
International Energy Module

The National Energy Modeling System International Energy Module (IEM) simulates the interaction between U.S. and global petroleum markets. The IEM uses assumptions of economic growth and expectations of future U.S. and world crude-like liquids production and consumption to estimate the effects of changes in U.S. liquid fuels markets on the international petroleum market. For each year of the projection period, the IEM computes Brent crude oil prices, provides a supply curve of world crude-like liquids, and generates a worldwide oil supply-demand balance with regional detail. The IEM also provides, for each year of the projection period, endogenous assumptions for petroleum products for U.S. import and export.

Changes in the Brent oil price are computed in response to

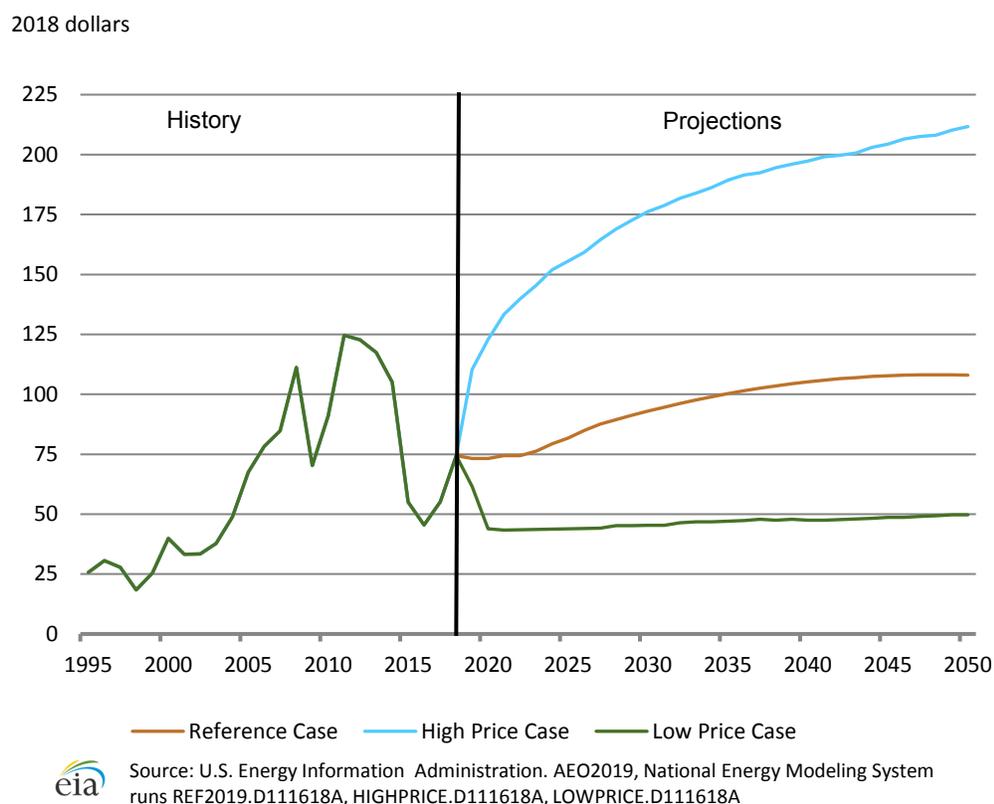
1. The difference between projected U.S. total crude-like liquids production and the expected U.S. total crude-like liquids production at the current oil price (estimated using the current oil price and the exogenous U.S. total crude-like liquids supply curve for each year)
2. The difference between projected U.S. total crude-like liquids consumption and the expected U.S. total crude-like liquids consumption at the current oil price (estimated using the current oil price and the exogenous U.S. total crude-like liquids demand curve).

Key assumptions

Annual Energy Outlook 2019 (AEO2019) considers a number of factors related to the uncertainty of future oil prices, including changes in worldwide demand for petroleum products, investment and production decisions by the Organization of the Petroleum Exporting Countries (OPEC), non-OPEC petroleum liquid fuels supply, and supplies of other liquid fuels. AEO2019 also considers the International Maritime Organization (IMO) convention that limits sulfur in fuel oil to be used on ships from 2020 to 2025.

In the AEO2019 Reference case, the steady increase in U.S. crude oil production, combined with the moderate increase in world crude oil production, contributes to a stagnant oil price of \$73 to \$74 per barrel (2018 dollars) until 2022. Oil prices rise steadily after 2022 in response to growth in demand from countries outside of the Organization for Economic Cooperation and Development (OECD), even as downward pressure from increases in U.S. oil production keeps the oil price lower than \$95 per barrel through 2031. Growth in demand from non-OECD countries combined with a decrease in U.S. crude oil production pushes the oil price to \$108 per barrel in 2050 (Figure 1). The AEO2019 Reference case also assumes that the OPEC market share of liquids production will increase from 39% in 2018 to 43% in 2050.

Figure 1. World oil prices in three cases, 1995–2050



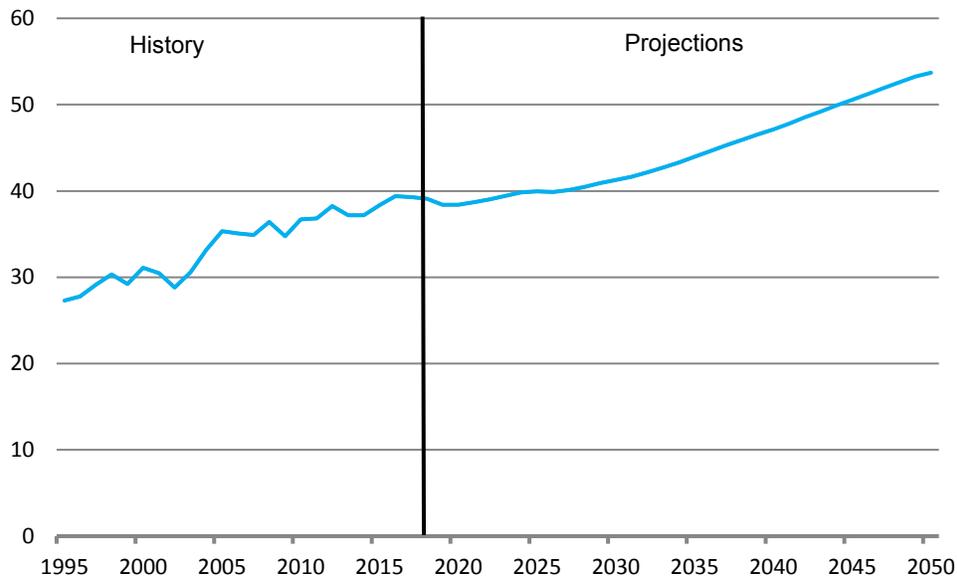
In the AEO2019 Low Oil Price case, the oil price drops to \$44 per barrel in 2020, followed by a gradual increase to \$50 per barrel in 2050. This trend is in response to higher upstream investment by OPEC and lower global demand. OPEC members increase their liquids production, and their market share increases from 39% in 2018 to 53% in 2050.

In the AEO2019 High Oil Price case, the oil price increases to \$110 per barrel in 2019 and \$212 per barrel in 2050. This trend is in response to significantly lower OPEC production, higher non-OECD demand for petroleum products, and more limited international supply of other liquid fuels than in the Reference case. As a result, U.S. production is significantly higher and U.S. domestic consumption is lower, which leads to lower U.S. net imports of crude oil through 2050. OPEC countries’ share of world liquids production decreases to 30% by 2030 and then slowly increases to 33% by 2050.

OPEC petroleum and other liquids production in the AEO2019 Reference case is assumed to increase throughout the 2019–2050 projection period (Figure 2), a rate that enables the organization to achieve a 43% market share of the world’s total petroleum and other liquids in 2050. OPEC is assumed to be an important source of additional production because its member nations held at the end of 2017 a major share of the world’s total proved oil reserves—approximately 1,218 billion barrels, or about 74% of the world’s estimated total. [1]

Figure 2. OPEC total liquids production in the Reference case, 1995–2050

million barrels per day



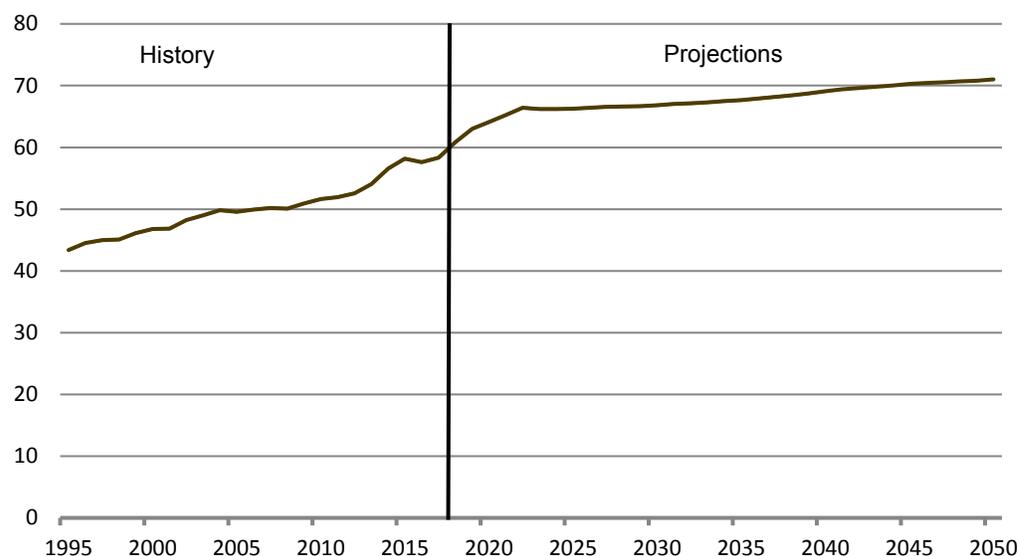
OPEC = Organization of Petroleum Exporting Countries

Source: U.S. Energy Information Administration. AEO2019 National Energy Modeling System run REF2019.D111618A

Non-U.S., non-OPEC oil production projections in AEO2019 are developed in two stages. Projections of liquids production before 2019 are based largely on project-by-project assessments of major fields—including volumes and expected schedules—with consideration given to the decline rates of producing projects, planned exploration and development activity, and country-specific geopolitical situations and fiscal regimes. Incremental production estimates from existing and new fields after 2019 are based on country-specific considerations of economics and ultimate technically recoverable resource estimates. Non-OPEC total liquids production in the AEO2019 Reference case is shown in Figure 3.

Figure 3. Non-OPEC total liquids production in the Reference case, 1995–2050

million barrels per day



 OPEC = Organization of Petroleum Exporting Countries
 Source: U.S. Energy Information Administration. AEO2019 National Energy Modeling System run REF2019.D111618A

The non-U.S. oil production projections in AEO2019 are limited by country-level assumptions regarding technically recoverable oil resources. Inputs to these resource estimates include the United States Geological Survey (USGS) *World Petroleum Assessment of 2012* and oil reserves published in the *Oil & Gas Journal* by PennWell Publishing Company, a summary of which is shown in Table 1.

Table 1. Worldwide oil reserves as of January 1, 2018

billion barrels

Region	Proved oil reserves
Western Hemisphere	540.9
Western Europe	10.2
Asia-Pacific	45.6
Eastern Europe and Former Soviet Union	120.0
Middle East	807.7
Africa	127.4
Total World	1,651.8
Total OPEC	1,217.9

Source: PennWell Corporation, *Oil & Gas Journal*, Vol 115. 12 (Dec. 4, 2017).

The AEO2019 Reference case growth rates for gross domestic product (GDP) for various regions in the world are shown in Table 2. The GDP growth rate assumptions for non-U.S. countries/regions are taken from the Oxford Economic Model (March 2017).

Table 2. Average annual real gross domestic product rates, 2010–50

2010 purchasing power parity weights and prices

Region	Average annual percentage change
OECD	1.6%
OECD Americas	2.1%
OECD Europe	1.4%
OECD Asia	1.2%
Non-OECD	3.6%
Non-OECD Europe and Eurasia	1.6%
Non-OECD Asia	4.2%
Middle East	2.8%
Africa	3.9%
Non-OECD Americas	2.1%
Total World	2.8%

Source: U.S. Energy Information Administration, derived from Oxford Economic Model (March 2017).

The values for growth in total liquids demand in the IEM, which depend on oil price levels and GDP growth rates, are shown by region in Table 3 for the Reference case.

Table 3. Average annual growth rates for total liquids demand in the Reference case, 2010–50

percent per year

Region	Demand growth
OECD	-0.08%
OECD Americas	0.12%
OECD Europe	-0.48%
OECD Asia	0.00%
Non-OECD	1.50%
Non-OECD Europe and Eurasia	0.09%
Non-OECD Asia	1.96%
Middle East	1.08%
Africa	1.94%
Non-OECD Americas	0.90%
Total World	0.78%

Source: U.S. Energy Information Administration, National Energy Modeling System run REF2018.D121317A.

Notes and sources

[1] PennWell Corporation, *Oil and Gas Journal*, Vol. 115.12 (December 4, 2017).