

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 forecast, 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

AEO2016 considers a number of factors related to the uncertainty of future oil prices, including changes in worldwide demand for petroleum products, OPEC investment and production decisions, non-OPEC petroleum liquid fuels supply, and supplies of other liquid fuels.

In the AEO2016 Reference case, the growth in U.S. crude oil production, combined with the fall in world oil prices, contributes to a decrease in the oil price to \$37 (2014 dollars) per barrel in 2016 (Figure 3.1). Oil prices rise steadily after 2016 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 2020. Growth in demand from non-OECD countries will push the oil price to \$136 per barrel in 2040. The AEO2016 Reference case also assumes that the OPEC market share of liquids production will increase from 39% in 2015 to 42% in 2040.

In the AEO2016 Low Oil Price case, the oil price drops to \$35 per barrel in 2016 followed by a slow increase to \$73 per barrel in 2040. This is in response to higher upstream investment by OPEC and lower non-OECD demand. In the AEO2016 Low Oil Price case, OPEC countries increase their liquids production to obtain an increase in market share from 39% in 2015 to 47% in 2040.

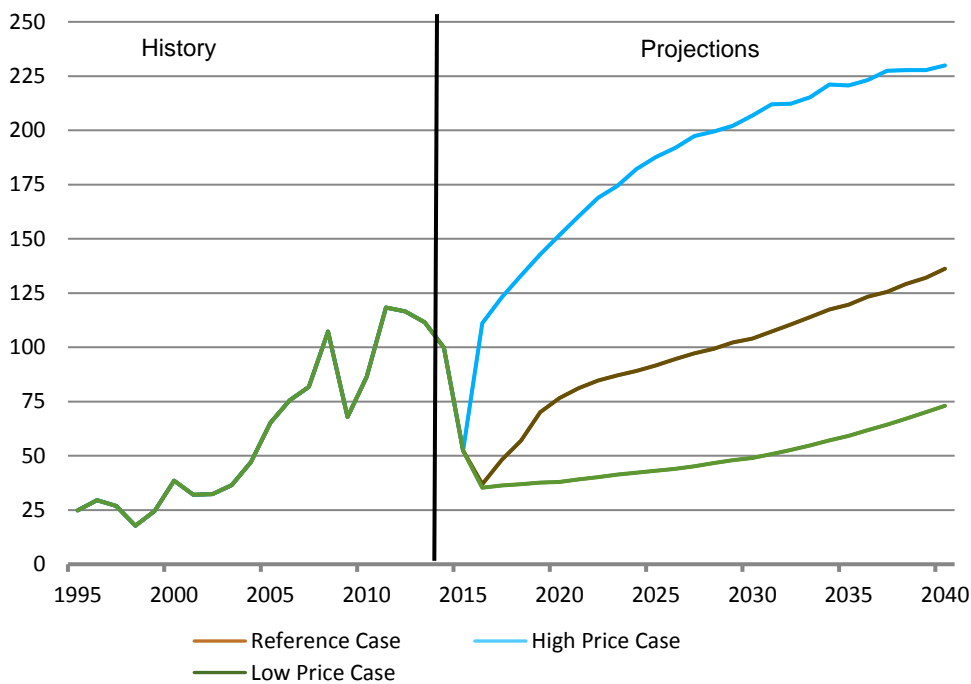
In the AEO2016 High Oil Price case, the oil price increases to \$111 per barrel in 2016 and to \$230 per barrel in 2040. This is in response to significantly lower OPEC production and higher non-OECD demand, higher demand for petroleum products, and a more limited supply of other liquid fuels than in the Reference case. Also, U.S. production is significantly greater, resulting in lower net imports of crude oil. In the AEO2016 High Oil Price case, OPEC countries' share of world liquids production decreases to 36% by 2025 and 34% by 2040.

OPEC oil production in the AEO2016 Reference case is assumed to increase throughout the 2016-2040 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 reserves—around 1,200 billion barrels, about 73% of the world’s estimated total, at the end of 2014. [4]

Non-U.S., non-OPEC oil production projections in the AEO2016 are developed in two stages. Projections of liquids production before 2016 are based largely on a project-by-project assessment of major fields, including volumes and expected schedules, with consideration given to the decline rates of active 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 estimated based on country-specific consideration of economics and ultimate technically recoverable resource estimates. The non-OPEC production path for the AEO2016 Reference case is shown in Figure 3.3.

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

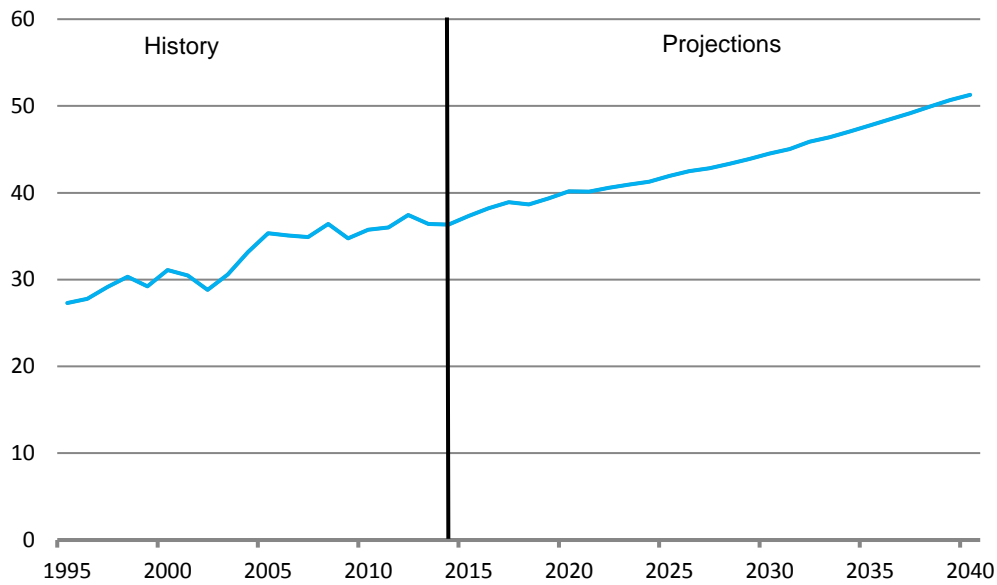
million barrels per day



Source: U.S. Energy Information Administration. AEO2016, National Energy Modeling System runs REF2016.D032416A, HIGHPRICE.D041916A, LOWPRICE.D041916A

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

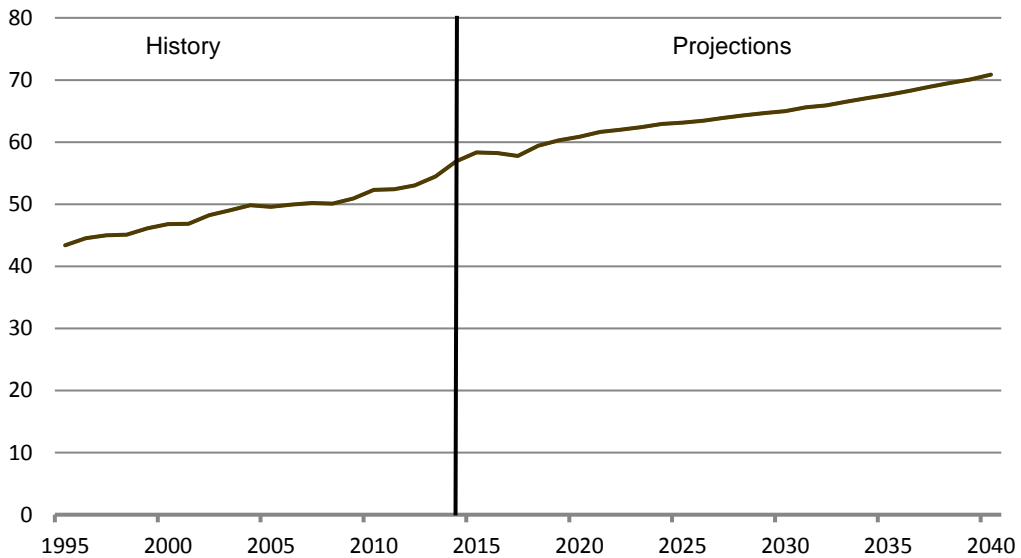
million barrels per day



OPEC = Organization of Petroleum Exporting Countries
 Source: U.S. Energy Information Administration. AEO2016 National Energy Modeling System run REF2016.D032416A

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. AEO2016 National Energy Modeling System run REF2016.D032416A

The non-U.S. oil production projections in AEO2016 are limited by country-level assumptions regarding technically recoverable oil resources. Inputs to these resource estimates include the 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.

The AEO2016 Reference case growth rates for 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 (February 2014).

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

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

million barrels

Region	Proved Oil Reserves
Western Hemisphere	544.9
Western Europe	11.1
Asia-Pacific	46.0
Eastern Europe and Former Soviet Union (F.S.U.)	120.0
Middle East	798.6
Africa	126.7
Total World	1,647.4
Total OPEC	1,200.8

Source: Pennwell Corporation, Oil and Gas Journal, Vol 112. 12 (Dec. 1, 2014).

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

2005 purchasing power parity weights and prices

Region	Average Annual Percentage Change
OECD	2.1%
OECD Americas	2.4%
OECD Europe	2.0%
OECD Asia	1.4%
Non-OECD	4.6%
Non-OECD Europe and Eurasia	2.9%
Non-OECD Asia	5.3%
Middle East	3.9%
Africa	4.8%
Central and South America	3.2%
Total World	3.5%

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

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	0.24%
OECD Europe	-0.22%
OECD Asia	-0.17%
Non-OECD	1.98%
Non-OECD Europe and Eurasia	0.68%
Non-OECD Asia	2.31%
Middle East	2.07%
Africa	2.27%
Central and South America	1.46%
Total World	1.08%

Source: U.S. Energy Information Administration, National Energy Modeling System run REF2016.d032416A.

Notes and sources

[4] PennWell Corporation, Oil and Gas Journal, Vol. 111.12 (December 1, 2014).