Chapter 3. International Energy Module

The National Energy Modeling System International Energy Module (IEM) simulates the interaction between U.S. and global petroleum markets. It 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 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 import and export in the United States.

Changes in the oil price (Brent) 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).

and

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).

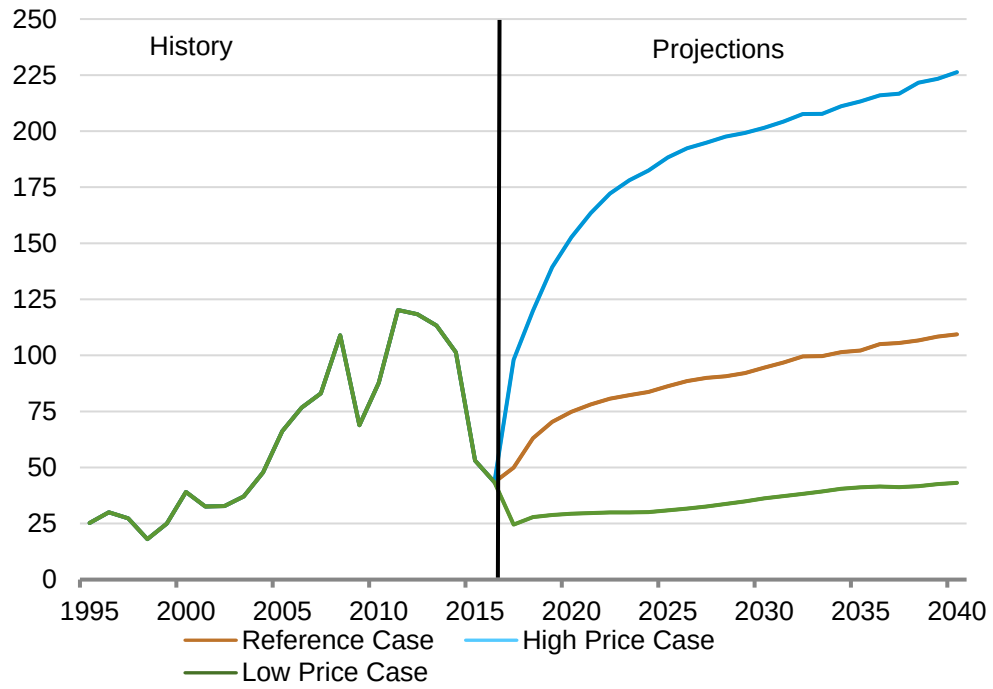
Key assumptions

AEO2017 considers a number of factors related to the uncertainty of future oil prices, including changes in worldwide demand for petroleum products, Organization of the Petroleum Exporting Countries (OPEC) investment and production decisions, non-OPEC petroleum liquid fuels supply, and supplies of other liquid fuels.

In the AEO2017 Reference case, the small decrease in U.S. crude oil production, combined with the increase in world oil prices, contributes to an increase in the oil price to $50 (2016 dollars) per barrel in 2017. Oil prices rise steadily after 2017 in response to growth in demand from countries outside of the Organization for Economic Cooperation and Development (OECD), even if downward pressure from increases in U.S. oil production keeps the oil price below $80 per barrel through 2021. Growth in demand from non-OECD countries will push the oil price to $109 per barrel in 2040 (Figure 3.1). The AEO2017 Reference case also assumes that the OPEC market share of liquids production will increase from 39% in 2017 to 43% in 2040.

Figure 3.1. World oil prices in three cases, 1995-2040

2016 dollars



Source: U.S. Energy Information Administration. AEO2017, National Energy Modeling System runs REF2017.D120816A, HIGHPRICE.D120816A, LOWPRICE.D120816A

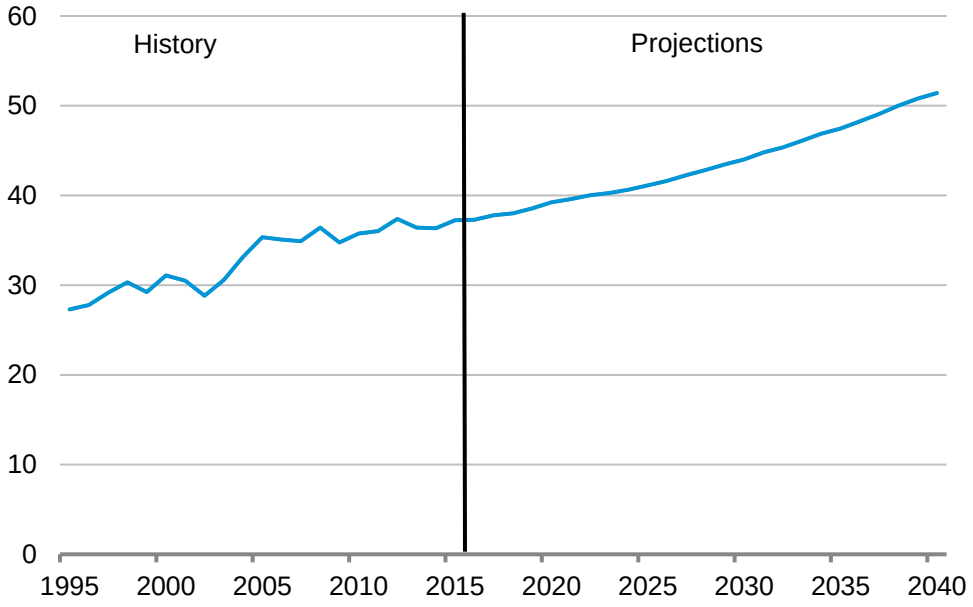
In the AEO2017 Low Oil Price case, the oil price drops to $25 per barrel in 2017, followed by a slow increase to $43 per barrel in 2040. This is in response to higher upstream investment by OPEC and lower OECD demand. In the AEO2017 Low Oil Price case, OPEC countries increase their liquids production to obtain an increase in market share from 41% in 2017 to 48% in 2040.

In the AEO2017 High Oil Price case, the oil price increases to $98 per barrel in 2017 and $226 per barrel in 2040. This is in response to significantly lower OPEC production and higher non-OECD demand, higher demand for petroleum products, and a more limited supply of other liquid fuels than in the Reference case. Also, U.S. production is significantly greater and results in lower net U.S. imports of crude oil through 2030. In the AEO2017 High Oil Price case, OPEC countries' share of world liquids production slowly decreases to 35% by 2025 and 33% by 2040.

OPEC oil production in the AEO2017 Reference case is assumed to increase throughout the 2017-2040 projection period (Figure 3.2), at a rate that enables the organization to achieve a 42% market share of the world's total petroleum and other liquids in 2040. OPEC is assumed to be an important source of additional production because its member-nations hold a major portion of the world's total proved oil reserves—approximately 1,200 billion barrels, about 73% of the world's estimated total, at the end of 2015. [3.1]

Figure 3.2. OPEC total liquids production in the Reference case, 1995-2040

million barrels per day

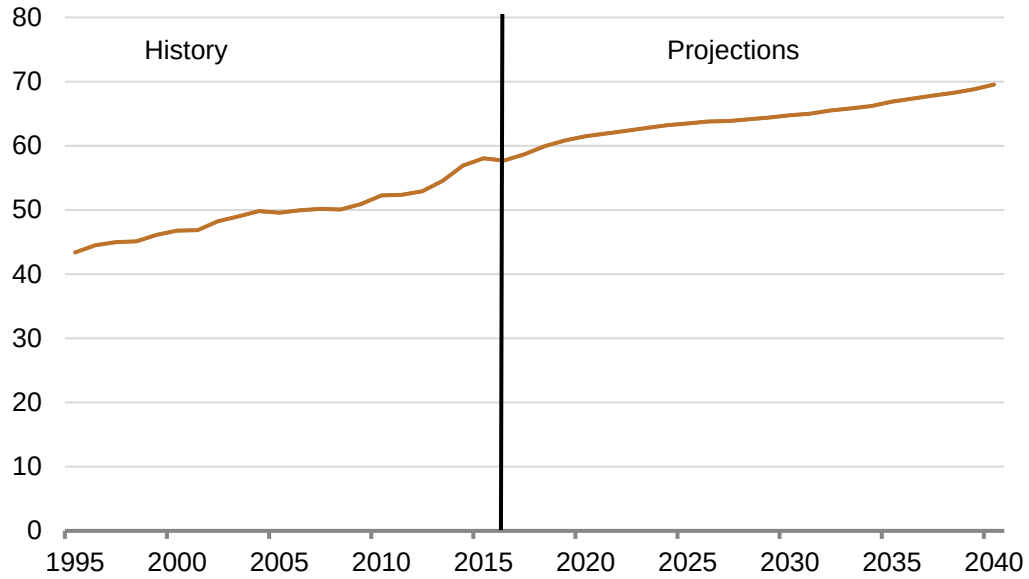


OPEC = Organization of Petroleum Exporting Countries
Source: U.S. Energy Information Administration. AEO2017 National Energy Modeling System run REF2017.D120816A

Non-U.S., non-OPEC oil production projections in the AEO2017 are developed in two stages. Projections of liquids production before 2017 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 2016 are based on country-specific consideration of economics and ultimate technically recoverable resource estimates. The non-OPEC total liquids production path for the AEO2017 Reference case is shown in Figure 3.3.

Figure 3.3. Non-OPEC total liquids production in the Reference case, 1995-2040

million barrels per day



OPEC = Organization of Petroleum Exporting Countries
Source: U.S. Energy Information Administration. AEO2017 National Energy Modeling System run REF2017.D120816A

The non-U.S. oil production projections in AEO2017 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 2000 and oil reserves published in the Oil & Gas Journal by PennWell Publishing Company, a summary of which is shown in Table 3.1.

Table 3.1. Worldwide oil reserves as of January 1, 2014

million barrels

Region	Proved Oil Reserves
Western Hemisphere	551.7
Western Europe	9.9
Asia-Pacific	45.1
Eastern Europe and Former Soviet Union (FSU)	120.0
Middle East	802.7
Africa	125.9
Total World	1,655.3
Total OPEC	1,211.7

Source: Pennwell Corporation, Oil and Gas Journal, Vol 113. 12 (Dec. 7, 2015).

The AEO2017 Reference case growth rates for gross domestic product (GDP) for various regions in the world are shown in Table 3.2. The GDP growth rate assumptions for non-U.S. countries/regions are taken from Oxford Economic Model (June 2015).

Table 3.2. Average annual real gross domestic product rates, 2010-40

2010 purchasing power parity weights and prices

Region	Average Annual Percentage Change
OECD	2.0%
OECD Americas	2.5%
OECD Europe	1.8%
OECD Asia	1.3%
Non-OECD	4.2%
Non-OECD Europe and Eurasia	3.0%
Non-OECD Asia	4.5%
Middle East	3.8%
Africa	5.0%
Non-OECD Americas	2.8%
Total World	3.3%

Source: U.S. Energy Information Administration, Derived from Oxford Economic Model (February 2014).

The values for growth in total liquids demand in the International Energy Module, which depend on oil price levels and GDP growth rates, are shown by region in Table 3.3 for the Reference case.

Table 3.3. Average annual growth rates for total liquids demand in the Reference case, 2010-40

percent per year

Region	Demand Growth
OECD	0.03%
OECD Americas	0.08%
OECD Europe	0.04%
OECD Asia	-0.17%
Non-OECD	1.80%
Non-OECD Europe and Eurasia	0.49%
Non-OECD Asia	2.07%
Middle East	1.89%
Africa	2.36%
Non-OECD Americas	1.28%
Total World	1.03%

Source: U.S. Energy Information Administration, National Energy Modeling System run REF2017.d120816A.

Notes and sources

[3.1] PennWell Corporation, Oil and Gas Journal, Vol. 113.12 (December 7, 2015).