

# AEO2020 Electricity Sector Working Group: AEO2019 Response, Policy Assumptions, Key Model Updates



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*For*

*EIA Electricity Working Group*

*April 10, 2019*

*By*

*Electricity Analysis Team*

*Office of Electricity, Coal, Nuclear, and Renewables Analysis*

# Overview AEO2020 Electric Sector Working Group

## First teleconference

- Overview/feedback on AEO2019
  - FAQs from AEO2019 release
- Emerging factors for analysis in AEO2020
  - Current laws and regulations
    - EPA revisions to existing rules
    - Federal tax law
    - State programs affecting the electric sector
- Proposed modeling enhancements for AEO2020
- Considerations for future long-term domestic modeling

## Overview/feedback on AEO2019: FAQs

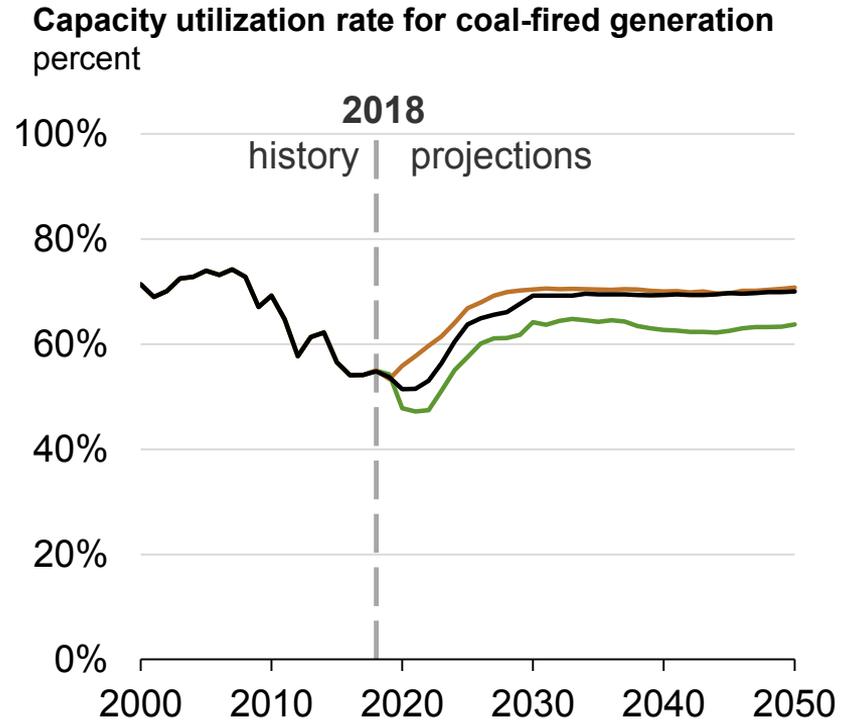
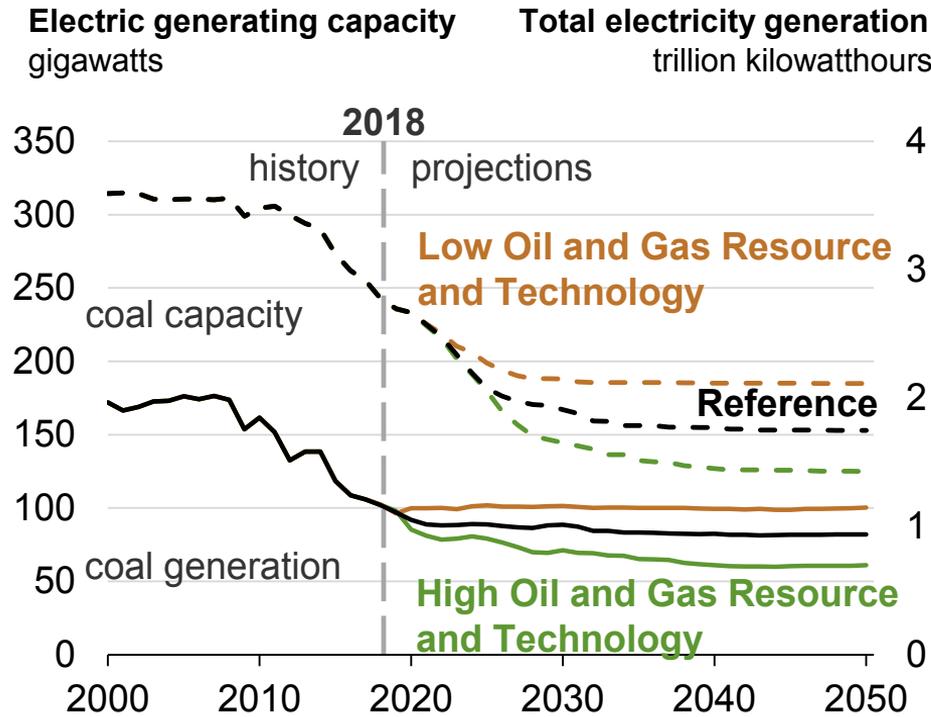
Q1. Coal generation is projected to decline somewhat and then level off to 2050, so why don't coal retirements occur then, as many will reach 60 years of age?

Q2. Why do electricity prices continue to rise while gas prices are flat or grow at lower rates?

Q3. Why does the cost of new advanced combined-cycle technology decline significantly in AEO2019?

Q4. Why have average emissions/kWh declined relative to AEO2018 levels?

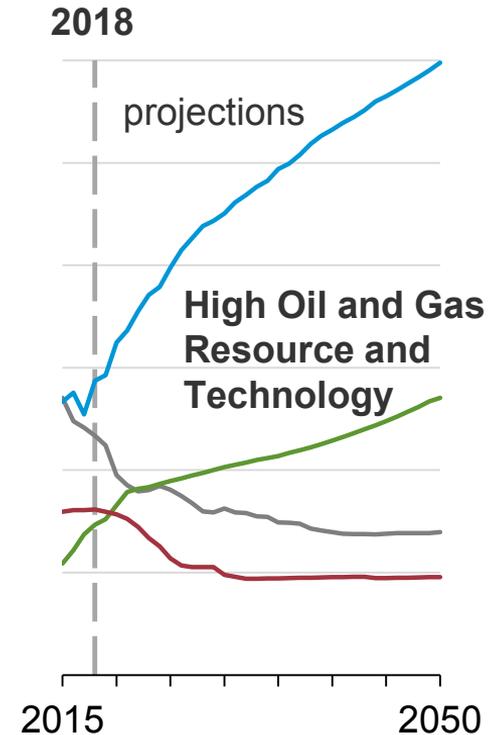
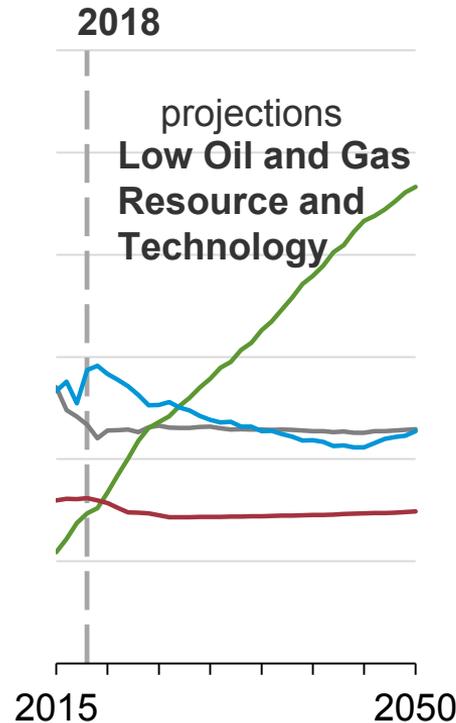
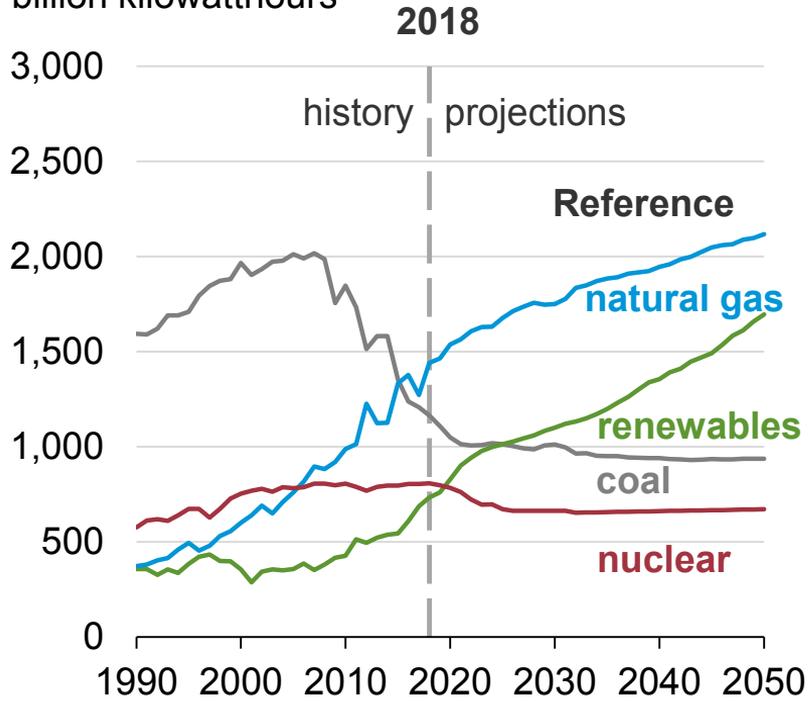
# A1a. Coal-fired generating capacity retires at a faster pace than generation in Reference case as capacity factors for coal units improve over time



# A1b. The abundance of natural gas supports its growth in the electric generation fuel mix, but the results are sensitive to resource and price assumptions

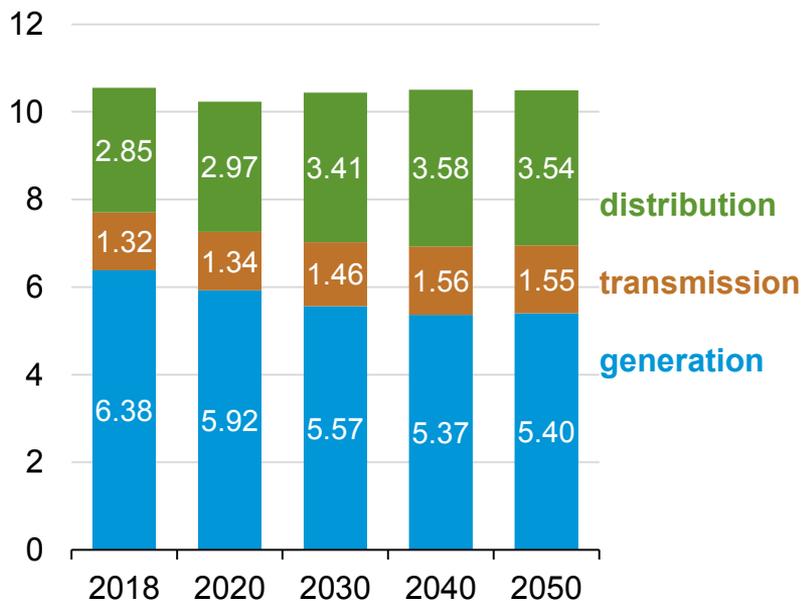
## Electricity generation from selected fuels

billion kilowatthours



## A2. Electricity prices decline slightly as decreasing generation costs offset increasing transmission and distribution costs

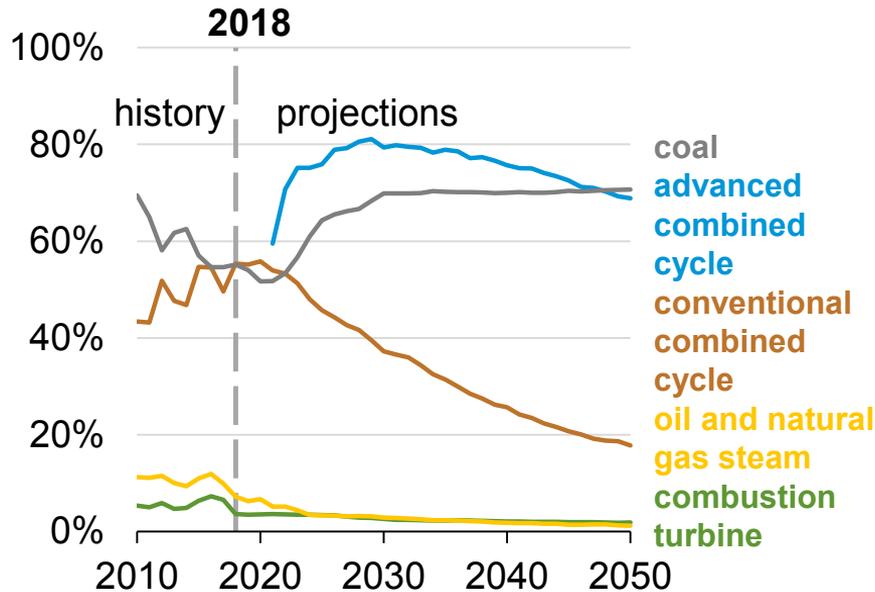
**Electricity prices by service category: Reference case**  
2018 cents per kilowatthours



- Generation costs, which account for the largest share of the price of electricity, decrease 15% from 2018 to 2050.
  - Fuel and operating costs are projected to remain flat as more efficient generators and renewable sources offset long-term increases in fuel prices.
- Transmission and distribution costs increase by 18% and 24%, respectively, as a result of replacing aging infrastructure and upgrading the grid to integrate wind and solar capacity.

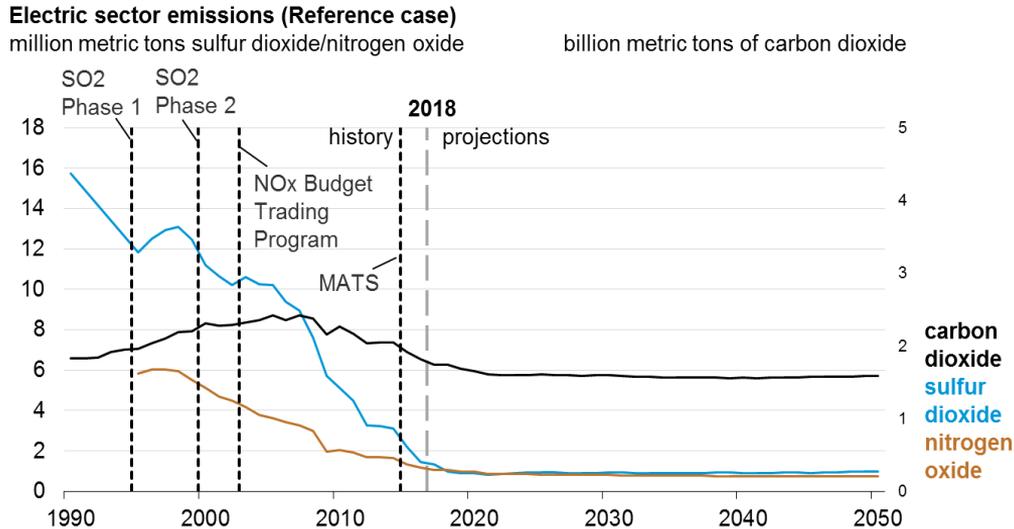
# A3. Lower operating costs and higher efficiencies result in advanced natural gas-fired combined-cycle capacity factors of 80% by 2030

Utilization of fossil-fired capacity (Reference case)  
percent



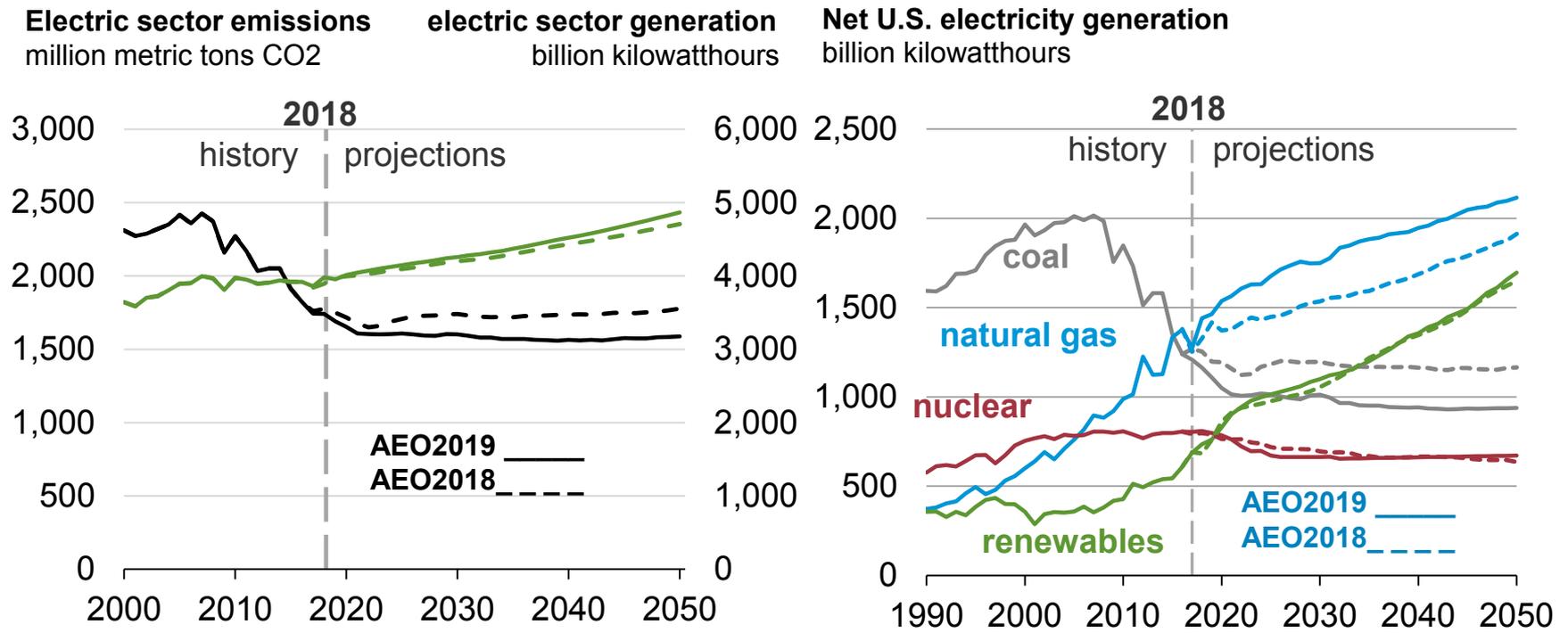
- New, larger CC designs result in substantial economies of scale for this technology.
- According to the April 2018 PJM Report, *PJM Cost of New Entry*, PJM's next generating capacity auction cost per unit of installed capacity for the advanced CC design will be 25% to 30% lower compared with older CC units.
- Through 2050, 235 gigawatts of advanced CC technology will be installed.

# A4a. Why have average emissions/kWh declined relative to AEO2018 levels?



- Generation mix projections have shifted more to natural gas/renewables and away from coal.
- In the absence of additional federal regulations, CO<sub>2</sub> emissions remain relatively unchanged in the Reference case from 2018 to 2050, despite a 30% increase in generation during the projection period.

# A4b. Why have average emissions/kWh declined relative to AEO2018 levels?



# Legislation and Regulations: AEO2019 Assumptions and Outlook for AEO2020

# AEO2020—current laws and regulation—addressing EPA revisions to existing rules

- Affordable Clean Energy (ACE) Rule
- New Source Performance Standards (NSPS) for greenhouse gases from electric generators
- Mercury and Air Toxics Standards (MATS) in all AEO2019 cases
- Cross State Air Pollution Rule (CSAPR)

# Addressing EPA revisions to existing rules: Affordable Clean Energy (ACE) Rule

- EPA proposed ACE rule to replace the Clean Power Plan
  - Revises EPA's BSER (*best system of emission reduction*) finding for GHG emissions from existing power plants to include only heat-rate efficiency improvements
  - Rather than setting specific technology-based standards, it gives states a list of *candidate technologies* they use to establish performance standards in state plans
- Status: ACE rule was not final and not included in AEO2019 Reference case
  - Proposed in August 2018
  - Final rule expected in spring of 2019
  - Will be included in AEO2020 if the rule is finalized in 2019 in time

# Addressing EPA revisions to existing rules: Affordable Clean Energy (ACE) Rule

## Proposed approach to implementation of ACE rule in EMM

- By 2025, offer existing coal units the choice to either upgrade to the HRI option identified in EIA's CPP study or retire them
- Relies on 2015 EIA study of heat rate improvement (HRI) potential and costs for existing coal units (*see next slide for detail*)

# Addressing EPA revisions to existing rules: Proposed approach to modeling Affordable Clean Energy (ACE) Rule

## Heat rate improvement (HRI) potential and cost (capital, fixed O&M) by plant type and quartile

ECP type	RETROFIT COST (2017\$/KW) QUARTILE				ECP type	HEAT RATE IMPROVEMENT QUARTILE			
	Q1	Q2	Q3	Q4		Q1	Q2	Q3	Q4
B1	NA	\$ 124	\$ 247	\$ 1,131	B1	NA	0.8%	4.0%	6.0%
B3	NA	\$ 62	\$ 238	\$ 722	B3	NA	0.7%	6.0%	9.0%
B5	NA	\$ 38	\$ 124	\$ 247	B5	NA	0.8%	7.0%	10.0%
B7	NA	\$ 49	\$ 361	\$ 361	B7	NA	0.8%	7.0%	7.0%
C1	NA	\$ 124	\$ 494	\$ 1,331	C1	NA	0.8%	4.0%	7.0%
C4	NA	\$ 50	\$ 228	\$ 361	C4	NA	0.8%	6.0%	10.0%
C7	NA	\$ 38	\$ 124	\$ 247	C7	NA	0.8%	7.0%	10.0%
C8	NA	\$ 38	\$ 124	\$ 247	C8	NA	0.8%	7.0%	10.0%
CX	\$ 131	\$ 247	\$ 247	\$ 247	CX	7.00%	7.0%	7.0%	7.0%
CY	\$ 131	\$ 247	\$ 247	\$ 247	CY	7.00%	7.0%	7.0%	7.0%
H1	NA	\$ 124	\$ 494	\$ 1,331	H1	NA	0.8%	4.0%	7.0%
H4	\$ 126	\$ 238	\$ 238	NA	H4	3.00%	3.0%	3.0%	NA
H5	\$ 126	\$ 238	\$ 238	NA	H5	3.00%	3.0%	3.0%	NA
H7	NA	NA	\$ 124	\$ 247	H7	NA	NA	7.0%	10.0%
H8	NA	NA	\$ 124	\$ 247	H8	NA	NA	7.0%	10.0%
HA	NA	NA	NA	NA	HA	NA	NA	NA	NA
wtd avg	\$ 126	\$ 80	\$ 205	\$ 369	wtd avg	3.0%	1.4%	6.3%	9.5%

<https://www.eia.gov/analysis/studies/powerplants/heatrate/>

## Coal unit classification by type of pollution controls

Plant Type Code	Coal Unit Classification	Type of Controls		
		SO2	NOx	Other
B1	Bag house	NA	Any	NA
B3	Bag house	Wet FGD	-	NA
B5	Bag house	Wet FGD	SCR	NA
B7	Bag house	Dry FGD	-	NA
C1	Cold side ESP	NA	-	NA
C4	Cold side ESP	Wet FGD	-	NA
C7	Cold side ESP	Wet FGD	SCR	NA
C8	Cold side ESP	Wet FGD	SCR	FF
CX	Cold side ESP	Dry FGD	-	NA
CY	Cold side ESP	Dry FGD	-	FF
H1	Hot Side ESP/Other/None	NA	-	NA
H4	Hot Side ESP/Other/None	Wet FGD	-	NA
H5	Hot Side ESP/Other/None	Wet FGD	-	FF
H7	Hot Side ESP/Other/None	Wet FGD	SCR	NA
H8	Hot Side ESP/Other/None	Wet FGD	SCR	FF
HA	Hot Side ESP/Other/None	Dry FGD	-	NA

**Key:** ESP: electrostatic precipitator FGD: flue gas desulfurization (scrubber)  
SCR: selective catalytic reduction FF: fabric filter

# Addressing EPA revisions to existing rules: Revised New Source Performance Standards NSPS for GHG from EGUs

- All AEO2019 cases include EPA's NSPS limiting CO<sub>2</sub> from new plants
  - Proposed revisions would:
    - Eliminate the CCS requirement
    - Specify CO<sub>2</sub> emission limits for large units (super-critical), small units (sub-critical), and new coal refuse-fired units
    - Change applicability of rules to modified units
  - Included in AEO2020 if the rule is finalized in 2019 in time
  - Study underway to update cost and performance for coal units in AEO2020
  - AEO2020 will continue to apply a 3% adder to the cost of capital for new coal with less than 90% carbon capture

	NSPS CO <sub>2</sub> emission standard		
	EPA Proposed	EPA seeking comment on alternative range	
	<i>lbs/CO<sub>2</sub>/mmBtu (gross energy output)</i>		
<b>Large units (super-critical)</b>	2,000	1,700 - 1,900	
<b>Small units (sub-critical)</b>	1,900	1,800 - 2,000	
<b>New coal refuse-fired units</b>	2,200	2,000 - 2,200	
Source:			
EPA Proposal: NSPS for GHG Emissions from New, Modified, and Reconstructed EGUs; pg. 146			
<a href="https://www.epa.gov/stationary-sources-air-pollution/proposal-nsps-ghg-emissions-new-modified-and-reconstructed-egus">https://www.epa.gov/stationary-sources-air-pollution/proposal-nsps-ghg-emissions-new-modified-and-reconstructed-egus</a>			

# AEO2020—current laws and regulation—addressing EPA revisions to existing rules

- Mercury and Air Toxics Standards (MATS) are included in all AEO2019 cases
  - “EPA issued a proposed revised Supplemental Cost Finding for the Mercury and Air Toxics Standards, as well as the Clean Air Act required ‘risk and technology review.’...and proposes to determine that it is not ‘appropriate and necessary’ to regulate HAP emissions from power plants under Section 112 of the Clean Air Act. The emission standards and other requirements of the MATS rule, first promulgated in 2012, **would remain in place**, however, since EPA is not proposing to remove coal- and oil-fired power plants from the list of sources that are regulated under Section 112 of the Act.” (quoted from [EPA website](#); emphasis added).
  - MATS will be included in all AEO2020 cases, unless further guidance is issued to the contrary
- EPA’s Cross State Air Pollution Rule (CSAPR) is included in all AEO2019 cases and will be maintained in all AEO2020 cases

## AEO2020—current laws and regulation—federal tax law: Section 45Q tax credit for Carbon Capture and Storage

- Section 45Q tax credit for Carbon Capture and Storage is not reflected in AEO2019
  - Revised (from \$20) to \$50 per metric ton for secure geologic storage, and (from \$10) to \$35 per metric ton for Enhanced Oil or Gas Recovery (EOR/EGR) or utilization
  - Changes in tax code will be incorporated into AEO2020, with possible indirect implications for coal disposition
  - Modeling of CCS and 45Q occurs in the Electricity Market Module (EMM) and the Oil and Gas Supply Module (OGSM)

# AEO2020—current laws and regulation—state/regional programs

- Twelve states are actively considering relatively strict carbon emission policies
  - New Mexico enacted legislation in March 2019 calling for IOUs and co-ops to get at least 50% of their fuel source from renewables by 2030 and 80% by 2040; 100% carbon-free mandate by 2045 for utilities and by 2055 for co-ops
  - Other states are considering similar options with targets of 50% to 100% carbon-free electricity generation targets, including: AZ, FL, IL, MD, ME, MN, NC, NV, WA, WI
  - California regulations included in AEO2019
    - AB 398 Global Warming Solutions Act requires statewide greenhouse gas emissions to return to the 1990 level by 2020 and be 40% lower than the 1990 level by 2030 (Cap-and-trade program under AB 32)
    - SB-1368 prohibits CA utilities from entering into long-term financial commitments for base load generation, unless in compliance with the CO2 emissions performance standard of 1,100 lbs/MWh
- Regional Greenhouse Gas Initiative (RGGI) program
  - New Jersey and Virginia recently opted in and may be included in AEO2020
- Renewable Portfolio Standard (RPS)/ Zero Emission Credit (ZEC) programs

# Pending AEO2020 modeling—enhancements to NEMS EMM

- Regional redefinition
- Update capital cost and performance characteristics for new generation
- Addition of short-term wholesale market price projections



# Current EMM regional mapping: summary of regional changes

- **PJM** split into four regions East/West/Dominion/ComEd
- Expanded **MISO** region split into 4 pricing zones
- Expanded **SPP** region split into 3 pricing zones
- **SERC** reduced to 3 regions
- **California** split into North/South regions
- **WECC** region split into 6 regions
- **Unchanged:** ISO-New England, Florida, Texas

# Generating technologies proposed for updated capital cost and performance characteristics for AEO2020

EMM Generating Technology Plant Types Proposed			
<i>Fossil/Nuclear</i>			
Fuel Type	Plant Type description	Proposed Configuration	Case Description
Coal	Coal w/o CCS	650 MW Net	Ultra-supercritical coal (NSPS for NOX, Sox, PM, Hg)
Coal	Coal w/Partial Sequestration	650 MW Net	NSPS compliant ultra-supercritical coal (with 30% CCS or other compliance technology)
Coal	Coal w/90% Sequestration	650 MW Net	Ultra-supercritical coal (with 90% CCS)
Gas-Peaking	Internal Combustion Engine	20 MW (4x 5.6 MW)	Internal combustion engine (natural gas or oil-fired diesel)
Gas-Peaking	Conv Combustion Turbine	100 MW, 2 x LM6000	Combustion oil/natural gas turbine
Gas- Baseload	Adv Gas/Oil Comb Cycle	1100 MW, H-Class, 2x2x1	Combined-cycle oil/natural gas turbine
Gas-Baseload	Adv Gas/Oil Comb Cycle	430 MW, H-Class 1x1x1	Combined cycle single shaft
Gas- Baseload	Adv CC w/Sequestration	430 MW, H-Class 1x1x1	Combined-cycle gas turbine (with 90% CCS)
Nuclear	Advanced Nuclear	2 x 1117 MW, PWR	Advanced Nuclear AP 1000
Nuclear	SMR Nuclear	600 MW	Small Modular Reactor (SMR)

# Long-term modeling enhancements

- Dynamic regional definition modeling capability
- Revised methodology: T&D spending projections
- International coal supply curves

# AEO2020 Schedule

- Model development: Jun-Oct 2019
- Second Working Group Session: Sep/Oct 2019
- Expected AEO release: Jan 2020

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