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

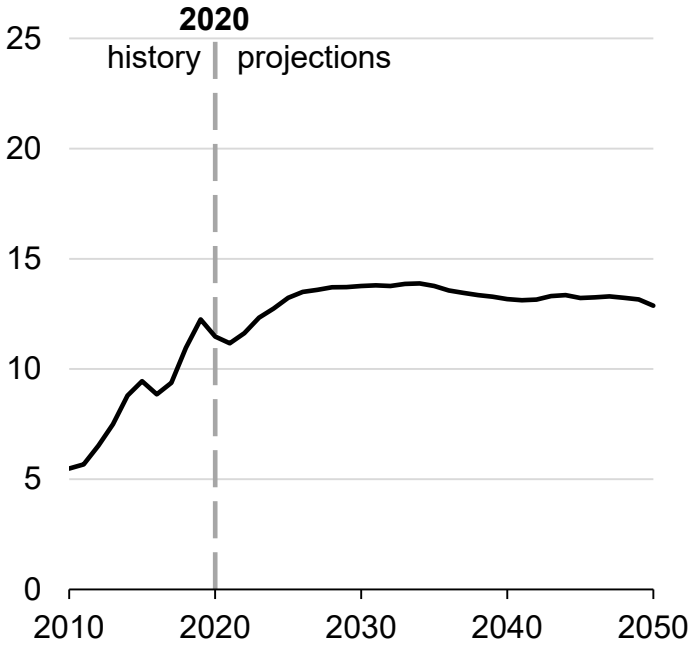
Oil and natural gas supply

Agenda

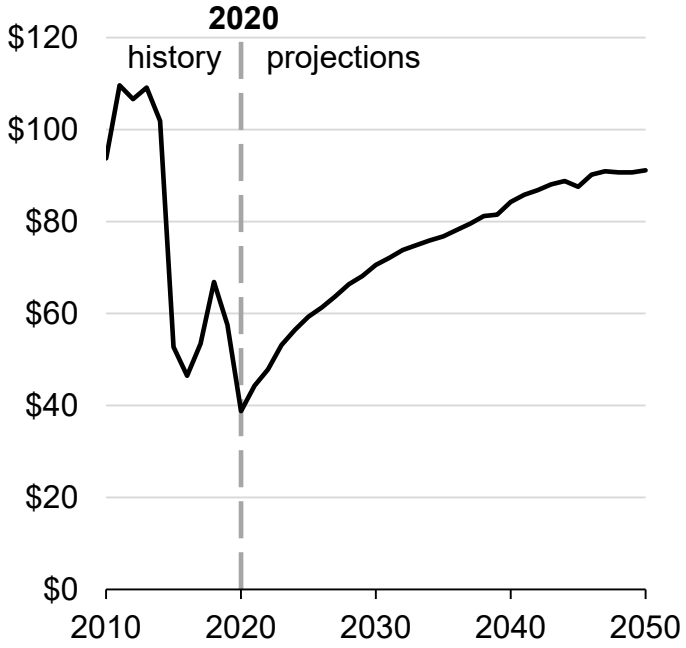
- Overview of U.S. crude oil and dry natural gas production and prices in the AEO2021
- Planned updates for AEO2022
- Recent laws and executive orders that affect oil and natural gas development
- Assumptions and questions to evaluate

Crude oil production and prices

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

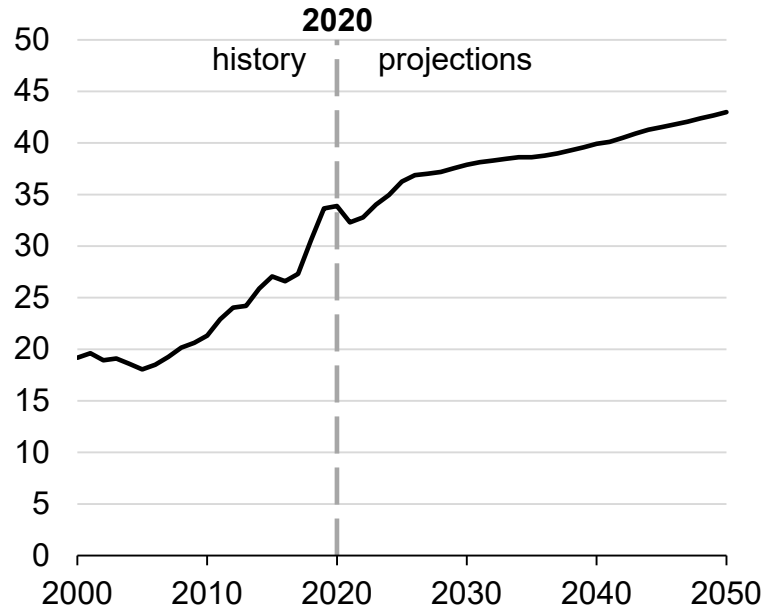


West Texas Intermediate spot price
AEO2021 Reference case
2020 dollars per barrel

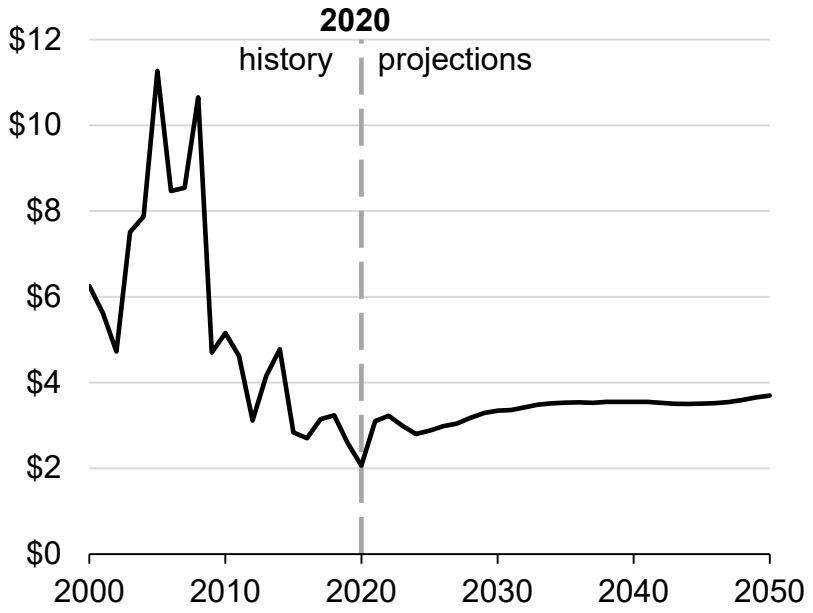


Natural gas production and prices

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



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



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

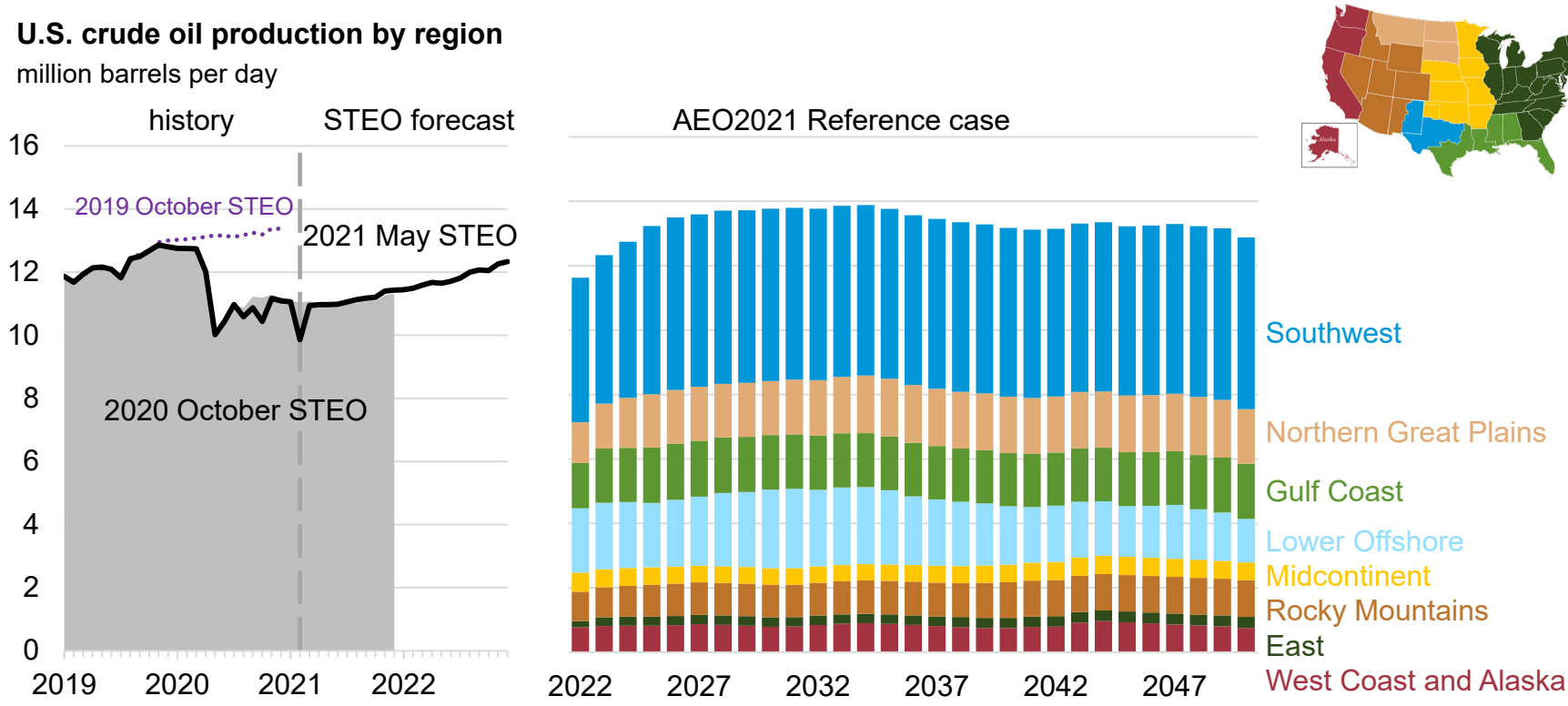
Recent laws and executive orders that affect oil and natural gas development

- 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



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

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

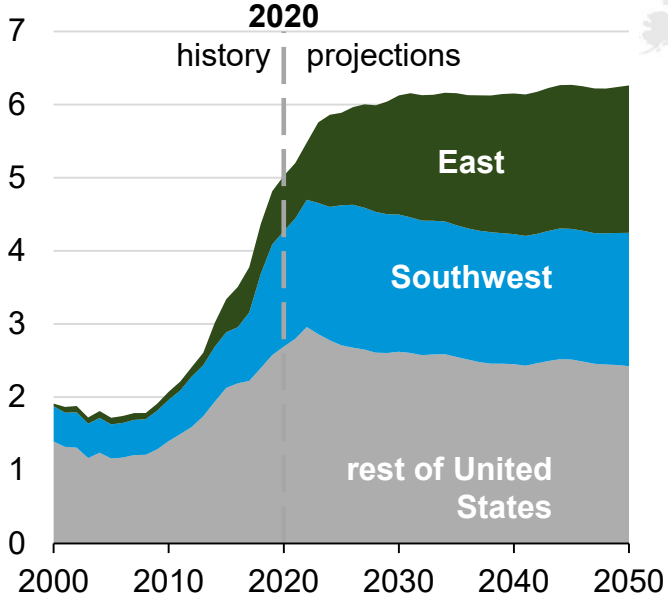
- What developments in natural gas plant liquids production are not being captured?

- 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?

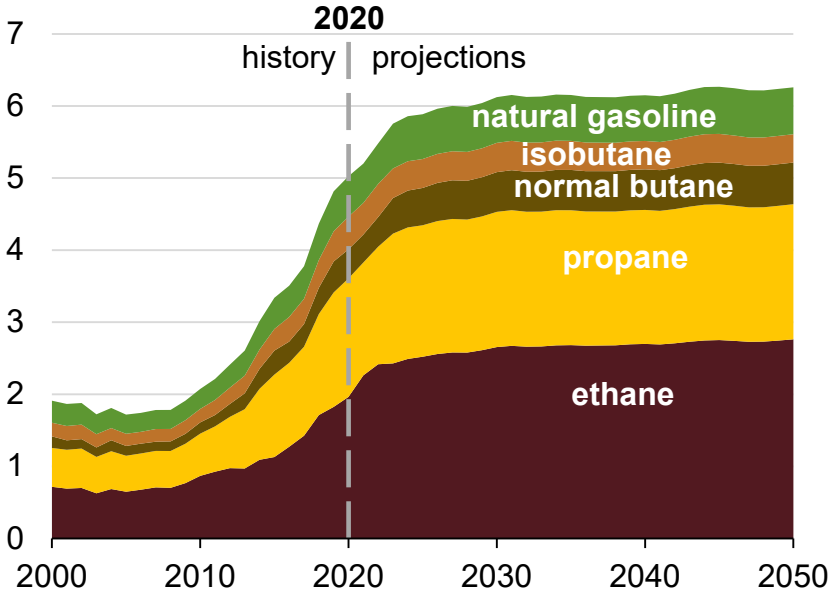
- What concerns exist about the projected growth in dry natural gas production from oil formations, particularly in the Permian Basin (Southwest region)?

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

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



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

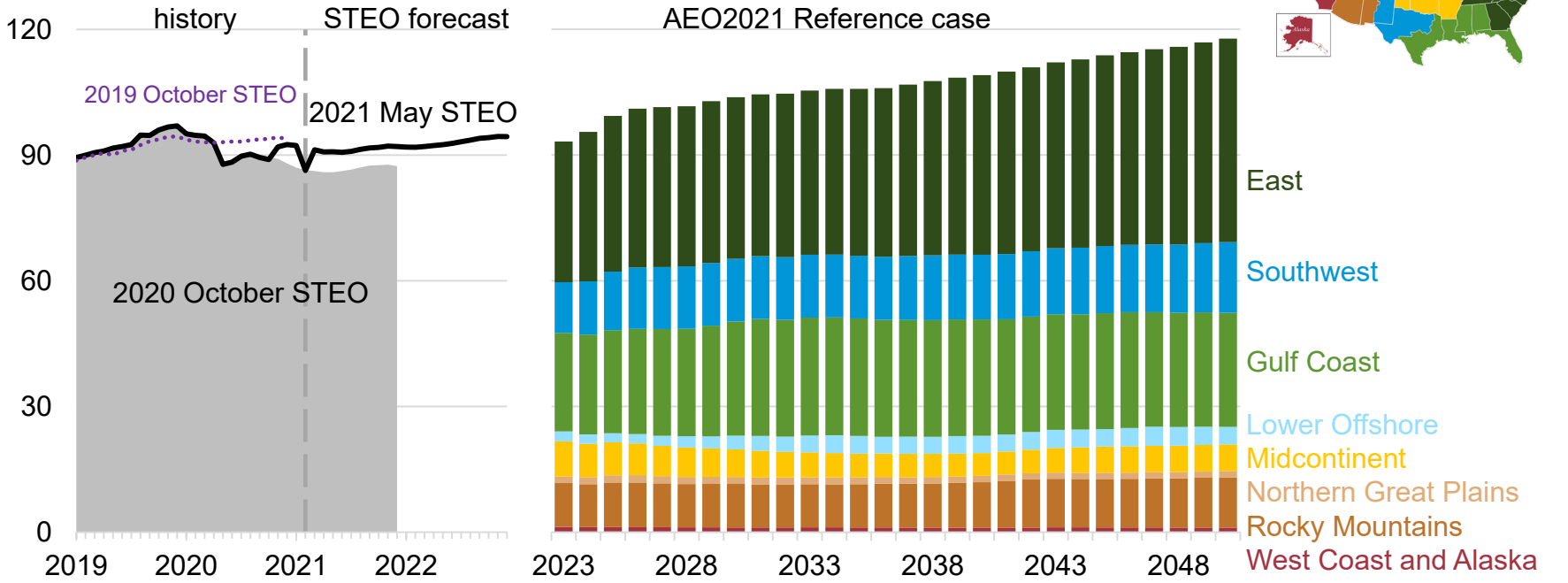


Assumptions and questions to evaluate for AEO2022

- 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 dry natural gas production

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



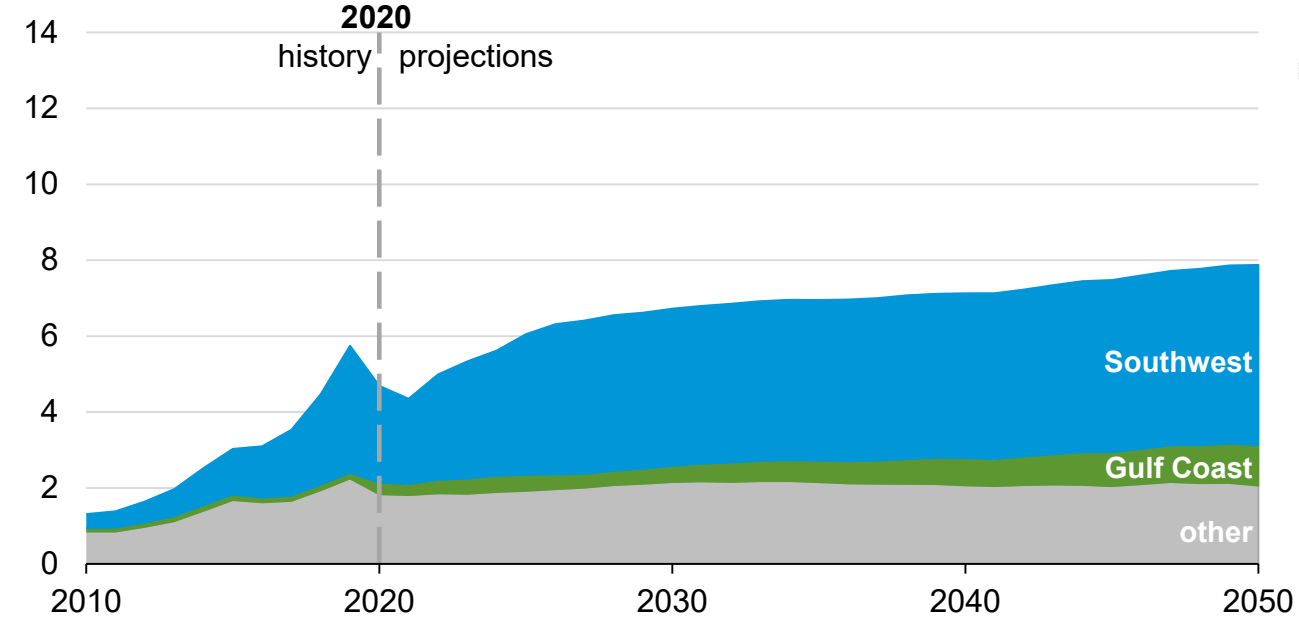
Source: U.S. Energy Information Administration, *Short-Term Energy Outlooks* (STEO) and *Annual Energy Outlook 2021* (AEO2021) Reference case

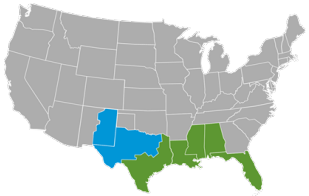
Assumptions and questions to evaluate for AEO2022

- 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)?

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





Assumptions and questions to evaluate for AEO2022: oil and natural gas supply

- 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)?

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

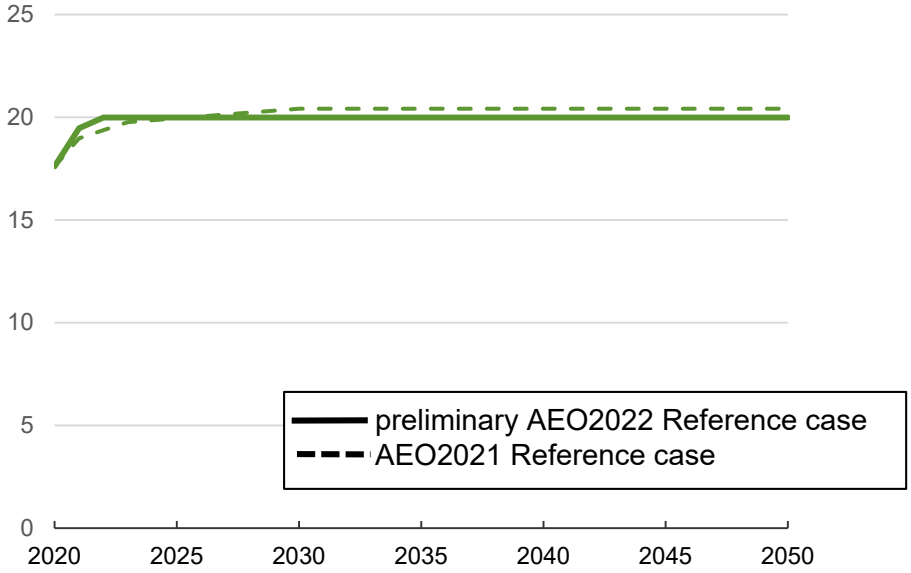
- LFMM: key data updates planned
  - Renewable Fuels Standard (RFS) mandate levels
  - Refinery and biofuels capacity (existing and planned)
  - Liquid fuels pipeline capacity (existing and planned)
  - Historical and STEO data
- IEM: key data updates once world oil price path projection is set
  - International 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

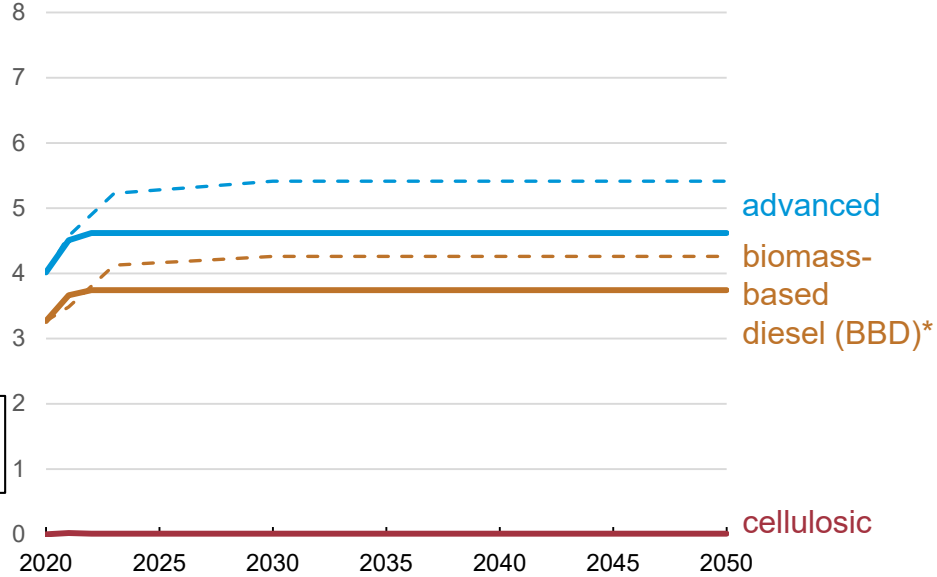
- RFS mandates defined for AEO2022
  - Will use STEO estimate for renewable volume obligations (RVOs) for years 2021 and 2022
    - This decision may change if the U.S. Environmental Protection Agency (EPA) releases its final RVO for 2021 (delayed) and 2022 in time
  - Will maintain approach for reducing 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

RFS total mandate
billion credits



RFS advanced, cellulosic, BBD mandates
billion credits



Source: U.S. Energy Information Administration, *Annual Energy Outlook 2021*, Reference case (ref2021/d113020a)

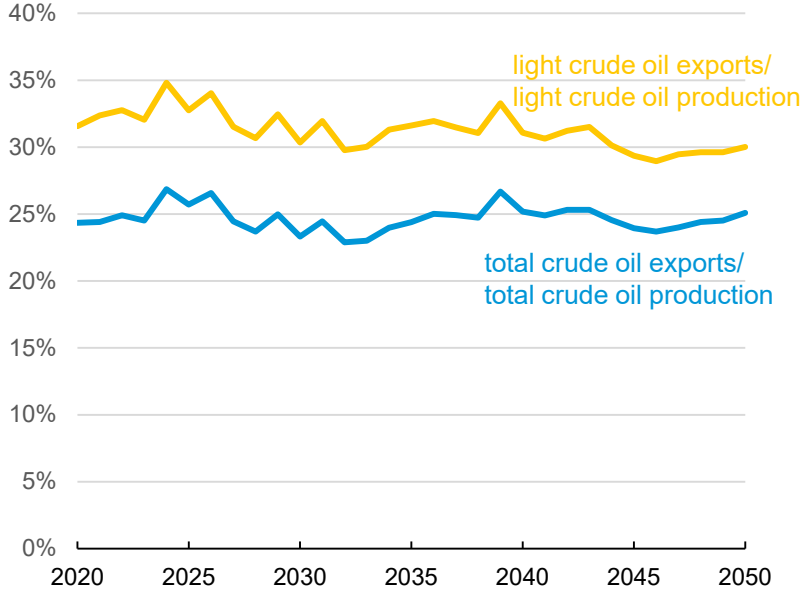
* biomass-based diesel = biodiesel + renewable diesel. See https://www.eia.gov/survey/form/eia_819/glossary.pdf for glossary of all renewable fuel terms

Assumptions and questions to evaluate for AEO2022

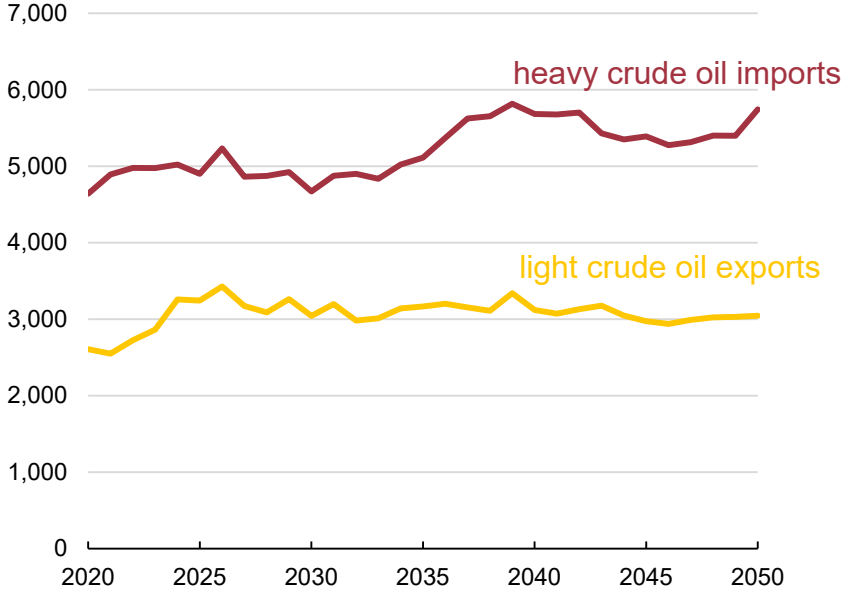
- What percentage of domestic production of light crude oil is expected to be exported? Will it be balanced by heavy crude imports?
- Will refinery utilization continue to be high and balanced by product exports?
- What expectations exist between biodiesel and renewable diesel production levels? Both 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



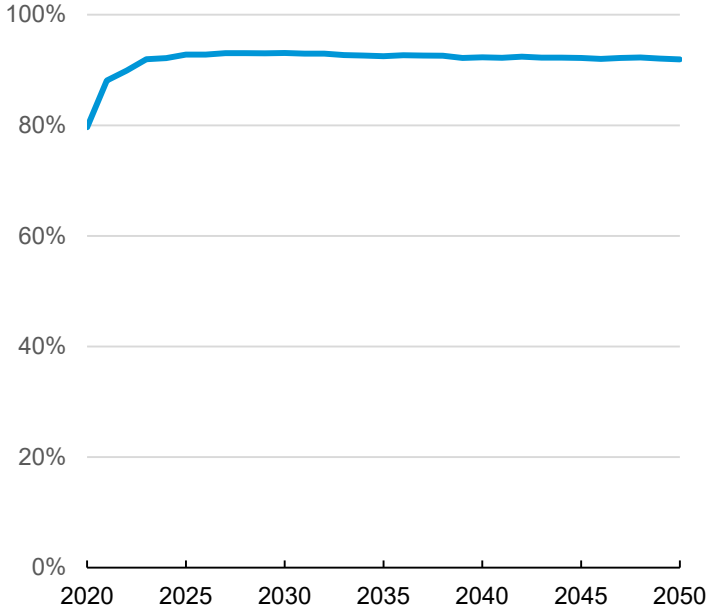
Source: U.S. Energy Information Administration, *Annual Energy Outlook 2021*, Reference case (ref2021/d113020a)

Assumptions/questions to evaluate for AEO2022

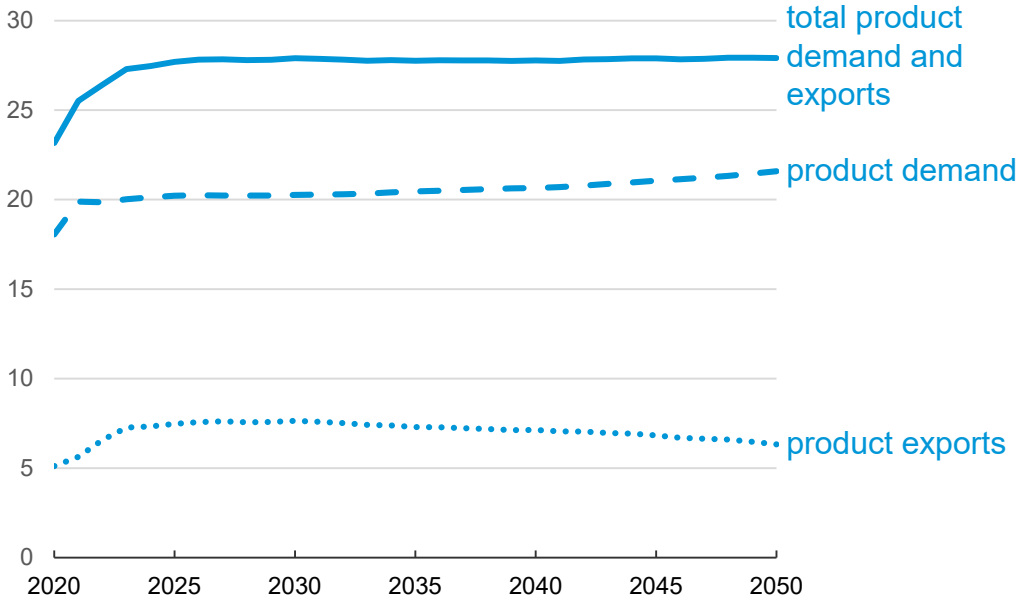
- What percentage of domestic production of light crude oil is expected to be exported? Will it be balanced by heavy crude imports?
- Will refinery utilization continue to be high and balanced by product exports?
- What expectations exist between biodiesel and renewable diesel production levels? Both 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?

Will high refinery utilization be supported by product exports?

Refinery utilization
percentage



Product demand and exports
million barrels per day



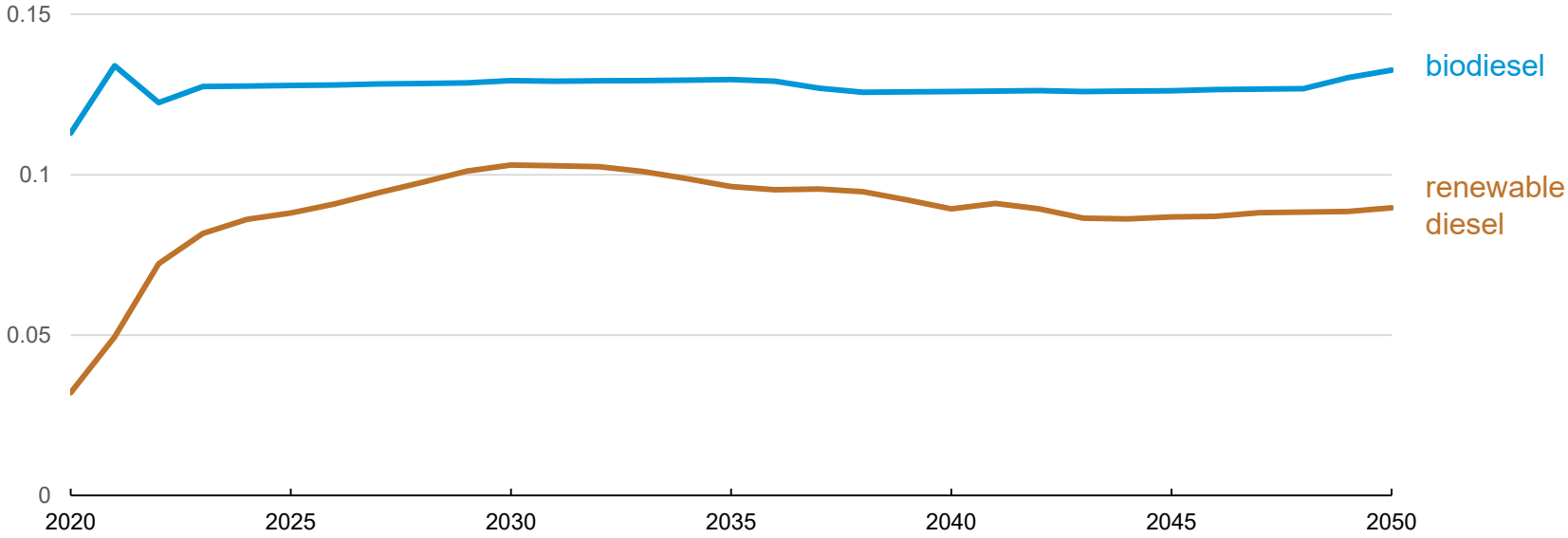
Source: U.S. Energy Information Administration, *Annual Energy Outlook 2021*, Reference case (ref2021/d113020a)

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?
- 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?

Biodiesel production exceeds renewable diesel production in AEO2021 reference case

Biodiesel and renewable diesel production
million barrels per day



Source: U.S. Energy Information Administration, *Annual Energy Outlook 2021*, Reference case (ref2021/d113020a)

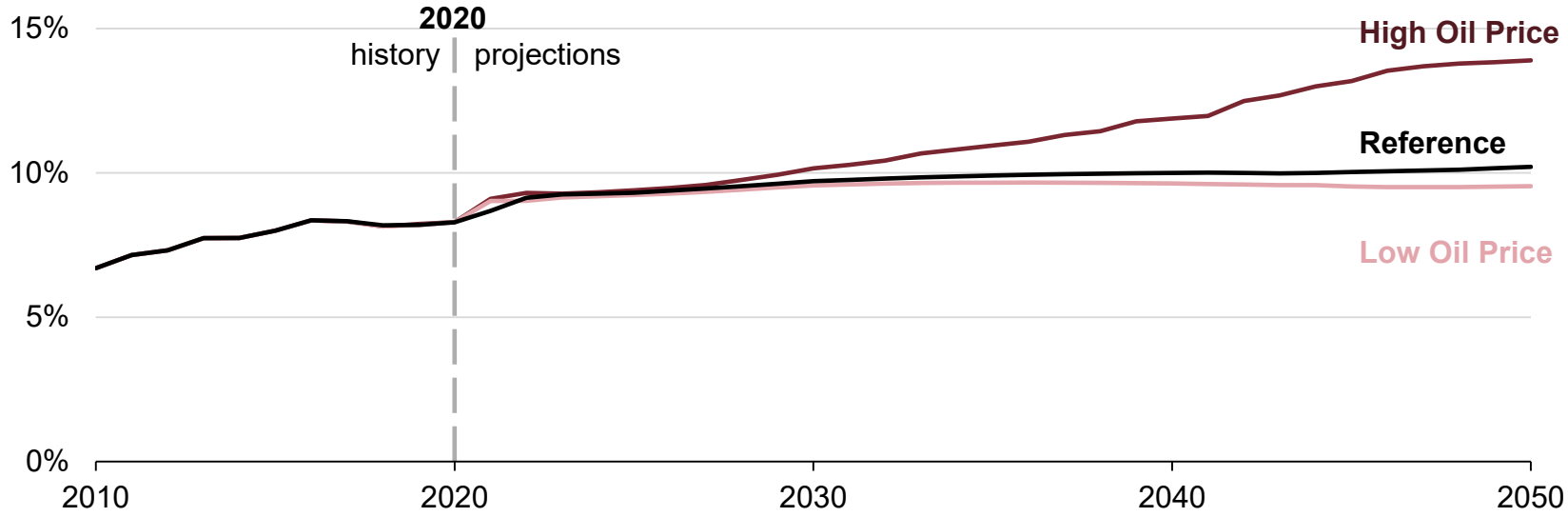
Assumptions and questions to evaluate for AEO2022

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

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

percentage



Source: U.S. Energy Information Administration, *Annual Energy Outlook 2021*, Reference case (ref2021/d113020a)

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

- 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?

Natural gas markets

Planned data updates and changes for AEO2022

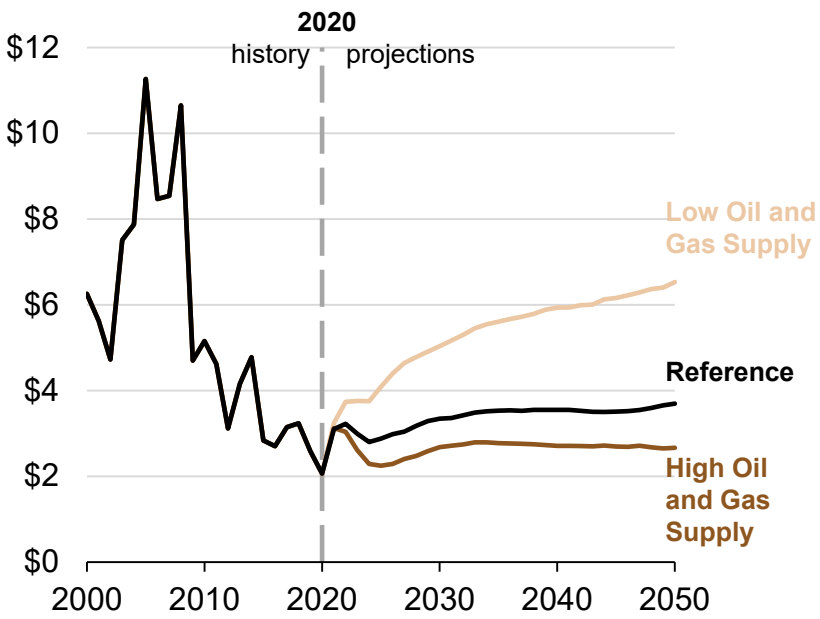
- *Natural Gas Annual* data through 2019
- Historical data on Mexico and Canada through 2020
- Pipeline capacity and pipeline projects tracked that we track
- Natural gas spot price data
- Additional changes that can drive projections include:
  - World oil price assumption
  - Economic recovery from COVID-19 and the related consumption changes
  - *Short-Term Energy Outlook* forecast (2020-2022 data)

Assumptions and questions to evaluate for AEO2022

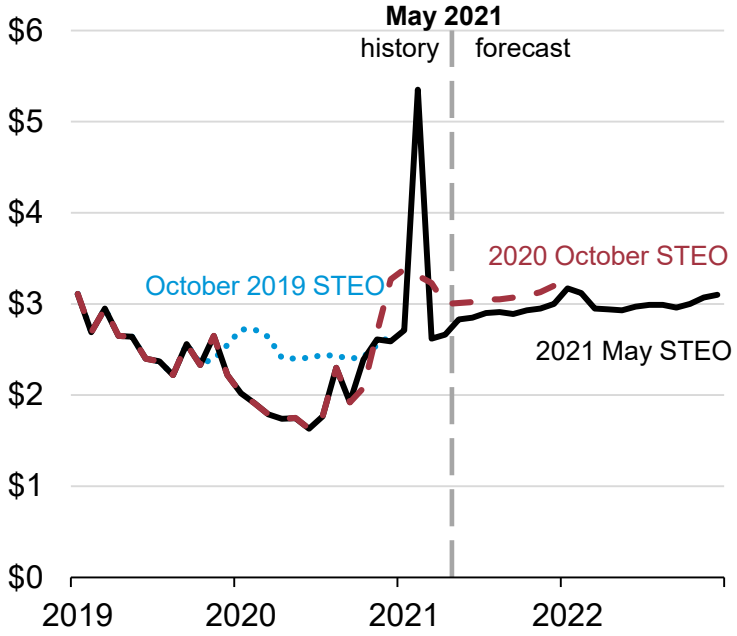
- Which consumption sectors are most likely to see growth or declines over the next 30 years?
- What changes to interstate natural gas flows and pipeline infrastructure can we expect?
- Which liquefied natural gas (LNG) facilities that have yet to reach a final investment decision (FID) are most likely 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



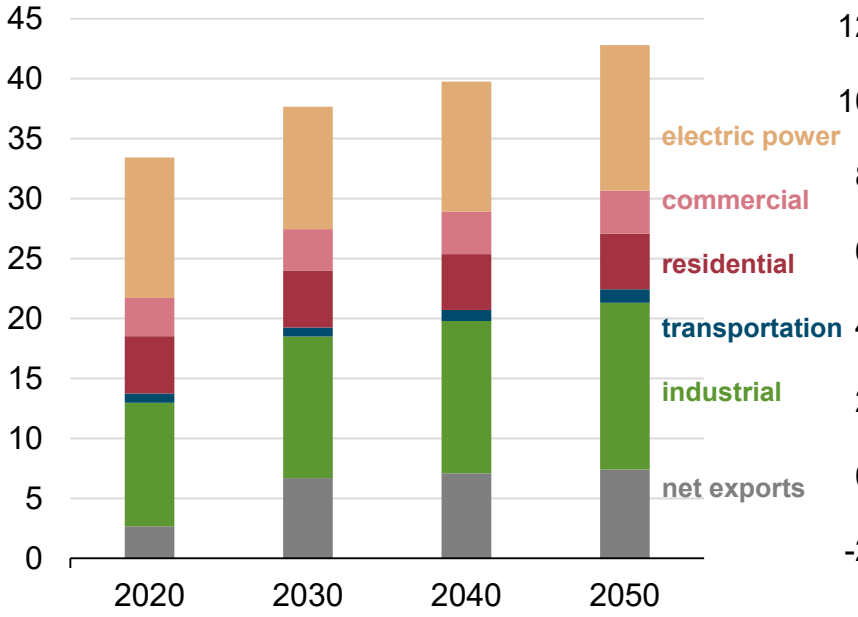
STEO Henry Hub natural gas spot price
dollars per million British thermal units



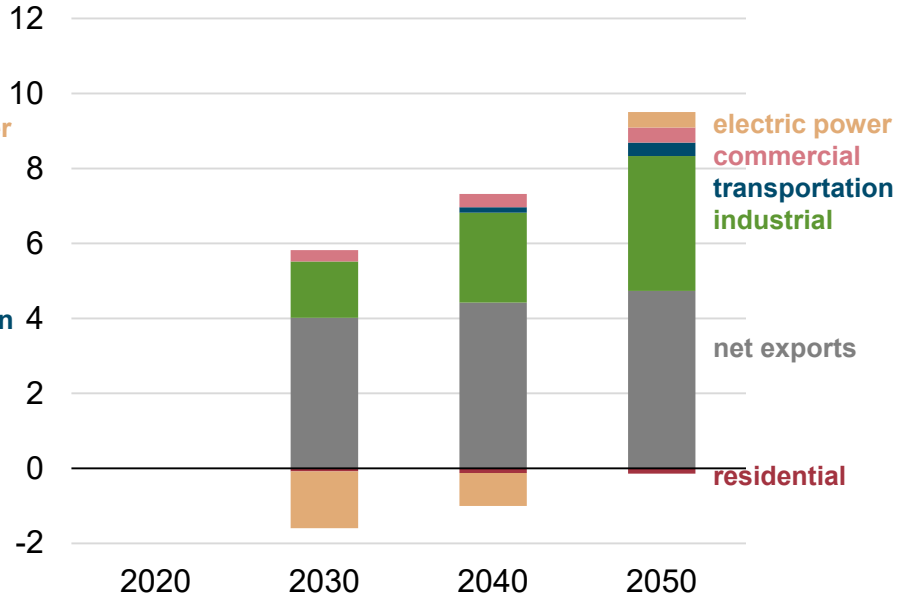
Source: U.S. Energy Information Administration, *Annual Energy Outlook 2021* Reference Case and *Short-Term Energy Outlooks*

Change in natural gas disposition by sector and net exports

Natural gas disposition by sector and net export
trillion cubic feet



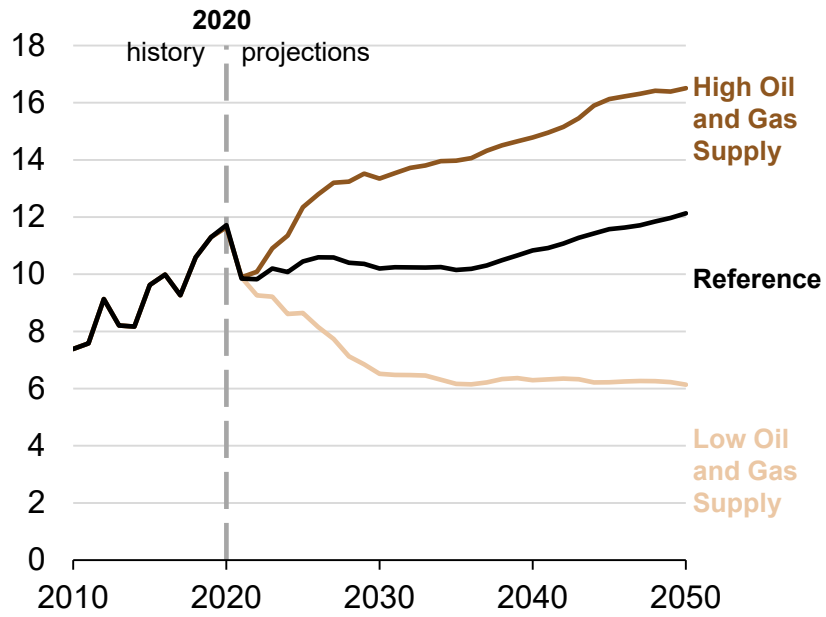
Change in natural gas disposition and net exports
relative to 2020 in trillion cubic feet



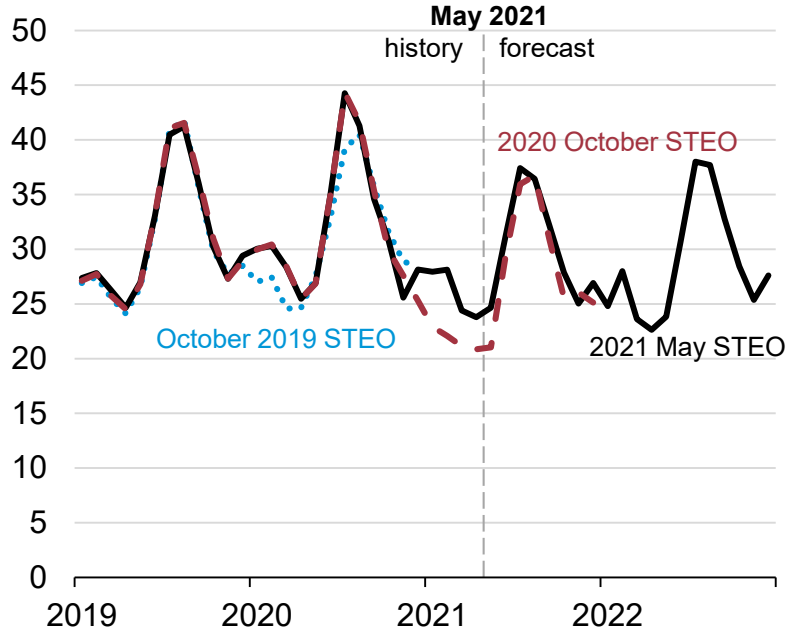
Source: U.S. Energy Information Administration, *Annual Energy Outlook 2021* Reference Case

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



Source: U.S. Energy Information Administration, *Annual Energy Outlook 2021* Reference Case and *Short-Term Energy Outlooks*

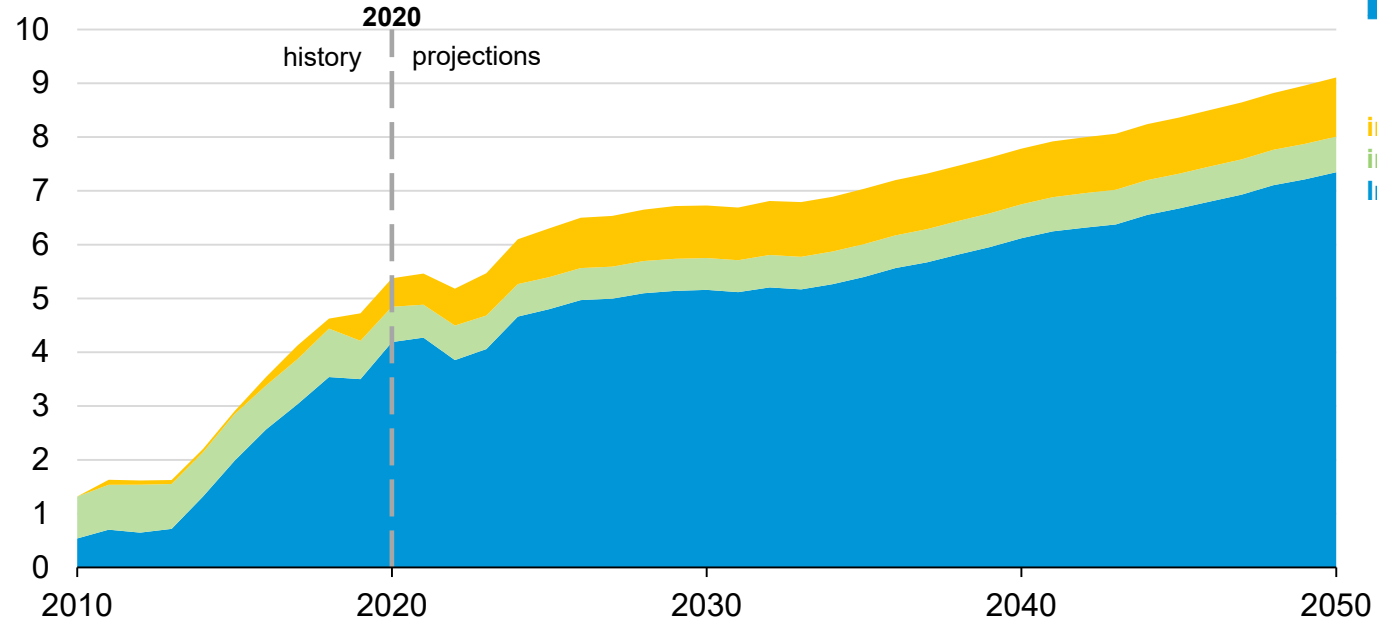
Assumptions and questions to evaluate for AEO2022

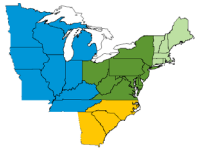
- Which consumption sectors are most likely to see growth or declines over the next 30 years?
- What changes to interstate natural gas flows and pipeline infrastructure can we expect?
- Which liquefied natural gas (LNG) facilities that have yet to reach a final investment decision (FID) are most likely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

Mid-Atlantic and Ohio natural gas flows

Natural gas flows from mid-Atlantic and Ohio

trillion cubic feet





into Southeast
into New England
Into East Midwest

Source: U.S. Energy Information Administration, *Annual Energy Outlook 2021* Reference Case

Natural gas pipeline infrastructure

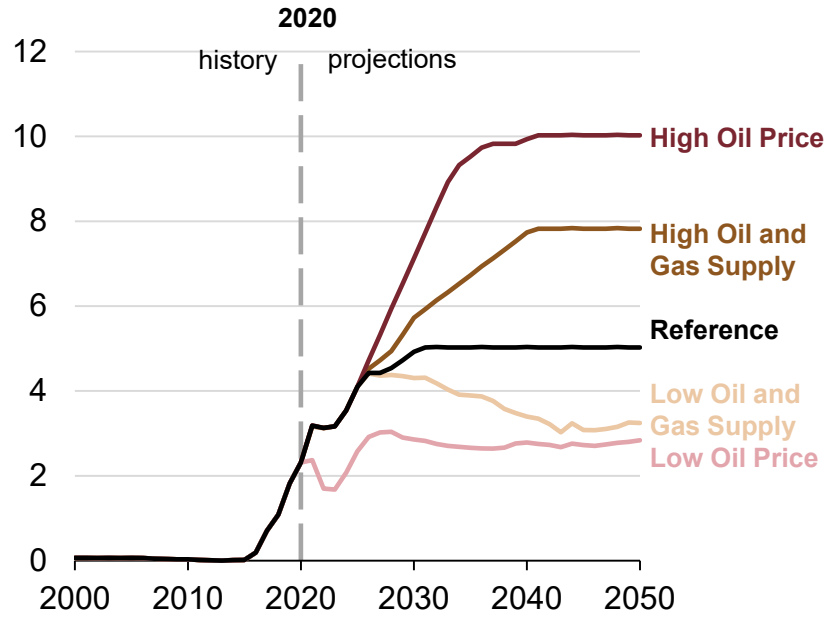
- Recently completed interstate natural gas projects include:
  - Buckeye Xpress (December 2020)
  - Atlantic Bridge Project Phase 2 (January 2021)
  - NGPL Gulf Coast Southbound Project Phase II (March 2021)
  - Southeastern Trail Expansion Project (March 2021)
- Interstate projects currently under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

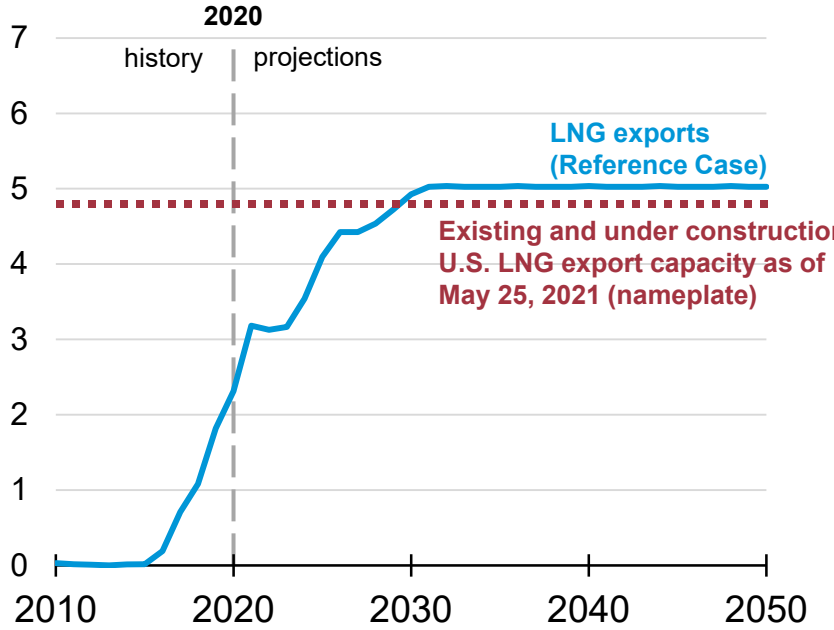
- Which consumption sectors are most likely to see growth or declines over the next 30 years?
- What changes to interstate natural gas flows and pipeline infrastructure can we expect?
- Which liquefied natural gas (LNG) facilities that have yet to reach a final investment decision (FID) are most likely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

LNG exports

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



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



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)

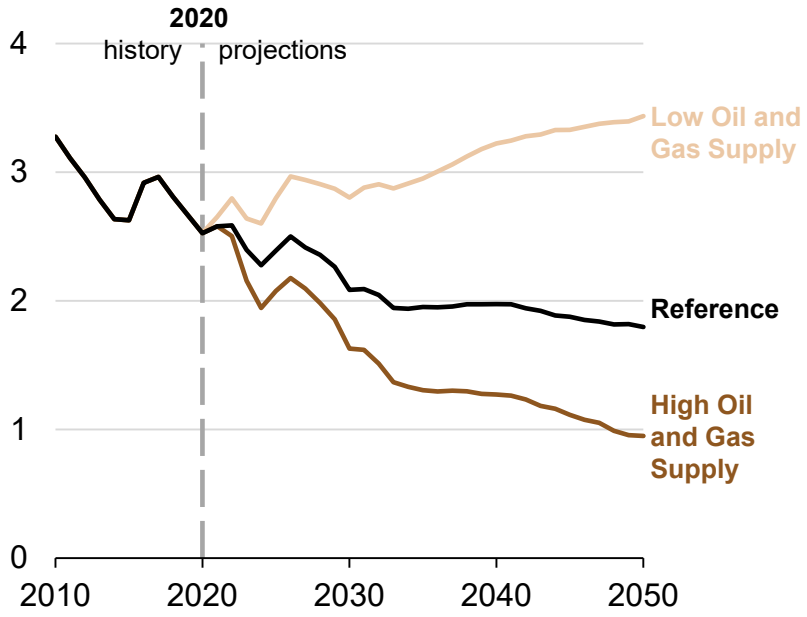
- Other potential projects:
  - Costa Azul LNG (FID announced, planned in-service for 2024)
  - Texas LNG and Rio Grande LNG (approved by Federal Energy Regulatory Commission, no FID yet)
  - Annova LNG (cancelled in March 2021)

Assumptions and questions to evaluate for AEO2022

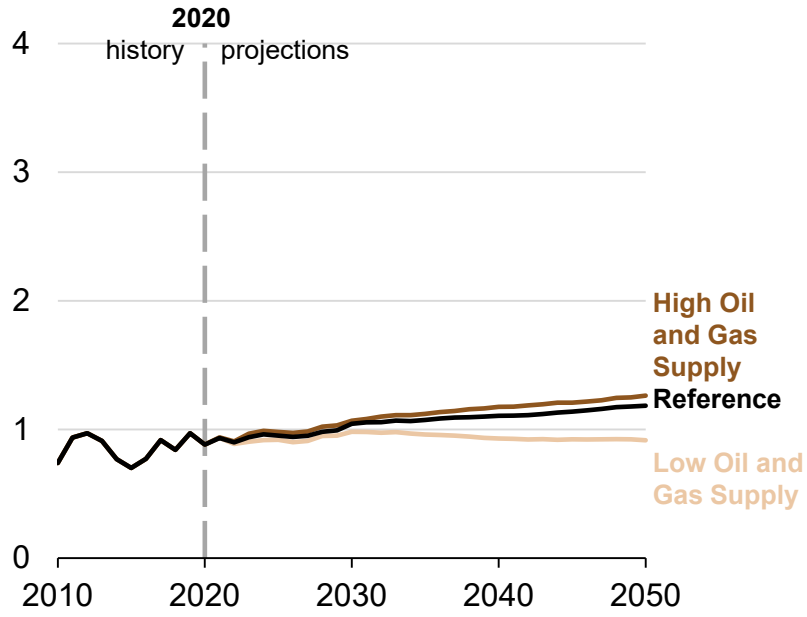
- Which consumption sectors are most likely to see growth or declines over the next 30 years?
- What changes to interstate natural gas flows and pipeline infrastructure can we expect?
- Which liquefied natural gas (LNG) facilities that have yet to reach a final investment decision (FID) are most likely 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



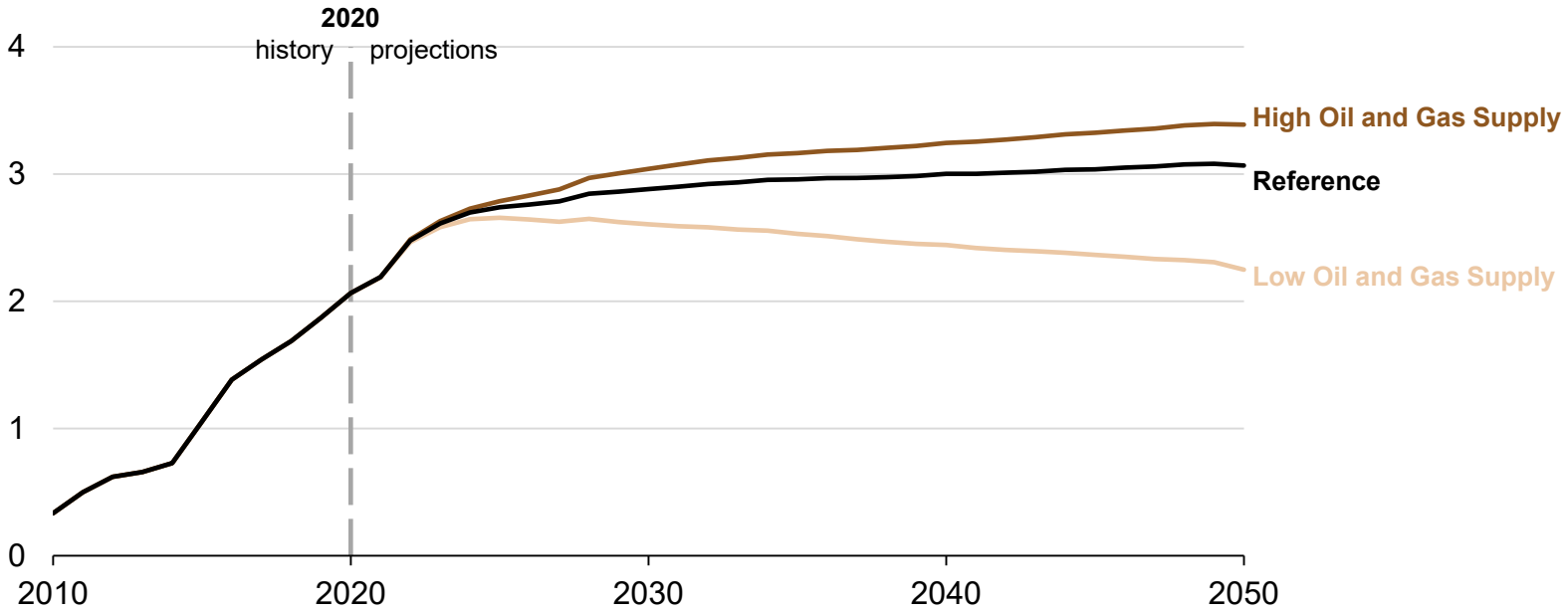
Pipeline exports to Canada
trillion cubic feet



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?

Contacts

Petroleum & Natural Gas Modeling Team Lead:
Mindi Farber-DeAnda: mindi.farber-deanda@eia.gov

Lead Modeler:
Katie Dyl: kathryn.dyl@eia.gov

Liquid Fuels Market Module:
General: Peter Colletti: peter.colletti@eia.gov
Elizabeth May: elizabeth.may@eia.gov
Biofuels: Estella Shi: estella.shi@eia.gov

International Energy Module:
Adrian Geagla: adrian.geagla@eia.gov

Oil & Gas Supply Module:
Albert Painter: albert.painter@eia.gov
Dana Van Wagener: dana.vanwagener@eia.gov

Natural Gas Markets Module:
Stephen York: stephen.york@eia.gov
Mary Lewis: mary.lewis@eia.gov

We welcome feedback on our assumptions and documentation

- Working group meetings: www.eia.gov/forecasts/aeo/workinggroup/
- The AEO Assumptions report: www.eia.gov/forecasts/aeo/assumptions/
- NEMS Model Documentation:
  - Oil and gas supply (OGSM) www.eia.gov/outlooks/aeo/nems/documentation/ogsm/pdf/m063(2020).pdf
  - Natural gas market (NGMM) www.eia.gov/outlooks/aeo/nems/documentation/ngmm/pdf/mgmm(2020).pdf
  - Liquid fuels market (LFMM) www.eia.gov/outlooks/aeo/nems/documentation/lfmm/pdf/m059(2020).pdf
  - International energy (IEM) www.eia.gov/outlooks/aeo/nems/documentation/international/pdf/m071(2020).pdf
- *Trends and Expectations Surrounding the Outlook for Energy Markets:* www.eia.gov/outlooks/aeo/trends_expectations.php/

For more information

U.S. Energy Information Administration home page | www.eia.gov

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

To receive emails concerning releases related to the *Annual Energy Outlook* or other EIA publications, please subscribe at www.eia.gov/tools/emailupdates/.

Central AEO email address: AnnualEnergyOutlook@eia.gov