	**18.5**	**21.0**	**23.8**	**26.7**	**29.8**	**3.0**
China	2.3	5.2	5.6	8.7	10.0	11.7	13.2	15.0	3.8
India	1.2	2.3	2.3	2.9	3.3	3.7	4.1	4.5	2.4
Other Non-OECD Asia	3.1	5.5	5.6	6.9	7.7	8.5	9.4	10.3	2.3
Middle East	**3.5**	**5.1**	**5.3**	**6.1**	**6.6**	**7.0**	**7.4**	**7.8**	**1.5**
Africa	**2.1**	**2.7**	**2.7**	**3.7**	**4.0**	**4.3**	**4.5**	**4.9**	**2.3**
Central and South America	**3.8**	**5.3**	**5.3**	**6.2**	**6.8**	**7.3**	**7.9**	**8.5**	**1.8**
Brazil	1.5	2.1	2.1	2.4	2.6	2.8	3.1	3.3	1.7
Other Central and South America	2.3	3.1	3.2	3.8	4.2	4.5	4.8	5.2	1.9
Total Non-OECD	**25.3**	**30.7**	**31.6**	**39.9**	**44.5**	**48.7**	**53.3**	**58.2**	**2.3**
Total World	**66.6**	**78.5**	**80.1**	**91.6**	**98.3**	**104.1**	**110.7**	**118.0**	**1.4**

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run AEO2006.D111905A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table A5. World Natural Gas Consumption by Region, Reference Case, 1990-2030
(Trillion Cubic Feet)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**22.5**	**27.6**	**27.4**	**29.6**	**32.7**	**34.7**	**35.7**	**36.6**	**1.1**
United States[a]	19.2	23.0	22.3	23.4	25.9	26.9	27.0	26.9	0.7
Canada	2.4	3.1	3.2	4.2	4.2	4.7	5.0	5.3	1.9
Mexico	0.9	1.5	1.8	2.1	2.6	3.1	3.8	4.5	3.4
OECD Europe	**11.6**	**17.2**	**17.8**	**21.1**	**23.9**	**25.8**	**28.2**	**30.8**	**2.0**
OECD Asia	**2.8**	**4.8**	**5.0**	**5.4**	**5.9**	**6.3**	**6.5**	**6.8**	**1.2**
Japan	1.9	2.9	3.1	3.2	3.5	3.6	3.6	3.8	0.8
South Korea	0.1	0.8	0.9	1.0	1.2	1.3	1.3	1.3	1.7
Australia/New Zealand	0.8	1.1	1.1	1.1	1.3	1.5	1.6	1.7	1.7
Total OECD	**36.8**	**49.6**	**50.2**	**56.1**	**62.6**	**66.8**	**70.5**	**74.2**	**1.5**
Non-OECD									
Non-OECD Europe and Eurasia	**26.7**	**22.3**	**23.6**	**28.6**	**31.5**	**34.8**	**37.5**	**40.5**	**2.0**
Russia	17.3	14.6	15.3	18.1	19.3	21.2	22.4	23.6	1.6
Other	9.5	7.8	8.3	10.5	12.2	13.6	15.1	16.9	2.7
Non-OECD Asia	**2.9**	**6.9**	**7.5**	**11.7**	**15.6**	**19.6**	**24.0**	**28.8**	**5.1**
China	0.5	1.1	1.2	3.0	3.9	5.1	6.2	7.0	6.8
India	0.4	0.9	1.0	1.5	1.7	2.2	3.1	4.5	5.9
Other Non-OECD Asia	2.0	4.9	5.4	7.3	10.0	12.3	14.7	17.3	4.4
Middle East	**3.6**	**7.6**	**7.9**	**11.0**	**13.0**	**15.0**	**17.1**	**19.6**	**3.4**
Africa	**1.4**	**2.4**	**2.6**	**3.3**	**4.6**	**5.6**	**6.8**	**8.1**	**4.4**
Central and South America	**2.0**	**3.6**	**3.8**	**5.8**	**7.0**	**8.1**	**9.5**	**10.8**	**3.9**
Brazil	0.1	0.5	0.5	1.0	1.1	1.2	1.4	1.7	4.6
Other Central and South America	1.9	3.1	3.3	4.8	6.0	6.9	8.1	9.1	3.8
Total Non-OECD	**36.5**	**42.9**	**45.3**	**60.4**	**71.8**	**83.1**	**94.9**	**107.8**	**3.3**
Total World	**73.4**	**92.5**	**95.5**	**116.5**	**134.3**	**149.9**	**165.5**	**182.0**	**2.4**

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run AEO2006.D111905A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table A6. World Coal Consumption by Region, Reference Case, 1990-2030
(Million Short Tons)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**972**	**1,151**	**1,185**	**1,331**	**1,402**	**1,537**	**1,748**	**1,948**	**1.9**
United States[a]	904	1,066	1,095	1,233	1,276	1,390	1,592	1,784	1.8
Canada	59	68	69	73	97	110	117	123	2.1
Mexico	9	17	20	25	29	36	39	40	2.5
OECD Europe	**1,298**	**892**	**887**	**879**	**878**	**893**	**896**	**928**	**0.2**
OECD Asia	**280**	**400**	**404**	**469**	**494**	**508**	**531**	**560**	**1.2**
Japan	126	172	176	177	181	176	170	169	-0.1
South Korea	48	80	81	120	133	142	158	175	2.9
Australia/New Zealand	106	148	147	172	180	190	203	216	1.4
Total OECD	**2,551**	**2,442**	**2,476**	**2,680**	**2,774**	**2,938**	**3,175**	**3,436**	**1.2**
Non-OECD									
Non-OECD Europe and Eurasia	**1,028**	**530**	**543**	**595**	**668**	**736**	**796**	**856**	**1.7**
Russia	447	240	251	263	296	330	355	382	1.6
Other	581	290	292	333	372	405	440	474	1.8
Non-OECD Asia	**1,507**	**2,041**	**2,168**	**3,351**	**3,987**	**4,585**	**5,191**	**5,855**	**3.7**
China	1,124	1,413	1,531	2,535	3,045	3,530	4,043	4,645	4.2
India	256	431	431	583	686	775	842	887	2.7
Other Non-OECD Asia	127	197	206	234	257	280	306	323	1.7
Middle East	**6**	**16**	**16**	**16**	**16**	**17**	**17**	**19**	**0.8**
Africa	**152**	**187**	**203**	**266**	**293**	**304**	**312**	**320**	**1.7**
Central and South America	**27**	**34**	**35**	**47**	**53**	**63**	**68**	**74**	**2.8**
Brazil	17	22	24	30	35	39	42	46	2.4
Other Central and South America	10	12	11	17	18	23	25	29	3.5
Total Non-OECD	**2,718**	**2,808**	**2,964**	**4,276**	**5,018**	**5,704**	**6,383**	**7,125**	**3.3**
Total World	**5,269**	**5,250**	**5,440**	**6,956**	**7,792**	**8,642**	**9,558**	**10,561**	**2.5**

[a]Includes the 50 States and the District of Columbia.

Notes: Totals may not equal sum of components due to independent rounding. To convert short tons to metric tons, divide each number in the table by 1.102.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run AEO2006.D111905A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table A7. World Nuclear Energy Consumption by Region, Reference Case, 1990-2030
(Billion Kilowatthours)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**649**	**861**	**844**	**923**	**953**	**994**	**989**	**989**	**0.6**
United States[a]	577	780	764	809	829	871	871	871	0.5
Canada	69	72	71	104	113	113	108	108	1.6
Mexico	3	9	10	11	11	11	11	11	0.2
OECD Europe	**743**	**923**	**930**	**896**	**877**	**807**	**748**	**707**	**-1.0**
OECD Asia	**242**	**393**	**360**	**416**	**464**	**518**	**567**	**610**	**2.0**
Japan	192	280	237	274	289	318	350	371	1.7
South Korea	50	113	123	142	175	200	217	239	2.5
Australia/New Zealand	0	0	0	0	0	0	0	0	—
Total OECD	**1,635**	**2,178**	**2,135**	**2,234**	**2,294**	**2,320**	**2,304**	**2,307**	**0.3**
Non-OECD									
Non-OECD Europe and Eurasia	**219**	**254**	**258**	**278**	**323**	**393**	**441**	**443**	**2.0**
Russia	115	134	138	151	190	233	286	321	3.2
Other	104	120	120	127	133	160	155	122	0.1
Non-OECD Asia	**38**	**83**	**97**	**187**	**268**	**356**	**434**	**504**	**6.3**
China	0	25	42	79	130	171	230	304	7.6
India	6	18	16	56	76	99	106	112	7.4
Other Non-OECD Asia	32	40	39	52	62	85	98	89	3.1
Middle East	**0**	**0**	**0**	**6**	**6**	**6**	**6**	**6**	**—**
Africa	**8**	**12**	**13**	**14**	**15**	**15**	**15**	**15**	**0.7**
Central and South America	**9**	**19**	**20**	**21**	**35**	**32**	**33**	**24**	**0.6**
Brazil	2	14	13	13	22	23	23	19	1.2
Other Central and South America	7	5	7	7	12	10	10	5	-1.1
Total Non-OECD	**274**	**368**	**388**	**505**	**647**	**802**	**929**	**993**	**3.5**
Total World	**1,909**	**2,546**	**2,523**	**2,739**	**2,940**	**3,122**	**3,233**	**3,299**	**1.0**

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run AEO2006.D111905A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table A8. World Consumption of Hydroelectricity and Other Renewable Energy by Region, Reference Case, 1990-2030
(Quadrillion Btu)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**9.5**	**9.8**	**9.5**	**11.5**	**12.0**	**12.8**	**13.9**	**14.7**	**1.6**
United States[a]	6.1	5.9	5.7	7.2	7.5	8.1	8.7	9.1	1.7
Canada	3.1	3.6	3.5	3.8	3.8	4.0	4.3	4.6	1.0
Mexico	0.3	0.4	0.3	0.6	0.7	0.8	0.9	1.1	4.5
OECD Europe	**4.8**	**6.1**	**6.0**	**7.9**	**8.0**	**8.3**	**8.4**	**8.5**	**1.3**
OECD Asia	**1.6**	**1.7**	**1.9**	**2.2**	**2.3**	**2.4**	**2.4**	**2.5**	**0.9**
Japan	1.1	1.1	1.4	1.4	1.5	1.5	1.5	1.6	0.4
South Korea	0.0	0.0	0.1	0.2	0.3	0.3	0.3	0.3	6.7
Australia/New Zealand	0.4	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.8
Total OECD	**15.9**	**17.6**	**17.4**	**21.7**	**22.3**	**23.5**	**24.7**	**25.7**	**1.5**
Non-OECD									
Non-OECD Europe and Eurasia	**2.8**	**3.0**	**3.0**	**4.0**	**4.6**	**4.7**	**4.9**	**5.0**	**1.9**
Russia	1.8	1.9	1.8	2.4	2.9	2.9	3.0	3.1	2.0
Other	1.0	1.1	1.2	1.6	1.7	1.9	1.9	1.9	1.8
Non-OECD Asia	**3.0**	**4.9**	**5.1**	**9.8**	**10.8**	**11.9**	**13.2**	**14.8**	**4.0**
China	1.3	2.8	2.9	6.1	6.8	7.1	7.3	7.6	3.7
India	0.7	0.7	0.7	1.3	1.3	1.5	1.8	2.2	4.2
Other Non-OECD Asia	0.9	1.4	1.5	2.4	2.6	3.3	4.1	4.9	4.5
Middle East	**0.1**	**0.2**	**0.2**	**0.6**	**0.6**	**0.7**	**0.7**	**0.8**	**4.5**
Africa	**0.6**	**0.9**	**0.9**	**1.2**	**1.3**	**1.3**	**1.3**	**1.5**	**1.9**
Central and South America	**3.9**	**5.7**	**6.0**	**8.1**	**9.5**	**11.1**	**12.9**	**14.7**	**3.3**
Brazil	2.2	3.0	3.3	4.2	5.0	5.8	6.7	7.6	3.2
Other Central and South America	1.7	2.7	2.8	3.9	4.5	5.3	6.3	7.1	3.6
Total Non-OECD	**10.3**	**14.6**	**15.2**	**23.6**	**26.8**	**29.6**	**33.1**	**36.7**	**3.3**
Total World	**26.3**	**32.2**	**32.7**	**45.2**	**49.1**	**53.1**	**57.8**	**62.4**	**2.4**

[a]Includes the 50 States and the District of Columbia.

Notes: Totals may not equal sum of components due to independent rounding. U.S. totals include net electricity imports, methanol, and liquid hydrogen.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run AEO2006.D111905A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table A9. World Net Electricity Consumption by Region, Reference Case, 1990-2030
(Billion Kilowatthours)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**3,379**	**4,337**	**4,384**	**5,036**	**5,495**	**5,969**	**6,444**	**6,969**	**1.7**
United States[a]	2,837	3,629	3,669	4,155	4,491	4,844	5,208	5,619	1.6
Canada	435	518	521	605	660	706	740	776	1.5
Mexico	107	190	194	277	344	419	496	574	4.1
OECD Europe	**2,355**	**2,916**	**2,965**	**3,343**	**3,519**	**3,692**	**3,890**	**4,107**	**1.2**
OECD Asia	**1,024**	**1,463**	**1,487**	**1,749**	**1,870**	**1,956**	**2,041**	**2,132**	**1.3**
Japan	764	964	946	1,054	1,092	1,112	1,131	1,151	0.7
South Korea	93	268	303	424	487	534	578	625	2.7
Australia/New Zealand	166	231	238	271	291	311	333	356	1.5
Total OECD	**6,758**	**8,715**	**8,836**	**10,129**	**10,885**	**11,618**	**12,375**	**13,208**	**1.5**
Non-OECD									
Non-OECD Europe and Eurasia	**1,672**	**1,318**	**1,350**	**1,836**	**2,123**	**2,396**	**2,629**	**2,850**	**2.8**
Russia	955	796	812	1,082	1,236	1,394	1,523	1,641	2.6
Other	717	522	539	755	887	1,002	1,106	1,208	3.0
Non-OECD Asia	**1,150**	**2,655**	**2,917**	**4,713**	**5,896**	**7,154**	**8,513**	**10,027**	**4.7**
China	551	1,452	1,671	2,783	3,504	4,256	5,062	5,971	4.8
India	257	525	519	845	1,042	1,251	1,474	1,730	4.6
Other Non-OECD Asia	342	678	726	1,085	1,350	1,646	1,978	2,326	4.4
Middle East	**214**	**457**	**471**	**681**	**782**	**872**	**955**	**1,034**	**3.0**
Africa	**286**	**420**	**436**	**561**	**660**	**750**	**846**	**951**	**2.9**
Central and South America	**463**	**736**	**772**	**1,125**	**1,353**	**1,582**	**1,815**	**2,047**	**3.7**
Brazil	229	353	371	520	610	698	784	871	3.2
Other Central and South America	234	383	400	605	743	884	1,031	1,176	4.1
Total Non-OECD	**3,785**	**5,586**	**5,944**	**8,916**	**10,814**	**12,753**	**14,758**	**16,908**	**3.9**
Total World	**10,543**	**14,301**	**14,781**	**19,045**	**21,699**	**24,371**	**27,133**	**30,116**	**2.7**

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run AEO2006.D111905A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table A10. World Carbon Dioxide Emissions by Region, Reference Case, 1990-2030
(Million Metric Tons Carbon Dioxide)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**5,753**	**6,687**	**6,797**	**7,505**	**7,997**	**8,513**	**9,096**	**9,735**	**1.3**
United States[a]	4,978	5,748	5,796	6,365	6,718	7,119	7,587	8,115	1.3
Canada	474	570	596	683	753	799	839	873	1.4
Mexico	300	369	405	457	526	595	670	747	2.3
OECD Europe	**4,089**	**4,203**	**4,264**	**4,474**	**4,632**	**4,741**	**4,909**	**5,123**	**0.7**
OECD Asia	**1,536**	**2,063**	**2,090**	**2,269**	**2,390**	**2,455**	**2,540**	**2,638**	**0.9**
Japan	1,011	1,191	1,206	1,200	1,228	1,218	1,214	1,219	0.0
South Korea	234	462	470	608	675	723	781	843	2.2
Australia/New Zealand	291	410	415	462	487	515	545	576	1.2
Total OECD	**11,378**	**12,952**	**13,150**	**14,249**	**15,020**	**15,709**	**16,545**	**17,496**	**1.1**
Non-OECD									
Non-OECD Europe and Eurasia	**4,193**	**2,634**	**2,725**	**3,113**	**3,444**	**3,758**	**4,047**	**4,352**	**1.7**
Russia	2,334	1,546	1,606	1,799	1,949	2,117	2,246	2,374	1.5
Other	1,859	1,088	1,118	1,314	1,495	1,641	1,801	1,978	2.1
Non-OECD Asia	**3,626**	**5,733**	**6,072**	**9,079**	**10,753**	**12,407**	**14,113**	**15,984**	**3.6**
China	2,241	3,273	3,541	5,857	7,000	8,159	9,349	10,716	4.2
India	578	1,011	1,023	1,369	1,592	1,799	2,008	2,205	2.9
Other Non-OECD Asia	807	1,449	1,508	1,853	2,161	2,449	2,756	3,062	2.7
Middle East	**704**	**1,152**	**1,182**	**1,463**	**1,647**	**1,811**	**1,987**	**2,177**	**2.3**
Africa	**649**	**850**	**893**	**1,188**	**1,363**	**1,477**	**1,593**	**1,733**	**2.5**
Central and South America	**673**	**993**	**1,006**	**1,270**	**1,436**	**1,586**	**1,758**	**1,933**	**2.4**
Brazil	220	347	348	423	469	508	559	610	2.1
Other Central and South America	453	645	659	847	967	1,078	1,199	1,323	2.6
Total Non-OECD	**9,846**	**11,362**	**11,878**	**16,113**	**18,643**	**21,039**	**23,500**	**26,180**	**3.0**
Total World	**21,223**	**24,314**	**25,028**	**30,362**	**33,663**	**36,748**	**40,045**	**43,676**	**2.1**

[a]Includes the 50 States and the District of Columbia.

Note: The U.S. numbers include carbon dioxide emissions attributable to renewable energy sources.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run AEO2006.D111905A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table A11. World Carbon Dioxide Emissions from Oil Use by Region, Reference Case, 1990-2030
(Million Metric Tons Carbon Dioxide)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**2,636**	**2,969**	**3,034**	**3,331**	**3,538**	**3,721**	**3,922**	**4,160**	**1.2**
United States[a]	2,181	2,456	2,498	2,740	2,900	3,061	3,221	3,421	1.2
Canada	224	262	276	305	320	314	323	327	0.6
Mexico	231	250	260	286	318	346	378	412	1.7
OECD Europe	**1,864**	**2,069**	**2,094**	**2,137**	**2,147**	**2,129**	**2,162**	**2,196**	**0.2**
OECD Asia	**913**	**1,035**	**1,052**	**1,086**	**1,127**	**1,147**	**1,179**	**1,208**	**0.5**
Japan	663	654	667	648	655	649	653	652	-0.1
South Korea	140	244	246	292	324	345	367	392	1.7
Australia/New Zealand	110	137	138	145	148	153	158	164	0.6
Total OECD	**5,412**	**6,073**	**6,180**	**6,554**	**6,811**	**6,996**	**7,263**	**7,563**	**0.8**
Non-OECD									
Non-OECD Europe and Eurasia	**1,350**	**657**	**669**	**757**	**829**	**870**	**932**	**989**	**1.5**
Russia	782	351	356	379	407	415	437	452	0.9
Other	568	306	312	377	422	455	495	538	2.0
Non-OECD Asia	**949**	**1,775**	**1,853**	**2,536**	**2,879**	**3,261**	**3,650**	**4,074**	**3.0**
China	325	686	737	1,153	1,327	1,549	1,760	1,999	3.8
India	160	298	305	387	437	481	535	586	2.4
Other Non-OECD Asia	464	791	810	997	1,114	1,231	1,355	1,488	2.3
Middle East	**492**	**695**	**714**	**818**	**890**	**945**	**1,002**	**1,053**	**1.5**
Africa	**298**	**372**	**379**	**518**	**567**	**603**	**637**	**692**	**2.3**
Central and South America	**503**	**721**	**719**	**845**	**930**	**1,001**	**1,082**	**1,170**	**1.8**
Brazil	180	280	276	315	346	370	406	433	1.7
Other Central and South America	323	441	443	530	585	631	676	737	1.9
Total Non-OECD	**3,592**	**4,219**	**4,333**	**5,474**	**6,095**	**6,680**	**7,303**	**7,978**	**2.3**
Total World	**9,005**	**10,291**	**10,513**	**12,029**	**12,907**	**13,675**	**14,566**	**15,541**	**1.5**

[a]Includes the 50 States and the District of Columbia.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run AEO2006.D111905A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table A12. World Carbon Dioxide Emissions from Natural Gas Use by Region, Reference Case, 1990-2030
(Million Metric Tons Carbon Dioxide)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**1,207**	**1,479**	**1,474**	**1,608**	**1,779**	**1,885**	**1,944**	**1,995**	**1.1**
United States[a]	1,026	1,228	1,196	1,262	1,400	1,455	1,459	1,452	0.7
Canada	127	165	173	224	227	252	270	286	1.9
Mexico	54	86	105	122	151	178	216	257	3.4
OECD Europe	**590**	**934**	**967**	**1,145**	**1,296**	**1,402**	**1,533**	**1,670**	**2.0**
OECD Asia	**152**	**270**	**277**	**300**	**333**	**354**	**365**	**381**	**1.2**
Japan	102	163	169	179	192	198	202	211	0.8
South Korea	6	48	50	60	68	75	78	79	1.7
Australia/New Zealand	44	59	58	62	73	81	86	92	1.7
Total OECD	**1,949**	**2,683**	**2,718**	**3,053**	**3,407**	**3,641**	**3,843**	**4,046**	**1.5**
Non-OECD									
Non-OECD Europe and Eurasia	**1,450**	**1,213**	**1,281**	**1,551**	**1,710**	**1,888**	**2,036**	**2,201**	**2.0**
Russia	928	789	828	978	1,044	1,147	1,212	1,280	1.6
Other	521	424	452	573	666	742	824	921	2.7
Non-OECD Asia	**160**	**384**	**415**	**657**	**875**	**1,097**	**1,344**	**1,613**	**5.2**
China	30	69	72	183	241	313	378	431	6.8
India	24	48	52	82	95	120	170	247	5.9
Other Non-OECD Asia	106	267	290	393	540	663	796	935	4.4
Middle East	**199**	**422**	**435**	**611**	**721**	**830**	**948**	**1,082**	**3.4**
Africa	**80**	**139**	**145**	**185**	**260**	**320**	**388**	**459**	**4.4**
Central and South America	**116**	**203**	**217**	**330**	**400**	**459**	**540**	**614**	**3.9**
Brazil	6	26	27	53	59	66	75	92	4.6
Other Central and South America	110	177	190	277	341	394	465	521	3.8
Total Non-OECD	**2,005**	**2,361**	**2,493**	**3,334**	**3,967**	**4,595**	**5,257**	**5,969**	**3.3**
Total World	**3,954**	**5,044**	**5,211**	**6,387**	**7,374**	**8,236**	**9,099**	**10,015**	**2.4**

[a]Includes the 50 States and the District of Columbia.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run AEO2006.D111905A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table A13. World Carbon Dioxide Emissions from Coal Use by Region, Reference Case, 1990-2030
(Million Metric Tons Carbon Dioxide)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**1,910**	**2,239**	**2,287**	**2,553**	**2,667**	**2,893**	**3,215**	**3,565**	**1.7**
United States[a]	1,772	2,064	2,100	2,350	2,404	2,589	2,892	3,226	1.6
Canada	123	143	147	154	206	233	247	260	2.1
Mexico	15	32	40	49	57	71	76	78	2.5
OECD Europe	**1,635**	**1,199**	**1,203**	**1,192**	**1,190**	**1,211**	**1,214**	**1,258**	**0.2**
OECD Asia	**471**	**758**	**761**	**883**	**931**	**954**	**995**	**1,049**	**1.2**
Japan	245	375	369	373	380	371	359	356	-0.1
South Korea	88	170	173	256	283	303	336	373	2.9
Australia/New Zealand	137	213	218	254	267	281	301	320	1.4
Total OECD	**4,016**	**4,196**	**4,251**	**4,628**	**4,787**	**5,058**	**5,424**	**5,871**	**1.2**
Non-OECD									
Non-OECD Europe and Eurasia	**1,393**	**764**	**775**	**806**	**905**	**999**	**1,079**	**1,161**	**1.5**
Russia	624	406	422	442	498	556	597	642	1.6
Other	770	359	353	364	407	444	482	519	1.4
Non-OECD Asia	**2,517**	**3,574**	**3,805**	**5,886**	**7,000**	**8,049**	**9,119**	**10,297**	**3.8**
China	1,886	2,518	2,731	4,521	5,432	6,297	7,212	8,286	4.2
India	394	665	666	901	1,060	1,198	1,302	1,372	2.7
Other Non-OECD Asia	237	391	408	464	508	554	605	639	1.7
Middle East	**14**	**35**	**33**	**34**	**35**	**36**	**37**	**42**	**0.8**
Africa	**271**	**339**	**369**	**485**	**535**	**555**	**568**	**583**	**1.7**
Central and South America	**54**	**69**	**70**	**95**	**106**	**126**	**136**	**150**	**2.9**
Brazil	34	41	44	55	64	73	79	85	2.4
Other Central and South America	20	28	25	39	42	53	57	65	3.5
Total Non-OECD	**4,248**	**4,782**	**5,052**	**7,305**	**8,581**	**9,764**	**10,940**	**12,233**	**3.3**
Total World	**8,264**	**8,978**	**9,303**	**11,933**	**13,368**	**14,822**	**16,364**	**18,104**	**2.5**

[a]Includes the 50 States and the District of Columbia.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run AEO2006.D111905A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table A14. World Population by Region, Reference Case, 1990-2030
(Millions)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**366**	**424**	**427**	**457**	**478**	**498**	**518**	**537**	**0.9**
United States[a]	254	289	291	310	324	337	351	365	0.8
Canada	28	32	32	34	35	36	38	39	0.8
Mexico	84	104	104	113	119	125	129	133	0.9
OECD Europe	**497**	**529**	**530**	**543**	**550**	**555**	**559**	**562**	**0.2**
OECD Asia	**187**	**198**	**199**	**202**	**204**	**204**	**203**	**202**	**0.1**
Japan	124	128	128	128	128	127	125	123	-0.2
South Korea	43	47	47	49	49	49	49	49	0.1
Australia/New Zealand	20	24	24	25	27	28	29	30	0.9
Total OECD	**1,050**	**1,151**	**1,156**	**1,203**	**1,232**	**1,257**	**1,280**	**1,300**	**0.4**
Non-OECD									
Non-OECD Europe and Eurasia	**348**	**343**	**343**	**338**	**334**	**330**	**325**	**319**	**-0.3**
Russia	148	145	145	140	137	133	129	125	-0.5
Other	200	198	198	198	198	197	196	193	-0.1
Non-OECD Asia	**2,748**	**3,300**	**3,316**	**3,592**	**3,783**	**3,958**	**4,108**	**4,231**	**0.9**
China	1,155	1,296	1,299	1,355	1,393	1,424	1,441	1,446	0.4
India	849	1,064	1,070	1,183	1,260	1,332	1,395	1,449	1.1
Other Non-OECD Asia	743	940	946	1,054	1,129	1,202	1,271	1,335	1.3
Middle East	**137**	**185**	**187**	**216**	**238**	**260**	**281**	**301**	**1.8**
Africa	**636**	**861**	**869**	**1,007**	**1,115**	**1,228**	**1,344**	**1,463**	**2.0**
Central and South America	**360**	**439**	**442**	**486**	**515**	**542**	**567**	**589**	**1.1**
Brazil	149	180	181	198	209	219	228	236	1.0
Other Central and South America	210	259	260	287	306	323	339	354	1.1
Total Non-OECD	**4,228**	**5,129**	**5,156**	**5,638**	**5,986**	**6,319**	**6,626**	**6,903**	**1.1**
Total World	**5,278**	**6,280**	**6,312**	**6,841**	**7,217**	**7,576**	**7,906**	**8,203**	**1.0**

[a]Includes the 50 States and the District of Columbia.

Sources: **United States:** *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run AEO2006.D111905A, web site www.eia.doe.gov/oiaf/aeo/. **Other Countries:** United Nations, Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2004 Revision and World Urbanization Prospects (February 25, 2005), web site http://esa.un.org/unpp.

Appendix B

High Economic Growth Case Projections:

- **World Energy Consumption**
- **Gross Domestic Product**
- **Carbon Dioxide Emissions**

Table B1. World Total Energy Consumption by Region, High Economic Growth Case, 1990-2030
(Quadrillion Btu)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**100.8**	**117.5**	**118.3**	**134.1**	**145.3**	**156.5**	**168.7**	**181.5**	**1.6**
United States[a]	84.6	98.1	98.1	110.2	118.7	127.2	136.6	146.4	1.5
Canada	11.1	13.1	13.5	15.8	17.1	18.2	19.4	20.6	1.6
Mexico	5.0	6.2	6.8	8.1	9.5	11.0	12.7	14.5	2.8
OECD Europe	**69.9**	**77.9**	**78.9**	**85.5**	**89.4**	**92.2**	**96.1**	**101.2**	**0.9**
OECD Asia	**26.7**	**36.5**	**37.1**	**40.9**	**44.2**	**46.6**	**49.2**	**52.0**	**1.3**
Japan	18.4	22.2	22.4	23.1	24.1	24.7	25.5	26.2	0.6
South Korea	3.8	8.4	8.6	11.1	12.8	14.1	15.4	16.9	2.5
Australia/New Zealand	4.4	6.0	6.0	6.7	7.2	7.7	8.3	8.8	1.4
Total OECD	**197.4**	**231.9**	**234.3**	**260.5**	**278.9**	**295.3**	**314.0**	**334.6**	**1.3**
Non-OECD									
Non-OECD Europe and Eurasia	**67.2**	**46.9**	**48.5**	**58.5**	**67.4**	**76.5**	**85.4**	**94.5**	**2.5**
Russia	39.0	28.1	29.1	34.6	39.4	44.4	49.4	54.6	2.4
Other	28.3	18.8	19.4	23.9	28.0	32.1	36.0	40.0	2.7
Non-OECD Asia	**47.5**	**78.4**	**83.1**	**131.8**	**160.7**	**194.0**	**231.3**	**275.2**	**4.5**
China	27.0	42.1	45.5	79.9	99.0	119.8	142.5	169.8	5.0
India	8.0	13.8	14.0	20.0	24.0	28.4	33.1	38.7	3.8
Other Non-OECD Asia	12.5	22.5	23.6	31.8	37.7	45.7	55.7	66.7	3.9
Middle East	**11.3**	**19.1**	**19.6**	**25.9**	**30.4**	**34.5**	**39.4**	**44.6**	**3.1**
Africa	**9.5**	**12.8**	**13.3**	**18.3**	**22.1**	**25.0**	**28.3**	**32.6**	**3.4**
Central and South America	**14.5**	**21.3**	**21.9**	**29.2**	**34.8**	**40.7**	**47.2**	**53.9**	**3.4**
Brazil	5.8	8.6	8.8	11.1	13.0	14.7	16.8	18.9	2.9
Other Central and South America	8.8	12.7	13.1	18.1	21.8	26.0	30.4	35.0	3.7
Total Non-OECD	**150.0**	**178.4**	**186.4**	**263.7**	**315.3**	**370.7**	**431.6**	**500.8**	**3.7**
Total World	**347.3**	**410.3**	**420.7**	**524.2**	**594.2**	**666.0**	**745.6**	**835.4**	**2.6**

[a]Includes the 50 States and the District of Columbia.

Notes: Energy totals include net imports of coal coke and electricity generated from biomass in the United States. Totals may not equal sum of components due to independent rounding. The electricity portion of the national fuel consumption values consists of generation for domestic use plus an adjustment for electricity trade based on a fuel's share of total generation in the exporting country.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run HM2006.D112505B, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table B2. World Total Energy Consumption by Region and Fuel, High Economic Growth Case, 1990-2030
(Quadrillion Btu)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America									
Oil	40.5	46.3	47.2	53.6	58.1	62.2	66.8	71.7	1.6
Natural Gas	23.2	28.4	28.3	31.3	35.0	37.3	38.8	40.5	1.3
Coal	20.7	24.0	24.4	27.8	29.7	32.9	37.8	42.7	2.1
Nuclear	6.9	9.0	8.9	9.7	10.2	10.5	10.4	10.4	0.6
Other	9.5	9.8	9.5	11.6	12.3	13.6	15.0	16.1	2.0
Total	**100.8**	**117.5**	**118.3**	**134.1**	**145.3**	**156.5**	**168.7**	**181.5**	**1.6**
OECD Europe									
Oil	28.4	31.6	32.0	33.0	33.6	33.7	34.6	35.5	0.4
Natural Gas	11.2	17.7	18.3	22.3	25.8	28.5	31.2	34.6	2.4
Coal	17.6	12.8	12.8	12.8	12.8	13.1	13.9	14.2	0.4
Nuclear	7.9	9.7	9.8	9.5	9.3	8.5	7.9	7.5	-1.0
Other	4.8	6.1	6.0	7.9	8.0	8.3	8.5	9.4	1.7
Total	**69.9**	**77.9**	**78.9**	**85.5**	**89.4**	**92.2**	**96.1**	**101.2**	**0.9**
OECD Asia									
Oil	14.5	17.5	17.8	18.7	19.5	20.1	20.9	21.6	0.7
Natural Gas	2.9	5.1	5.3	5.9	6.8	7.3	7.8	8.5	1.8
Coal	5.2	8.2	8.4	9.9	10.7	11.4	12.1	13.0	1.6
Nuclear	2.5	4.0	3.7	4.2	4.7	5.3	5.8	6.2	2.0
Other	1.6	1.7	1.9	2.2	2.4	2.5	2.6	2.7	1.3
Total	**26.7**	**36.5**	**37.1**	**40.9**	**44.2**	**46.6**	**49.2**	**52.0**	**1.3**
Total OECD									
Oil	83.4	95.4	97.0	105.4	111.2	116.1	122.2	128.8	1.1
Natural Gas	37.2	51.2	51.9	59.5	67.6	73.1	77.8	83.7	1.8
Coal	43.5	44.9	45.6	50.5	53.2	57.4	63.8	69.9	1.6
Nuclear	17.3	22.7	22.3	23.4	24.1	24.3	24.1	24.1	0.3
Other	15.9	17.6	17.4	21.8	22.7	24.4	26.0	28.2	1.8
Total	**197.4**	**231.9**	**234.3**	**260.5**	**278.9**	**295.3**	**314.0**	**334.6**	**1.3**
Non-OECD									
Non-OECD Europe and Eurasia									
Oil	19.5	9.9	10.1	11.8	13.4	14.8	19.2	18.0	2.2
Natural Gas	27.5	23.0	24.3	30.5	35.1	39.4	41.2	49.4	2.7
Coal	15.1	8.3	8.4	8.9	10.4	12.4	14.0	15.4	2.3
Nuclear	2.5	2.8	2.8	3.1	3.5	4.3	4.8	4.9	2.0
Other	2.8	3.0	3.0	4.2	5.1	5.6	6.2	6.8	3.1
Total	**67.2**	**46.9**	**48.5**	**58.5**	**67.4**	**76.5**	**85.4**	**94.5**	**2.5**
Non-OECD Asia									
Oil	13.9	26.7	27.9	39.8	47.0	55.5	64.6	76.4	3.8
Natural Gas	3.0	7.3	7.9	14.4	18.4	23.9	30.9	37.7	6.0
Coal	27.2	38.7	41.2	66.0	81.5	98.2	115.7	136.3	4.5
Nuclear	0.4	0.9	1.0	2.0	2.9	3.8	4.6	5.3	6.3
Other	3.0	4.9	5.1	9.6	11.0	12.6	15.5	19.4	5.1
Total	**47.5**	**78.4**	**83.1**	**131.8**	**160.7**	**194.0**	**231.3**	**275.2**	**4.5**

See notes at end of table.

Table B2. World Total Energy Consumption by Region and Fuel, High Economic Growth Case, 1990-2030 (Continued)
(Quadrillion Btu)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
Non-OECD (Continued)									
Middle East									
Oil	7.2	10.5	10.8	12.9	14.7	16.1	17.7	19.6	2.2
Natural Gas	3.8	8.0	8.2	12.0	14.6	17.2	20.3	23.3	3.9
Coal	0.1	0.4	0.4	0.4	0.4	0.4	0.4	0.5	1.0
Nuclear	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	—
Other	0.1	0.2	0.2	0.6	0.7	0.8	1.0	1.2	6.1
Total	**11.3**	**19.1**	**19.6**	**25.9**	**30.4**	**34.5**	**39.4**	**44.6**	**3.1**
Africa									
Oil	4.3	5.4	5.5	7.9	9.0	9.9	10.9	12.3	3.0
Natural Gas	1.5	2.6	2.7	3.7	5.5	6.7	8.3	10.3	5.0
Coal	3.0	3.7	4.1	5.4	6.2	6.8	7.3	7.8	2.4
Nuclear	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.7
Other	0.6	0.9	0.9	1.2	1.3	1.4	1.7	2.0	3.1
Total	**9.5**	**12.8**	**13.3**	**18.3**	**22.1**	**25.0**	**28.3**	**32.6**	**3.4**
Central and South America									
Oil	7.7	10.8	10.8	13.2	15.3	17.5	20.3	22.3	2.7
Natural Gas	2.2	3.8	4.1	6.6	7.9	9.7	11.3	14.0	4.6
Coal	0.6	0.7	0.8	1.0	1.2	1.4	1.5	1.6	2.9
Nuclear	0.1	0.2	0.2	0.2	0.4	0.3	0.4	0.3	0.5
Other	3.9	5.7	6.0	8.1	10.0	11.8	13.7	15.7	3.6
Total	**14.5**	**21.3**	**21.9**	**29.2**	**34.8**	**40.7**	**47.2**	**53.9**	**3.4**
Total Non-OECD									
Oil	52.7	63.3	65.1	85.6	99.3	113.8	132.7	148.7	3.1
Natural Gas	38.0	44.7	47.2	67.1	81.5	97.0	111.9	134.8	4.0
Coal	45.9	51.8	54.8	81.7	99.6	119.1	138.9	161.6	4.1
Nuclear	3.1	4.0	4.2	5.5	7.0	8.7	10.0	10.6	3.5
Other	10.3	14.6	15.2	23.8	28.0	32.2	38.0	45.0	4.1
Total	**150.0**	**178.4**	**186.4**	**263.7**	**315.3**	**370.7**	**431.6**	**500.8**	**3.7**
Total World									
Oil	136.1	158.7	162.1	191.0	210.5	229.8	254.9	277.5	2.0
Natural Gas	75.2	95.9	99.1	126.6	149.1	170.1	189.8	218.5	3.0
Coal	89.4	96.8	100.4	132.2	152.9	176.5	202.8	231.5	3.1
Nuclear	20.4	26.7	26.5	28.9	31.1	32.9	34.0	34.7	1.0
Other	26.3	32.2	32.7	45.6	50.6	56.6	64.1	73.2	3.0
Total	**347.3**	**410.3**	**420.7**	**524.2**	**594.2**	**666.0**	**745.6**	**835.4**	**2.6**

Notes: Energy totals include net imports of coal coke and electricity generated from biomass in the United States. Totals may not equal sum of components due to independent rounding. The electricity portion of the national fuel consumption values consists of generation for domestic use plus an adjustment for electricity trade based on a fuel's share of total generation in the exporting country.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run HM2006.D112505B, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table B3. World Gross Domestic Product (GDP) by Region Using Purchasing Power Parity, High Economic Growth Case, 1990-2030
(Billion 2000 Dollars)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**8,477**	**11,968**	**12,273**	**16,082**	**19,159**	**22,728**	**26,964**	**31,684**	**3.6**
United States[a]	7,113	10,049	10,321	13,561	16,110	19,073	22,603	26,471	3.6
Canada	684	957	977	1,219	1,410	1,597	1,779	1,980	2.7
Mexico	680	962	976	1,301	1,638	2,058	2,582	3,233	4.5
OECD Europe	**8,017**	**10,647**	**10,799**	**13,027**	**14,903**	**16,999**	**19,303**	**21,911**	**2.7**
OECD Asia	**3,655**	**4,628**	**4,716**	**5,754**	**6,578**	**7,328**	**8,097**	**8,955**	**2.4**
Japan	2,898	3,329	3,375	3,954	4,403	4,777	5,134	5,517	1.8
South Korea	330	663	683	989	1,238	1,469	1,718	2,003	4.1
Australia/New Zealand	428	637	657	811	937	1,081	1,246	1,435	2.9
Total OECD	**20,150**	**27,243**	**27,788**	**34,862**	**40,640**	**47,055**	**54,364**	**62,550**	**3.1**
Non-OECD									
Non-OECD Europe and Eurasia	**3,387**	**2,672**	**2,878**	**4,587**	**6,041**	**7,801**	**9,910**	**12,473**	**5.6**
Russia	2,241	1,658	1,780	2,718	3,529	4,532	5,734	7,167	5.3
Other	1,146	1,013	1,099	1,869	2,511	3,269	4,176	5,306	6.0
Non-OECD Asia	**5,780**	**12,559**	**13,516**	**22,148**	**30,328**	**40,800**	**54,236**	**71,821**	**6.4**
China	1,807	5,494	5,994	10,597	14,863	20,274	27,263	36,484	6.9
India	1,684	3,160	3,429	5,410	7,356	9,960	13,359	17,863	6.3
Other Non-OECD Asia	2,289	3,905	4,093	6,140	8,108	10,566	13,614	17,474	5.5
Middle East	**810**	**1,295**	**1,357**	**2,040**	**2,614**	**3,304**	**4,145**	**5,190**	**5.1**
Africa	**1,461**	**2,074**	**2,173**	**3,222**	**4,195**	**5,402**	**6,917**	**8,846**	**5.3**
Central and South America	**2,174**	**3,011**	**3,075**	**4,339**	**5,454**	**6,818**	**8,500**	**10,588**	**4.7**
Brazil	1,022	1,370	1,378	1,884	2,342	2,899	3,577	4,403	4.4
Other Central and South America	1,153	1,641	1,697	2,454	3,113	3,919	4,923	6,185	4.9
Total Non-OECD	**13,612**	**21,611**	**22,999**	**36,335**	**48,631**	**64,125**	**83,708**	**108,918**	**5.9**
Total World	**33,761**	**48,854**	**50,786**	**71,198**	**89,271**	**111,180**	**138,072**	**171,468**	**4.6**

[a]Includes the 50 States and the District of Columbia.

Notes: Totals may not equal sum of components due to independent rounding. GDP growth rates for China and India were adjusted, based on the analyst's judgment.

Sources: **History:** Global Insight, Inc., *World Overview* (Lexington, MA, various issues). **Projections:** Global Insight, Inc., *World Overview*, Fourth Quarter 2005 (Lexington, MA, January 2006); and Energy Information Administration, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington DC, February 2006), Table B4.

Table B4. World Oil Consumption by Region, High Economic Growth Case, 1990-2030
(Million Barrels per Day)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**20.5**	**23.8**	**24.3**	**27.5**	**29.9**	**32.0**	**34.3**	**36.8**	**1.6**
United States[a]	17.0	19.8	20.1	22.8	24.7	26.5	28.4	30.5	1.6
Canada	1.7	2.1	2.2	2.4	2.5	2.6	2.7	2.8	0.9
Mexico	1.8	1.9	2.0	2.3	2.6	2.9	3.2	3.5	2.1
OECD Europe	**13.7**	**15.3**	**15.5**	**16.0**	**16.3**	**16.4**	**16.8**	**17.2**	**0.4**
OECD Asia	**7.1**	**8.6**	**8.8**	**9.2**	**9.6**	**9.9**	**10.2**	**10.6**	**0.7**
Japan	5.2	5.5	5.6	5.5	5.5	5.5	5.5	5.5	-0.1
South Korea	1.0	2.1	2.2	2.6	3.0	3.2	3.5	3.8	2.1
Australia/New Zealand	0.8	1.0	1.0	1.1	1.1	1.2	1.2	1.3	0.8
Total OECD	**41.3**	**47.7**	**48.5**	**52.7**	**55.7**	**58.2**	**61.3**	**64.6**	**1.1**
Non-OECD									
Non-OECD Europe and Eurasia	**9.3**	**4.8**	**4.9**	**5.7**	**6.4**	**7.2**	**9.3**	**8.7**	**2.2**
Russia	5.4	2.6	2.7	3.0	3.3	3.7	5.4	4.3	1.8
Other	3.9	2.1	2.2	2.7	3.1	3.5	3.9	4.4	2.6
Non-OECD Asia	**6.6**	**12.9**	**13.5**	**19.2**	**22.7**	**26.8**	**31.2**	**37.0**	**3.8**
China	2.3	5.2	5.6	9.0	10.7	13.1	15.5	18.3	4.5
India	1.2	2.3	2.3	3.0	3.6	4.1	4.7	5.3	3.1
Other Non-OECD Asia	3.1	5.5	5.6	7.2	8.4	9.7	11.1	13.4	3.3
Middle East	**3.5**	**5.1**	**5.3**	**6.3**	**7.2**	**7.9**	**8.6**	**9.6**	**2.2**
Africa	**2.1**	**2.7**	**2.7**	**3.9**	**4.4**	**4.8**	**5.3**	**6.0**	**3.0**
Central and South America	**3.8**	**5.3**	**5.3**	**6.5**	**7.5**	**8.5**	**9.9**	**10.9**	**2.7**
Brazil	1.5	2.1	2.1	2.5	2.8	3.1	3.5	3.8	2.3
Other Central and South America	2.3	3.1	3.2	4.0	4.7	5.4	6.4	7.0	3.0
Total Non-OECD	**25.3**	**30.7**	**31.6**	**41.5**	**48.2**	**55.2**	**64.4**	**72.2**	**3.1**
Total World	**66.6**	**78.5**	**80.1**	**94.3**	**103.9**	**113.4**	**125.7**	**136.8**	**2.0**

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run HM2006.D112505B, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table B5. World Natural Gas Consumption by Region, High Economic Growth Case, 1990-2030
(Trillion Cubic Feet)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**22.5**	**27.6**	**27.4**	**30.3**	**33.9**	**36.1**	**37.4**	**39.1**	**1.3**
United States[a]	19.2	23.0	22.3	24.0	26.8	27.9	28.0	28.4	0.9
Canada	2.4	3.1	3.2	4.2	4.4	4.9	5.3	5.7	2.2
Mexico	0.9	1.5	1.8	2.2	2.7	3.3	4.1	5.0	3.8
OECD Europe	**11.6**	**17.2**	**17.8**	**21.7**	**25.1**	**27.7**	**30.4**	**33.6**	**2.4**
OECD Asia	**2.8**	**4.8**	**5.0**	**5.5**	**6.4**	**6.9**	**7.4**	**8.0**	**1.8**
Japan	1.9	2.9	3.1	3.4	3.9	4.1	4.4	4.8	1.7
South Korea	0.1	0.8	0.9	1.0	1.2	1.3	1.3	1.4	1.9
Australia/New Zealand	0.8	1.1	1.1	1.2	1.4	1.5	1.7	1.8	1.9
Total OECD	**36.8**	**49.6**	**50.2**	**57.5**	**65.4**	**70.7**	**75.2**	**80.8**	**1.8**
Non-OECD									
Non-OECD Europe and Eurasia	**26.7**	**22.3**	**23.6**	**29.7**	**34.1**	**38.3**	**40.0**	**48.1**	**2.7**
Russia	17.3	14.6	15.3	18.8	21.3	23.9	23.7	29.5	2.5
Other	9.5	7.8	8.3	10.9	12.9	14.4	16.3	18.6	3.0
Non-OECD Asia	**2.9**	**6.9**	**7.5**	**13.6**	**17.4**	**22.6**	**29.2**	**35.7**	**5.9**
China	0.5	1.1	1.2	3.1	4.3	5.5	6.6	8.0	7.3
India	0.4	0.9	1.0	1.8	2.2	2.8	4.5	6.7	7.5
Other Non-OECD Asia	2.0	4.9	5.4	8.8	10.9	14.3	18.1	21.0	5.2
Middle East	**3.6**	**7.6**	**7.9**	**11.4**	**13.9**	**16.4**	**19.3**	**22.2**	**3.9**
Africa	**1.4**	**2.4**	**2.6**	**3.4**	**5.1**	**6.2**	**7.7**	**9.6**	**5.0**
Central and South America	**2.0**	**3.6**	**3.8**	**6.1**	**7.4**	**9.0**	**10.5**	**13.0**	**4.7**
Brazil	0.1	0.5	0.5	1.0	1.2	1.3	1.6	2.0	5.3
Other Central and South America	1.9	3.1	3.3	5.1	6.2	7.7	8.9	11.0	4.5
Total Non-OECD	**36.5**	**42.9**	**45.3**	**64.2**	**77.9**	**92.6**	**106.8**	**128.6**	**3.9**
Total World	**73.4**	**92.5**	**95.5**	**121.8**	**143.3**	**163.3**	**182.0**	**209.4**	**3.0**

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run HM2006.D112505B, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table B6. World Coal Consumption by Region, High Economic Growth Case, 1990-2030
(Million Short Tons)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**972**	**1,151**	**1,185**	**1,358**	**1,462**	**1,635**	**1,934**	**2,194**	**2.3**
United States[a]	904	1,066	1,095	1,250	1,321	1,486	1,774	2,025	2.3
Canada	59	68	69	82	109	113	120	127	2.3
Mexico	9	17	20	25	31	36	40	42	2.7
OECD Europe	**1,298**	**892**	**887**	**883**	**888**	**909**	**961**	**986**	**0.4**
OECD Asia	**280**	**400**	**404**	**478**	**517**	**550**	**587**	**630**	**1.7**
Japan	126	172	176	181	189	190	190	190	0.3
South Korea	48	80	81	124	142	159	182	204	3.5
Australia/New Zealand	106	148	147	174	187	201	216	237	1.8
Total OECD	**2,551**	**2,442**	**2,476**	**2,719**	**2,866**	**3,094**	**3,482**	**3,810**	**1.6**
Non-OECD									
Non-OECD Europe and Eurasia	**1,028**	**530**	**543**	**605**	**713**	**865**	**986**	**1,085**	**2.6**
Russia	447	240	251	264	299	331	367	401	1.8
Other	581	290	292	341	415	534	619	684	3.2
Non-OECD Asia	**1,507**	**2,041**	**2,168**	**3,472**	**4,290**	**5,168**	**6,086**	**7,159**	**4.5**
China	1,124	1,413	1,531	2,649	3,317	4,042	4,859	5,826	5.1
India	256	431	431	586	710	837	902	969	3.0
Other Non-OECD Asia	127	197	206	237	263	290	324	364	2.1
Middle East	**6**	**16**	**16**	**16**	**17**	**17**	**18**	**20**	**1.0**
Africa	**152**	**187**	**203**	**271**	**310**	**341**	**364**	**389**	**2.4**
Central and South America	**27**	**34**	**35**	**47**	**53**	**63**	**68**	**74**	**2.8**
Brazil	17	22	24	30	35	39	42	45	2.4
Other Central and South America	10	12	11	17	18	23	25	29	3.5
Total Non-OECD	**2,718**	**2,808**	**2,964**	**4,411**	**5,384**	**6,454**	**7,521**	**8,728**	**4.1**
Total World	**5,269**	**5,250**	**5,440**	**7,131**	**8,250**	**9,548**	**11,003**	**12,538**	**3.1**

[a]Includes the 50 States and the District of Columbia.

Notes: Totals may not equal sum of components due to independent rounding. To convert short tons to metric tons, divide each number in the table by 1.102.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run HM2006.D112505B, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table B7. World Nuclear Energy Consumption by Region, High Economic Growth Case, 1990-2030
(Billion Kilowatthours)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**649**	**861**	**844**	**923**	**964**	**994**	**989**	**989**	**0.6**
United States[a]	577	780	764	809	840	871	871	871	0.5
Canada	69	72	71	104	113	113	108	108	1.6
Mexico	3	9	10	11	11	11	11	11	0.2
OECD Europe	**743**	**923**	**930**	**896**	**877**	**807**	**748**	**707**	**-1.0**
OECD Asia	**242**	**393**	**360**	**416**	**464**	**518**	**567**	**610**	**2.0**
Japan	192	280	237	274	289	318	350	371	1.7
South Korea	50	113	123	142	175	200	217	239	2.5
Australia/New Zealand	0	0	0	0	0	0	0	0	—
Total OECD	**1,635**	**2,178**	**2,135**	**2,234**	**2,304**	**2,320**	**2,304**	**2,307**	**0.3**
Non-OECD									
Non-OECD Europe and Eurasia	**219**	**254**	**258**	**278**	**323**	**393**	**441**	**443**	**2.0**
Russia	115	134	138	151	190	233	286	321	3.2
Other	104	120	120	127	133	160	155	122	0.1
Non-OECD Asia	**38**	**83**	**97**	**187**	**268**	**356**	**434**	**504**	**6.3**
China	0	25	42	79	130	171	230	304	7.6
India	6	18	16	56	76	99	106	112	7.4
Other Non-OECD Asia	32	40	39	52	62	85	98	89	3.1
Middle East	**0**	**0**	**0**	**6**	**6**	**6**	**6**	**6**	**—**
Africa	**8**	**12**	**13**	**14**	**15**	**15**	**15**	**15**	**0.7**
Central and South America	**9**	**19**	**20**	**21**	**35**	**32**	**33**	**24**	**0.6**
Brazil	2	14	13	13	22	23	23	19	1.2
Other Central and South America	7	5	7	7	12	10	10	5	-1.1
Total Non-OECD	**274**	**368**	**388**	**505**	**647**	**802**	**929**	**993**	**3.5**
Total World	**1,909**	**2,546**	**2,523**	**2,739**	**2,951**	**3,122**	**3,233**	**3,299**	**1.0**

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run HM2006.D112505B, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table B8. World Consumption of Hydroelectricity and Other Renewable Energy by Region, High Economic Growth Case, 1990-2030
(Quadrillion Btu)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**9.5**	**9.8**	**9.5**	**11.6**	**12.3**	**13.6**	**15.0**	**16.1**	**2.0**
United States[a]	6.1	5.9	5.7	7.2	7.7	8.5	9.3	9.9	2.0
Canada	3.1	3.6	3.5	3.8	3.8	4.3	4.7	5.1	1.4
Mexico	0.3	0.4	0.3	0.6	0.7	0.9	1.0	1.1	4.7
OECD Europe	**4.8**	**6.1**	**6.0**	**7.9**	**8.0**	**8.3**	**8.5**	**9.4**	**1.7**
OECD Asia	**1.6**	**1.7**	**1.9**	**2.2**	**2.4**	**2.5**	**2.6**	**2.7**	**1.3**
Japan	1.1	1.1	1.4	1.4	1.6	1.6	1.7	1.8	0.9
South Korea	0.0	0.0	0.1	0.2	0.3	0.3	0.3	0.3	6.8
Australia/New Zealand	0.4	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.8
Total OECD	**15.9**	**17.6**	**17.4**	**21.8**	**22.7**	**24.4**	**26.0**	**28.2**	**1.8**
Non-OECD									
Non-OECD Europe and Eurasia	**2.8**	**3.0**	**3.0**	**4.2**	**5.1**	**5.6**	**6.2**	**6.8**	**3.1**
Russia	1.8	1.9	1.8	2.7	3.2	3.6	4.1	4.5	3.5
Other	1.0	1.1	1.2	1.6	1.9	2.0	2.0	2.3	2.4
Non-OECD Asia	**3.0**	**4.9**	**5.1**	**9.6**	**11.0**	**12.6**	**15.5**	**19.4**	**5.1**
China	1.3	2.8	2.9	6.1	6.8	7.1	7.3	7.9	3.8
India	0.7	0.7	0.7	1.3	1.4	1.7	2.2	3.0	5.3
Other Non-OECD Asia	0.9	1.4	1.5	2.2	2.8	3.8	5.9	8.5	6.7
Middle East	**0.1**	**0.2**	**0.2**	**0.6**	**0.7**	**0.8**	**1.0**	**1.2**	**6.1**
Africa	**0.6**	**0.9**	**0.9**	**1.2**	**1.3**	**1.4**	**1.7**	**2.0**	**3.1**
Central and South America	**3.9**	**5.7**	**6.0**	**8.1**	**10.0**	**11.8**	**13.7**	**15.7**	**3.6**
Brazil	2.2	3.0	3.3	4.2	5.1	5.9	6.8	7.8	3.3
Other Central and South America	1.7	2.7	2.8	3.9	4.9	5.8	6.9	7.9	3.9
Total Non-OECD	**10.3**	**14.6**	**15.2**	**23.8**	**28.0**	**32.2**	**38.0**	**45.0**	**4.1**
Total World	**26.3**	**32.2**	**32.7**	**45.6**	**50.6**	**56.6**	**64.1**	**73.2**	**3.0**

[a]Includes the 50 States and the District of Columbia.

Notes: Totals may not equal sum of components due to independent rounding. U.S. totals include net electricity imports, methanol, and liquid hydrogen.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run HM2006.D112505B, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table B9. World Net Electricity Consumption by Region, High Economic Growth Case, 1990-2030
(Billion Kilowatthours)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**3,379**	**4,337**	**4,384**	**5,055**	**5,539**	**6,045**	**6,559**	**7,127**	**1.8**
United States[a]	2,837	3,629	3,669	4,155	4,491	4,844	5,208	5,619	1.6
Canada	435	518	521	616	685	745	795	848	1.8
Mexico	107	190	194	284	364	456	556	660	4.6
OECD Europe	**2,355**	**2,916**	**2,965**	**3,397**	**3,636**	**3,881**	**4,162**	**4,475**	**1.5**
OECD Asia	**1,024**	**1,463**	**1,487**	**1,781**	**1,938**	**2,063**	**2,190**	**2,328**	**1.7**
Japan	764	964	946	1,071	1,129	1,167	1,206	1,246	1.0
South Korea	93	268	303	433	507	567	626	690	3.1
Australia/New Zealand	166	231	238	277	303	329	359	391	1.9
Total OECD	**6,758**	**8,715**	**8,836**	**10,233**	**11,114**	**11,989**	**12,911**	**13,930**	**1.7**
Non-OECD									
Non-OECD Europe and Eurasia	**1,672**	**1,318**	**1,350**	**1,926**	**2,337**	**2,733**	**3,128**	**3,551**	**3.6**
Russia	955	796	812	1,141	1,375	1,635	1,876	2,135	3.6
Other	717	522	539	785	962	1,098	1,253	1,416	3.6
Non-OECD Asia	**1,150**	**2,655**	**2,917**	**4,930**	**6,449**	**8,211**	**10,242**	**12,620**	**5.6**
China	551	1,452	1,671	2,910	3,822	4,863	6,044	7,449	5.7
India	257	525	519	879	1,127	1,406	1,724	2,108	5.3
Other Non-OECD Asia	342	678	726	1,141	1,500	1,942	2,474	3,063	5.5
Middle East	**214**	**457**	**471**	**707**	**842**	**971**	**1,100**	**1,230**	**3.6**
Africa	**286**	**420**	**436**	**588**	**725**	**862**	**1,020**	**1,208**	**3.9**
Central and South America	**463**	**736**	**772**	**1,184**	**1,502**	**1,857**	**2,246**	**2,653**	**4.7**
Brazil	229	353	371	541	662	790	924	1,064	4.0
Other Central and South America	234	383	400	643	841	1,067	1,322	1,589	5.2
Total Non-OECD	**3,785**	**5,586**	**5,944**	**9,336**	**11,856**	**14,634**	**17,737**	**21,262**	**4.8**
Total World	**10,543**	**14,301**	**14,781**	**19,568**	**22,970**	**26,623**	**30,648**	**35,192**	**3.3**

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run HM2006.D112505B, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table B10. World Carbon Dioxide Emissions by Region, High Economic Growth Case, 1990-2030
(Million Metric Tons Carbon Dioxide)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**5,753**	**6,687**	**6,797**	**7,670**	**8,322**	**9,003**	**9,836**	**10,709**	**1.7**
United States[a]	4,978	5,748	5,796	6,502	6,987	7,543	8,232	8,957	1.6
Canada	474	570	596	702	789	828	879	928	1.6
Mexico	300	369	405	466	547	632	725	825	2.7
OECD Europe	**4,089**	**4,203**	**4,264**	**4,539**	**4,764**	**4,946**	**5,219**	**5,490**	**0.9**
OECD Asia	**1,536**	**2,063**	**2,090**	**2,311**	**2,480**	**2,603**	**2,740**	**2,895**	**1.2**
Japan	1,011	1,191	1,206	1,222	1,268	1,284	1,302	1,324	0.3
South Korea	234	462	470	622	708	780	861	949	2.6
Australia/New Zealand	291	410	415	467	503	539	576	622	1.5
Total OECD	**11,378**	**12,952**	**13,150**	**14,520**	**15,566**	**16,552**	**17,795**	**19,094**	**1.4**
Non-OECD									
Non-OECD Europe and Eurasia	**4,193**	**2,634**	**2,725**	**3,217**	**3,699**	**4,212**	**4,741**	**5,237**	**2.4**
Russia	2,334	1,546	1,606	1,860	2,096	2,343	2,618	2,850	2.1
Other	1,859	1,088	1,118	1,357	1,603	1,869	2,123	2,387	2.8
Non-OECD Asia	**3,626**	**5,733**	**6,072**	**9,491**	**11,614**	**14,008**	**16,608**	**19,661**	**4.4**
China	2,241	3,273	3,541	6,110	7,608	9,287	11,128	13,312	5.0
India	578	1,011	1,023	1,403	1,691	1,981	2,257	2,561	3.5
Other Non-OECD Asia	807	1,449	1,508	1,978	2,315	2,740	3,223	3,787	3.5
Middle East	**704**	**1,152**	**1,182**	**1,518**	**1,774**	**2,005**	**2,274**	**2,569**	**2.9**
Africa	**649**	**850**	**893**	**1,228**	**1,471**	**1,654**	**1,850**	**2,097**	**3.2**
Central and South America	**673**	**993**	**1,006**	**1,327**	**1,551**	**1,811**	**2,095**	**2,383**	**3.2**
Brazil	220	347	348	436	498	556	629	700	2.6
Other Central and South America	453	645	659	891	1,053	1,255	1,466	1,683	3.5
Total Non-OECD	**9,846**	**11,362**	**11,878**	**16,781**	**20,108**	**23,690**	**27,567**	**31,946**	**3.7**
Total World	**21,223**	**24,314**	**25,028**	**31,302**	**35,675**	**40,241**	**45,362**	**51,040**	**2.7**

[a]Includes the 50 States and the District of Columbia.

Note: The U.S. numbers include carbon dioxide emissions attributable to renewable energy sources.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run HM2006.D112505B, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table B11. World Carbon Dioxide Emissions from Oil Use by Region, High Economic Growth Case, 1990-2030
(Million Metric Tons Carbon Dioxide)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**2,636**	**2,969**	**3,034**	**3,410**	**3,692**	**3,954**	**4,251**	**4,578**	**1.5**
United States[a]	2,181	2,456	2,498	2,814	3,039	3,258	3,502	3,773	1.5
Canada	224	262	276	305	321	326	340	351	0.9
Mexico	231	250	260	291	333	370	410	454	2.1
OECD Europe	**1,864**	**2,069**	**2,094**	**2,165**	**2,201**	**2,210**	**2,268**	**2,328**	**0.4**
OECD Asia	**913**	**1,035**	**1,052**	**1,100**	**1,145**	**1,181**	**1,221**	**1,261**	**0.7**
Japan	663	654	667	656	657	658	662	658	-0.1
South Korea	140	244	246	297	336	365	395	430	2.1
Australia/New Zealand	110	137	138	146	152	158	164	173	0.8
Total OECD	**5,412**	**6,073**	**6,180**	**6,675**	**7,039**	**7,345**	**7,740**	**8,167**	**1.0**
Non-OECD									
Non-OECD Europe and Eurasia	**1,350**	**657**	**669**	**787**	**890**	**989**	**1,273**	**1,203**	**2.2**
Russia	782	351	356	398	443	490	715	578	1.8
Other	568	306	312	389	447	499	558	625	2.6
Non-OECD Asia	**949**	**1,775**	**1,853**	**2,631**	**3,106**	**3,668**	**4,272**	**5,057**	**3.8**
China	325	686	737	1,196	1,428	1,739	2,058	2,430	4.5
India	160	298	305	400	470	535	615	695	3.1
Other Non-OECD Asia	464	791	810	1,036	1,208	1,394	1,600	1,931	3.3
Middle East	**492**	**695**	**714**	**853**	**967**	**1,060**	**1,167**	**1,297**	**2.2**
Africa	**298**	**372**	**379**	**540**	**615**	**679**	**748**	**844**	**3.0**
Central and South America	**503**	**721**	**719**	**885**	**1,026**	**1,172**	**1,361**	**1,493**	**2.7**
Brazil	180	280	276	326	370	409	463	505	2.3
Other Central and South America	323	441	443	560	657	762	899	987	3.0
Total Non-OECD	**3,592**	**4,219**	**4,333**	**5,696**	**6,605**	**7,568**	**8,821**	**9,893**	**3.1**
Total World	**9,005**	**10,291**	**10,513**	**12,371**	**13,644**	**14,913**	**16,562**	**18,060**	**2.0**

[a]Includes the 50 States and the District of Columbia.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run HM2006.D112505B, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table B12. World Carbon Dioxide Emissions from Natural Gas Use by Region, High Economic Growth Case, 1990-2030
(Million Metric Tons Carbon Dioxide)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**1,207**	**1,479**	**1,474**	**1,645**	**1,840**	**1,963**	**2,037**	**2,131**	**1.4**
United States[a]	1,026	1,228	1,196	1,295	1,450	1,508	1,514	1,534	0.9
Canada	127	165	173	224	237	263	286	309	2.2
Mexico	54	86	105	126	153	191	237	288	3.8
OECD Europe	**590**	**934**	**967**	**1,177**	**1,360**	**1,504**	**1,649**	**1,826**	**2.4**
OECD Asia	**152**	**270**	**277**	**310**	**359**	**385**	**413**	**450**	**1.8**
Japan	102	163	169	185	214	226	241	268	1.7
South Korea	6	48	50	60	70	76	79	85	1.9
Australia/New Zealand	44	59	58	64	75	84	93	98	1.9
Total OECD	**1,949**	**2,683**	**2,718**	**3,131**	**3,559**	**3,853**	**4,100**	**4,407**	**1.8**
Non-OECD									
Non-OECD Europe and Eurasia	**1,450**	**1,213**	**1,281**	**1,613**	**1,853**	**2,081**	**2,174**	**2,610**	**2.7**
Russia	928	789	828	1,017	1,151	1,296	1,286	1,597	2.5
Other	521	424	452	595	702	785	888	1,013	3.0
Non-OECD Asia	**160**	**384**	**415**	**759**	**972**	**1,264**	**1,631**	**1,992**	**6.0**
China	30	69	72	188	262	338	403	490	7.3
India	24	48	52	97	122	152	247	367	7.5
Other Non-OECD Asia	106	267	290	474	587	773	981	1,135	5.2
Middle East	**199**	**422**	**435**	**631**	**771**	**908**	**1,069**	**1,229**	**3.9**
Africa	**80**	**139**	**145**	**194**	**291**	**354**	**438**	**544**	**5.0**
Central and South America	**116**	**203**	**217**	**347**	**418**	**513**	**597**	**741**	**4.6**
Brazil	6	26	27	55	64	74	88	111	5.3
Other Central and South America	110	177	190	292	354	440	510	630	4.5
Total Non-OECD	**2,005**	**2,361**	**2,493**	**3,544**	**4,305**	**5,120**	**5,910**	**7,117**	**4.0**
Total World	**3,954**	**5,044**	**5,211**	**6,675**	**7,864**	**8,972**	**10,009**	**11,524**	**3.0**

[a]Includes the 50 States and the District of Columbia.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run HM2006.D112505B, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table B13. World Carbon Dioxide Emissions from Coal Use by Region, High Economic Growth Case, 1990-2030
(Million Metric Tons Carbon Dioxide)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**1,910**	**2,239**	**2,287**	**2,602**	**2,776**	**3,071**	**3,532**	**3,984**	**2.1**
United States[a]	1,772	2,064	2,100	2,380	2,485	2,762	3,201	3,634	2.1
Canada	123	143	147	173	231	238	253	268	2.3
Mexico	15	32	40	49	60	71	78	82	2.7
OECD Europe	**1,635**	**1,199**	**1,203**	**1,197**	**1,203**	**1,232**	**1,303**	**1,336**	**0.4**
OECD Asia	**471**	**758**	**761**	**901**	**975**	**1,037**	**1,105**	**1,184**	**1.7**
Japan	245	375	369	380	397	400	399	399	0.3
South Korea	88	170	173	264	302	339	387	435	3.5
Australia/New Zealand	137	213	218	257	276	297	319	350	1.8
Total OECD	**4,016**	**4,196**	**4,251**	**4,701**	**4,954**	**5,340**	**5,940**	**6,504**	**1.6**
Non-OECD									
Non-OECD Europe and Eurasia	**1,393**	**764**	**775**	**817**	**956**	**1,141**	**1,294**	**1,423**	**2.3**
Russia	624	406	422	445	502	557	617	675	1.8
Other	770	359	353	373	454	584	677	749	2.8
Non-OECD Asia	**2,517**	**3,574**	**3,805**	**6,101**	**7,536**	**9,077**	**10,705**	**12,612**	**4.5**
China	1,886	2,518	2,731	4,726	5,917	7,209	8,668	10,392	5.1
India	394	665	666	906	1,099	1,294	1,396	1,499	3.0
Other Non-OECD Asia	237	391	408	469	520	573	642	721	2.1
Middle East	**14**	**35**	**33**	**34**	**36**	**37**	**38**	**43**	**1.0**
Africa	**271**	**339**	**369**	**494**	**566**	**621**	**663**	**709**	**2.4**
Central and South America	**54**	**69**	**70**	**95**	**106**	**126**	**136**	**149**	**2.8**
Brazil	34	41	44	56	65	73	78	83	2.4
Other Central and South America	20	28	25	39	42	53	57	65	3.5
Total Non-OECD	**4,248**	**4,782**	**5,052**	**7,541**	**9,199**	**11,002**	**12,836**	**14,936**	**4.1**
Total World	**8,264**	**8,978**	**9,303**	**12,242**	**14,153**	**16,342**	**18,776**	**21,441**	**3.1**

[a]Includes the 50 States and the District of Columbia.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run HM2006.D112505B, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Appendix C

Low Economic Growth Case Projections:

- **World Energy Consumption**
- **Gross Domestic Product**
- **Carbon Dioxide Emissions**

Table C1. World Total Energy Consumption by Region, Low Economic Growth Case, 1990-2030
(Quadrillion Btu)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**100.8**	**117.5**	**118.3**	**128.6**	**134.6**	**140.5**	**145.8**	**151.3**	**0.9**
United States[a]	84.6	98.1	98.1	105.4	109.7	114.0	117.7	121.5	0.8
Canada	11.1	13.1	13.5	15.4	16.2	16.7	17.3	17.8	1.0
Mexico	5.0	6.2	6.8	7.8	8.8	9.7	10.8	11.9	2.1
OECD Europe	**69.9**	**77.9**	**78.9**	**83.3**	**85.0**	**86.0**	**86.8**	**88.8**	**0.4**
OECD Asia	**26.7**	**36.5**	**37.1**	**39.6**	**41.4**	**42.3**	**43.2**	**44.3**	**0.7**
Japan	18.4	22.2	22.4	22.3	22.6	22.5	22.5	22.5	0.0
South Korea	3.8	8.4	8.6	10.7	11.9	12.6	13.3	14.1	1.8
Australia/New Zealand	4.4	6.0	6.0	6.6	6.9	7.1	7.4	7.7	0.9
Total OECD	**197.4**	**231.9**	**234.3**	**251.5**	**261.0**	**268.7**	**275.8**	**284.4**	**0.7**
Non-OECD									
Non-OECD Europe and Eurasia	**67.2**	**46.9**	**48.5**	**54.6**	**58.8**	**62.2**	**65.3**	**67.8**	**1.2**
Russia	39.0	28.1	29.1	32.1	34.0	35.5	36.9	37.9	1.0
Other	28.3	18.8	19.4	22.5	24.8	26.7	28.3	29.9	1.6
Non-OECD Asia	**47.5**	**78.4**	**83.1**	**121.9**	**138.8**	**154.1**	**169.3**	**185.9**	**3.0**
China	27.0	42.1	45.5	74.2	85.2	94.9	104.2	114.7	3.5
India	8.0	13.8	14.0	18.9	21.1	23.3	25.4	27.7	2.5
Other Non-OECD Asia	12.5	22.5	23.6	28.9	32.4	35.9	39.7	43.5	2.3
Middle East	**11.3**	**19.1**	**19.6**	**24.3**	**26.3**	**28.1**	**30.0**	**32.3**	**1.9**
Africa	**9.5**	**12.8**	**13.3**	**17.1**	**19.2**	**20.2**	**21.3**	**22.8**	**2.0**
Central and South America	**14.5**	**21.3**	**21.9**	**27.1**	**29.8**	**32.2**	**35.1**	**37.5**	**2.0**
Brazil	5.8	8.6	8.8	10.5	11.5	12.4	13.4	14.4	1.8
Other Central and South America	8.8	12.7	13.1	16.6	18.3	19.8	21.7	23.1	2.1
Total Non-OECD	**150.0**	**178.4**	**186.4**	**244.9**	**272.9**	**296.8**	**321.0**	**346.2**	**2.3**
Total World	**347.3**	**410.3**	**420.7**	**496.5**	**533.9**	**565.5**	**596.8**	**630.6**	**1.5**

[a]Includes the 50 States and the District of Columbia.

Notes: Energy totals include net imports of coal coke and electricity generated from biomass in the United States. Totals may not equal sum of components due to independent rounding. The electricity portion of the national fuel consumption values consists of generation for domestic use plus an adjustment for electricity trade based on a fuel's share of total generation in the exporting country.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run LM2006.D113005A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table C2. World Total Energy Consumption by Region and Fuel, Low Economic Growth Case, 1990-2030
(Quadrillion Btu)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America									
Oil	40.5	46.3	47.2	51.0	52.8	54.7	56.3	58.6	0.8
Natural Gas	23.2	28.4	28.3	29.8	32.5	34.2	34.9	35.4	0.8
Coal	20.7	24.0	24.4	26.7	27.9	29.1	31.6	33.7	1.2
Nuclear	6.9	9.0	8.9	9.7	9.8	10.3	10.3	10.3	0.5
Other	9.5	9.8	9.5	11.4	11.7	12.1	12.8	13.3	1.2
Total	**100.8**	**117.5**	**118.3**	**128.6**	**134.6**	**140.5**	**145.8**	**151.3**	**0.9**
OECD Europe									
Oil	28.4	31.6	32.0	32.2	32.0	31.3	31.5	31.7	0.0
Natural Gas	11.2	17.7	18.3	21.1	23.3	25.6	26.4	28.6	1.7
Coal	17.6	12.8	12.8	12.7	12.5	12.6	12.7	12.6	-0.1
Nuclear	7.9	9.7	9.8	9.5	9.3	8.5	7.9	7.5	-1.0
Other	4.8	6.1	6.0	7.9	8.0	8.0	8.4	8.4	1.3
Total	**69.9**	**77.9**	**78.9**	**83.3**	**85.0**	**86.0**	**86.8**	**88.8**	**0.4**
OECD Asia									
Oil	14.5	17.5	17.8	18.3	18.7	18.8	18.9	19.2	0.3
Natural Gas	2.9	5.1	5.3	5.5	6.0	6.2	6.3	6.5	0.8
Coal	5.2	8.2	8.4	9.5	9.7	9.7	9.9	10.1	0.7
Nuclear	2.5	4.0	3.7	4.2	4.7	5.3	5.8	6.2	2.0
Other	1.6	1.7	1.9	2.1	2.3	2.3	2.3	2.3	0.7
Total	**26.7**	**36.5**	**37.1**	**39.6**	**41.4**	**42.3**	**43.2**	**44.3**	**0.7**
Total OECD									
Oil	83.4	95.4	97.0	101.5	103.5	104.8	106.7	109.5	0.4
Natural Gas	37.2	51.2	51.9	56.4	61.7	66.0	67.7	70.6	1.1
Coal	43.5	44.9	45.6	48.8	50.1	51.4	54.1	56.4	0.8
Nuclear	17.3	22.7	22.3	23.4	23.8	24.1	23.9	23.9	0.3
Other	15.9	17.6	17.4	21.5	21.9	22.4	23.4	24.1	1.2
Total	**197.4**	**231.9**	**234.3**	**251.5**	**261.0**	**268.7**	**275.8**	**284.4**	**0.7**
Non-OECD									
Non-OECD Europe and Eurasia									
Oil	19.5	9.9	10.1	10.7	11.4	11.7	12.1	12.5	0.8
Natural Gas	27.5	23.0	24.3	28.5	30.4	32.4	34.0	35.6	1.4
Coal	15.1	8.3	8.4	8.6	9.6	10.0	10.4	10.9	1.0
Nuclear	2.5	2.8	2.8	3.1	3.5	4.3	4.8	4.9	2.0
Other	2.8	3.0	3.0	3.7	3.9	3.9	3.9	3.9	1.0
Total	**67.2**	**46.9**	**48.5**	**54.6**	**58.8**	**62.2**	**65.3**	**67.8**	**1.2**
Non-OECD Asia									
Oil	13.9	26.7	27.9	37.0	40.5	44.5	47.5	51.2	2.3
Natural Gas	3.0	7.3	7.9	11.9	14.7	17.7	21.1	24.5	4.3
Coal	27.2	38.7	41.2	61.2	70.0	76.9	84.0	91.5	3.0
Nuclear	0.4	0.9	1.0	2.0	2.9	3.8	4.6	5.3	6.3
Other	3.0	4.9	5.1	9.8	10.8	11.2	12.2	13.4	3.6
Total	**47.5**	**78.4**	**83.1**	**121.9**	**138.8**	**154.1**	**169.3**	**185.9**	**3.0**

See notes at end of table.

Table C2. World Total Energy Consumption by Region and Fuel, Low Economic Growth Case, 1990-2030 (Continued)
(Quadrillion Btu)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
Non-OECD (Continued)									
Middle East									
Oil	7.2	10.5	10.8	11.9	12.4	12.7	12.8	13.2	0.7
Natural Gas	3.8	8.0	8.2	11.4	12.8	14.3	16.0	18.0	2.9
Coal	0.1	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.7
Nuclear	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	—
Other	0.1	0.2	0.2	0.6	0.6	0.7	0.7	0.7	4.0
Total	**11.3**	**19.1**	**19.6**	**24.3**	**26.3**	**28.1**	**30.0**	**32.3**	**1.9**
Africa									
Oil	4.3	5.4	5.5	7.3	7.6	7.7	7.9	8.3	1.5
Natural Gas	1.5	2.6	2.7	3.5	4.6	5.5	6.3	7.2	3.7
Coal	3.0	3.7	4.1	5.1	5.7	5.8	5.8	5.9	1.4
Nuclear	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.7
Other	0.6	0.9	0.9	1.1	1.1	1.1	1.1	1.1	0.9
Total	**9.5**	**12.8**	**13.3**	**17.1**	**19.2**	**20.2**	**21.3**	**22.8**	**2.0**
Central and South America									
Oil	7.7	10.8	10.8	12.1	12.9	13.3	14.0	14.7	1.2
Natural Gas	2.2	3.8	4.1	5.8	6.9	7.7	8.7	9.6	3.2
Coal	0.6	0.7	0.8	1.0	1.1	1.2	1.3	1.3	2.1
Nuclear	0.1	0.2	0.2	0.2	0.4	0.3	0.4	0.3	0.5
Other	3.9	5.7	6.0	7.8	8.6	9.6	10.7	11.7	2.5
Total	**14.5**	**21.3**	**21.9**	**27.1**	**29.8**	**32.2**	**35.1**	**37.5**	**2.0**
Total Non-OECD									
Oil	52.7	63.3	65.1	79.0	84.8	89.9	94.4	99.9	1.6
Natural Gas	38.0	44.7	47.2	61.1	69.4	77.6	86.1	94.8	2.6
Coal	45.9	51.8	54.8	76.4	86.7	94.2	101.9	110.1	2.6
Nuclear	3.1	4.0	4.2	5.5	7.0	8.7	10.0	10.6	3.5
Other	10.3	14.6	15.2	23.0	24.9	26.4	28.6	30.8	2.6
Total	**150.0**	**178.4**	**186.4**	**244.9**	**272.9**	**296.8**	**321.0**	**346.2**	**2.3**
Total World									
Oil	136.1	158.7	162.1	180.5	188.3	194.7	201.1	209.4	1.0
Natural Gas	75.2	95.9	99.1	117.5	131.2	143.6	153.8	165.4	1.9
Coal	89.4	96.8	100.4	125.2	136.8	145.7	156.0	166.4	1.9
Nuclear	20.4	26.7	26.5	28.9	30.8	32.8	33.9	34.6	1.0
Other	26.3	32.2	32.7	44.5	46.8	48.8	52.0	54.9	1.9
Total	**347.3**	**410.3**	**420.7**	**496.5**	**533.9**	**565.5**	**596.8**	**630.6**	**1.5**

Notes: Energy totals include net imports of coal coke and electricity generated from biomass in the United States. Totals may not equal sum of components due to independent rounding. The electricity portion of the national fuel consumption values consists of generation for domestic use plus an adjustment for electricity trade based on a fuel's share of total generation in the exporting country.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run LM2006.D113005A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table C3. World Gross Domestic Product (GDP) by Region Using Purchasing Power Parity, Low Economic Growth Case, 1990-2030

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**8,477**	**11,968**	**12,273**	**14,931**	**16,825**	**19,183**	**21,262**	**23,864**	**2.5**
United States[a]	7,113	10,049	10,321	12,529	14,058	16,022	17,668	19,771	2.4
Canada	684	957	977	1,161	1,279	1,379	1,463	1,550	1.7
Mexico	680	962	976	1,240	1,488	1,782	2,131	2,543	3.6
OECD Europe	**8,017**	**10,647**	**10,799**	**12,406**	**13,515**	**14,680**	**15,872**	**17,156**	**1.7**
OECD Asia	**3,655**	**4,628**	**4,716**	**5,480**	**5,966**	**6,327**	**6,656**	**7,008**	**1.5**
Japan	2,898	3,329	3,375	3,764	3,991	4,121	4,214	4,311	0.9
South Korea	330	663	683	943	1,125	1,272	1,416	1,573	3.1
Australia/New Zealand	428	637	657	772	850	934	1,025	1,124	2.0
Total OECD	**20,150**	**27,243**	**27,788**	**32,817**	**36,306**	**40,190**	**43,790**	**48,028**	**2.0**
Non-OECD									
Non-OECD Europe and Eurasia	**3,387**	**2,672**	**2,878**	**4,056**	**4,726**	**5,400**	**6,071**	**6,770**	**3.2**
Russia	2,241	1,658	1,780	2,355	2,647	2,941	3,218	3,477	2.5
Other	1,146	1,013	1,099	1,702	2,079	2,459	2,853	3,293	4.1
Non-OECD Asia	**5,780**	**12,559**	**13,516**	**20,158**	**25,106**	**30,711**	**37,113**	**44,673**	**4.5**
China	1,807	5,494	5,994	9,653	12,320	15,284	18,687	22,736	5.1
India	1,684	3,160	3,429	4,922	6,086	7,493	9,138	11,108	4.4
Other Non-OECD Asia	2,289	3,905	4,093	5,583	6,701	7,934	9,287	10,829	3.7
Middle East	**810**	**1,295**	**1,357**	**1,855**	**2,158**	**2,477**	**2,822**	**3,209**	**3.2**
Africa	**1,461**	**2,074**	**2,173**	**2,929**	**3,466**	**4,055**	**4,716**	**5,479**	**3.5**
Central and South America	**2,174**	**3,011**	**3,075**	**3,941**	**4,499**	**5,106**	**5,779**	**6,536**	**2.8**
Brazil	1,022	1,370	1,378	1,712	1,931	2,170	2,430	2,716	2.5
Other Central and South America	1,153	1,641	1,697	2,229	2,568	2,936	3,349	3,820	3.1
Total Non-OECD	**13,612**	**21,611**	**22,999**	**32,939**	**39,955**	**47,749**	**56,501**	**66,666**	**4.0**
Total World	**33,761**	**48,854**	**50,786**	**65,755**	**76,261**	**87,939**	**100,291**	**114,694**	**3.1**

[a]Includes the 50 States and the District of Columbia.

Notes: Totals may not equal sum of components due to independent rounding. GDP growth rates for China and India were adjusted, based on the analyst's judgment.

Sources: **History:** Global Insight, Inc., *World Overview* (Lexington, MA, various issues). **Projections:** Global Insight, Inc., *World Overview*, Fourth Quarter 2005 (Lexington, MA, January 2006); and Energy Information Administration, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington DC, February 2006), Table B4.

Table C4. World Oil Consumption by Region, Low Economic Growth Case, 1990-2030
(Million Barrels per Day)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**20.5**	**23.8**	**24.3**	**26.2**	**27.1**	**28.2**	**28.9**	**30.1**	**0.8**
United States[a]	17.0	19.8	20.1	21.5	22.4	23.3	23.8	24.7	0.8
Canada	1.7	2.1	2.2	2.4	2.4	2.4	2.4	2.6	0.6
Mexico	1.8	1.9	2.0	2.2	2.4	2.5	2.7	2.9	1.3
OECD Europe	**13.7**	**15.3**	**15.5**	**15.6**	**15.5**	**15.2**	**15.3**	**15.4**	**0.0**
OECD Asia	**7.1**	**8.6**	**8.8**	**9.0**	**9.2**	**9.2**	**9.3**	**9.4**	**0.3**
Japan	5.2	5.5	5.6	5.4	5.4	5.2	5.2	5.1	-0.3
South Korea	1.0	2.1	2.2	2.5	2.8	2.9	3.0	3.2	1.4
Australia/New Zealand	0.8	1.0	1.0	1.1	1.1	1.1	1.1	1.2	0.5
Total OECD	**41.3**	**47.7**	**48.5**	**50.8**	**51.8**	**52.6**	**53.5**	**54.9**	**0.5**
Non-OECD									
Non-OECD Europe and Eurasia	**9.3**	**4.8**	**4.9**	**5.2**	**5.5**	**5.7**	**5.8**	**6.0**	**0.8**
Russia	5.4	2.6	2.7	2.6	2.7	2.7	2.8	2.8	0.2
Other	3.9	2.1	2.2	2.6	2.8	2.9	3.1	3.2	1.5
Non-OECD Asia	**6.6**	**12.9**	**13.5**	**17.9**	**19.6**	**21.5**	**23.0**	**24.7**	**2.3**
China	2.3	5.2	5.6	8.4	9.3	10.4	11.3	12.4	3.0
India	1.2	2.3	2.3	2.8	3.1	3.3	3.5	3.8	1.8
Other Non-OECD Asia	3.1	5.5	5.6	6.6	7.2	7.8	8.1	8.6	1.6
Middle East	**3.5**	**5.1**	**5.3**	**5.8**	**6.1**	**6.2**	**6.3**	**6.4**	**0.7**
Africa	**2.1**	**2.7**	**2.7**	**3.6**	**3.7**	**3.8**	**3.9**	**4.1**	**1.5**
Central and South America	**3.8**	**5.3**	**5.3**	**5.9**	**6.3**	**6.5**	**6.8**	**7.2**	**1.2**
Brazil	1.5	2.1	2.1	2.3	2.5	2.5	2.7	2.8	1.1
Other Central and South America	2.3	3.1	3.2	3.6	3.8	4.0	4.1	4.3	1.2
Total Non-OECD	**25.3**	**30.7**	**31.6**	**38.3**	**41.2**	**43.6**	**45.8**	**48.5**	**1.6**
Total World	**66.6**	**78.5**	**80.1**	**89.1**	**93.0**	**96.2**	**99.3**	**103.4**	**0.9**

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run LM2006.D113005A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table C5. World Natural Gas Consumption by Region, Low Economic Growth Case, 1990-2030
(Trillion Cubic Feet)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**22.5**	**27.6**	**27.4**	**28.9**	**31.4**	**33.1**	**33.8**	**34.2**	**0.8**
United States[a]	19.2	23.0	22.3	22.8	24.6	25.5	25.6	25.5	0.5
Canada	2.4	3.1	3.2	4.0	4.2	4.5	4.7	4.7	1.4
Mexico	0.9	1.5	1.8	2.1	2.6	3.1	3.5	4.1	3.0
OECD Europe	**11.6**	**17.2**	**17.8**	**20.5**	**22.6**	**24.9**	**25.7**	**27.9**	**1.7**
OECD Asia	**2.8**	**4.8**	**5.0**	**5.2**	**5.6**	**5.8**	**6.0**	**6.1**	**0.8**
Japan	1.9	2.9	3.1	3.1	3.3	3.3	3.3	3.3	0.3
South Korea	0.1	0.8	0.9	1.0	1.1	1.2	1.3	1.3	1.6
Australia/New Zealand	0.8	1.1	1.1	1.1	1.3	1.3	1.4	1.5	1.3
Total OECD	**36.8**	**49.6**	**50.2**	**54.5**	**59.7**	**63.8**	**65.5**	**68.2**	**1.1**
Non-OECD									
Non-OECD Europe and Eurasia	**26.7**	**22.3**	**23.6**	**27.7**	**29.6**	**31.4**	**33.0**	**34.6**	**1.4**
Russia	17.3	14.6	15.3	17.6	18.2	19.1	19.6	19.9	1.0
Other	9.5	7.8	8.3	10.1	11.4	12.4	13.4	14.7	2.1
Non-OECD Asia	**2.9**	**6.9**	**7.5**	**11.2**	**13.8**	**16.6**	**19.8**	**23.0**	**4.2**
China	0.5	1.1	1.2	3.0	3.7	4.8	5.6	6.1	6.3
India	0.4	0.9	1.0	1.3	1.6	2.0	2.4	3.0	4.4
Other Non-OECD Asia	2.0	4.9	5.4	6.9	8.6	9.9	11.8	13.9	3.6
Middle East	**3.6**	**7.6**	**7.9**	**10.8**	**12.2**	**13.7**	**15.3**	**17.2**	**2.9**
Africa	**1.4**	**2.4**	**2.6**	**3.3**	**4.3**	**5.1**	**5.9**	**6.7**	**3.7**
Central and South America	**2.0**	**3.6**	**3.8**	**5.4**	**6.4**	**7.2**	**8.1**	**8.9**	**3.2**
Brazil	0.1	0.5	0.5	0.9	1.0	1.1	1.2	1.4	3.8
Other Central and South America	1.9	3.1	3.3	4.5	5.4	6.1	6.9	7.5	3.1
Total Non-OECD	**36.5**	**42.9**	**45.3**	**58.4**	**66.3**	**74.0**	**82.1**	**90.4**	**2.6**
Total World	**73.4**	**92.5**	**95.5**	**113.0**	**126.0**	**137.8**	**147.5**	**158.6**	**1.9**

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run LM2006.D113005A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table C6. World Coal Consumption by Region, Low Economic Growth Case, 1990-2030
(Million Short Tons)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**972**	**1,151**	**1,185**	**1,304**	**1,370**	**1,436**	**1,602**	**1,722**	**1.4**
United States[a]	904	1,066	1,095	1,211	1,254	1,307	1,451	1,563	1.3
Canada	59	68	69	72	91	101	113	119	2.0
Mexico	9	17	20	21	26	28	38	39	2.5
OECD Europe	**1,298**	**892**	**887**	**876**	**867**	**874**	**876**	**870**	**-0.1**
OECD Asia	**280**	**400**	**404**	**460**	**471**	**474**	**483**	**494**	**0.7**
Japan	126	172	176	173	171	164	156	149	-0.6
South Korea	48	80	81	116	125	129	138	146	2.2
Australia/New Zealand	106	148	147	171	175	181	190	198	1.1
Total OECD	**2,551**	**2,442**	**2,476**	**2,640**	**2,708**	**2,784**	**2,961**	**3,085**	**0.8**
Non-OECD									
Non-OECD Europe and Eurasia	**1,028**	**530**	**543**	**586**	**650**	**679**	**712**	**743**	**1.2**
Russia	447	240	251	260	292	298	309	319	0.9
Other	581	290	292	326	358	381	403	425	1.4
Non-OECD Asia	**1,507**	**2,041**	**2,168**	**3,224**	**3,685**	**4,050**	**4,421**	**4,818**	**3.0**
China	1,124	1,413	1,531	2,421	2,792	3,077	3,371	3,718	3.3
India	256	431	431	571	641	700	755	802	2.3
Other Non-OECD Asia	127	197	206	232	252	273	295	298	1.4
Middle East	**6**	**16**	**16**	**16**	**16**	**16**	**17**	**19**	**0.7**
Africa	**152**	**187**	**203**	**256**	**284**	**288**	**292**	**296**	**1.4**
Central and South America	**27**	**34**	**35**	**47**	**51**	**56**	**59**	**61**	**2.1**
Brazil	17	22	24	30	32	34	36	38	1.8
Other Central and South America	10	12	11	17	18	21	23	23	2.6
Total Non-OECD	**2,718**	**2,808**	**2,964**	**4,129**	**4,686**	**5,089**	**5,500**	**5,937**	**2.6**
Total World	**5,269**	**5,250**	**5,440**	**6,769**	**7,394**	**7,872**	**8,461**	**9,022**	**1.9**

[a]Includes the 50 States and the District of Columbia.

Notes: Totals may not equal sum of components due to independent rounding. To convert short tons to metric tons, divide each number in the table by 1.102.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run LM2006.D113005A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table C7. World Nuclear Energy Consumption by Region, Low Economic Growth Case, 1990-2030
(Billion Kilowatthours)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**649**	**861**	**844**	**923**	**930**	**980**	**975**	**975**	**0.5**
United States[a]	577	780	764	809	807	856	856	856	0.4
Canada	69	72	71	104	113	113	108	108	1.6
Mexico	3	9	10	11	11	11	11	11	0.2
OECD Europe	**743**	**923**	**930**	**896**	**877**	**807**	**748**	**707**	**-1.0**
OECD Asia	**242**	**393**	**360**	**416**	**464**	**518**	**567**	**610**	**2.0**
Japan	192	280	237	274	289	318	350	371	1.7
South Korea	50	113	123	142	175	200	217	239	2.5
Australia/New Zealand	0	0	0	0	0	0	0	0	—
Total OECD	**1,635**	**2,178**	**2,135**	**2,234**	**2,271**	**2,305**	**2,290**	**2,292**	**0.3**
Non-OECD									
Non-OECD Europe and Eurasia	**219**	**254**	**258**	**278**	**323**	**393**	**441**	**443**	**2.0**
Russia	115	134	138	151	190	233	286	321	3.2
Other	104	120	120	127	133	160	155	122	0.1
Non-OECD Asia	**38**	**83**	**97**	**187**	**268**	**356**	**434**	**504**	**6.3**
China	0	25	42	79	130	171	230	304	7.6
India	6	18	16	56	76	99	106	112	7.4
Other Non-OECD Asia	32	40	39	52	62	85	98	89	3.1
Middle East	**0**	**0**	**0**	**6**	**6**	**6**	**6**	**6**	**—**
Africa	**8**	**12**	**13**	**14**	**15**	**15**	**15**	**15**	**0.7**
Central and South America	**9**	**19**	**20**	**21**	**35**	**32**	**33**	**24**	**0.6**
Brazil	2	14	13	13	22	23	23	19	1.2
Other Central and South America	7	5	7	7	12	10	10	5	-1.1
Total Non-OECD	**274**	**368**	**388**	**505**	**647**	**802**	**929**	**993**	**3.5**
Total World	**1,909**	**2,546**	**2,523**	**2,739**	**2,918**	**3,108**	**3,218**	**3,285**	**1.0**

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run LM2006.D113005A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table C8. World Consumption of Hydroelectricity and Other Renewable Energy by Region, Low Economic Growth Case, 1990-2030
(Quadrillion Btu)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**9.5**	**9.8**	**9.5**	**11.4**	**11.7**	**12.1**	**12.8**	**13.3**	**1.2**
United States[a]	6.1	5.9	5.7	7.0	7.2	7.6	8.1	8.4	1.4
Canada	3.1	3.6	3.5	3.7	3.8	3.7	3.9	4.1	0.6
Mexico	0.3	0.4	0.3	0.6	0.7	0.8	0.8	0.9	3.8
OECD Europe	**4.8**	**6.1**	**6.0**	**7.9**	**8.0**	**8.0**	**8.4**	**8.4**	**1.3**
OECD Asia	**1.6**	**1.7**	**1.9**	**2.1**	**2.3**	**2.3**	**2.3**	**2.3**	**0.7**
Japan	1.1	1.1	1.4	1.4	1.4	1.4	1.4	1.4	0.0
South Korea	0.0	0.0	0.1	0.2	0.3	0.3	0.3	0.3	6.6
Australia/New Zealand	0.4	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.8
Total OECD	**15.9**	**17.6**	**17.4**	**21.5**	**21.9**	**22.4**	**23.4**	**24.1**	**1.2**
Non-OECD									
Non-OECD Europe and Eurasia	**2.8**	**3.0**	**3.0**	**3.7**	**3.9**	**3.9**	**3.9**	**3.9**	**1.0**
Russia	1.8	1.9	1.8	2.2	2.3	2.3	2.3	2.3	0.9
Other	1.0	1.1	1.2	1.6	1.6	1.6	1.6	1.7	1.2
Non-OECD Asia	**3.0**	**4.9**	**5.1**	**9.8**	**10.8**	**11.2**	**12.2**	**13.4**	**3.6**
China	1.3	2.8	2.9	6.2	6.8	7.1	7.3	7.6	3.7
India	0.7	0.7	0.7	1.3	1.4	1.4	1.5	1.8	3.2
Other Non-OECD Asia	0.9	1.4	1.5	2.4	2.6	2.7	3.4	4.0	3.8
Middle East	**0.1**	**0.2**	**0.2**	**0.6**	**0.6**	**0.7**	**0.7**	**0.7**	**4.0**
Africa	**0.6**	**0.9**	**0.9**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**0.9**
Central and South America	**3.9**	**5.7**	**6.0**	**7.8**	**8.6**	**9.6**	**10.7**	**11.7**	**2.5**
Brazil	2.2	3.0	3.3	4.0	4.6	5.1	5.7	6.2	2.4
Other Central and South America	1.7	2.7	2.8	3.8	4.0	4.5	5.0	5.4	2.5
Total Non-OECD	**10.3**	**14.6**	**15.2**	**23.0**	**24.9**	**26.4**	**28.6**	**30.8**	**2.6**
Total World	**26.3**	**32.2**	**32.7**	**44.5**	**46.8**	**48.8**	**52.0**	**54.9**	**1.9**

[a]Includes the 50 States and the District of Columbia.

Notes: Totals may not equal sum of components due to independent rounding. U.S. totals include net electricity imports, methanol, and liquid hydrogen.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run LM2006.D113005A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table C9. World Net Electricity Consumption by Region, Low Economic Growth Case, 1990-2030
(Billion Kilowatthours)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**3,379**	**4,337**	**4,384**	**4,953**	**5,298**	**5,639**	**5,955**	**6,294**	**1.3**
United States[a]	2,837	3,629	3,669	4,084	4,334	4,585	4,820	5,080	1.2
Canada	435	518	521	594	637	670	691	712	1.2
Mexico	107	190	194	276	326	384	444	502	3.6
OECD Europe	**2,355**	**2,916**	**2,965**	**3,289**	**3,407**	**3,520**	**3,641**	**3,779**	**0.9**
OECD Asia	**1,024**	**1,463**	**1,487**	**1,718**	**1,805**	**1,856**	**1,904**	**1,956**	**1.0**
Japan	764	964	946	1,036	1,057	1,059	1,061	1,064	0.4
South Korea	93	268	303	416	467	502	534	566	2.3
Australia/New Zealand	166	231	238	266	281	294	309	325	1.2
Total OECD	**6,758**	**8,715**	**8,836**	**9,961**	**10,509**	**11,014**	**11,500**	**12,028**	**1.1**
Non-OECD									
Non-OECD Europe and Eurasia	**1,672**	**1,318**	**1,350**	**1,753**	**1,936**	**2,088**	**2,196**	**2,283**	**2.0**
Russia	955	796	812	1,027	1,115	1,194	1,244	1,279	1.7
Other	717	522	539	725	821	893	951	1,004	2.3
Non-OECD Asia	**1,150**	**2,655**	**2,917**	**4,503**	**5,385**	**6,237**	**7,092**	**8,006**	**3.8**
China	551	1,452	1,671	2,661	3,208	3,724	4,238	4,794	4.0
India	257	525	519	811	962	1,112	1,263	1,427	3.8
Other Non-OECD Asia	342	678	726	1,032	1,214	1,401	1,592	1,785	3.4
Middle East	**214**	**457**	**471**	**656**	**727**	**784**	**831**	**873**	**2.3**
Africa	**286**	**420**	**436**	**534**	**601**	**653**	**703**	**754**	**2.1**
Central and South America	**463**	**736**	**772**	**1,071**	**1,222**	**1,355**	**1,484**	**1,605**	**2.8**
Brazil	229	353	371	500	563	619	672	723	2.5
Other Central and South America	234	383	400	572	659	736	812	883	3.0
Total Non-OECD	**3,785**	**5,586**	**5,944**	**8,518**	**9,871**	**11,117**	**12,307**	**13,522**	**3.1**
Total World	**10,543**	**14,301**	**14,781**	**18,479**	**20,380**	**22,131**	**23,807**	**25,551**	**2.0**

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run LM2006.D113005A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table C10. World Carbon Dioxide Emissions by Region, Low Economic Growth Case, 1990-2030
(Million Metric Tons Carbon Dioxide)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**5,753**	**6,687**	**6,797**	**7,339**	**7,702**	**8,036**	**8,412**	**8,793**	**1.0**
United States[a]	4,978	5,748	5,796	6,219	6,476	6,720	6,991	7,284	0.9
Canada	474	570	596	673	722	760	799	825	1.2
Mexico	300	369	405	446	503	555	622	684	2.0
OECD Europe	**4,089**	**4,203**	**4,264**	**4,409**	**4,498**	**4,584**	**4,646**	**4,767**	**0.4**
OECD Asia	**1,536**	**2,063**	**2,090**	**2,230**	**2,300**	**2,317**	**2,347**	**2,388**	**0.5**
Japan	1,011	1,191	1,206	1,178	1,182	1,151	1,125	1,109	-0.3
South Korea	234	462	470	594	644	673	709	746	1.7
Australia/New Zealand	291	410	415	458	474	493	513	534	0.9
Total OECD	**11,378**	**12,952**	**13,150**	**13,977**	**14,499**	**14,937**	**15,405**	**15,948**	**0.7**
Non-OECD									
Non-OECD Europe and Eurasia	**4,193**	**2,634**	**2,725**	**3,015**	**3,248**	**3,408**	**3,564**	**3,717**	**1.2**
Russia	2,334	1,546	1,606	1,742	1,839	1,900	1,951	1,989	0.8
Other	1,859	1,088	1,118	1,273	1,409	1,508	1,612	1,728	1.6
Non-OECD Asia	**3,626**	**5,733**	**6,072**	**8,737**	**9,926**	**10,987**	**12,016**	**13,135**	**2.9**
China	2,241	3,273	3,541	5,614	6,442	7,164	7,862	8,652	3.4
India	578	1,011	1,023	1,331	1,484	1,625	1,766	1,903	2.3
Other Non-OECD Asia	807	1,449	1,508	1,792	2,001	2,198	2,389	2,580	2.0
Middle East	**704**	**1,152**	**1,182**	**1,418**	**1,531**	**1,629**	**1,727**	**1,859**	**1.7**
Africa	**649**	**850**	**893**	**1,149**	**1,285**	**1,346**	**1,410**	**1,492**	**1.9**
Central and South America	**673**	**993**	**1,006**	**1,214**	**1,325**	**1,409**	**1,516**	**1,610**	**1.8**
Brazil	220	347	348	409	437	457	487	517	1.5
Other Central and South America	453	645	659	805	888	952	1,029	1,093	1.9
Total Non-OECD	**9,846**	**11,362**	**11,878**	**15,533**	**17,316**	**18,780**	**20,233**	**21,813**	**2.3**
Total World	**21,223**	**24,314**	**25,028**	**29,511**	**31,815**	**33,716**	**35,639**	**37,761**	**1.5**

[a]Includes the 50 States and the District of Columbia.

Note: The U.S. numbers include carbon dioxide emissions attributable to renewable energy sources.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run LM2006.D113005A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table C11. World Carbon Dioxide Emissions from Oil Use by Region, Low Economic Growth Case, 1990-2030
(Million Metric Tons Carbon Dioxide)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**2,636**	**2,969**	**3,034**	**3,264**	**3,376**	**3,506**	**3,610**	**3,766**	**0.8**
United States[a]	2,181	2,456	2,498	2,674	2,768	2,880	2,957	3,072	0.8
Canada	224	262	276	305	303	301	306	322	0.6
Mexico	231	250	260	285	304	324	347	372	1.3
OECD Europe	**1,864**	**2,069**	**2,094**	**2,110**	**2,095**	**2,050**	**2,063**	**2,075**	**0.0**
OECD Asia	**913**	**1,035**	**1,052**	**1,073**	**1,099**	**1,102**	**1,111**	**1,127**	**0.3**
Japan	663	654	667	642	641	625	616	611	-0.3
South Korea	140	244	246	287	312	326	342	358	1.4
Australia/New Zealand	110	137	138	144	146	151	153	157	0.5
Total OECD	**5,412**	**6,073**	**6,180**	**6,448**	**6,569**	**6,658**	**6,784**	**6,968**	**0.4**
Non-OECD									
Non-OECD Europe and Eurasia	**1,350**	**657**	**669**	**716**	**758**	**782**	**809**	**838**	**0.8**
Russia	782	351	356	350	361	366	372	376	0.2
Other	568	306	312	366	397	416	437	462	1.5
Non-OECD Asia	**949**	**1,775**	**1,853**	**2,447**	**2,682**	**2,942**	**3,140**	**3,380**	**2.3**
China	325	686	737	1,113	1,235	1,381	1,505	1,644	3.0
India	160	298	305	375	407	435	467	496	1.8
Other Non-OECD Asia	464	791	810	959	1,039	1,126	1,168	1,240	1.6
Middle East	**492**	**695**	**714**	**784**	**820**	**836**	**846**	**870**	**0.7**
Africa	**298**	**372**	**379**	**498**	**524**	**532**	**545**	**571**	**1.5**
Central and South America	**503**	**721**	**719**	**812**	**860**	**890**	**937**	**983**	**1.2**
Brazil	180	280	276	304	322	334	356	372	1.1
Other Central and South America	323	441	443	508	538	557	581	611	1.2
Total Non-OECD	**3,592**	**4,219**	**4,333**	**5,257**	**5,643**	**5,982**	**6,277**	**6,641**	**1.6**
Total World	**9,005**	**10,291**	**10,513**	**11,705**	**12,212**	**12,640**	**13,061**	**13,609**	**1.0**

[a]Includes the 50 States and the District of Columbia.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run LM2006.D113005A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table C12. World Carbon Dioxide Emissions from Natural Gas Use by Region, Low Economic Growth Case, 1990-2030
(Million Metric Tons Carbon Dioxide)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**1,207**	**1,479**	**1,474**	**1,566**	**1,708**	**1,800**	**1,838**	**1,862**	**0.9**
United States[a]	1,026	1,228	1,196	1,229	1,332	1,377	1,382	1,376	0.5
Canada	127	165	173	216	227	245	256	251	1.4
Mexico	54	86	105	121	148	177	200	235	3.0
OECD Europe	**590**	**934**	**967**	**1,111**	**1,228**	**1,349**	**1,396**	**1,512**	**1.7**
OECD Asia	**152**	**270**	**277**	**291**	**316**	**327**	**335**	**343**	**0.8**
Japan	102	163	169	172	180	181	181	184	0.3
South Korea	6	48	50	59	66	72	75	76	1.6
Australia/New Zealand	44	59	58	60	70	74	79	84	1.3
Total OECD	**1,949**	**2,683**	**2,718**	**2,968**	**3,252**	**3,476**	**3,568**	**3,718**	**1.2**
Non-OECD									
Non-OECD Europe and Eurasia	**1,450**	**1,213**	**1,281**	**1,505**	**1,607**	**1,709**	**1,794**	**1,878**	**1.4**
Russia	928	789	828	955	987	1,033	1,060	1,077	1.0
Other	521	424	452	550	620	676	734	802	2.1
Non-OECD Asia	**160**	**384**	**415**	**629**	**774**	**934**	**1,113**	**1,292**	**4.3**
China	30	69	72	183	226	294	343	375	6.3
India	24	48	52	73	85	107	132	166	4.4
Other Non-OECD Asia	106	267	290	374	463	533	638	750	3.6
Middle East	**199**	**422**	**435**	**600**	**677**	**757**	**844**	**949**	**2.9**
Africa	**80**	**139**	**145**	**185**	**244**	**289**	**333**	**382**	**3.7**
Central and South America	**116**	**203**	**217**	**308**	**363**	**407**	**461**	**505**	**3.2**
Brazil	6	26	27	50	55	59	65	75	3.8
Other Central and South America	110	177	190	258	309	347	396	430	3.1
Total Non-OECD	**2,005**	**2,361**	**2,493**	**3,226**	**3,665**	**4,096**	**4,545**	**5,006**	**2.6**
Total World	**3,954**	**5,044**	**5,211**	**6,195**	**6,917**	**7,573**	**8,113**	**8,725**	**1.9**

[a]Includes the 50 States and the District of Columbia.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run LM2006.D113005A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table C13. World Carbon Dioxide Emissions from Coal Use by Region, Low Economic Growth Case, 1990-2025
(Million Metric Tons Carbon Dioxide)

Region/Country	History			Projections					Average Annual Percent Change, 2003-2030
	1990	2002	2003	2010	2015	2020	2025	2030	
OECD									
OECD North America	**1,910**	**2,239**	**2,287**	**2,496**	**2,605**	**2,717**	**2,950**	**3,149**	**1.2**
United States[a]	1,772	2,064	2,100	2,303	2,363	2,449	2,637	2,821	1.1
Canada	123	143	147	153	192	213	238	252	2.0
Mexico	15	32	40	40	50	55	75	77	2.5
OECD Europe	**1,635**	**1,199**	**1,203**	**1,187**	**1,175**	**1,184**	**1,187**	**1,179**	**-0.1**
OECD Asia	**471**	**758**	**761**	**865**	**884**	**887**	**902**	**918**	**0.7**
Japan	245	375	369	364	360	345	328	314	-0.6
South Korea	88	170	173	248	265	274	293	311	2.2
Australia/New Zealand	137	213	218	254	259	268	281	293	1.1
Total OECD	**4,016**	**4,196**	**4,251**	**4,548**	**4,665**	**4,788**	**5,038**	**5,247**	**0.8**
Non-OECD									
Non-OECD Europe and Eurasia	**1,393**	**764**	**775**	**794**	**883**	**918**	**960**	**1,001**	**1.0**
Russia	624	406	422	437	492	501	519	536	0.9
Other	770	359	353	357	391	416	441	465	1.0
Non-OECD Asia	**2,517**	**3,574**	**3,805**	**5,661**	**6,471**	**7,111**	**7,764**	**8,462**	**3.0**
China	1,886	2,518	2,731	4,318	4,981	5,489	6,014	6,632	3.3
India	394	665	666	883	992	1,083	1,167	1,240	2.3
Other Non-OECD Asia	237	391	408	459	498	539	583	590	1.4
Middle East	**14**	**35**	**33**	**34**	**35**	**35**	**37**	**40**	**0.7**
Africa	**271**	**339**	**369**	**467**	**517**	**525**	**532**	**539**	**1.4**
Central and South America	**54**	**69**	**70**	**94**	**101**	**112**	**118**	**122**	**2.1**
Brazil	34	41	44	55	60	64	66	71	1.8
Other Central and South America	20	28	25	39	42	48	52	51	2.6
Total Non-OECD	**4,248**	**4,782**	**5,052**	**7,050**	**8,008**	**8,702**	**9,412**	**10,165**	**2.6**
Total World	**8,264**	**8,978**	**9,303**	**11,598**	**12,672**	**13,489**	**14,450**	**15,412**	**1.9**

[a]Includes the 50 States and the District of Columbia.

Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run LM2006.D113005A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Appendix D

Reference Case Projections by End-Use Sector and Region

Table D1. Total World Delivered Energy Consumption by End-Use Sector and Fuel, 2003-2030
(Quadrillion Btu)

Sector/Fuel	2003	Projections					Average Annual Percent Change, 2003-2030
		2010	2015	2020	2025	2030	
Residential							
Oil	10.6	12.3	12.8	13.1	13.4	13.7	1.0
Natural Gas	18.0	19.7	20.8	21.8	22.8	23.9	1.1
Coal	2.8	4.3	4.3	4.1	3.9	3.9	1.3
Electricity	13.8	18.9	21.7	24.3	27.2	30.4	3.0
Heat	4.5	5.5	5.6	5.5	5.5	5.4	0.7
Renewables	0.6	0.7	0.8	0.8	0.8	0.9	1.7
Total	**50.1**	**61.5**	**65.9**	**69.5**	**73.7**	**78.1**	**1.7**
Commercial							
Oil	5.0	5.2	5.5	5.7	5.9	6.1	0.7
Natural Gas	6.7	6.8	7.3	7.7	8.1	8.5	0.9
Coal	0.6	0.9	0.9	1.0	1.0	1.0	1.8
Electricity	11.3	14.6	16.6	18.5	20.5	22.6	2.6
Heat	0.7	0.8	0.8	0.7	0.7	0.7	-0.2
Renewables	0.1	0.1	0.1	0.2	0.2	0.2	2.1
Total	**24.4**	**28.4**	**31.2**	**33.8**	**36.3**	**39.0**	**1.8**
Industrial							
Oil	52.8	61.1	67.2	72.8	77.8	82.6	1.7
Natural Gas	43.1	55.7	64.2	72.8	81.3	90.5	2.8
Coal	29.9	39.9	46.8	53.3	60.2	67.6	3.1
Electricity	24.0	29.9	34.2	38.6	43.0	47.8	2.6
Heat	5.4	4.5	5.2	5.9	6.9	7.6	1.3
Renewables	1.9	2.1	2.2	2.3	2.4	2.6	1.2
Total	**157.1**	**193.2**	**219.7**	**245.8**	**271.7**	**298.5**	**2.4**
Transportation							
Oil	83.5	94.3	100.2	105.1	112.5	121.4	1.4
Natural Gas	0.9	0.9	1.0	1.1	1.1	1.2	1.0
Coal	0.2	0.3	0.3	0.2	0.2	0.1	-1.7
Electricity	0.8	0.9	1.0	1.0	1.0	1.1	0.9
Renewables	0.5	0.8	1.0	1.1	1.2	1.2	3.6
Total	**85.9**	**97.2**	**103.5**	**108.6**	**116.0**	**125.0**	**1.4**
All End-Use Sectors							
Oil	151.9	173.0	185.7	196.7	209.6	223.8	1.4
Natural Gas	68.7	83.0	93.4	103.4	113.4	124.1	2.2
Coal	33.5	45.3	52.2	58.6	65.3	72.5	2.9
Electricity	49.9	64.4	73.4	82.4	91.7	101.8	2.7
Heat	10.6	10.8	11.5	12.1	13.1	13.7	0.9
Renewables	3.0	3.8	4.1	4.4	4.6	4.8	1.8
Delivered Energy	**317.5**	**380.3**	**420.3**	**457.7**	**497.7**	**540.7**	**2.0**
Electricity-Related Losses	103.2	129.3	143.0	155.4	167.8	180.9	2.1
Total	**420.8**	**509.7**	**563.4**	**613.0**	**665.4**	**721.6**	**2.0**
Electric Power[a]							
Oil	10.2	12.6	13.4	14.1	14.7	15.3	1.5
Natural Gas	30.4	38.1	46.4	52.7	59.1	65.8	2.9
Coal	66.9	83.5	92.1	101.5	111.4	123.0	2.3
Nuclear	26.5	28.9	31.0	32.9	34.0	34.7	1.0
Renewables	29.6	41.4	44.9	48.7	53.2	57.5	2.5
Total	**163.7**	**204.5**	**227.9**	**249.9**	**272.6**	**296.4**	**2.2**
Total Energy Consumption							
Oil	162.1	185.6	199.1	210.8	224.3	239.1	1.4
Natural Gas	99.1	121.1	139.8	156.1	172.5	189.9	2.4
Coal	100.4	128.8	144.4	160.1	176.7	195.5	2.5
Nuclear	26.5	28.9	31.0	32.9	34.0	34.7	1.0
Renewables	32.7	45.2	49.0	53.1	57.8	62.4	2.4
Total	**420.7**	**509.7**	**563.4**	**613.0**	**665.4**	**721.6**	**2.0**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.

Sources: **2003:** Derived from Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run AEO2006.D111905A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table D2. Total OECD Delivered Energy Consumption by End-Use Sector and Fuel, 2003-2030
(Quadrillion Btu)

Sector/Fuel	2003	Projections					Average Annual Percent Change, 2003-2030
		2010	2015	2020	2025	2030	
Residential							
Oil	5.7	5.5	5.5	5.6	5.6	5.6	0.0
Natural Gas	12.2	12.2	12.6	12.9	13.2	13.5	0.4
Coal	0.4	0.3	0.3	0.3	0.3	0.3	-1.0
Electricity	9.1	10.5	11.1	11.7	12.4	13.1	1.4
Heat	0.9	0.9	0.8	0.7	0.7	0.6	-1.5
Renewables	0.5	0.7	0.7	0.7	0.7	0.7	1.0
Total	**28.8**	**30.1**	**31.1**	**31.9**	**32.8**	**33.8**	**0.6**
Commercial							
Oil	3.7	3.5	3.6	3.7	3.7	3.8	0.1
Natural Gas	5.6	5.5	5.8	6.1	6.4	6.7	0.6
Coal	0.2	0.1	0.1	0.1	0.1	0.1	-0.4
Electricity	8.5	10.1	11.0	11.9	12.8	13.8	1.8
Heat	0.3	0.2	0.2	0.2	0.2	0.2	-1.6
Renewables	0.1	0.1	0.1	0.1	0.1	0.2	1.5
Total	**18.3**	**19.6**	**21.0**	**22.2**	**23.4**	**24.7**	**1.1**
Industrial							
Oil	27.6	30.0	31.2	32.5	33.6	34.6	0.8
Natural Gas	20.1	23.1	25.0	27.0	28.6	30.5	1.6
Coal	8.9	9.6	10.1	10.8	11.9	12.7	1.3
Electricity	11.6	12.9	13.9	14.8	15.7	16.7	1.4
Heat	0.6	0.5	0.5	0.6	0.9	0.8	1.0
Renewables	1.8	2.0	2.1	2.2	2.3	2.5	1.1
Total	**70.6**	**78.1**	**82.8**	**87.9**	**93.0**	**97.8**	**1.2**
Transportation							
Oil	55.8	60.1	62.5	64.0	66.7	70.0	0.8
Natural Gas	0.7	0.7	0.8	0.9	0.9	0.9	0.9
Coal	0.0	0.0	0.0	0.0	0.0	0.0	—
Electricity	0.4	0.4	0.5	0.5	0.5	0.5	0.4
Renewables	0.0	0.2	0.3	0.4	0.4	0.3	9.3
Total	**57.0**	**61.5**	**64.1**	**65.8**	**68.4**	**71.7**	**0.9**
All End-Use Sectors							
Oil	92.7	99.1	102.9	105.7	109.6	114.0	0.8
Natural Gas	38.7	41.5	44.3	46.9	49.1	51.6	1.1
Coal	9.5	10.0	10.5	11.3	12.4	13.2	1.2
Electricity	29.6	34.0	36.5	38.9	41.4	44.1	1.5
Heat	1.7	1.7	1.6	1.5	1.7	1.5	-0.5
Renewables	2.5	3.0	3.2	3.4	3.5	3.6	1.4
Delivered Energy	**174.7**	**189.3**	**199.0**	**207.7**	**217.6**	**228.0**	**1.0**
Electricity-Related Losses	59.6	66.7	70.9	73.8	76.8	80.8	1.1
Total	**234.3**	**256.1**	**269.9**	**281.6**	**294.5**	**308.8**	**1.0**
Electric Power[a]							
Oil	4.3	4.2	4.6	4.6	4.9	5.1	0.6
Natural Gas	13.2	16.5	20.4	22.2	23.9	25.2	2.4
Coal	36.1	39.7	40.9	43.1	45.9	49.9	1.2
Nuclear	22.3	23.4	24.0	24.3	24.1	24.1	0.3
Renewables	14.9	18.6	19.0	20.1	21.1	22.0	1.5
Total	**90.9**	**102.4**	**109.0**	**114.3**	**119.9**	**126.4**	**1.2**
Total Energy Consumption							
Oil	97.0	103.3	107.5	110.3	114.5	119.1	0.8
Natural Gas	51.9	58.0	64.7	69.1	72.9	76.8	1.5
Coal	45.6	49.7	51.4	54.3	58.3	63.1	1.2
Nuclear	22.3	23.4	24.0	24.3	24.1	24.1	0.3
Renewables	17.4	21.7	22.3	23.5	24.7	25.7	1.5
Total	**234.3**	**256.1**	**269.9**	**281.6**	**294.5**	**308.8**	**1.0**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.

Sources: **2003:** Derived from Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run AEO2006.D111905A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table D3. Delivered Energy Consumption in the United States by End-Use Sector and Fuel, 2003-2030
(Quadrillion Btu)

Sector/Fuel	2003	Projections					Average Annual Percent Change, 2003-2030
		2010	2015	2020	2025	2030	
Residential							
Oil	1.5	1.5	1.5	1.4	1.4	1.3	-0.5
Natural Gas	5.2	5.3	5.5	5.7	5.7	5.8	0.4
Coal	0.0	0.0	0.0	0.0	0.0	0.0	-0.4
Electricity	4.3	5.0	5.4	5.8	6.1	6.5	1.5
Heat	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	0.4	0.4	0.4	0.4	0.4	0.4	0.1
Total	**11.5**	**12.2**	**12.8**	**13.3**	**13.6**	**14.0**	**0.7**
Commercial							
Oil	0.8	0.8	0.8	0.8	0.8	0.8	0.3
Natural Gas	3.3	3.2	3.5	3.7	3.9	4.1	0.8
Coal	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Electricity	4.1	4.9	5.4	6.0	6.6	7.3	2.2
Heat	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	0.1	0.1	0.1	0.1	0.1	0.1	0.0
Total	**8.3**	**9.0**	**9.9**	**10.7**	**11.5**	**12.4**	**1.5**
Industrial							
Oil	9.3	10.0	10.3	10.6	11.1	11.7	0.8
Natural Gas	8.5	9.2	9.5	9.8	10.0	10.3	0.7
Coal	2.1	2.1	2.2	2.5	3.3	3.6	2.1
Electricity	3.4	3.6	3.8	3.9	4.1	4.3	0.8
Heat	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	1.6	1.8	1.9	2.0	2.1	2.3	1.4
Total	**24.9**	**26.7**	**27.7**	**28.9**	**30.6**	**32.2**	**1.0**
Transportation							
Oil	26.3	29.9	32.2	34.3	36.3	38.7	1.4
Natural Gas	0.7	0.7	0.8	0.9	0.9	0.9	0.9
Coal	0.0	0.0	0.0	0.0	0.0	0.0	—
Electricity	0.1	0.1	0.1	0.1	0.1	0.1	0.9
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	6.4
Total	**27.1**	**30.7**	**33.1**	**35.3**	**37.3**	**39.7**	**1.4**
All End-Use Sectors							
Oil	37.8	42.2	44.7	47.2	49.6	52.5	1.2
Natural Gas	17.8	18.4	19.3	20.1	20.5	21.1	0.6
Coal	2.2	2.2	2.3	2.6	3.3	3.7	2.0
Electricity	12.0	13.6	14.7	15.8	16.9	18.2	1.6
Heat	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	2.1	2.3	2.4	2.5	2.7	2.8	1.1
Delivered Energy	**71.9**	**78.6**	**83.5**	**88.2**	**93.0**	**98.4**	**1.2**
Electricity-Related Losses	26.2	29.2	30.7	32.4	33.9	35.5	1.1
Total	**98.1**	**107.9**	**114.2**	**120.6**	**127.0**	**133.9**	**1.2**
Electric Power[a]							
Oil	1.1	1.0	1.0	1.0	1.0	1.1	-0.2
Natural Gas	5.2	5.6	7.3	7.6	7.2	6.5	0.8
Coal	20.2	22.9	23.4	25.0	27.5	30.7	1.6
Nuclear	8.0	8.4	8.7	9.1	9.1	9.1	0.5
Renewables	3.6	4.8	5.0	5.5	6.0	6.2	2.0
Total	**38.1**	**42.8**	**45.4**	**48.2**	**50.9**	**53.7**	**1.3**
Total Energy Consumption							
Oil	39.0	43.1	45.7	48.1	50.6	53.6	1.2
Natural Gas	23.0	24.0	26.7	27.7	27.8	27.7	0.7
Coal	22.4	25.1	25.7	27.6	30.9	34.5	1.6
Nuclear	8.0	8.4	8.7	9.1	9.1	9.1	0.5
Renewables	5.7	7.2	7.5	8.1	8.7	9.1	1.7
Total	**98.1**	**107.9**	**114.2**	**120.6**	**127.0**	**133.9**	**1.2**

[a]Fuel inputs used in the production of electricity and heat at central-station generators. Includes net electricity imports.

Sources: **2003:** Based on 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), AEO2006 National Energy Modeling System, run AEO2006.D111905A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table D4. Delivered Energy Consumption in Canada by End-Use Sector and Fuel, 2003-2030
(Quadrillion Btu)

Sector/Fuel	2003	Projections					Average Annual Percent Change, 2003-2030
		2010	2015	2020	2025	2030	
Residential							
Oil	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Natural Gas	0.6	0.6	0.6	0.6	0.6	0.7	0.3
Coal	0.0	0.0	0.0	0.0	0.0	0.0	-0.7
Electricity	0.5	0.6	0.7	0.7	0.7	0.8	1.6
Heat	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	—
Total	**1.3**	**1.4**	**1.4**	**1.5**	**1.5**	**1.6**	**0.9**
Commercial							
Oil	0.4	0.3	0.4	0.4	0.4	0.4	0.5
Natural Gas	0.5	0.5	0.5	0.5	0.6	0.6	0.7
Coal	0.0	0.0	0.0	0.0	0.0	0.0	—
Electricity	0.4	0.6	0.6	0.7	0.7	0.8	2.1
Heat	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	—
Total	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.2**
Industrial							
Oil	1.5	1.7	1.8	1.9	2.0	2.0	1.3
Natural Gas	1.9	2.6	2.7	2.9	3.2	3.5	2.2
Coal	0.2	0.9	0.9	1.0	1.0	1.1	5.9
Electricity	0.8	0.9	0.9	1.0	1.0	1.1	1.1
Heat	0.0	0.0	0.0	0.0	0.1	0.1	1.7
Renewables	0.1	0.1	0.1	0.1	0.1	0.0	-3.1
Total	**4.6**	**6.1**	**6.5**	**6.9**	**7.4**	**7.8**	**2.0**
Transportation							
Oil	2.2	2.3	2.3	2.3	2.3	2.3	0.3
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	1.5
Coal	0.0	0.0	0.0	0.0	0.0	0.0	—
Electricity	0.0	0.0	0.0	0.0	0.0	0.0	0.6
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	—
Total	**2.2**	**2.3**	**2.3**	**2.3**	**2.3**	**2.3**	**0.3**
All End-Use Sectors							
Oil	4.1	4.4	4.6	4.7	4.8	4.9	0.7
Natural Gas	3.0	3.7	3.9	4.1	4.4	4.7	1.7
Coal	0.2	0.9	0.9	1.0	1.0	1.1	5.9
Electricity	1.8	2.1	2.3	2.4	2.5	2.6	1.5
Heat	0.0	0.0	0.0	0.0	0.1	0.1	1.7
Renewables	0.1	0.1	0.1	0.1	0.1	0.1	-1.3
Delivered Energy	**9.3**	**11.2**	**11.8**	**12.3**	**12.9**	**13.5**	**1.4**
Electricity-Related Losses	4.2	4.4	4.8	5.2	5.4	5.7	1.1
Total	**13.5**	**15.6**	**16.6**	**17.5**	**18.4**	**19.2**	**1.3**
Electric Power[a]							
Oil	0.2	0.3	0.4	0.2	0.2	0.2	0.0
Natural Gas	0.3	0.6	0.4	0.7	0.7	0.7	3.6
Coal	1.4	0.8	1.3	1.6	1.7	1.7	0.9
Nuclear	0.8	1.2	1.3	1.3	1.2	1.2	1.6
Renewables	3.4	3.7	3.7	3.9	4.2	4.5	1.1
Total	**6.0**	**6.5**	**7.1**	**7.6**	**8.0**	**8.4**	**1.2**
Total Energy Consumption							
Oil	4.3	4.8	5.0	4.9	5.1	5.1	0.6
Natural Gas	3.3	4.2	4.3	4.8	5.1	5.4	1.9
Coal	1.6	1.7	2.2	2.5	2.7	2.8	2.1
Nuclear	0.8	1.2	1.3	1.3	1.2	1.2	1.6
Renewables	3.5	3.8	3.8	4.0	4.3	4.6	1.0
Total	**13.5**	**15.6**	**16.6**	**17.5**	**18.4**	**19.2**	**1.3**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.

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).

Table D5. Delivered Energy Consumption in Mexico by End-Use Sector and Fuel, 2003-2030
(Quadrillion Btu)

Sector/Fuel	2003	Projections					Average Annual Percent Change, 2003-2030
		2010	2015	2020	2025	2030	
Residential							
Oil	0.3	0.4	0.5	0.6	0.7	0.7	2.8
Natural Gas	0.0	0.1	0.1	0.1	0.1	0.1	3.5
Coal	0.0	0.0	0.0	0.0	0.0	0.0	—
Electricity	0.2	0.3	0.4	0.5	0.6	0.7	5.8
Heat	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	—
Total	**0.5**	**0.8**	**1.0**	**1.2**	**1.4**	**1.5**	**4.1**
Commercial							
Oil	0.0	0.1	0.1	0.1	0.1	0.1	3.4
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	3.5
Coal	0.0	0.0	0.0	0.0	0.0	0.0	—
Electricity	0.1	0.1	0.2	0.2	0.3	0.3	5.8
Heat	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	5.5
Total	**0.1**	**0.2**	**0.3**	**0.4**	**0.4**	**0.5**	**5.0**
Industrial							
Oil	0.9	0.9	1.0	1.1	1.2	1.3	1.4
Natural Gas	1.2	1.5	1.7	1.9	2.1	2.4	2.4
Coal	0.1	0.2	0.2	0.2	0.3	0.3	4.2
Electricity	0.4	0.5	0.6	0.7	0.8	0.9	2.8
Heat	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	6.7
Total	**2.7**	**3.1**	**3.5**	**3.9**	**4.4**	**4.9**	**2.2**
Transportation							
Oil	1.9	2.0	2.2	2.3	2.6	3.0	1.7
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	5.4
Coal	0.0	0.0	0.0	0.0	0.0	0.0	—
Electricity	0.0	0.0	0.0	0.0	0.0	0.0	2.0
Renewables	0.0	0.0	0.0	0.1	0.1	0.1	—
Total	**1.9**	**2.1**	**2.2**	**2.4**	**2.7**	**3.0**	**1.8**
All End-Use Sectors							
Oil	3.2	3.5	3.9	4.2	4.6	5.1	1.8
Natural Gas	1.3	1.5	1.7	2.0	2.2	2.5	2.4
Coal	0.1	0.2	0.2	0.2	0.3	0.3	4.2
Electricity	0.7	0.9	1.2	1.4	1.7	2.0	4.1
Heat	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	0.0	0.1	0.1	0.1	0.1	0.1	14.5
Delivered Energy	**5.2**	**6.2**	**7.1**	**7.9**	**8.9**	**10.0**	**2.4**
Electricity-Related Losses	1.6	1.7	2.0	2.4	2.8	3.2	2.7
Total	**6.8**	**7.9**	**9.1**	**10.3**	**11.7**	**13.2**	**2.5**
Electric Power[a]							
Oil	0.8	0.8	1.0	1.1	1.1	1.1	1.4
Natural Gas	0.7	0.8	1.1	1.4	1.9	2.4	4.7
Coal	0.3	0.3	0.4	0.6	0.6	0.6	1.9
Nuclear	0.1	0.1	0.1	0.1	0.1	0.1	0.2
Renewables	0.3	0.5	0.6	0.7	0.8	0.9	4.1
Total	**2.2**	**2.6**	**3.2**	**3.9**	**4.5**	**5.1**	**3.2**
Total Energy Consumption							
Oil	3.9	4.3	4.8	5.3	5.7	6.3	1.7
Natural Gas	2.0	2.3	2.9	3.4	4.1	4.9	3.4
Coal	0.4	0.5	0.6	0.8	0.8	0.9	2.5
Nuclear	0.1	0.1	0.1	0.1	0.1	0.1	0.2
Renewables	0.3	0.6	0.7	0.8	0.9	1.1	4.5
Total	**6.8**	**7.9**	**9.1**	**10.3**	**11.7**	**13.2**	**2.5**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.

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).

Table D6. Delivered Energy Consumption in OECD Europe by End-Use Sector and Fuel, 2003-2030
(Quadrillion Btu)

Sector/Fuel	2003	Projections					Average Annual Percent Change, 2003-2030
		2010	2015	2020	2025	2030	
Residential							
Oil	2.8	2.7	2.7	2.7	2.7	2.7	-0.1
Natural Gas	5.4	5.4	5.5	5.6	5.8	6.0	0.3
Coal	0.4	0.3	0.3	0.3	0.3	0.3	-1.0
Electricity	2.8	3.1	3.2	3.2	3.4	3.5	0.8
Heat	0.8	0.9	0.8	0.7	0.6	0.5	-1.8
Renewables	0.1	0.1	0.1	0.1	0.2	0.2	2.2
Total	**12.3**	**12.4**	**12.5**	**12.5**	**12.8**	**13.1**	**0.2**
Commercial							
Oil	1.0	1.0	1.0	1.0	1.0	1.0	-0.3
Natural Gas	1.5	1.4	1.5	1.5	1.5	1.6	0.3
Coal	0.1	0.0	0.0	0.0	0.0	0.0	-1.3
Electricity	2.5	2.8	2.9	3.0	3.2	3.3	1.1
Heat	0.2	0.2	0.2	0.2	0.2	0.1	-1.8
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	5.5
Total	**5.3**	**5.5**	**5.6**	**5.8**	**5.9**	**6.1**	**0.5**
Industrial							
Oil	8.9	9.6	9.8	10.1	10.2	10.2	0.5
Natural Gas	7.0	8.3	9.1	10.3	10.9	11.8	1.9
Coal	3.3	3.3	3.3	3.6	3.8	3.9	0.7
Electricity	4.6	5.2	5.7	6.1	6.5	6.9	1.5
Heat	0.5	0.5	0.5	0.5	0.8	0.7	0.9
Renewables	0.1	0.1	0.1	0.1	0.1	0.1	0.8
Total	**24.5**	**27.0**	**28.5**	**30.6**	**32.2**	**33.7**	**1.2**
Transportation							
Oil	18.0	18.3	18.1	17.6	17.8	18.2	0.0
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	-3.7
Coal	0.0	0.0	0.0	0.0	0.0	0.0	—
Electricity	0.3	0.3	0.3	0.3	0.3	0.3	0.2
Renewables	0.0	0.1	0.2	0.2	0.2	0.2	7.4
Total	**18.3**	**18.7**	**18.6**	**18.1**	**18.3**	**18.7**	**0.1**
All End-Use Sectors							
Oil	30.8	31.6	31.6	31.3	31.7	32.1	0.2
Natural Gas	14.0	15.1	16.1	17.4	18.2	19.4	1.2
Coal	3.7	3.6	3.7	3.9	4.1	4.2	0.5
Electricity	10.1	11.4	12.0	12.6	13.3	14.0	1.2
Heat	1.6	1.6	1.4	1.4	1.5	1.3	-0.7
Renewables	0.2	0.4	0.4	0.5	0.5	0.5	3.2
Delivered Energy	**60.4**	**63.6**	**65.2**	**67.0**	**69.3**	**71.5**	**0.6**
Electricity-Related Losses	18.5	20.8	22.0	21.7	22.0	23.0	0.8
Total	**78.9**	**84.4**	**87.2**	**88.7**	**91.3**	**94.5**	**0.7**
Electric Power[a]							
Oil	1.2	1.0	1.1	1.2	1.3	1.4	0.7
Natural Gas	4.3	6.6	8.4	9.2	10.8	12.3	3.9
Coal	9.1	9.1	9.0	9.0	8.8	9.2	0.0
Nuclear	9.8	9.5	9.3	8.5	7.9	7.5	-1.0
Renewables	5.8	7.6	7.6	7.8	7.9	8.0	1.2
Total	**30.2**	**33.8**	**35.4**	**35.7**	**36.8**	**38.3**	**0.9**
Total Energy Consumption							
Oil	32.0	32.6	32.8	32.5	33.0	33.5	0.2
Natural Gas	18.3	21.7	24.5	26.6	29.0	31.6	2.0
Coal	12.8	12.7	12.7	12.9	12.9	13.4	0.2
Nuclear	9.8	9.5	9.3	8.5	7.9	7.5	-1.0
Renewables	6.0	7.9	8.0	8.3	8.4	8.5	1.3
Total	**78.9**	**84.4**	**87.2**	**88.7**	**91.3**	**94.5**	**0.7**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.

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).

Table D7. Delivered Energy Consumption in Japan by End-Use Sector and Fuel, 2003-2030
(Quadrillion Btu)

Sector/Fuel	2003	Projections					Average Annual Percent Change, 2003-2030
		2010	2015	2020	2025	2030	
Residential							
Oil	0.7	0.6	0.6	0.6	0.6	0.6	-0.8
Natural Gas	0.4	0.3	0.3	0.3	0.3	0.3	-0.5
Coal	0.0	0.0	0.0	0.0	0.0	0.0	—
Electricity	0.9	1.0	1.0	1.0	1.0	1.0	0.6
Heat	0.0	0.0	0.0	0.0	0.0	0.0	-0.7
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	1.2
Total	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**-0.1**
Commercial							
Oil	1.1	1.0	1.0	1.0	1.0	1.0	-0.4
Natural Gas	0.2	0.2	0.2	0.2	0.2	0.2	0.0
Coal	0.0	0.0	0.0	0.0	0.0	0.0	-0.2
Electricity	0.9	1.0	1.1	1.1	1.1	1.1	0.7
Heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	3.2
Total	**2.3**	**2.3**	**2.3**	**2.4**	**2.4**	**2.4**	**0.1**
Industrial							
Oil	4.4	4.5	4.6	4.7	4.8	4.7	0.2
Natural Gas	0.5	0.5	0.6	0.6	0.6	0.6	1.0
Coal	2.2	2.1	2.2	2.2	2.2	2.2	0.0
Electricity	1.4	1.5	1.6	1.6	1.7	1.7	0.8
Heat	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	0.1	0.0	0.0	0.0	0.0	0.0	-3.2
Total	**8.5**	**8.7**	**9.0**	**9.1**	**9.2**	**9.2**	**0.3**
Transportation							
Oil	4.3	4.1	4.1	3.9	3.8	3.8	-0.4
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	—
Coal	0.0	0.0	0.0	0.0	0.0	0.0	—
Electricity	0.1	0.1	0.1	0.1	0.1	0.1	0.0
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	—
Total	**4.3**	**4.2**	**4.2**	**4.0**	**3.9**	**3.9**	**-0.4**
All End-Use Sectors							
Oil	10.6	10.2	10.3	10.2	10.2	10.1	-0.2
Natural Gas	1.1	1.1	1.1	1.1	1.2	1.2	0.3
Coal	2.2	2.1	2.2	2.2	2.2	2.2	0.0
Electricity	3.2	3.6	3.7	3.8	3.9	3.9	0.7
Heat	0.0	0.0	0.0	0.0	0.0	0.0	1.2
Renewables	0.1	0.1	0.1	0.1	0.1	0.1	-0.1
Delivered Energy	**17.2**	**17.2**	**17.5**	**17.4**	**17.5**	**17.5**	**0.1**
Electricity-Related Losses	5.3	5.6	6.0	6.2	6.5	6.8	1.0
Total	**22.4**	**22.7**	**23.4**	**23.6**	**24.0**	**24.3**	**0.3**
Electric Power[a]							
Oil	0.8	0.8	0.8	0.9	0.9	0.9	0.7
Natural Gas	2.1	2.3	2.5	2.6	2.7	2.8	1.1
Coal	1.9	2.0	2.0	1.9	1.8	1.8	-0.3
Nuclear	2.4	2.8	3.0	3.3	3.6	3.8	1.7
Renewables	1.3	1.3	1.4	1.4	1.4	1.5	0.5
Total	**8.5**	**9.2**	**9.7**	**10.1**	**10.4**	**10.8**	**0.9**
Total Energy Consumption							
Oil	11.3	11.0	11.1	11.0	11.1	11.1	-0.1
Natural Gas	3.2	3.4	3.6	3.7	3.8	4.0	0.8
Coal	4.1	4.1	4.2	4.1	4.0	4.0	-0.1
Nuclear	2.4	2.8	3.0	3.3	3.6	3.8	1.7
Renewables	1.4	1.4	1.5	1.5	1.5	1.6	0.4
Total	**22.4**	**22.7**	**23.4**	**23.6**	**24.0**	**24.3**	**0.3**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.

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).

Table D8. Delivered Energy Consumption in South Korea by End-Use Sector and Fuel, 2003-2030
(Quadrillion Btu)

Sector/Fuel	2003	Projections					Average Annual Percent Change, 2003-2030
		2010	2015	2020	2025	2030	
Residential							
Oil	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Natural Gas	0.4	0.4	0.4	0.4	0.4	0.4	0.7
Coal	0.0	0.0	0.0	0.0	0.0	0.0	-1.7
Electricity	0.1	0.2	0.2	0.3	0.3	0.3	2.7
Heat	0.0	0.1	0.1	0.1	0.1	0.1	1.7
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	7.0
Total	**0.8**	**0.8**	**0.9**	**0.9**	**1.0**	**1.0**	**1.1**
Commercial							
Oil	0.3	0.3	0.4	0.4	0.4	0.4	1.1
Natural Gas	0.1	0.1	0.1	0.1	0.1	0.1	1.6
Coal	0.0	0.0	0.0	0.0	0.0	0.0	—
Electricity	0.3	0.5	0.5	0.5	0.6	0.6	2.5
Heat	0.0	0.0	0.0	0.0	0.0	0.0	1.0
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	15.8
Total	**0.7**	**0.9**	**1.0**	**1.0**	**1.1**	**1.1**	**1.8**
Industrial							
Oil	2.0	2.6	3.0	3.3	3.6	3.9	2.4
Natural Gas	0.2	0.3	0.4	0.5	0.6	0.7	4.9
Coal	0.8	0.8	0.9	0.9	1.0	1.1	1.2
Electricity	0.6	0.8	0.9	1.0	1.1	1.2	2.9
Heat	0.0	0.0	0.0	0.0	0.0	0.0	2.8
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	20.2
Total	**3.5**	**4.4**	**5.2**	**5.8**	**6.3**	**6.9**	**2.5**
Transportation							
Oil	1.8	2.0	2.1	2.1	2.2	2.4	1.1
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Coal	0.0	0.0	0.0	0.0	0.0	0.0	—
Electricity	0.0	0.0	0.0	0.0	0.0	0.0	0.8
Renewables	0.0	0.0	0.0	0.0	0.1	0.1	32.3
Total	**1.8**	**2.0**	**2.1**	**2.2**	**2.3**	**2.4**	**1.2**
All End-Use Sectors							
Oil	4.2	5.1	5.6	6.0	6.4	6.8	1.8
Natural Gas	0.6	0.8	0.9	1.0	1.1	1.3	2.5
Coal	0.8	0.8	0.9	0.9	1.0	1.1	1.2
Electricity	1.0	1.4	1.7	1.8	2.0	2.1	2.7
Heat	0.1	0.1	0.1	0.1	0.1	0.1	1.8
Renewables	0.0	0.0	0.0	0.1	0.1	0.1	15.3
Delivered Energy	**6.8**	**8.2**	**9.2**	**9.9**	**10.7**	**11.5**	**2.0**
Electricity-Related Losses	1.9	2.7	3.1	3.4	3.7	4.0	2.9
Total	**8.6**	**10.9**	**12.3**	**13.3**	**14.4**	**15.5**	**2.2**
Electric Power[a]							
Oil	0.3	0.2	0.3	0.3	0.3	0.3	1.0
Natural Gas	0.3	0.3	0.4	0.4	0.3	0.2	-1.1
Coal	1.1	2.0	2.2	2.4	2.7	3.0	3.8
Nuclear	1.2	1.4	1.8	2.0	2.2	2.4	2.5
Renewables	0.1	0.2	0.2	0.2	0.3	0.3	5.9
Total	**3.0**	**4.2**	**4.9**	**5.3**	**5.8**	**6.2**	**2.8**
Total Energy Consumption							
Oil	4.5	5.3	5.9	6.3	6.7	7.2	1.7
Natural Gas	1.0	1.1	1.3	1.4	1.5	1.5	1.7
Coal	1.9	2.8	3.1	3.3	3.7	4.1	2.9
Nuclear	1.2	1.4	1.8	2.0	2.2	2.4	2.5
Renewables	0.1	0.2	0.3	0.3	0.3	0.3	6.7
Total	**8.6**	**10.9**	**12.3**	**13.3**	**14.4**	**15.5**	**2.2**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.

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).

Table D9. Delivered Energy Consumption in Australia/New Zealand by End-Use Sector and Fuel, 2003-2030
(Quadrillion Btu)

Sector/Fuel	2003	Projections					Average Annual Percent Change, 2003-2030
		2010	2015	2020	2025	2030	
Residential							
Oil	0.0	0.0	0.0	0.0	0.0	0.0	0.3
Natural Gas	0.1	0.1	0.1	0.1	0.1	0.1	0.6
Coal	0.0	0.0	0.0	0.0	0.0	0.0	-0.7
Electricity	0.2	0.3	0.3	0.3	0.3	0.3	1.4
Heat	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	2.2
Total	**0.4**	**0.4**	**0.4**	**0.4**	**0.5**	**0.5**	**1.1**
Commercial							
Oil	0.0	0.0	0.0	0.0	0.0	0.0	0.3
Natural Gas	0.0	0.0	0.1	0.1	0.1	0.1	0.6
Coal	0.0	0.0	0.0	0.0	0.0	0.0	-0.3
Electricity	0.2	0.2	0.3	0.3	0.3	0.3	1.8
Heat	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	8.4
Total	**0.3**	**0.3**	**0.3**	**0.4**	**0.4**	**0.4**	**1.4**
Industrial							
Oil	0.5	0.6	0.6	0.6	0.7	0.7	1.1
Natural Gas	0.7	0.8	1.0	1.1	1.2	1.3	2.4
Coal	0.2	0.3	0.4	0.4	0.5	0.5	2.7
Electricity	0.4	0.4	0.5	0.5	0.5	0.6	1.4
Heat	0.0	0.0	0.0	0.0	0.0	0.0	-1.5
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	-0.9
Total	**1.9**	**2.1**	**2.4**	**2.6**	**2.9**	**3.1**	**1.9**
Transportation							
Oil	1.5	1.5	1.5	1.5	1.6	1.6	0.4
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	5.6
Coal	0.0	0.0	0.0	0.0	0.0	0.0	—
Electricity	0.0	0.0	0.0	0.0	0.0	0.0	0.9
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	—
Total	**1.5**	**1.5**	**1.5**	**1.5**	**1.6**	**1.6**	**0.4**
All End-Use Sectors							
Oil	2.0	2.1	2.2	2.2	2.3	2.4	0.6
Natural Gas	0.8	1.0	1.1	1.3	1.4	1.5	2.1
Coal	0.3	0.3	0.4	0.4	0.5	0.5	2.6
Electricity	0.8	0.9	1.0	1.1	1.1	1.2	1.5
Heat	0.0	0.0	0.0	0.0	0.0	0.0	-1.5
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	3.2
Delivered Energy	**4.0**	**4.4**	**4.7**	**5.0**	**5.3**	**5.6**	**1.3**
Electricity-Related Losses	2.0	2.3	2.3	2.4	2.5	2.6	0.9
Total	**6.0**	**6.6**	**7.0**	**7.4**	**7.8**	**8.2**	**1.2**
Electric Power[a]							
Oil	0.0	0.0	0.0	0.0	0.0	0.0	6.4
Natural Gas	0.3	0.2	0.2	0.3	0.2	0.3	0.1
Coal	2.1	2.4	2.5	2.6	2.8	3.0	1.3
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	0.5	0.5	0.6	0.6	0.6	0.6	0.7
Total	**2.9**	**3.2**	**3.3**	**3.5**	**3.7**	**3.9**	**1.1**
Total Energy Consumption							
Oil	2.0	2.1	2.2	2.3	2.3	2.4	0.6
Natural Gas	1.1	1.2	1.4	1.5	1.6	1.7	1.7
Coal	2.4	2.8	2.9	3.0	3.3	3.5	1.4
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	0.5	0.6	0.6	0.6	0.6	0.6	0.8
Total	**6.0**	**6.6**	**7.0**	**7.4**	**7.8**	**8.2**	**1.2**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.

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).

Table D10. Total Non-OECD Delivered Energy Consumption by End-Use Sector and Fuel, 2003-2030
(Quadrillion Btu)

Sector/Fuel	2003	Projections					Average Annual Percent Change, 2003-2030
		2010	2015	2020	2025	2030	
Residential							
Oil	4.9	6.8	7.3	7.5	7.8	8.0	1.8
Natural Gas	5.8	7.5	8.3	8.9	9.6	10.4	2.2
Coal	2.3	4.0	3.9	3.7	3.6	3.5	1.5
Electricity	4.7	8.4	10.5	12.6	14.8	17.3	4.9
Heat	3.6	4.6	4.7	4.8	4.8	4.8	1.1
Renewables	0.0	0.1	0.1	0.1	0.2	0.2	6.7
Total	**21.4**	**31.4**	**34.9**	**37.6**	**40.9**	**44.3**	**2.7**
Commercial							
Oil	1.4	1.7	1.9	2.0	2.2	2.3	2.0
Natural Gas	1.0	1.3	1.5	1.6	1.7	1.8	2.2
Coal	0.4	0.7	0.8	0.8	0.8	0.8	2.4
Electricity	2.8	4.5	5.6	6.6	7.7	8.8	4.3
Heat	0.5	0.5	0.5	0.5	0.5	0.5	0.3
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	16.3
Total	**6.1**	**8.8**	**10.3**	**11.6**	**12.9**	**14.3**	**3.2**
Industrial							
Oil	25.2	31.2	35.9	40.4	44.2	48.0	2.4
Natural Gas	23.1	32.5	39.2	45.8	52.8	60.0	3.6
Coal	21.0	30.3	36.7	42.5	48.3	54.9	3.6
Electricity	12.4	17.0	20.3	23.8	27.3	31.0	3.5
Heat	4.8	4.0	4.6	5.3	6.0	6.8	1.3
Renewables	0.1	0.1	0.1	0.1	0.1	0.1	2.2
Total	**86.5**	**115.1**	**136.9**	**157.9**	**178.7**	**200.7**	**3.2**
Transportation							
Oil	27.7	34.2	37.7	41.1	45.8	51.5	2.3
Natural Gas	0.2	0.2	0.2	0.2	0.2	0.3	1.5
Coal	0.2	0.3	0.3	0.2	0.2	0.1	-1.6
Electricity	0.4	0.5	0.5	0.5	0.6	0.6	1.3
Renewables	0.4	0.6	0.7	0.7	0.8	0.9	2.5
Total	**28.9**	**35.7**	**39.3**	**42.8**	**47.6**	**53.3**	**2.3**
All End-Use Sectors							
Oil	59.2	73.9	82.8	91.0	100.0	109.8	2.3
Natural Gas	30.0	41.5	49.1	56.5	64.3	72.5	3.3
Coal	24.0	35.3	41.7	47.3	52.9	59.3	3.4
Electricity	20.3	30.4	36.9	43.5	50.4	57.7	3.9
Heat	8.9	9.1	9.9	10.6	11.3	12.1	1.2
Renewables	0.5	0.8	0.9	1.0	1.1	1.2	3.0
Delivered Energy	**142.9**	**191.0**	**221.4**	**249.9**	**280.0**	**312.7**	**2.9**
Electricity-Related Losses	43.6	62.6	72.1	81.6	90.9	100.1	3.1
Total	**186.5**	**253.6**	**293.5**	**331.5**	**371.0**	**412.8**	**3.0**
Electric Power[a]							
Oil	5.9	8.4	8.8	9.4	9.8	10.2	2.0
Natural Gas	17.2	21.7	26.0	30.6	35.3	40.6	3.2
Coal	30.8	43.8	51.2	58.4	65.5	73.1	3.3
Nuclear	4.2	5.5	7.0	8.7	10.0	10.6	3.5
Renewables	14.7	22.8	25.9	28.6	32.0	35.5	3.3
Total	**72.8**	**102.1**	**118.9**	**135.7**	**152.6**	**170.0**	**3.2**
Total Energy Consumption							
Oil	65.1	82.3	91.6	100.4	109.8	120.0	2.3
Natural Gas	47.2	63.1	75.1	87.0	99.6	113.1	3.3
Coal	54.8	79.1	92.9	105.7	118.4	132.4	3.3
Nuclear	4.2	5.5	7.0	8.7	10.0	10.6	3.5
Renewables	15.2	23.6	26.8	29.6	33.1	36.7	3.3
Total	**186.5**	**253.6**	**293.5**	**331.5**	**371.0**	**412.8**	**3.0**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.

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).

Table D11. Delivered Energy Consumption in Russia by End-Use Sector and Fuel, 2003-2030
(Quadrillion Btu)

Sector/Fuel	2003	Projections					Average Annual Percent Change, 2003-2030
		2010	2015	2020	2025	2030	
Residential							
Oil	0.2	0.1	0.2	0.2	0.2	0.2	0.1
Natural Gas	2.1	2.1	2.2	2.3	2.4	2.5	0.7
Coal	0.2	0.2	0.2	0.2	0.2	0.2	-0.6
Electricity	0.5	0.6	0.7	0.8	0.9	0.9	1.9
Heat	2.8	3.3	3.4	3.4	3.5	3.4	0.8
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	—
Total	**5.8**	**6.4**	**6.7**	**6.9**	**7.1**	**7.2**	**0.8**
Commercial							
Oil	0.0	0.0	0.0	0.0	0.0	0.0	-0.4
Natural Gas	0.1	0.1	0.1	0.1	0.1	0.1	0.7
Coal	0.0	0.0	0.0	0.0	0.0	0.0	-0.4
Electricity	0.3	0.3	0.3	0.4	0.4	0.4	2.0
Heat	0.4	0.4	0.4	0.4	0.4	0.4	0.2
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	—
Total	**0.8**	**0.9**	**1.0**	**1.0**	**1.0**	**1.1**	**0.9**
Industrial							
Oil	2.8	2.9	3.1	3.2	3.3	3.4	0.7
Natural Gas	8.0	9.1	9.7	10.7	11.5	12.2	1.5
Coal	2.0	1.7	2.2	2.5	2.7	3.0	1.5
Electricity	1.8	2.5	2.9	3.4	3.7	4.1	3.1
Heat	2.7	1.7	1.9	2.0	2.2	2.4	-0.4
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	4.3
Total	**17.3**	**18.0**	**19.9**	**21.8**	**23.6**	**25.0**	**1.4**
Transportation							
Oil	2.2	2.5	2.7	2.8	2.9	3.1	1.3
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	8.3
Coal	0.0	0.0	0.0	0.0	0.0	0.0	—
Electricity	0.2	0.2	0.2	0.2	0.2	0.2	0.1
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	—
Total	**2.4**	**2.7**	**2.9**	**3.0**	**3.2**	**3.3**	**1.3**
All End-Use Sectors							
Oil	5.2	5.6	6.0	6.1	6.5	6.7	0.9
Natural Gas	10.2	11.3	12.0	13.2	14.1	14.8	1.4
Coal	2.2	1.9	2.4	2.7	2.9	3.2	1.4
Electricity	2.8	3.7	4.2	4.8	5.2	5.6	2.6
Heat	5.9	5.5	5.8	5.9	6.1	6.3	0.3
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	6.5
Delivered Energy	**26.3**	**27.9**	**30.4**	**32.6**	**34.8**	**36.7**	**1.2**
Electricity-Related Losses	2.8	5.4	6.1	7.0	7.6	8.2	4.1
Total	**29.1**	**33.3**	**36.5**	**39.6**	**42.4**	**44.8**	**1.6**
Electric Power[a]							
Oil	0.3	0.3	0.3	0.3	0.3	0.3	-0.3
Natural Gas	5.5	7.3	7.7	8.6	8.9	9.4	2.1
Coal	2.4	2.9	3.1	3.4	3.6	3.8	1.8
Nuclear	1.5	1.7	2.1	2.6	3.1	3.5	3.2
Renewables	1.8	2.4	2.9	2.8	3.0	3.0	2.0
Total	**11.4**	**14.6**	**16.1**	**17.7**	**18.9**	**20.1**	**2.1**
Total Energy Consumption							
Oil	5.5	5.9	6.3	6.4	6.7	7.0	0.9
Natural Gas	15.7	18.5	19.8	21.7	23.0	24.2	1.6
Coal	4.6	4.8	5.4	6.1	6.5	7.0	1.6
Nuclear	1.5	1.7	2.1	2.6	3.1	3.5	3.2
Renewables	1.8	2.4	2.9	2.9	3.0	3.1	2.0
Total	**29.1**	**33.3**	**36.5**	**39.6**	**42.4**	**44.8**	**1.6**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.

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).

Table D12. Delivered Energy Consumption in Other Non-OECD Europe and Eurasia by End-Use Sector and Fuel, 2003-2030
(Quadrillion Btu)

Sector/Fuel	2003	Projections					Average Annual Percent Change, 2003-2030
		2010	2015	2020	2025	2030	
Residential							
Oil	0.2	0.2	0.2	0.2	0.2	0.2	0.5
Natural Gas	1.6	1.8	1.9	2.0	2.0	2.1	0.9
Coal	0.1	0.1	0.1	0.1	0.1	0.1	-0.4
Electricity	0.5	0.7	0.8	0.9	1.0	1.0	2.8
Heat	0.5	0.7	0.8	0.8	0.8	0.8	1.7
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	15.1
Total	**2.9**	**3.5**	**3.8**	**4.0**	**4.1**	**4.2**	**1.4**
Commercial							
Oil	0.1	0.1	0.1	0.1	0.1	0.1	1.0
Natural Gas	0.5	0.6	0.6	0.6	0.7	0.7	1.1
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.5
Electricity	0.2	0.3	0.4	0.4	0.5	0.5	3.7
Heat	0.0	0.1	0.1	0.1	0.1	0.1	1.3
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	12.4
Total	**0.8**	**1.0**	**1.1**	**1.2**	**1.3**	**1.4**	**2.0**
Industrial							
Oil	1.9	2.5	2.9	3.2	3.5	3.8	2.5
Natural Gas	3.2	4.3	5.1	5.9	6.7	7.5	3.2
Coal	1.5	2.2	2.7	3.1	3.4	3.7	3.5
Electricity	1.1	1.5	1.7	2.0	2.2	2.4	3.1
Heat	0.8	0.7	0.8	0.9	1.0	1.1	1.2
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	2.6
Total	**8.5**	**11.2**	**13.2**	**15.0**	**16.8**	**18.6**	**2.9**
Transportation							
Oil	1.9	2.3	2.5	2.6	2.8	3.1	1.8
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	—
Coal	0.0	0.0	0.0	0.0	0.0	0.0	-4.6
Electricity	0.1	0.1	0.1	0.1	0.1	0.1	1.6
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	—
Total	**2.0**	**2.4**	**2.6**	**2.8**	**3.0**	**3.2**	**1.9**
All End-Use Sectors							
Oil	4.1	5.0	5.6	6.1	6.6	7.2	2.1
Natural Gas	5.4	6.8	7.7	8.5	9.3	10.3	2.4
Coal	1.6	2.3	2.8	3.2	3.5	3.9	3.3
Electricity	1.8	2.6	3.0	3.4	3.8	4.1	3.0
Heat	1.3	1.5	1.6	1.7	1.9	2.0	1.4
Renewables	0.0	0.0	0.1	0.1	0.1	0.1	13.0
Delivered Energy	**14.2**	**18.2**	**20.7**	**22.9**	**25.1**	**27.5**	**2.5**
Electricity-Related Losses	5.2	5.0	5.6	6.1	6.5	6.7	0.9
Total	**19.4**	**23.2**	**26.3**	**29.1**	**31.6**	**34.1**	**2.1**
Electric Power[a]							
Oil	0.5	0.5	0.5	0.6	0.6	0.7	1.1
Natural Gas	3.2	4.1	5.0	5.6	6.3	7.2	3.0
Coal	2.2	1.6	1.6	1.6	1.7	1.7	-0.9
Nuclear	1.3	1.4	1.4	1.7	1.7	1.3	0.1
Renewables	1.2	1.5	1.7	1.8	1.8	1.9	1.6
Total	**8.4**	**9.1**	**10.2**	**11.3**	**12.1**	**12.8**	**1.6**
Total Energy Consumption							
Oil	4.6	5.5	6.1	6.6	7.2	7.8	2.0
Natural Gas	8.6	10.8	12.6	14.0	15.6	17.5	2.7
Coal	3.8	3.9	4.4	4.8	5.2	5.6	1.4
Nuclear	1.3	1.4	1.4	1.7	1.7	1.3	0.1
Renewables	1.2	1.6	1.7	1.9	1.9	1.9	1.8
Total	**19.4**	**23.2**	**26.3**	**29.1**	**31.6**	**34.1**	**2.1**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.

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).

Table D13. Delivered Energy Consumption in China by End-Use Sector and Fuel, 2003-2030
(Quadrillion Btu)

Sector/Fuel	2003	Projections					Average Annual Percent Change, 2003-2030
		2010	2015	2020	2025	2030	
Residential							
Oil	0.7	1.1	1.2	1.3	1.4	1.5	2.8
Natural Gas	0.4	0.9	1.3	1.6	1.9	2.3	7.1
Coal	1.6	3.1	3.0	2.7	2.6	2.4	1.5
Electricity	0.8	2.0	2.7	3.5	4.4	5.6	7.4
Heat	0.3	0.5	0.5	0.5	0.5	0.5	2.0
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	—
Total	**3.8**	**7.6**	**8.7**	**9.6**	**10.8**	**12.3**	**4.5**
Commercial							
Oil	0.7	0.9	1.0	1.0	1.1	1.1	1.7
Natural Gas	0.0	0.1	0.1	0.2	0.2	0.2	6.4
Coal	0.2	0.3	0.3	0.3	0.3	0.3	1.6
Electricity	0.4	0.9	1.1	1.3	1.5	1.8	5.5
Heat	0.0	0.0	0.0	0.0	0.0	0.0	-0.5
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	—
Total	**1.4**	**2.2**	**2.5**	**2.8**	**3.2**	**3.6**	**3.5**
Industrial							
Oil	5.3	7.5	9.5	11.7	13.5	15.5	4.1
Natural Gas	0.8	2.0	2.6	3.2	3.8	4.5	6.7
Coal	11.2	18.6	23.1	27.3	31.4	36.5	4.5
Electricity	4.4	6.6	8.1	9.6	11.2	12.8	4.0
Heat	1.3	1.5	1.9	2.3	2.8	3.3	3.5
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	—
Total	**22.9**	**36.3**	**45.2**	**54.1**	**62.7**	**72.6**	**4.4**
Transportation							
Oil	4.1	6.2	7.4	8.8	10.5	12.5	4.2
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	5.6
Coal	0.2	0.3	0.3	0.2	0.2	0.1	-1.6
Electricity	0.1	0.1	0.1	0.1	0.1	0.1	3.1
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	—
Total	**4.4**	**6.6**	**7.8**	**9.2**	**10.9**	**12.9**	**4.1**
All End-Use Sectors							
Oil	10.8	15.7	19.1	22.8	26.5	30.7	3.9
Natural Gas	1.2	3.1	4.0	4.9	6.0	7.1	6.8
Coal	13.2	22.2	26.6	30.5	34.5	39.3	4.1
Electricity	5.7	9.5	12.0	14.5	17.3	20.4	4.8
Heat	1.6	2.0	2.4	2.9	3.3	3.8	3.2
Renewables	0.0	0.0	0.1	0.1	0.1	0.1	—
Delivered Energy	**32.5**	**52.6**	**64.1**	**75.7**	**87.6**	**101.4**	**4.3**
Electricity-Related Losses	13.0	24.4	27.7	30.9	34.1	37.7	4.0
Total	**45.5**	**77.0**	**91.8**	**106.6**	**121.7**	**139.1**	**4.2**
Electric Power[a]							
Oil	0.5	2.0	1.4	1.1	0.7	0.2	-4.3
Natural Gas	0.2	0.4	0.6	1.0	1.2	1.0	7.0
Coal	16.3	26.6	32.0	37.4	43.3	50.1	4.2
Nuclear	0.4	0.8	1.3	1.7	2.3	3.1	7.6
Renewables	2.9	6.1	6.8	7.0	7.2	7.5	3.6
Total	**20.3**	**35.9**	**42.1**	**48.2**	**54.7**	**61.9**	**4.2**
Total Energy Consumption							
Oil	11.4	17.8	20.5	23.9	27.2	30.9	3.8
Natural Gas	1.4	3.5	4.6	5.9	7.2	8.2	6.8
Coal	29.5	48.8	58.6	67.9	77.8	89.4	4.2
Nuclear	0.4	0.8	1.3	1.7	2.3	3.1	7.6
Renewables	2.9	6.1	6.8	7.1	7.3	7.6	3.7
Total	**45.5**	**77.0**	**91.8**	**106.6**	**121.7**	**139.1**	**4.2**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.

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).

Table D14. Delivered Energy Consumption in India by End-Use Sector and Fuel, 2003-2030
(Quadrillion Btu)

Sector/Fuel	2003	Projections					Average Annual Percent Change, 2003-2030
		2010	2015	2020	2025	2030	
Residential							
Oil	1.0	1.3	1.4	1.4	1.4	1.4	1.2
Natural Gas	0.0	0.0	0.1	0.1	0.1	0.1	4.9
Coal	0.2	0.4	0.4	0.4	0.5	0.5	2.9
Electricity	0.4	0.8	1.0	1.3	1.5	1.8	5.9
Heat	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	—
Total	**1.7**	**2.6**	**2.9**	**3.2**	**3.5**	**3.8**	**3.1**
Commercial							
Oil	0.0	0.0	0.0	0.0	0.0	0.0	—
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	—
Coal	0.1	0.3	0.4	0.4	0.4	0.3	3.6
Electricity	0.3	0.7	0.9	1.0	1.2	1.5	6.0
Heat	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	—
Total	**0.4**	**1.0**	**1.2**	**1.4**	**1.6**	**1.8**	**5.4**
Industrial							
Oil	2.2	2.8	3.3	3.7	4.2	4.6	2.7
Natural Gas	0.6	0.7	0.9	1.2	1.6	2.0	4.8
Coal	1.9	2.3	2.6	3.1	3.5	3.8	2.7
Electricity	1.0	1.3	1.6	1.9	2.2	2.6	3.4
Heat	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	13.8
Total	**5.7**	**7.1**	**8.4**	**9.9**	**11.5**	**13.0**	**3.1**
Transportation							
Oil	1.4	1.8	2.0	2.3	2.6	2.9	2.8
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	—
Coal	0.0	0.0	0.0	0.0	0.0	0.0	—
Electricity	0.0	0.1	0.1	0.1	0.1	0.1	2.3
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	—
Total	**1.4**	**1.8**	**2.1**	**2.4**	**2.7**	**3.0**	**2.9**
All End-Use Sectors							
Oil	4.6	5.9	6.7	7.3	8.1	8.9	2.5
Natural Gas	0.6	0.8	1.0	1.3	1.7	2.1	4.9
Coal	2.2	2.9	3.4	3.9	4.3	4.7	2.7
Electricity	1.8	2.9	3.6	4.3	5.0	5.9	4.6
Heat	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	16.5
Delivered Energy	**9.2**	**12.5**	**14.6**	**16.8**	**19.2**	**21.6**	**3.2**
Electricity-Related Losses	4.8	6.9	7.9	8.9	9.8	10.9	3.1
Total	**14.0**	**19.4**	**22.5**	**25.7**	**29.0**	**32.5**	**3.2**
Electric Power[a]							
Oil	0.2	0.2	0.2	0.3	0.3	0.3	2.0
Natural Gas	0.4	0.8	0.8	1.0	1.5	2.6	7.1
Coal	5.0	6.9	8.2	9.2	9.9	10.3	2.7
Nuclear	0.2	0.7	0.9	1.2	1.3	1.4	7.4
Renewables	0.7	1.3	1.3	1.5	1.8	2.2	4.1
Total	**6.6**	**9.8**	**11.5**	**13.2**	**14.8**	**16.8**	**3.5**
Total Energy Consumption							
Oil	4.8	6.1	6.9	7.6	8.4	9.2	2.4
Natural Gas	1.0	1.5	1.8	2.3	3.2	4.7	5.9
Coal	7.3	9.9	11.6	13.1	14.2	15.0	2.7
Nuclear	0.2	0.7	0.9	1.2	1.3	1.4	7.4
Renewables	0.7	1.3	1.3	1.5	1.8	2.2	4.2
Total	**14.0**	**19.4**	**22.5**	**25.7**	**29.0**	**32.5**	**3.2**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.

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).

Table D15. Delivered Energy Consumption in Other Non-OECD Asia by End-Use Sector and Fuel, 2003-2030
(Quadrillion Btu)

Sector/Fuel	2003	Projections					Average Annual Percent Change, 2003-2030
		2010	2015	2020	2025	2030	
Residential							
Oil	0.8	1.1	1.2	1.2	1.2	1.2	1.7
Natural Gas	0.2	0.6	0.6	0.6	0.7	0.7	4.5
Coal	0.0	0.0	0.0	0.0	0.0	0.0	1.1
Electricity	0.7	1.3	1.7	2.1	2.5	3.0	5.5
Heat	0.0	0.0	0.0	0.0	0.0	0.0	4.3
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	—
Total	**1.7**	**3.0**	**3.5**	**4.0**	**4.5**	**5.0**	**4.0**
Commercial							
Oil	0.2	0.2	0.3	0.3	0.3	0.4	2.8
Natural Gas	0.1	0.2	0.3	0.3	0.3	0.3	3.2
Coal	0.0	0.0	0.0	0.0	0.0	0.0	2.9
Electricity	0.5	0.6	0.8	0.9	1.0	1.1	3.0
Heat	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	—
Total	**0.8**	**1.1**	**1.3**	**1.5**	**1.7**	**1.8**	**3.0**
Industrial							
Oil	4.1	4.9	5.4	5.8	6.2	6.6	1.8
Natural Gas	2.4	3.4	4.6	5.8	6.9	8.1	4.6
Coal	2.2	2.7	2.9	3.2	3.5	3.8	2.0
Electricity	1.3	1.8	2.2	2.7	3.2	3.8	4.2
Heat	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	9.6
Total	**10.0**	**12.7**	**15.1**	**17.5**	**19.9**	**22.3**	**3.0**
Transportation							
Oil	5.8	6.9	7.7	8.4	9.4	10.6	2.2
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	4.2
Coal	0.0	0.0	0.0	0.0	0.0	0.0	—
Electricity	0.0	0.0	0.0	0.0	0.0	0.0	2.8
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	—
Total	**5.8**	**6.9**	**7.7**	**8.5**	**9.5**	**10.6**	**2.3**
All End-Use Sectors							
Oil	10.8	13.1	14.5	15.8	17.2	18.7	2.1
Natural Gas	2.8	4.1	5.5	6.7	7.9	9.1	4.5
Coal	2.3	2.7	3.0	3.3	3.6	3.8	1.9
Electricity	2.5	3.7	4.6	5.6	6.7	7.9	4.4
Heat	0.0	0.0	0.0	0.0	0.0	0.0	2.3
Renewables	0.0	0.0	0.0	0.0	0.1	0.1	15.0
Delivered Energy	**18.3**	**23.8**	**27.6**	**31.4**	**35.5**	**39.8**	**2.9**
Electricity-Related Losses	5.2	6.0	7.4	9.2	10.9	12.3	3.2
Total	**23.5**	**29.8**	**35.1**	**40.6**	**46.4**	**52.0**	**3.0**
Electric Power[a]							
Oil	0.9	1.3	1.7	2.1	2.5	2.8	4.2
Natural Gas	2.7	3.3	4.8	5.9	7.2	8.6	4.3
Coal	2.2	2.3	2.5	2.7	3.0	3.1	1.4
Nuclear	0.4	0.5	0.6	0.8	1.0	0.9	3.1
Renewables	1.5	2.3	2.6	3.3	4.1	4.9	4.5
Total	**7.7**	**9.8**	**12.1**	**14.8**	**17.7**	**20.3**	**3.6**
Total Energy Consumption							
Oil	11.7	14.4	16.1	17.8	19.6	21.6	2.3
Natural Gas	5.5	7.4	10.2	12.6	15.1	17.7	4.4
Coal	4.4	5.0	5.5	6.0	6.6	6.9	1.7
Nuclear	0.4	0.5	0.6	0.8	1.0	0.9	3.1
Renewables	1.5	2.4	2.6	3.3	4.1	4.9	4.5
Total	**23.6**	**29.8**	**35.1**	**40.6**	**46.4**	**52.0**	**3.0**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.

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).

Table D16. Delivered Energy Consumption in the Middle East by End-Use Sector and Fuel, 2003-2030
(Quadrillion Btu)

Sector/Fuel	2003	Projections					Average Annual Percent Change, 2003-2030
		2010	2015	2020	2025	2030	
Residential							
Oil	0.8	0.9	1.0	1.0	1.1	1.1	1.1
Natural Gas	1.0	1.1	1.2	1.3	1.3	1.4	1.5
Coal	0.0	0.0	0.0	0.0	0.0	0.0	-1.5
Electricity	0.6	1.0	1.2	1.3	1.4	1.5	3.4
Heat	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	0.0	0.1	0.1	0.1	0.1	0.1	5.3
Total	**2.5**	**3.2**	**3.5**	**3.7**	**4.0**	**4.2**	**2.0**
Commercial							
Oil	0.2	0.2	0.2	0.2	0.3	0.3	2.6
Natural Gas	0.1	0.2	0.2	0.2	0.2	0.2	2.2
Coal	0.0	0.0	0.0	0.0	0.0	0.0	—
Electricity	0.4	0.5	0.6	0.7	0.8	0.9	3.4
Heat	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	9.9
Total	**0.7**	**0.9**	**1.0**	**1.2**	**1.3**	**1.4**	**3.0**
Industrial							
Oil	3.6	4.2	4.6	5.0	5.3	5.3	1.5
Natural Gas	4.1	7.4	8.9	10.4	12.1	14.1	4.7
Coal	0.0	0.1	0.1	0.1	0.1	0.2	4.6
Electricity	0.6	0.7	0.8	0.9	1.0	1.1	2.2
Heat	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	24.0
Total	**8.4**	**12.4**	**14.4**	**16.5**	**18.5**	**20.8**	**3.4**
Transportation							
Oil	4.2	4.9	5.2	5.3	5.7	6.2	1.5
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	—
Coal	0.0	0.0	0.0	0.0	0.0	0.0	—
Electricity	0.0	0.0	0.0	0.0	0.0	0.0	3.3
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	—
Total	**4.2**	**4.9**	**5.2**	**5.3**	**5.7**	**6.2**	**1.5**
All End-Use Sectors							
Oil	8.8	10.2	11.0	11.6	12.3	13.0	1.5
Natural Gas	5.2	8.7	10.3	11.9	13.7	15.8	4.2
Coal	0.0	0.1	0.1	0.1	0.1	0.2	4.6
Electricity	1.6	2.3	2.7	3.0	3.3	3.5	3.0
Heat	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	0.0	0.1	0.1	0.1	0.1	0.1	6.2
Delivered Energy	**15.7**	**21.3**	**24.1**	**26.7**	**29.6**	**32.6**	**2.8**
Electricity-Related Losses	4.0	3.7	4.1	4.4	4.8	5.1	0.9
Total	**19.6**	**25.0**	**28.2**	**31.2**	**34.3**	**37.7**	**2.4**
Electric Power[a]							
Oil	2.0	2.2	2.5	2.7	2.8	3.0	1.4
Natural Gas	3.0	2.9	3.4	3.8	4.3	4.7	1.7
Coal	0.3	0.3	0.3	0.3	0.3	0.3	-0.3
Nuclear	0.0	0.1	0.1	0.1	0.1	0.1	—
Renewables	0.2	0.5	0.5	0.6	0.6	0.6	4.2
Total	**5.6**	**6.0**	**6.8**	**7.4**	**8.0**	**8.7**	**1.6**
Total Energy Consumption							
Oil	10.8	12.4	13.5	14.3	15.2	16.0	1.5
Natural Gas	8.2	11.6	13.7	15.7	18.0	20.5	3.4
Coal	0.4	0.4	0.4	0.4	0.4	0.5	0.8
Nuclear	0.0	0.1	0.1	0.1	0.1	0.1	—
Renewables	0.2	0.6	0.6	0.7	0.7	0.8	4.5
Total	**19.6**	**25.0**	**28.2**	**31.2**	**34.3**	**37.7**	**2.4**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.

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).

Table D17. Delivered Energy Consumption in Africa by End-Use Sector and Fuel, 2003-2030
(Quadrillion Btu)

Sector/Fuel	2003	Projections					Average Annual Percent Change, 2003-2030
		2010	2015	2020	2025	2030	
Residential							
Oil	0.6	1.2	1.2	1.1	1.1	1.1	2.3
Natural Gas	0.1	0.3	0.4	0.4	0.4	0.4	4.1
Coal	0.1	0.2	0.2	0.2	0.3	0.3	3.4
Electricity	0.4	0.7	0.9	1.0	1.2	1.3	4.2
Heat	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	—
Total	**1.3**	**2.5**	**2.7**	**2.8**	**3.0**	**3.1**	**3.3**
Commercial							
Oil	0.1	0.1	0.1	0.1	0.1	0.1	2.7
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	4.3
Coal	0.1	0.1	0.1	0.1	0.1	0.1	2.3
Electricity	0.2	0.3	0.3	0.4	0.5	0.5	4.5
Heat	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	—
Total	**0.3**	**0.5**	**0.5**	**0.6**	**0.7**	**0.7**	**3.8**
Industrial							
Oil	1.5	2.0	2.3	2.4	2.4	2.6	1.9
Natural Gas	1.3	2.1	3.1	3.7	4.3	5.0	5.2
Coal	1.6	2.1	2.3	2.5	2.7	2.9	2.2
Electricity	0.9	0.9	1.0	1.1	1.2	1.4	1.7
Heat	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	2.9
Total	**5.3**	**7.1**	**8.8**	**9.7**	**10.6**	**11.9**	**3.0**
Transportation							
Oil	2.9	3.6	3.9	4.2	4.6	5.1	2.2
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	-5.3
Coal	0.0	0.0	0.0	0.0	0.0	0.0	-4.0
Electricity	0.0	0.0	0.0	0.0	0.0	0.0	0.7
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	—
Total	**2.9**	**3.6**	**3.9**	**4.2**	**4.7**	**5.2**	**2.2**
All End-Use Sectors							
Oil	5.0	6.8	7.4	7.8	8.2	8.9	2.1
Natural Gas	1.4	2.4	3.5	4.1	4.7	5.5	5.1
Coal	1.8	2.5	2.7	2.9	3.1	3.3	2.2
Electricity	1.5	1.9	2.3	2.6	2.9	3.2	2.9
Heat	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	7.1
Delivered Energy	**9.7**	**13.6**	**15.9**	**17.3**	**18.9**	**20.9**	**2.9**
Electricity-Related Losses	3.6	4.1	4.6	5.0	5.4	5.9	1.9
Total	**13.3**	**17.7**	**20.5**	**22.3**	**24.3**	**26.8**	**2.6**
Electric Power[a]							
Oil	0.5	0.7	0.9	1.0	1.0	1.2	3.3
Natural Gas	1.3	1.1	1.4	2.0	2.6	3.2	3.3
Coal	2.3	2.9	3.2	3.2	3.2	3.1	1.2
Nuclear	0.1	0.1	0.2	0.2	0.2	0.2	0.7
Renewables	0.9	1.2	1.2	1.2	1.3	1.5	1.9
Total	**5.1**	**6.0**	**6.9**	**7.6**	**8.3**	**9.1**	**2.2**
Total Energy Consumption							
Oil	5.5	7.6	8.3	8.8	9.3	10.1	2.3
Natural Gas	2.7	3.5	4.9	6.1	7.4	8.7	4.4
Coal	4.1	5.3	5.9	6.1	6.2	6.4	1.7
Nuclear	0.1	0.1	0.2	0.2	0.2	0.2	0.7
Renewables	0.9	1.2	1.3	1.3	1.3	1.5	1.9
Total	**13.3**	**17.7**	**20.5**	**22.3**	**24.3**	**26.8**	**2.6**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.

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).

Table D18. Delivered Energy Consumption in Brazil by End-Use Sector and Fuel, 2003-2030
(Quadrillion Btu)

Sector/Fuel	2003	Projections					Average Annual Percent Change, 2003-2030
		2010	2015	2020	2025	2030	
Residential							
Oil	0.3	0.4	0.4	0.5	0.5	0.6	2.6
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	4.6
Coal	0.0	0.0	0.0	0.0	0.0	0.0	—
Electricity	0.3	0.5	0.5	0.6	0.6	0.7	3.2
Heat	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	—
Total	**0.6**	**0.9**	**1.0**	**1.1**	**1.2**	**1.3**	**2.9**
Commercial							
Oil	0.1	0.1	0.1	0.1	0.1	0.1	2.0
Natural Gas	0.0	0.0	0.0	0.0	0.0	0.0	2.6
Coal	0.0	0.0	0.0	0.0	0.0	0.0	—
Electricity	0.3	0.5	0.6	0.7	0.9	1.0	4.5
Heat	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	—
Total	**0.4**	**0.6**	**0.7**	**0.9**	**1.0**	**1.1**	**4.1**
Industrial							
Oil	1.6	1.9	2.1	2.4	2.6	2.7	2.0
Natural Gas	0.4	0.5	0.6	0.6	0.7	0.8	2.7
Coal	0.4	0.5	0.5	0.5	0.5	0.6	1.5
Electricity	0.7	0.8	0.9	1.1	1.2	1.3	2.5
Heat	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	-2.3
Total	**3.1**	**3.7**	**4.2**	**4.6**	**5.1**	**5.5**	**2.1**
Transportation							
Oil	2.3	2.5	2.6	2.7	2.9	3.2	1.2
Natural Gas	0.0	0.0	0.0	0.0	0.1	0.1	1.3
Coal	0.0	0.0	0.0	0.0	0.0	0.0	—
Electricity	0.0	0.0	0.0	0.0	0.0	0.0	1.8
Renewables	0.2	0.3	0.3	0.3	0.3	0.3	1.5
Total	**2.5**	**2.8**	**2.9**	**3.0**	**3.3**	**3.6**	**1.3**
All End-Use Sectors							
Oil	4.2	4.8	5.2	5.6	6.2	6.6	1.7
Natural Gas	0.5	0.6	0.6	0.7	0.8	0.9	2.6
Coal	0.4	0.5	0.5	0.5	0.5	0.6	1.5
Electricity	1.3	1.8	2.1	2.4	2.7	3.0	3.2
Heat	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	0.3	0.3	0.3	0.3	0.3	0.4	1.1
Delivered Energy	**6.6**	**7.9**	**8.8**	**9.5**	**10.5**	**11.4**	**2.1**
Electricity-Related Losses	2.1	2.9	3.6	4.3	5.0	5.7	3.8
Total	**8.7**	**10.8**	**12.4**	**13.8**	**15.5**	**17.2**	**2.5**
Electric Power[a]							
Oil	0.1	0.1	0.1	0.2	0.2	0.2	2.3
Natural Gas	0.1	0.4	0.5	0.5	0.6	0.8	9.8
Coal	0.1	0.1	0.2	0.3	0.3	0.3	6.1
Nuclear	0.1	0.1	0.2	0.2	0.2	0.2	1.2
Renewables	3.0	3.9	4.7	5.5	6.3	7.2	3.3
Total	**3.4**	**4.7**	**5.7**	**6.7**	**7.7**	**8.7**	**3.6**
Total Energy Consumption							
Oil	4.3	4.9	5.4	5.8	6.3	6.8	1.7
Natural Gas	0.5	1.0	1.1	1.2	1.4	1.7	4.6
Coal	0.5	0.6	0.7	0.8	0.8	0.9	2.4
Nuclear	0.1	0.1	0.2	0.2	0.2	0.2	1.2
Renewables	3.3	4.2	5.0	5.8	6.7	7.6	3.2
Total	**8.8**	**10.8**	**12.4**	**13.8**	**15.5**	**17.2**	**2.5**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.

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).

Table D19. Delivered Energy Consumption in Other Central and South America by End-Use Sector and Fuel, 2003-2030
(Quadrillion Btu)

Sector/Fuel	2003	Projections					Average Annual Percent Change, 2003-2030
		2010	2015	2020	2025	2030	
Residential							
Oil	0.4	0.6	0.6	0.7	0.7	0.8	2.6
Natural Gas	0.3	0.5	0.6	0.7	0.8	0.8	3.4
Coal	0.0	0.0	0.0	0.0	0.0	0.0	1.8
Electricity	0.4	0.7	0.9	1.1	1.3	1.5	5.0
Heat	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	6.6
Total	**1.1**	**1.8**	**2.2**	**2.5**	**2.8**	**3.2**	**3.8**
Commercial							
Oil	0.1	0.1	0.1	0.1	0.2	0.2	2.5
Natural Gas	0.1	0.1	0.1	0.2	0.2	0.2	2.8
Coal	0.0	0.0	0.0	0.0	0.0	0.0	—
Electricity	0.3	0.5	0.6	0.8	0.9	1.0	4.8
Heat	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	—
Total	**0.5**	**0.7**	**0.9**	**1.1**	**1.2**	**1.4**	**4.1**
Industrial							
Oil	2.1	2.5	2.8	3.1	3.2	3.4	1.8
Natural Gas	2.2	3.1	3.7	4.3	5.2	5.7	3.5
Coal	0.2	0.2	0.3	0.3	0.4	0.4	3.5
Electricity	0.7	0.9	1.0	1.1	1.3	1.5	3.0
Heat	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	0.0	0.0	0.0	0.0	0.0	0.0	1.1
Total	**5.2**	**6.7**	**7.8**	**8.8**	**10.0**	**11.0**	**2.8**
Transportation							
Oil	3.0	3.6	3.8	4.0	4.3	4.8	1.7
Natural Gas	0.1	0.1	0.1	0.1	0.1	0.1	0.3
Coal	0.0	0.0	0.0	0.0	0.0	0.0	—
Electricity	0.0	0.0	0.0	0.0	0.0	0.0	1.6
Renewables	0.2	0.3	0.3	0.3	0.3	0.4	2.1
Total	**3.3**	**4.0**	**4.2**	**4.4**	**4.8**	**5.2**	**1.7**
All End-Use Sectors							
Oil	5.6	6.8	7.4	7.9	8.4	9.1	1.8
Natural Gas	2.8	3.8	4.5	5.2	6.2	6.8	3.4
Coal	0.2	0.2	0.3	0.3	0.4	0.4	3.5
Electricity	1.4	2.1	2.5	3.0	3.5	4.0	4.1
Heat	0.0	0.0	0.0	0.0	0.0	0.0	—
Renewables	0.2	0.3	0.3	0.3	0.4	0.4	2.1
Delivered Energy	**10.1**	**13.2**	**15.0**	**16.8**	**18.9**	**20.8**	**2.7**
Electricity-Related Losses	3.0	4.1	5.0	5.8	6.8	7.7	3.5
Total	**13.2**	**17.4**	**20.1**	**22.7**	**25.7**	**28.5**	**2.9**
Electric Power[a]							
Oil	0.8	1.0	1.2	1.3	1.4	1.6	2.5
Natural Gas	0.8	1.4	1.9	2.2	2.6	3.0	4.9
Coal	0.1	0.2	0.2	0.3	0.3	0.3	3.6
Nuclear	0.1	0.1	0.1	0.1	0.1	0.1	-1.1
Renewables	2.5	3.6	4.2	5.0	5.9	6.7	3.7
Total	**4.4**	**6.2**	**7.6**	**8.9**	**10.3**	**11.7**	**3.7**
Total Energy Consumption							
Oil	6.4	7.7	8.5	9.2	9.9	10.7	1.9
Natural Gas	3.6	5.3	6.5	7.5	8.8	9.9	3.8
Coal	0.3	0.4	0.5	0.6	0.6	0.7	3.5
Nuclear	0.1	0.1	0.1	0.1	0.1	0.1	-1.1
Renewables	2.8	3.9	4.5	5.3	6.3	7.1	3.6
Total	**13.1**	**17.4**	**20.1**	**22.7**	**25.7**	**28.5**	**2.9**

[a]Fuel inputs used in the production of electricity and heat at central-station generators.

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).

Appendix E

Projections of Oil Production Capacity and Oil Production in Three Cases:

- **Reference**
- **High World Oil Price**
- **Low World Oil Price**

Table E1. World Oil Production Capacity by Region and Country, Reference Case, 1990-2030
(Million Barrels per Day)

Region/Country	History (Estimates)		Projections				
	1990	2003	2010	2015	2020	2025	2030
OPEC							
Persian Gulf							
Iran	3.2	4.2	3.8	4.0	3.9	4.0	4.3
Iraq	2.2	2.3	3.3	3.8	4.3	5.1	5.5
Kuwait	1.7	2.4	2.8	3.3	3.8	4.2	4.5
Qatar	0.5	0.9	0.7	0.7	0.7	0.7	0.8
Saudi Arabia	8.6	10.6	14.4	14.8	14.5	15.1	17.1
United Arab Emitates	2.5	3.3	3.3	3.5	3.9	4.4	4.6
Total Persian Gulf	**18.7**	**23.7**	**28.3**	**30.1**	**31.1**	**33.5**	**36.8**
Other OPEC							
Indonesia	1.5	1.4	1.5	1.4	1.3	1.2	1.1
Algeria	1.3	1.5	1.8	1.8	1.9	1.8	1.8
Libya	1.5	1.5	1.8	1.9	1.9	1.9	1.8
Nigeria	1.8	2.0	2.4	2.7	2.7	2.9	3.2
Venezuela	2.4	3.0	4.1	4.8	5.0	5.5	5.9
Total Other OPEC	**8.5**	**9.3**	**11.6**	**12.7**	**12.8**	**13.2**	**13.9**
Total OPEC	**27.1**	**33.0**	**39.9**	**42.8**	**43.9**	**46.7**	**50.7**
Non-OPEC							
OECD							
United States	9.7	8.8	9.9	10.3	10.4	10.4	10.4
Canada	2.0	3.1	3.6	3.7	4.2	4.7	5.0
Mexico	3.0	3.8	4.0	4.2	4.5	4.8	5.1
North Sea	4.0	6.3	5.5	5.1	5.1	4.7	4.3
Australia and New Zealand	0.7	0.7	0.9	0.8	0.9	0.9	0.9
Other	0.7	0.5	0.5	0.5	0.5	0.5	0.5
Total OECD	**20.1**	**23.2**	**24.3**	**24.7**	**25.5**	**26.0**	**26.1**
Non-OECD							
Russia	11.4	8.5	9.6	10.0	10.9	11.3	11.6
Caspian Area	0.0	1.9	3.0	4.2	5.2	6.3	7.5
Other Non-OECD Europe and Eurasia	0.3	0.2	0.3	0.3	0.4	0.4	0.5
China	2.8	3.4	3.8	3.7	3.8	4.0	4.2
India	0.7	0.9	1.1	1.3	1.4	1.5	1.6
Other Non-OECD Asia	1.0	2.0	1.7	1.8	1.8	1.7	1.7
Middle East	1.4	1.9	2.0	2.2	2.4	2.7	2.9
Africa	2.2	3.2	3.8	4.8	5.8	7.2	8.6
Brazil	0.8	1.8	2.7	3.5	3.9	4.2	4.5
Other South and Central America	1.8	2.4	2.1	2.4	2.7	3.0	3.4
Total Non-OECD	**22.2**	**26.0**	**30.0**	**34.1**	**38.2**	**42.2**	**46.5**
Total Non-OPEC	**42.4**	**49.3**	**54.4**	**58.8**	**63.7**	**68.2**	**72.6**
Total World	**69.5**	**82.3**	**94.3**	**101.6**	**107.6**	**114.9**	**123.3**

Note: OPEC = Organization of Petroleum Exporting Countries.

Sources: **History:** Energy Information Administration (EIA), Energy Markets and Contingency Information Division. **Projections:** EIA, System for the Analysis of Global Energy Markets (2006); and U.S. Department of the Interior, U.S. Geological Survey, *World Petroleum Assessment 2000* (Reston, VA, July 2000).

Table E2. World Oil Production Capacity by Region and Country, High Oil Price Case, 1990-2030
(Million Barrels per Day)

Region/Country	History (Estimates)		Projections				
	1990	2003	2010	2015	2020	2025	2030
OPEC							
Persian Gulf							
Iran	3.2	4.2	3.4	2.9	2.8	2.7	2.9
Iraq	2.2	2.3	2.9	2.7	3.1	3.5	3.6
Kuwait	1.7	2.4	2.5	2.4	2.7	2.8	3.0
Qatar	0.5	0.9	0.6	0.5	0.6	0.5	0.5
Saudi Arabia	8.6	10.6	12.7	11.1	10.8	11.0	12.4
United Arab Emitates	2.5	3.3	2.9	2.6	2.8	3.0	3.2
Total Persian Gulf	**18.7**	**23.7**	**25.0**	**22.3**	**22.7**	**23.6**	**25.5**
Other OPEC							
Indonesia	1.5	1.4	1.3	1.0	0.9	0.8	0.7
Algeria	1.3	1.5	1.5	1.3	1.3	1.2	1.1
Libya	1.5	1.5	1.5	1.3	1.3	1.2	1.2
Nigeria	1.8	2.0	2.1	1.9	1.9	2.0	2.1
Venezuela	2.4	3.0	4.1	4.4	4.9	5.5	6.1
Total Other OPEC	**8.5**	**9.3**	**10.6**	**9.9**	**10.3**	**10.6**	**11.2**
Total OPEC	**27.1**	**33.0**	**35.6**	**32.2**	**33.1**	**34.2**	**36.7**
Non-OPEC							
OECD							
United States	9.7	8.8	9.8	10.3	10.7	11.3	11.9
Canada	2.0	3.1	3.5	4.1	4.9	5.4	5.9
Mexico	3.0	3.8	3.9	4.4	4.3	4.4	4.2
North Sea	4.0	6.3	5.8	5.5	5.0	4.4	3.7
Australia and New Zealand	0.7	0.7	0.9	0.9	0.9	0.9	0.8
Other	0.7	0.5	0.2	0.2	0.2	0.2	0.2
Total OECD	**20.1**	**23.2**	**24.1**	**25.4**	**26.0**	**26.5**	**26.8**
Non-OECD							
Russia	11.4	8.5	9.5	10.6	10.8	10.7	10.2
Caspian Area	0.0	1.9	3.0	4.4	5.1	5.8	6.4
Other Non-OECD Europe and Eurasia	0.3	0.2	0.2	0.3	0.3	0.4	0.4
China	2.8	3.4	3.7	4.0	4.1	4.7	5.4
India	0.7	0.9	1.1	1.3	1.5	1.6	1.8
Other Non-OECD Asia	1.0	2.0	1.7	2.0	2.0	1.9	2.0
Middle East	1.4	1.9	2.0	2.3	2.3	2.3	2.3
Africa	2.2	3.2	3.8	5.3	6.2	7.5	8.6
Brazil	0.8	1.8	3.0	3.7	3.9	4.0	4.0
Other South and Central America	1.8	2.4	2.0	2.6	2.8	2.9	3.1
Total Non-OECD	**22.2**	**26.0**	**30.1**	**36.4**	**39.0**	**41.8**	**44.2**
Total Non-OPEC	**42.4**	**49.3**	**54.2**	**61.8**	**65.0**	**68.3**	**71.0**
Total World	**69.5**	**82.3**	**89.8**	**94.0**	**98.0**	**102.5**	**107.7**

Note: OPEC = Organization of Petroleum Exporting Countries.

Sources: **History:** Energy Information Administration (EIA), Energy Markets and Contingency Information Division. **Projections:** EIA, System for the Analysis of Global Energy Markets (2006); and U.S. Department of the Interior, U.S. Geological Survey, *World Petroleum Assessment 2000* (Reston, VA, July 2000).

Table E3. World Oil Production Capacity by Region and Country, Low Oil Price Case, 1990-2030
(Million Barrels per Day)

Region/Country	History (Estimates)		Projections				
	1990	2003	2010	2015	2020	2025	2030
OPEC							
Persian Gulf							
Iran	3.2	4.2	3.8	4.1	4.1	4.3	4.8
Iraq	2.2	2.3	3.3	3.9	4.5	5.6	6.1
Kuwait	1.7	2.4	2.8	3.3	4.0	4.5	5.0
Qatar	0.5	0.9	0.7	0.7	0.8	0.8	0.8
Saudi Arabia	8.6	10.6	14.3	15.0	15.1	16.2	18.6
United Arab Emitates	2.5	3.3	3.3	3.5	4.1	4.8	5.2
Total Persian Gulf	**18.7**	**23.7**	**28.3**	**30.6**	**32.7**	**36.1**	**40.6**
Other OPEC							
Indonesia	1.5	1.4	1.5	1.5	1.4	1.3	1.3
Algeria	1.3	1.5	1.8	1.9	2.0	2.0	2.0
Libya	1.5	1.5	1.8	2.0	2.1	2.0	2.1
Nigeria	1.8	2.0	2.5	2.7	2.9	3.2	3.5
Venezuela	2.4	3.0	4.2	5.0	5.5	5.7	6.0
Total Other OPEC	**8.5**	**9.3**	**11.9**	**13.1**	**13.8**	**14.2**	**14.8**
Total OPEC	**27.1**	**33.0**	**40.1**	**43.7**	**46.5**	**50.3**	**55.4**
Non-OPEC							
OECD							
United States	9.7	8.8	10.0	10.5	10.2	9.9	9.5
Canada	2.0	3.1	2.8	3.5	4.0	4.4	4.5
Mexico	3.0	3.8	4.1	4.5	5.0	5.5	5.8
North Sea	4.0	6.3	5.8	5.4	5.6	5.4	5.2
Australia and New Zealand	0.7	0.7	0.9	0.9	1.0	1.0	1.0
Other	0.7	0.5	0.6	0.6	0.6	0.5	0.2
Total OECD	**20.1**	**23.2**	**24.2**	**25.3**	**26.3**	**26.6**	**26.2**
Non-OECD							
Russia	11.4	8.5	9.8	10.6	11.8	12.6	13.0
Caspian Area	0.0	1.9	3.1	4.4	5.7	7.0	8.4
Other Non-OECD Europe and Eurasia	0.3	0.2	0.3	0.3	0.4	0.4	0.5
China	2.8	3.4	3.9	3.9	4.1	4.3	4.2
India	0.7	0.9	1.1	1.3	1.3	1.4	1.6
Other Non-OECD Asia	1.0	2.0	1.7	1.8	1.9	1.9	1.8
Middle East	1.4	1.9	2.1	2.4	2.7	3.1	3.3
Africa	2.2	3.2	3.9	5.0	6.3	7.9	9.6
Brazil	0.8	1.8	3.0	3.5	4.1	4.6	5.0
Other South and Central America	1.8	2.4	2.1	2.6	2.9	3.4	3.8
Total Non-OECD	**22.2**	**26.0**	**31.0**	**35.7**	**41.2**	**46.6**	**51.2**
Total Non-OPEC	**42.4**	**49.3**	**55.2**	**61.0**	**67.5**	**73.1**	**77.4**
Total World	**69.5**	**82.3**	**95.3**	**104.7**	**114.0**	**123.5**	**132.8**

Note: OPEC = Organization of Petroleum Exporting Countries.

Sources: **History:** Energy Information Administration (EIA), Energy Markets and Contingency Information Division. **Projections:** EIA, System for the Analysis of Global Energy Markets (2006); and U.S. Department of the Interior, U.S. Geological Survey, *World Petroleum Assessment 2000* (Reston, VA, July 2000).

Table E4. World Oil Production by Region and Country, Reference Case, 1990-2030
(Million Barrels per Day)

Region/Country	History (Estimates)		Projections				
	1990	2003	2010	2015	2020	2025	2030
Conventional Production	**66.5**	**77.9**	**86.7**	**91.4**	**96.1**	**101.0**	**106.4**
OPEC	**24.4**	**30.0**	**36.1**	**38.1**	**38.6**	**40.5**	**43.0**
Asia	1.5	1.4	1.5	1.4	1.3	1.2	1.1
Middle East	16.1	21.2	25.2	26.6	27.3	29.0	31.2
North Africa	2.7	3.0	3.5	3.7	3.7	3.6	3.5
West Africa	1.8	2.0	2.4	2.6	2.6	2.8	3.1
South America	2.3	2.5	3.4	3.8	3.7	3.9	4.2
Non-OPEC	**42.1**	**47.8**	**50.6**	**53.3**	**57.4**	**60.5**	**63.4**
OECD	**20.1**	**22.2**	**22.0**	**21.6**	**21.7**	**21.2**	**20.7**
OECD North America	**14.7**	**14.8**	**15.0**	**15.2**	**15.4**	**15.4**	**15.4**
United States	9.7	8.6	9.4	9.6	9.5	9.1	8.9
Canada	2.0	2.3	1.7	1.4	1.5	1.5	1.4
Mexico	3.0	3.8	4.0	4.2	4.5	4.8	5.0
OECD Europe	**4.6**	**6.7**	**6.0**	**5.4**	**5.3**	**4.9**	**4.5**
OECD Asia	**0.8**	**0.8**	**1.0**	**0.9**	**0.9**	**0.9**	**0.9**
Japan	0.1	0.1	0.1	0.1	0.1	0.1	0.1
South Korea	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Australia and New Zealand	0.7	0.7	0.9	0.8	0.8	0.8	0.8
Non-OECD	**21.9**	**25.6**	**28.6**	**31.8**	**35.7**	**39.3**	**42.7**
Non-OECD Europe and Eurasia	**11.6**	**10.6**	**12.7**	**14.3**	**16.1**	**17.7**	**19.1**
Russia	11.3	8.5	9.5	9.9	10.7	11.1	11.3
Caspian Area	0.0	1.9	3.0	4.2	5.2	6.2	7.4
Other	0.3	0.2	0.3	0.3	0.3	0.4	0.4
Non-OECD Asia	**4.4**	**6.0**	**5.9**	**5.7**	**5.9**	**5.9**	**5.7**
China	2.8	3.3	3.4	3.2	3.3	3.3	3.2
India	0.7	0.8	1.1	1.2	1.3	1.4	1.4
Other	1.0	1.9	1.4	1.3	1.3	1.2	1.1
Middle East	**1.3**	**1.9**	**2.0**	**2.2**	**2.4**	**2.7**	**2.9**
Africa	**2.2**	**3.1**	**3.6**	**4.5**	**5.4**	**6.7**	**8.0**
Central and South America	**2.4**	**4.0**	**4.3**	**5.0**	**5.8**	**6.4**	**7.0**
Brazil	0.8	1.7	2.4	2.8	3.2	3.5	3.9
Other	1.6	2.4	2.0	2.3	2.6	2.9	3.2
Unconventional Production	**0.0**	**1.8**	**4.9**	**6.9**	**8.0**	**9.7**	**11.5**
United States	0.0	0.2	0.5	0.7	0.9	1.3	1.5
Other North America	0.0	0.8	1.8	2.3	2.7	3.2	3.6
OECD Europe	0.0	0.0	0.1	0.1	0.1	0.1	0.1
Asia	0.0	0.2	0.7	1.1	1.3	1.5	2.1
Middle East	0.0	0.0	0.5	0.6	0.7	0.9	1.1
Africa	0.0	0.1	0.2	0.4	0.5	0.7	0.9
Central and South America	0.0	0.5	1.1	1.7	1.8	2.1	2.3
Total Liquids Production	**66.5**	**79.6**	**91.6**	**98.3**	**104.1**	**110.7**	**118.0**
OPEC	24.5	30.7	37.3	39.7	40.4	42.5	45.3
Non-OPEC	42.1	48.9	54.4	58.6	63.7	68.2	72.6
Persian Gulf Production as a Percentage of World Consumption	**26.2%**	**29.6%**	**32.0%**	**32.2%**	**31.6%**	**32.2%**	**33.0%**

Notes: OPEC = Organization of Petroleum Exporting Countries. Conventional production includes crude oil (including lease condensates), natural gas liquids, other hydrogen hydrocarbons for refinery feedstocks, refinery gains, alcohol, and liquids produced from coal and other sources. Unconventional liquids include production from oil sands, ultra-heavy oils, gas-to-liquids technologies, coal-to-liquids technologies, biofuel technologies, and shale oil. Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), Energy Markets and Contingency Information Division. **Projections:** EIA, System for the Analysis of Global Energy Markets (2006); and U.S. Department of the Interior, U.S. Geological Survey, *World Petroleum Assessment 2000* (Reston, VA, July 2000).

Table E5. World Oil Production by Region and Country, High Oil Price Case, 1990-2030
(Million Barrels per Day)

Region/Country	History (Estimates)		Projections				
	1990	2003	2010	2015	2020	2025	2030
Conventional Production	**66.5**	**77.9**	**81.1**	**81.2**	**81.7**	**81.7**	**80.8**
OPEC	**24.4**	**30.0**	**31.3**	**26.2**	**26.2**	**26.1**	**26.7**
Asia	1.5	1.4	1.3	1.0	0.9	0.8	0.7
Middle East	16.1	21.2	21.8	18.3	18.5	18.7	19.4
North Africa	2.7	3.0	3.1	2.5	2.5	2.3	2.2
West Africa	1.8	2.0	2.1	1.8	1.8	1.8	1.9
South America	2.3	2.5	3.0	2.6	2.5	2.5	2.6
Non-OPEC	**42.1**	**47.8**	**49.9**	**54.9**	**55.5**	**55.5**	**54.1**
OECD	**20.1**	**22.2**	**21.7**	**21.8**	**21.0**	**19.9**	**18.4**
OECD North America	**14.7**	**14.8**	**14.9**	**15.4**	**15.2**	**14.8**	**14.0**
United States	9.7	8.6	9.3	9.6	9.5	9.3	8.8
Canada	2.0	2.3	1.6	1.4	1.3	1.2	1.1
Mexico	3.0	3.8	3.9	4.4	4.3	4.3	4.2
OECD Europe	**4.6**	**6.7**	**5.9**	**5.5**	**5.0**	**4.3**	**3.6**
OECD Asia	**0.8**	**0.8**	**1.0**	**0.9**	**0.9**	**0.8**	**0.7**
Japan	0.1	0.1	0.1	0.1	0.1	0.1	0.1
South Korea	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Australia and New Zealand	0.7	0.7	0.9	0.8	0.8	0.7	0.7
Non-OECD	**21.9**	**25.6**	**28.2**	**33.1**	**34.5**	**35.6**	**35.7**
Non-OECD Europe and Eurasia	**11.6**	**10.6**	**12.6**	**15.0**	**15.6**	**16.0**	**16.0**
Russia	11.3	8.5	9.4	10.3	10.3	10.0	9.4
Caspian Area	0.0	1.9	3.0	4.4	5.0	5.7	6.3
Other	0.3	0.2	0.2	0.3	0.3	0.3	0.3
Non-OECD Asia	**4.4**	**6.0**	**5.8**	**5.9**	**5.6**	**5.2**	**4.7**
China	2.8	3.3	3.3	3.3	3.2	2.9	2.6
India	0.7	0.8	1.1	1.2	1.3	1.4	1.4
Other	1.0	1.9	1.3	1.4	1.2	0.9	0.7
Middle East	**1.3**	**1.9**	**2.0**	**2.3**	**2.3**	**2.3**	**2.3**
Africa	**2.2**	**3.1**	**3.6**	**4.7**	**5.3**	**6.1**	**6.8**
Central and South America	**2.4**	**4.0**	**4.3**	**5.3**	**5.7**	**5.9**	**5.9**
Brazil	0.8	1.7	2.4	2.9	3.1	3.2	3.2
Other	1.6	2.4	1.9	2.4	2.5	2.6	2.7
Unconventional Production	**0.0**	**1.8**	**5.9**	**9.4**	**12.5**	**16.3**	**21.1**
United States	0.0	0.2	0.5	0.8	1.2	2.0	3.2
Other North America	0.0	0.8	1.9	2.7	3.5	4.1	4.9
OECD Europe	0.0	0.0	0.1	0.1	0.2	0.2	0.2
Asia	0.0	0.2	0.8	1.6	2.3	3.5	5.1
Middle East	0.0	0.0	0.7	1.0	1.1	1.3	1.5
Africa	0.0	0.1	0.3	0.7	1.1	1.6	2.1
Central and South America	0.0	0.5	1.6	2.5	3.1	3.6	4.2
Total Liquids Production	**66.5**	**79.6**	**87.0**	**90.6**	**94.2**	**98.0**	**101.9**
OPEC	24.5	30.7	32.9	28.7	29.3	29.8	30.9
Non-OPEC	42.1	48.9	54.1	61.9	64.9	68.2	71.0
Persian Gulf Production as a Percentage of World Consumption	**26.2%**	**29.6%**	**30.2%**	**26.6%**	**26.8%**	**27.3%**	**28.7%**

Notes: OPEC = Organization of Petroleum Exporting Countries. Conventional production includes crude oil (including lease condensates), natural gas liquids, other hydrogen hydrocarbons for refinery feedstocks, refinery gains, alcohol, and liquids produced from coal and other sources. Unconventional liquids include production from oil sands, ultra-heavy oils, gas-to-liquids technologies, coal-to-liquids technologies, biofuel technologies, and shale oil. Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), Energy Markets and Contingency Information Division. **Projections:** EIA, System for the Analysis of Global Energy Markets (2006); and U.S. Department of the Interior, U.S. Geological Survey, *World Petroleum Assessment 2000* (Reston, VA, July 2000).

Table E6. World Oil Production by Region and Country, Low Oil Price Case, 1990-2030
(Million Barrels per Day)

Region/Country	History (Estimates)		Projections				
	1990	2003	2010	2015	2020	2025	2030
Conventional Production	**66.5**	**77.9**	**88.8**	**95.9**	**104.3**	**112.8**	**120.6**
OPEC	**24.4**	**30.0**	**36.8**	**39.4**	**41.6**	**45.1**	**49.2**
Asia	1.5	1.4	1.5	1.5	1.4	1.3	1.3
Middle East	16.1	21.2	25.7	27.5	29.4	32.2	35.7
North Africa	2.7	3.0	3.6	3.8	4.0	4.0	4.0
West Africa	1.8	2.0	2.5	2.7	2.8	3.1	3.5
South America	2.3	2.5	3.5	3.9	4.0	4.4	4.7
Non-OPEC	**42.1**	**47.8**	**52.0**	**56.5**	**62.6**	**67.7**	**71.5**
OECD	**20.1**	**22.2**	**22.5**	**22.7**	**23.2**	**23.2**	**22.7**
OECD North America	**14.7**	**14.8**	**15.3**	**15.9**	**16.2**	**16.4**	**16.4**
United States	9.7	8.6	9.5	9.8	9.6	9.2	8.8
Canada	2.0	2.3	1.7	1.6	1.7	1.8	1.8
Mexico	3.0	3.8	4.1	4.5	5.0	5.4	5.8
OECD Europe	**4.6**	**6.7**	**6.2**	**5.8**	**6.0**	**5.7**	**5.3**
OECD Asia	**0.8**	**0.8**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**
Japan	0.1	0.1	0.1	0.1	0.1	0.1	0.1
South Korea	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Australia and New Zealand	0.7	0.7	0.9	0.9	0.9	1.0	0.9
Non-OECD	**21.9**	**25.6**	**29.5**	**33.8**	**39.4**	**44.5**	**48.8**
Non-OECD Europe and Eurasia	**11.6**	**10.6**	**13.1**	**15.2**	**17.8**	**20.0**	**21.8**
Russia	11.3	8.5	9.8	10.5	11.7	12.5	12.9
Caspian Area	0.0	1.9	3.1	4.4	5.7	7.0	8.4
Other	0.3	0.2	0.3	0.3	0.4	0.4	0.5
Non-OECD Asia	**4.4**	**6.0**	**6.1**	**6.1**	**6.6**	**6.8**	**6.7**
China	2.8	3.3	3.5	3.4	3.7	3.8	3.8
India	0.7	0.8	1.1	1.2	1.3	1.4	1.4
Other	1.0	1.9	1.5	1.5	1.6	1.6	1.5
Middle East	**1.3**	**1.9**	**2.1**	**2.4**	**2.7**	**3.1**	**3.3**
Africa	**2.2**	**3.1**	**3.7**	**4.7**	**5.9**	**7.4**	**9.0**
Central and South America	**2.4**	**4.0**	**4.5**	**5.3**	**6.4**	**7.3**	**7.9**
Brazil	0.8	1.7	2.5	2.9	3.5	4.0	4.4
Other	1.6	2.4	2.0	2.4	2.9	3.3	3.6
Unconventional Production	**0.0**	**1.8**	**3.7**	**5.5**	**6.1**	**6.7**	**7.1**
United States	0.0	0.2	0.5	0.6	0.6	0.6	0.6
Other North America	0.0	0.8	1.1	1.9	2.3	2.5	2.7
OECD Europe	0.0	0.0	0.1	0.1	0.1	0.1	0.1
Asia	0.0	0.2	0.6	0.8	0.8	0.9	0.9
Middle East	0.0	0.0	0.1	0.2	0.2	0.3	0.3
Africa	0.0	0.1	0.2	0.3	0.4	0.5	0.6
Central and South America	0.0	0.5	1.1	1.6	1.7	1.9	1.9
Total Liquids Production	**66.5**	**79.6**	**92.5**	**101.4**	**110.4**	**119.5**	**127.7**
OPEC	24.5	30.7	37.9	41.0	43.3	46.9	51.0
Non-OPEC	42.1	48.9	54.6	60.4	67.1	72.6	76.7
Persian Gulf Production as a Percentage of World Consumption	**26.2%**	**29.6%**	**31.3%**	**31.3%**	**30.9%**	**31.5%**	**32.6%**

Notes: OPEC = Organization of Petroleum Exporting Countries. Conventional production includes crude oil (including lease condensates), natural gas liquids, other hydrogen hydrocarbons for refinery feedstocks, refinery gains, alcohol, and liquids produced from coal and other sources. Unconventional liquids include production from oil sands, ultra-heavy oils, gas-to-liquids technologies, coal-to-liquids technologies, biofuel technologies, and shale oil. Totals may not equal sum of components due to independent rounding.

Sources: **History:** Energy Information Administration (EIA), Energy Markets and Contingency Information Division. **Projections:** EIA, System for the Analysis of Global Energy Markets (2006); and U.S. Department of the Interior, U.S. Geological Survey, *World Petroleum Assessment 2000* (Reston, VA, July 2000).

Appendix F

Reference Case Projections for Electricity Capacity and Generation by Fuel

Table F1. World Total Installed Generating Capacity by Region and Country, 2003-2030
(Gigawatts)

Region/Country	History	Projections					Average Annual Percent Change, 2003-2030
	2003	2010	2015	2020	2025	2030	
OECD							
OECD North America	**1,091**	**1,200**	**1,197**	**1,280**	**1,370**	**1,483**	**1.1**
United States[a]	922	988	965	1,027	1,098	1,186	0.9
Canada	119	127	138	148	157	167	1.3
Mexico	50	85	95	105	116	129	3.6
OECD Europe	**751**	**801**	**806**	**846**	**874**	**912**	**0.7**
OECD Asia	**379**	**425**	**439**	**446**	**458**	**472**	**0.8**
Japan	261	277	278	277	278	276	0.2
South Korea	60	84	92	98	105	116	2.5
Australia/New Zealand	58	64	69	71	75	80	1.2
Total OECD	**2,221**	**2,427**	**2,442**	**2,573**	**2,702**	**2,866**	**0.9**
Non-OECD							
Non-OECD Europe and Eurasia	**400**	**503**	**547**	**580**	**614**	**641**	**1.8**
Russia	216	272	298	316	337	351	1.8
Other	184	231	249	264	277	290	1.7
Non-OECD Asia	**657**	**1,062**	**1,252**	**1,450**	**1,653**	**1,897**	**4.0**
China	337	552	673	797	932	1,086	4.4
India	117	200	235	273	316	368	4.3
Other Non-OECD Asia	203	310	345	381	406	443	2.9
Middle East	**123**	**237**	**251**	**261**	**269**	**276**	**3.0**
Africa	**109**	**156**	**170**	**181**	**194**	**210**	**2.5**
Central and South America	**200**	**271**	**319**	**368**	**417**	**459**	**3.1**
Brazil	86	122	144	164	184	202	3.2
Other Central and South America	114	149	175	205	233	258	3.1
Total Non-OECD	**1,489**	**2,229**	**2,539**	**2,840**	**3,147**	**3,483**	**3.2**
Total World	**3,710**	**4,656**	**4,981**	**5,413**	**5,850**	**6,349**	**2.0**

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Derived from Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run AEO2006.D111905A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table F2. World Installed Oil-Fired Generating Capacity by Region and Country, 2003-2030
(Gigawatts)

Region/Country	History	Projections					Average Annual Percent Change, 2003-2030
	2003	2010	2015	2020	2025	2030	
OECD							
OECD North America	**87**	**83**	**68**	**69**	**74**	**82**	**-0.2**
United States[a]	68	54	38	39	44	53	-0.9
Canada	5	5	5	5	5	5	-0.2
Mexico	14	24	25	26	26	25	2.2
OECD Europe	**66**	**66**	**66**	**65**	**64**	**63**	**-0.1**
OECD Asia	**68**	**69**	**69**	**67**	**66**	**65**	**-0.2**
Japan	60	61	61	60	59	57	-0.2
South Korea	6	6	6	6	6	6	0.0
Australia/New Zealand	1	1	1	1	1	1	0.1
Total OECD	**220**	**218**	**204**	**202**	**204**	**210**	**-0.2**
Non-OECD							
Non-OECD Europe and Eurasia	**30**	**31**	**31**	**31**	**30**	**30**	**0.0**
Russia	8	8	8	8	8	8	-0.1
Other	22	23	23	22	22	22	0.0
Non-OECD Asia	**53**	**79**	**79**	**78**	**77**	**81**	**1.6**
China	13	35	35	35	35	34	3.7
India	5	7	8	8	8	8	1.9
Other Non-OECD Asia	35	36	36	36	35	38	0.4
Middle East	**28**	**46**	**48**	**49**	**50**	**52**	**2.3**
Africa	**16**	**17**	**18**	**18**	**21**	**22**	**1.2**
Central and South America	**26**	**27**	**30**	**34**	**37**	**38**	**1.4**
Brazil	4	4	4	4	5	5	0.9
Other Central and South America	23	23	26	29	33	34	1.5
Total Non-OECD	**152**	**200**	**206**	**210**	**216**	**223**	**1.4**
Total World	**372**	**418**	**410**	**412**	**420**	**433**	**0.6**

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Derived from Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run AEO2006.D111905A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table F3. World Installed Natural-Gas-Fired Generating Capacity by Region and Country, 2003-2030
(Gigawatts)

Region/Country	History	Projections					Average Annual Percent Change, 2003-2030
	2003	2010	2015	2020	2025	2030	
OECD							
OECD North America	**368**	**458**	**451**	**488**	**517**	**543**	**1.5**
United States[a]	332	392	377	406	423	433	1.0
Canada	17	26	25	28	31	36	2.9
Mexico	19	41	48	54	63	74	5.2
OECD Europe	**148**	**188**	**197**	**237**	**271**	**308**	**2.7**
OECD Asia	**101**	**112**	**114**	**112**	**109**	**109**	**0.3**
Japan	71	74	74	72	71	70	-0.1
South Korea	18	21	21	21	21	20	0.5
Australia/New Zealand	13	17	18	18	18	19	1.5
Total OECD	**617**	**758**	**761**	**836**	**898**	**959**	**1.6**
Non-OECD							
Non-OECD Europe and Eurasia	**136**	**218**	**248**	**274**	**296**	**323**	**3.3**
Russia	93	133	145	158	166	174	2.4
Other	43	85	103	116	130	149	4.7
Non-OECD Asia	**99**	**221**	**260**	**311**	**351**	**396**	**5.3**
China	9	24	34	57	68	68	7.7
India	13	41	45	53	70	96	7.8
Other Non-OECD Asia	77	155	181	202	213	232	4.2
Middle East	**84**	**167**	**177**	**184**	**189**	**193**	**3.1**
Africa	**30**	**60**	**66**	**76**	**84**	**96**	**4.4**
Central and South America	**41**	**67**	**78**	**89**	**102**	**109**	**3.7**
Brazil	6	18	19	20	21	21	4.6
Other Central and South America	35	49	60	69	81	88	3.5
Total Non-OECD	**390**	**732**	**830**	**934**	**1,022**	**1,118**	**4.0**
Total World	**1,007**	**1,490**	**1,591**	**1,769**	**1,920**	**2,077**	**2.7**

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Derived from Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run AEO2006.D111905A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table F4. World Installed Coal-Fired Generating Capacity by Region and Country, 2003-2030
(Gigawatts)

Region/Country	History	Projections					Average Annual Percent Change, 2003-2030
	2003	2010	2015	2020	2025	2030	
OECD							
OECD North America	**333**	**334**	**344**	**377**	**423**	**491**	**1.5**
United States[a]	310	319	319	345	390	457	1.4
Canada	18	11	19	23	24	25	1.3
Mexico	5	5	6	9	9	9	2.5
OECD Europe	**196**	**198**	**198**	**196**	**193**	**198**	**0.0**
OECD Asia	**85**	**102**	**107**	**110**	**117**	**126**	**1.5**
Japan	38	41	41	40	39	38	0.1
South Korea	17	32	35	37	42	49	4.0
Australia/New Zealand	30	30	32	34	36	39	1.0
Total OECD	**613**	**635**	**650**	**683**	**733**	**816**	**1.1**
Non-OECD							
Non-OECD Europe and Eurasia	**108**	**108**	**108**	**107**	**105**	**104**	**-0.1**
Russia	49	49	49	48	48	47	-0.1
Other	59	59	59	58	57	57	-0.1
Non-OECD Asia	**348**	**496**	**615**	**728**	**853**	**1,005**	**4.0**
China	239	348	438	531	643	785	4.5
India	67	95	119	140	153	161	3.3
Other Non-OECD Asia	42	52	57	57	57	59	1.2
Middle East	**5**	**6**	**6**	**6**	**6**	**6**	**0.5**
Africa	**39**	**49**	**54**	**54**	**54**	**53**	**1.1**
Central and South America	**5**	**8**	**10**	**12**	**13**	**14**	**3.4**
Brazil	1	3	4	5	6	6	5.4
Other Central and South America	4	5	5	7	7	8	2.5
Total Non-OECD	**505**	**667**	**792**	**907**	**1,031**	**1,181**	**3.2**
Total World	**1,119**	**1,302**	**1,442**	**1,590**	**1,763**	**1,997**	**2.2**

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Derived from Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run AEO2006.D111905A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table F5. World Installed Nuclear Generating Capacity by Region and Country, 2003-2030
(Gigawatts)

Region/Country	History	Projections					Average Annual Percent Change, 2003-2030
	2003	2010	2015	2020	2025	2030	
OECD							
OECD North America	**111**	**117**	**121**	**125**	**125**	**125**	**0.4**
United States[a]	99	101	104	109	109	109	0.3
Canada	11	14	15	15	14	14	1.2
Mexico	1	1	1	1	1	1	0.2
OECD Europe	**134**	**126**	**122**	**111**	**102**	**95**	**-1.3**
OECD Asia	**59**	**65**	**70**	**76**	**82**	**86**	**1.4**
Japan	44	47	49	51	55	56	0.9
South Korea	15	18	22	25	27	30	2.6
Australia/New Zealand	0	0	0	0	0	0	—
Total OECD	**304**	**308**	**313**	**313**	**308**	**306**	**0.0**
Non-OECD							
Non-OECD Europe and Eurasia	**39**	**41**	**46**	**55**	**61**	**60**	**1.6**
Russia	21	23	27	33	39	43	2.7
Other	18	18	18	22	22	17	-0.2
Non-OECD Asia	**14**	**26**	**36**	**47**	**57**	**65**	**5.9**
China	6	11	18	23	30	39	7.1
India	3	8	11	13	14	15	6.8
Other Non-OECD Asia	5	7	8	11	13	12	3.0
Middle East	**0**	**1**	**1**	**1**	**1**	**1**	**—**
Africa	**2**	**2**	**2**	**2**	**2**	**2**	**0.5**
Central and South America	**3**	**3**	**5**	**4**	**4**	**3**	**0.4**
Brazil	2	2	3	3	3	3	1.0
Other Central and South America	1	1	2	1	1	1	-1.1
Total Non-OECD	**57**	**72**	**90**	**110**	**125**	**132**	**3.1**
Total World	**361**	**380**	**403**	**422**	**433**	**438**	**0.7**

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Derived from Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run AEO2006.D111905A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table F6. World Installed Renewable Generating Capacity by Region and Country, 2003-2030
(Gigawatts)

Region/Country	History	Projections					Average Annual Percent Change, 2003-2030
	2003	2010	2015	2020	2025	2030	
OECD							
OECD North America	**193**	**208**	**213**	**221**	**232**	**242**	**0.8**
United States[a]	113	123	126	129	133	135	0.7
Canada	69	72	74	77	82	87	0.9
Mexico	11	13	14	15	17	19	2.1
OECD Europe	**208**	**222**	**222**	**238**	**244**	**248**	**0.7**
OECD Asia	**66**	**77**	**79**	**81**	**84**	**86**	**0.9**
Japan	48	54	54	54	54	54	0.4
South Korea	4	7	8	9	10	11	3.7
Australia/New Zealand	14	16	17	18	20	21	1.4
Total OECD	**467**	**507**	**514**	**539**	**559**	**575**	**0.8**
Non-OECD							
Non-OECD Europe and Eurasia	**88**	**104**	**114**	**114**	**121**	**123**	**1.3**
Russia	46	59	68	68	76	78	2.0
Other	42	46	46	46	46	46	0.3
Non-OECD Asia	**143**	**241**	**262**	**285**	**315**	**349**	**3.3**
China	70	134	148	152	156	160	3.1
India	30	48	52	59	71	87	4.0
Other Non-OECD Asia	43	59	62	74	88	102	3.2
Middle East	**7**	**17**	**19**	**21**	**23**	**24**	**4.8**
Africa	**22**	**29**	**30**	**30**	**33**	**37**	**1.9**
Central and South America	**124**	**166**	**196**	**229**	**261**	**295**	**3.3**
Brazil	73	96	113	131	149	168	3.1
Other Central and South America	51	70	82	98	111	127	3.4
Total Non-OECD	**384**	**558**	**622**	**680**	**754**	**829**	**2.9**
Total World	**851**	**1,065**	**1,136**	**1,219**	**1,313**	**1,404**	**1.9**

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Derived from Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run AEO2006.D111905A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table F7. World Total Net Electricity Generation From Central Producers by Region and Country, 2003-2030
(Billion Kilowatthours)

Region/Country	History	Projections					Average Annual Percent Change, 2003-2030
	2003	2010	2015	2020	2025	2030	
OECD							
OECD North America	**4,442**	**5,109**	**5,553**	**6,017**	**6,439**	**6,944**	**1.7**
United States[a]	3,720	4,196	4,501	4,827	5,121	5,497	1.5
Canada	531	627	691	745	786	829	1.7
Mexico	191	286	361	444	531	618	4.4
OECD Europe	**2,975**	**3,471**	**3,679**	**3,849**	**4,073**	**4,350**	**1.4**
OECD Asia	**1,465**	**1,799**	**1,941**	**2,044**	**2,141**	**2,257**	**1.6**
Japan	916	1,060	1,112	1,143	1,169	1,206	1.0
South Korea	308	456	524	574	622	674	2.9
Australia/New Zealand	241	283	305	327	350	377	1.7
Total OECD	**8,882**	**10,380**	**11,174**	**11,909**	**12,653**	**13,551**	**1.6**
Non-OECD							
Non-OECD Europe and Eurasia	**1,377**	**1,985**	**2,293**	**2,586**	**2,836**	**3,071**	**3.0**
Russia	812	1,178	1,345	1,516	1,655	1,781	3.0
Other	565	807	949	1,070	1,181	1,290	3.1
Non-OECD Asia	**3,014**	**5,027**	**6,307**	**7,649**	**9,049**	**10,599**	**4.8**
China	1,782	3,003	3,779	4,588	5,456	6,436	4.9
India	516	900	1,113	1,340	1,574	1,854	4.8
Other Non-OECD Asia	715	1,124	1,415	1,721	2,019	2,309	4.4
Middle East	**448**	**738**	**846**	**938**	**1,025**	**1,108**	**3.4**
Africa	**408**	**607**	**713**	**815**	**921**	**1,035**	**3.5**
Central and South America	**756**	**1,162**	**1,426**	**1,677**	**1,938**	**2,196**	**4.0**
Brazil	323	491	594	690	791	890	3.8
Other Central and South America	433	670	833	987	1,148	1,306	4.2
Total Non-OECD	**6,003**	**9,518**	**11,587**	**13,665**	**15,769**	**18,009**	**4.2**
Total World	**14,885**	**19,898**	**22,761**	**25,575**	**28,423**	**31,560**	**2.8**

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Derived from Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run AEO2006.D111905A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table F8. World Net Oil-Fired Electricity Generation From Central Producers by Region and Country, 2003-2030
(Billion Kilowatthours)

Region/Country	History	Projections					Average Annual Percent Change, 2003-2030
	2003	2010	2015	2020	2025	2030	
OECD							
OECD North America	**189**	**189**	**196**	**207**	**216**	**223**	**0.6**
United States[a]	115	93	91	92	95	101	-0.5
Canada	13	17	15	16	17	18	1.2
Mexico	60	79	90	99	104	103	2.0
OECD Europe	**92**	**82**	**88**	**95**	**103**	**111**	**0.7**
OECD Asia	**103**	**106**	**114**	**122**	**126**	**132**	**0.9**
Japan	81	83	90	93	96	100	0.8
South Korea	21	21	23	25	27	28	1.2
Australia/New Zealand	1	2	1	3	3	3	6.4
Total OECD	**384**	**377**	**398**	**424**	**445**	**466**	**0.7**
Non-OECD							
Non-OECD Europe and Eurasia	**48**	**48**	**51**	**53**	**56**	**59**	**0.8**
Russia	20	18	18	17	17	17	-0.5
Other	28	30	34	36	38	42	1.5
Non-OECD Asia	**122**	**308**	**290**	**299**	**296**	**282**	**3.1**
China	31	170	117	93	55	5	-6.4
India	11	18	21	23	25	28	3.5
Other Non-OECD Asia	80	120	152	183	216	249	4.3
Middle East	**157**	**193**	**217**	**235**	**251**	**265**	**2.0**
Africa	**39**	**57**	**67**	**77**	**87**	**98**	**3.5**
Central and South America	**73**	**90**	**111**	**127**	**144**	**159**	**2.9**
Brazil	7	11	13	14	16	16	3.0
Other Central and South America	66	80	98	112	128	143	2.9
Total Non-OECD	**438**	**697**	**736**	**791**	**833**	**863**	**2.5**
Total World	**823**	**1,074**	**1,134**	**1,215**	**1,277**	**1,329**	**1.8**

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Derived from Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run AEO2006.D111905A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table F9. World Net Natural-Gas-Fired Electricity Generation From Central Producers by Region and Country, 2003-2030
(Billion Kilowatthours)

Region/Country	History	Projections					Average Annual Percent Change, 2003-2030
	2003	2010	2015	2020	2025	2030	
OECD							
OECD North America	**658**	**877**	**1,149**	**1,267**	**1,302**	**1,295**	**2.5**
United States[a]	567	673	902	968	917	824	1.4
Canada	29	81	71	78	87	94	4.5
Mexico	62	123	175	221	298	377	6.9
OECD Europe	**441**	**784**	**1,011**	**1,189**	**1,453**	**1,697**	**5.1**
OECD Asia	**311**	**393**	**427**	**439**	**431**	**436**	**1.3**
Japan	255	325	347	355	359	374	1.4
South Korea	35	43	48	52	43	28	-0.8
Australia/New Zealand	20	25	31	33	30	34	1.9
Total OECD	**1,410**	**2,053**	**2,587**	**2,895**	**3,186**	**3,428**	**3.3**
Non-OECD							
Non-OECD Europe and Eurasia	**479**	**999**	**1,211**	**1,433**	**1,604**	**1,829**	**5.1**
Russia	322	609	689	817	874	957	4.1
Other	156	390	522	615	730	872	6.6
Non-OECD Asia	**282**	**685**	**935**	**1,212**	**1,505**	**1,839**	**7.2**
China	10	44	77	147	174	145	10.3
India	26	122	123	151	238	401	10.6
Other Non-OECD Asia	246	518	735	914	1,092	1,292	6.3
Middle East	**241**	**460**	**537**	**603**	**669**	**729**	**4.2**
Africa	**93**	**169**	**218**	**305**	**392**	**481**	**6.3**
Central and South America	**93**	**279**	**364**	**428**	**507**	**587**	**7.1**
Brazil	5	69	76	86	100	121	12.2
Other Central and South America	87	210	289	342	407	466	6.4
Total Non-OECD	**1,188**	**2,591**	**3,265**	**3,980**	**4,676**	**5,465**	**5.8**
Total World	**2,598**	**4,644**	**5,851**	**6,875**	**7,863**	**8,893**	**4.7**

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Derived from Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run AEO2006.D111905A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table F10. World Net Coal-Fired Electricity Generation From Central Producers by Region and Country, 2003-2030
(Billion Kilowatthours)

Region/Country	History	Projections					Average Annual Percent Change, 2003-2030
	2003	2010	2015	2020	2025	2030	
OECD							
OECD North America	**2,101**	**2,297**	**2,411**	**2,659**	**2,990**	**3,446**	**1.8**
United States[a]	1,953	2,195	2,239	2,435	2,757	3,205	1.9
Canada	115	69	130	158	167	175	1.6
Mexico	33	33	42	66	66	66	2.5
OECD Europe	**969**	**982**	**976**	**968**	**954**	**1,002**	**0.1**
OECD Asia	**533**	**685**	**719**	**739**	**780**	**830**	**1.7**
Japan	233	251	251	240	227	219	-0.2
South Korea	123	230	253	269	303	341	3.8
Australia/New Zealand	177	204	215	230	250	269	1.6
Total OECD	**3,603**	**3,964**	**4,106**	**4,366**	**4,724**	**5,278**	**1.4**
Non-OECD							
Non-OECD Europe and Eurasia	**307**	**282**	**294**	**293**	**290**	**287**	**-0.2**
Russia	162	166	178	177	177	176	0.3
Other	145	116	117	116	114	111	-1.0
Non-OECD Asia	**2,027**	**2,919**	**3,795**	**4,676**	**5,603**	**6,636**	**4.5**
China	1,414	2,109	2,788	3,489	4,287	5,243	5.0
India	389	572	748	902	1,005	1,069	3.8
Other Non-OECD Asia	224	238	259	284	311	324	1.4
Middle East	**28**	**25**	**24**	**23**	**23**	**26**	**-0.3**
Africa	**178**	**252**	**289**	**295**	**292**	**288**	**1.8**
Central and South America	**18**	**39**	**49**	**67**	**72**	**78**	**5.5**
Brazil	5	16	25	33	38	37	7.7
Other Central and South America	13	23	23	34	34	41	4.3
Total Non-OECD	**2,558**	**3,518**	**4,452**	**5,355**	**6,279**	**7,314**	**4.0**
Total World	**6,160**	**7,482**	**8,557**	**9,721**	**11,003**	**12,592**	**2.7**

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Derived from Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run AEO2006.D111905A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table F11. World Net Nuclear Electricity Generation From Central Producers by Region and Country, 2003-2030
(Billion Kilowatthours)

Region/Country	History	Projections					Average Annual Percent Change, 2003-2030
	2003	2010	2015	2020	2025	2030	
OECD							
OECD North America	**844**	**923**	**953**	**994**	**989**	**989**	**0.6**
United States[a]	764	809	829	871	871	871	0.5
Canada	71	104	113	113	108	108	1.6
Mexico	10	11	11	11	11	11	0.2
OECD Europe	**930**	**896**	**877**	**807**	**748**	**707**	**-1.0**
OECD Asia	**360**	**416**	**464**	**518**	**567**	**610**	**2.0**
Japan	237	274	289	318	350	371	1.7
South Korea	123	142	175	200	217	239	2.5
Australia/New Zealand	0	0	0	0	0	0	—
Total OECD	**2,135**	**2,234**	**2,293**	**2,320**	**2,304**	**2,306**	**0.3**
Non-OECD							
Non-OECD Europe and Eurasia	**258**	**278**	**323**	**393**	**441**	**443**	**2.0**
Russia	138	151	190	233	286	321	3.2
Other	120	127	133	160	155	122	0.1
Non-OECD Asia	**97**	**186**	**268**	**356**	**433**	**504**	**6.3**
China	42	79	130	171	230	303	7.6
India	16	56	76	99	106	112	7.4
Other Non-OECD Asia	39	52	62	85	98	89	3.1
Middle East	**0**	**5**	**6**	**6**	**6**	**6**	**—**
Africa	**13**	**14**	**15**	**15**	**15**	**15**	**0.7**
Central and South America	**20**	**21**	**35**	**32**	**33**	**24**	**0.6**
Brazil	13	13	22	23	23	19	1.2
Other Central and South America	7	7	12	10	10	5	-1.1
Total Non-OECD	**388**	**504**	**646**	**802**	**928**	**992**	**3.5**
Total World	**2,523**	**2,739**	**2,940**	**3,122**	**3,232**	**3,299**	**1.0**

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Derived from Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run AEO2006.D111905A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Table F12. World Net Renewable Electricity Generation From Central Producers by Region and Country, 2003-2030
(Billion Kilowatthours)

Region/Country	History	Projections					Average Annual Percent Change, 2003-2030
	2003	2010	2015	2020	2025	2030	
OECD							
OECD North America	**649**	**823**	**845**	**888**	**942**	**991**	**1.6**
United States[a]	321	427	439	460	481	495	1.6
Canada	303	356	363	379	408	434	1.3
Mexico	25	40	42	48	54	62	3.5
OECD Europe	**543**	**728**	**728**	**791**	**816**	**833**	**1.6**
OECD Asia	**158**	**201**	**218**	**226**	**237**	**249**	**1.7**
Japan	110	127	135	137	138	142	1.0
South Korea	5	21	25	29	33	37	7.6
Australia/New Zealand	43	53	58	60	67	71	1.8
Total OECD	**1,350**	**1,751**	**1,790**	**1,904**	**1,995**	**2,073**	**1.6**
Non-OECD							
Non-OECD Europe and Eurasia	**286**	**377**	**415**	**415**	**445**	**453**	**1.7**
Russia	170	234	271	271	301	309	2.2
Other	116	144	144	144	144	144	0.8
Non-OECD Asia	**485**	**928**	**1,019**	**1,106**	**1,212**	**1,338**	**3.8**
China	285	601	667	688	710	740	3.6
India	74	132	144	165	200	244	4.5
Other Non-OECD Asia	126	195	208	253	302	355	3.9
Middle East	**23**	**55**	**63**	**71**	**77**	**83**	**4.9**
Africa	**85**	**115**	**124**	**123**	**136**	**153**	**2.2**
Central and South America	**552**	**732**	**867**	**1,023**	**1,183**	**1,347**	**3.4**
Brazil	292	382	457	534	614	697	3.3
Other Central and South America	260	350	410	489	569	650	3.5
Total Non-OECD	**1,430**	**2,208**	**2,488**	**2,738**	**3,053**	**3,374**	**3.2**
Total World	**2,781**	**3,959**	**4,277**	**4,642**	**5,048**	**5,447**	**2.5**

[a]Includes the 50 States and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: **History:** Derived from Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), AEO2006 National Energy Modeling System, run AEO2006.D111905A, web site www.eia.doe.gov/oiaf/aeo/; and System for the Analysis of Global Energy Markets (2006).

Appendix G

Key Assumptions for the *IEO2006* Kyoto Protocol Case

Energy-Related Emissions of Greenhouse Gases

The System for the Analysis of Global energy Markets (SAGE)—the model used by EIA to prepare the *IEO2006* mid-term projections—does not include non-energy-related emissions of greenhouse gases, which are estimated at about 15 to 20 percent of total greenhouse gas emissions, based on inventories submitted to the United Nations Framework Convention on Climate Change (UNFCCC). SAGE models global energy supply and demand and, therefore, does not address agricultural and other non-energy-related emissions.

EIA implicitly assumes that percentage reductions of non-energy-related emissions and their associated abatement costs will be similar to those for energy-related emissions. Non-energy-related greenhouse gas emissions are likely to grow faster than energy-related emissions; however, the marginal abatement costs for non-energy-related greenhouse gas emissions are not known and cannot be estimated reliably. In SAGE, each region's emissions reduction goal under the Kyoto Protocol is based only on the corresponding estimate of that region's energy-related carbon dioxide emissions, as determined by EIA data. It is assumed that the required reductions will also be proportionately less than if all gases were included.

Carbon Dioxide Emissions

For *IEO2006*, EIA modeled only energy-related carbon dioxide emissions. Energy-related emissions of other greenhouse gases, such as methane, nitrous oxide, and sulfur hexafluoride, are not included in the analysis. The current SAGE framework uses historical data on fuel consumption and emissions from EIA's *International Energy Annual 2003* to calibrate the base year for the model's Reference Energy System (RES).[19] The *International Energy Annual* does not provide historical data for methane and nitrous oxide emissions, and currently there are no plans to do so in the future.

EIA assumes that emissions reduction proportions and abatement costs for energy-related methane and nitrous oxide will be sufficiently similar to those for carbon dioxide that—given their lesser share of total emissions (approximately 15 percent from energy and non-energy sources combined)—the per-unit carbon price derived by modeling carbon dioxide alone is representative of the abatement costs for all energy-related greenhouse gas emissions. The UNFCCC estimates that total Annex I emissions of greenhouse gases (in carbon dioxide equivalents) in 2003 had the following composition: carbon dioxide, 81.1 percent; methane, 9.1 percent; nitrous oxide, 6.5 percent; and other gases, 1.6 percent.[20]

[19]EIA data differ slightly from the data submitted to the UNFCCC for energy-related carbon dioxide emissions. It is assumed that the differences will not have a significant effect on estimates of abatement costs.

[20]United Nations Framework Convention on Climate Change (UNFCCC), Greenhouse Gas Inventory Database, Queried for 2003 "National Totals" and "Total Fuel Combustion (Sectoral Approach)" for all greenhouse gases for all Annex I countries except Russia, Poland, and Liechtenstein, web site http://ghg.unfccc.int/index.html.

Appendix H

Comparisons With Other Forecasts, and Performance of Past *IEO* Forecasts for 1990, 1995, and 2000

Forecast Comparisons

Energy Consumption by Region

Three organizations provide forecasts comparable with the projections in *IEO2006*, which extend to 2030 for the first time. The International Energy Agency (IEA) provides "business as usual" projections to 2030 in its *World Energy Outlook 2004*; Petroleum Economics, Ltd. (PEL) publishes world energy projections to 2025; and Petroleum Industry Research Associates (PIRA) provides projections to 2020. For comparison, 2002 is used as the base year for all the projections. Comparisons between *IEO2006* and *IEO2005* extend only to 2025, the last year of the *IEO2005* projections.

Regional breakouts vary among the different projections, complicating the comparisons. For example, *IEO2006*, PIRA, and IEA include Mexico in OECD North America, but PEL includes Mexico in Latin America. Because PEL does not provide separate projections for Mexico, its numbers for North America are somewhat inconsistent with the other projections. PIRA includes only Japan in OECD Asia, whereas OECD Asia in the *IEO2006* and IEA projections comprises Japan, South Korea, Australia, and New Zealand. *IEO2006* and IEA provide forecasts for OECD Europe, which includes Turkey, the Czech Republic, Hungary, Poland, and Slovakia. PEL places Turkey in Western Europe but includes all Eastern and Western European countries in "Europe," including those that are not OECD members. *IEO2005* reported Eastern Europe and Western Europe separately and, in addition, placed Turkey in the Middle East. PIRA reports the Eastern European countries in its former Soviet Union region. The differences in the regional aggregations contribute to the variations among the forecasts.

All the forecasts provide projections out to 2010 (Table H1). The 2002-2010 projections vary widely, reflecting in part the volatility of world energy markets over the past several years. Growth rates for energy consumption among the reference case forecasts range from 2.2

Table H1. Comparison of Energy Consumption Growth Rates by Region, 2002-2010
(Average Annual Percent Growth)

Region	*IEO2006* Low Growth	*IEO2006* Reference	*IEO2006* High Growth	*IEO2005*	IEA	PIRA	PEL
OECD	**1.0**	**1.2**	**1.5**	**1.3**	**1.4**	**1.2**	**1.2**
North America	1.1	1.4	1.7	1.7	1.5	1.3	1.4
Europe	0.8	1.0	1.2	0.5	1.1	1.3	1.3
Asia	1.0	1.2	1.4	1.3	1.6	0.4	0.5
Non-OECD	**4.0**	**4.5**	**5.0**	**3.9**	**2.8**	**3.9**	**3.8**
Europe and Eurasia	1.9	2.4	2.8	2.0	1.8	2.5	1.6
China	7.3	7.8	8.4	6.8	3.4	7.0	6.2
Other Non-OECD Asia	3.5	3.9	4.5	3.9	3.2	3.0	3.7
Middle East	3.0	3.4	3.9	3.4	3.2	4.8	4.5
Africa	3.7	4.2	4.6	3.4	2.7	3.3	3.0
Central and South America	3.0	3.6	4.0	3.0	2.7	2.5	2.4
Total World	**2.4**	**2.7**	**3.1**	**2.6**	**2.2**	**2.7**	**2.4**

Notes: For *IEO2005*, the Czech Republic, Hungary, Poland, and Slovakia are included in non-OECD Europe and Eurasia; for *IEO2006* they are included in OECD Europe. For PIRA, all Eastern European and former Soviet Union countries are included in non-OECD Europe and Eurasia, OECD Asia includes only Japan, and Australia/New Zealand and South Korea are included in other non-OECD Asia. For PEL, OECD Europe includes both Western Europe and Eastern Europe, and non-OECD Europe and Eurasia includes only the former Soviet Union.

Sources: ***IEO2006*:** Energy Information Administration (EIA), System for the Analysis of Global Energy Markets (2006). ***IEO2005*:** EIA, *International Energy Outlook 2005*, DOE/EIA-0484(2005) (Washington, DC, July 2005), Table A1, p. 89. **IEA:** International Energy Agency, *World Energy Outlook 2004* (Paris, France, October 2004), pp. 430-517. **PIRA:** PIRA Energy Group, *Retainer Client Seminar* (New York, NY, October 2005), Table II-4. **PEL:** Petroleum Economics, Ltd., *World Long Term Oil and Energy Outlook* (London, United Kingdom, May 2005), Tables 3i and 3ii.

percent per year (IEA) to 2.7 percent per year (*IEO2006* and PIRA). All agree that OECD energy demand will expand more slowly than non-OECD demand, and that the fastest growth in world energy use will occur in non-OECD Asia; however, within the OECD, the *IEO2006* reference case, as well as the IEA business as usual case, show slower energy demand growth for Europe than do PEL and PIRA. Both PEL and PIRA show growth in the region that exceeds the *IEO2006* high economic growth case projection for the 2002-2010 period.

IEA anticipates much higher growth for OECD Asia than do any of the other forecasts, and the IEA growth rate exceeds that in the *IEO2006* high economic growth case. It should be noted that the IEA forecast is the oldest of the five being compared, which could explain its deviation from the other forecasts in the short term. A 2005 edition of the IEA's *World Energy Outlook* has been released, but it does not contain a complete worldwide forecast of energy demand by region and, as a result, could not be used for this comparison.

PIRA and PEL report much lower growth rates for OECD Asia than does *IEO2006*. Their growth rates fall below those in the *IEO2006* low economic growth case. For PIRA, this may be because the figures do not include projections for South Korea (in addition to Japan, Australia, and New Zealand). For PEL, expectations that Japan's energy use will decline over the 2002-2010 period counter fairly strong growth projected for South Korea and Australia/New Zealand.

IEO2006 anticipates overall growth among the non-OECD nations that is somewhat higher than other forecasts over the 2002-2010 period. Non-OECD growth rates range from 2.8 percent per year (IEA) to 4.5 percent per year (*IEO2006*). The growth rates for total non-OECD energy demand in the other forecasts fall below the *IEO2006* low economic growth case. For China, Africa, and Central and South America, all the other forecasts fall below the *IEO2006* low economic growth case. The only region in which *IEO2006* shows slower growth than the other projections is the Middle East, where the PEL and PIRA growth rates for 2002-2010 exceed those in the *IEO2006* high economic growth case.

The *IEO2006* and *IEO2005* reference case projections for the OECD in the 2002-2010 period are similar. An exception is OECD Europe, for which *IEO2005* did not include the Czech Republic, Hungary, Poland, Slovakia, or Turkey—all economies with potentially more rapid growth than the more mature economies of Western Europe, including Germany, France, Italy, and the United Kingdom. Among the non-OECD regions, the *IEO2005* growth rates for China and Africa are much lower than this year's projections, falling below the *IEO2006* low economic growth case.

IEO2006, PIRA, and PEL provide forecasts for energy use in 2015 (Table H2). Their reference case projections

Table H2. Comparison of Energy Consumption Growth Rates by Region, 2002-2015
(Average Annual Percent Growth)

Region	*IEO2006*			*IEO2005*	PIRA	PEL
	Low Growth	Reference	High Growth			
OECD	**0.9**	**1.2**	**1.4**	**1.2**	**1.1**	**1.1**
North America	1.1	1.4	1.6	1.5	1.2	1.3
Europe	0.7	0.9	1.1	0.5	1.1	1.1
Asia	1.0	1.2	1.5	1.3	0.4	0.6
Non-OECD	**3.3**	**3.9**	**4.5**	**3.4**	**3.6**	**3.5**
Europe and Eurasia	1.8	2.3	2.8	1.9	2.3	1.4
China	5.6	6.2	6.8	5.4	6.1	5.2
Other Non-OECD Asia	3.0	3.6	4.2	3.5	2.8	3.6
Middle East	2.5	3.1	3.6	3.0	4.7	4.3
Africa	3.2	3.7	4.3	3.2	2.9	2.9
Central and South America	2.6	3.3	3.8	2.8	2.3	2.4
Total World	**2.0**	**2.5**	**2.9**	**2.3**	**2.5**	**2.2**

Notes: For *IEO2005*, the Czech Republic, Hungary, Poland, and Slovakia are included in non-OECD Europe and Eurasia; for *IEO2006* they are included in OECD Europe. For PIRA, all Eastern European and former Soviet Union countries are included in non-OECD Europe and Eurasia, OECD Asia includes only Japan, and Australia/New Zealand and South Korea are included in other non-OECD Asia. For PEL, OECD Europe includes both Western Europe and Eastern Europe, and non-OECD Europe and Eurasia includes only the former Soviet Union.

Sources: ***IEO2006*:** Energy Information Administration (EIA), System for the Analysis of Global Energy Markets (2006). ***IEO2005*:** EIA, *International Energy Outlook 2005*, DOE/EIA-0484(2005) (Washington, DC, July 2005), Table A1, p. 89. **PIRA:** PIRA Energy Group, *Retainer Client Seminar* (New York, NY, October 2005), Table II-4. **PEL:** Petroleum Economics, Ltd., *World Long Term Oil and Energy Outlook* (London, United Kingdom, May 2005), Tables 3i and 3ii.

for worldwide growth in energy consumption from 2002 to 2015 vary from 2.2 percent per year (PEL) to 2.5 percent per year (*IEO2006* and PIRA). As was true for the 2002-2010 period, PEL and PIRA show much faster growth in energy use for the Middle East from 2002 to 2015 than does *IEO2006*, exceeding the *IEO2006* high economic growth case. Moreover, both the PEL and PIRA forecasts for demand growth in Africa and in Central and South America fall well below those in the *IEO2006* reference case. PEL also projects much slower growth than does *IEO2006* for China and for non-OECD Europe and Eurasia in the 2002-2015 period, below the *IEO2006* low economic growth case projections. PIRA's projections for the two regions closely resemble those in the *IEO2006* reference case All the forecasts have similar expectations for overall growth among the OECD nations, but as was true for the 2002-2010 comparisons, the PEL and PIRA growth rates for OECD Asia are much lower than in the *IEO2006* reference case.

The *IEO2006* reference case projection for worldwide growth in energy use from 2002 to 2015, at 2.5 percent per year, is higher than projected in *IEO2005*. By region, the largest differences between the two forecasts are for OECD Europe and for China, both of which are below those in the *IEO2006* low economic growth case. In the case of China, the unanticipated strong expansion in income and resulting energy demand in 2003 and 2004—especially for oil but also for other fuels—was not fully anticipated in last year's forecast. For both OECD Europe and non-OECD Europe and Eurasia, economic growth is slightly higher in *IEO2006*.

All the forecasts provide energy consumption projections for 2020 (Table H3), PIRA's final forecast year. The four forecasts have similar projections for energy demand growth from 2002 to 2020, with average annual increases in the world's total energy consumption that range from 1.9 percent (IEA) to 2.3 percent (*IEO2006*) and with non-OECD growth higher than the OECD growth rate. The largest variation among the regional projections is for China, ranging from 2.9 percent per year (IEA) to 4.6 percent per year (*IEO2006*). For 2002-2020, as for 2002-2015, the PEL and PIRA projections for OECD Asia falling below the *IEO2006* low economic growth case.

The largest differences between the *IEO2006* and *IEO2005* reference case growth rates for energy demand from 2002 to 2020 are for China and OECD Europe. *IEO2005* projected annual energy demand growth for China that is 0.7 percentage points lower than in *IEO2006*; and the *IEO2005* reference case projection for OECD Europe is lower than in the *IEO2006* low economic growth case, largely due to lower expectations for economic growth and differences in regional definitions.

Table H3. Comparison of Energy Consumption Growth Rates by Region, 2002-2020
(Average Annual Percent Growth)

Region	*IEO2006*			*IEO2005*	IEA	PIRA	PEL
	Low Growth	Reference	High Growth				
OECD	**0.8**	**1.1**	**1.4**	**1.1**	**1.1**	**1.1**	**1.0**
North America	1.0	1.3	1.6	1.5	1.2	1.2	1.2
Europe	0.6	0.7	0.9	0.5	0.9	1.2	0.9
Asia	0.8	1.1	1.4	1.1	1.3	0.4	0.6
Non-OECD	**2.9**	**3.5**	**4.1**	**3.1**	**2.6**	**3.3**	**3.3**
Europe and Eurasia	1.6	2.1	2.8	1.7	1.5	2.1	1.3
China	4.6	5.3	6.0	4.6	2.9	5.5	4.6
Other Non-OECD Asia	2.7	3.4	4.0	3.3	2.9	2.6	3.5
Middle East	2.2	2.8	3.4	2.7	3.0	4.4	4.1
Africa	2.6	3.2	3.8	2.9	2.6	2.6	2.8
Central and South America	2.3	3.0	3.7	2.5	2.7	2.1	2.4
Total World	**1.8**	**2.3**	**2.7**	**2.1**	**1.9**	**2.4**	**2.1**

Notes: For *IEO2005*, the Czech Republic, Hungary, Poland, and Slovakia are included in non-OECD Europe and Eurasia; for *IEO2006* they are included in OECD Europe. For PIRA, all Eastern European and former Soviet Union countries are included in non-OECD Europe and Eurasia, OECD Asia includes only Japan, and Australia/New Zealand and South Korea are included in other non-OECD Asia. For PEL, OECD Europe includes both Western Europe and Eastern Europe, and non-OECD Europe and Eurasia includes only the former Soviet Union.

Sources: ***IEO2006*:** Energy Information Administration (EIA), System for the Analysis of Global Energy Markets (2006). ***IEO2005*:** EIA, *International Energy Outlook 2005*, DOE/EIA-0484(2005) (Washington, DC, July 2005), Table A1, p. 89. **IEA:** International Energy Agency, *World Energy Outlook 2004* (Paris, France, October 2004), pp. 430-517. **PIRA:** PIRA Energy Group, *Retainer Client Seminar* (New York, NY, October 2005), Table II-4. **PEL:** Petroleum Economics, Ltd., *World Long Term Oil and Energy Outlook* (London, United Kingdom, May 2005), Tables 3i and 3ii.

Only the *IEO2006* and PEL projections cover 2025 (IEA extends to 2030 but does not include projections for 2025). The two forecasts are largely in agreement on a worldwide basis (Table H4), with PEL projecting 2.0-percent average annual growth in world energy demand and *IEO2006* 2.1 percent. There are some regional differences between the two, particularly for OECD Asia, non-OECD Europe and Eurasia, and the Middle East. For the Middle East, the PEL projections exceed the *IEO2006* high economic growth case, as they do for the other time periods compared here. Although the *IEO2006* and PEL projections for economic growth in the Middle East region are similar (4.3 percent and 4.0 percent per year, respectively), *IEO2006* projects stronger gains in energy intensity over the 2002-2025 period, whereas PEL expects GDP and energy demand to continue increasing at about the same pace.

IEO2006 and IEA are the only projections that run through 2030 (Table H5). Generally they agree, with

Table H4. Comparison of Energy Consumption Growth Rates by Region, 2002-2025
(Average Annual Percent Growth)

Region	*IEO2006*			*IEO2005*	PEL
	Low Growth	Reference	High Growth		
OECD	**0.8**	**1.0**	**1.3**	**1.1**	**0.9**
North America	0.9	1.3	1.6	1.4	1.1
Europe	0.5	0.7	0.9	0.5	0.8
Asia	0.7	1.0	1.3	1.1	0.6
Non-OECD	**2.6**	**3.2**	**3.9**	**2.8**	**3.1**
Europe and Eurasia	1.4	2.0	2.6	1.6	1.2
China	4.0	4.7	5.4	4.1	4.1
Other Non-OECD Asia	2.6	3.2	4.0	3.1	3.4
Middle East	2.0	2.6	3.2	2.5	4.0
Africa	2.3	2.8	3.5	2.7	2.8
Central and South America	2.2	2.9	3.5	2.3	2.4
Total World	**1.6**	**2.1**	**2.6**	**2.0**	**2.0**

Notes: For *IEO2005*, the Czech Republic, Hungary, Poland, and Slovakia are included in non-OECD Europe and Eurasia; for *IEO2006* they are included in OECD Europe. For PEL, OECD Europe includes both Western Europe and Eastern Europe, and non-OECD Europe and Eurasia includes only the former Soviet Union.

Sources: ***IEO2006*:** Energy Information Administration (EIA), System for the Analysis of Global Energy Markets (2006). ***IEO2005*:** EIA, *International Energy Outlook 2005*, DOE/EIA-0484(2005) (Washington, DC, July 2005), Table A1, p. 89. **PEL:** Petroleum Economics, Ltd., *World Long Term Oil and Energy Outlook* (London, United Kingdom, May 2005), Tables 3i and 3ii.

Table H5. Comparison of Energy Consumption Growth Rates by Region, 2002-2030
(Average Annual Percent Growth)

Region	*IEO2006*			IEA
	Low Growth	Reference	High Growth	
OECD	**0.7**	**1.0**	**1.3**	**0.9**
North America	0.9	1.2	1.6	1.1
Europe	0.5	0.7	0.9	0.7
Asia	0.7	1.0	1.3	1.0
Non-OECD	**2.4**	**3.0**	**3.8**	**2.4**
Europe and Eurasia	1.3	1.9	2.5	1.3
China	3.6	4.4	5.1	2.6
Other Non-OECD Asia	2.4	3.1	3.9	2.7
Middle East	1.9	2.5	3.1	2.5
Africa	2.1	2.7	3.4	2.6
Central and South America	2.0	2.8	3.4	2.6
Total World	**1.5**	**2.0**	**2.6**	**1.8**

Sources: ***IEO2006*:** Energy Information Administration (EIA), System for the Analysis of Global Energy Markets (2006). ***IEO2005*:** EIA, *International Energy Outlook 2005*, DOE/EIA-0484(2005) (Washington, DC, July 2005), Table A1, p. 89. **IEA:** International Energy Agency, *World Energy Outlook 2004* (Paris, France, October 2004), pp. 430-517.

worldwide energy demand growing by 2.0 percent per year from 2002 to 2030 in the *IEO2006* reference case and by 1.8 percent per year in the IEA business as usual case. The largest difference between the two is for China: the IEA projection for China is nearly 2 percentage points lower than the *IEO2006* reference case and is a full percentage point lower than the *IEO2006* low economic growth case.

Energy Consumption by Fuel

The forecasts vary not only with respect to levels of total energy demand but also with respect to the mix of primary energy inputs. All the forecasts provide energy consumption projections by fuel in 2010 (Table H6), with a wide range of views regarding the mix of fuels that will be used to meet projected demand. Whereas *IEO2006* and PIRA expect coal to be the fastest growing fuel source in the 2002-2010 period—at 3.6 percent per year and 3.4 percent per year, respectively—IEA and PEL expect much lower growth for coal.

IEA and PEL project relatively strong growth in nuclear power demand over the time period, whereas the *IEO2006* and PIRA projections are relatively modest. *IEO2006*, IEA, and PIRA project average growth in worldwide renewable energy use at more than 3.0 percent per year from 2002 to 2010; in contrast, PEL projects an average of 1.9 percent per year. All the projections for growth in world oil demand are between 2.0 percent per year (*IEO2006* and IEA) and 2.2 percent per year (PEL), and all expect relatively strong growth in natural gas use.

In comparison with *IEO2005*, the *IEO2006* projections are lower for oil and nuclear power and higher for every other energy source. The *IEO2006* projection for world oil prices in the 2002-2010 period are higher, leading to slower growth in oil demand and fuel substitution where possible. For nuclear power, *IEO2006* projects slightly slower growth in generating capacity through 2010 and lower capacity utilization rates for some than were projected in *IEO2005*.

PEL, PIRA, and *IEO2006* provide world energy consumption projections by fuel for 2015 (Table H7). Again, the forecasts agree on the outlook for oil demand, with

Table H6. Comparison of World Energy Consumption Growth Rates by Fuel, 2002-2010
(Average Annual Percent Growth)

Fuel	*IEO2006* Low Growth	*IEO2006* Reference	*IEO2006* High Growth	*IEO2005*	IEA	PIRA	PEL
Oil	1.6	2.0	2.3	2.4	2.0	2.1	2.2
Natural Gas	2.6	3.0	3.5	2.4	2.7	2.9	3.1
Coal	3.3	3.6	4.0	3.1	1.8	3.4	1.9
Nuclear	1.0	1.0	1.0	1.5	1.5	0.7	2.6
Renewable/Other	4.1	4.3	4.4	2.7	3.2	3.6	1.9
Total	**2.4**	**2.7**	**3.1**	**2.6**	**2.2**	**2.7**	**2.4**

Note: For IEA, Renewable/Other excludes traditional biomass.

Sources: ***IEO2006*:** Energy Information Administration (EIA), System for the Analysis of Global Energy Markets (2006). ***IEO2005*:** EIA, *International Energy Outlook 2005*, DOE/EIA-0484(2005) (Washington, DC, July 2005), Table A2, p. 91. **IEA:** International Energy Agency, *World Energy Outlook 2004* (Paris, France, October 2004), pp. 430-517. **PIRA:** PIRA Energy Group, *Retainer Client Seminar* (New York, NY, October 2005). **PEL:** Petroleum Economics, Ltd., *World Long Term Oil and Energy Outlook* (London, United Kingdom, May 2005).

Table H7. Comparison of World Energy Consumption Growth Rates by Fuel, 2002-2015
(Average Annual Percent Growth)

Fuel	*IEO2006* Low Growth	*IEO2006* Reference	*IEO2006* High Growth	*IEO2005*	PIRA	PEL
Oil	1.3	1.8	2.2	2.2	1.9	1.9
Natural Gas	2.4	2.9	3.5	2.6	2.8	3.2
Coal	2.7	3.1	3.6	2.6	3.1	1.7
Nuclear	1.1	1.2	1.2	1.3	0.7	2.3
Renewable/Other	2.9	3.3	3.5	2.2	3.3	2.1
Total	**2.0**	**2.5**	**2.9**	**2.3**	**2.5**	**2.2**

Sources: ***IEO2006*:** Energy Information Administration (EIA), System for the Analysis of Global Energy Markets (2006). ***IEO2005*:** EIA, *International Energy Outlook 2005*, DOE/EIA-0484(2005) (Washington, DC, July 2005), Table A2, p. 91. **PIRA:** PIRA Energy Group, *Retainer Client Seminar* (New York, NY, October 2005). **PEL:** Petroleum Economics, Ltd., *World Long Term Oil and Energy Outlook* (London, United Kingdom, May 2005).

growth rates ranging from 1.8 percent per year (*IEO2006*) to 1.9 percent per year (PEL and PIRA) from 2002 to 2015. There is a wider range of expectations for the other energy sources. The largest variation is for nuclear power generation, ranging from 0.7 percent per year (PIRA) to 2.3 percent per year (PEL), with *IEO2006* at 1.2 percent per year. PEL's bullish forecast for nuclear power offsets its fairly pessimistic forecasts for coal (1.7 percent per year) and renewables (2.1 percent per year). Both *IEO2006* and PIRA project average demand growth of 3.1 percent per year for coal and 3.3 percent per year for renewables.

All the forecasts provide energy consumption projections for 2020 (Table H8). They are largely in agreement on the growth rate for world oil use, at 1.6 percent (*IEO2006*), 1.7 percent (PEL), and 1.8 percent per year (IEA and PIRA) from 2002 to 2020. Expectations for the other energy sources differ. Again, the largest differences are in the projections for nuclear power. The projections for growth in nuclear power generation vary from 0.6 percent per year (IEA) to 2.2 percent per year (PEL), with *IEO2006* projecting 1.2 percent per year. Among the growth projections for total world energy consumption from 2002 to 2020, IEA and PEL are lower than *IEO2006* and PIRA, and IEA is the lowest.

The *IEO2006* reference case projections for growth in oil consumption from 2002 to 2020 are lower than those in *IEO2005* as a result of the higher oil prices in *IEO2006*. For all other energy sources, the *IEO2006* projections are higher, with other fuels replacing oil where possible. In particular, coal demand is expected to grow by 2.8 percent per year from 2002 to 2020 in *IEO2006*, compared with 2.3 percent per year in *IEO2005*. Growth in renewable energy use is also significantly higher in *IEO2006*, at 2.8 percent per year, as compared with 1.9 percent per year in *IEO2005*. For natural gas, higher prices that result from increased demand as natural gas replaces oil use, mostly for industrial purposes, make renewable energy sources more competitive, especially for electric power generation.

As noted above, the only two forecasts for the 2002-2025 period, *IEO2006* and PEL, are largely in agreement with respect to the increase in total energy demand (Table H9). PEL projects average annual growth of 2.0 percent for total world demand and *IEO2006* 2.1 percent per

Table H8. Comparison of World Energy Consumption Growth Rates by Fuel, 2002-2020
(Average Annual Percent Growth)

Fuel	*IEO2006*			*IEO2005*	IEA	PIRA	PEL
	Low Growth	Reference	High Growth				
Oil	1.1	1.6	2.1	2.0	1.8	1.8	1.7
Natural Gas	2.3	2.7	3.2	2.4	2.6	2.7	3.1
Coal	2.3	2.8	3.4	2.3	1.6	2.7	1.5
Nuclear	1.1	1.2	1.2	1.1	0.6	1.6	2.2
Renewable/Other	2.3	2.8	3.2	1.9	2.7	3.2	2.1
Total	**1.8**	**2.3**	**2.7**	**2.1**	**1.9**	**2.4**	**2.1**

Note: For IEA, Renewable/Other excludes traditional biomass.

Sources: ***IEO2006*:** Energy Information Administration (EIA), System for the Analysis of Global Energy Markets (2006). ***IEO2005*:** EIA, *International Energy Outlook 2005*, DOE/EIA-0484(2005) (Washington, DC, July 2005), Table A2, p. 91. **IEA:** International Energy Agency, *World Energy Outlook 2004* (Paris, France, October 2004), pp. 430-517. **PIRA:** PIRA Energy Group, *Retainer Client Seminar* (New York, NY, October 2005). **PEL:** Petroleum Economics, Ltd., *World Long Term Oil and Energy Outlook* (London, United Kingdom, May 2005).

Table H9. Comparison of World Energy Consumption Growth Rates by Fuel, 2002-2025
(Average Annual Percent Growth)

Fuel	*IEO2006*			*IEO2005*	PEL
	Low Growth	Reference	High Growth		
Oil	1.0	1.5	2.1	1.9	1.4
Natural Gas	2.1	2.6	3.0	2.3	3.1
Coal	2.1	2.7	3.3	2.0	1.4
Nuclear	1.0	1.1	1.1	1.0	2.1
Renewable/Other	2.1	2.6	3.0	1.9	2.1
Total	**1.6**	**2.1**	**2.6**	**2.0**	**2.0**

Sources: ***IEO2006*:** Energy Information Administration (EIA), System for the Analysis of Global Energy Markets (2006). ***IEO2005*:** EIA, *International Energy Outlook 2005*, DOE/EIA-0484(2005) (Washington, DC, July 2005), Table A2, p. 91. **PEL:** Petroleum Economics, Ltd., *World Long Term Oil and Energy Outlook* (London, United Kingdom, May 2005).

year. The fuel mix does vary between the two forecasts, however, with PEL projecting stronger growth in natural gas use and nuclear power generation than *IEO2006*. PEL's growth rate for natural gas demand exceeds the projection in the *IEO2006* high economic growth case and is a full percentage point higher than the *IEO2006* projection for nuclear power. In contrast, *IEO2006* expects stronger growth in coal and renewable energy use. The *IEO2006* reference case shows generally higher consumption growth rates for all fuels from 2002 to 2025, except for oil.

IEO2006 and IEA are the only forecasts that extend to 2030 (Table H10). In the IEA projections, worldwide energy use grows at a slower pace than in the *IEO2006* reference case (1.7 percent and 2.0 percent per year, respectively). IEA projects somewhat higher growth for oil and renewable energy demand than does *IEO2006*, but much lower growth for coal and nuclear power consumption. The IEA growth forecast for coal use is a full percentage point lower than the *IEO2006* reference case and falls below the *IEO2006* low economic growth case. Similarly, the IEA projection for growth in nuclear power generation (0.4 percent per year) is less than one-half the *IEO2006* projection (0.9 percent per year).

Performance of Past *IEO* Forecasts for 1990, 1995, and 2000

In an effort to measure how well the *IEO* projections have estimated future energy consumption trends over the 20-year history of the series, a comparison of *IEO* forecasts produced for the years 1990, 1995, and 2000 is presented here. The forecasts are compared with actual data published in EIA's *International Energy Annual 2002*, as part of EIA's commitment to provide users of the *IEO* with a set of performance measures to assess the forecasts produced by this agency.

The *IEO* has been published since 1985. In *IEO85*, mid-term projections were derived only for the world's market economies. That is, no projections were prepared for the centrally planned economies (CPE) of the Soviet Union, Eastern Europe, Cambodia, China, Cuba, Laos, Mongolia, North Korea, and Vietnam. The *IEO85* projections extended to 1995 and included forecasts of energy consumption for 1990 and 1995 and primary consumption of oil, natural gas, coal, and "other fuels." *IEO85* projections were also presented for several individual countries and subregions: the United States, Canada, Japan, the United Kingdom, France, West Germany, Italy, the Netherlands, other OECD Europe, other OECD (Australia, New Zealand, and the U.S. Territories), OPEC, and other developing countries. Beginning with *IEO86*, nuclear power projections were published separately from the "other fuel" category.

Regional aggregations have changed from report to report. In 1990, the report coverage was expanded for the first time from only the market economies to the entire world. Projections for China, the FSU, and other CPE countries were provided separately. Starting with *IEO94*, the regional presentation was changed from market economies and CPE countries to OECD, Eurasia (China, FSU, and Eastern Europe), and "Rest of World." Beginning in 1995 and essentially continuing until the current issue, the regional presentation changed to further group the nations of the world according to economic development: industrialized nations (essentially the OECD before the entry of South Korea and the Eastern European nations, the Czech Republic, Hungary, Poland, and Slovakia), the transitional economies of the EE/FSU, and the developing world (including China and India).

The forecast time horizon has also changed over the years (Table H11). In the first edition of the report, *IEO85*, projections were made for 1990 and 1995. *IEO86* saw the addition of projection year 2000. In *IEO91*, forecasts were no longer published for 1990, but forecasts for 2010 were added. The projection horizon remained the same until *IEO96*, when projection year 2015 was added. In 1998, the forecast was extended again, out to 2020. With *IEO2003*, the forecast period was extended to 2025;

Table H10. Comparison of World Energy Consumption Growth Rates by Fuel, 2002-2030
(Average Annual Percent Growth)

Fuel	*IEO2006*			IEA
	Low Growth	Reference	High Growth	
Oil	1.0	1.5	2.0	1.6
Natural Gas	2.0	2.5	3.0	2.3
Coal	2.0	2.5	3.2	1.5
Nuclear	0.9	0.9	0.9	0.4
Renewable/Other	1.9	2.4	3.0	2.7
Total	**1.5**	**2.0**	**2.6**	**1.7**

Note: For IEA, Renewable/Other excludes traditional biomass.

Sources: ***IEO2006*:** Energy Information Administration (EIA), System for the Analysis of Global Energy Markets (2006). **IEA:** International Energy Agency, *World Energy Outlook 2004* (Paris, France, October 2004), pp. 430-517.

and for the first time, the forecast period extends to 2030 in *IEO2006*.

Comparisons of Forecasts for Market Economies

Projections for market economies were made in the eight issues of the *IEO* that were published between 1985 and 1993 (no *IEO* was published in 1988). Historical data for total regional energy consumption in 1990 show that the *IEO* projections from those early years were consistently lower than the actual data for the market economies. For the four editions of the *IEO* printed between 1985 and 1989 in which 1990 projections were presented, total projected energy consumption in the market economies ran between 4 and 7 percent below the actual amounts published in the *International Energy Annual 2001* (Figure H1).

In addition, market economy projections for 1995 in the 1985 through 1993 *IEO* reports (EIA did not release forecasts for 1995 after the 1993 report) were consistently lower than the actual, historical 1995 data (Figure H2). Most of the difference is attributed to those market economy countries outside the OECD. Through the years, EIA's economic growth assumptions for OPEC and other market economy countries outside the OECD have been low. The 1993 forecast was, as one might expect, the most accurate of the forecasts for 1995, and its projection for OPEC and the other market economy countries was about 2 percent below the actual number.

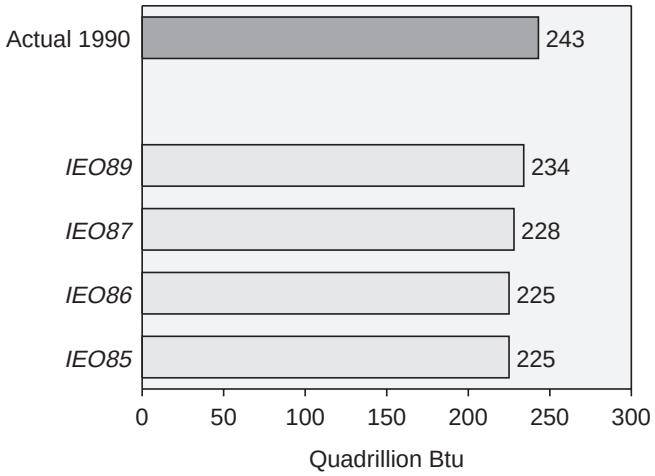
Table H11. Years Included in *IEO* Projections by Edition, 1985-2006

Edition	1990	1995	2000	2005	2010	2015	2020	2025	2030
IEO85	x	x							
IEO86	x	x	x						
IEO87	x	x	x						
IEO89	x	x	x						
IEO90		x	x		x				
IEO91		x	x		x				
IEO92		x	x		x				
IEO93		x	x		x				
IEO94			x	x	x				
IEO95			x	x	x				
IEO96		x	x	x	x	x			
IEO97			x	x	x	x			
IEO98			x	x	x	x	x	x	
IEO99			x	x	x	x	x	x	
IEO2000				x	x	x	x	x	
IEO2001				x	x	x	x	x	
IEO2002				x	x	x	x	x	
IEO2003				x	x	x	x	x	
IEO2004					x	x	x	x	
IEO2005					x	x	x	x	
IEO2006					x	x	x	x	x

Sources: Energy Information Administration, *International Energy Outlook*, DOE/EIA-0484 (Washington, DC, various years).

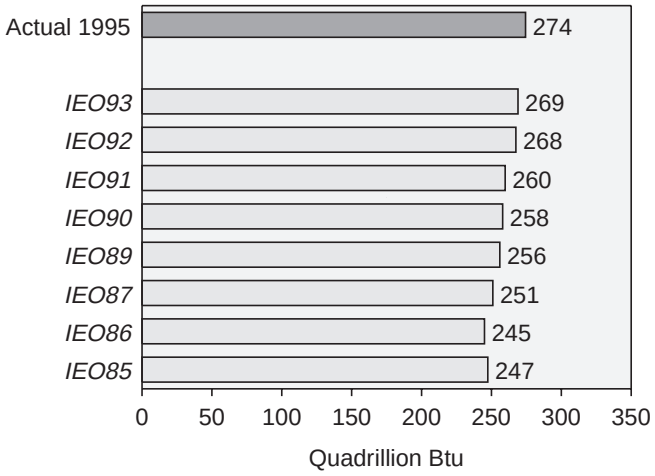
Similarly to the year 1995 projections, year 2000 projections were also consistently lower than actual 2000 data in each of the *IEO*s published between 1986 and 1993 (Figure H3). The consumption estimates for the market economies increased in each edition, from 265 quadrillion Btu in *IEO86* to 292 quadrillion Btu in *IEO93*. As late as 1993, the *IEO* forecasts were underestimating consumption of all energy sources in the market economies, by between 2 percent (oil) and 7 percent (natural gas and nuclear power).

Figure H1. Comparison of *IEO* Forecasts with 1990 Energy Consumption in Market Economies



Sources: Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/, and *International Energy Outlook*, DOE/EIA-0484 (Washington, DC, various years).

Figure H2. Comparison of *IEO* Forecasts with 1995 Energy Consumption in Market Economies



Sources: Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/, and *International Energy Outlook*, DOE/EIA-0484 (Washington, DC, various years).

As noted above, in the 1994 edition of the *IEO*, the regional aggregation "market economies" was dropped altogether and replaced with delineation of member countries of the OECD, Eurasia, and Rest of World (ROW). As a result of that reorganization, it is not possible to recreate a forecast for the CPE countries: except for China, the FSU, and Eastern Europe, the remaining CPE countries—noted above—were included in "other ROW."

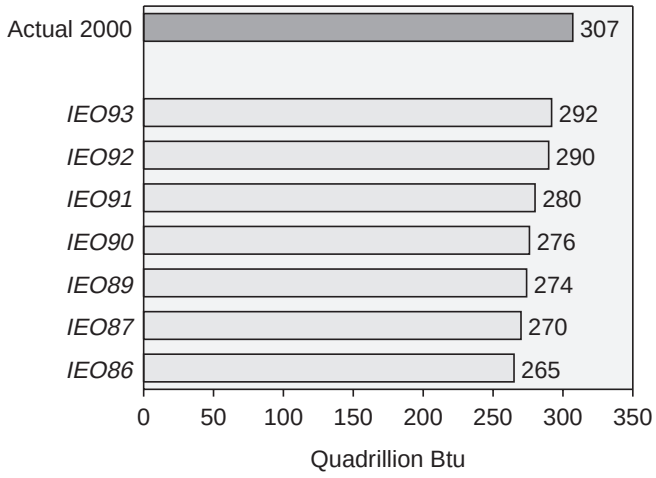
Comparisons of Forecasts for Year 1995

IEO90 marked the first release of a worldwide energy consumption forecast. In *IEO90* through *IEO93*, the forecasts for worldwide energy demand in 1995 were between 1 and 4 percent higher than the actual amounts consumed (Figure H4). Much of the difference can be explained by the unanticipated collapse of the Soviet Union economies in the early 1990s. The *IEO* forecasters could not foresee the extent to which energy consumption would fall in the FSU region. In *IEO90*, total energy consumption in the FSU was projected to reach 67 quadrillion Btu in 1995. The projection was reduced steadily in the next three *IEO* reports, but even in *IEO93* energy demand for 1995 in the FSU region was projected to be 53 quadrillion Btu, as compared with its actual 1995 energy consumption of 42 quadrillion Btu—a difference equivalent to about 5 million barrels of oil per day.

Forecasts for 1995 can also be compared in terms of their depiction of the fuel mix. Every *IEO* after 1990 projected the share of each energy source relative to total energy consumption within 2.6 percentage points of the actual 1995 distribution. The earliest *IEO*s tended to be too optimistic about the growth of coal use in the market economies (Figure H5) and too pessimistic about the recovery of oil consumption after the declines in the early 1980s that followed the price shocks caused by oil embargoes in 1973 and 1974 and the 1979-1980 revolution in Iran (Figure H6). The *IEO85* and *IEO86* reports projected that oil would account for only about 40 percent of total energy consumption for the market economies in 1995, whereas oil actually accounted for 45 percent of the total in 1995.

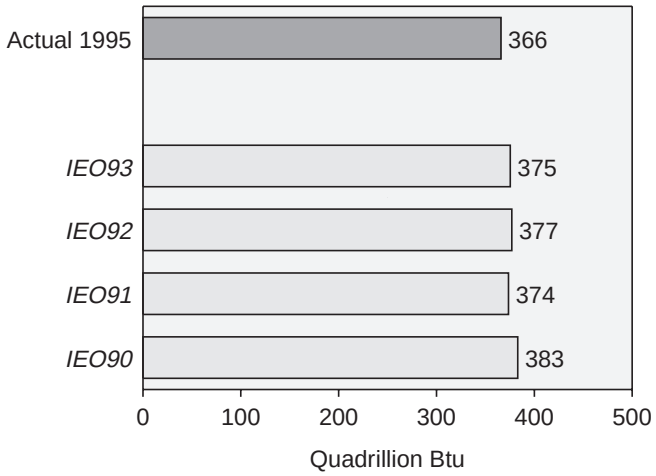
The 1995 forecasts for world coal consumption that appeared in the *IEO*s printed between 1990 and 1993 were consistently high, between 5 and 17 percent higher than actual coal use (Figure H7), largely because of

Figure H3. Comparison of *IEO* Forecasts with 2000 Energy Consumption in Market Economies



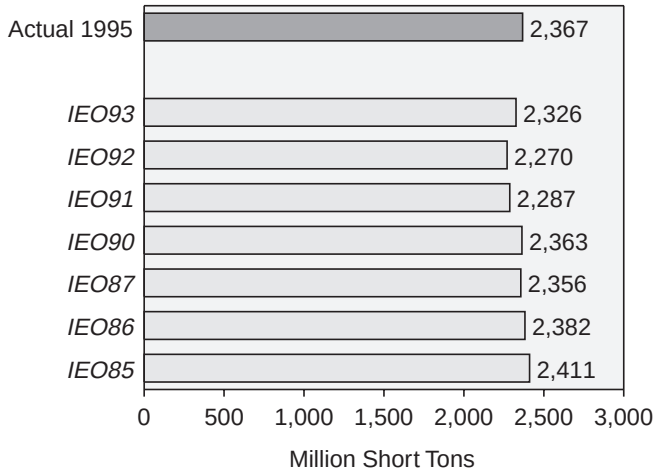
Sources: Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/, and *International Energy Outlook*, DOE/EIA-0484 (Washington, DC, various years).

Figure H4. Comparison of *IEO* Forecasts with 1995 World Energy Consumption



Sources: Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/, and *International Energy Outlook*, DOE/EIA-0484 (Washington, DC, various years).

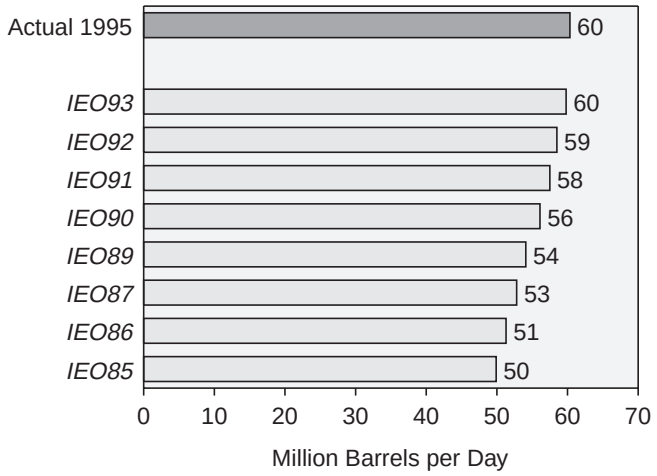
Figure H5. Comparison of *IEO* Forecasts with 1995 Coal Consumption in Market Economies



Sources: Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/, and *International Energy Outlook*, DOE/EIA-0484 (Washington, DC, various years).

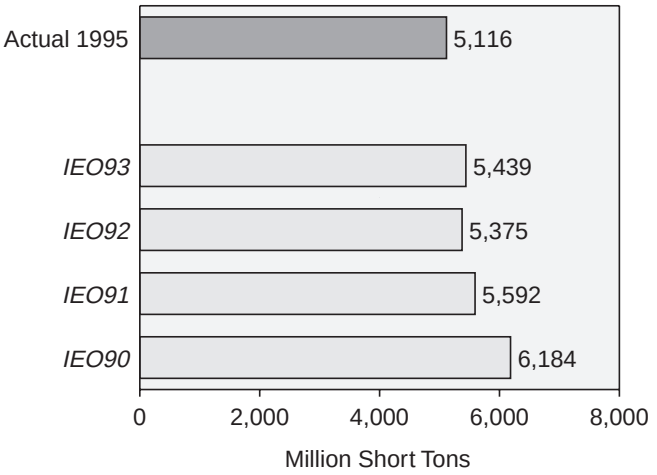
overestimates for the FSU and Eastern Europe—regions that experienced substantial declines in coal consumption during the years following the collapse of the Soviet Union. Most of the projections for the FSU by fuel were greater than the actual consumption numbers, with the exception of hydroelectricity and other renewable resources (Figure H8). Natural gas use in the FSU countries did not decline as much as oil and coal use, because natural gas is a plentiful resource in the region and was used extensively to fuel the domestic infrastructure; however, even the *IEO* estimates for 1995 natural gas use were 19 to 27 percent higher than the actual use.

Figure H6. Comparison of *IEO* Forecasts with 1995 Oil Consumption in Market Economies



Sources: Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/, and *International Energy Outlook*, DOE/EIA-0484 (Washington, DC, various years).

Figure H7. Comparison of *IEO* Forecasts with 1995 World Coal Consumption

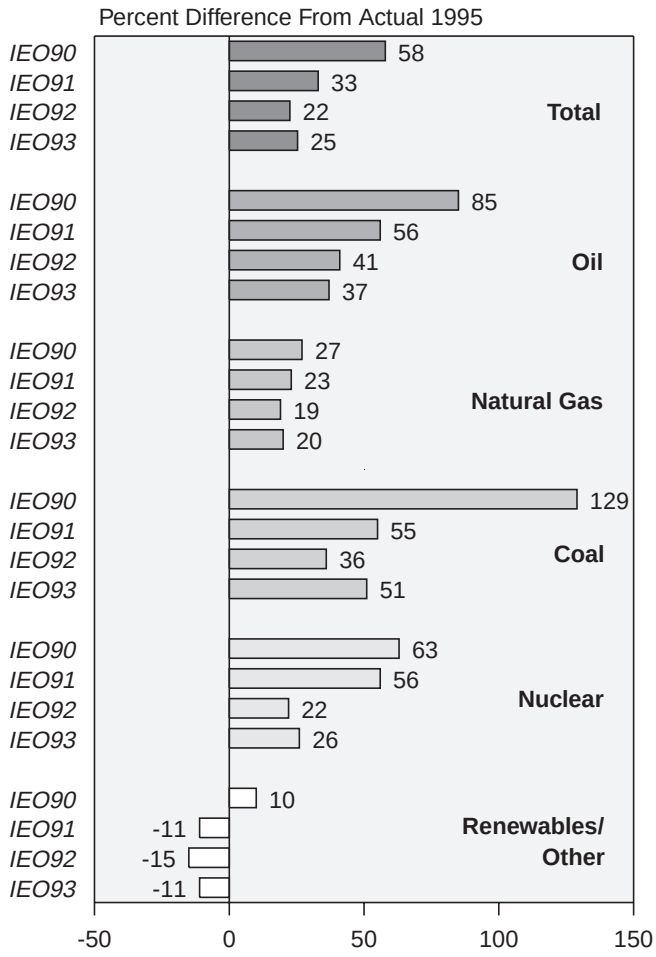


Sources: Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/, and *International Energy Outlook*, DOE/EIA-0484 (Washington, DC, various years).

The *IEO* projections for total energy consumption in China were below the actual 1995 consumption level in *IEO90* (by 12 percent) and *IEO91* (by 8 percent) but higher in *IEO92* (by 6 percent) and about the same in *IEO93*. The underestimates in the earlier *IEO*s balanced, in part, the overestimates for the EE/FSU countries; however, even the 4- to 14-percent underestimate of projected 1995 coal use in China could not make up for the 36- to 129-percent overestimate of FSU coal use.

For other fuels, the *IEO* forecasts consistently overestimated China's natural gas consumption and underestimated its oil consumption. Nuclear power forecasts were fairly close for China, within 5 percent of the actual consumption (Figure H9). It is noteworthy, however, that consumption of natural gas and nuclear power was quite small in 1995, so that any variation between actual historical consumption and the projections results in a

Figure H8. Comparison of *IEO* Forecasts with 1995 Energy Consumption in the Former Soviet Union by Fuel Type



Sources: Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/, and *International Energy Outlook*, DOE/EIA-0484 (Washington, DC, various years).

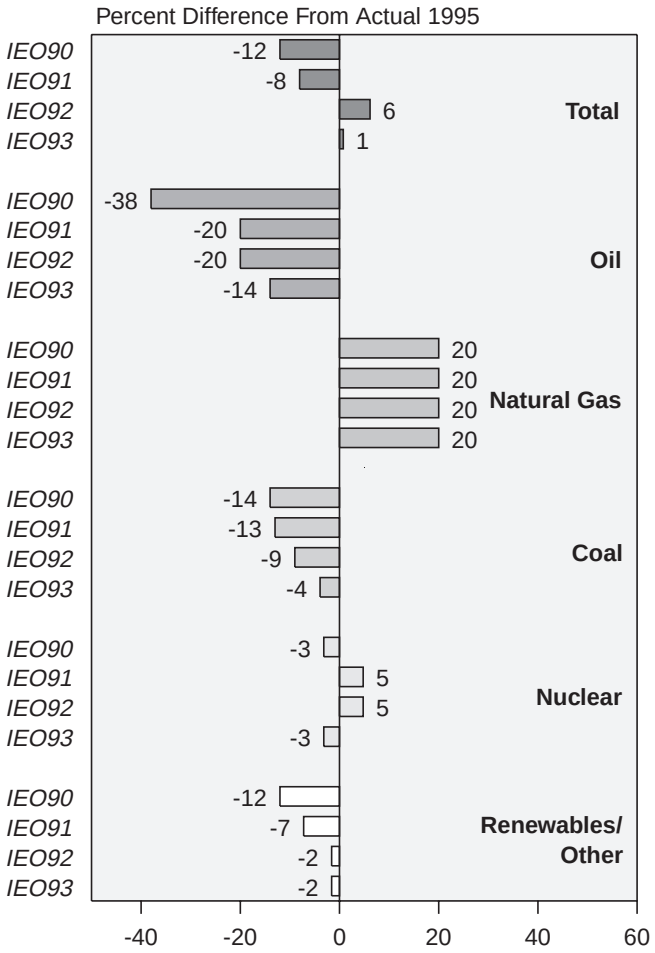
large percentage difference. EIA consistently underestimated economic growth in China. As late as 1993, EIA expected GDP in China to grow by about 7.3 percent per year during the decade of the 1990s, whereas it actually grew by 10.7 percent per year between 1990 and 1995.

Comparisons of Forecasts for Year 2000

Ten editions of the *IEO* report contained worldwide forecasts for the year 2000 (*IEO90* through *IEO99*). The forecasts of total world energy consumption for 2000 were all above, but within 5 percent of, the actual total (Figure H10). *IEO97* provided the highest estimate of world energy use in 2000. This may seem surprising at first glance, but it is also true that the economic recession that would take hold in 1998 among the emerging economies of southeast Asia had not occurred and was not foreseen in the *IEO97* forecast. In fact, *IEO97* overestimated year 2000 energy use in developing Asia by 9 quadrillion Btu, or about 12 percent (Figure H11) and in industrialized Asia (Japan, Australia, New Zealand, and the U.S. Territories) by 3 quadrillion Btu, or 9 percent.

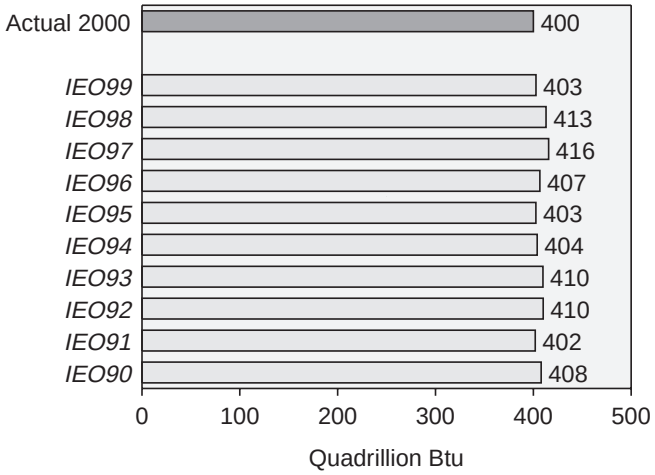
Projections for the EE/FSU in *IEO97* were also too optimistic, overestimating the rate of economic recovery in the region and as a result overestimating the growth in energy consumption by 12 quadrillion Btu (22 percent). *IEO97* did not anticipate the August 1998 devaluation of the Russian ruble and the economic recession that followed in the FSU region. By *IEO99*, total EE/FSU energy use had been adjusted downward to 52 quadrillion

Figure H9. Comparison of *IEO* Forecasts with 1995 Energy Consumption in China by Fuel Type



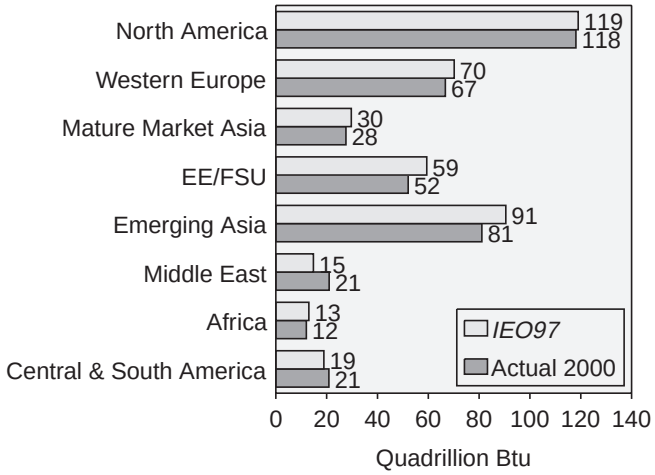
Sources: Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/, and *International Energy Outlook*, DOE/EIA-0484 (Washington, DC, various years).

Figure H10. Comparison of *IEO* Forecasts with 2000 World Energy Consumption



Sources: Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/, and *International Energy Outlook*, DOE/EIA-0484 (Washington, DC, various years).

Figure H11. Comparison of *IEO97* Forecasts with 2000 Energy Consumption by Region



Sources: Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/, and *International Energy Outlook 1997*, DOE/EIA-0484(97) (Washington, DC, April 1997).

Btu—just slightly lower than the region's actual consumption in 2000.

The projections for year 2000 by fuel were mixed in terms of accuracy. For all energy sources except coal, total world consumption forecasts fell within 13 percent of the actual levels. As was the case with forecasts for the years 1990 and 1995, world coal consumption projections were consistently high relative to actual consumption in 2000. The world coal forecast presented in *IEO90* was 30 percent higher than actual 2000 values. The forecasts for the CPE countries were responsible for the large discrepancy between projected *IEO90* and actual coal consumption in 2000. In fact, *IEO90* projected that the market economies would consume 2,801 million short tons of coal in 2000, and the actual estimate for coal use among the market economies was 2,974. However, in the CPE countries—including the EE/FSU—*IEO90* projected that coal use would climb to 3,841 million short tons in 2000, whereas actual coal consumption was only 2,108 million short tons.

Much of the discrepancy between the *IEO90* projection and actual 2000 coal consumption can be attributed to the FSU. As noted above, *IEO90* did not foresee the collapse of the Soviet regime in 1990 when the report projections were prepared. Indeed, coal use in the FSU in *IEO90* was expected to expand to 1,132 million short tons in 2000, whereas in reality coal use in the FSU began to decline precipitously after 1990, hitting a low of 388 million short tons in 1998 before edging up to 400 million short tons in 2000. The story was similar for Eastern Europe and the other CPE countries (excluding China), where coal use in 2000 was overestimated by 202 percent in *IEO90*.

The year 2000 forecasts for oil, natural gas, and hydroelectricity and other renewable energy sources were, for the most part, higher than actual levels. In contrast, projections for nuclear power were consistently lower than the actual 2000 values. Interestingly, the forecasts for the United States were largely responsible for the underestimation. Even in *IEO99*—the latest *IEO* that included projections for 2000—analysts were expecting nuclear power to begin to decline. In *IEO90* there was widespread pessimism about the future of nuclear power in the mid-term, given the aftermath of the Chernobyl disaster and the problems associated with nuclear waste disposal. In the political climate of the early 1990s, *IEO90* could not anticipate the life extensions and consistently improving efficiencies that have allowed nuclear power plants to generate more electricity and operate with shorter downtimes for maintenance, even without expanding their installed capacities.

The comparison of *IEO* projections and historical data in the context of political and social events underscores the importance of those events in shaping the world's energy markets. Such comparisons also point out how important a model's assumptions are to the derivation of accurate forecasts. The political and social upheaval in the EE/FSU dramatically affected the accuracy of the projections for the region. On the other hand, if higher economic growth rates had been assumed for China, more accurate forecasts for that region might have been achieved. It is important for users of the *IEO* or any other projection series to realize the limitations of the forecasts. Failing an ability to predict future volatility in social, political, or economic events, the projections should be viewed as a plausible path or trend for the future and not as a precise prediction of future events.

Appendix I

System for the Analysis of Global Energy Markets (SAGE)

The projections of world energy consumption appearing in *IEO2006* are based on EIA's international energy modeling tool, SAGE. SAGE is an integrated set of regional models that provide a technology-rich basis for estimating regional energy consumption. For each region, reference case estimates of 42 end-use energy service demands (e.g., car, commercial truck, and heavy truck road travel; residential lighting; steam heat requirements in the paper industry) are developed on the basis of economic and demographic projections. Projections of energy consumption to meet the energy demands are estimated on the basis of each region's existing energy use patterns, the existing stock of energy-using equipment, and the characteristics of available new technologies, as well as new sources of primary energy supply.

Period-by-period market simulations aim to provide each region's energy services at minimum cost by simultaneously making end-use equipment and primary energy supply decisions. For example, in SAGE, if there is an increase in residential lighting energy service, either existing generation equipment must be used more intensively or new equipment must be installed. The choice of generation equipment (type and fuel) incorporates analysis of both the characteristics of alternative generation technologies and the economics of primary energy supply.

The *IEO* provides projections of total world primary energy consumption, as well as projections of energy consumption by primary energy type (oil, natural gas, coal, nuclear, and hydroelectric and other renewable resources) and projections of net electricity consumption. Projections of carbon dioxide emissions resulting from fossil fuel use are also provided. All projections are computed in 5-year intervals through the year 2030. More detailed tables emphasize the end-use demand-driven nature of SAGE.

SAGE provides projections for 16 regions or countries, including the North American countries of the United States, Canada, and Mexico; OECD Europe; the OECD Asian countries of Japan, South Korea, and Australia/New Zealand; Russia; other non-OECD Europe and Eurasia; China; India; other non-OECD Asia; the Middle East; Africa; Brazil; and other Central and South America.

Projections of world oil prices over the projection horizon are provided to SAGE from EIA's International Energy Module, which is a submodule of the National Energy Modeling System (NEMS). Projections of world nuclear energy consumption are derived from installed nuclear power capacity projections developed by nuclear power experts within EIA. All U.S. projections are taken from EIA's *Annual Energy Outlook* (*AEO*).

A full description of the SAGE model is available in a two-volume set. The first volume provides a general understanding of the model's design, theoretical basis, necessary user-defined assumptions, and output. It also lists the software necessary to develop and analyze the results of SAGE-based policy and energy market scenarios. In addition, Volume I includes a Reference Guide, which explains each equation in detail. The second volume serves as a User's Guide for those actively developing SAGE-based scenario analyses. The documentation is available on EIA's web site in the model documentation section of "Current Publications" (http://www.eia.doe.gov/bookshelf/docs.html). SAGE documentation is also available as part of the documentation for the MARKAL family of models (http://www.etsap.org/MRKLDOC-III_SAGE.pdf).

Appendix J

Regional Definitions

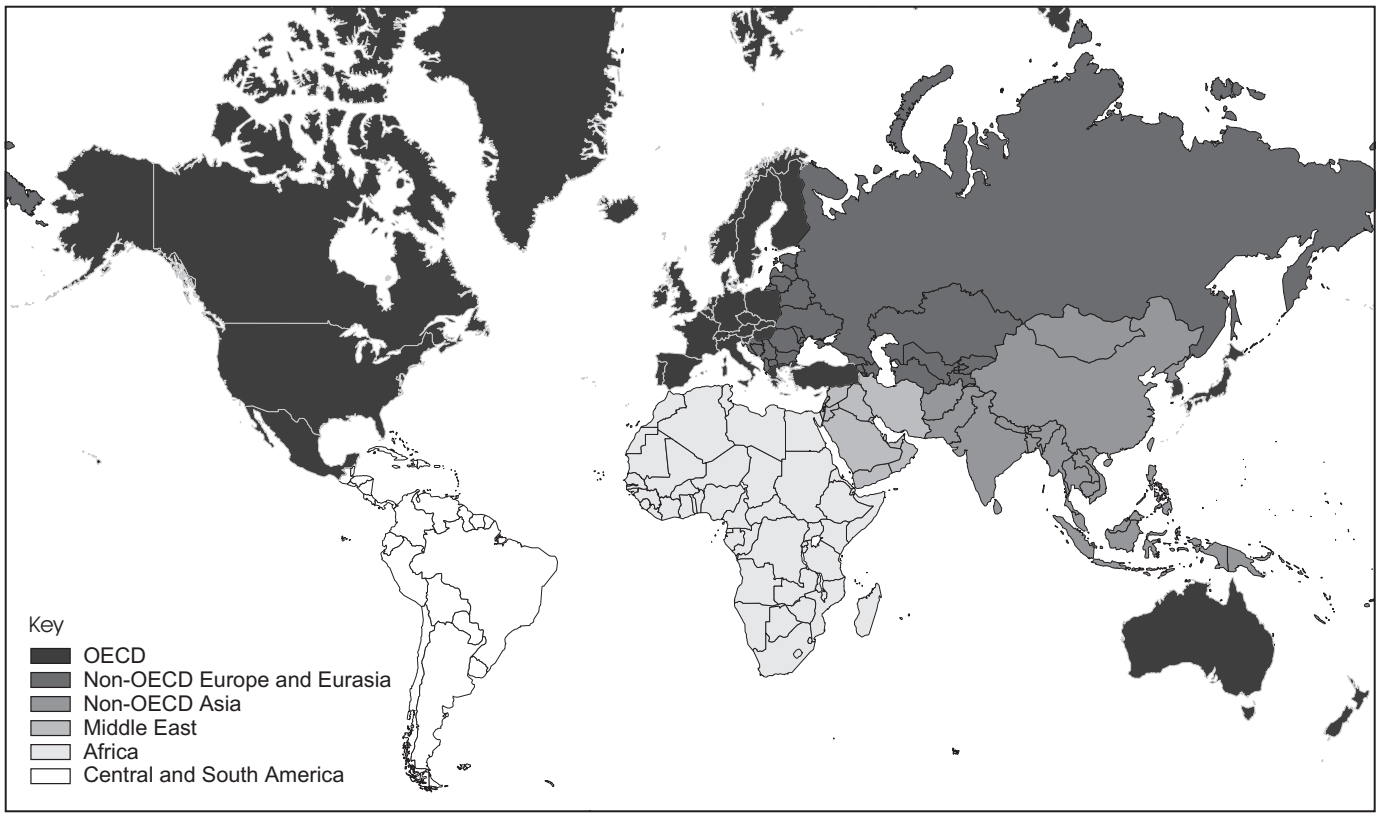
The six basic country groupings used in this report (Figure J1) are defined as follows:

- **OECD** (18 percent of the 2006 world population): **North America**—United States, Canada, and Mexico; **OECD Europe**—Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland, Turkey, and the United Kingdom. **OECD Asia**—Japan, South Korea, Australia, and New Zealand.

- **Non-OECD** (82 percent of the 2006 world population):

  - **Non-OECD Europe and Eurasia** (5 percent of the 2006 world population)—Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Estonia, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Macedonia, Malta, Moldova, Romania, Russia, Serbia and Montenegro, Slovenia, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan.
  - **Non-OECD Asia** (53 percent of the 2006 world population)—Afghanistan, Bangladesh, Bhutan, Brunei, Cambodia (Kampuchea), China, Fiji, French Polynesia, Guam, Hong Kong, India, Indonesia, Kiribati, Laos, Malaysia, Macau, Maldives, Mongolia, Myanmar (Burma), Nauru, Nepal, New Caledonia, Niue, North Korea, Pakistan, Papua New Guinea, Philippines, Samoa, Singapore, Solomon Islands, Sri Lanka, Taiwan, Thailand, Tonga, Vanuatu, and Vietnam.
  - **Middle East** (3 percent of the 2006 world population)—Bahrain, Cyprus, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, the United Arab Emirates, and Yemen.
  - **Africa** (14 percent of the 2006 world population)—Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo (Brazzaville), Congo (Kinshasa), Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Kenya,

Figure J1. Map of the Six Basic Country Groupings



Source: Energy Information Administration, Office of Integrated Analysis and Forecasting.

Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Reunion, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, St. Helena, Sudan, Swaziland, Tanzania, Togo, Tunisia, Uganda, Western Sahara, Zambia, and Zimbabwe.

- **Central and South America** (7 percent of the 2006 world population)—Antarctica, Antigua and Barbuda, Argentina, Aruba, Bahama Islands, Barbados, Belize, Bolivia, Brazil, British Virgin Islands, Cayman Islands, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Falkland Islands, French Guiana, Grenada, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Montserrat, Netherlands Antilles, Nicaragua, Panama Republic, Paraguay, Peru, Puerto Rico, St. Kitts-Nevis, St. Lucia, St. Vincent/Grenadines, Suriname, Trinidad and Tobago, Turks and Caicos Islands, Uruguay, U.S. Virgin Islands, and Venezuela.

In addition, the following commonly used country groupings are referenced in this report:

- **Countries that have ratified, accepted, acceded, or approved the Kyoto Climate Change Protocol on Greenhouse Gas Emissions as of April 16, 2006:** Albania, Algeria, Antigua and Barbuda, Argentina, Armenia, Austria, Azerbaijan, Bahamas, Bahrain, Bangladesh, Barbados, Belarus, Belgium, Belize, Benin, Bhutan, Bolivia, Botswana, Brazil, Bulgaria, Burkina Faso, Burundi, Cambodia, Cameroon, Canada, Cape Verde, Chile, China, Colombia, Costa Rica, Cuba, Cyprus, Czech Republic, Congo (Kinshasa), Denmark, Djibouti, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Equatorial Guinea, Eritrea, Estonia, Ethiopia, Fiji, Finland, France, Gambia, Georgia, Germany, Ghana, Greece, Grenada, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Hungary, Iceland, India, Indonesia, Iran, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Kiribati, Kuwait, Kyrgyzstan, Laos, Latvia, Lesotho, Liberia, Liechtenstein, Lithuania, Luxembourg, Macedonia, Madagascar, Malawi, Malaysia, Maldives, Mali, Malta, Marshall Islands, Mauritania, Mauritius, Mexico, Micronesia, Monaco, Moldova, Mongolia, Morocco, Mozambique, Myanmar, Namibia, Nauru, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Niue, North Korea, Norway, Oman, Pakistan, Palau, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Qatar, Romania, Russia, Rwanda, Saint Lucia, St. Vincent/Grenadines, Samoa, Saudi Arabia, Senegal, Seychelles, Singapore, Slovakia, Slovenia, Solomon Islands, South Africa, South Korea, Spain, Sri Lanka, Sudan, Swaziland, Sweden, Switzerland, Syria, Tanzania, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkmenistan, Tuvalu, Uganda, Ukraine, United Arab Emirates, United Kingdom, Uruguay, Uzbekistan, Vanuatu, Venezuela, Vietnam, and Yemen.
- **Annex I Countries participating in the Kyoto Climate Change Protocol on Greenhouse Gas Emissions:** Austria, Belgium, Bulgaria, Canada, Croatia, Czech Republic, Denmark, Estonia, European Community, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Liechtenstein, Lithuania, Luxembourg, Monaco, the Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine, and the United Kingdom.[21]
- **European Union (EU):** Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom.
- **G8:** Canada, France, Germany, Italy, Japan, Russia, United Kingdom, and the United States.
- **North American Free Trade Agreement (NAFTA) Member Countries:** Canada, Mexico, and the United States.
- **Organization for Economic Cooperation and Development (OECD):** Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, South Korea, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States.
- **Organization of Petroleum Exporting Countries (OPEC):** Algeria, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates, and Venezuela.
- **Pacific Rim Developing Countries:** Hong Kong, Indonesia, Malaysia, Philippines, Singapore, South Korea, Taiwan, and Thailand.
- **Persian Gulf Countries:** Bahrain, Iran, Iraq, Kuwait, Qatar, Saudi Arabia, and the United Arab Emirates.

[21]Turkey and Croatia are Annex I nations that have not ratified the Framework Convention on Climate Change and did not commit to quantifiable emissions targets under the Kyoto Protocol. In 2001, the United States withdrew from the Protocol, and in 2002 Australia announced that it will not ratify the Kyoto Protocol unless the United States does.