

## Chapter 1

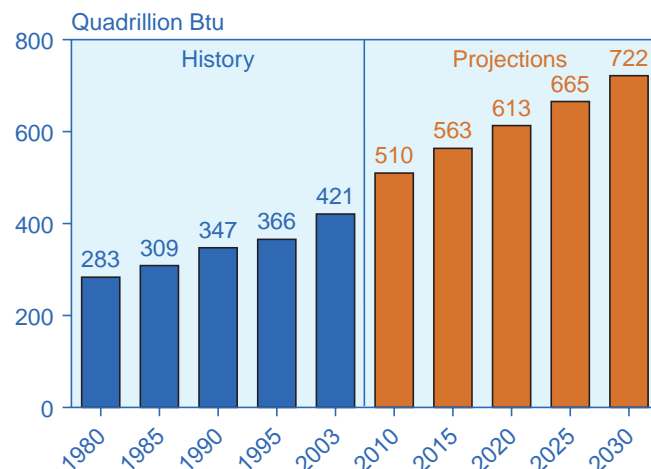
# World Energy and Economic Outlook

*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)<sup>2</sup> 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/](http://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
<b>OECD</b> .....	<b>234.3</b>	<b>256.1</b>	<b>269.9</b>	<b>281.6</b>	<b>294.5</b>	<b>308.8</b>	<b>1.0</b>
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
<b>Non-OECD</b> .....	<b>186.4</b>	<b>253.6</b>	<b>293.5</b>	<b>331.5</b>	<b>371.0</b>	<b>412.8</b>	<b>3.0</b>
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
<b>Total World</b> .....	<b>420.7</b>	<b>509.7</b>	<b>563.4</b>	<b>613.0</b>	<b>665.4</b>	<b>721.6</b>	<b>2.0</b>

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/](http://www.eia.doe.gov/iea/). **2010-2030:** EIA, *System for the Analysis of Global Energy Markets* (2006).

<sup>2</sup>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

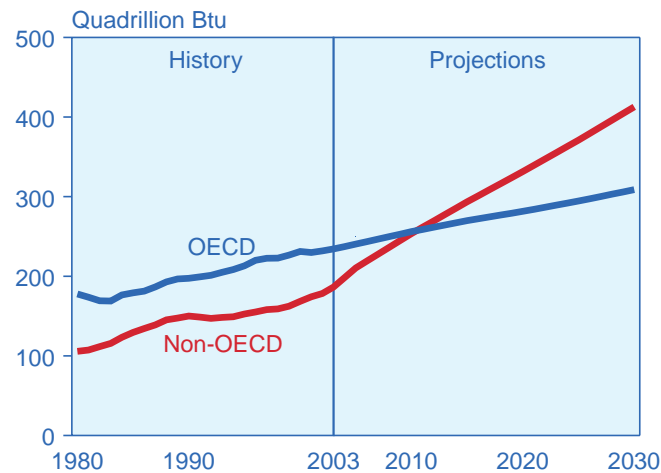
projections in the context of recent economic developments in key OECD and non-OECD regions. Macroeconomic growth and energy intensity are key factors underlying the projections of future energy demand, and different assumptions result in substantially different projections, underscoring the uncertainty 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.

## 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.

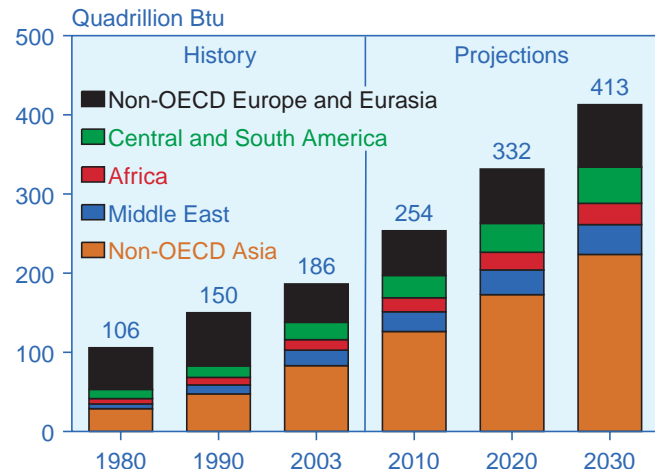
Worldwide oil consumption rises from 80 million barrels per day in 2003 to 98 million barrels per day in 2015 and then to 118 million barrels per day in 2030. The *IEO2006* projection for oil demand in 2025 is 8 million barrels lower than the 119 million barrels per day projected in last year's outlook,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

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



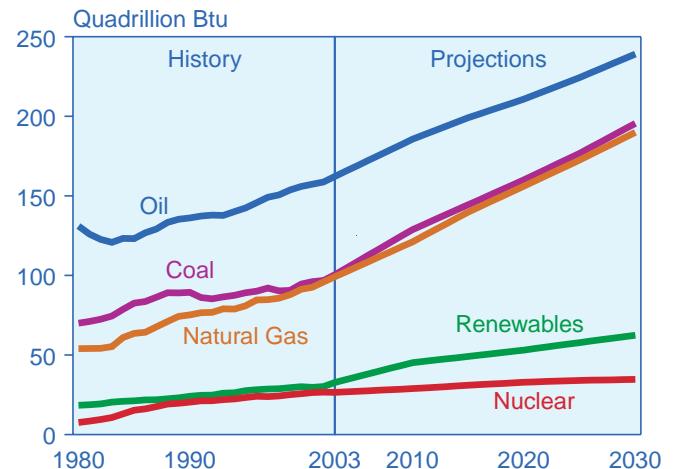
Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site [www.eia.doe.gov/iea/](http://www.eia.doe.gov/iea/). **Projections:** EIA, System for the Analysis of Global Energy Markets (2006).

**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/](http://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/](http://www.eia.doe.gov/iea/). **Projections:** EIA, System for the Analysis of Global Energy Markets (2006).

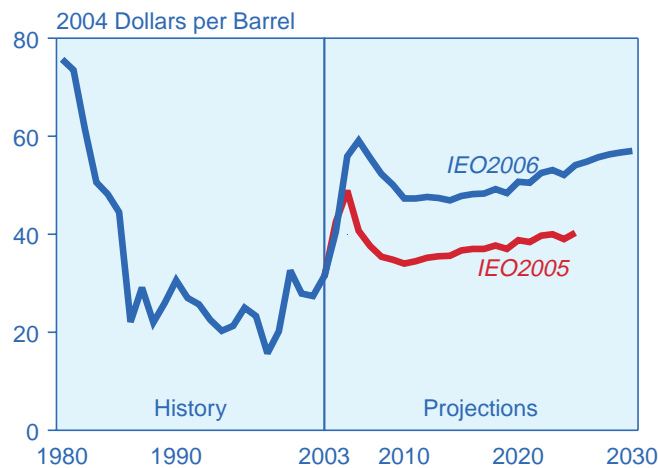
(*IEO2005*) is in large part explained by substantially higher projections for world oil prices in the *IEO2006* reference case, which in 2025 are 35 percent higher than projected in *IEO2005* (Figure 11).

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,

**Figure 11. Comparison of *IEO2005* and *IEO2006* World Oil Price Projections, 1980-2030**



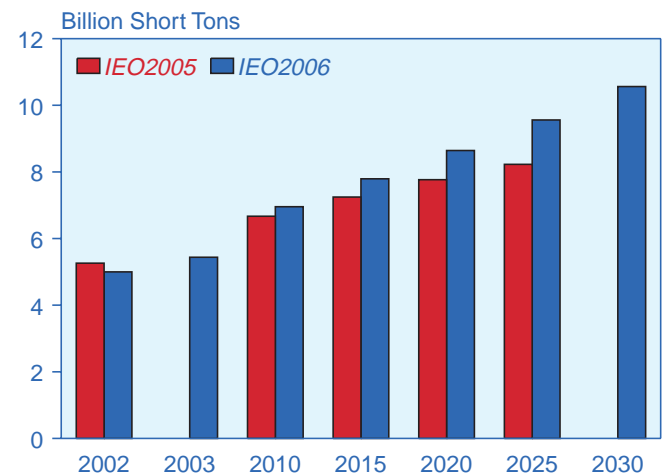
Sources: **History:** Energy Information Administration (EIA), *Annual Energy Review 2004*, DOE/EIA-0384(2004) (Washington, DC, August 2005), web site [www.eia.doe.gov/emeu/aer/contents.html](http://www.eia.doe.gov/emeu/aer/contents.html). **IEO2005:** EIA, *International Energy Outlook 2005*, DOE/EIA-0484(2005) (Washington, DC, July 2005), web site [www.eia.doe.gov/oiaf/ieo/index.html](http://www.eia.doe.gov/oiaf/ieo/index.html). **IEO2006:** EIA, System for the Analysis of Global Energy Markets (2006).

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 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/](http://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](http://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

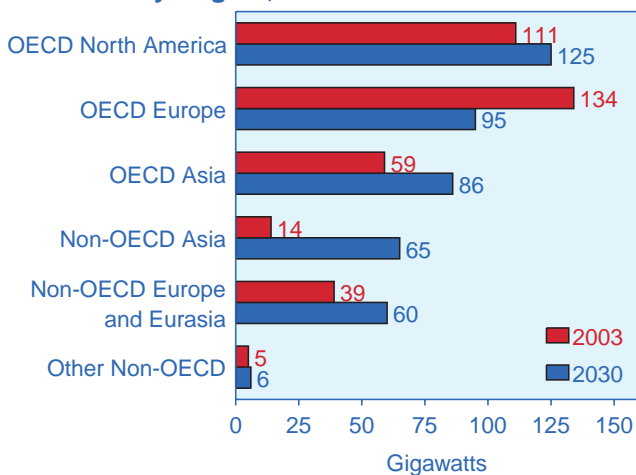
renewable energy sources to compete more effectively in the electric power sector. In addition, coal is the regional economic choice in some power markets, like the United States and non-OECD Asia, where coal resources are ample and high natural gas prices lead to an increase in coal's share of the electricity market.

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 retired 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.

**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/](http://www.eia.doe.gov/iea/). **2030:** EIA, System for the Analysis of Global Energy Markets (2006).



## 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
<b>OECD North America</b> .....	<b>2.9</b>	<b>2.5</b>	<b>4.1</b>	<b>3.5</b>	<b>3.1</b>	<b>2.9</b>	<b>3.1</b>
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
<b>OECD Europe</b> .....	<b>2.4</b>	<b>1.4</b>	<b>2.6</b>	<b>1.9</b>	<b>2.3</b>	<b>2.1</b>	<b>2.2</b>
<b>OECD Asia</b> .....	<b>3.0</b>	<b>1.9</b>	<b>3.0</b>	<b>2.6</b>	<b>2.3</b>	<b>1.6</b>	<b>1.9</b>
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
<b>Total OECD</b> .....	<b>2.7</b>	<b>2.0</b>	<b>3.4</b>	<b>2.7</b>	<b>2.7</b>	<b>2.4</b>	<b>2.6</b>
<b>Non-OECD Europe and Eurasia</b> ...	<b>-0.3</b>	<b>7.7</b>	<b>8.1</b>	<b>6.5</b>	<b>4.9</b>	<b>3.7</b>	<b>4.4</b>
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
<b>Non-OECD Asia</b> .....	<b>6.7</b>	<b>7.6</b>	<b>7.8</b>	<b>7.5</b>	<b>5.8</b>	<b>4.9</b>	<b>5.5</b>
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
<b>Middle East</b> .....	<b>2.6</b>	<b>4.8</b>	<b>6.4</b>	<b>6.7</b>	<b>4.4</b>	<b>3.7</b>	<b>4.2</b>
<b>Africa</b> .....	<b>2.9</b>	<b>4.8</b>	<b>5.1</b>	<b>4.9</b>	<b>4.8</b>	<b>4.1</b>	<b>4.4</b>
<b>Central and South America</b> .....	<b>2.3</b>	<b>2.1</b>	<b>5.9</b>	<b>4.5</b>	<b>3.8</b>	<b>3.5</b>	<b>3.8</b>
Brazil .....	2.5	0.5	4.9	2.7	3.7	3.3	3.5
<b>Total Non-OECD</b> .....	<b>3.7</b>	<b>6.4</b>	<b>7.2</b>	<b>6.7</b>	<b>5.3</b>	<b>4.5</b>	<b>5.0</b>
<b>Total World</b>							
<b>Purchasing Power Parity Rates</b> ..	<b>3.1</b>	<b>4.0</b>	<b>5.1</b>	<b>4.6</b>	<b>4.0</b>	<b>3.6</b>	<b>3.8</b>
<b>Market Exchange Rates</b> .....	<b>2.8</b>	<b>3.5</b>	<b>4.1</b>	<b>3.1</b>	<b>3.1</b>	<b>2.6</b>	<b>3.0</b>

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—

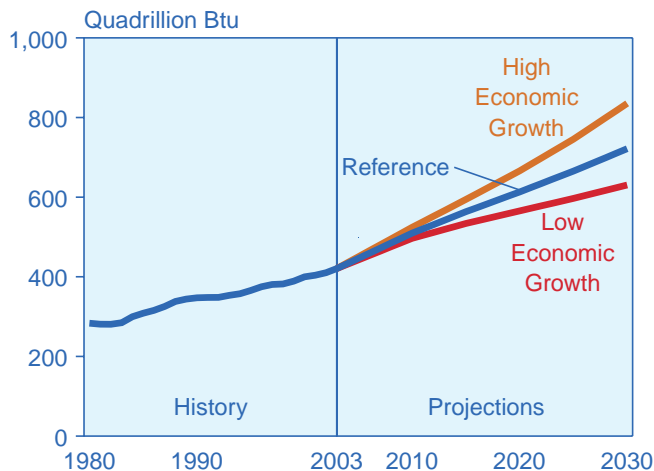
between the projections in the high and low economic growth cases (Figure 14).

## 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.

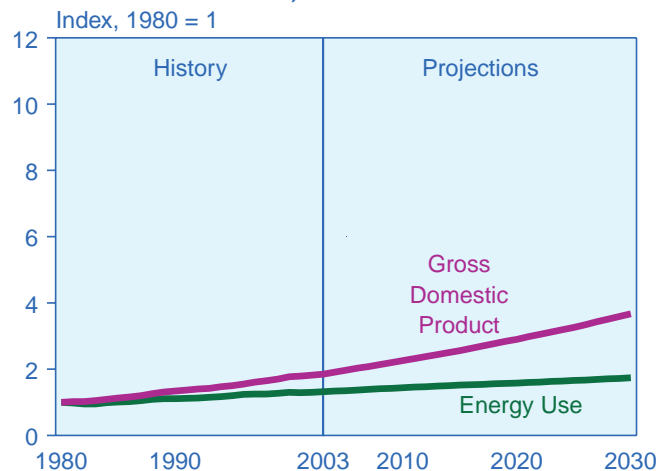
The historical behavior of energy intensity in non-OECD Europe and Eurasia is problematic. Since World War II, the economies of the region have had higher levels of energy intensity than either the OECD or the other non-OECD economies. In non-OECD Europe and Eurasia, however, energy consumption generally 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/](http://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**

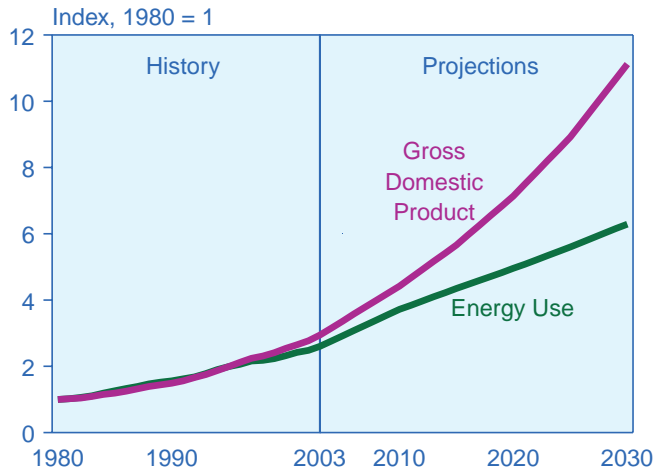


Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site [www.eia.doe.gov/iea/](http://www.eia.doe.gov/iea/). **Projections:** EIA, *System for the Analysis of Global Energy Markets* (2006).



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).

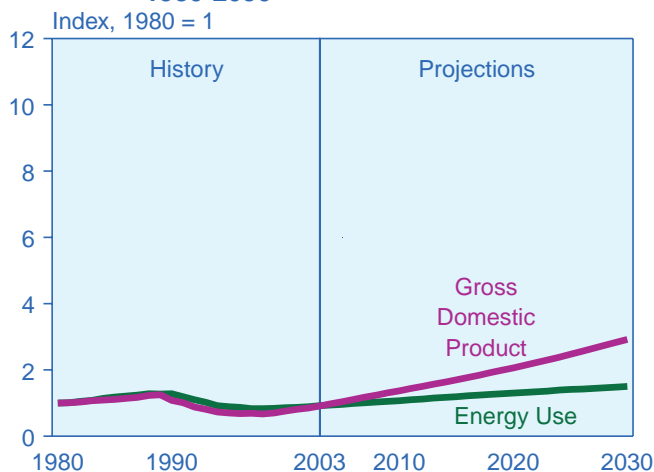
**Figure 16. Growth in Energy Use and Gross Domestic Product for the Non-OECD Economies, 1980-2030**



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/](http://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**

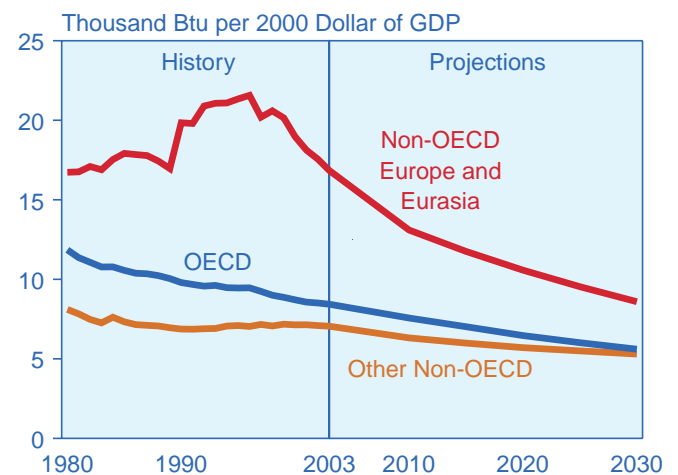


Sources: **History:** Derived from Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site [www.eia.doe.gov/iea/](http://www.eia.doe.gov/iea/). **Projections:** EIA, System for the Analysis of Global Energy Markets (2006).

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/](http://www.eia.doe.gov/iea/). **Projections:** EIA, System for the Analysis of Global Energy Markets (2006).

