Overview

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Energy Trends to 2030

The Energy Information Administration (EIA), in preparing projections for the *Annual Energy Outlook 2006* (*AEO2006*), evaluated a wide range of trends and issues that could have major implications for U.S. energy markets between today and 2030. *AEO2006* is the first edition of the *Annual Energy Outlook* (*AEO)* to provide projections through 2030. This overview focuses on one case, the reference case, which is presented and compared with the *Annual Energy Outlook 2005* (*AEO2005*) reference case.

Trends in energy supply and demand are affected by a large number of factors that are difficult to predict, such as energy prices, U.S. economic growth, advances in technologies, changes in weather patterns, and future public policy decisions. In preparing *AEO2006*, EIA reevaluated its prior expectations about world oil prices in light of the current circumstances in oil markets. Since 2000, world oil prices have risen sharply as supply has tightened, first as a result of strong demand growth in developing economies such as China and later as a result of supply constraints resulting from disruptions and inadequate investment to meet demand growth. As a result of this review, the *AEO2006* reference case includes much higher world oil prices than were projected in *AEO2005*. In the *AEO2006* reference case, world crude oil prices, which are now expressed in terms of the average price of imported low-sulfur crude oil to U.S. refiners, are projected to increase from $40.49 per barrel (2004 dollars) in 2004 to $54.08 per barrel in 2025 (about $21 per barrel higher than the projected 2025 price in *AEO2005*) and to $56.97 per barrel in 2030.

The higher world oil prices in the *AEO2006* reference case have important implications for energy markets. The most significant impact is on the outlook for U.S. petroleum imports. Net imports of petroleum are projected to meet a growing share of total petroleum demand in both *AEO2006* and *AEO2005*; however, the higher world oil prices in the *AEO2006* reference case lead to more domestic crude oil production, lower demand for petroleum products, and consequently lower levels of petroleum imports. Net petroleum imports are expected to account for 60 percent of demand (on the basis of barrels per day) in 2025 in the *AEO2006* reference case, up from 58 percent in 2004. In the *AEO2005* reference case, net petroleum imports were projected to account for 68 percent of U.S. petroleum demand in 2025.

Higher world oil prices are also projected to affect fuel choice and vehicle efficiency decisions in the transportation sector. Higher oil prices increase the demand for unconventional sources of transportation fuel, such as ethanol and biodiesel, and are projected to stimulate coal-to-liquids (CTL) production in the reference case. In some of the alternative *AEO2006* cases, with even higher oil prices, domestic production of liquid fuels from natural gas—"gas-to-liquids" (GTL)—is also stimulated. The production of alternative liquid fuels is highly sensitive to oil price levels.

The projected fuel economy of new light-duty vehicles in the *AEO2006* reference case in 2025 is higher than was projected in the *AEO2005* reference case, primarily because of higher petroleum prices. The *AEO2006* reference case does not include implementation of the proposed, but not yet final, increase in fuel economy standards based on vehicle footprint for light trucks—including pickups, sport utility vehicles, and minivans—for model years 2008 through 2011.

Much of the increase in new light-duty vehicle fuel economy in the *AEO2006* reference case reflects greater penetration by hybrid and diesel vehicles. Sales of "full hybrid" vehicles in 2025 are 31 percent (340,000 vehicles) higher in the *AEO2006* reference case, and diesel vehicle sales are 29 percent (290,000 vehicles) higher, than projected in the *AEO2005* reference case. In spite of the higher projected sales of hybrid (1.5 million) and diesel (1.3 million) vehicles in 2025, each is expected to account for only 7 percent of new vehicle sales in the *AEO2006* reference case, even though the projected hybrid sales are higher than current industry expectations. The projected

World Oil Price Concept Used in *AEO2006*

In previous *AEO*s, the world crude oil price was defined on the basis of the average imported refiner acquisition cost of crude oil to the United States (IRAC), which represented the weighted average of all imported crude oil. Historically, the IRAC price has tended to be a few dollars less than the widely cited prices of premium crudes, such as West Texas Intermediate (WTI) and Brent, which refiners generally prefer for their low viscosity and sulfur content. In the past 2 years, the price difference between premium crudes and IRAC has widened—in particular, the price spread between premium crudes and heavier, high-sulfur crudes. In an effort to provide a crude oil price that is more consistent with those generally reported in the media, *AEO2006* uses the average price of imported low-sulfur crude oil to U.S. refiners.

sales figures for hybrids do not include sales of "mild hybrids," which like full hybrids incorporate an integrated starter generator, that allows for improved efficiency by shutting the engine off when the vehicle is idling, but do not incorporate an electric motor that provides tractive power to the vehicle when it is moving.

The *AEO2006* reference case includes minimal market penetration by hydrogen fuel cell vehicles, as a result of State mandates. Although significant research and development (R&D) is being conducted through the FreedomCAR Program, a co-funded partnership between the Federal Government and private industry, those efforts are not expected to have a significant impact on the market for fuel cell vehicles before 2030.

The *AEO2006* reference case projection for U.S. imports of liquefied natural gas (LNG) is lower than was projected in the *AEO2005* reference case. LNG imports are projected to grow from 0.6 trillion cubic feet in 2004 to 4.1 trillion cubic feet in 2025, as compared with 6.4 trillion cubic feet in the *AEO2005* reference case. More rapid growth in worldwide demand for natural gas in the *AEO2006* reference case reduces the availability of LNG supplies to the United States and raises worldwide natural gas prices, making LNG less economical in U.S. markets.

AEO2006 includes consideration of the impacts of the Energy Policy Act of 2005 (EPACT2005), signed into law on August 8, 2005. Consistent with the general approach adopted in the *AEO*, the reference case does not consider those sections of EPACT2005 that require funding appropriations for implementation or sections with highly uncertain impacts on energy markets. For example, EIA does not try to anticipate the policy response to the many studies required by EPACT2005 or the impacts of the R&D funding authorizations included in the bill. The *AEO2006* reference case includes only those sections of EPACT2005 that establish specific tax credits, incentives, or standards—about 30 of the roughly 500 sections in the legislation.

Of the EPACT2005 provisions analyzed, incentives intended to stimulate the development of advanced nuclear and renewable plants have particularly noteworthy impacts. A total of 6 gigawatts of newly constructed nuclear capacity is projected to be added by 2030 in the *AEO2006* reference case as a result of the incentives in EPACT2005.

EPACT2005 also has important implications for energy consumption in the residential and commercial sectors. In the residential sector, EPACT2005 sets efficiency standards for torchiere lamps, dehumidifiers, and ceiling fans and creates tax credits for energy-efficient furnaces, water heaters, and air conditioners. It also allows home builders to claim tax credits for energy-efficient new construction. In the commercial sector, the legislation creates efficiency standards that affect energy use in a number of commercial applications. It also includes investment tax credits for solar technologies, fuel cells, and microturbines. These policies are expected to help reduce energy use for space conditioning and lighting in both sectors.

Economic Growth

The projections for key interest rates—the Federal funds rate, the nominal yield on the 10-year Treasury note, and the AA utility bond rate—in the *AEO2006* reference case are slightly lower than those in the *AEO2005* reference case. Also, the projected value of industrial shipments has been revised downward, in part in response to the higher projected energy prices in the *AEO2006* reference case.

Despite the higher forecast for energy prices, gross domestic product (GDP) is projected to grow at an average annual rate of 3.0 percent from 2004 to 2030 in *AEO2006*, identical to the projected growth rate from 2004 through 2025 in *AEO2005*. The ratio of final energy expenditures to GDP has generally fallen over time and was only about 0.07 in 2004, down from a high of 0.14 during the 1970s. It is projected to fall to about 0.05 in 2030 as a result of continued declines in energy use per unit of output and growth in other areas of the economy. The main factors influencing long-term economic growth are growth in the labor force and sustained growth in labor productivity, not energy prices.

Energy Prices

In the reference case—one of several cases included in *AEO2006*—the average world crude oil price continues to rise through 2006 and then declines to $46.90 per barrel in 2014 (2004 dollars) as new supplies enter the market. It then rises slowly to $54.08 per barrel in 2025 (Figure 1), about $21 per barrel higher than the price in *AEO2005* ($32.95 per barrel). Alternative *AEO2006* cases address higher and lower world oil prices.

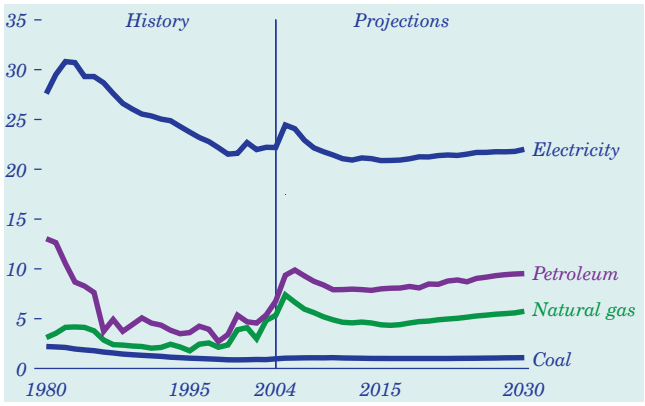
The prices in the *AEO2006* reference case reflect a shift in EIA's thinking about long-term trends in oil markets. World oil markets have been extremely volatile for the past several years, and EIA now believes that the price path in *AEO2005* did not fully reflect the causes of that volatility and the implications for

long-term average oil prices. In the *AEO2006* reference case, the combined production capacity of members of the Organization of the Petroleum Exporting Countries (OPEC) does not increase as much as previously projected, and consequently world oil supplies are assumed to remain tight. The United States and emerging Asia—notably, China— are expected to lead the increase in demand for world oil supplies, keeping pressure on prices though 2030.

In the *AEO2006* reference case, world petroleum demand is projected to increase from about 82 million barrels per day in 2004 to 111 million barrels per day in 2025. The additional demand is expected to be met by increased oil production from both OPEC and non-OPEC nations. In *AEO2005*, world petroleum demand was projected to reach a higher level of 121 million barrels per day in 2025. The *AEO2006* reference case projects OPEC oil production of 44 million barrels per day in 2025, 44 percent higher than the 31 million barrels per day produced in 2004. In the *AEO-2005* reference case, OPEC production was projected to reach 55 million barrels per day in 2025, more than 11 million barrels per day higher than in the *AEO-2006* reference case. In the *AEO2006* reference case, non-OPEC oil production increases from 52 million barrels per day in 2004 to 67 million in 2025, as compared with the *AEO2005* reference case projection of 65 million barrels per day.

The average U.S. wellhead price for natural gas in the *AEO2006* reference case declines gradually from the current level as increased drilling brings on new supplies and new import sources become available. The average price falls to $4.46 per thousand cubic feet in 2016 (2004 dollars), then rises gradually to more than $5.40 per thousand cubic feet in 2025 (equivalent to about $10 per thousand cubic feet in nominal dollars) and more than $5.90 per thousand cubic feet in 2030.

Figure 1. Energy prices, 1980-2030 (2004 dollars per million Btu)



LNG imports, Alaskan natural gas production, and lower 48 production from unconventional sources are not expected to increase sufficiently to offset the impacts of resource depletion and increased demand. The projected wellhead natural gas prices in the *AEO2006* reference case from 2016 to 2025 are consistently higher than the comparable prices in the *AEO2005* reference case, by about 30 to 60 cents per thousand cubic feet, primarily as a result of higher exploration and development costs.

In the *AEO2006* reference case, the combination of slow but continued improvements in expected mine productivity and a continuing shift to low-cost coal from the Powder River Basin in Wyoming leads to a gradual decline in the projected average minemouth coal price, to approximately $20.00 per ton ($1.00 per million British thermal units [Btu]) in 2021 (2004 dollars). Prices then increase slowly as rising natural gas prices and the need for baseload generating capacity lead to the construction of many new coal-fired generating plants. In 2025, the average minemouth price in the *AEO2006* reference case is projected to be $20.63 per ton ($1.03 per million Btu), an increase over the *AEO2005* reference case projection of $18.64 per ton ($0.93 per million Btu). Trends in coal prices measured in terms of tonnage differ slightly from the trends in prices measured in terms of energy content, because the average energy content per ton of coal consumed falls over time as Western subbituminous coal, which has a relatively low Btu content, claims a larger share of the market.

Average delivered electricity prices are projected to decline from 7.6 cents per kilowatthour (2004 dollars) in 2004 to a low of 7.1 cents per kilowatthour in 2015 as a result of declines in natural gas prices and, to a lesser extent, coal prices. After 2015, average real electricity prices are projected to increase, to 7.4 cents per kilowatthour in 2025 and 7.5 cents per kilowatthour in 2030. In the *AEO2005* reference case, electricity prices were lower in the early years of the projection but reached about the same level in 2025. The higher near-term electricity prices projected in the *AEO2006* reference case result primarily from higher expected fuel costs for natural-gas- and coal-fired electric power plants.

Energy Consumption

Total primary energy consumption in the *AEO2006* reference case is projected to increase at an average rate of 1.2 percent per year, from 99.7 quadrillion Btu in 2004 to 127.0 quadrillion Btu in 2025—6.2 quadrillion Btu less than in *AEO2005*. In 2025, coal, nuclear, and renewable energy consumption are higher—

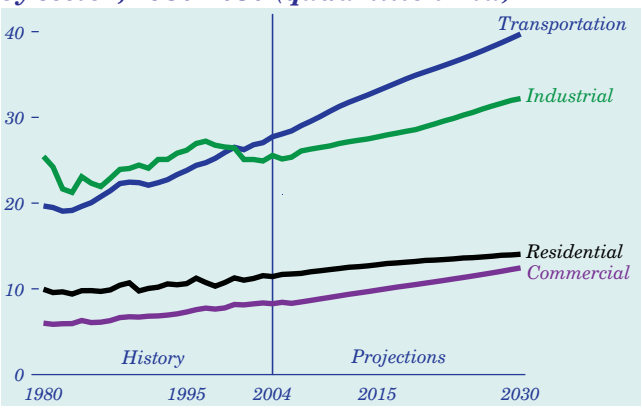
while petroleum and natural gas consumption are lower—in the *AEO2006* reference case than in *AEO2005*. Among the most important factors accounting for the differences are higher energy prices, particularly for petroleum and natural gas; lower projected growth rates in the manufacturing portion of the industrial sector, which traditionally includes the most energy-intensive industries; greater penetration by hybrid and diesel vehicles in the transportation sector as consumers focus more on fuel efficiency; and the impacts of the recently passed EPACT2005, which are projected to reduce energy consumption in the residential and commercial sectors and slow the growth of electricity demand.

As a result of demographic trends and housing preferences, delivered residential energy consumption in the *AEO2006* reference case is projected to grow from 11.4 quadrillion Btu in 2004 to 13.6 quadrillion Btu in 2025 (Figure 2), 0.6 quadrillion Btu lower than in *AEO2005*. Higher projected energy prices in *AEO2006* and the impacts of EPACT2005 are expected to help reduce energy consumption for space conditioning and lighting.

Consistent with projected growth in commercial floorspace in the *AEO2006* reference case, delivered commercial energy consumption is projected to reach 11.5 quadrillion Btu in 2025. In comparison, the *AEO2005* reference case projected 12.5 quadrillion Btu of commercial delivered energy consumption in 2025. Three changes contribute to the lower projection in *AEO2006*: significantly higher fossil fuel energy prices, adoption of a revised projection of commercial floorspace based on updated historical data, and the impacts of the EPACT2005 provisions included in the reference case.

After falling to relatively low levels in the early 1980s, industrial energy consumption recovered and peaked in 1997. In the 2000 to 2003 period, industrial sector activity was reduced by an economic recession. The industrial sector is projected to experience more typical output growth rates over the *AEO2006* projection period, and industrial energy consumption is expected to reflect this trend. The industrial value of shipments in the *AEO2006* reference case is projected to grow by 2.0 percent per year from 2004 to 2025, more slowly than in *AEO2005* (2.2 percent per year) due to a slight slowdown in projected investment spending, higher energy prices, and increased competition from imports. Delivered industrial energy consumption in the *AEO2006* reference case is projected to reach 30.6 quadrillion Btu in 2025, slightly lower than the *AEO2005* projection of 30.8 quadrillion Btu. The *AEO2006* projection includes 1.2 quadrillion Btu of coal consumption in CTL plants, which was not included in *AEO2005*.

Figure 2. Delivered energy consumption by sector, 1980-2030 (quadrillion Btu)



Delivered energy consumption in the transportation sector in the *AEO2006* reference case is projected to total 37.3 quadrillion Btu in 2025, 2.7 quadrillion Btu lower than the *AEO2005* projection. The lower level of consumption reflects both slower growth in miles traveled and higher vehicle efficiency. Over the past 20 years, light-duty vehicle travel has grown by about 3 percent annually. In the *AEO2006* reference case it is projected to grow at a rate of 1.8 percent per year through 2025 (as compared with 2.1 percent per year in *AEO2005*), reflecting demographic factors (for example, the leveling off of increases in the labor force participation rate for women) and higher energy prices. The projected average fuel economy of new light-duty vehicles in 2025 is also higher in the *AEO2006* reference case than was projected in *AEO2005*, primarily because the higher projected fuel prices in the *AEO2006* forecast are expected to lead consumers to demand better fuel economy, slowing the growth in sales of new pickup trucks and sport utility vehicles.

Total electricity consumption, including both purchases from electric power producers and on-site generation, is projected to grow from 3,729 billion kilowatthours in 2004 to 5,208 billion kilowatthours in 2025, increasing at an average annual rate of 1.6 percent in the *AEO2006* reference case. In comparison, total electricity consumption of 5,467 billion kilowatthours in 2025 was projected in *AEO2005*. Growth in electricity use for computers, office equipment, and a variety of electrical appliances in the end-use sectors is partially offset in the *AEO2006* reference case by improved efficiency in these and other, more traditional, electrical applications.

Total consumption of natural gas in the *AEO2006* reference case is projected to increase from 22.4 trillion

cubic feet in 2004 to 27.0 trillion cubic feet in 2025 (Figure 3), 3.7 trillion cubic feet lower than projected in the *AEO2005* reference case, mostly as a result of higher natural gas prices. After peaking at 27.0 trillion cubic feet in 2024, natural gas consumption is projected to fall slightly by 2030, as higher natural gas prices result in a larger market share for coal in the electric power sector in the later years of the projection. The projected growth in natural gas demand in *AEO2006* results primarily from increased use of natural gas for electricity generation and industrial applications, which together account for 62 percent of the projected demand growth from 2004 to 2025. In addition, demand for natural gas in the residential and commercial sectors is projected to grow by 1.5 trillion cubic feet in total from 2004 to 2025.

In the *AEO2006* reference case, total coal consumption is projected to increase from 1,104 million short tons in 2004 to 1,592 million short tons in 2025 (Figure 3), 84 million short tons more than the 1,508 million tons projected to be consumed in 2025 in the *AEO2005* reference case. Coal consumption is projected to grow at a faster rate in *AEO2006* toward the end of the projection, particularly after 2020, as coal captures market share from natural gas, and as coal use for CTL production grows. Coal was not projected to be used for CTL production in the *AEO2005* reference case. In the *AEO2006* reference case, coal consumption in the electric power sector is projected to increase from 1,235 million short tons in 2020 to 1,502 million short tons in 2030, at an average rate of 2.0 percent per year; and coal use at CTL plants is projected to increase from 62 million short tons in 2020 to 190 million short tons in 2030.

Total petroleum consumption is projected to grow from 20.8 million barrels per day in 2004 to 26.1 million barrels per day in 2025 (Figure 3) in the *AEO2006* reference case (1.9 million barrels per day lower than the *AEO2005* projection). Petroleum demand growth in the *AEO2006* reference case is lower in all sectors than was projected in *AEO2005*, due largely to the impact of the much higher oil prices in *AEO2006*. Most of the difference—almost two-thirds—is in the transportation sector.

Total consumption of marketed renewable fuels in the *AEO2006* reference case (including ethanol for gasoline blending, of which 1.0 quadrillion Btu in 2025 is included with "petroleum products" consumption) is projected to grow from 6.0 quadrillion Btu in 2004 to 9.6 quadrillion Btu in 2025 (Figure 3), as a result of State programs—renewable portfolio standards (RPS), mandates, and goals—for renewable electricity generation, technological advances, higher petroleum and natural gas prices, and the effects of Federal tax credits, including those in EPACT2005. In *AEO2005*, total marketed renewable fuel consumption was projected to grow to 8.5 quadrillion Btu in 2025. In *AEO2006*, more than 60 percent of the projected demand for renewables in the reference case is for grid-related electricity generation, including combined heat and power (CHP), and the rest is for dispersed heating and cooling, industrial uses, and fuel blending.

Energy Intensity

Energy intensity, measured as energy use per dollar of GDP (2000 dollars), is projected to decline at an average annual rate of 1.8 percent from 2004 to 2030 in the *AEO2006* reference case (Figure 4), with efficiency gains and structural shifts in the economy dampening growth in demand for energy services. The rate of decline in energy intensity is faster than the 1.6-percent annual rate of decline projected in *AEO2005* between 2004 and 2025, largely because of higher energy prices in *AEO2006*, resulting in generally lower projected levels of energy consumption.

Figure 3. Energy consumption by fuel, 1980-2030 (quadrillion Btu)

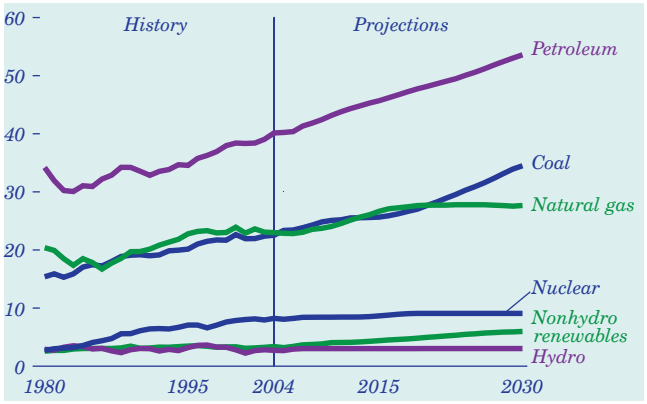
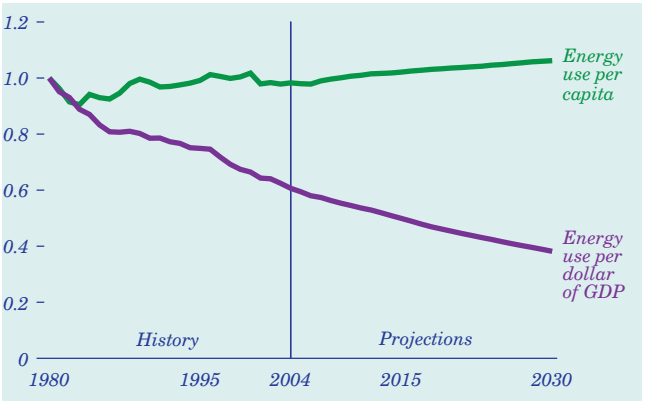


Figure 4. Energy use per capita and per dollar of gross domestic product, 1980-2030 (index, 1980 = 1)



Since 1992, the energy intensity of the U.S. economy has declined on average by 1.9 percent per year, and the share of total industrial production accounted for by the energy-intensive industries has fallen sharply, by 1.3 percent per year on average from 1992 to 2004. In the *AEO2006* reference case, the energy-intensive industries' share of total industrial output is projected to continue to decline, but at a slower rate of 0.8 percent per year, leading to a slower rate of reduction in energy intensity.

Historically, energy use per person has varied over time with the level of economic growth, weather conditions, and energy prices, among many other factors. During the late 1970s and early 1980s, energy consumption per capita fell in response to high energy prices and weak economic growth. Starting in the late 1980s and lasting through 2000, energy consumption per capita generally increased with declining energy prices and strong economic growth. Per capita energy use is projected to increase in the *AEO2006* reference case, with growth in demand for energy services only partially offset by efficiency gains. Per capita energy use increases by an average of 0.3 percent per year between 2004 and 2030 in the *AEO2006* reference case, less than was projected in the *AEO2005* reference case, 0.5 percent per year between 2004 and 2025, primarily because of the higher projected energy prices in *AEO2006*.

Recently, as energy prices have risen, the potential for more energy conservation has received increased attention. Although some additional energy conservation is induced by higher energy prices in the *AEO2006* reference case, no policy-induced conservation measures are assumed beyond those in existing legislation and regulation, nor does the reference case assume behavioral changes beyond those observed in the past.

Electricity Generation

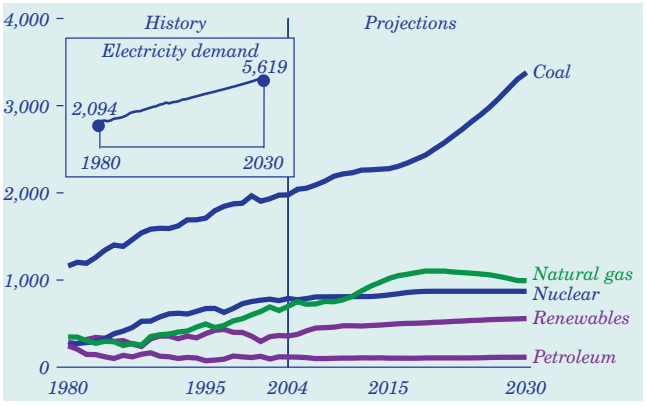
In the *AEO2006* reference case, the projected average prices of natural gas and coal delivered to electricity generators in 2025 are, respectively, 31 cents and 11 cents per million Btu higher than the comparable prices in *AEO2005*. Although the projected levels of coal consumption for electricity generation in 2025 are similar in the two forecasts, higher natural gas prices and slower growth in electricity demand in *AEO2006* lead to significantly lower levels of natural gas consumption for electricity generation. As a result, projected cumulative capacity additions and generation from natural-gas-fired power plants are lower in the *AEO2006* reference case, and capacity additions and generation from coal-fired power plants through 2025 are similar to those in *AEO2005*. In the later years of the *AEO2006* projection, natural-gas-fired generation is expected to decline, displaced by generation from new coal-fired plants (Figure 5). The *AEO2006* projection of 1,070 billion kilowatthours of electricity generation from natural gas in 2025 is 24 percent lower than the *AEO2005* projection of 1,406 billion kilowatthours.

In the *AEO2006* reference case, the natural gas share of electricity generation (including generation in the end-use sectors) is projected to increase from 18 percent in 2004 to 22 percent around 2020, before falling to 17 percent in 2030. The coal share is projected to decline slightly, from 50 percent in 2004 to 49 percent in 2020, before increasing to 57 percent in 2030. Additions to coal-fired generating capacity in the *AEO2006* reference case are projected to total 102 gigawatts between 2004 and 2025, as compared with 86 gigawatts in *AEO2005*. Over the entire period from 2004 to 2030, 174 gigawatts of new coal-fired generating capacity is projected to be added in the *AEO2006* reference case, including 19 gigawatts at CTL plants.

Nuclear generating capacity in the *AEO2006* reference case is projected to increase from about 100 gigawatts in 2004 to about 109 gigawatts in 2019 and to remain at that level (about 10 percent of total U.S. generating capacity) through 2030. The total projected increase in nuclear capacity between 2004 and 2030 includes 3 gigawatts expected to come from uprates of existing plants that continue operating and 6 gigawatts of capacity at newly constructed power plants, stimulated by the provisions in EPACT2005, that are expected to begin operation between 2014 and 2020.

Additional nuclear capacity is projected in some of the alternative *AEO2006* cases. Total electricity generation from nuclear power plants is projected to grow

Figure 5. Electricity generation by fuel, 1980-2030 (billion kilowatthours)



from 789 billion kilowatthours in 2004 to 871 billion kilowatthours in 2030 in the *AEO2006* reference case, accounting for about 15 percent of total generation in 2030.

The use of renewable technologies for electricity generation is projected to grow, stimulated by improved technology, higher fossil fuel prices, and extended tax credits in EPACT2005 and in State renewable energy programs (RPS, mandates, and goals). The expected impacts of State RPS programs, which specify a minimum share of generation or sales from renewable sources, are included in the projection. The *AEO2006* reference case also includes the extension and expansion of the Federal tax credit for renewable generation through December 31, 2007, as enacted in EPACT2005. Total renewable generation in the *AEO2006* reference case, including CHP, is projected to grow by 1.7 percent per year, from 358 billion kilowatthours in 2004 to 559 billion kilowatthours in 2030.

The Clean Air Interstate Rule (CAIR) and the Clean Air Mercury Rule (CAMR), issued by the U.S. Environmental Protection Agency (EPA) in March 2005, are expected to result in large reductions of pollutant emissions from power plants. In the *AEO2006* reference case, projected emissions of sulfur dioxide (SO_2) from electric power plants in 2025 are 58 percent lower, emissions of nitrogen oxide 50 percent lower, and emissions of mercury 70 percent lower than projected in the *AEO2005* reference case.

Energy Production and Imports

Net imports of energy on a Btu basis are projected to meet a growing share of total U.S. energy demand (Figure 6). In the *AEO2006* reference case, net imports are expected to constitute 32 percent and 33 percent of total U.S. energy consumption in 2025 and 2030, respectively, up from 29 percent in 2004. In comparison, the *AEO2005* reference case projected a 38-percent share for net imports in 2025. Higher projections for crude oil and natural gas prices in *AEO2006* are expected to lead to increases in domestic energy production (Figure 7) and reductions in demand, reducing the projected growth in imports as compared with the *AEO2005* projections.

The projections for U.S. crude oil production, domestic petroleum supply, and net petroleum imports in the *AEO2006* reference case are also significantly different from those in *AEO2005*. U.S. crude oil production in the *AEO2006* reference case is projected to increase from 5.4 million barrels per day in 2004 to a peak of 5.9 million barrels per day in 2014 as a result of increased production offshore, predominantly from the deep waters of the Gulf of Mexico. Production is then projected to fall to 4.6 million barrels per day in 2030. In the *AEO2005* reference case, U.S. crude oil production was projected to peak in 2009 at 6.2 million barrels per day and then fall to 4.7 million barrels per day in 2025.

Total domestic petroleum supply (crude oil, natural gas plant liquids, refinery processing gains, and other refinery inputs) follows the same pattern as crude oil production in the *AEO2006* reference case, increasing from 8.6 million barrels per day in 2004 to a peak of 10.5 million barrels per day in 2021, then declining to 10.4 million barrels per day in 2025 and remaining at about that level through 2030. The *AEO2005* projection for total domestic petroleum supply in 2025 was lower, at 8.8 million barrels per day.

In 2025, net petroleum imports, including both crude oil and refined products, are expected to account for 60 percent of demand (on the basis of barrels per day) in the *AEO2006* reference case, up from 58 percent in 2004. In *AEO2005*, net petroleum imports accounted for 68 percent of demand in 2025. The market share

Figure 6. Total energy production and consumption, 1980-2030 (quadrillion Btu)

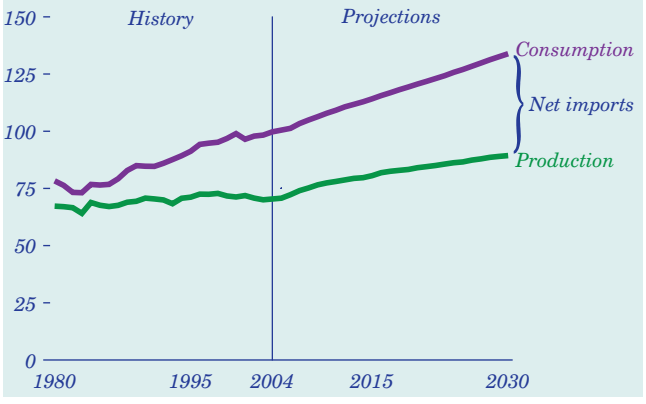
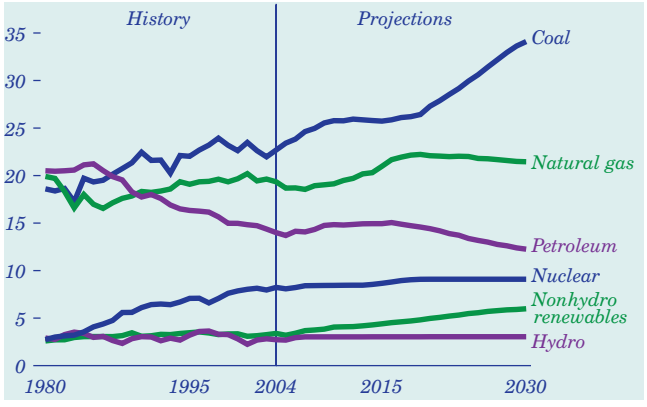


Figure 7. Energy production by fuel, 1980-2030 (quadrillion Btu)



of net petroleum imports grows to 62 percent of demand in 2030 in the *AEO2006* reference case. Despite an expected increase in distillation capacity at domestic refineries in *AEO2006*, net imports of refined petroleum products account for a growing portion of total net imports, increasing from 17 percent in 2004 to 22 percent in 2030.

Total domestic natural gas production, excluding supplemental natural gas supplies, increases from 18.5 trillion cubic feet in 2004 to 21.6 trillion cubic feet in 2019, before declining to 20.8 trillion cubic feet in 2030 in the *AEO2006* reference case. In 2025, domestic natural gas production is projected to be 21.2 trillion cubic feet, compared with 21.8 trillion cubic feet in the *AEO2005* reference case. The lower level of domestic natural gas production in the *AEO2006* reference case is entirely attributable to lower levels of offshore production. Offshore natural gas production in 2025 is lower in the *AEO2006* reference case than it was in *AEO2005*, due at least in part to the impacts of Hurricanes Katrina and Rita, which are expected to delay offshore drilling projects because of a lack of rigs and to have a long-term effect on production levels as a result of the slow recovery of production from existing fields.

The incorporation of EIA data showing a lower level of new reserve discoveries in 2004 than had been anticipated also affects the long-term forecast for offshore natural gas production. Lower 48 offshore production is projected to fall slightly from the 2004 level of 4.3 trillion cubic feet and then grow steadily through 2015, peaking at 5.1 trillion cubic feet as new resources come on line in the Gulf of Mexico. After 2015, lower 48 offshore production declines to 4.3 trillion cubic feet in 2025 and 4.0 trillion cubic feet in 2030. In the *AEO2005* reference case, offshore natural gas production was projected to increase more quickly and reach higher levels, peaking at 5.3 trillion cubic feet in 2014 before falling to 4.9 trillion cubic feet in 2025. The projection for onshore production of natural gas is also generally lower for most of the projection period in the *AEO2006* reference case than was projected in *AEO2005*. In the later years of the *AEO2006* reference case, however, with higher natural gas prices, onshore production grows strongly, to 14.7 trillion cubic feet in 2025—equal to the *AEO2005* projection. Projected onshore production in *AEO2006* remains at the 2025 level through 2030.

Lower 48 production of unconventional natural gas is expected to be a major contributor to growth in U.S. natural gas supplies. Unconventional natural gas production is projected to account for 45 percent of domestic U.S. natural gas production in 2030, as compared with the *AEO2005* reference case projection of 39 percent in 2025. In *AEO2006*, however, unconventional natural gas production is lower in the mid-term (between 2006 and 2020) than was projected in *AEO2005*. The lower levels of production in *AEO2006* before 2021 reflect a decline in overall natural gas consumption in response to higher prices. Starting in 2021, the projected levels of unconventional natural gas production in the *AEO2006* reference case are higher than those in *AEO2005,* reaching 9.5 trillion cubic feet in 2030.

Construction planning for the Alaska natural gas pipeline is expected to start soon, and the new pipeline is expected to be completed by 2015. When the pipeline goes into operation, Alaska's total natural gas production is projected to increase to 2.2 trillion cubic feet in 2025 (from 0.4 trillion cubic feet in 2004), the same level as projected in the *AEO2005* reference case.

The projection for net U.S. pipeline imports of natural gas from Canada and Mexico (predominantly Canada) in the *AEO2006* reference case in 2025 is 1.3 trillion cubic feet lower than was projected in *AEO2005*. *AEO2006* projects a continued decline in net pipeline imports, to 1.2 trillion cubic feet in 2030, as a result of depletion effects and growing domestic demand in Canada. The *AEO2006* reference case reflects an expectation that growth in Canada's unconventional natural gas production (primarily from coal seams) will not be adequate to offset a decline in conventional production in Alberta, based in part on data and projections from Canada's National Energy Board and other sources.

Growth in LNG imports is projected to meet much of the increased demand for natural gas in the *AEO2006* reference case, but the increase is less than was projected in the *AEO2005* reference case. The growth in LNG imports is moderated by three factors: higher natural gas prices reduce domestic consumption; higher world oil prices increase worldwide demand for natural gas and LNG imports, which raises the price of LNG; and, to a lesser extent, higher world oil prices lead to higher foreign demand for GTL production, which uses more natural gas as a feedstock, further increasing the price pressure on natural gas and LNG. Except for expansions of three of the four existing onshore U.S. LNG terminals (Cove Point, Maryland; Elba Island, Georgia; and Lake Charles, Louisiana), the completion of U.S. terminals currently under construction, and the addition of new facilities to serve the Gulf Coast, Southern California, Florida, and New England, no other new facilities are

projected to be built to serve U.S. markets in the *AEO2006* reference case.

Total net imports of LNG to the United States in the *AEO2006* reference case are projected to increase from 0.6 trillion cubic feet in 2004 to 4.1 trillion cubic feet in 2025 (about two-thirds of the import volumes projected in the *AEO2005* reference case) and to 4.4 trillion cubic feet in 2030. In some of the *AEO2006* alternative cases, however, particularly those with relatively higher natural gas prices, additional LNG imports and new terminals are projected.

As domestic coal demand grows in the *AEO2006* reference case, U.S. coal production increases at an average rate of 1.5 percent per year, from 1,125 million tons in 2004 to 1,530 million tons in 2025 (higher than the 2025 projection of 1,488 million tons in *AEO2005*) and to 1,703 million tons in 2030. Production from mines west of the Mississippi River is expected to provide the largest share of the incremental coal production. In 2030, almost 63 percent of coal production is projected to originate from the western States if coal transportation costs remain stable.

Typically, U.S. coal production is driven by demand for electricity generation; however, projected electricity demand in 2025 is lower in *AEO2006* than in *AEO2005*, and the projected demand for coal in the electric power sector in 2025 is also lower (1,354 million tons in the *AEO2006* reference case, compared with 1,425 million tons in the *AEO2005* reference case), despite greater reliance on coal for electric power generation in the *AEO2006* forecast. The projected increase in coal production in *AEO2006* is the result of higher levels of coal use in CTL production, projected to grow to 62 million short tons in 2020 and 190 million short tons in 2030. No coal use for CTL production was projected in the *AEO2005* reference case.

Carbon Dioxide Emissions

Carbon dioxide (CO_2) emissions from energy use are projected to increase from 5,900 million metric tons in 2004 to 7,587 million metric tons in 2025 and 8,114 million metric tons in 2030 in the *AEO2006* reference case (Figure 8), an average annual increase of 1.2 percent per year. The CO_2 emissions intensity of the U.S. economy is projected to fall from 549 metric tons per million dollars of GDP in 2004 to 377 metric tons per million dollars of GDP in 2025, an average decline of 1.8 percent per year, and to 351 metric tons per million dollars of GDP in 2030. In comparison, the *AEO2005* reference case projected a 1.5-percent average annual decline in emissions intensity between 2004 and 2025 and 8,062 million metric tons of CO_2 emissions in 2025.

Projected CO_2 emissions in 2025 are lower in all sectors in the *AEO2006* reference case than they were in *AEO2005*, as higher energy prices slow energy consumption growth in all sectors. Total primary energy consumption in 2025 is more than 6 quadrillion Btu lower in *AEO2006* than was projected in *AEO2005*. Some of the effect of the lower projected consumption on CO_2 emissions in the *AEO2006* reference case after 2020 is offset by a proportionately higher share of coal use for electricity generation and the increased use of coal at CTL plants.

Figure 8. Projected U.S. carbon dioxide emissions by sector and fuel, 1990-2030 (million metric tons)

Table 1. Total energy supply and disposition in the *AEO2006* reference case: summary, 2003-2030

Energy and economic factors	2003	2004	2010	2015	2020	2025	2030	Average annual change, 2004-2030
Primary energy production (quadrillion Btu)								
Petroleum	14.40	13.93	14.83	14.94	14.41	13.17	12.25	-0.5%
Dry natural gas	19.63	19.02	19.13	20.97	22.09	21.80	21.45	0.5%
Coal	22.12	22.86	25.78	25.73	27.30	30.61	34.10	1.6%
Nuclear power	7.96	8.23	8.44	8.66	9.09	9.09	9.09	0.4%
Renewable energy	5.69	5.74	7.08	7.43	8.00	8.61	9.02	1.8%
Other	0.72	0.64	2.16	2.85	3.16	3.32	3.44	6.7%
Total	**70.52**	**70.42**	**77.42**	**80.58**	**84.05**	**86.59**	**89.36**	**0.9%**
Net imports (quadrillion Btu)								
Petroleum	24.19	25.88	26.22	28.02	30.39	33.11	36.49	1.3%
Natural gas	3.39	3.49	4.45	5.23	5.15	5.50	5.72	1.9%
Coal/other (- indicates export)	-0.45	-0.42	-0.58	0.20	0.90	1.54	2.02	NA
Total	**27.13**	**28.95**	**30.09**	**33.44**	**36.44**	**40.15**	**44.23**	**1.6%**
Consumption (quadrillion Btu)								
Petroleum products	38.96	40.08	43.14	45.69	48.14	50.57	53.58	1.1%
Natural gas	23.04	23.07	24.04	26.67	27.70	27.78	27.66	0.7%
Coal	22.38	22.53	25.09	25.66	27.65	30.89	34.49	1.7%
Nuclear power	7.96	8.23	8.44	8.66	9.09	9.09	9.09	0.4%
Renewable energy	5.70	5.74	7.08	7.43	8.00	8.61	9.02	1.8%
Other	0.02	0.04	0.07	0.08	0.05	0.05	0.05	0.9%
Total	**98.05**	**99.68**	**107.87**	**114.18**	**120.63**	**126.99**	**133.88**	**1.1%**
Petroleum (million barrels per day)								
Domestic crude production	5.69	5.42	5.88	5.84	5.55	4.99	4.57	-0.7%
Other domestic production	3.10	3.21	3.99	4.50	4.90	5.45	5.84	2.3%
Net imports	11.25	12.11	12.33	13.23	14.42	15.68	17.24	1.4%
Consumption	20.05	20.76	22.17	23.53	24.81	26.05	27.57	1.1%
Natural gas (trillion cubic feet)								
Production	19.11	18.52	18.65	20.44	21.52	21.24	20.90	0.5%
Net imports	3.29	3.40	4.35	5.10	5.02	5.37	5.57	1.9%
Consumption	22.34	22.41	23.35	25.91	26.92	26.99	26.86	0.7%
Coal (million short tons)								
Production	1,083	1,125	1,261	1,272	1,355	1,530	1,703	1.6%
Net imports	-18	-21	-26	5	36	63	83	NA
Consumption	1,095	1,104	1,233	1,276	1,390	1,592	1,784	1.9%
Prices (2004 dollars)								
Imported low-sulfur light crude oil (dollars per barrel)	31.72	40.49	47.29	47.79	50.70	54.08	56.97	1.3%
Imported crude oil (dollars per barrel)	28.46	35.99	43.99	43.00	44.99	47.99	49.99	1.3%
Domestic natural gas at wellhead (dollars per thousand cubic feet)	5.08	5.49	5.03	4.52	4.90	5.43	5.92	0.3%
Domestic coal at minemouth (dollars per short ton)	18.40	20.07	22.23	20.39	20.20	20.63	21.73	0.3%
Average electricity price (cents per kilowatthour)	7.6	7.6	7.3	7.1	7.2	7.4	7.5	0.0%
Economic indicators								
Real gross domestic product (billion 2000 dollars)	10,321	10,756	13,043	15,082	17,541	20,123	23,112	3.0%
GDP chain-type price index (index, 2000=1.000)	1.063	1.091	1.235	1.398	1.597	1.818	2.048	2.5%
Real disposable personal income (billion 2000 dollars)	7,742	8,004	9,622	11,058	13,057	15,182	17,562	3.1%
Value of manufacturing shipments (billion 2000 dollars)	5,378	5,643	6,355	7,036	7,778	8,589	9,578	2.1%
Energy intensity (thousand Btu per 2000 dollar of GDP)	**9.51**	**9.27**	**8.28**	**7.58**	**6.88**	**6.32**	**5.80**	**-1.8%**
Carbon dioxide emissions (million metric tons)	**5,785**	**5,900**	**6,365**	**6,718**	**7,119**	**7,587**	**8,114**	**1.2%**

Notes: Quantities are derived from historical volumes and assumed thermal conversion factors. Other production includes liquid hydrogen, methanol, supplemental natural gas, and some inputs to refineries. Net imports of petroleum include crude oil, petroleum products, unfinished oils, alcohols, ethers, and blending components. Other net imports include coal coke and electricity. Some refinery inputs appear as petroleum product consumption. Other consumption includes net electricity imports, liquid hydrogen, and methanol.

Source: AEO2006 National Energy Modeling System, run AEO2006.D111905A.