MISO CSAPR Workshop

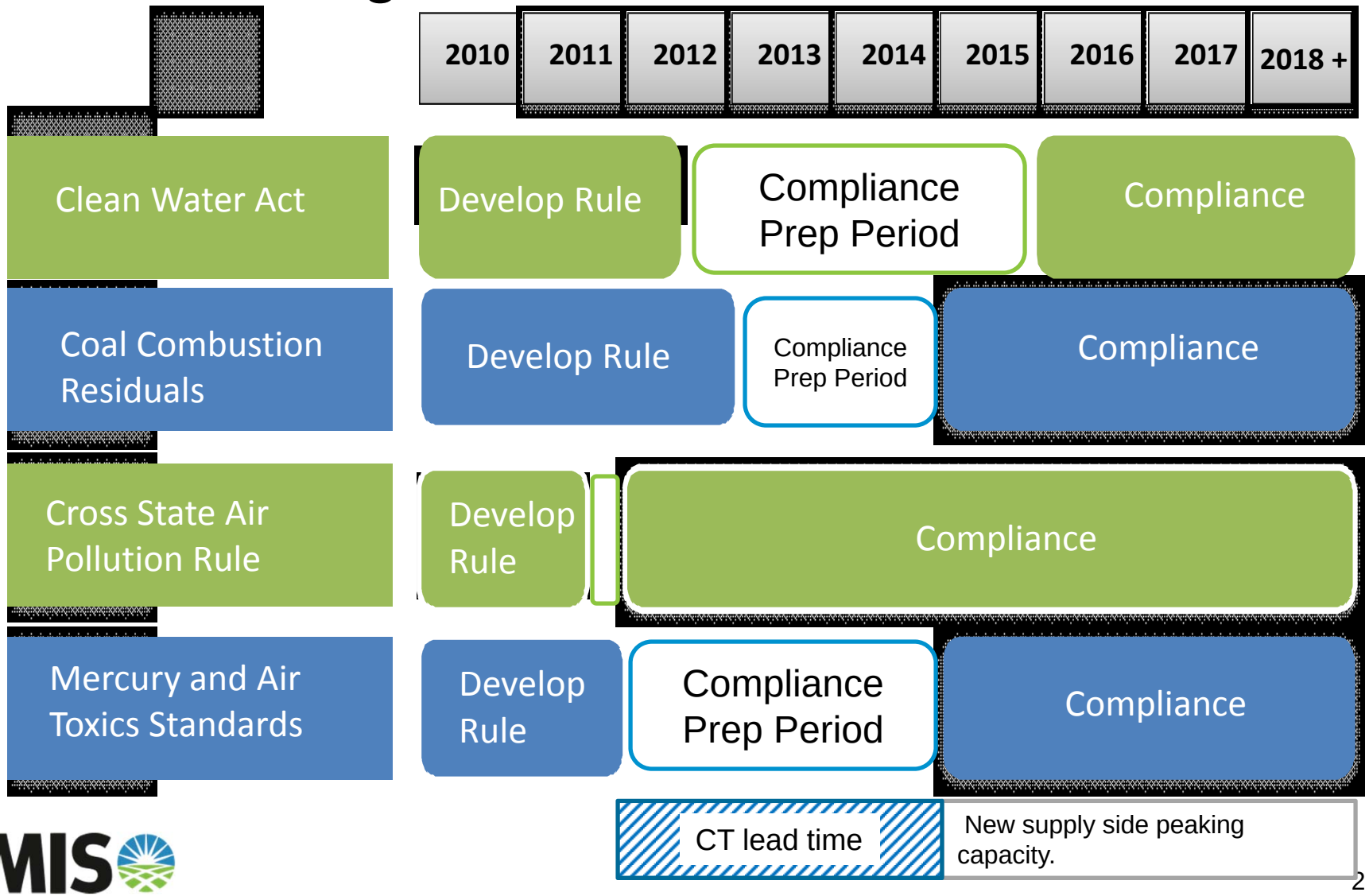
Planning Overview:

EPA Proposed Rule Impacts on the MISO System

October 26, 2011

JT Smith

Environmental Protection Agency Proposing Four New Regulations



Study Overview

- **Given proposed EPA regulations, study goal is to address four key questions:**
  - Are there resource adequacy risks?
  - Are there transmission adequacy risks?
  - What are the impacts on the energy markets?
  - What are the impacts on capital costs to the system?

- **A multi-step study methodology was applied**
  - Performed 400 sensitivity screens which identified nearly 13,000 MW at risk of retirement
  - Considered at-risk units in the regional resource forecast model to determine whether retirement or retrofit was the more economic option
  - Evaluated localized impacts to system reliability from unit retirement
  - Estimated impacts to energy prices from generation portfolio changes

Overview of Impacts

- **12.6 GW of Coal Capacity Identified as at-risk**

- **Capital Investment of $31.6 to $33.0 Billion will be required to retrofit and/or replace units**
    - 12.6 GW of retirement will require replacement of 10 GW to maintain reserve margins through year 2016

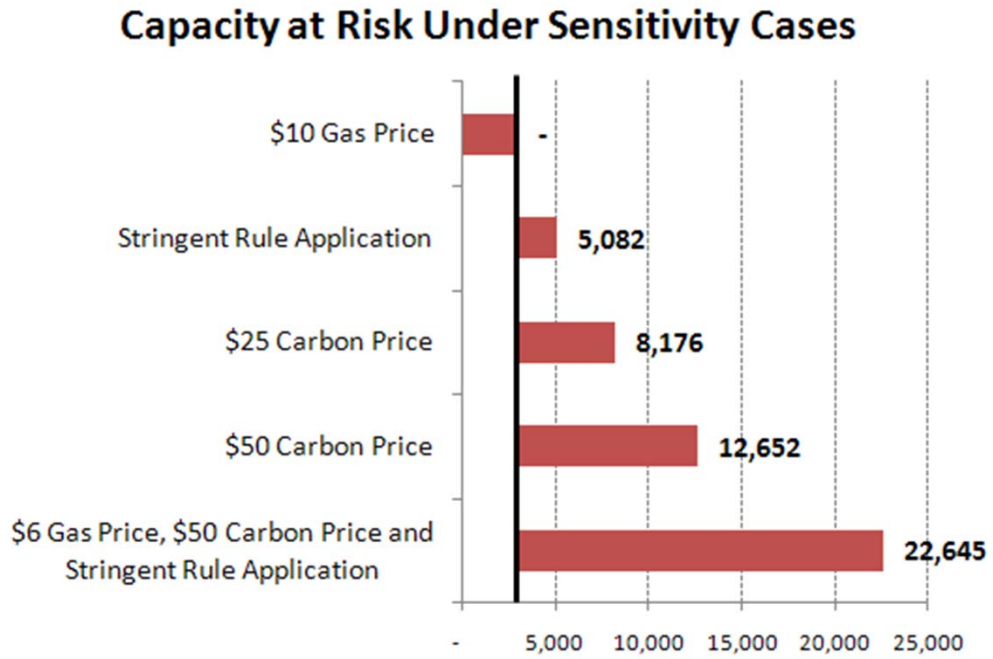
- **Energy Prices will increase from $1/MWh to as high as $5/MWh**

Results reflect inclusion of proposed CATR and not finalized CSAPR

MISO

Uncertainties Could Drive Higher Numbers of At Risk Units and Increased Cost Impact

- 3 of the 4 rules have not been finalized
  - Cross State Air Pollutants final rule more aggressive than initial proposal
- Energy prices could increase with a higher natural gas price or a carbon cost
- Carbon constraints, if implemented and significant, will result in fleet configuration changes
- Total system costs difference is only 1.2% between 2.9 GW and 12.6 GW retirements



Results reflect inclusion of proposed CATR and not finalized CSAPR

Resource Expansion Model Characteristics

- **Expands resource fleet to maintain resource adequacy on the system**
  - MISO utilized the 17.4% reserve margin target for this analysis

- **Model optimizes the resource fleet by identifying the lowest cost solution to meet resource adequacy needs**
  - Costs include capital investment, annual fixed O&M, and energy costs
  - Identifies all solutions that meet resource adequacy needs and outputs the expansion plan that satisfies given constraints at the lowest system cost
  - Based on a 20 year planning period plus extension period

- **MISO EPA study optimized total system NPV costs**
  - Total system retrofits: $422 billion
  - Retrofits and 2.9 GW of retirement and replace: $421 billion
  - Retrofits and 12.6 GW of retirement and replace: $426 billion
  - 1.2% maximum difference in solutions well within realm of assumption error

Impacts on Resource Adequacy*

		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
No retirements	Reserve Margin (MW)	23,930	22,438	22,064	21,368	20,760	20,065	19,287	19,950	19,031	18,032
	Reserve Margin (percent)	27.0%	24.8%	24.2%	23.3%	22.5%	21.5%	20.5%	21.0%	19.9%	18.6%
2.9 GW Retirements (impacts adjusted for expected derates)	Reserve Margin (MW)	21,603	20,111	19,737	19,041	18,433	17,738	16,960	17,623	16,704	15,705
	Reserve Margin (percent)	24.3%	22.2%	21.7%	20.8%	19.9%	19.0%	18.1%	18.6%	17.5%	16.2%
12.6 GW Retirements (impacts adjusted for expected derates)	Reserve Margin (MW)	12,544	11,052	10,678	9,982	9,374	8,679	7,901	8,564	7,645	6,646
	Reserve Margin (percent)	14.1%	12.2%	11.7%	10.9%	10.1%	9.3%	8.4%	9.0%	8.0%	6.6%

MISO

*Data sourced from 2011 Long Term Resource Assessment Information

Transmission Reliability Impact Analysis

- **Two separate EPA impacted generation retirement scenarios studied**
  - Scenario 1: Retirement of 12,652 MW of generation
    - 160 units at 73 stations
  - Scenario 2: Retirement of 2,919 MW of generation
    - 45 units at 22 stations

Estimated Transmission Investment – 12,652 MW of Retirements

- **Total estimated transmission investment is $880 million**
  - Driven by 32 unit retirements involving 2,901 MW at 12 stations
  - Other identified violations addressed by existing MTEP transmission plans
- **$523 million represents long lead time upgrades for retirements at 2 stations**
- **Balance of $357 million of upgrades can be implemented before 2015 if committed by end of 2011 or early 2012**

MISO

Estimated Transmission Investment – 2,919 MW of Retirements

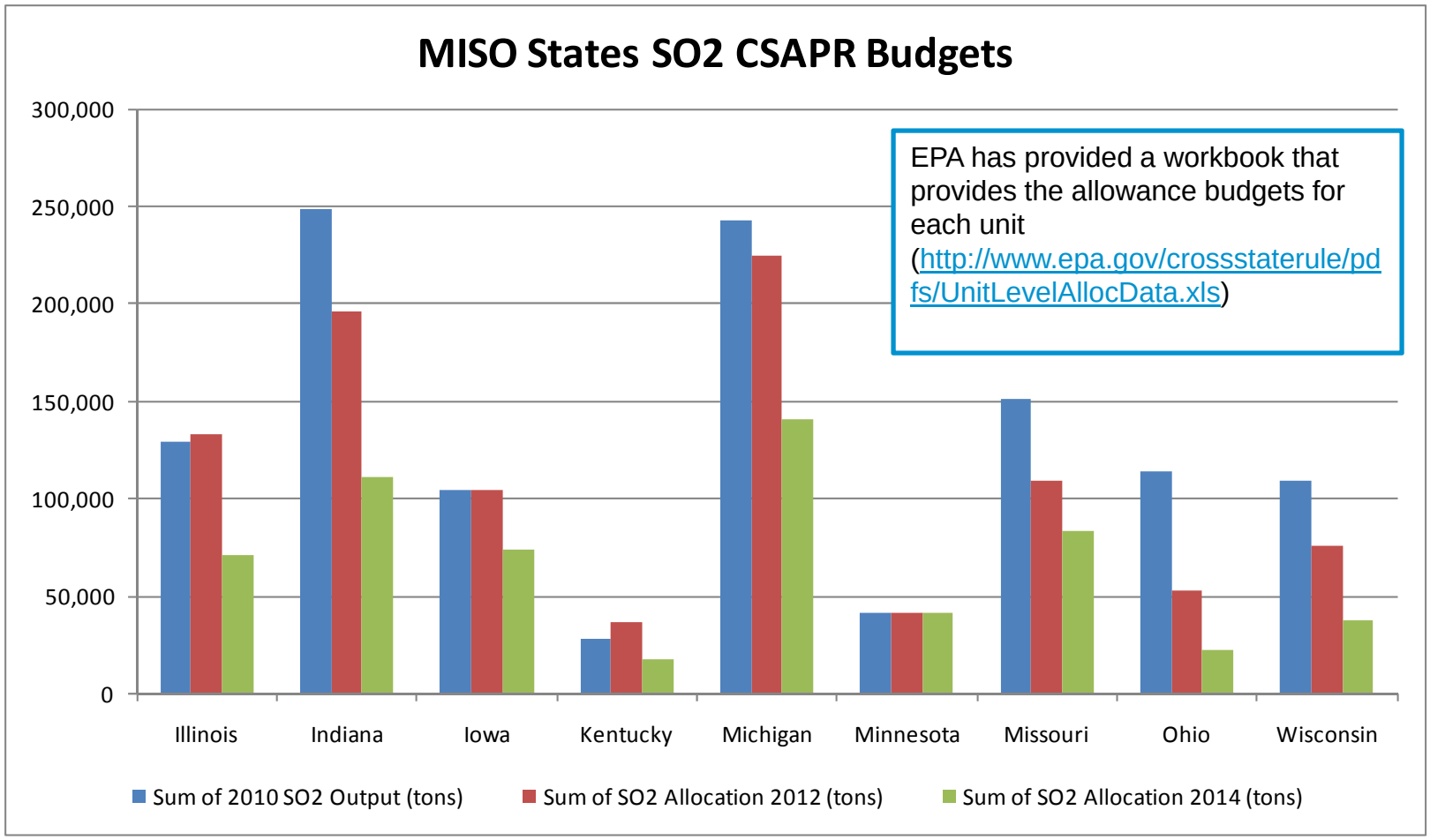
- **Total estimated transmission investment is $580 million**
  - Driven by 15 unit retirements involving 1,237 MW at 6 stations
  - Other identified violations addressed by existing MTEP transmission plans
- **$500 million represents long lead time upgrades for retirements at 1 station**
- **Balance of $80 million of upgrades can be implemented before 2015 if committed by end of 2011 or early 2012**

EPA Impact Study and Attachment Y

- **3,026 MW's of capacity set to retire or under study to retire after 1/1/2011 in Attachment Y**
- **2,507 MW's of the 3,026 MW's showed up in the 12.6 GW of at-risk capacity from the EPA Impact Study**
- **100% of the coal units under active study in the Attachment Y process are in the MISO EPA Study 12.6 GW at-risk list**
- **The remaining 519 MW's are non-coal fired facilities**

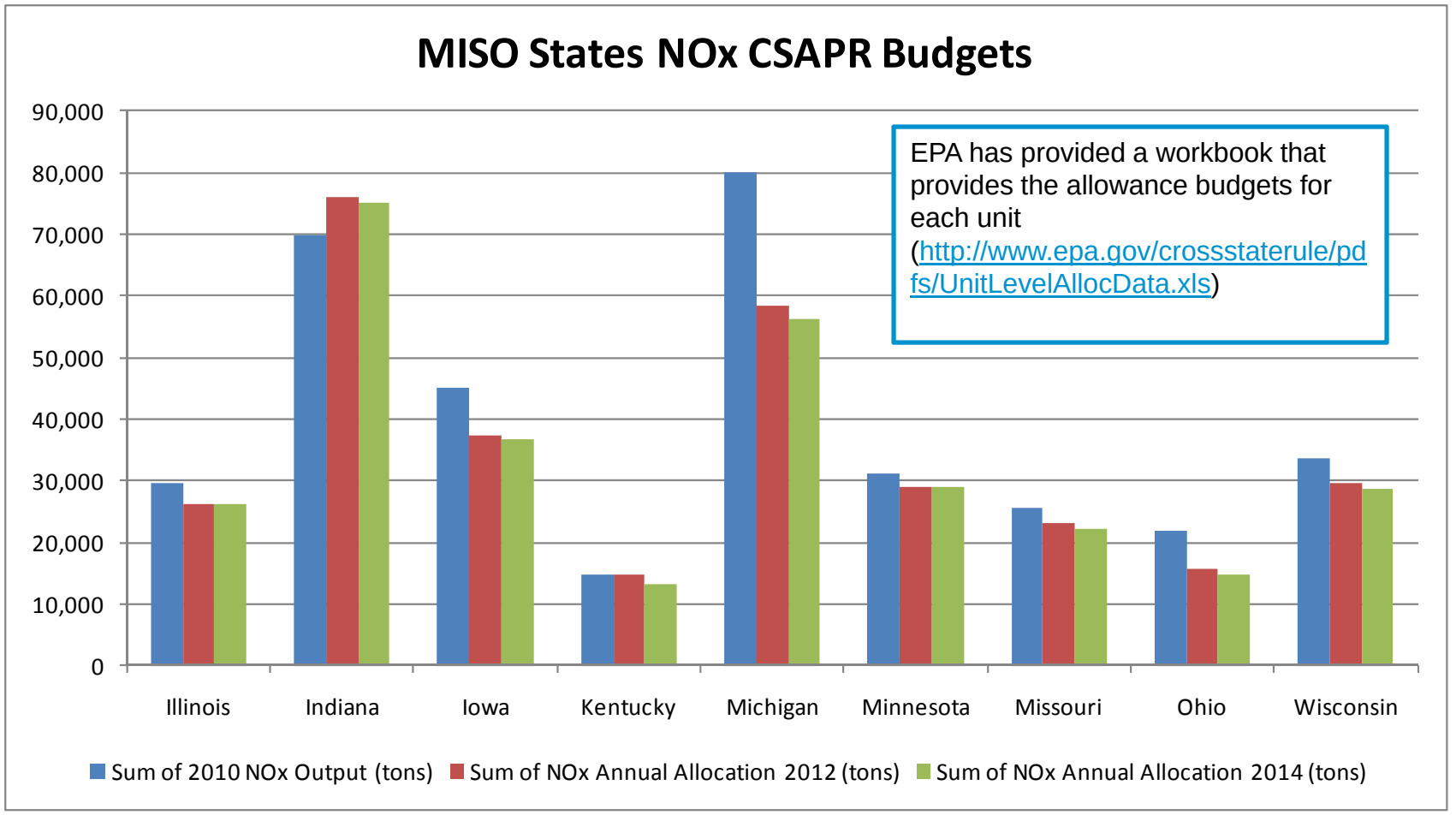
Recent CSAPR Analysis

Impact of Cross State Air Pollutants Rule SO2 Budgets



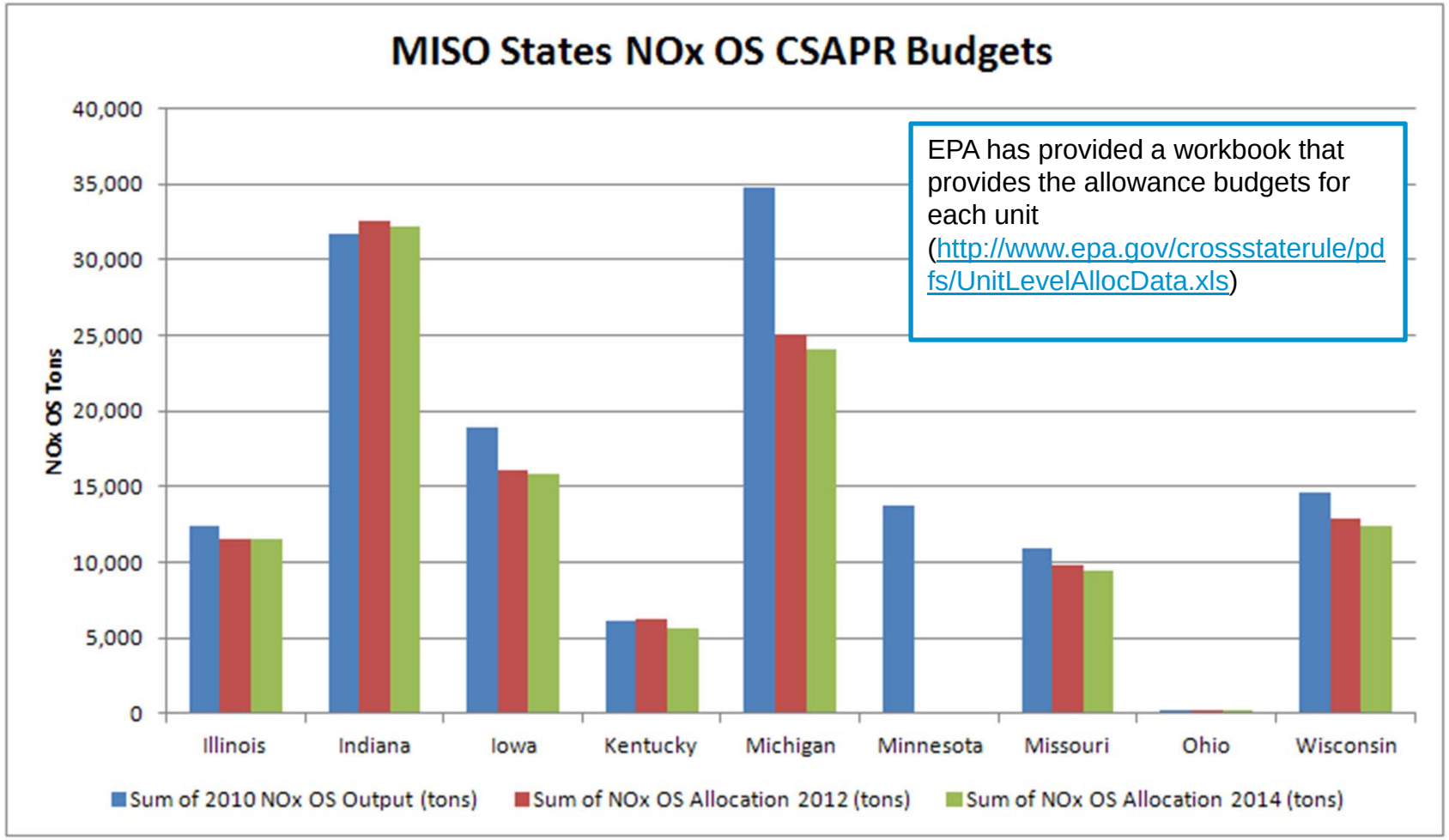
MISO designated unit allocation and production only

Impact of Cross State Air Pollutants Rule NOx Budgets



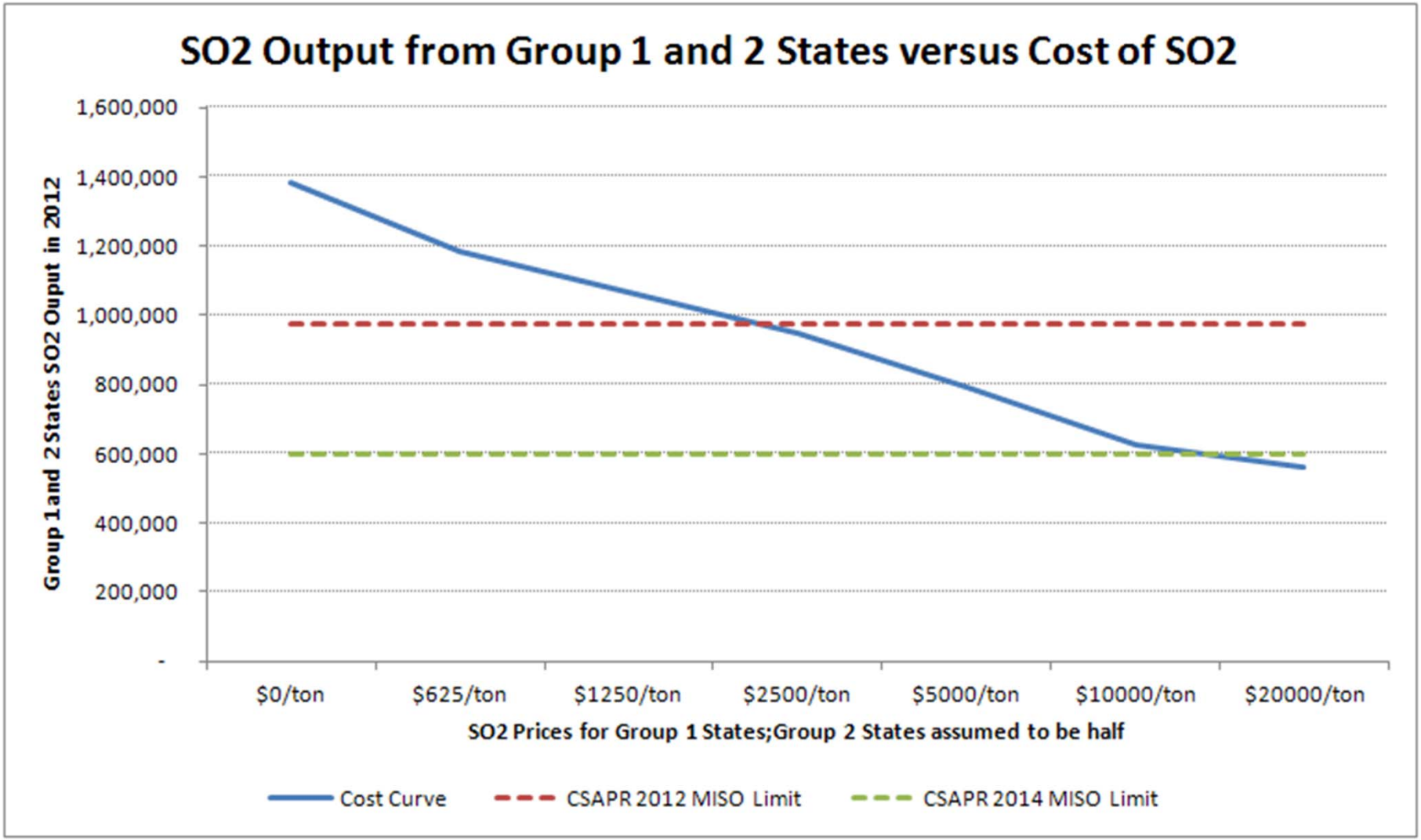
MISO designated unit allocation and production only

Impact of Cross State Air Pollutants Rule on Seasonal NOx Budgets

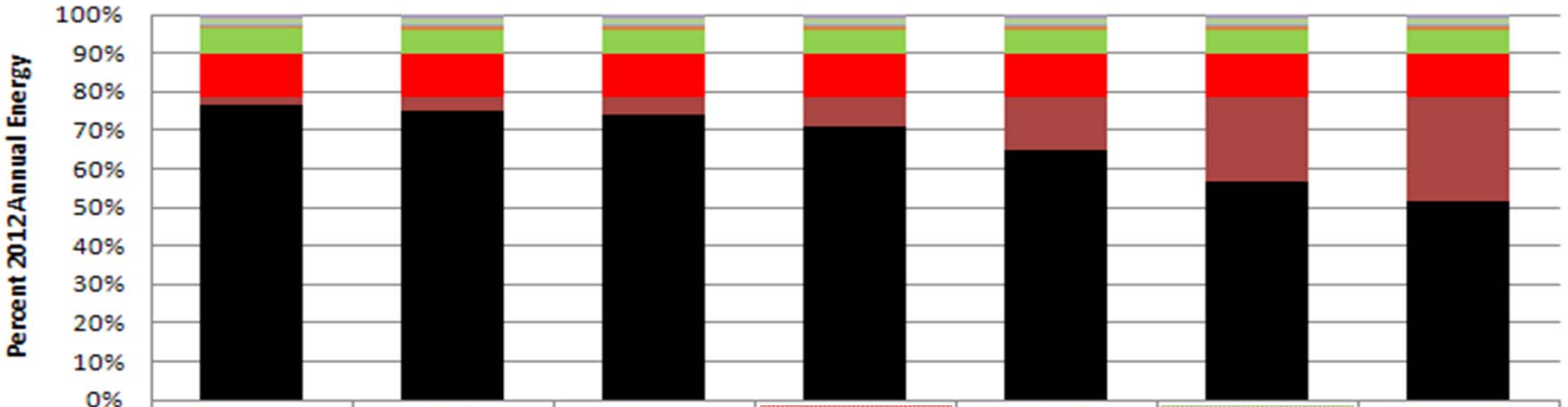


MISO designated unit allocation and production only

Implied Allowance Cost to Meet Compliance



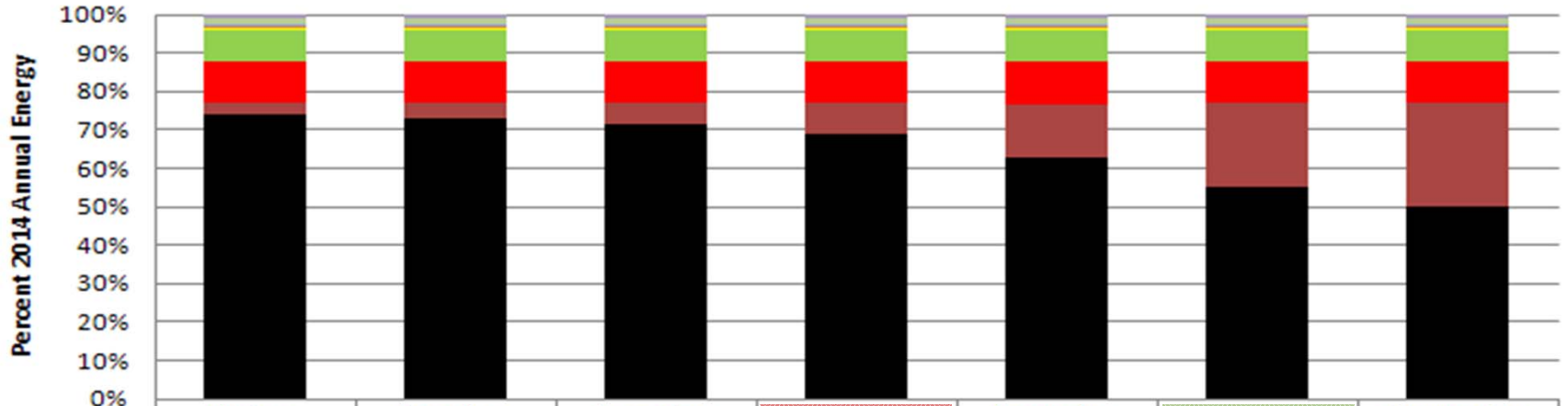
MISO 2012 Energy Mix under SO2 Costs



	$0/ton	$625/ton	$1250/ton	$2500/ton	$5000/ton	$10000/ton	$20000/ton
Import	0.91%	0.91%	0.91%	0.91%	0.91%	0.91%	0.91%
Storage	1.37%	1.38%	1.39%	1.44%	1.46%	1.44%	1.43%
Oil	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
Hydro	0.67%	0.66%	0.66%	0.66%	0.66%	0.66%	0.66%
Biomass	0.82%	0.82%	0.82%	0.82%	0.82%	0.82%	0.82%
Solar	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Wind	6.44%	6.43%	6.43%	6.43%	6.43%	6.43%	6.43%
Nuclear	11.06%	11.06%	11.05%	11.05%	11.04%	11.05%	11.05%
Gas	2.32%	3.46%	4.73%	7.71%	13.86%	21.93%	27.27%
Coal	76.42%	75.28%	73.99%	70.98%	64.82%	56.76%	51.42%

	$625/ton	$1250/ton	$2500/ton	$5000/ton	$10000/ton	$20000/ton
Greater than 25% point decrease in Capacity Factor	15 Units; 1,433 MWs	28 Units; 3,712 MWs	45 Units; 6,226 MWs	90 Units; 15,666 MWs	122 Units; 26,077 MWs	145 Units; 32,495 MWs
Greater than 50% point decrease in Capacity Factor	5 Units; 575 MWs	12 Units; 1,250 MWs	17 Units; 1,608 MWs	33 Units; 3,548 MWs	57 Units; 6,613 MWs	65 Units; 7,396 MWs

MISO 2014 Energy Mix under SO2 Costs



	$0/ton	$625/ton	$1250/ton	$2500/ton	$5000/ton	$10000/ton	$20000/ton
Import	0.90%	0.90%	0.90%	0.90%	0.90%	0.90%	0.90%
Storage	1.36%	1.36%	1.38%	1.42%	1.44%	1.38%	1.41%
Oil	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
Hydro	0.63%	0.63%	0.63%	0.63%	0.63%	0.63%	0.63%
Biomass	0.80%	0.80%	0.80%	0.80%	0.80%	0.80%	0.80%
Solar	0.10%	0.10%	0.10%	0.10%	0.10%	0.10%	0.10%
Wind	8.43%	8.43%	8.42%	8.42%	8.42%	8.42%	8.42%
Nuclear	10.88%	10.88%	10.88%	10.88%	10.87%	10.88%	10.88%
Gas	2.99%	4.07%	5.20%	7.97%	13.83%	21.59%	26.70%
Coal	73.90%	72.82%	71.67%	68.88%	63.01%	55.29%	50.15%

	$625/ton	$1250/ton	$2500/ton	$5000/ton	$10000/ton	$20000/ton
Greater then 25% point Decrease in Capacity Factor	12 Units; 1,169 MWs	24 Units; 2,828 MWs	48 Units; 5,859 MWs	91 Units; 15,121 MWs	119 Units; 24,719 MWs	140 Units; 30,886 MWs
Greater then 50% point Decrease in Capacity Factor	5 Units; 575 MWs	12 Units; 1,250 MWs	17 Units; 1,537 MWs	33 Units; 3,517 MWs	53 Units; 6,720 MWs	61 Units; 8,017 MWs

EPA Proposed Technical Adjustments to CSAPR – Reported on 10/6/2011

- **Revised assumptions of the EPA CSAPR analysis**
  - Assuming controls on units without controls
  - Operational requirements at specific units
- **Assurance penalty provision start in 2014 instead of 2012**
- **Revise certain unit-level affected by consent decrees**
  - Prevent CSAPR unit-level allocations from exceeding the terms of the consent decrees
- **MISO States Impacted**
  - Michigan – NOx budgets impacts
  - Wisconsin – SO2 and NOx budgets impacted
  - Indiana and Kentucky – Unit level allocation changes