
AEO 2018 Review & AEO 2019 Plans



For

Natural Gas Working Group

May 23, 2018 / Washington, D.C.

By

Katie Dyl, Natural Gas Markets Team

**WORKING GROUP PRESENTATION FOR DISCUSSION PURPOSES
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U.S. Energy Information Administration

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Outline

- Brief overview of new Natural Gas Markets Module (NGMM)
- Evaluation and discussion of results from AEO 2018
- Current plans and expectations for AEO 2019+
 - AEO 2019: short-term NGMM improvements to fix issues identified from AEO 2018
 - Post-AEO 2019: long- term NGMM improvements that require more time and resources to implement
 - STEO: changes in the *Short Term Energy Outlook* that will impact NGMM near-term projections in AEO 2019

Transition to new Natural Gas Markets Module (NGMM)

- The NGMM will replace the Natural Gas Transmission and Distribution Module (NGTDM) in NEMS to serve the same following functions:
 - **Represent** the transmission, distribution, and pricing of natural gas in North America, with representations of Canada, Mexico, and LNG trade.
 - Given annual regional/sectoral natural gas consumption and short-term regional supply curves, **balance** supply and demand across the network on marginal cost basis
 - **Determine** annual interregional flows, production, imports, exports, and associated wellhead and delivered natural gas prices
 - **Include** seasonal storage, transmission and distribution pricing, pipeline capacity and expansion, as necessary to capture the impact on the primary outputs
 - **Produce** projections that both align well with history and capture likely future market behavior
- NGMM was designed to solve for flow reversals, is significantly more granular to improve results (particularly marginal pricing), and balances supply/demand with a quadratic program, rather than the heuristic used in the NGTDM

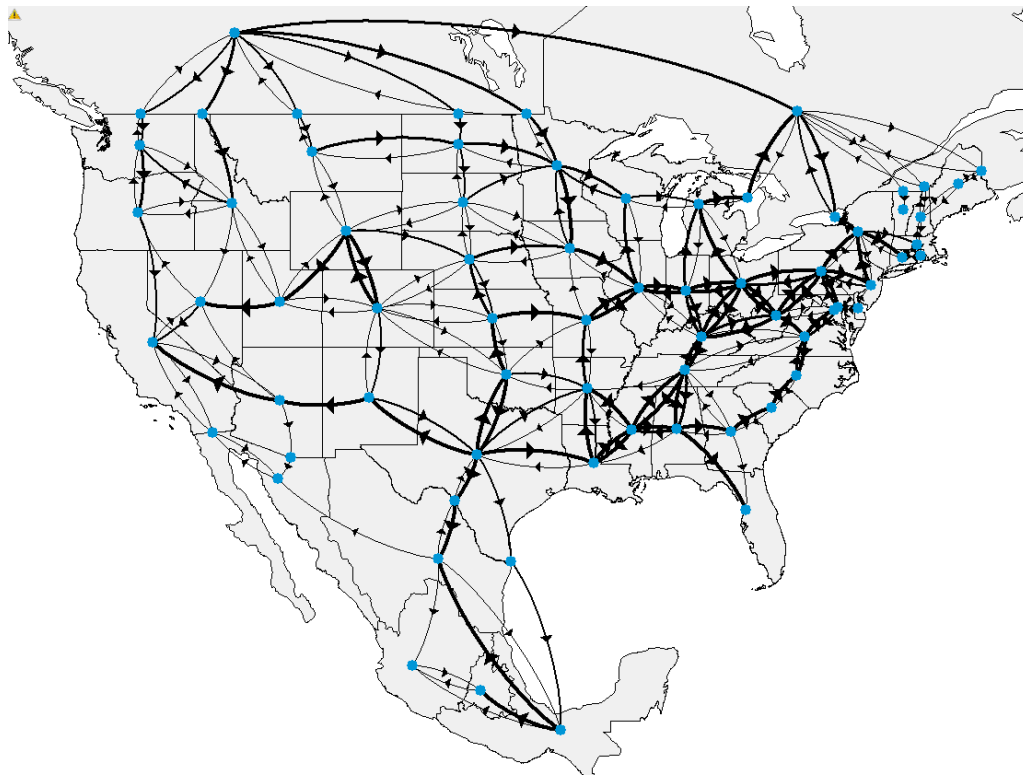
Decision to redesign NGTDM

- Being too constrained to previous year, limits ability to respond to larger annual changes in the market
- Limitations in modeling flows, capacities, and pricing at such an aggregate level – some calibration factors too large
- Heuristic algorithm limited in ability to represent bidirectional flows and changing primary flows
- Model has become difficult to modify and update after many incremental code and data changes, complicating the need for it to be managed by new people

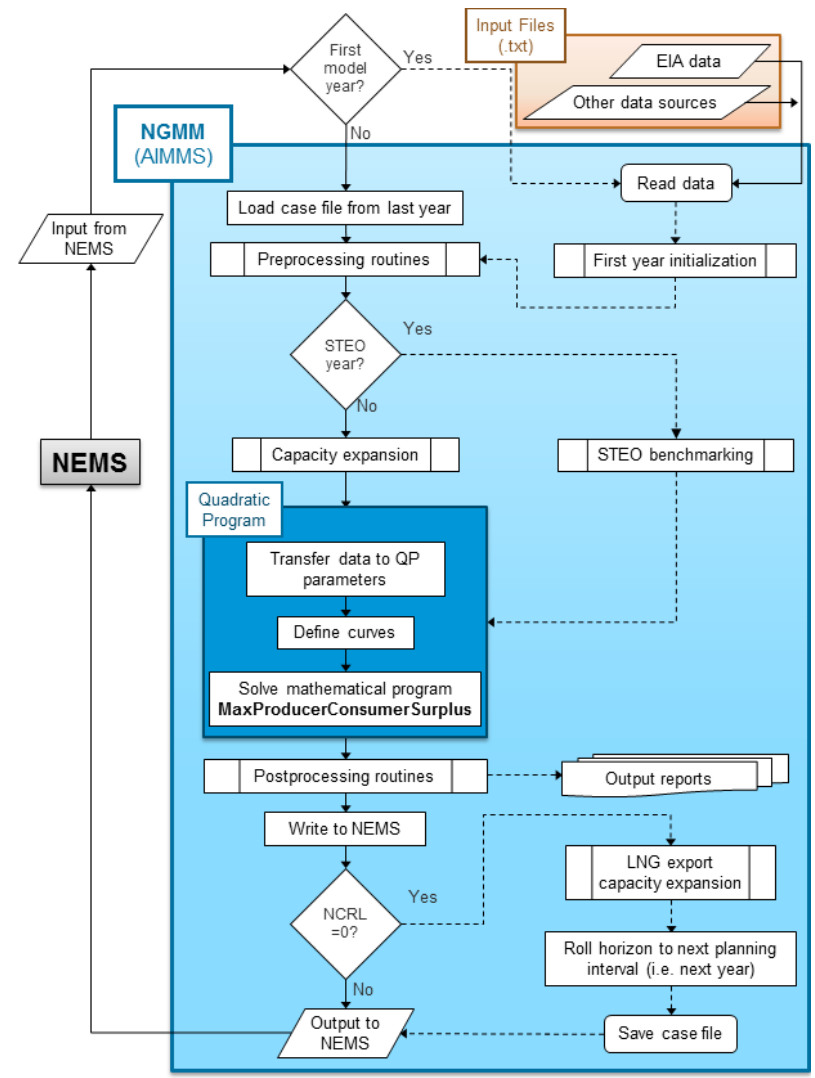
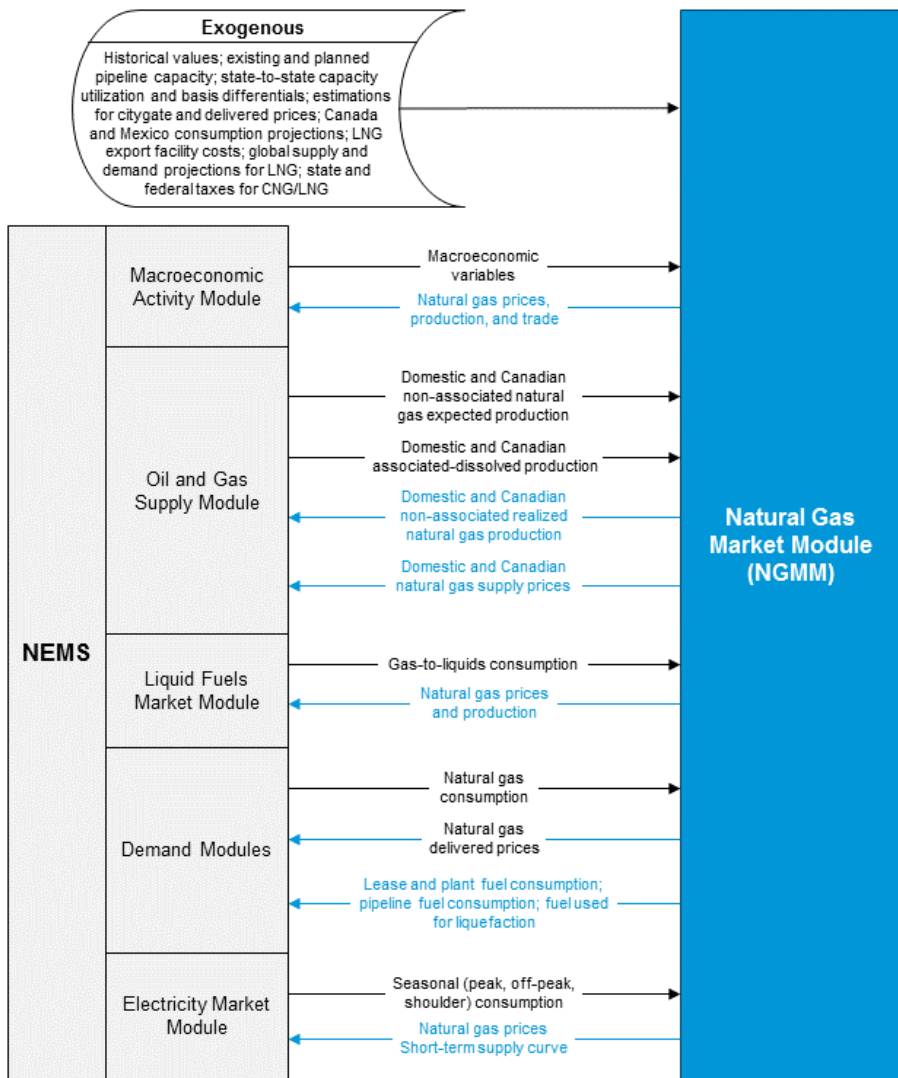
NGMM model requirements

- Project delivered, wellhead, import, and export prices given delivered volumes and regional short-term supply curves
- Balance market and establish production, imports, and exports, as well as lease, plant, and pipeline fuel, and supplemental supplies
- Project region-to-region flows and pipeline capacity
- Produce reasonable projections, align well with history, but capture likely future market behavior (such as under different scenarios)
- Be easier to maintain, update, debug, and learn

NGMM Network and Structure



- Transshipment nodes (hubs) at each Lower 48 state, in Canada (2), in Mexico (5), and at each border crossing, including generic LNG points at coastal states
- Solves for monthly/state spot prices at each hub and associated flows between neighboring regions based on variable transport costs and capacity
- Twelve months (solved independently with no interrelationships)



Quadratic program (QP) (with linear constraints)

- Max consumer plus producer surplus minus variable transportation costs, subject to mass balance constraints
- Variable transportation costs include pipeline fuel charge and variable tariff
- Variable supply, flows, and marginal prices (fixed charges post-processing)

Decision variables:

Supply

LNG exports

Flow between nodes (supply, hub, demand, LNG exports, storage)

Tariff curve quantity (variable transportation costs)

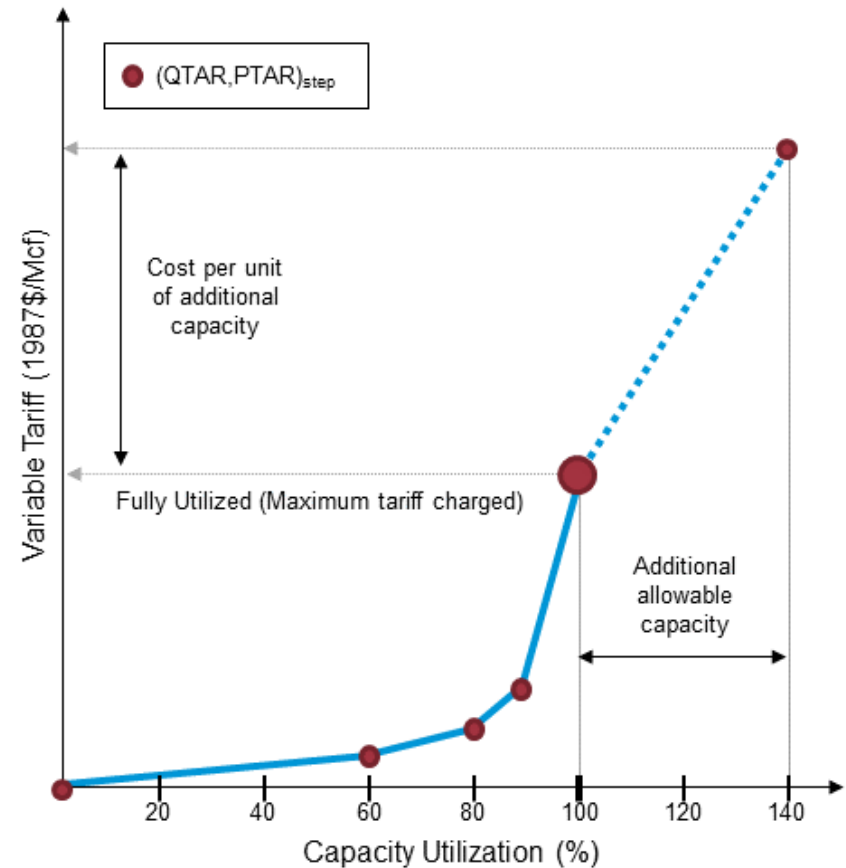
Primary Constraints:

Mass balance for all node types

Flows between nodes limited to previously projected pipeline capacity

Variable tariff curves

- Based on historical spot price differentials between states/regions
- Components of basis differentials
 - Pipeline fuel charge
 - Variable Tariff
- Assumptions
 - Differences in spot prices are pipeline fuel and variable charges
 - Difference between spot and city gate prices are the fixed charges
- Variable tariff set in a QP using a curve for each arc, function of utilization
- Extended beyond existing capacity when projecting capacity expansion, reflecting the consideration of reservation fees



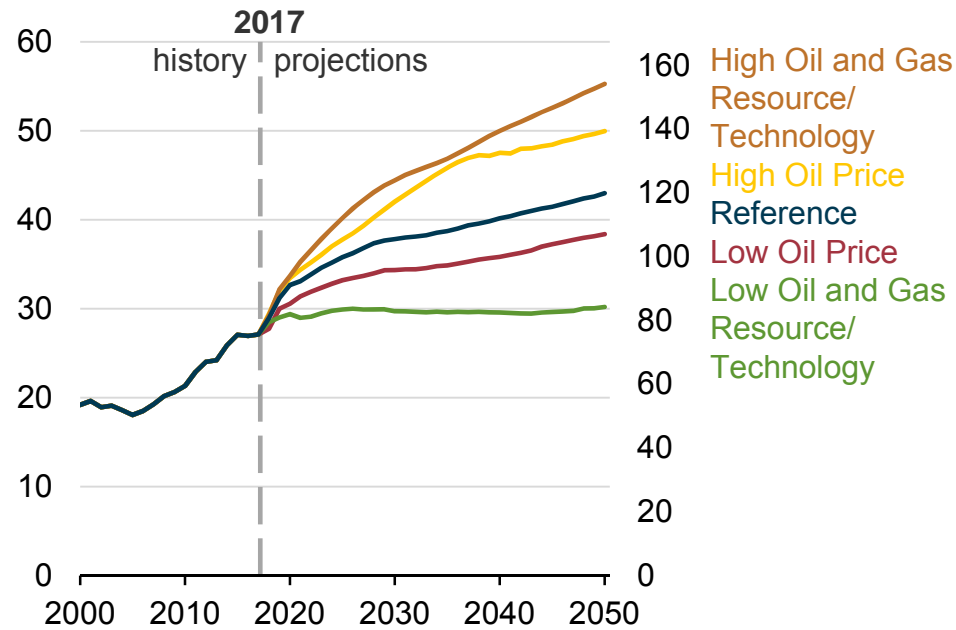
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U.S. natural gas production and consumption continue to increase in most cases

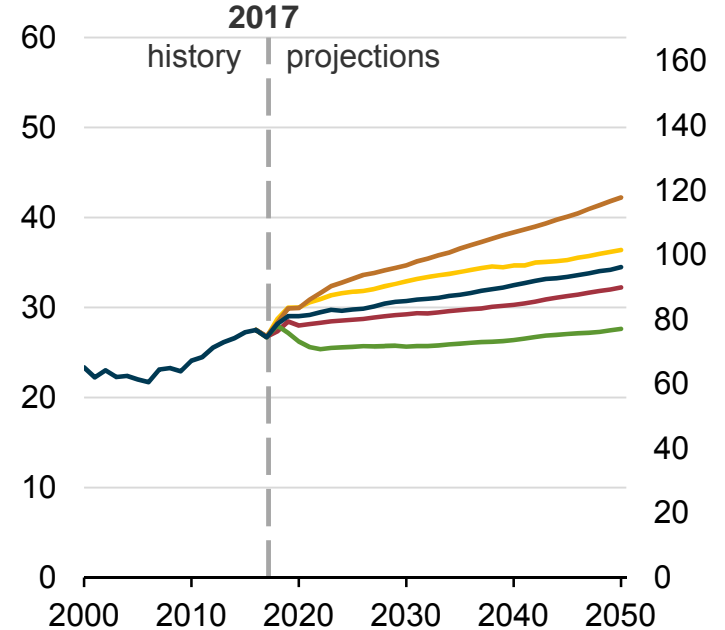
U.S. natural gas production

trillion cubic feet per year billion cubic feet per day



U.S. natural gas consumption

trillion cubic feet per year billion cubic feet per day



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



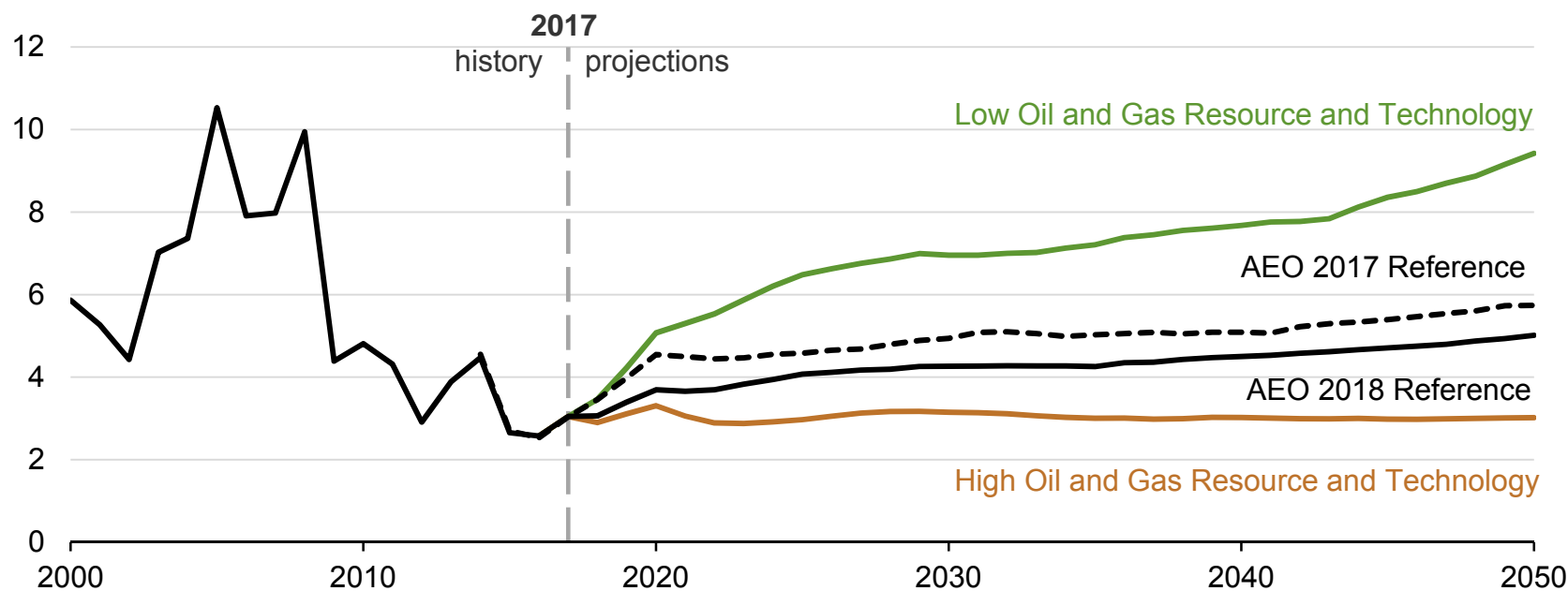
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Natural gas prices remain relatively low compared to historic values

Natural gas spot price at Henry Hub

2017 dollars per million British thermal units



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



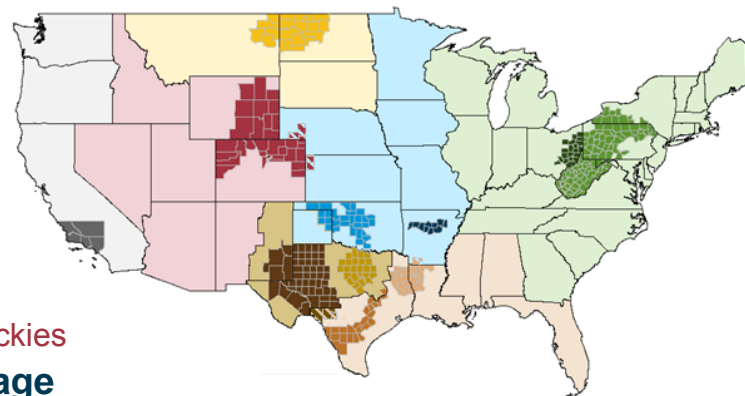
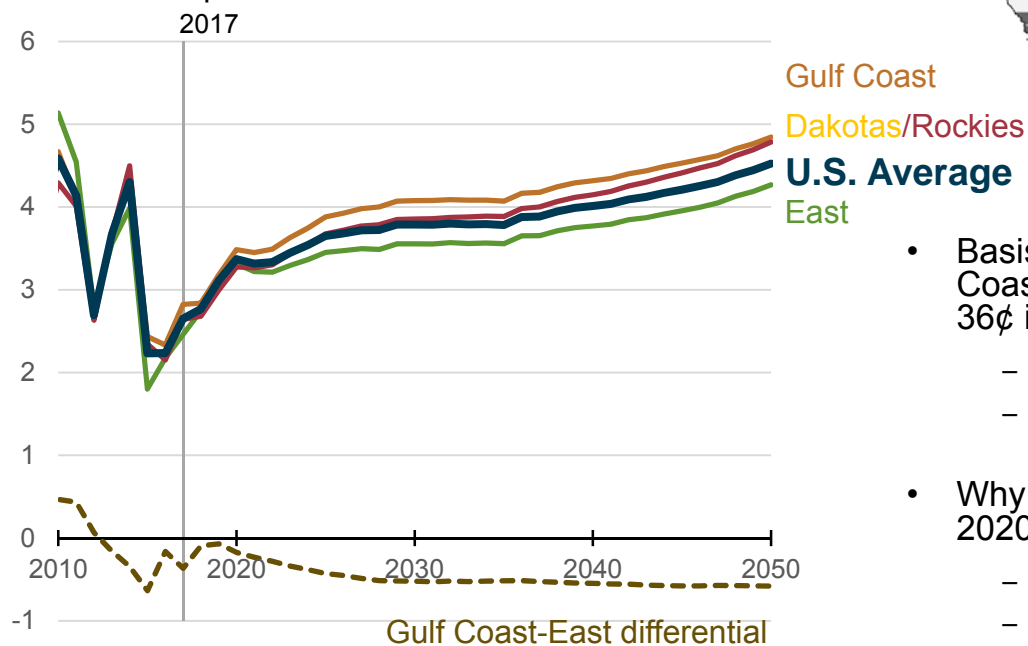
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Regional Supply Prices

Natural gas supply price

2017 dollars per thousand cubic feet



- Basis between East (Marcellus) and Gulf Coast (Henry Hub) supply prices grow from 36¢ in 2017 to 57¢ in 2050
 - Consistent with tariff charges on pipelines
 - Historical 2017 differential larger than projection
- Why does this narrow in the near-term through 2020?
 - Historical calibration
 - STEO benchmarking

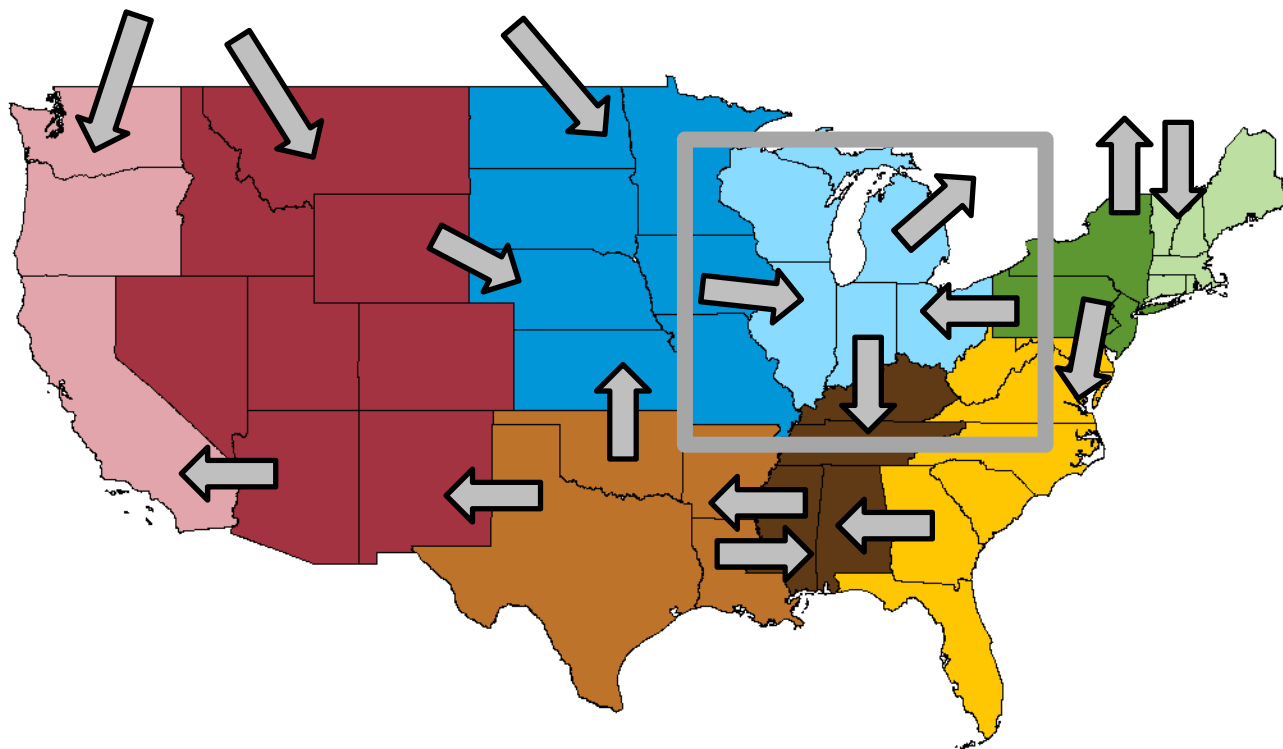
Source: U.S. Energy Information Administration, Annual Energy Outlook 2018



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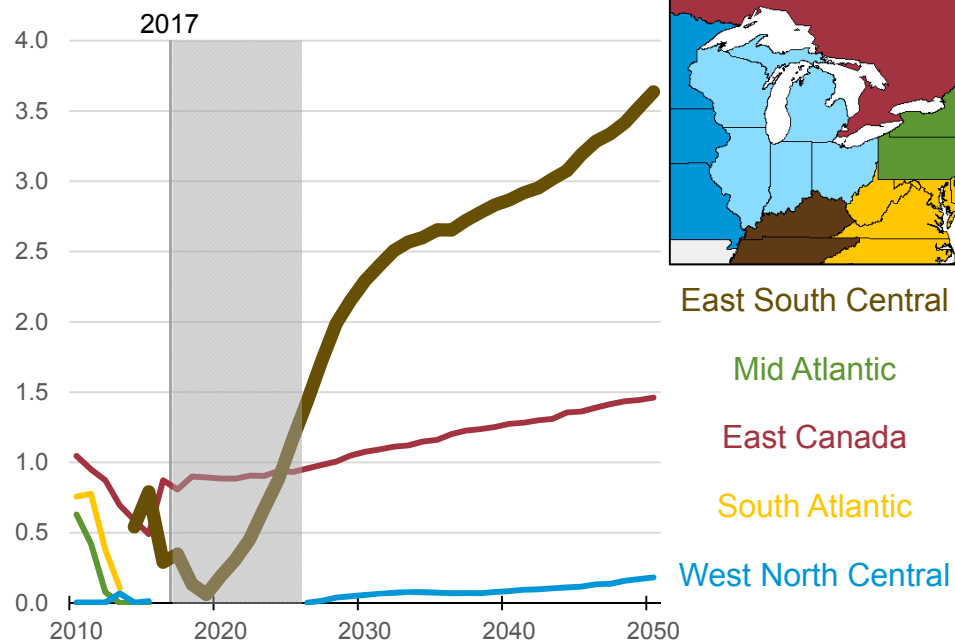
General expectation is that regional flows will be out of the Northeast, into the East North Central (Midwest) and Southeast, and down to the Gulf Coast



Regional flows into and out of Midwest illustrate NGMM likely underestimating flows from Appalachia to Gulf Coast in near- to mid-term

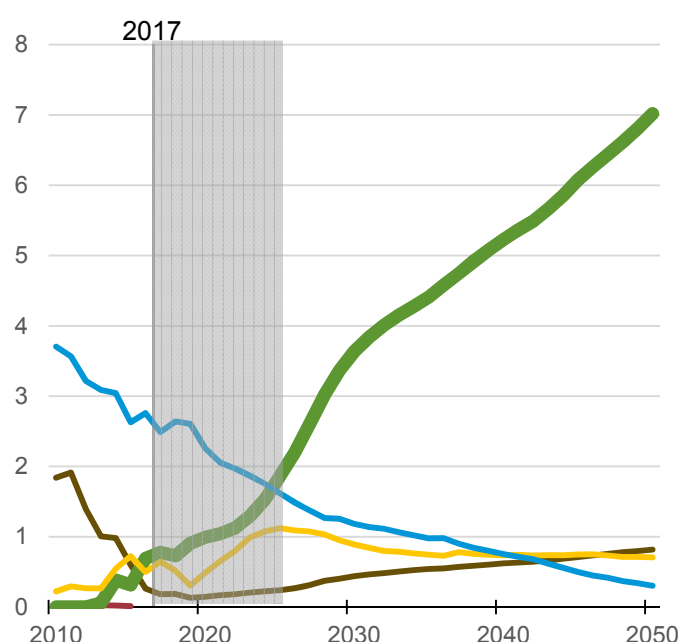
Flows out of East North Central into

Trillion cubic feet



Flows into East North Central from

Trillion cubic feet



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



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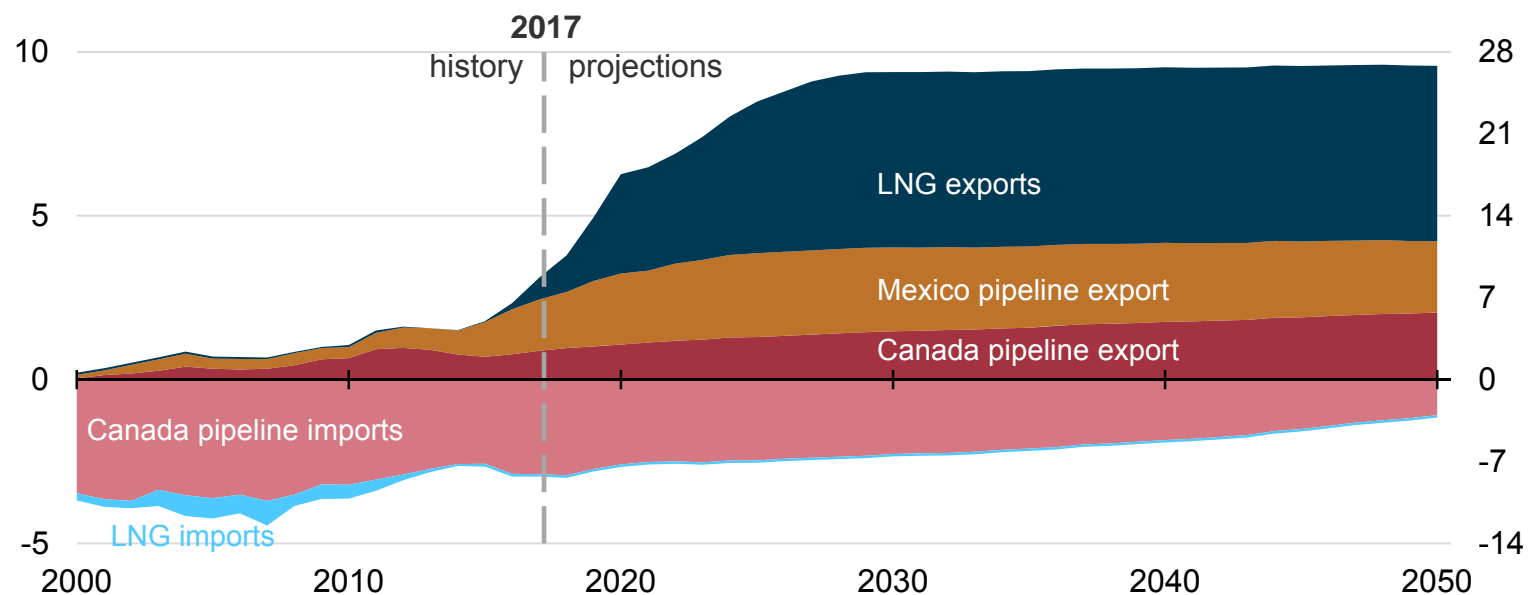
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The United States is a net natural gas exporter in the Reference case because of near-term export growth and continued import decline

Natural gas trade

trillion cubic feet per year

billion cubic feet per day



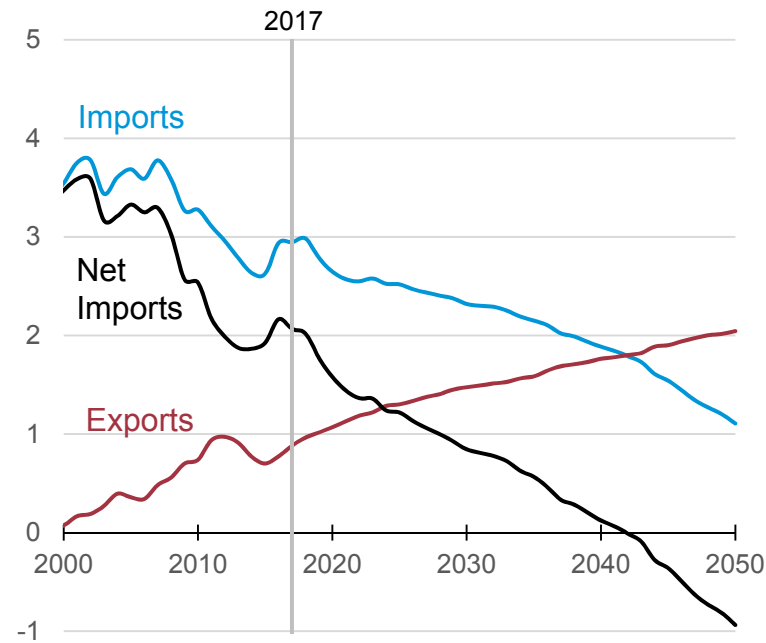
Source: U.S. Energy Information Administration, Annual Energy Outlook 2018

Canada results in detail:

U.S. imports from Canada continue to decline while U.S. exports to Canada rise due to increased pipeline capacity from the Northeast into eastern Canadian and Midwestern markets

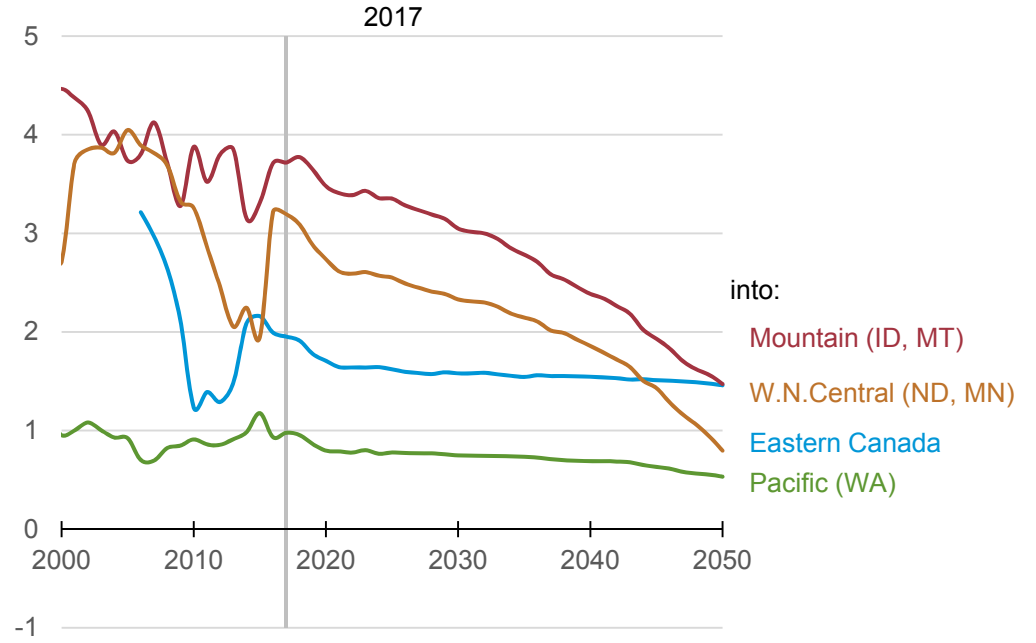
U.S. natural gas trade with Canada

trillion cubic feet per year



Flows out of Western Canada

billion cubic feet per day



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



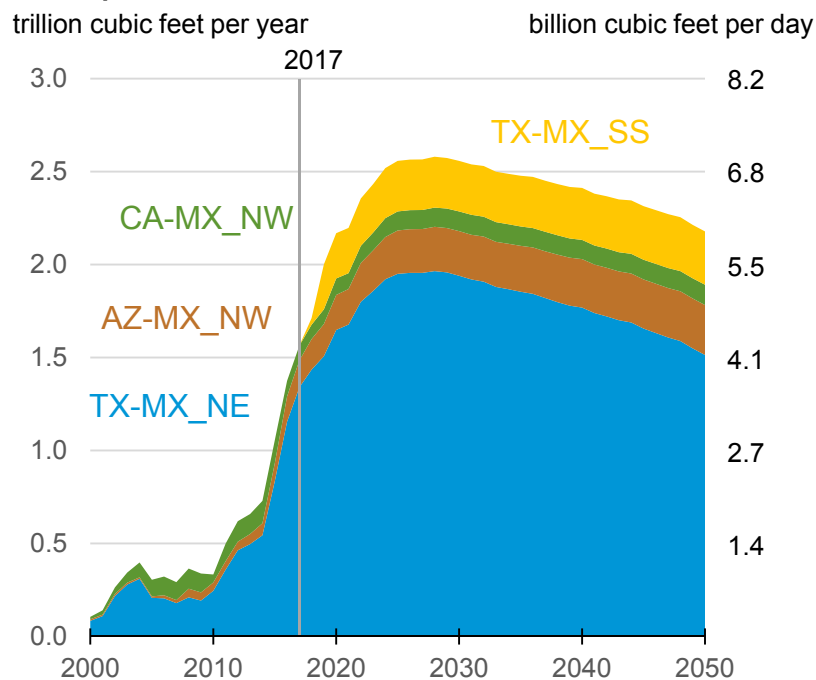
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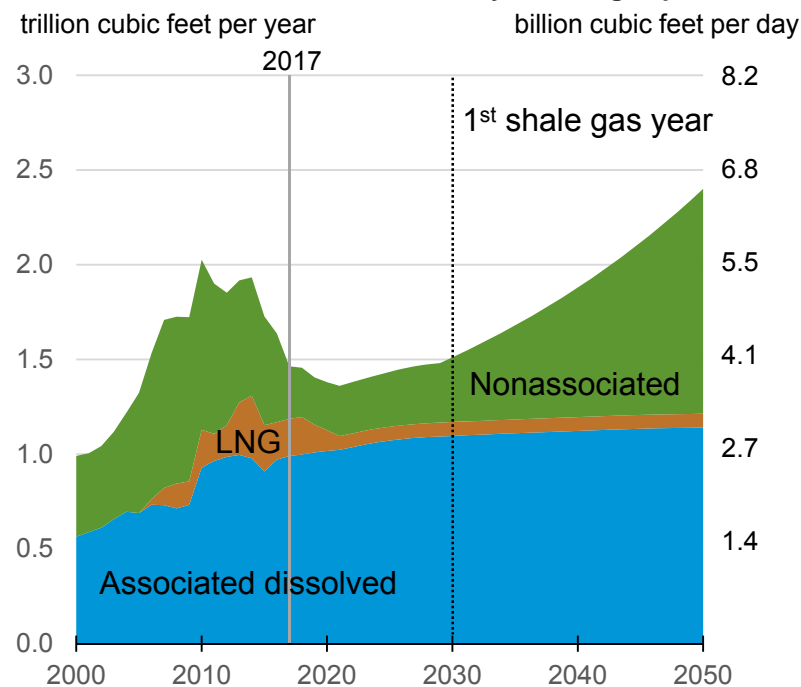
Mexico results in detail:

U.S. exports to Mexico continue current growth trajectory in short- to mid-term, leveling off as reforms to Mexico’s energy market take hold

U.S. exports to Mexico



Mexico dry natural gas production



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



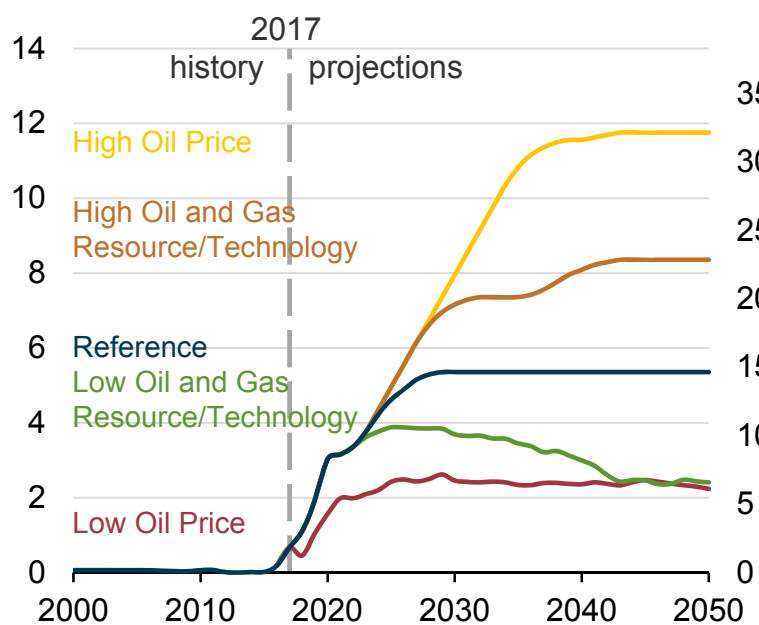
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The United States becomes a net exporter of natural gas before 2020, although the level of LNG exports is uncertain, resulting in a wide range of expected U.S. LNG export levels

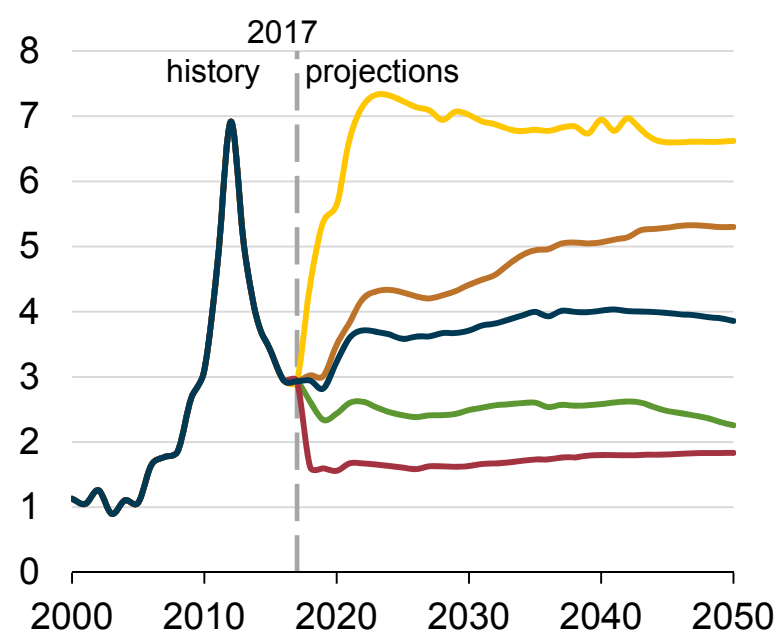
Liquefied natural gas exports

trillion cubic feet per year billion cubic feet per day



Oil-to-natural gas price ratio

energy-equivalent terms



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



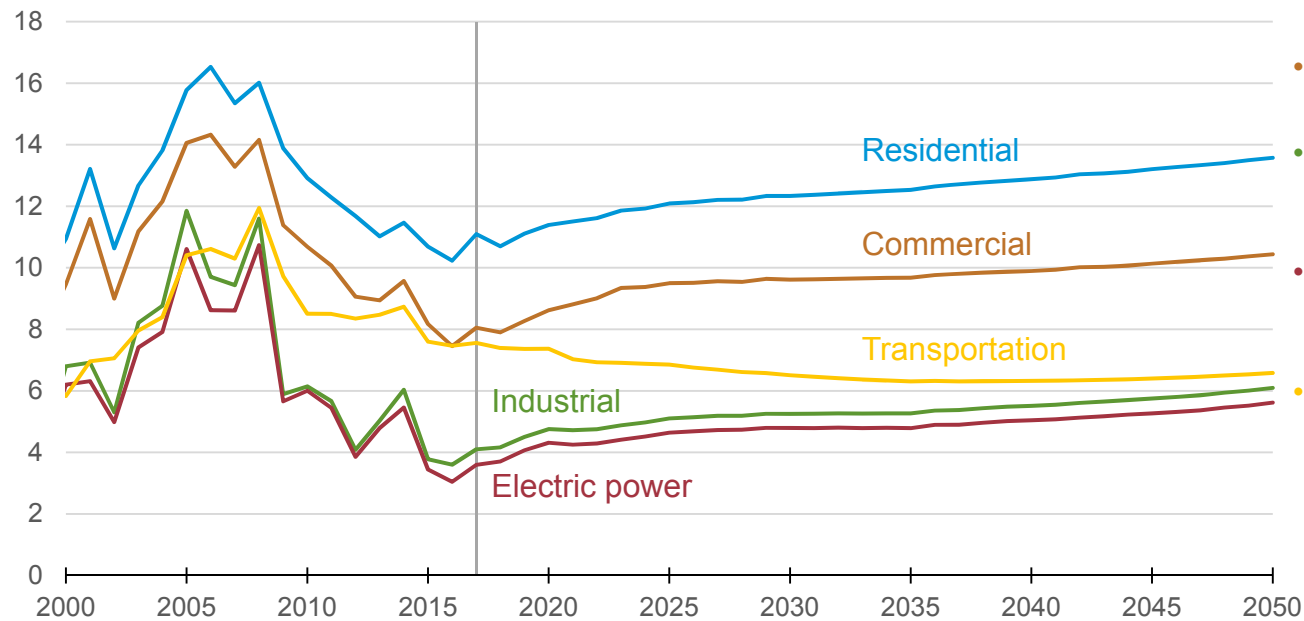
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Delivered prices to consumers: Markups off of both city gate and spot prices as well as estimations using updated historical data series

Delivered natural gas prices by sector

2017 dollars per thousand cubic feet



- **Residential:** Number of households, city gate price
- **Commercial:** Floor space, city gate price
- **Industrial:** Industrial-weighted spot price
- **Electric power:** Electric-weighted spot price
- **Transportation:** EERE historical data and city gate price for personal and fleet vehicles, industrial price for rail and marine

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



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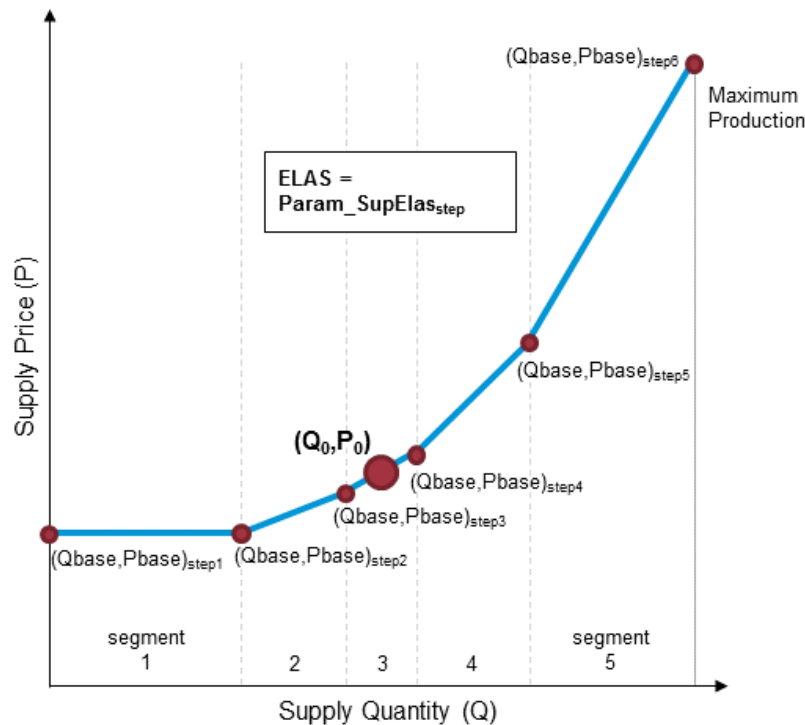
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AEO 2019: Miscellaneous planned improvements

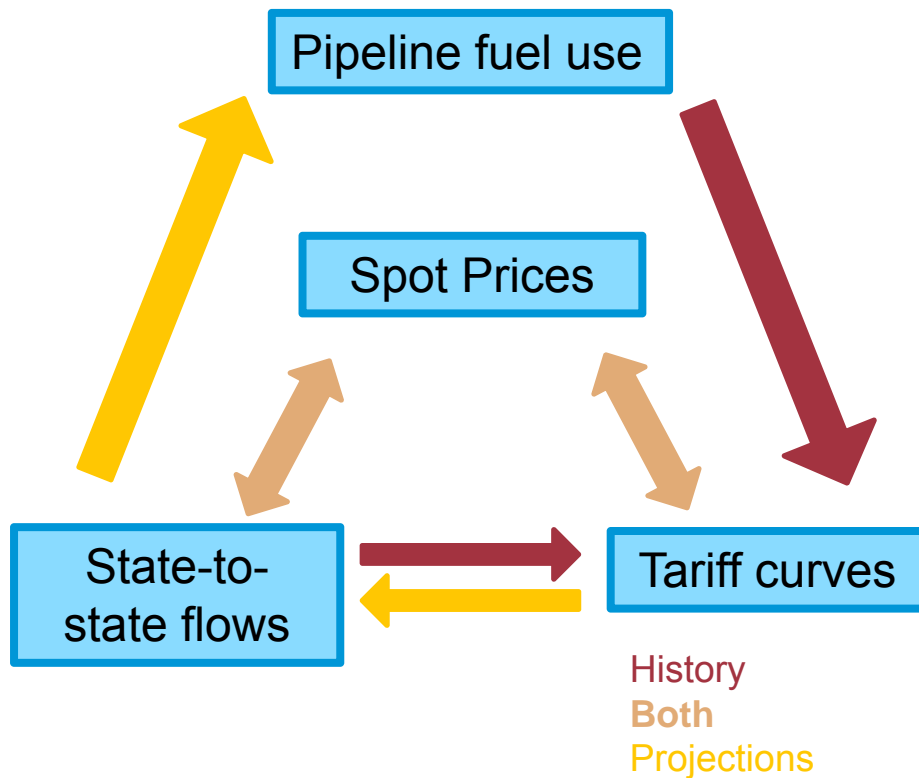
- Re-evaluate and modify select variable tariff curves
 - Improve regional flows
 - Ensure tariffs produce reasonable flow patterns throughout projection
 - “Placeholder” for more thorough and permanent fix long term
- Assess interaction with Electricity Market Module (EMM) to improve convergence
 - Understand what is driving oscillations in some regions (e.g. disparate regionality between the two models, competition with renewables)
 - Analyze seasonal patterns and interactions between NGMM/EMM
 - Assess natural gas price sensitivity of EMM

AEO 2019: Supply curve optionality



- 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
- Testing in conjunction with OGSM to 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

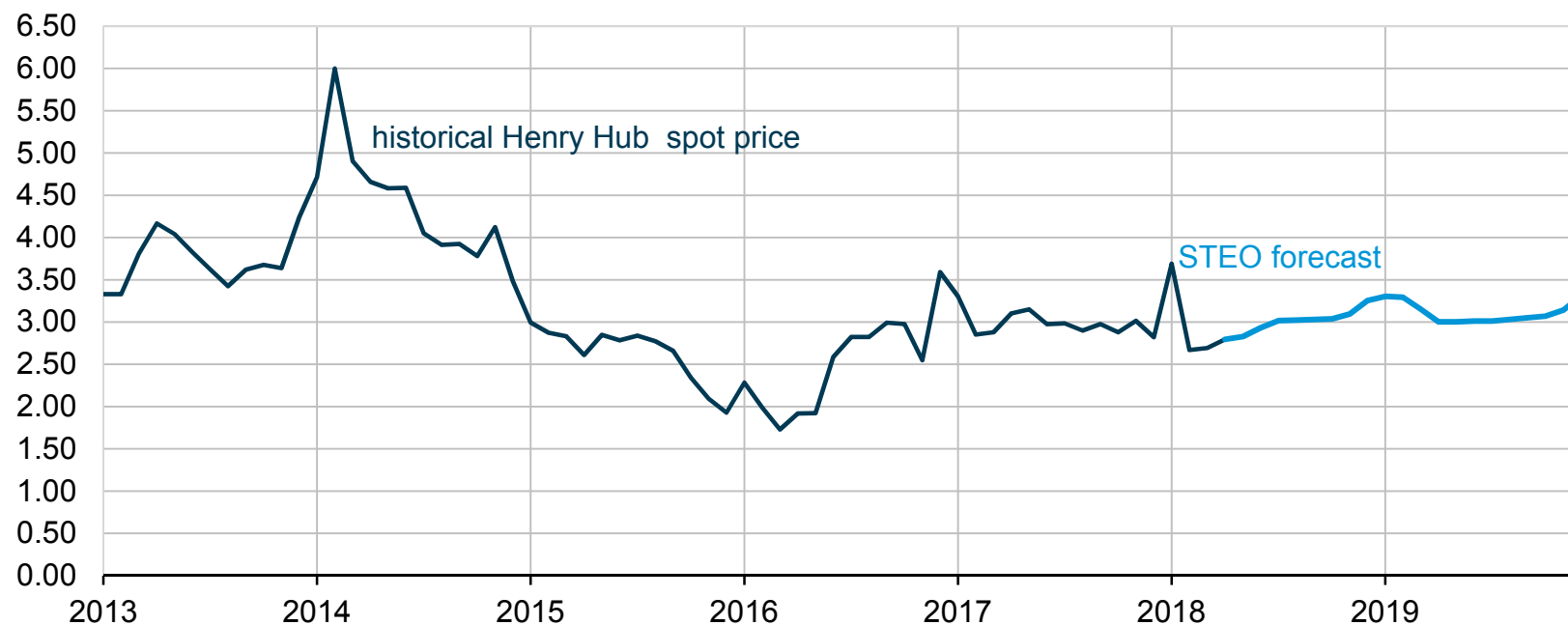
Post-AEO 2019: Historical Calibration



- Adapt code to run in historical years
 - NGMM validation/backcasting
 - Calibrate spot prices, flows, and tariff curves for use in projection
- Roadblocks to completion in AEO 2018/9
 - Data quality
 - Pipeline capacities by month historically
 - Pipeline fuel use data by state highly variable; subject to respondent error
 - Resources and time required
 - Gross vs. net flows
 - Granularity of model not at market level
 - Texas acts as 3+ regions
 - Rockies/Mountain region too granular

STEO: Henry Hub prices are forecast to average \$3.01/MMBtu in 2018 and \$3.11/MMBtu in 2019

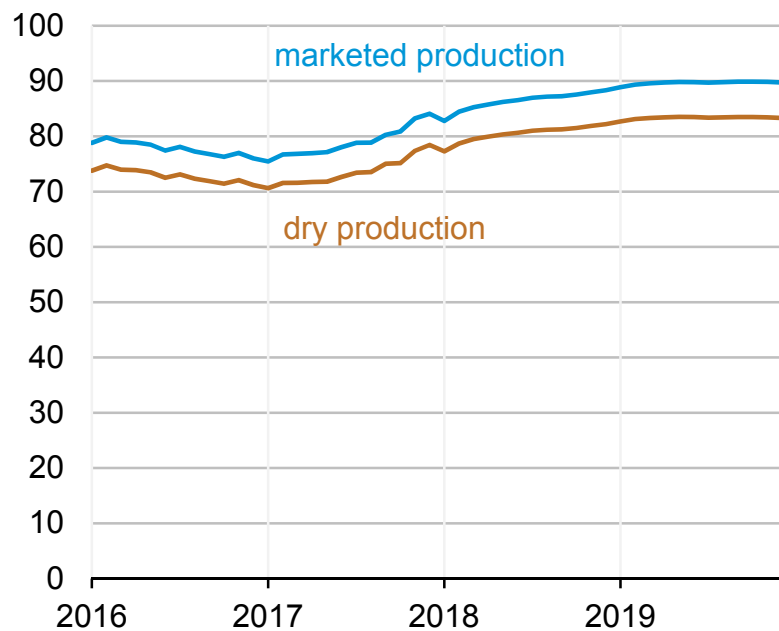
Henry Hub natural gas price
dollars per million British thermal units



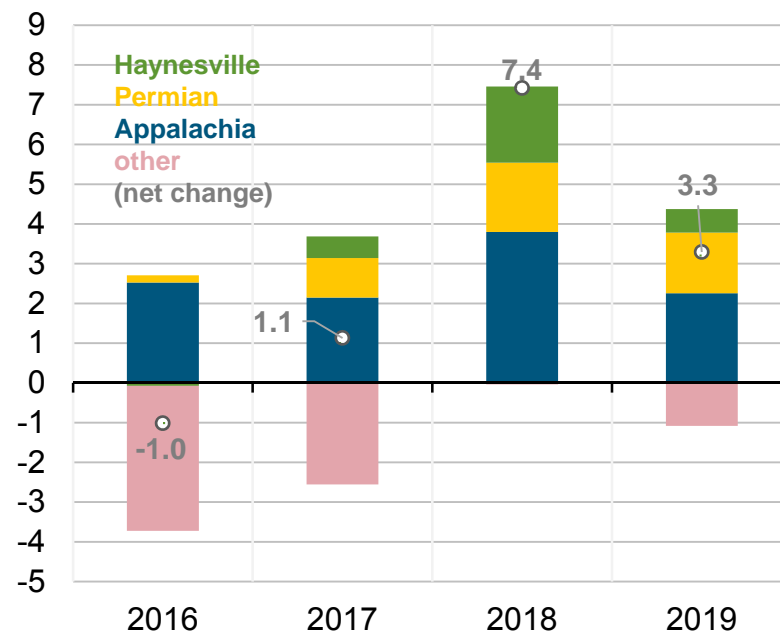
Source: EIA Short-Term Energy Outlook, May 2018, and Thomson Reuters.

STEO: EIA forecasts marketed natural gas production to grow by a record 7.4 Bcf/d on average in 2018

U.S. marketed natural gas production
billion cubic feet per day



Components of annual change
billion cubic feet per day



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

For more information

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

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



Supplemental Slides



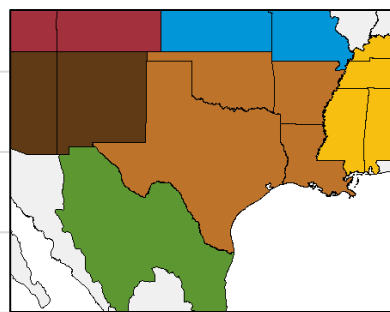
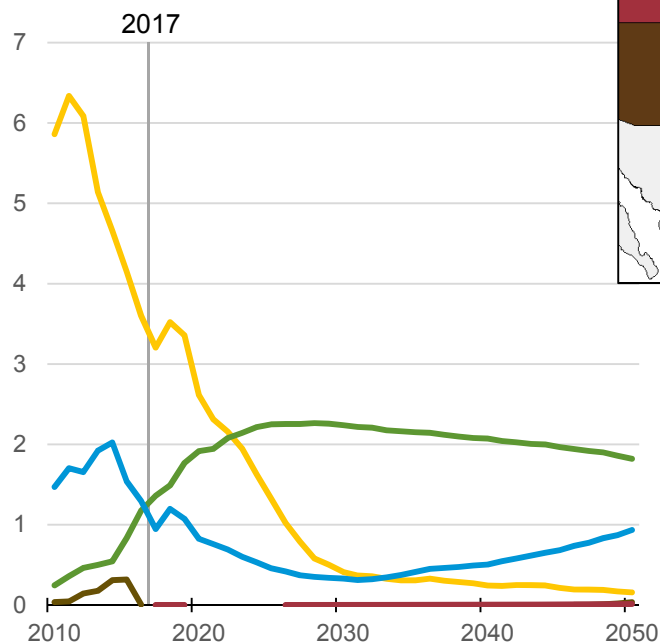
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Regional flows into and out of TX, OK, AR, LA illustrate that NGMM is underestimating east-to-west flows in the United States

Flows out of West South Central into

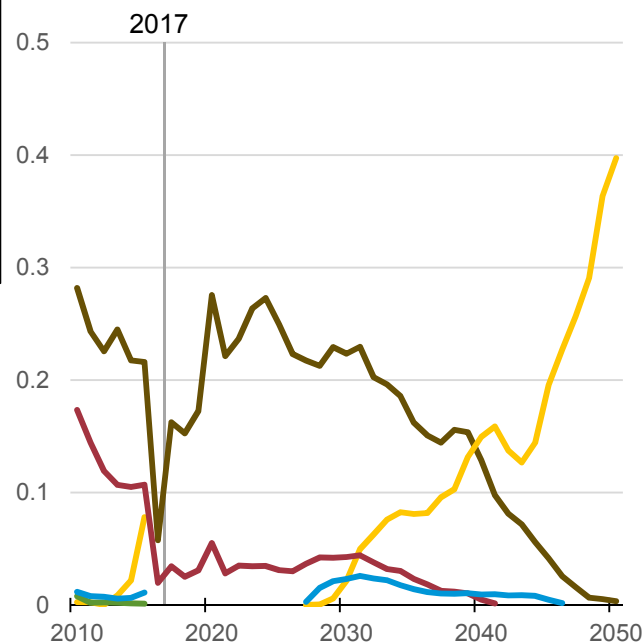
Trillion cubic feet



East South Central
 Mexico
 Rockies
 West North Central
 AZ/NM

Flows into West South Central from

Trillion cubic feet



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

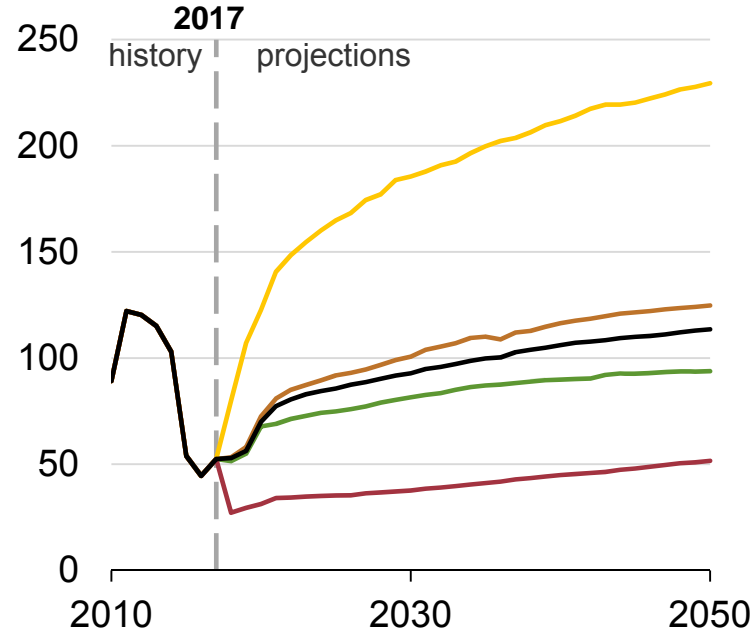


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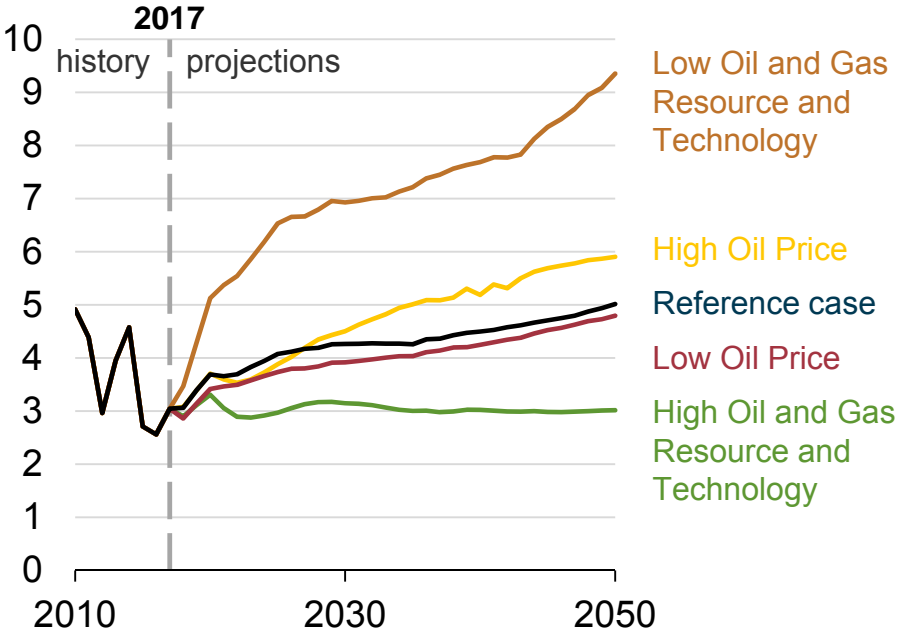
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While global conditions lead oil price projections, resource size and technology assumptions drive U.S. natural gas prices

North Sea Brent oil price
2017 dollars per barrel



Henry Hub natural gas price
2017 dollars per million Btu



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



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