

**WORKING GROUP PRESENTATION FOR DISCUSSION PURPOSES.
DO NOT QUOTE OR CITE AS AEO2017 MODELING ASSUMPTIONS
AND INPUTS ARE SUBJECT TO CHANGE.**

Annual Energy Outlook 2017

1st Coal Working Group



*Coal and Uranium Analysis Team
August 31, 2016/ Washington, D.C.*

Agenda

- EIA ongoing activities
- Modeling focus for AEO2017
- Review of AEO2016 results
- General Modeling Assumptions
 - Focus on productivity and other factors affecting price
 - Feedback from CWG participants
- Other stakeholder concerns/comments
- Appendix: Regulations having potential to impact coal

Coal Fleet Aging Meeting

(Adjunct Meeting to Coal Working Group)

- Modeler's forum held in June 2016 as follow up to the June 2015 EIA post-conference session
- Meeting Purpose: guide next steps and priorities for tangible research initiatives or focused modeling efforts that:
 - (1) Address issues associated with operating an aging coal fleet
 - (2) Can be represented in the Electricity Market Module of EIA's National Energy Modeling System
- Key findings:
 - (1) Determination of when aging/cycling costs should be incurred is important.
 - (2) An attempt to characterize the data (heat rate, O&M, mode of cycling) and establish relationships among the data could be an important next step for EIA.
 - (3) EIA should concentrate its costing effort on the numerous smaller, but still expensive costs that are more likely to be incurred by a plant over time.
- Current effort: NETL is leading a contracting effort to explore coal plant operations information to improve understanding of the implications of suboptimal operation of the aging coal fleet
- See: <http://www.eia.gov/forecasts/aeo/workinggroup/coal/> for meeting notes and presentation.

Status of Development Efforts

- Use of recoded Coal Market Module (CMM) in AIMMS successful
- Final EPA Clean Power Plan (CPP) implemented in NEMS
- Approach successfully developed and implemented to automate AEO-STEEO benchmarking
- Progress made in re-estimating the underlying coal supply curve regressions in the CMM Coal Pricing Submodule to incorporate 2010-2013 data, but additional modeling required
- EPA's Coal Ash, Cooling Water Intake, and Effluent Guidelines final regulations not explicitly modeled in NEMS
 - EPA analysis indicated minimal incremental impact on coal retirements
 - Rules are site-specific and limited cost data is available
 - Inclusion would require significant structural modeling changes with limited expected impact on projections
- Re-estimating international coal export supply curves and equations for estimating ocean freight rates (for AEO2018)
- Assessment of transportation rate methodology (for AEO2018)

Modeling Focus for AEO2017

- AEO2017 will be a short edition, with a limited number of side cases – tentative release date January 2017
- Final CPP in the Reference case (as it was in the AEO2016)
- Extension to 2050 and other modelling and process improvements
 - Extending to 2050 enables EIA to conduct longer-term policy assessments
 - Closing AIMMS each cycle limits the number of licenses needed to conduct parallel runs
- Focus on assessment of productivity
 - Limited staff and stringent deadlines prevent comprehensive update of all assumptions
 - Last full data update year 2013, limited data updates for 2014, and 2015 will not be updated
- EPA’s Coal Ash, Cooling Water Intake, and Effluent Guidelines final rules will not be explicitly modeled in AEO2017” (as in AEO2016)

AEO2016 Projections

Current trends already having an impact on coal consumption even before the CPP

- Nationally

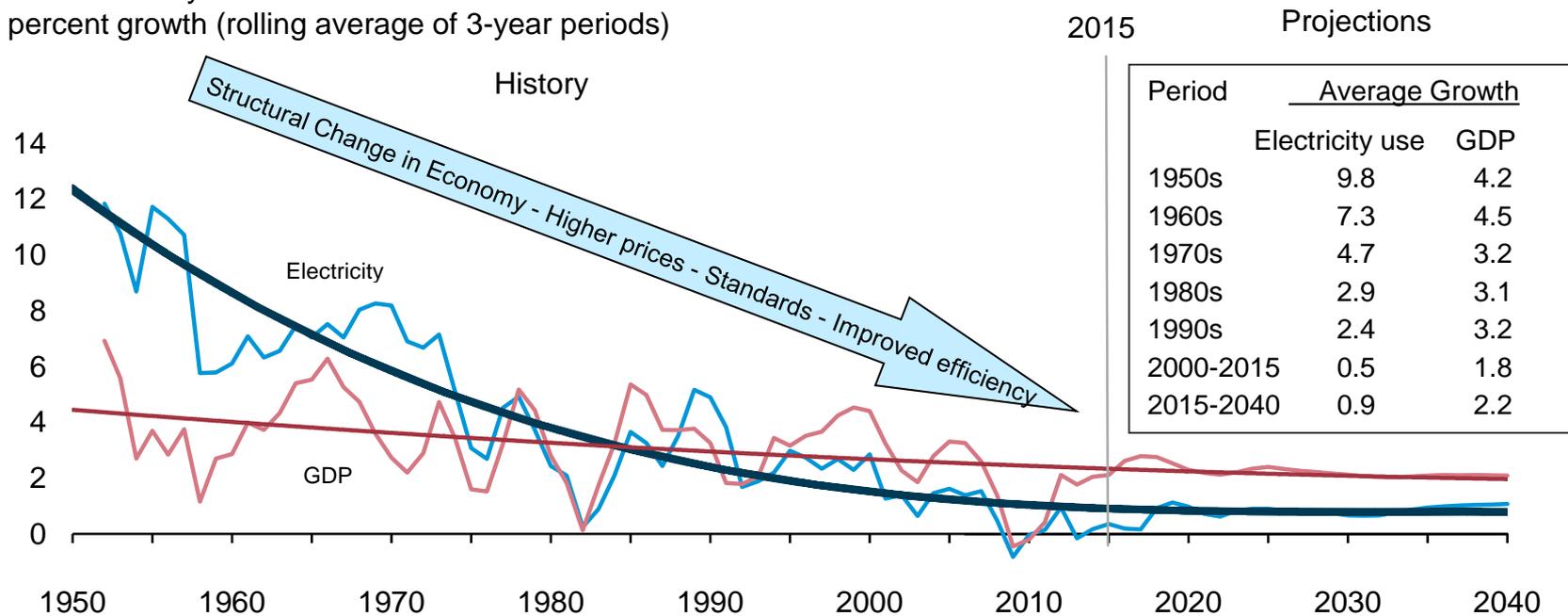
- Slowing growth in electricity demand
- Competition with relatively low-cost natural gas
- Increasing competition with renewable energy
- Compliance with the Mercury Air Toxics Standard (MATS)
- High plant construction costs relative to natural gas and renewables

- Regionally

- Central Appalachia encountering thinning seams and reserve depletion
- Illinois Basin coals competing more effectively as plants add SO₂ controls
- Coal export markets weakening

Electricity use (including direct use) continues to grow, but the rate of growth slows as it has almost continuously over the past 60 years

U.S. electricity use and GDP
percent growth (rolling average of 3-year periods)



Source: EIA, Annual Energy Outlook 2016

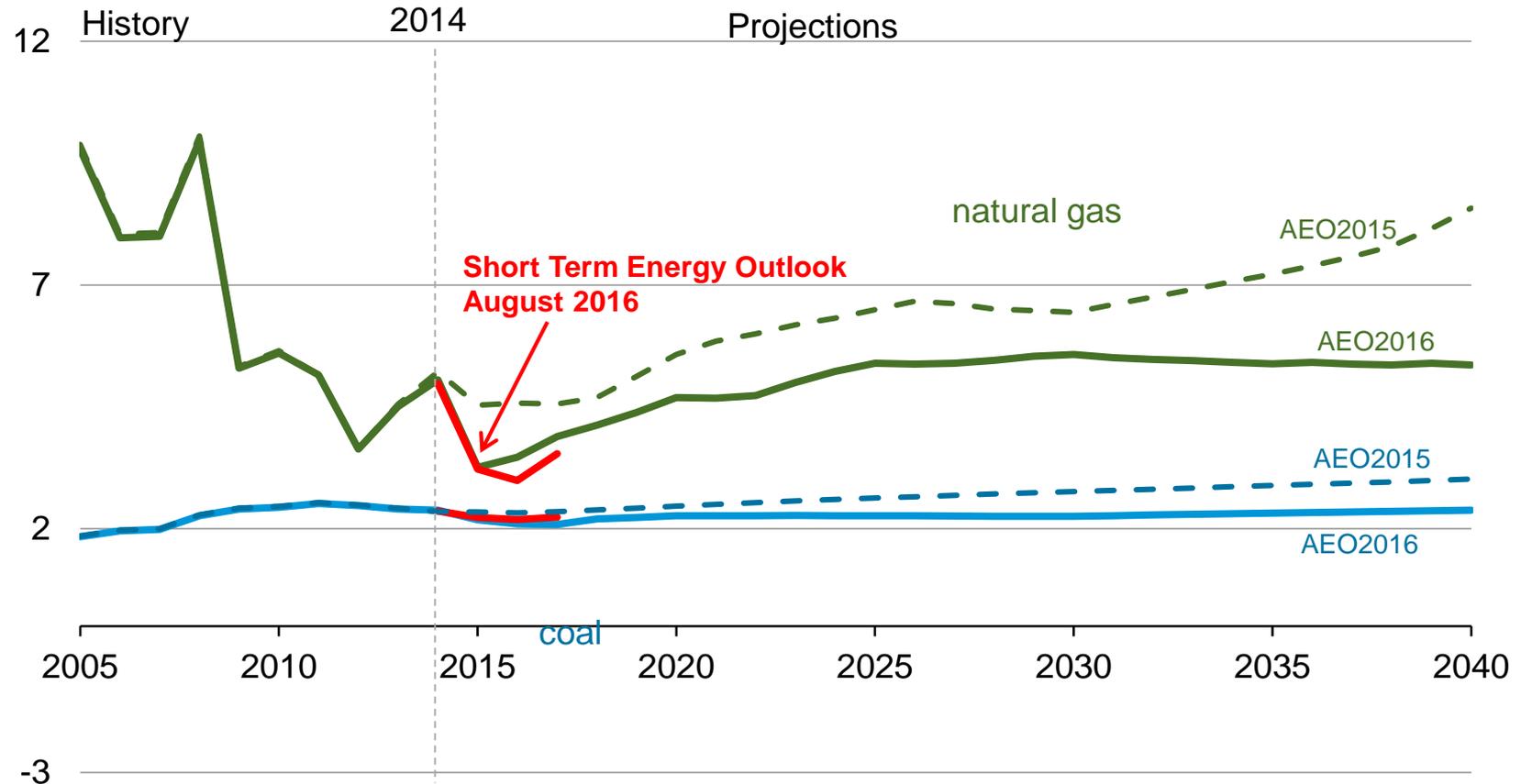


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Delivered prices of natural gas and coal to the electric power sector in the Reference case

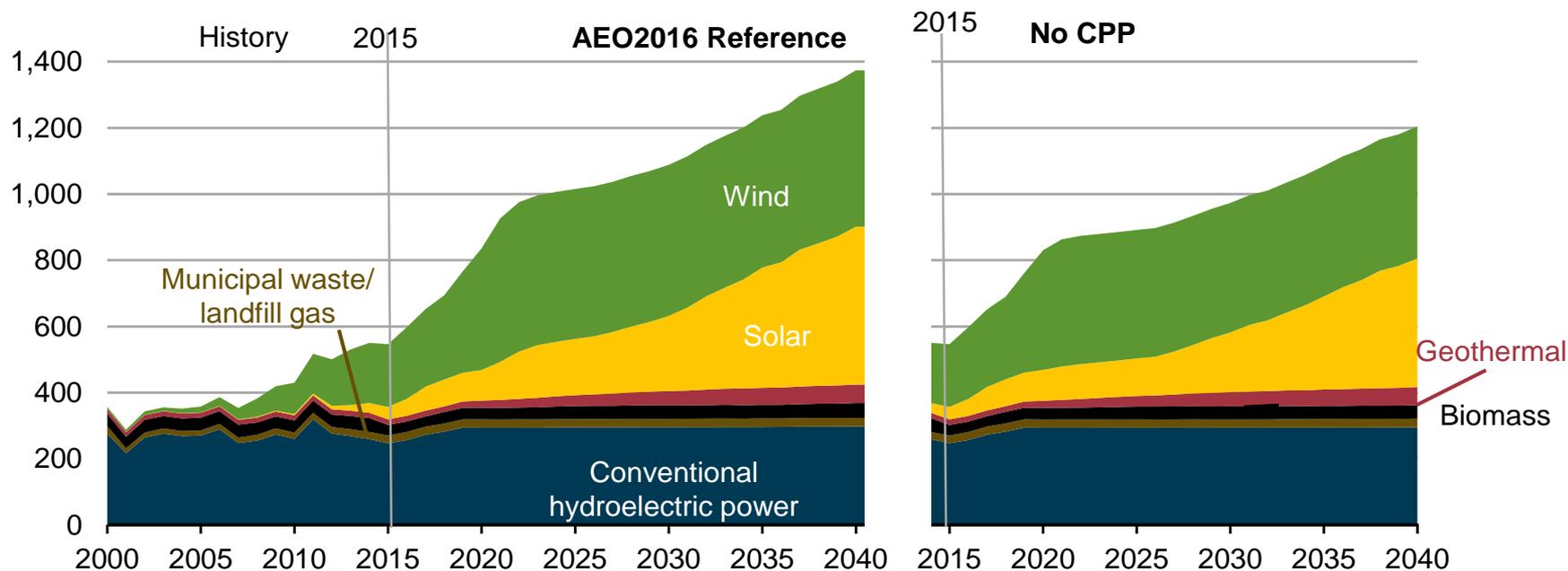
average delivered fuel prices to electric power plants, 2015 dollars per million Btu



Source: AEO2016 (ref2016.d032416a) and AEO2015 Reference case (April 2015).

Changing tax and cost assumptions contribute to stronger solar growth, with the CPP providing a boost to renewables

renewable electricity generation by fuel type
billion kilowatthours

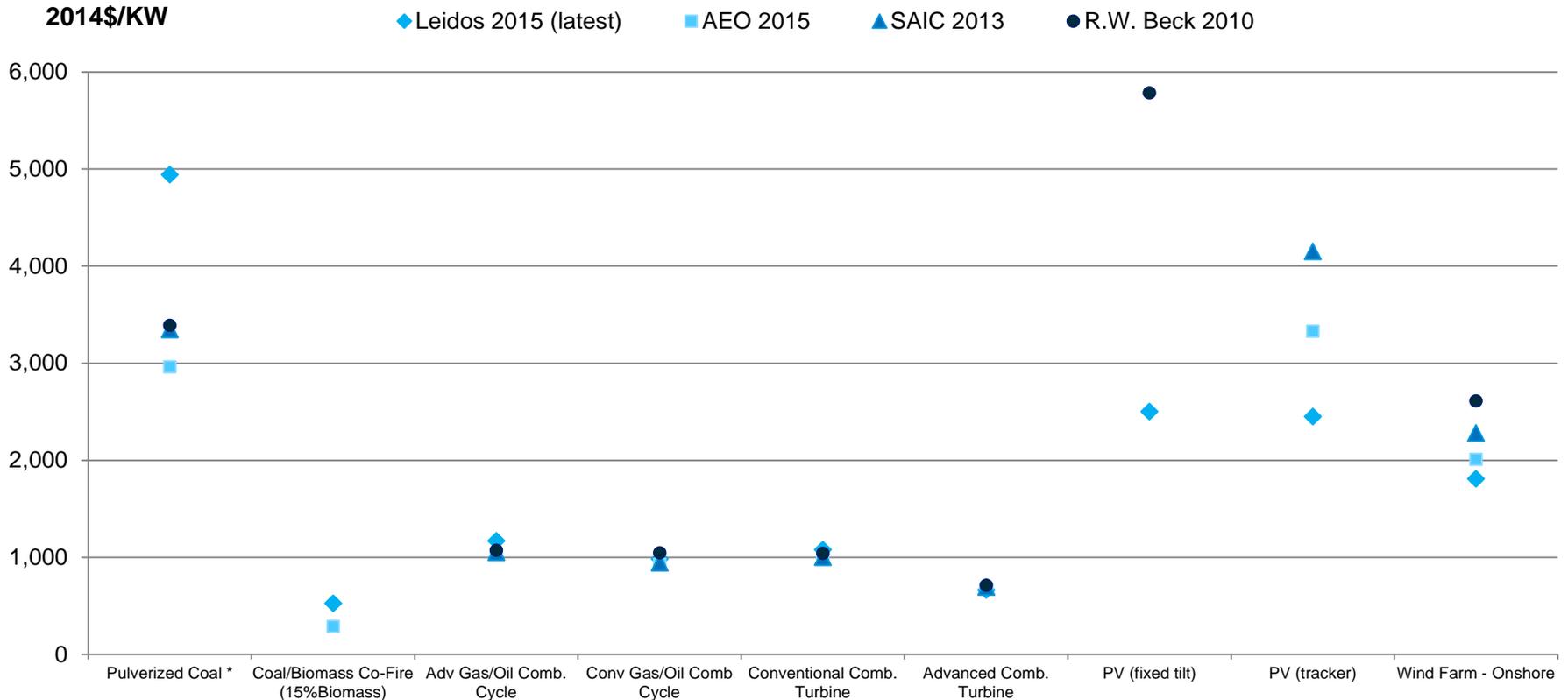


Source: AEO2016 (ref2016.d032416a) and AEO2015 Reference case (April 2015).



Coal, solar, and wind capital costs differ significantly from AEO2015 assumptions

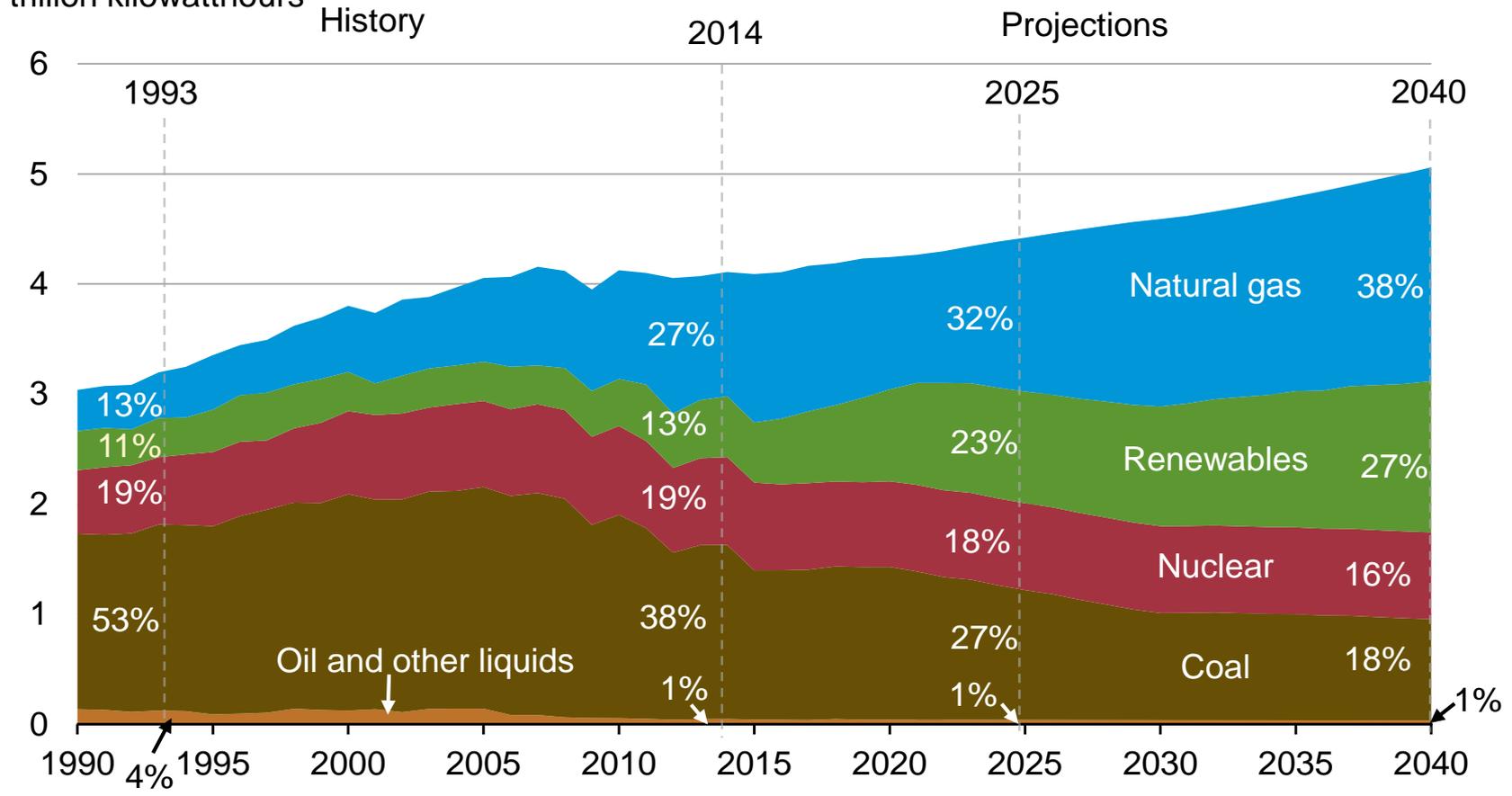
Total Overnight Capital Costs (2014\$/KW)



* Technology specification on some items may have changed from report to report. Pulverized coal has changed from super-critical to ultra-supercritical with 30% CCS.

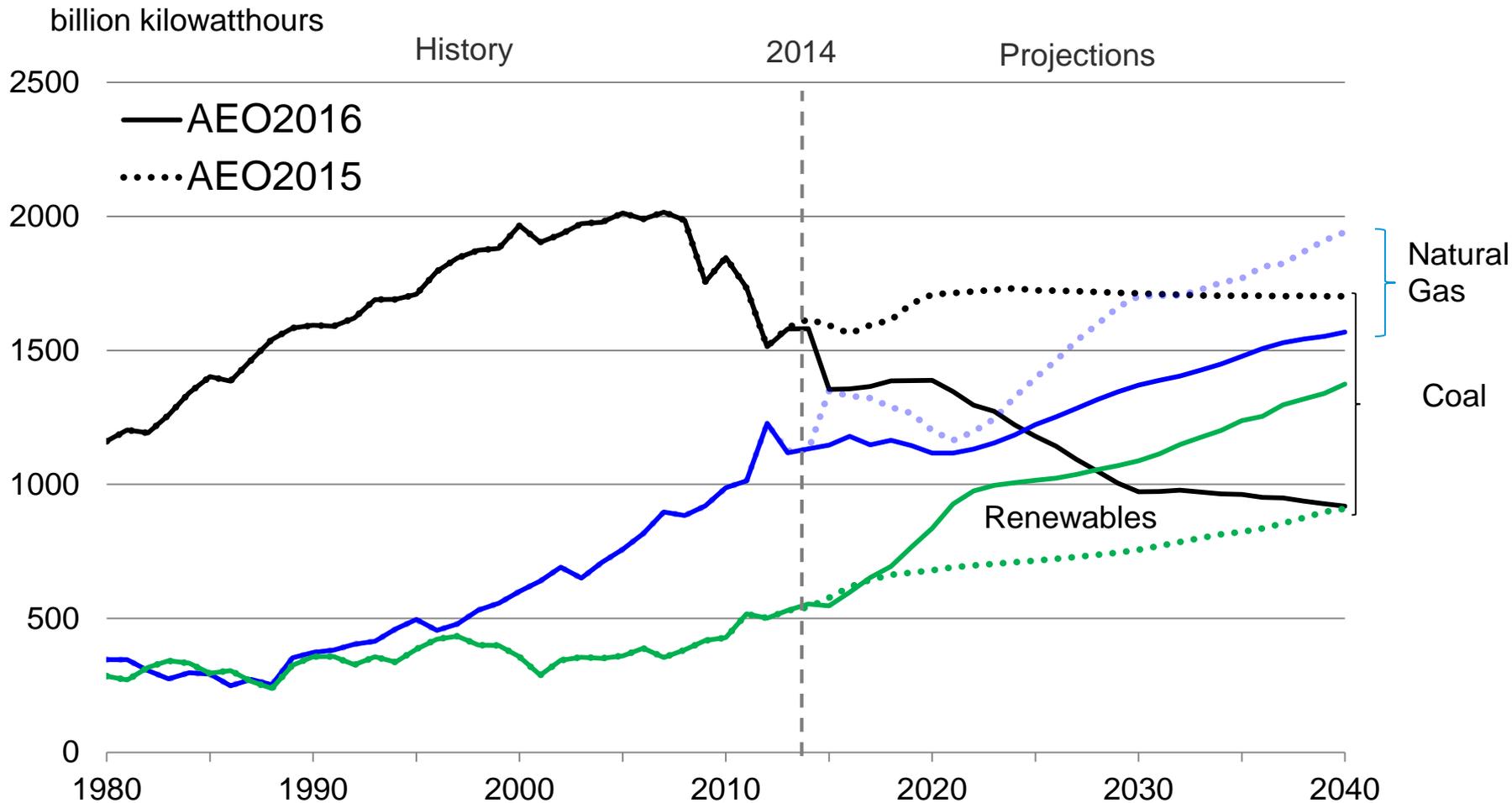
Renewables and natural gas together account for 65% of generation in 2040 while coal's share falls to 18%

U.S. electricity net generation
trillion kilowatthours



Source: AEO2016 (NEMS run ref2016.d032416a)

Electricity Generation by Fuel, 1980-2040

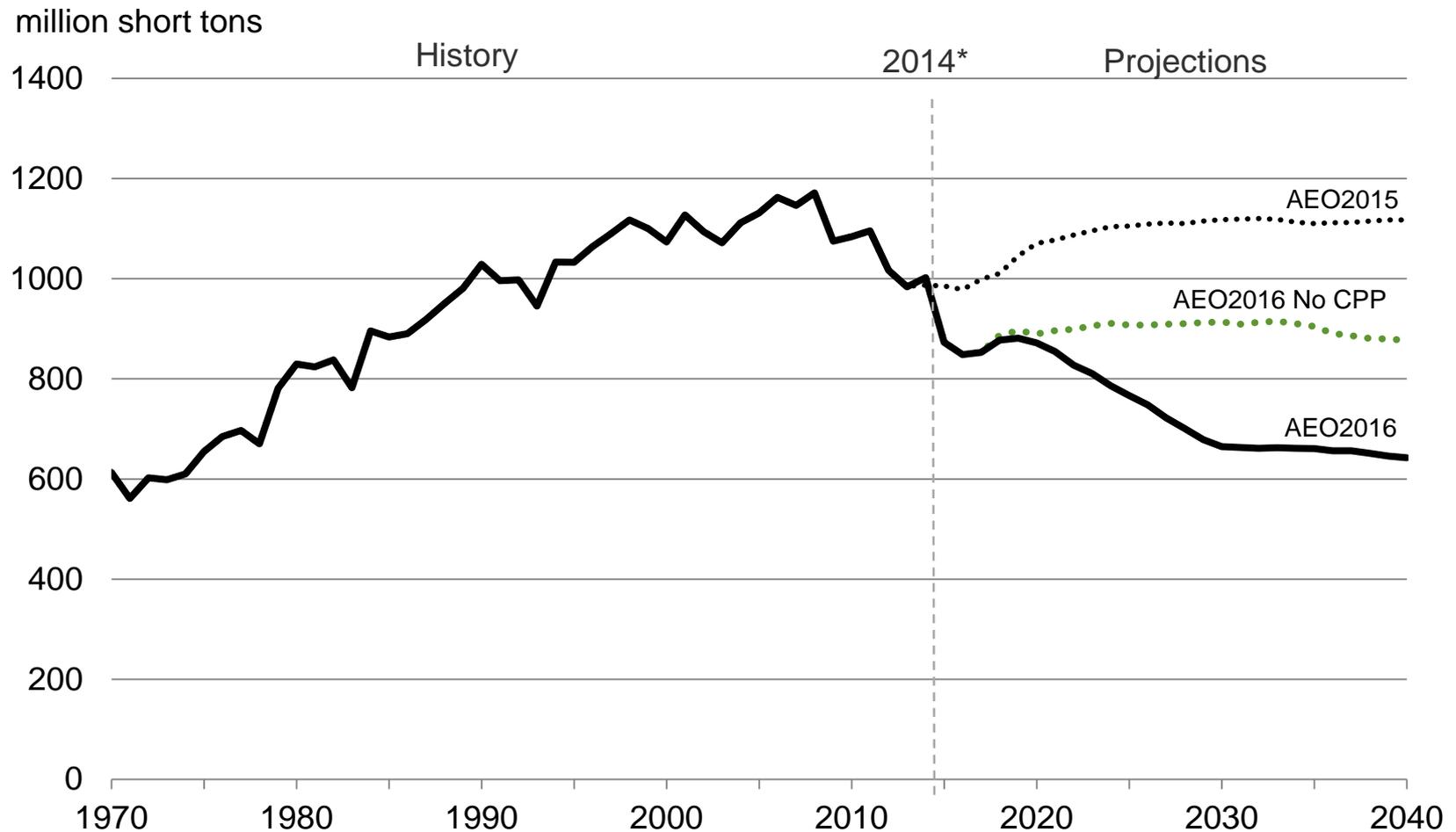


Note: Includes generation from plants in both the electric power and end-use sectors.

Source: History: U.S. Energy Information Administration (EIA), *Annual Energy Review*;

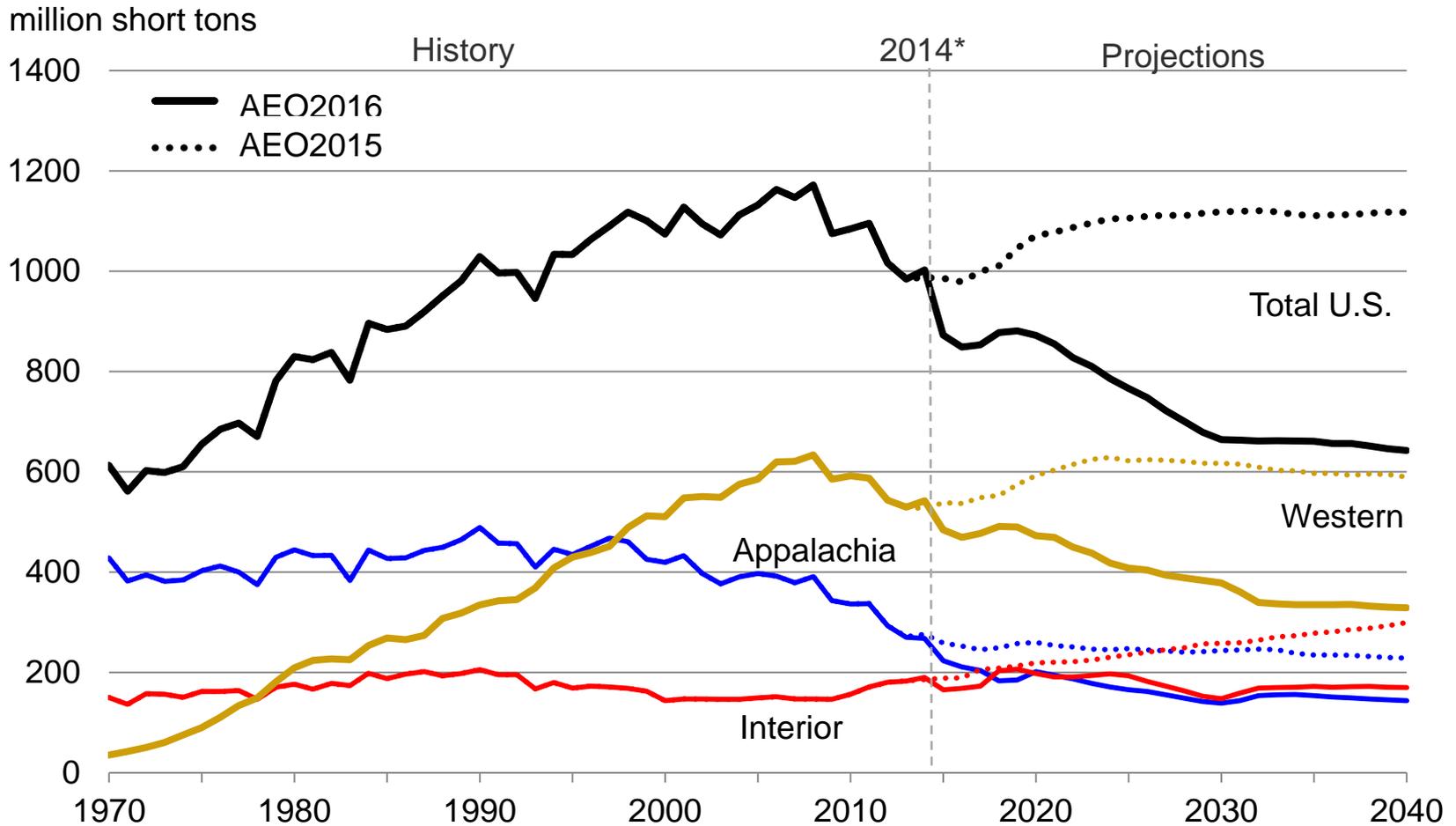
Projections: Preliminary AEO2016 (NEMS run ref2016.d032416a), AEO2015 Reference Case (April 2015).

Total coal production, 1970-2040



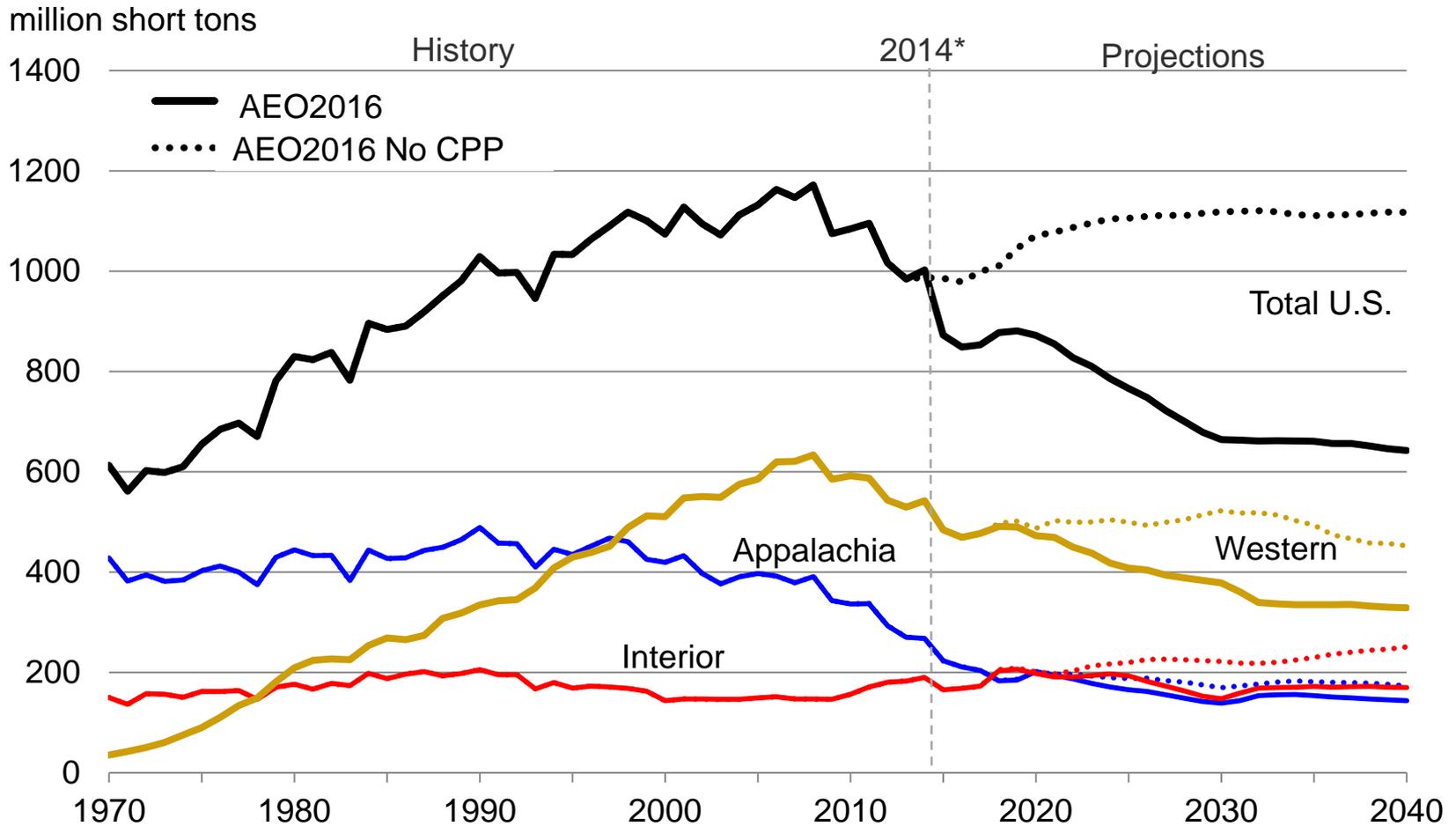
Source: AEO2016 (ref2016.d032416a), AEO2015 Reference Case (April 2015), No Clean Power Plan (ref_no_cpp.d032316a; *2014 data is estimated).

Coal production by region, 1970-2040



Source: AEO2016 (ref2016.d032416a), AEO2015 Reference Case (April 2015), No Clean Power Plan (ref_no_cpp.d032316a; *2014 data is estimated).

Coal production by region, 1970-2040

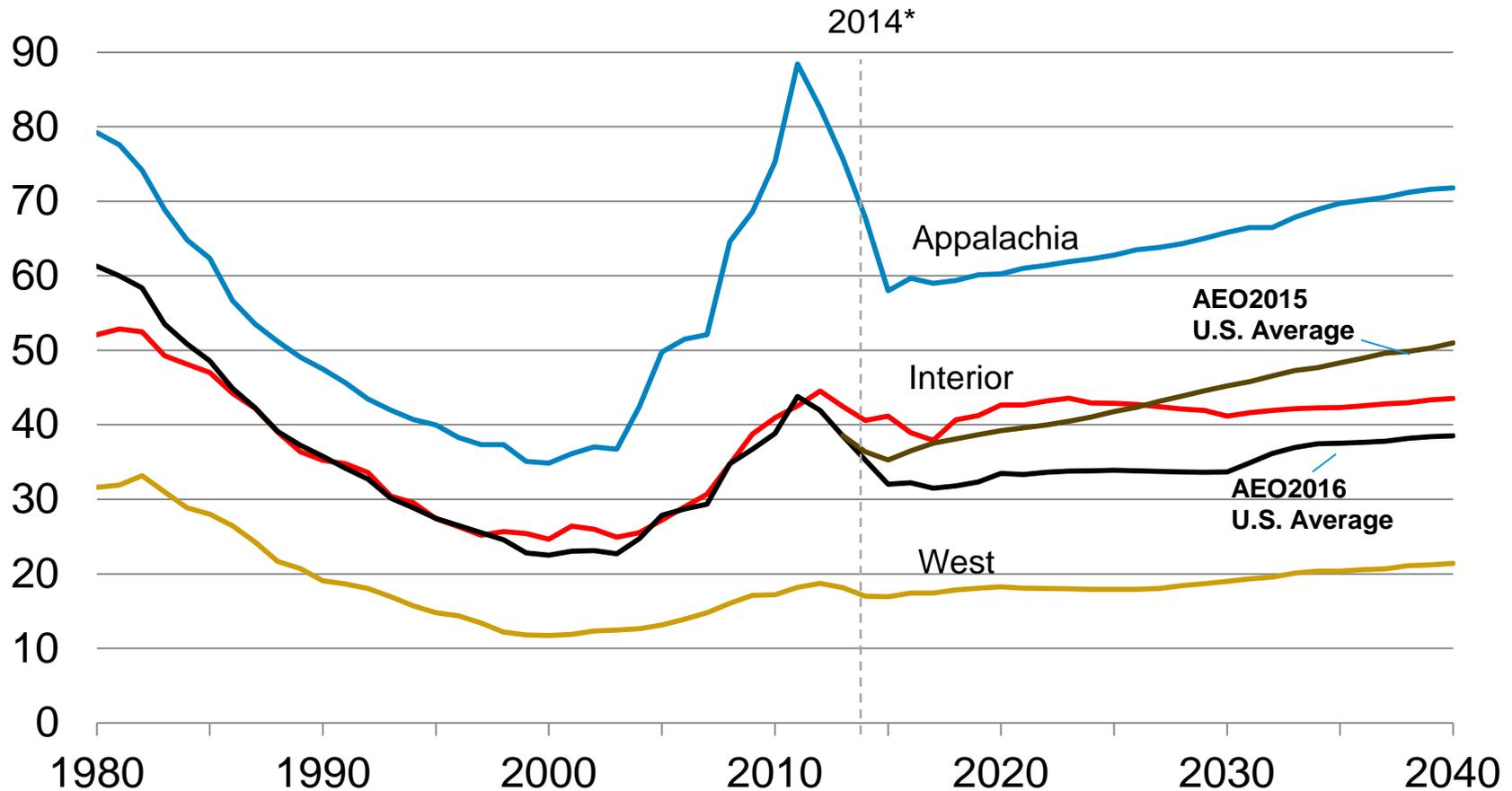


Source: AEO2016 (ref2016.d032416a), No Clean Power Plan Case (ref_no_cpp.d032316a);

*2014 data is estimated.

Average minemouth coal prices by region, 1980-2040

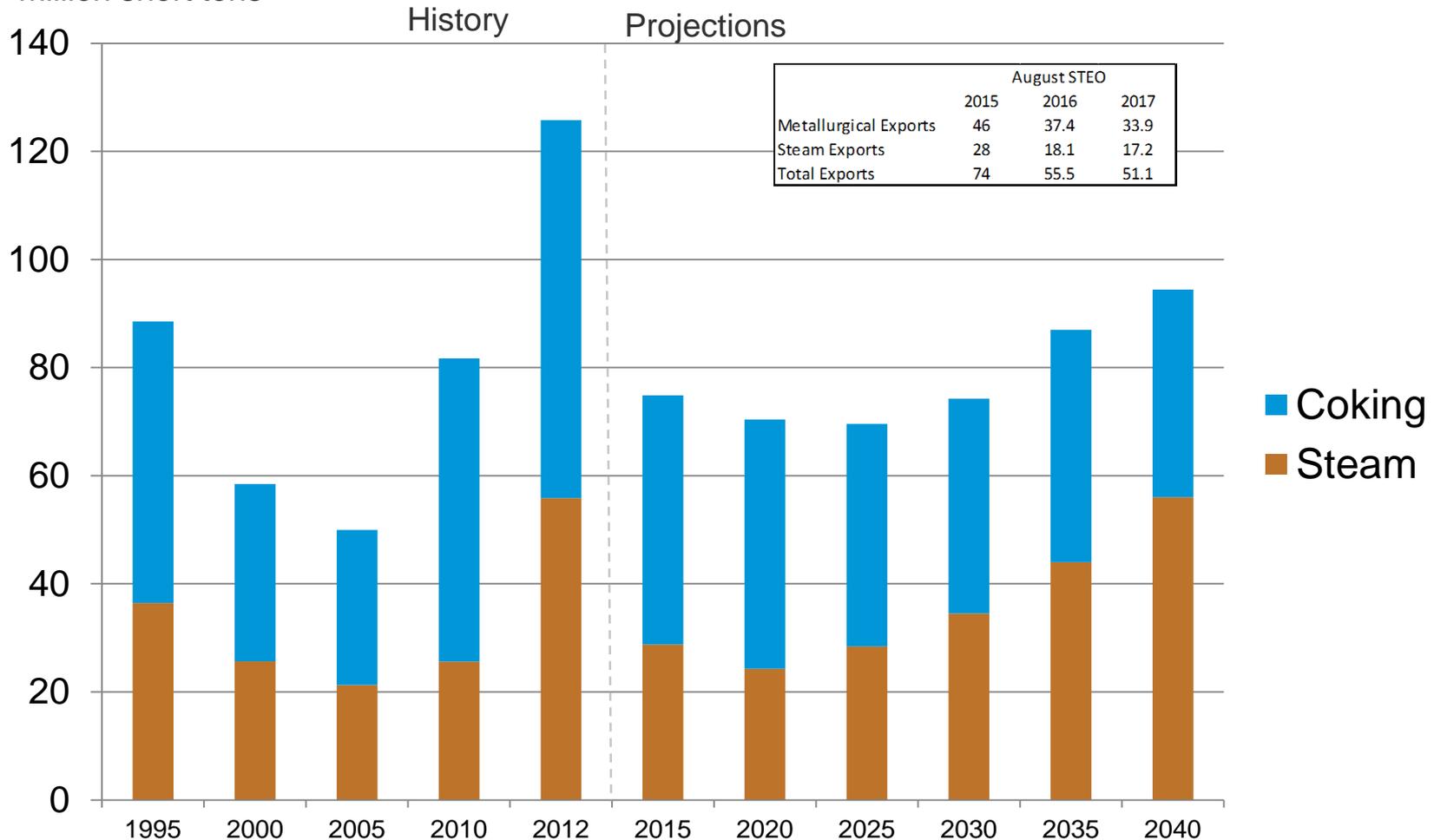
2015 dollars per short ton



Source: Preliminary AEO2016 (ref2016.d032416a), AEO2015 Reference Case (April 2015), *2014 is estimated.

U.S. Coal Exports, 1995-2040

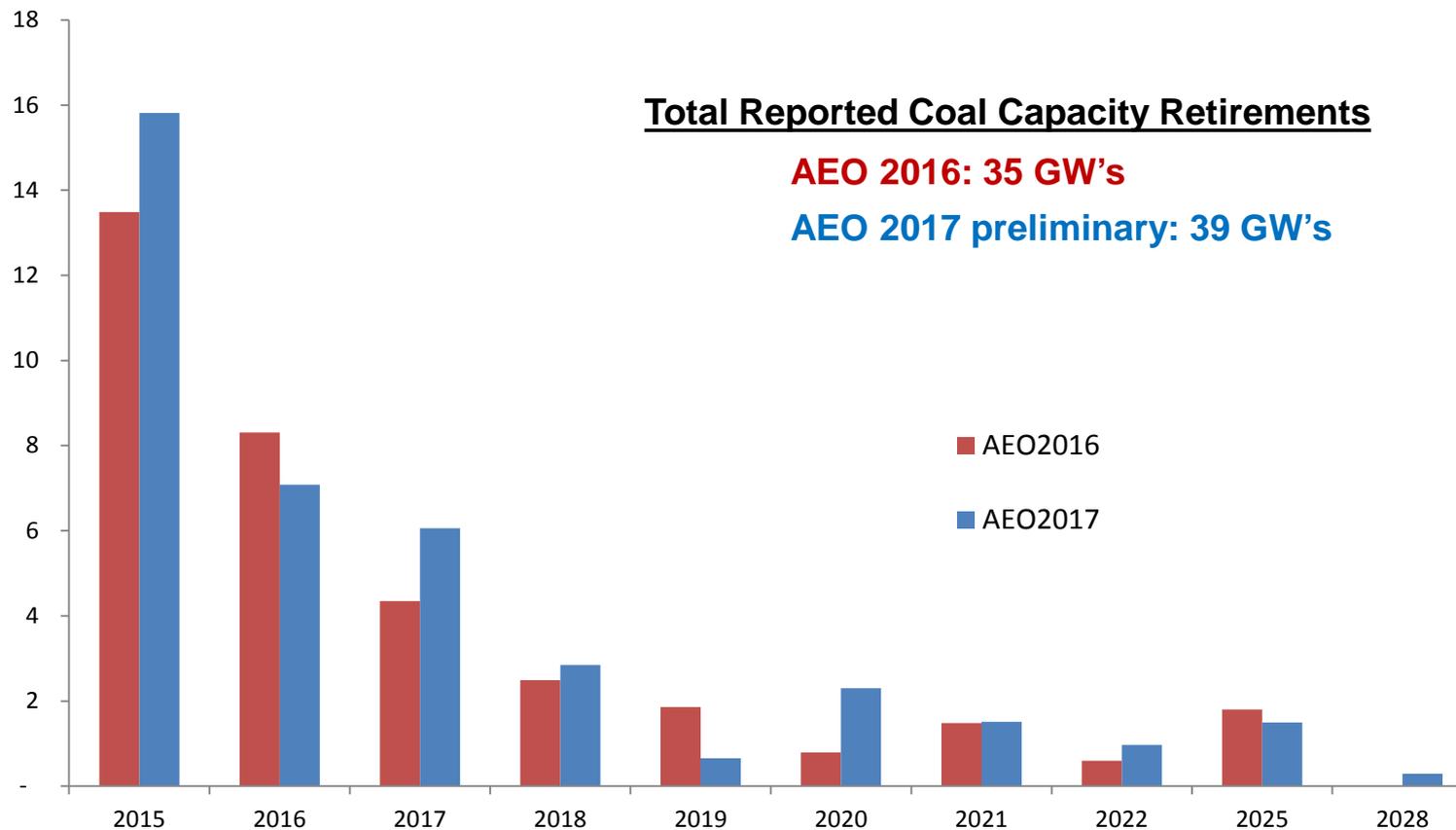
million short tons



Source: History: U.S. Energy Information Administration (EIA), *Quarterly Coal Report*;
Projections: AEO2016 (NEMS run ref2016.d032416a).

Initial assessment shows that reported coal retirements are slightly higher for AEO2017 than AEO2016

Gigawatts



Discussion Slides

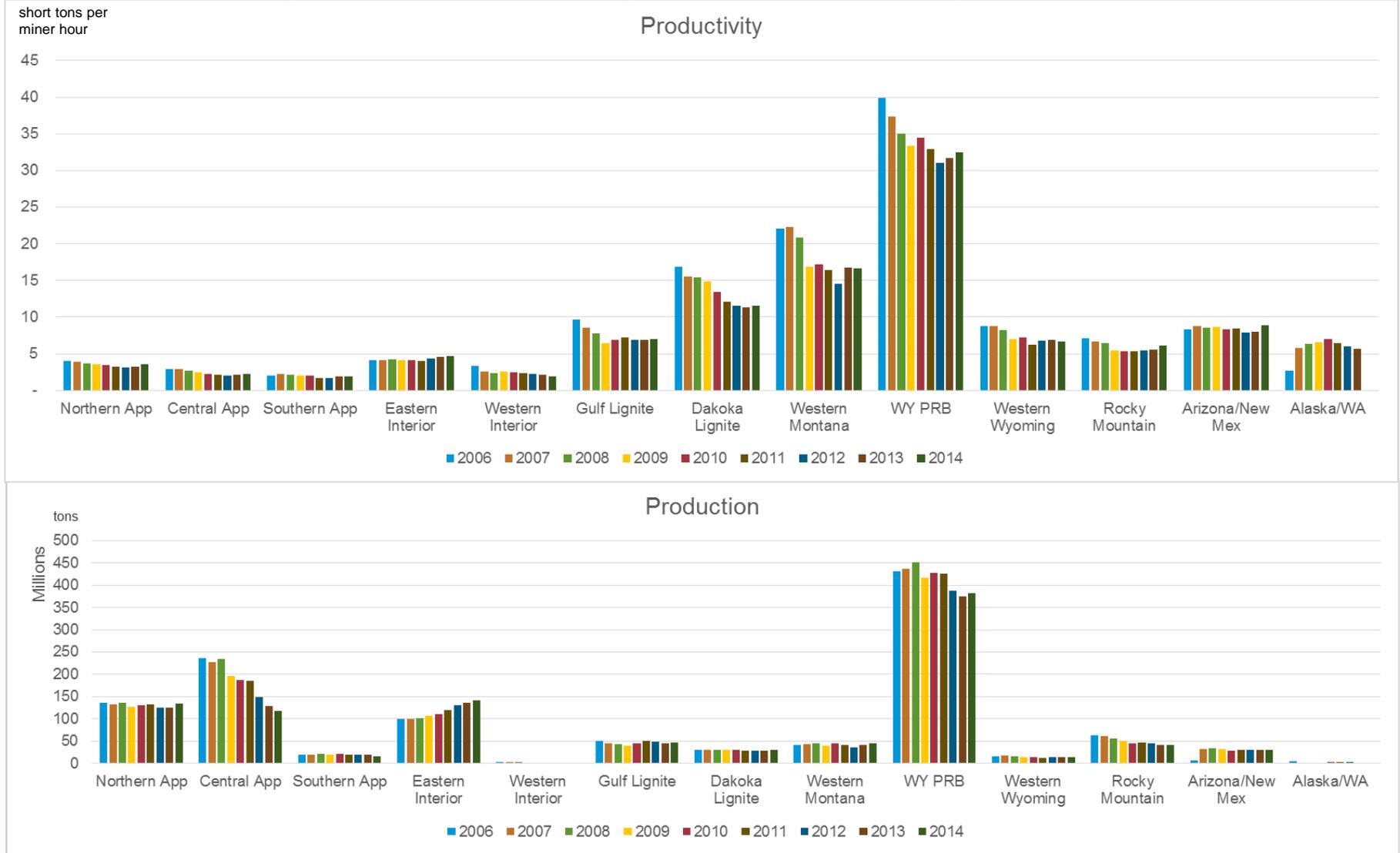
Average annual growth in coal mining labor productivity for selected supply regions (percent)

	1980 - 2013			Recent year-over-year changes			AEO2016 projections
Coal Supply Region	1980-1990	1990-2000	2000-2013	2011-2012	2012-2013	2013-2014	2014-2040
Northern Appalachia	5.4	5.5	-2.2	-4.9	3.7	11.2	-1.2
Central Appalachia	7.3	4.4	-5.2	-3.8	3.1	5.5	-2.7
Eastern Interior	4.8	3.7	-0.2	6.1	7.1	0.9	0.7
Gulf Lignite	2.6	2.4	-2.8	-4.2	-1.2	0.9	-1.0
Dakota Lignite	6.0	1.0	-3.3	-4.8	-1.7	0.7	-0.7
Western Montana	4.6	2.0	-2.4	-11.7	15.4	-0.9	-1.0
WY, Northern Powder River Basin	7.5	3.2	-3.2	-5.7	-2.6	3.2	-1.1
WY, Southern Powder River Basin	7.2	4.9	-2.4	-6.4	4.9	1.3	-1.1
Rocky Mountain	7.8	5.5	-2.4	3.5	1.3	9.3	-1.6
U.S. Average	7.1	6.2	-1.8	-0.2	6.7	7.6	-0.9

Source: History: U.S. Energy Information Administration (EIA), *Annual Coal Report*, and Mine Safety and Health Administration, Form 7000-2, "Quarterly Mine and Employment and Coal Production Report;"

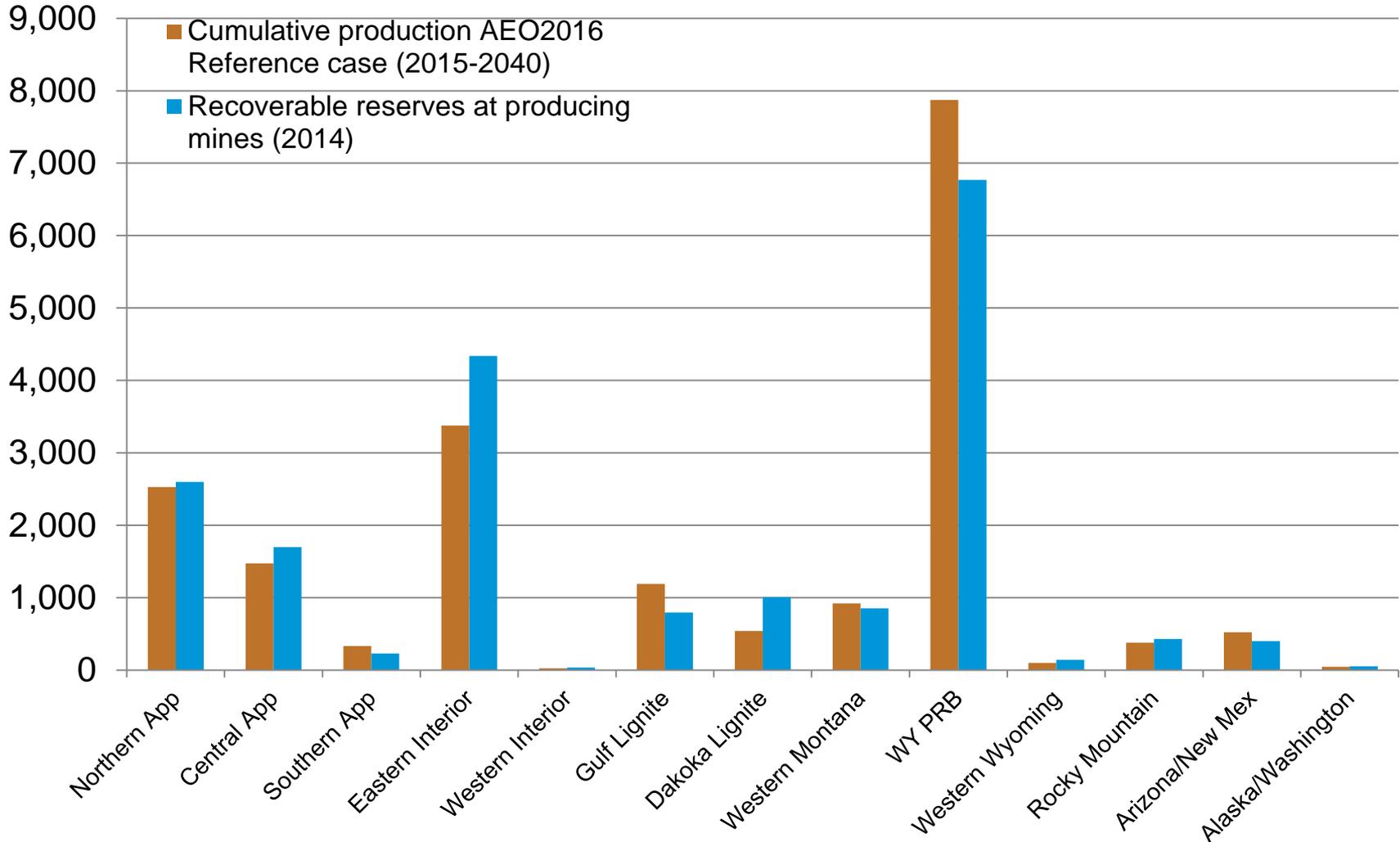
Projections: AEO2016 Reference Case (ref2016.d032416a).

Historical productivity and production by region



Recoverable Reserves at Existing Mines vs. Cumulative Regional Production Totals

million short tons



Projections: AEO2016 (NEMS run ref2016.d032416a), U.S. Energy Information Administration (EIA), EIA-7A

Productivity discussion topics

- How might an outlook of declining coal demand impact productivity?
 - How has maintenance of existing equipment and capital investments been affected by lower demand for coal? Are companies investing more in maintenance activities rather than buying new equipment?
 - Will productivity appear to be improving because mining assets and production are focused on the best performing mines? If so, when can we expect this to bottom out?
 - How is productivity affected by a loss of economies of scale?
- What are companies doing to improve productivity? What sort of cost cutting efforts have been taking place at mines, and what might the impacts (direct or indirect) be on productivity?
- What sort of evolutionary changes might be expected in the future to enhance productivity? (Is there anything revolutionary on the horizon?)
- Is there a potential to achieve the higher productivity levels seen in 2006-2008 (for various supply regions)?
- How might expectations of labor costs and employee demographics impact productivity and price?
- What about other mine production costs? Tires, explosives, steel, general machinery costs?

For more information

greg.adams@eia.gov, (202) 586-7343

diane.kearney@eia.gov, (202) 586-2415 (AEO)

ayaka.jones@eia.gov, (202) 586-0998 (International/China)

elias.johnson@eia.gov, (202) 586-7277 (STEO)

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

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EIA Information Center

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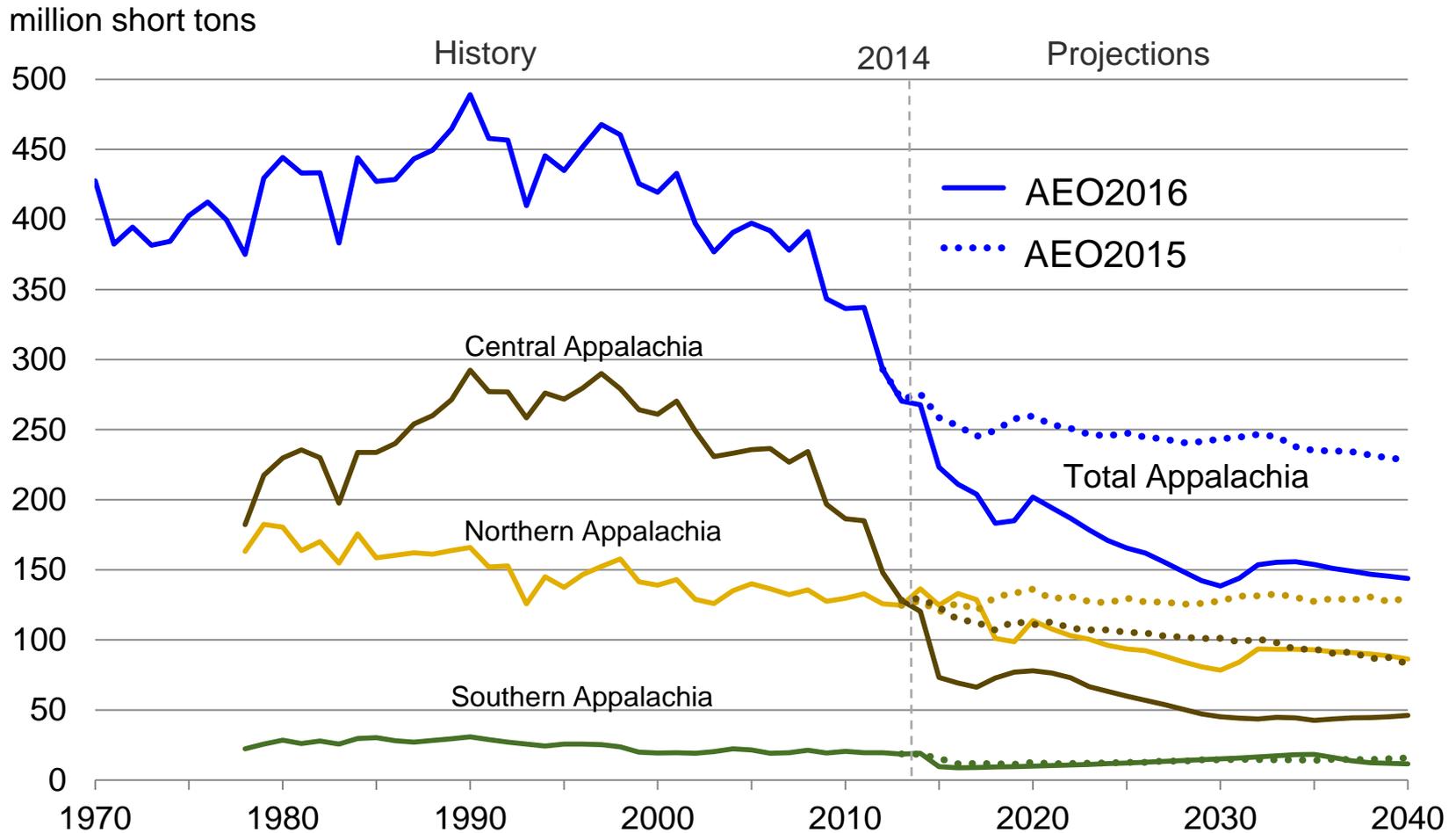
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Extra Slides

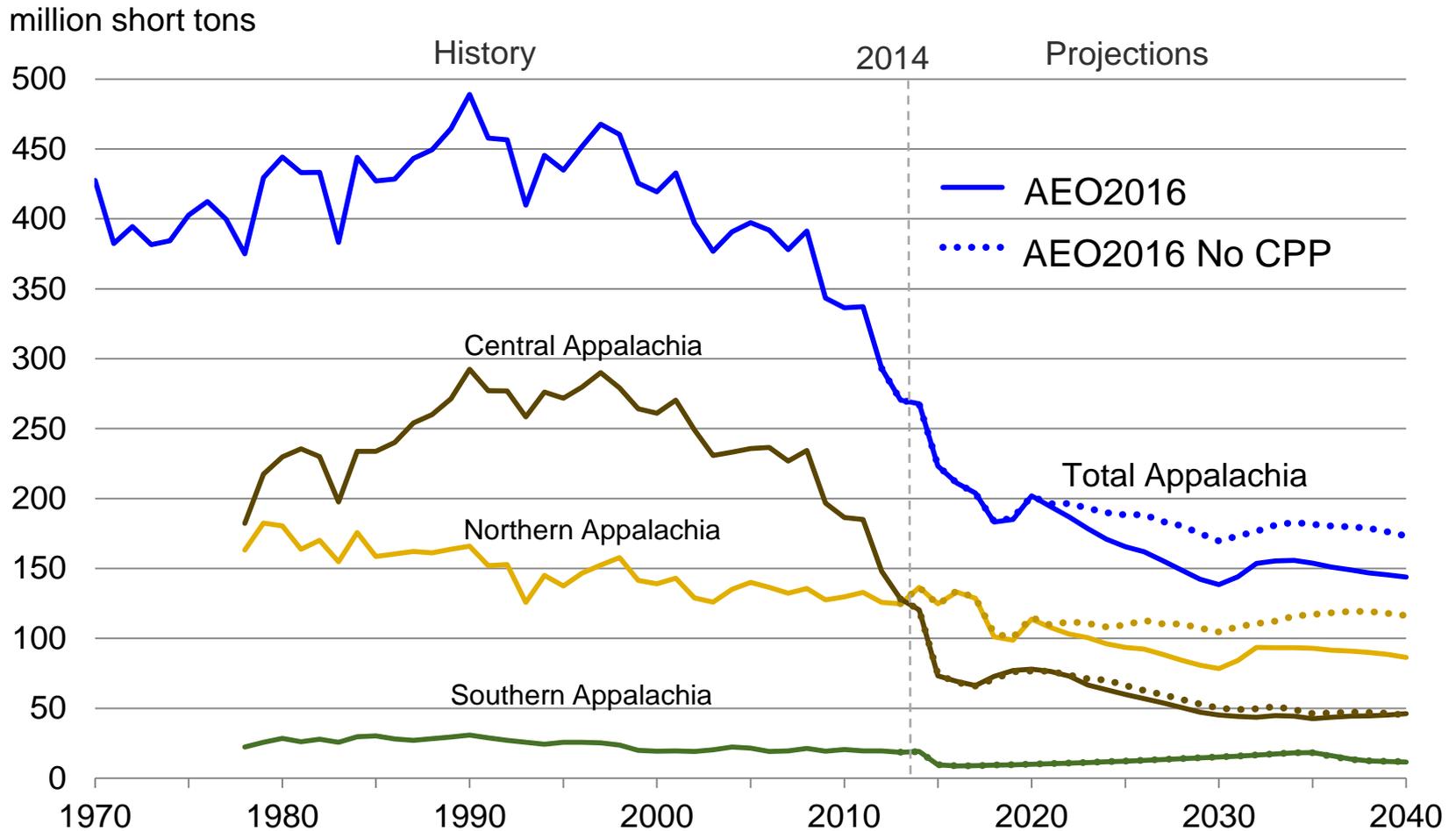
Appalachian coal production, 1970-2040



Source: Preliminary AEO2016 (ref2016.d032416a), AEO2015 Reference Case (April 2015)

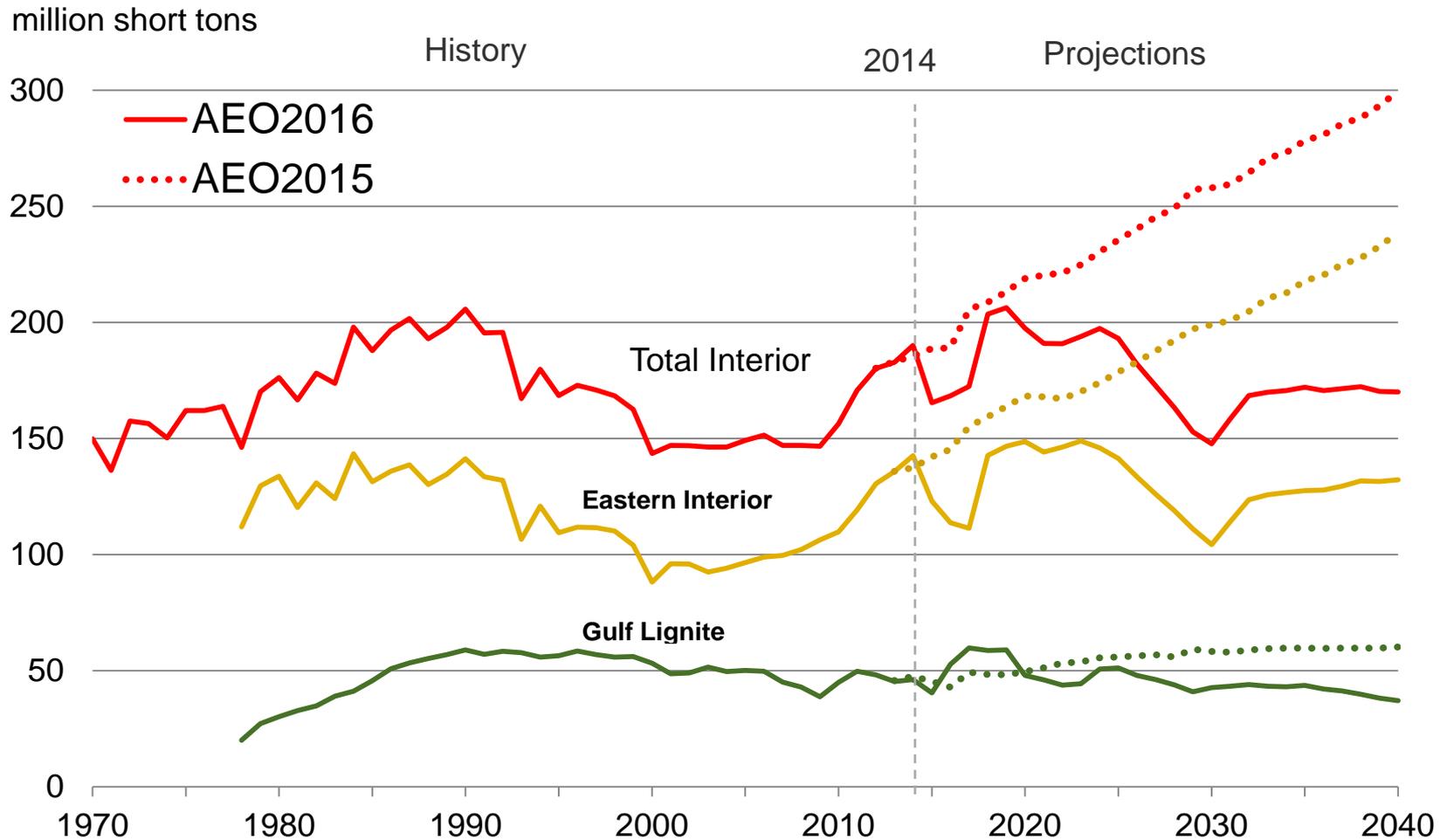
Except for Appalachian total, data for 1978-1985 exclude production from small (<10,000 short tons) coal mines

Appalachian coal production, 1970-2040



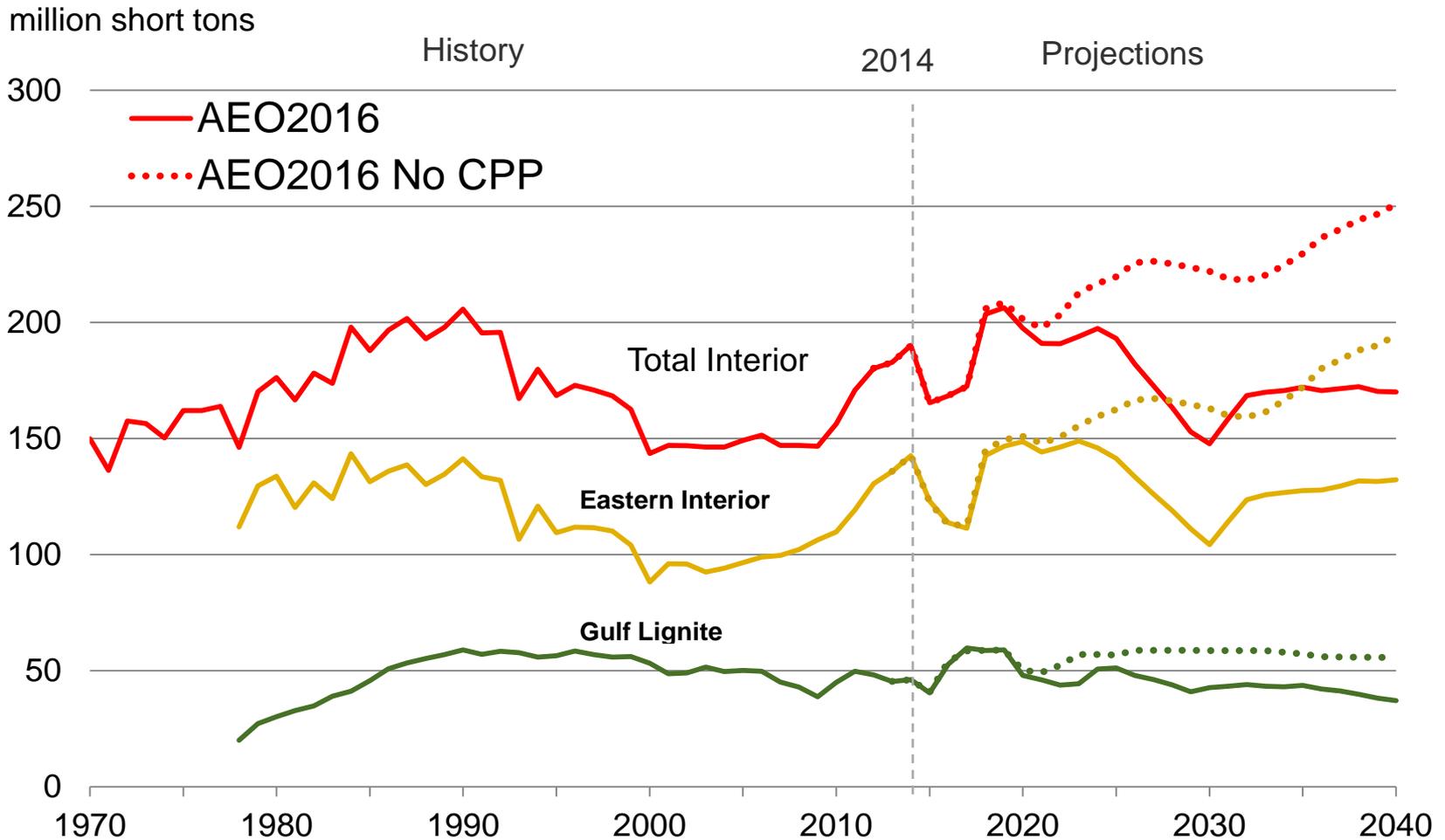
Source: Preliminary AEO2016 (ref2016.d020616a), AEO2016 No Clean Power Plan Case (ref_no_cpp.d032316a)
 Except for Appalachian total, data for 1978-1985 exclude production from small (<10,000 short tons) coal mines

Interior coal production, 1970-2040



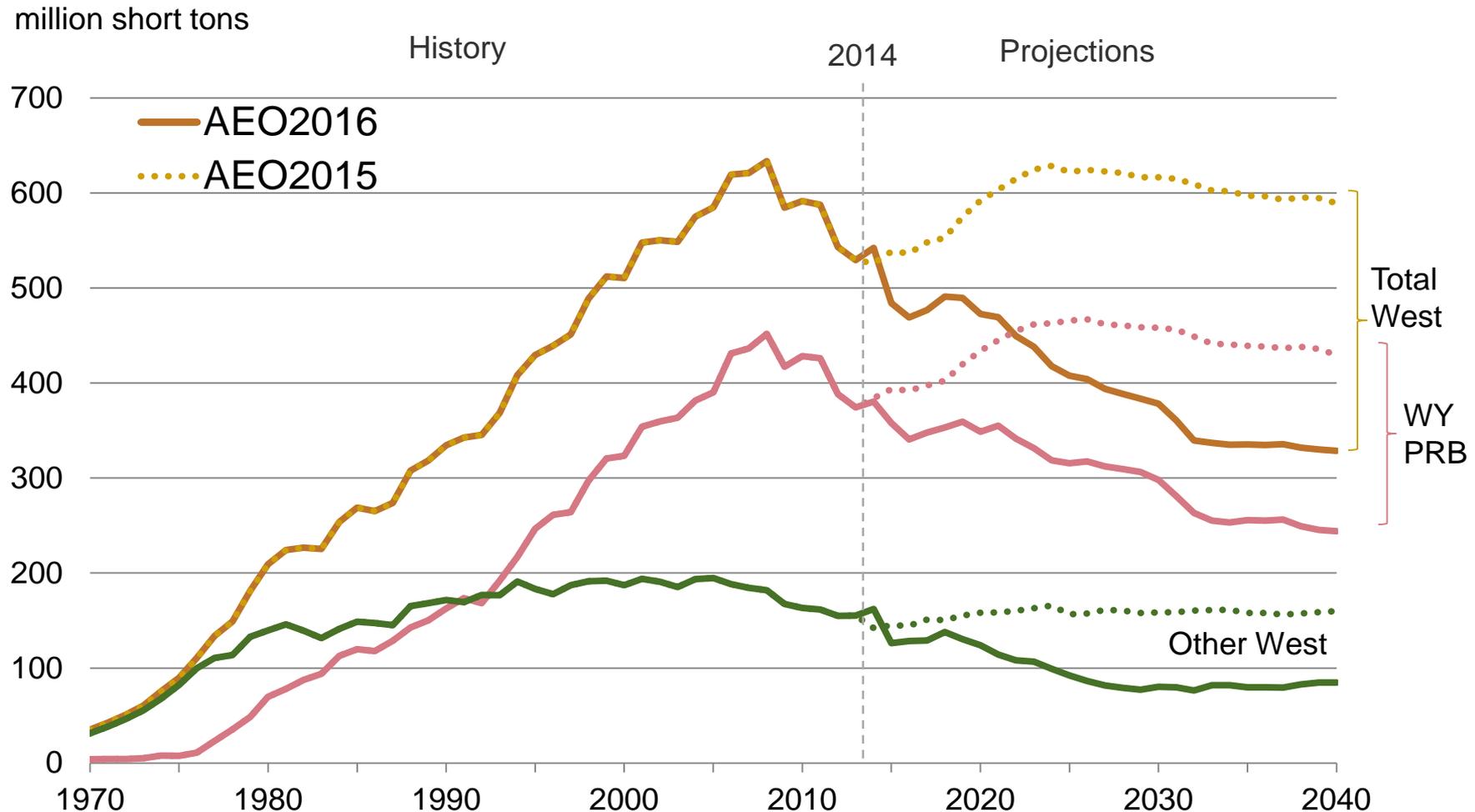
Source: Preliminary AEO2016 (ref2016.d020616a), AEO2015 Reference Case (April 2015),
 Except for Interior total, data for 1978-1985 exclude production from small (<10,000 short tons) coal mines

Interior coal production, 1970-2040



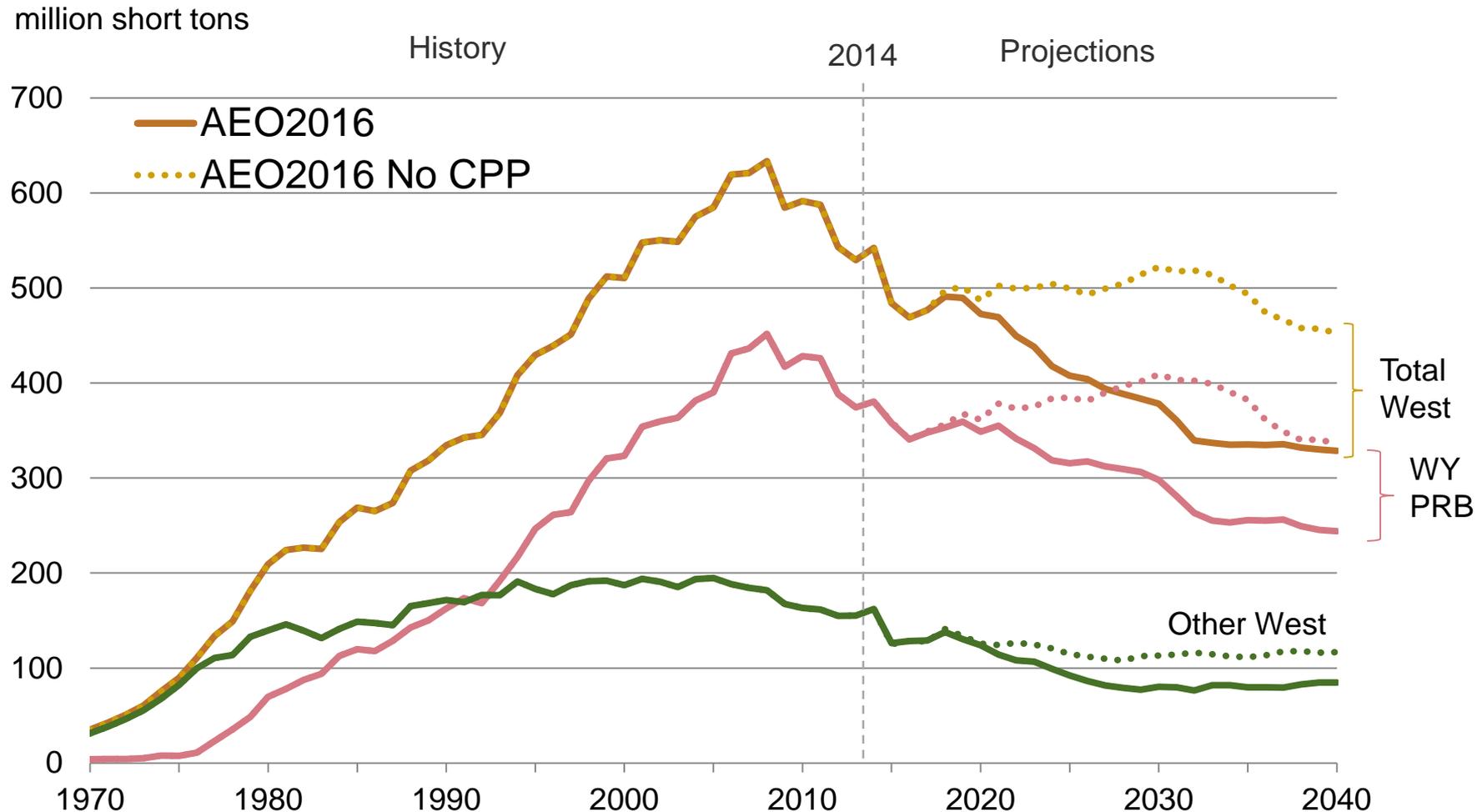
Source: Preliminary AEO2016 (ref2016.d020616a), AEO2016 No Clean Power Plan Case (ref_no_cpp.d032316a), Except for Interior total, data for 1978-1985 exclude production from small (<10,000 short tons) coal mines

Western coal production, 1970-2040



Source: Preliminary AEO2016 (ref2016.d020616a), AEO2015 Reference Case (April 2015),
 Except for Interior total, data for 1978-1985 exclude production from small (<10,000 short tons) coal mines

Western coal production, 1970-2040



Source: Preliminary AEO2016 (ref2016.d032416a), AEO2016 No Clean Power Plan Case (ref_no_cpp.d032316a),
 Except for Interior total, data for 1978-1985 exclude production from small (<10,000 short tons) coal mines

Legislation and Regulations

EPA and the courts have been busy issuing or confirming regulations affecting the power sector

Regulation	AEO2016 Assumption	AEO2017 Assumption	Comment
Cross State Air Pollution Rule- CSAPR (<i>SO₂/NO_x</i>)	Will model CSAPR	Will model CSAPR	
Mercury and Air Toxics Program (<i>Hg/SO₃</i>)	Update retirements to match announced plans	Update retirements to match announced plans and review/verify retrofit status for some plants	
New Source Performance Standards limiting CO₂ emissions from new plants (<i>Clean Air Act S. 111b</i>)	Will be included in Reference case	Will be included in Reference case	Part of CPP package; requires coal units to install USC with partial CCS to achieve max. rate of 1,400 lb CO ₂ /MWh
Regional Haze (<i>Best Available Retrofit Technology</i>)	Assumes compliance is reflected in EIA-860 filings on plants	Assumes compliance is reflected in EIA-860 filings on plants	Not expecting significant impact
Coal Combustion Residuals (<i>Coal ash</i>)	Not modeled	Not modeled	Not expecting significant impact (approx. 0.8 GW)
Cooling Water Intakes (<i>Clean Water Act S. 316b</i>)	Not modeled	Not modeled	Not expecting significant impact (approx. 1 GW)
Effluent Limitation Guidelines	Not modeled	Not modeled	Not expecting significant impact (approx. 1 GW)

Coal Combustion Residual (Coal Ash) Final Rule

- Final guidelines released April 2015
 - Rule sets national minimum criteria for the new and existing landfills and impoundments used for the disposal of coal ash.
 - All CCR units must monitor groundwater.
 - Impoundments and landfills that fail to meet location requirements or impoundments that fail to meet structural integrity requirements (i.e. those that pose the greatest risk) must close.
 - Some existing disposal sites may be required to retrofit or decide to close (avoiding all compliance costs) .
 - Unlined impoundments can continue to operate, but if unacceptable groundwater contamination occurs, they must retrofit or close. Similarly, unlined landfills can continue to operate but corrective action must occur to address any releases.
 - Coal ash will continue to be regulated as a non-hazardous waste under Subtitle D of the Resource Conservation Recovery Act.
 - Rule allows CCR products to remain unregulated if the CCR is encapsulated in a product having a beneficial use. This includes gypsum wallboard and concrete but specifically excludes the use of coal ash as ground fill.
 - Rule is unenforceable by EPA, but facilities that do not comply may be subject to litigation from other interested parties.
- Implementation timeline
 - Specific timelines vary depending on type of characteristics of CCR unit and compliance option chosen.
- EPA's estimate of electric power capacity retirements: ~ 0.8 gigawatts
- EPA's incremental cost estimate:
 - \$509-\$735 million annually (depending on discount rate)

Cooling Water Intakes (316(b)) Final Rule

- Final rule effective as of October 2014
 - Sets impingement controls for new and existing electric generating and manufacturing facilities with design intake flow of at least 2 million gallons per day (MGD) and use at least 25% of the water withdrawals for cooling.
 - Requires facilities having >125 MGD design intake flow to conduct studies to help permitting authorities determine what, if any, entrainment controls are needed.
 - Establishes a best technology available (BTA) standard for both impingement mortality and entrainment at new and existing facilities.
 - Existing BTA technologies for impingement include a closed cycle system, reduction of intake flows to 0.5 feet per second, minimum 800-foot distance offshore intakes with use of bar screens, or use of modified travelling screens.
 - BTA for entrainment will be determined on a site-specific basis.
 - Requires that new units must have the equivalent of closed loop cooling.
- Implementation time frame
 - Based on expiration of National Pollutant Discharge Elimination System (NPDES) permits but no later than 2023; a plan must be submitted by July 14, 2018.
 - Early choice of evaporative thermal cooling can allow implementation delay to 2023.
- EPA's estimated electric power capacity retirements: ~1 gigawatt
- EPA's estimated incremental costs:
 - \$275-297 million per year (excludes entrainment costs)

Effluent Limitation Guidelines

- Final guidelines released September 2015
 - Addresses liquid waste streams from plants (primarily coal plants) discharged directly and indirectly to water bodies (e.g. lakes, rivers)
 - In response to the transfer of pollutants from air to water as a result of the Clean Air Act
 - Regulates wastewaters associated with flue gas desulfurization, fly ash, bottom ash, flue gas mercury control, and gasification of fuels such as coal and petroleum coke
 - Addresses discharge of mercury, arsenic, selenium, nitrites/nitrate wastes from flue gas desulfurization equipment
 - Includes zero discharge pollution limits for ash transport water and flue gas mercury control water
- Implementation timeline
 - Effective as of January 2016
 - Compliance deadlines vary according to the expiration of the plant's National Pollutant Discharge Elimination System (NPDES) permit but will occur between 2018 and 2023.
- EPA's estimate of electric power capacity retirements: ~ 1 gigawatt
- EPA's incremental cost estimate:
 - \$471-\$480 million annually (depending on the discount rate)

Other laws and regulations affecting coal

- EPA's regional haze program is aimed at protecting national parks through implementation of Best Available Retrofit Technology (BART)
 - Requires states to lower NO_x and SO₂ emissions over time through state implementation plans (SIPs) or federal implementation plans (FIPs)
 - Implementation to occur between 2014 and 2018
 - Retrofits or retirements associated with finalized plans captured in reporting data
- California's cap-and-trade program (AB 32) and the Northeast's Regional Greenhouse Gas Initiative (RGGI) program
- California SB1368 that prohibits CA utilities from entering into long-term financial commitments for base load generation, unless it complies with the CO₂ emissions performance standard of 1,100 lbs/MWh
 - Reduce firm imports to represent expiration of contracts with the Four Corners, Navajo, Reid Gardner, San Juan, and Boardman plants and retire Intermountain in 2025
 - Adjust carbon emission rate for firm imports in accordance with the expiration of contracts
- The 3% adder on the cost of capital for upgrades to coal units without *maximum* sequestration options included to account for risk of future tightening of CO₂ emissions standards and other policies affecting coal

Monitoring proposed regulatory actions

- **California post-2020 Greenhouse Gas (GHG) emissions target**
 - EO-S-3-05 (2005) requires California to reduce its emissions to 20% of 2020 levels by 2050.
 - Guidelines for meeting post-2020 targets are expected in 2017.
- **OSM’s Stream Protection Rule (Proposed in July 2015)**
 - Affects surface mines and underground mines that impact the surface.
 - Requires pre-mining collection of data to establish baseline environmental conditions.
 - Specifies that mining area must be returned to a condition appropriate for its pre-mining use.
 - Requires permits to specify maximum acceptable material damage levels from the mine operation.
 - Earliest implementation date: January 2017
- **EPA’s “Waters of the United States” (Final as of June 2015, but subject to court stay in October 2015)**
 - Expands scope of “waters of the United States” (WOTUS) that are protected under the Clean Water Act.
 - Key changes relate to tributaries, adjacent wetlands, and “other waters.”
 - Coal industry concerns include permitting delays.
- **Potential changes to the federal coal leasing program**
 - DOI held recent listening sessions.
- **Outcome of coal export terminal permitting processes**