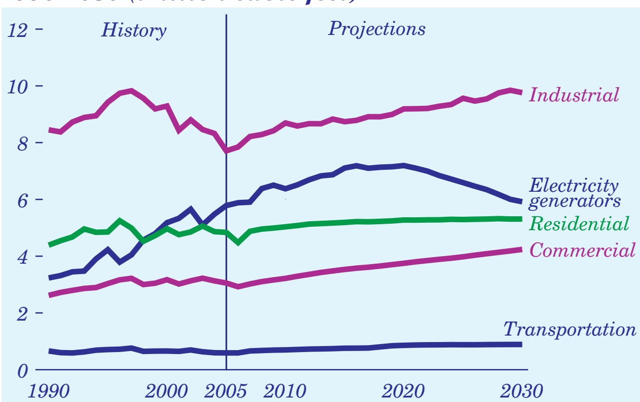
Projected Natural Gas Use for Electricity Generation Peaks in 2020

Figure 67. Natural gas consumption by sector, 1990-2030 (trillion cubic feet)

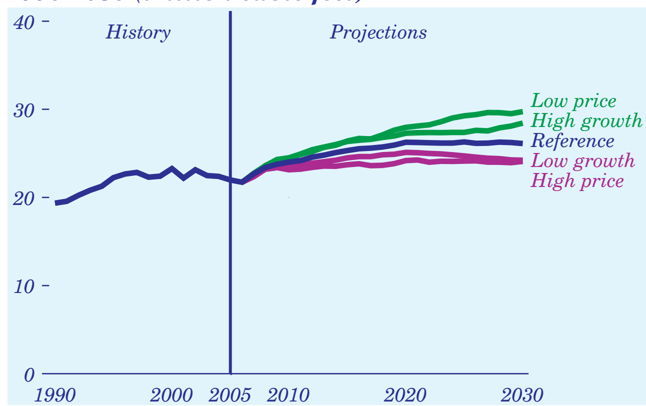


Total natural gas consumption in the United States is projected to increase from 22.0 trillion cubic feet in 2005 to 26.1 trillion cubic feet in 2030 in the *AEO2007* reference case. Much of the growth is expected before 2020, with demand for natural gas in the electric power sector growing from 5.8 trillion cubic feet in 2005 to a peak of 7.2 trillion cubic feet in 2020 (Figure 67). Natural gas use in the electric power sector declines after 2020, to 5.9 trillion cubic feet in 2030, as new coal-fired generating capacity displaces natural-gas-fired generation. Much of the projected decline in natural gas consumption for electricity generation results from higher delivered prices for natural gas in the reference case projection after 2020.

Continued growth in residential, commercial, and industrial consumption of natural gas is roughly offset by the projected decline in natural gas demand for electricity generation. As a result, overall natural gas consumption is almost flat between 2020 and 2030 in the *AEO2007* reference case, and the natural gas share of total projected energy consumption drops from 23 percent in 2005 to 20 percent in 2030.

Natural Gas Consumption Varies with Fuel Prices and Economic Growth

Figure 68. Total natural gas consumption, 1990-2030 (trillion cubic feet)



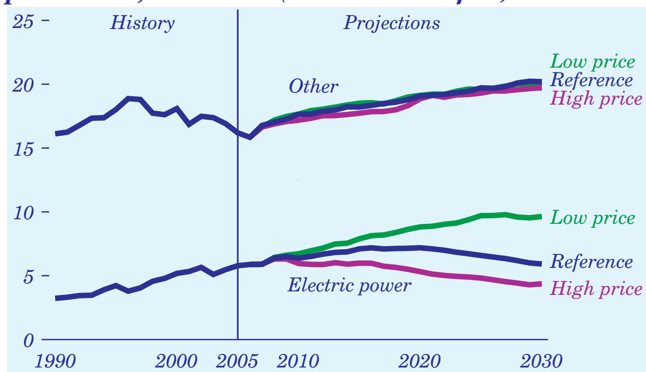
In the *AEO2007* projections, domestic natural gas consumption is influenced by the level of natural gas prices and the rate of economic growth. Higher (or lower) natural gas prices reduce (or increase) consumption, while higher (or lower) rates of economic growth increase (or reduce) gas consumption. The greatest variation occurs in the high and low price cases, where natural gas consumption in 2030 ranges from 29.7 trillion cubic feet in the low price case to 24.1 trillion cubic feet in the high price case (Figure 68). The high and low economic growth cases project natural gas consumption in 2030 at 28.4 trillion cubic feet and 24.2 trillion cubic feet, respectively.

The effects of economic growth on natural gas consumption are not as large as the effects of prices, because only a part of the incremental change in disposable personal income in the high and low economic growth cases is directed toward energy purchases. For example, when higher GDP growth is assumed, energy purchases make up a smaller proportions of GDP and of personal expenditures.

In contrast, the price of natural gas directly affects the level of natural gas consumption. High prices provide a direct economic incentive for users to reduce their natural gas consumption, and low prices encourage more consumption. The strength of the relationship between natural gas prices and consumption depends on the short- and long-term capabilities for fuel conservation and substitution in each consuming sector.

Natural Gas Use in the Electric Power Sector Is Sensitive to Prices

Figure 69. Natural gas consumption in the electric power and other end-use sectors in alternative price cases, 1990-2030 (trillion cubic feet)



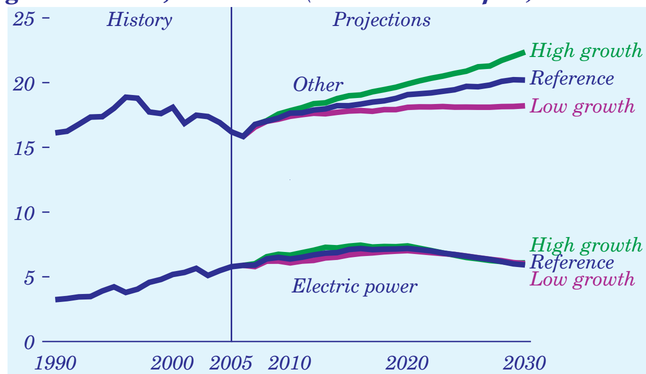
In the *AEO2007* projections, the largest variation in sectoral demand for natural gas in response to high and low price assumptions occurs in the electric power sector (Figure 69). Natural gas consumption by electricity producers in 2030, projected at 5.9 trillion cubic feet in the reference case, increases to 9.6 trillion cubic feet in the low price case but falls to 4.4 trillion cubic feet in the high price case.

Much of the variation in projected natural gas demand in the electric power sector between the low and high price cases is the result of different projections for the amount of natural-gas-fired generating capacity built—and consequently the amount of electricity generated from natural gas—from 2006 to 2030. In the high price case, a cumulative 70 gigawatts of new natural-gas-fired generating capacity is added between 2006 and 2030. In the low price case, cumulative natural-gas-fired capacity additions total 192 gigawatts over the same period. The projected totals for electricity generation from natural gas in 2030 are 649 billion kilowatthours in the high price case and 1,548 billion kilowatthours in the low price case.

In the residential, commercial, industrial, and transportation sectors, fuel price assumptions have a considerably smaller effect on natural gas consumption, because fuel substitution options are limited and the stocks of equipment that use natural gas have relatively slow turnover rates.

Natural Gas Use in Other Sectors Is Sensitive to Economic Growth

Figure 70. Natural gas consumption in the electric power and other end-use sectors in alternative growth cases, 1990-2030 (trillion cubic feet)

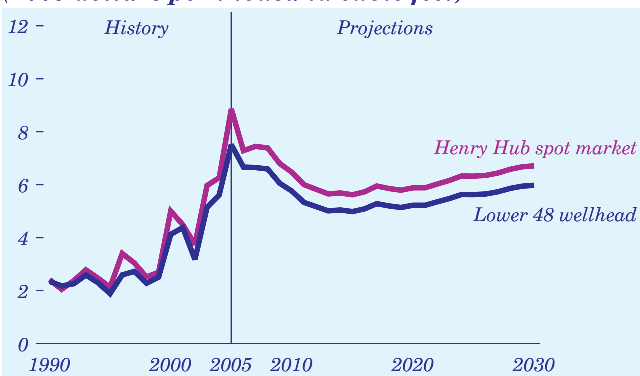


The largest variation in natural gas consumption in the residential, commercial, industrial, and transportation end-use sectors results from different assumptions about economic growth rates. In the high economic growth case, natural gas consumption in the other end-use sectors is projected to total 22.4 trillion cubic feet in 2030. In the low growth case, the projected total in 2030 is 18.2 trillion cubic feet (Figure 70). Most of the difference between the projections in the two cases is attributable to the industrial sector, where projected natural gas consumption in 2030 varies from 7.4 trillion cubic feet in the low growth case to 10.1 trillion cubic feet in the high growth case.

Natural gas consumption in the electric power sector is sensitive to natural gas prices because other fuels, such as coal, can be substituted directly for natural gas in generating electricity. In the high and low economic growth cases, however, natural gas consumption in the electric power sector shows little variation from the reference case projection. In the three cases (reference, high growth, and low growth), natural gas use for electricity generation in 2030 remains roughly constant, at about 6 trillion cubic feet. In the high economic growth case, when natural gas consumption in the electric power sector begins to rise, natural gas prices increase significantly, and in response coal and nuclear power are substituted for natural gas.

Projected Natural Gas Prices Remain Above Historical Levels

Figure 71. Lower 48 wellhead and Henry Hub spot market prices for natural gas, 1990-2030 (2005 dollars per thousand cubic feet)



In the *AEO2007* reference case, lower 48 wellhead prices for natural gas are projected to decline from current levels to an average of $5.01 per thousand cubic feet (2005 dollars) in 2013, then rise to $5.98 per thousand cubic feet in 2030. Henry Hub spot market prices are projected to decline to $5.49 per million Btu ($5.33 per thousand cubic feet) in 2013 and then rise to $6.52 per million Btu ($6.33 per thousand cubic feet) in 2030 (Figure 71).

Current high natural gas prices are expected to stimulate the construction of new LNG terminal capacity, resulting in a significant increase in LNG import capacity. Projected natural gas prices in the reference case also are expected to stimulate the construction of an Alaska natural gas pipeline (projected to begin operation in 2018), as well as increased unconventional natural gas production.

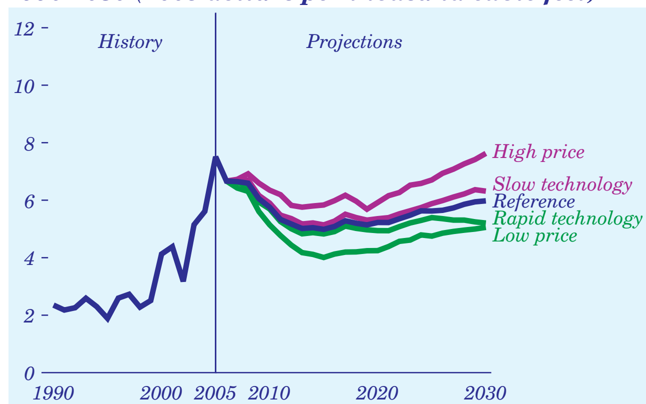
On the demand side, current natural gas prices are sufficiently high to reduce growth in consumption. The combination of increased natural gas supply and slower growth in demand leads to a decline in natural gas prices through 2013. After 2013, wellhead natural gas prices increase largely as a result of rising costs, as technically recoverable U.S. natural gas resources decline from the current level (Table 17).

Table 17. Technically recoverable U.S. natural gas resources as of January 1, 2005 (trillion cubic feet)

Proved	Unproved	Total
192.5	1,148.5	1,341.0

Prices Vary With Resource Size and Technology Progress Assumptions

Figure 72. Lower 48 wellhead natural gas prices, 1990-2030 (2005 dollars per thousand cubic feet)

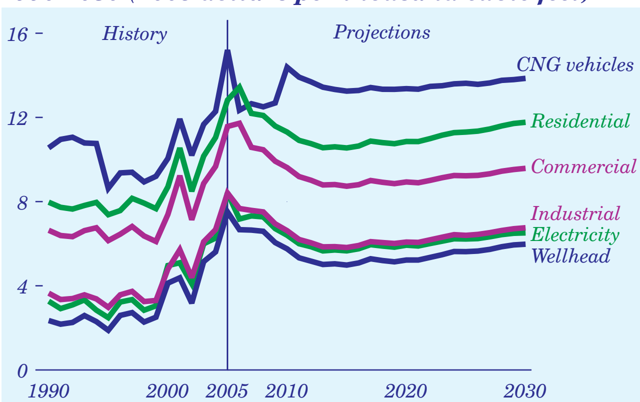


The high and low price cases assume that the unproven U.S. natural gas resource base is 15 percent lower and higher, respectively, than the estimate used in the reference case (Table 17). As a result, E&P costs—and wellhead prices—are higher in the high price case and lower in the low price case than projected in the reference case (Figure 72). In the low price case, wellhead natural gas prices increase to $5.06 per thousand cubic feet in 2030 (2005 dollars), as compared with $5.98 per thousand cubic feet in 2030 in the reference case. In the high price case, wellhead prices rise to $7.63 per thousand cubic feet in 2030.

Technological progress affects the future production of natural gas by reducing production costs and expanding the economically recoverable resource base. In the *AEO2007* reference case, the rate of improvement in natural gas production technology is based on the historical rate. The slow oil and natural gas technology case assumes an improvement rate 50 percent lower than in the reference case. As a result, future capital and operating costs are higher, causing the projected average wellhead price of natural gas to increase to $6.32 per thousand cubic feet in 2030. The rapid technology case assumes a rate of technology improvement 50 percent higher than in the reference case, reducing natural gas development and production costs. In the rapid technology case, wellhead natural gas prices are projected to average $5.21 per thousand cubic feet in 2030.

Delivered Natural Gas Prices Follow Trends in Wellhead Prices

Figure 73. Natural gas prices by end-use sector, 1990-2030 (2005 dollars per thousand cubic feet)



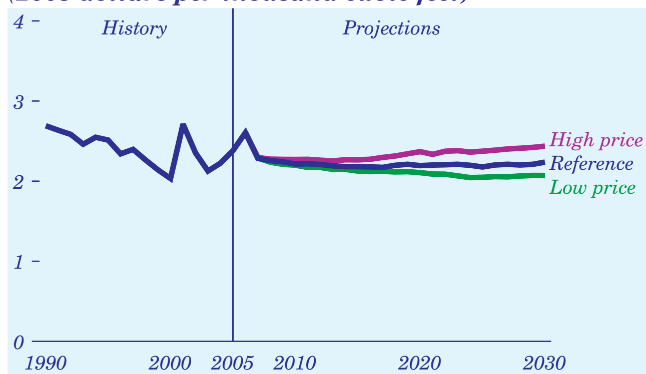
Trends in delivered natural gas prices largely reflect changes in projected wellhead prices. In the *AEO2007* reference case, prices for natural gas delivered to the end-use sectors decline through 2015 as wellhead gas prices decline, then increase along with wellhead prices over the rest of the projection period (Figure 73).

On average, projected end-use transmission and distribution margins remain relatively constant, because the cost of adding new facilities largely offsets the reduced depreciation expenses of existing facilities. Transmission and distribution margins in the end-use sectors reflect both the volumes of natural gas delivered and the infrastructure arrangements of the different sectors. The industrial and electricity generation sectors have the lowest end-use prices, because they receive most of their natural gas directly from interstate pipelines, avoiding local distribution charges. In addition, summer-peaking electricity generators reduce transmission costs by using interruptible transportation services during the summer, when there is spare pipeline capacity. As power generators take a larger share of the natural gas market, however, they are expected to rely more on higher cost firm transportation service.

The reference case assumes that sufficient transmission and distribution capacity will be built to accommodate the projected growth in natural gas consumption. If public opposition were to prevent infrastructure expansion, however, delivered prices could be higher than projected in the reference case.

Transmission and Distribution Costs Are Reduced With Higher Volumes

Figure 74. Average natural gas transmission and distribution margins, 1990-2030 (2005 dollars per thousand cubic feet)

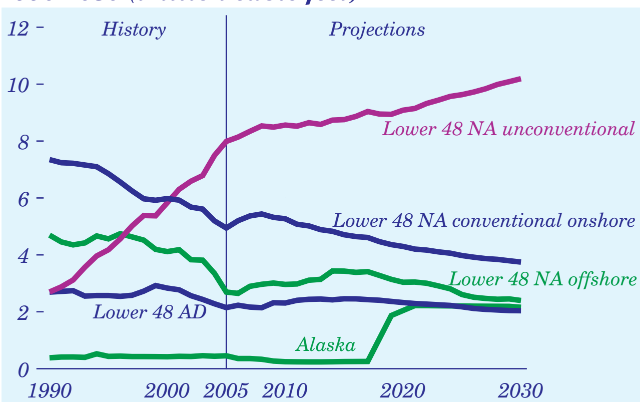


The transmission and distribution margin for natural gas delivered to end users is the difference between the average delivered price and the average source price, which is the quantity-weighted average of the lower 48 wellhead price and the average import price. It reflects both the capital and operating costs for pipelines and the volume of natural gas transported. Although operating costs vary with the level of pipeline utilization, capital costs are fixed for the most part. Variations in pipeline throughput result in higher or lower transmission and distribution costs per thousand cubic feet of natural gas transported. Thus, because the high and low price case projections show the greatest variation in total natural gas consumption, the greatest variation in transmission and distribution margins is also seen in those cases.

In the high price case, total natural gas consumption in 2030 is projected to be only 24.1 trillion cubic feet. As a result, the average transmission and distribution margin for delivered natural gas is projected to increase from $2.38 per thousand cubic feet in 2005 to $2.44 per thousand cubic feet in 2030 (2005 dollars). In the low price case, total natural gas consumption in 2030 grows to 29.7 trillion cubic feet, and the average transmission and distribution margin in 2030 drops to $2.07 per thousand cubic feet. In the reference case, with projected natural gas consumption of 26.1 trillion cubic feet in 2030, the projected average transmission and distribution margin in 2030 is $2.24 per thousand cubic feet (Figure 74).

Unconventional Production Is a Growing Source of U.S. Gas Supply

Figure 75. Natural gas production by source, 1990-2030 (trillion cubic feet)



A large proportion of the onshore lower 48 conventional natural gas resource base has been discovered. Discoveries of new conventional natural gas reservoirs are expected to be smaller and deeper, and thus more expensive and riskier to develop and produce. Accordingly, total lower 48 onshore conventional natural gas production declines in the *AEO2007* reference case from 6.4 trillion cubic feet in 2005 to 4.9 trillion cubic feet in 2030 (Figure 75).

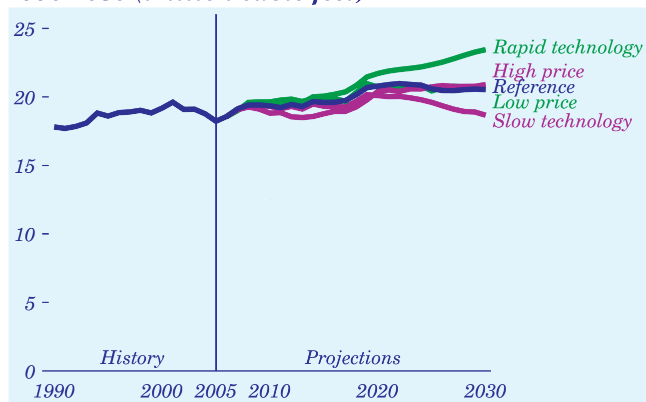
Incremental production of lower 48 onshore natural gas comes primarily from unconventional resources, including coalbed methane, tight sandstones, and gas shales. Lower 48 unconventional production increases in the reference case from 8.0 trillion cubic feet in 2005 to 10.2 trillion cubic feet in 2030, when it accounts for 50 percent of projected domestic U.S. natural gas production.

The Alaska natural gas pipeline is expected to begin transporting natural gas to the lower 48 States in 2018. In 2030, Alaska's natural gas production totals 2.2 trillion cubic feet in the reference case.

Considerable natural gas resources remain in the offshore Gulf of Mexico, especially in the deep waters. Deepwater natural gas production in the Gulf of Mexico increases in the reference case from 1.4 trillion cubic feet in 2005 to a peak volume of 3.1 trillion cubic feet in 2015, then declines to 2.1 trillion cubic feet in 2030. Production in the shallow waters declines throughout the projection period, from 2.0 trillion cubic feet in 2005 to 1.1 trillion cubic feet in 2030.

Natural Gas Supply Projections Reflect Rates of Technology Progress

Figure 76. Total U.S. natural gas production, 1990-2030 (trillion cubic feet)



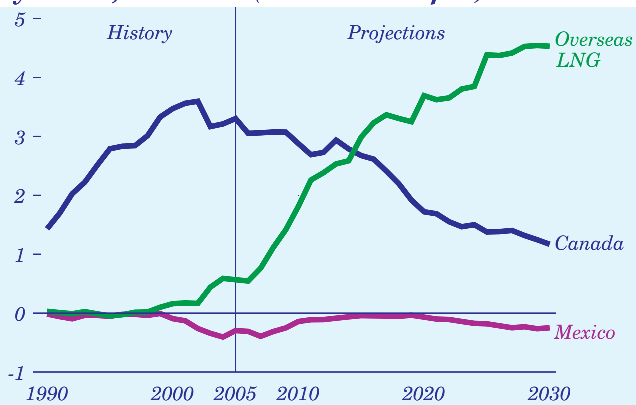
Exploration for and production of natural gas becomes more profitable when prices increase and when exploration and development costs decline. The rapid and slow technology cases show the effects of different assumed rates of technology improvement in the oil and natural gas industries. The high and low price cases show the effects of different assumptions for oil prices and unproved oil and natural gas resources.

Technological progress generally reduces the cost of natural gas production, leading to lower wellhead prices, more end-use consumption, and more production. More rapid progress increases domestic natural gas production and slower progress lowers production in the technology cases. U.S. natural gas production in 2030 is 14.2 percent higher in the rapid technology case and 9.1 percent lower in the slow technology case than in the reference case (Figure 76).

The high and low price cases show smaller effects on total production than do the technology cases. Domestic natural gas production is determined by balancing total U.S. natural gas supply and demand. Higher world oil prices—in combination with a smaller world natural gas resource base—lead to higher costs for developing domestic resources, higher wellhead natural gas prices, and lower levels of U.S. consumption and imports of natural gas. Lower world oil prices—and a larger oil and natural gas resource base—lead to lower resource development costs, lower prices, and higher levels of consumption and imports. The net effect in each case is a small variation in U.S. natural gas production, as changes in production costs, consumption, and imports counter the impacts of higher or lower natural gas prices.

Net Imports of Natural Gas Grow in the Projections

Figure 77. Net U.S. imports of natural gas by source, 1990-2030 (trillion cubic feet)



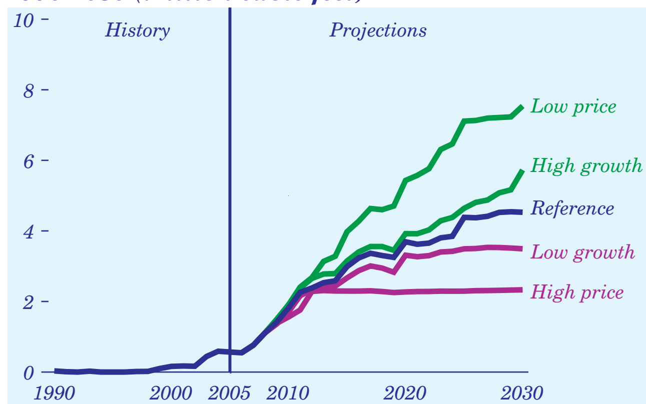
With U.S. natural gas production remaining relatively constant, imports of natural gas are projected to rise to meet an increasing share of domestic consumption. Most of the expected growth in U.S. natural gas imports is in the form of LNG. The total capacity of U.S. LNG receiving terminals increases from 1.4 trillion cubic feet in 2005 to 6.5 trillion cubic feet in 2030 in the reference case, and net LNG imports grow from 0.6 trillion cubic feet in 2005 to 4.5 trillion cubic feet in 2030 (Figure 77). Nevertheless, the U.S. LNG market is expected to be tight until 2012, because of supply constraints at a number of liquefaction facilities, delays in the completion of new liquefaction projects, and rapid growth in global LNG demand.

A projected decline in Canada's non-Arctic conventional natural gas production is only partly offset by an increase in its Arctic and unconventional production. Although a MacKenzie Delta natural gas pipeline is expected to begin transporting natural gas in 2012 in the *AEO2007* reference case, its impact is offset by an expected decline in conventional natural gas resources in Alberta and increases in Canada's domestic consumption. Accordingly, net imports of natural gas from Canada are projected to fall in the reference case from 3.3 trillion cubic feet in 2005 to 1.2 trillion cubic feet in 2030.

Net exports of U.S. natural gas to Mexico are projected to decline from nearly 400 billion cubic feet in 2007 to 35 billion in 2019. After 2019 they are expected to increase steadily to nearly 250 billion cubic feet in 2030.

LNG Imports Are the Source of Supply Most Affected in the Price Cases

Figure 78. Net U.S. imports of liquefied natural gas, 1990-2030 (trillion cubic feet)



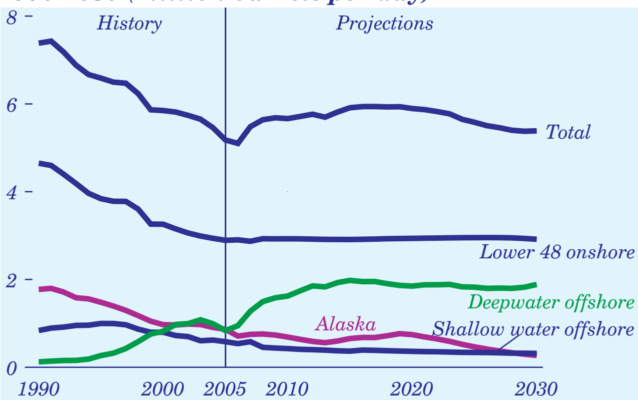
Changes in LNG imports account for most of the variation in net U.S. natural gas imports across the alternative price and economic growth cases. Unlike the situation in Canada and the United States, in much of the rest of the world the natural gas resource base has not been significantly exploited. Thus, there is ample potential for growth in LNG supply.

The *AEO2007* reference case projects net U.S. imports of LNG totaling 4.5 trillion cubic feet in 2030. The alternative projections of net LNG imports in 2030 are 7.5 trillion cubic feet in the low price case, 2.3 trillion cubic feet in the high price case, 5.7 trillion cubic feet in the high economic growth case, and 3.5 trillion cubic feet in the low economic growth case (Figure 78).

Higher oil prices are expected to reduce world petroleum consumption and increase natural gas consumption. In addition, some LNG contract prices are tied directly to crude oil prices, which could exert upward pressure on LNG prices. Higher oil prices are also projected to spur greater GTL production around the world, further increasing the pressure on natural gas prices. Collectively, these trends are expected to increase natural gas and LNG prices in both U.S. and international energy markets. Higher LNG prices, in turn, are projected to slow the rate of expansion of U.S. LNG terminal capacity and lower the capacity utilization rates at existing LNG terminals.

U.S. Crude Oil Production Is Expected To Grow Over the Next Decade

Figure 79. Domestic crude oil production by source, 1990-2030 (million barrels per day)



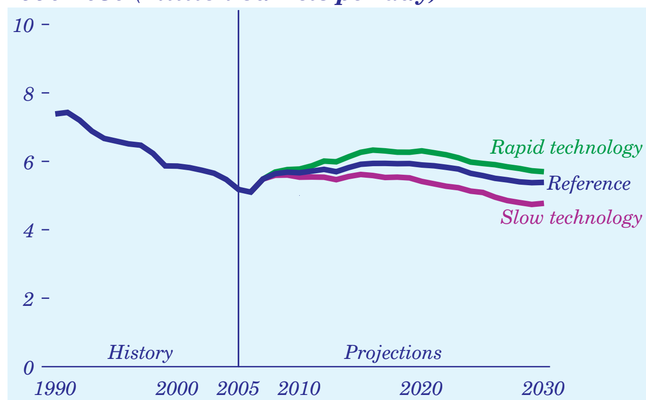
A large portion of the total U.S. resource base of onshore conventional oil has been produced. New oil reservoir discoveries are likely to be smaller, more remote (e.g., Alaska), and increasingly costly to exploit. However, higher oil prices, increased production with enhanced oil recovery techniques, and recent resource discoveries in the Bakken shale formation in Montana allow lower 48 onshore production to remain relatively constant at about 2.9 million barrels per day over the projection period in the *AEO2007* reference case (Figure 79).

Because drilling currently is prohibited in the Arctic National Wildlife Refuge (ANWR), the reference case does not project any production from ANWR. Alaska's projected oil production declines from 860,000 barrels per day in 2005 to 270,000 barrels per day in 2030.

Considerable oil resources remain offshore, especially in the deep waters of the Gulf of Mexico. Deepwater oil production in the Gulf of Mexico is projected to increase from 840,000 barrels per day in 2005 to a peak of 2.0 million barrels per day in 2015 and then fluctuate between 1.8 and 1.9 million barrels per day over the last 15 years of the projection. Production from the shallow waters of the Gulf is projected to continue declining, from 470,000 barrels per day in 2005 to 290,000 barrels per day in 2030. As a result, total domestic offshore oil production increases in the reference case from 1.4 million barrels per day in 2005 to a peak of 2.3 million barrels per day in 2015, then declines to 2.2 million barrels per day in 2030.

More Rapid Technology Advances Could Raise U.S. Oil Production

Figure 80. Total U.S. crude oil production, 1990-2030 (million barrels per day)



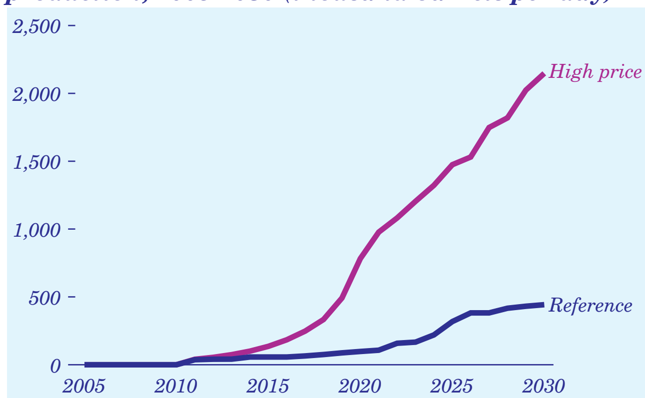
The rapid and slow oil and gas technology cases assume rates of technological progress in the petroleum industry that are 50 percent higher and 50 percent lower, respectively, than the historical rate. The rate of technological progress determines the projected cost of developing and producing the remaining domestic oil resource base. Higher (or lower) rates of technological progress result in lower (or higher) oil development and production costs, which in turn allow more (or less) oil production.

With domestic oil consumption determined largely by oil prices and economic growth rates, oil consumption does not change significantly in the technology cases. Domestic crude oil production in 2030, which is 5.4 million barrels per day in the reference case, increases to 5.7 million barrels per day in the rapid technology case and drops to 4.8 million barrels per day in the slow technology case (Figure 80). The projected changes in domestic oil production result in different projections for petroleum imports. In 2030, projected net crude oil and petroleum product imports range from 16.0 million barrels per day in the rapid technology case to 17.0 million barrels per day in the slow technology case, as compared with 16.4 million barrels per day in the reference case.

Cumulative U.S. crude oil production from 2006 through 2030 is projected to be 2.6 billion barrels (4.9 percent) higher in the rapid technology case and 3.3 billion barrels (6.4 percent) lower in the slow technology case than the reference case projection of 51.8 billion barrels.

Unconventional Liquids Production Increases With Higher Oil Prices

Figure 81. Total U.S. unconventional oil production, 2005-2030 (thousand barrels per day)



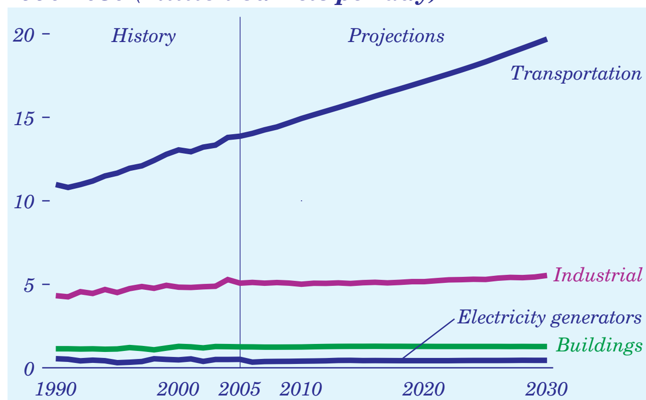
The future of unconventional oil and liquids production (such as oil shale, CTL, and GTL) will depend on oil prices. For example, CTL production is projected in both the reference and high price cases; GTL and oil shale production are projected only in the high price case; and no unconventional oil production of any kind is projected in the low price case.

In the reference case, CTL production is projected to start at about 40,000 barrels per day in 2011 and increase to about 440,000 barrels per day in 2030. In the high price case, CTL, oil shale, and GTL production are projected to be economically feasible, and total domestic production of unconventional oil is projected to reach 2.1 million barrels per day in 2030 (Figure 81). Of that total, CTL is projected to account for 1.6 million barrels per day and oil shale 405,000 barrels per day. Because natural gas prices are relatively high throughout the projections, GTL production reaches only about 100,000 barrels per day in 2030 in the high price case.

The costs of unconventional oil production are uncertain. As an example, current CTL technology produces significant amounts of CO_2, and if Federal restrictions on CO_2 emissions were enacted in the future, CTL production costs could rise substantially.

Transportation Uses Lead Growth in Liquid Fuels Consumption

Figure 82. Liquid fuels consumption by sector, 1990-2030 (million barrels per day)



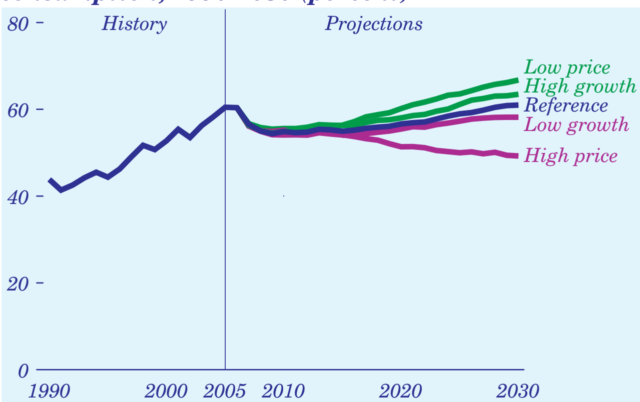
U.S. consumption of liquid fuels—including fuels from petroleum-based sources and, increasingly, those derived from such nonpetroleum primary fuels as coal, biomass, and natural gas—is projected to total 26.9 million barrels per day in 2030, an increase of 6.2 million barrels per day over the 2005 total. Most of the increase is in the transportation sector, which is projected to account for 73 percent of total liquid fuels consumption in 2030, up from 67 percent in 2005 (Figure 82).

Liquid fuels use for transportation increases by 5.8 million barrels per day from 2005 to 2030 in the *AEO2007* reference case, by 7.8 million barrels per day in the high economic growth case, and by 3.8 million barrels per day in the high price case. Gasoline, ULSD, and jet fuel are the main transportation fuels. The reference case includes the effects of technology improvements that are expected to increase the efficiency of motor vehicles and aircraft, but the projected growth in demand for each mode outpaces those improvements as the demand for transportation services grows in proportion to increases in population and GDP.

Consumption of liquid fuels from nonpetroleum sources increases substantially over the projection period. Ethanol, which made up 3 percent of the motor gasoline pool in 2005, increases to approximately 8 percent of the total motor gasoline pool in 2030. Total production of liquid fuels from CTL plants, which are expected to commence operation in 2011, increases in the reference case to 440,000 barrels per day—equivalent to 7 percent of the total pool of distillate fuel—in 2030.

Imports of Liquid Fuels Increase With Rising U.S. Demand

Figure 83. Net import share of U.S. liquid fuels consumption, 1990-2030 (percent)

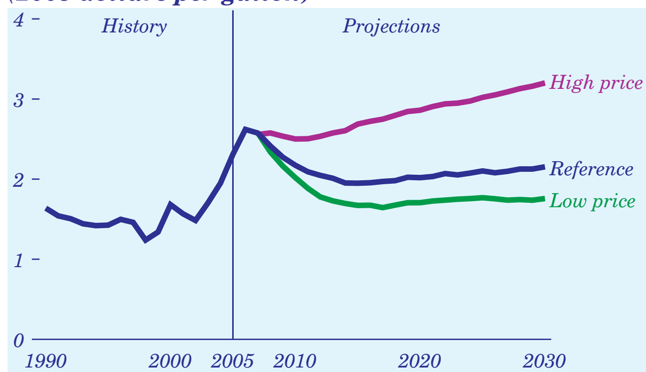


In 2005, net imports of liquid fuels, primarily petroleum, accounted for 60 percent of domestic consumption. The United States is expected to continue its dependence on liquid fuel imports in the *AEO2007* reference case. The import share of domestic consumption declines slightly to 55 percent in 2015 before climbing to 61 percent in 2030 (Figure 83). Dependence on imports is tied to total consumption. In the high price case, net imports as a share of domestic consumption of liquid fuels fall to 49 percent in 2030. In the low price case, dependence on petroleum imports increases to 67 percent in 2030 as U.S. demand for lower priced fuels increases more rapidly than domestic production.

In the reference case, demand for refined products continues to increase more rapidly than refining capacity. Historically, the availability of product imports has been limited by a lack of foreign refineries capable of meeting the stringent U.S. standards for liquids products. More recently, however, liquids demand has grown rapidly in some countries of Eastern Europe and Asia, and those nations are moving to adopt the same quality standards as the developed world. As a result, refineries throughout the world are becoming more sophisticated, and in the future more of them will be able to provide products suitable for the U.S. market, which they may do if it is profitable.

U.S. Motor Gasoline Prices Rise and Fall With Changes in World Oil Price

Figure 84. Average U.S. delivered prices for motor gasoline, 1990-2030 (2005 dollars per gallon)



The retail prices of petroleum products largely follow changes in crude oil prices. In the reference case, the world oil price path reaches a low of about $50 per barrel in 2014, then increases slowly to about $59 in 2030 (2005 dollars). The reference case projections for average U.S. average motor gasoline prices follow the same trend, rising from $1.95 per gallon in 2014 to $2.15 in 2030.

In the high price case, with the price of imported crude oil projected to rise to more than $100 per barrel in 2030, the average price of U.S. motor gasoline follows the higher price path of world oil prices, increasing from $2.61 per gallon in 2014 to a high of $3.20 per gallon in 2030. In the low price case, gasoline prices decline to a low of $1.64 per gallon in 2017, increase slowly through the early 2020s, and level off at about $1.76 per gallon through 2030 (Figure 84).

Because changes from the reference case assumptions for economic growth rates have less pronounced effects on projected motor gasoline prices than do changes in oil price assumptions, the projected average prices for U.S. motor gasoline in the high and low economic growth cases are close to those in the reference case. In the high growth case, the average gasoline price falls to a low of $2.00 per gallon in 2016, then rises to $2.21 per gallon in 2030. In the low growth case, the average price reaches a low of $1.92 per gallon in 2014, then rises to $2.08 per gallon in 2030.