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# AEO2021 First Coal Working Group Meeting

*Coal and Uranium Analysis Team*

*August 13, 2020 | Washington, D.C.*

# AEO2021 First Coal Working Group Meeting Agenda

- AEO2021 schedule and incorporation of COVID-19 impacts
- What we're working on for AEO2021
- Update on legislation and regulations affecting coal use
- Summary of AEO2020 projections and August STEO with emphasis on coal
- **Meeting protocols**
  - This presentation and accompanying meeting minutes will be made available within the next few weeks to the EIA Working Group website
  - Please mute yourself and enter questions using the WebEx chat feature–we will pause at points during the presentation to address them; select the raised-hand button if you want to speak
  - The meeting will follow Chatham-house rules and will not be recorded
  - Please send an email to David.Fritsch@eia.gov to confirm your attendance if your name in the list of participants is insufficient to establish your identity

# Overview of *Annual Energy Outlook 2021* (AEO2021)

- What will be included in the AEO2021 release posted on the EIA website?
  - Working group presentations and minutes
  - Flip-book covering the Reference and core side cases
  - Assumptions reports, including costs for new/existing electric plants and levelized costs
  - No Issues in Focus papers planned at this time
  - Model documentation not updated (two-year cycle)

- AEO2021 schedule
  - Coal Market Module (CMM) model development: Jun-Sep 2020
  - Second Working Group Session: Sep 2020
  - Expected AEO release (event): Jan 2021

# The new context: Global economic disruption under COVID-19 pandemic

- Short-term impacts of COVID-19 have been reflected in STEO forecasts
- Long-term impacts of COVID-19 are still under review
  - These effects will be largely reflected in inputs from Macroeconomic/End Use models
- AEO2021 Macro/Industrial Working Group meeting: week of August 24
- EIA will host a series of workshops on the near- and long-term impacts on energy markets (detailed announcement forthcoming in the next few weeks)

# What we're working on for AEO2021

- **Improving run result diagnostic capabilities within CMM/AIMMS (complete)**
- **Implementing a new coal transportation rate escalation methodology**
- **Evaluating utility Integrated Resource Plans (IRP) and implications for coal retirements**
- Updating historical coal input data in the CMM to base year 2019
- Endogenizing fuel cost assumptions in the seaborne coal trade formulation
- Assessing base year coal transportation rates and routes
- Modifying database feeds to the CMM to enable transition from AIMMS v. 4.37 (32-bit) to v.4.72 (64-bit) during AEO2022 development cycle

# Improving run result diagnostic capabilities within CMM/AIMMS (completed)

- New automatic cycle saves of the model results and outputs at the end of each cycle allows for review of any cycle of an integrated NEMS run
- A new section of code for creating display parameters was added that included lookup tables for regions, types, subsector names, and category descriptions
- 19 new report pages for display of the coal model results including four main groups:
  - A: Coal Supply
  - B: Coal Demand
  - C: Coal Transport
  - D: International Coal Trade
- New interface to run the model in stand-alone mode for testing, which replaces an old manual year loop procedure

# Implementing a new coal transportation rate escalation methodology

- EIA staff developed an approach for escalating coal transportation rates in light of declining coal production volumes shipped in the United States based on contractor recommendations* and staff analysis**
  - Current East/West econometric approach to rate escalation would be replaced by a national share-weighted approach based on rail transportation cost components adjusted for productivity improvements in years with decreasing coal shipments
  - The specification of base year coal transportation rates and Tier II rate adjustments will remain the same, while fuel costs would be incorporated as a weighted cost component rather than a fuel surcharge approach
- EIA staff is working to implement its approach to rate escalation in-house for AEO2021

*Hellerworx, Inc., "DOE/EIA Coal Market Module: Coal Transportation Rate Methodology Assessment," September 29, 2017 (Unpublished)

**U.S. Energy Information Administration, Coal and Uranium Analysis Team, "Improving the Method for Coal Transportation Rate Escalation in the NEMS Coal Market Module," August, 2020, EIA Website

# What are the differences between the rate escalation methods?

- Current method
  - Estimates separate coal transportation rate escalators for eastern and western coal shipments
  - Applies to all modes of coal transport
  - Uses econometric model to estimate the relationship between the projected inputs
    - East modeled as a function of rail productivity, the User Cost of Capital, and diesel fuel prices
    - West modeled as a function of rail productivity, investment, and the western share of U.S. coal shipments
    - User Cost of Capital is based on the Producer Price Index (PPI) for railroad equipment, a proxy for interest rates based on the AA Utility Bond Rate and 3% risk premium, and the estimated annual depreciation (10%)
  - Has separate accounting for fuel cost adjustments

- Proposed method
  - Estimates single, national transportation rate escalation profile using rail as a proxy for other modes of transportation
  - Applies to all modes of coal transport
  - Uses a structural approach to weight key projected cost and productivity inputs
    - Weight fuel, labor, equipment, and other cost components by the latest component weightings for the rail industry published by the American Association of Railroads (AAR)
    - Adjust index each year based on change in related indexes projected within NEMS
    - Adjust component shares each year as the index components evolve over time
    - Add 50% of estimated average, annual STB productivity improvements (%) over the past 10 years to the extent coal production in decline
  - Eliminates separate fuel cost adjustments

# What will the process look like going forward?

- At the start of each NEMS cycle, EIA will calculate the real rate of change in selected indexes relative to the Gross Domestic Product Deflator, apply the base year shares to project the first projection year's escalation rate, and use the share-weighted values for that year to generate shares for application in the next projection year, and so on
- Productivity adjustment would still be necessary based in part on analyst judgment

| RCAF variable | 2018 share* | NEMS long-term projections escalator basis |
|---|---|---|
| Labor | 33.0% | Employment Cost Index–Total Private Compensation (2005=1.00) |
| Fuel | 15.9% | Indexed Ultra-Low Sulfur Diesel Fuel Price |
| Materials & supplies | 5.1% | Wholesale Price Index–Metals and Metal Products (1982=1.00) |
| Equipment rentals | 5.3% | Wholesale Price Index–Transportation Equipment (1982=1.00) |
| Depreciation | 15.0% | Wholesale Price Index–Fuel and Power (1982=1.00) |
| Interest | 2.1% | Indexed 10-year U.S. Treasury Bond Rate |
| Other | 23.6% | Wholesale Price Index–Industrial Commodities less Energy (1982=1.00) |

**Source: American Association of Railroads, Second Quarther 2020 All-Inclusive Index, Ex Parte No. 290 (Sub-No. 5) (2020-2), Quarterly Rail Cost Adjustment Factor, Surface Transportation Board, March 5, 2020.*

# How do the approaches compare to one another?

- Table compares the rate escalation methodologies by AEO2019 Side Case and year from the base year (2017) used in the evaluation

- EIA Alternative Approach produces results in line with NEMS indexes and fuel prices

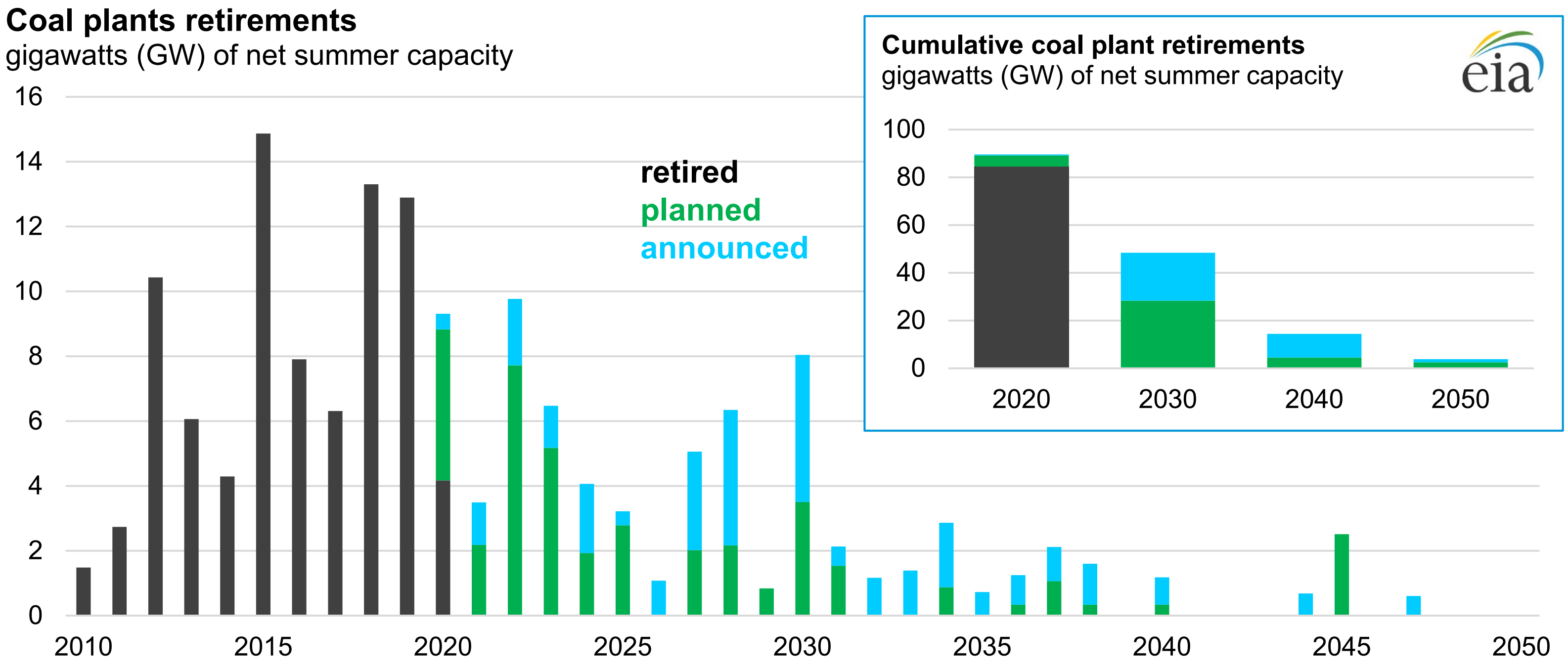
| | 2017 | 2020 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|
| **Reference Case** | | | | | |
| EIA Current Methodology | 1.000 | 1.090 | 1.078 | 1.051 | 1.017 |
| Contractor-Recommended Methodology | 1.000 | 1.034 | 1.007 | 0.968 | 0.915 |
| EIA Alternative Approach | 1.000 | 1.045 | 1.031 | 1.021 | 0.998 |
| **High Macro** | | | | | |
| EIA Current Methodology | 1.000 | 1.092 | 1.078 | 1.054 | 1.025 |
| Contractor-Recommended Methodology | 1.000 | 1.035 | 1.008 | 0.969 | 0.921 |
| EIA Alternative Approach | 1.000 | 1.047 | 1.038 | 1.053 | 1.054 |
| **Low Macro** | | | | | |
| EIA Current Methodology | 1.000 | 1.091 | 1.058 | 1.015 | 0.980 |
| Contractor-Recommended Methodology | 1.000 | 1.033 | 1.004 | 0.963 | 0.913 |
| EIA Alternative Approach | 1.000 | 1.054 | 1.089 | 1.116 | 1.120 |
| **High Price** | | | | | |
| EIA Current Methodology | 1.000 | 1.183 | 1.144 | 1.112 | 1.096 |
| Contractor-Recommended Methodology | 1.000 | 1.189 | 1.224 | 1.188 | 1.142 |
| EIA Alternative Approach | 1.000 | 1.129 | 1.209 | 1.185 | 1.156 |
| **Low Price** | | | | | |
| EIA Current Methodology | 1.000 | 1.032 | 1.009 | 0.994 | 0.970 |
| Contractor-Recommended Methodology | 1.000 | 0.979 | 0.929 | 0.882 | 0.835 |
| EIA Alternative Approach | 1.000 | 0.994 | 0.928 | 0.916 | 0.913 |
| **High Resource** | | | | | |
| EIA Current Methodology | 1.000 | 1.088 | 1.055 | 1.030 | 0.997 |
| Contractor-Recommended Methodology | 1.000 | 1.026 | 0.991 | 0.950 | 0.894 |
| EIA Alternative Approach | 1.000 | 1.041 | 1.007 | 0.986 | 0.954 |
| **Low Resource** | | | | | |
| EIA Current Methodology | 1.000 | 1.094 | 1.094 | 1.077 | 1.040 |
| Contractor-Recommended Methodology | 1.000 | 1.041 | 1.026 | 0.993 | 0.937 |
| EIA Alternative Approach | 1.000 | 1.048 | 1.050 | 1.050 | 1.042 |

***Note**: The EIA Current Methodology results assume 1000-mile rail hauls with base values of $26.31 per ton (East) and $20.62 per ton (West) weighted by the share of western coal production in total U.S. production each year to account for the impact of the regional fuel surcharges. The Contractor-Recommended Methodology reflects the constant factor weighting option with only the 0.7% annual rail productivity improvement included. The EIA Alternative Approach includes the annual rail productivity improvement adjusted for coal production trends.*

# Addressing voluntary commitments to de-carbonization and implications for coal retirements

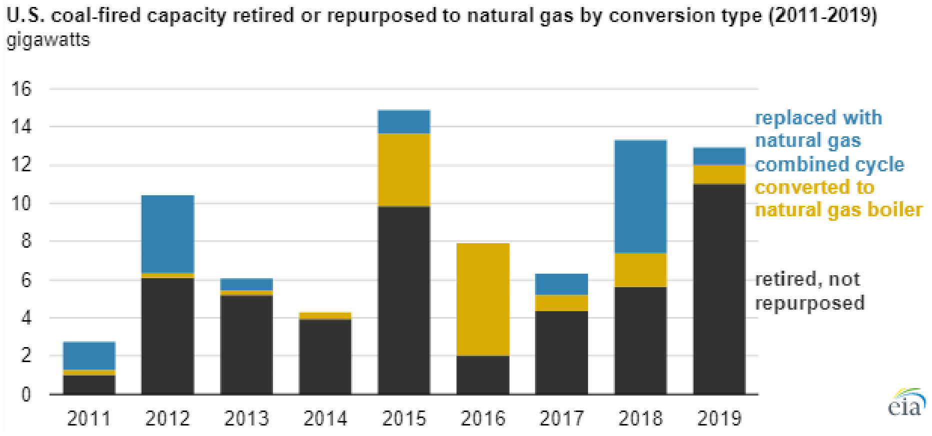
- **No change in EIA precedent**: "current laws and regulations" will remain the basis for input assumptions to Reference Case
- Common question in preceding working groups: how does EIA account for utility plans/commitments to de-carbonize?
  - EIA has seen Integrated Resource Plans (IRPs) as more aspirational and thus not appropriate to model
  - Increasing number and specificity of de-carbonization announcements may indicate a move toward implementation
- Considering different approaches to if/how to incorporate IRP statements into modeling
- Completed supplemental research on announced coal retirements during the past year to supplement IRP reviews and help identify additional coal retirements to include in the Reference case

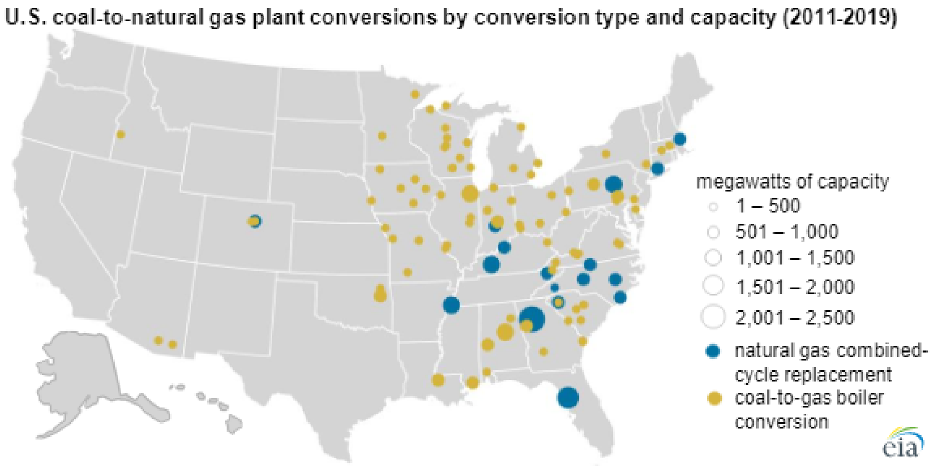
# Wave of coal retirements is expected to continue based on review of already planned or announced retirements




*Source for actual and planned retirements: Survey Form EIA 860-M data as of May 2020 and analyst research on specific announcements. Announced retirements are based on analyst research and have not been classified as a planned retirement for inclusion in the AEO2021 Reference case.*

# More than 100 coal-fired plants have been replaced or converted to natural gas since 2011




- From 2011 to 2019, 121 U.S. coal-fired power plants were repurposed to burn other types of fuels, 103 of which were converted to or replaced by natural gas-fired plants
- Among the natural gas-fired conversions, 14.3 GW had the boiler converted to burn natural gas, and 15.3 GW was replaced with natural gas combined cycle
- Motives behind these transitions include: stricter emissions standards, low natural gas prices, and more efficient new natural gas turbine technology.

*Source: U.S. Energy Information Administration, Today in Energy, "More than 100 coal-fired plants have been replaced or converted to natural gas since 2011", Principal Contributor: Lindsay Aramayo, August 5, 2020.*

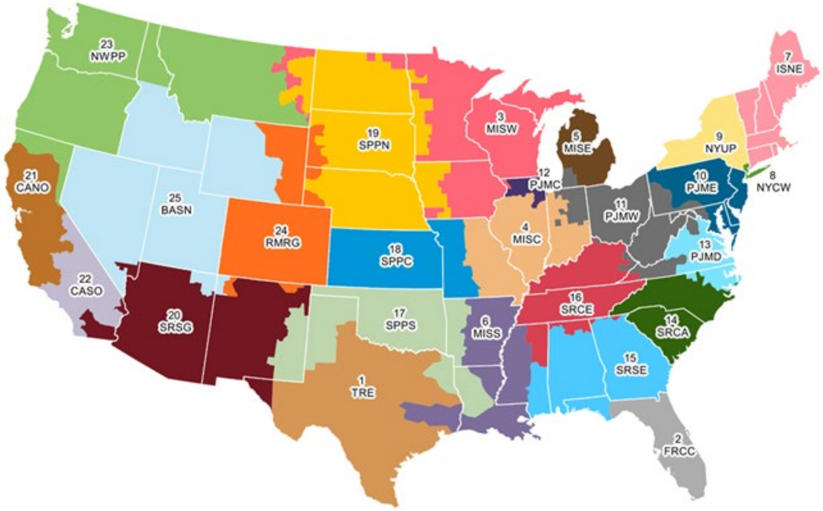
# Update on other coal-related development and communication efforts

- Developing an International Coal Market Module (ICMM) in WEPS+
  - Developing a linear programming-based approach using EIA's Global Hydrocarbon Supply Model (GHySMo) platform in AIMMS and Python
  - Taking advantage of efforts to improve the modeling of international coal supply curves (ICSC) and seaborne coal shipping costs during ICMM development
  - Anticipating application in the 2021 *International Energy Outlook* (IEO2021) cycle
  - Updating of ICSC in the CMM dependent on outcomes of ICMM development
- Bi-annual *Short-Term Energy Outlook* (STEO) coal forecasting working groups on hold as COVID-19 market effects play out; anticipate resuming in 2021 Q1

# The Electricity Markets Module (EMM) is moving toward dynamic regional redefinition capability

- New for AEO2021- regional inputs read from SQLite database generated by new Python tool
  - First step in being able to more easily change region definitions for specific analyses
- AEO2021 will remain at the same region configuration as AEO2020
  - Which alternative regional configurations should be considered as regional redefinition capability is developed?

**Retain AEO2020 region mapping in AEO2021**



# Legislation and regulations update

# EPA CO2 regulations included in AEO

- Affordable Clean Energy (ACE) rule
  - In the NEMS Electricity Markets Module (EMM), existing coal units need to either upgrade to an HRI option identified in EIA's CPP study or retire by 2025; this approach relies on the 2015 EIA study of heat rate improvement (HRI) potential and costs for existing coal units
  - Revises EPA's BSER ("best system of emission reduction") finding for GHG emissions from existing power plants to include only heat-rate efficiency improvements and gives states a list of "candidate technologies" that can be used to establish performance standards for use in state plans, rather than setting specific technology-based standards
- New Source Performance Standards (NSPS) limit CO2 emissions from new plants
  - The EPA released proposed revisions that would eliminate the Carbon Capture and Sequestration (CCS) requirement and specify CO2 emission rates of 2,000 lb CO2/MWh-gross for large units (super-critical), 1,900 lb for small units (sub-critical), and 2,200 lb for new coal refuse-fired units; and it would change applicability of rules to modified units
- A 3% adder is applied to the cost of capital for new coal across all AEO cases
  - Includes units or upgrades to existing units without maximum sequestration options (90% removal) to account for risk of future tightening of CO2 emissions standards and other policies affecting coal use

# Other EPA air quality regulations affecting electricity generation

- The Mercury and Air Toxics Standards (MATS) are included in all AEO cases
  - On July 17, 2020, EPA finalized a revision to the 2012 MATS rule based on its determination that it is not “appropriate and necessary” to regulate HAP emissions from power plants under Section 112 of the Clean Air Act.
  - EPA also determined that “emissions of HAP have been reduced such that residual risk is at acceptable levels, that there are no developments in HAP emissions controls to achieve further cost-effective reductions beyond the current standards, and, therefore, **no changes to the MATS rule are warranted**.” (quoted from EPA website; emphasis added).
- EPA’s Cross-State Air Pollution Rule (CSAPR) is included in all AEO cases
- Regional Haze compliance is reflected in survey Form EIA-860 filings as each coal plant takes action to comply
  - Compliance follows from State Implementation Plans due on July 31, 2021 with implementation by 2028; Regional Haze Reform Roadmap dated September 11, 2018
  - On June 30, 2020, EPA reaffirmed a 2017 determination that participation in CSAPR qualifies as a BART alternative to satisfy Regional Haze requirements (for example, Texas)

# EPA's Coal Combustion Residual regulations

- EPA issued a final rule on July 29, 2020 to update 2015 Coal Combustion Residual (CCR) regulations in response to a August 2018 court ruling that certain provisions were insufficiently protective of public health
  - The July 29 rule defines clay-lined impoundments as "unlined" and shifts the deadline for unlined facilities to April 11, 2021, but contains a "site-specific alternative" that allows eligible unlined impoundments to continue receiving coal ash until October 15, 2024 if the operator can demonstrate a lack of capacity
  - The July 29 rule also allows impoundments larger than 40 acres to delay initiating closure until October 17, 2028; a separate proposal issued in February would allow for up to five two-year extensions beyond that date if finalized
  - Legacy impoundment rule to address court decision findings is in advanced notice of proposed rulemaking with a target of July 2021 for a proposed rule
- Modeling CCR regulations is difficult because the potential cost implications vary considerably by individual electric generating unit and are incorporated into the AEO on as-revealed basis by reporting on survey Form EIA-860

# Other EPA regulations affecting coal generating units

- EPA's Effluent Limitation Guidelines compliance is reflected in survey Form EIA-860 filings as each coal plant takes action to comply
  - EPA's Proposed Rule published November 22, 2019 to extend compliance deadlines for up to two years, expand technology options for achieving compliance, provide flexibility in managing ELG systems under a voluntary incentives program that allows facilities until 2028 to implement new limits if they adopt additional measures to achieve stricter limitations on specific pollutants, and imposing less-stringent requirements for high-flow facilities, low-utilization units, and facilities retiring by 2028
  - EPA's economic analysis of the 2015 final rule projected minimal coal retirements; the projected reduction of $175 million in annual pre-tax costs under the current proposed rule would further limit the impact

- EPA issued the Navigable Water Protection Rule on January 23, 2020 after repealing the Waters of the U.S. (WOTUS) rule in September 2019
  - Agencies would no longer oversee permits involving ephemeral features such as streams and pools that form because of rain or melting snow and applies a *typical year* standard
  - Excludes waste treatment systems from review, including coal ash ponds, as well as groundwater, storm water run-off and control systems, artificial lakes and ponds, and other agricultural lands

# Other federal legislation affecting coal

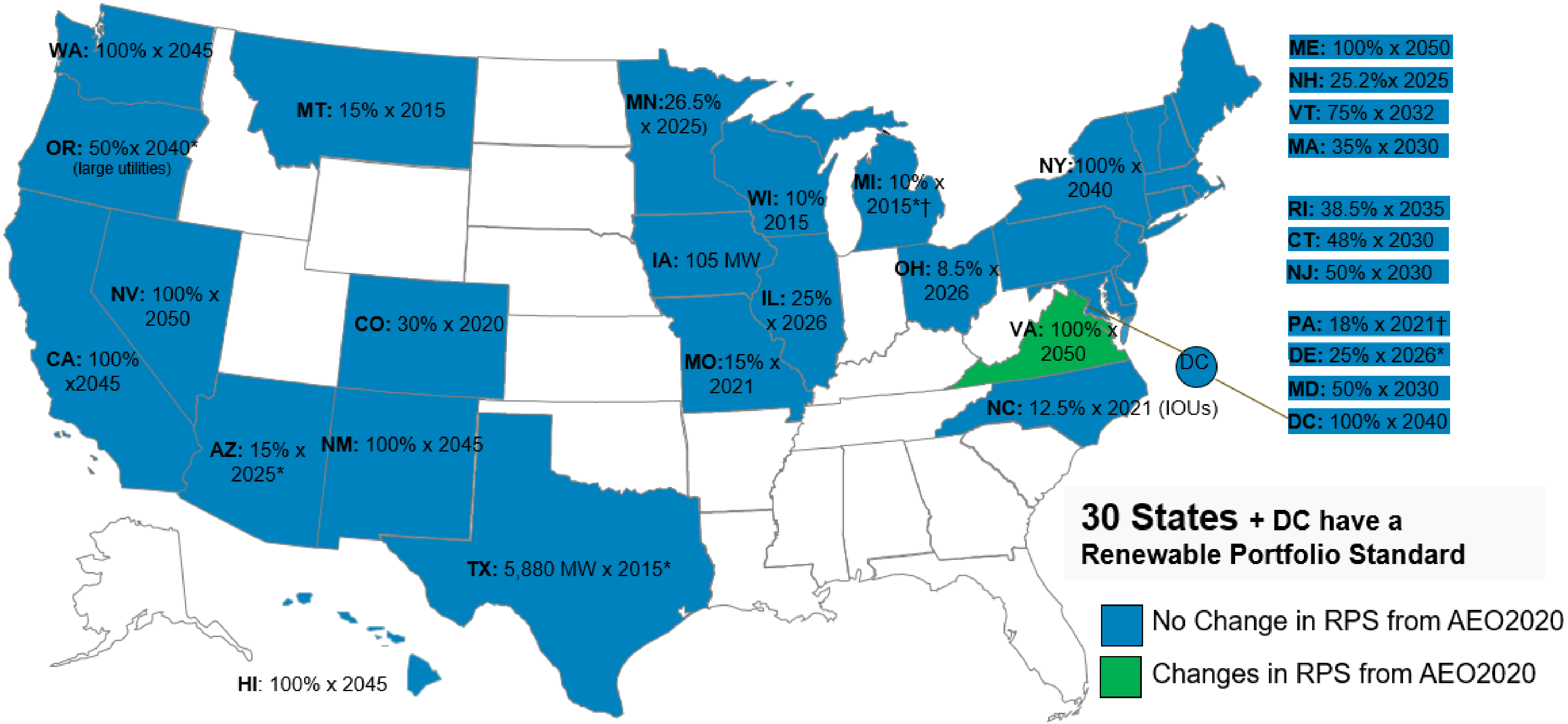
- Coal excise tax rates for the Black Lung Disability Trust Fund increased as of January 1, 2020 to $1.10 per ton for underground, and to $0.55 for surface-mined coal, or 4.4% of the sales price, whichever is lower (not applicable to lignite coal and coal intended for export); set to expire December 31, 2020 and would reduce back to $0.55 and $0.25 per ton, or 2% of the sales price, whichever is lower thereafter

- Section 45Q tax credit for Carbon Capture and Storage (CCS) is included in the AEO, which may have indirect implications for coal under certain market conditions
  - Per the Bipartisan Budget Act of 2018, rates of $50 per metric ton of CO2 for secure geologic storage, and $35 per metric ton of CO2 for Enhanced Oil or Gas Recovery (EOR/EGR) or utilization projects initiated before January 1, 2024 and for the first 12 years of operation
  - The modeling of CCS and 45Q occurs in the Electricity Market Module (EMM); Capture, Transport, Utilization and Storage Module (CTUS); and the Oil and Gas Supply Module (OGSM)

# State actions to control greenhouse gas emissions

- Regional Greenhouse Gas Initiative expanding to include Virginia in AEO2021
  - Virginia Clean Economy Act (Senate Bill 851/House Bill 1526)
    - 2021: $CO_2$ allowance of 27.16/metric ton (mt)
    - Allocation decreases each year through 2030 by 0.84/mt $CO_2$, and remains at 19.6/mt $CO_2$ thereafter
  - Dominion Energy and Appalachian Power required to retire carbon-emitting electric generating units by Dec. 31, 2045
- Existing California regulations are included in AEO
  - AB 398 Global Warming Solutions Act requires statewide greenhouse gas emissions to return to the 1990 level by 2020 and be 40% below the 1990 level by 2030; the cap-and-trade program is covered under AB 32
  - SB-1368 prohibits California utilities from entering into long-term financial commitments for base load generation, unless in compliance with $CO_2$ emissions performance standard of 1,100 lbs/MWh
  - SB-100 clean energy standard calls for a 60% renewable generation requirement by 2030, as required under previous legislation, and for carbon-free electric generation by 2045
- Viability of existing Zero Emission Credit (ZEC) programs may be in question
  - Monitoring what, if any, consequences may occur in light of recently announced investigations in OH and IL
  - Federal response: FERC Minimum Offer Price Rule (MOPR), which would also affect subsidized renewables

# Changes to state RPS policies will be finalized toward the end of the AEO cycle



# Issues affecting western U.S. coal producers

- Oregon passed S.B. 1547 in 2016 that requires utilities to exit out-of-state coal contracts by 2030
  - Potential implications for coal holdings by PacifiCorp, including Jim Bridger (WY; 2/3 owner), Hunter, Huntington, Dave Johnston, Naughton, Wyodak, Craig (partial owner), Colstrip (partial owner), and Hayden (partial owner)
  - Wyoming passed Senate File 159 requiring utilities to make a good faith attempt to sell coal plants purchased under an agreement approved by the state's commission, and ratepayers in Wyoming would assume the costs of buying the coal plant in operation
- U.S. Pacific-Northwest coal terminal development stalled/challenged at this time
  - Lawsuit is ongoing by the proposed, 44-MMtpy Millennium terminal's stakeholders to challenge Washington state's 2017 denial of the Clean Water Act Section 401 certification
  - Army Corps revived its environmental review of the project in October 2018, although it cannot issue a permit for the project unless the Washington state's certification denial is reversed or set aside
  - State board's shoreline construction permits denial decision affirmed by state appeals court in March 2020
  - Other federal lawsuits pending by Millennium project sponsors
  - Ridley expansion could free up some capacity at Westshore for U.S. exports through Canada

# AEO2020 assumptions and trends

# What is the Reference case?

- The Reference case projection assumes trend improvement in known technologies along with a view of economic and demographic trends reflecting the current views of leading economic forecasters and demographers.

- The Reference case generally assumes that current laws and regulations affecting the energy sector, including sunset dates for laws that have them, are unchanged throughout the projection period.

- The potential impacts of proposed legislation, regulations, and standards are not included.

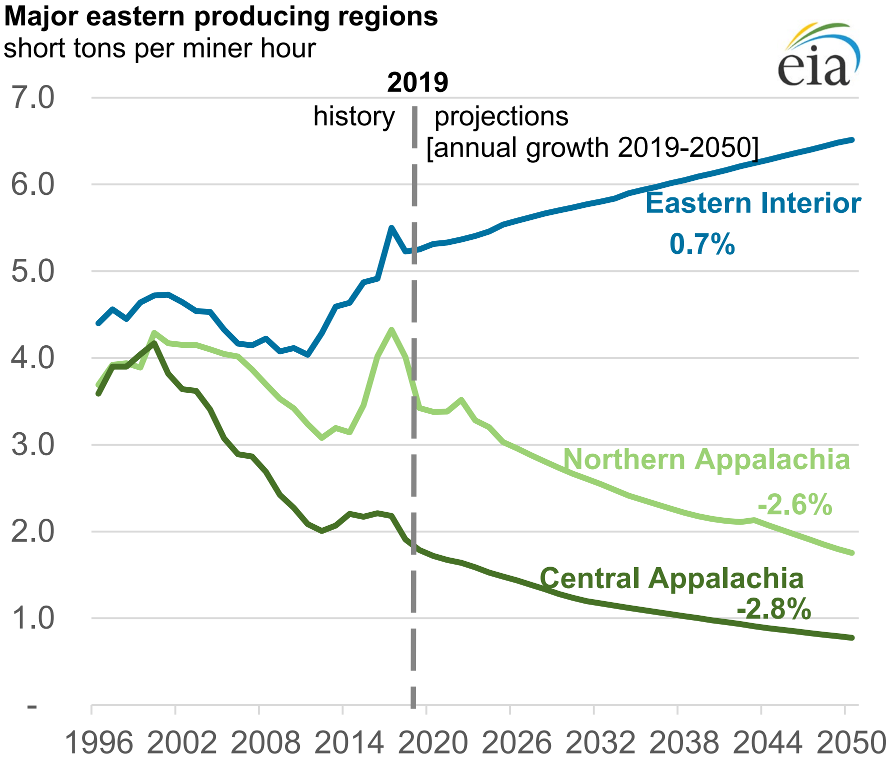
- EIA addresses the uncertainty inherent in energy projections by developing side sensitivity cases with different assumptions of macroeconomic growth, world oil prices, technological progress, and energy policies.

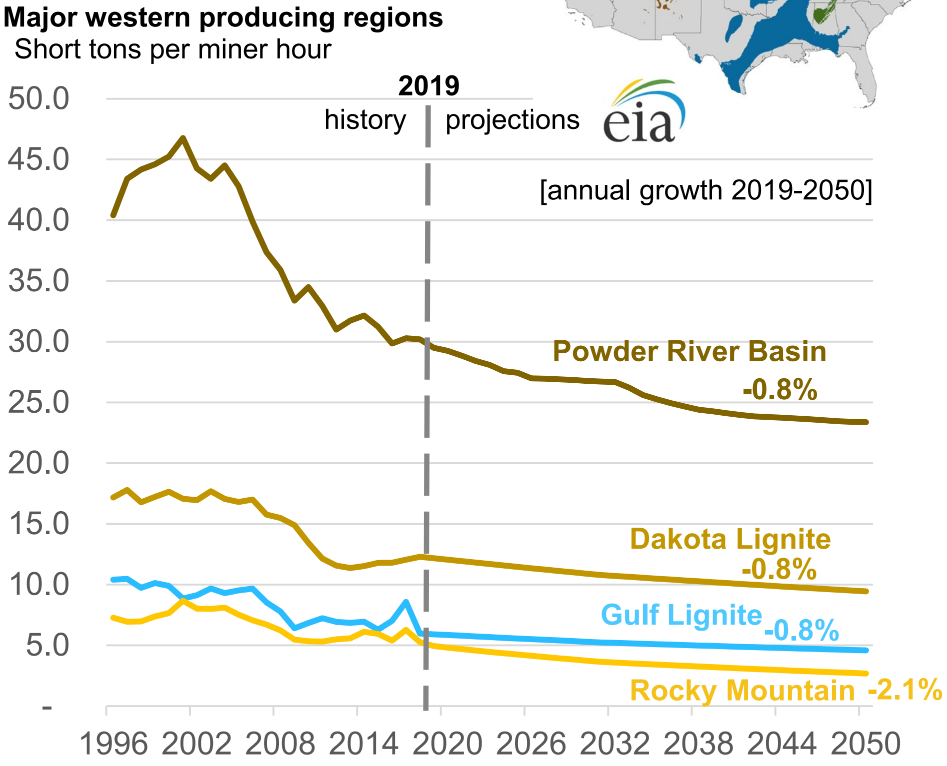
- Projections in the AEO should be interpreted with a clear understanding of the assumptions that inform them and the limitations inherent in any modeling effort.

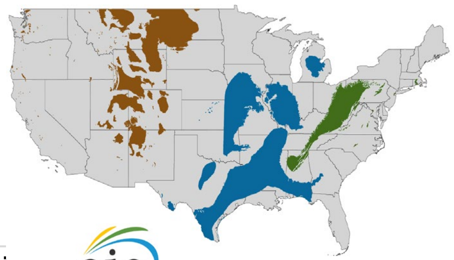
# AEO2020 sensitivity cases examine impacts of alternative market assumptions

| Selected sensitivity cases | Description |
|---|---|
| **Reference** | Assumes trend improvement in known technologies and expects current economic and demographic trends to continue |
| **High Oil and Natural Gas Supply (HOGS)** | Applies lower oil and natural gas extraction costs and higher resource availability than in the Reference case, which allows for higher levels of oil and natural gas production at lower delivered prices |
| **Low Oil and Natural Gas Supply (LOGS)** | Applies higher oil and natural gas extraction costs and lower resource availability than in the Reference case, which results in lower levels of oil and natural gas production at higher delivered prices |
| **High Renewables Cost** | The overnight capital cost is held constant at the 2019 level throughout the projection period for all renewable technologies, including conventional hydropower, in the electric power sector and for small wind and solar technologies in the end-use sectors. |
| **Low Renewables Cost** | Overnight capital costs, operating and maintenance (O&M) costs, and fuel prices, where applicable, are assumed to decline more rapidly than in the Reference case, reaching levels 40% lower than their Reference case equivalents by 2050 for all renewable generation technologies, including in end-use applications |

# Coal productivities projected to continue declining, except in the Eastern Interior

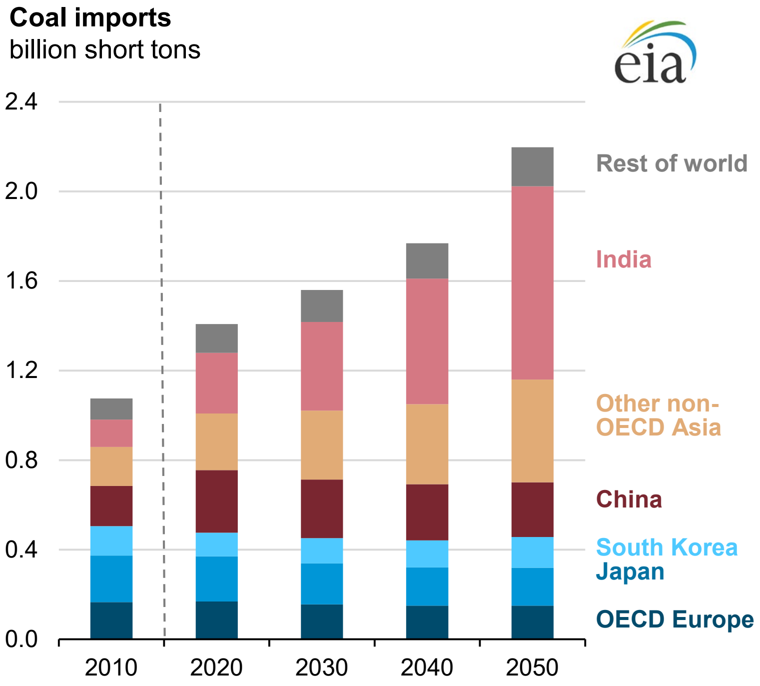


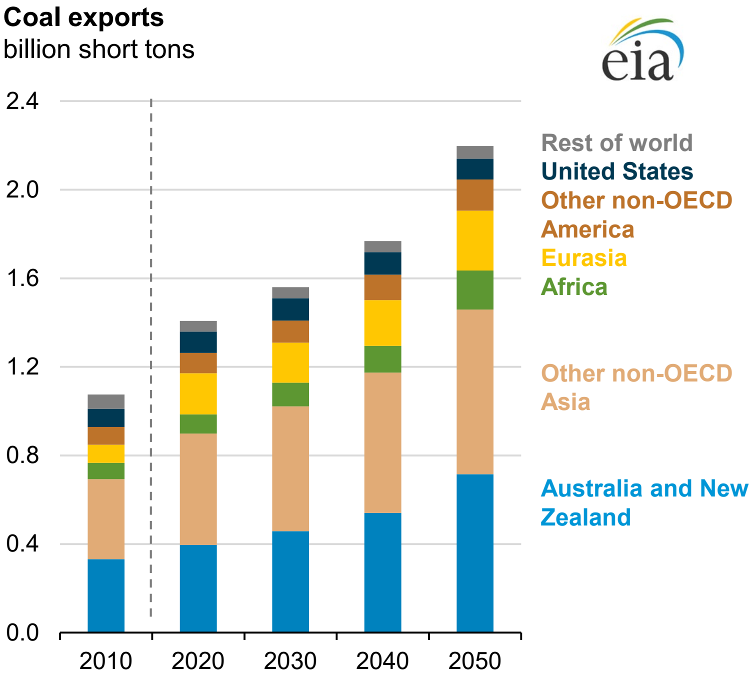



*Source: U.S. Energy Information Administration, Annual Energy Outlook 2020.*

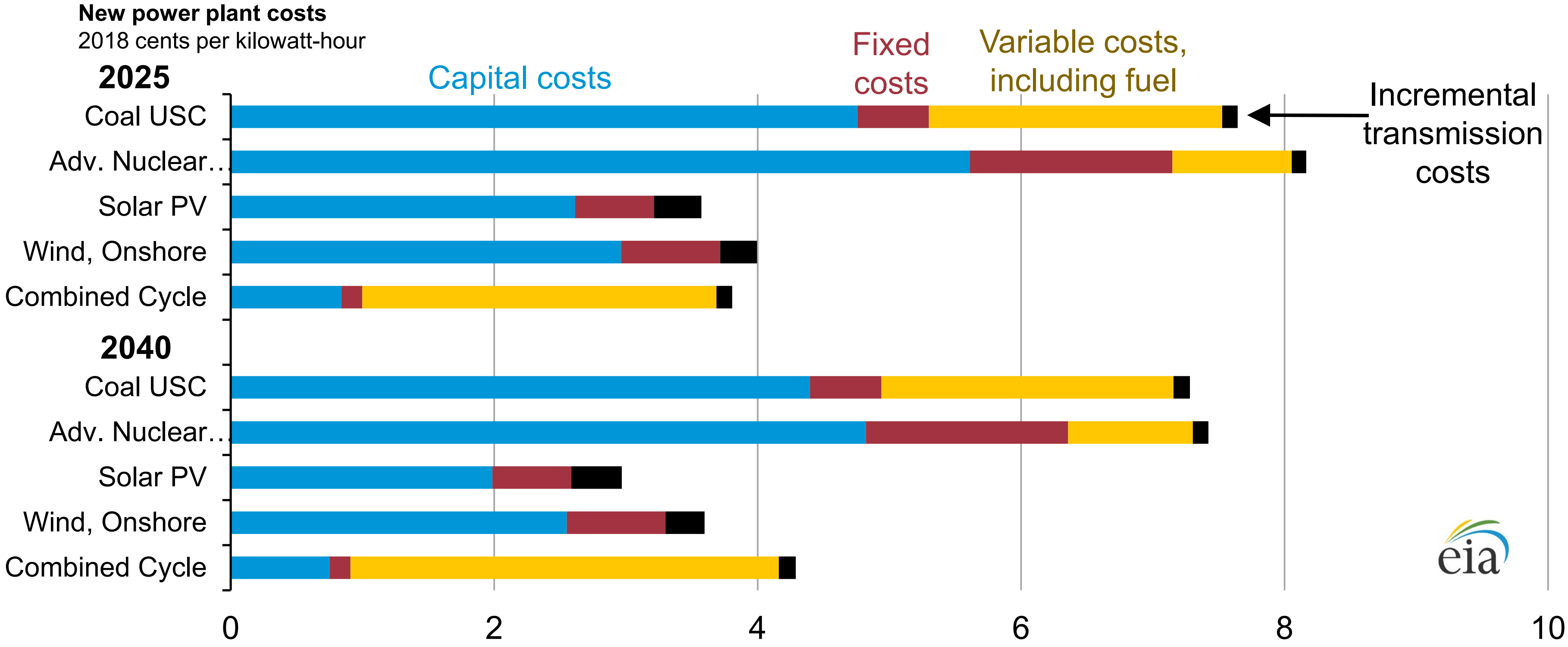
# International seaborne coal trade projected to increase 56% (400 million short tons) in AEO2020 (2020–2050)




Source: U.S. Energy Information Administration, International Energy Outlook 2019.

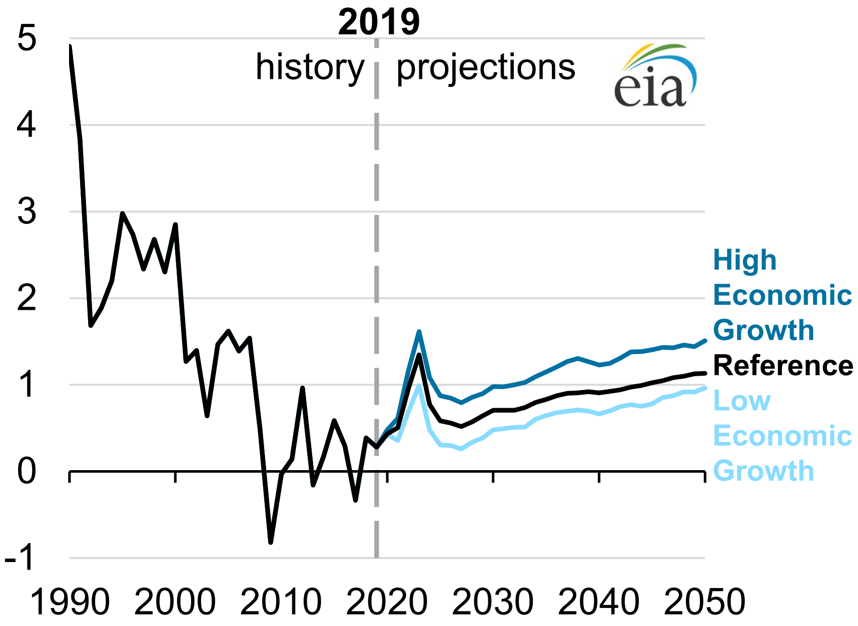
# Relatively high levelized cost of electricity for coal prohibits the addition of coal in any case evaluated in AEO2020



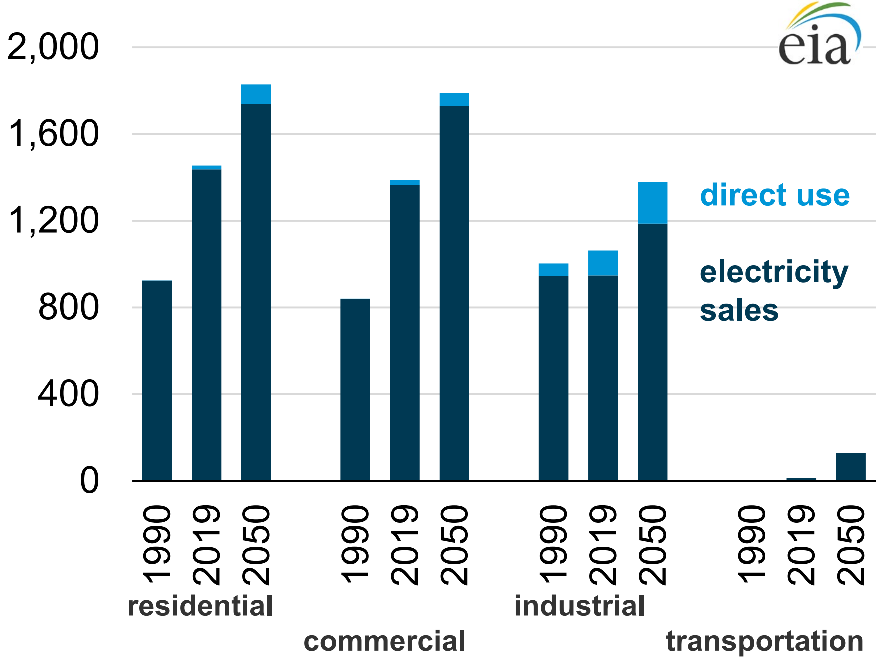

*Source: U.S. Energy Information Administration, "Levelized Cost and Levelized Avoided Cost of New Generation Resources in the AEO2020", February 2020, excerpted from Table 1b (2025) and Table B1b (2040)*

# After decades of slowing growth, electricity consumption is expected to grow gradually through 2050 across all sectors

**AEO2020 Electricity use growth rate**
percentage growth (three-year rolling average)



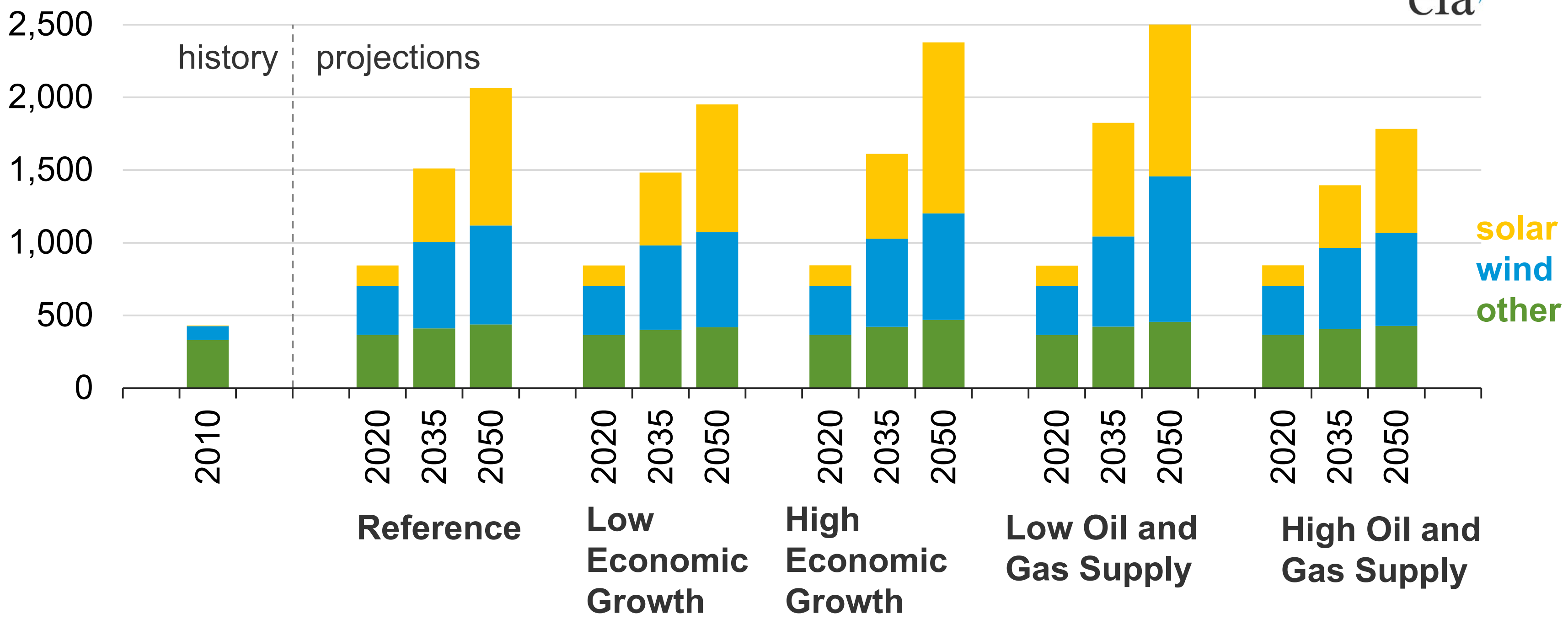

**Electricity use by end-use sector (AEO2020 Reference case)**
billion kilowatthours




*Source: U.S. Energy Information Administration, Annual Energy Outlook 2020.*

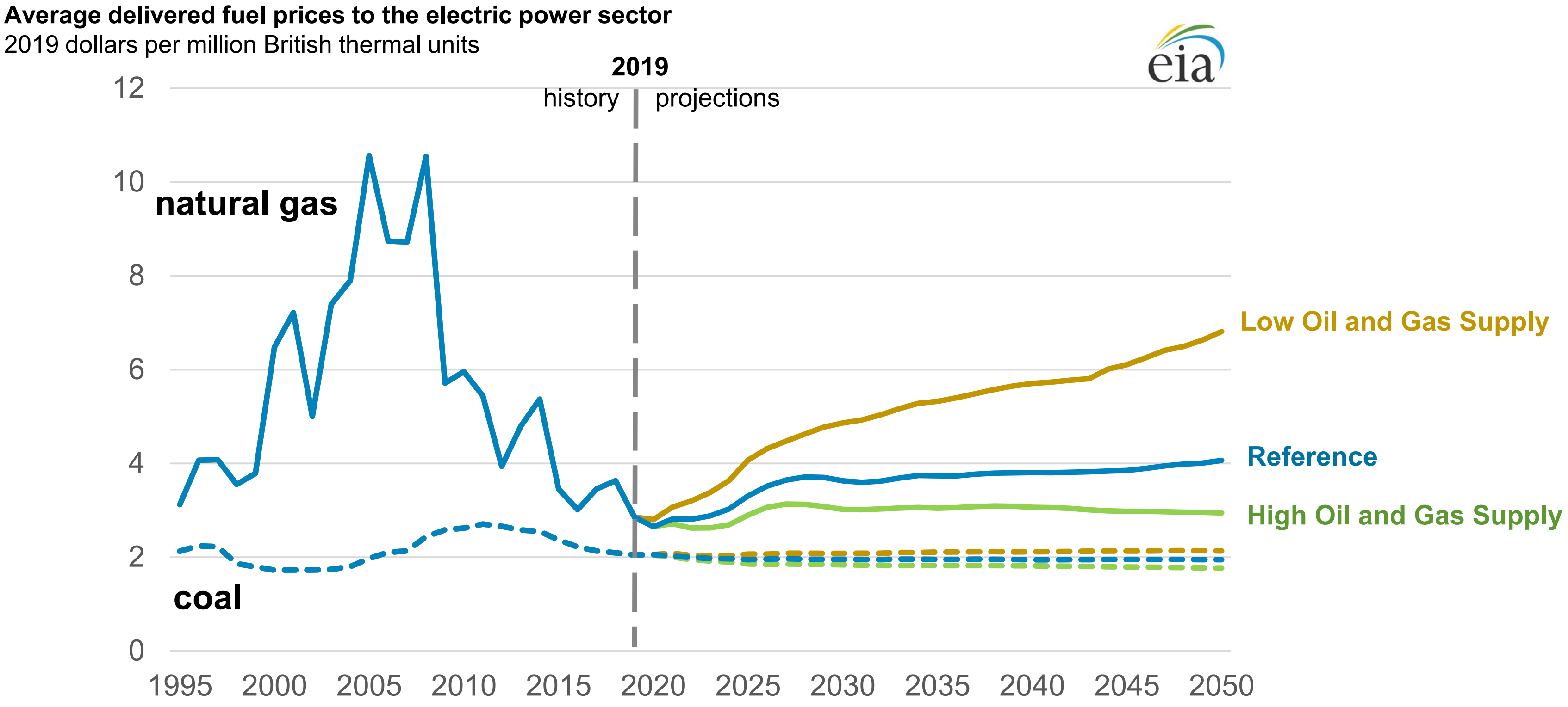
# Increasing cost competitiveness of renewables leads to growth in generation even with projection for low electricity demand and low natural gas prices

**Renewables electricity generation (all sectors) by case**
billion kilowatthours




Source: U.S. Energy Information Administration, Annual Energy Outlook 2020.

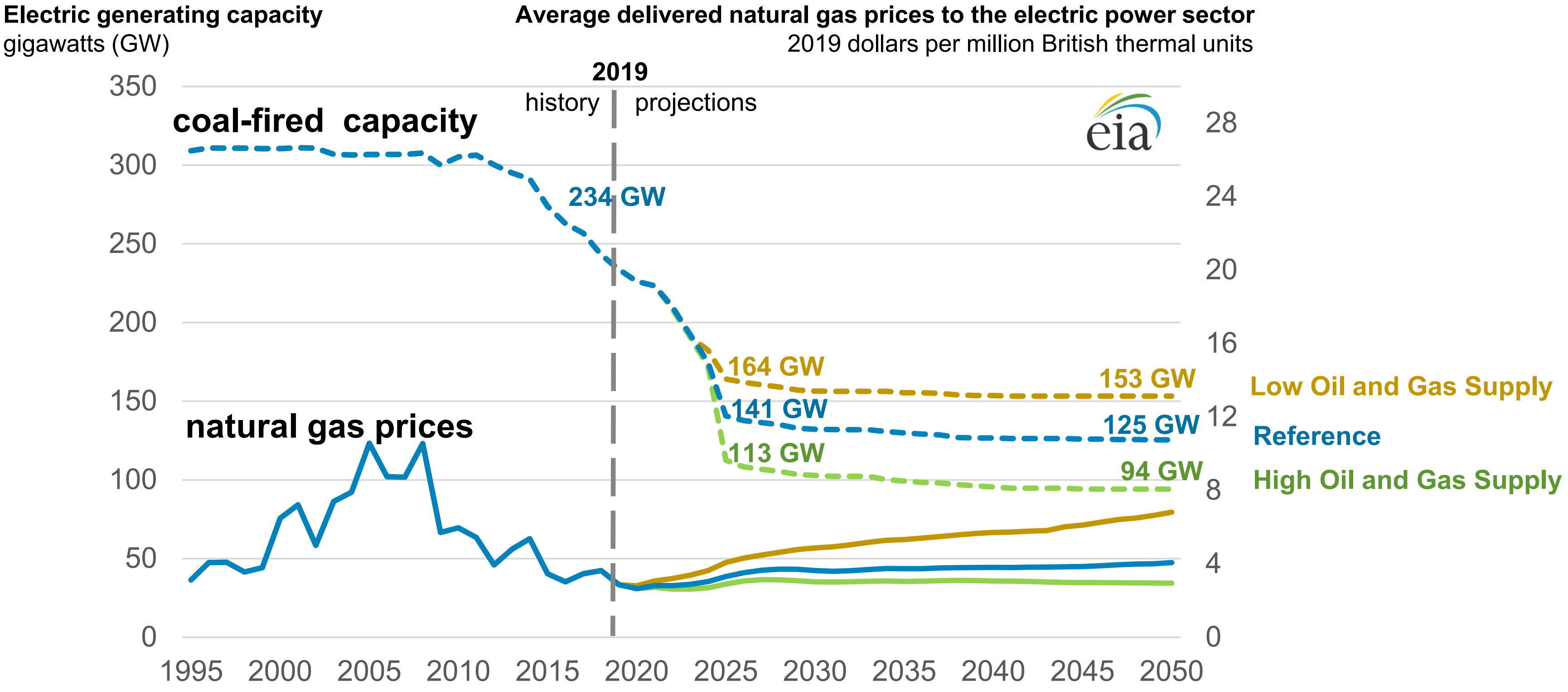
# Average delivered coal and natural gas prices to the electric power sector indicate limited competitive opportunity for coal




*Source: U.S. Energy Information Administration, Annual Energy Outlook 2020.*

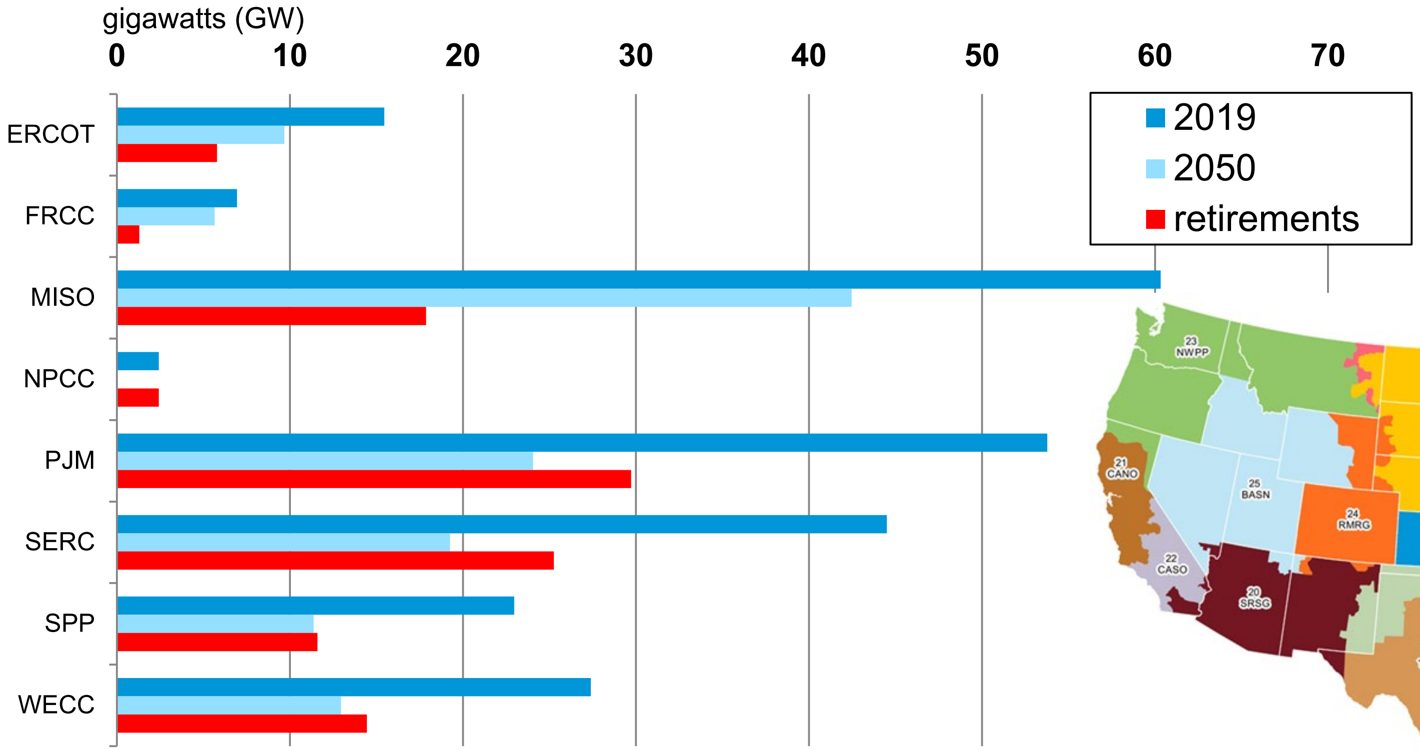
# AEO2020 results with emphasis on coal

# Coal-fired generating capacity decreases through 2025 in all AEO side cases and is sensitive to the projection for natural gas prices

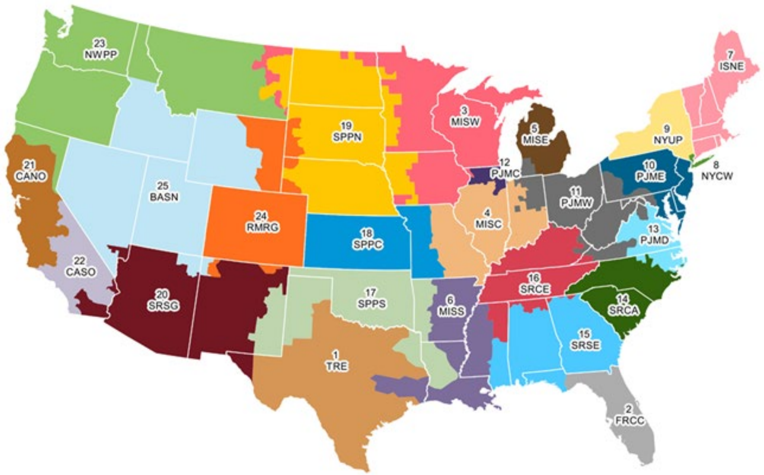



Source: U.S. Energy Information Administration, Annual Energy Outlook 2020.

# Net summer coal-fired generating capacity in the electric power sector declines disproportionately by region in the AEO2020 Reference case

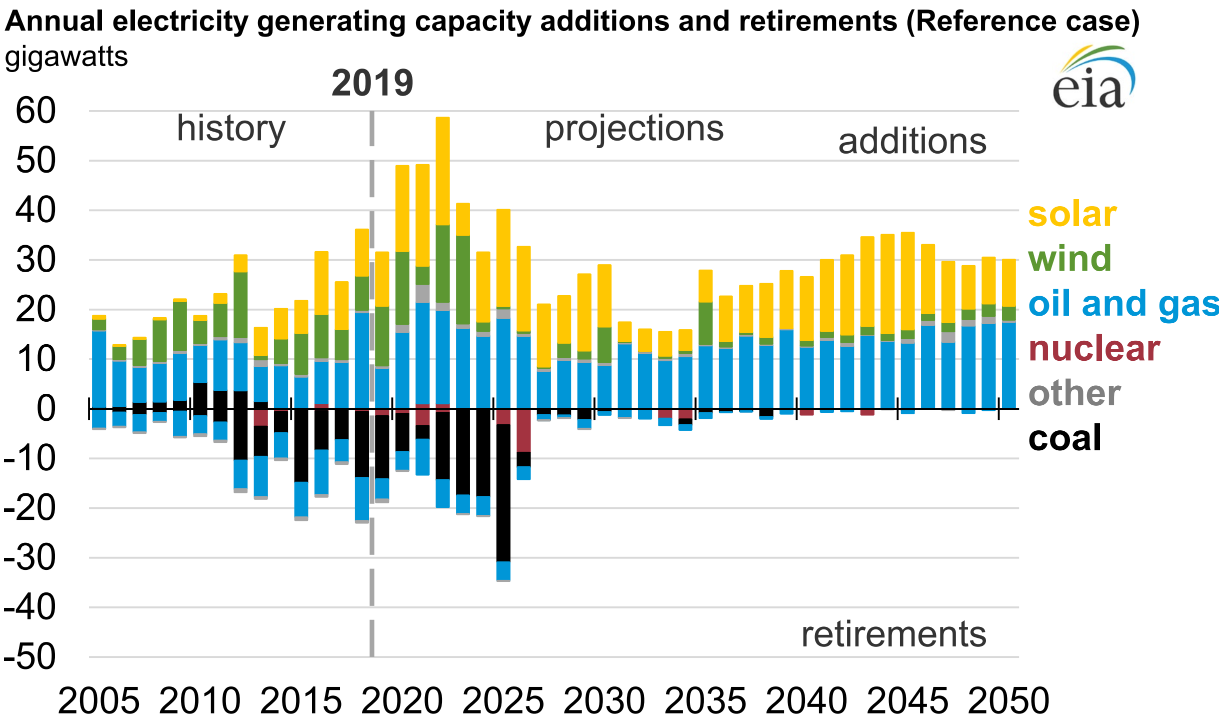


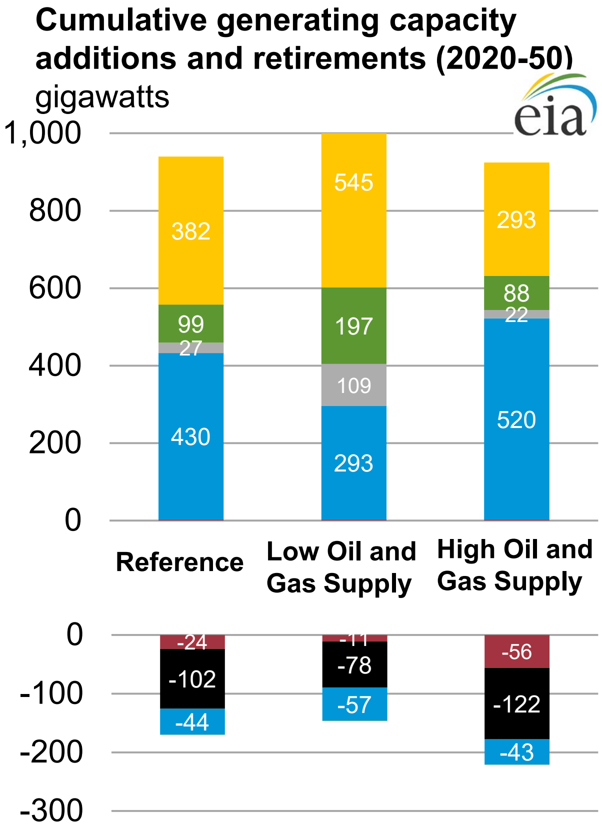

**U.S. Total**
2019: 234 GW
AEO2020 2050: 125 GW




**Source:** *U.S. Energy Information Administration, Annual Energy Outlook 2020.*

# Economics and policy drive changes to electric generation capacity



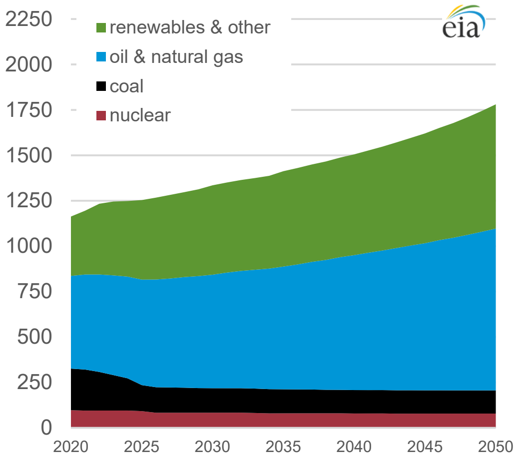




Source: U.S. Energy Information Administration, Annual Energy Outlook 2020.

# Comparison of generating capacity across the Reference and High/Low Oil and Gas Supply cases

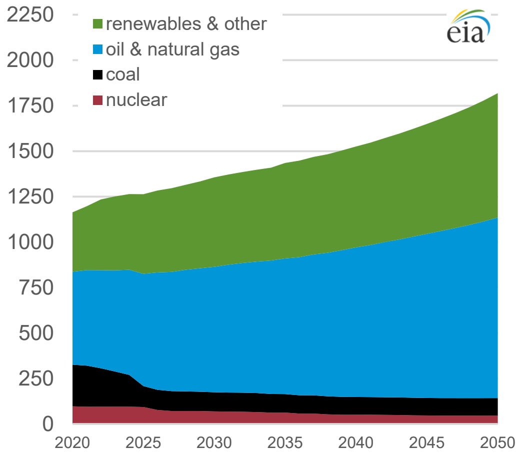
**Reference**

generation capacity (GW)



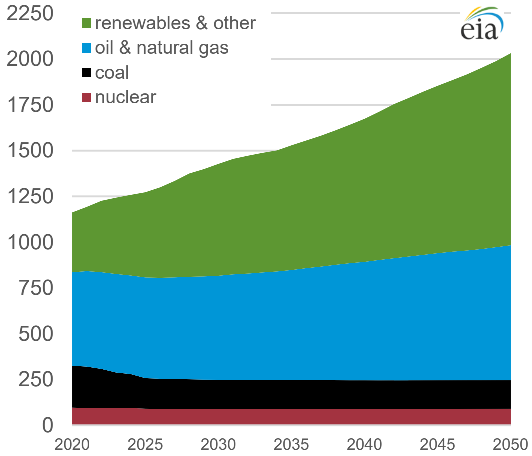

**High Oil and Gas Supply**

generation capacity (GW)




**Low Oil and Gas Supply**

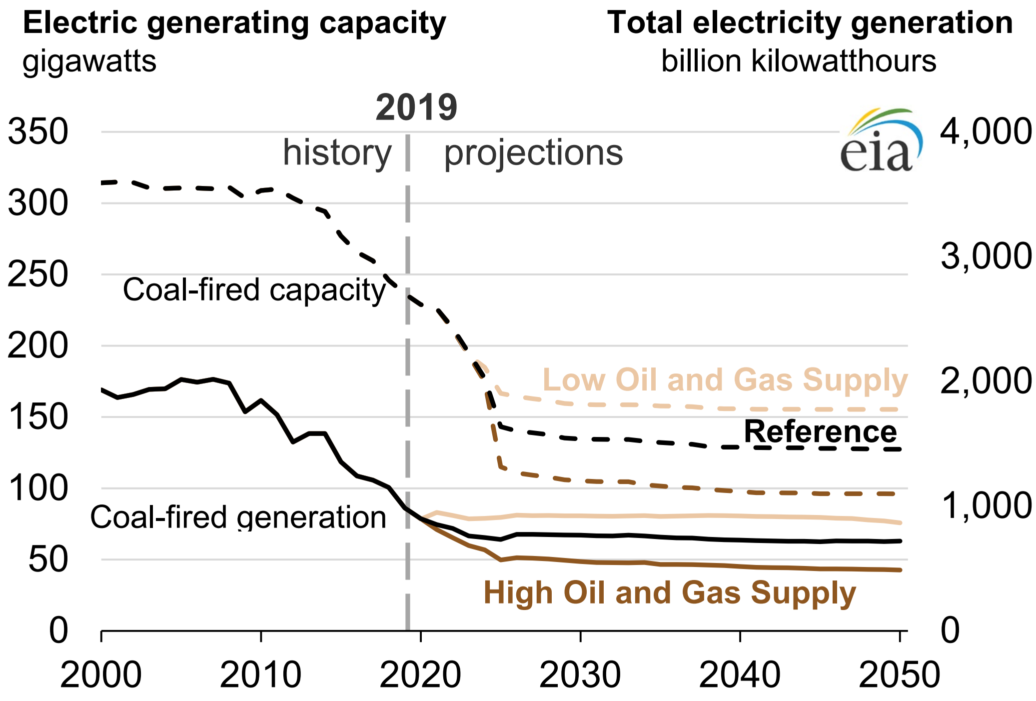
generation capacity (GW)

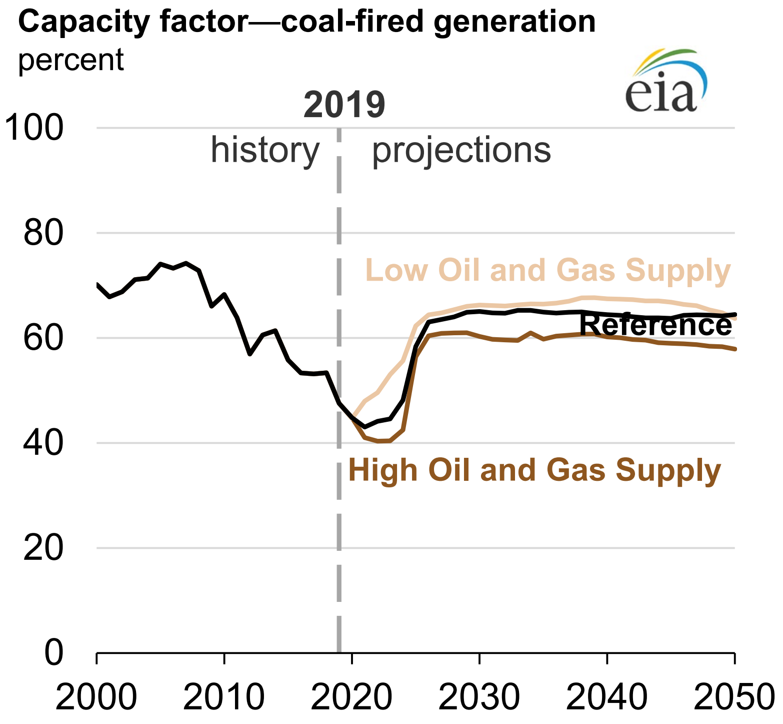



- In the High Oil and Gas Supply case, coal-fired capacity declines by an additional 31 GW to 96 GW as low-cost natural gas increases 102 GW through 2050 compared with the Reference case. Nuclear declines by an additional 32 GW and renewables by 101 GW.
- In the Low Oil and Gas Supply case, coal-fired capacity declines 28 GW less to 155 GW through 2050, compared with a surge of 264 GW of additional renewables compared to the Reference case. Nuclear capacity declines by an additional 13 GW less.

*Source: U.S. Energy Information Administration, Annual Energy Outlook 2020.*

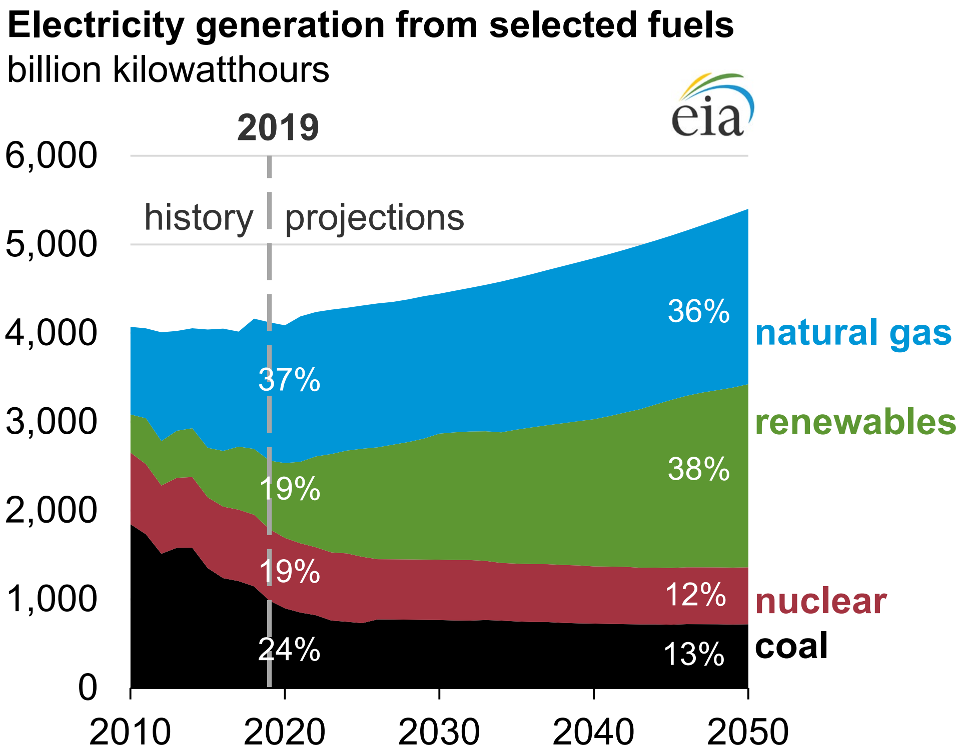
# Although coal capacity declines, capacity factors for remaining coal units recover as much as natural gas prices allow

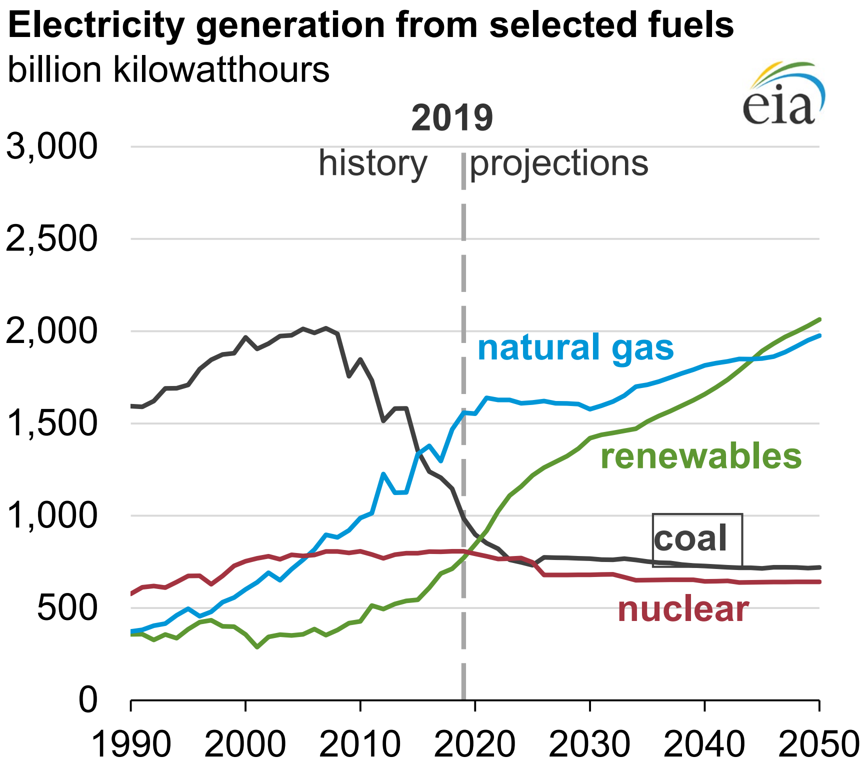



Source: U.S. Energy Information Administration, Annual Energy Outlook 2020.

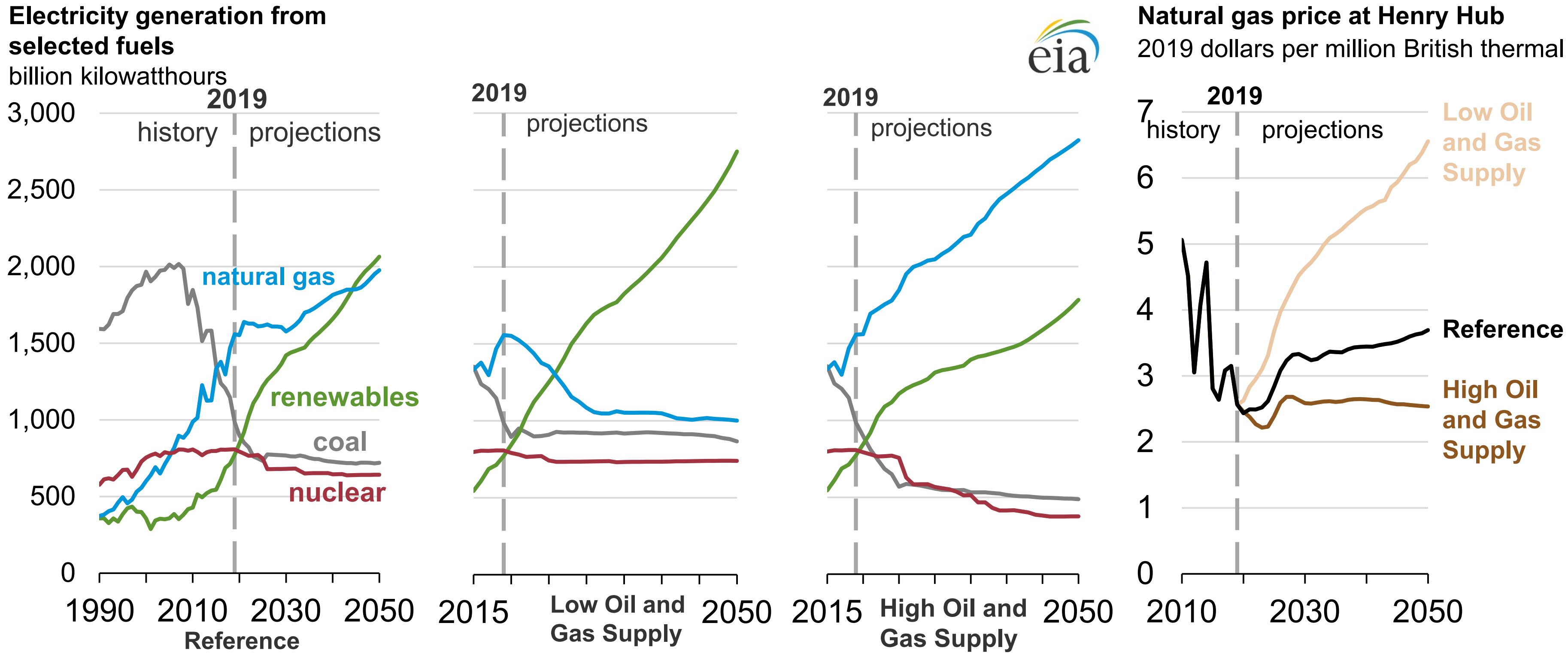
# Electricity generation from natural gas and renewables increases steadily with coal and nuclear projected to remain relatively flat in the AEO2020 Reference case




*Source: U.S. Energy Information Administration, Annual Energy Outlook 2020.*

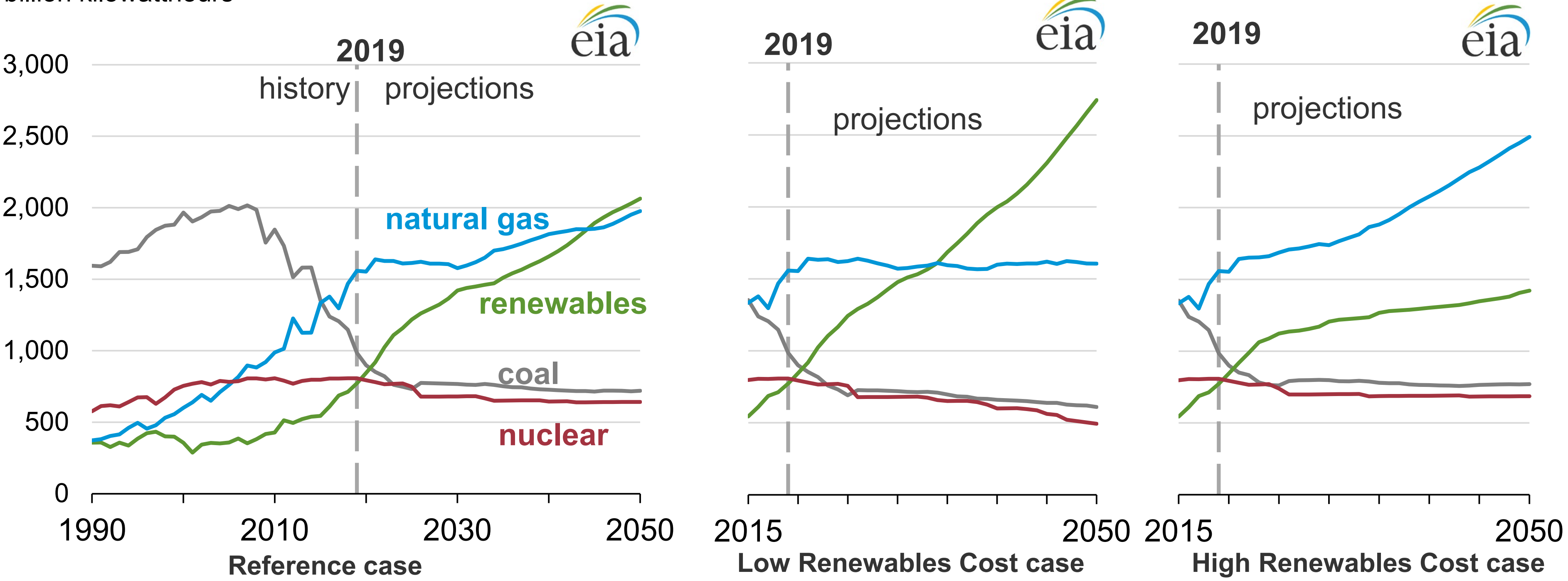
# The projected mix of electricity generation varies widely across cases because differences in natural gas prices result in significant substitution




*Source: U.S. Energy Information Administration, Annual Energy Outlook 2020.*

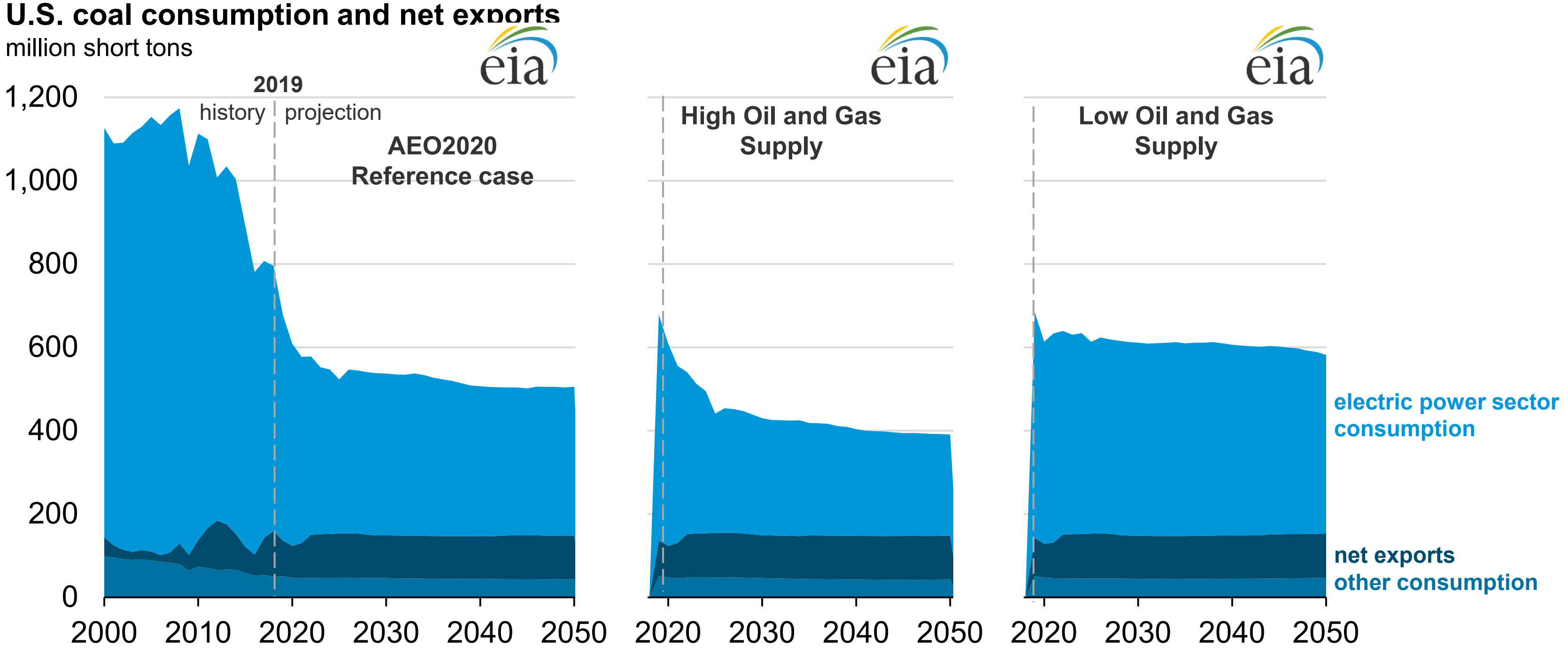
# Changes in cost assumptions for new wind and solar projects result in significantly different projected fuel mixes for electricity generation

**AEO2020 electricity generation from selected fuels**
billion kilowatthours



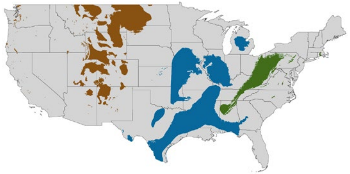

*Source: U.S. Energy Information Administration, Annual Energy Outlook 2020.*

# Electricity sector consumption drives total U.S. coal disposition with stable industrial and slowly increasing export demand

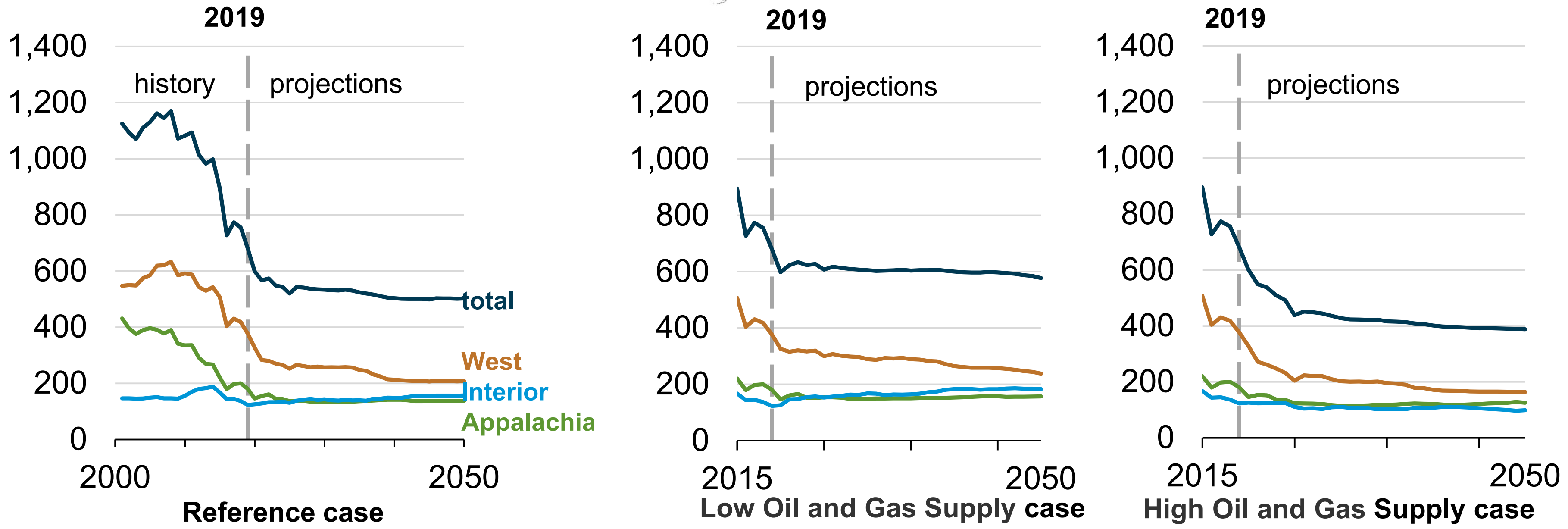



- *Source:* U.S. Energy Information Administration, Annual Energy Outlook 2020.

# Coal production decreases through 2025 as a result of retiring coal-fired electric generating capacity, but federal rule compliance and higher natural gas prices lead to coal production leveling off

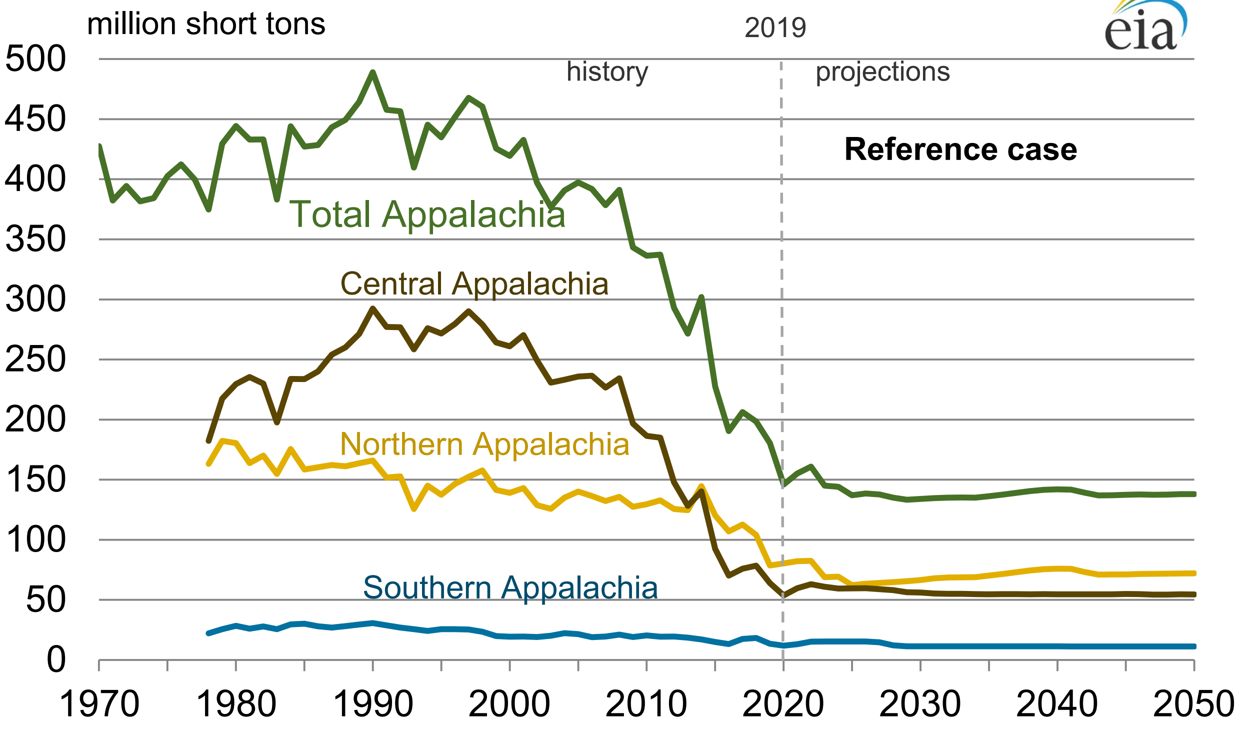


**AEO2020 coal production by region**
million short tons



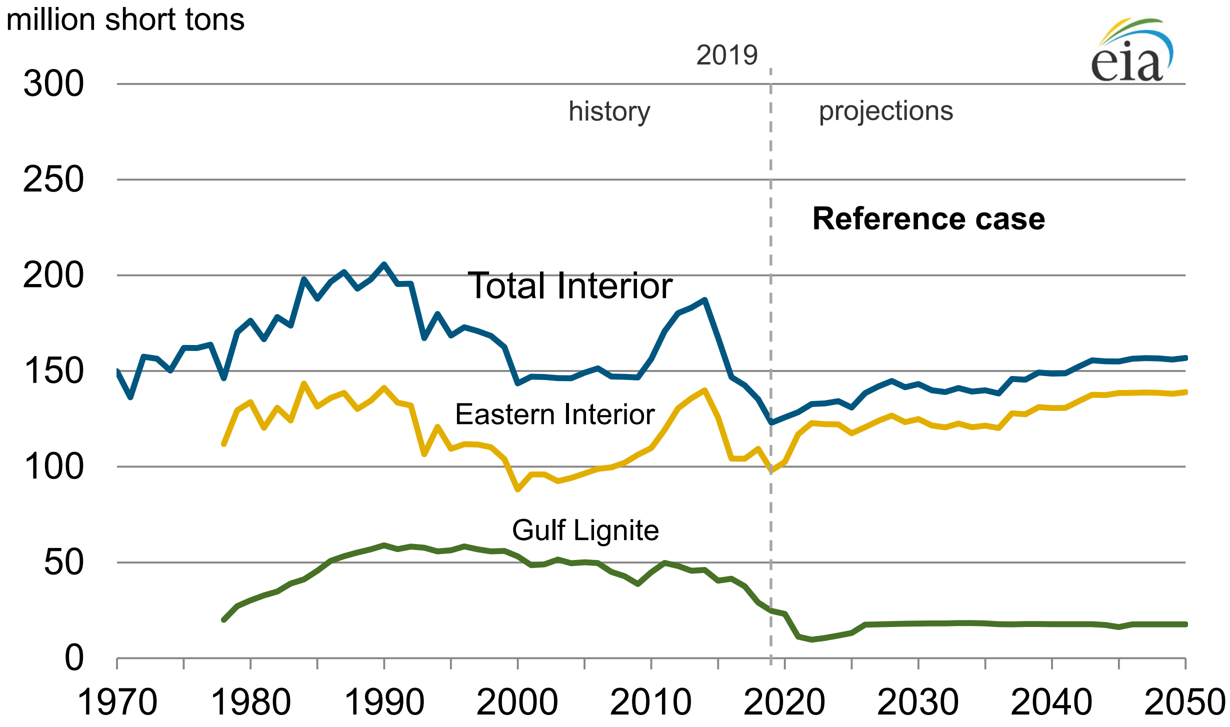

Source: U.S. Energy Information Administration, Annual Energy Outlook 2020.

# Appalachian coal production shows big declines through 2020, with eastern coal exports providing some support through 2050



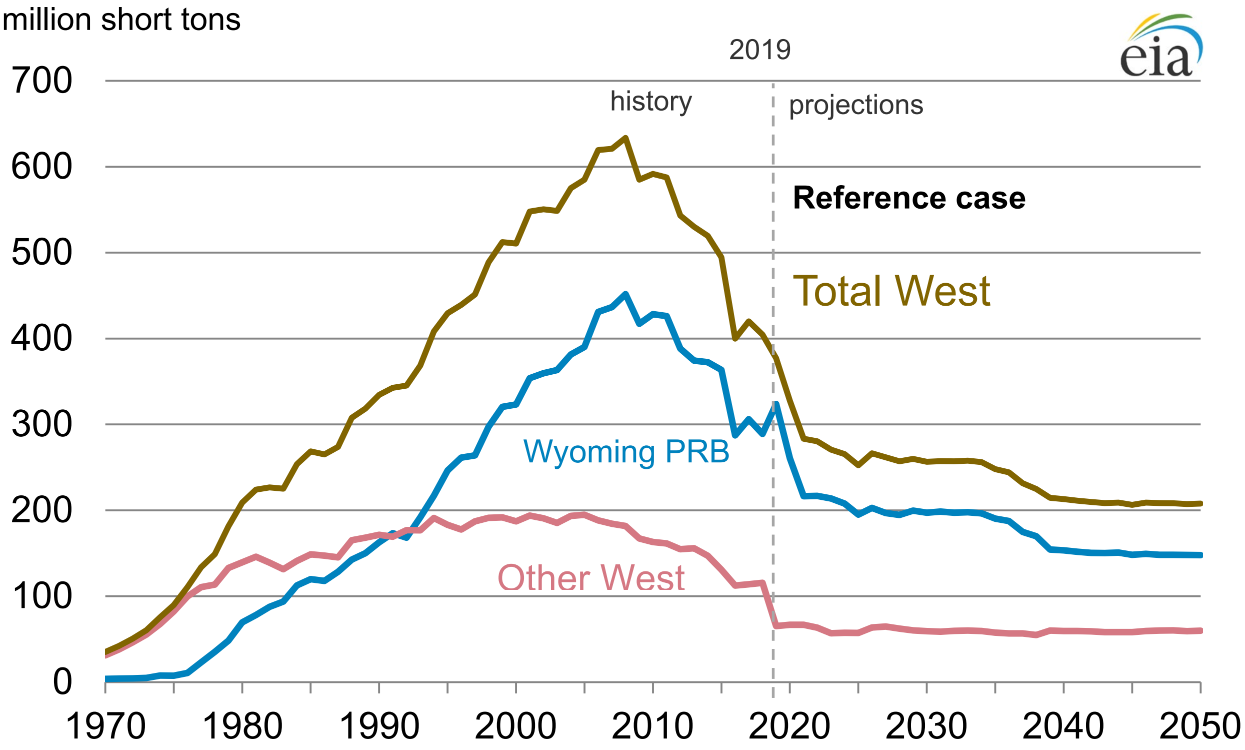

*Source: U.S. Energy Information Administration, Annual Energy Outlook 2020.*

# Interior coal production has declined in recent years but Illinois Basin coal mines are still productive while lignite regions show continued to decline with plant closures



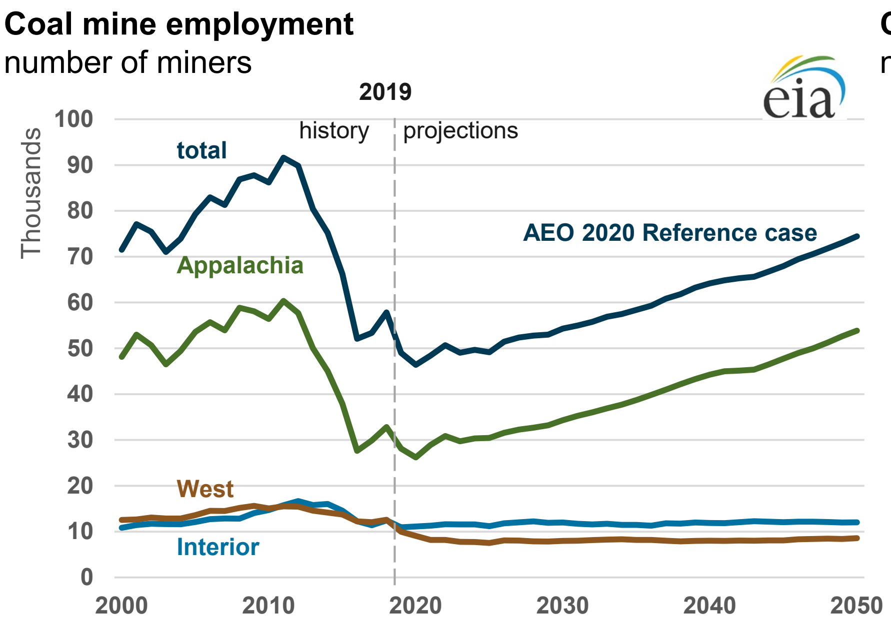

*Source: U.S. Energy Information Administration, Annual Energy Outlook 2020.*

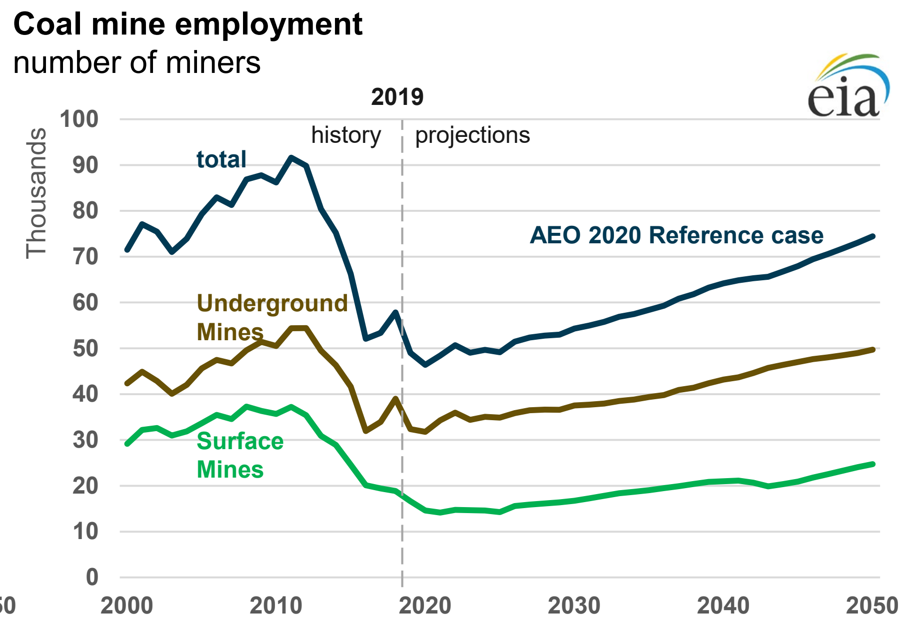
# Western coal production has seen the greatest rate of decline since 2009




Source: U.S. Energy Information Administration, Annual Energy Outlook 2020.

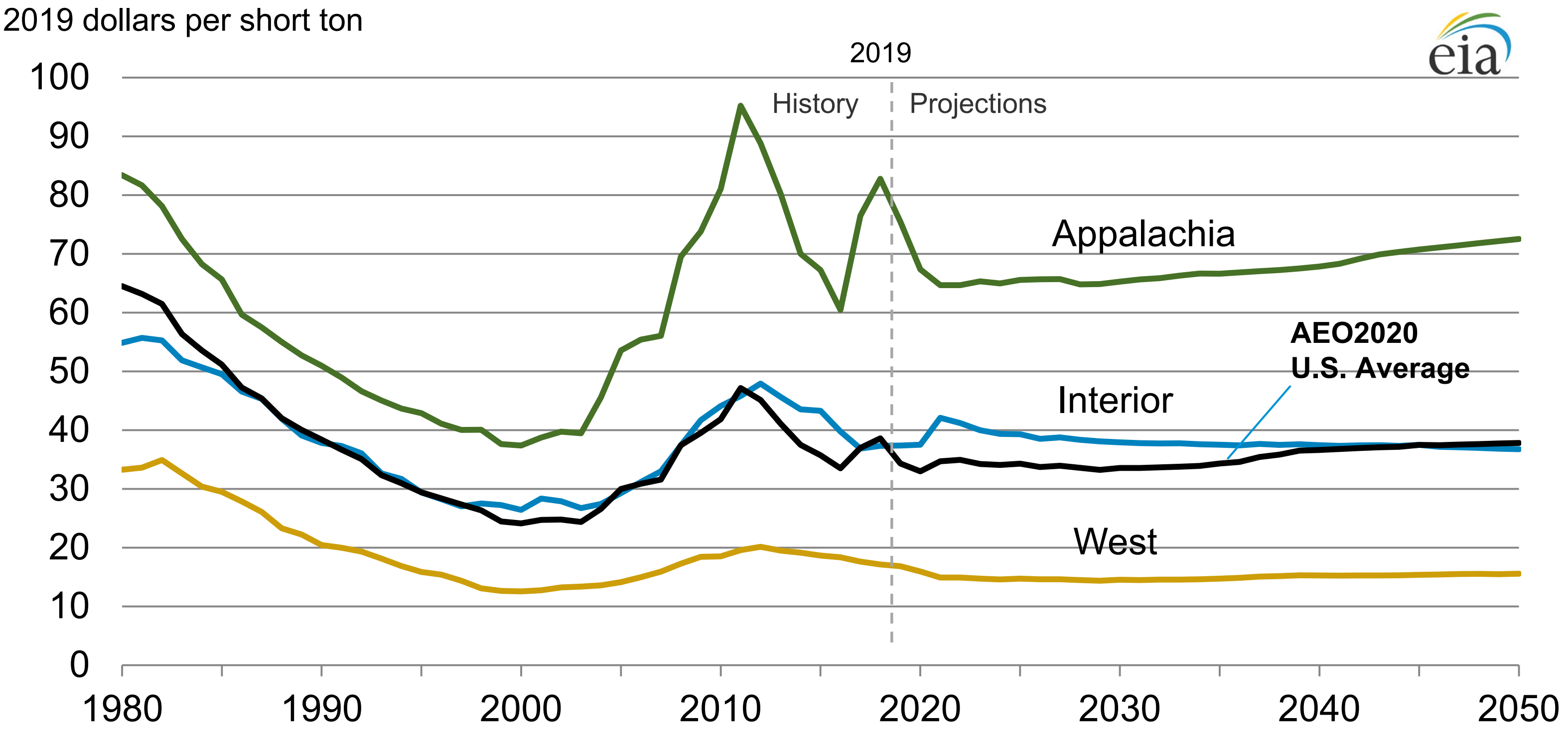
# Coal mine employment trends reflect impact of declining labor productivity against backdrop of declining production



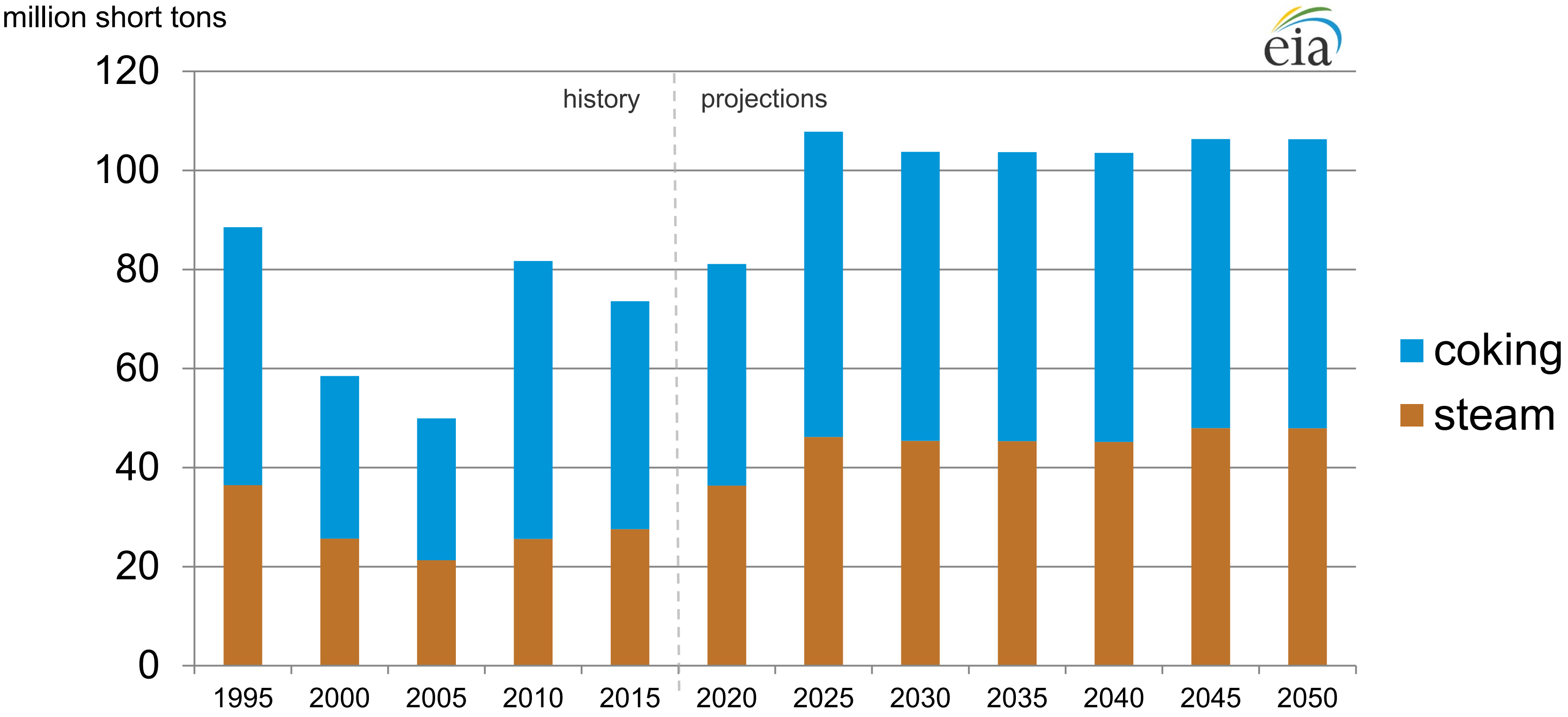

*Source: U.S. Energy Information Administration, Annual Energy Outlook 2020.*

# Average U.S. minemouth coal prices remain relatively stable in light of declining production volumes




Source: U.S. Energy Information Administration, Annual Energy Outlook 2020.

# U.S. coal exports driven by strong demand for coking coal for steel production




*Sources: U.S. Energy Information Administration (EIA); Projections – U.S. Energy Information Administration, Annual Energy Outlook 2020; History –. Quarterly Coal Report.*

# Comparison of August 2020 STEO forecasts and AEO2020 projections for selected coal indicators

| Indicator (million short tons) | August 2020 STEO 2019 | August 2020 STEO 2020 | August 2020 STEO 2021 | | AEO2020 2019 | AEO2020 2020 | AEO2020 2021 |
|---|---|---|---|---|---|---|---|
| Total production | 705.3 | 502.2 | 564.1 | | 680.5 | 599.4 | 567.0 |
| Appalachia | 193.0 | 133.0 | 136.4 | | 180.5 | 146.0 | 155.1 |
| Interior | 130.7 | 88.1 | 100.6 | | 123.0 | 125.8 | 128.5 |
| West | 381.7 | 281.1 | 327.1 | | 377.1 | 327.6 | 283.4 |
| Exports | 92.9 | 59.8 | 63.0 | | 92.1 | 81.1 | 85.3 |
| Metallurgical | 55.1 | 37.9 | 42.4 | | 51.2 | 44.8 | 50.7 |
| Steam | 37.7 | 21.9 | 20.6 | | 40.8 | 36.4 | 34.6 |
| Total consumption | 587.3 | 435.4 | 520.4 | | 592.1 | 532.8 | 493.0 |
| Electric power sector | 539.4 | 391.3 | 475.0 | | 542.0 | 485.3 | 447.0 |
| Coke plants | 17.9 | 16.6 | 17.0 | | 20.8 | 20.8 | 20.8 |
| Other industry and retail | 30.0 | 27.5 | 28.3 | | 29.3 | 26.7 | 25.2 |
| Natural gas at Henry Hub ($/MMBtu) | $2.57 | $2.03 | $3.14 | | $2.57 | $2.49 | $2.62 |

*Sources: U.S. Energy Information, Short-Term Energy Outlook, August 11, 2020; Annual Energy Outlook 2020.*

# For more information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U.S. Energy Mapping System