Consideration of Forthcoming Environmental Rules for Resource Adequacy in PJM

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Stylized Summary of Environmentally Related Rules Impacting Resource Adequacy

	GHG Tailoring Rule	Clean Air Transport Rule	HAP MACT	CWA 316(b)	High Electricity Demand Day	Renewable Portfolio Standards
Pollutant or target issue	CO_2 and other GHG	SO_2 and NO_x	Mercury and Acid Gases	Cooling water intake structures	Ozone formation from NO_x on hot days	Ensure a certain percentage of renewables
Relevant Dates	1/1/2011	1/1/2012 1/1/2014	2011 rulemaking, 1/1/2015	2011 2015-2018	NJ currently 2015-2018	various
Units impacted	All fossil units	All fossil units Primarily coal	Coal and oil, primarily coal	All existing units	Oil and gas peaking	All units
Standard	BACT case-by-case, state-by-state	Limited cap & trade. Use of FGD and SCR likely	MACT to be defined, likely FGD, ACI, fabric filter	BTA to be defined, likely not once thru cooling	NO_x rate standard. Use of SCR and other controls likely	Mandated percentage of electricity sales from renewables
Impact on Units	Mostly fixed costs	Fixed and variable costs	Mostly fixed costs	Mostly fixed costs	Mostly fixed costs	Reduced net energy market revenues

Range of Estimates for Environmental Retrofits and New Entry Gas

	FGD	SCR	ACI and Baghouse	Cooling Towers
Capital Cost ($/kW)	$400-$500	$150-$300	$100-$200	$200-$300

	Combined Cycle	Combustion Turbine
Capital Cost ($/kW)	$1000-$1500	$600-$1000

Sources: NERC, EPA, EIA, Brattle, 2009 State of the Market Report

- Resource Adequacy:
  - Resources can only be attracted and maintained if there are deemed to be sufficient revenues to cover costs plus a return on investment
  - This includes the costs of any retrofits to meet environmental rules or the cost of new entry of resources without the same environmental liabilities
  - What are the transmission security/reliability implications of retirement and new entry decisions?
  - How much will achieving resource adequacy cost?
  - How many units will choose deactivation over retrofit?

Composition of Coal-fired Capacity in PJM (MW of Summer Net Dependable Capacity)

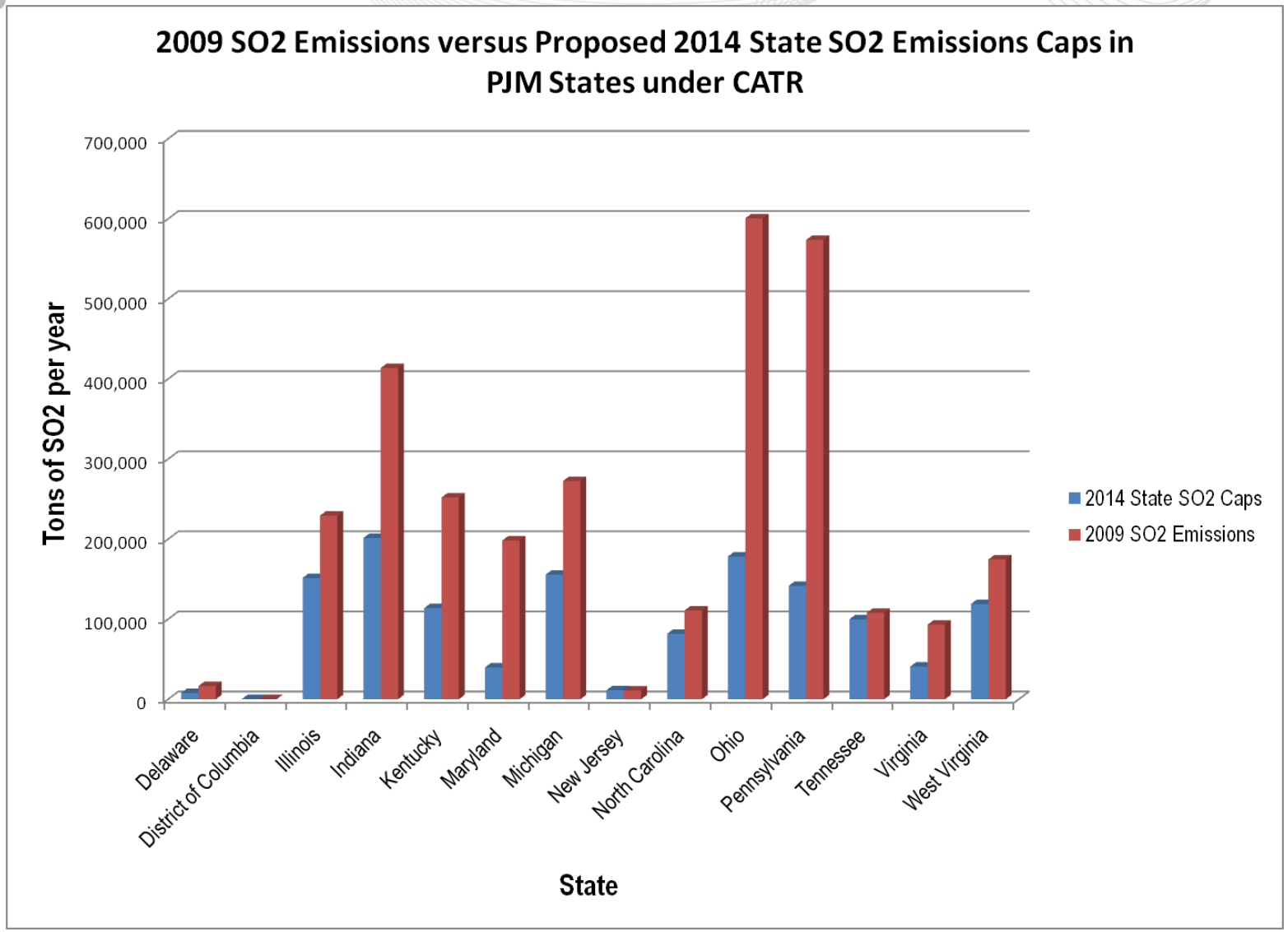
	PJM RTO	MAAC	Rest of PJM
Total Coal	66,098	19,722	46,367
Coal > 40 years	36,107	13,822	22,286
Coal < 400 MW	22,475	8,644	13,831
Coal > 40 years, < 400 MW	18,417	7,257	11,160

Source: PJM EIA-411 Submittal as of January 1, 2009

Composition of Coal-fired Capacity in PJM (MW of Summer Net Dependable Capacity)

- Characteristics by size:
  - Units ≥ 400 MW: 2009 average capacity factor = 69.7%
  - Units < 400 MW: 2009 average capacity factor = 33.2%
  - Units ≥ 400 MW: 2009 average gross heat rate = 9,387 Btu/kWh
  - Units < 400 MW: 2009 average gross heat rate = 10,367 Btu/kWh
- Characteristics by age:
  - Units ≤ 40 years: 2009 average capacity factor = 49.25%
  - Units > 40 years: 2009 average capacity factor = 42.4%
  - Units ≤ 40 years: 2009 average gross heat rate = 9,783 Btu/kWh
  - Units > 40 years: 2009 average gross heat rate = 10,109 Btu/kWh

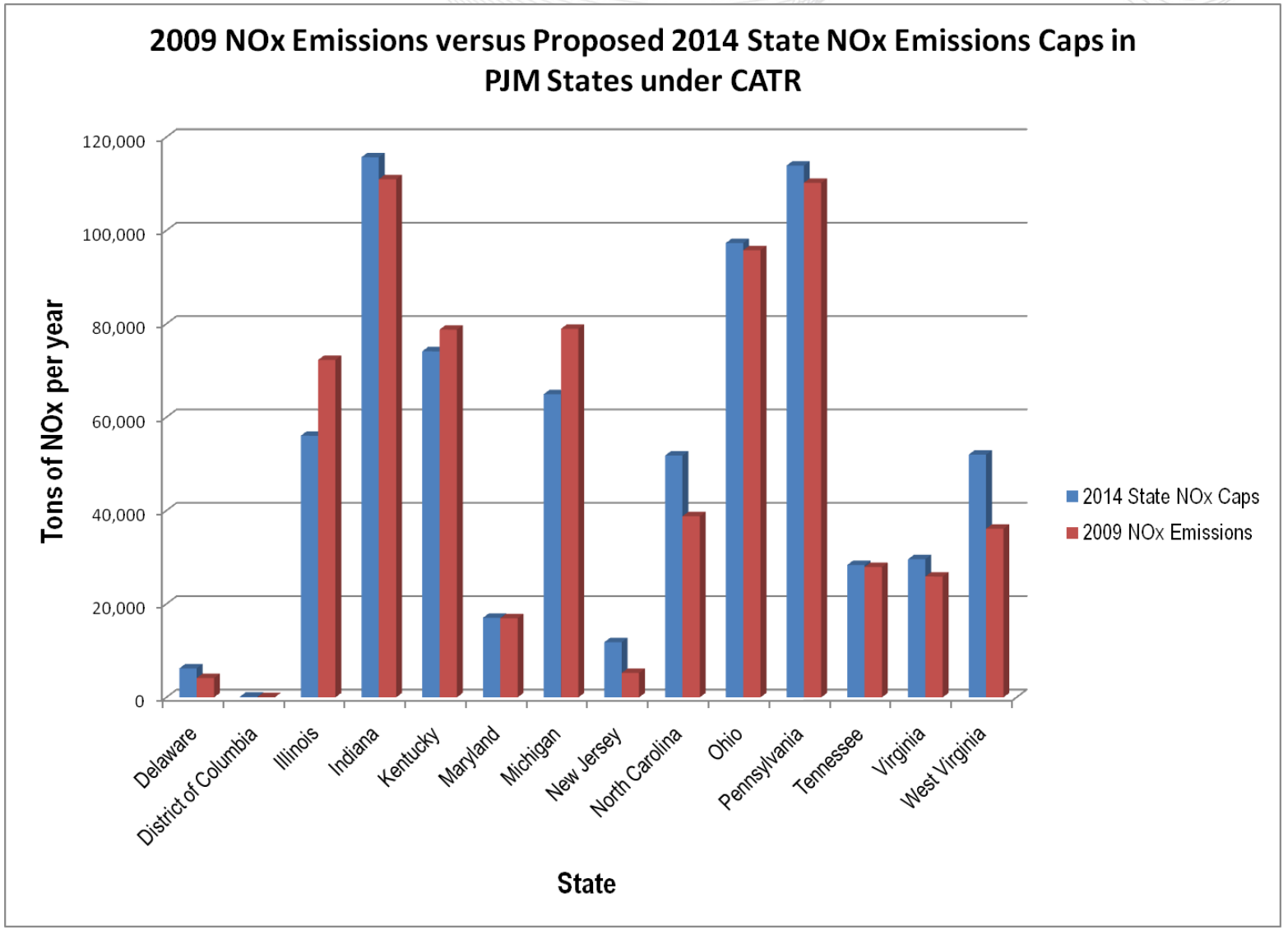
Source: PJM EIA-411 Submittal as of January 1, 2009 and
United States Environmental Protection Agency Database of Unit Characteristics


2009 SO2 Emissions versus Proposed 2014 State SO2 Emissions Caps in PJM States under CATR
Tons of SO2 per year
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
Delaware
District of Columbia
Illinois
Indiana
Kentucky
Maryland
Michigan
New Jersey
North Carolina
Ohio
Pennsylvania
Tennessee
Virginia
West Virginia
State
2014 State SO2 Caps
2009 SO2 Emissions

Composition of Coal-fired Capacity in PJM without Limestone FGD or Fluidized Bed Combustion for controlling SO_2 Emissions

	PJM RTO	MAAC	Rest of PJM
Total Coal	30,156	8,873	21,283
Coal > 40 years	23,601	8,199	15,402
Coal < 400 MW	17,387	6,651	10,736
Coal > 40 years, < 400 MW	16,830	6,407	10,423

Source: PJM EIA-411 Submittal as of January 1, 2009 and
United States Environmental Protection Agency Database of Unit Characteristics
MW of Net Dependable Summer Capacity


2009 NOx Emissions versus Proposed 2014 State NOx Emissions Caps in PJM States under CATR
Tons of NOx per year
120,000
100,000
80,000
60,000
40,000
20,000
0
Delaware
District of Columbia
Illinois
Indiana
Kentucky
Maryland
Michigan
New Jersey
North Carolina
Ohio
Pennsylvania
Tennessee
Virginia
West Virginia
State
2014 State NOx Caps
2009 NOx Emissions

Composition of Coal-fired Capacity in PJM without Limestone FGD or Fluidized Bed Combustion for SO_2 and No SCR for Controlling NO_x Emissions

	PJM RTO	MAAC	Rest of PJM
Total Coal	22,849	6,326	16,523
Coal > 40 years	17,724	5,652	12,072
Coal < 400 MW	15,237	5,338	9,899
Coal > 40 years, < 400 MW	14,680	5,094	9,586

Source: PJM EIA-411 Submittal as of January 1, 2009 and
United States Environmental Protection Agency Database of Unit Characteristics
MW of Summer Net Dependable Capacity

Composition of Coal-fired Capacity in PJM without Wet Limestone FGD and Baghouses for Expected Mercury Controls under HAP MACT

	PJM RTO	MAAC	Rest of PJM
Total Coal	28,227	7,084	21,143
Coal > 40 years	21,577	6,400	15,177
Coal < 400 MW	15,458	4,862	10,596
Coal > 40 years, < 400 MW	14,806	4,608	10,198

Source: PJM EIA-411 Submittal as of January 1, 2009 and
United States Environmental Protection Agency Database of Unit Characteristics
MW of Summer Net Dependable Capacity

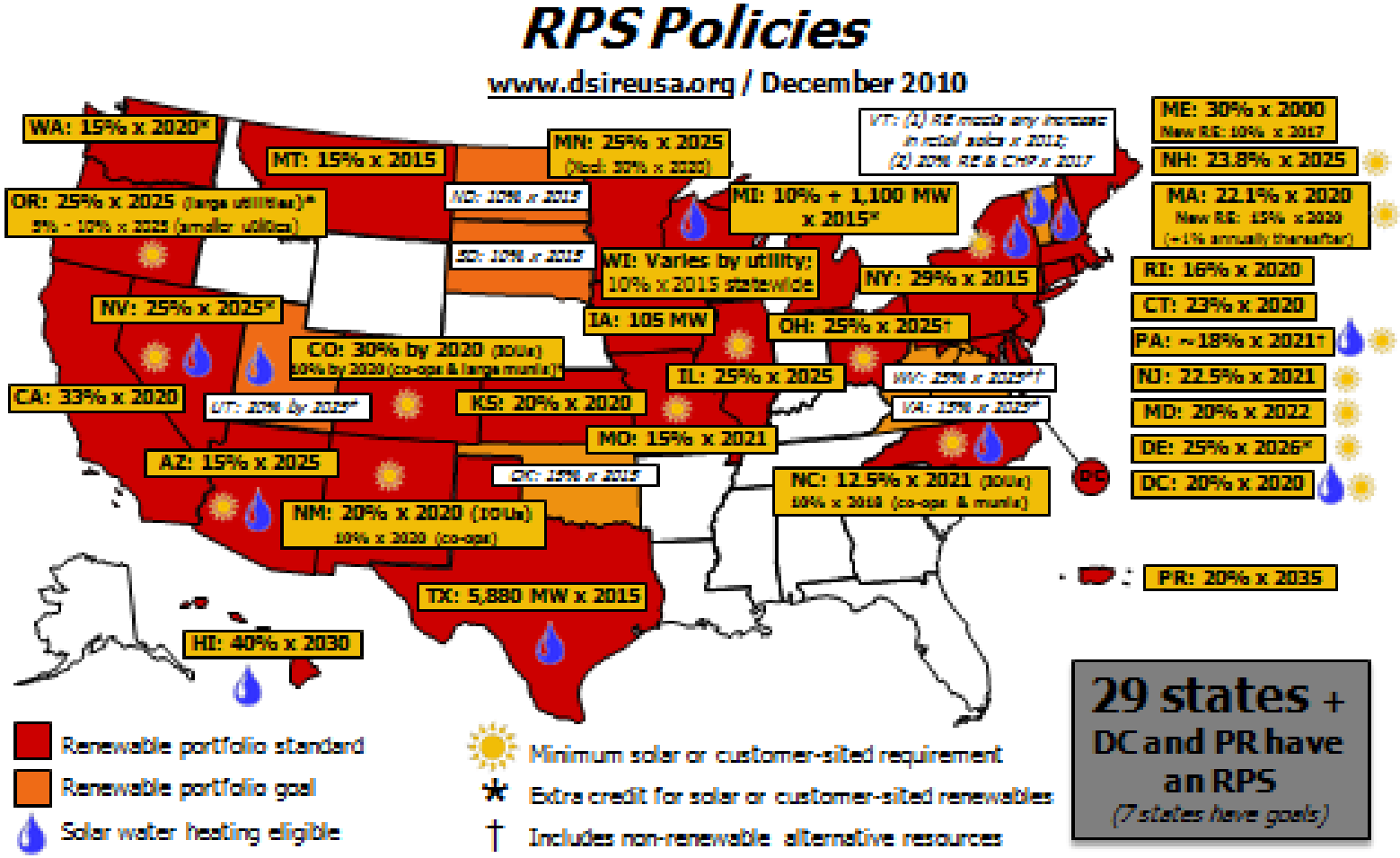
Composition of Capacity in PJM Employing Once Through Cooling

	PJM RTO	MAAC	Rest of PJM
Oil and Gas	4,271	3,070	1,201
Nuclear	11,930	4,658	7,271
Coal	28,167	9,498	18,669
Coal > 40 years	25,554	8,878	16,676
Coal < 400 MW	17,470	6,947	10,523
Coal > 40 years, < 400 MW	17,157	6,947	10,210

Source: PJM EIA-411 Submittal as of January 1, 2009 and EIA-767, 2000 and 2005, EIA-860, 2008
MW of Summer Net Dependable Capacity

Composition of Capacity in PJM Employing Once Through Cooling

- Oil and Gas Units:
  - All identified operated at a capacity factor of 7% or less in 2009
  - All but approximately 100 MW are located east of major west to east constraints
  - Approximately 550 MW have requested deactivation by the end of 2011
  - Average age 48.5 years
- Coal Units:
  - Average unit size is 220 MW
  - Average capacity factor of 39%



PJM's 2009 CO_2 whitepaper showed 15 GW of wind reduced LMP by $5.00-$5.50/MWh on average

Reliability Pricing Model (RPM) Capacity Market

- PJM cannot mandate new entry or prevent existing units from deactivating
  - PJM markets are designed to supply sufficient revenue opportunities to cover costs plus a return on investment in expectation
- RPM
  - 3-year forward capacity market designed to work in concert with energy market outcomes
  - Offers can include the costs of environmental retrofits
  - Offers are capped at avoidable costs (fixed costs including costs of needed investment) less expected net energy market revenues
  - Expected net energy market revenues are effected by RPS over time

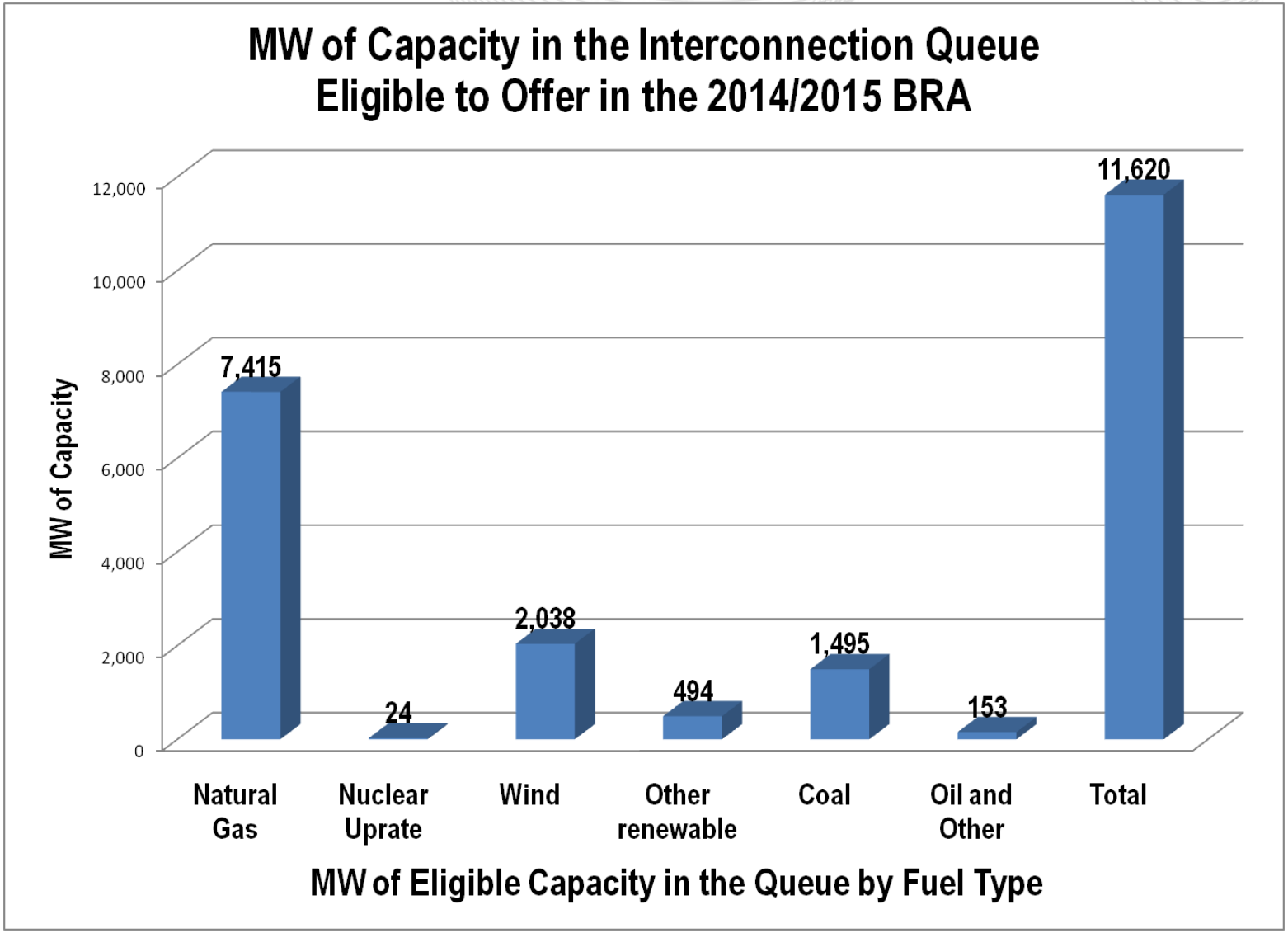
- Aspects of capped offers
  - Expected net energy market revenues are based on 3-year average of historic net revenues prior to the auction for delivery 3 years in the future
  - Actual resource owner expectations may be different from historic performance
- Actual market offers are often below the allowed caps indicating flexibility in offers
  - Different expectations on future energy market outcomes driven by gas prices
  - Different expectations on future policies such as climate change and RPS
  - Differing hurdle rates of return and payback period for investment

Recent RPM Capacity Prices in PJM ($/MW-day of Unforced Capacity)

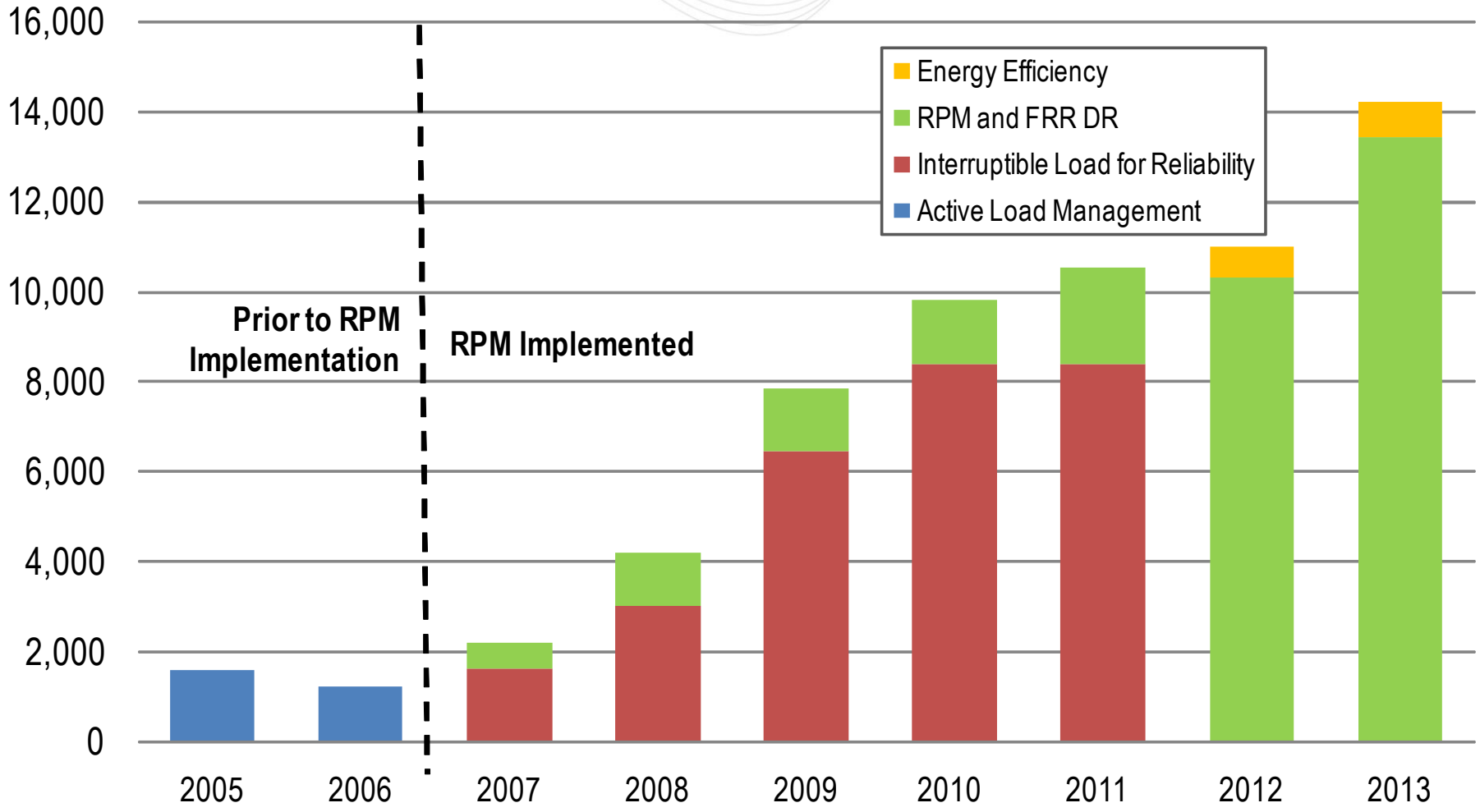
Delivery Year	MAAC	Rest of PJM RTO
2011/2012	$110.00	$110.00
2012/2013	$133.37	$16.46
2013/2014	$226.15	$27.73

Net Cost of New Entry in MAAC $227.20 UCAP
Net Cost of New Entry in RTO $317.95 UCAP
Cleared 2754.6 MW UCAP more than needed to just meet the reliability requirement in 2013/2014

Potential Non-Demand Response Sources of New Entry



Offers of Demand-Side Resources as Capacity in PJM by Delivery Year



- In one word, it is “uncertainty”
- It is unclear how many units will retrofit to meet the more stringent emissions requirements
  - Owner specific beliefs about any future profitability
  - Final form of rules under consideration at EPA
  - Unit/site specific considerations
  - Economics of natural gas effects retrofit/retire decisions!
  - How much more new natural gas capacity will enter?
  - How much more demand response will enter?
  - What is the shape of future climate policy?