Impact of the Clean Power Plan
Annual Energy Outlook 2016 Reference/Alternative Cases

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by

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Key conclusions: variety of potential impacts of Clean Power Plan (CPP) in AEO2016- Reference Case vs. Alternatives

- How the states implement the Clean Power Plan influences its impact on the power sector
- CO2 emission reduction requirements under Clean Power Plan accelerate a shift in generation mix already underway
- Pressure on coal continues even in absence of Clean Power Plan, leading to natural gas as predominant utility fuel
- Significant level of coal retirements expected even without CPP

Key updates in AEO2016

- Incorporation of the U.S. Environmental Protection Agency's final rules for the Clean Power Plan
- Updated renewable capital costs
- Latest California zero-emission vehicle sales mandates, which have been adopted by a number of other states
- Extension of the production tax credit for wind and 30% investment tax credit for solar
- Lower near-term crude oil prices

What everyone must know about CPP

- EPA's application of Clean Air Act framework to utility CO2 emissions
- Federal role: EPA sets CO2 performance standards for existing generators
- State role: states develop implementation plans with significant potential flexibility
  - Major choices available to states: 1) type of approach to regulation; 2) cooperation with other states, 3) integration with other programs.
- Rule stayed by Supreme Court Feb. 2016, pending arguments before D.C. Circuit (now scheduled for Fall 2016.)

Logic behind Clean Power Plan (CPP) implementation in AEO2016 Reference case

- Familiarity: selected mass-based as apparent preferred option
- Uniformity: all states assumed to follow same program type
- Avoid regulatory pitfalls: applied budgets covering existing units and new source complement (no “leakage”)
- Minimize rate impacts: assumes allocation to load-serving entities

How states choose to implement CPP influences its impact on power sector

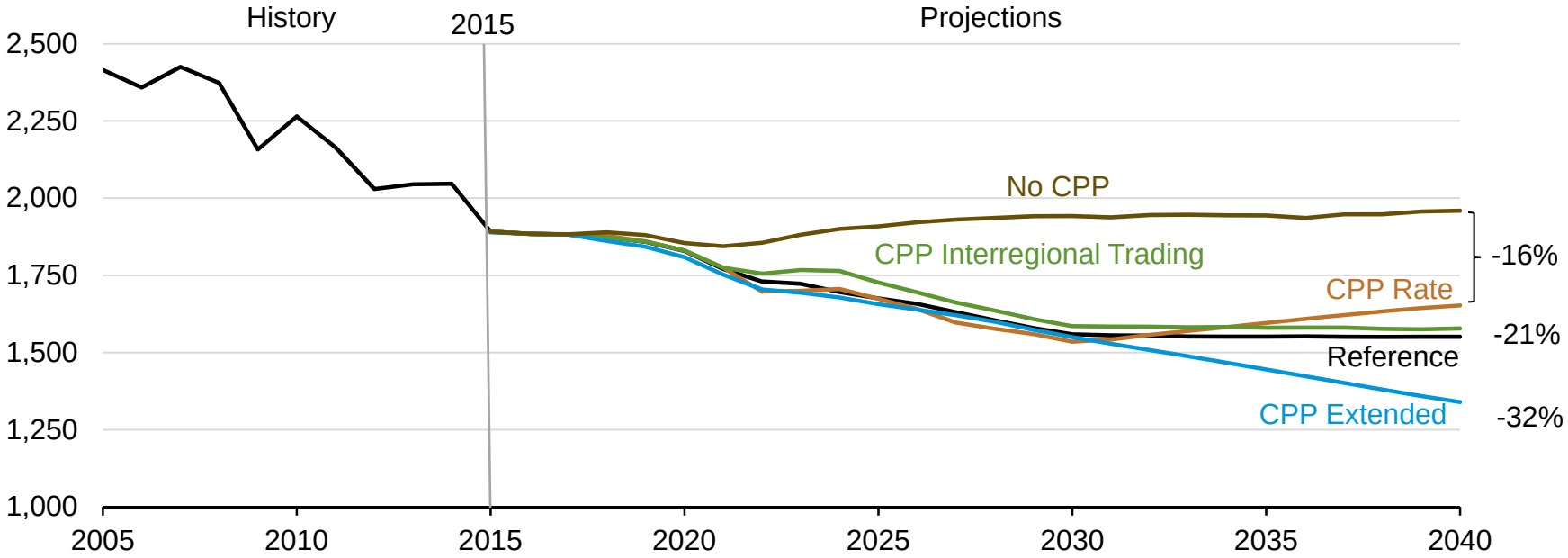
Case	What type of target to set?	What level of cooperation w/ other states?	To whom to allocate CO2 allowances?	General impact vs. Reference	Avg retail electricity price impact per yr vs No CPP 2022-2040
Reference	Mass	Intra-regional (EMM level)	Load-serving entities	N/A	2.8%
No CPP	N/A	N/A	N/A	Stable coal generation	N/A
CPP Rate	Rate	Intra-regional	N/A	More renewable generation	2.9%
CPP Interregional Trading	Mass	Inter-regional (Interconnect level)	Load-serving entities	More renewable generation, fewer coal retirements	2.5%
CPP Allocation to Generators	Mass	Intra-regional	Generators	Higher electricity prices	4.3%
CPP Extended	Mass	Intra-regional	Load-serving entities	More coal retirements, gas, renewables	3.2%

Source: EIA, Annual Energy Outlook 2016

By 2040, CPP electric sector CO2 emissions are 32-36% below the 2005 level vs. a 19% reduction in No CPP and 45% drop in Extended case

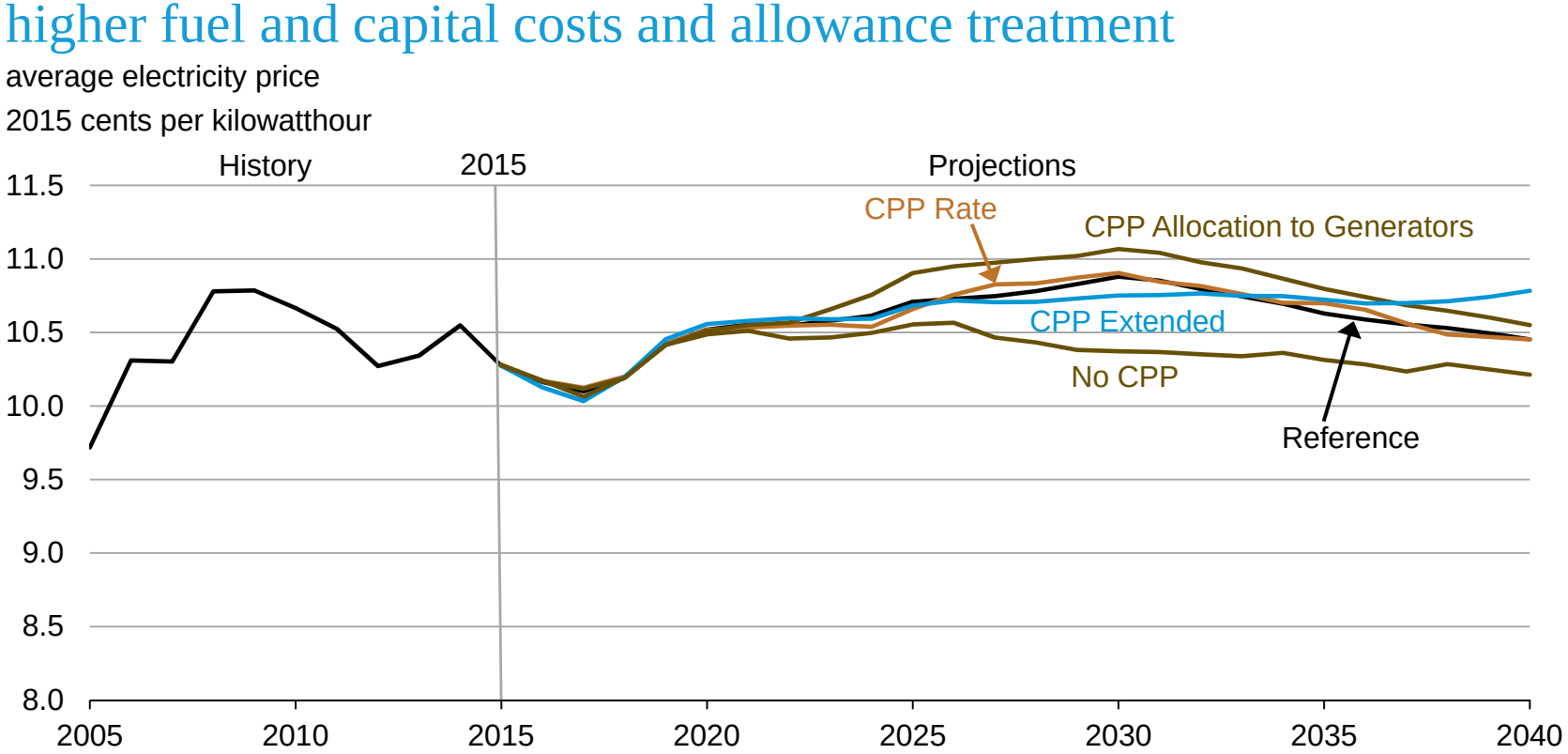
electric power sector carbon dioxide (CO2) emissions

million metric tons



Source: EIA, Annual Energy Outlook 2016

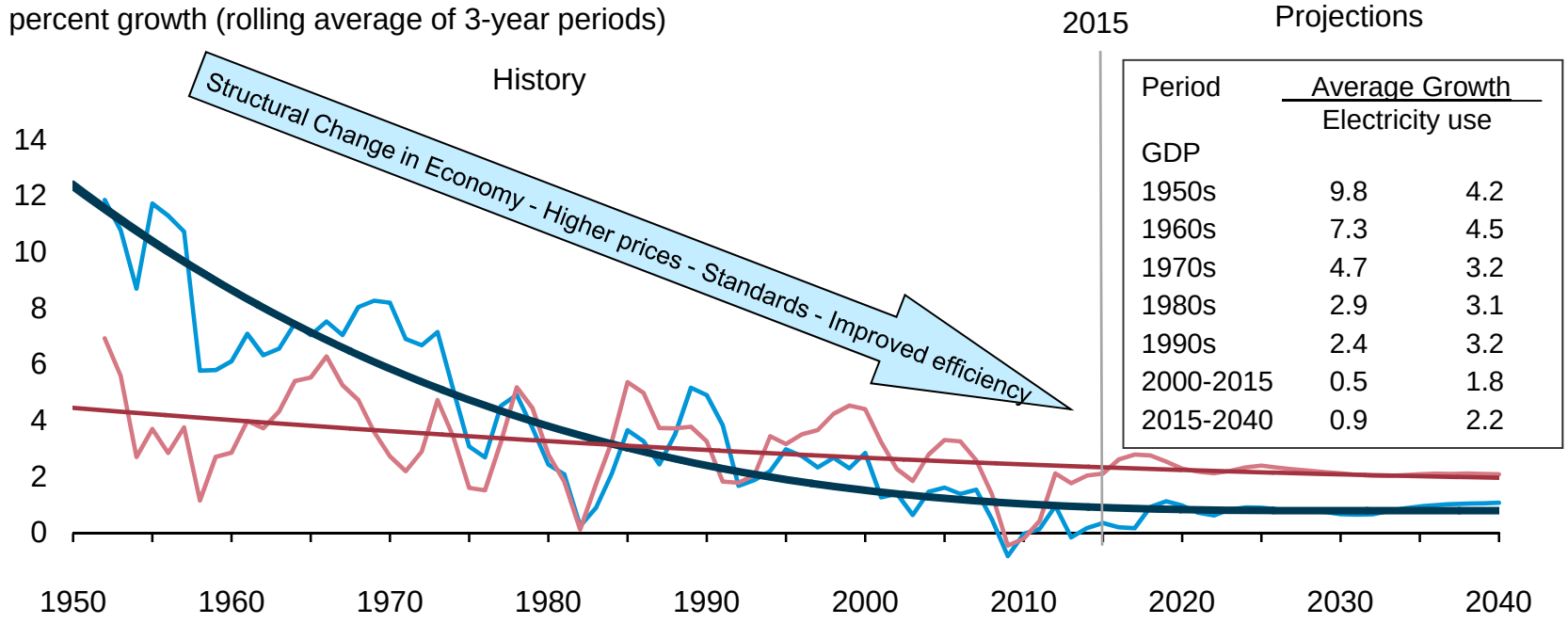
CPP increases retail electricity prices between 4% - 7% in 2030 due to higher fuel and capital costs and allowance treatment



Source: EIA, Annual Energy Outlook 2016

Electricity demand growth slows while onsite generation increases, dampening the need for central power station generation.

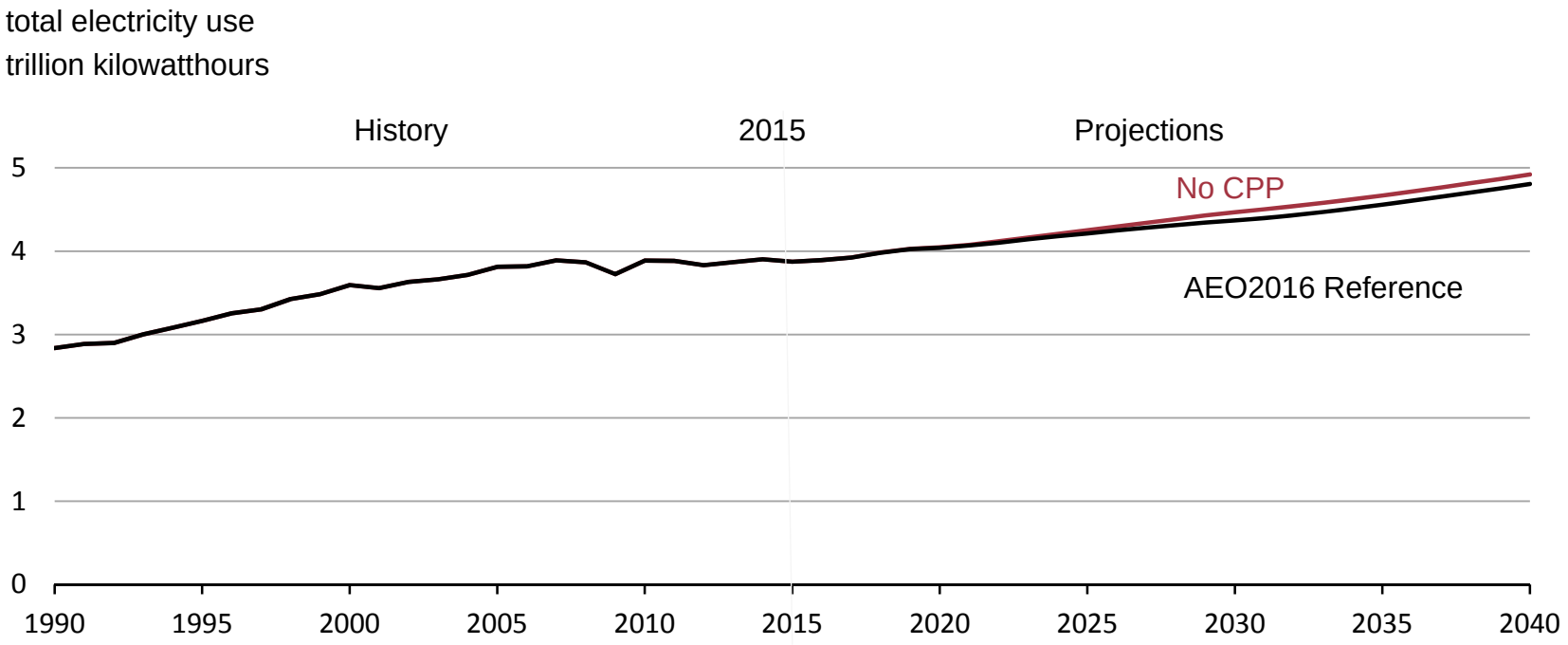
U.S. electricity use and GDP
percent growth (rolling average of 3-year periods)



Period	Average Growth	
		Electricity use
GDP		
1950s	9.8	4.2
1960s	7.3	4.5
1970s	4.7	3.2
1980s	2.9	3.1
1990s	2.4	3.2
2000-2015	0.5	1.8
2015-2040	0.9	2.2

Source: EIA, Annual Energy Outlook 2016

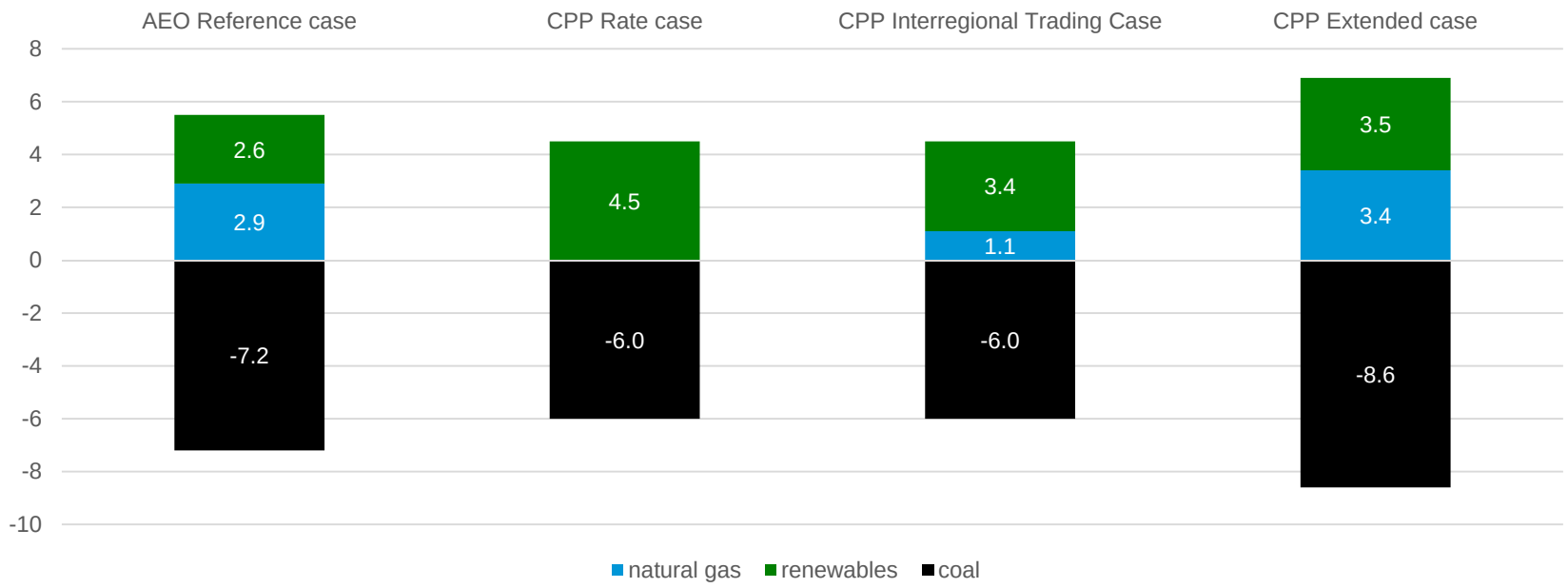
Electricity demand is 2% lower in 2030 in the Reference case than in the No CPP case, reflecting both CPP compliance actions and higher prices



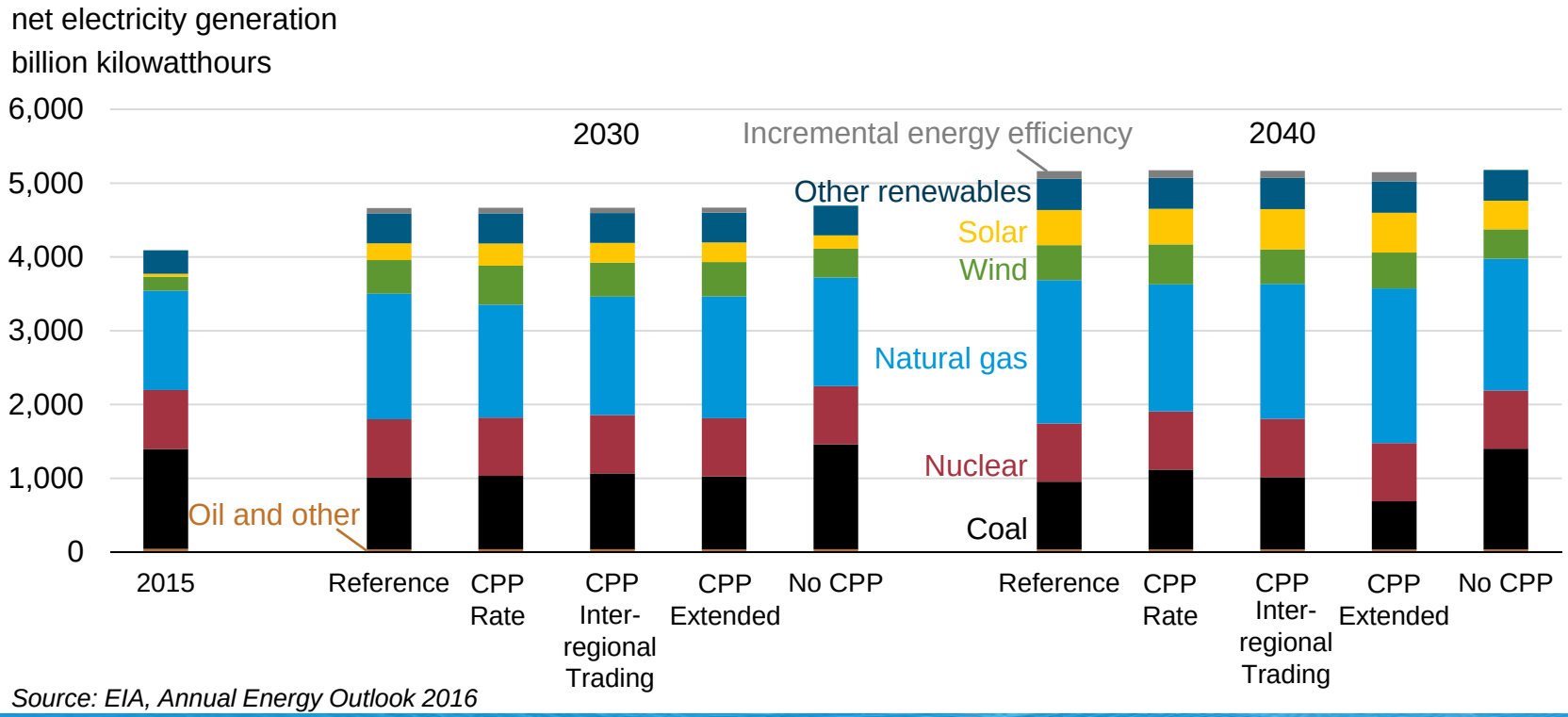
Source: EIA, Annual Energy Outlook 2016

CPP reduces coal- and increases renewable and gas-fired generation; mass-based standards result in more gas and less renewables vs. rate-based targets

Cumulative difference from No Clean Power Plan case, 2016-40
trillion kilowatthours



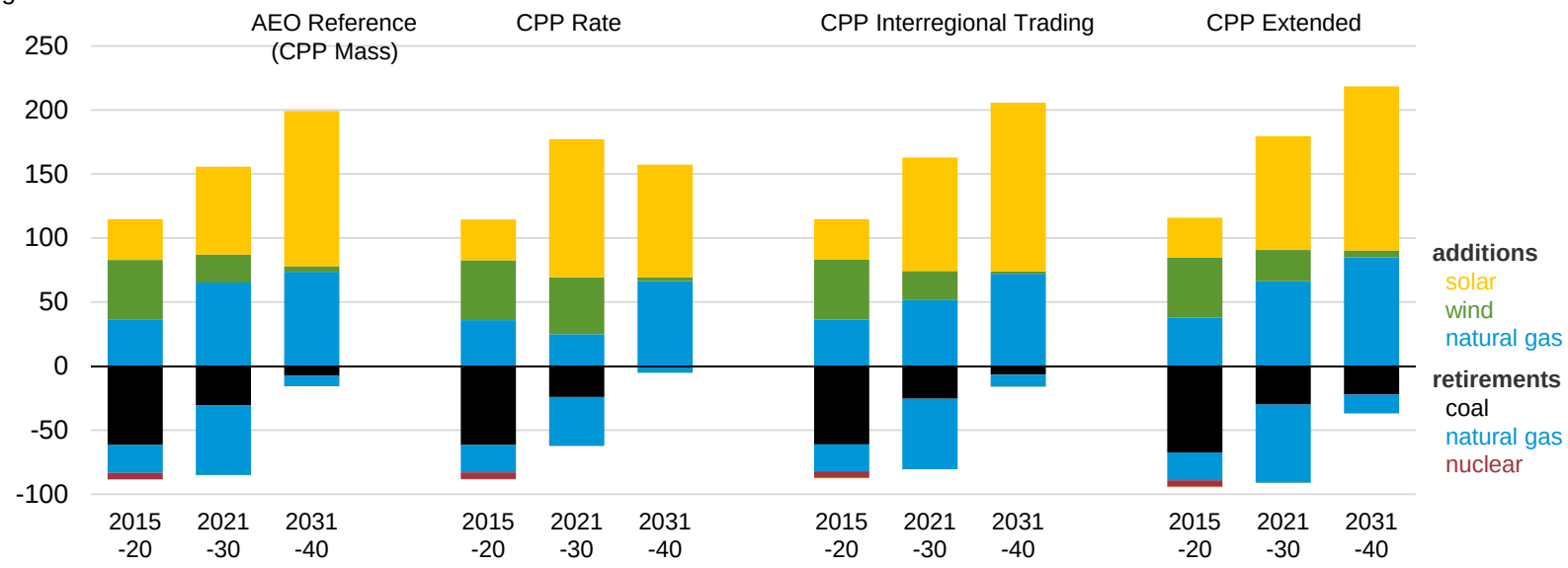
CPP reduces coal- and increases renewable and gas-fired generation; mass-based standards result in more gas and less renewables vs. rate-based *(cont.')*



Source: EIA, Annual Energy Outlook 2016

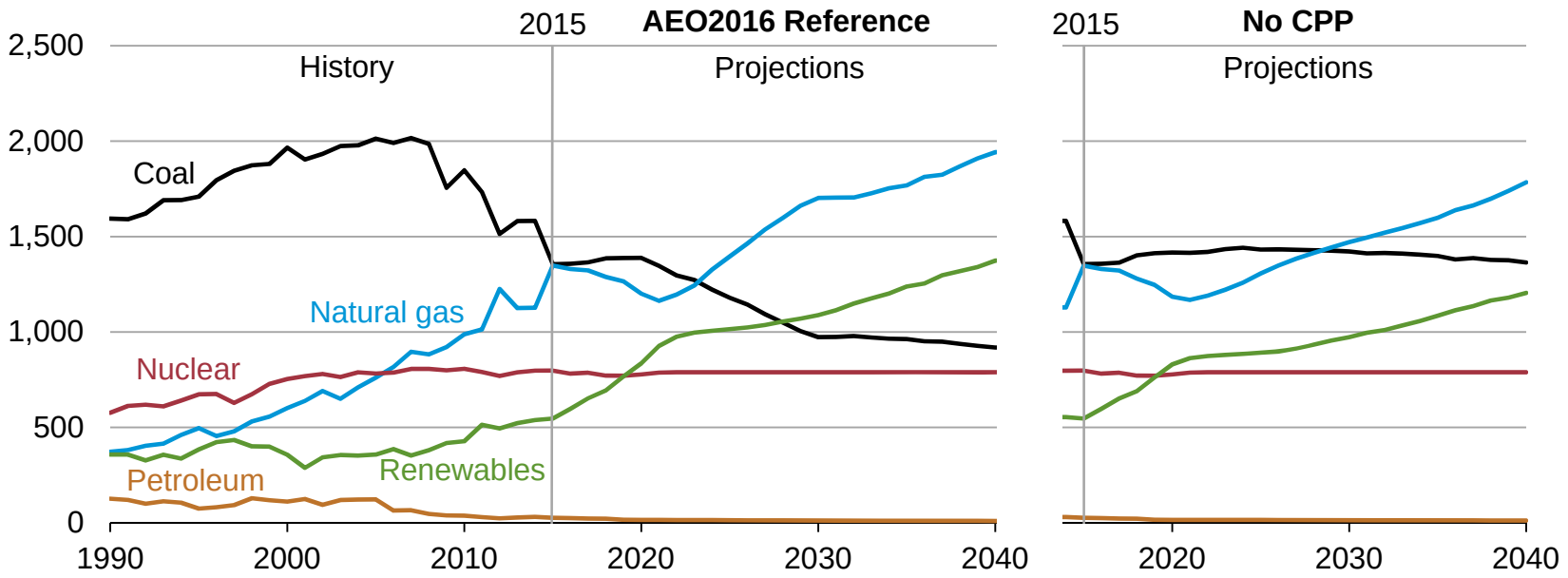
Low- and zero-emitting generating capacity grows more rapidly under rate- vs. mass-based programs; little change in coal retirements

Cumulative additions and retirements of electric generating capacity, 2015-40
gigawatts



Gas generation falls through 2021; both gas and renewable generation surpass coal by 2030 in the Reference case, only gas does in No CPP case

net electricity generation
billion kilowatthours

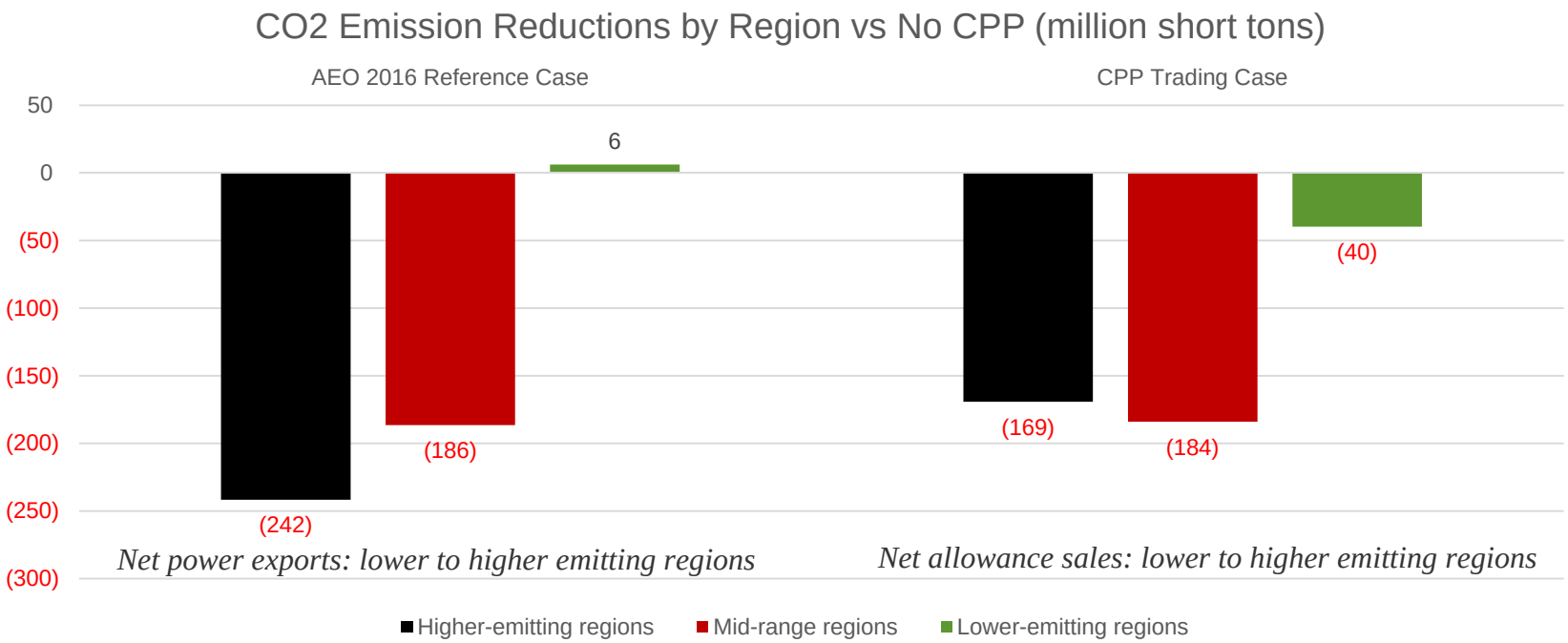


Source: EIA, Annual Energy Outlook 2016

Regional implications of Clean Power Plan (CPP) in AEO2016-Reference Case vs. Alternatives

- Coal-dependent regions have greater reduction requirements and larger shifts in generation mix
  - while lower-emitting regions are generally expected to increase power imports and in mass-based programs, make additional allowance sales.
- Some regions have apparent advantages relative to others, including higher renewable resource quality
- These interregional differences affect calculation of regional cost impacts but are unlikely to be significant at a national level

Flexibility under Clean Power Plan shifts emission reductions between lower and higher emitting regions

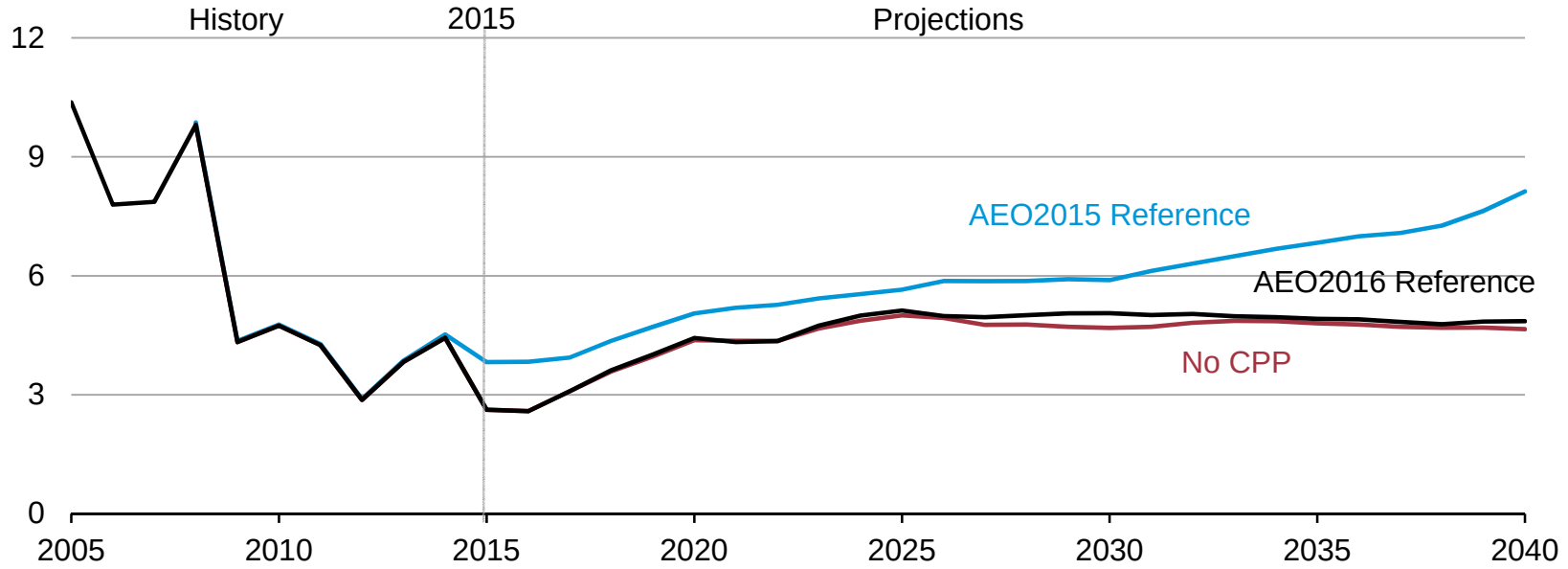


Impacts on Fuel

Natural gas prices are projected to remain below $5 per million Btu through most of the projection period with or without CPP

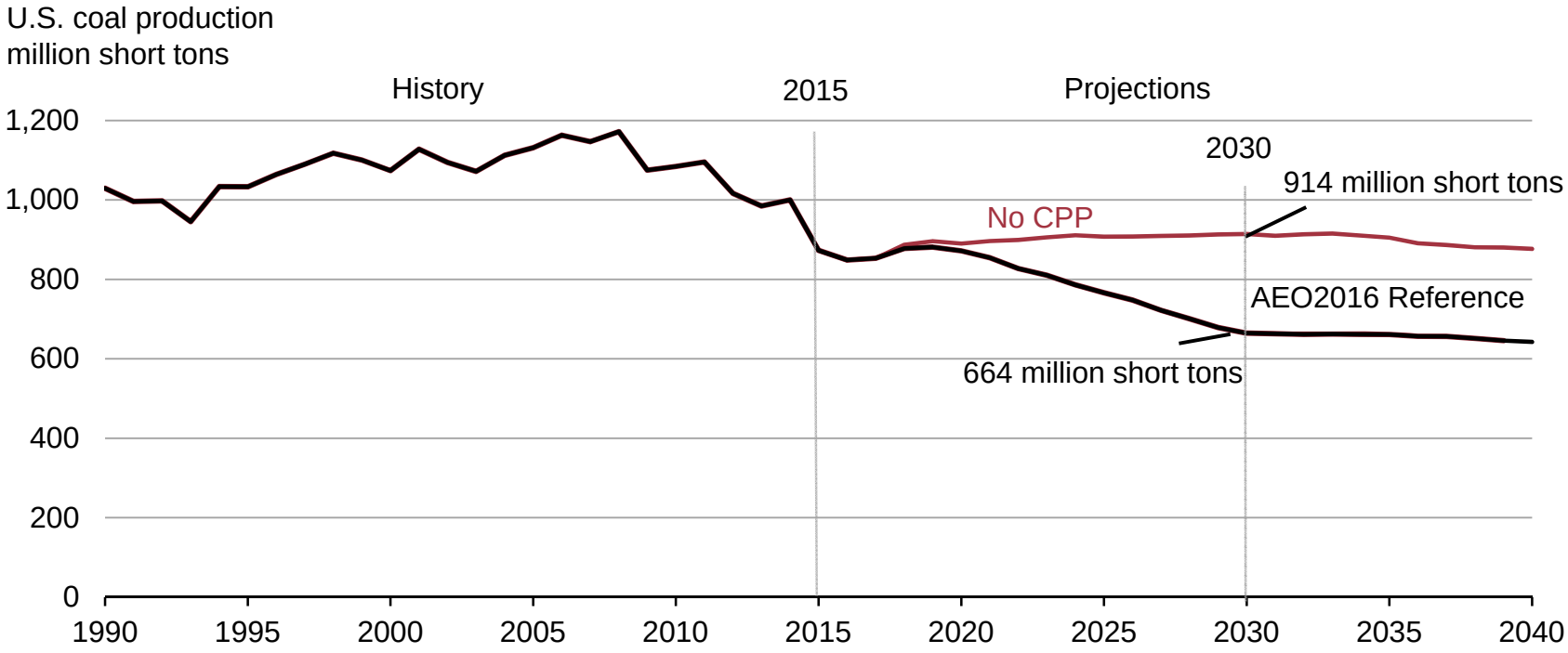
average Henry Hub spot prices for natural gas

2015 dollars per million Btu



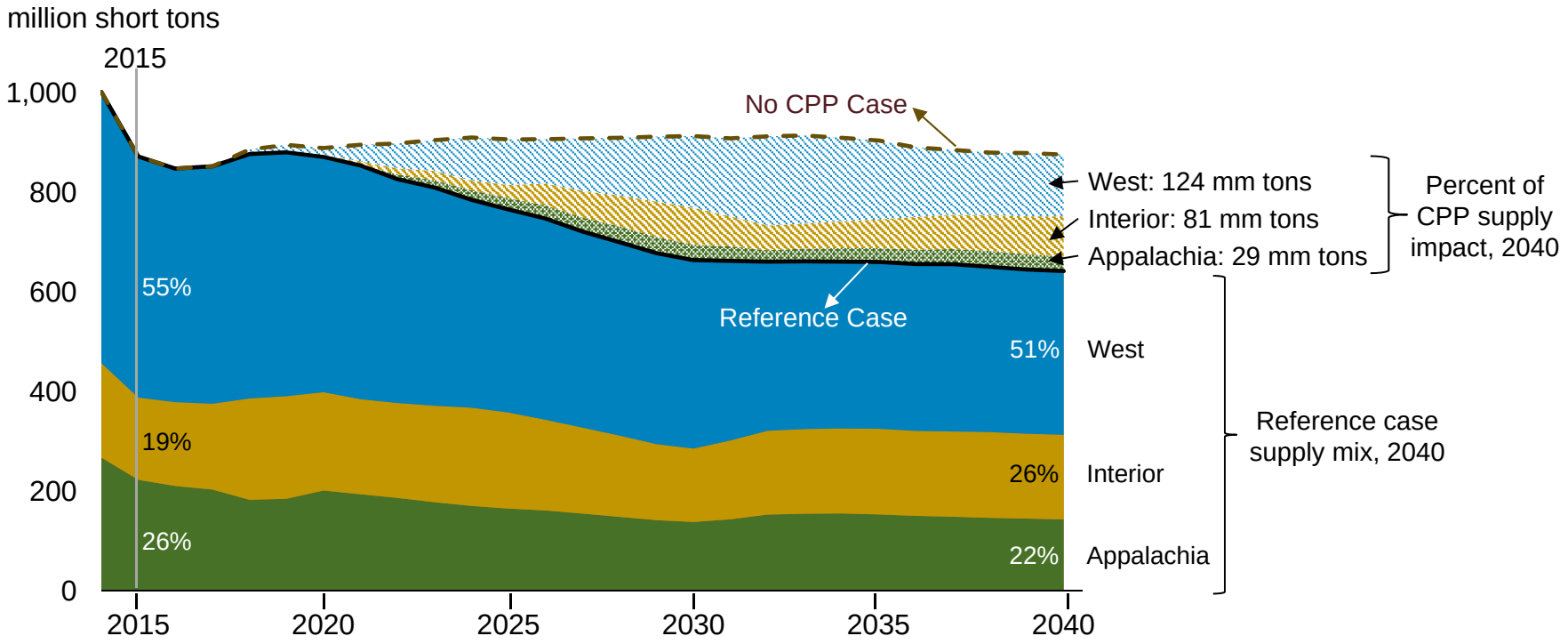
Source: EIA, Annual Energy Outlook 2016

Reference case U.S. coal production in 2030 is 27% below the level in the No CPP case



Source: EIA, Annual Energy Outlook 2016

All coal supply regions are challenged when the CPP is implemented



Source: EIA, Annual Energy Outlook 2016

Summary of key results: Clean Power Plan (CPP) in AEO2016-Reference Case vs. Alternatives

- CPP under a range of alternative implementation paths is projected to continue CO2 reductions, down 16% from 2005 levels in 2015, to ~35% by 2030
- CPP escalates changes already underway in generation mix, with gas eclipsing coal in mid-2020's/renewables exceeding coal by late 2020's
- Retail electricity prices rise on average between 2.8-4.3% from 2022-2040, depending upon implementation decisions made by states
- Increases in energy efficiency, as well as price-related response result in 2030 electricity sales reductions of ~2% vs. No CPP case

For more information

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

Annual Energy Outlook | www.eia.gov/forecasts/aeo

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

International Energy Outlook | www.eia.gov/forecasts/ieo

Today In Energy | www.eia.gov/todayinenergy

Monthly Energy Review | www.eia.gov/totalenergy/data/monthly

State Energy Portal | www.eia.gov/state

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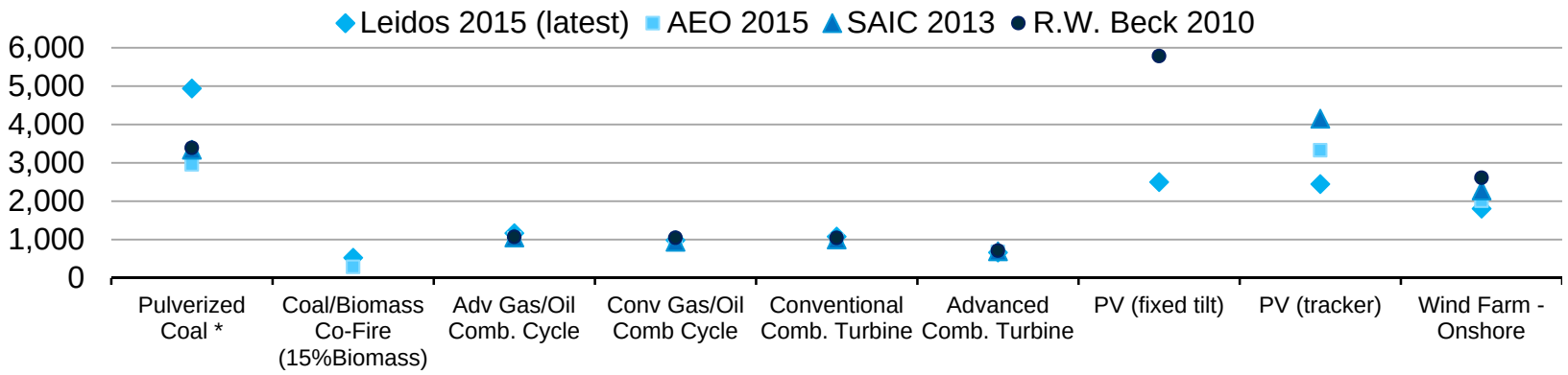
Supplemental

Capital costs per kW have changed most for solar, wind and coal; for coal, changes reflect new 111(b) rule

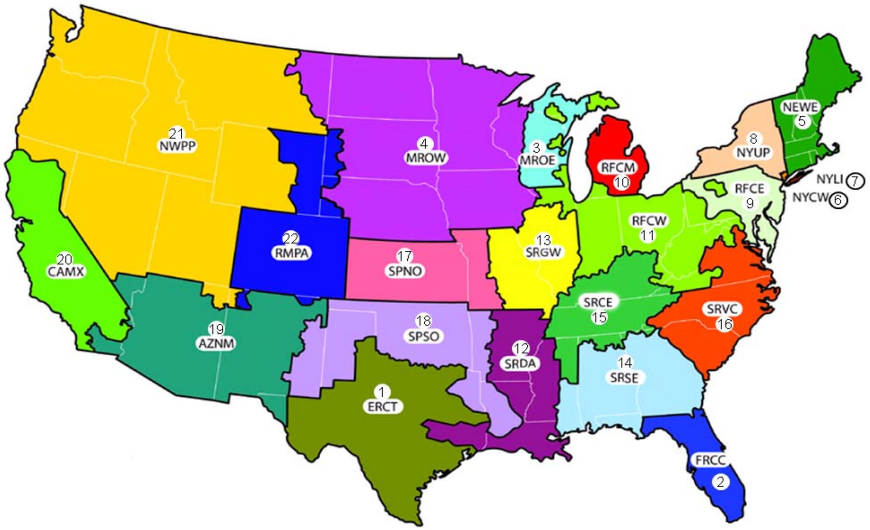
total overnight capital costs
2014$/KW



- The change in coal was primarily the result of the change to a 111(b) compliant technology (USC with 30% capture)
- We currently model fixed-tilt PV, and cost estimates suggest little cost differentiation between this and tracking technologies
- Unweighted national “average” cost for wind of $1810/kW vs. $1710/kW from LBNL

New wind costs yield a capacity-weighted average of approximately $1770/kW (in 2015$), when compared to 2014 capacity additions

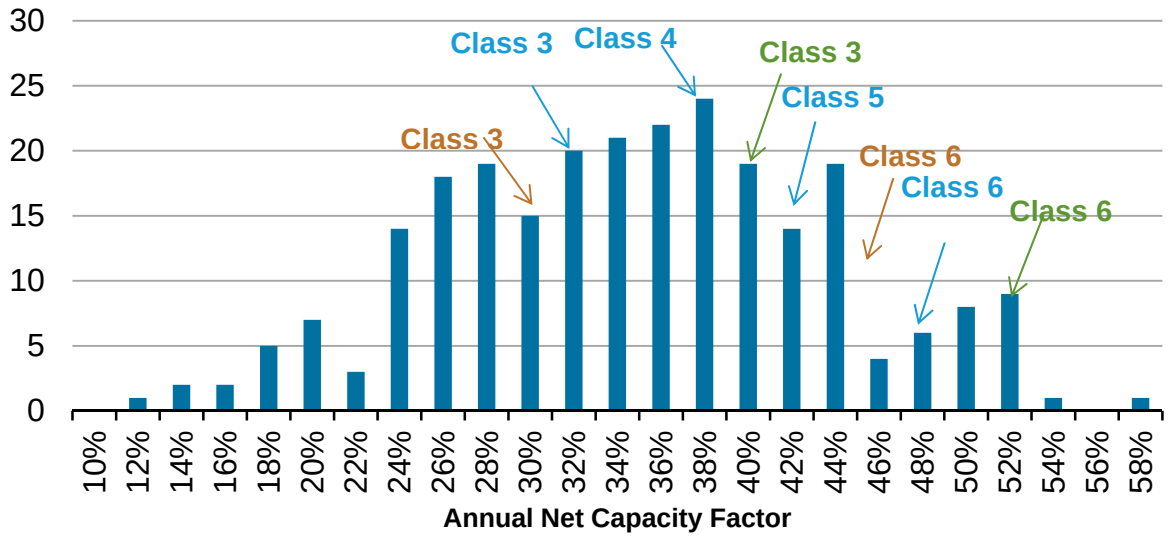
LBNL reports $1743/kW capacity-weighted average for 2014 (2015$, reported as $1710/KW in 2014$)



	Region																					
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
Net Cost (2015$/KW)	1,654	2,444	2,256	1,861	2,301	2,301	2,301	2,301	2,301	2,256	2,256	2,444	2,256	2,444	2,444	2,444	1,555	1,555	2,021	2,021	2,021	1,555
2014 New Cap. (MW)	577	0	0	1,259	0	0	0	37	0	317	240	0	0	0	0	0	0	1,781	0	331	20	235

Stakeholder review process highlighted the correlation between technology cost and performance assumptions for wind

Capacity Factor Distribution (Number of plants at indicated level, Form EIA-860) Wind Plants Built in 2011-2013
number of observations

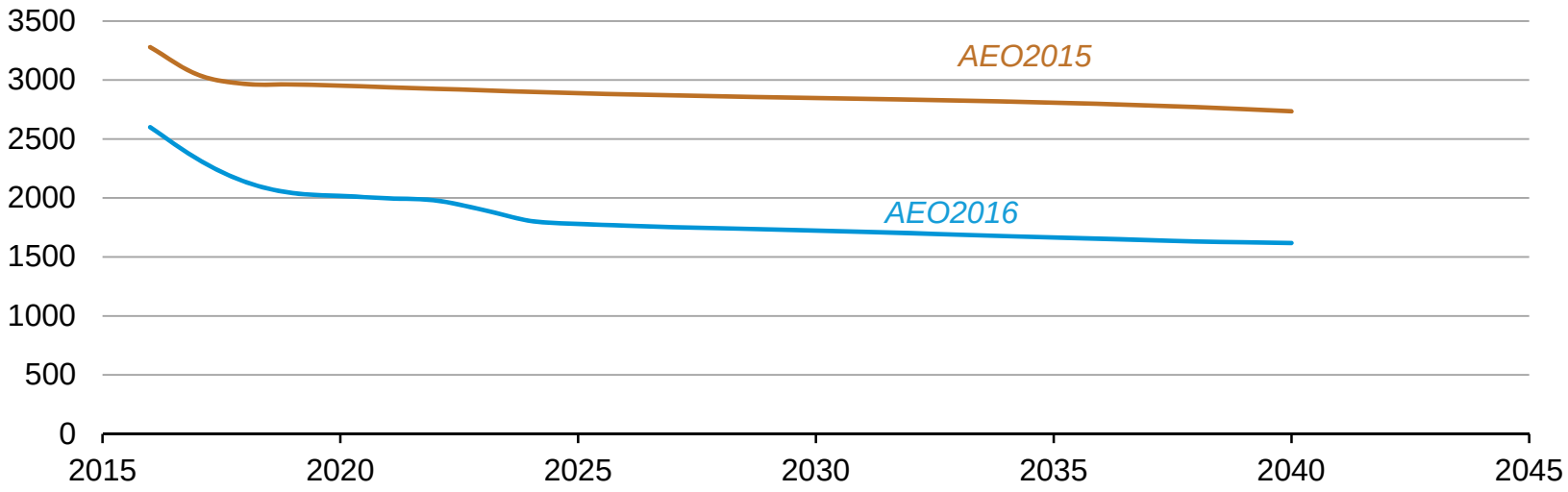


Performance by Class (2015 vintage):
AEO2016
AEO2015
NREL (GE 1.7 x 100m)

- EIA increased wind capacity factor assumptions by 3 percentage points, about 10%, to reflect recent turbine models
- However, capacity-weighted average capital costs approximately match recent installations
  - Performance also reflects performance of the fleet, not just an individual model

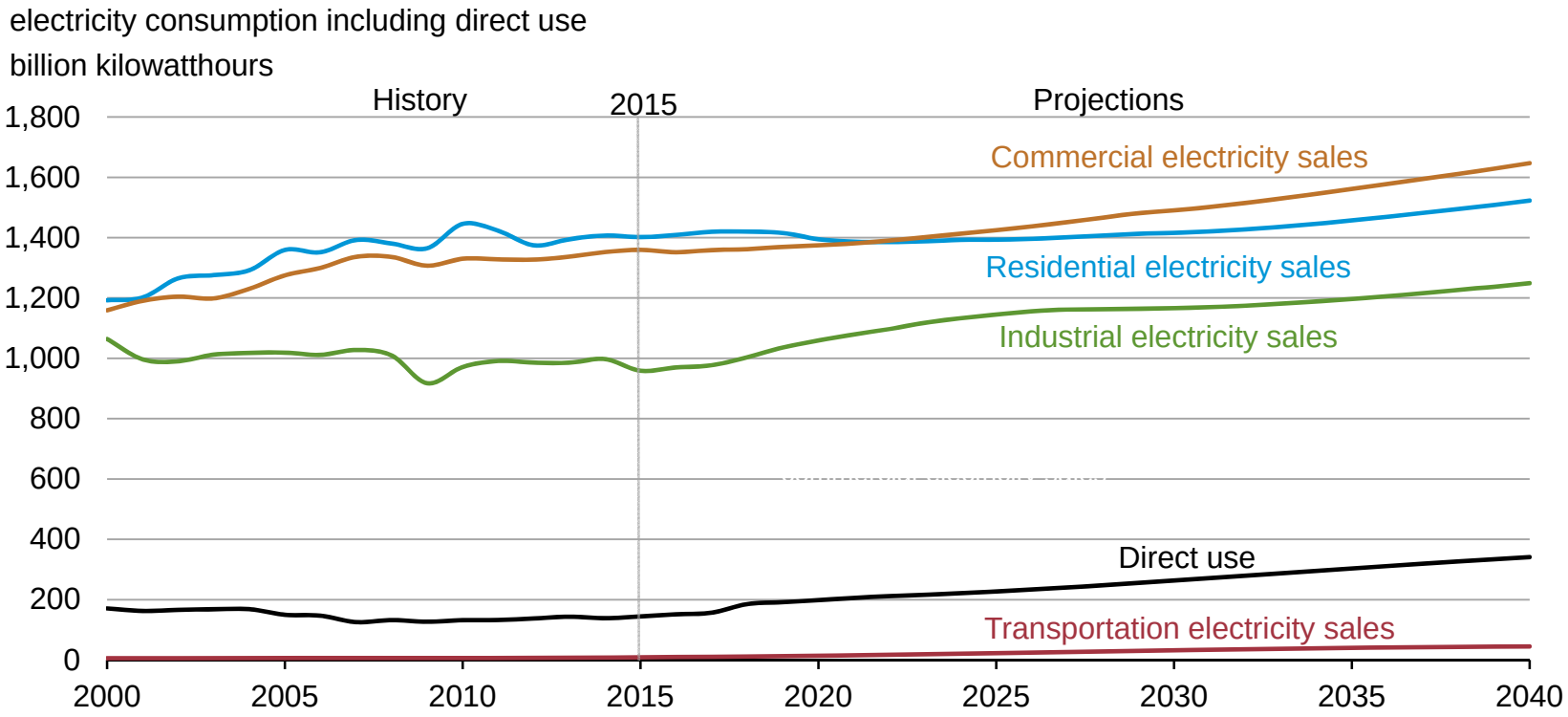
Initial lower solar costs results in increased PV uptake, faster and deeper cost reductions over time

PV cost trajectory
$/kWAC



- By 2020, costs drop by over 20% with new assumptions, compared to 10% in AEO 2015
- For 2014, LBNL reports $3,800/kW capacity-weighted average (all tech), with $2,800/kW median for fixed-tilt c-Si

Industrial activity bolsters growth in projected electricity consumption relative to recent history



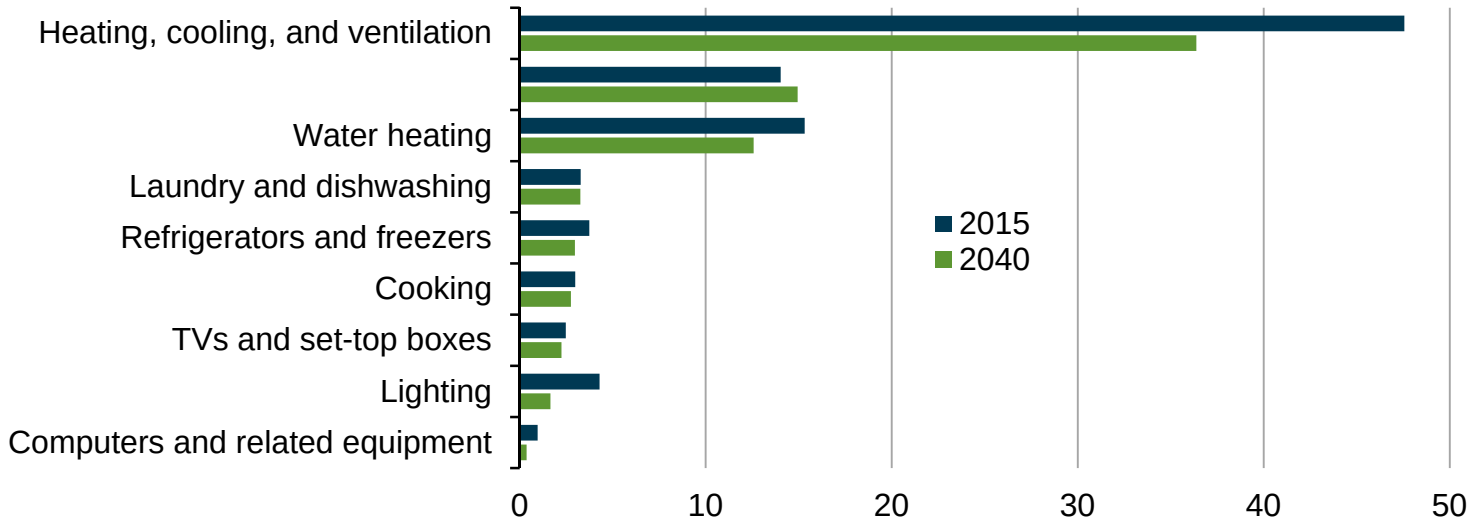
Source: EIA, Annual Energy Outlook 2016

Energy efficiency policies and standards, and population shifts to warmer climates in the south and west, contribute to declining energy intensity in the residential sector

Residential sector delivered energy intensity for selected end uses in the Reference case, 2015 and 2040

energy intensity

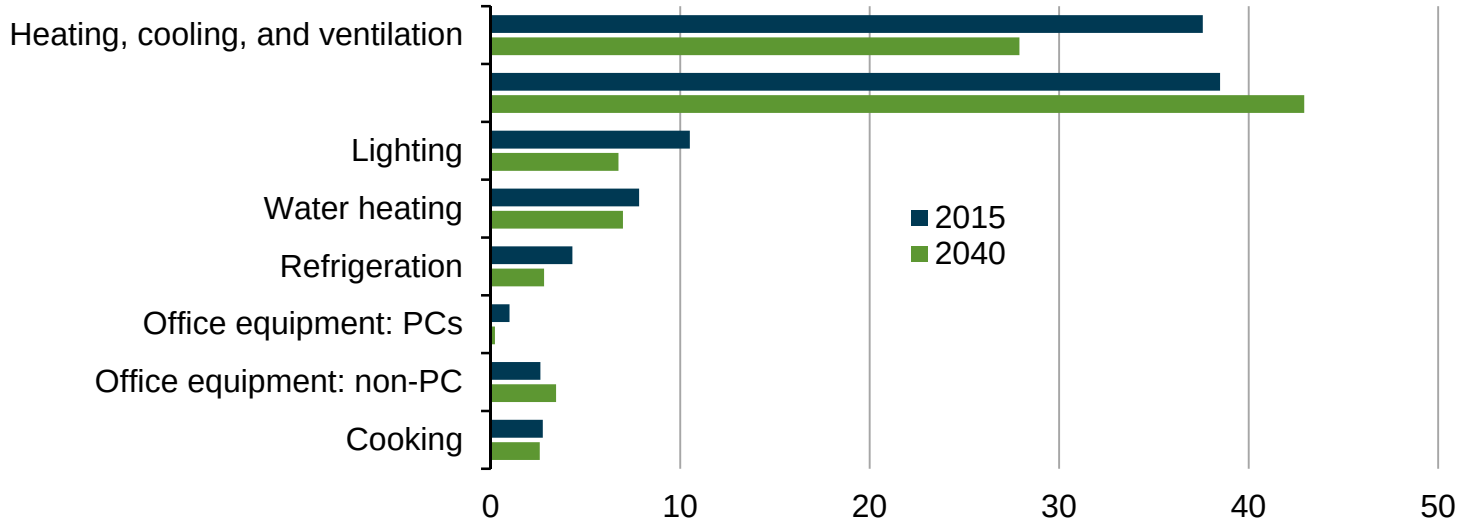
million Btu per household per year



Source: EIA, Annual Energy Outlook 2016

Despite 1.1% average annual growth in commercial floorspace from 2015 to 2040, commercial delivered energy intensity (energy use per square foot) decreases 0.5%/year in the Reference case

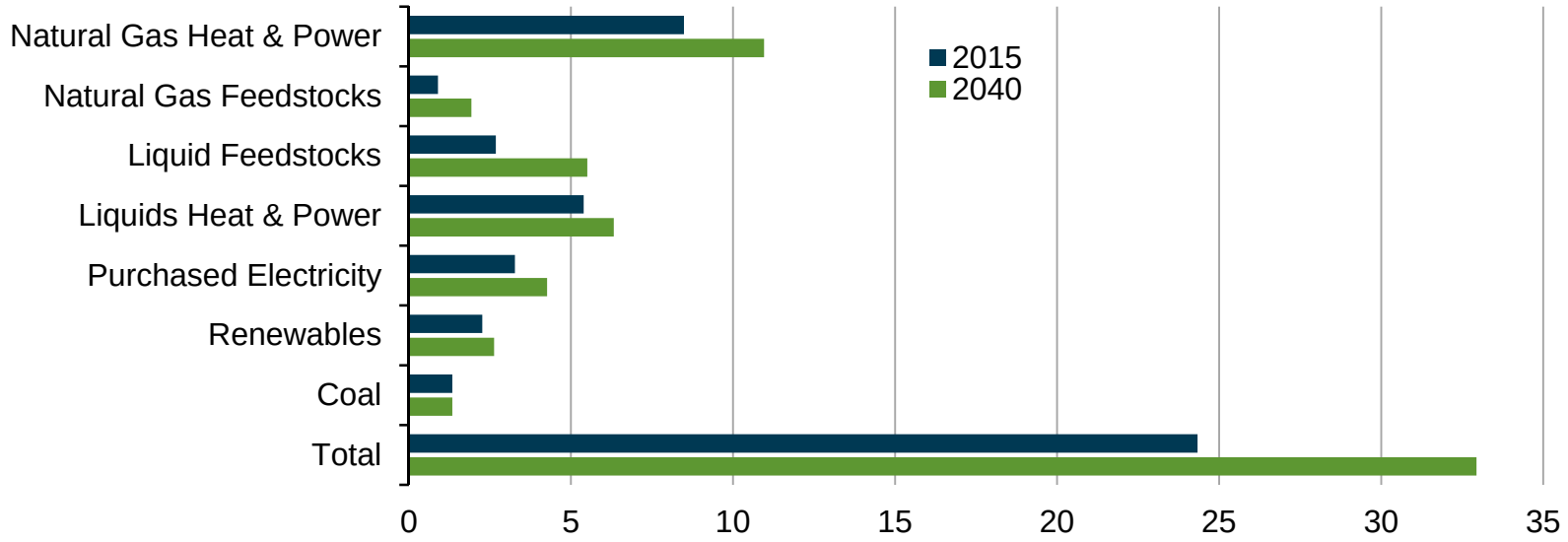
Commercial sector delivered energy intensity for selected end uses in the Reference case, 2015 and 2040
energy intensity
thousand Btu per square foot per year



Source: EIA, Annual Energy Outlook 2016

Total delivered industrial energy consumption grows by 1.2%/year from 2015-40, while the value of industrial shipments grows 1.9%/year

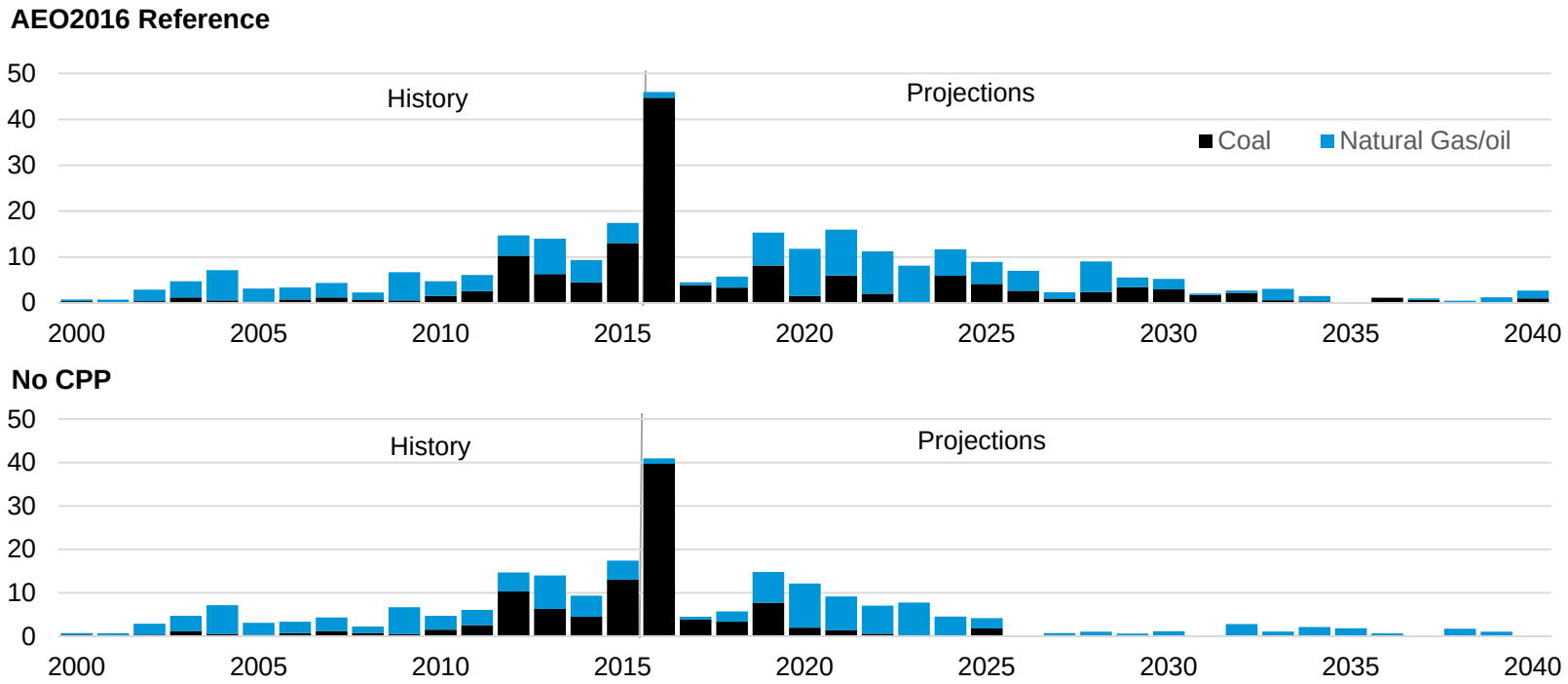
Delivered energy consumption for industrial sector by fuel in the Reference case, 2015 and 2040
energy consumption
quadrillion Btu



Source: EIA, Annual Energy Outlook 2016

The Mercury and Air Toxics rule (MATS) rule and low natural gas prices are the main near-term driver of coal plant retirements; CPP increases near-term coal plant retirements modestly and adds more retirements in later years

annual capacity retired, gigawatts

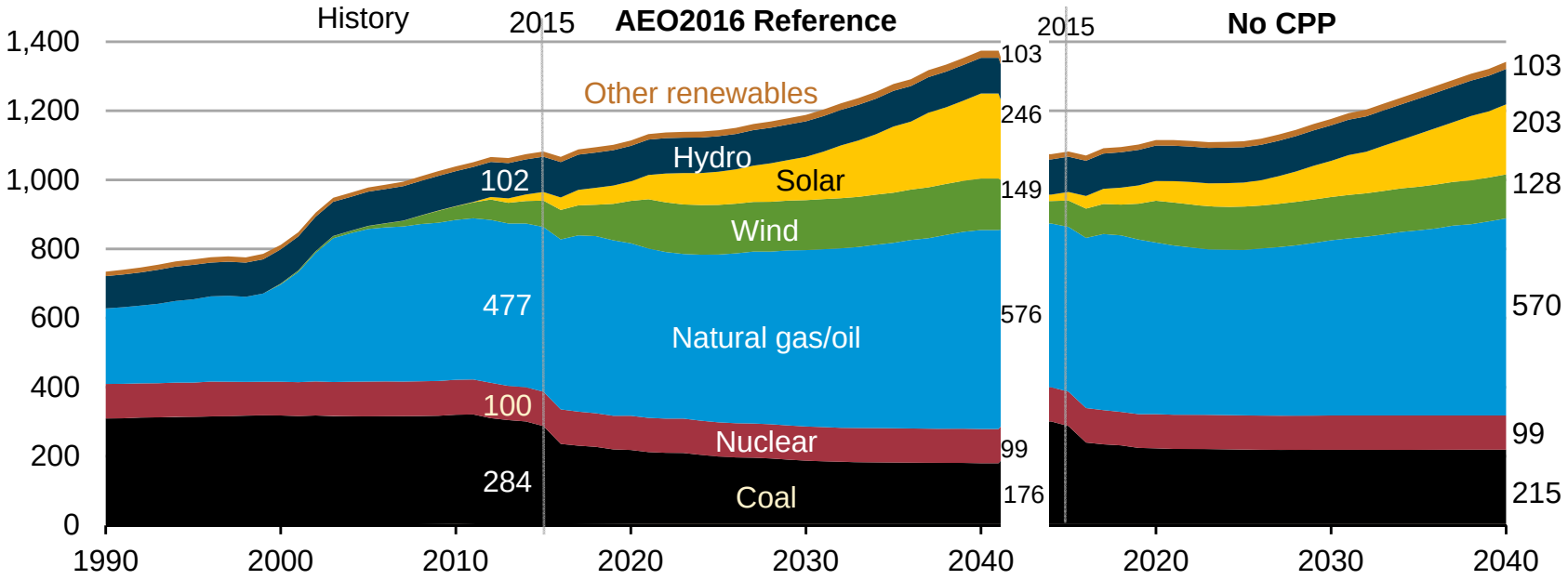


Source: EIA, Annual Energy Outlook 2016

Reference case projects slightly higher levels of total capacity because of higher levels of renewable capacity

total electric generating capacity

gigawatts



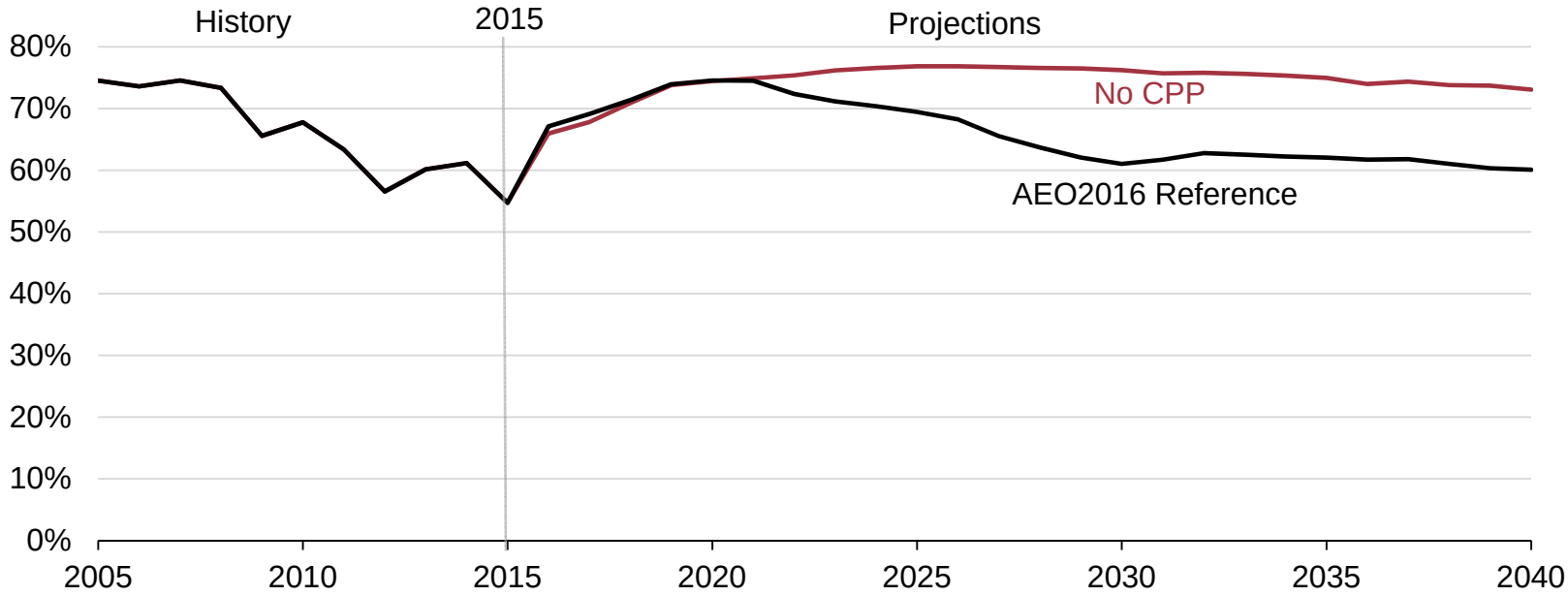
Notes: prior to 2000 wind and solar data is not broken out, and is reflected in 'Other Renewable'; Hydro includes pumped storage

Source: EIA, Annual Energy Outlook 2016

Average capacity factor for coal-fired generating units falls by 15 percentage points by 2030 in the Reference case when compared with the No CPP case

capacity factor of central station coal-fired electricity generating units

percent utilization

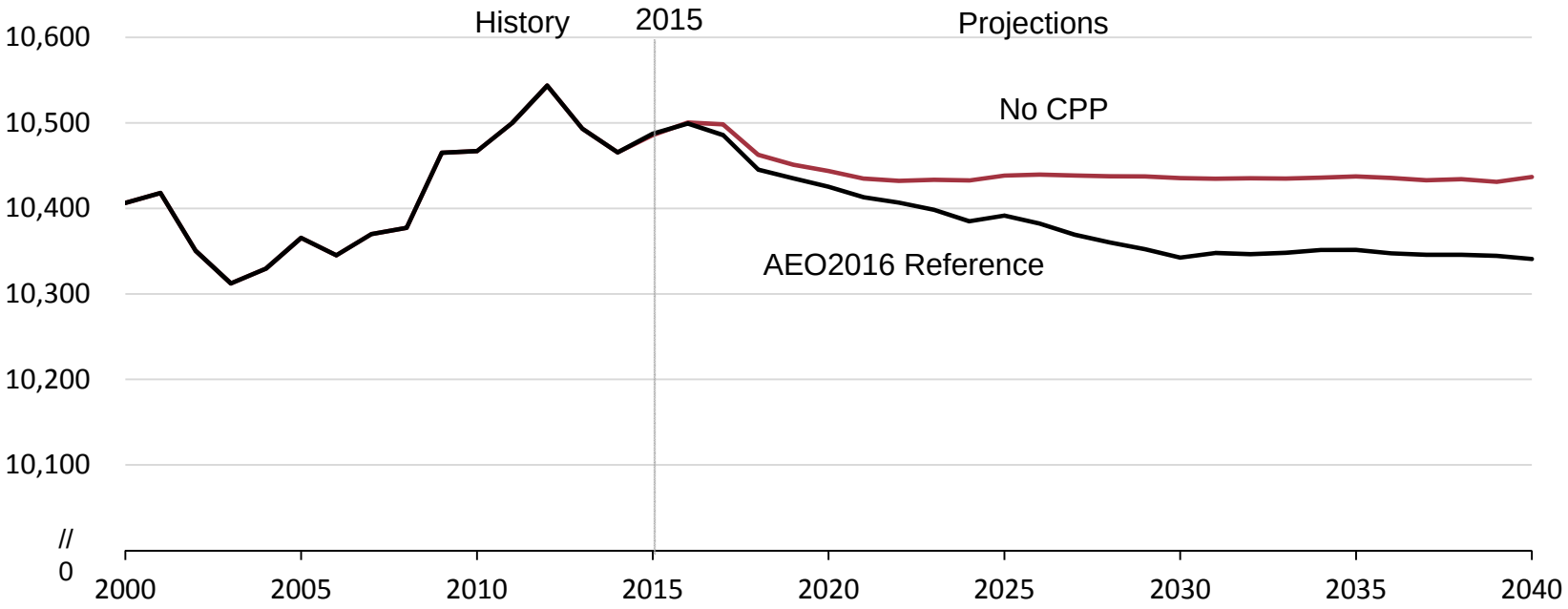


Source: EIA, Annual Energy Outlook 2016

Heat rates for coal-fired plants are up to 1% lower due to heat rate improvement and retirements in Reference case than in the No CPP case

heat rate of coal plants

Btu per kilowatthour

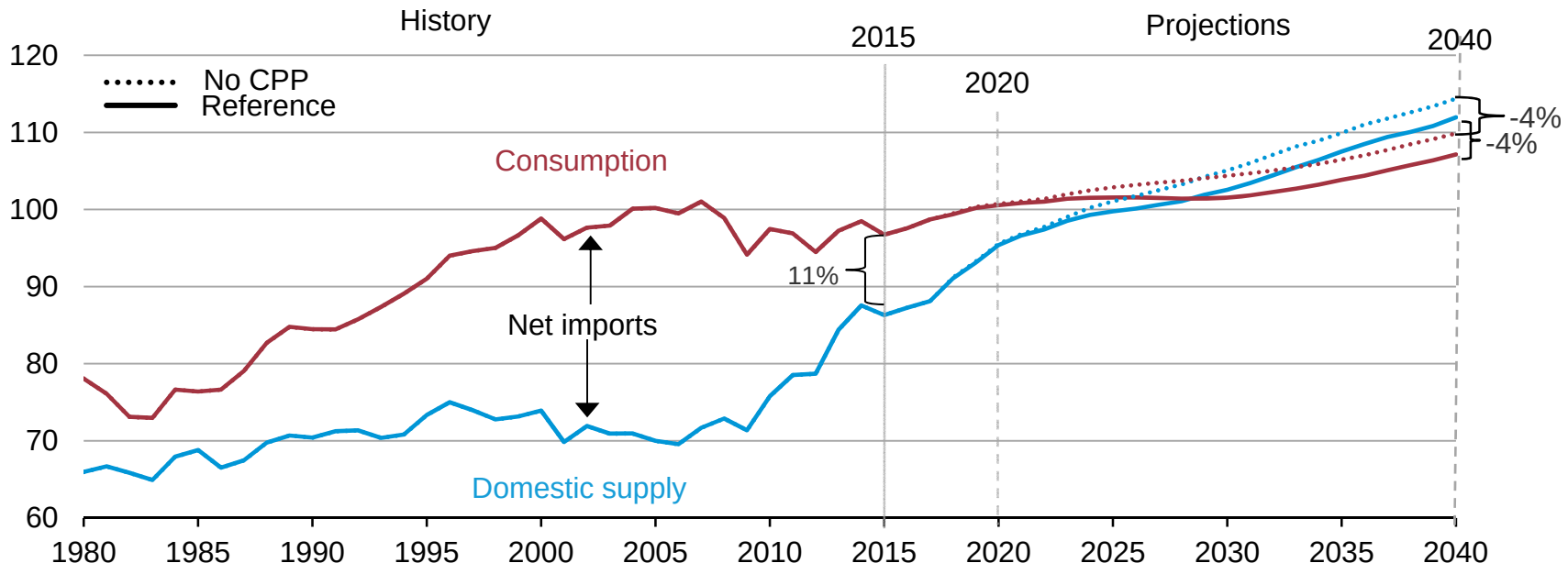


Source: EIA, Annual Energy Outlook 2016

U.S. energy production outstrips consumption, making the United States a net energy exporter

U.S. energy production and consumption

quadrillion Btu



Source: EIA, Annual Energy Outlook 2016