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Case Descriptions

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Overview

Uncertainty surrounds economic growth, future oil prices, the ultimate size of domestic energy resources, and technological change. To capture that uncertainty, EIA ran sensitivity cases to show how the model responds to changes in key variables compared with the Reference case. The seven sensitivity cases covered in the *Annual Energy Outlook 2019* (AEO2019) are described in this document:

- Reference
- High Economic Growth
- Low Economic Growth
- High Oil Price
- Low Oil Price
- High Oil and Gas Resource and Technology
- Low Oil and Gas Resource and Technology

Table 1 provides the formal case names, scenario names, and datekeys. Results for all AEO2019 cases are available on the AEO table browser.

Macroeconomic growth cases

The Low Economic Growth and High Economic Growth cases were developed to reflect the uncertainty in projections of economic growth. These cases show the effects of alternative growth assumptions that are higher than and lower than the Reference case energy market projections. In the Reference case, population (including armed forces overseas) grows by an average rate of 0.5% per year, nonfarm employment by 0.6% per year, and productivity by 1.5% per year from 2018 to 2050. Economic output as measured by real gross domestic product (GDP) increases by 1.9% per year from 2018 through 2050, and growth in real disposable income per capita averages 2.1% per year.

The Low Economic Growth case assumes lower average annual growth rates for population (0.4% per year) and nonfarm labor productivity (1.1% per year), resulting in lower growth in nonfarm employment (0.4% per year), higher prices and interest rates, and lower growth in industrial output. In the Low Economic Growth case, economic output as measured by real GDP increases by 1.4% per year from 2018 through 2050, and growth in real disposable income per capita averages 1.9% per year.

The High Economic Growth case assumes higher average growth rates for population (0.7% per year) and productivity (1.9% per year), resulting in higher nonfarm employment (0.8% per year). With higher productivity gains and employment growth, inflation and interest rates are lower than in the Reference case for most years, and as a result, economic output, as measured by real GDP, grows at a higher rate (2.4% per year) than in the Reference case (1.9% per year). Real disposable income per capita grows by 2.5% per year.

Oil price cases

The historical record shows substantial variability in oil prices and even more uncertainty about long-term future prices. AEO2019 considers three oil price cases (Reference, Low Oil Price, and High Oil Price) to assess alternative views on the future course of oil prices. The benchmark crude oil price in AEO2019 is based on the spot price for North Sea Brent crude oil, which is an international standard for light, sweet crude oil prices. Data tables also include West Texas Intermediate (WTI) prices—a critical reference point for the value of growing oil production in the U.S. Midcontinent—as well as the imported refiner acquisition cost for crude oil. The WTI spot price is generally lower than the North Sea Brent price. With the price spread between Brent and WTI estimated to have been $6/barrel (b) in 2018, EIA expects the price spread in the Reference and Low Oil Price cases to range between $3/b and $6/b from 2019 through 2050, and between $3/b and $7/b in the High Oil Price case. The December 2015 decision by the U.S. Congress to remove restrictions on U.S. crude oil exports has the potential to narrow the spread between the Brent price and the price of domestic production streams under certain cases involving high levels of U.S. crude oil production.

In the Reference case, real oil prices (2018 dollars) steadily rise from $73/b in 2019 to almost $108/b by 2050. The Reference case Brent spot price path is based on an increasing trend projection for both global oil supply and demand. Global petroleum and other liquids consumption increases steadily throughout the Reference case, in part, because of an increase in the number of vehicles across the world—which is offset somewhat by improvements in light-duty vehicle (LDV) and heavy-duty vehicle (HDV) fuel economy in developing countries and increased natural gas consumption for transportation in most regions. Economic growth is steady during the projection period, and some substitution away from liquid fuels in the industrial sector occurs. The market share of total liquids production by the Organization of the Petroleum Exporting Countries (OPEC) rises from 37% in 2022 (39% in 2018) to 40% in 2038 and then to 43% in 2050.

The Low and High Oil Price cases reflect a wide range of potential price paths, resulting from a variation in global demand and supply of petroleum and other liquid fuels. The Low Oil Price case assumes conditions under which global liquids demand is low and supply is high, and the High Oil Price case assumes the opposite. Both cases show shifts in global supply and demand that offset one another, which makes liquids consumption close to Reference case levels although prices are substantially different.

In the Low Oil Price case, crude oil prices fall to an average of $44/b (2018 dollars) in 2020 and remain lower than $50/b, with the Brent crude oil price in 2050 at about $49.75/b. Relatively low global demand compared with the Reference case occurs as a result of several factors:

- Economic growth that is relatively slow compared with historical trends
- Reduced consumption in developed countries as a result of adopting more efficient technologies, extending Corporate Average Fuel Economy (CAFE) standards, lowering travel demand, and increasing natural gas or electricity consumption

- Efficiency improvement in nonmanufacturing industries in the non-Organization for Economic Cooperation and Development countries
- Industrial fuel switching from liquids to natural gas feedstocks used to produce methanol and ammonia

Low oil prices also result from a lower demand for petroleum and other liquids in the non-OECD nations and from higher global supply. Producers face lower costs of production for both crude oil and other liquids production technologies.

In the High Oil Price case, Brent crude oil prices average slightly more than $210/b (2018 dollars) in 2050. A lack of global investment in the oil sector is the primary cause of higher prices, which eventually leads to higher production from non-OPEC producers relative to the Reference case. Higher prices stimulate increased supply of more costly resources—including tight oil and bitumen—and also lead to significant increases in production of renewable liquid fuels, as well as natural gas-to-liquids and coal-to-liquids, compared with the Reference case. The main reason for increased demand in the High Oil Price case is higher economic growth, particularly in developing countries, than in the Reference case. In the developing countries, consumers demand greater personal mobility and more consumption of goods. Fewer efficiency gains occur in the industrial sector, and growing demand for fuel in the non-manufacturing sector continues to be met with liquid fuels.

Oil and natural gas resource and technology cases

Estimates of technically recoverable tight/shale crude oil and natural gas resources are particularly uncertain and change over time as new information is gained through drilling, production, and technology experimentation. Over the past decade, as more tight/shale formations have gone into production, the estimate of technically recoverable tight oil and shale gas resources has increased. However, these increases in technically recoverable resources are based on many assumptions that might not prove to be true over the long term and over the entire tight/shale formation. For example, these resource estimates assume that crude oil and natural gas production rates achieved in a limited portion of the formation are representative of an entire formation, even though neighboring well production rates can vary by as much as a factor of three within the same play. In addition, the tight/shale formation can vary significantly across the petroleum basin with respect to depth, thickness, porosity, carbon content, pore pressure, clay content, thermal maturity, and water content. Technological improvements and innovations may also result in developing crude oil and natural gas resources that have not been identified yet and, as a result, are not included in the Reference case.

The sensitivity of the AEO2019 projections to changes in assumptions about domestic crude oil and natural gas resources and technological progress is examined in two cases. These cases do not represent a confidence interval for future domestic oil and natural gas supply, but rather they provide a framework to examine the effects of higher and lower domestic supply on energy demand, imports, and prices. Assumptions associated with these cases are described below.

In the Low Oil and Gas Resource and Technology case, the estimated ultimate recovery per well for tight oil, tight gas, or shale gas in the United States and undiscovered resources in Alaska and the offshore Lower 48 states is assumed to be 50% lower than in the Reference case. Rates of technological improvement that reduce costs and increase productivity in the United States are also 50% lower than in the Reference case. These assumptions increase the per-unit cost of crude oil and natural gas development in the United States. The total unproved technically recoverable resource of crude oil is reduced to 167 billion barrels, and the natural gas resource is reduced to 1,204 trillion cubic feet (Tcf), as compared with unproved resource estimates of 267 billion barrels of crude oil and 2,137 Tcf of natural gas as of January 1, 2017, in the Reference case.

In the High Oil and Gas Resource and Technology case, the estimated ultimate recovery per well for tight oil, tight gas, or shale gas in the United States and undiscovered resources in Alaska and the offshore Lower 48 states is assumed to be 50% higher than in the Reference case. Rates of technological improvement that reduce costs and increase productivity in the United States are also 50% higher than in the Reference case. In addition, tight oil and shale gas resources are added to reflect new plays or the expansion of known plays. The total unproved technically recoverable resource of crude oil increases to 419 billion barrels, and the natural gas resource increases to 3,075 Tcf compared with unproved resource estimates of 267 billion barrels of crude oil and 2,137 Tcf of natural gas in the Reference case at the start of 2017.

Summary of AEO2019 cases

Case name	Scenario name	Date key
Reference	ref2019	d111618a
Low Economic Growth	lowmacro	d111618a
High Economic Growth	highmacro	d111618a
Low Oil Price	lowprice	d111618a
High Oil Price	highprice	d111618a
Low Oil and Gas Resource and Technology	lowrt	d111618a
High Oil and Gas Resource and Technology	highrt	d111618a