

Coal Outlook through 2040: Annual Energy Outlook 2015 Reference Case and the Proposed Clean Power Plan

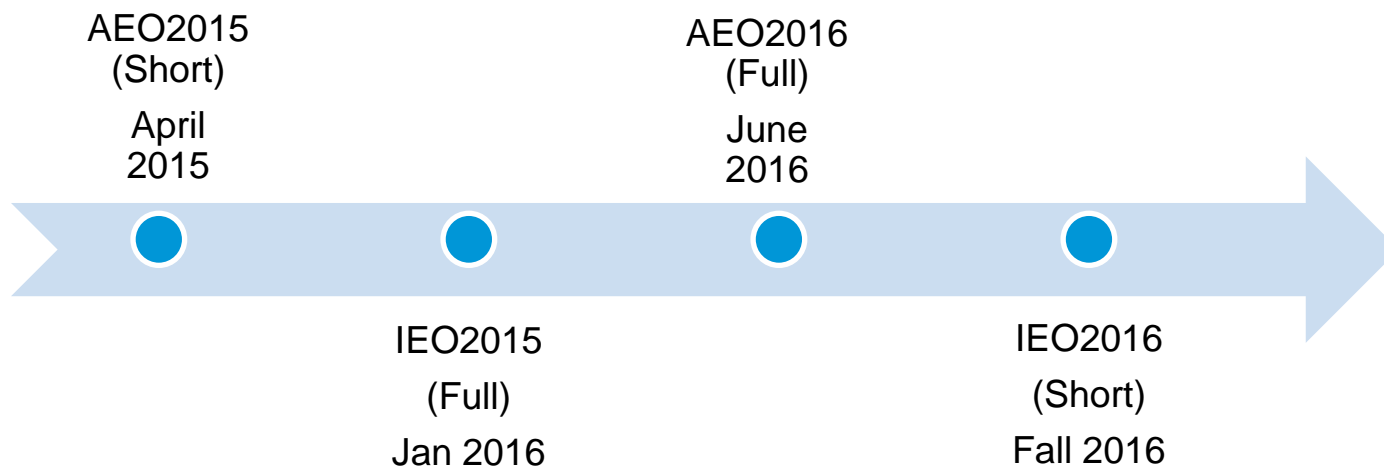


Diane Kearney

December 1, 2015 | Rail Energy Transportation Advisory Committee to the Surface Transportation Board, Washington, D.C.

The *AEO2015* - abridged compared to *AEO2014*

- The U.S. Energy Information Administration revised the schedule for production of the *Annual Energy Outlook (AEO)* and the *International Energy Outlook (IEO)*. The *AEO* and *IEO* now alternate annually between full and short versions.
- The *AEO2015* is the first short version of the Annual Energy Outlook.
- The shorter version includes an abbreviated discussion and results from select cases.



Legislation and Regulations

AEO2015 legislation and regulation assumptions

- Current laws and regulations included in the AEO2015 Reference case
 - Clean Air Interstate Rule (CAIR)
 - Mercury and Air Toxics Standards (MATS) with full compliance by 2016
 - Regional Haze Rule plans are captured in annual reporting data
 - California's cap-and-trade program (AB 32) and the Northeast's Regional Greenhouse Gas Initiative (RGGI) program
 - Uncertainty with respect to CO₂ policy addressed through a 3% higher cost of capital for new coal-fired power and coal-to-liquids plants and capital investment projects at existing coal-fired power plants
 - State Renewable Portfolio Standards (RPS)
 - Wind facilities under construction by 2015 are allowed to take the production tax credit (a 2.3 cent per kilowatthour tax incentive)

Legislative and regulatory actions not addressed in the AEO2015 Reference case

- EPA's cooling water intake regulations per section 316(b) of the Clean Water Act
- EPA's coal effluent guidelines and coal combustion residuals
- California post-2020 Greenhouse Gas (GHG) emissions target
- EPA's CO₂ New and Existing Source Performance Standards per section 111(b) and 111(d) of the Clean Air Act (aka Clean Power Plan), respectively

Review of AEO2015 Reference Case

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

- Regionally

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

Key results for the AEO2015 Reference case

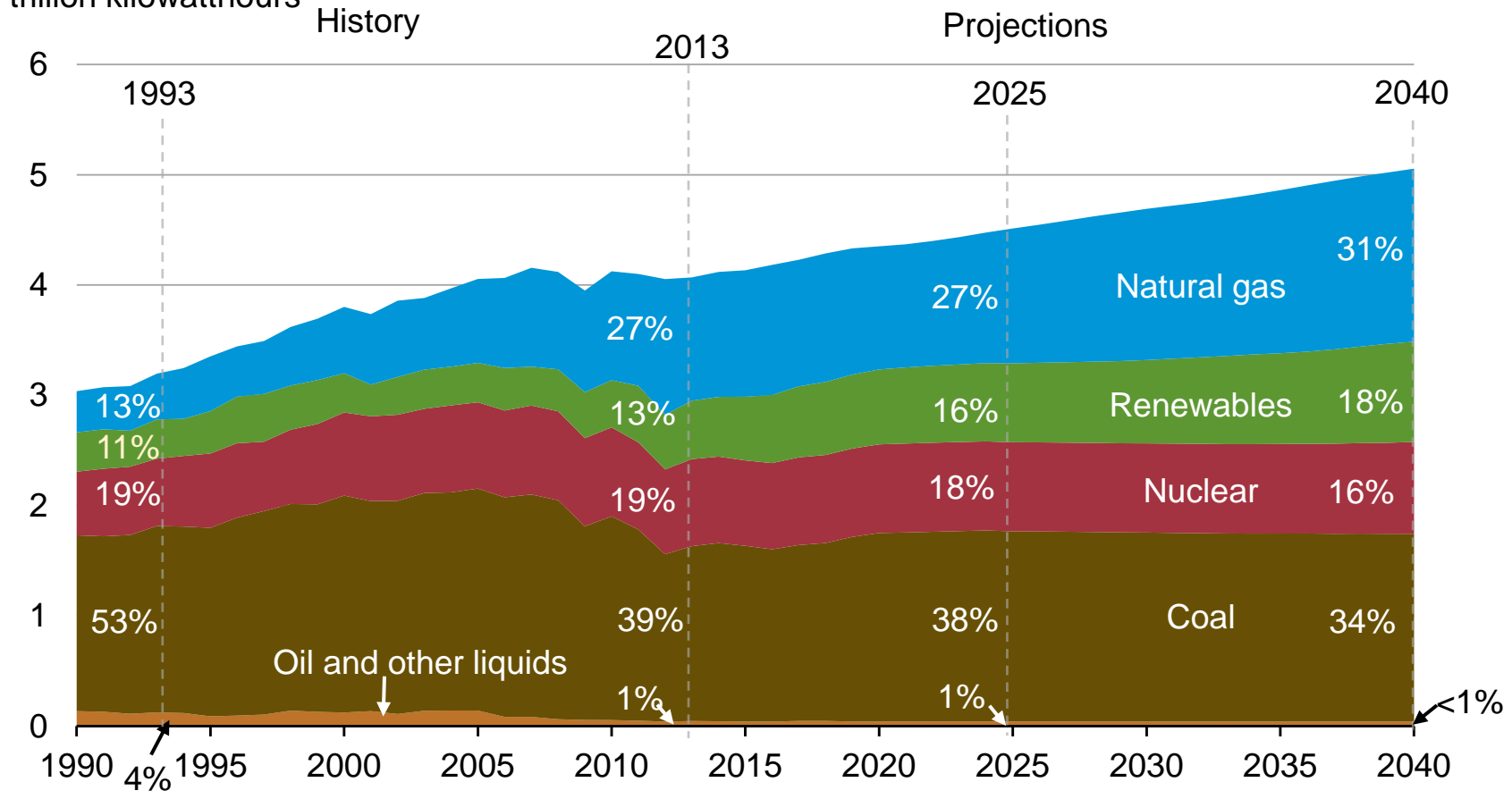
- Coal is the leading fuel for U.S. electricity generation in 2040. But, coal's share of total generation decreases over time to 34% in 2040 from 39% in 2013.
- The Interior region increases both production and share of total production.
 - Coal producers in the Interior region gain share while Appalachia loses share of total U.S. coal production. From 2013 to 2040, the Appalachian region's share of total coal production (on a Btu basis) falls from about 35% to 27%.
 - From 2013 to 2040, Interior coal production rises by 113 million tons while West production rises by 59 million tons.
- Much of the 40 GW of coal-fired capacity retirements occur by 2016 largely because of the combination of MATS, relatively low natural gas prices, and relatively low electricity demand. (32 GW have been reported to EIA.)

Key results for the AEO2015 Reference case

- Expanding development of shale gas resources drives increased production and competitive prices for natural gas.
- In the years around MATS implementation (2016), coal use is low compared to history. But, as overall electricity demand and natural gas prices rise, coal use also increases. Coal consumption is steady -- about 1 billion tons in the 2020 time frame and then remains at about 990 million tons after 2030.
- Between 2015 and 2040, coal exports rise by about 60 million tons – predicated on rising demand for coal internationally.
- 1.1 GW of coal capacity additions (0.7GW planned)
- Delivered coal prices increase gradually through 2040 at an average rate of 0.7% per year (on a per ton basis) due to declining coal mine productivity and slightly higher transportation costs.

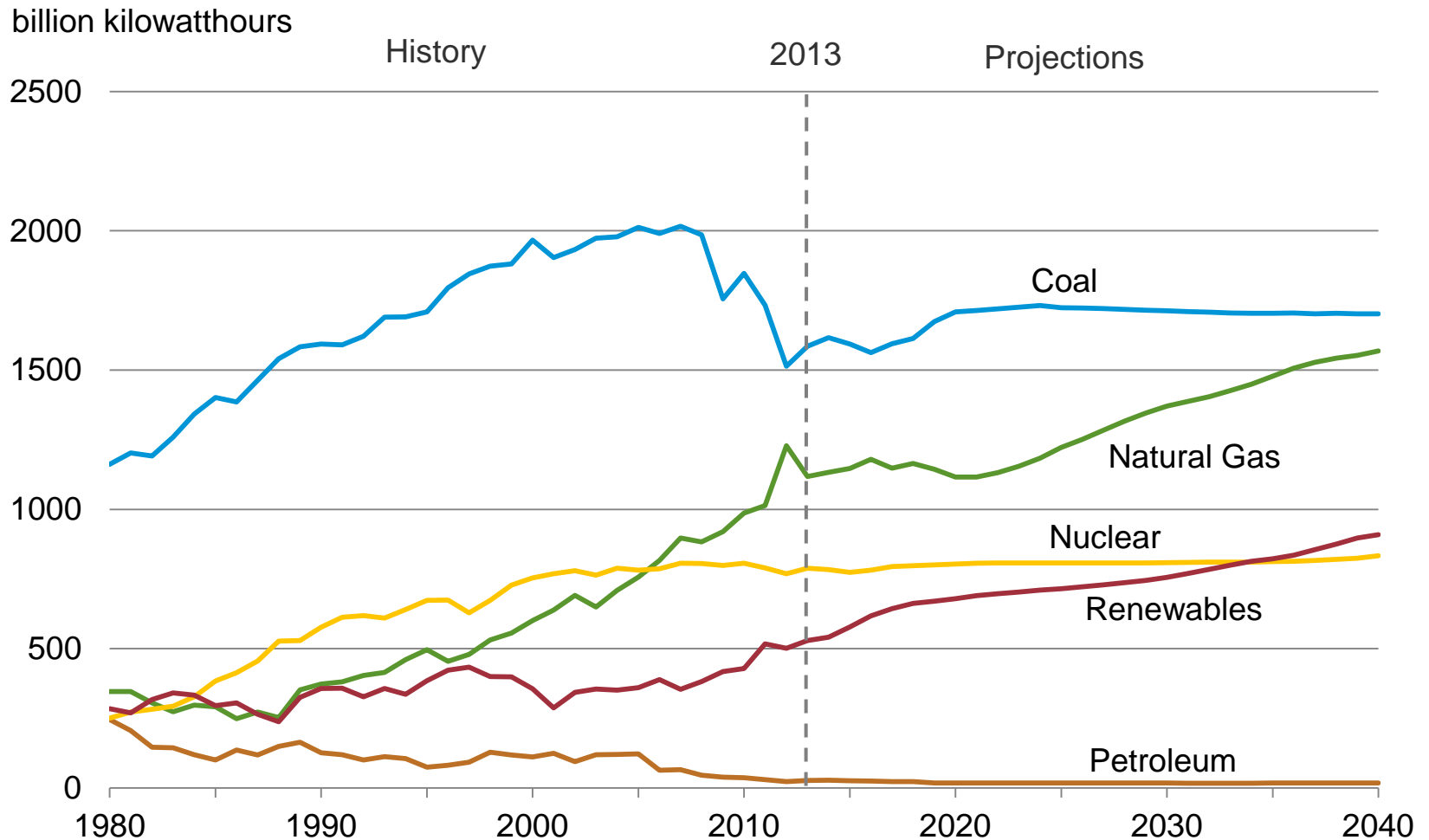
Over time the electricity mix gradually shifts towards larger shares of natural gas and renewable generation

U.S. electricity net generation
trillion kilowatthours



Source: EIA, Annual Energy Outlook 2015

Electricity Generation by Fuel, 1980-2040



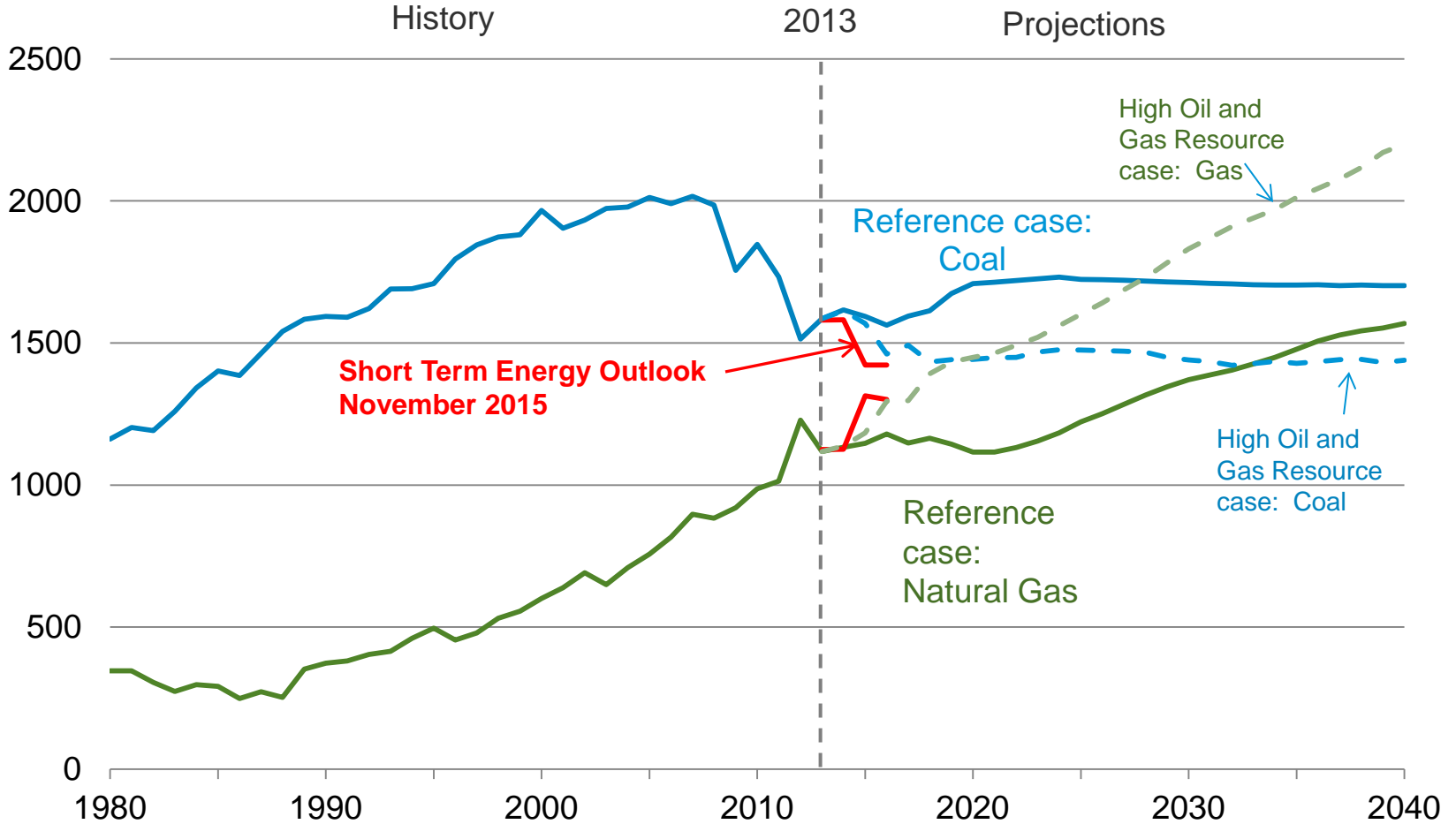
Note: Includes generation from plants in both the electric power and end-use sectors.

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

Projections: AEO2015 Reference Case (April 2015).

Electricity Generation for Coal and Gas in the Reference case and the High Oil and Gas Resource Case, 1980-2040

billion kilowatthours



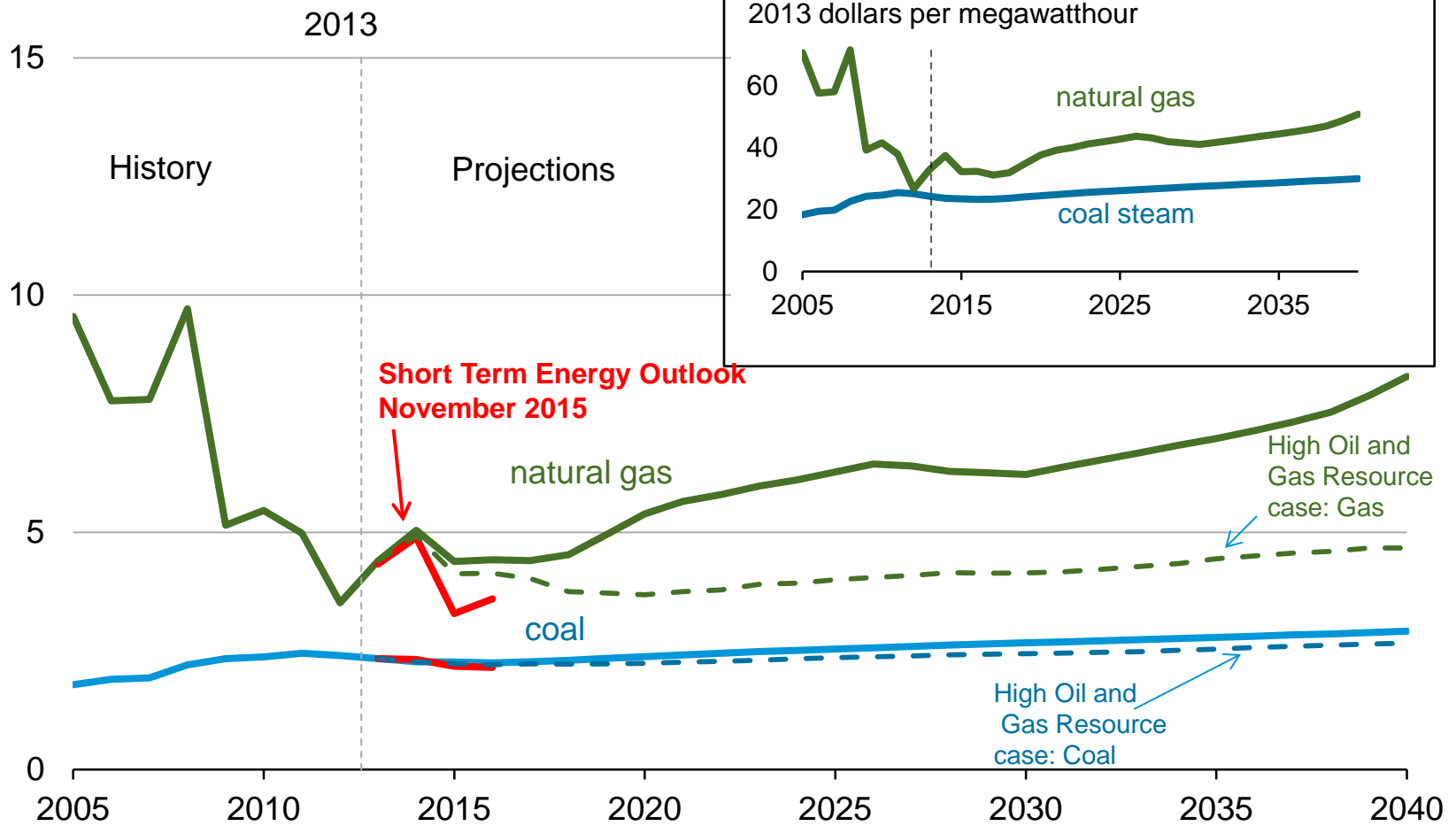
Note: Includes generation from plants in both the electric power and end-use sectors.

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

Projections: AEO2015 Reference Case (April 2015).

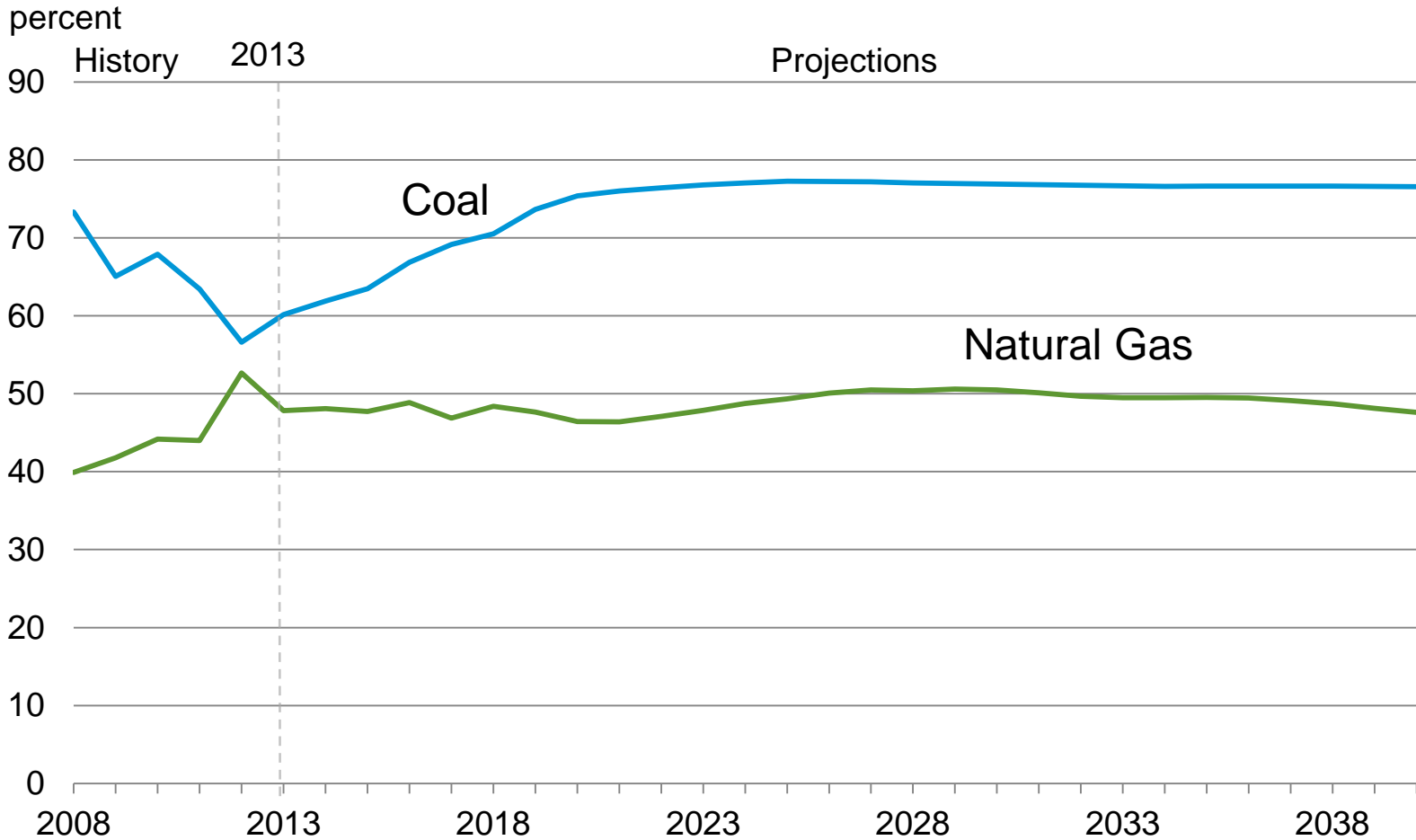
Delivered prices of natural gas and coal to the electric power sector in the Reference case

average delivered fuel prices to electric power plants, 2013 dollars per million Btu



Source: AEO2015 Reference case (April 2015).

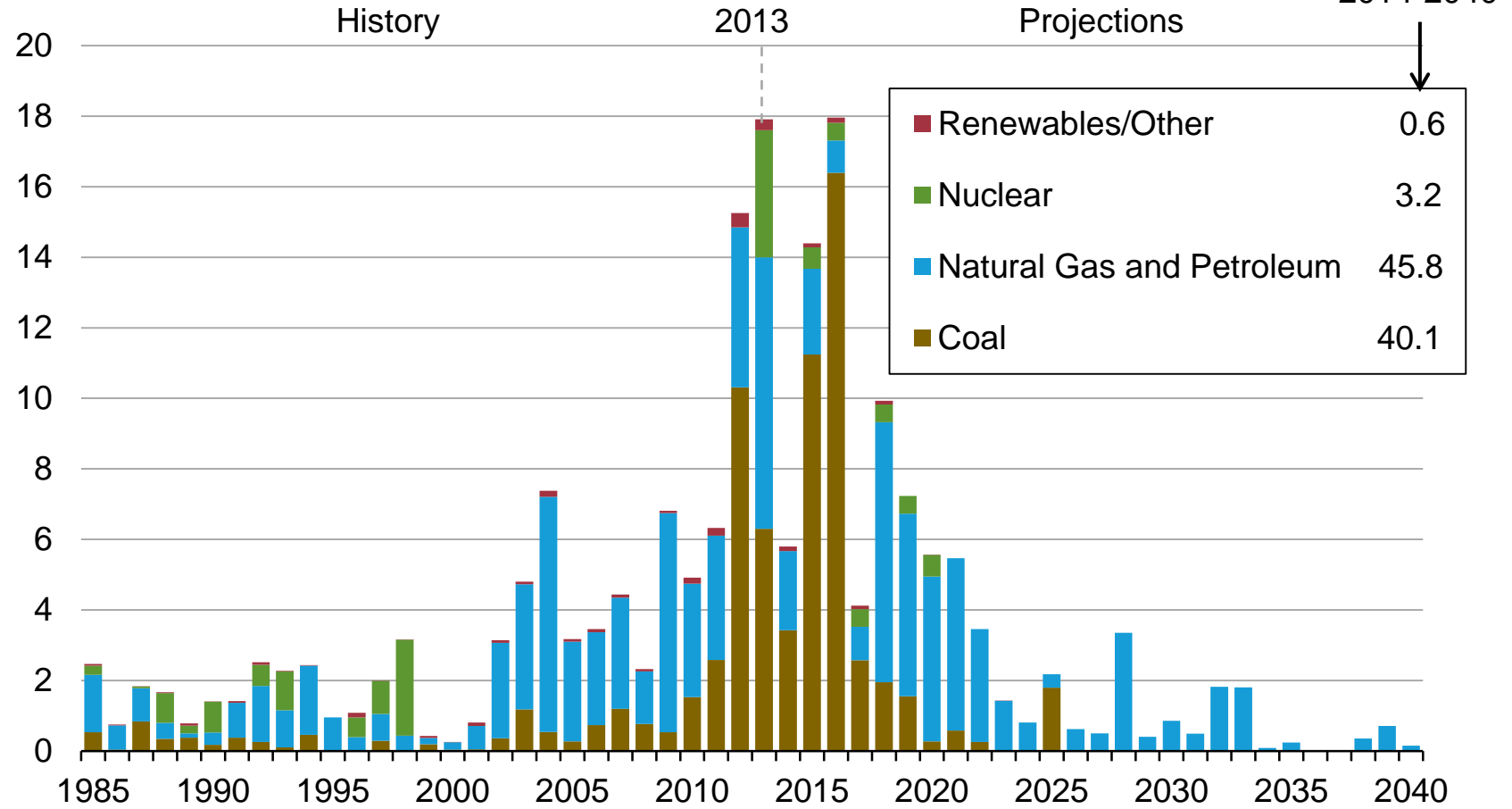
Average capacity utilization of natural gas combined cycle and coal generating capacity, 2008-2040



Source: AEO2015 Reference Case (April 2015)

28 Gigawatts of coal capacity to retire in 2015 and 2016

U.S. electricity generation capacity retirements
gigawatts



Source: Form EIA-860 and AEO2015 Reference Case (April 2015)

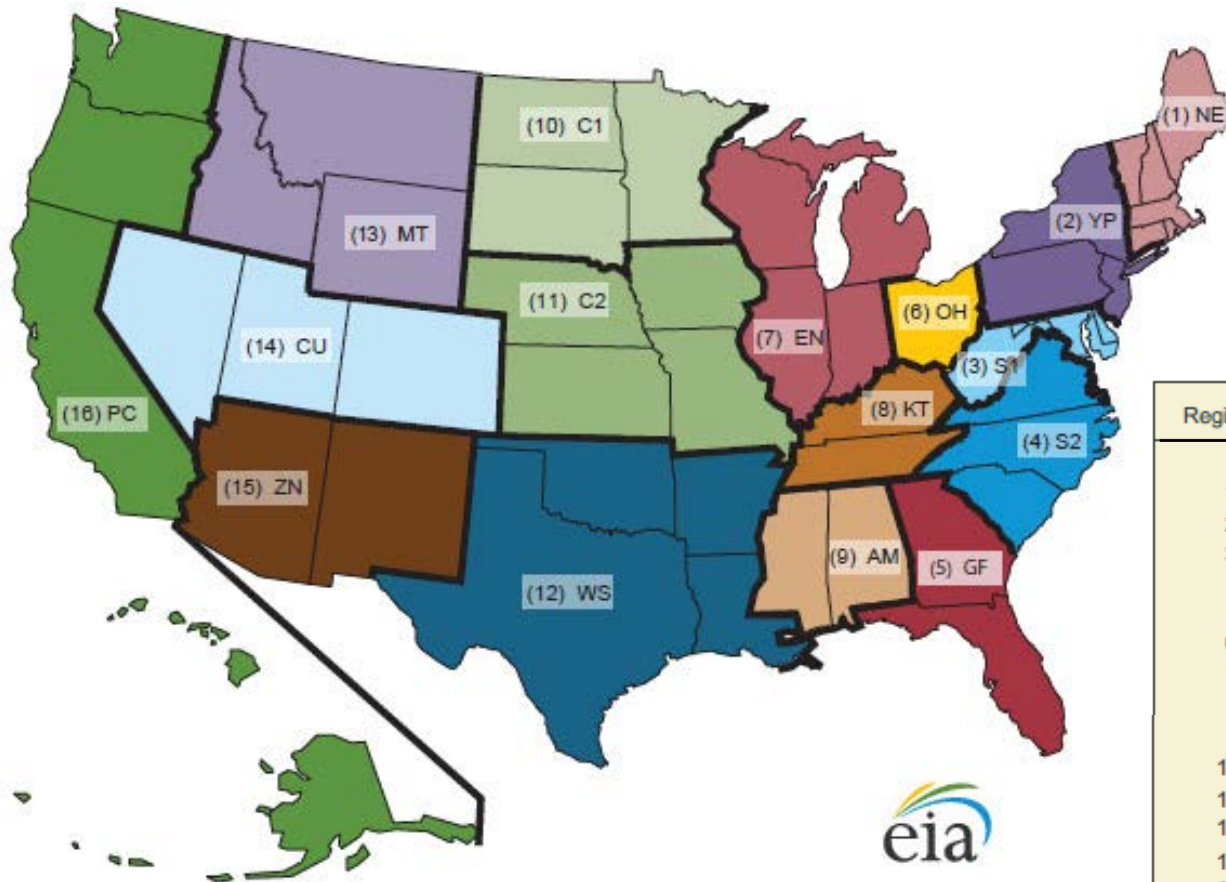
Electric Net Summer Generating Capacity by Fuel, 2008-2040 (gigawatts)

Fuel	2008	2011	2013	2015	2016*	2020	2030	2040
Coal	311	316	304	290	269	263	260	260
Electric Power Sector	308	313	300	286	266	260	257	257
End-Use Sectors	4	4	3	3	3	3	3	3
Natural Gas & Petroleum	450	463	470	480	486	482	519	595
Nuclear Power	101	101	99	100	100	101	102	105
Renewable Sources	117	143	167	192	202	207	227	275
Other (includes pumped storage)	25	25	25	26	26	26	26	26
Total	1004	1049	1065	1085	1082	1079	1133	1261

Source: AEO2015 Reference Case (April 2015)

**MATS compliance assumed to begin*

Coal demand regions



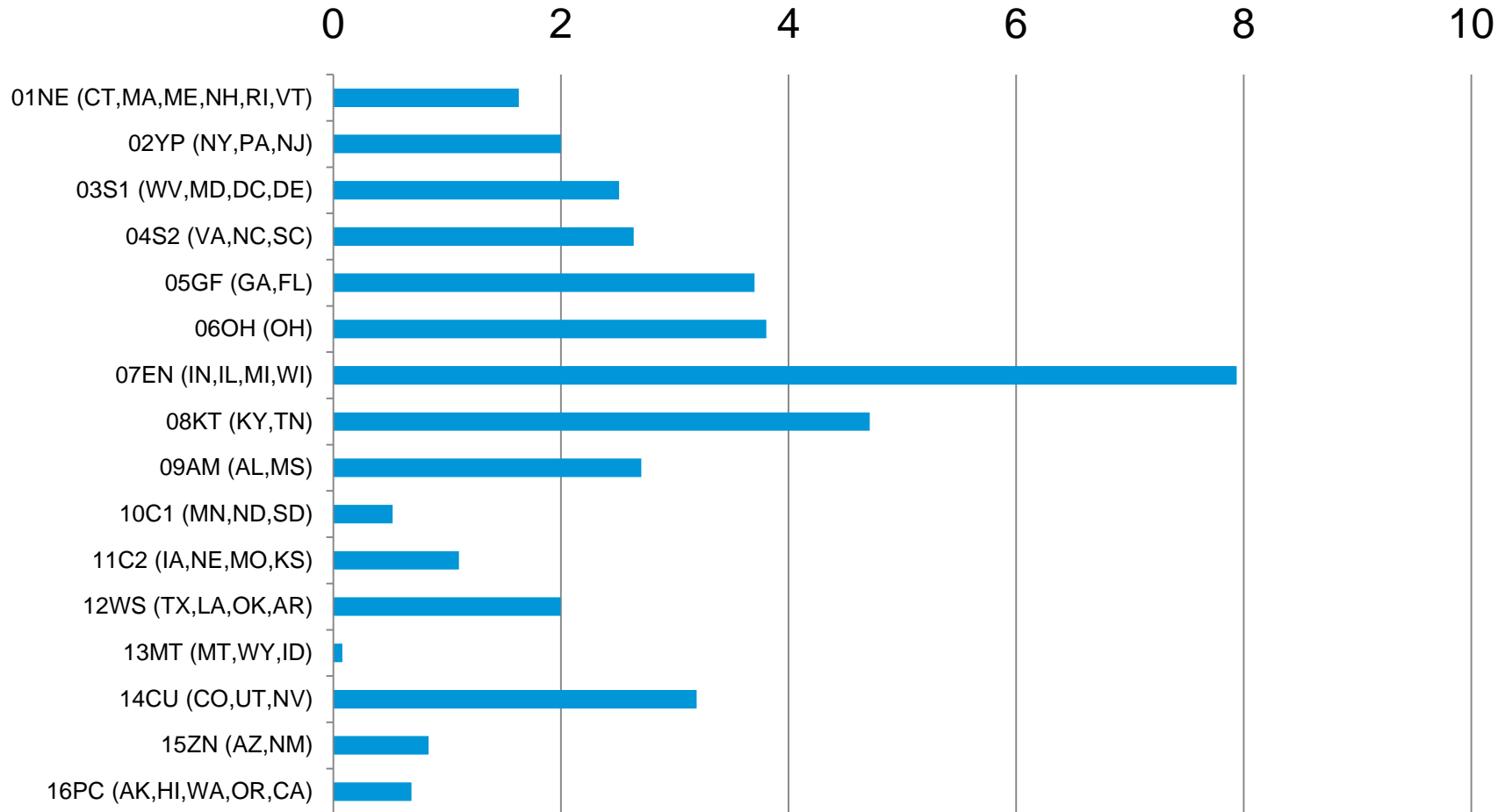
Region Code	Region Content
1. NE	CT,MA,ME,NH,RI,VT
2. YP	NY,PA,NJ
3. S1	WV,MD,DC,DE
4. S2	VA,NC,SC
5. GF	GA,FL
6. OH	OH
7. EN	IN,IL,MI,WI
8. KT	KY,TN
9. AM	AL,MS
10. C1	MN,ND,SD
11. C2	IA,NE,MO,KS
12. WS	TX,LA,OK,AR
13. MT	MT,WY,ID
14. CU	CO,UT,NV
15. ZN	AZ,NM
16. PC	AK,HI,WA,OR,CA

Source: U.S. Energy Information Administration, Office of Energy Analysis



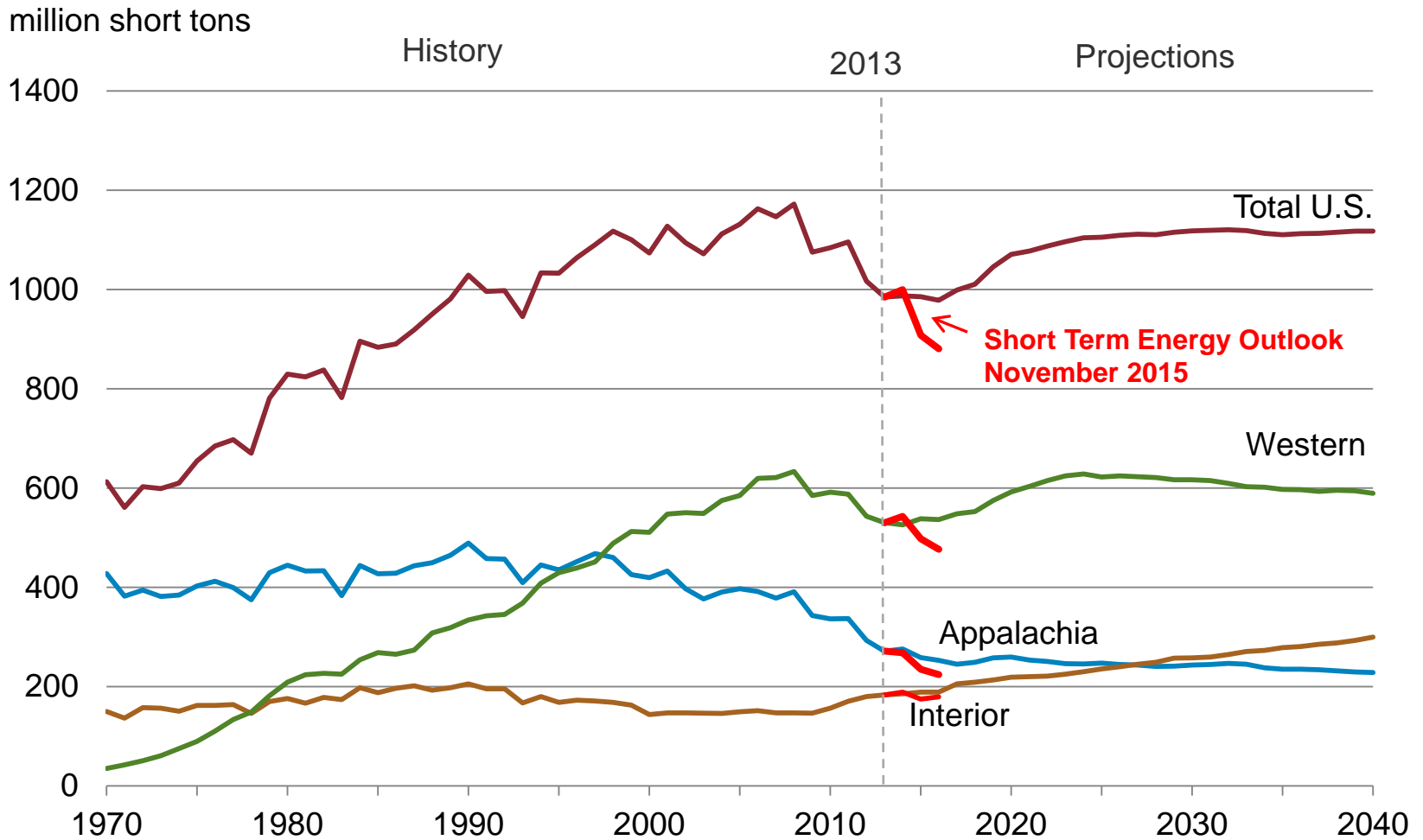
Cumulative net summer coal-fired capacity retirements by coal demand region, 2014-2040

gigawatts



Source: AEO2015 Reference Case (April 2015)

Coal production by region, 1970-2040



Source: AEO2015 Reference Case (April 2015)

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

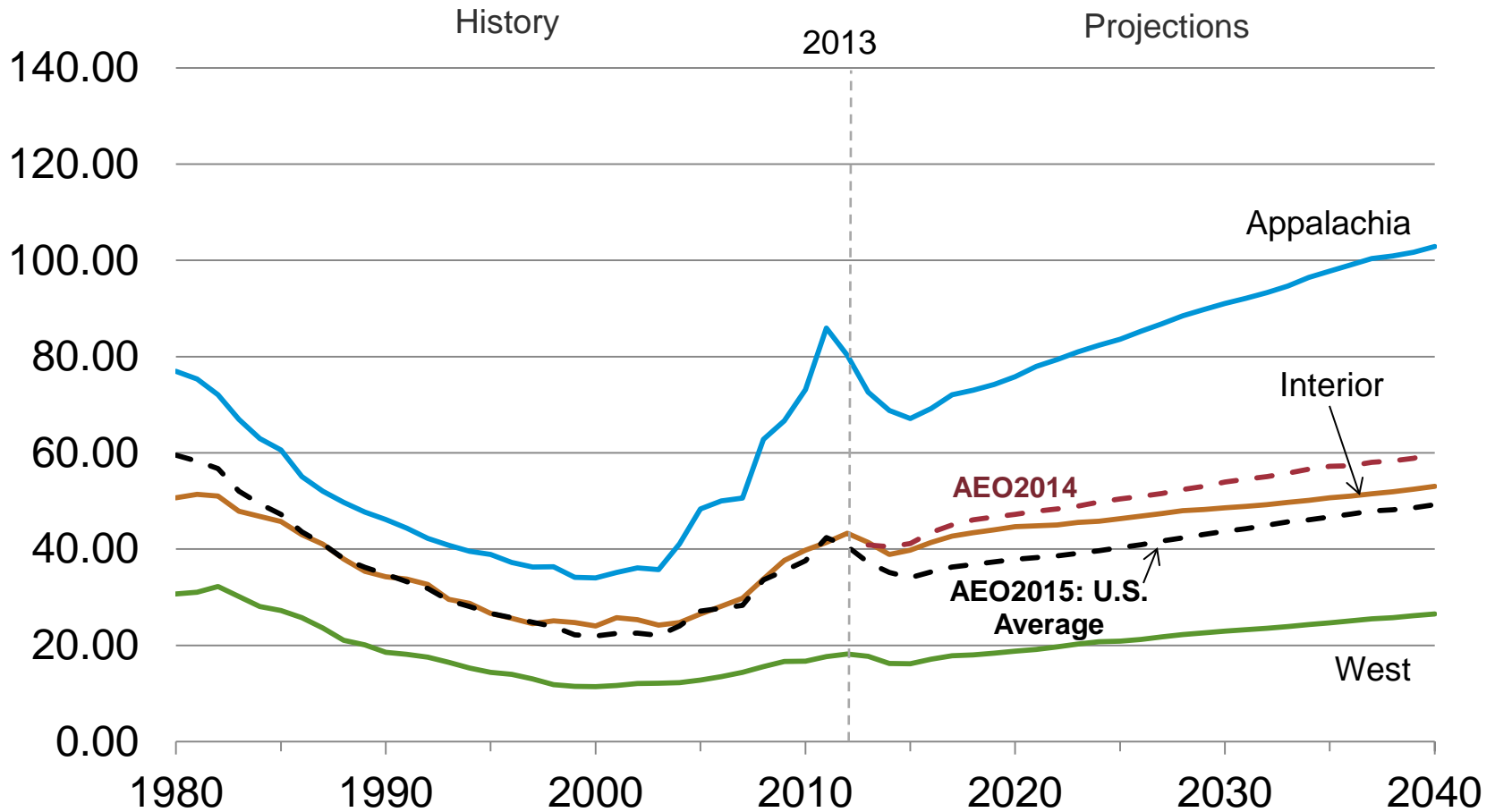
Coal Supply Region	1980 - 2013			Recent year-over-year changes		AEO2015 projections
	1980-1990	1990-2000	2000-2013	2011-2012	2012-2013	2013-2040
Northern Appalachia	5.4	5.5	-2.2	-4.9	3.7	-1.2
Central Appalachia	7.3	4.4	-5.2	-3.8	3.1	-2.9
Eastern Interior	4.8	3.7	-0.2	6.1	7.1	0.7
Gulf Lignite	2.6	2.4	-2.8	-4.2	-1.2	-1.0
Dakota Lignite	6.0	1.0	-3.3	-4.8	-1.7	-0.6
Western Montana	4.6	2.0	-2.4	-11.7	15.4	-1.0
WY, Northern Powder River Basin	7.5	3.2	-3.2	-5.7	-2.6	-1.1
WY, Southern Powder River Basin	7.2	4.9	-2.4	-6.4	4.9	-1.1
Rocky Mountain	7.8	5.5	-2.4	3.5	1.3	-1.5
U.S. Average	7.1	6.2	-1.8	-0.2	6.7	-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: AEO2015 Reference Case (April 2015).

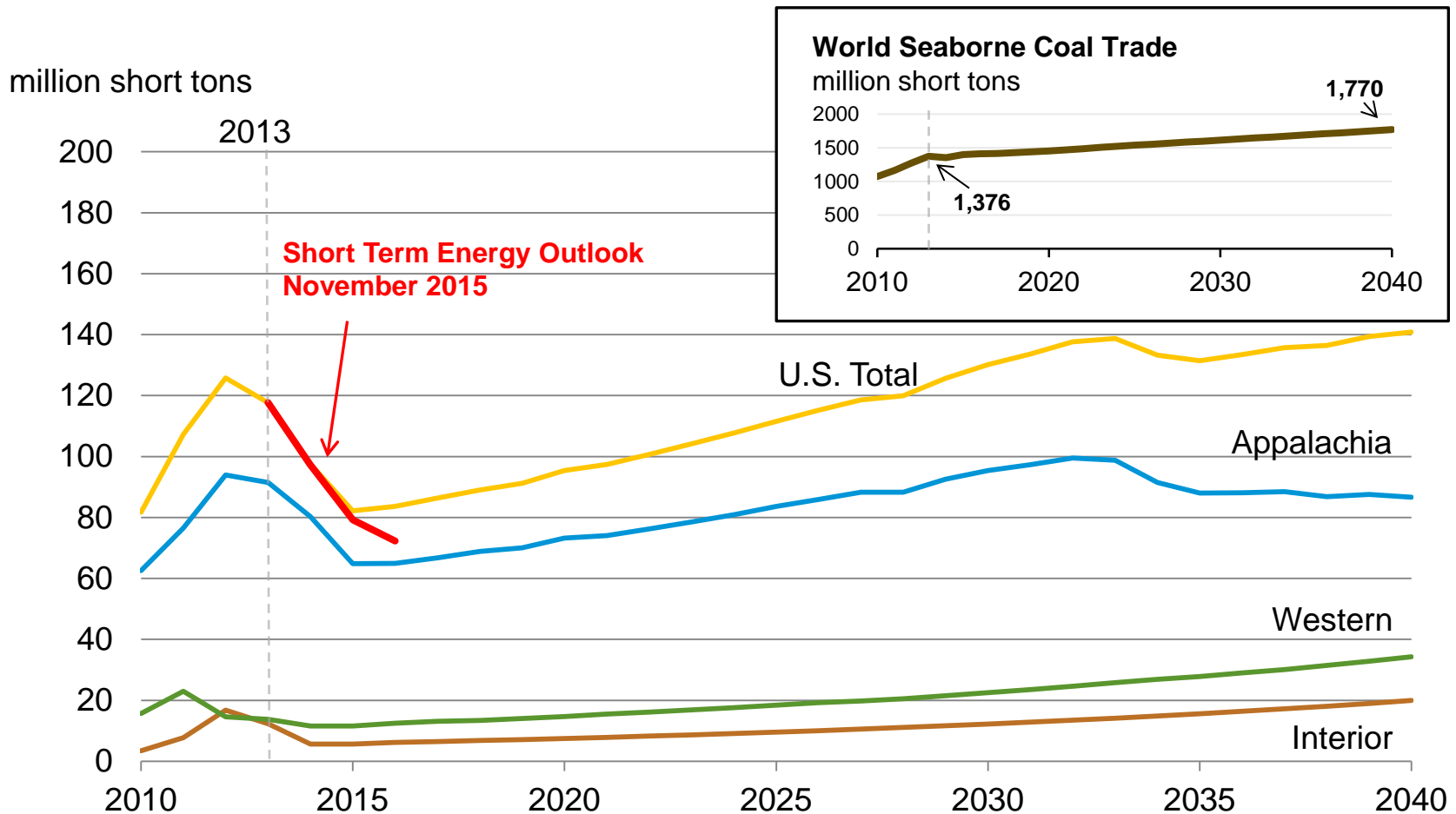
Average minemouth coal prices by region, 1980-2040

2013 dollars per short ton



Source: AEO2015 Reference Case (April 2015) and AEO2014 Reference Case (April 2014)

Coal exports by major supply region, 2010-2040



Source: 2010-2012: U.S. Energy Information Administration (EIA), Annual Coal Distribution Report; 2013-2040: AEO2015 Reference Case (April 2015).

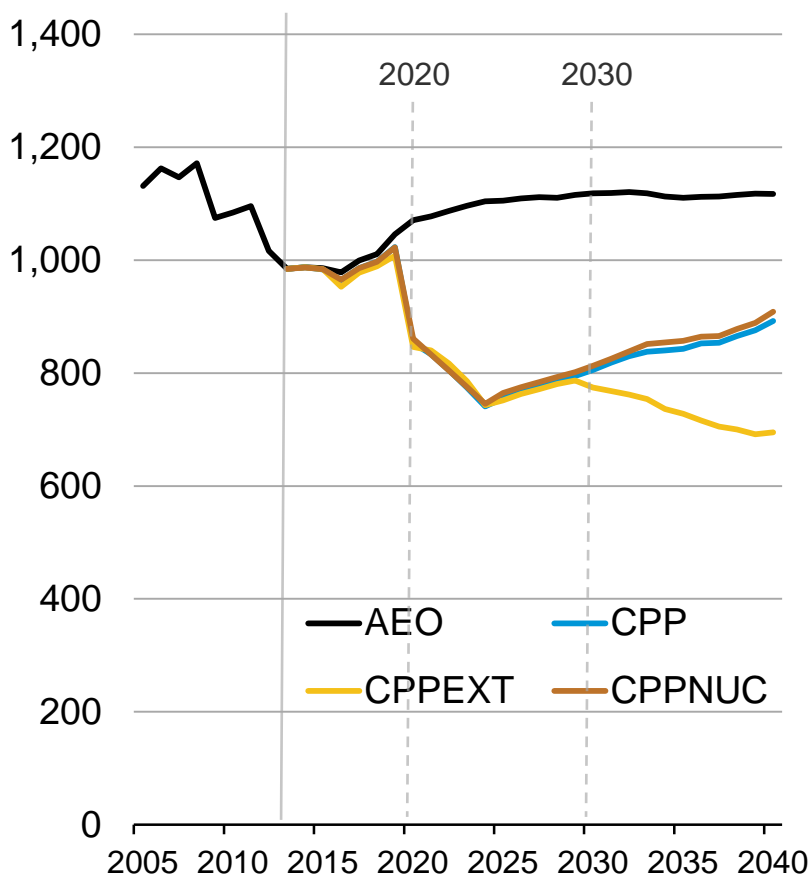
Proposed Clean Power Plan

Draft EPA Clean Power Plan (CPP) cases considered by EIA demonstrate potential impacts that may occur under the Final Rule

Case name	Description
Reference (AEO)	EIA's <i>AEO2015</i> Reference case presents long-term annual projections of energy supply, demand, and prices through 2040. The Reference case is based generally on federal, state, and local laws and regulations in effect as of the end of October 2014.
Policy Cases	<i>Regional CO₂ emission intensity targets were developed and added as a modeling constraint, based on specified state-level CO₂ emission intensity targets.</i>
Base Policy (CPP)	The Base Policy case models the proposed Clean Power Plan using the <i>AEO2015</i> Reference case as the underlying baseline, allowing regions to choose compliance strategies endogenously from among the four building blocks in EPA's proposed Best System of Emissions Reduction.
Policy Extension (CPPEXT)	The Policy Extension case extends CO ₂ reduction targets beyond 2030, in order to reduce CO ₂ emissions from the power sector by 45% below 2005 levels in 2040, using the <i>AEO2015</i> Reference case as the baseline.
Policy with New Nuclear (CPPNUC)	The CPPNUC case assumes that generation from new nuclear power plants that are not currently under construction is counted in compliance calculations in the same manner as new renewable generation.

Coal production levels for the Base Policy case (CPP) are substantially below baseline – 20% lower in 2020 and 32% lower in 2025

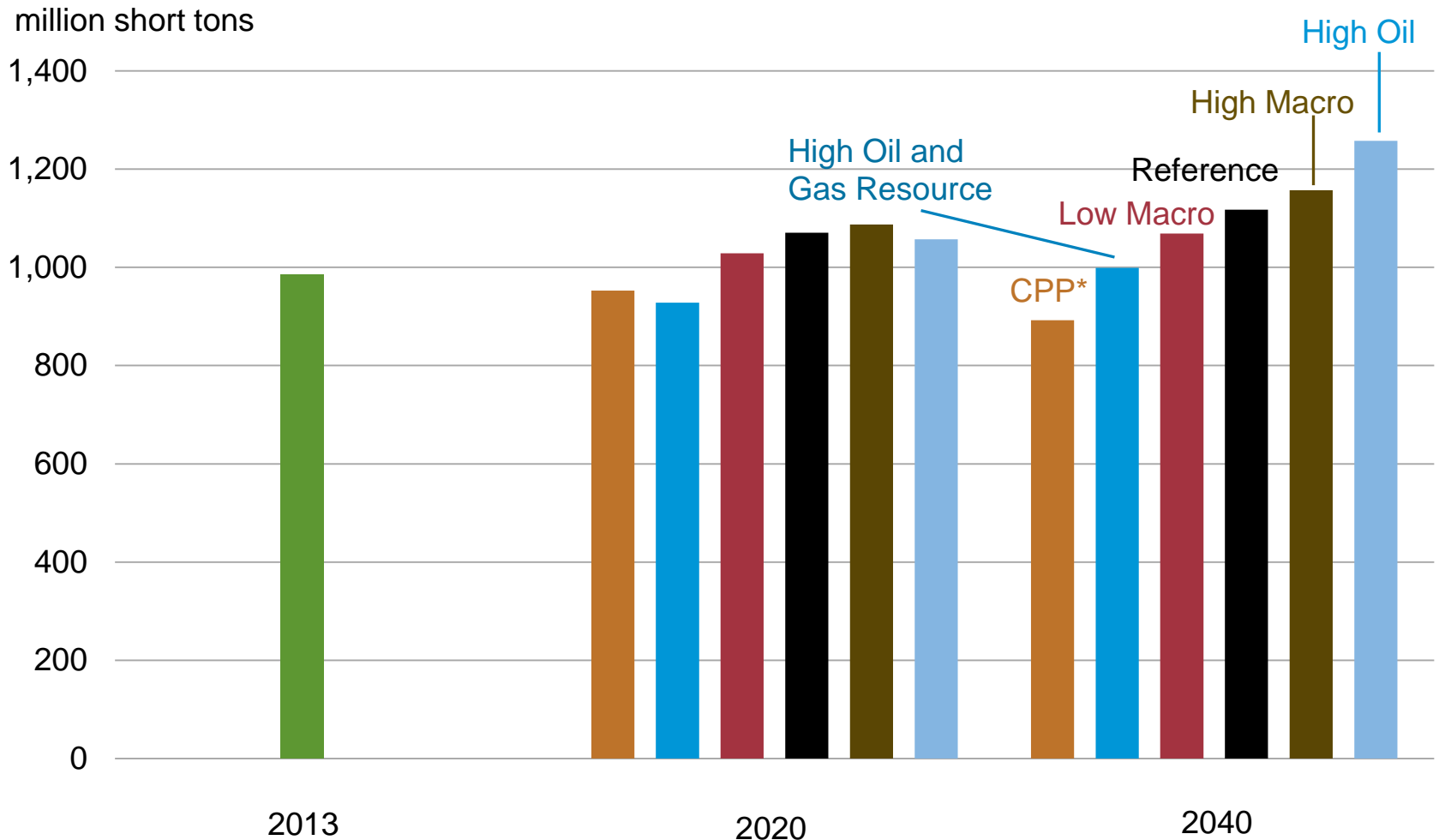
million short tons



- Coal production in the Base Policy case increases by 151 million tons after 2024 as utilization of remaining coal units improves due to increasing electricity demand, expanded use of renewables, rising natural gas prices, and static CPP targets in the post-2030 period

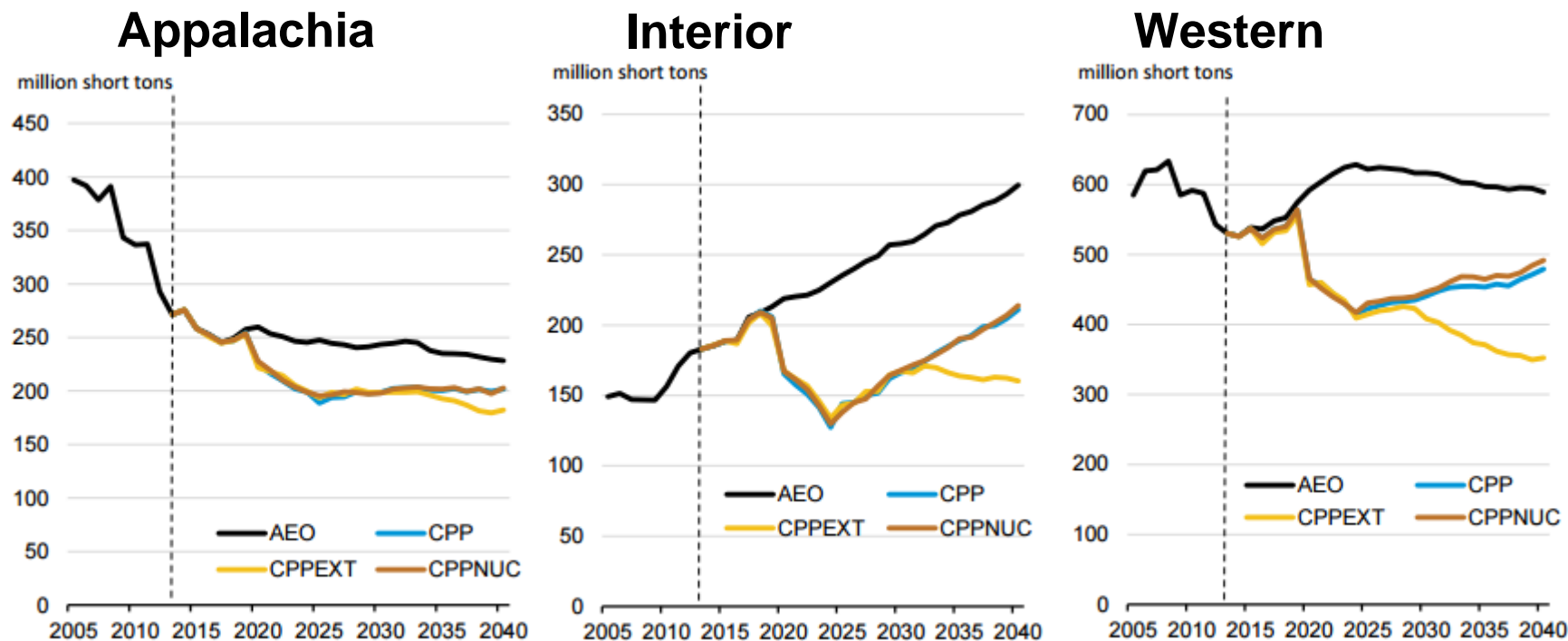
Source: EIA, Annual Energy Outlook 2015 and Analysis of Impacts of the Clean Power Plan, May 2015

U.S. Coal Production, 2020 and 2040



Source: U.S. Energy Information Administration, Annual Energy Outlook 2015 National Energy Modeling System runs RF15_111_ALL.D030615A (*proposed Clean Power Plan), HIGHRESOURCE.D112913B, LOWMACRO.D021915A, REF2015.D021915A, HIGHMACRO.D021915A, and HIGHOIL.D021915A.

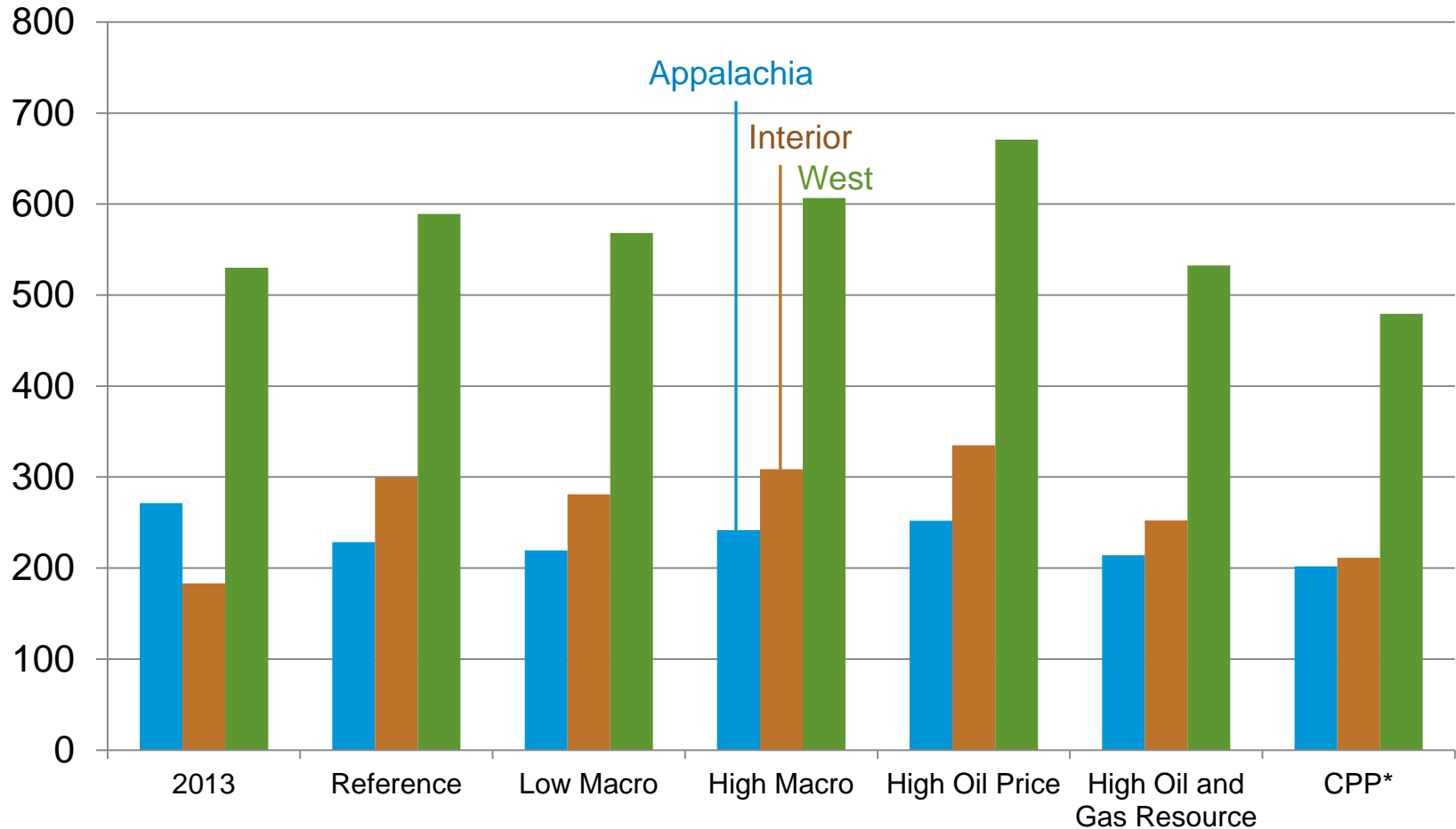
Regional coal production impacts vary across regions and Proposed Clean Power Plan scenario



Source: EIA, Annual Energy Outlook 2015 and Analysis of Impacts of the Clean Power Plan, May 2015

Coal production by region, 2040

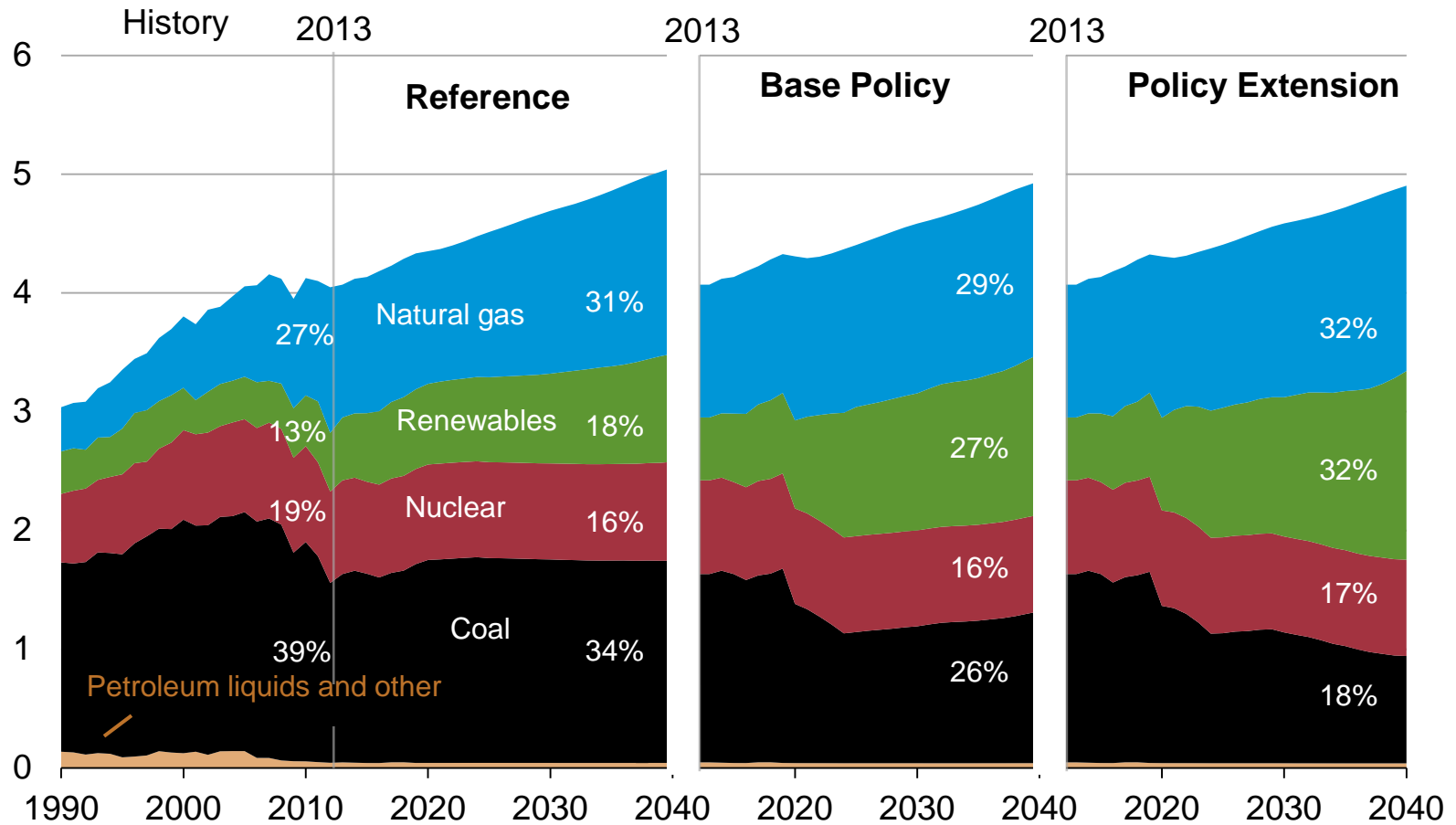
Million short tons



Source: U.S. Energy Information Administration, Annual Energy Outlook 2015 National Energy Modeling System runs RF15_111_ALL.D030615A (*proposed Clean Power Plan), HIGHRESOURCE.D112913B, LOWMACRO.D021915A, REF2015.D021915A, HIGHMACRO.D021915A, and HIGHOIL.D021915A

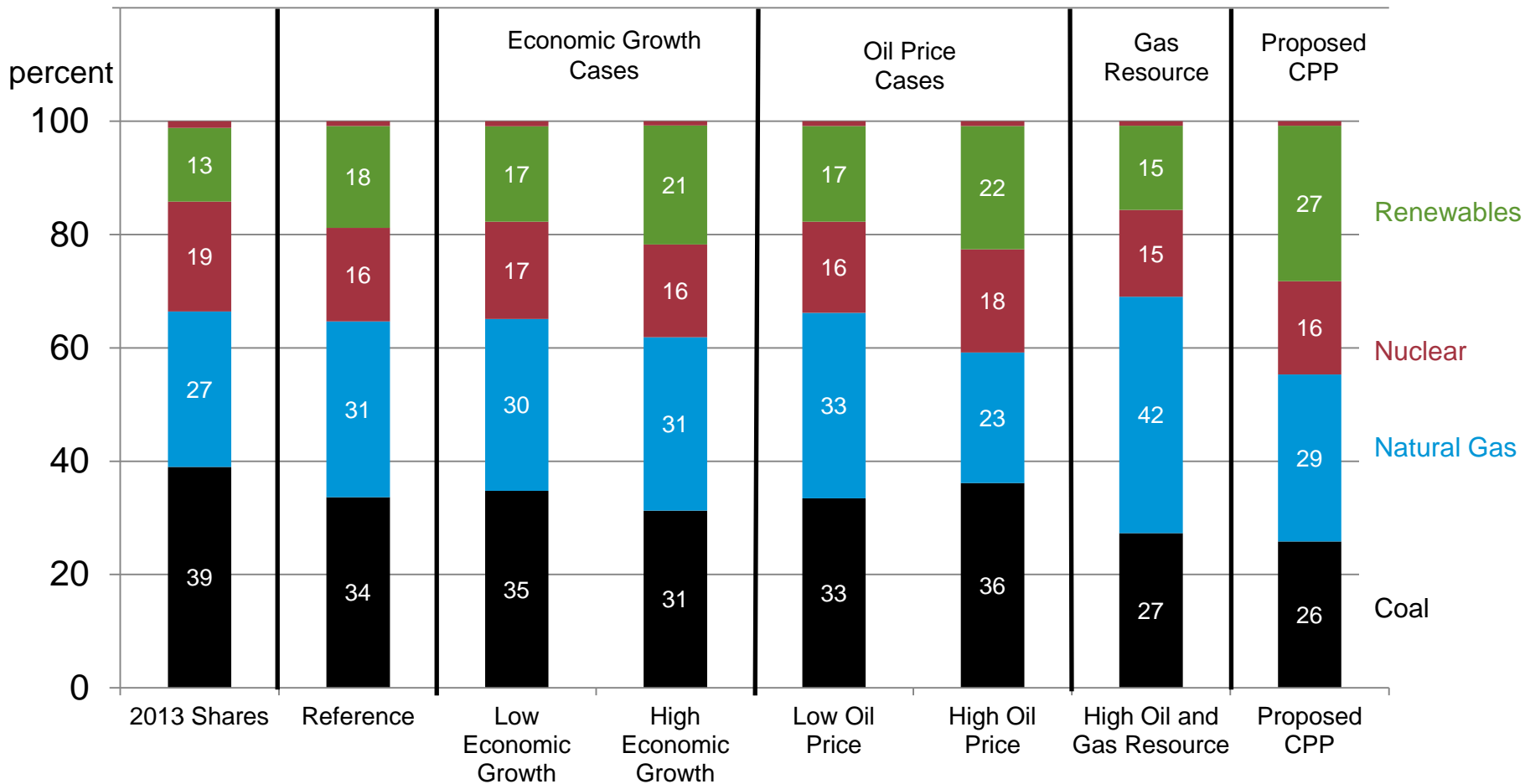
The proposed CPP rule causes a significant reduction in generation from coal

total electricity generation
trillion kilowatthours



Source: EIA, Annual Energy Outlook 2015 and Analysis of Impacts of the Clean Power Plan, May 2015

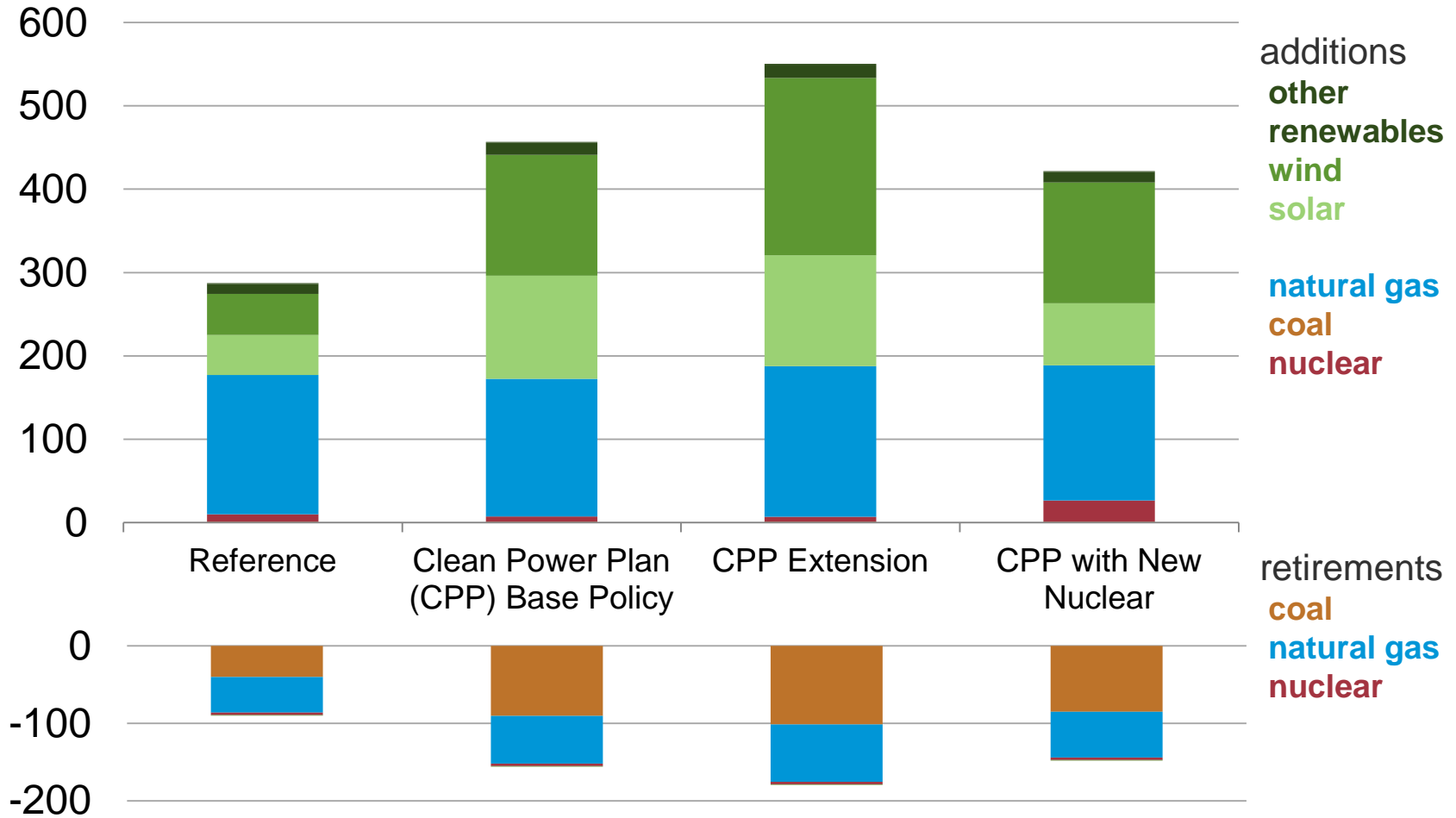
2040 electricity generation shares



Source: U.S. Energy Information Administration, Annual Energy Outlook 2015 National Energy Modeling System runs RF15_111_ALL.D030615A (*proposed Clean Power Plan), HIGHRESOURCE.D112913B, LOWMACRO.D021915A, REF2015.D021915A, HIGHMACRO.D021915A, and HIGHOIL.D021915A

From 2014-2040, CPP case retirements (mostly coal) are 66 GW above Reference; renewable capacity adds are 174 GW above Reference

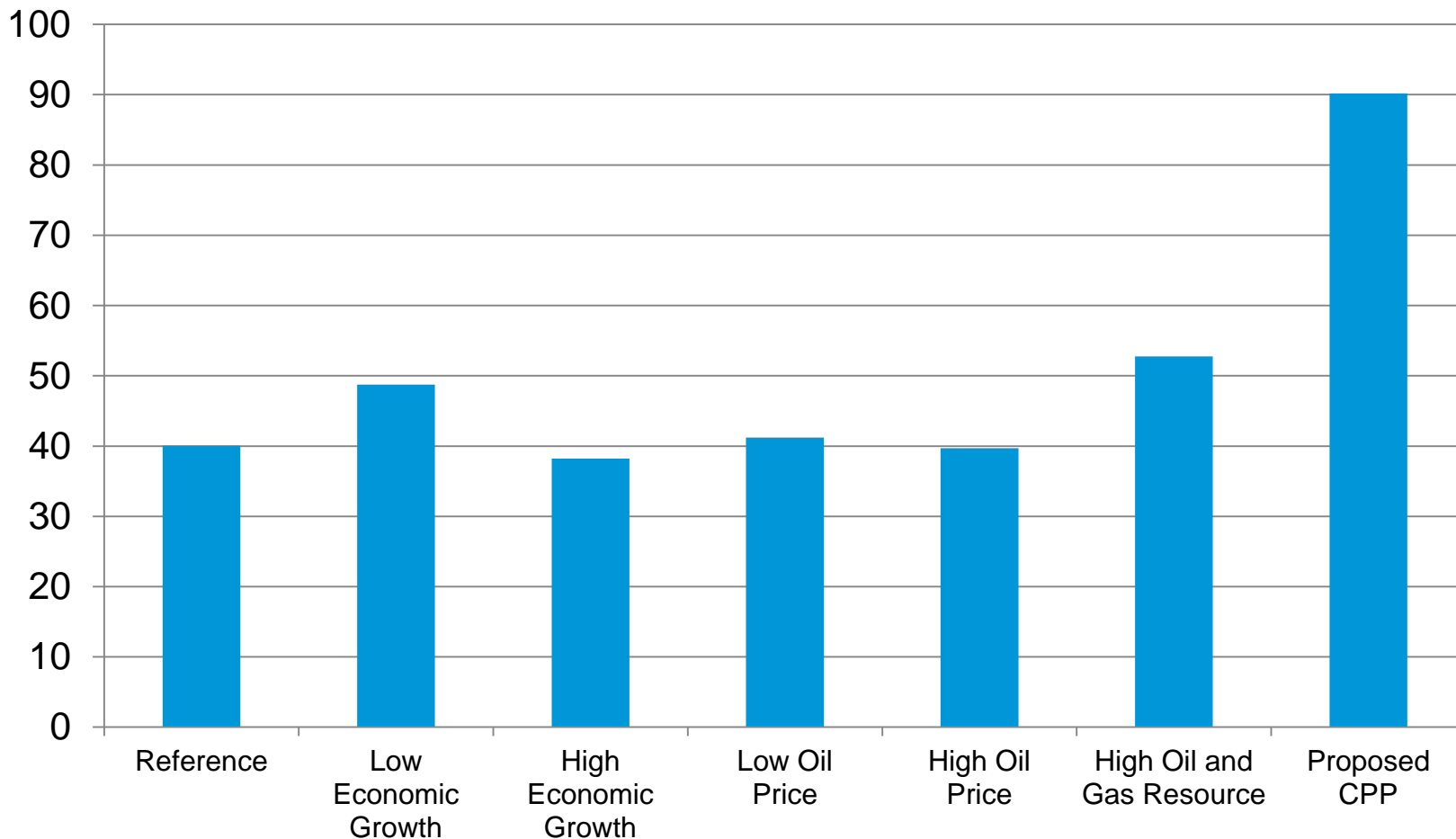
Cumulative additions and retirements, 2014-40
gigawatts



Source: EIA, Annual Energy Outlook 2015 and Analysis of Impacts of the Clean Power Plan, May 2015

Cumulative coal-fired capacity retirements, 2012-2040

gigawatts



Source: U.S. Energy Information Administration, Annual Energy Outlook 2015 National Energy Modeling System runs RF15_111_ALL.D030615A (*proposed Clean Power Plan), HIGHRESOURCE.D112913B, LOWMACRO.D021915A, REF2015.D021915A, HIGHMACRO.D021915A, and HIGHOIL.D021915A

Final rule delays start, improves phase-in, changes coverage, and increases flexibility

Proposed Rule	Final Rule
Compliance begins in 2020 with one interim period from 2020 – 2029; Final targets in 2030	Compliance start delayed to 2022 with three interim periods (2022–2024, 2025-2027, 2028-2029); Final targets in 2030
Four building blocks (heat rate improvement, switching to NG, zero-carbon technologies, EE)	Three building blocks (heat rate improvement, switching to NG, zero-carbon technologies); EE counts for compliance but is not included in target calculation
Existing nonhydro renewables and incremental (new) renewables are included; end-use renewables excluded	Existing renewables excluded; incremental (post-2012) additions only; end-use renewables (incremental) included
Existing “at-risk” and incremental (post-2012) nuclear included	Existing (“at-risk”) nuclear excluded; incremental (post-2012) additions only
Fossil emission rates based on each State’s existing capacity resulting in considerable variation	Source specific (fossil steam, NGCC) rates determined at interconnect level reducing variation
Existing fossil steam, NGCC, and “large” or “higher-utilization” combustion turbines included	Existing fossil steam, NGCC; all combustion turbines excluded
Mass-based targets described but not specified	Two mass-based targets specified for fossil (existing, all)
Credit trading described but not sufficiently specified	Credit trading options more fully defined

EIA Data Browsers and Energy Mapping System

Analysis of the proposed Clean Power Plan -

<http://www.eia.gov/analysis/requests/powerplants/cleanplan/>

Electricity Data Browser - <http://www.eia.gov/electricity/data/browser/>

Coal Data Browser (Beta) - <http://www.eia.gov/beta/coal/data/browser/>

Nuclear Outage Browser (Beta) - <http://www.eia.gov/beta/outages/>

Energy Mapping System - <http://www.eia.gov/state/maps.cfm>

Short-Term Energy Outlook - <http://www.eia.gov/forecasts/steo/query/>

Annual Energy Outlook - <http://www.eia.gov/oiaf/aeo/tablebrowser/>

International Energy Outlook - <http://www.eia.gov/oiaf/aeo/tablebrowser/>

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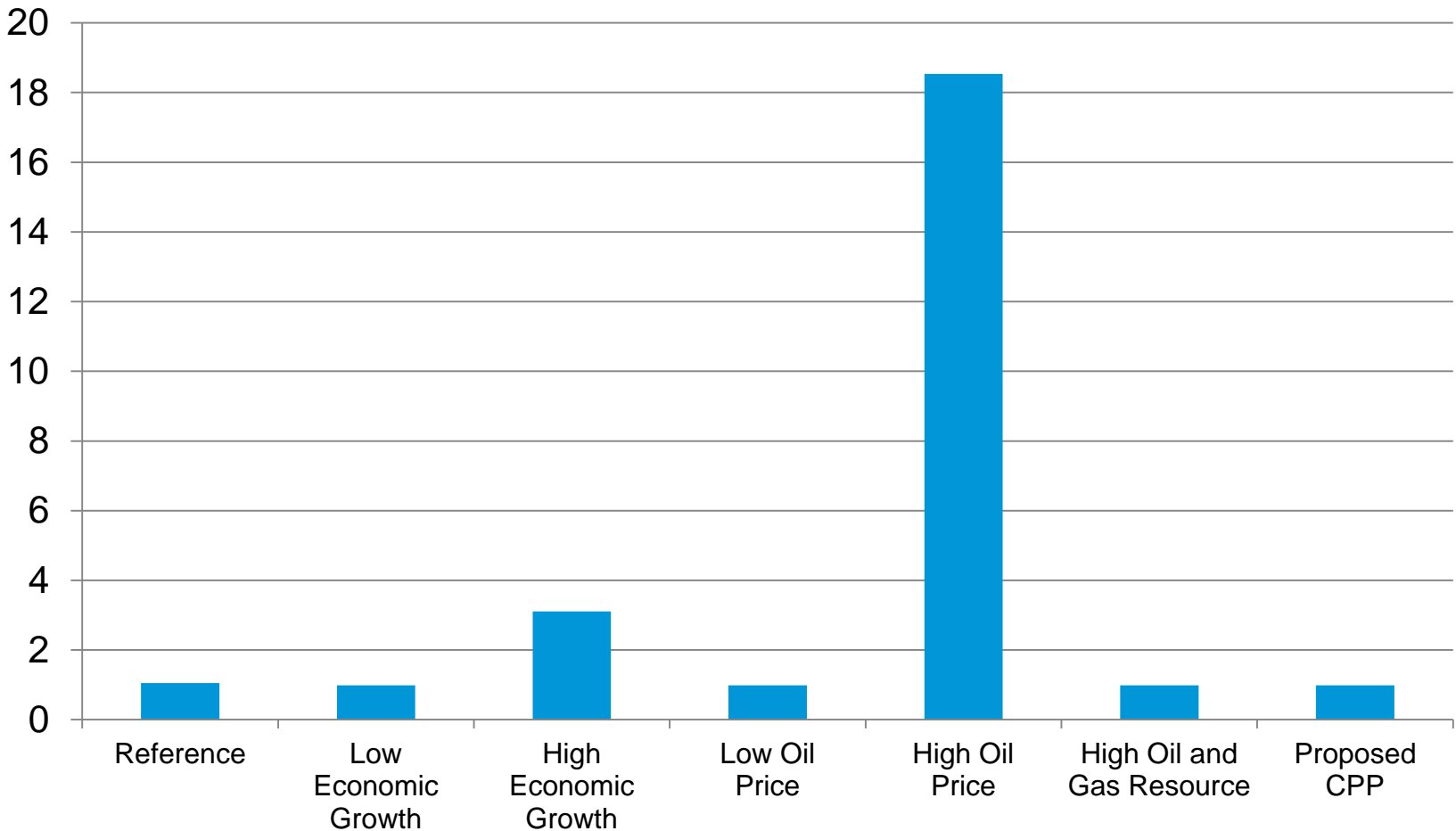
Supplemental Slides

Key differences between alternate AEO cases

	AEO2015 Reference	Low Economic Growth	High Economic Growth	High Oil and Gas Resource	High Oil Price	Low Oil Price
GDP growth (avg. annual change from 2013)	2.4%	1.8%	2.9%			
Electricity demand (avg. annual change from 2013)	0.8%	0.5%	1.2%			
Delivered natural gas price to the electricity sector, 2040 (2013 dollars per million Btu)	\$8.28			\$4.67	\$10.08	\$7.77

Cumulative coal-fired capacity additions, 2012-2040

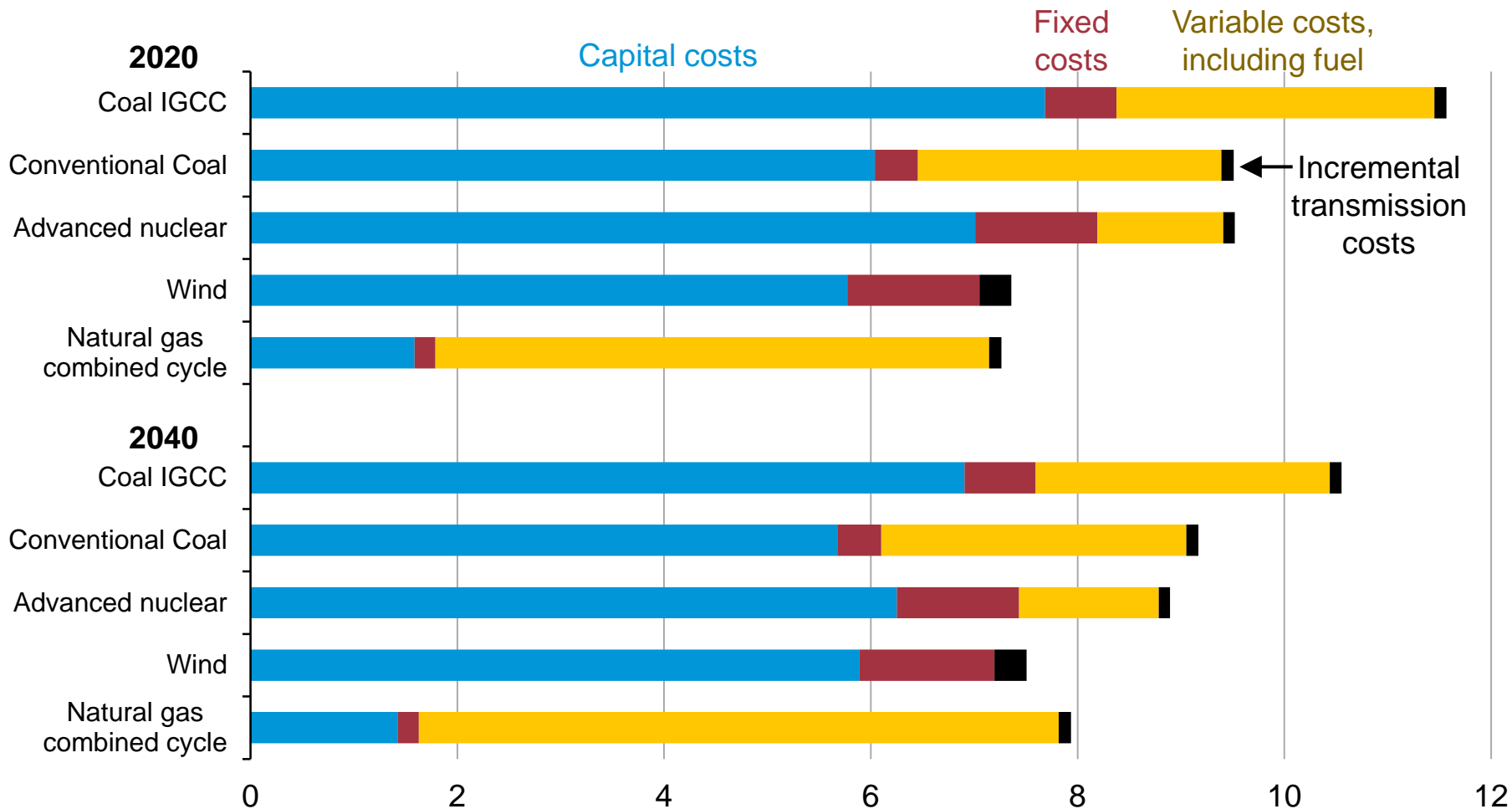
gigawatts



Source: U.S. Energy Information Administration, Annual Energy Outlook 2015 National Energy Modeling System runs RF15_111_ALL.D030615A (*proposed Clean Power Plan), HIGHRESOURCE.D112913B, LOWMACRO.D021915A, REF2015.D021915A, HIGHMACRO.D021915A, and HIGHOIL.D021915A

Average levelized electricity costs for new power plants, excluding subsidies, in the Reference case, 2020 and 2040

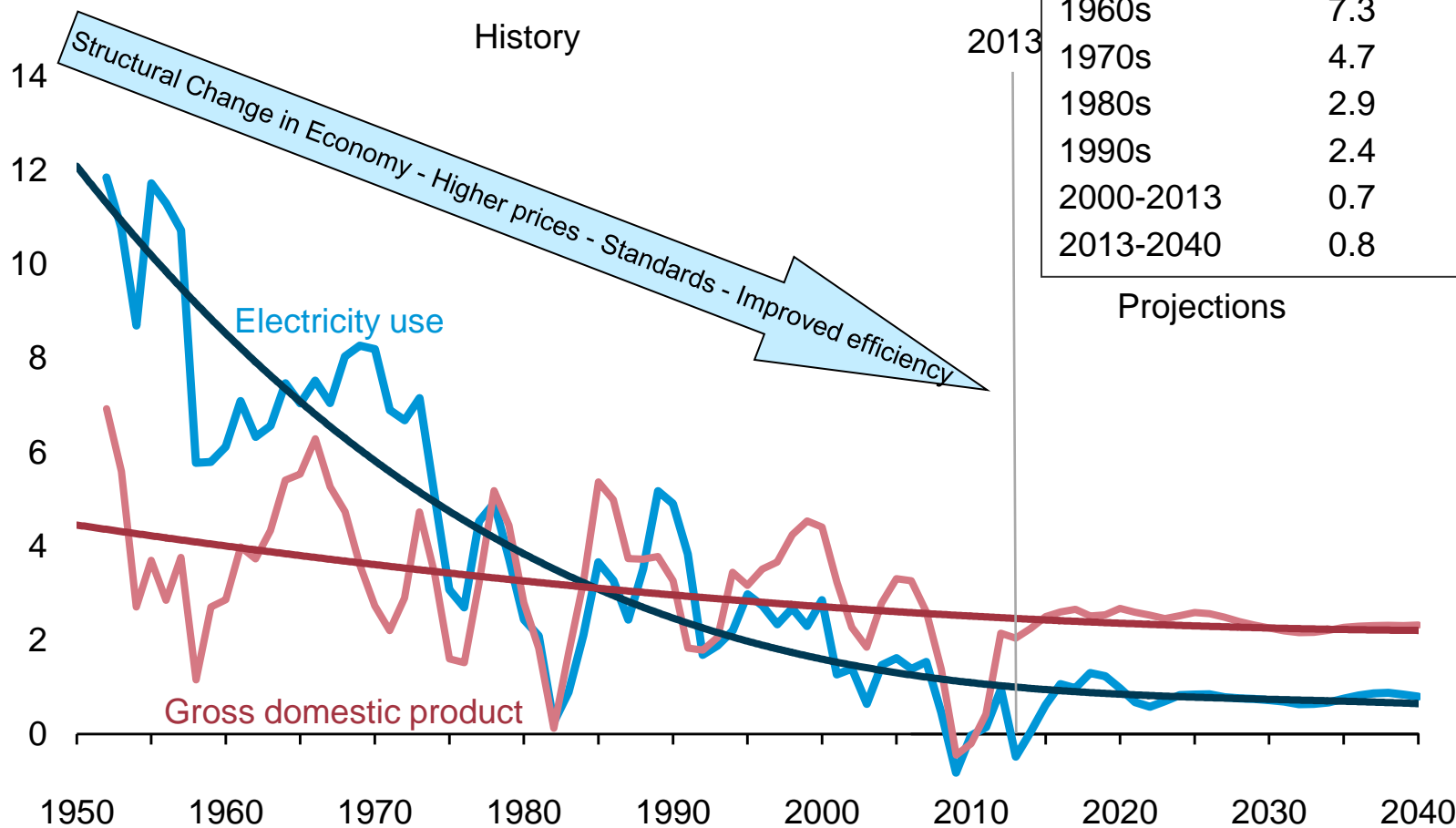
new power plant costs, 2013 cents per kilowatthour



Source: AEO2015 Reference Case (April 2015)

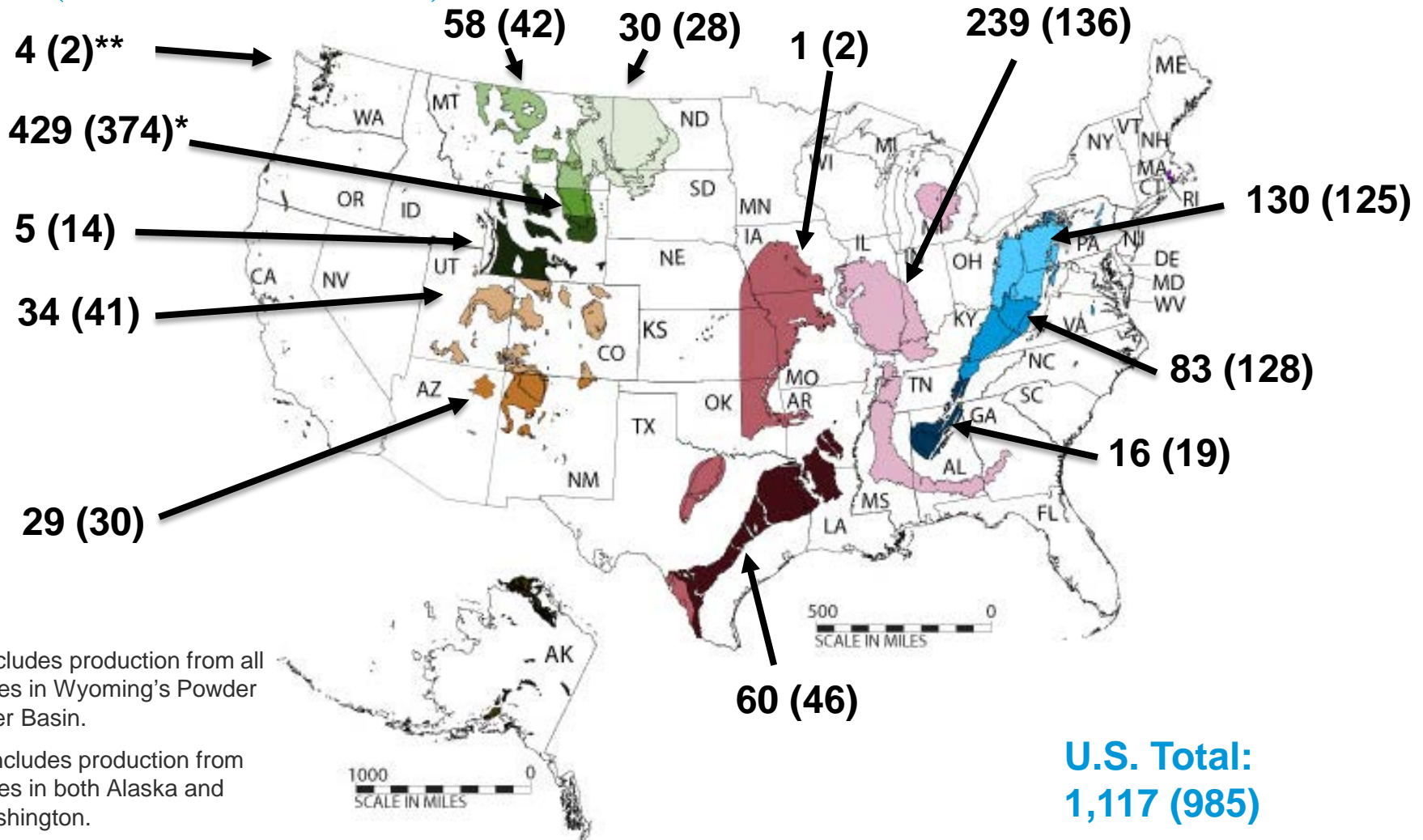
Growth in electricity use slows, but electricity use still increases by 24% from 2013 to 2040

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



Source: EIA, Annual Energy Outlook 2015 Reference case

Coal production, AEO2015 in 2040 (vs. 2013) (million short tons)

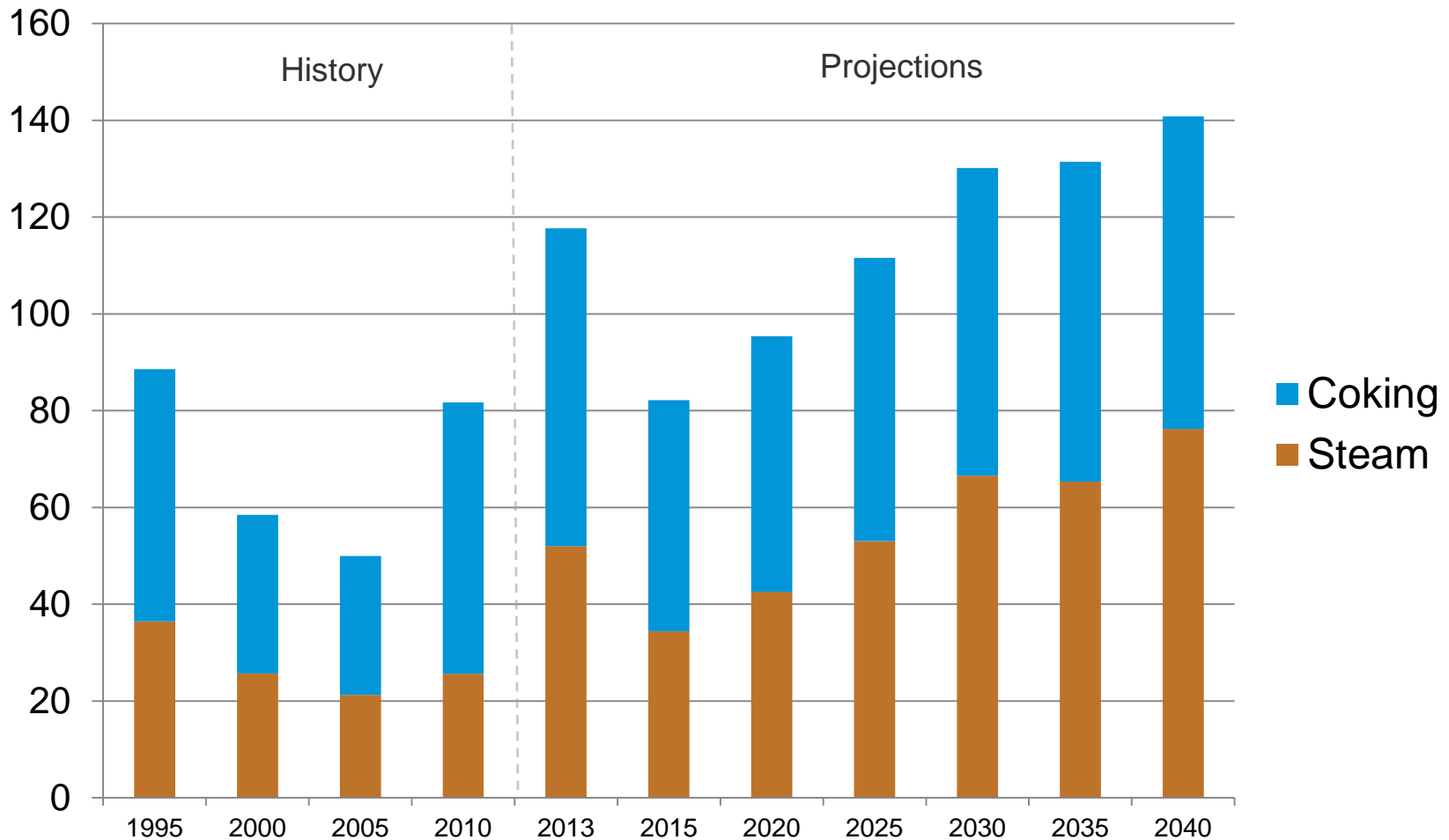


* Includes production from all mines in Wyoming's Powder River Basin.
 ** Includes production from mines in both Alaska and Washington.

Source: 2013: Mine Safety and Health Administration, Form 7000-2, "Quarterly Mine and Employment and Coal Production Report;" 2040: AEO2015 Reference Case (April 2015).

U.S. Coal Exports, 1995-2040

million short tons

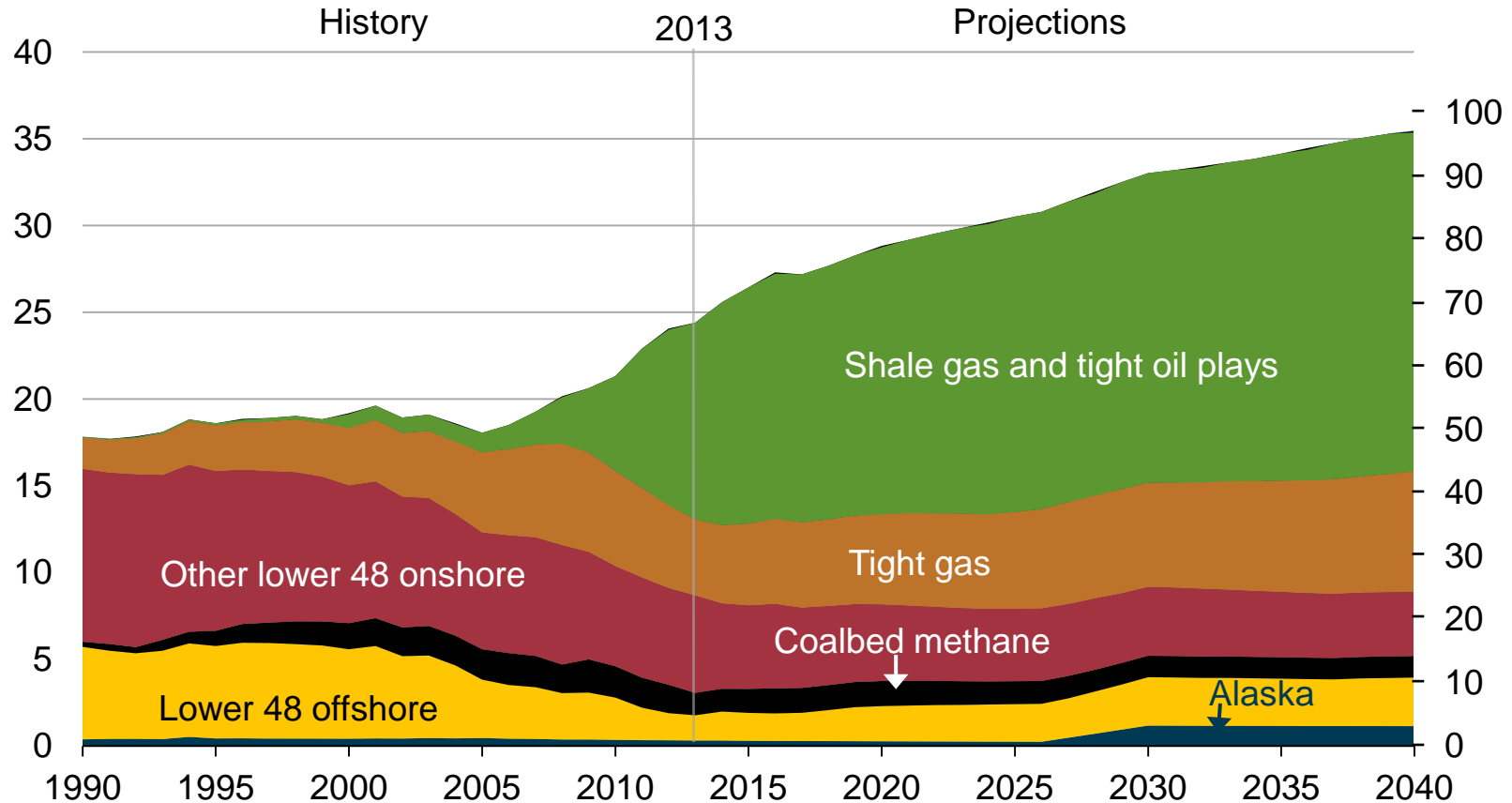


Source: History: U.S. Energy Information Administration (EIA), *Quarterly Coal Report*;
Projections: AEO2015 Reference Case (April 2015).

Shale resources remain the dominant source of U.S. natural gas production growth

U.S. dry natural gas production
trillion cubic feet

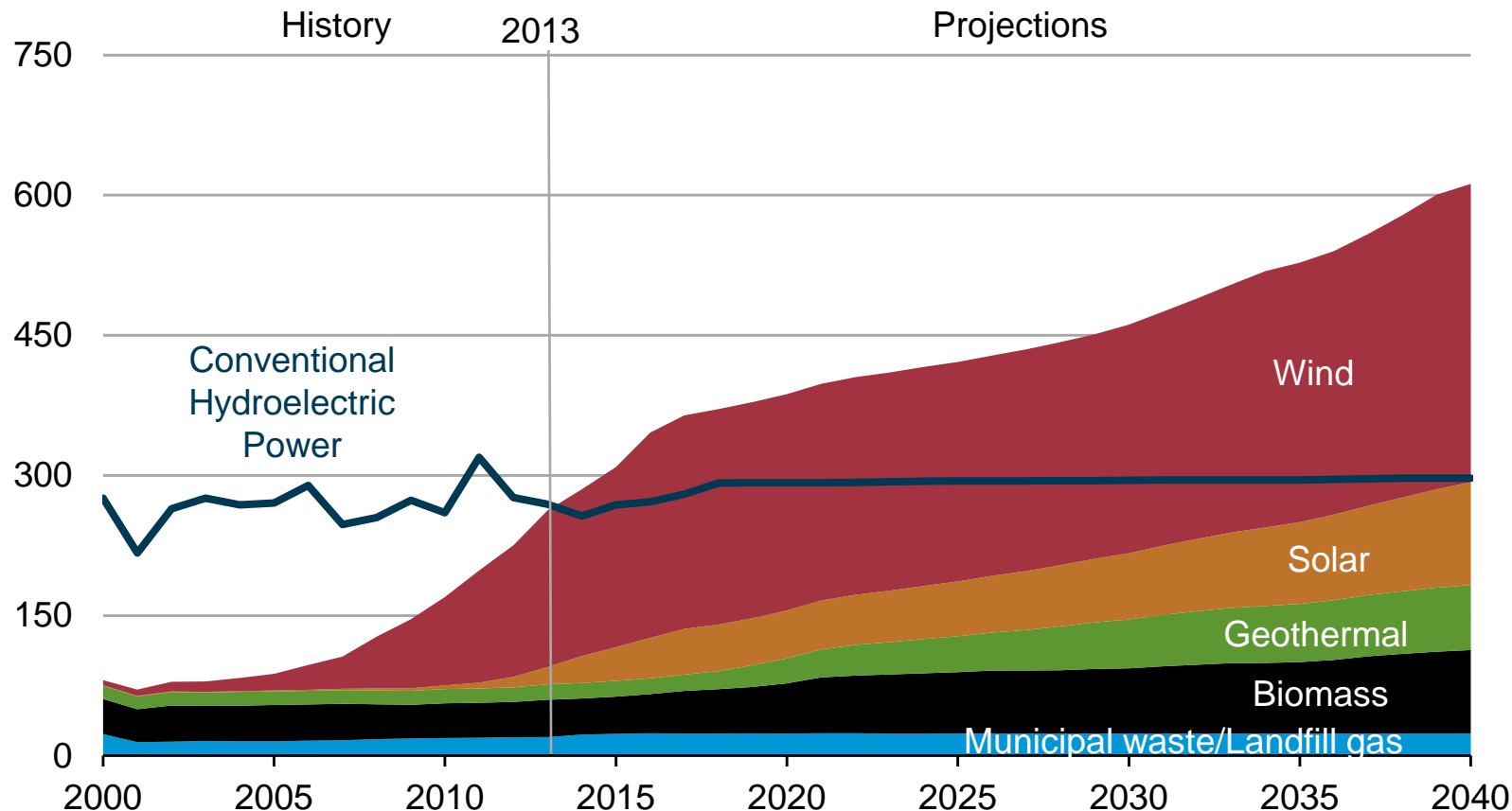
billion cubic feet per day



Source: EIA, Annual Energy Outlook 2015 Reference case

Non-hydro renewable generation grows to double hydropower generation by 2040

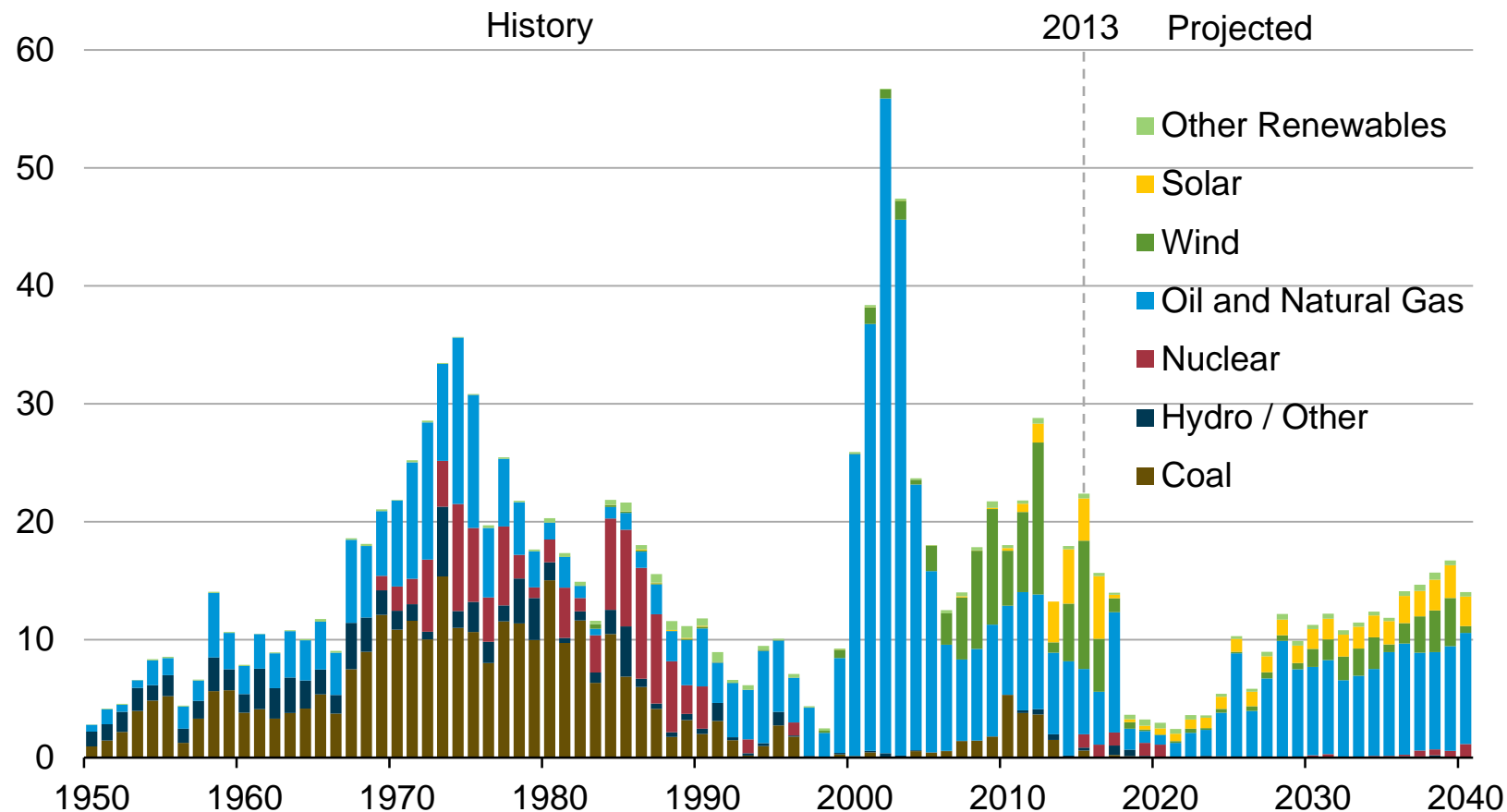
renewable electricity generation by fuel type
billion kilowatthours



Source: EIA, Annual Energy Outlook 2015 Reference case

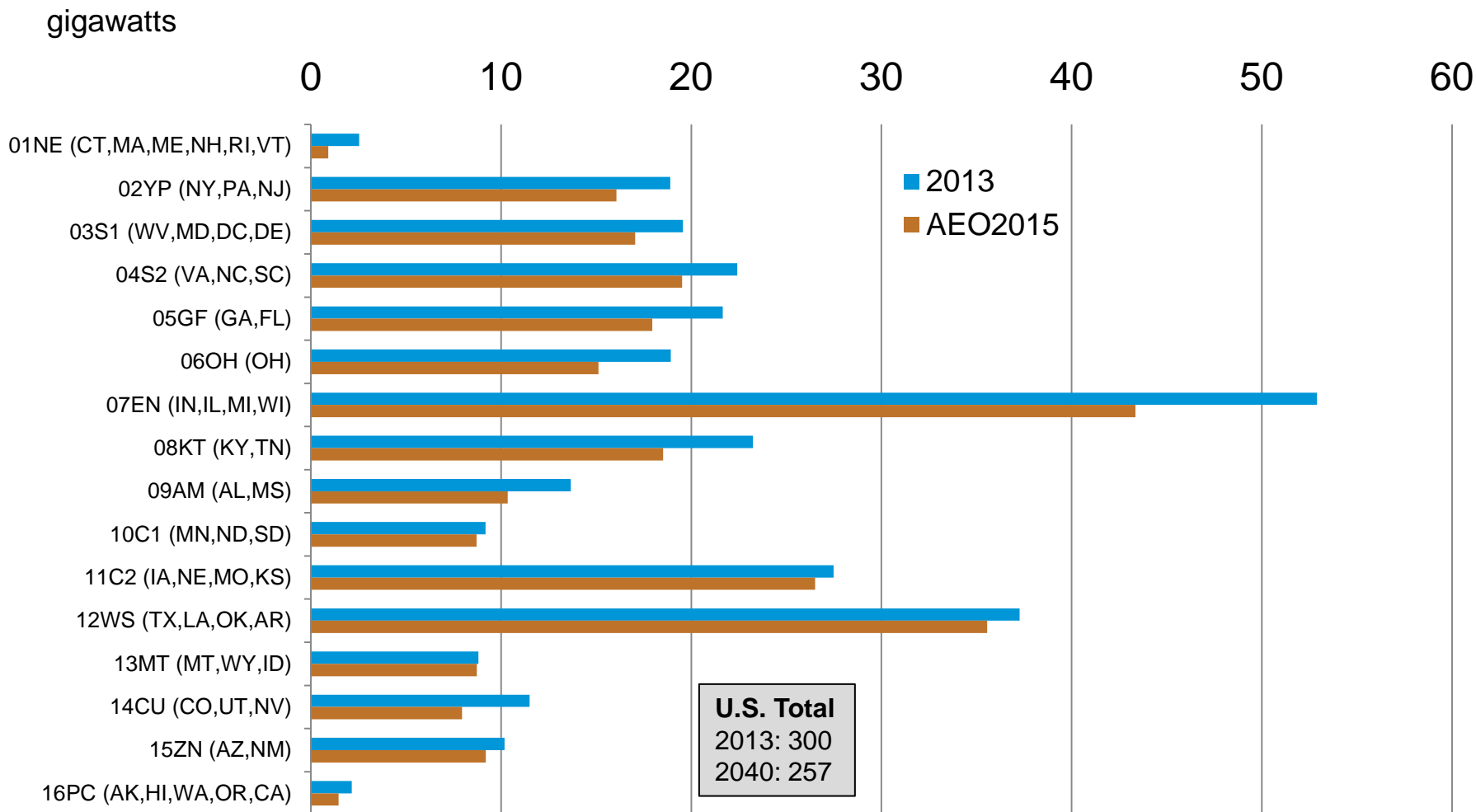
Gas-fueled units account for most projected capacity additions in the AEO2015 Reference case

U.S. electricity generation capacity additions
gigawatts



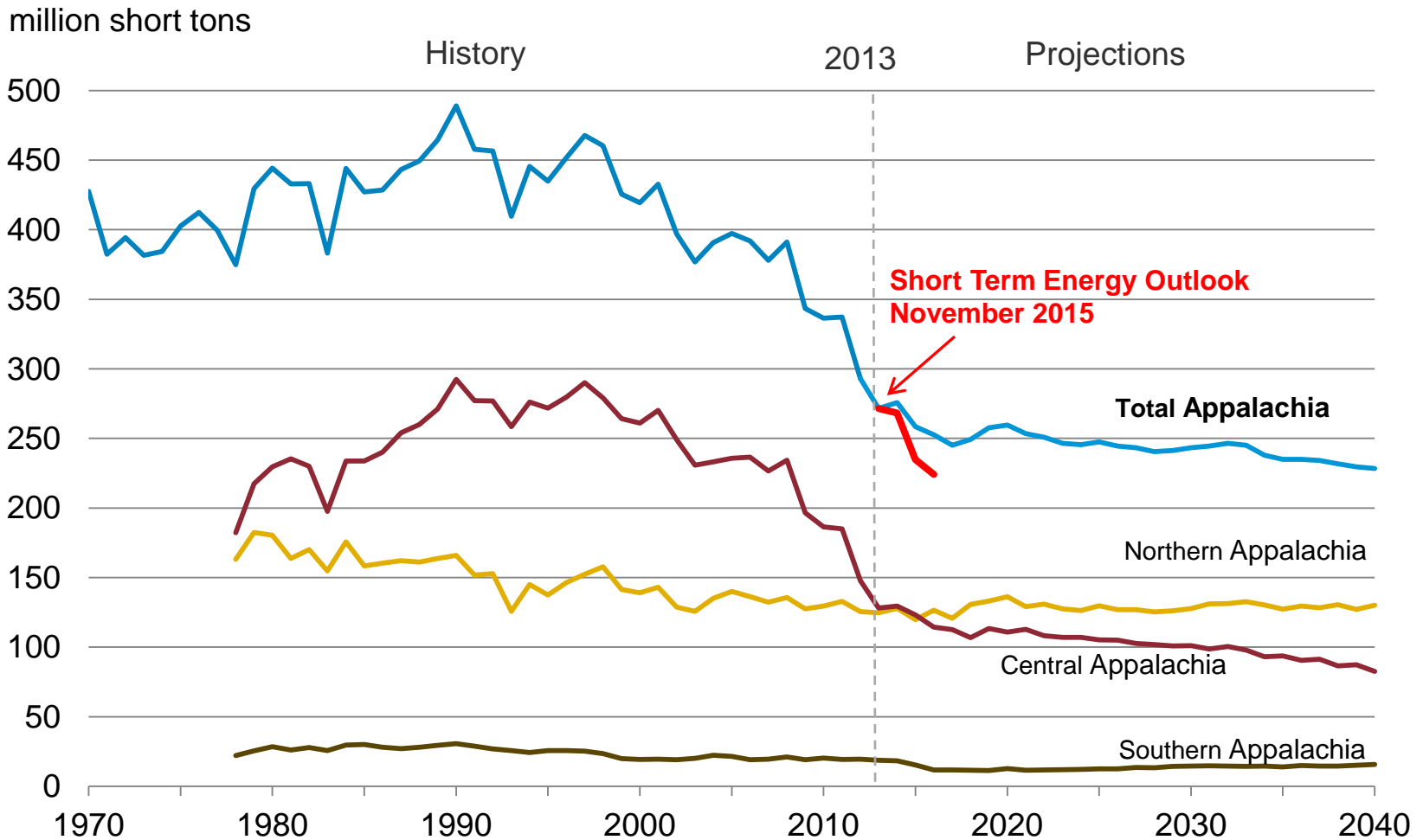
Source: Form EIA-860 & EIA Annual Energy Outlook 2015

Net summer coal-fired generating capacity in the electric power sector by coal demand region, 2013 and 2040



Source: AEO2015 Reference Case (April 2015)

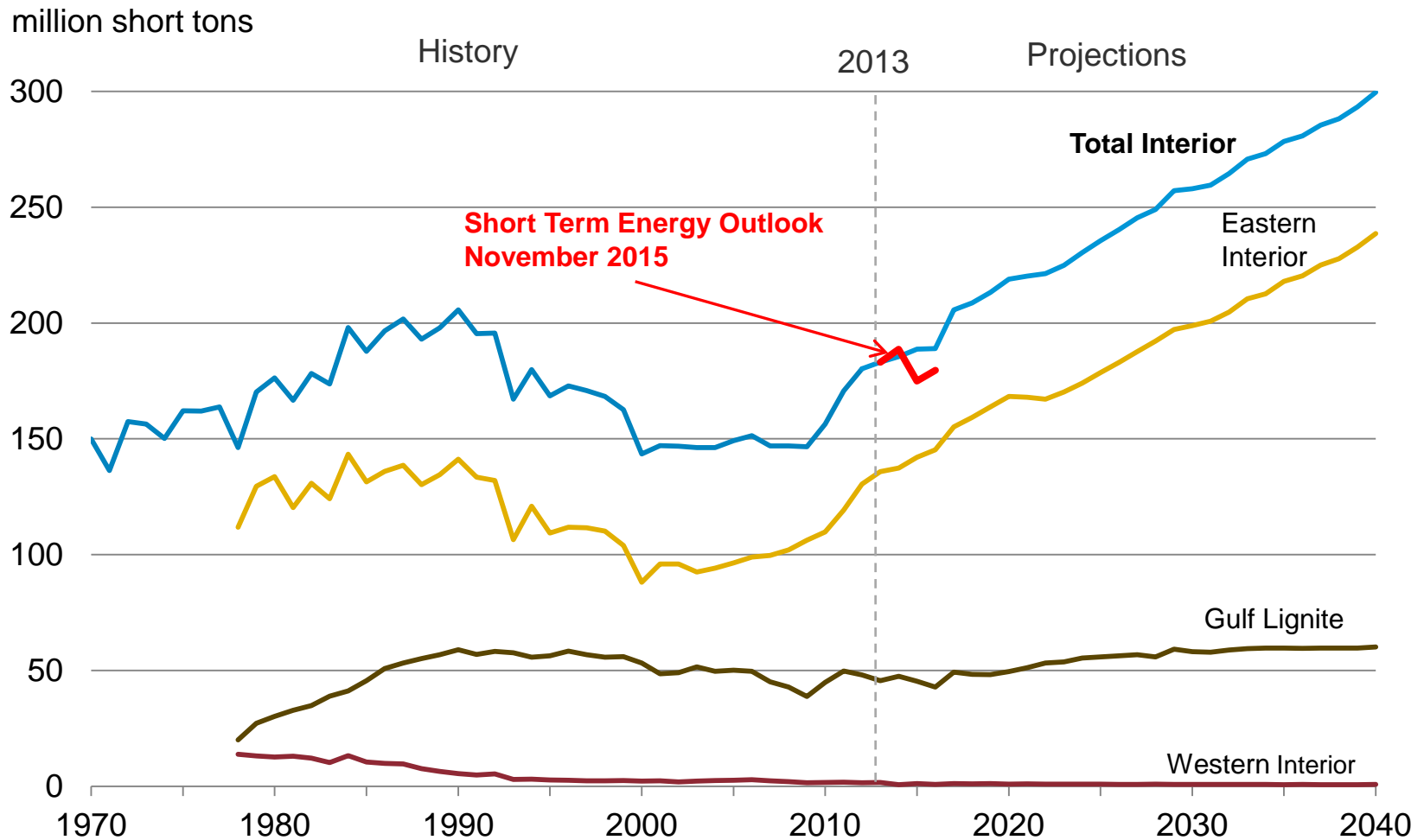
Appalachian coal production, 1970-2040



Source: AEO2015 Reference Case (April 2015)

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

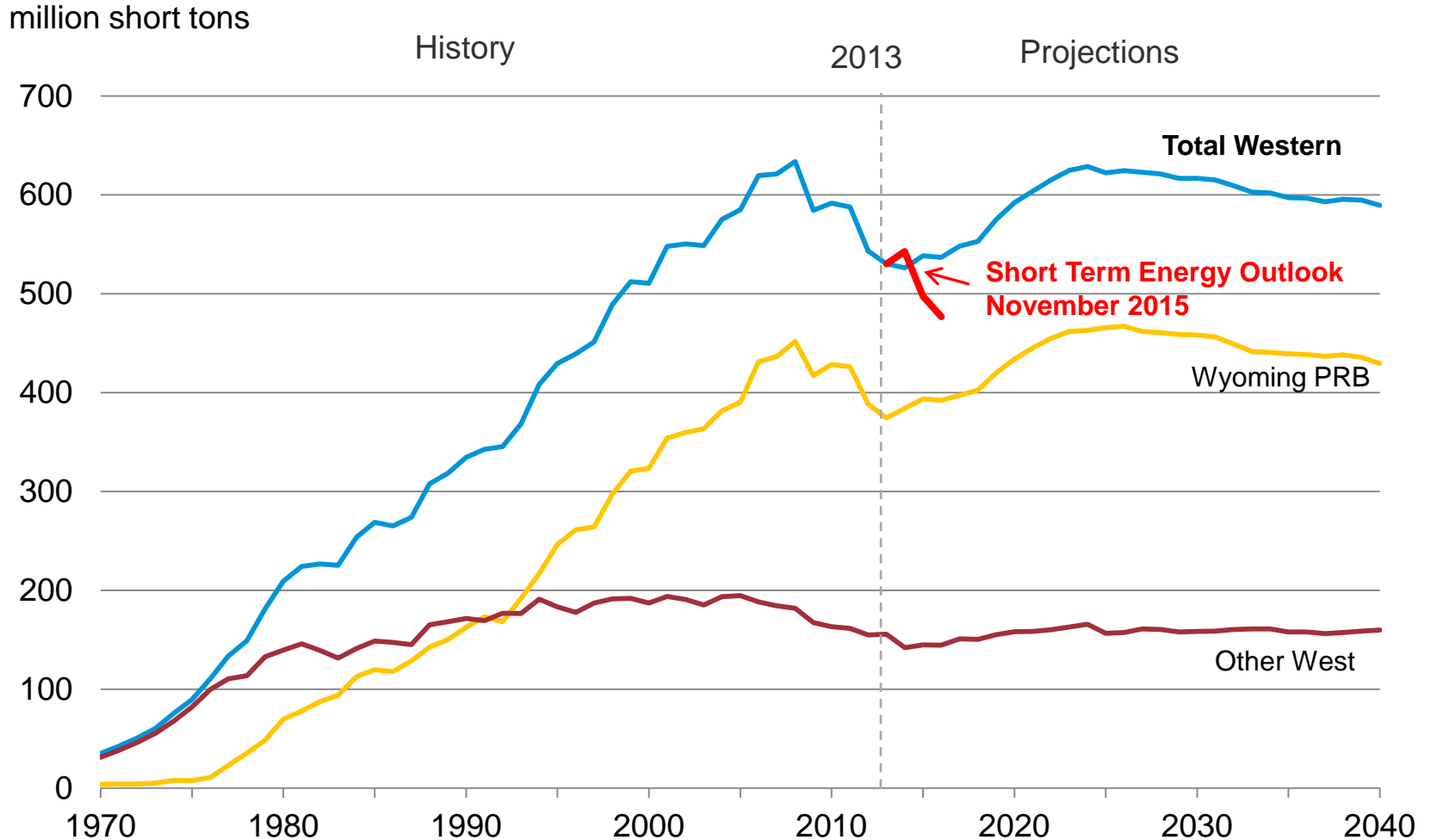
Interior coal production, 1970-2040



Source: 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: AEO2015 Reference Case (April 2015)

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