

Benefits of Reduced Air Pollution in the United States



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Resources for the Future

Presentation to EMEP Conference
October 8, 2003

Background materials at
<http://www.rff.org/rff/news/features/making-sense-of-multipollutant-legislation.cfm>

Roadmap

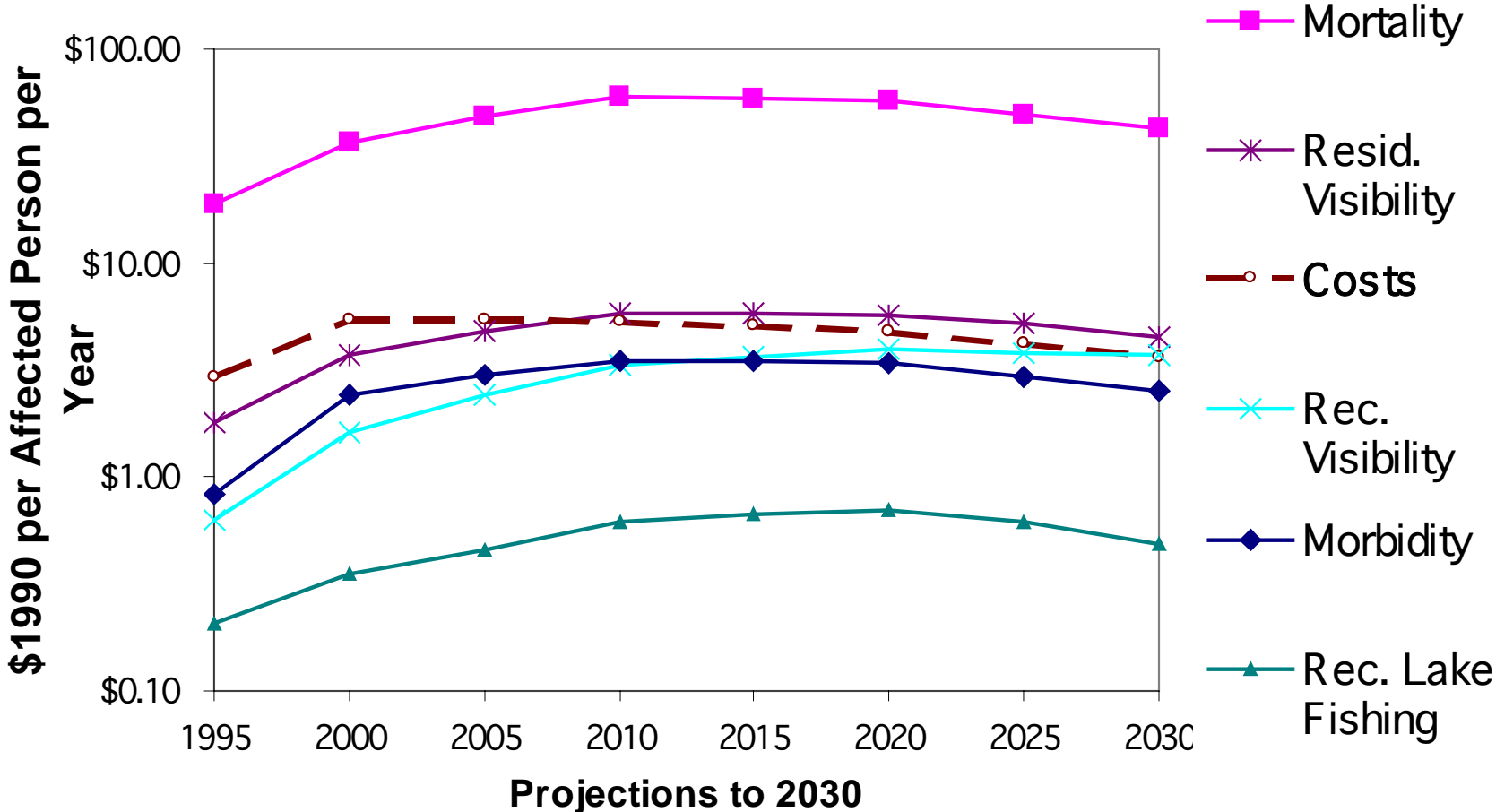
- **Integrated Assessment Approach**
- **1990 CAAA**
- **NO_x SIP Call**
- **Multi-pollutant legislation**
 - Efficient Emission Fees for SO₂, NO_x
 - Proposal Targets, Benefits
 - Errors and Uncertainties in Benefit Estimates
 - Guidelines for Hg
 - Architecture for Carbon

Integrated Assessment: Meaning and Method

- Integration of full-form models with “internal” validity
- Emphasis on “external” integrity
- Account for correlated uncertainty
- Include assessment
- Value of additional information

NYSERDA played a path-breaking role in the application of integrated assessment in the early 1990s with co-sponsorship of the ESEERCO externality study.

TAF Findings: Benefits and Costs of Title IV



“Integrated Assessment” (NAPAP, 97) and “Benefits and Costs of Title IV” (CEP, 98)

The Weak Links

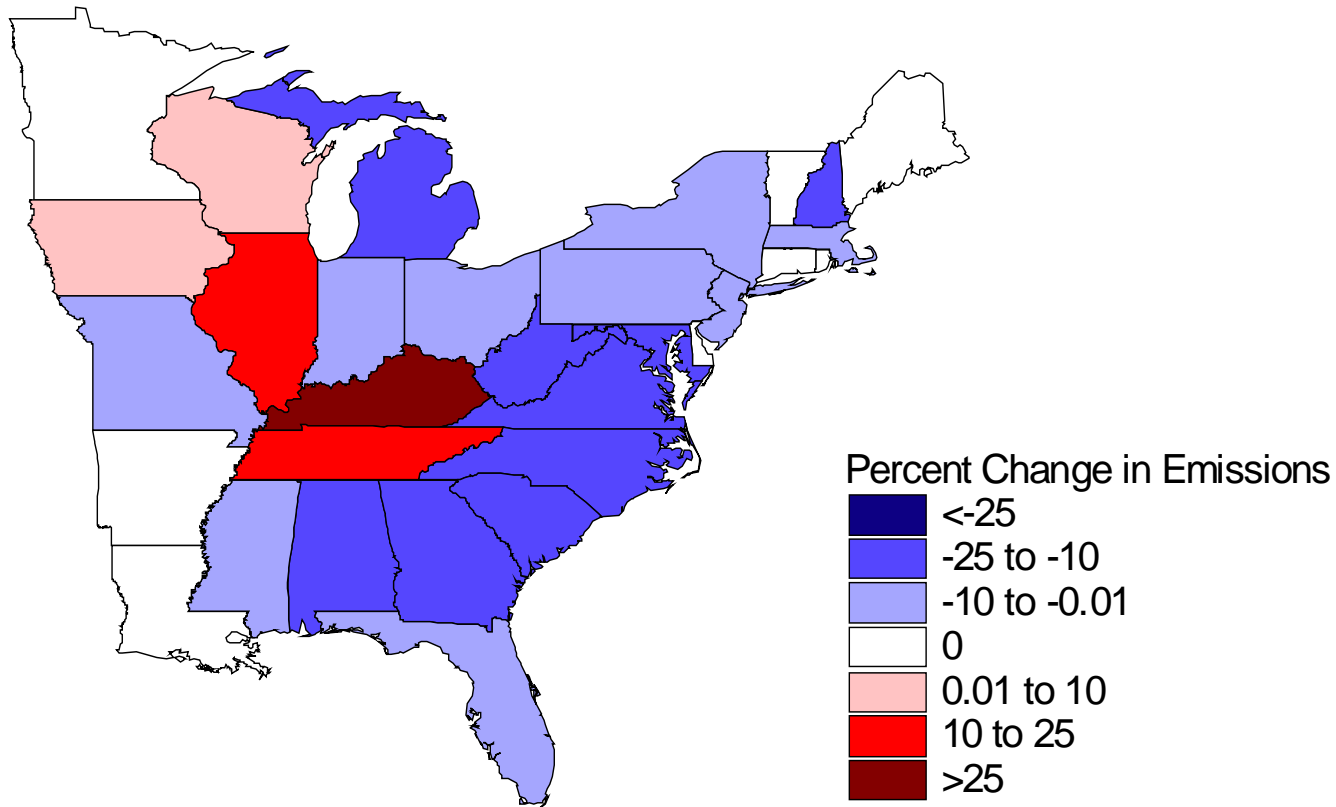
	Expected Benefit:	<i>Short-Term</i> Value of Additional Information:
Health: Mortality	●	●
Health: Morbidity	◉	◉
Visibility	◉	◉
Materials and Cultural Resources	◉	◉
Nonuse Values: Ecosystem Health	●	●
Aquatics: Recreation	◉	●
Forests: Recreation	◉	◉
Ag / Commercial Forestry	◉	◉
Radiative Forcing	◉	○

Spatial Effects of Trading

- In 1993, the NY AG sued EPA to restrict allowance sales.
- NY Assembly, later Senate, voted to constrain trades.
- 1998 agreement with Long Island Lighting Company (LILCO).
- 1998 Senator D'Amato likened long-range transport of acid rain to “airborne terrorism.”
- 2000 Governor Pataki signed into law legislation to monitor and control sale of SO₂ allowances.
- 2003 Appeals court strikes down NY law.

Effect of Trading on Emissions

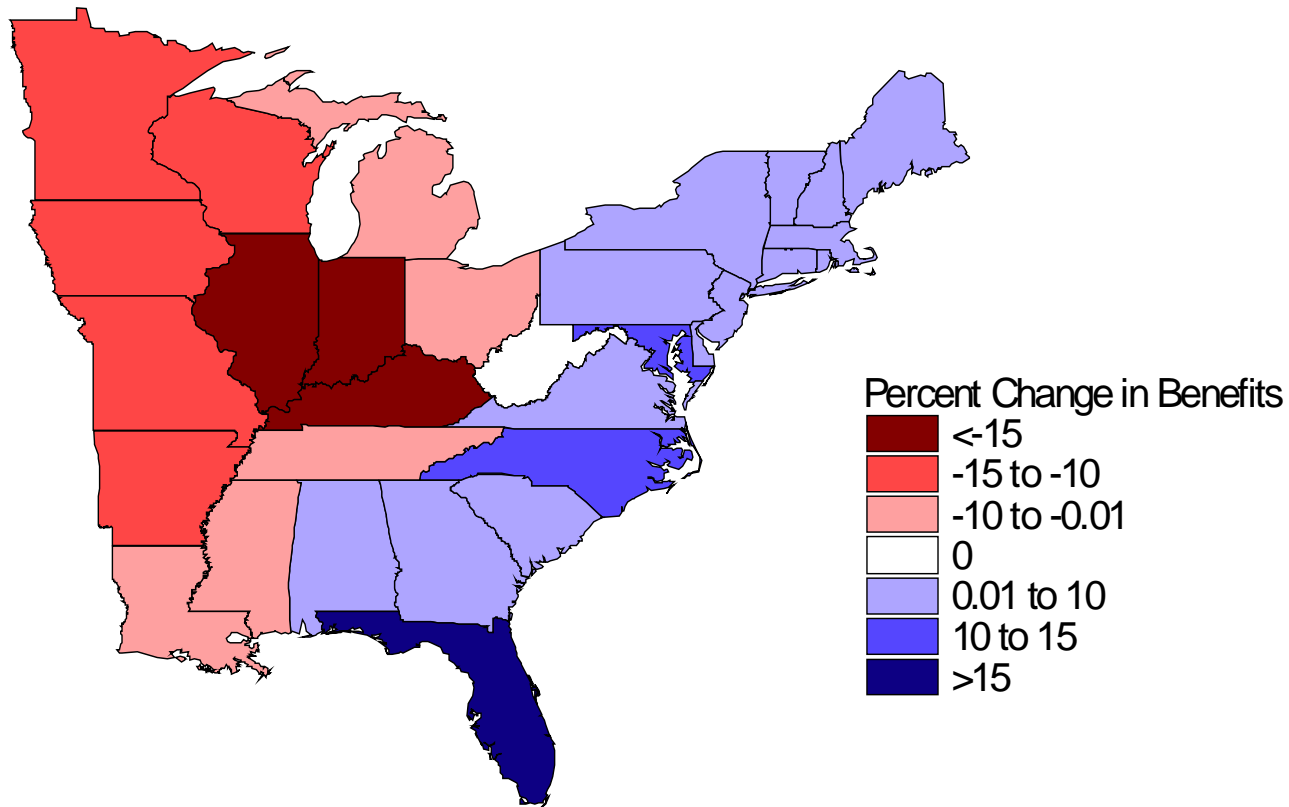
Percent Change in Title IV Baseline
Utility Emissions Attributable to Trading for 2005



“Regional Analysis of SO₂ Allowance Trading” (EST, 99)

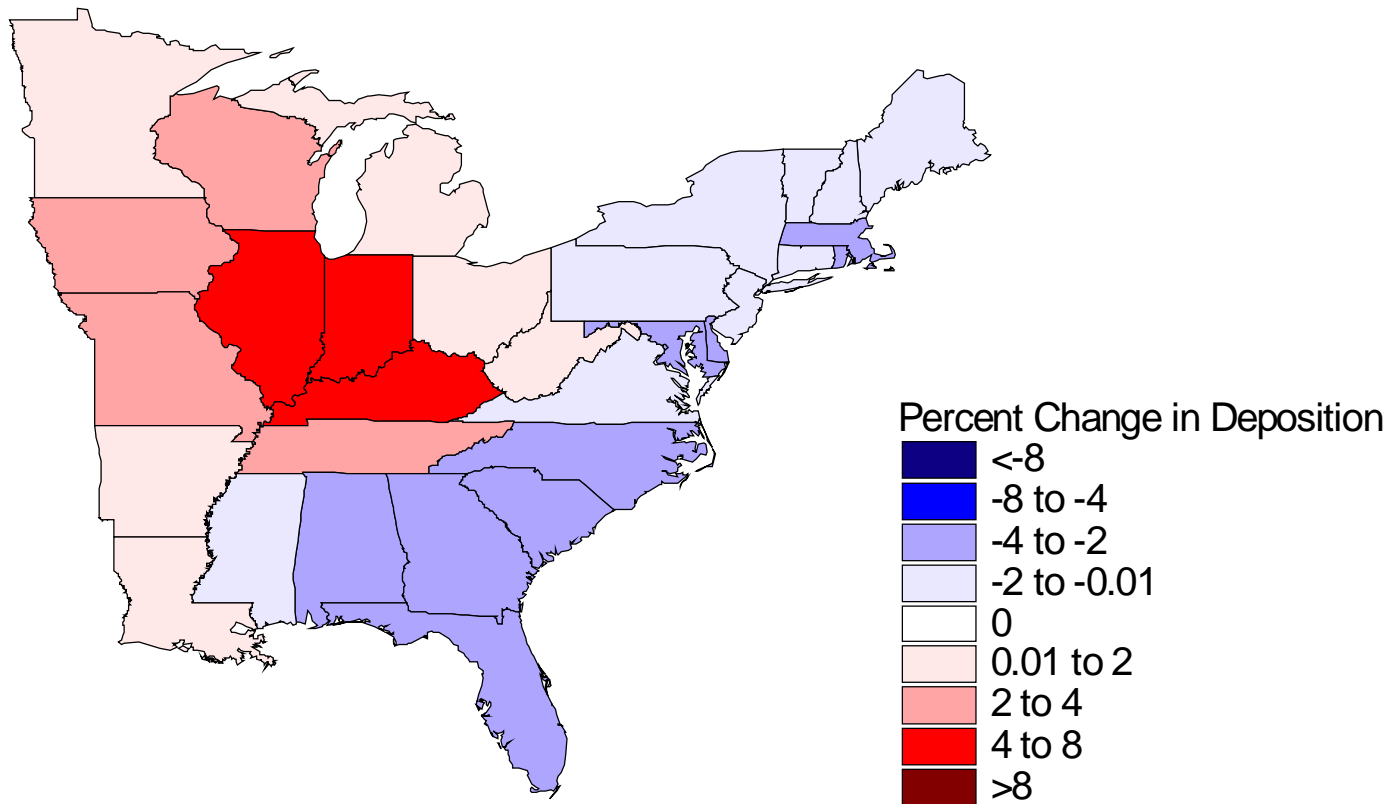
Effect of Trading on Health

Percent Change in Title IV Baseline Benefits Attributable to Trading for 2005

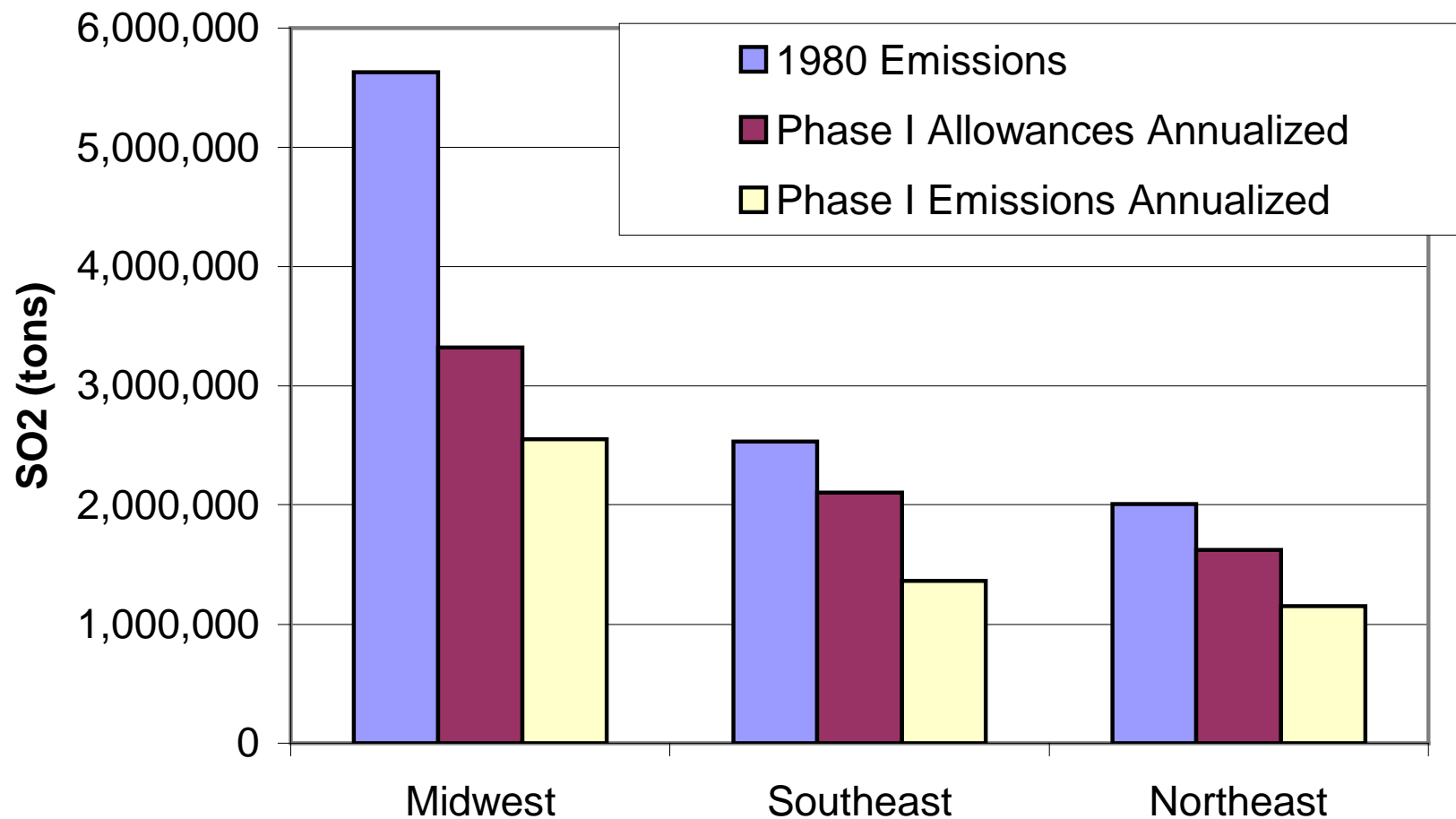


Effect of Trading on Deposition

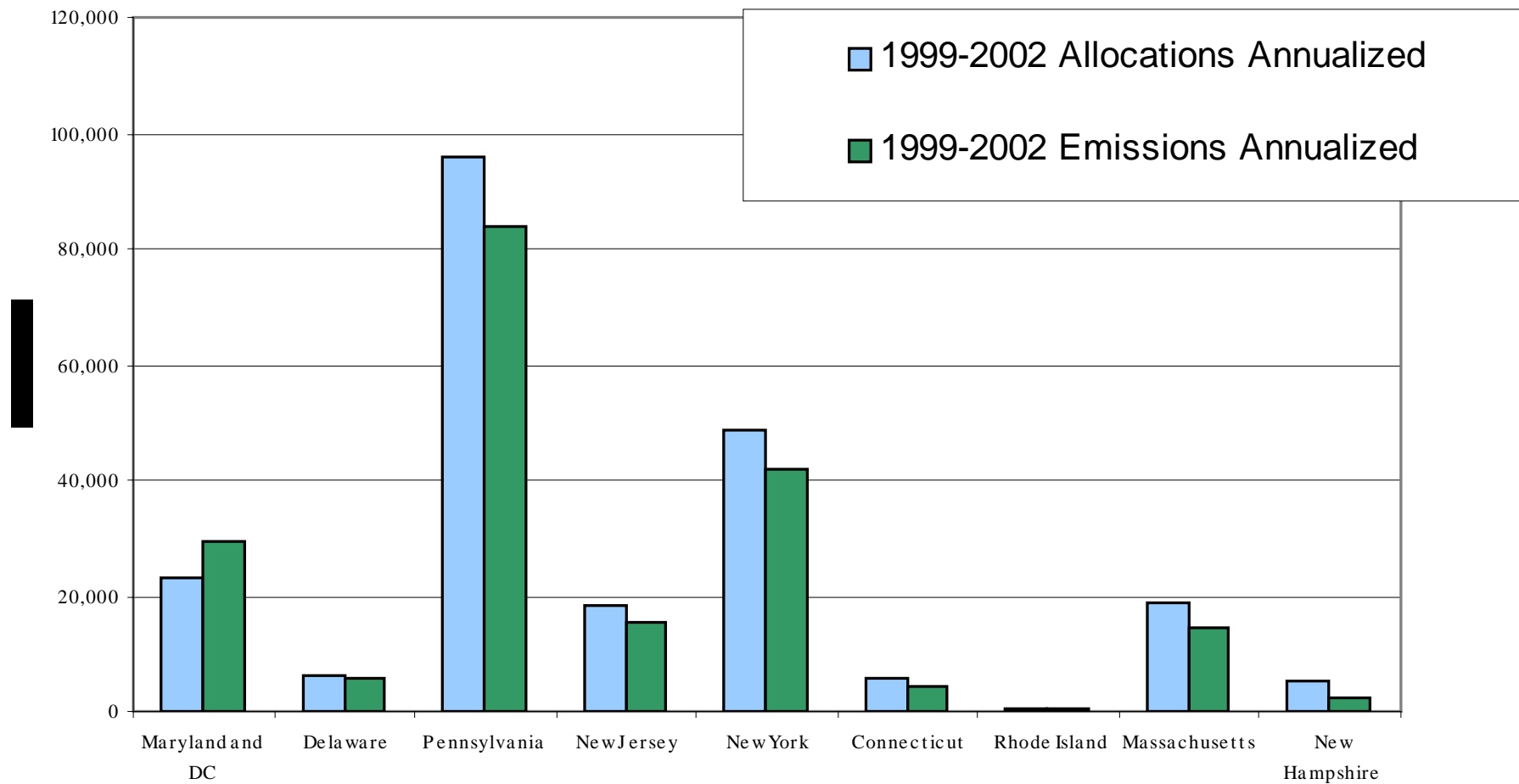
Percent Change in Title IV Baseline Sulfur Deposition Attributable to Trading for 2005

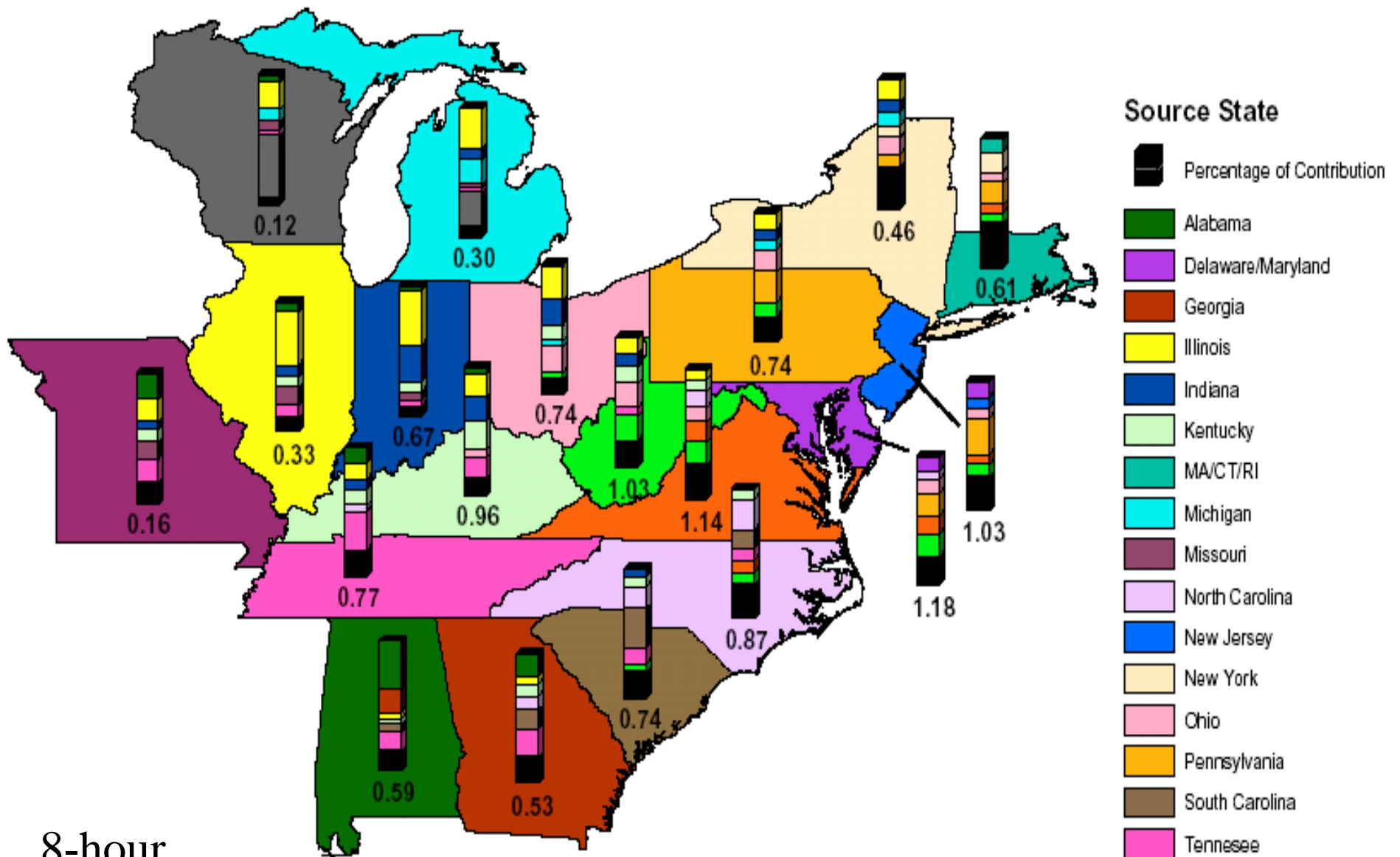


Baseline Emissions, with Phase I Allocations and Emissions of SO₂ by Region



Allowances Allocated and Emissions of NO_x Under OTC Program





8-hour Ozone change and state shares for 30% NO_x Reduction

The Second Grand Experiment: NO_x SIP Call

- NO_x emissions contribute to multiple problems:
 - ozone, particulates, nitrogen deposition, visibility
- Nonattainment of ozone standard provides regulatory handle for EPA NO_x SIP Call
- Policy aimed at ozone, a seasonal problem
- But, other NO_x-related effects are realized throughout the year
- Costs of NO_x control are largely fixed and capital costs.

Annual vs. Seasonal NO_x Controls” (*JAWMA 01; Land 03*)

Question: What is the most cost-effective way to achieve NO_x reductions given full set of NO_x related problems?

Three NO_x reduction scenarios:

- Summer cap in 19 state SIP Call region**
- Annual cap in the same SIP Call region**
- National Annual cap**

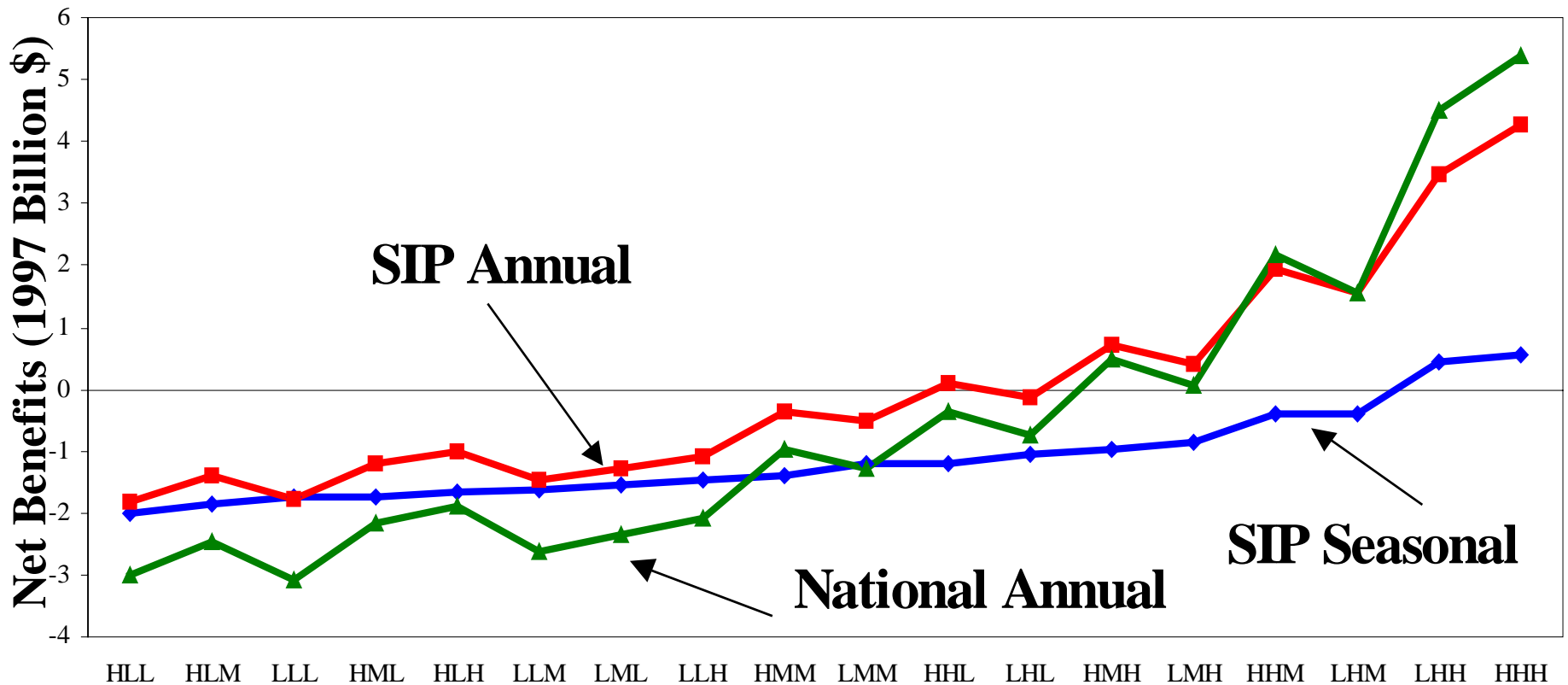
Major Uncertainties

- Market Structure
- Epidemiology / Mortality
- Valuation / Mortality

RFF “Haiku” Electricity Model

- Intra-regional market modeling
 - Market equilibrium in 13 regions
 - Demand: 3 customer classes, 4 time periods, 3 seasons
 - Supply constructed using model plants
 - Defined by technology, fuel type, vintage
 - Investment and retirement
 - Emission compliance
 - Fuel market prices adjust
- Inter-regional power trading
 - Equilibrates regional prices, transmission constraints

Net Benefits for the Nation, 2008



Combinations of assumptions in scenario analysis characterizing market structure, epidemiology and valuation.

Main Findings Favor Annual NO_x Controls

- Under all scenarios **SIP Annual policy** yields greater net benefits than current policy; Ohio Valley included.
- National annual policy is slightly less cost-effective than current under preferred assumptions
...but it is more cost-effective under majority of scenarios.
- SIP region always realizes greatest net benefits under National Annual policy.
- Omitted benefits do not change ranking for SIP Annual

State Actions in SIP Call region

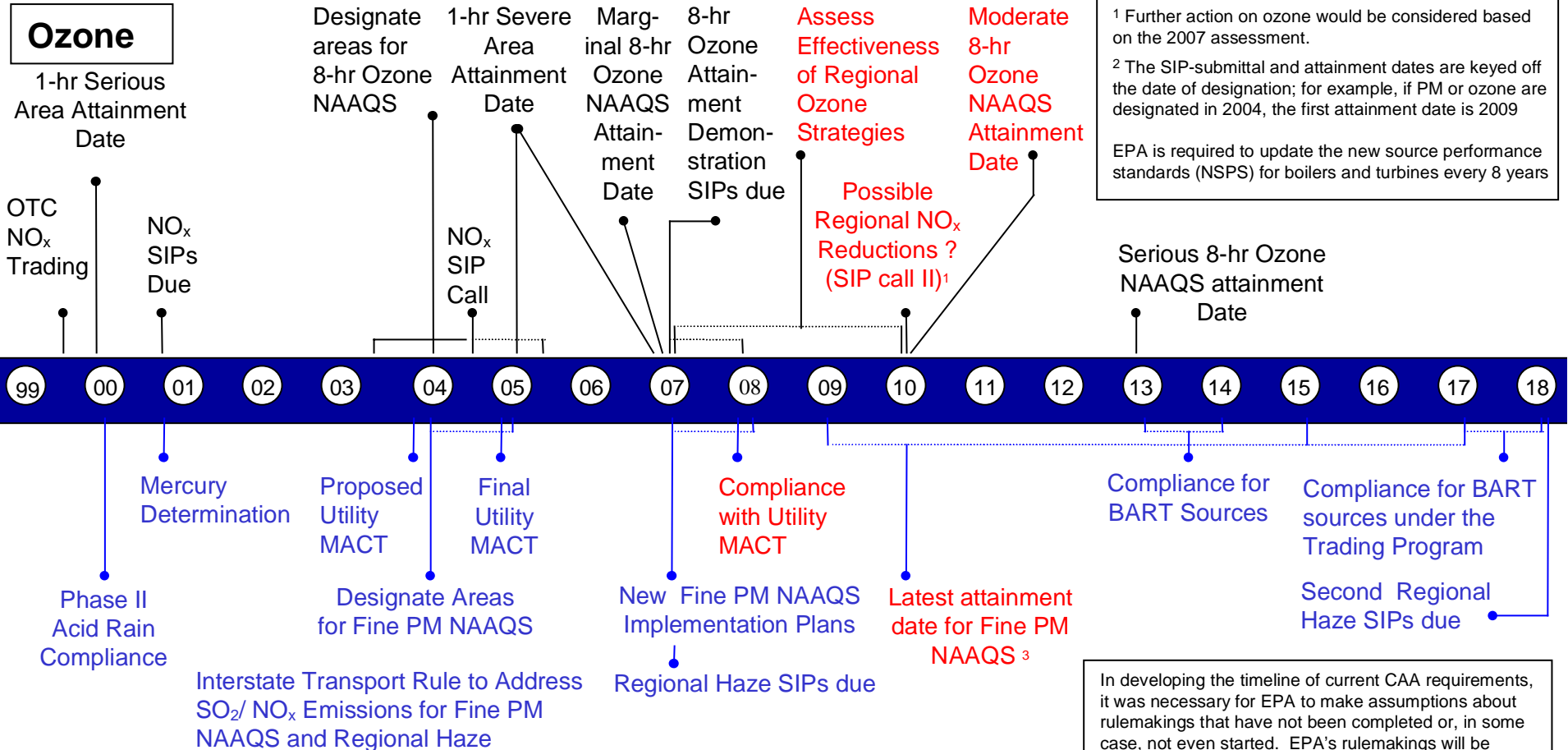
Connecticut, Massachusetts, New Hampshire, North Carolina and New York have moved to annual controls on NO_x and SO₂.

State actions amplify the challenges to resource planning for electricity generators.

The Clean Air Act's Requirements

NSR Permits for new sources & modifications that increase emissions

Ozone



Note: Dotted lines indicate a range of possible dates.

¹ Further action on ozone would be considered based on the 2007 assessment.

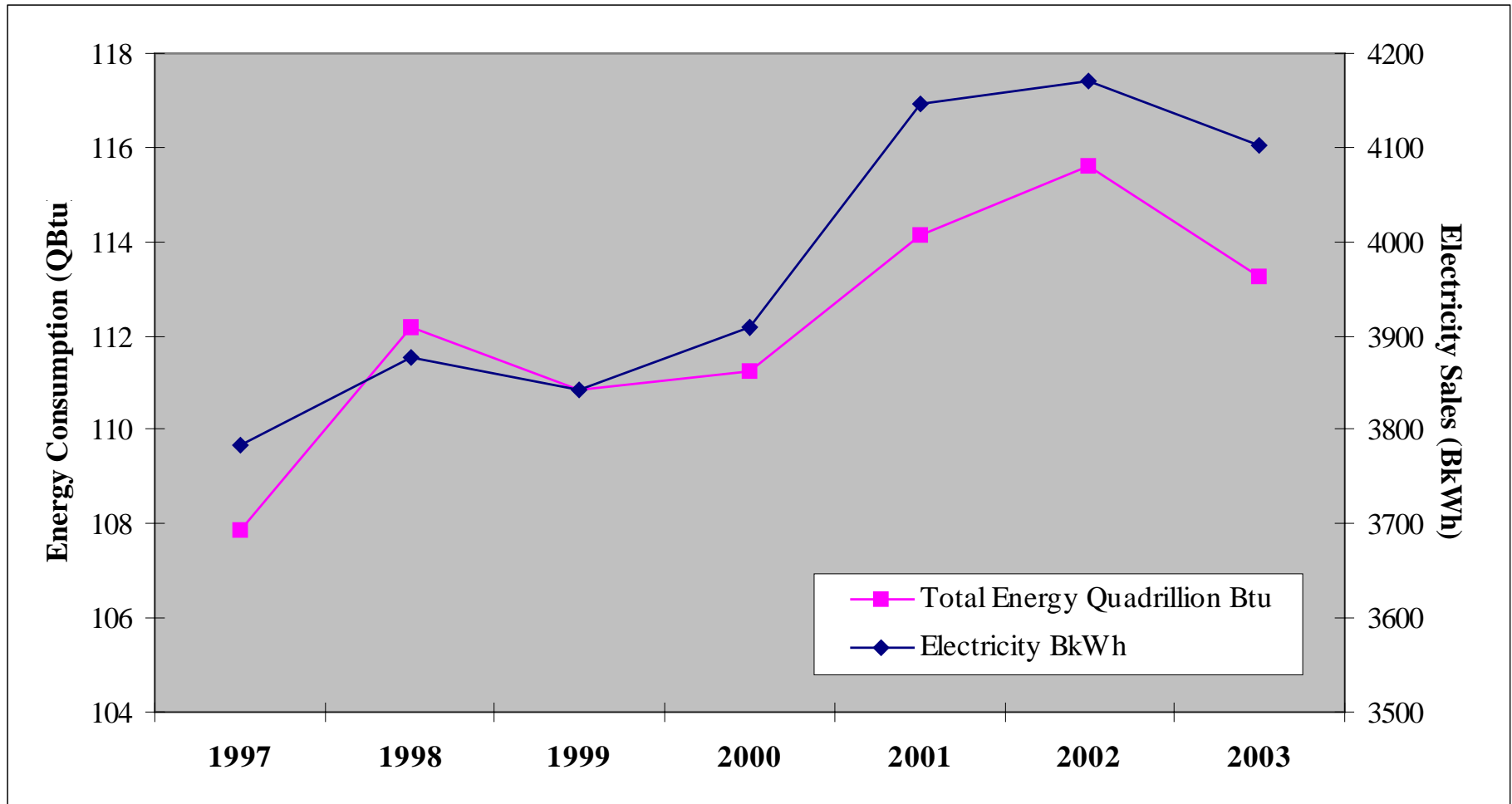
² The SIP-submittal and attainment dates are keyed off the date of designation; for example, if PM or ozone are designated in 2004, the first attainment date is 2009

EPA is required to update the new source performance standards (NSPS) for boilers and turbines every 8 years

Acid Rain, PM_{2.5}, Haze, Toxics

In developing the timeline of current CAA requirements, it was necessary for EPA to make assumptions about rulemakings that have not been completed or, in some case, not even started. EPA's rulemakings will be conducted through the usual notice-and-comment process, and the conclusions may vary from these assumptions.

EIA forecasts over time for 2010

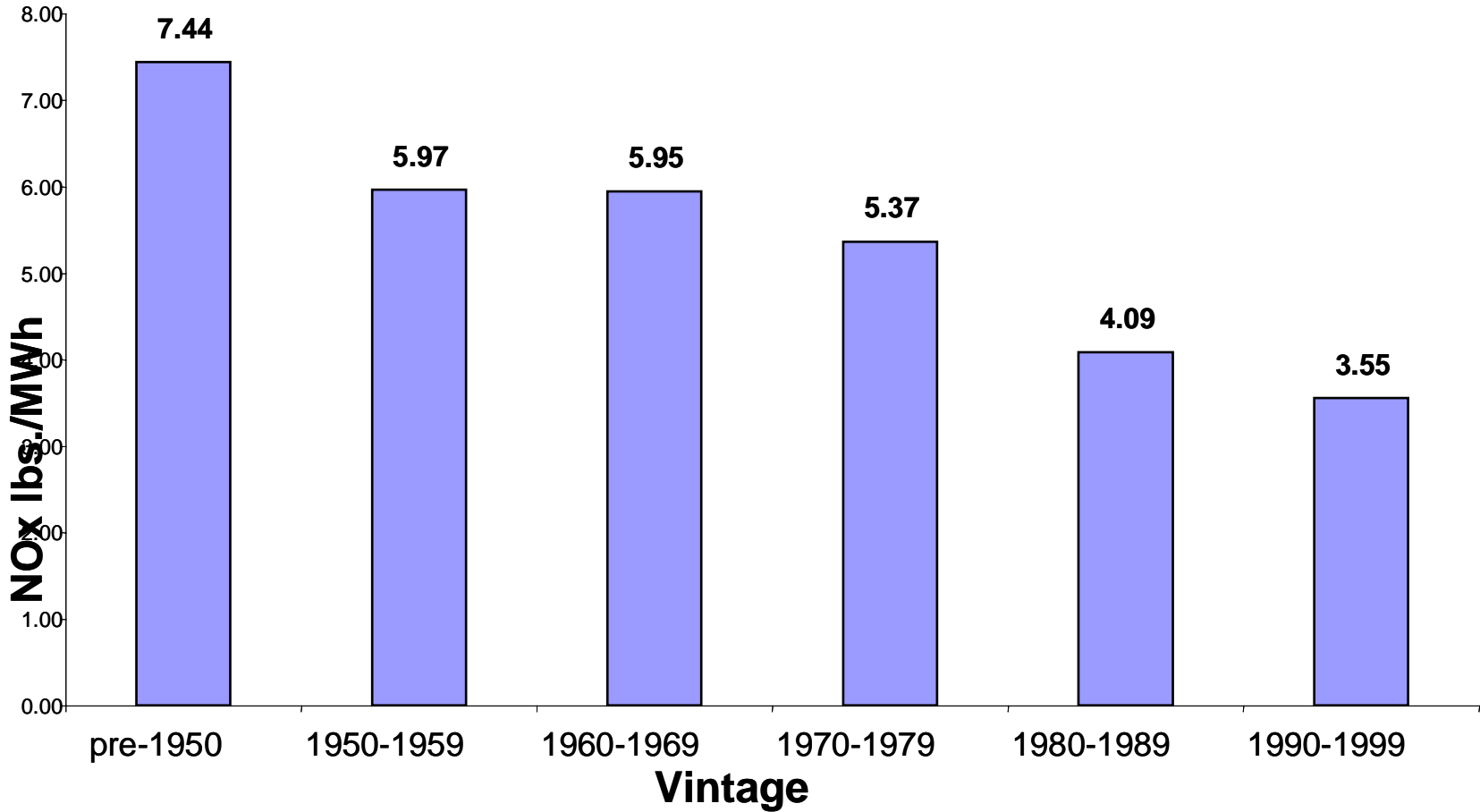


Percent of Total Generation in the Baseline

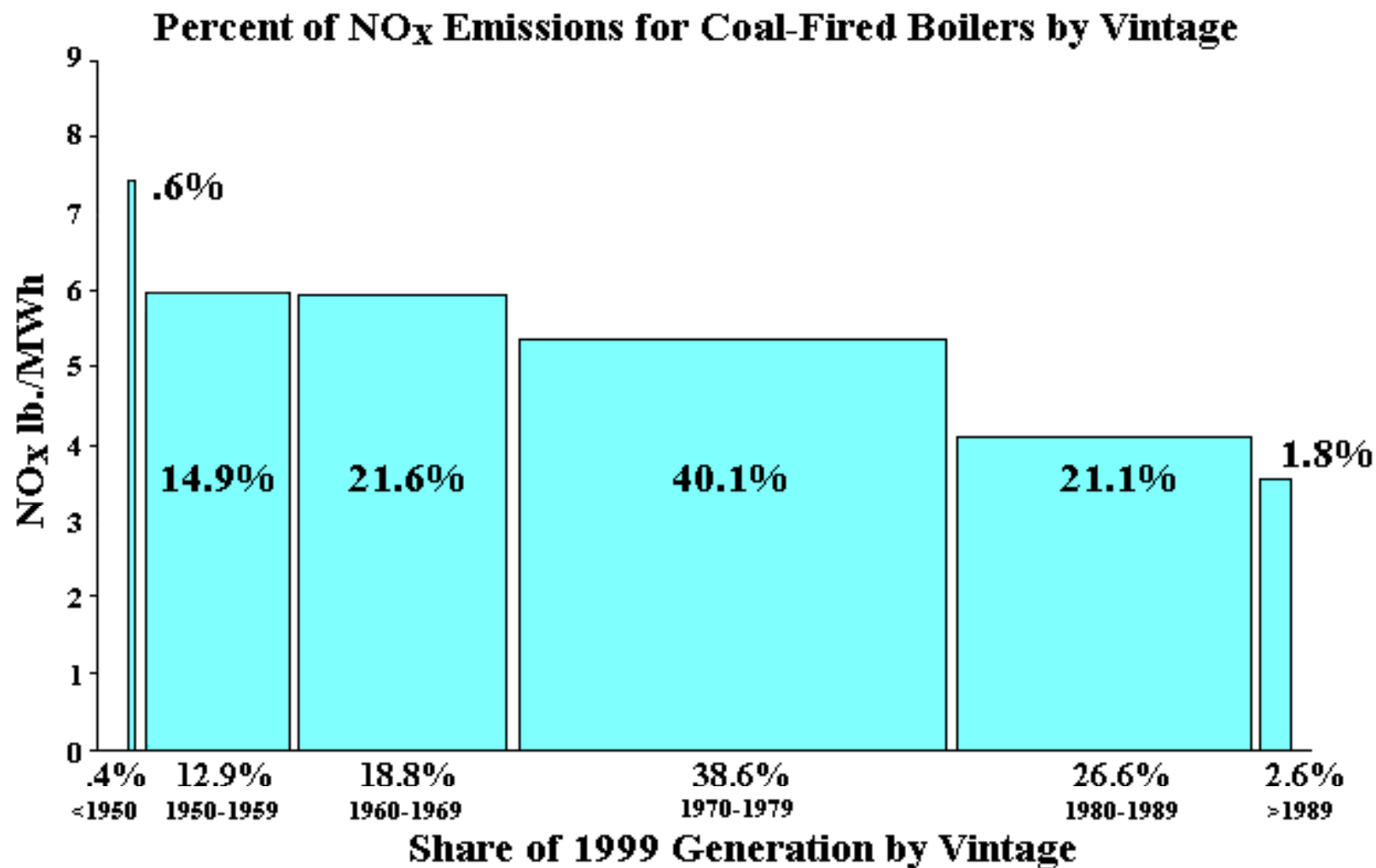
	Coal	Gas
Today	54%	15%
Forecast for 2020	48%	25%
Growth	20%	106%

Old generating units have highest emission rates...

Average NOx Emission Rates for Coal-Fired Boilers by Vintage



But just a small share of emissions



Legislative Comparison of Multipollutant Proposals:
S. 366, S. 485, and S. 843.

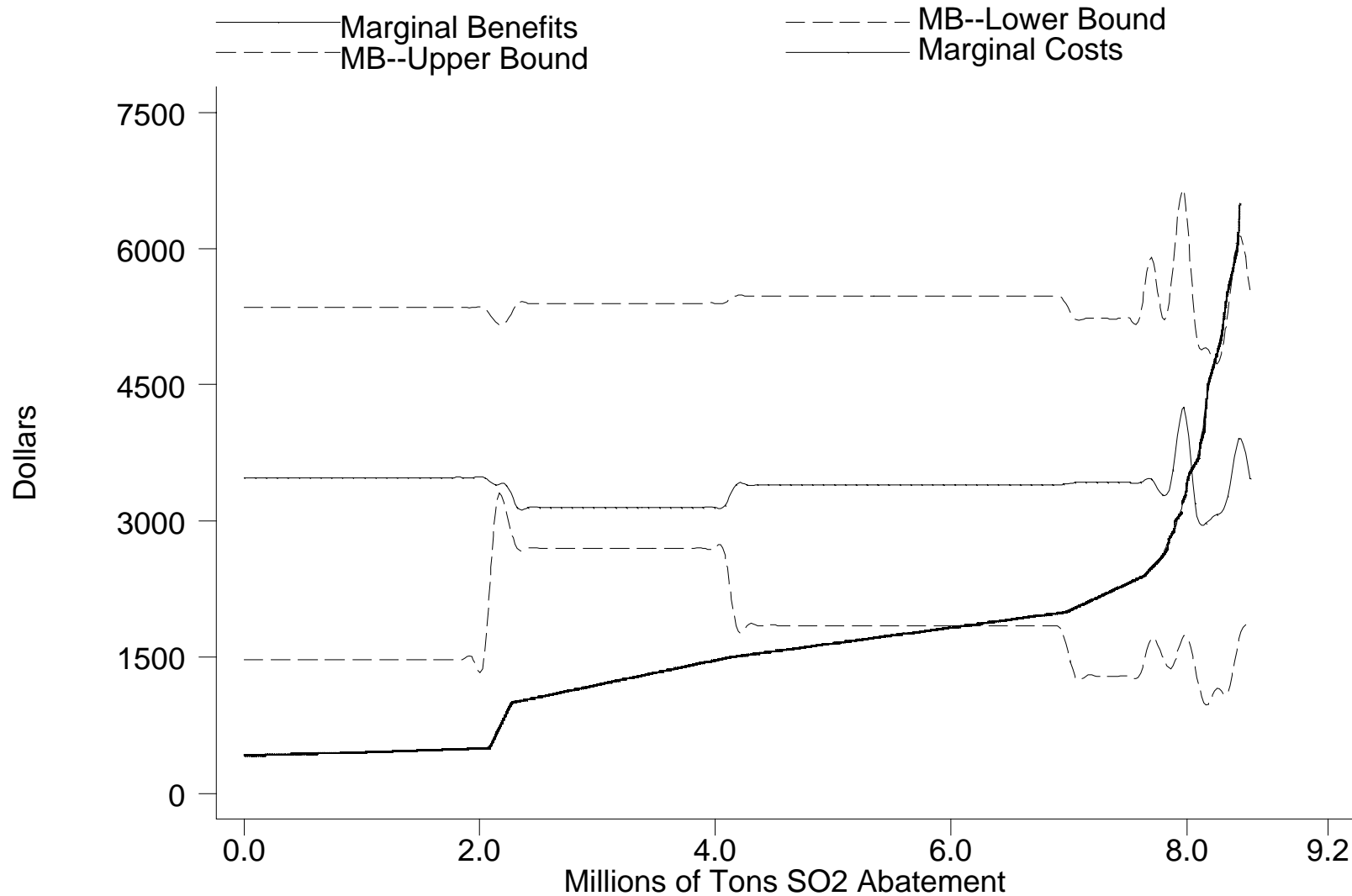
Legislative Proposal	S. 366 Jeffords (108 th)	S. 485 Clear Skies (108 th)	S. 843 Carper (108 th)
National Annual Allowance Allocation Caps			
Sulfur Dioxide (SO₂) Million Tons	2.25 in 2009. Two regions.	4.5 in 2010. 3.0 in 2018.	4.5 in 2008. 3.5 in 2013. 2.25 in 2016.
Nitrogen Oxides (NO_x) Million Tons	1.51 in 2009.	2.1 in 2008. 1.7 in 2018. Two regions.	1.87 in 2009. 1.7 in 2013.
Mercury (Hg) Tons	5 in 2008. Facility specific. Non-tradable.	26 in 2010. 15 in 2018.	24 in 2009. 5 to 16 in 2013. Facility specific.
Carbon Dioxide (CO₂) Billion Tons	2.05 in 2009.	No CO ₂ policy.	2.57+ in 2009. 2.47+ in 2013. + Sequestration increases CO ₂ cap.

Efficient Emission Levels for SO₂ and NO_x

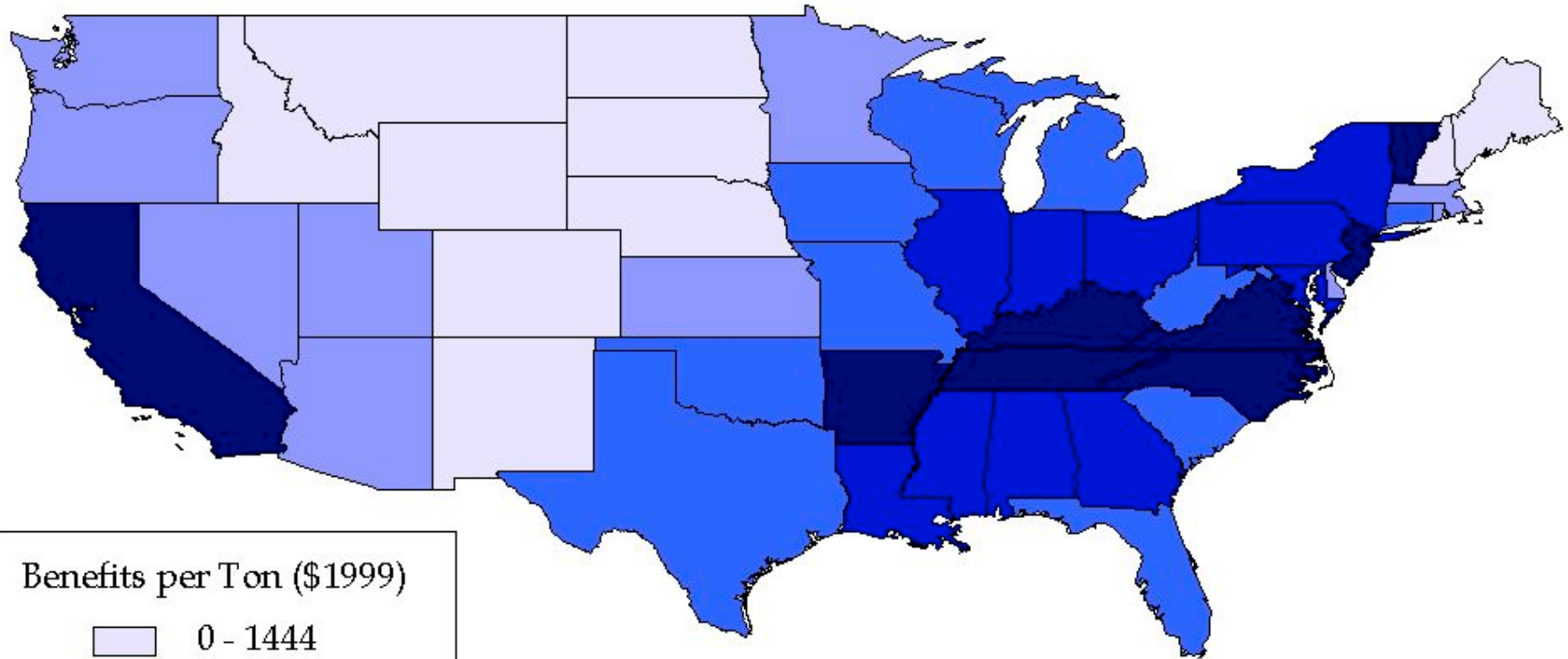
Scenario and Key Assumptions

- PM-health modeled only; no ozone benefits
- Examine SO₂ and NO_x emission fees
- No CO₂ or mercury requirements
- Results for 2010
- Title IV SO₂, SIP Call NO_x baseline
- Pope et al. (1995) for sulfates
- Nitrates as ordinary PM₁₀
- VSL=\$2.25 million (Mrozek and Taylor, 2001)

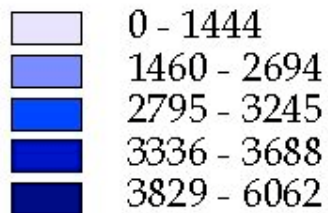
Marginal Benefits and Costs: SO₂



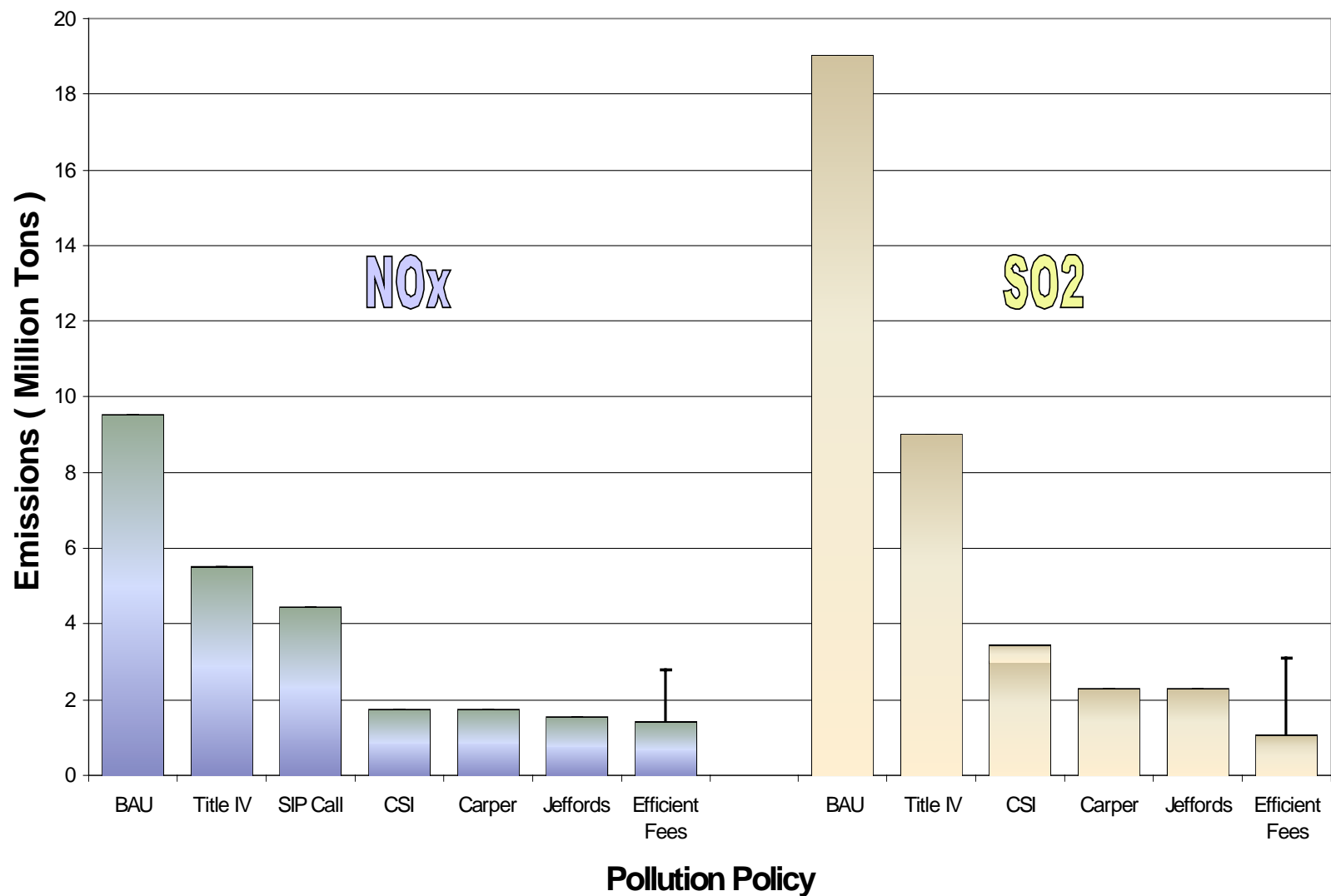
Value of SO₂ Emission Reductions by State



Benefits per Ton (\$1999)



NO_x & SO₂ Electricity Sector Emissions in 2020



Major Research Issues and Uncertainties in Valuation of Health-Related Benefits

Emissions Modeling

- Source apportionment:
Who is to blame (location and types of sources)?

Epidemiology

- Long-term exposures and disease.
- Which particulates matter?

Valuation

- Valuation of children and elderly and other vulnerable groups. Evidence suggests:
 - ✓ Parents value childrens' health $>$ own health.
 - ✓ Seniors value selves $<$ younger adults... But far greater than Life-Year-Lost approach suggests.

Acidification Benefits

- Acidification played a leading role in 1990 Clean Air Act Amendments.
- Thin literature on value of improvements in acid-sensitive ecosystems.
- NAPAP/TAF developed limited estimate of recreation benefits, but value of information assessment suggested nonuse values were more important.

Ongoing Study of Adirondacks

Motivation: Nonuse values are implicitly zero in B/C analysis until a study shows they are larger. Information on the size of values could guide further policy initiatives.

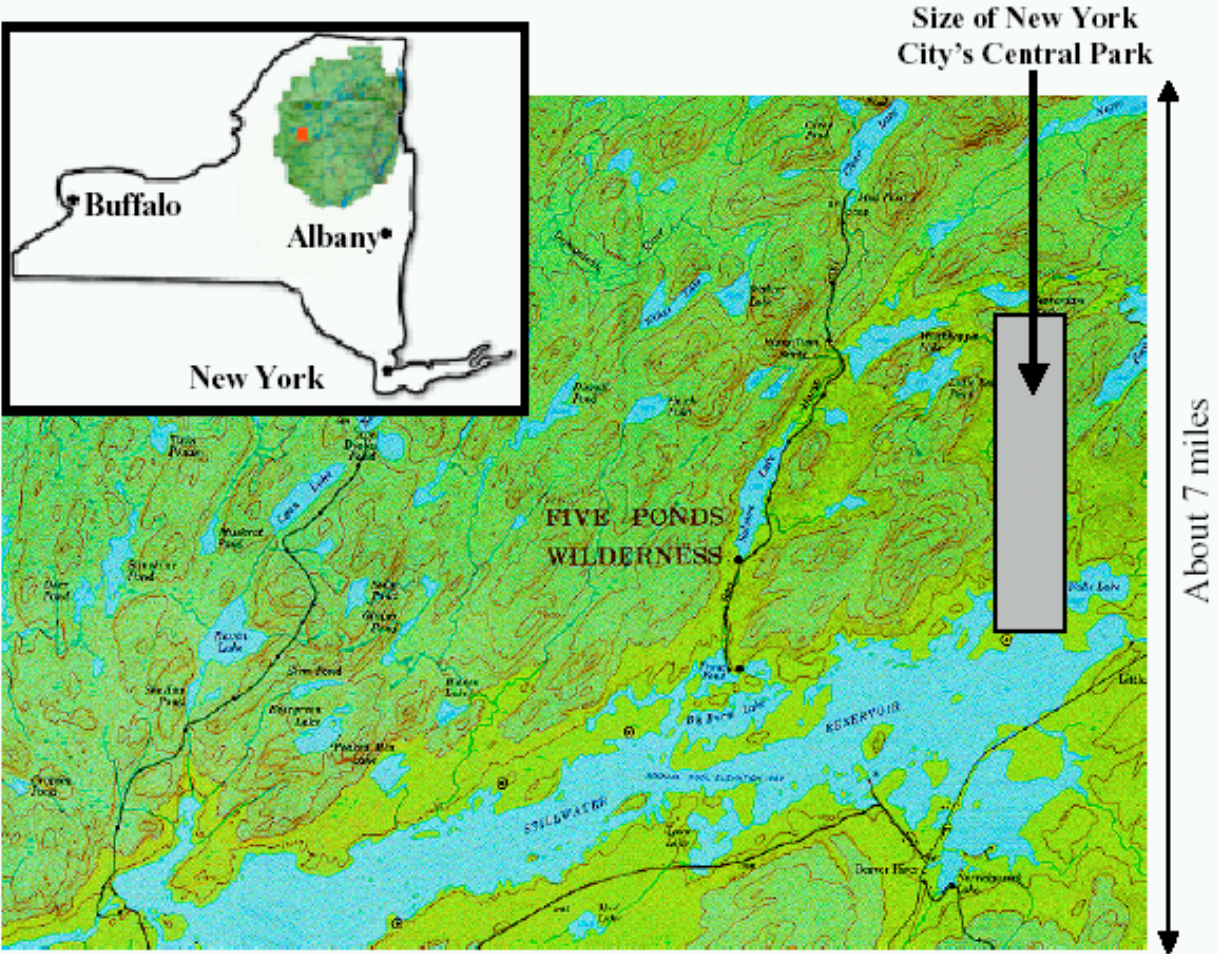
Purpose of Study: Elicit total Willingness to Pay for ecological improvements in the Adirondack State Park region consistent with scenarios for emissions reductions.

Goals:

- Laymen's Summary of the Science Report.
- CVM estimates consistent with the science and state of the art in economics.

Screen Shot Example

This map illustrates one small part of the Adirondack State Park. This part is located where the red dot is on the inset map. Most of the lakes affected by past air pollution are small; they are typically much smaller than Central Park in New York City. The large lakes that you may have heard of (such as Saranac Lake or Lake George) are much bigger than Central Park and are not lakes of concern.



Status

- Numerous focus groups and peer reviewed instrument design.
- Instrument in field currently.
- Mode of administration includes internet and mail. Approximately 2300 responses anticipated.

No results yet... Of responses we can share qualitative result that 44% feel problem is very important, 46% feel problem is somewhat important.

Main Points on Criteria Pollutants

- SO₂ and NO_x caps for all of the proposals appear justified... there is room for more SO₂ reductions; NO_x reductions about right.
 - Efficient SO₂ fee (\$4,700 - \$1,800 per ton) would yield 0.9 – 3.1 million tons.
 - Efficient NO_x fee (\$1,200 - \$700 per ton) would yield 1.0 – 2.8 million tons.
- Evidence supporting regional caps.
- Ancillary CO₂ reductions.

Benefits of Reducing Mercury Emissions

- Estimates linking health benefits to mercury emission reductions are needed.
- One study used Chesapeake Bay angler population to account for:
 - Change in averting behavior among anglers under fish consumption advisory implies a change in mercury exposure.
 - Commercial market behavior.
 - Using epidemiological and economic literature, estimate changes in health endpoints and value where possible.

Paul Jakus, Meghan McGuinness, and Alan Krupnick, 2002

Results

- Health benefits of Fish Consumption Advisories: \$0-\$13-\$71million
 - Utility loss to recreation from FCA: \$9 million
 - Commercial fisheries loss: \$0.5 million
- ⇒ These results apply to a narrow population. General results for benefit-cost analysis are still needed.

Mercury

Target:

What does benefit literature say?

MACT~7.4 tons/yr to Ancillary~28 tons/yr

(current levels in coal burned for electricity: ~75 tons/yr)

Design:

Trading enables tougher goals. Perhaps with...

- Maximum emission rate constraint

(not minimum emission rate reduction), and

- State opt out of trading for local protection

Key Ingredients to Multipollutant Policy

- **SO₂ and NO_x caps** are justified on benefit-cost.
- **Mercury trading**, with constraints, can lower costs; benefits not well quantified.
- Architecture is very important for **carbon** policy.
 - ✓ Start soon rather than start large.
 - ✓ Auction is **less costly** to society, and preserves **asset values** better than output-based allocation.
 - ✓ The auction institution is **expandable** beyond electricity.
 - ✓ A hybrid allocation approach to balance **compensation** and **efficiency**.