Data and Analysis from EIA to Inform Policymakers, Industry, and the Public Regarding Power Sector Trends

for

Power Sector Trends in the Eastern Interconnection

September 13, 2016 | Atlanta, GA

by

Howard Gruenspecht, Deputy Administrator

Key takeaways

- EIA is developing both data and analyses to provide relevant power sector information at the state and regional level

- Recent data initiatives include new state-level monthly data on distributed PV generation, the new EIA Electricity Operations Report, and commercial buildings efficiency data

- Recent EIA analysis of the Clean Power Plan focuses on the key role of implementation decisions below the federal level

- EIA wants to collaborate with states and regions in prioritizing and addressing additional issues, such as the future of existing nuclear generation and updates to regional boundaries and efficiency representations in our models

NEW: combined (utility scale and distributed) PV data

- Beginning in November 2015, EIA started publishing monthly estimated generation and capacity for small-scale solar PV (e.g., residential roof-top solar) by state and sector.
- The capacity and generation values are based on collected and estimated data. The capacity estimates align closely with Solar Energy Industries Association (SEIA). (SEIA does not regularly estimate generation.)
- Small-scale solar PV estimates show significant capacity and generation growth. The first ten months of 2015 show an increase in generation of 29% and capacity of 34% over same time period in 2014.
- The growth rate for residential (and utility scale) solar PV capacity since January 2014 has outstripped the rate for other small-scale solar PV capacity.
- The estimated production rate (kWh per kW) for estimated small-scale solar PV is significantly lower than for utility scale installations.

PV Generation by Census Division and State (Thousand MWhs), June 2016 [EPM Table 1.17A]

Census Division and State	PV Generation		
	Total	Utility	Distributed
New England	241	89	152
Connecticut	NM	NM	28
Maine	3	0	3
Massachusetts	182	77	106
New Hampshire	5	0	5
Rhode Island	NM	NM	2
Vermont	17	8	9
Middle Atlantic	367	119	248
New Jersey	231	90	140
New York	102	20	82
Pennsylvania	34	9	26
East North Central	73	48	25
Illinois	10	7	3
Indiana	32	30	2
Michigan	NM	NM	5
Ohio	20	9	11
Wisconsin	NM	NM	4
West North Central	NM	NM	27
Iowa	5	0	5
Kansas	NM	NM	1
Minnesota	NM	NM	4
Missouri	NM	NM	18
Nebraska	NM	NM	NM
North Dakota	0	0	0
South Dakota	0	0	0

Census Division and State	PV Generation		
	Total	Utility	Distributed
South Atlantic	620	506	114
Delaware	16	7	9
District of Columbia	4	0	4
Florida	37	17	19
Georgia	NM	68	NM
Maryland	73	19	54
North Carolina	405	394	11
South Carolina	NM	NM	2
Virginia	NM	NM	4
West Virginia	1	0	1
East South Central	21	13	8
Alabama	0	0	0
Kentucky	4	2	2
Mississippi	0	0	0
Tennessee	17	11	6
West South Central	122	73	49
Arkansas	NM	NM	1
Louisiana	19	0	19
Oklahoma	1	1	0
Texas	99	70	29

Census Division and State	PV Generation		
	Total	Utility	Distributed
Mountain	966	721	246
Arizona	447	315	132
Colorado	99	51	48
Idaho	1	0	1
Montana	1	0	1
Nevada	263	230	32
New Mexico	94	78	16
Utah	61	47	14
Wyoming	NM	0	NM
Pacific Contiguous	2,316	1,595	720
California	2,288	1,590	698
Oregon	NM	NM	13
Washington	9	0	9
Pacific Noncontiguous	77	10	67
Alaska	0	0	0
Hawaii	77	10	67
U.S. Total	4,835	3,179	1,656

Source: based on EIA data

PV Capacity by Census Division and State (MWs), June 2016 [EPM Table 6.2B]

Census Division and State	PV Capacity Total	PV Capacity Utility	PV Capacity Distributed
New England	1,405.1	390.6	1,014.5
Connecticut	191.7	12.2	179.5
Maine	16.9	0.0	16.9
Massachusetts	1,050.9	335.1	715.8
New Hampshire	30.3	0.0	30.3
Rhode Island	21.5	8.9	12.6
Vermont	93.8	34.4	59.4
Middle Atlantic	2,185.1	576.5	1,608.6
New Jersey	1,357.1	442.7	914.4
New York	620.9	91.6	529.3
Pennsylvania	207.1	42.2	164.9
East North Central	365.5	215.3	150.2
Illinois	51.6	32.8	18.8
Indiana	144.6	131.9	12.7
Michigan	36.2	6.9	29.3
Ohio	109.0	42.7	66.3
Wisconsin	24.1	1.0	23.1
West North Central	184.4	23.5	160.9
Iowa	28.1	0.0	28.1
Kansas	4.8	1.0	3.8
Minnesota	26.3	4.0	22.3
Missouri	119.6	14.5	105.1
Nebraska	NM	4.0	NM
North Dakota	0.2	0.0	0.2
South Dakota	0.4	0.0	0.4

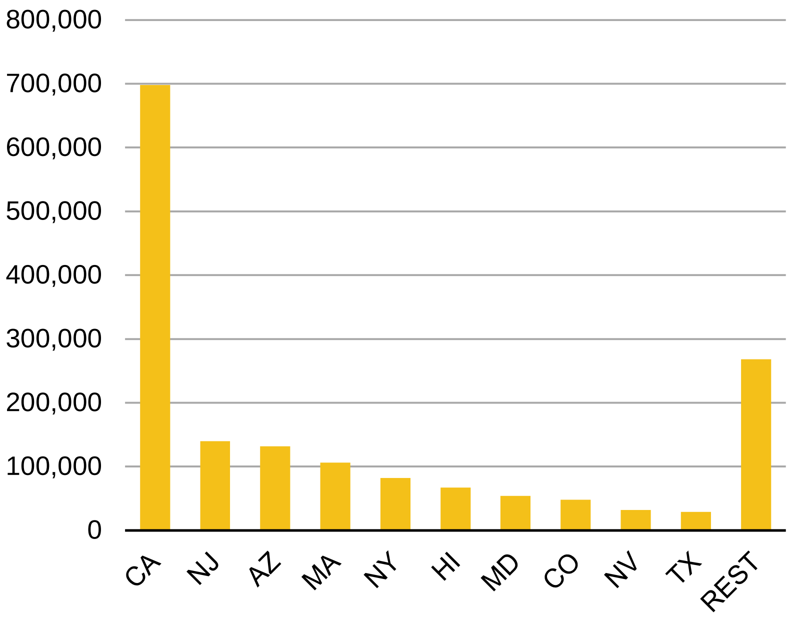
Census Division and State	PV Capacity Total	PV Capacity Utility	PV Capacity Distributed
South Atlantic	2,927.3	2,183.7	743.6
Delaware	88.2	30.7	57.5
District of Columbia	24.3	0.0	24.3
Florida	208.7	87.8	120.9
Georgia	NM	293.6	NM
Maryland	442.1	82.4	359.7
North Carolina	1,760.8	1,683.7	77.1
South Carolina	19.5	2.5	17.0
Virginia	29.1	3.0	26.1
West Virginia	3.6	0.0	3.6
East South Central	105.4	55.2	50.2
Alabama	2.0	0.0	2.0
Kentucky	20.0	10.0	10.0
Mississippi	1.2	0.0	1.2
Tennessee	82.3	45.2	37.1
West South Central	625.0	332.4	292.6
Arkansas	16.2	12.0	4.2
Louisiana	117.2	0.0	117.2
Oklahoma	4.7	2.5	2.2
Texas	486.8	317.9	168.9

Census Division and State	PV Capacity Total	PV Capacity Utility	PV Capacity Distributed
Mountain	4,200.4	2,880.2	1,320.2
Arizona	1,944.7	1,243.1	701.6
Colorado	477.1	206.2	270.9
Idaho	5.9	0.0	5.9
Montana	6.9	0.0	6.9
Nevada	1,117.9	949.1	168.8
New Mexico	399.9	315.4	84.5
Utah	245.9	166.4	79.5
Wyoming	NM	0.0	NM
Pacific Contiguous	10,429.5	6,488.2	3,941.3
California	10,265.7	6,466.5	3,799.2
Oregon	102.8	21.2	81.6
Washington	61.0	0.5	60.5
Pacific Noncontiguous	452.8	44.2	408.6
Alaska	0.0	0.0	0.0
Hawaii	452.8	44.2	408.6
U.S. Total	22,880.4	13,189.8	9,690.6

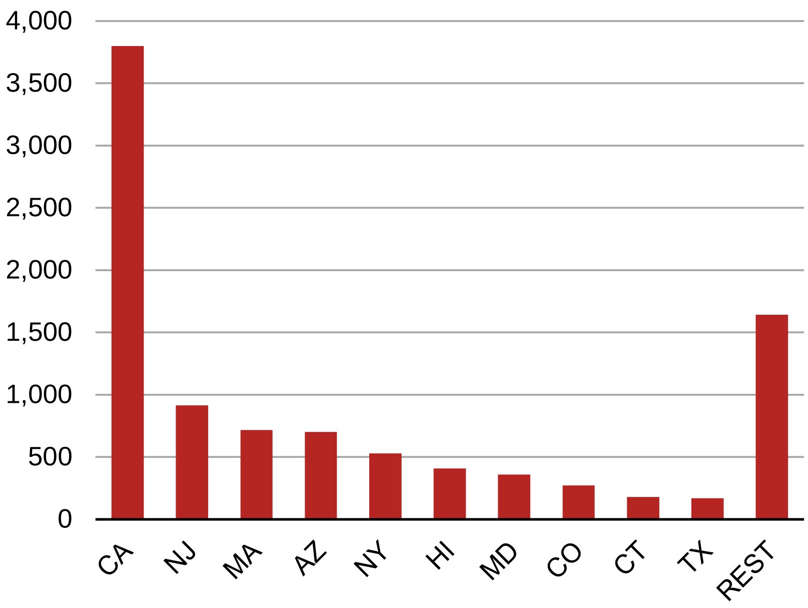
Source: based on EIA data

As of June 2016, California dominates all other states in small-scale PV; however, 3 of top 5 are in Northeast

Small Scale Solar PV Generation by State, June 2016 (MWh)

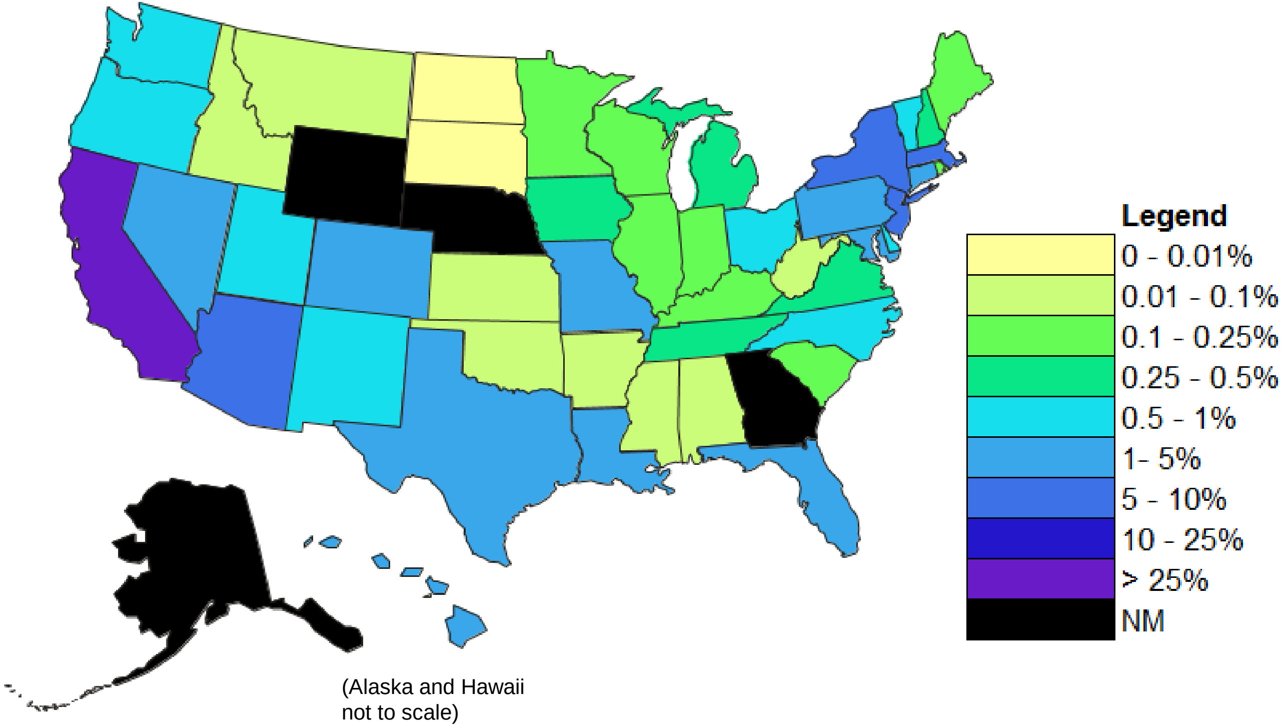


Small Scale Solar PV Capacity by State, June 2016 (MW)



Source: based on EIA-826 data

Outside of California, small-scale solar PV capacity tends to be in the southwest and northeast states



Source: based on EIA data

NEW: EIA is collecting and posting near real-time data on the operation of the U.S. electric system

- EIA is receiving hourly demand data in near real time – every 60 minutes – from the 66 balancing authorities that operate the grid in the contiguous states (The "EIA-930" data collection)

- EIA posts data an hour and twenty minutes after the operating hour (For example, demand for the hour ending 2:00 p.m. eastern time is posted around 3:20 p.m.)

- Additional system operating data is posted around 8:20 a.m. each morning:
  - Hourly demand forecast for the current day
  - Hourly net generation for the prior day (metered internal supply)
  - Hourly net actual interchange for the prior day (metered flow of electricity in or out of the system)
  - Updated hourly actual demand for the prior day

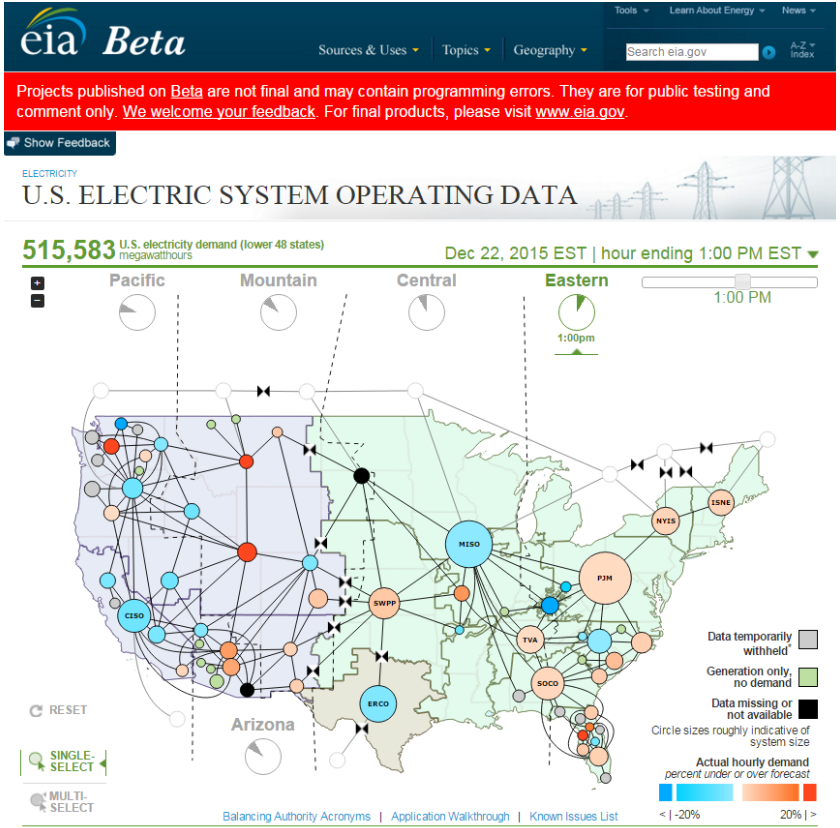
The collection and posting of operating data serves multiple objectives

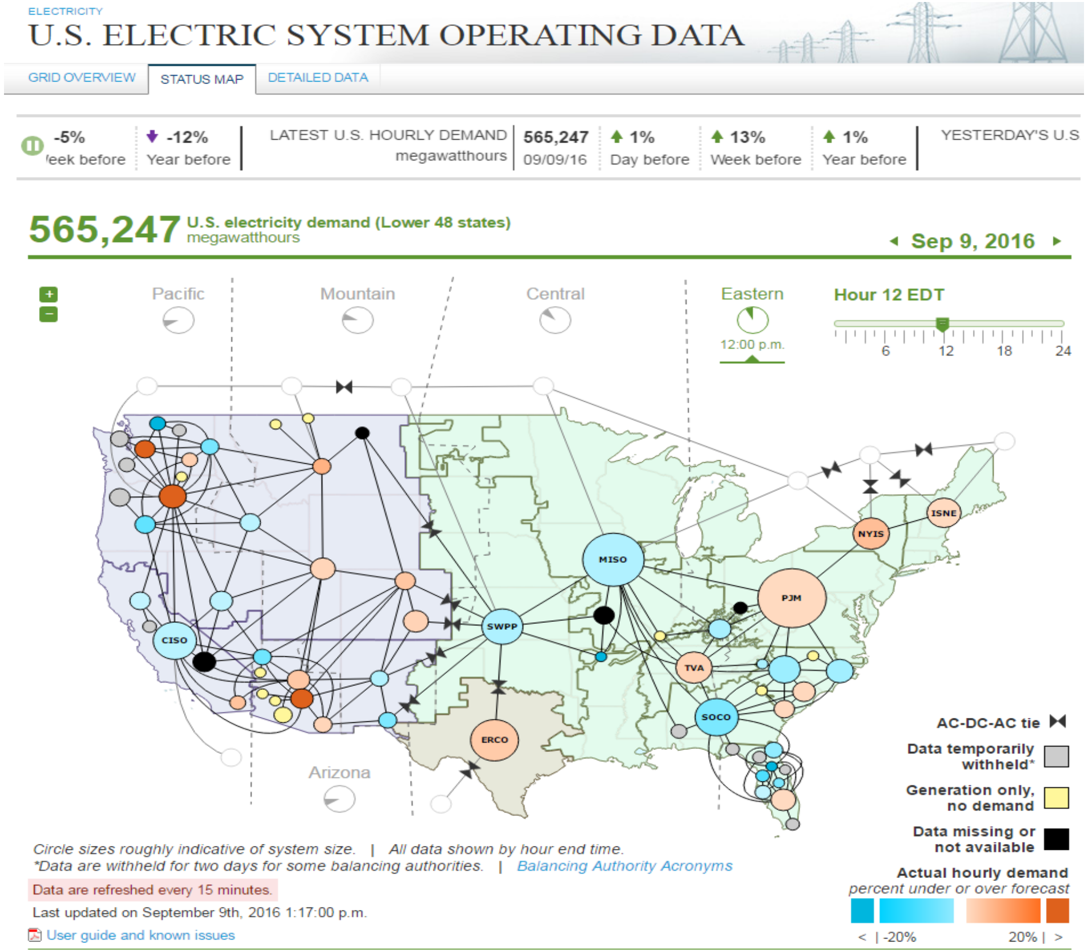
- Situational awareness
  - To track the current status of the U.S. electric system
  - To provides a baseline for tracking the recovery of the power system in the wake of system disruptions (e.g., hurricanes, wide-area blackouts)
- Educational
  - To help policymakers and the public better understand the dynamic nature of electric industry operations
- Technology development and policy analysis
  - To evaluate the effect of renewable power, smart grid, energy efficiency and demand response programs on the power industry
  - To inform policy makers, researchers, and market participants about the best ways to invest in research, development, production and implementation of technologies and programs to take advantage of the time varying nature of electric system operations

The system can be used to investigate the dynamic nature of electric system operations

- Sample Question that can be addressed with the tool: To what extent does a particular balancing authority New England electric system rely on outside sources of electricity?

- Readily accessible long-term data series: supports analysis of intra-day and seasonal patterns of demand



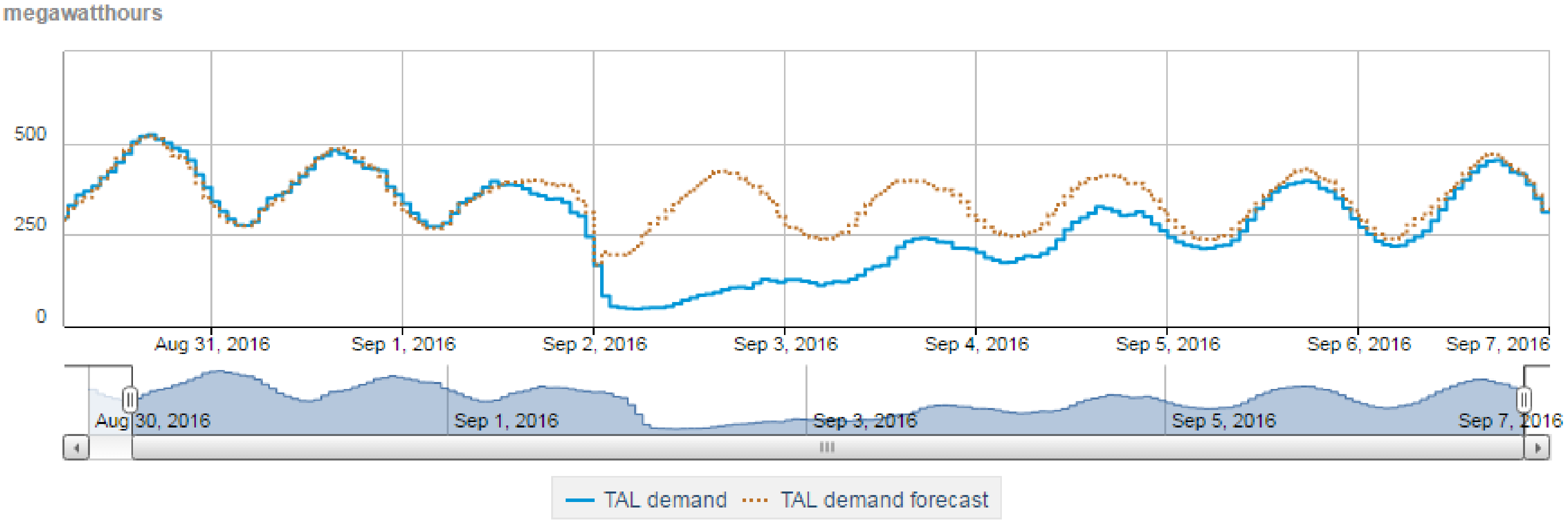

ELECTRICITY
U.S. ELECTRIC SYSTEM OPERATING DATA
GRID OVERVIEW
STATUS MAP
DETAILED DATA
-5%
/eek before
-12%
Year before
LATEST U.S. HOURLY DEMAND
megawatthours
565,247
09/09/16
1%
Day before
13%
Week before
1%
Year before
YESTERDAY'S U.S
565,247
U.S. electricity demand (Lower 48 states)
megawatthours
Sep 9, 2016
Pacific
Mountain
Central
Eastern
12:00 p.m.
Hour 12 EDT
6
12
18
24
MISO
PJM
NYIS
ISNE
SWPP
CISO
TVA
SOCO
ERCO
Arizona
AC-DC-AC tie
Data temporarily withheld*
Generation only, no demand
Data missing or not available
Actual hourly demand
percent under or over forecast
< | -20%
20% | >
Circle sizes roughly indicative of system size. | All data shown by hour end time.
*Data are withheld for two days for some balancing authorities. | Balancing Authority Acronyms
Data are refreshed every 15 minutes.
Last updated on September 9th, 2016 1:17:00 p.m.
User guide and known issues

Tallahassee's Hurricane Recovery Captured by EIA-930

Balancing authority electricity demand

Balancing authority hourly actual and forecast demand 08/30/2016 – 09/06/2016, EDT

DOWNLOAD



Source: U.S. Energy Information Administration

EIA’s Clean Power Plan Analysis

Key conclusions: electric power sector-impacts of Clean Power Plan (CPP) in AEO2016

- How the states implement the Clean Power Plan influences its impact on the power sector (note: AEO2016 Reference case assumes mass-based implementation, coverage of new units under cap to avoid “leakage”, and allowance allocation to load-serving entities to minimize rate impacts)

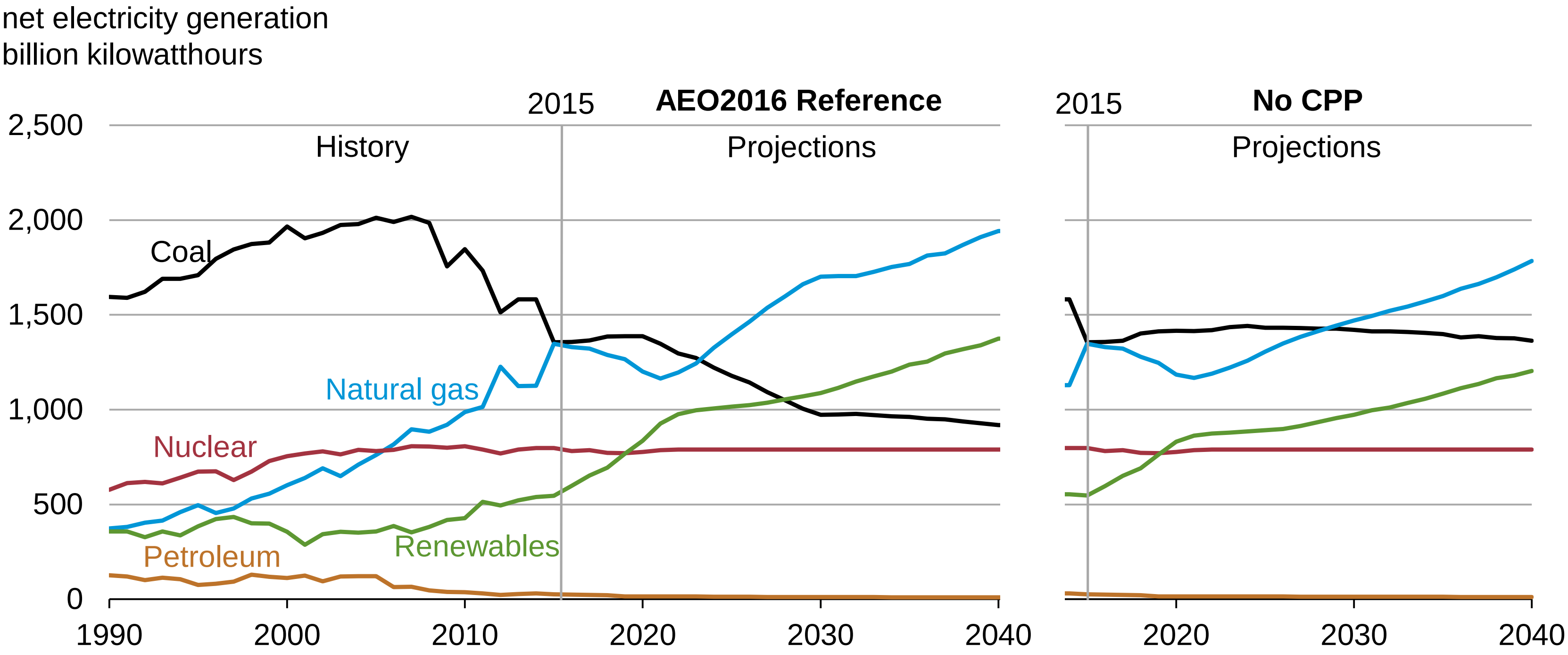
- CO_2 emission reduction requirements under Clean Power Plan accelerate a shift in generation mix already underway

- Pressure on coal continues even in absence of Clean Power Plan

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

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



Source: EIA, Annual Energy Outlook 2016

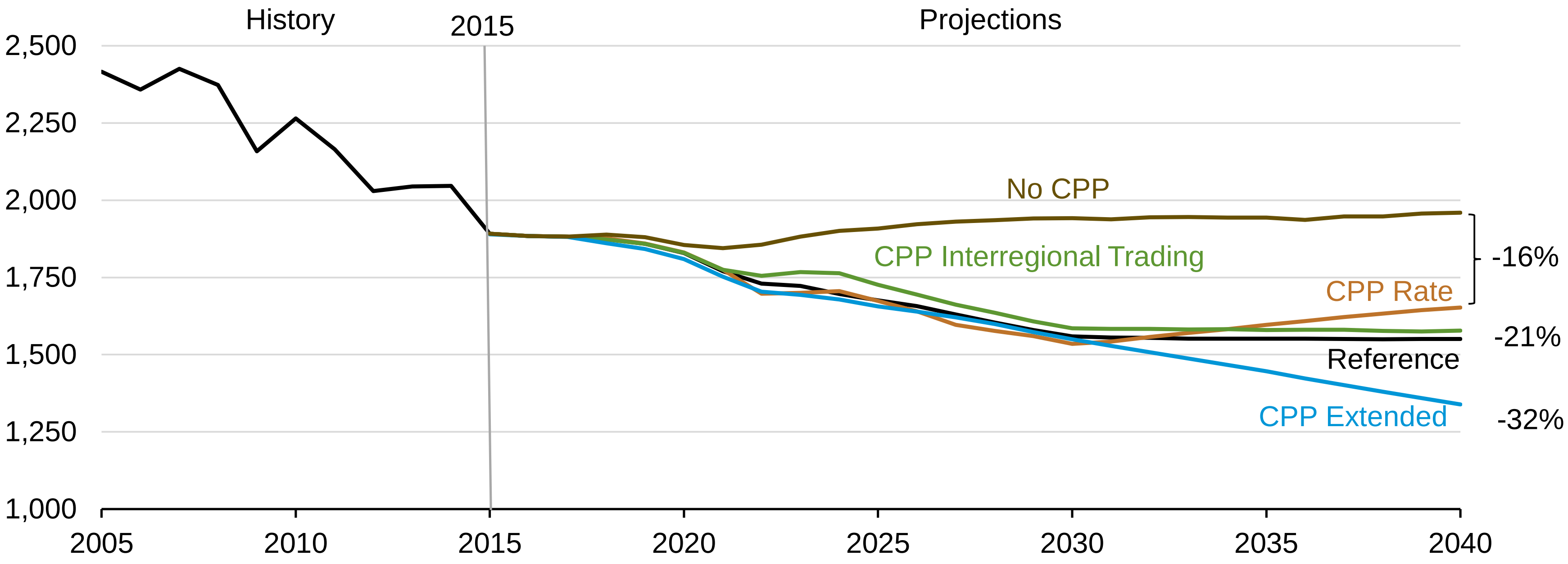
How states choose to implement CPP influences its impact on power sector

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

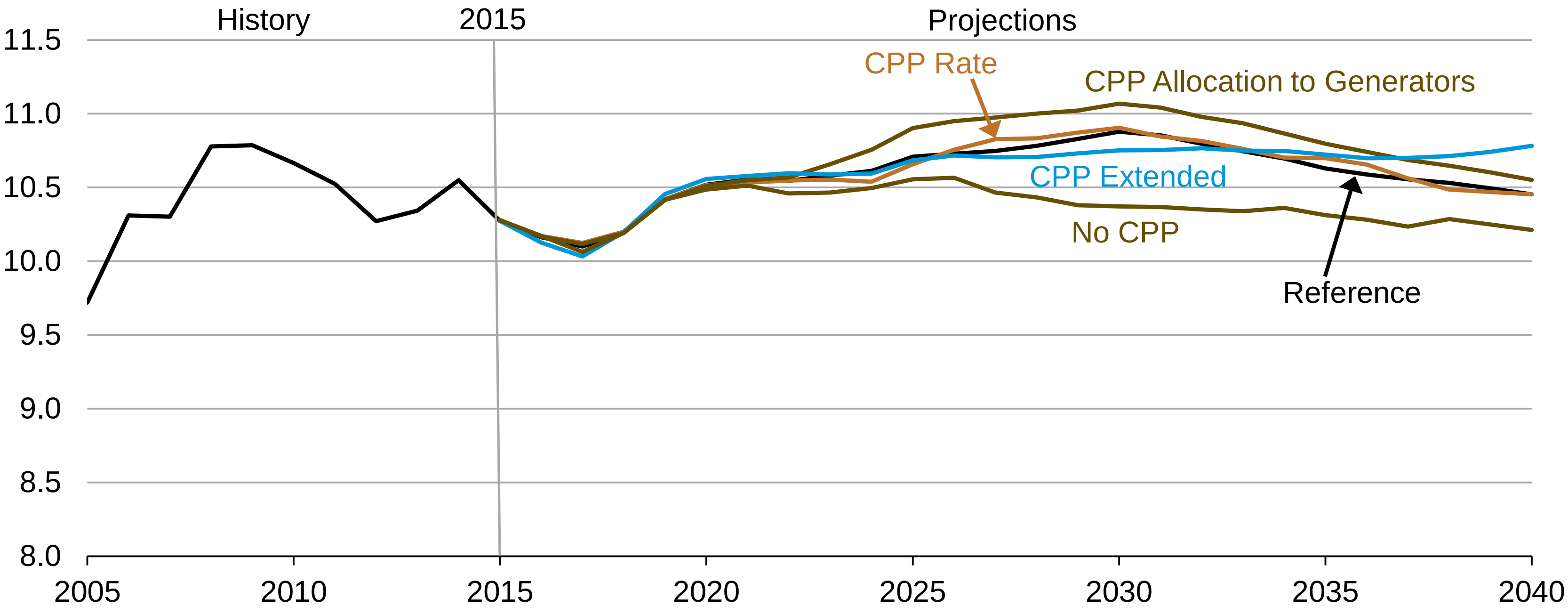


Source: EIA, Annual Energy Outlook 2016

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

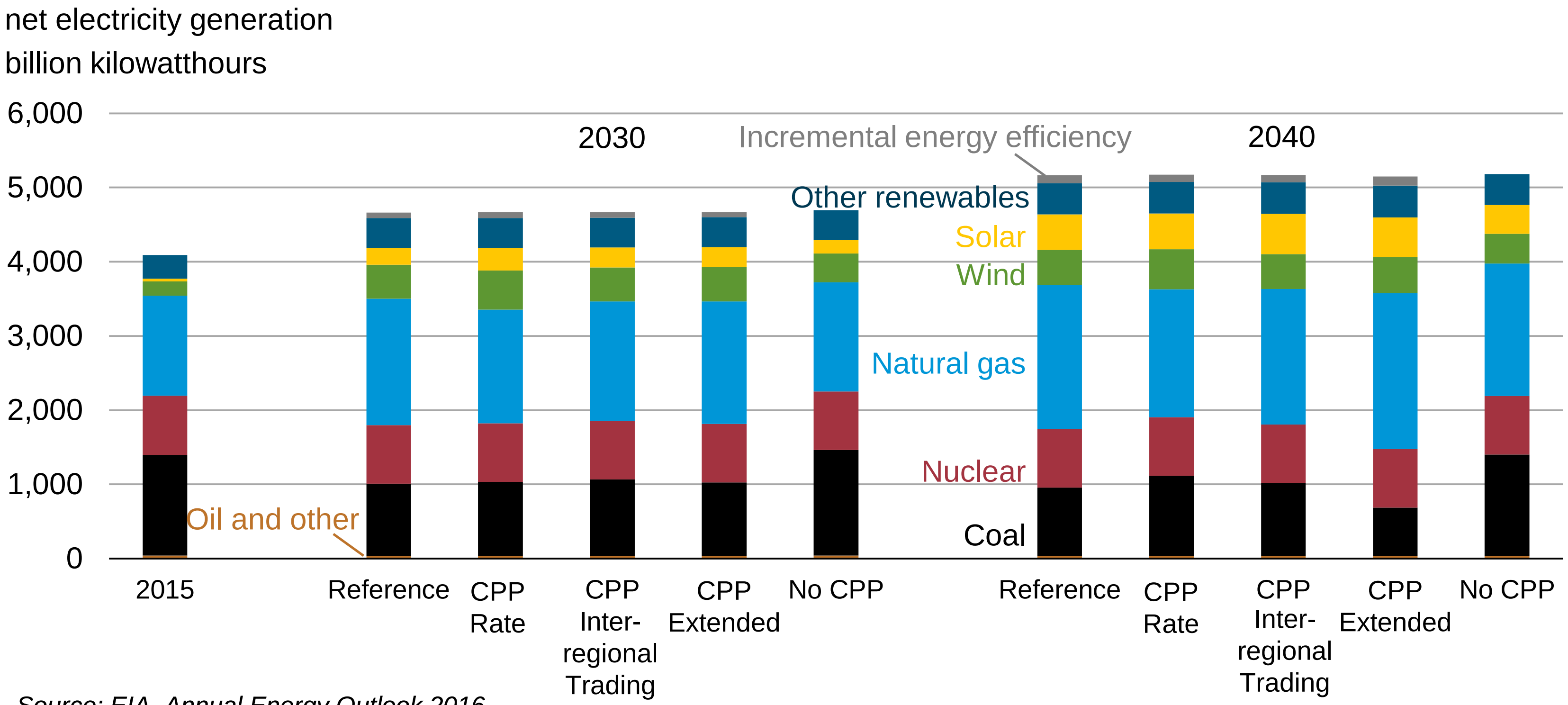
average electricity price

2015 cents per kilowatthour



Source: EIA, Annual Energy Outlook 2016

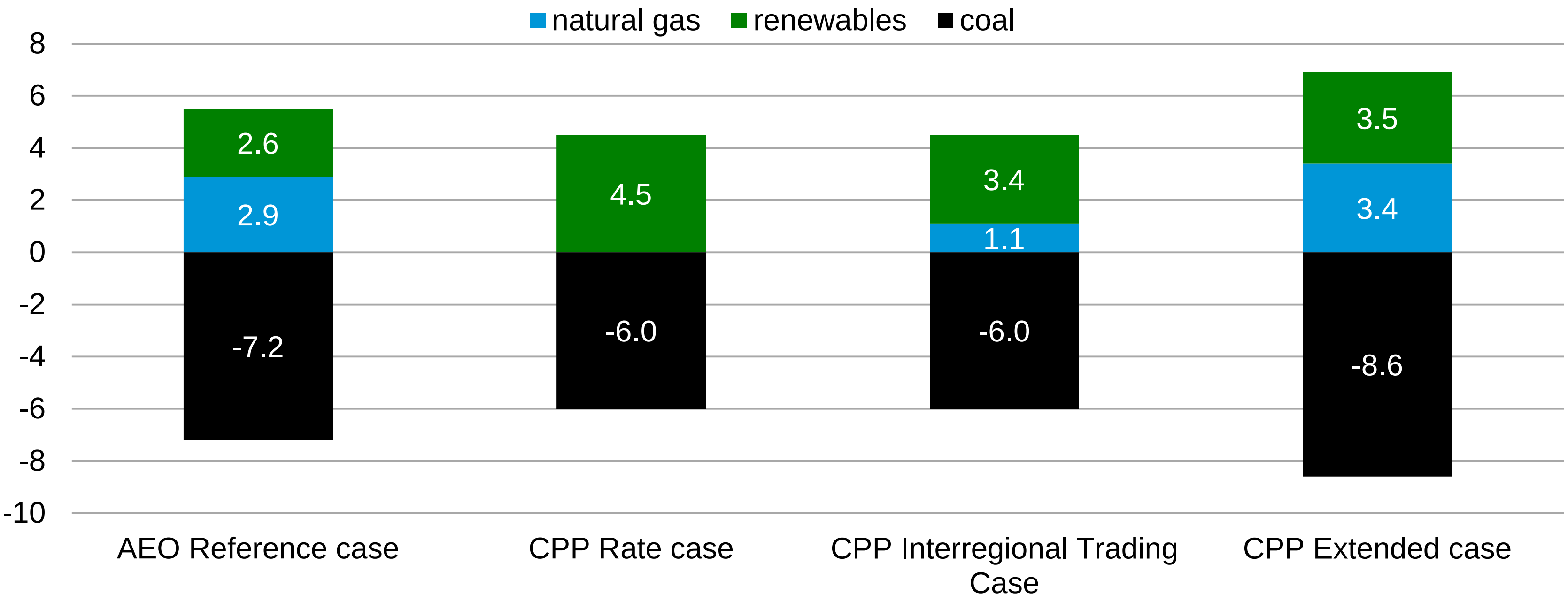
CPP reduces coal- and increases renewable and gas-fired generation; mass-based standards result in more gas and less renewables vs. rate-based *(cont.')*



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

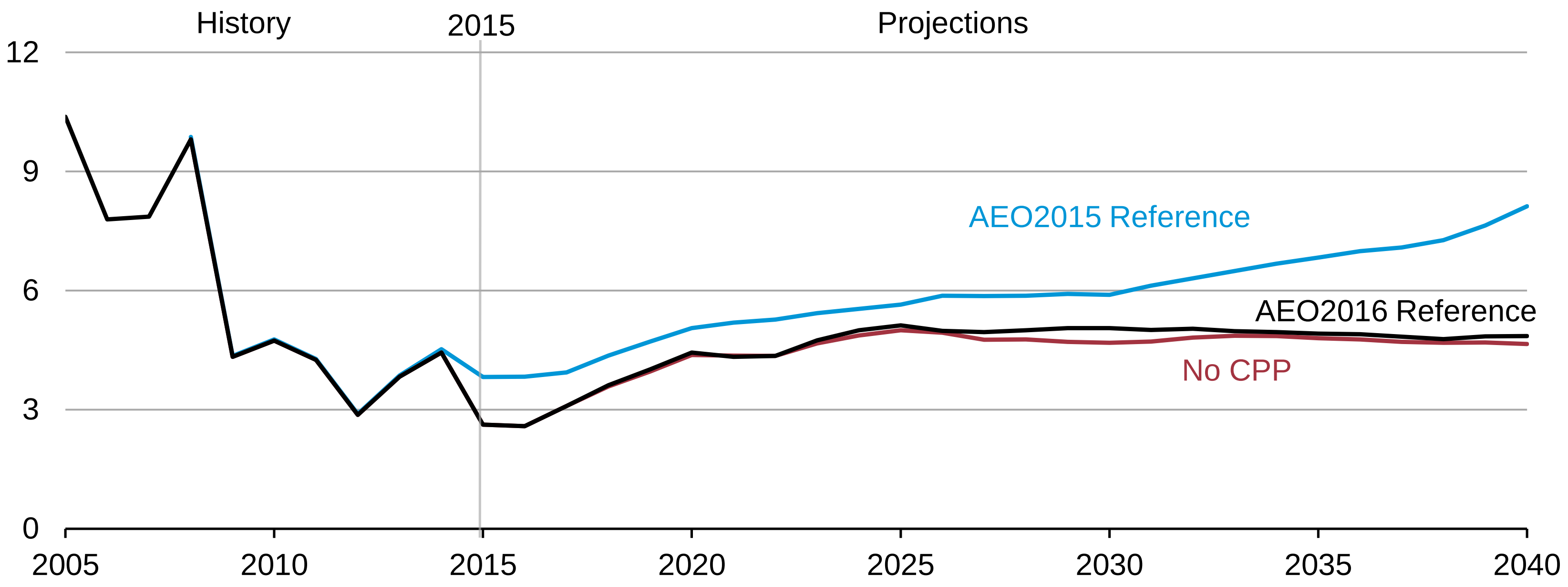


Impacts on Fuel

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

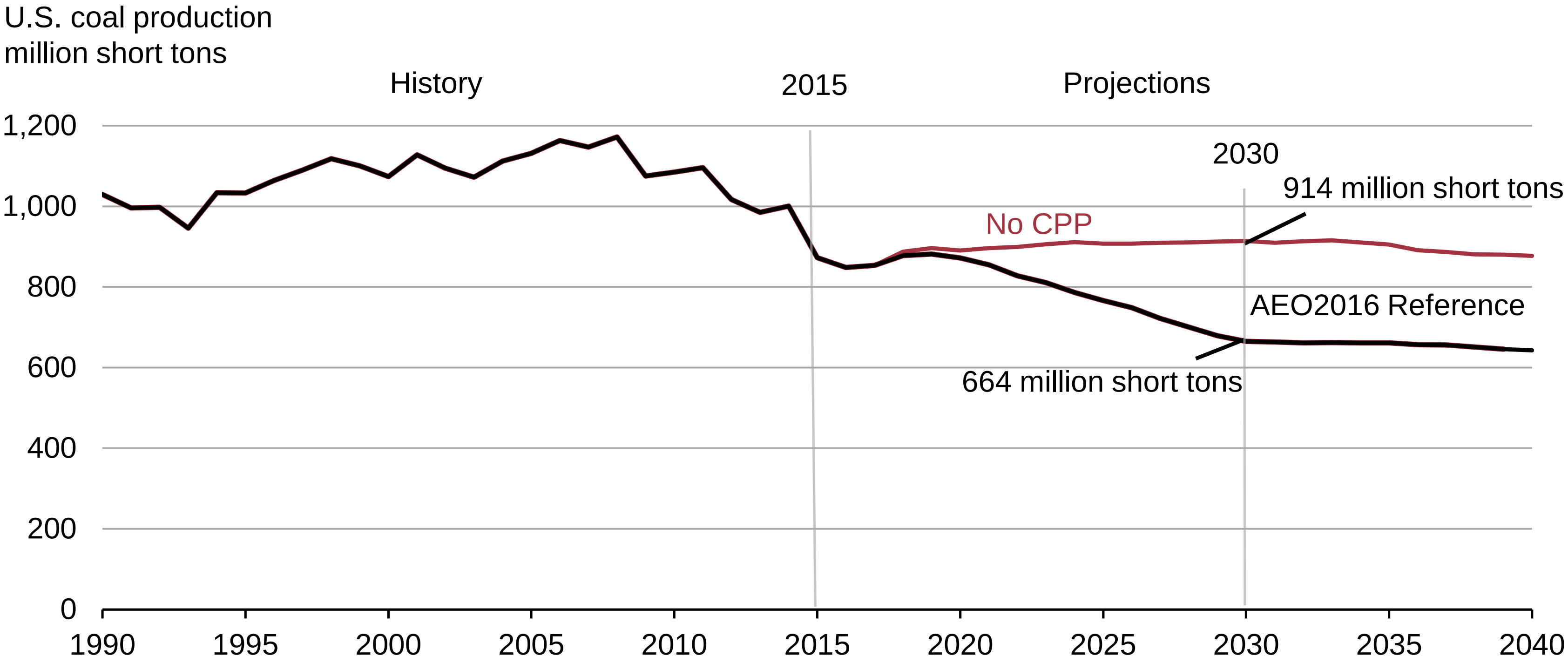
average Henry Hub spot prices for natural gas

2015 dollars per million Btu



Source: EIA, Annual Energy Outlook 2016

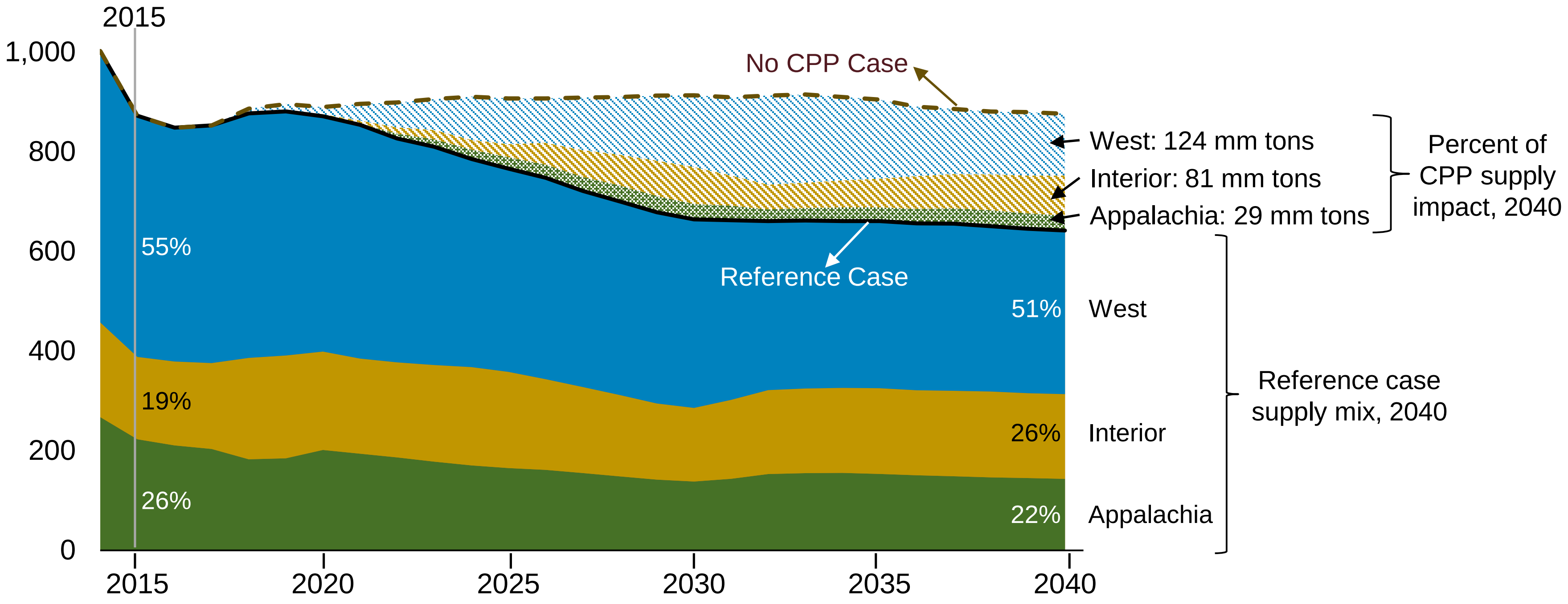
Reference case U.S. coal production in 2030 is 27% below the level in the No CPP case



Source: EIA, Annual Energy Outlook 2016

All coal supply regions are challenged when the CPP is implemented

million short tons



Source: EIA, Annual Energy Outlook 2016

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

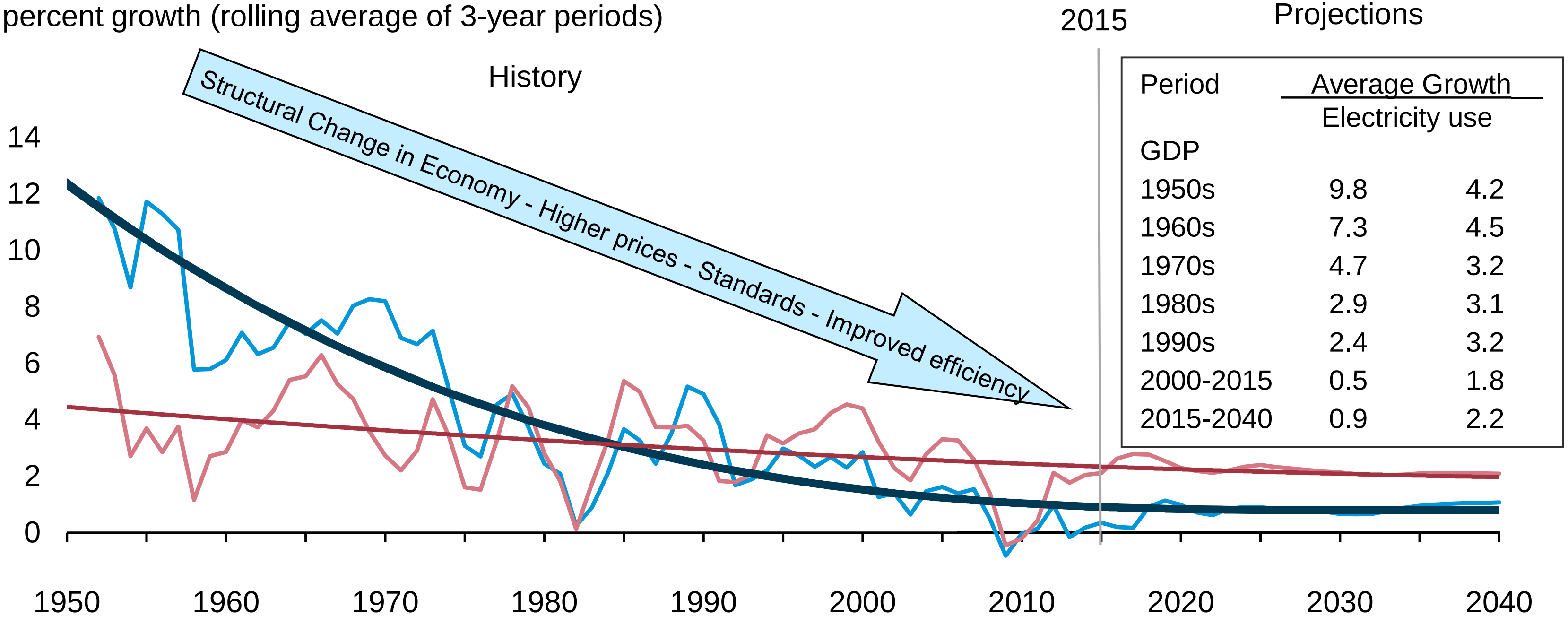
Today In Energy | www.eia.gov/todayinenergy

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

State Energy Portal | www.eia.gov/state

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)

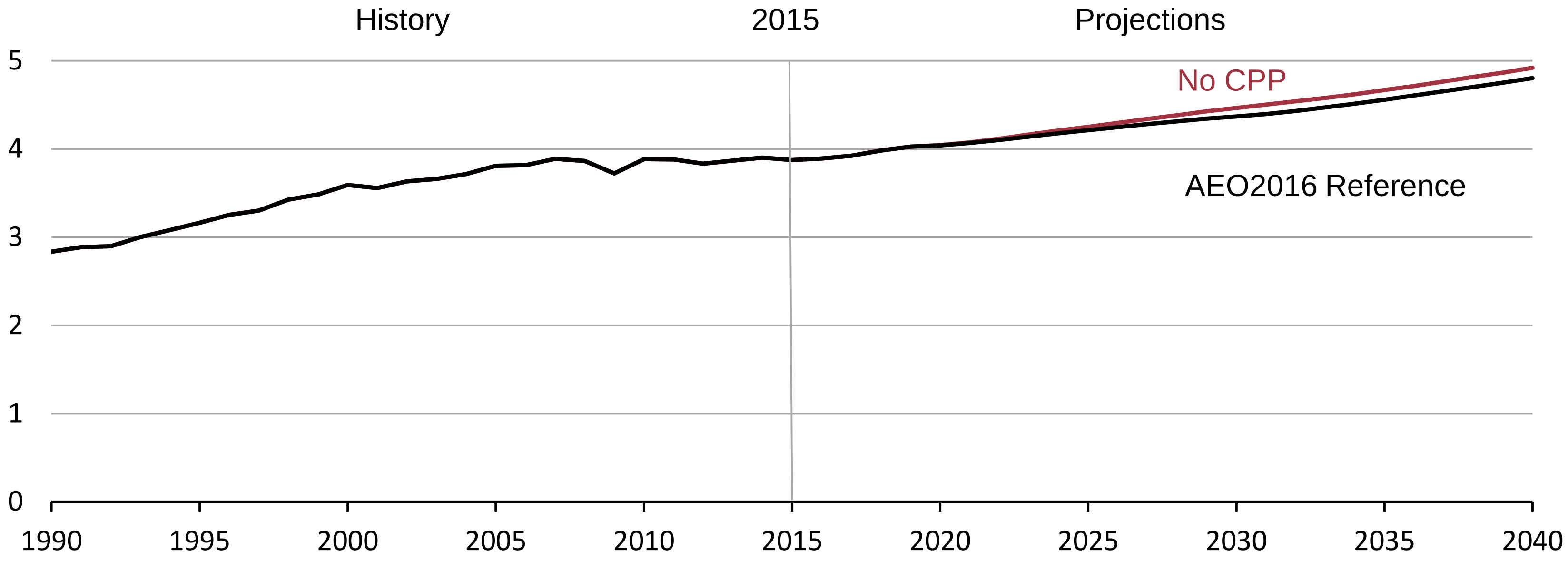


Period	Average Growth: Electricity use	GDP
1950s	9.8	4.2
1960s	7.3	4.5
1970s	4.7	3.2
1980s	2.9	3.1
1990s	2.4	3.2
2000-2015	0.5	1.8
2015-2040	0.9	2.2

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

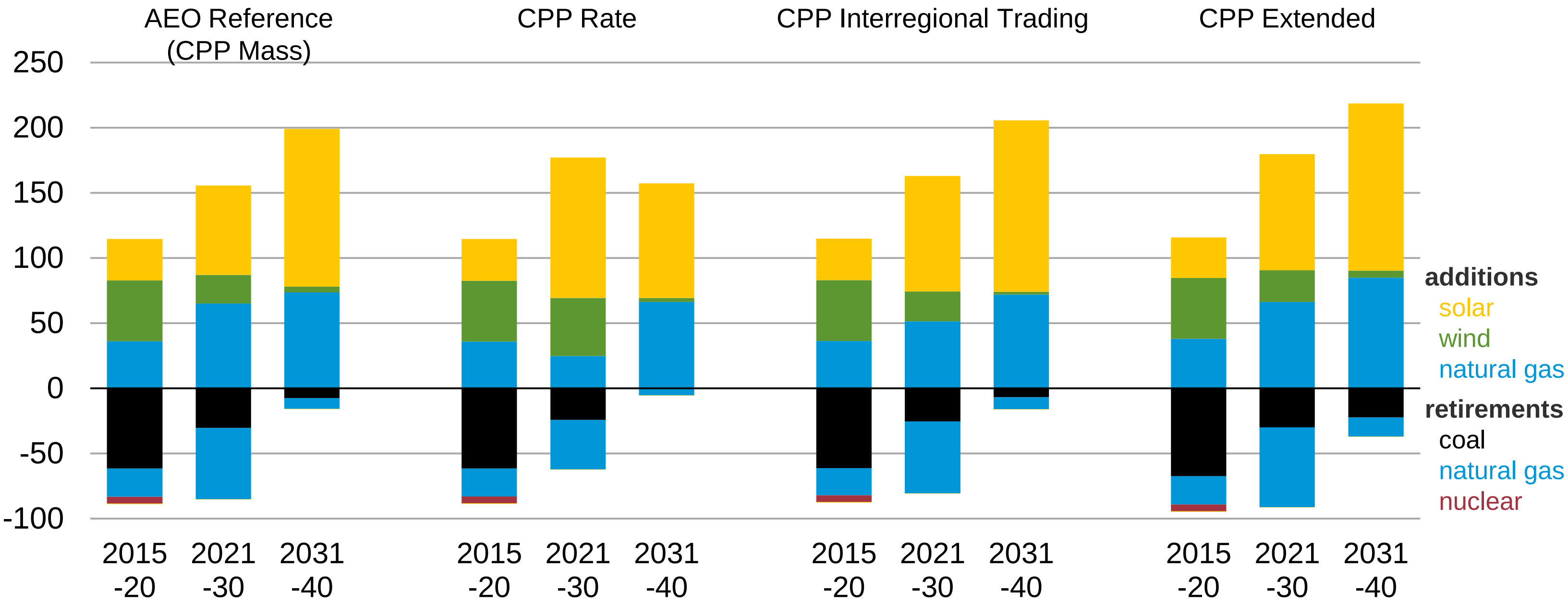
total electricity use
trillion kilowatthours



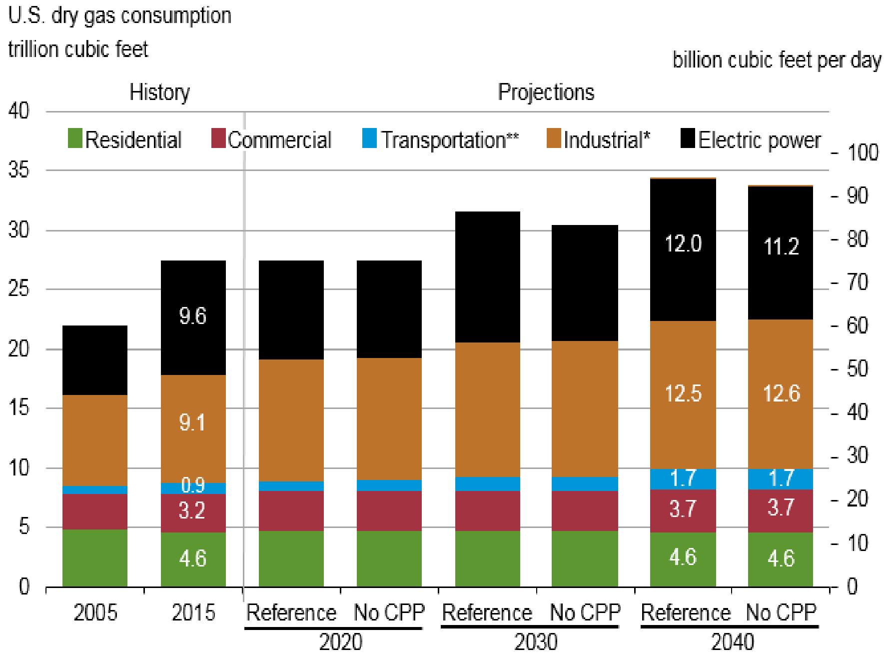
Source: EIA, Annual Energy Outlook 2016

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



Natural gas consumption growth is led by electricity generation and industrial uses; natural gas use rises in all sectors except residential



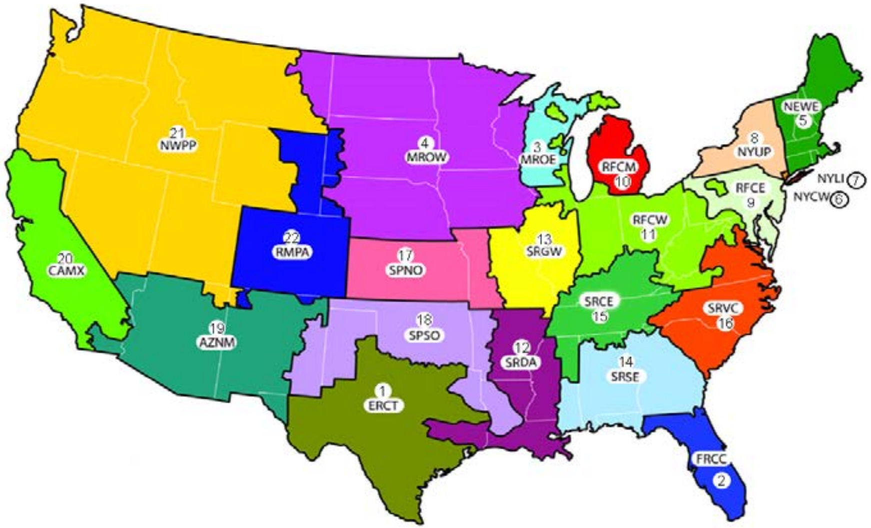
Source: *EIA, Annual Energy Outlook 2016*

**Includes combined heat-and-power and lease, plant, and export liquefaction fuel*
***Includes pipeline fuel*

- Natural gas consumption grows with increased supply and competitive prices, with the largest growth seen in the electric power and industrial sectors after 2020, the Clean Power Plan results in increased natural gas consumption for electricity generation.
- In the early years, when prices rise off of their low levels in 2015 and 2016, the growth in consumption slows and reverses for several years, particularly in the electric power sector. After 2016, natural gas-fired generation grows as coal use continues to decline and natural gas prices remain competitive.
- Strong and continued growth in the industrial sector is driven by energy-intensive industries that use natural gas as a feedstock, such as bulk chemicals, lease and plant fuel (which grows with production), and liquefaction fuel used in producing liquefied natural gas for export.
- Although, historically, little natural gas has been used in the transportation sector, the sector uses a small but growing share of natural gas in AEO2016.

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

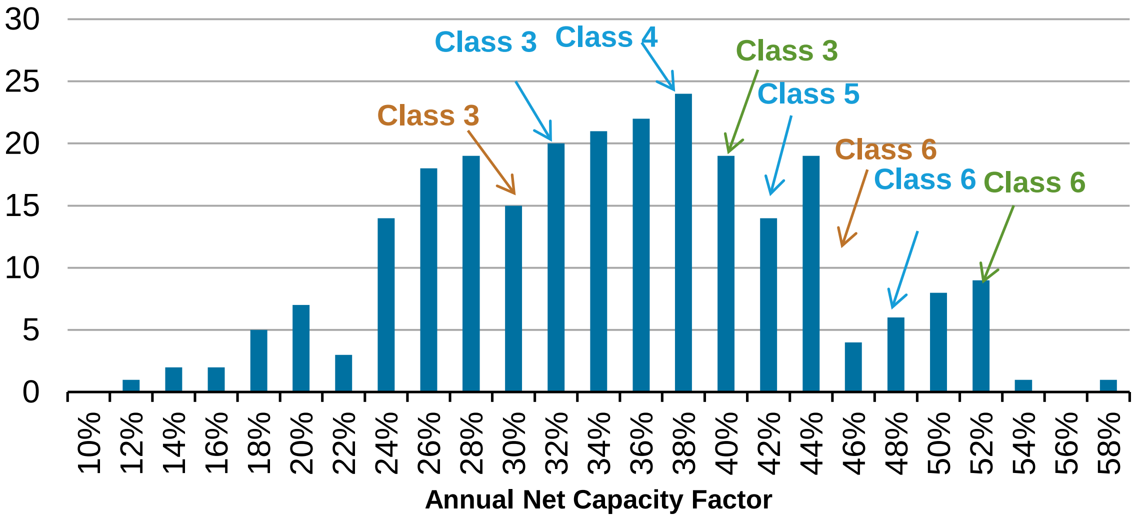
LBNL reports $1743/kW capacity-weighted average for 2014 (2015$, reported as $1710/KW in 2014$)



	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

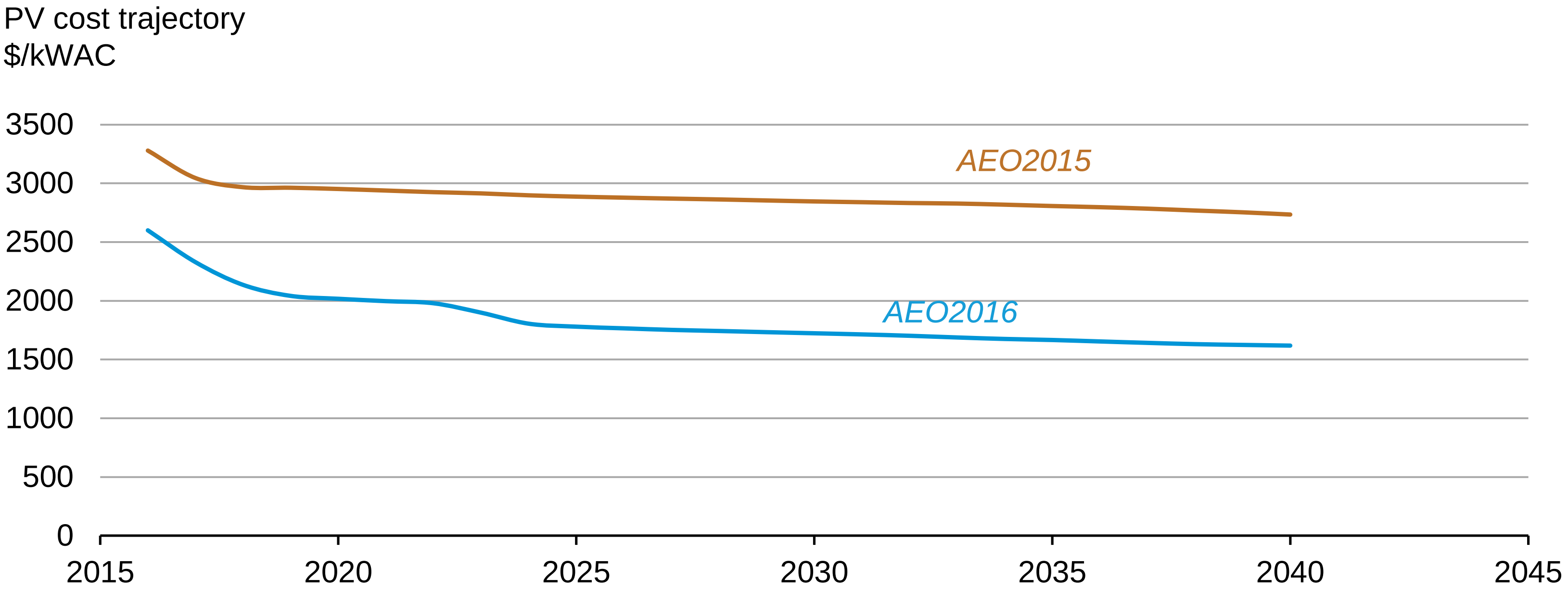
capacity factor distribution (number of plants at indicated level, Form EIA-860) wind plants built in 2011-2013
number of observations



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

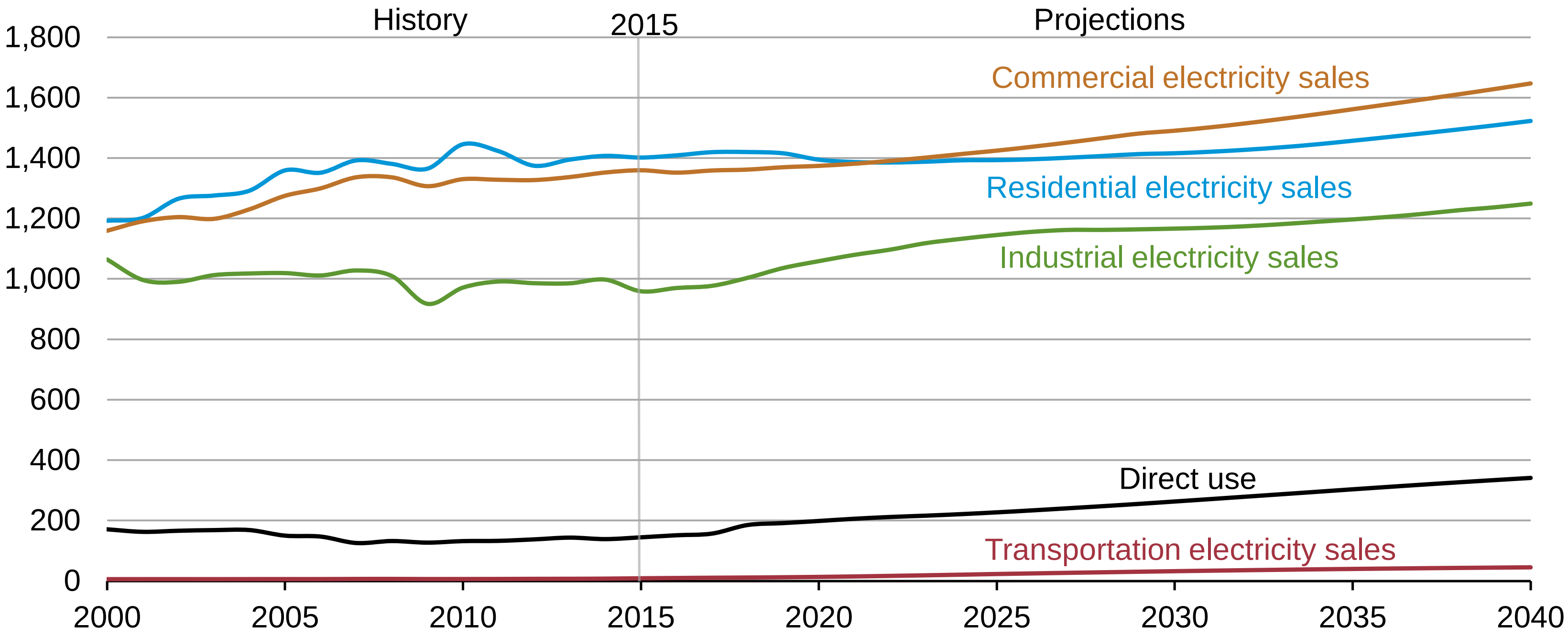


- By 2020, costs drop by over 20% with new assumptions, compared to 10% in AEO 2015
- For 2014, LBNL reports $3,800/kW capacity-weighted average (all tech), with $2,800/kW median for fixed-tilt c-Si

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

electricity consumption including direct use

billion kilowatthours

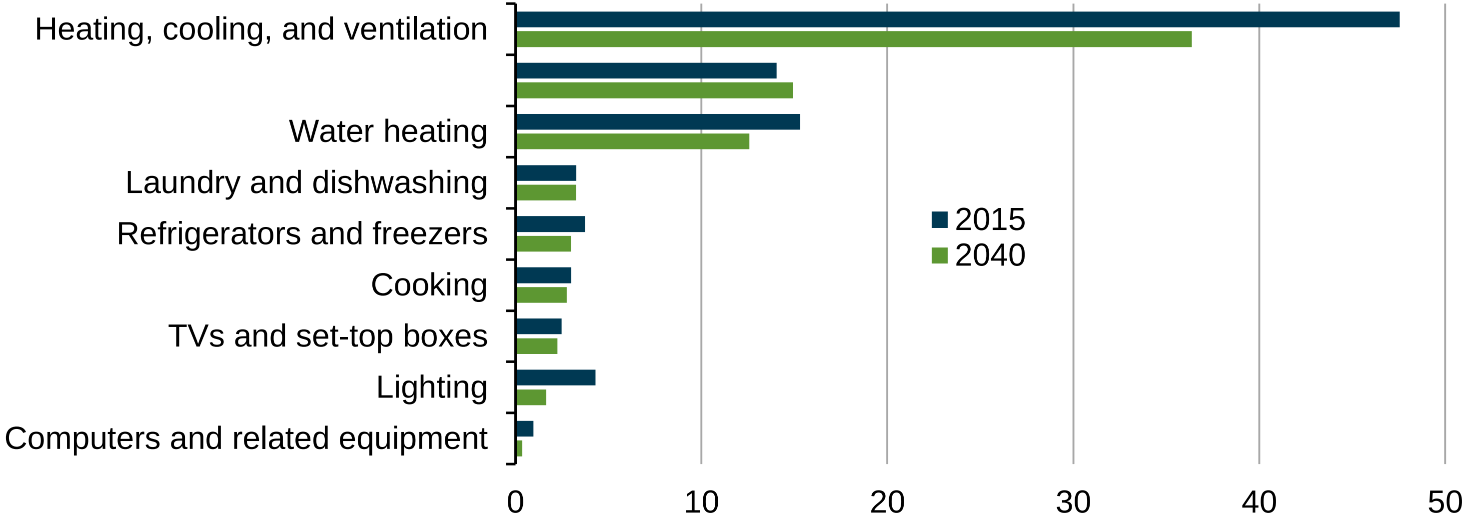


Source: EIA, Annual Energy Outlook 2016

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

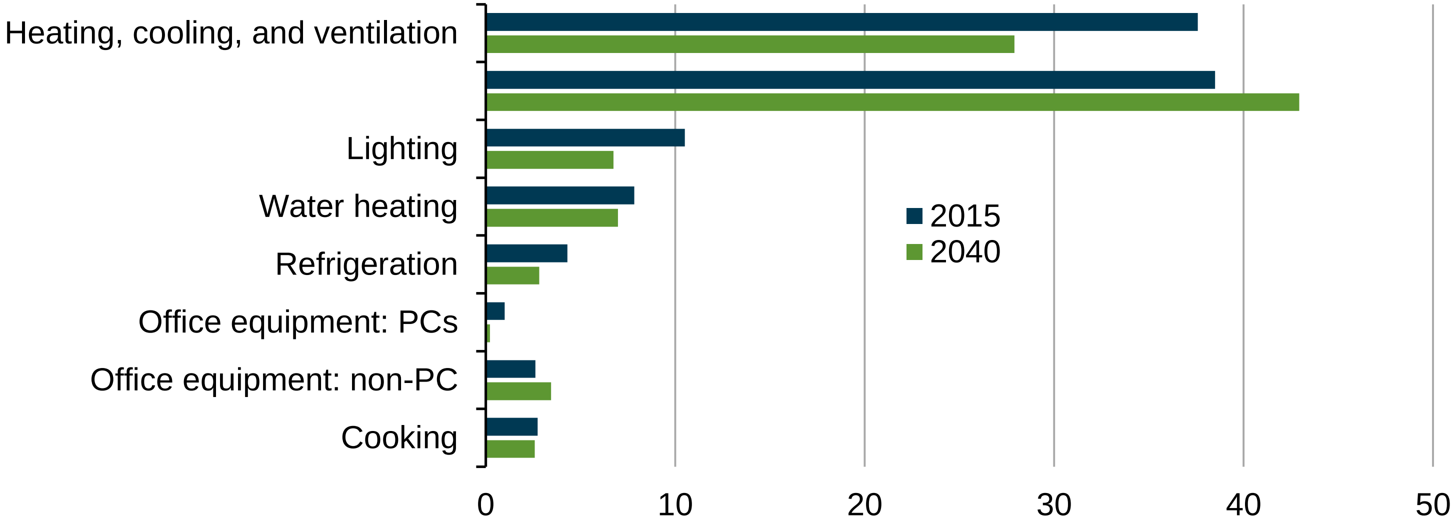


Source: EIA, Annual Energy Outlook 2016

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