

World Energy and Economic Outlook

The IEO2005 projections indicate continued growth in world energy use, including large increases for the emerging economies of Asia. Energy resources are thought to be adequate to support the growth expected through 2025.

The *International Energy Outlook 2005 (IEO2005)* projects strong growth for worldwide energy demand over the 23-year projection period from 2002 to 2025. Total world consumption of marketed energy is expected to expand from 412 quadrillion British thermal units (Btu) in 2002 to 553 quadrillion Btu in 2015 and then to 645 quadrillion Btu in 2025, or a 57-percent increase over the 2002 to 2025 time period (Table 1 and Figure 7).

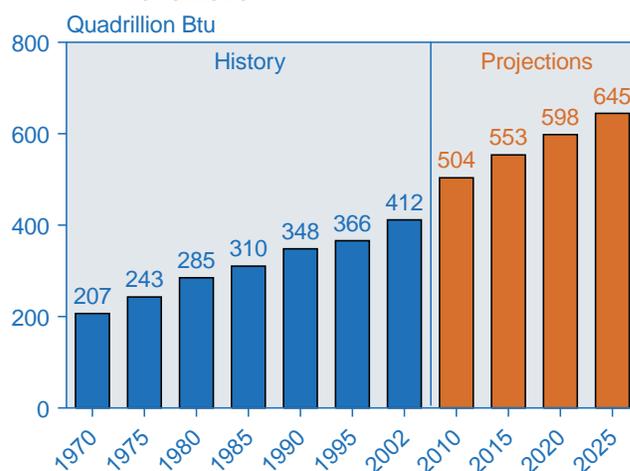
In the *IEO2005* mid-term outlook, the emerging economies account for nearly two-thirds of the increase in world energy use, surpassing energy use in the mature market economies for the first time in 2020 (Figure 8). In 2025, energy demand in the emerging economies is expected to exceed that of the mature market economies by 9 percent.

Much of the growth in energy demand among the emerging economies is expected to occur in emerging Asia, which includes China and India; demand in this region is projected to more than double over the forecast period (Figure 9). Primary energy consumption in the emerging economies as a whole is projected to grow at an average annual rate of 3.2 percent between 2002 and 2025. In contrast, in the mature market economies—where energy consumption patterns are well established—energy use is expected to grow at a much slower average rate of 1.1 percent per year over the same period. In the transitional economies of Eastern Europe

and the former Soviet Union (EE/FSU), growth in energy demand is projected to average 1.6 percent per year.

This chapter presents an overview of the *IEO2005* outlook for energy consumption by primary energy source

Figure 7. World Marketed Energy Consumption, 1970-2025



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

Table 1. World Marketed Energy Consumption by Region, 1990-2025
(Quadrillion Btu)

Region	1990	2002	2015	2025	Average Annual Percent Change	
					1990-2002	2002-2025
Mature Market Economies	183.6	213.5	247.3	271.8	1.3	1.1
Transitional Economies	76.2	53.6	68.4	77.7	-2.9	1.6
Emerging Economies	88.4	144.3	237.8	295.1	4.2	3.2
Asia	51.5	88.4	155.8	196.7	4.6	3.5
Middle East	13.1	22.0	32.4	38.9	4.4	2.5
Africa	9.3	12.7	19.3	23.4	2.7	2.7
Central and South America	14.5	21.2	30.4	36.1	3.2	2.3
Total World	348.2	411.5	553.5	644.6	1.4	2.0

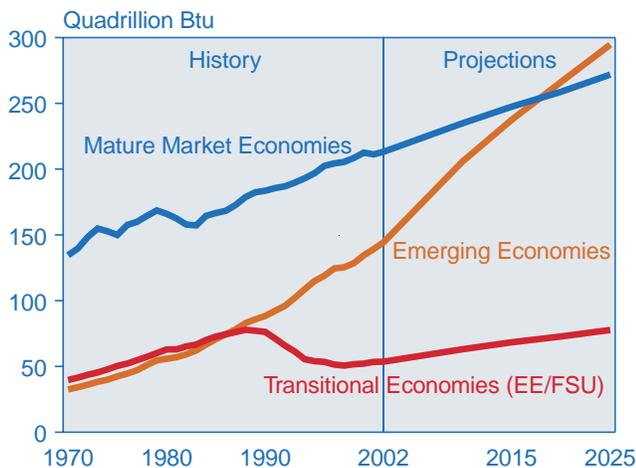
Note: Totals may not equal sum of components due to independent rounding.

Sources: **1990 and 2002:** Energy Information Administration (EIA), *International Energy Annual 2002*, DOE/EIA-0219(2002) (Washington, DC, March 2004), web site www.eia.doe.gov/iea/. **2015 and 2025:** EIA, System for the Analysis of Global Energy Markets (2005).

and a look at the major assumptions that form the basis of the forecasts that appear in the report. The chapter includes a discussion of the *IEO2005* macroeconomic forecast in the context of recent economic developments in key mature market, transitional, and emerging economies.

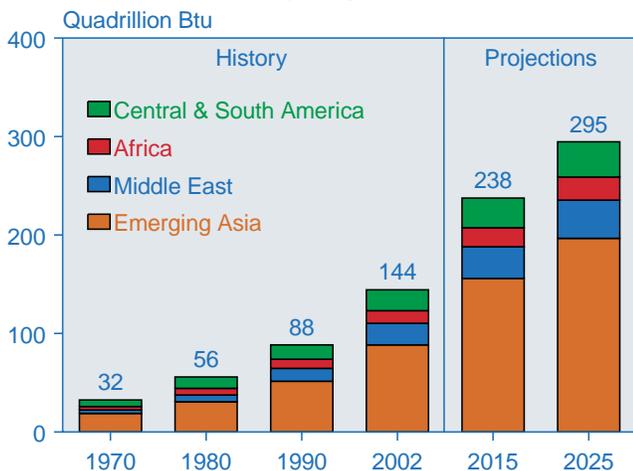
As with any set of forecasts, there is uncertainty associated with the *IEO2005* energy projections. In an effort to assess issues of uncertainty in the forecast, the following section considers some of the elements that drive the

Figure 8. World Marketed Energy Use by Region, 1970-2025



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

Figure 9. Marketed Energy Use in the Emerging Economies by Region, 1970-2025



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

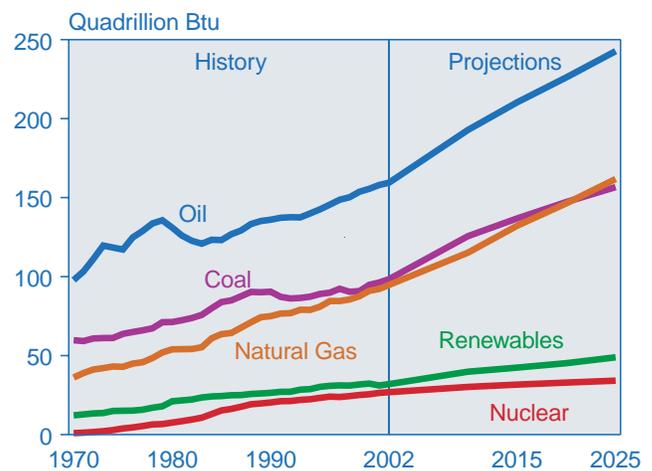
IEO2005 projections, which can result in a fair amount of variation in forecasting. Alternative assumptions about economic growth and their impacts on the *IEO2005* projections are considered, as well as the possible effects of future trends in energy intensity on the reference case projections.

Outlook for World Energy Consumption

The *IEO2005* reference case projects increased consumption of primary energy from all sources over the next two decades. Fossil fuels continue to supply much of the increment in marketed energy use worldwide throughout the forecast. Oil is expected to remain the dominant energy source over the projection period, with its share of total world energy consumption declining only slightly, from 39 percent in 2002 to 38 percent in 2025 (Figure 10).

Worldwide oil consumption is expected to rise from 78 million barrels per day in 2002 to 103 million barrels per day in 2015 and then to 119 million barrels per day in 2025. The projection for oil demand in 2025 is slightly lower than the 121 million barrels per day forecast in the *International Energy Outlook 2004* (*IEO2004*), and the difference is in large part explained by the change in expectations for world oil prices (Figure 11). In this year's outlook, world oil prices are assumed to stay higher for longer than anticipated in last year's report, and this dampens the mid-term projections for oil demand in many regions of the world—especially in the mature market economies and the EE/FSU. The impact of higher prices on world oil demand would be even

Figure 10. World Marketed Energy Use by Fuel Type, 1970-2025



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

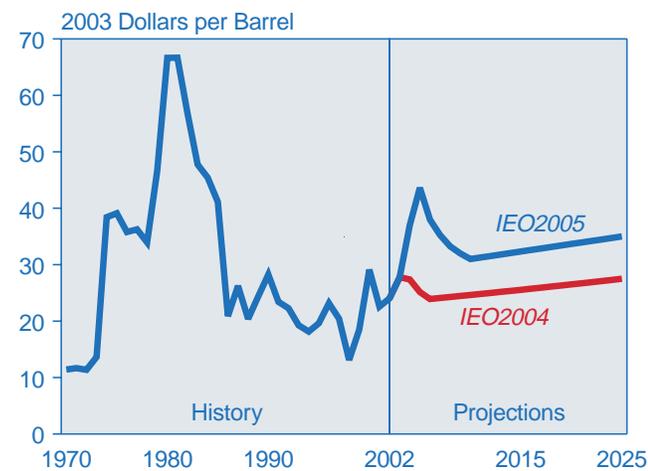
stronger without the robust growth expected for China in the near-term forecast. China's oil consumption is projected to increase at an average annual rate of 5.8 percent between 2002 and 2015, then slow to about half that rate in the remaining years of the forecast.

Worldwide, transportation and industry are the major growth sectors for oil demand. On a worldwide basis, the transportation sector—where there are currently no alternative fuels that compete widely with oil—accounts for about 60 percent of the total projected increase in oil use between 2002 and 2025, with the industrial sector accounting for virtually all the rest of the incremental demand.

Natural gas is projected to be the fastest growing primary energy source worldwide, maintaining average growth of 2.3 percent annually over the 2002 to 2025 period. Total world natural gas consumption is projected to rise from 92 trillion cubic feet in 2002 to 128 trillion cubic feet in 2015 and 156 trillion cubic feet in 2025.

Natural gas is expected to remain an important supply source for new electric power generation in the forecast. It 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. The industrial sector also remains an important

Figure 11. Comparison of IEO2004 and IEO2005 Projections for the U.S. Refiner Acquisition Cost of Imported Crude Oil, 1970-2025



Sources: **History:** Energy Information Administration (EIA), *Annual Energy Review 2003*, DOE/EIA-0384(2003) (Washington, DC, September 2004), web site www.eia.doe.gov/emeu/aer/contents.html. **IEO2004:** EIA, *International Energy Outlook 2004*, DOE/EIA-0484(2004) (Washington, DC, April 2004), web site www.eia.doe.gov/oiaf/ieo/index.html. **IEO2005:** *AEO-2005 October Futures Case* from EIA, *Annual Energy Outlook 2005*, DOE/EIA-0383(2005) (Washington, DC, February 2005), web site www.eia.doe.gov/oiaf/aEO/index.html.

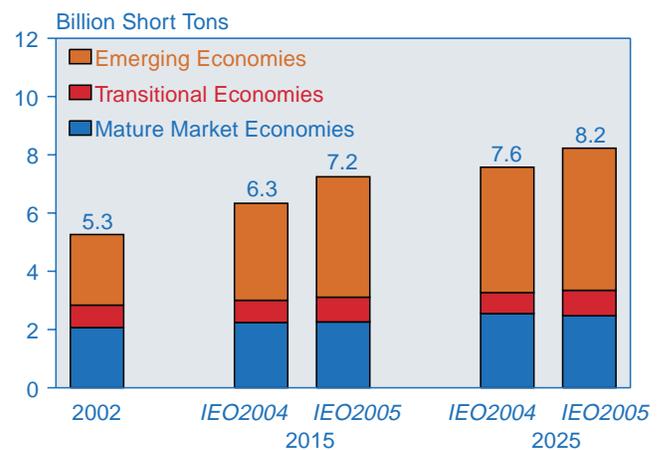
end-use consumer for natural gas worldwide. The electric power sector accounts for nearly 50 percent of the increase in global natural gas demand over the 2002 to 2025 period, and the industrial sector accounts for another 36 percent.

Coal use worldwide is projected to increase by 2.0 billion short tons between 2002 and 2015 and by another 1.0 billion short tons between 2015 and 2025. In this year's outlook for coal, all regions of the world show some increase in coal use, except for Western Europe, where natural gas and, to a lesser extent, renewable energy sources are increasingly being substituted for coal to fuel electric power generation. On a regional basis, slightly lower coal use is anticipated relative to last year's outlook in the mature market economies. In the transitional economies of the EE/FSU region, coal use was expected to decline somewhat in the *IEO2004* forecast, but in this year's forecast it is expected to increase by 0.5 percent per year between 2002 and 2025.

The *IEO2005* forecast for coal use in the emerging economies is nearly 13 percent higher than in *IEO2004* (Figure 12). The largest increases in coal use worldwide are projected for China and India, where coal supplies are plentiful. Together, China and India account for 87 percent of the projected rise in coal use in the emerging economies region and 72 percent of the total world increase in coal demand over the forecast period.

Electricity generation is expected to nearly double between 2002 and 2025, from 14,275 billion kilowatt-hours to 26,018 billion kilowatt-hours. The strongest

Figure 12. Comparison of IEO2004 and IEO2005 Projections for World Coal Consumption by Region, 2015 and 2025



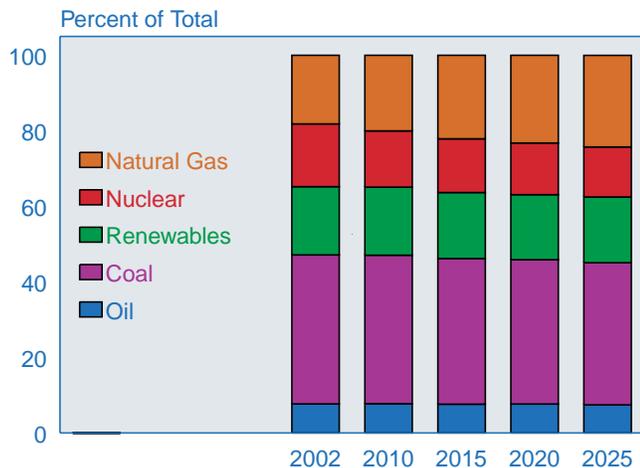
Sources: **2002:** Energy Information Administration (EIA), *International Energy Annual 2002*, DOE/EIA-0219(2002) (Washington, DC, March 2004), web site www.eia.doe.gov/iea/. **IEO2004:** EIA, *International Energy Outlook 2004*, DOE/EIA-0484(2004) (Washington, DC, April 2004), web site www.eia.doe.gov/oiaf/ieo/index.html. **IEO2005:** EIA, *System for the Analysis of Global Energy Markets* (2005).

growth in net electricity consumption is projected for the emerging economies of the world, averaging 4.0 percent per year in the *IEO2005* reference case, compared with a projected average increase of 2.6 percent per year worldwide. Robust economic growth in many of the emerging economies is expected to boost demand for electricity to run newly purchased home appliances for air conditioning, cooking, space and water heating, and refrigeration. More modest growth, averaging 1.5 percent per year, is projected for the mature market economies.

As noted above, natural gas is expected to be a favored choice for new electricity generation capacity built over the next two decades (Figure 13). Its relative environmental benefits and efficiency make natural gas an attractive alternative to coal-fired generation. Moreover, where fuel diversification is desired (as in China, where generation is heavily reliant on coal-fired capacity), natural gas is expected to gain share in the electric power mix over the forecast period. The natural gas share of total energy used to generate electricity worldwide increases in the forecast, from 18 percent in 2002 to 24 percent in 2025, with other energy sources showing small losses in market share.

Worldwide, consumption of electricity generated from nuclear power is expected to increase from 2,560 billion kilowatthours in 2002 to 3,032 billion kilowatthours in 2015 and 3,270 billion kilowatthours in 2025. The *IEO2005* world forecast for nuclear electricity generation is, in general, more optimistic than last year's forecast; the projection for nuclear generation in 2025 is 13 percent higher in *IEO2005* than it was in *IEO2004*. Prospects for nuclear power have improved in recent years, with higher capacity utilization rates reported for many

Figure 13. Fuel Shares of World Electricity Generation, 2002-2025



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

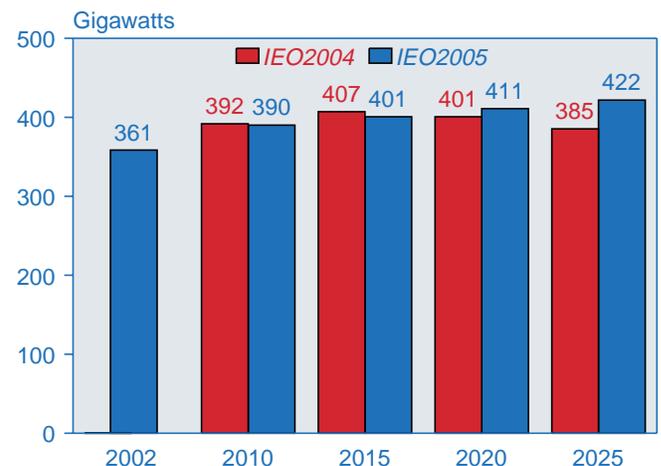
existing nuclear facilities and expectations that most existing plants in the mature market and transitional economy nations will receive approvals for extensions of their operating lives.

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 forecast period, and the world nuclear generation forecast includes new construction of nuclear plants in several countries. In *IEO2005*, unlike past *IEOs*, the world's total installed nuclear capacity is not projected to decline before 2025 (Figure 14). In the *IEO2005* reference case, world nuclear capacity is projected to rise from 361 gigawatts in 2002 to 401 gigawatts in 2015 and 422 gigawatts in 2025.

In the emerging economies, consumption of electricity from nuclear power is projected to increase by 4.9 percent per year between 2002 and 2025. Emerging Asia, in particular, is expected to see the largest increment in installed nuclear generating capacity over the forecast, accounting for 96 percent of the total projected increase in nuclear power capacity for the emerging economies. Of the 55 gigawatts of additional installed nuclear generating capacity projected for emerging Asia, 24 gigawatts is projected for China, 12 gigawatts for India, and 12 gigawatts for South Korea.

Although the use of hydroelectricity and other grid-connected renewable energy sources is expected to continue to expand over the projection period, increasing by 1.9 percent per year, more rapid growth is projected for both natural gas and coal demand in the reference case.

Figure 14. Comparison of *IEO2004* and *IEO2005* Projections for World Nuclear Generating Capacity, 2010-2025



Sources: **2002:** Energy Information Administration (EIA), *International Energy Annual 2002*, DOE/EIA-0219(2002) (Washington, DC, March 2004), web site www.eia.doe.gov/iea/. **IEO2004:** EIA, *International Energy Outlook 2004*, DOE/EIA-0484(2004) (Washington, DC, April 2004), web site www.eia.doe.gov/oiaf/ieo/index.html. **IEO2005:** EIA, System for the Analysis of Global Energy Markets (2005).

Still, renewables are expected to retain an 8-percent share of total world energy consumption throughout the 2002 to 2025 period. Much of the growth in renewable energy sources is expected to result from large-scale hydroelectric power projects in the developing world, particularly among the nations of emerging Asia. China, India, and Laos, among other emerging Asian economies, 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 future energy consumption. In the *IEO2005* forecast, 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 (see

box on page 13 for discussion of real GDP at purchasing power parity rates).

Over the 2002 to 2025 period, world economic growth is projected to average 3.9 percent annually (Table 2). This growth projection is slightly higher than the *IEO2004* projection, because economic performance in most regions of the world was exceptionally strong in 2003 and 2004. The medium- to long-term outlook for worldwide economic growth depends on the underlying demographic and productivity trends in each economy, which will determine the nature and character of long-term growth, especially in developed, mature market economies that have well-established and stable political institutions and markets for goods and services, labor, and financial assets.

In emerging nations that still are in the process of building human and physical capital infrastructures,

Table 2. Average Annual Growth in World Gross Domestic Product by Selected Countries and Regions, 1979-2025
(Percent per Year)

Region	History				Projections			
	1979-2002	2002	2003	2004	2005	2005-2015	2015-2025	2002-2025
Mature Market Economies	2.6	1.4	2.1	3.4	2.8	2.6	2.4	2.5
United States	2.9	1.9	3.0	4.4	3.6	3.1	2.9	3.1
Canada	2.8	3.4	2.0	3.0	3.3	2.8	2.0	2.4
Mexico	2.7	0.7	1.3	4.0	3.7	3.9	4.1	3.9
Japan	2.5	-0.3	2.5	4.1	2.0	1.7	1.2	1.7
Western Europe	2.3	1.1	0.9	2.2	2.1	2.1	2.0	2.0
Australia/New Zealand	3.2	4.0	3.0	3.8	3.2	2.6	2.4	2.6
Transitional Economies	-0.5	4.4	6.6	7.0	6.2	4.5	3.7	4.4
Former Soviet Union	-1.0	5.2	7.9	7.8	6.7	4.6	3.7	4.6
Eastern Europe	0.9	2.7	3.7	5.1	4.9	4.3	3.8	4.1
Emerging Economies	5.0	4.8	5.9	6.4	5.9	5.3	4.7	5.1
Emerging Asia	6.8	5.9	7.3	6.9	6.4	5.7	4.9	5.5
China	9.4	8.0	9.1	8.6	7.2	6.4	5.3	6.2
India	5.6	4.6	8.2	5.7	6.4	5.4	5.2	5.5
South Korea	6.7	6.9	3.1	4.3	5.8	4.8	2.8	3.9
Other Asia	5.4	4.1	4.8	5.8	5.1	4.8	4.3	4.6
Middle East	2.4	4.8	3.1	7.4	6.2	4.4	3.9	4.3
Africa	2.4	3.4	3.9	4.6	5.0	4.2	3.6	4.0
Central and South America	2.2	-0.5	1.2	4.1	3.7	4.0	4.0	3.9
Brazil	2.4	1.9	-0.2	4.3	3.8	3.9	4.0	3.8
Total World								
Purchasing Power Parity Rates	3.0	2.9	3.9	4.9	4.3	3.9	3.6	3.9
Market Exchange Rates	2.7	2.0	2.3	3.1	3.4	3.1	3.0	3.0

Note: All growth rates presented in this table are expressed as purchasing power parity rates, except for the final line of the table, which presents world GDP growth rates expressed as market exchange rates.

Sources: **Purchasing Power Parity Rates:** A. Heston, R. Summers, and B. Aten, "Penn World Table Version 6.1" (Philadelphia, PA: Center for International Comparisons at the University of Pennsylvania (CICUP), October 2002), web site http://pwt.econ.upenn.edu/php_site/pwt_index.php. **Historical Growth Rates:** Global Insight, Inc., *World Overview* (Lexington, MA, various issues). **Projected GDP Growth Rates:** Global Insight, Inc., *World Overview*, First Quarter 2005 (Lexington, MA, March 2005); and Energy Information Administration, *Annual Energy Outlook 2005*, DOE/EIA-0383(2005) (Washington DC, January 2005). China's growth rates were adjusted downward, based on the analyst's judgment.

establishing credible and effective regulatory mechanisms to govern markets, and ensuring political stability, progress in achieving those goals will play an equally important role in determining medium- to long-term growth. The transitional economies face their own unique sets of problems as they continue moving from centrally planned to decentralized private markets. Therefore, in contrast to the mature market economies, there is a broader range of uncertainty around the reference case projections of economic growth for emerging and transitional economies.

Mature Market Economies

In the United States, GDP is projected to grow by an average of 3.1 percent per year between 2005 and 2015, with somewhat slower growth—2.9 percent per year—expected between 2015 and 2025 as the baby boom generation retires and labor force growth slows. Compared with the second half of the 1990s, U.S. GDP growth rates were lower from 2000 to 2002 but rebounded to 3.0 percent in 2003 and an estimated 4.4 percent in 2004. In the forecast, the U.S. economy stabilizes at its long-term growth path between 2005 and 2010.

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 3.0 percent to 2.8 percent per year between 2005 and 2015 and 2.0 percent per year between 2015 and 2025.

In the *IEO2005* reference case, Mexico's GDP is projected to grow by an average of 3.9 percent per year from 2002 to 2025. 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.

Western Europe's GDP is projected to grow by 2.0 percent per year between 2002 and 2025 in the reference case. Over the medium to long term there are structural impediments to economic growth in many Western European countries, 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 [1].

Japan's GDP growth is projected to average 1.7 percent per year from 2002 to 2015 and then to slow to 1.2 percent per year from 2015 to 2025. 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. Toward the end of this decade, normal attrition is expected to eliminate surplus employment levels, especially in the industrial sector, allowing consolidation and improved efficiencies. More importantly, the bankrupt firms kept afloat by creditors are expected to be gone and, therefore, no longer a drain on the economy. In addition, the bad loans that have plagued Japan's banks are expected to be reduced to a point at which lending can resume. In the long term, after 2010, Japan's population is expected to decline, and the average age will continue to rise as a result of low birth rates and high longevity. As a result, transfer payments by the government to the elderly could become increasingly burdensome, leading to slower GDP growth.

Transitional Economies

Over the 2002-2025 period, an average annual growth of 4.6 percent is expected for the FSU as a whole. For the past several years, the FSU economies have been largely sheltered from global economic uncertainties, recording strong growth in each year since 2000. This trend is largely the result of robust domestic demand, in addition to the impact that rising oil prices have had 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. Given the volatility of energy market prices, however, it is unlikely that these 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 FSU economies hinge on their success in economic diversification, as well as further improvements in domestic product and financial markets.

An average annual expansion of 4.1 percent per year is projected for Eastern Europe's GDP over the 2002 to 2025 period. The accession of 10 Eastern European countries to membership in the European Union in May 2004 (Poland, Czech Republic, Slovakia, Hungary, Estonia, Latvia, Lithuania, Slovenia, Malta, and Cyprus) is expected to boost consumer confidence and economic activity in the medium to long term. Membership in the European Union is expected to result in more foreign direct investment, bolstering domestic investment and growth.

Emerging Economies

Much of the growth in world economic activity between 2002 and 2025 is expected to occur among the nations of emerging Asia, where regional GDP is projected to grow by 5.5 percent per year. China, emerging Asia's largest economy, is expected to continue playing a major role on both the supply and demand sides of the global

economy. *IEO2005* projects an average annual growth rate of approximately 6.2 percent for China's economy over the 2002 to 2025 period. The country's economic growth is expected to be the highest in the world. In 2025, based on share of world GDP (converted using

purchase power parity rates), China is expected to be the world's largest economy.

In terms of structural issues that have implications for the medium to long term, China still needs to reform

GDP Comparisons Based on Purchasing Power Parity Exchange Rates

Regular readers of the *International Energy Outlook (IEO)* will notice that, in this edition, the projections of real gross domestic product (GDP) for different countries and regions have been converted to U.S. dollars by using purchasing power parity (PPP) exchange rates. In all previous editions of the *IEO*, starting from 1985, market exchange rates were used for the conversion of real GDP projections.

PPP exchange rates are defined as rates of currency conversion that equalize the purchasing power of different currencies. For example, if the price of a hamburger in India is 60 rupees and in the United States it is \$2.20, then the PPP exchange rate for hamburgers between India and the United States is 60 rupees to \$2.20 or 27.3 rupees to the dollar. This concept of PPP for one good is generalized to a common basket of goods and services in the different countries to obtain PPP rates in practice. Market exchange rates on the other hand are the foreign currency prices of the dollar (or alternatively the dollar prices of foreign currencies) as traded in the foreign exchange markets.

In 2004 the average market exchange rate for a dollar in terms of Indian rupees was 45.3, compared with an average PPP rate of 7.3. Generally, PPP rates are much lower than market exchange rates in emerging economies, implying that a dollar buys a lot more in, for example, India or China than in the United States. Thus, converting emerging countries' GDPs into dollars at market exchange rates can understate the true size of their economies and their living standards.

Real GDP projections for country and regions have been employed as one of the major determinants in the world energy forecasts contained in every edition of *IEO*. It was stated in the *International Energy Outlook 2004* (pp. 17-18) that the energy projections were not

affected by the choice between market exchange and PPP rates for GDP conversions, because both rates of conversion would leave unchanged the underlying rates of growth of real economic activity.^a in the various countries/regions. However, some readers have rightly objected to the presentation of real GDP projections in a common currency based on market exchange rates,^b because they understate the true size of emerging economies. As a result, their growth rates get relatively less weight than they should, and when they are aggregated to regions and finally to the world, the regional and world growth rates are underestimated. Furthermore, the internationally agreed System of National Accounts 1993, to which the United States is a signatory, states, "When the objective is to compare volumes of goods and services produced or consumed per head, data in national currencies must be converted into a common currency by means of purchasing power parities and not exchange rates."^c

The use of PPP rates for converting national GDPs to a common currency has become widely accepted, and the Energy Information Administration has also adopted their use. Nevertheless, care needs to be exercised in interpreting the results.^d Market exchange rates are appropriate when the outcome is closely linked to the current exchange rate (for example, for exports and imports, especially of internationally traded commodities like crude oil, automobiles, etc.). PPP exchange rates are generally regarded as providing a better measure of the change in global economic well-being and cost of living. In addition, they are generally thought to provide a more balanced estimate of the relative importance of rich and poor countries. On the other hand, while PPP is useful for showing how much a country's currency is worth in its home market, it does not measure effective purchasing power across borders.

^aFor *IEO2005*, GDP projections were first prepared for individual countries in terms of their own currencies and the 2000 prices of goods and services. The projections were then converted to 2000 U.S. PPP dollars by dividing each country's real GDP projections by the PPP exchange rate between the United States and that country in 2000. Had the market exchange rate that existed, on average, in 2000 between each currency and the dollar been used instead, the growth rate of the resulting series would not differ from the growth rate of the real GDP series derived by using the 2000 PPP rate.

^bIan Castles, Visiting Fellow, Asia Pacific School of Government, the Australian National University (formerly head of Australia's National Statistical Office); and David Henderson, Visiting Professor, Westminster School of Business, University of Westminster (formerly Chief Economist at the Organization for Economic Cooperation and Development).

^cSNA 1993, para. 1.38. See web site <http://unstats.un.org/unsd/sna1993/toctop.asp>.

^dThe International Monetary Fund, the Organization for Economic Cooperation and Development, and some private-sector organizations use PPP exchange rates for their world economic growth projections. The World Bank and other groups in the private sector use market exchange rates.

overstaffed and inefficient state-owned companies and a banking system that is carrying a significant amount of nonperforming loans. Membership in the World Trade Organization is expected to force the government to pursue these reforms, which are expected to transform the Chinese economy into one that is more market oriented and, hence, more efficient.

Another Asian country with a rapidly emerging economy is India. The mid-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 2002 to 2025 forecast period is projected at 5.5 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 stimulating potential growth and reducing poverty in the medium to long term [2]. With its vast and cheap labor force, India is well placed to reap the benefits of globalization in the long run.

Although the nations of Central and South America are on favorable economic growth paths, the region's growth rate remains well 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. In the long term, beyond macroeconomic stability and commitment to sound fiscal and monetary policies, the countries of Central and South America will have to tackle governance issues and attempt to correct severe economic disparities between the wealthy and the poor in the region's societies.

Higher oil prices have helped boost growth in the oil-exporting countries of the Middle East and Africa, and strong prices for many other commodities have helped a number of the region's commodity-exporting countries. For Africa as a whole, average annual GDP growth of 4.0 percent is projected over the 2002 to 2025 period. In the longer run, Africa will continue to face formidable obstacles to growth, such as low savings and investment rates, 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.

Alternative Growth Cases

Expectations for the future rates of economic growth are a major source of uncertainty in the *IEO2005* forecast. To account for the uncertainties associated with economic growth trends, *IEO2005* 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 regional assumptions about economic growth paths—measured by GDP—and energy elasticity (the relationship between changes in energy consumption and changes in 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 industrial, transitional EE/FSU, and emerging economies. For the mature market economies, 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 industrialized world (excluding the FSU), reference case GDP growth rates are increased and decreased by 1.0 percentage point to provide the high and low economic growth case estimates.

The FSU 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 2002, its annual GDP growth rate has varied from -14 percent in 1992 to +9 percent in 2000. Given this wide range, the FSU nations can be characterized as having a considerably more uncertain economic future than the nations in other regions 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 forecasts for the FSU region.

The *IEO2005* reference case shows total world energy consumption reaching 645 quadrillion Btu in 2025, with the mature market economies projected to consume 272 quadrillion Btu, the transitional EE/FSU countries 78 quadrillion Btu, and the emerging economies 295 quadrillion Btu. In the high economic growth case, total world energy use in 2025 is projected to be 708 quadrillion Btu, 64 quadrillion Btu (or 32 million barrels oil equivalent per day) higher than in the reference case. Under the assumptions of the low economic growth case, worldwide energy consumption in 2025 is projected to be 58 quadrillion Btu (29 million barrels oil equivalent per day) lower than in the reference case, at 586 quadrillion Btu. Thus, there is a range of 122 quadrillion Btu—about one-fifth of the total consumption projected for 2025 in the reference case—between the projections in the high and low economic growth cases (Figure 15).

Trends in Energy Intensity

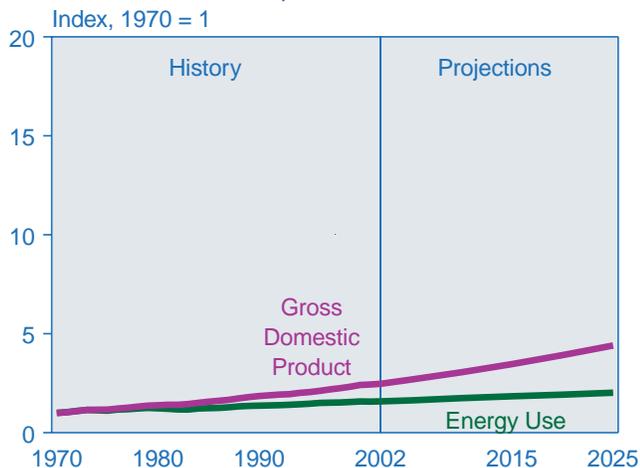
Another major source of uncertainty surrounding long-term forecasts is the relationship of energy use to

GDP—or energy intensity—over time. Economic growth and energy demand are linked, but the strength of that link varies among regions over time. In the mature market economies, history shows the link to be a relatively weak one, with energy demand lagging behind economic growth (Figure 16). In the emerging economies, demand and economic growth have been closely correlated with energy demand growth for much of the past three decades (Figure 17). 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 the FSU is problematic. Since World War II, the EE/FSU economies have had higher levels of energy intensity than either the mature market or emerging economies. In the FSU, however, energy consumption generally grew more quickly than GDP until 1990 (Figure 18), 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 the FSU has begun to outpace growth in energy use significantly, and energy intensity has begun to decline precipitously. Over the forecast horizon, energy intensity in the EE/FSU region is expected to continue to decline but still remain higher than in any other region of the world (Figure 19).

The stage of economic development and the standard of living of individuals in a given region strongly influence

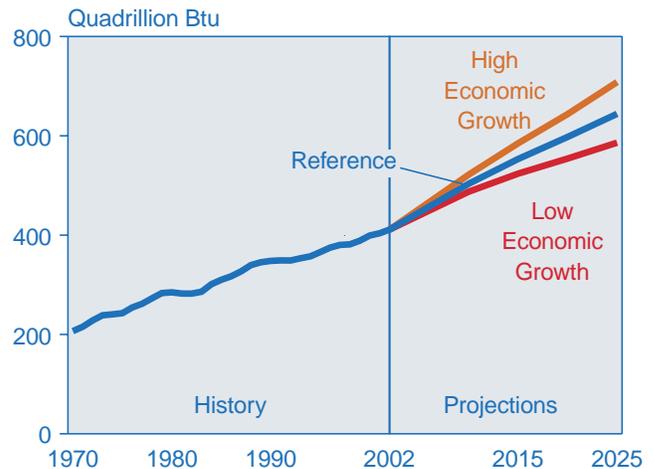
Figure 16. Growth in Energy Use and Gross Domestic Product for the Mature Market Economies, 1970-2025



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

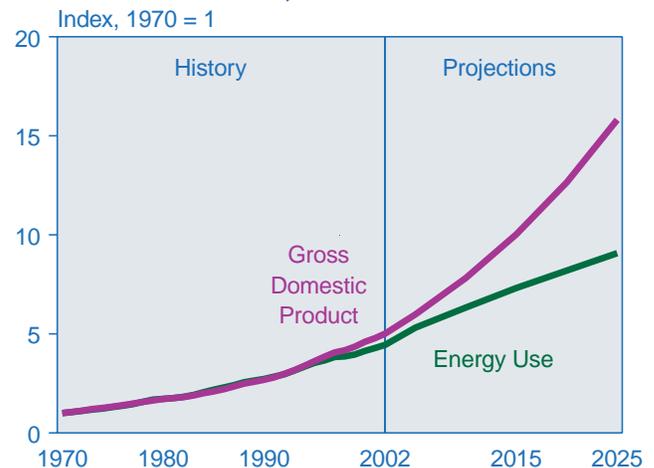
the link between economic growth and energy demand. Advanced economies with high living standards have a relatively high level of energy use per capita, but they also tend to be economies where per capita energy use is stable or changes very slowly. In mature market economies, there is a high penetration 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

Figure 15. World Marketed Energy Consumption in Three Economic Growth Cases, 1970-2025



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

Figure 17. Growth in Energy Use and Gross Domestic Product for the Emerging Economies, 1970-2025



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

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.

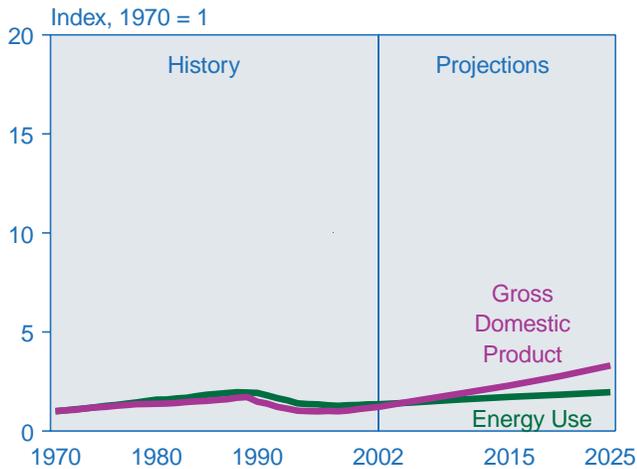
The pace of improvement in energy intensity may change, given different assumptions of macroeconomic growth over time. Faster growth in income means a faster rate of decline in energy intensity. Worldwide energy intensity in the *IEO2005* high economic growth rate is projected to improve by 2.1 percent per year on average from 2002 to 2025, compared with 1.9 percent in the reference case. On the other hand, slower economic growth would result in a slower rate of decline in energy intensity. Under the *IEO2005* assumptions for GDP

growth in the low macroeconomic growth case, world energy intensity is projected to decline by an average of only 1.5 percent per year over the projection period.

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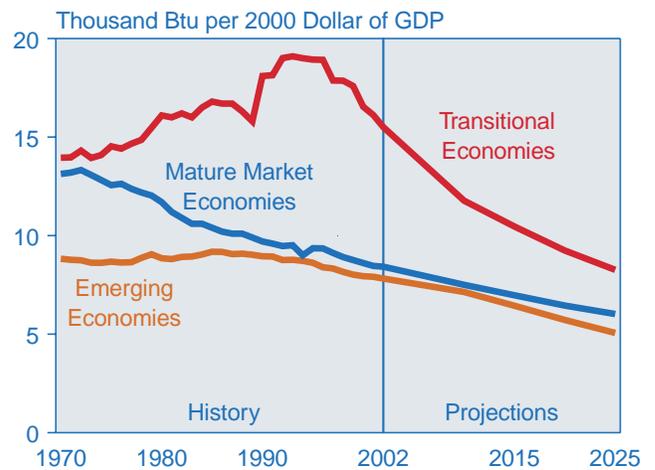
1. International Monetary Fund, "Economic Prospects and Policy Issues," in *World Economic Outlook* (Washington, DC, April 2005), p. 28, web site www.imf.org/external/pubs/ft/weo/2003/02/.
2. International Monetary Fund, "Economic Prospects and Policy Issues," in *World Economic Outlook: Globalization and External Imbalances* (Washington, DC, April 2005), p. 29, web site www.imf.org/external/pubs/ft/weo/2005/01/.

Figure 18. Growth in Energy Use and Gross Domestic Product for the Transitional Economies, 1970-2025



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

Figure 19. Energy Intensity by Region, 1970-2025



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