The Wind Energy Paradox

Presented to:

Wyoming Infrastructure Authority's Spring Board Meeting

May 10, 2011

Key Points

- While wind produces electricity without emissions, when integrated into complex utility systems wind causes system integration issues that diminish the environmental and economic benefits of wind generation.
- The impact that wind energy has on emissions vary significantly by region and are lower than is commonly understood.
- Emission savings decline as gas replaces coal for baseload or shoulder generation.
- Wind energy does not appear to be a cost effective means of reducing air emissions.

Study Objectives & Methodology

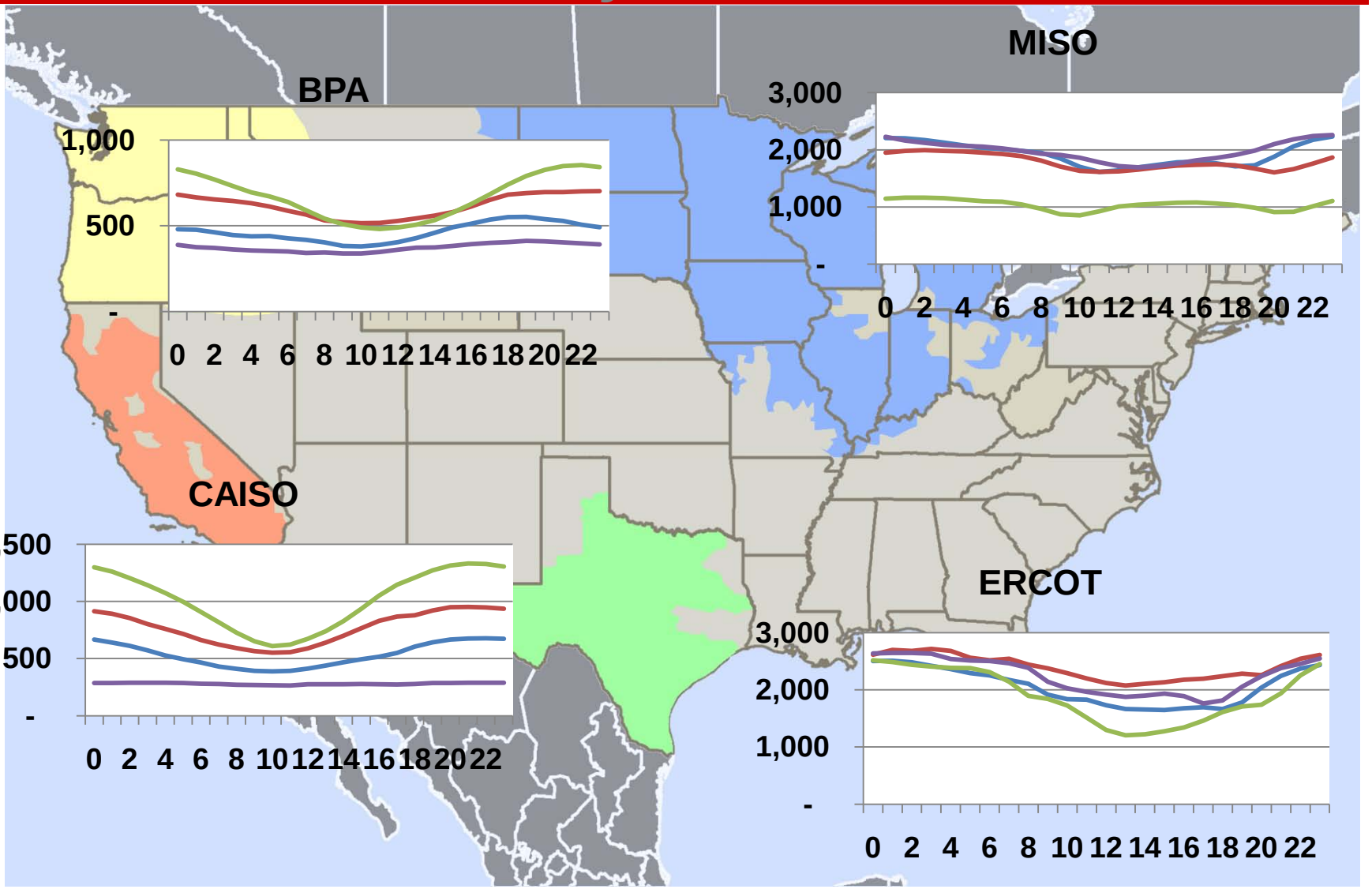
Objective:

- Quantify the SO2, NOX and CO2 emissions savings that have resulted from adding wind to the generation mix in the BPA, CAISO, ERCOT and MISO.
- Test the generally accepted assumption that 1 MW of wind saves 5.7 lbs S02, 2.3 lbs of NOX and 0.8 tons of CO2 (AWEA Values).
- Calculate the MWs of wind generation needed to save 1 ton of CO2, then, estimate the cost.

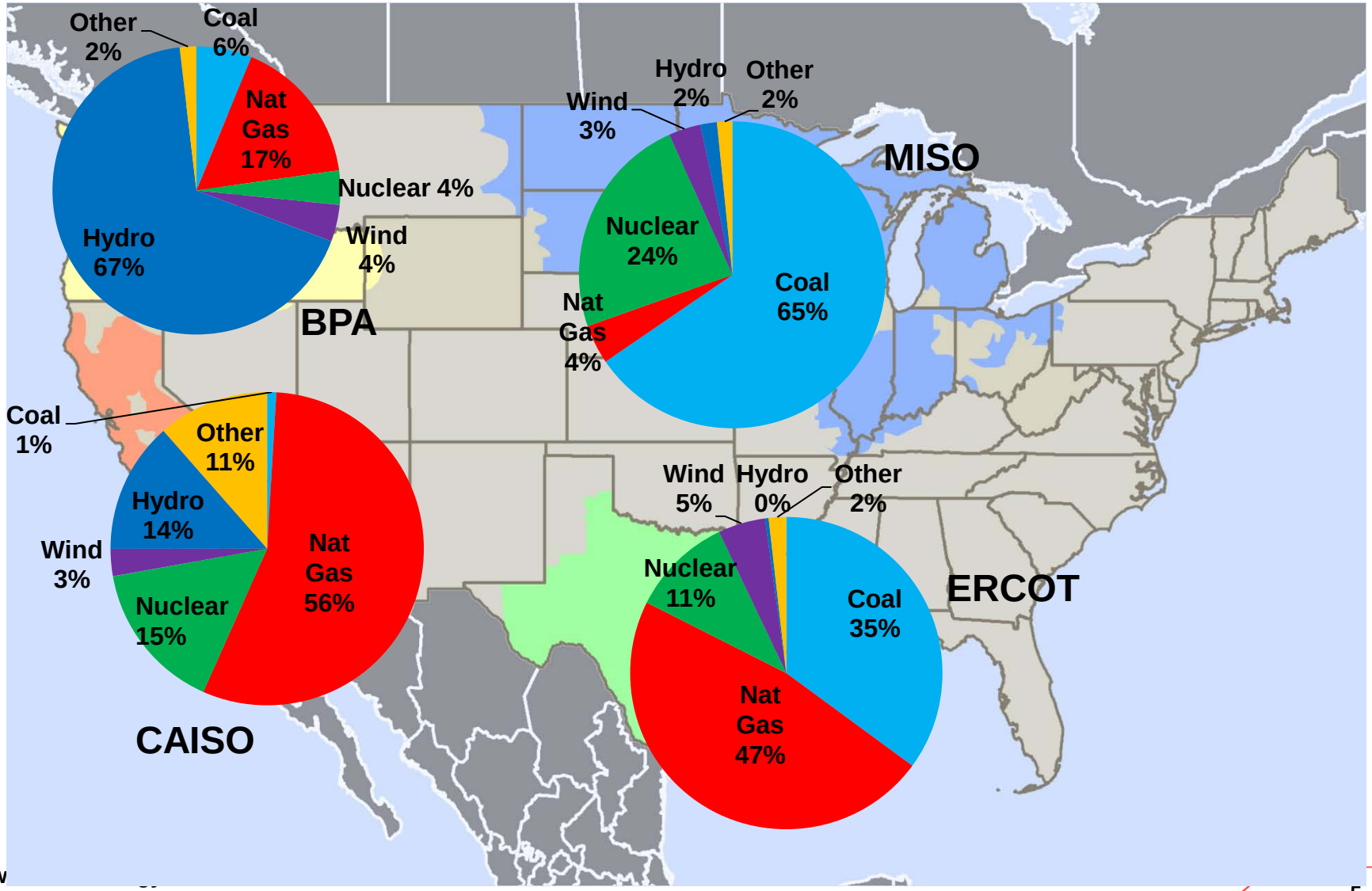
Methodology:

- Use hourly wind and other fuel generation data from the four RTOs.
- Use hourly emission data from the EPA Continuous Emission Monitor System (CEMS).
- Construct a regression model to identify the relationship between incidence of wind generation and emissions, accounting for variation in:
  - Demand
  - Month, week day, hour
  - Weather

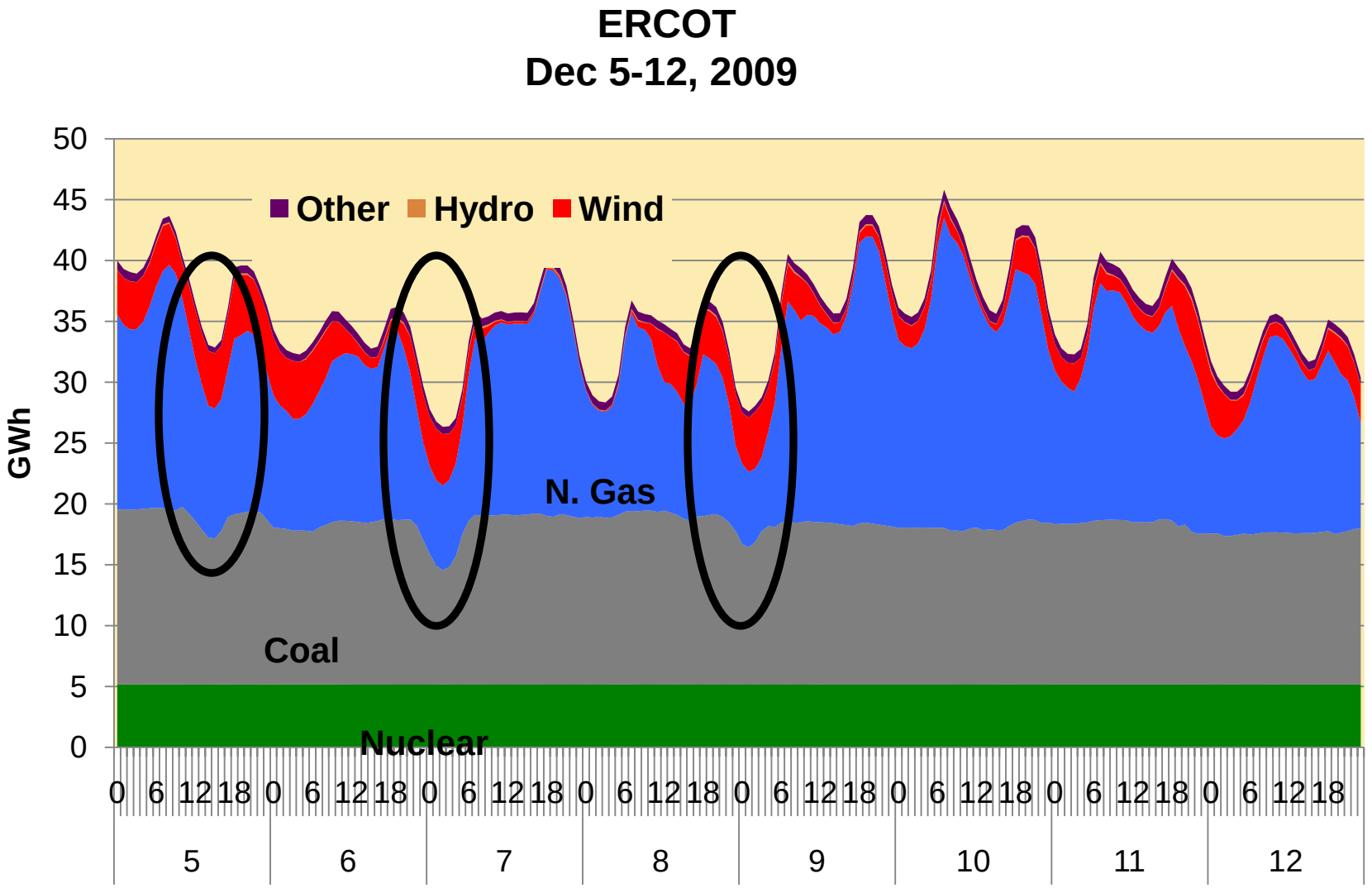
Wind Tends To Blow Strongest Early & Late In The Day



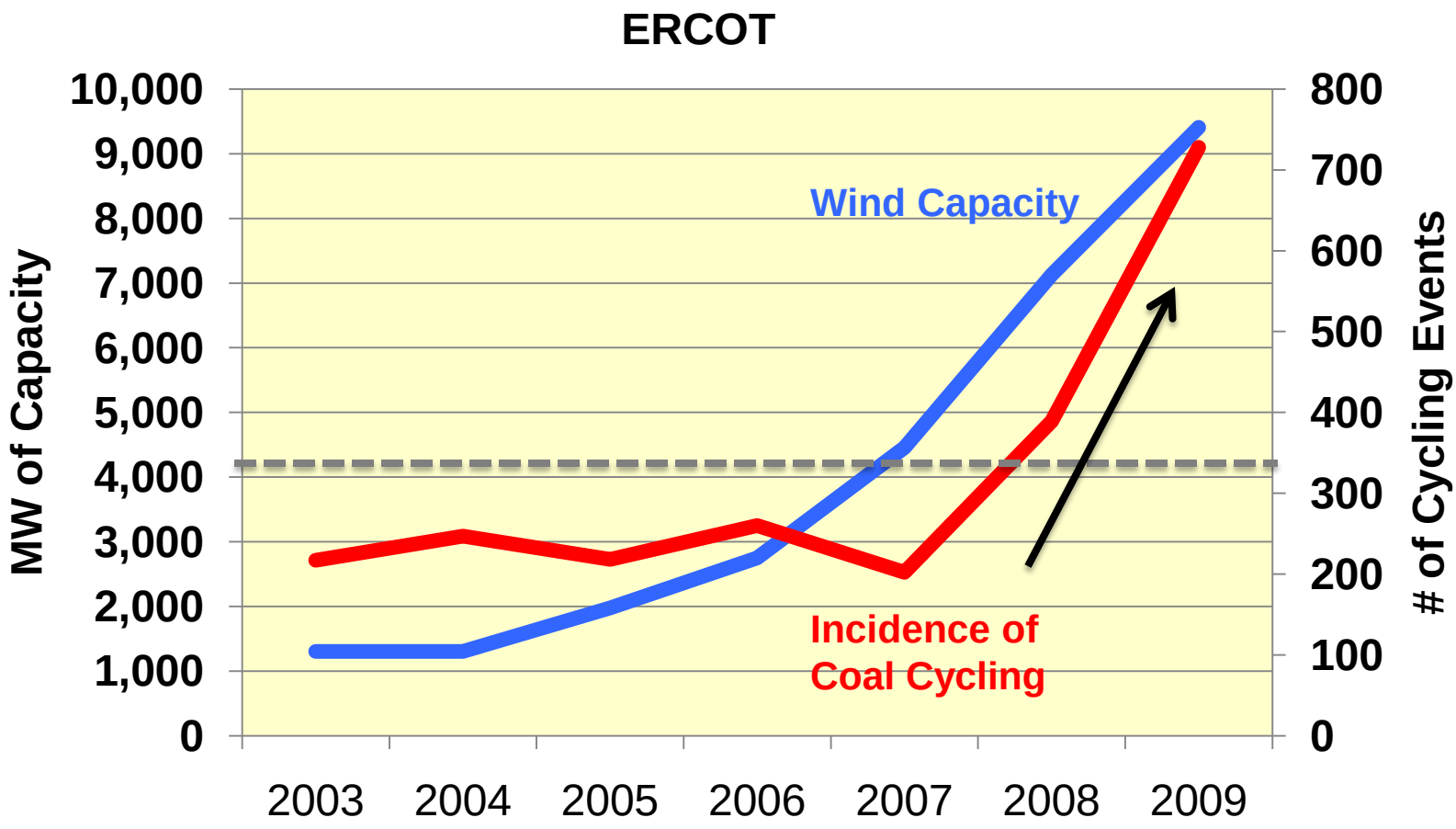
Generation Stacks Differ Across The Country



Coal Plants Are Cycled to Accommodate for Wind

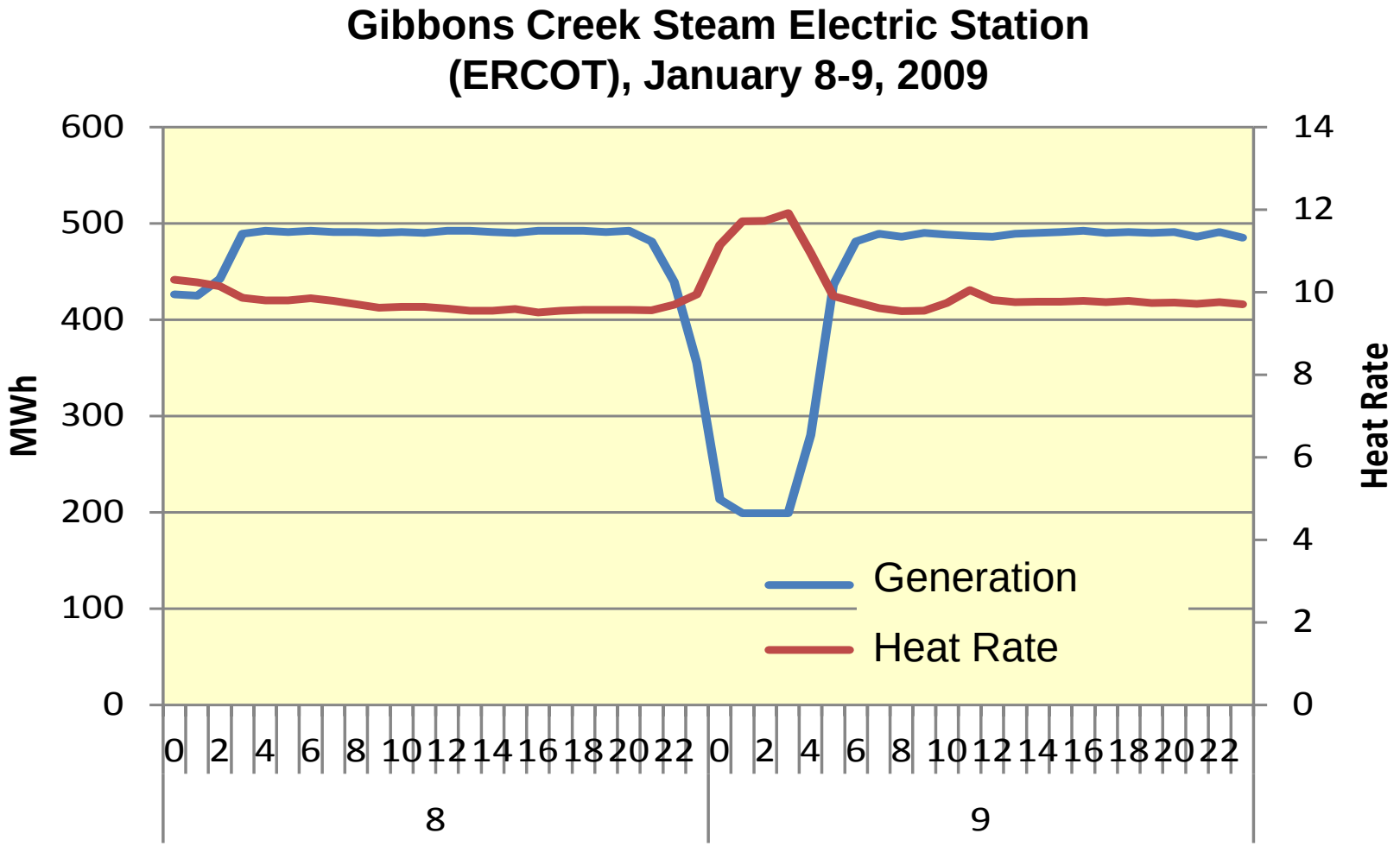


Cycling of Coal Plants Has Increased With Greater Wind Generation

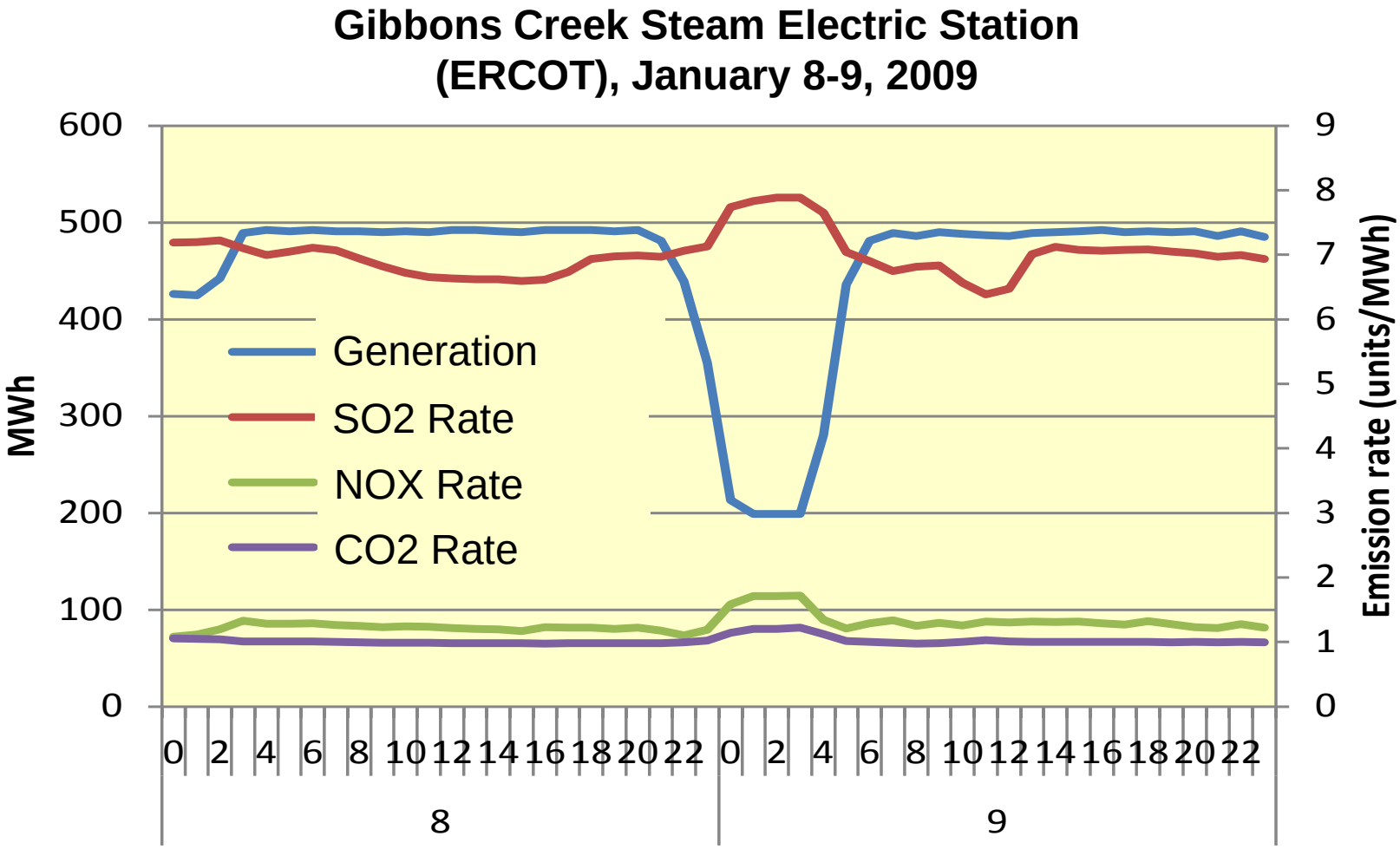


Cycling event is defined as a > 5% change in generation output hour over hour

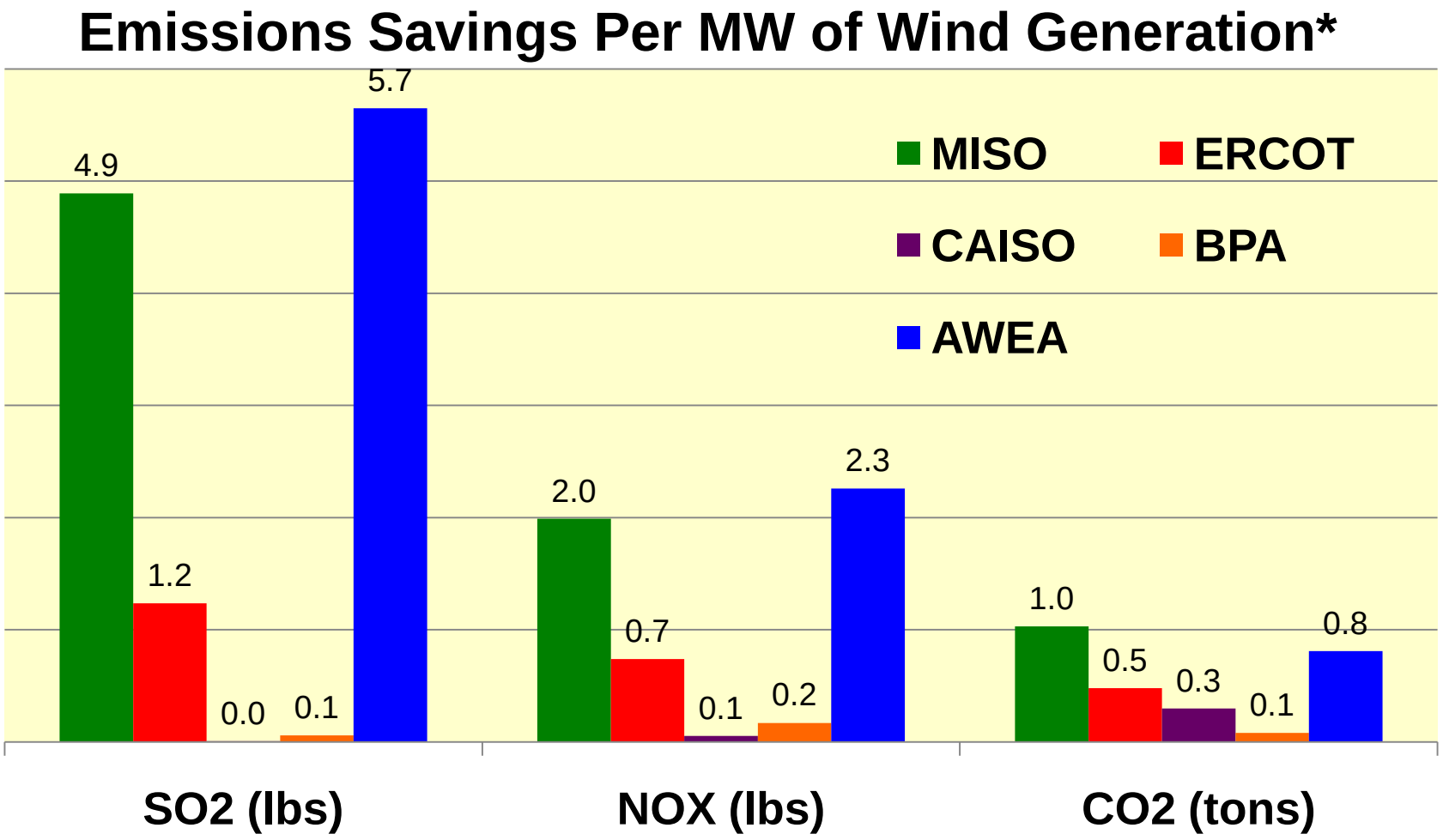
As Thermal Plants Are Cycled, Heat Rate Increases. . .



And, Emission Rates Increase As Well

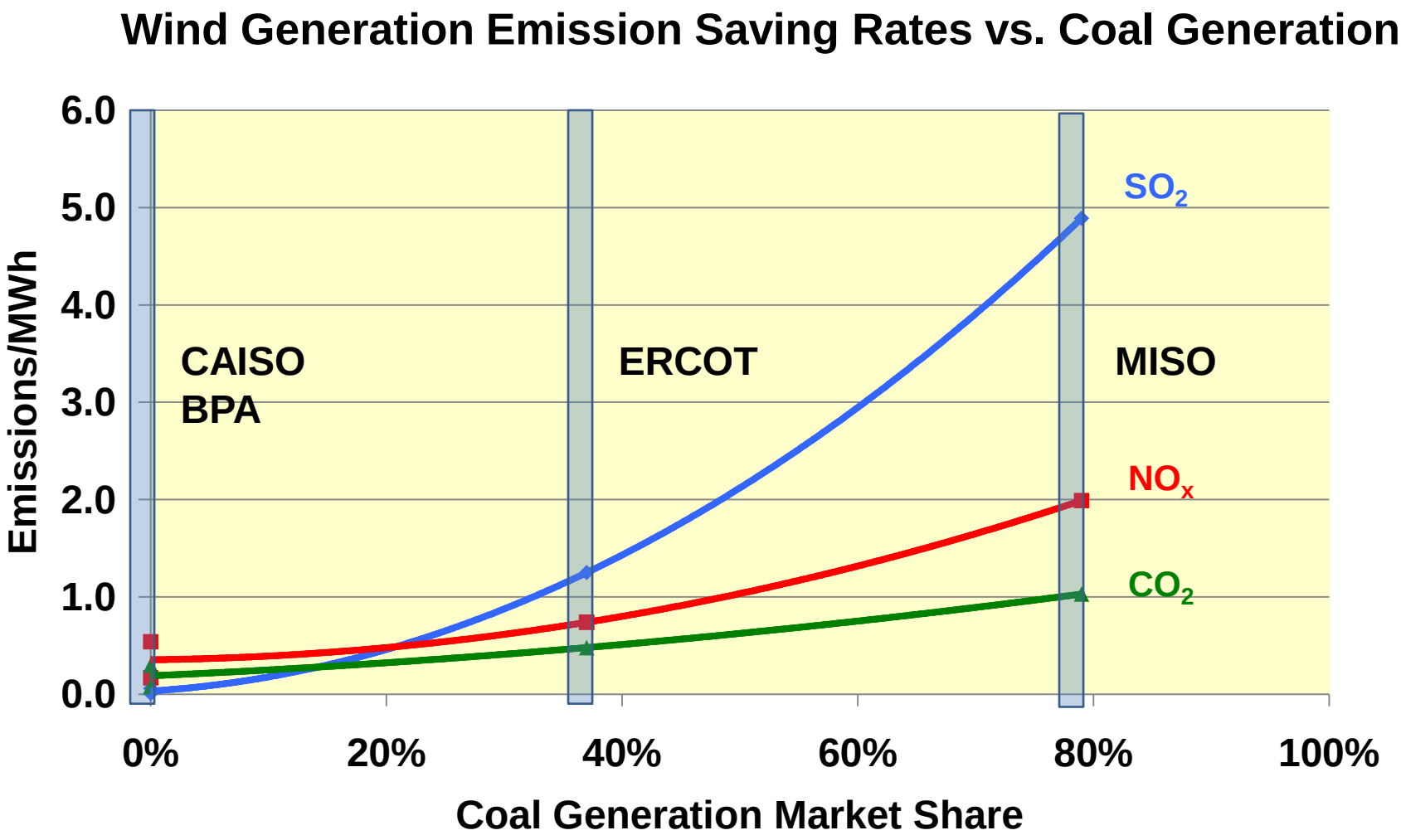


Emissions Savings From Wind Vary By Region

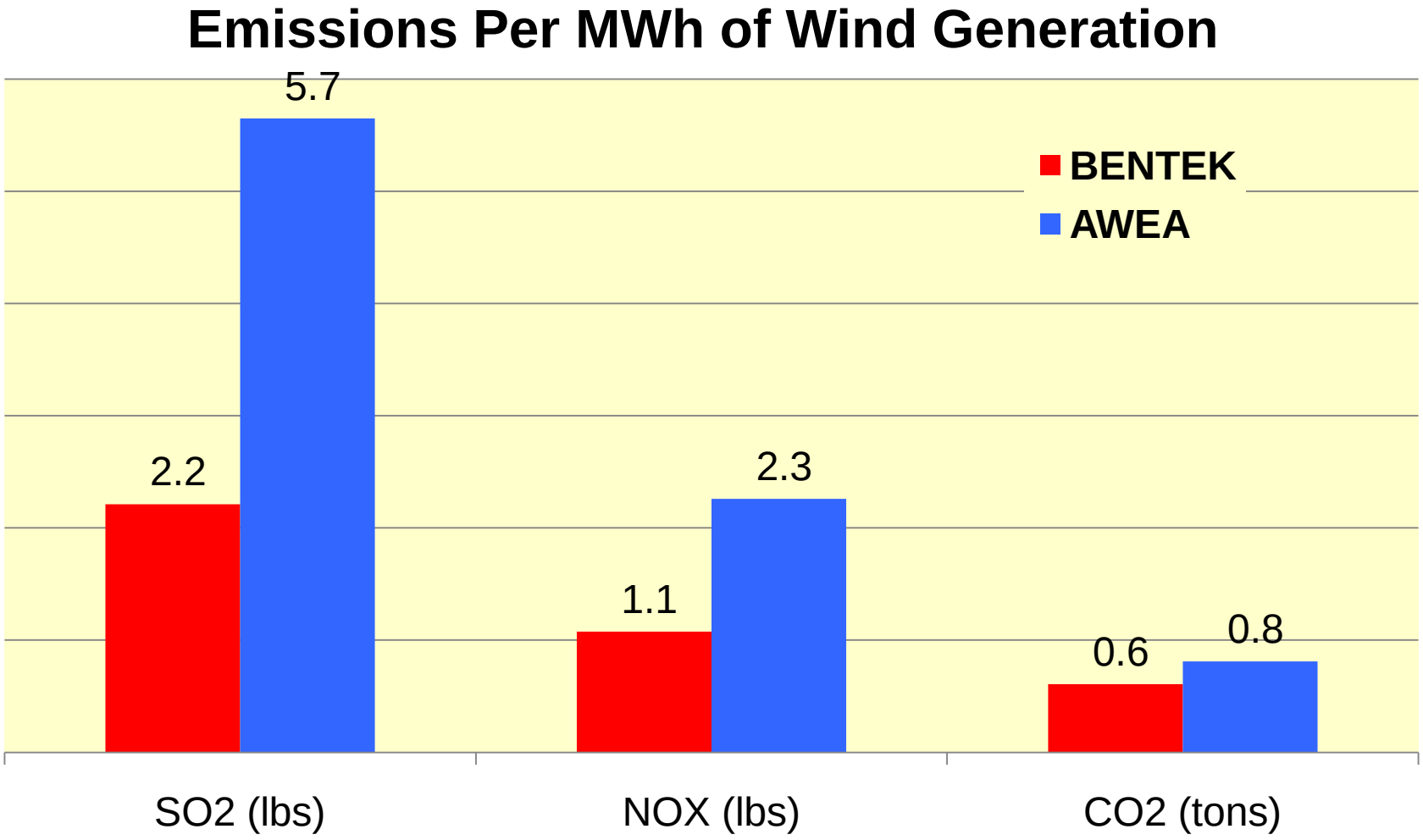


*All results are statistically significant with P-Values of 0.05 or less, T-Stats above 15.

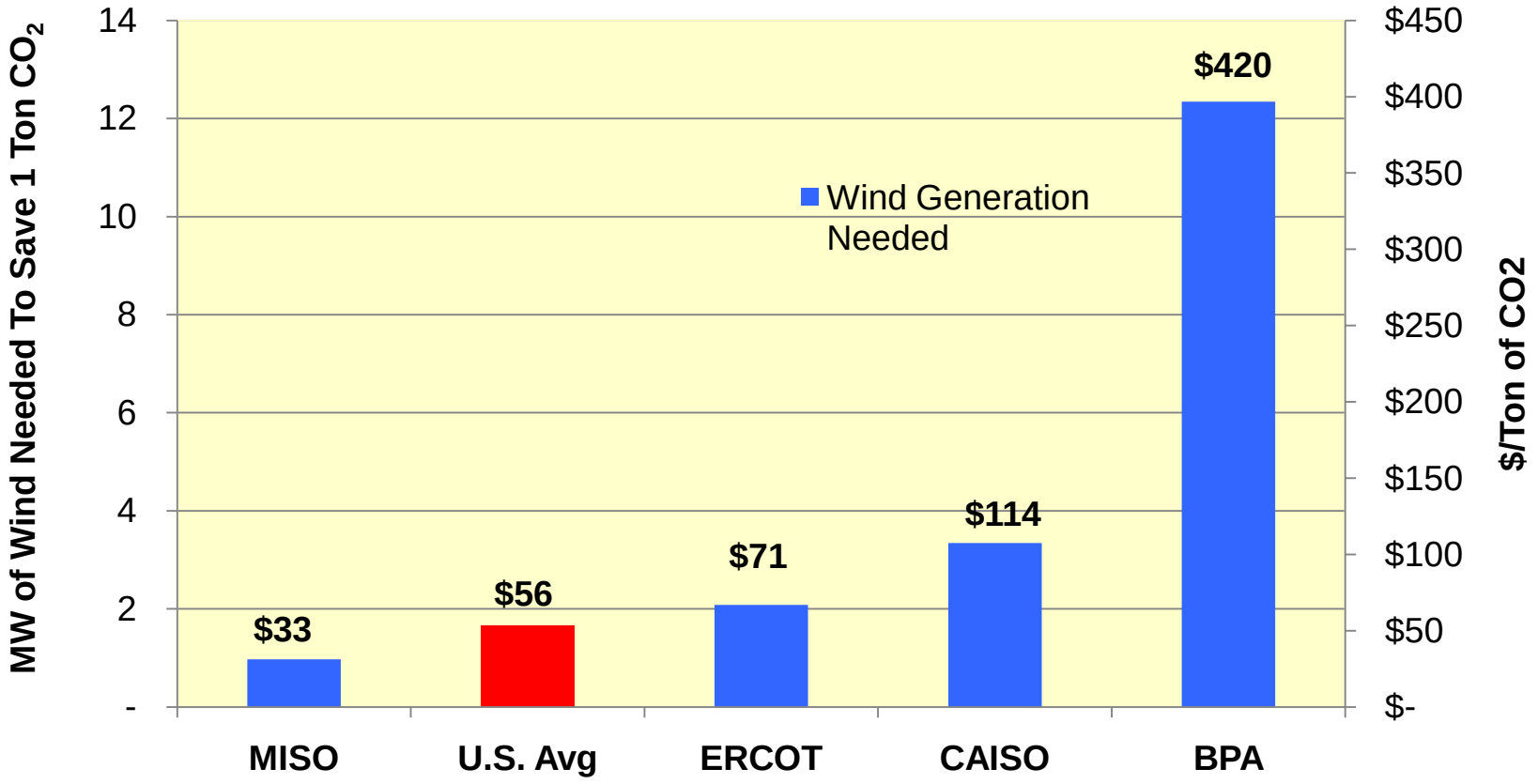
Emissions Savings Are Dependent on the Generation Mix



U.S. Average SO_2 and NO_x Savings From Wind Are Lower Than Are Generally Assumed



Average US Cost For Saving CO2: $56/ton



Assumes tax subsidy of $22/MWh, with pre-tax value of $34/MWh

Conclusions

- Emission savings due to wind generation vary by territory based on fuel mix of offset. The greater the market share of natural gas, the lower the savings potential.
- Cost of offsetting carbon through wind generation is far above values implied by recent legislative efforts for most of US suggesting that subsidizing wind generation is not a cost-effective means of reducing CO2
- Emission savings rates from wind will decline as the market share of natural gas increases. In this sense, policies to promote wind are in conflict with efforts by the EPA to tighten limits on criteria pollutants.

Questions?

Brannin McBee
32045 Castle Court, Suite 200
Evergreen, CO 80439
Office: 303-988-1320
Toll Free: 888-251-1264
bmcbee@bentekenergy.com

Appendices

Results of Regression Model Analysis

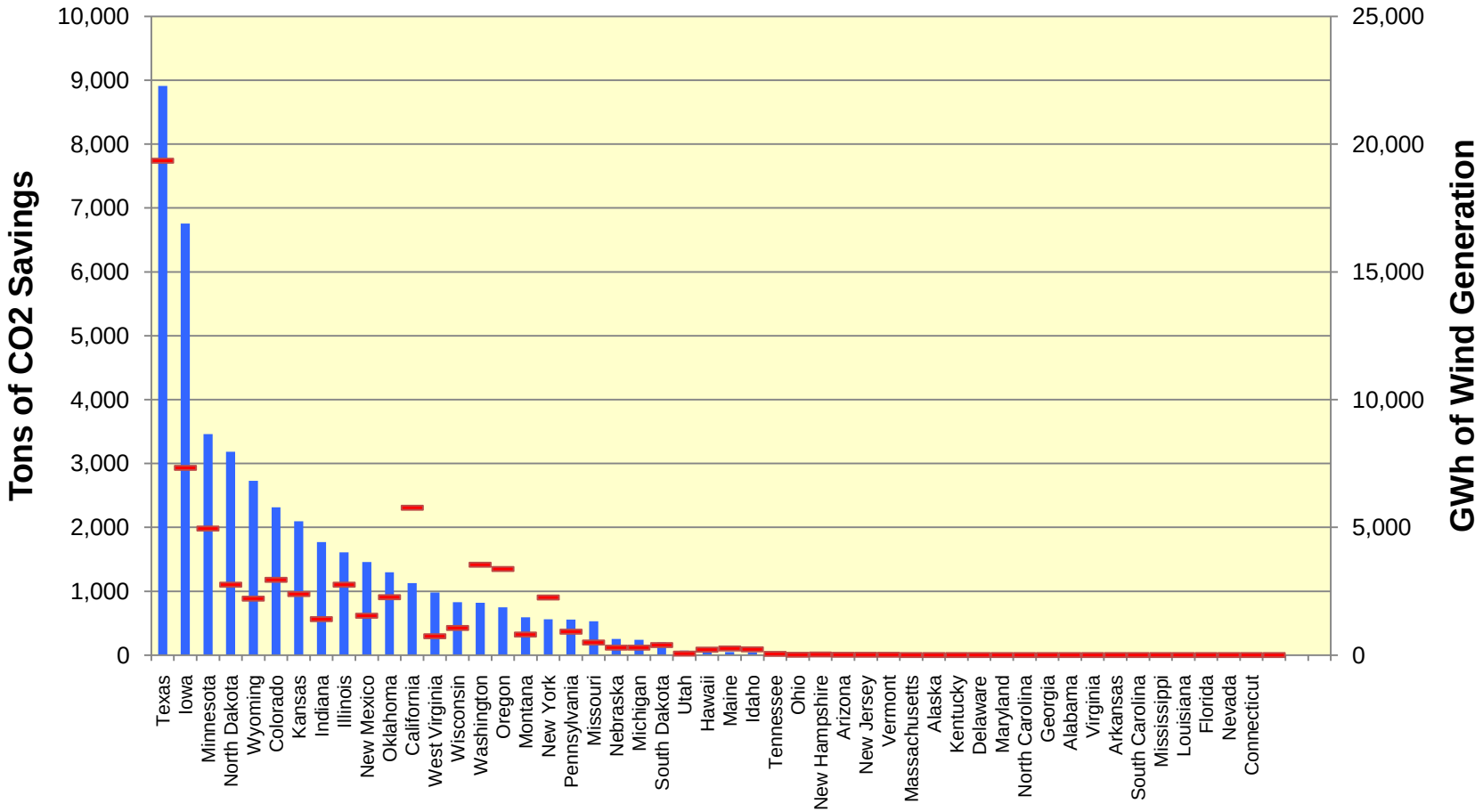
	ERCOT		MISO		CAISO		BPA	
	Reduction per MWh	P-Value	Reduction per MWh	P-Value	Reduction per MWh	P-Value	Reduction per MWh	P-Value
SO2	1.235	<1%	4.890	<1%	0.008	5%	0.059	5%
NOX	0.739	<1%	1.995	<1%	0.054	<5%	0.016	<1%
CO2	0.484	<1%	1.025	<1%	0.299	<1%	0.081	<1%

Reduced Form Equation For Estimating Emission Savings

$$E_{irt} = \alpha_{ir} + \beta_{ir} W_{rt} + \gamma_{1ir} T_{rt} + \gamma_{2ir} T_{rt}^2 + \delta_{ir} X_t + \epsilon_{irt}.$$

- E_{irt} = emissions of pollutant i in region r and time t
- $Alpha_{ir}$ = constant regression term for pollutant i in region r
- $Beta_{ir}$ = the change in emissions due to a MWh change in wind generation
- W_{rt} = wind generation in MWh in region r at time t
- T_{rt} = temperature in degrees F in region r at time t
- e_{irt} = the idiosyncratic unobserved error term
- X_t = vector of time-controlling dummy variables

Actual CO2 Emission Savings By State & Total Wind Generation in 2009



Independent Research

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