Annual Energy Outlook 2014: Electricity Working Group Meeting July 24, 2013

Electricity Analysis Team
Office of Electricity, Coal, Nuclear, and Renewables Analysis
Office of Energy Analysis

Annual Energy Outlook 2014 Reference Case: Key Changes

- *Environmental Rules*
  - *Updates to NEMS modeling of MATS*
  - *RGGI cap tightened to reflect February 2013 MOU*
- *Enhancements*
  - *Reserve margins and capacity payments*
  - *Spinning and operating reserves*
  - *Operations and maintenance cost updates*
  - *Municipal utility pricing data updates*
  - *Carbon transportation, utilization, and storage updates*
- *Reflects 10-year plans reported to EIA for:*
  - *Generating unit retirements*
  - *New generating unit installations*

Environmental Rules

- Updates to the modeling of MATS in NEMS
- RGGI cap tightened to reflect February 2013 MOU
- Emerging environmental issues

MATS Modeling Update to NEMS

- *AEO 2013* approach
  - All units with an FGD are in compliance with the acid gas and particulate requirements
  - All units without an FGD are required to add a FGD scrubber or dry sorbent injection (DSI) system with a fabric filter

- *AEO 2014* proposed approach
  - Incorporate upgrades to electrostatic precipitators (ESP) to units identified by EPA as being potentially eligible for an ESP upgrade
    - List of applicable units can be found in Appendix 5-6 of the *Documentation Supplement for EPA Base Case v.4.10_MATS – Updates for Final Mercury and Air Toxics Standards (MATS) Rule**
  - Require plants with dry scrubbers to include fabric filter to meet particulate requirements
  - Updated retrofit costs for DSI and fabric filters

Proposed MATS Compliance Strategies in *AEO 2014*

		Existing SOx Controls		
		Wet FGD	**Dry FGD**	**No Controls**
Existing Particulate Controls	**Fabric Filter (FF)**	Complies	Complies	Add DSI OR FGD
	ESP *	Upgrade ESP	Upgrade ESP	Upgrade ESP and either DSI + FF OR FGD
	No Controls	Complies	Add FF	Add FGD OR DSI + FF

Notes:

- Units must have applicable Particulate control (ESP, FF, or Wet Scrubber) and adequate Acid Gas controls (Wet FGD, Dry FGD, or Dry Sorbent Injection (DSI))
- DSI Can only be used if a fabric filter (FF) is in place
- ESPs may be upgraded for Acid Gas Controls ; generally most cost effective method

Average Cost of Environmental Retrofits (2011 $'s)

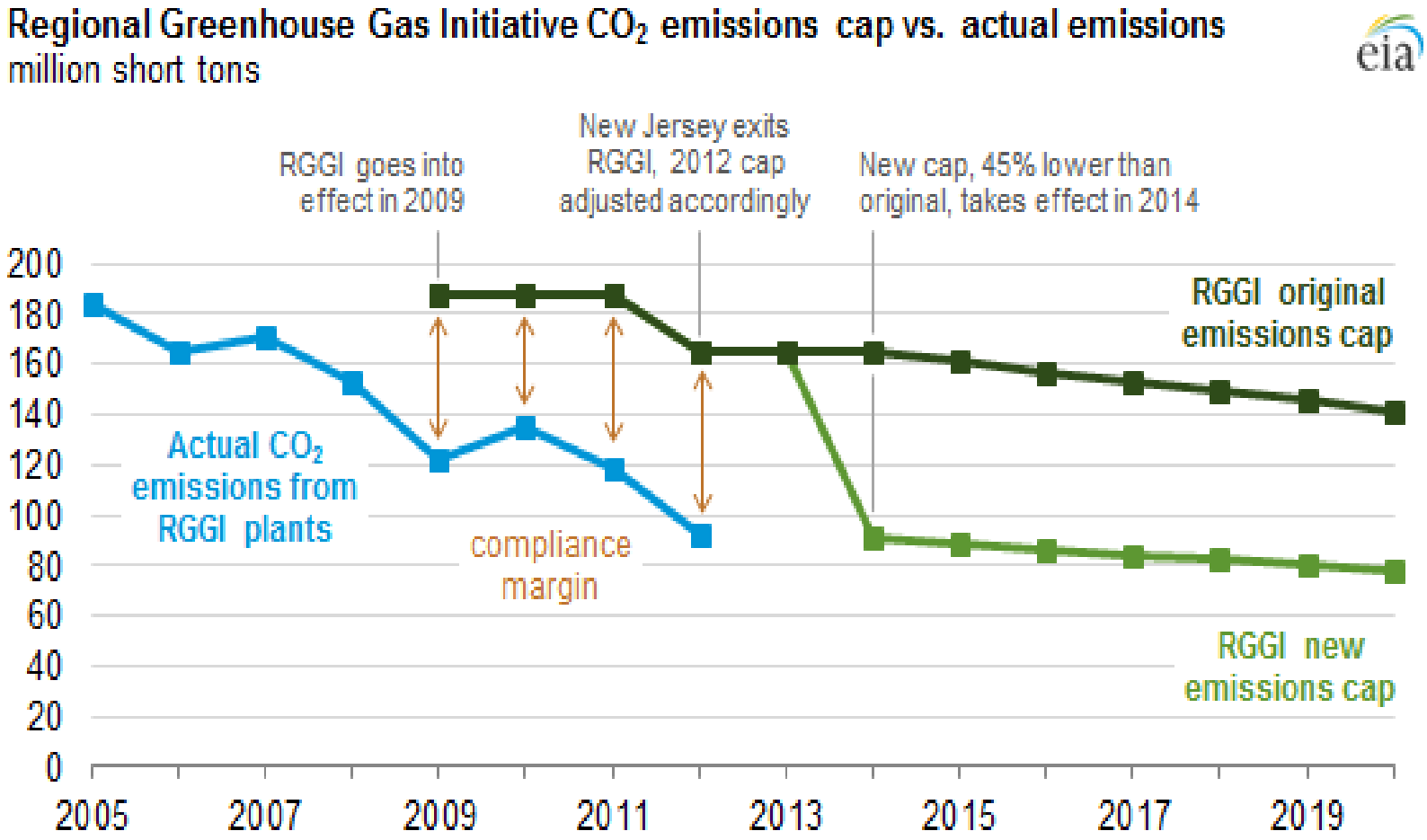
Flue Gas Desulfurization			
MW	Capital ($/kW)	FOM ($/kW-yr)	VOM ($/MWh)
<100	$803.66	$35.65	$1.76
100-299	$592.12	$16.64	$1.39
300-499	$450.69	$9.06	$1.18
500-699	$399.81	$8.04	$1.07
>700	$357.19	$6.43	$1.19

Fabric Filter			
MW	Capital ($/kW)	FOM ($/kW-yr)	VOM ($/MWh)
<100	$254.68	$3.30	$0.12
100-299	$187.32	$1.59	$0.12
300-499	$155.11	$0.98	$0.12
500-699	$140.94	$0.81	$0.12
>700	$129.76	$0.70	$0.12

Dry Sorbent Injection			
MW	Capital ($/kW)	FOM ($/kW-yr)	VOM ($/MWh)
<100	$108.02	$2.37	$5.78
100-299	$70.34	$1.39	$5.35
300-499	$60.13	$1.17	$5.69
500-699	$60.67	$1.14	$5.72
>700	$54.10	$1.01	$5.39

Selective Catalytic Reduction			
MW	Capital ($/kW)	FOM ($/kW-yr)	VOM ($/MWh)
<100	$391.72	$1.60	$2.60
100-299	$252.28	$0.89	$1.67
300-499	$198.94	$0.66	$1.19
500-699	$182.60	$0.61	$1.17
>700	$168.95	$0.58	$1.20

Regional Greenhouse Gas Initiative (RGGI) Updates



Emerging Environmental Issues

- GHG New Source Performance Standards
  - New Power Plants
  - Existing Plants
- Clean Water Act 316(b): Cooling Water Intake Structures
- Coal Combustion Residuals (CCRs)
- Regional Haze Rule
- Clean Air Act Settlements – validation with Form EIA-860 reporting

Model Enhancements

- Reserve margins/Capacity payments
- Spinning/Operating reserves
- O&M cost updates
- Municipal utility pricing data updates
- Carbon transport utilization and storage (CTUS)

Reserve Margins and Capacity Payments

- Previous algorithm
  - Reliability charge computed based on the expected level of unserved energy and the value of unserved energy
  - Reserve margin targets set to equilibrate reliability charge and cost of new capacity, based on reliability charge in final year
  - Sometimes resulted in unstable reliability charges and inconsistent results when under surplus
- New algorithm
  - Fixed input reserve margins by region, set based on NERC/ISO requirements
  - Capacity payment in $/kW calculated based on the levelized cost of a combustion turbine and the reduced cost of the reserve margin constraint in the electricity model
  - Total pool of dollars that must be recovered represents the capacity payment multiplied by the total capacity committed to meeting demand or reserve
  - Costs are allocated to sectors and divided by the sales of each sector to get the new price adder for reliability purposes
  - On average, the new price adder is likely to be higher than for previous method, but will be more stable and non-zero, even in periods of surplus

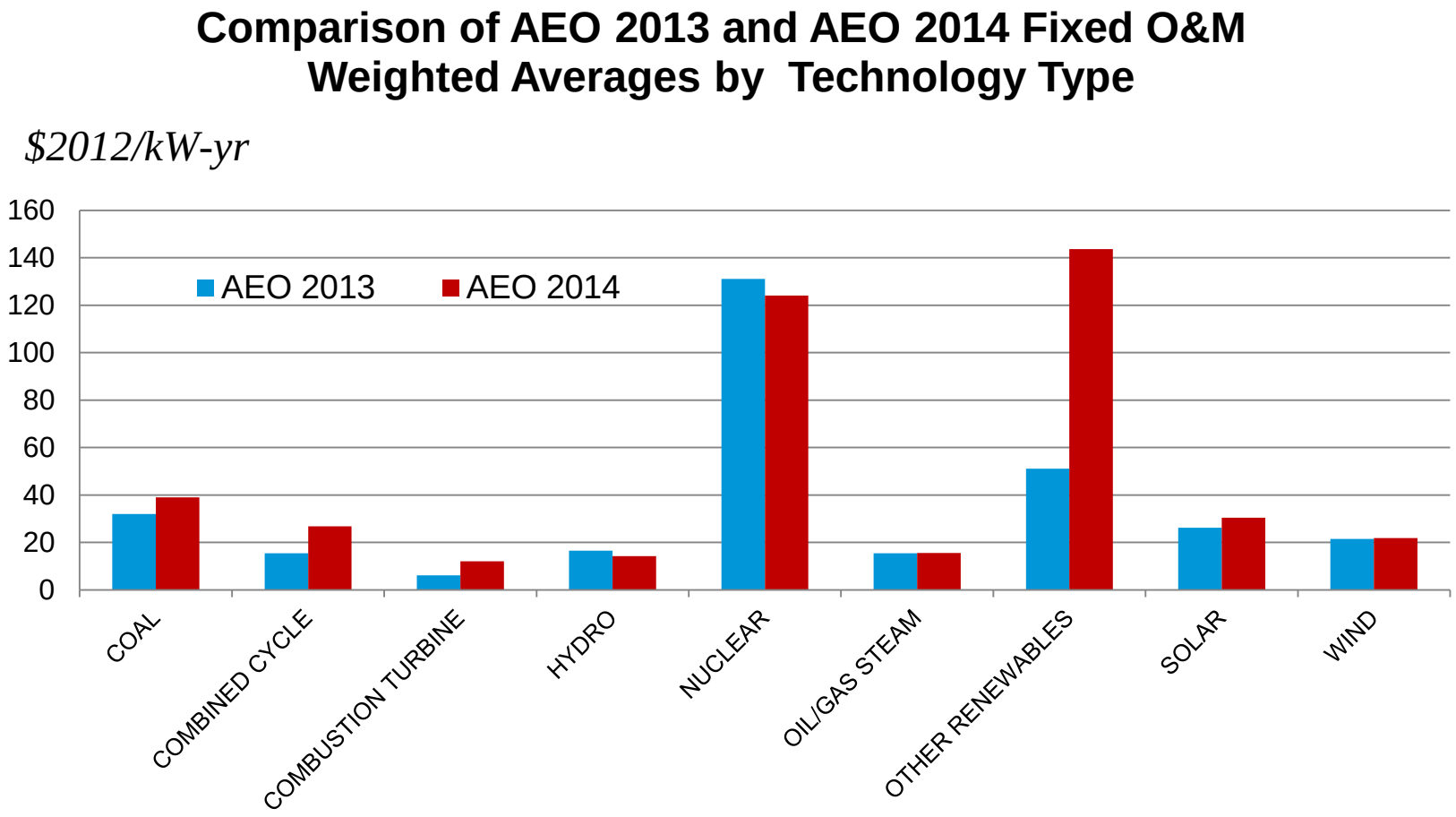
Operating/Spinning Reserves

- Current electricity modeling does not explicitly represent operating reserves
- In scenarios with high intermittent penetration, this may overstate the ability to meet load due to the uncertainty of the availability of intermittent generating resources
- Proposed change to include explicit constraints requiring set levels of spinning reserves (capacity operating, but able to provide additional output) and operating reserves (spinning reserves plus quick start technologies)
- Reserve requirements for each load slice will depend on the mix of generating technologies used to meet peak demand, by region
- Will result in additional costs on the system which will be passed to both competitive and regulated prices

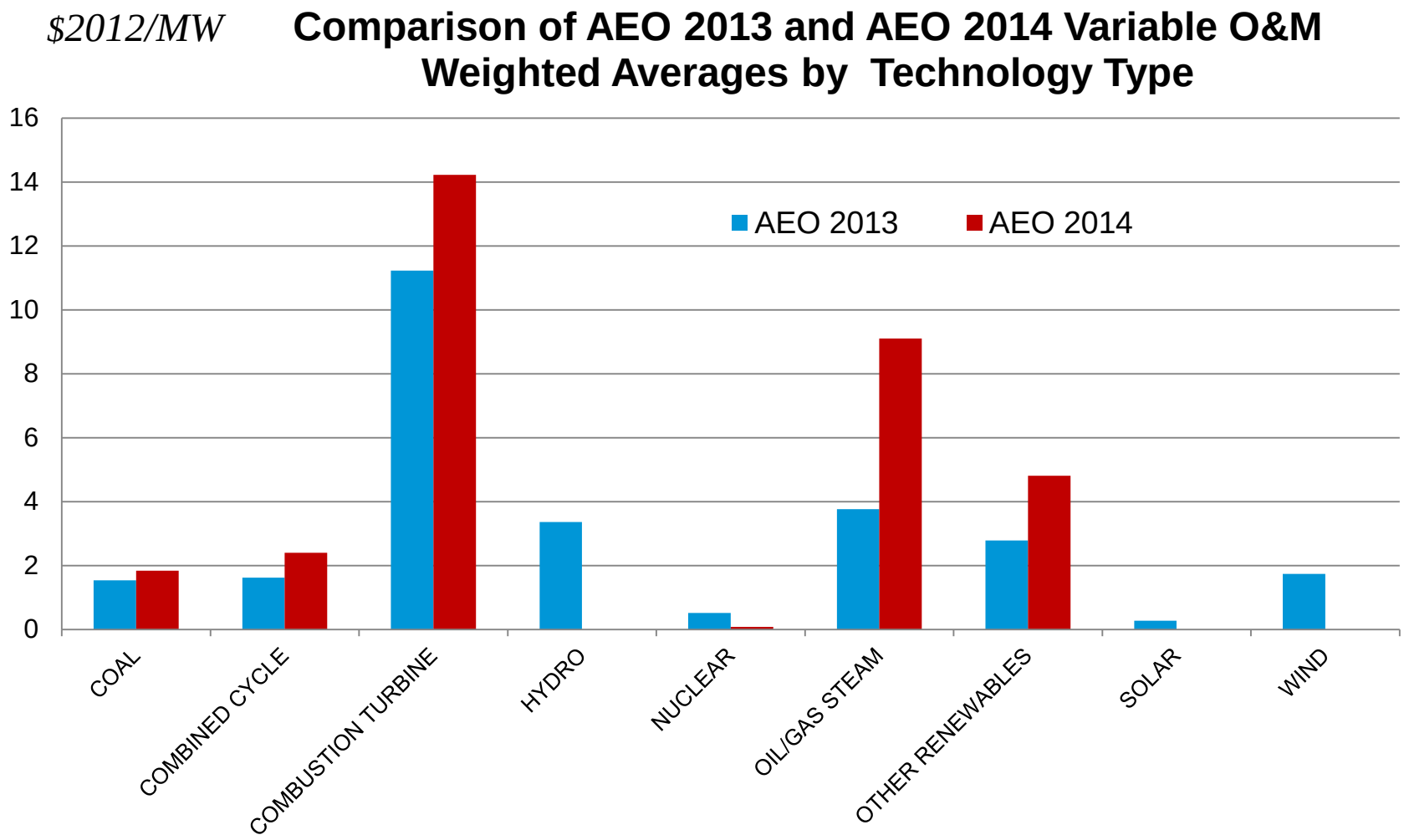
Updated Power Plant O&M Costs

- FERC Form 1 and RUS Financial and Operating Report Electric Power Supply
  - Reported costs for major utilities and rural cooperatives
  - Costs are reported at the owner – plant – capacity - type level
- Data Matching and Modeling 2008 – 2011
  - Matched owner-reported costs to the associated capacity across four years
  - Used boosted regression to model matched costs into O&M estimates
  - After weighting four-year averages of estimates, EIA used quartile normalization of the averages to generate O&M estimates for input to the model
  - Used SAIC updates for renewable technology averages in quartile normalization

Fixed O&M Update Comparison



Variable O&M Update Comparison



Collecting Municipal Financial Data for Electricity Pricing and Finance Module

Utility financial data is used to develop cost-of-service electricity prices in:

- regulated regions; and for
- all transmission and distribution price calculations

- EIA has not collected financial data for municipal and other government-owned and operated utilities since 2003 (formerly collected on Form EIA-412).

- Missing data has an impact, particularly for the smaller EMM regions. To compensate, analysts have used regression analysis to develop estimates for the missing data.

- Project currently underway to assemble roughly 40 key financial variables from municipal utility financial reports for input to the model.

Percent of Muni Revenue, Sales, and Regulated Load in Regions Most Affected by Missing Data

EMM Region	% Muni and Other Gvt Owned Utility Revenue	% Muni and Other Gvt Owned Utility Sales	% Regulated Load in Region
Northeast Power Coordinating Council/Long Island	100%	100%	0%
SERC Reliability Corporation/Central (TVA)	54%	55%	100%
Western Electricity Coordinating Council/Northwest	25%	32%	97%
Western Electricity Coordinating Council/Southwest	29%	31%	95%
Midwest Reliability Council/West	26%	28%	93%
Western Electricity Coordinating Council/California	21%	22%	93%
Midwest Reliability Council/East	20%	20%	99%
Florida Reliability Coordinating Council	18%	16%	100%
Western Electricity Coordinating Council/Rockies	15%	16%	100%
U.S. 48	15%	16%	65%

CO_2 Capture, Transport, Utilization, and Storage – Integration in NEMS

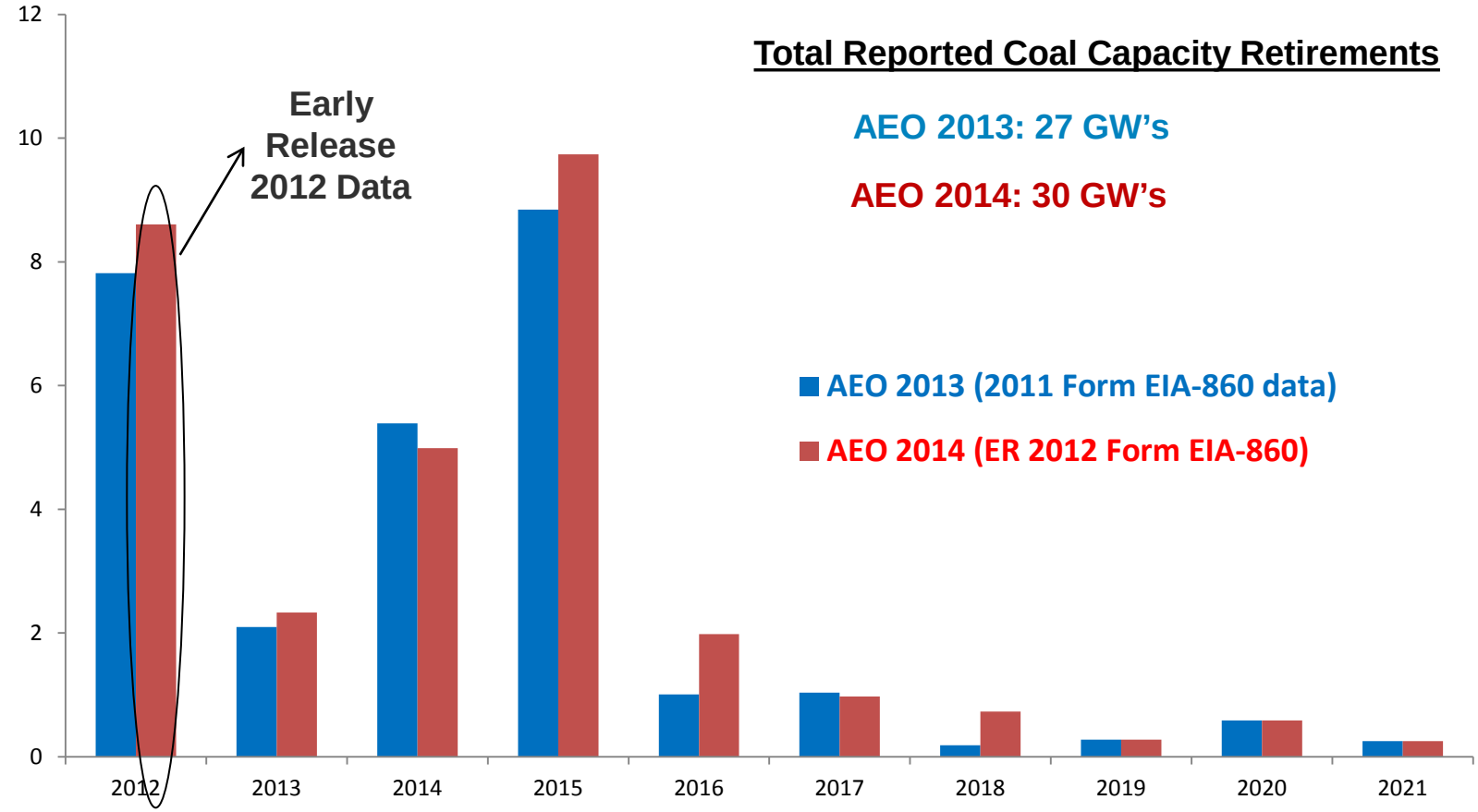
- EOR added to previous representation of saline
- CO_2 control policy is no longer the only driver for CO_2 capture
- Oil and Gas Supply Module (OGSM): EOR operations now "see" a location and availability-dependent price of CO_2 from power plants and CTL facilities
- Electricity Market Module (EMM): "sees" the opportunity from EOR operations for utilizing the CO_2 produced at power plants with CCS and provides quantities and prices for captured CO_2
- Liquid Fuels Market Module (LFMM): "sees" the CO_2 opportunity from EOR operations and provides a location and availability dependent price of CO_2 from CTL facilities (pending)

EIA Data Updates

- Planned Coal Plant Retirements
- Report Environmental Retrofits
- Planned Capacity Additions
- Nuclear Power Assumptions

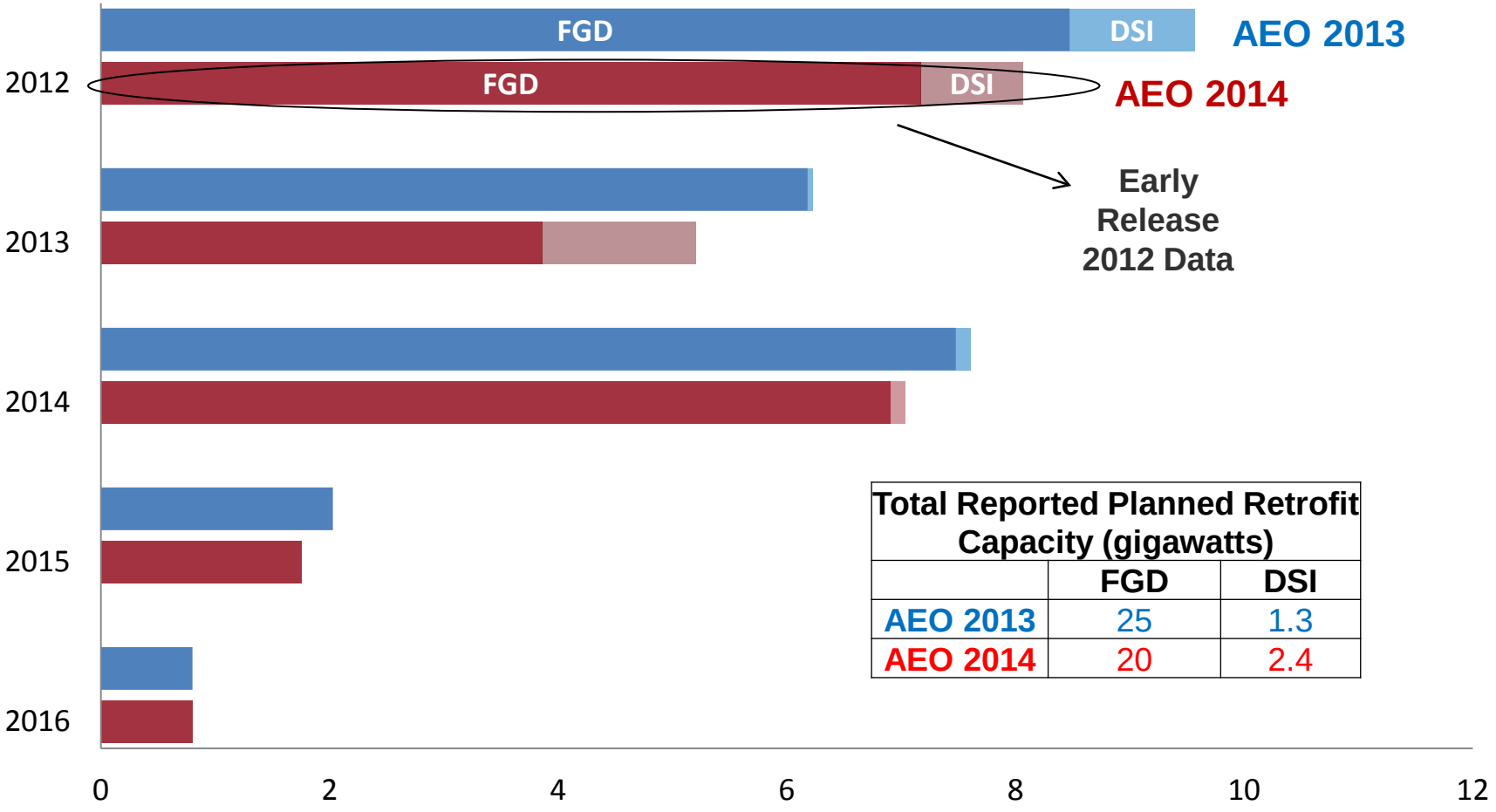
Reported Coal Retirements By Year

gigawatts



Reported Environmental Retrofits

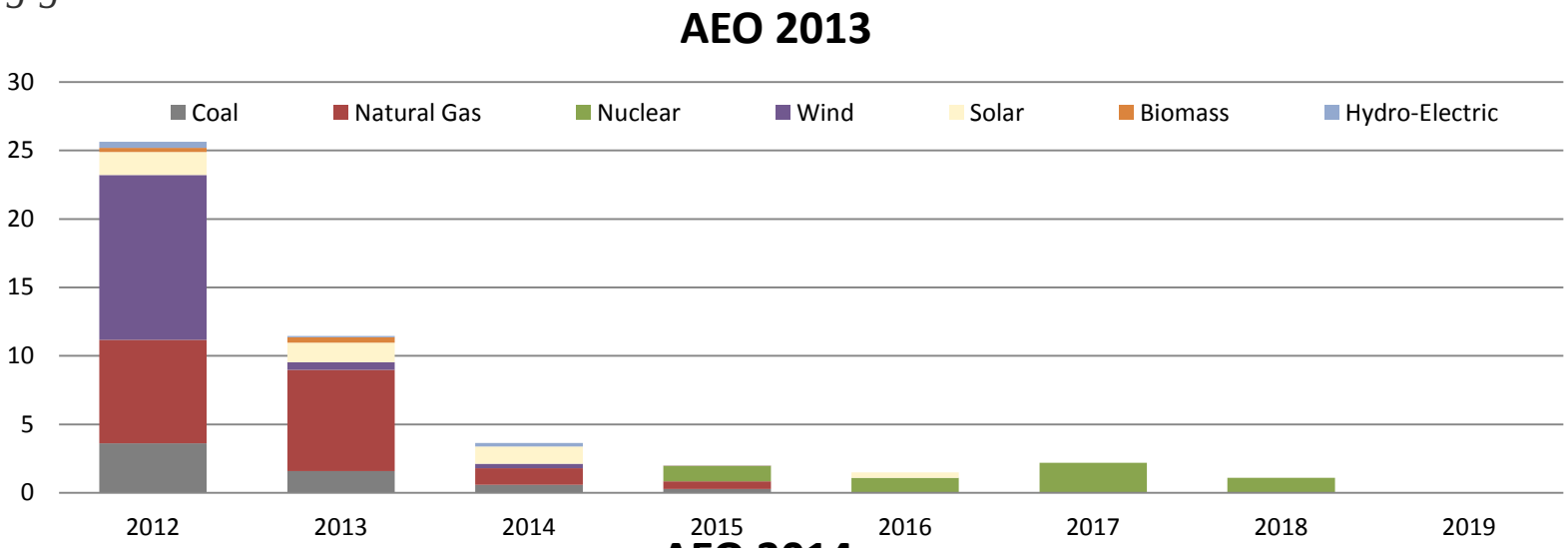
gigawatts

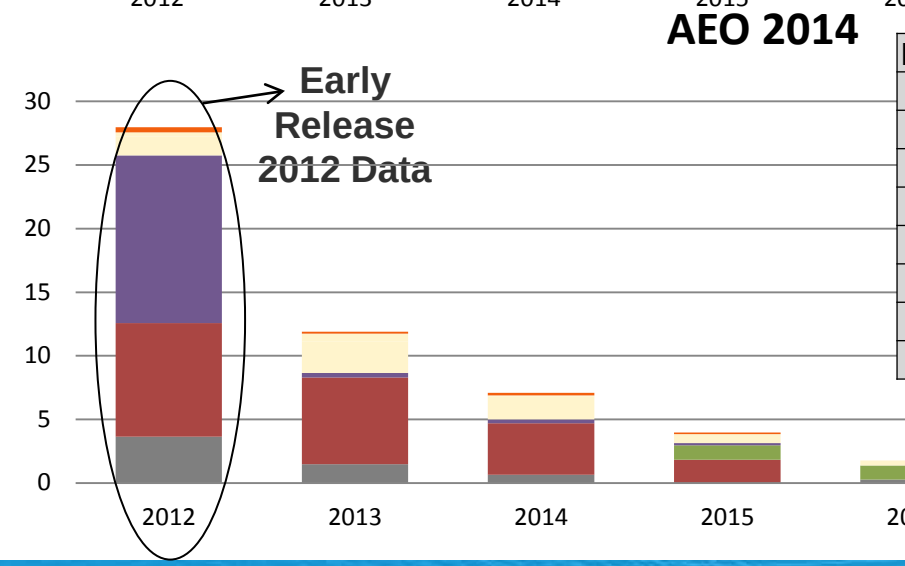


Total Reported Planned Retrofit Capacity (gigawatts)		
	FGD	DSI
AEO 2013	25	1.3
AEO 2014	20	2.4

Planned New Plant Capacity Additions

gigawatts





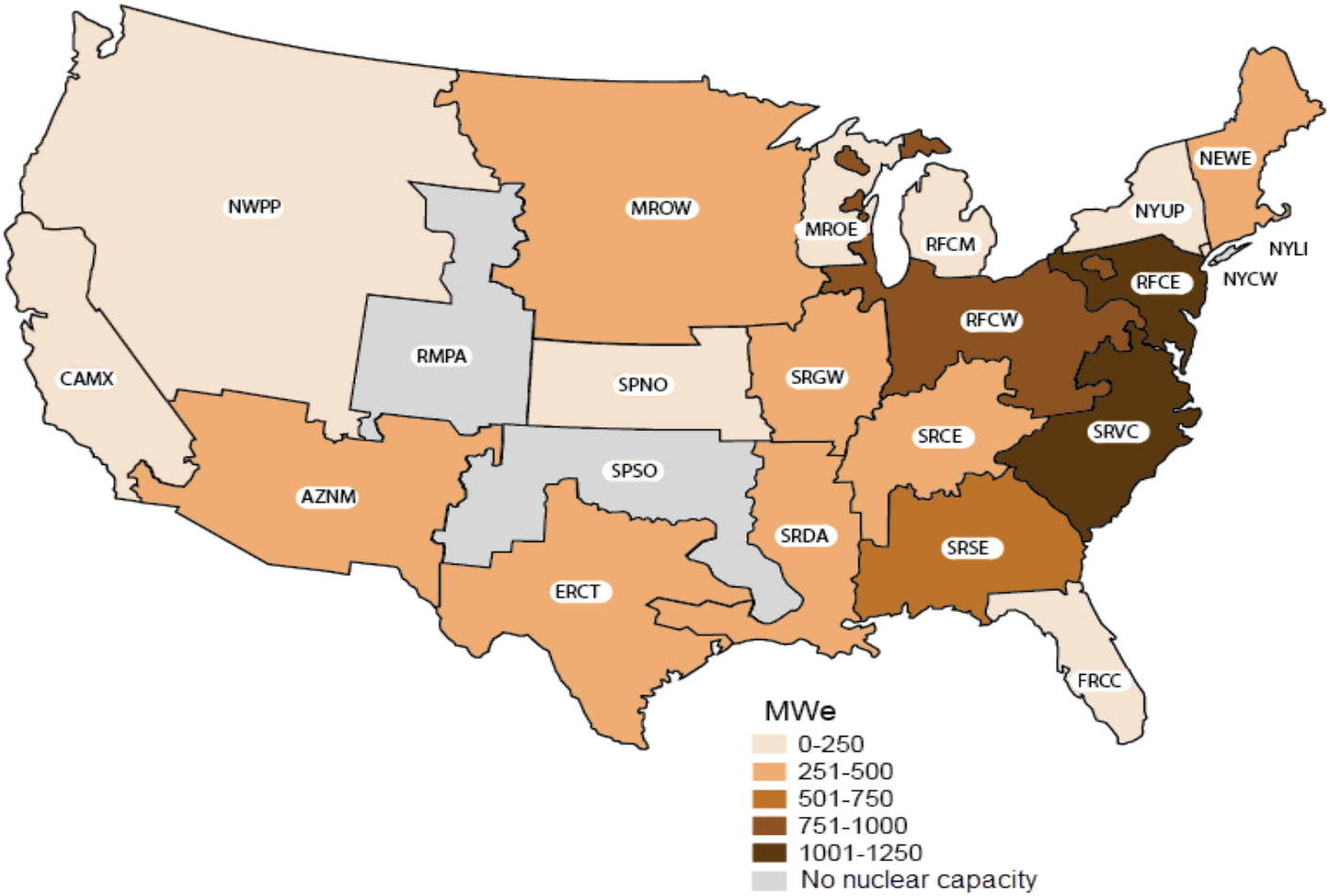
Planned Capacity Additions gigawatts (2012-2019)		
	AEO 2014	AEO 2013
Coal	6.06	6.06
Natural Gas	21.60	16.73
Nuclear	5.52	5.52
Wind	14.35	12.91
Solar	6.85	4.73
Biomass	1.07	0.74
Hydro-Electric	0.84	0.83

Nuclear Power Assumptions

- New Plants – 5,500 MW
  - Watts Bar (2015)
  - Summer 2 & 3 (2017 & 2018)
  - Vogtle 3 & 4 (2016 & 2017)
- Retirements – 4,190 MW
  - Kewaunee (2013)
  - San Onofre 2 & 3 (2013)
  - Crystal River (2013)
  - Oyster Creek (2019)
- Uprates (Potential of ~7,000 MW)

Nuclear Uprate Potential Map

megawatts of uprate potential



Feedback from the Working Group

- Issues with Prior AEO Studies
  - Assumptions
  - Results
- Suggestions for AEO2014 Analyses
  - Input Assumptions
  - Scenarios/Sensitivity Analyses

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