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**Before the  
SUBCOMMITTEE ON ENERGY AND MINERAL RESOURCES  
COMMITTEE ON RESOURCES  
U.S. HOUSE OF REPRESENTATIVES**

**March 16, 2005**

**Mr. Chairman and Members of the Committee:**

I appreciate the opportunity to appear before you today to discuss the impact of increases in global energy demand on U.S. energy needs, security, and policy, particularly the impact of sustained increases in emerging economies such as China and India.

The Energy Information Administration (EIA) is an independent statistical and analytical agency within the Department of Energy. We are charged with providing objective, timely, and relevant data, analysis, and projections for the use of Congress, the Administration, and the public. We do not take positions on policy issues, but we do produce data, analysis, and forecasts that are meant to assist policy makers in their energy policy deliberations. Because we have an element of statutory independence with respect to the analyses, our views are strictly those of EIA and should not be construed as representing those of the Department of Energy or the Administration. However, EIA's baseline projections on energy trends are widely used by government agencies, the private sector, and academia for their own energy analyses.

The *Annual Energy Outlook* provides projections and analysis of domestic energy consumption, supply, prices, and energy-related carbon dioxide emissions through 2025. *Annual Energy Outlook 2005 (AEO2005)* is based on Federal and State laws and regulations in effect on October 31, 2004. The potential impacts of pending or proposed legislation, regulations, and standards—or of sections of legislation that have been enacted but that require funds or implementing regulations that have not been provided or specified—are not reflected in the projections.

The U.S. projections in this testimony are based on the *AEO2005*, which was released on the EIA website on February 11, 2005. In addition to the long-term U.S. forecast of energy markets, EIA also prepares a long-term outlook for world energy markets, which is published annually in the *International Energy Outlook (IEO)*. The latest edition of this report, the *IEO2004*, was published in April 2004. The projections in the *AEO2005* and the *IEO2004* are not meant to be exact predictions of the future but represent likely energy futures, given technological and demographic trends, current laws and regulations, and consumer behavior as derived from known data. EIA recognizes that projections of energy markets are highly uncertain and subject to many random events that cannot be foreseen such as weather, political disruptions, and technological breakthroughs. In addition to these phenomena, long-term trends in technology development, demographics, economic growth, and energy resources may evolve along a different path than expected in the projections. Both the *AEO2005* and the *IEO2004* include a large number of alternative cases intended to examine these uncertainties. The *AEO2005* and *IEO2004* provide integrated projections of U.S. and world energy market trends for roughly the next two decades. The following discussion briefly summarizes the highlights from *AEO2005* for U.S. energy demand and supply. It is followed by a discussion of the key trends in world energy markets projected in the *IEO2004*, with a focus on China and India.

## U.S. Energy Outlook

### U.S. Energy Prices

In the *AEO2005* reference case, the annual average world oil price<sup>1</sup> increases from \$27.73 per barrel (2003 dollars) in 2003 (\$4.64 per million Btu) to \$35.00 per barrel in 2004 (\$5.86 per million Btu) and then declines to \$25.00 per barrel in 2010 (\$4.18 per million Btu) as new supplies enter the market. It then rises slowly to \$30.31 per barrel in 2025 (\$5.07 per million Btu) (**Figure 1**). In nominal dollars, the average world oil price is about \$52 per barrel in 2025 (\$8.70 per million Btu).

There is a great deal of uncertainty about the size and availability of crude oil resources, particularly conventional resources, the adequacy of investment capital, and geopolitical trends. For example, the *AEO2005* reference case assumes that world crude oil prices will decline as growth in consumption slows and producers increase their productive capacity and output in response to current high prices; however, the October 2004 oil futures prices case for West Texas Intermediate crude oil (WTI) on the New York Mercantile Exchange (NYMEX) implies that the average annual oil price in 2005 will exceed its 2004 level before declining to levels that still would be above those projected in the reference case. While not discussed here, the *AEO2005* includes other cases based on alternative world crude oil price paths to evaluate this uncertainty.

In the *AEO2005*, average wellhead prices for natural gas in the United States are projected to decrease from \$4.98 per thousand cubic feet (2003 dollars) in 2003 (\$4.84 per million Btu) to \$3.64 per thousand cubic feet in 2010 (\$3.54 per million Btu) as the availability of new import sources and increased drilling expand available supply. After 2010, wellhead prices are projected to increase gradually, reaching \$4.79 per thousand cubic feet in 2025 (\$4.67 per million Btu) (about \$8.20 per thousand cubic feet or \$7.95 per million Btu in nominal dollars). Growth in liquefied natural gas (LNG) imports, Alaska production, and lower-48 production from nonconventional sources is not expected to increase sufficiently to offset the impacts of resource depletion and increased demand in the lower-48 States.

In *AEO2005*, the combination of more moderate increases in coal production, expected improvements in mine productivity, and a continuing shift to low-cost coal from the Powder River Basin in Wyoming leads to a gradual decline in the average minemouth price, to approximately \$17 per ton (2003 dollars) (\$0.86 per million Btu) shortly after 2010. The price is projected to remain nearly constant between 2010 and 2020, increasing after 2020 as rising natural gas prices and the need for baseload generating capacity lead to the construction of many new coal-fired generating plants. By 2025, the average minemouth price is projected to be \$18.26 per ton (\$0.91 per million Btu). The *AEO2005* projection is equivalent to an average minemouth coal price of \$31.25 per ton in nominal dollars (\$1.56 per million Btu) in 2025.

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<sup>1</sup> World oil prices in *AEO2005* are defined based on the average refiner acquisition cost of imported oil to the United States (IRAC). The IRAC price tends to be a few dollars less than the widely-cited West Texas Intermediate (WTI) spot price and has been as much as six dollars per barrel lower than the WTI in recent months. For the first 11 months of 2004, WTI averaged \$41.31 per barrel (\$7.12 per million Btu), while IRAC averaged \$36.94 per barrel (nominal dollars) (\$6.26 per million Btu).

Average delivered electricity prices are projected to decline from 7.4 cents per kilowatthour (2003 dollars) (\$21.68 per million Btu) in 2003 to a low of 6.6 cents per kilowatthour (\$19.34 per million Btu) in 2011 as a result of an increasingly competitive generation market and a decline in natural gas prices. After 2011, average real electricity prices are projected to increase, reaching 7.3 cents per kilowatthour (2003 dollars) (\$21.38 per million Btu) in 2025 (equivalent to 12.5 cents per kilowatthour or \$36.61 per million Btu in nominal dollars).

## **U.S. Energy Consumption and Supply**

Total energy consumption is projected to grow at about one-half the rate (1.4 percent per year) of gross domestic product (GDP), with the strongest growth in energy consumption for electricity generation and commercial and transportation uses (**Figure 2**). Total energy consumption is expected to increase more rapidly than domestic energy supply through 2025. As a result, net imports of energy are projected to meet a growing share of energy demand. Net imports are expected to constitute 38 percent of total U.S. energy consumption in 2025, up from 27 percent in 2003 (**Figure 3**).

Total petroleum demand is projected to grow at an average annual rate of 1.5 percent in the *AEO2005* reference case forecast, from 20.0 million barrels per day in 2003 to 27.9 million barrels per day in 2025 (**Figure 4**) led by growth in transportation uses, which account for 67 percent of total petroleum demand in 2003, increasing to 71 percent in 2025. Improvements in the efficiency of vehicles, planes, and ships are more than offset by growth in travel. In 2025, net petroleum imports, including both crude oil and refined products (on the basis of barrels per day), are expected to account for 68 percent of demand, up from 56 percent in 2003.

In the U.S. energy markets, the transportation sector consumes about two-thirds of all petroleum products and the industrial sector about one-quarter. The remaining 10 percent is divided among the residential, commercial, and electric power sectors. With limited opportunities for fuel switching in the transportation and industrial sectors, large price-induced changes in U.S. petroleum consumption are unlikely, unless changes in petroleum prices are very large or there are significant changes in the efficiencies of petroleum-using equipment.

Total demand for natural gas is also projected to increase at an average annual rate of 1.5 percent from 2003 to 2025 (**Figure 5**). About 75 percent of the growth in gas demand from 2003 to 2025 results from increased use in power generation and in industrial applications. Growth in U.S. natural gas supplies will depend on unconventional domestic production, natural gas from Alaska, and imports of LNG. Total nonassociated unconventional natural gas production is projected to grow from 6.6 trillion cubic feet in 2003 to 8.6 trillion cubic feet in 2025. With completion of an Alaskan natural gas pipeline projected for 2016, total Alaskan production is forecast to increase from 0.4 trillion cubic feet in 2003 to 2.2 trillion cubic feet in 2025. Total net LNG imports in the United States and the Bahamas are projected to increase from 0.4 trillion cubic feet in 2003 to 6.4 trillion cubic feet in 2025.

Total coal consumption is projected to increase from 1,095 million short tons in 2003 to 1,508 million short tons in 2025, growing by 1.5 percent per year. About 90 percent of the coal is currently used for electricity generation. Coal remains the primary fuel for generation and its share of generation is expected to remain about 50 percent between 2003 and 2025. Total coal

consumption for electricity generation is projected to increase by an average of 1.6 percent per year, from 1,004 million short tons in 2003 to 1,425 million short tons in 2025.

Total electricity consumption, including both purchases from electric power producers and on-site generation, is projected to grow from 3,657 billion kilowatthours in 2003 to 5,467 billion kilowatthours in 2025, increasing at an average rate of 1.8 percent per year. Rapid growth in electricity use for computers, office equipment, and a variety of electrical appliances in the end-use sectors is partially offset in the *AEO2005* forecast by improved efficiency in these and other, more traditional electrical applications and by slower growth in electricity demand in the industrial sector.

Total marketed renewable fuel consumption, including ethanol for gasoline blending, is projected to grow by 1.5 percent per year in *AEO2005*, from 6.1 quadrillion Btu in 2003 to 8.5 quadrillion Btu in 2025, largely as a result of State mandates for renewable electricity generation and the effect of production tax credits. About 60 percent of the projected demand for renewables in 2025 is for grid-related electricity generation (including combined heat and power), and the rest is for dispersed heating and cooling, industrial uses, and fuel blending.

### **International Energy Outlook**

The *IEO2004* includes projections of regional energy consumption, energy consumption by primary fuel, electricity consumption, carbon dioxide emissions, nuclear generating capacity, and international coal trade flows. World oil production and natural gas production forecasts are also included in the report. The *IEO2004* projects strong growth for worldwide energy demand through 2025. Total world consumption of marketed energy is expected to increase by 54 percent, from 404 quadrillion Btu in 2001 to 623 quadrillion Btu in 2025.

### **World Energy Consumption by Region**

The *IEO2004* reference case outlook shows the strongest growth in energy consumption in the developing nations of the world (**Figure 6**). The fastest growth is projected for the nations of developing Asia, including China and India, where robust economic growth accompanies the increase in energy consumption over the forecast period. GDP in developing Asia is expected to grow at an average annual rate of 5.1 percent, compared with 3.0 percent per year for the world as a whole. With such strong growth in GDP, demand for energy in developing Asia is projected to double over the forecast period, accounting for 40 percent of the total projected increment in world energy consumption and 70 percent of the increment for the developing world alone. Energy demand increases by 3.0 percent per year in developing Asia as a whole and by 3.5 percent per year in China and 3.2 percent per year in India.

Developing world energy demand is projected to rise strongly outside of Asia, as well. In the Middle East, energy use increases by an average of 2.1 percent per year between 2001 and 2025, 2.3 percent per year in Africa, and 2.4 percent per year in Central and South America.

In contrast to the developing world, slower growth in energy demand is projected for the industrialized world, averaging 1.2 percent per year over the forecast period. Generally, the nations of the industrialized world can be characterized as mature energy consumers with comparatively slow population growth. Gains in energy efficiency and movement away from

energy-intensive manufacturing to service industries result in the lower growth in energy consumption. In the transitional economies of Eastern Europe and the former Soviet Union (EE/FSU) energy demand is projected to grow by 1.5 percent per year in the *IEO2004* reference case. Slow or declining population growth in this region, combined with strong projected gains in energy efficiency as old, inefficient equipment is replaced, leads to the projection of more modest growth in energy use than in the developing world.

### **World Energy Consumption by Energy Source**

Oil will continue to be the world's dominant energy source. Oil's share of world energy remains unchanged at 39 percent over the forecast period. China, India, and the other countries of developing Asia account for much of the increase in oil use in the developing world and, indeed, in the world as a whole (**Figure 7**). Developing Asia oil consumption is expected to grow from 14.8 million barrels per day in 2001 to 31.6 million barrels per day in 2025, an increase of 16.9 million barrels per day. The developing Asian increase in oil use accounts for 39 percent of the total world increment in oil use over the forecast period. China and India alone account for one-fourth of the world oil increment between 2001 and 2025. In the industrialized world, increases in oil use are projected primarily in the transportation sector. In the developing world, demand for oil increases for all end uses, as countries replace non-marketed fuels used for home heating and cooking with diesel generators and for industrial petroleum feedstocks.

The *IEO2004* reference case shows supply able to keep up with demand over the next 20 years, with world oil consumption in the range of 120 million barrels per day by 2025. EIA's view, which is based on information from the latest United States Geological Survey (USGS) World Petroleum Assessment on oil resources and reserves, is that potential supply concerns to 2025 arise primarily from obstacles to investment in capacity growth rather than resource adequacy. Our view in this regard is shared by many analysts, but differs from some analysts who are concerned about an imminent "peak oil" problem. In EIA's view, the ultimate size of an oil field is rarely known when it is discovered. Rather, with drilling and improved technology, the full extent of the recoverable resource typically increases over time. This process is demonstrated at the national level by the increase in U.S. proved reserves of oil in 5 of the last 7 years notwithstanding significant production and limited discoveries. Global proved reserves are also higher today than they were 30 years ago, despite substantially increased production.

While we believe that sufficient oil resources are available to meet the projected growth in demand to 2025, substantial investment will be required to bring these resources into production. Although the *IEO2004* reference case forecast assumes that the necessary investments will be made based on economic criteria, there are several important barriers to investment that could impede realization of this scenario. Some of the main challenges are: 1) international major producers lack access to resources in some key countries; 2) national oil companies are guided by governments and are not always motivated to expand capacity based on economic criteria; 3) political instability limits development in some regions; and 4) poor economic terms that slow investment.

Natural gas demand is projected to show an average annual growth of 2.2 percent over the forecast period. Gas is seen as a desirable option for electricity, given its efficiency relative to other energy sources and the fact that it burns more cleanly than either coal or oil. The most robust growth in gas demand is expected among the nations of the developing world, where overall demand is expected to grow by 2.9 percent per year from 2001 to 2025 in the reference case (**Figure 8**). In the industrialized world, where natural gas markets are more mature, consumption of natural gas is expected to increase by an average of 1.8 percent per year over that same time period, with the largest increment projected for North America at 12.9 trillion cubic feet. China, India, and the other nations of developing Asia are expected to experience among the fastest growth in gas use worldwide, increasing by 3.5 percent per year between 2001 and 2025.

Coal remains an important fuel in the world's electricity markets and is expected to continue to dominate fuel markets in developing Asia. Worldwide, coal use is expected to grow slowly, averaging 1.5 percent per year between 2001 and 2025. In the developing world, coal increases by 2.5 percent per year and will surpass coal use in the rest of the world (the industrialized world and the EE/FSU combined) by 2015. Coal continues to dominate energy markets in China and India, owing to those countries' large coal reserves and limited access to other sources of energy. China and India account for 67 percent of the total expected increase in coal use worldwide (on a Btu basis) (**Figure 9**). Coal use is projected to increase in all regions of the world except for Western Europe and the EE/FSU (excluding Russia), where coal is projected to be displaced by natural gas and, in the case of France, by nuclear power for electric power generation.

The largest increase in nuclear generation is expected for the developing world, where consumption of electricity from nuclear power is projected to increase by 4.1 percent per year between 2001 and 2025. Developing 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 increase in nuclear power capacity for the developing world as a whole. Of the 44 gigawatts of additional installed nuclear generating capacity projected for developing Asia, 19 gigawatts are projected for China, 15 for South Korea, and 6 for India.

Consumption of electricity from hydropower and other renewable energy sources is expected to grow by 1.9 percent per year over the projection period. Much of the growth in renewable energy use is expected to result from large-scale hydroelectric power facilities in the developing world, particularly among the nations of developing Asia. China, India, and other developing Asian countries are constructing or planning many new, large-scale hydroelectric projects over the forecast period, including China's 18.2-gigawatt Three Gorges Dam project which is scheduled to be fully operational by 2009. The Indian government has plans to add 50 gigawatts of hydroelectric generating capacity by 2012.

### **Alternative International Forecasts**

As noted earlier, there is considerable uncertainty associated with any long-term forecast. Changes in key assumptions about economic growth and energy intensity lead to substantial differences in the projections for 2025. To quantify this uncertainty, *IEO2004* includes high and low economic growth cases. The *IEO2004* reference case shows total world energy consumption reaching 623 quadrillion Btu in 2025, but this varies substantially under different assumptions about economic growth, ranging from 542 quadrillion Btu (in the low economic growth case) to

710 quadrillion Btu (in the high economic growth case). Thus, there is a substantial range of 168 quadrillion Btu, or about one-fourth of the total consumption projected for 2025 in the reference case, between the projections in the high and low economic growth cases.

While it is true that there is a great deal of uncertainty in long-term forecasts, it is equally true that EIA's forecast of worldwide energy use is largely in agreement with projections from other organizations that provide comparable forecasts. The International Energy Agency's (IEA) *World Energy Outlook 2004* (October 2004), Petroleum Economics, Ltd's (PEL) *World Long Term Oil and Energy Outlook* (March 2004), and PIRA Energy Group's (PIRA) *Retainer Client Seminar* (October 2004) all produce forecasts that are comparable to the *IEO2004*. Three of the four forecasts expect worldwide energy use to expand by about 1.8 to 1.9 percent per year (*IEO2004*, IEA, and PEL) between 2000 and 2020 (**Figure 10**). PIRA proffers a more robust forecast, expecting energy use to expand by 2.4 percent per year, but the PIRA forecast only extends to 2015.

The forecasts show some variation in expectations for the world's future fuel mix. The forecasts do have similar expectations about the growth of oil over the 2000 to 2020 time period (except for PIRA, which forecasts only to 2015), projecting average annual increases of between 1.6 percent (PEL) and 1.9 percent (PIRA). They also generally agree that natural gas will be among the fastest growing energy sources in the forecast, although the increase in world natural gas demand in the *IEO2004* at 2.1 percent per year is somewhat lower than the other forecasts, where the growth in natural gas use ranges from 2.6 percent per year to 2.8 percent per year. However, the PIRA forecast sees a much higher increase in coal use than do any of the other forecasts. *IEO2004* expects higher growth for nuclear power than the other forecasts, and the IEA projects higher expected growth in renewables than the other forecasts.

## Conclusion

Continuing economic growth in populous countries of the world, such as China, India, and the United States, is expected to stimulate more energy demand, with fossil fuels remaining the dominant source of energy. While our analysis suggests that world fossil energy resources are adequate to meet demand requirements, it also suggests that the countries accounting for most of the growth in fossil energy consumption will increasingly rely on imports. Dependence on foreign sources of oil is expected to increase significantly for China, India, and the United States. These three countries alone account for 45 percent of the world increase in projected oil demand over the 2001 to 2025 time frame. A key source of this oil is expected to be the Middle East.

Furthermore, although natural gas production is expected to increase in all of these countries, natural gas imports are expected to grow faster. In 2001, India and China produced sufficient natural gas to meet domestic demand, but, by 2025, natural gas production in these two countries will only account for about 60 percent of demand. In the United States, reliance on domestic gas supply to meet demand falls from 86 percent to 72 percent over the projection period. The growing dependence on imports in these three countries occurs despite efficiency improvements in both the consumption and the production of natural gas.

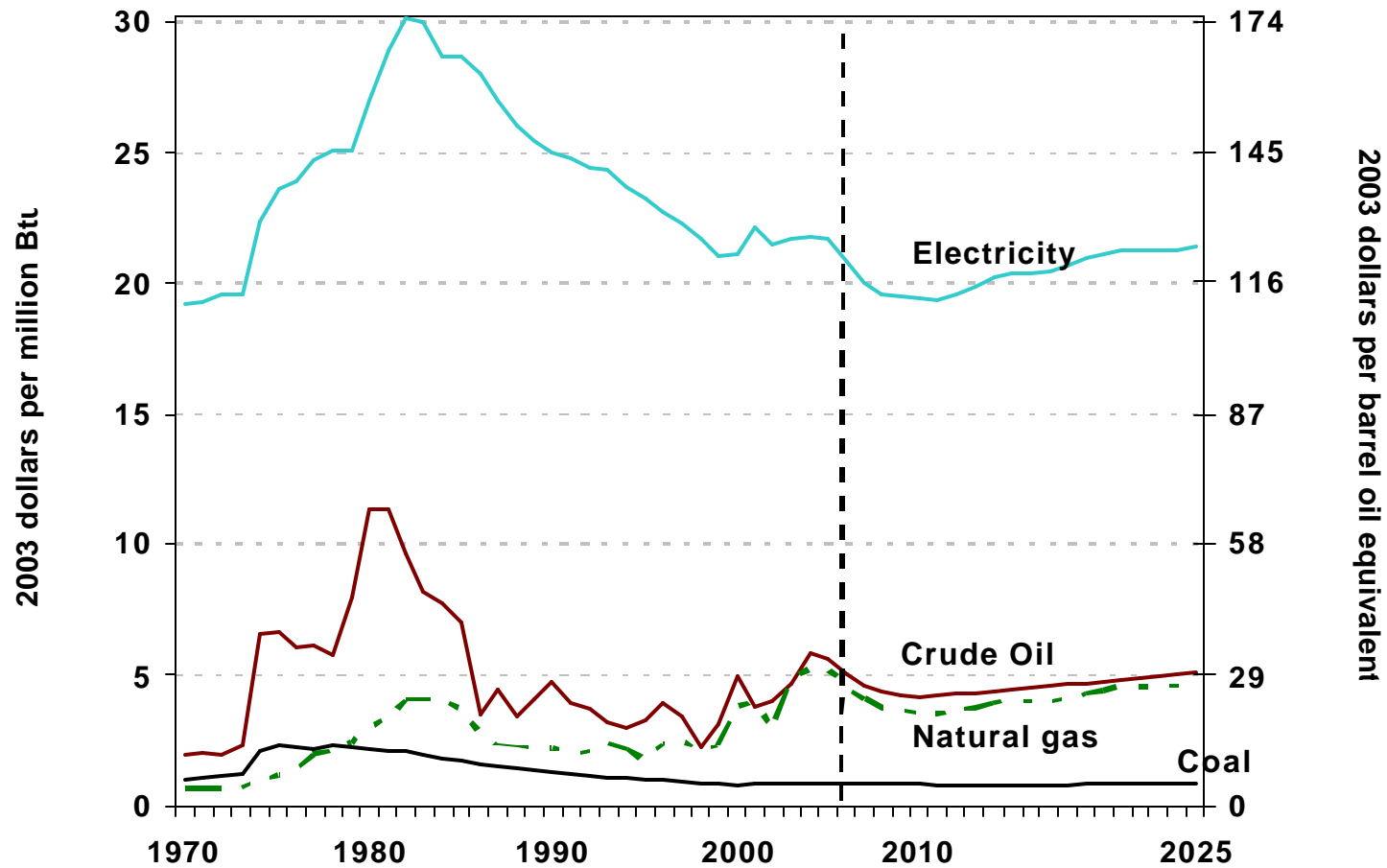
In this environment, the level of energy prices, particularly oil prices, is highly uncertain. It depends on the adequacy of investment in exploration and production efforts, technology, and



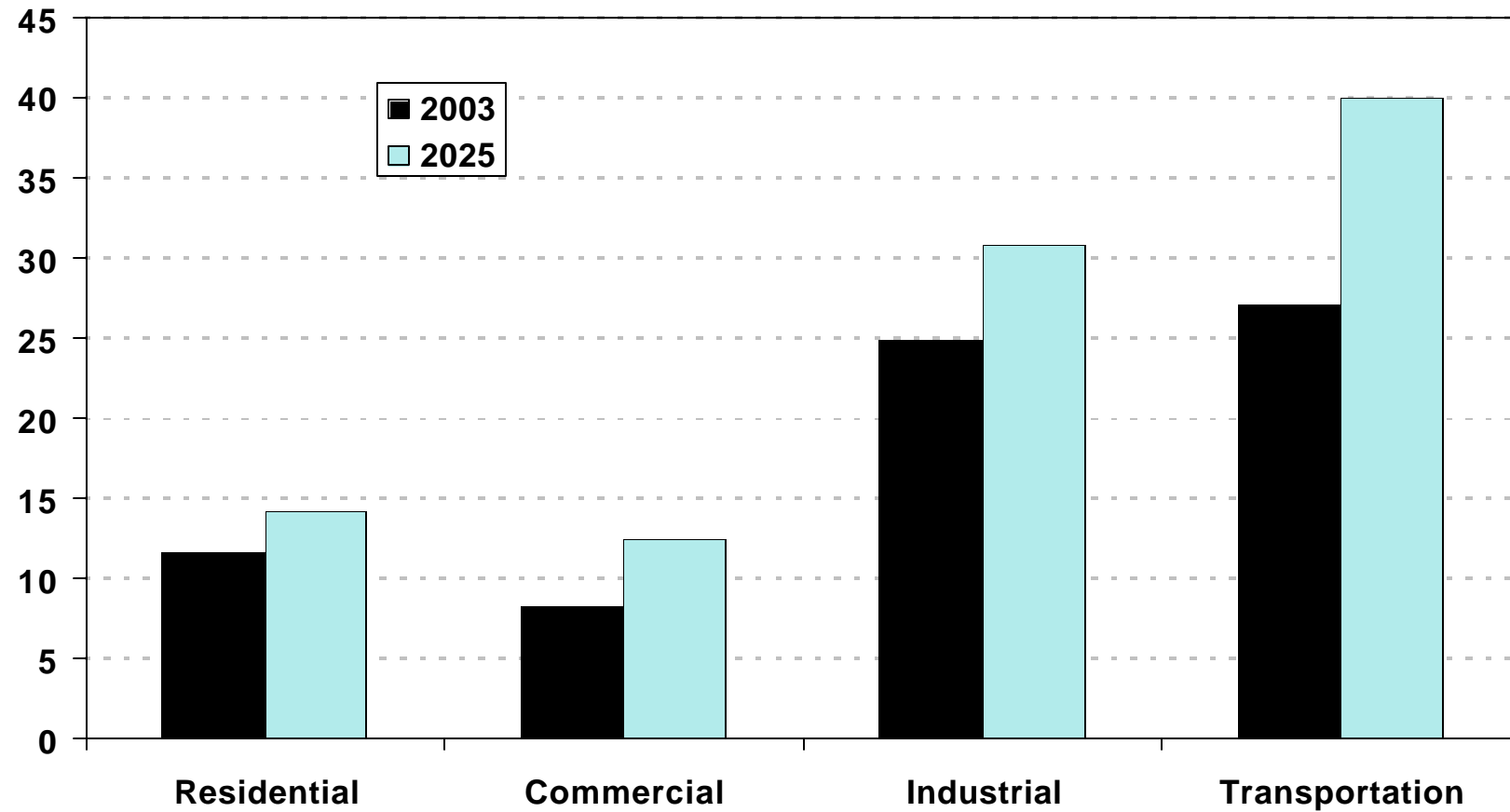
infrastructure. It also depends on the actual rate of growth in demand, political stability around the world, and improvement in end-use technologies. Higher energy price trends can lead to major changes in the energy supply slate and, if energy prices are high enough, the level of demand. For example, in a high oil price case completed as part of *AEO2005*, gas-to-liquids and coal-to-liquids became important parts of total U.S. energy supply by 2025. Unconventional oil and natural gas resources can also play a much larger role.

This concludes my testimony, Mr. Chairman and members of the Committee. I will be happy to answer any questions you may have.

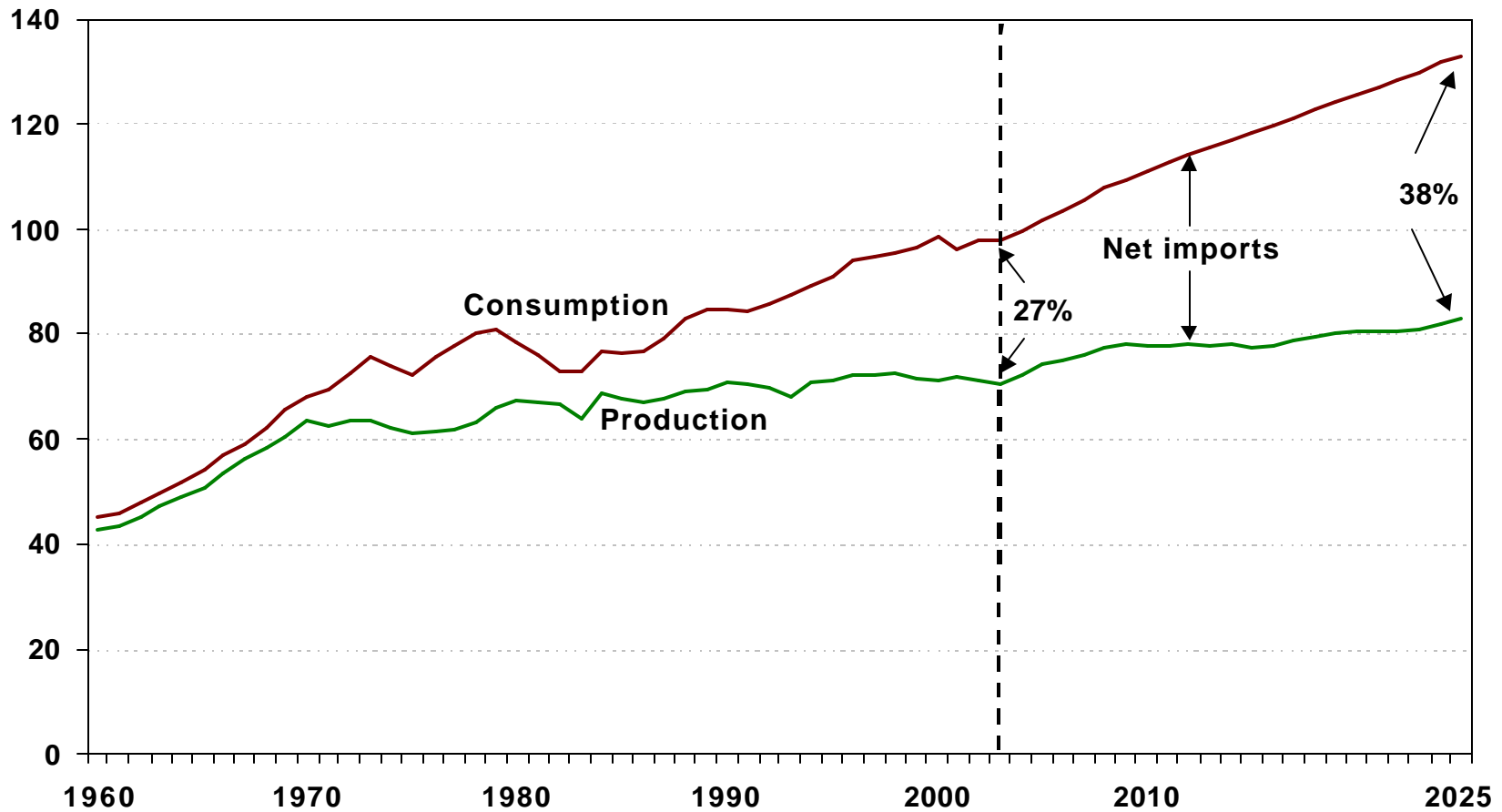
**Figure 1. U.S. Energy Prices, 1970-2025**



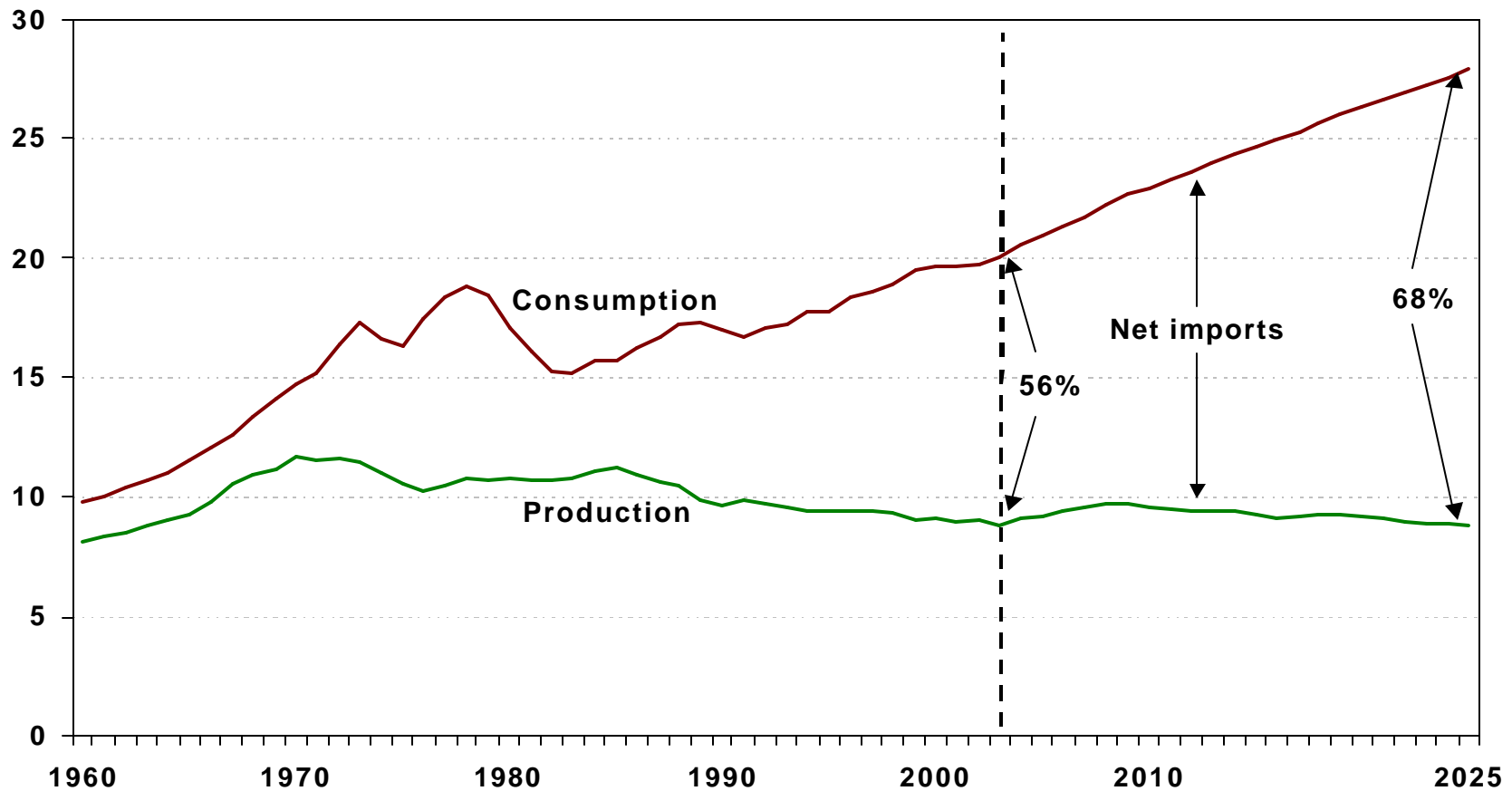
**Figure 2. U.S. Delivered Energy Consumption by Sector, 2003 and 2025 (quadrillion Btu)**



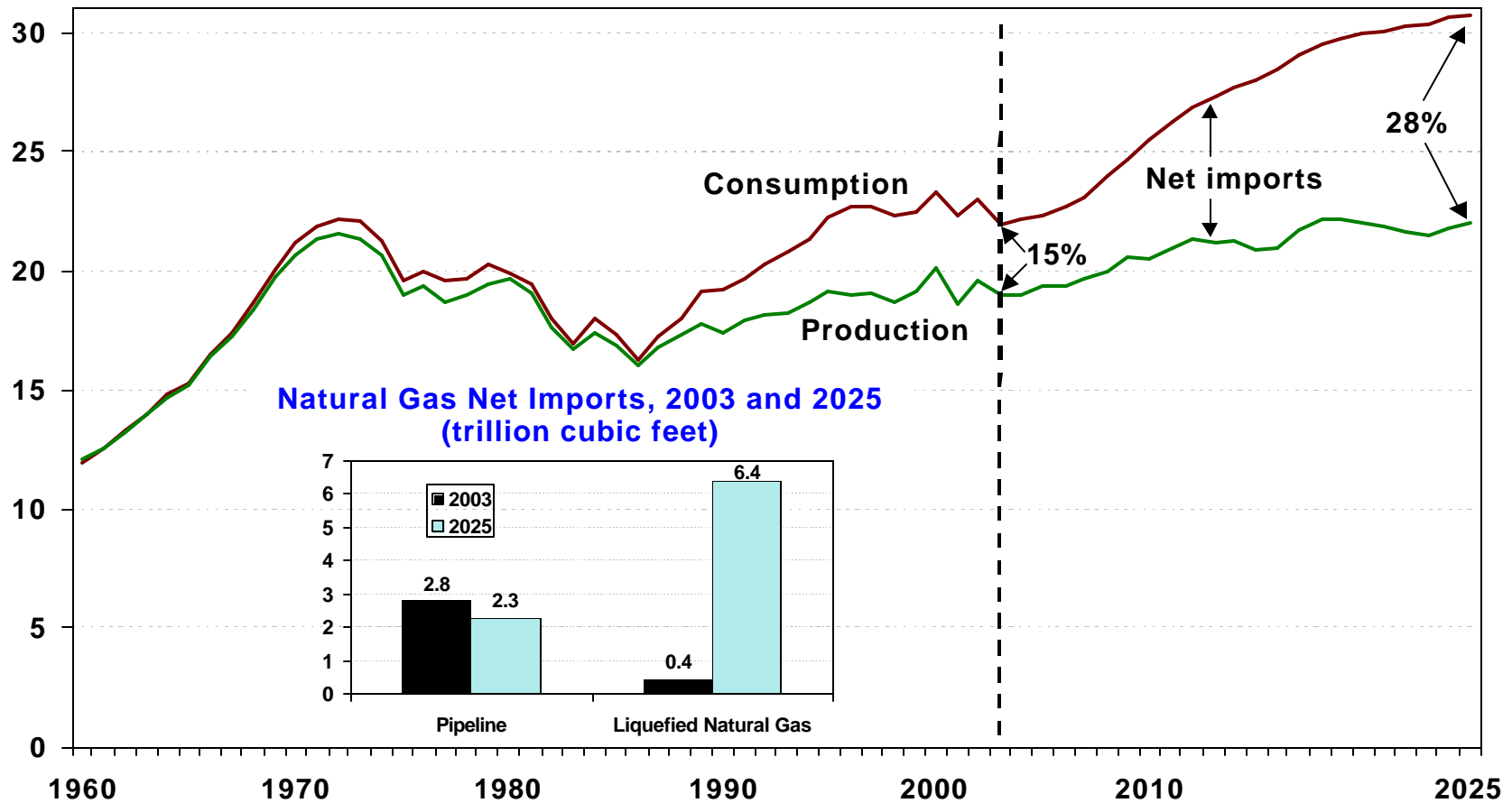
**Figure 3. U.S. Energy Production, Consumption, and Net Imports, 1960-2025 (quadrillion Btu)**



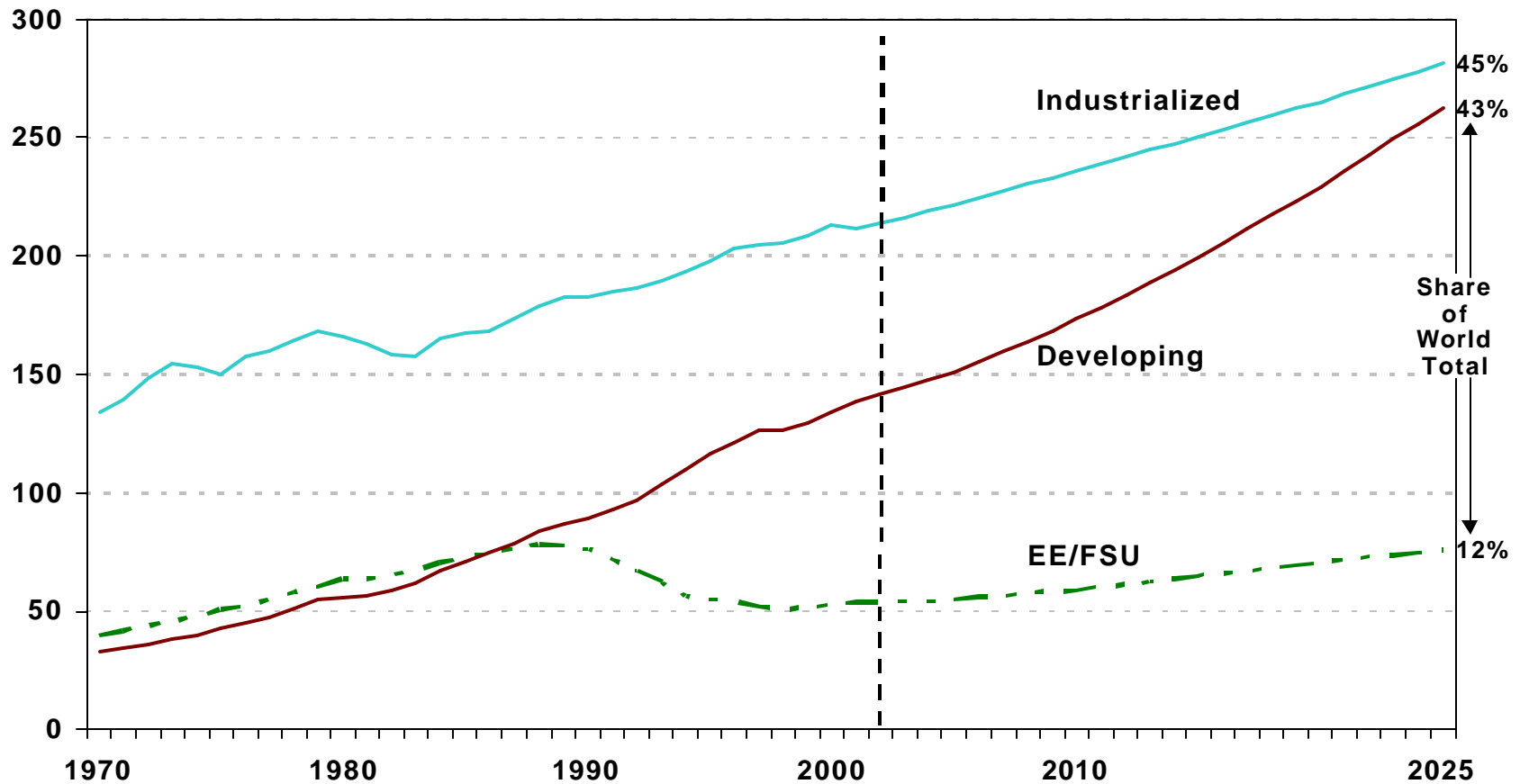
**Figure 4. U.S. Petroleum Supply, Consumption, and Imports, 1970-2025 (million barrels per day)**



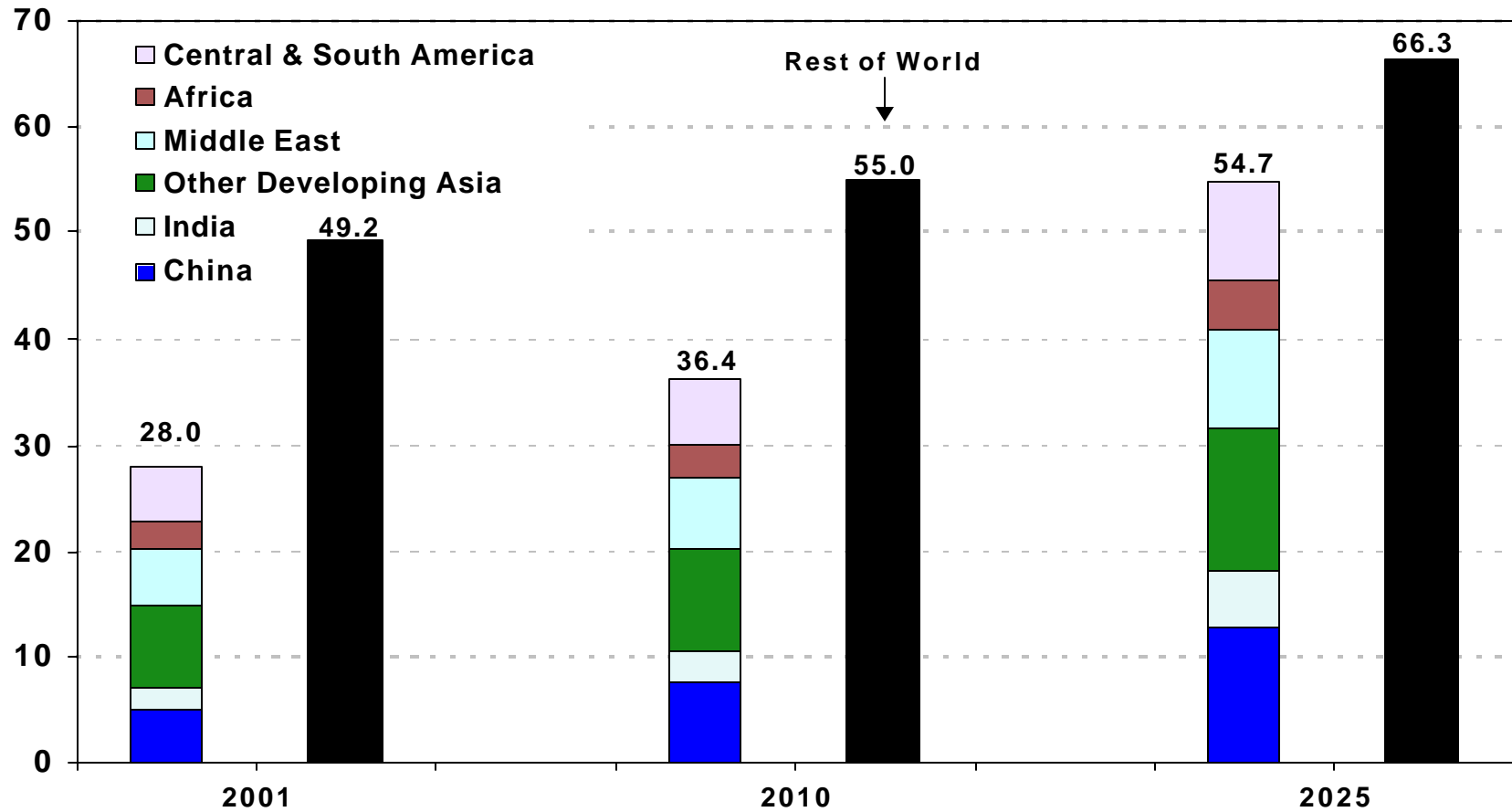
**Figure 5. U.S. Natural Gas Production, Consumption, and Imports, 1970-2025 (trillion cubic feet)**



**Figure 6. World Marketed Energy Consumption by Region, 1970-2025 (quadrillion Btu)**

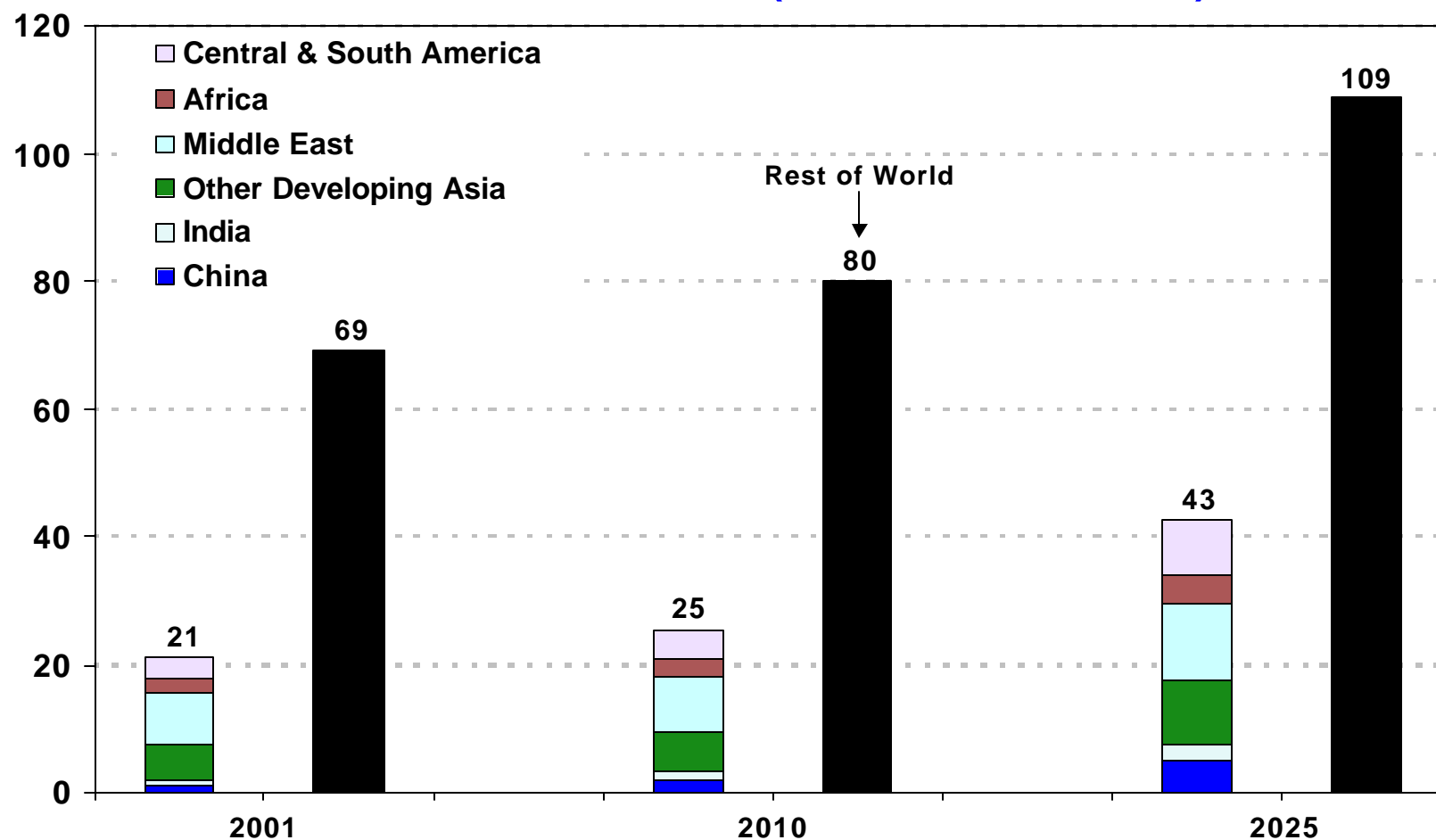


**Figure 7. World Oil Consumption by Region,  
2001, 2010, and 2025 (million barrels per day)**

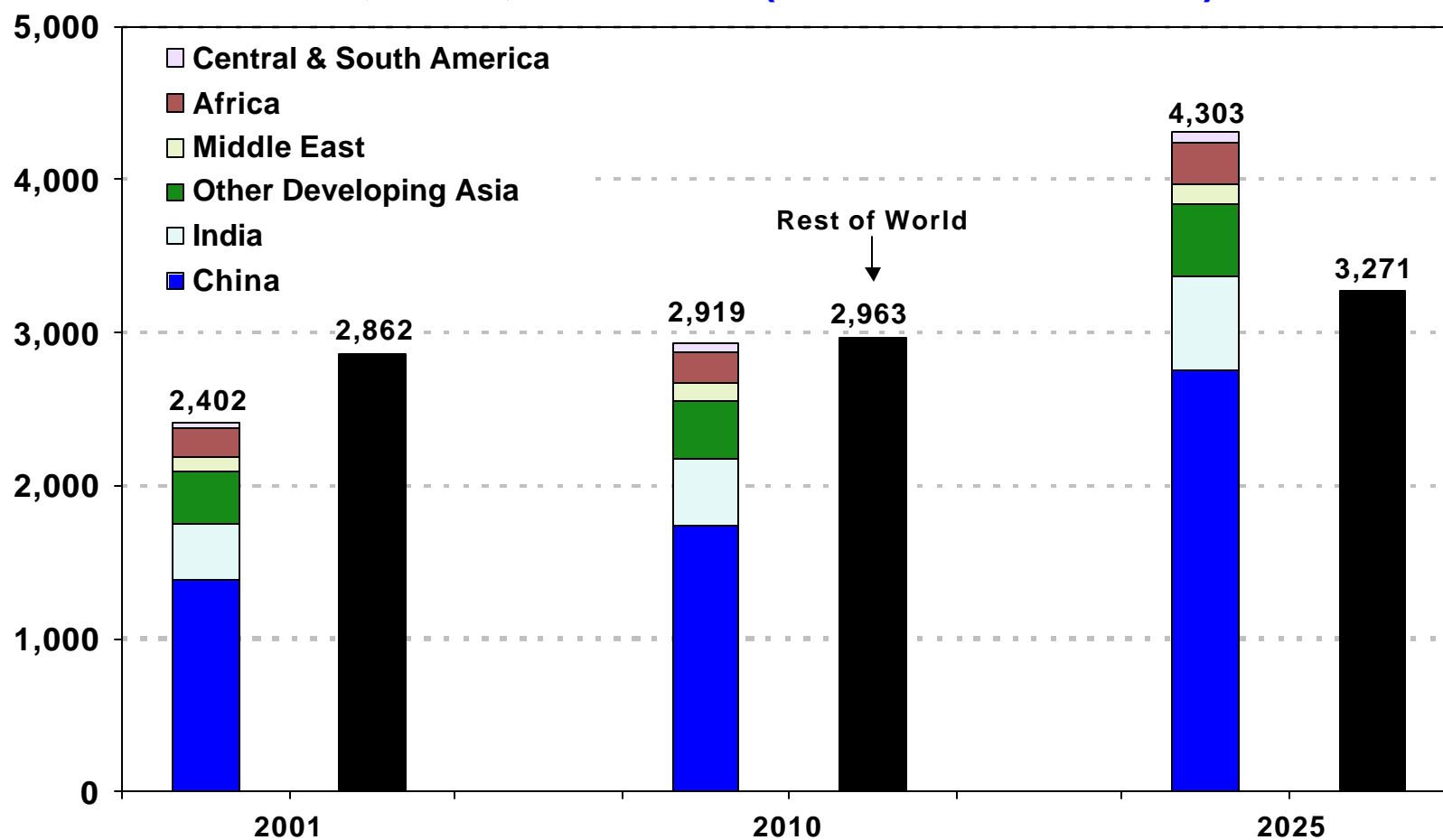




**Figure 8. Natural Gas Consumption by Region,  
2001, 2010, and 2025 (trillion cubic feet)**



**Figure 9. Coal Consumption by Region,  
2001, 2010, and 2025 (million short tons)**



**Figure 10. Projected Worldwide Increases in Energy Use by Fuel and Forecast, 2000-2020 (percent per year)**

