Annual Energy Outlook 2022 Working Group
AEO2021 Review and AEO2022 Plans

for
Oil and Gas Supply, Natural Gas Markets, & Liquid Fuels Markets Working Group
May 25, 2021 | Washington, DC

By
Petroleum & Natural Gas Modeling Team
Office of Long-Term Energy Modeling
AEO2021 examines a range of conditions from 2020 to 2050

Assumptions

• Current laws and regulations as of September 2020 remain unchanged

• Current views on economic and demographic trends as well as technology improvements (evolutionary not revolutionary)

• Compound annual growth rate for real U.S. GDP is 2.1% (Reference case)
  – High Economic Growth case (2.6%) and Low Economic Growth case (1.6%)

• The Brent crude oil price by 2050 is $95 per barrel (b) in constant 2020 dollars (Reference case)
  – High Oil Price case ($173/b) and Low Oil Price case ($48/b)

• Oil and natural gas supply cases
  – High: more accessible resources and lower extraction technology costs than the Reference case
  – Low: fewer accessible resources and higher extraction technology costs than the Reference case

• Renewables cost cases
  – High: no cost reductions in renewable technologies
  – Low: renewables achieve 40% lower overnight capital costs by 2050 compared with Reference case
Oil and natural gas supply
Agenda

• Overview of U.S. crude oil and dry natural gas production and prices in the AEO2021

• Planned updates for AEO2022

• Recent laws and executive orders that affect oil and natural gas development

• Assumptions and questions to evaluate
Crude oil production and prices

U.S. crude oil production
AEO2021 Reference case
million barrels per day

<table>
<thead>
<tr>
<th>Year</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
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</thead>
<tbody>
<tr>
<td>Production</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

2020 history | projections

West Texas Intermediate spot price
AEO2021 Reference case
2020 dollars per barrel

<table>
<thead>
<tr>
<th>Year</th>
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<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
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<tr>
<td>Price</td>
<td>$100</td>
<td>$80</td>
<td>$60</td>
<td>$40</td>
<td>$20</td>
</tr>
</tbody>
</table>

2020 history | projections

$0 $20 $40 $60 $80 $100 $120 | $0 $20 $40 $60 $80 $100 $120

2010 2020 2030 2040 2050

Office of Long-Term Energy Modeling
AEO2022 Working Group May 25, 2021

Working Group Presentation for discussion purposes
DO NOT QUOTE OR CITE
Natural gas production and prices

U.S. dry natural gas production
AEO2021 Reference case
trillion cubic feet

2020
history  projections

2000 2010 2020 2030 2040 2050

Natural gas spot price at Henry Hub
AEO2021 Reference case
2020 dollars per million British thermal units

2020
history  projections

2000 2010 2020 2030 2040 2050

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DO NOT QUOTE OR CITE
Planned oil and natural gas supply updates

• Data updates
  – Tight/shale estimated ultimate recovery (EUR) per well
  – Lower 48 states offshore and Alaska announced discoveries
  – Historical production through 2020 and estimated for 2021
  – Natural gas plant liquids (NGPL) factors for plays in the Denver/Jules Basin
  – Short-Term Energy Outlook (STEO) calibration

• Model improvements (if time allows)
  – Split onshore Lower 48 states production into federal versus non-federal
Recent laws and executive orders that affect oil and natural gas development

• Revision to oil and natural gas permitting rules in Colorado
  – Increased drilling setbacks from homes and business from 500 feet to 2,000 feet
  – Applies to new permit applications and still-pending applications submitted under the previous rules—does not affect approved permits
  – **AEO2022 change:**
    • Reduce the acreage that can be drilled and/or increase average lateral length—how much?

• Pause on leasing of federal lands and waters
  – Four planned lease sales for March have been postponed (Colorado, Montana, Nevada, and Utah)
  – Seven lease sales are pending for June through December (Colorado, Montana, and Nevada) as of May 11
  – **AEO2022 change:**
    • If short-term pause, then no change to accessibility to federal lands/waters
    • If long-term pause, then limit accessibility to federal lands/waters not currently leased—requires splitting federal lands into leased and non-leased in the model. We will not be able to represent unleased federal minerals areas
Assumptions and questions to evaluate for AEO2022

• Given current laws and regulations, what other considerations would affect the development of U.S. crude oil?

• What developments in natural gas plant liquids production are not being captured?

• In the AEO2021, increased production in the Appalachian Basin primarily drives the growth in dry natural gas production. What are potential impediments to this projected production growth?

• What concerns exist about the projected growth in dry natural gas production from oil formations, particularly in the Permian Basin (Southwest region)?
Comparison of STEO and AEO2021 crude oil production

U.S. crude oil production by region

Source: U.S. Energy Information Administration, Short-Term Energy Outlooks (STEO) and Annual Energy Outlook 2021 (AEO2021) Reference case
Assumptions and questions to evaluate for AEO2022

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Natural gas plant liquids (NGPL) production by region and type

**U.S. NGPL production by region**
AEO2021 Reference case
million barrels per day

- **East**
- **Southwest**
- **rest of United States**

**U.S. NGPL production by type**
AEO2021 Reference case
million barrels per day

- **natural gasoline**
- **isobutane**
- **normal butane**
- **propane**
- **ethane**
Assumptions and questions to evaluate for AEO2022

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Comparison of STEO and AEO2021 dry natural gas production

U.S. dry natural gas production by region
billion cubic feet per day (Bcf/d)

Source: U.S. Energy Information Administration, Short-Term Energy Outlooks (STEO) and Annual Energy Outlook 2021 (AEO2021) Reference case
Assumptions and questions to evaluate for AEO2022

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U.S. production of natural gas from oil formations

U.S. dry natural gas production from oil formations by region
AEO2021 Reference case
trillion cubic feet

2020

history projections

Southwest
Gulf Coast
other

2010 2020 2030 2040 2050
Assumptions and questions to evaluate for AEO2022: oil and natural gas supply

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Liquid fuels markets
Agenda

• Key data updates planned
  – Liquid Fuels Market Module (LFMM)
  – International Energy Module (IEM)

• Assumptions and questions to evaluate

• Recent events in the liquid fuels markets
Planned data updates for AEO2022

- LFMM: key data updates planned
  - Renewable Fuels Standard (RFS) mandate levels
  - Refinery and biofuels capacity (existing and planned)
  - Liquid fuels pipeline capacity (existing and planned)
  - Historical and STEO data

- IEM: key data updates once world oil price path projection is set
  - International crude oil supply curves
  - Crude oil price differentials for all 10 crude oil types traded in LFMM
  - U.S. petroleum products export and import curves
Planned changes to RFS mandates

• RFS mandates defined for AEO2022
  – Will use STEO estimate for renewable volume obligations (RVOs) for years 2021 and 2022
    • This decision may change if the U.S. Environmental Protection Agency (EPA) releases its final RVO for 2021 (delayed) and 2022 in time
  – Will maintain approach for reducing RVOs to reflect the biogas accounting not modeled in the LFMM
  – Will flat-line mandates at 2022 levels throughout projection years
  – Will adjust impact of small refinery exemptions (SRE) in line with current EPA position

• Expected impacts
  – No significant impacts expected for E85 levels and ethanol volumes in gasoline
  – No significant impacts expected for biodiesel production
  – May impact renewable diesel blends in California market
Planned changes to RFS mandates in LFMM are small


* biomass-based diesel = biodiesel + renewable diesel. See [https://www.eia.gov/survey/form/eia_819/glossary.pdf](https://www.eia.gov/survey/form/eia_819/glossary.pdf) for glossary of all renewable fuel terms
Assumptions and questions to evaluate for AEO2022

- What percentage of domestic production of light crude oil is expected to be exported? Will it be balanced by heavy crude imports?

- Will refinery utilization continue to be high and balanced by product exports?

- What expectations exist between biodiesel and renewable diesel production levels? Both use the same feedstock (seed oil, yellow and white grease).

- Under what circumstances would we expect biofuels to have a larger penetration in the liquid fuels market?
Trade-off between domestic light crude oil exports and heavy crude oil imports

Exports as a fraction of domestic crude production
percentage of domestic production

Light crude exports and heavy crude imports
thousand barrels per day

Source: U.S. Energy Information Administration, Annual Energy Outlook 2021, Reference case (ref2021/d113020a)
Assumptions/questions to evaluate for AEO2022

• What percentage of domestic production of light crude oil is expected to be exported? Will it be balanced by heavy crude imports?

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• Under what circumstances would we expect biofuels to have a larger penetration in the liquid fuels market?
Will high refinery utilization be supported by product exports?

Source: U.S. Energy Information Administration, Annual Energy Outlook 2021, Reference case (ref2021/d113020a)
Assumptions and questions to evaluate for AEO2022

• What percentage of domestic production of light crude oil is expected to be exported? Will it be balanced by heavy crude imports?

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Biodiesel production exceeds renewable diesel production in AEO2021 reference case

Source: U.S. Energy Information Administration, Annual Energy Outlook 2021, Reference case (ref2021/d113020a)
Assumptions and questions to evaluate for AEO2022

• What percentage of domestic production of light crude oil is expected to be exported? Will it be balanced by heavy crude imports?

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High oil price promotes a higher penetration of biofuels into the gasoline and diesel liquid fuels market

Projected biofuels percentage of gasoline and diesel consumption
AEO2021 oil price cases

Recent events in the liquid fuels market: modeling hurdles for LFMM

• Some refineries have converted to renewable diesel production facilities
  – What are the retrofit costs?
  – What refinery characteristics make this conversion potentially feasible: size, complexity, location?
  – How can we tie refinery rationalization with conversion to renewable diesel capacity additions?

• Washington State has passed a bill to create a low-carbon fuel standard (LCFS) program to start in 2023
  – What will be the LCFS requirements?
  – What will be the carbon intensities?
  – What fuels and vehicles will be included?
  – Washington is not a region in LFMM.
Assumptions and questions to evaluate for AEO2022: liquid fuels markets

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Natural gas markets
Planned data updates and changes for AEO2022

• *Natural Gas Annual* data through 2019

• Historical data on Mexico and Canada through 2020

• Pipeline capacity and pipeline projects tracked that we track

• Natural gas spot price data

• Additional changes that can drive projections include:
  – World oil price assumption
  – Economic recovery from COVID-19 and the related consumption changes
  – *Short-Term Energy Outlook* forecast (2020-2022 data)
Assumptions and questions to evaluate for AEO2022

- Which consumption sectors are most likely to see growth or declines over the next 30 years?
- What changes to interstate natural gas flows and pipeline infrastructure can we expect?
- Which liquefied natural gas (LNG) facilities that have yet to reach a final investment decision (FID) are most likely to come online, fueling LNG export growth?
- How much can U.S. natural gas pipeline exports grow?
AEO and STEO Henry Hub prices

AEO 2021 Henry Hub natural gas spot price
2020 dollars per million British thermal units

2020
history
projections

Low Oil and Gas Supply
Reference
High Oil and Gas Supply

STEO Henry Hub natural gas spot price
dollars per million British thermal units

May 2021
history
forecast

October 2019 STEO
2020 October STEO
2021 May STEO

Change in natural gas disposition by sector and net exports

Natural gas consumption by the electric power sector

AEO 2021 natural gas consumed for electric power
trillion cubic feet

STEO natural gas consumed for electric power
billion cubic feet per day

Assumptions and questions to evaluate for AEO2022

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• How much can U.S. natural gas pipeline exports grow?
Mid-Atlantic and Ohio natural gas flows

Natural gas flows from mid-Atlantic and Ohio
trillion cubic feet

Source: U.S. Energy Information Administration, Annual Energy Outlook 2021 Reference Case
Natural gas pipeline infrastructure

• Recently completed interstate natural gas projects include:
  – Buckeye Xpress (December 2020)
  – Atlantic Bridge Project Phase 2 (January 2021)
  – NGPL Gulf Coast Southbound Project Phase II (March 2021)
  – Southeastern Trail Expansion Project (March 2021)

• Interstate projects currently under construction or partially complete include:
  – Double E pipeline (construction, in-service planned for 2021)
  – Mountain Valley Pipeline (construction, in-service planned for 2022)
  – Supply Header Project (construction, in-service planned for 2022)

• Interstate natural gas pipeline projects that have been approved but have not yet started construction include:
  – Gulfstream Phase VI Expansion Project (planned in-service 2022)
  – Mountain Valley Pipeline Southgate (planned in-service 2023)
Assumptions and questions to evaluate for AEO2022

• Which consumption sectors are most likely to see growth or declines over the next 30 years?

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• Which liquefied natural gas (LNG) facilities that have yet to reach a final investment decision (FID) are most likely to come online, fueling LNG export growth?

• How much can U.S. natural gas pipeline exports grow?
LNG exports

AEO2021 U.S. LNG exports by side case
trillion cubic feet

2020

history projections

High Oil Price

High Oil and Gas Supply

Reference

Low Oil and Gas Supply

Low Oil Price

U.S. LNG exports in Reference case
trillion cubic feet

2020

history projections

LNG exports (Reference Case)

Existing and under construction U.S. LNG export capacity as of May 25, 2021 (nameplate)

Source: U.S. Energy Information Administration, Annual Energy Outlook 2021
LNG facilities

• LNG projects currently under construction that we assume will come online or have recently come online:
  – Corpus Christi Train 3 (in-service March 2021)
  – Sabine Pass Train 6 (June 2023)
  – Calcasieu Pass Train 1 and 2 (November 2023 and November 2024)
  – Golden Pass Train 1, 2, and 3 (November 2024, April 2025, and November 2025)

• Other potential projects:
  – Costa Azul LNG (FID announced, planned in-service for 2024)
  – Texas LNG and Rio Grande LNG (approved by Federal Energy Regulatory Commission, no FID yet)
  – Annova LNG (cancelled in March 2021)
Assumptions and questions to evaluate for AEO2022

• Which consumption sectors are most likely to see growth or declines over the next 30 years?

• What changes to interstate natural gas flows and pipeline infrastructure can we expect?

• Which liquefied natural gas (LNG) facilities that have yet to reach a final investment decision (FID) are most likely to come online, fueling LNG export growth?

• How much can U.S. natural gas pipeline exports grow?
Canada natural gas pipeline imports and exports

Pipeline imports from Canada
trillion cubic feet

Pipeline exports to Canada
trillion cubic feet

Source: U.S. Energy Information Administration, Annual Energy Outlook 2021
Mexico natural gas pipeline exports

Pipeline exports to Mexico (trillion cubic feet)

Source: U.S. Energy Information Administration, Annual Energy Outlook 2021
Assumptions and questions to evaluate for AEO2022: natural gas markets

• Which consumption sectors are most likely to see growth or declines over the next 30 years?

• What changes to interstate natural gas flows and pipeline infrastructure can we expect?

• Which liquefied natural gas (LNG) facilities that have yet to reach a final investment decision (FID) are most likely to come online, fueling LNG export growth?

• How much can U.S. natural gas pipeline exports grow?
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We welcome feedback on our assumptions and documentation

• Working group meetings: [www.eia.gov/forecasts/aeo/workinggroup/](http://www.eia.gov/forecasts/aeo/workinggroup/)

• The AEO Assumptions report: [www.eia.gov/forecasts/aeo/assumptions/](http://www.eia.gov/forecasts/aeo/assumptions/)

• NEMS Model Documentation:
  – Oil and gas supply (OGSM)
  – Natural gas market (NGMM)
  – Liquid fuels market (LFMM)
  – International energy (IEM)

For more information

Short-Term Energy Outlook | www.eia.gov/steo
Annual Energy Outlook | www.eia.gov/aeo
International Energy Outlook | www.eia.gov/ieo
International Energy Statistics database | www.eia.gov/ies

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