AEO2018 Review & AEO2019 Plans

For
AEO2019 Oil and Gas Supply & Liquid Fuels Markets Working Group
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Liquid Fuels Markets
Outline

• Brief background of the Liquid Fuels Market Module (LFMM) and International Energy Module (IEM)

• Evaluation and discussion of results from AEO2018

• Improvements for AEO2019
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• Brief background of the Liquid Fuels Market Module (LFMM) and International Energy Module (IEM)

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Background on Liquid Fuels Market Module (LFMM) and International Energy Module (IEM)

• LFMM is a linear program that projects petroleum product prices and sources of liquid fuels supply for meeting petroleum product demand. The sources of supply include crude oil refined into petroleum products, imports of petroleum products, and non-petroleum liquids such as biofuels, coal-to-liquids, and gas-to-liquids.

• IEM is an economic model that simulates the interaction between U.S. and global petroleum markets. It uses assumptions of economic growth and expectations of future world crude oil and liquids production and consumption to compute Brent crude oil prices, provides a supply curve of world crude like liquids, and generates a worldwide oil supply/demand balance with regional detail.
Outline

• Brief background of the Liquid Fuels Market Module (LFMM) and International Energy Module (IEM)

• Evaluation and discussion of results from AEO2018

• Improvements for AEO2019
Oil prices continue to rise in the reference case projection.

Source: U.S. Energy Information Administration, Annual Energy Outlook 2018
The United States becomes a net exporter of crude oil, petroleum products, and natural gas liquids in 2029

Petroleum net imports as a percentage of product supplied

Percent

2017

history | projections

Low Oil Price
Low Oil and Gas Resource/Technology

Reference

High Oil Price
High Oil and Gas Resource/Technology

Source: U.S. Energy Information Administration, Annual Energy Outlook 2018
While total crude oil imports decline in the reference case, imports of heavy crude oil increase to balance the crude slate.

Source: U.S. Energy Information Administration, Annual Energy Outlook 2018 Reference case
Refinery utilization rises in 2020 in reaction to increased international demand for diesel, but returns to historical levels.

Source: U.S. Energy Information Administration, Annual Energy Outlook 2018
Volumes of imports and exports of petroleum products shift as a result of the 2020 IMO regulation on sulfur content of marine fuel

Source: U.S. Energy Information Administration, Annual Energy Outlook 2018 Reference case
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• Brief background of the Liquid Fuels Market Module (LFMM) and International Energy Module (IEM)

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AEO2019 Planned improvements

• Update transportation costs between regions as well as import and exports costs for crude oil and petroleum products

• Assess the ability of the West Coast refineries to process additional volumes of Alaskan crude oil production

• Further analyze the effects of IMO regulations on sulfur content for marine gasoil starting in 2020 on international crude oil and product markets

• Some “under the hood” process improvements for benchmarking to the STEO forecast
Oil and Gas Supply
Outline

• Evaluation and discussion of results from AEO2018

• Review of changes to the short-term outlook

• Current plans for AEO2019
Outline

• Evaluation and discussion of results from AEO2018

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• Current plans for AEO2019
U.S. crude oil and natural gas production continues to be driven by growth in tight oil and shale gas supply

U.S. crude oil production

million barrels per day

2017

history projections

2017

U.S. dry natural gas production

trillion cubic feet

billion cubic feet per day

Note: Shale gas production includes associated natural gas from tight oil plays.

Source: U.S. Energy Information Administration, Annual Energy Outlook 2018 Reference case
The Southwest region leads growth in U.S. crude oil production and the East region leads growth in natural gas in the Reference case.

**Lower 48 onshore crude oil production by region**

- Million barrels per day
- 2017 projections
- Southwest
- Rocky Mountain/Dakotas
- Gulf Coast
- Midcontinent
- West Coast

**Lower 48 onshore dry natural gas production by region**

- Trillion cubic feet
- 2017 projections
- East
- Gulf Coast
- Southwest
- Rocky Mountain/Dakotas
- Midcontinent
- West Coast

Source: U.S. Energy Information Administration, Annual Energy Outlook 2018 Reference case
Bakken and Wolfcamp lead growth in tight oil production

U.S. tight oil production
million barrels per day

2017

history projections

Source: U.S. Energy Information Administration, Annual Energy Outlook 2018 Reference case
Marcellus and Utica lead production of shale gas

U.S. dry shale gas production
trillion cubic feet

2017
history projections

2010 2015 2020 2025 2030 2035 2040 2045 2050

Marcellus
Utica
Other
Haynesville/Bossier
Eagle Ford
Barnett
Fayetteville
Woodford
Bakken
Antrim

Note: Other includes natural gas production in tight oil plays.
Source: U.S. Energy Information Administration, Annual Energy Outlook 2018 Reference case
U.S. crude oil and natural gas production are sensitive to resource availability and technological improvements.

**U.S. crude oil production**

- Million barrels per day

**U.S. dry natural gas production**

- Trillion cubic feet per year
- Billion cubic feet per day

Source: U.S. Energy Information Administration, Annual Energy Outlook 2018

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**2017**

- History
- Projections

**High Oil and Gas Resource and Technology**

**High Oil Price**

**Reference case**

**Low Oil Price**

**Low Oil and Gas Resource and Technology**

Source: U.S. Energy Information Administration, Annual Energy Outlook 2018
Natural gas plant liquids production increases from 2017 levels in all AEO2018 cases

U.S. natural gas plant liquids production
million barrels per day

Source: U.S. Energy Information Administration, Annual Energy Outlook 2018
The East and Southwest regions lead the production of natural gas plant liquids in the Reference case.

U.S. natural gas plant liquids production by region

- **East**
- **Southwest**
- **Other U.S.**

Source: U.S. Energy Information Administration, Annual Energy Outlook 2018
Crude oil price projections are sensitive to global conditions, while U.S. natural gas prices depend more on domestic resource assumptions.

**West Texas Intermediate oil price**
2017 dollars per barrel

- 2017 history: $110
- 2017 projections: $224

**Henry Hub natural gas price**
2017 dollars per million Btu

- 2017 history: $3
- 2017 projections: $9

Source: U.S. Energy Information Administration, Annual Energy Outlook 2018
## Key oil and natural gas supply assumptions, AEO2018

### Technically recoverable resources (as of 1/1/2016)

<table>
<thead>
<tr>
<th>Region</th>
<th>Crude oil (billion barrels)</th>
<th>Natural gas (trillion cubic feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower 48 onshore</td>
<td>194.1</td>
<td>1,907.1</td>
</tr>
<tr>
<td>East</td>
<td>4.6</td>
<td>707.1</td>
</tr>
<tr>
<td>Gulf Coast</td>
<td>37.8</td>
<td>423.9</td>
</tr>
<tr>
<td>Midcontinent</td>
<td>16.5</td>
<td>189.2</td>
</tr>
<tr>
<td>Southwest</td>
<td>80.9</td>
<td>238.7</td>
</tr>
<tr>
<td>Rocky Mountain/Dakotas</td>
<td>47.6</td>
<td>312.4</td>
</tr>
<tr>
<td>West Coast</td>
<td>6.6</td>
<td>35.8</td>
</tr>
<tr>
<td>Lower 48 offshore</td>
<td>54.4</td>
<td>279.6</td>
</tr>
<tr>
<td>Atlantic</td>
<td>3.3</td>
<td>31.7</td>
</tr>
<tr>
<td>Gulf of Mexico</td>
<td>44.6</td>
<td>238.3</td>
</tr>
<tr>
<td>Pacific</td>
<td>6.5</td>
<td>9.6</td>
</tr>
<tr>
<td>Alaska</td>
<td>36.1</td>
<td>275.6</td>
</tr>
<tr>
<td><strong>Total U.S.</strong></td>
<td><strong>284.6</strong></td>
<td><strong>2,462.3</strong></td>
</tr>
</tbody>
</table>

### Annual average rate of technological improvement

<table>
<thead>
<tr>
<th>Resource Type</th>
<th>Drilling Cost</th>
<th>Lease Equipment &amp; Operating Cost</th>
<th>EUR Tier 1</th>
<th>EUR Tier 2</th>
<th>EUR Tier 2 drilling ramp-up period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tight oil</td>
<td>-1.00%</td>
<td>-0.50%</td>
<td>1.00%</td>
<td>3.00%</td>
<td>6.00%</td>
</tr>
<tr>
<td>Tight gas</td>
<td>-1.00%</td>
<td>-0.50%</td>
<td>1.00%</td>
<td>3.00%</td>
<td>6.00%</td>
</tr>
<tr>
<td>Shale gas</td>
<td>-1.00%</td>
<td>-0.50%</td>
<td>1.00%</td>
<td>3.00%</td>
<td>6.00%</td>
</tr>
<tr>
<td>All other</td>
<td>-0.25%</td>
<td>-0.25%</td>
<td>0.25%</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

EUR = estimated ultimate recovery
Outline

• Evaluation and discussion of results from AEO2018

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• Current plans for AEO2019
West Texas Intermediate oil prices are forecast to average over $60/barrel in both 2018 & 2019 in the latest Short-Term Energy Outlook.

<table>
<thead>
<tr>
<th>Year</th>
<th>Nominal $/barrel</th>
<th>AEO2018</th>
<th>May 2018 STEO</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>$49.69</td>
<td>$50.79</td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>$50.57</td>
<td>$65.58</td>
<td></td>
</tr>
<tr>
<td>2019</td>
<td>$55.26</td>
<td>$60.86</td>
<td></td>
</tr>
</tbody>
</table>

Source: EIA Short-Term Energy Outlook, May 2018
Higher prices drive crude oil production growth higher in the latest Short-Term Energy Outlook than in the AEO2018 Reference case.

U.S. crude oil production
million barrels per day

Components of annual change
million barrels per day

Source: EIA Short-Term Energy Outlook, May 2018
Henry Hub natural gas prices are forecast to average $3.01/MMBtu in 2018 and $3.11/MMBtu in 2019 in the latest Short-Term Energy Outlook.

### Henry Hub natural gas price

<table>
<thead>
<tr>
<th>Year</th>
<th>AEO2018</th>
<th>May 2018 STEO</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>$3.05</td>
<td>$2.99</td>
</tr>
<tr>
<td>2018</td>
<td>$3.13</td>
<td>$3.01</td>
</tr>
<tr>
<td>2019</td>
<td>$3.55</td>
<td>$3.11</td>
</tr>
</tbody>
</table>

Source: EIA Short-Term Energy Outlook, May 2018, and Thomson Reuters.
Marketed natural gas production is projected to grow by a record 7.4 Bcf/d on average in 2018 in the latest Short-Term Energy Outlook.

### U.S. marketed natural gas production

<table>
<thead>
<tr>
<th>Year</th>
<th>AEO2018 dry / marketed</th>
<th>May 2018 STEO dry / marketed</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>74.2 / --</td>
<td>73.6 / 78.9</td>
</tr>
<tr>
<td>2018</td>
<td>79.3 / --</td>
<td>80.5 / 86.3</td>
</tr>
<tr>
<td>2019</td>
<td>85.5 / --</td>
<td>83.3 / 89.6</td>
</tr>
</tbody>
</table>

### Components of annual change

- **Haynesville**: 7.4 Bcf/d
- **Permian**: 3.3 Bcf/d
- **Appalachia**: -1.0 Bcf/d
- **Other**: 1.1 Bcf/d

Source: EIA Short-Term Energy Outlook, May 2018
Outline

• Evaluation and discussion of results from AEO2018

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Add Northern Great Plains region to AEO2019 published regional crude oil and natural gas supply tables
Expand short-term supply curve options

- Currently there is only one form, or set of parameters, to define the short term supply curve for all OGSM districts (84)

- Code already includes optionality for up to 3 different forms of the supply curve, as well as fixed supply

- Allow for different supply elasticities for different types of regions
  - Improve more granular results
  - Allows different types of nonassociated supply (i.e. offshore, Marcellus, western Canada) to respond to price differently
Include the coastal plain of the Arctic National Wildlife Refuge

U.S. crude oil production
million barrels per day

Source: U.S. Energy Information Administration, Annual Energy Outlook 2018
Other AEO2019 updates

• Tight oil and shale gas
  – Estimated ultimate recovery
  – Lateral length
  – Well spacing

• NGPL assumptions for the DJ and Anadarko basins

• Lower 48 offshore and Alaska field declines and announced discoveries

• Current laws and regulations
We welcome feedback on our assumptions and documentation

• Working group meetings http://www.eia.gov/forecasts/aeo/workinggroup/

• The AEO Assumptions report http://www.eia.gov/forecasts/aeo/assumptions/

• NEMS Model Documentation
  – Oil and gas supply (OGSM)
  – Liquid Fuels Market Module (LFMM)
  – International Energy Module (IEM)

• Working papers series http://www.eia.gov/workingpapers/
For more information

Annual Energy Outlook | www.eia.gov/aeo

Short-Term Energy Outlook | www.eia.gov/steo

International Energy Outlook | www.eia.gov/ieo

Monthly Energy Review | www.eia.gov/mer

Today in Energy | www.eia.gov/todayinenergy

State Energy Profiles | www.eia.gov/state

Drilling Productivity Report | www.eia.gov/petroleum/drilling/

International Energy Portal | www.eia.gov/beta/international/?src=home-b1