Experience with Acid Rain and NOx Budget Programs

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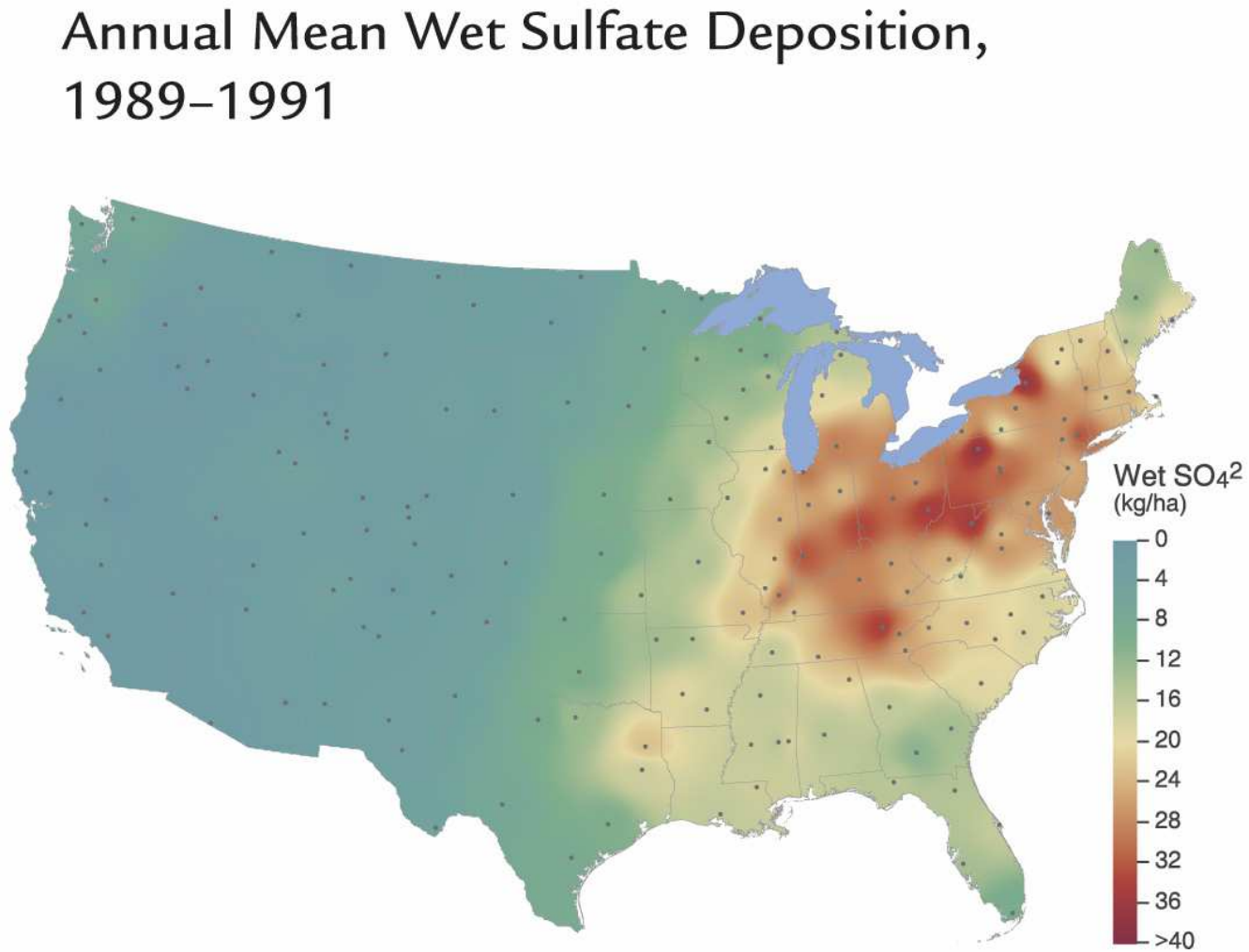
Overview

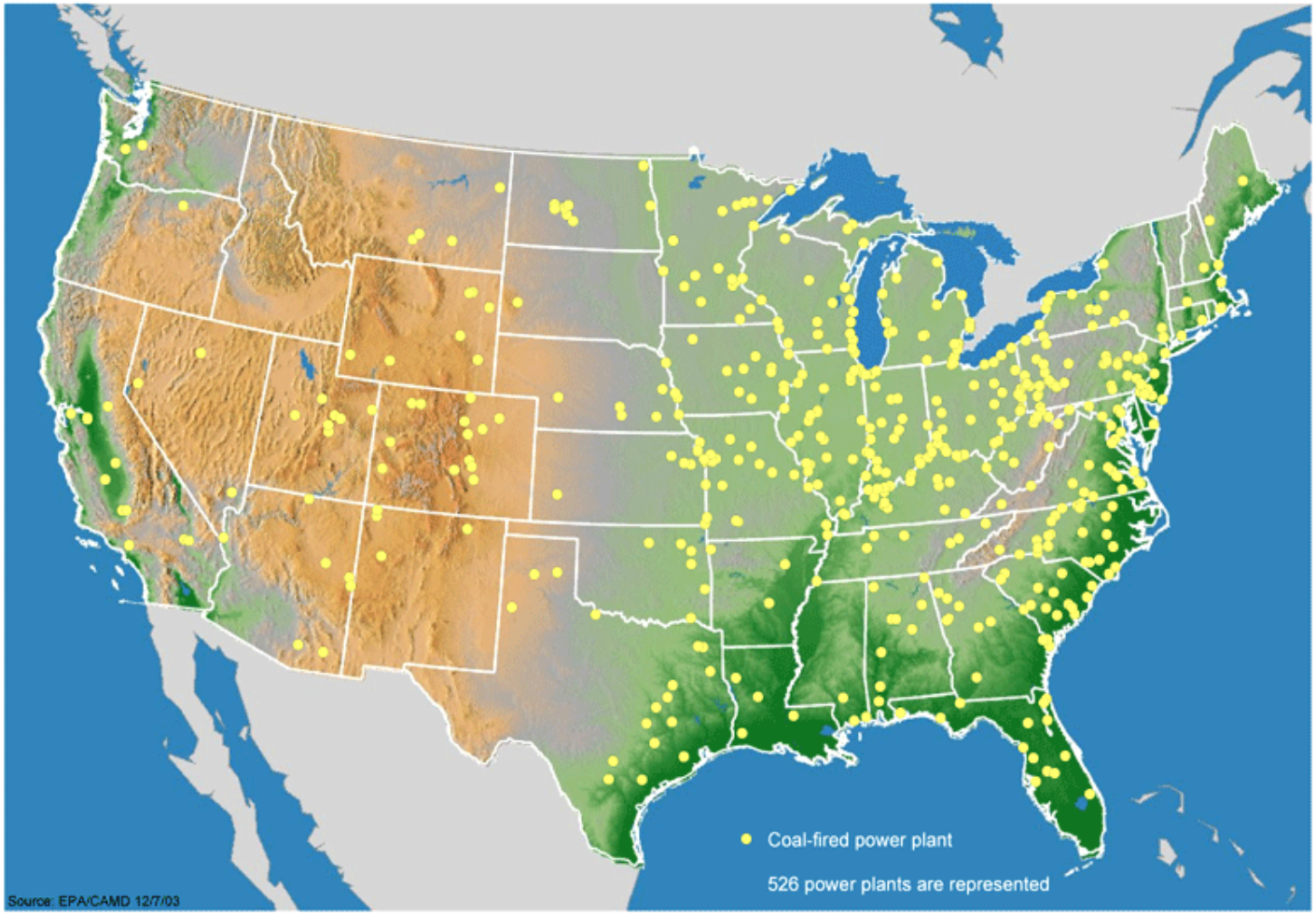
- Acid Rain, SO_2 Trading Program
  - Problem
  - Program
  - Results
- Ozone, NOx Budget Program
  - Problem
  - Program
  - Results
- Lessons Learned

Addressing Acid Rain



Source: National Atmospheric Deposition Program

Coal-Fired Power Plants Are the Dominant Source of Air Emissions



U.S. Coal-Fired Power Plants

- There are about 530 power plants with 305 GW of capacity that consists of about 1,300 units.
- Coal plants generate the vast majority of power sector emissions:
  - 95% SO_2
  - 90% of NO_x
  - 83% of CO_2

Traditional Regulation

- Reduced emissions significantly
- Typically a technology or rate based method with limited monitoring
- Very effective in many situations
- Established what needed to be done
- Prescribed how and when each source was to do it

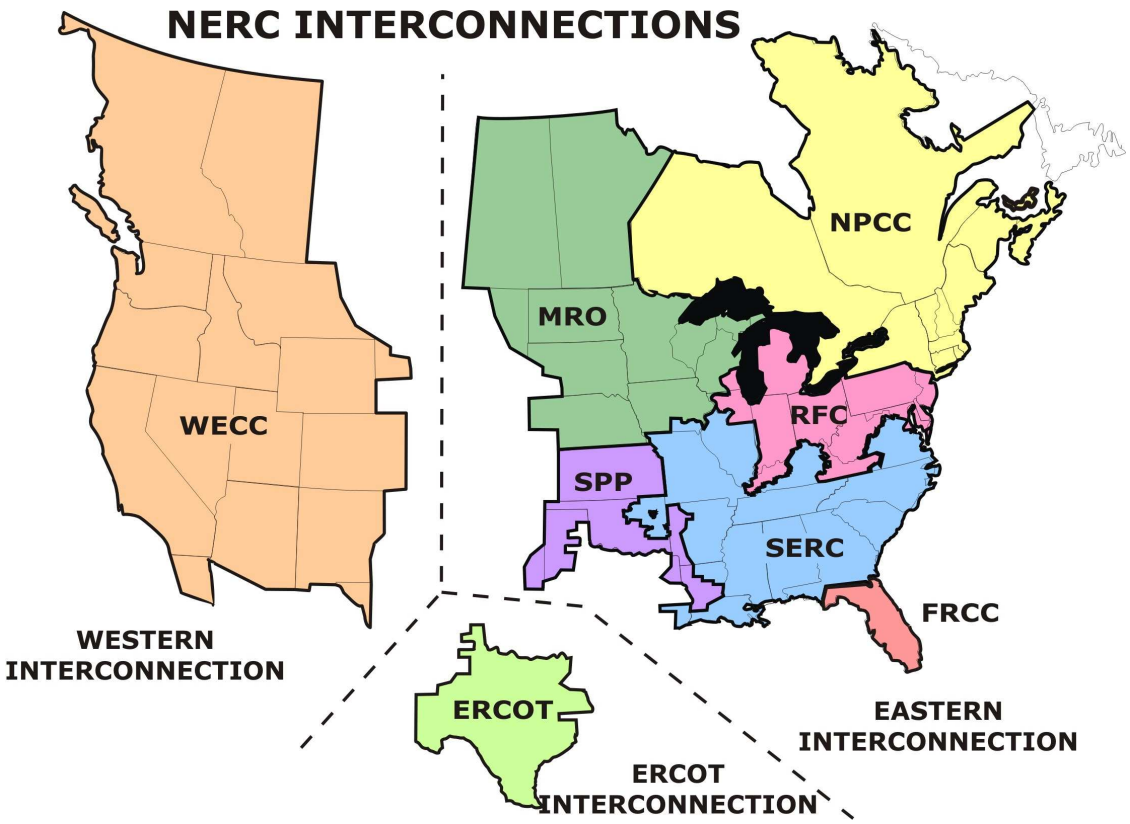
Bubbles, Offsets, and Credits

- Assumed command and control infrastructure
- Provided some flexibility in how a source could comply, i.e., by getting reductions from another source
- Required government approval to prevent:
  - "Paper Credits"
  - "Anyway Tons"
  - Unacceptable air quality impacts

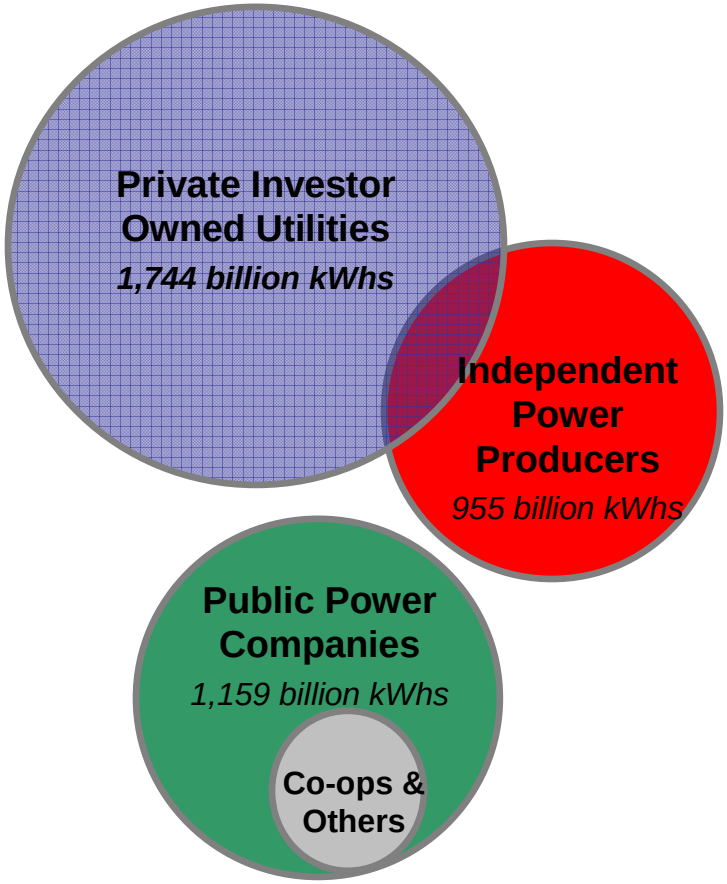
New Approach: Cap and Trade

- An alternative to traditional regulation and credit trading
  - Not simply a trading feature added to existing regulation
- An incentive for innovation, early reductions, and reducing cost
- Certainty that a specific emissions level is achieved and maintained
- More regulatory certainty, compliance flexibility, and lower permitting and transaction costs for sources
- Fewer administrative resources needed by industry and government (if kept simple)
  - Government focused on setting goals & assuring results, not on approving individual compliance actions
- Can be compatible with other mechanisms
- Lower costs make further improvements feasible

Power Sector: Electricity Grid & Ownership



Industry Ownership



Setting the Cap and Allocating Allowances: Acid Rain Program

- Legislation established
  - cap level
  - timing of reductions
  - allocations
- Allocation was not addressed until the cap was agreed upon
- Requests for additional allowances had to be balanced against losses of allowances

Distributing Allowances

- Considerations: Equity, environmental incentives, efficiency
- Recognition that vast majority of allocation approaches that EPA has considered all lead to the same level and distribution of emission reductions: the emission caps and banking drive reductions.
- Many ways, none are perfect:
  - Auction
  - Direct allocation to sources based on historical and/or current emissions, energy use (input), or production (output, e.g. MWH)
    - Set asides (new sources, renewables, demand side efficiency)
  - Hybrid
- Allowance allocation should balance need for certainty and allow for changing circumstances
  - EPA programs have allocations for several years into the future

SO_2 Allowance Allocations

- Phase I: 1995 - 1999
  - Limits 263 highest emitting sources

$$\frac{2.5 \text{ pounds}}{\text{mmBtu}} \times \text{Average Heat Input (1985-1987)}$$

- Phase II: 2000 -
  - Limits all combustion units with electricity generators greater than 25 MW

$$\frac{1.2 \text{ pounds}}{\text{mmBtu}} \times \text{Average Heat Input (1985-1987)}$$

  - Over 20 situation-specific formulas

SO_2 Allowance Allocations (cont.)

- New sources receive no allocation but must comply with program
- Clean plants and high growth states received additional allowances
- Government auctions 2.8% of allowances
- Government may sell allowances from within cap at price significantly higher than expected costs
- Government provides “set asides” to reward specific behavior (e.g., renewables)

Emissions Measurement Goals

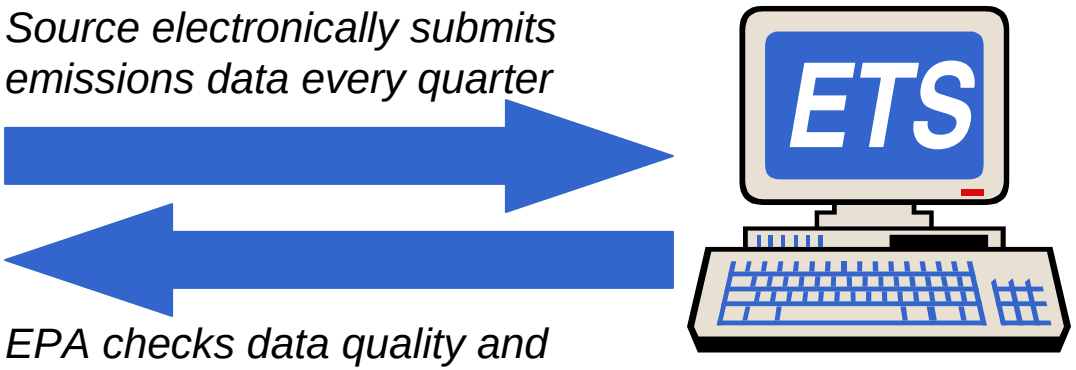
- Complete accounting with no underestimation
- Simplicity, consistency and transparency
- Incentives for accuracy and improvement
- Cost effectiveness
- Flexibility for small sources
  - 36% of units must use Continuous Emissions Monitors (CEMS)
  - Accounts for 96% of total SO2 emissions
- Electronic reporting, feedback, and auditing
- Public access to data

Quality Assurance and Verification by EPA

- Certification of emissions monitoring systems
- Stringent daily, quarterly and annual QA checks and tests
- Conservative data substitution for missing data
  - Provides incentive for monitoring
  - Monitors running over 99% of the time
- Near 100% electronic auditing of emissions data
- Random on-site field audits and witnessing of QA tests

Electronic Reporting and Feedback

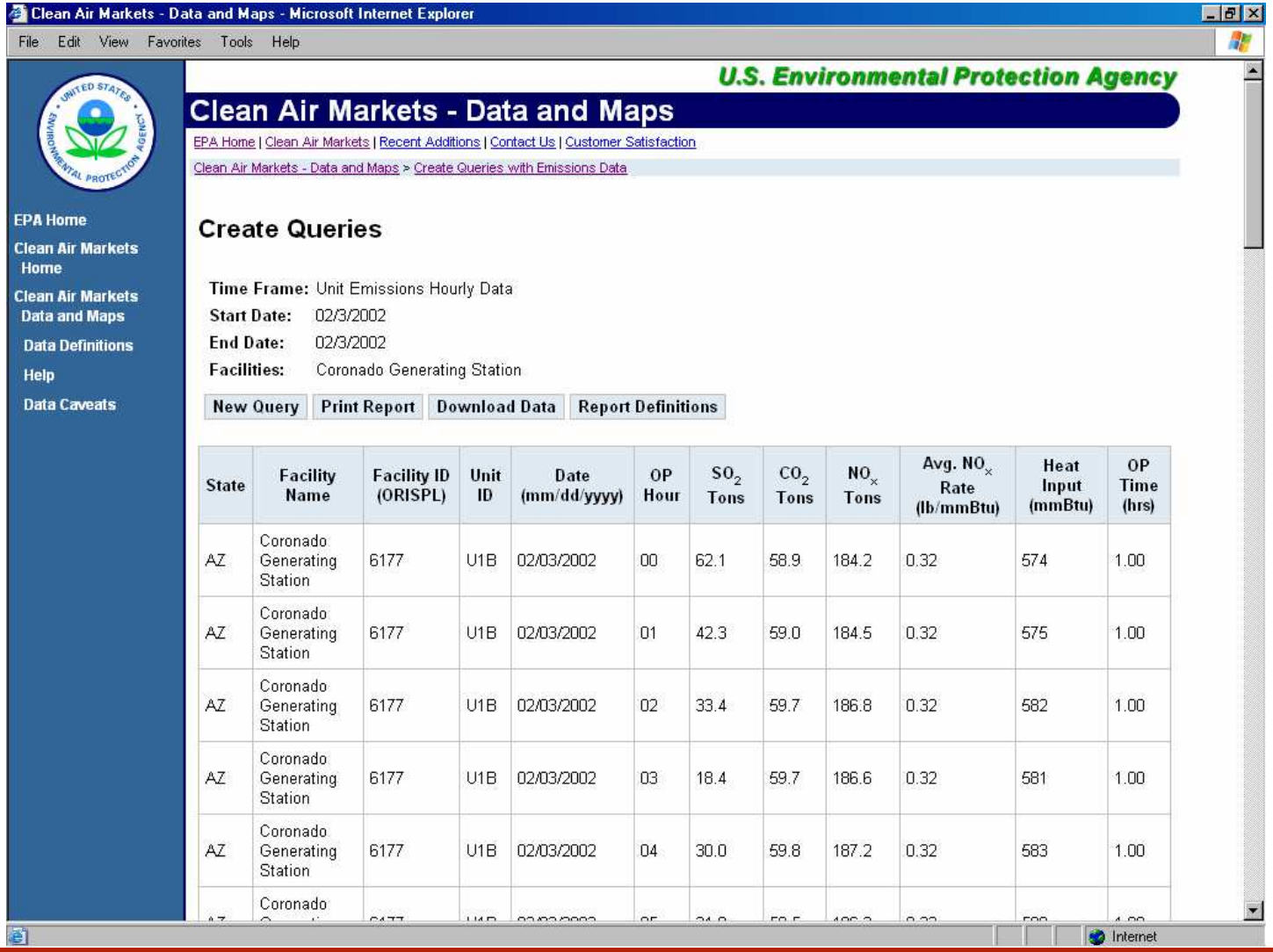
Source electronically submits emissions data every quarter



EPA checks data quality and provides automated feedback to source

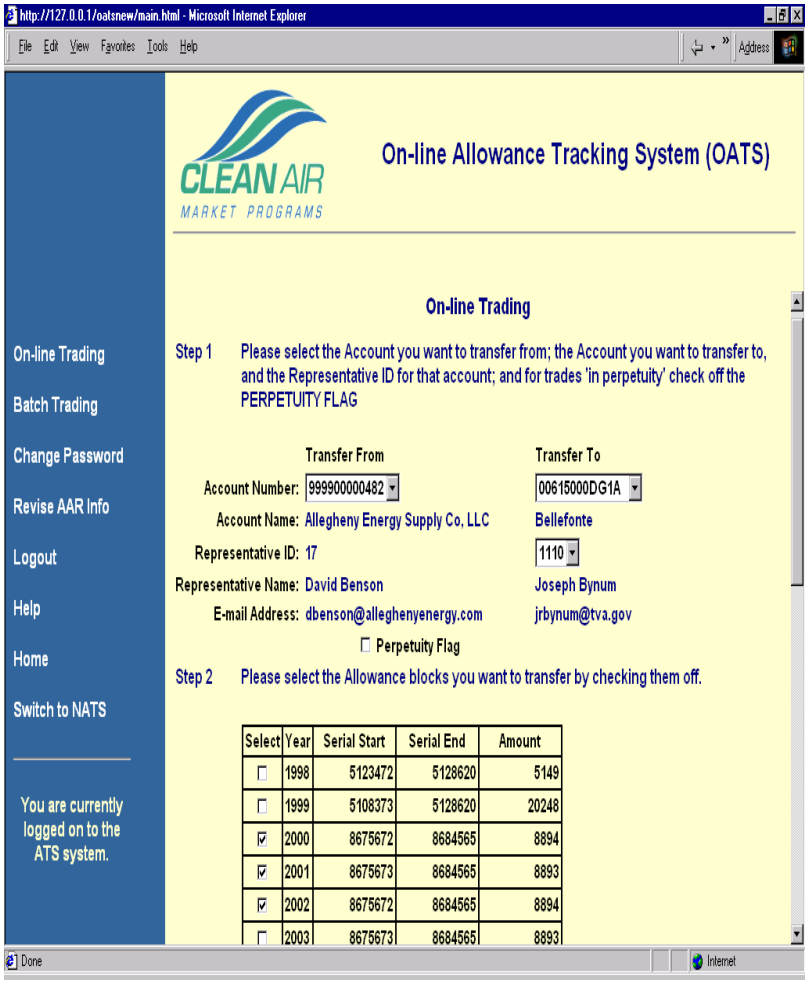
	Reporting Period or Quarterly	Cumulative Annual or Cumulative Ozone Season	EPA Accepted
SO2	2633.4	5629.1	2633.4
CO2	230774.0	601228.0	230774.0
Heat Input	2249279.0	5013635.0	2249279.0
NOx Rate	0.3	0.3	0.3

Public Access to Hourly Emissions Data



State	Facility Name	Facility ID (ORISPL)	Unit ID	Date (mm/dd/yyyy)	OP Hour	SO_2 Tons	CO_2 Tons	NO_x Tons	Avg. NO_x Rate (lb/mmBtu)	Heat Input (mmBtu)	OP Time (hrs)
AZ	Coronado Generating Station	6177	U1B	02/03/2002	00	62.1	58.9	184.2	0.32	574	1.00
AZ	Coronado Generating Station	6177	U1B	02/03/2002	01	42.3	59.0	184.5	0.32	575	1.00
AZ	Coronado Generating Station	6177	U1B	02/03/2002	02	33.4	59.7	186.8	0.32	582	1.00
AZ	Coronado Generating Station	6177	U1B	02/03/2002	03	18.4	59.7	186.6	0.32	581	1.00
AZ	Coronado Generating Station	6177	U1B	02/03/2002	04	30.0	59.8	187.2	0.32	583	1.00
AZ	Coronado										

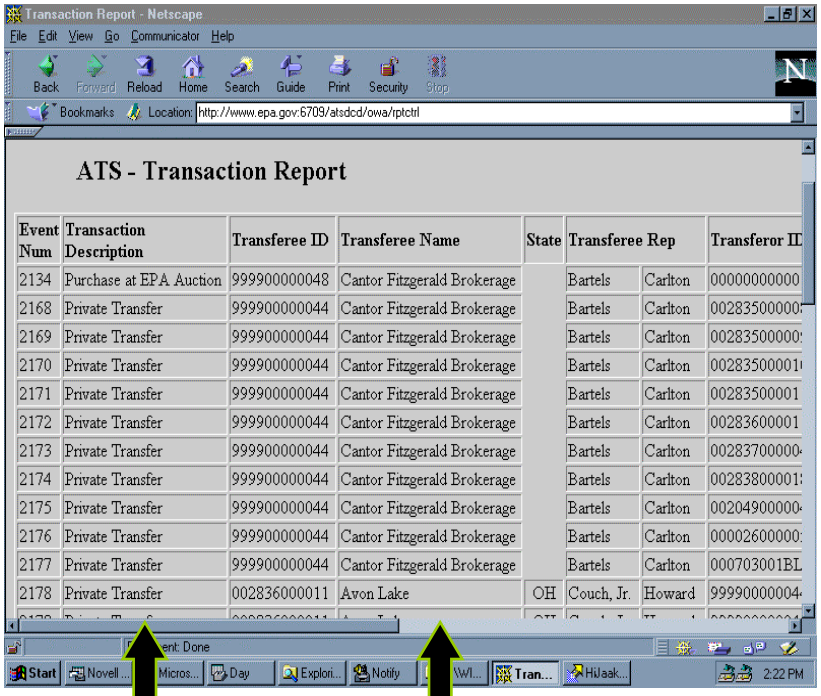
Allowance Registry

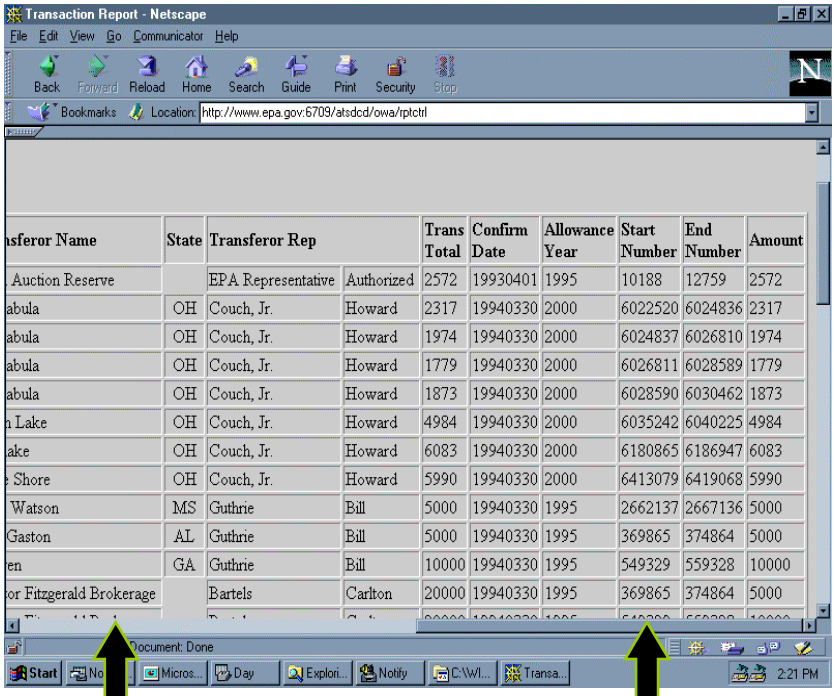


- Official record of allowance transfers
- Each allowance has a serial number
- Parties reach agreement, then authorise EPA to transfer allowances or transfer online
- Registry is not a trading platform

Public Access to Allowance Data

Internet query capability





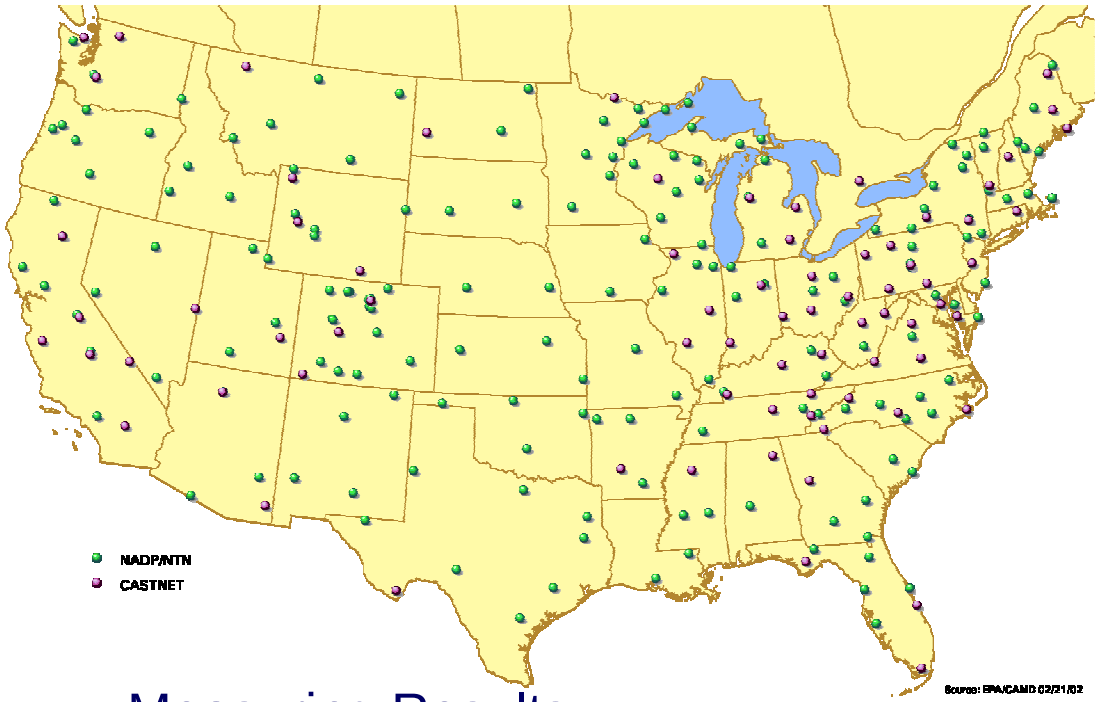
Type of transfer (auction, private)

Buyer name and account info

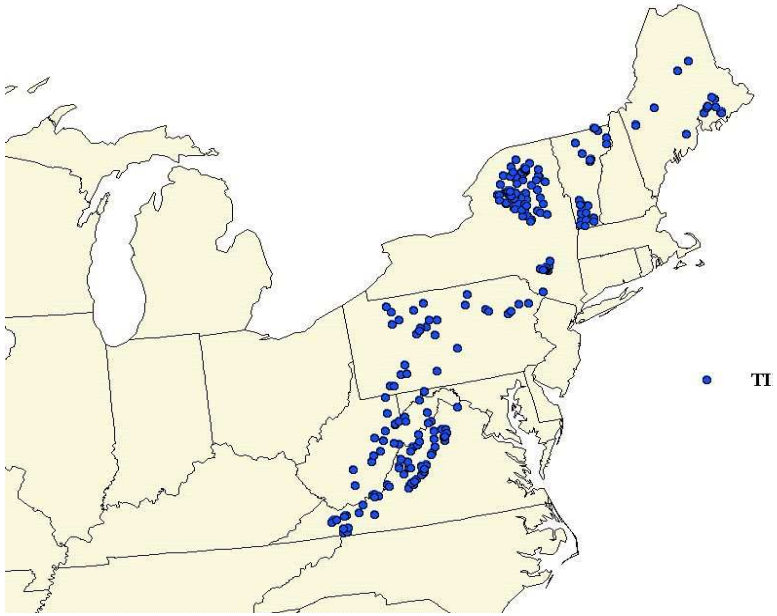
Seller name and account info

Confirmation date, serial numbers and total allowances transferred

Environmental Accountability

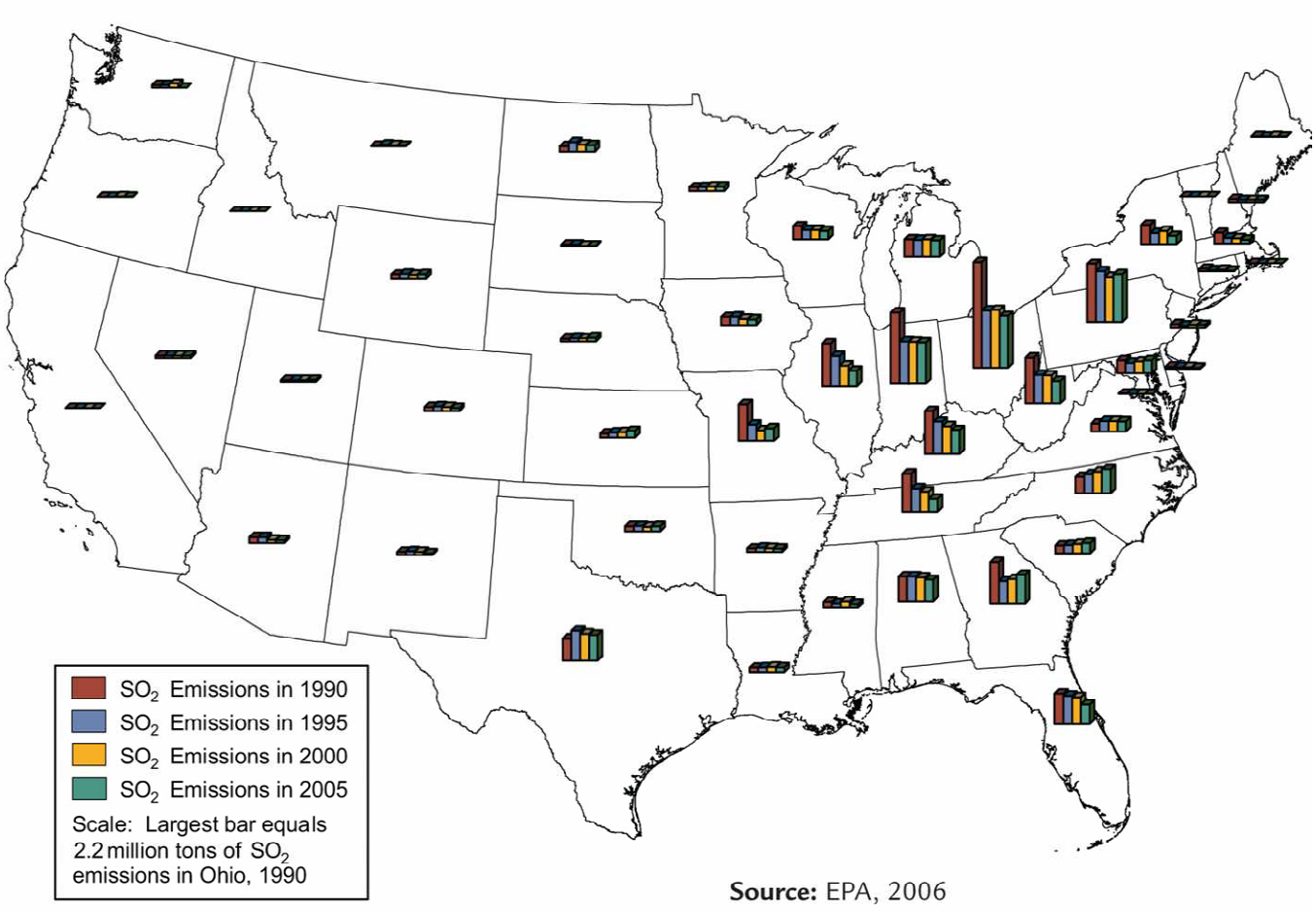


TIME/LTM
(Surface Water Monitoring)



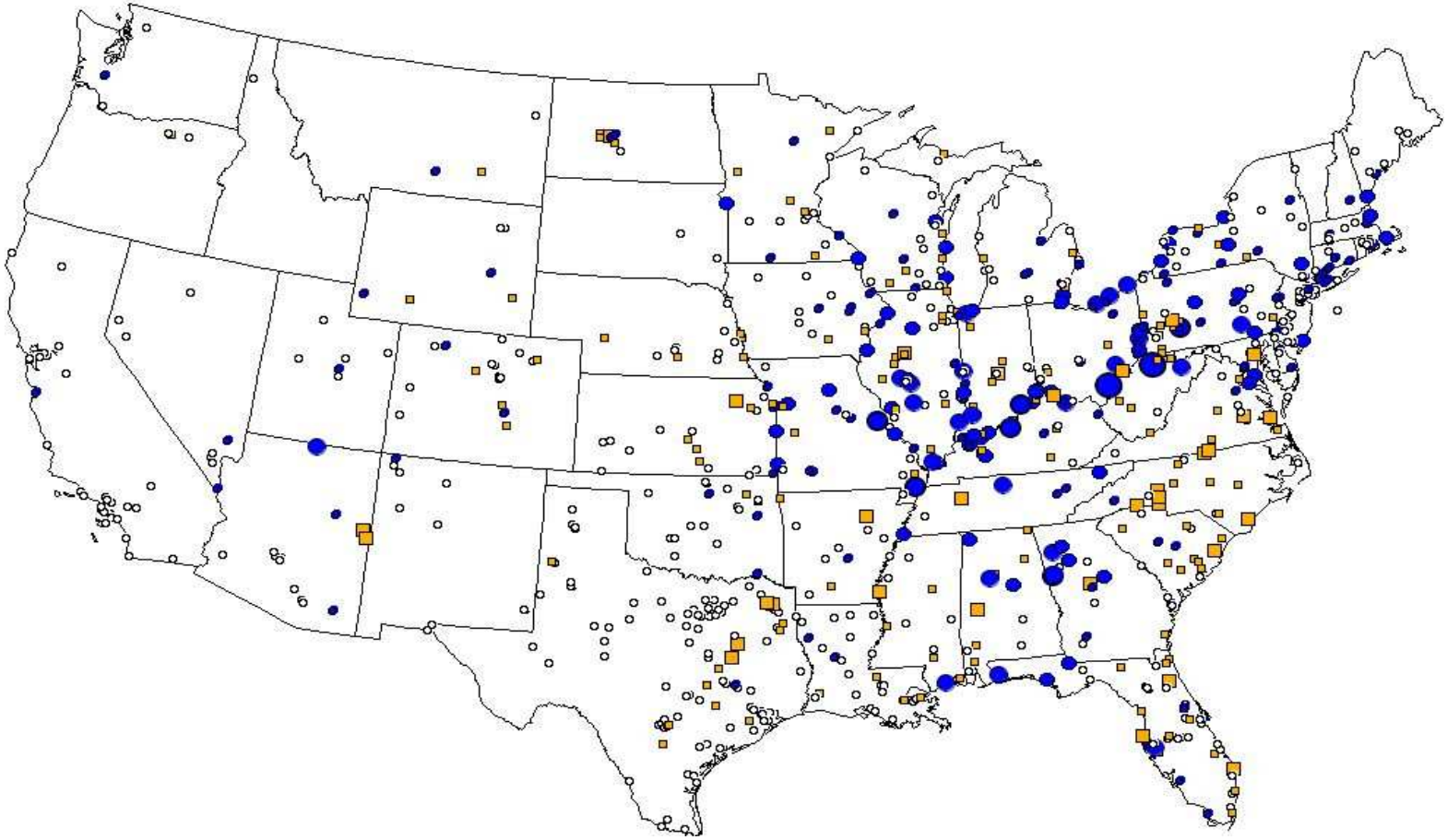
- Measuring Results
  - Changes to deposition and water quality
- Comparing to Goals
  - Are additional actions needed?

State by State SO_2 Emission Levels



Spatial Distribution of Emission Changes

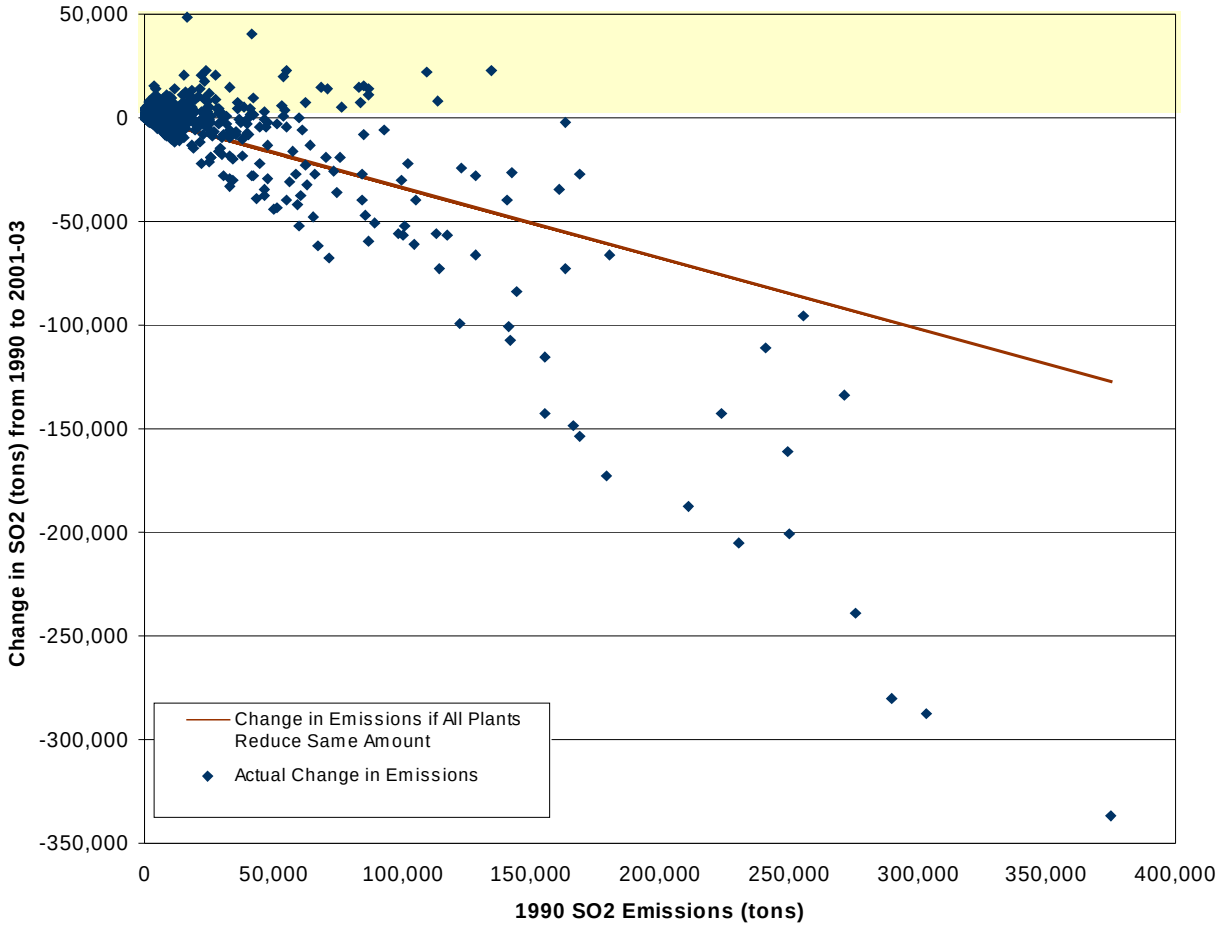
SO2 Emissions Changes Between 1990 and 2001-03 (Acid Rain Sources)



- Blue circles: sources that reduced emissions more than 1,000 tons.
- Orange squares: sources that increased emissions more than 1,000 tons.
- Size of symbols proportional to magnitude of change in emissions.
- Hollow circles: emissions did not change more than 1,000 tons.

Largest Reductions Occurred at Plants with Highest 1990 Emissions

Plant-Level 1990 SO2 Emissions and SO2 Emissions Changes by 2001-03

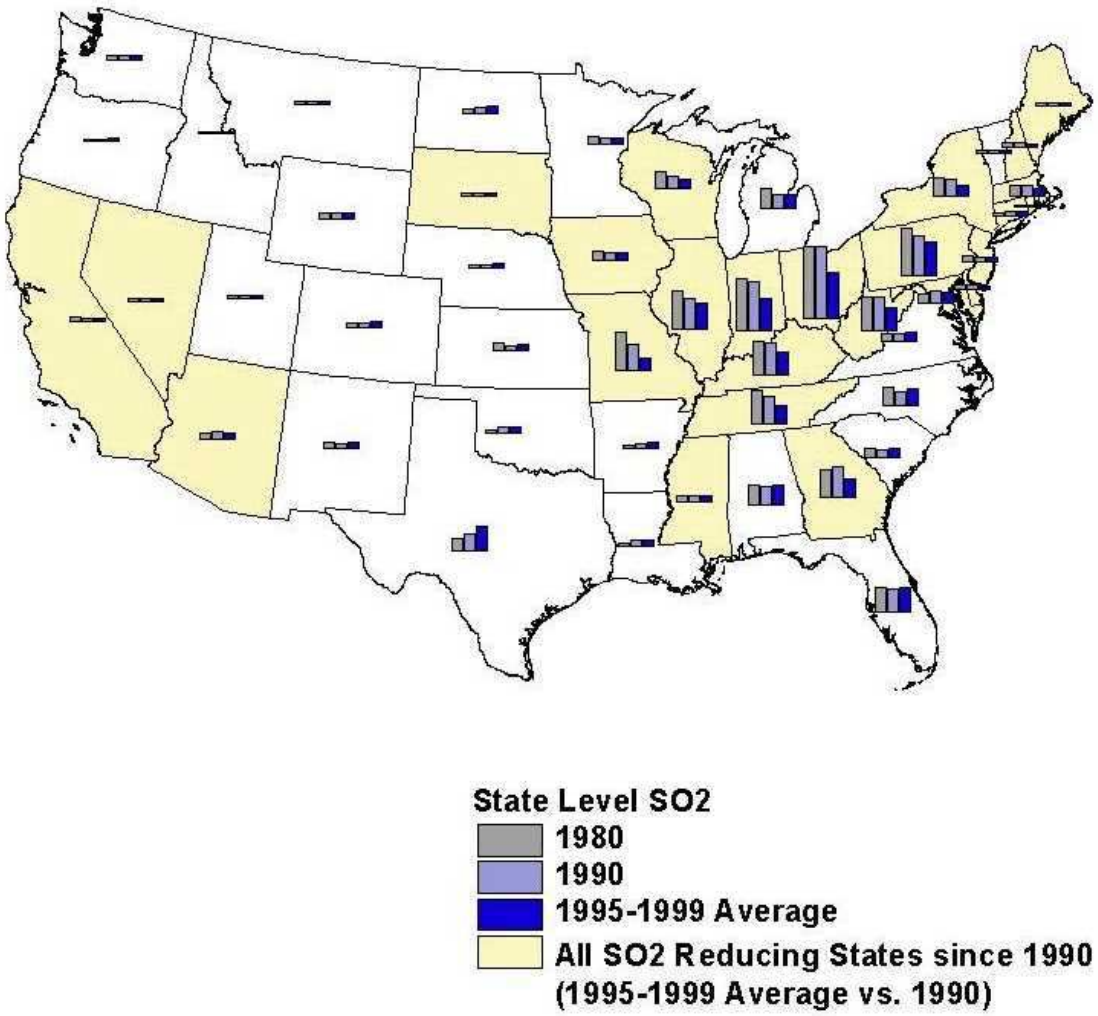


- Decreases tended to be large, while increases tended to be small (and smaller plants)
- 353 facilities decreased emissions by 6.5 million tons
- 274 facilities increased by 1.2 million tons).*

* This only includes facilities with emissions in 1990. It does not include new sources or sources that did not operate in 1990.

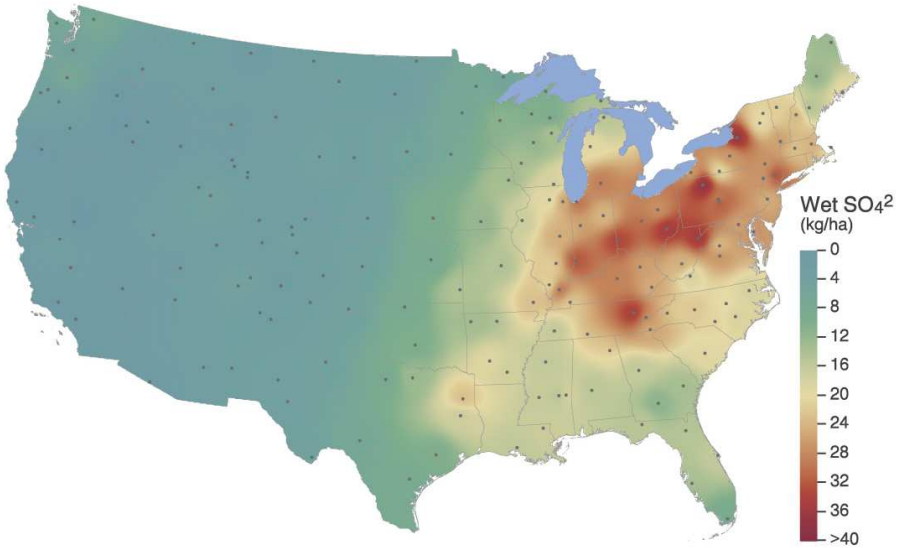
Spatial Issues (hotspots)

- Greatest reductions in States with highest emissions
- Independent analyses (i.e., ELI, RFF, and EDF) have found that trading under the Acid Rain Program has not created hot spots
- States and localities have authority to address local air quality problems (including setting facility permit levels that would preclude use of allowances)



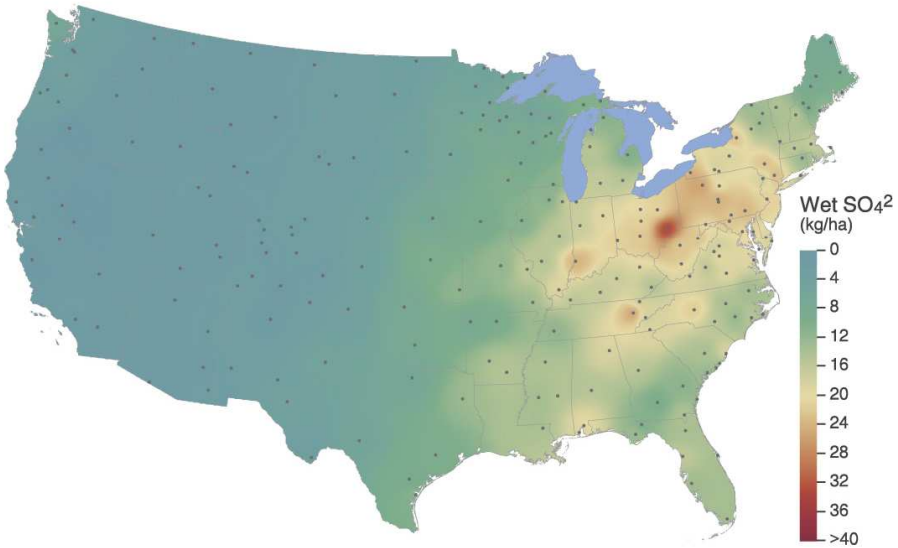
Acid Rain Program Progress

Annual Mean Wet Sulfate Deposition, 1989–1991



Source: National Atmospheric Deposition Program

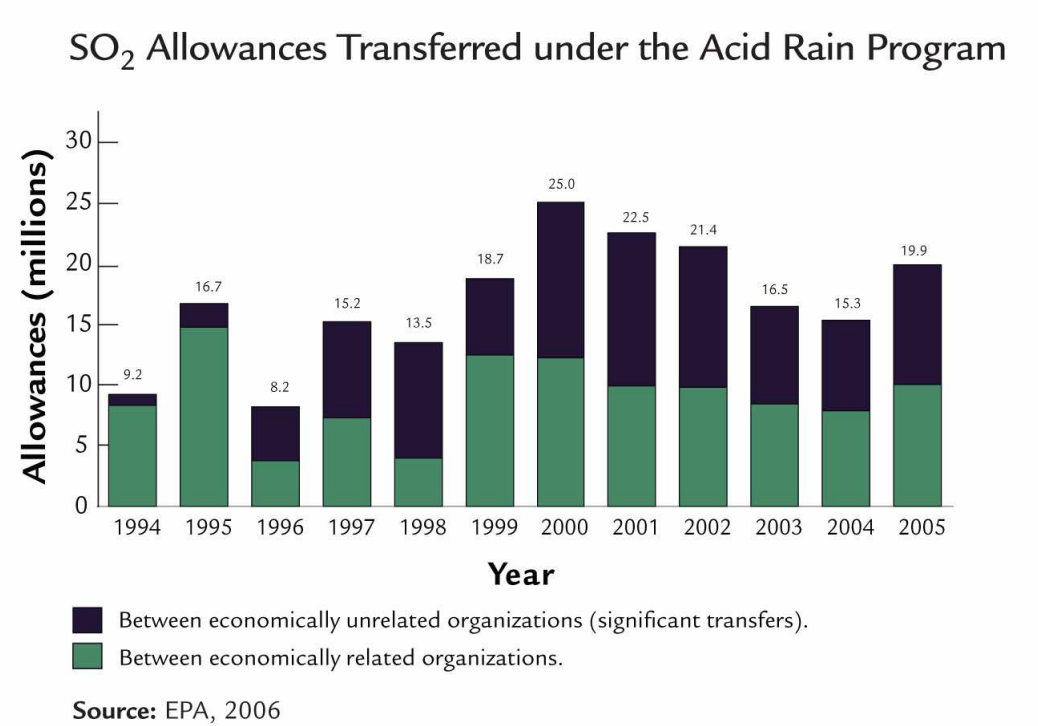
Annual Mean Wet Sulfate Deposition, 2003–2005



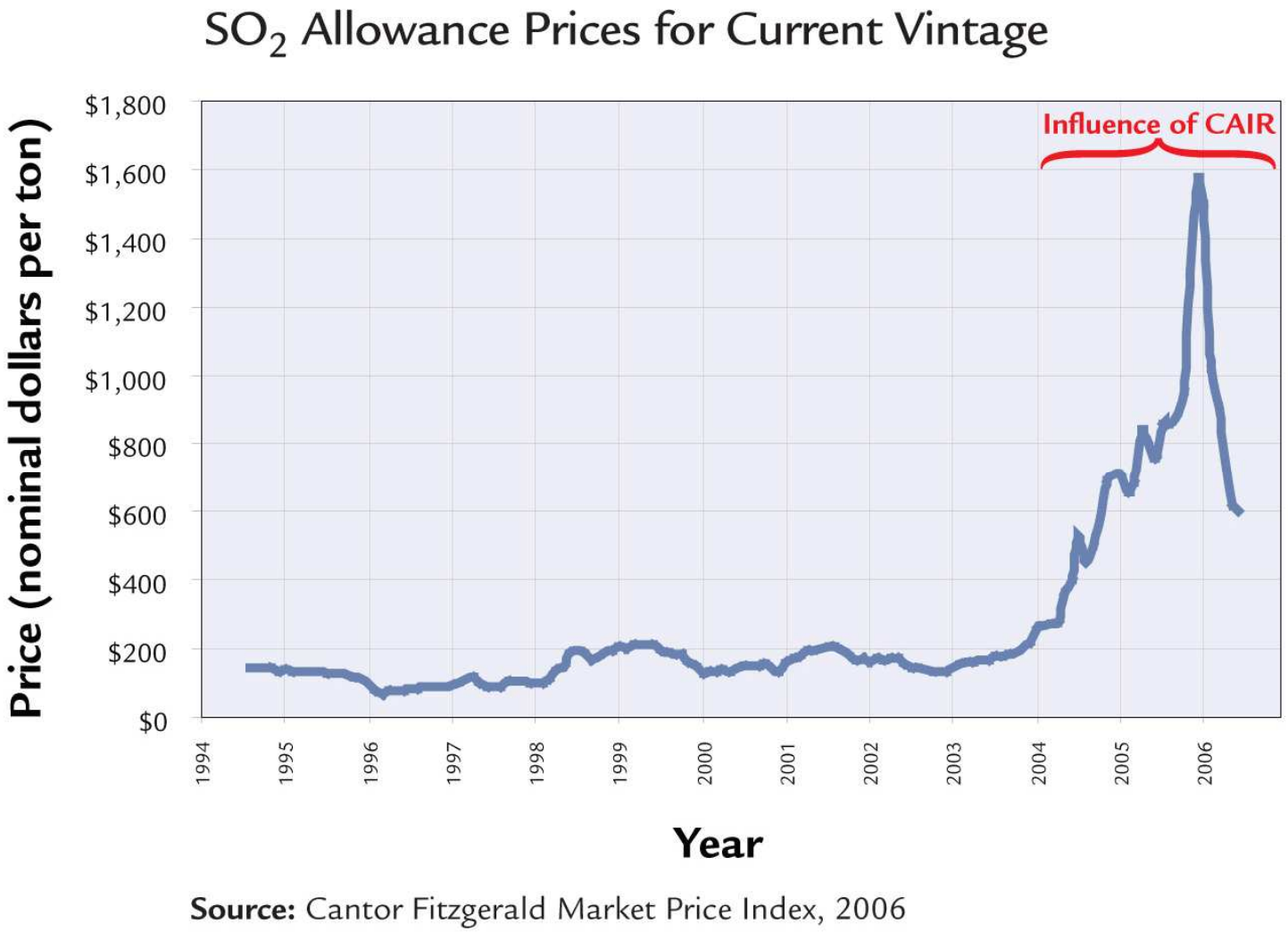
Source: National Atmospheric Deposition Program

Active Allowance Market

- Over 222 million allowances transferred and over 43 thousand transactions since 1994
- Approximately 45% of transfers are arms length trades
- Over 98% of transfers are handled online
- Low transaction costs

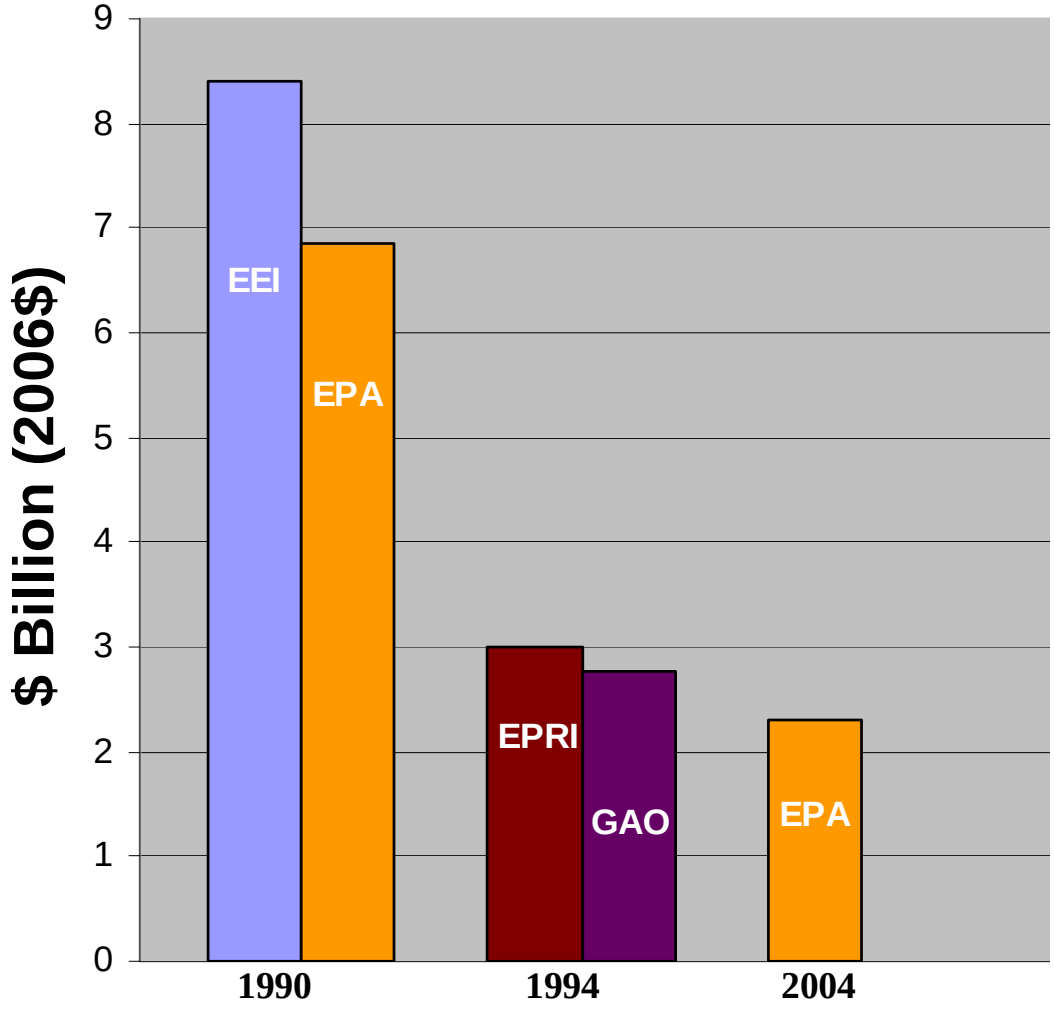


SO_2 Allowance Prices



Source: Cantor Fitzgerald Market Price Index, 2006

Acid Rain SO_2 Program Costs: Much Lower than Originally Predicted



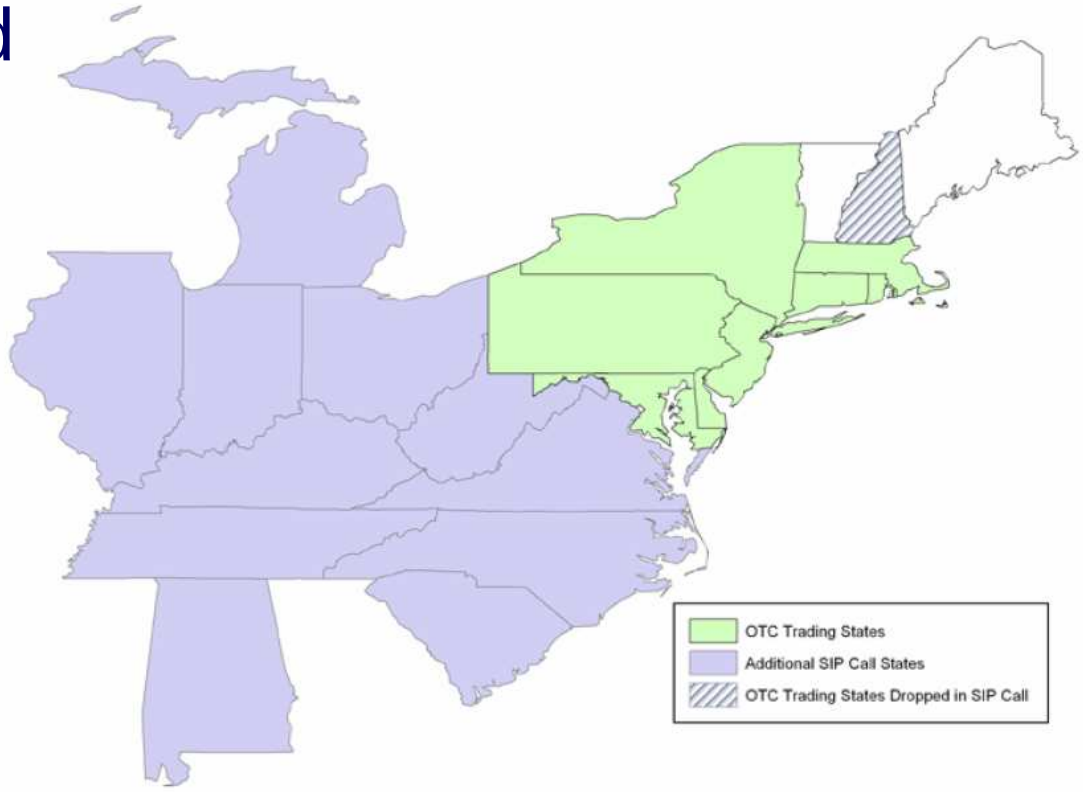
Source: EPA, 2006

NOx Trading Budget Trading Program: Addressing Ozone Transport

- Short term concentrations rather than total loadings
- Local + transport component
  - States could not address transport issue by themselves
- More diverse set of sources than SO_2
  - Power generation 30%
  - Industry 20%
  - Vehicles 50%

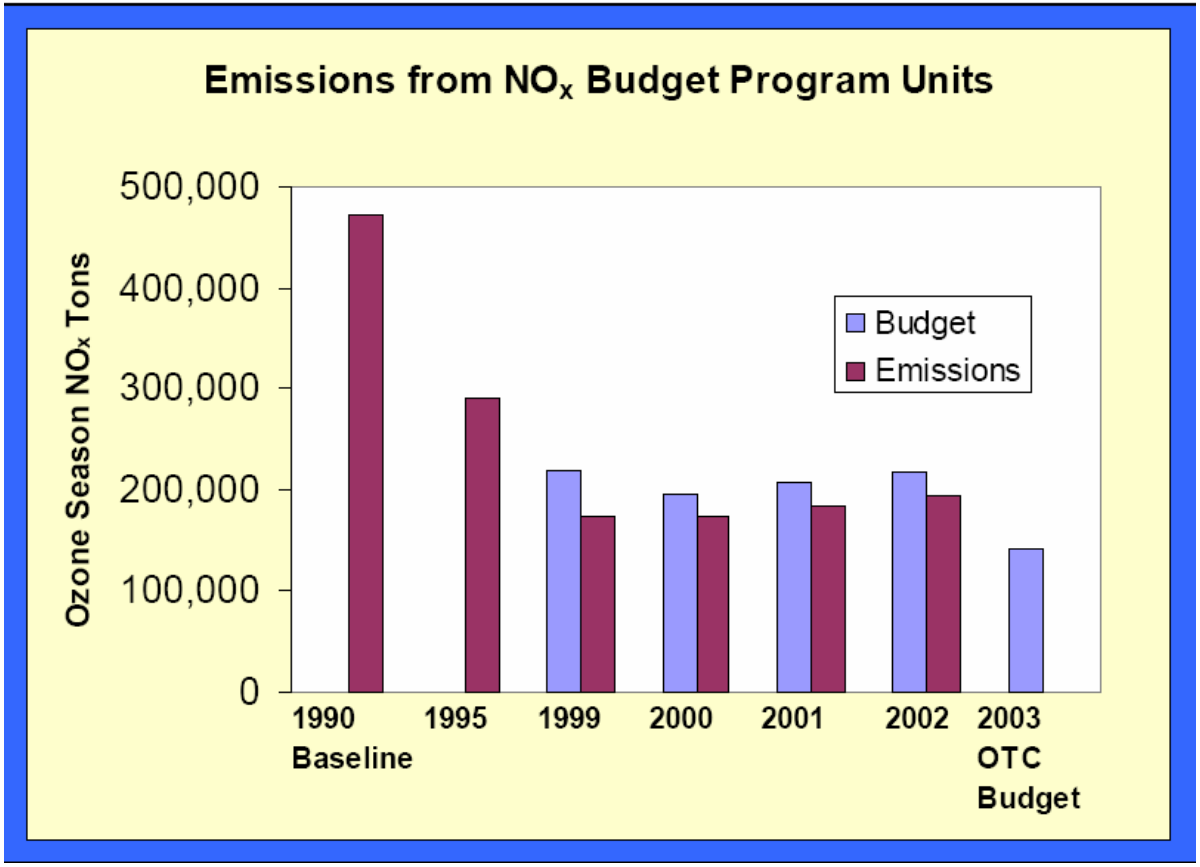
Extending Cap and Trade to NOx

- Collaboration between state and federal governments
- Ozone Transport Commission (OTC)
- SIP Call NOx Budget Trading Program



OTC Summary Results

- Substantial NOx reductions.
  - 2002 ozone season emissions 60% below 1990 levels.
- High compliance among affected boilers.
- Reductions distributed evenly throughout region.
- Emissions reduced on peak days.
- Cost lower than expected
- **Ozone problems persisted**
  - **more reductions were needed**



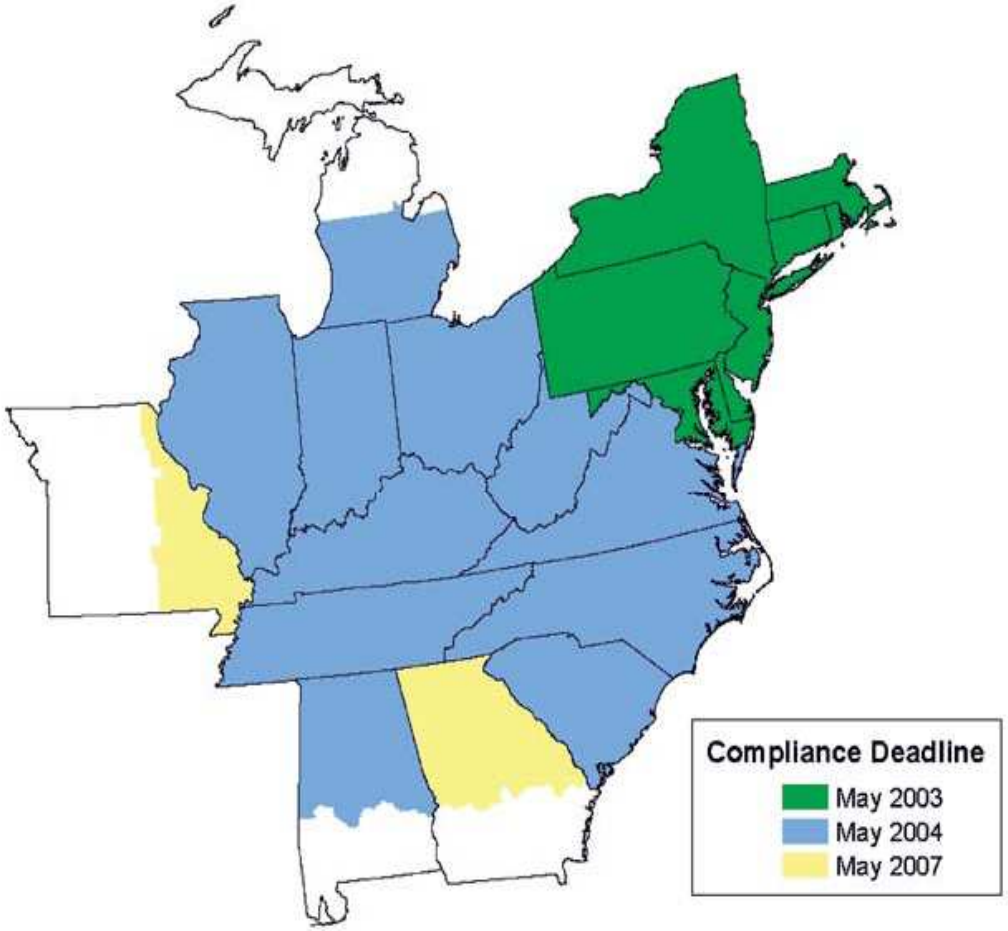
OTC Summary Results

- Industrial boilers successfully integrated:
  - Over 100 industrial boilers, turbines, and process heater units included in program.
  - Emissions consistently below budget
  - 70% bought or sold allowances
  - High level of compliance
- Healthy market emerged:
  - Transfers of allowances increased during the program and prices stabilized
  - Emissions never exceeded budget despite 90,000 allowances in bank.
    - Flow control provisions

Development of NOx SIP Call

- Persistent non-attainment problems
  - Further reductions required to reduce summertime ozone transport across eastern United States
- EPA promulgated SIP call
  - Establishes NOx budget for 19 states and DC
- Requires States to revise SIPs
- Requires emissions reductions by May 2004
- Provides optional cap and trade program for major combustion sources
  - Model rule

NOx Budget Trading Program (NBP)



- Problem: Reduce summer ozone/smog levels
- Scope: Eastern U.S.
- Target: Reduce NOx emissions from electric generators and industrial boilers by 1 million tons (70% below 1990 levels)
- Coverage: 2,570 units

Roles and Responsibilities: Federal/State Interaction

- The Federal Role
  - Set the NOx budgets for States
    - Based on unit specific data and performance standard, equitable across states, defensible
  - Issue model trading rule
    - Contains common elements for inter-state trading programs to ensure consistency, fairness, and environmental results
  - Administer program
    - Runs emissions & allowance tracking systems, compliance determination

Roles and Responsibilities: Federal/State Interaction

- The State Role
  - Determine how to meet NOx budget
    - Participate in trading, or use other measures
    - If states choose to participate in regional trading program, they must adopt the Model Rule
    - Take lead on enforcement actions
  - Decisions on program options that do not have to be consistent across all participating sources, e.g., allocation method
  - Create certainty and consistency
  - Avoid delays, inconsistent rules

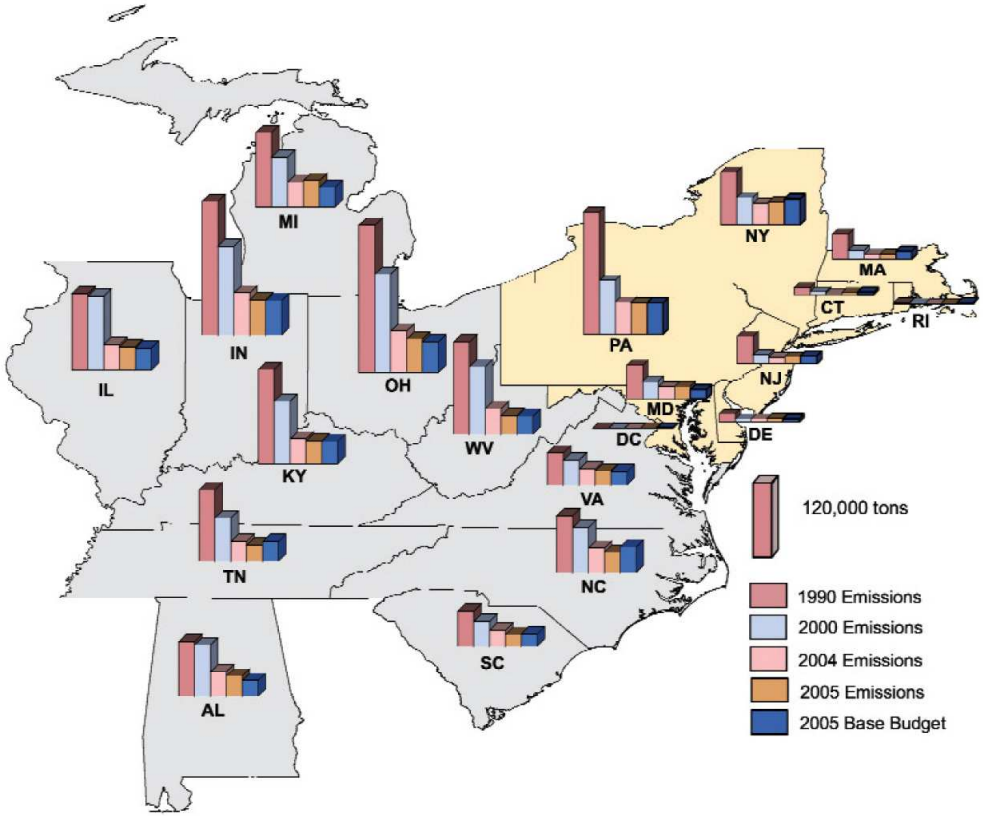
NOx Budget Program Design Elements

- Timing:
  - Five-month compliance period: May 1 –September 30 ozone season
  - Finalized in 1998, monitoring required in 2002 and reductions in 2003
    - Court order moved compliance date for all states back to 2004
- Applicability
  - Fossil fuel fired electric generators > 25 MW
  - Industrial boilers and turbines >250 mmBtu/hr
- Allowance Distribution
  - Allocations from state, who have discretion
  - Allocations must be within state trading budget
  - States may also set aside a portion of the budget (Renewables, new sources)
- Allowance Use
  - Allowance is defined as authorization to emit one ton of NOx during ozone season
  - Unrestricted trading can occur between sources
  - Progressive Flow Control if necessary
    - Requires portion of banked allowances to be surrendered 2:1 if needed to cover emissions

NOx Budget Program Design Elements

- Monitoring and Reporting Emissions
  - Sources required to continuously monitor emissions in accordance with Part 75–Updated Acid Rain Program monitoringregs•Additional guidelines:–Monitoring certification process–Data review–Quality assurance tests–Quarterly reporting
- Compliance and Enforcement
  - All sources must hold allowances sufficient to cover emissions
    - Compliance and overdraft accounts
  - Automatic excess emissions offset
    - 3 allowances for each ton of excess emissions
  - Other enforcement action possible

NO_X Budget Trading Program Ozone Season
NO_X Emissions from 1990, 2000, 2004, and 2005, and 2005 State Trading Budgets



Notes:

- The non-OTC states are shaded in gray; OTC states are shown in yellow.
- Results in Alabama and Michigan represent ozone season emissions from only the affected portion of each state (see Figure 3).

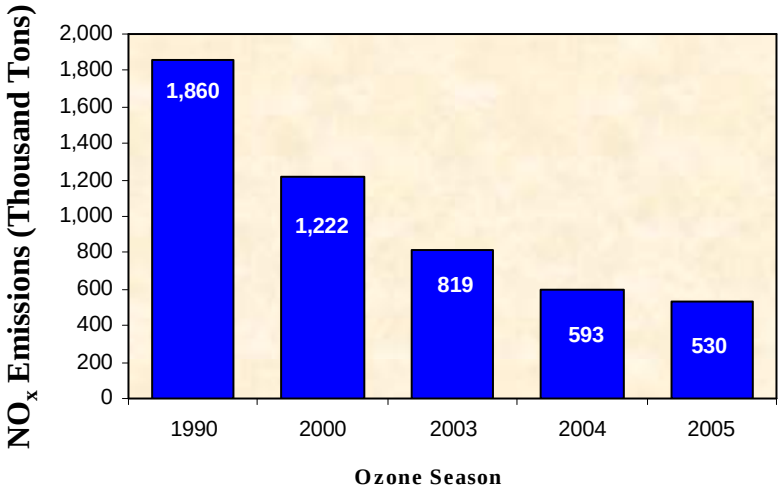
Source: EPA

Summertime NOx Emission Reductions

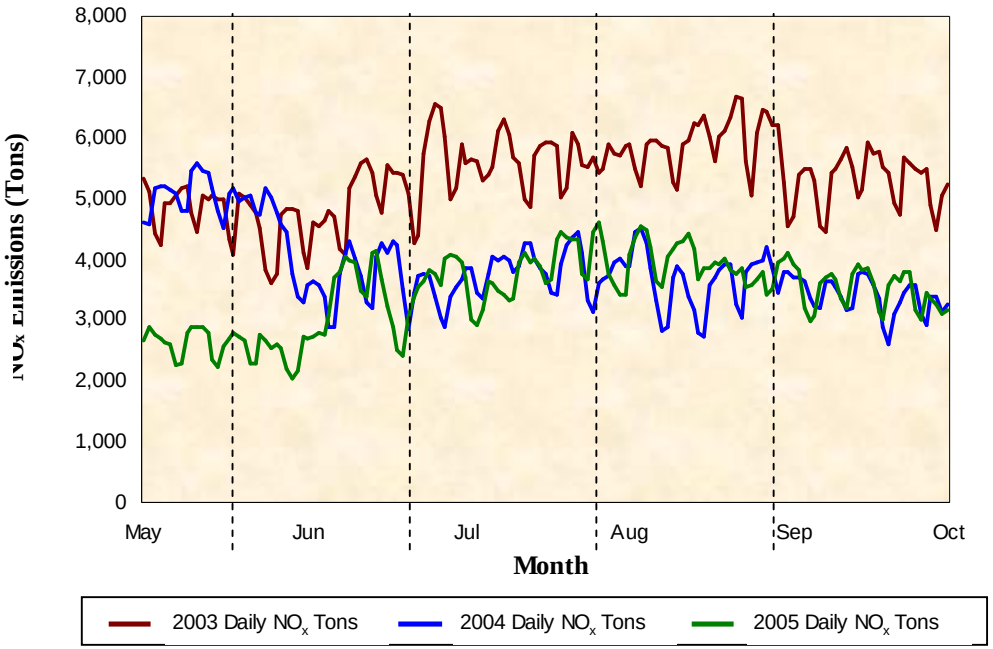
2005 NBP states' ozone season reductions (May 1 – September 30)

- 72% from 1990 baseline
- 57% from 2000 baseline
- 11% from 2004

Total NBP Ozone Season NOx



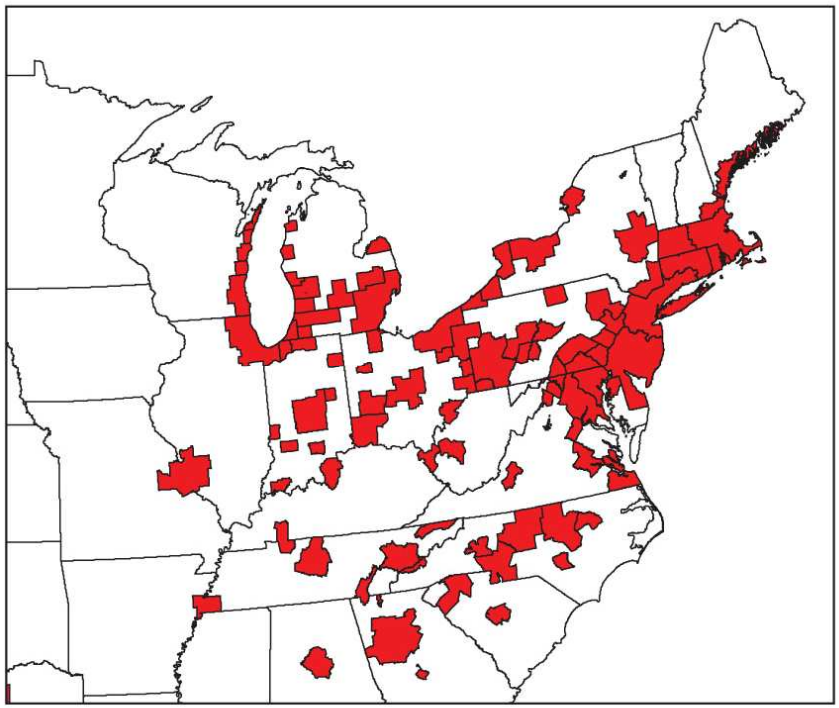
Daily Emission Trends for NOx Budget Trading Program Units in 2003, 2004 and 2005



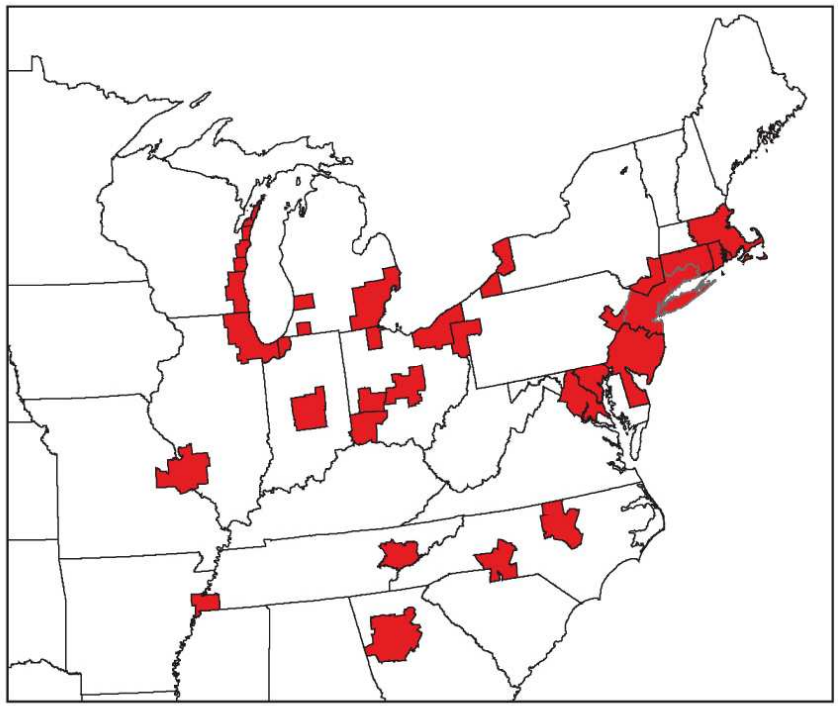
Source: EPA, 2006

70 % of Areas in the Eastern US that Didn't Meet the Ozone Std in 2004 Now Have Better Air than the Std Requires

8-Hour Ozone Nonattainment Areas, April 2004 (2001–2003 Air Quality Data)



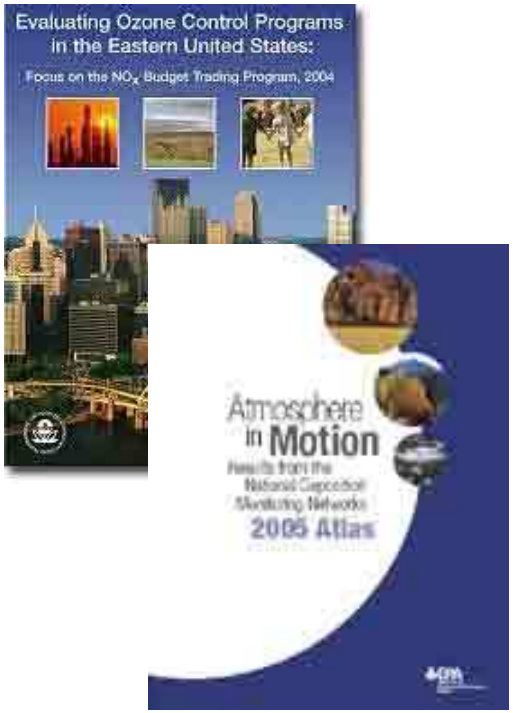
Areas Remaining Above Standard (2003–2005 Air Quality Data)

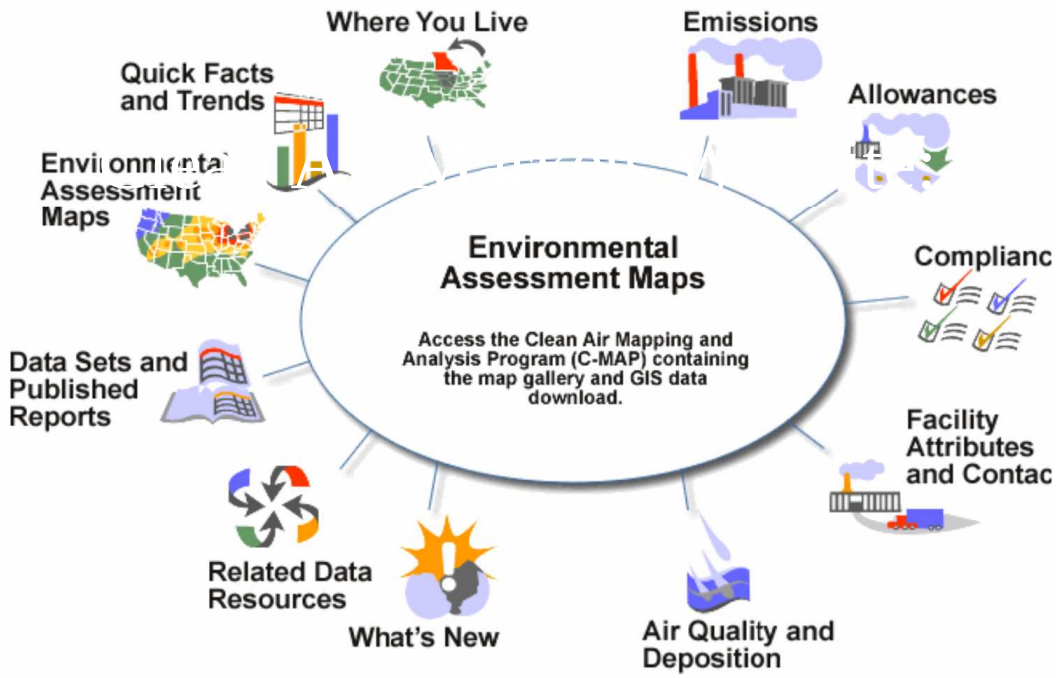


Note: Included on the maps, but excluded from the analysis, are four areas with incomplete data for 2003 to 2005 (Cass Co, MI; Dayton-Springfield, OH; Essex Co (Whiteface Mtn), NY; La Porte, IN).

Reporting Results

- Annual reports on program results
- Public access to data and reports





http://cfpub.epa.gov/gdm/

Lesson: To Trade or Not to Trade…

- Can the problem be addressed with a flexible approach?
  - Local or regional problem?
  - Episodic or cumulative problem?
- Can emissions be measured accurately and consistently?
- Do abatement costs differ among facilities?
- Is there an appropriate number of sources?
- Do the necessary governmental and market institutions exist?

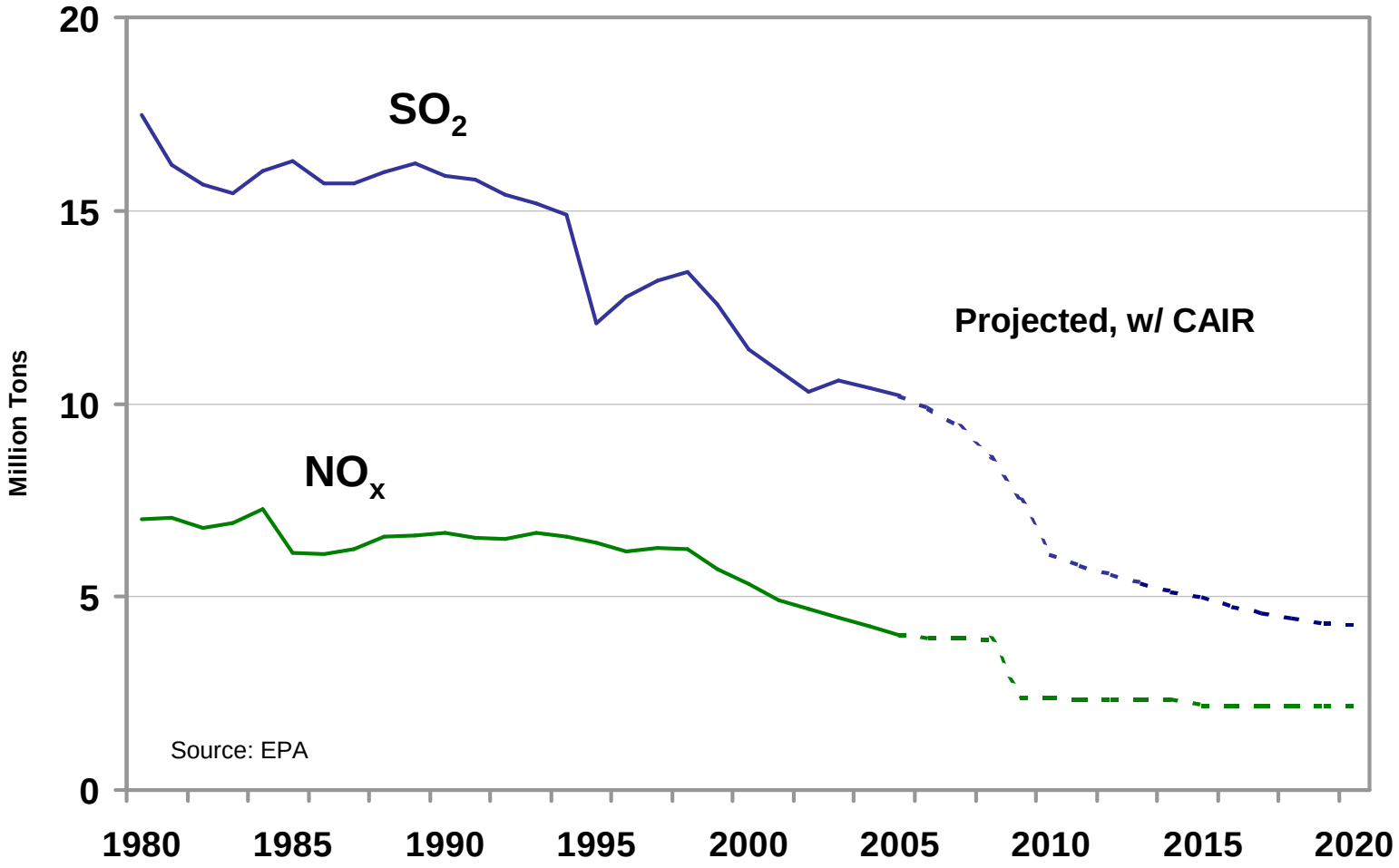
Lesson: Program Compatibility

- Cap & trade programs should complement, not undermine, existing environmental regulations
- An unambiguous legal framework defining the relationship between cap & trade programs and other policy instruments should be established before a trading program begins
- Hybrid approaches may be appropriate
- Programs are less confusing, less expensive, and more likely to succeed if they are simple

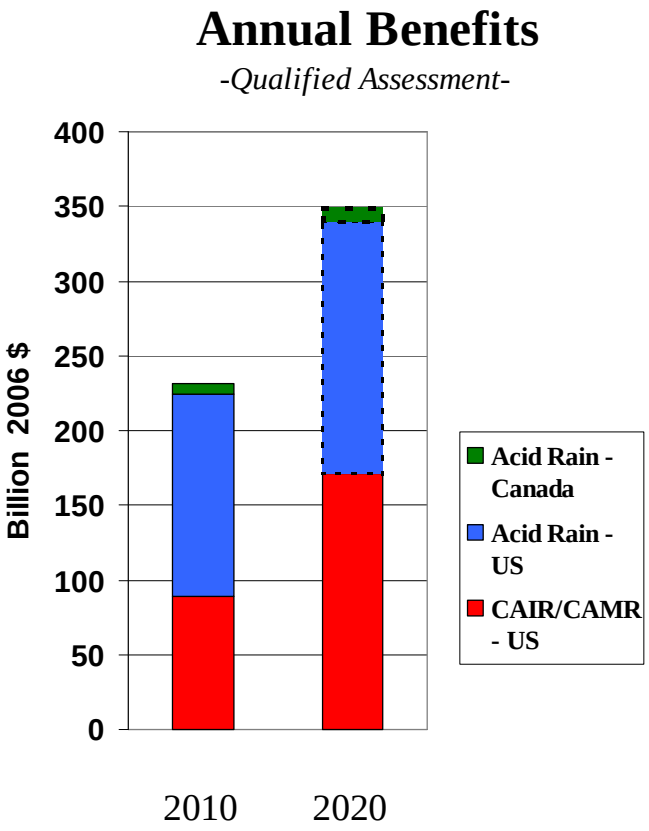
Lesson: Government Focus

- Achieving a specific environmental objective
- Supporting the allowance market by
  - Ensuring the integrity of the allowance, i.e., the authorization to emit
  - Minimizing administrative costs

National SO2 and NOx Power Plant Emissions



Benefits of Acid Rain and CAIR Program



Note: All estimates used a 3% discount rate. Use of 7% discount rate would lower estimates about 15 percent. CPI-U used to convert 1999$ and 2000$ to 2006$. Sources: Used Chestnut & Mills Analysis, "A fresh look at the benefits and costs of the US acid rain program" (Oct. 1, 2004) for 2010 Acid Rain Benefits and EPA's Multi-pollutant Regulatory Analysis: CAIR, CAVR, CAMR (Oct. 2005) for 2010 and 2020 estimates for these programs. Acid Rain 2020 benefits extrapolated from 2010 estimates.

- Benefits driven by:
  - Reduced premature deaths
  - Lowering aggravation and incidence of heart and lung ailments
- Other benefits:
  - increased worker productivity
  - reduced absences from school and work
  - visibility improvement in some parks
- Benefits not included:
  - CAIR's Canadian Health Benefits
  - Acid rain environmental benefits
  - Mercury benefits
  - Remaining visibility benefits from parks and urban areas
  - Others

Lesson: Cost Matters

- 1990 legislation expected cost of SO_2 reduction = $7-8 billion per year
- Today's expected cost = ~ $2 billion per year
- Expected cost savings = ~ cost of newly promulgated rules to reduce SO_2 and NOx by an additional 60-70%
- We are now getting significantly more environmental protection for the original expected price

Basic Elements of Cap and Trade

- **Full sector coverage** – All sources (existing and new) included
  - Minimizes shifting of production and emissions ("leakage")
  - Assures achievement of emission reduction goal without case-by-case review
  - Reduces administrative costs to government and industry
- **Cap on emissions** – Government issuance of a fixed quantity of allowances
  - Limits emissions to achieve and maintain environmental goal
  - Limits creation of "paper credits" and "anyway tons"
  - Provides certainty to allowance market
- **Monitoring** – Accurate measurement and reporting of all emissions
  - Assures accountability and results
  - Establishes integrity of allowances and confidence in the market
- **Trading** – Unrestricted trading and banking (with source-specific limits allowed to protect local air quality
  - Allows companies to choose (and change) compliance options
  - Minimizes compliance cost
  - Ensures that trading will not cause "hotspots"

For More Information

Visit **http://www.epa.gov/airmarkets/**

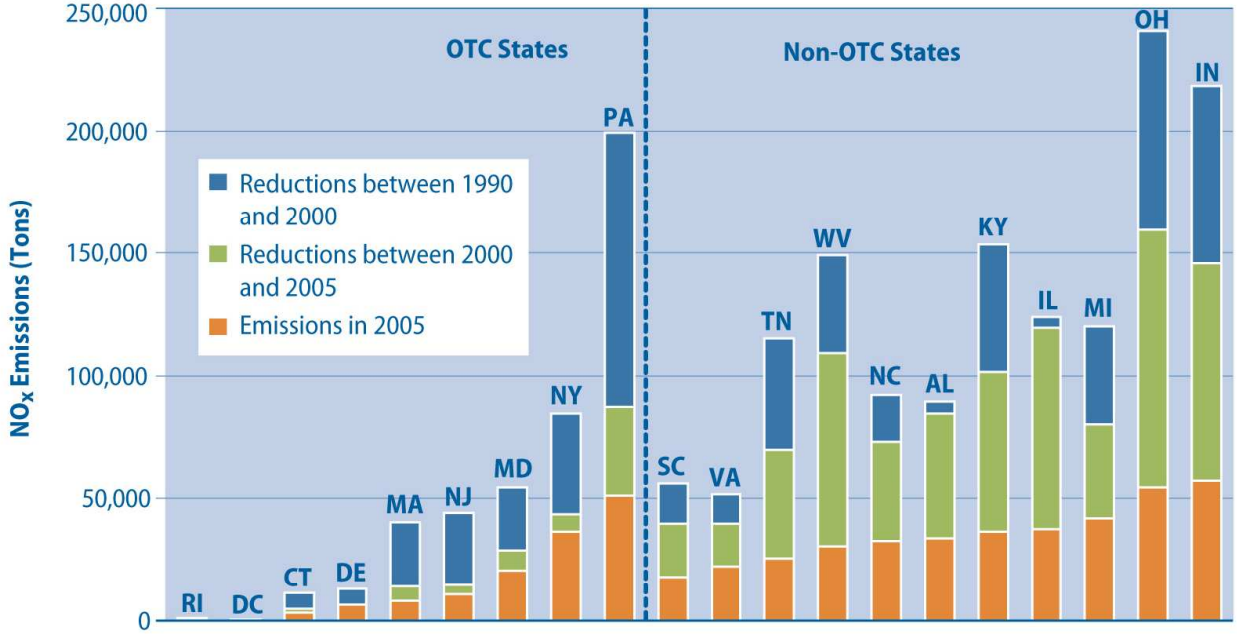
- NO_x/SO_2/CO_2 emissions data
- Allowance transfers
- Program information, rules, and reports

For more information about OAP

- Office of Atmospheric Programs: http://epa.gov/air/oap.html
- Clean Air Markets Division: http://epa.gov/airmarkets/
- Climate Change Division: http://www.epa.gov/air/ccd.html
- Climate Protection Partnership Division: http://epa.gov/cppd/
- Stratospheric Protection Division: http://www.epa.gov/ozone/

Appendix

NO_X Budget Trading Program State-by-State Ozone Season NO_X Emission Reductions from 1990 and 2000

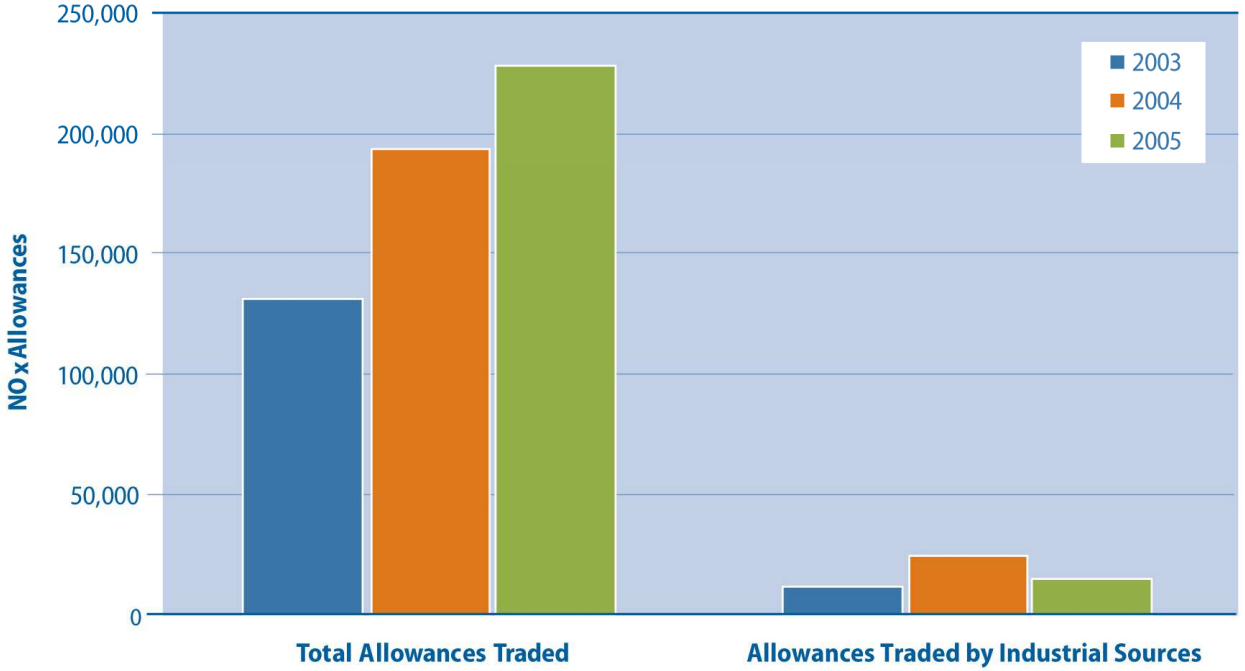


Notes:

- Because emissions in the District of Columbia and Delaware increased between 2000 and 2005 by approximately 146 and 1,282 tons, respectively, there is no green bar shown in the figure for those states.
- For each state, the total bar (i.e., the sum of the orange, green, and blue stacked bars) depicts emissions in 1990. The sum of the green and orange stacked bars depicts emissions in 2000, and the orange bar depicts emissions in 2005.
- Results in Alabama and Michigan represent ozone season emissions from only the affected portion of each state (see Figure 3).

Source: EPA

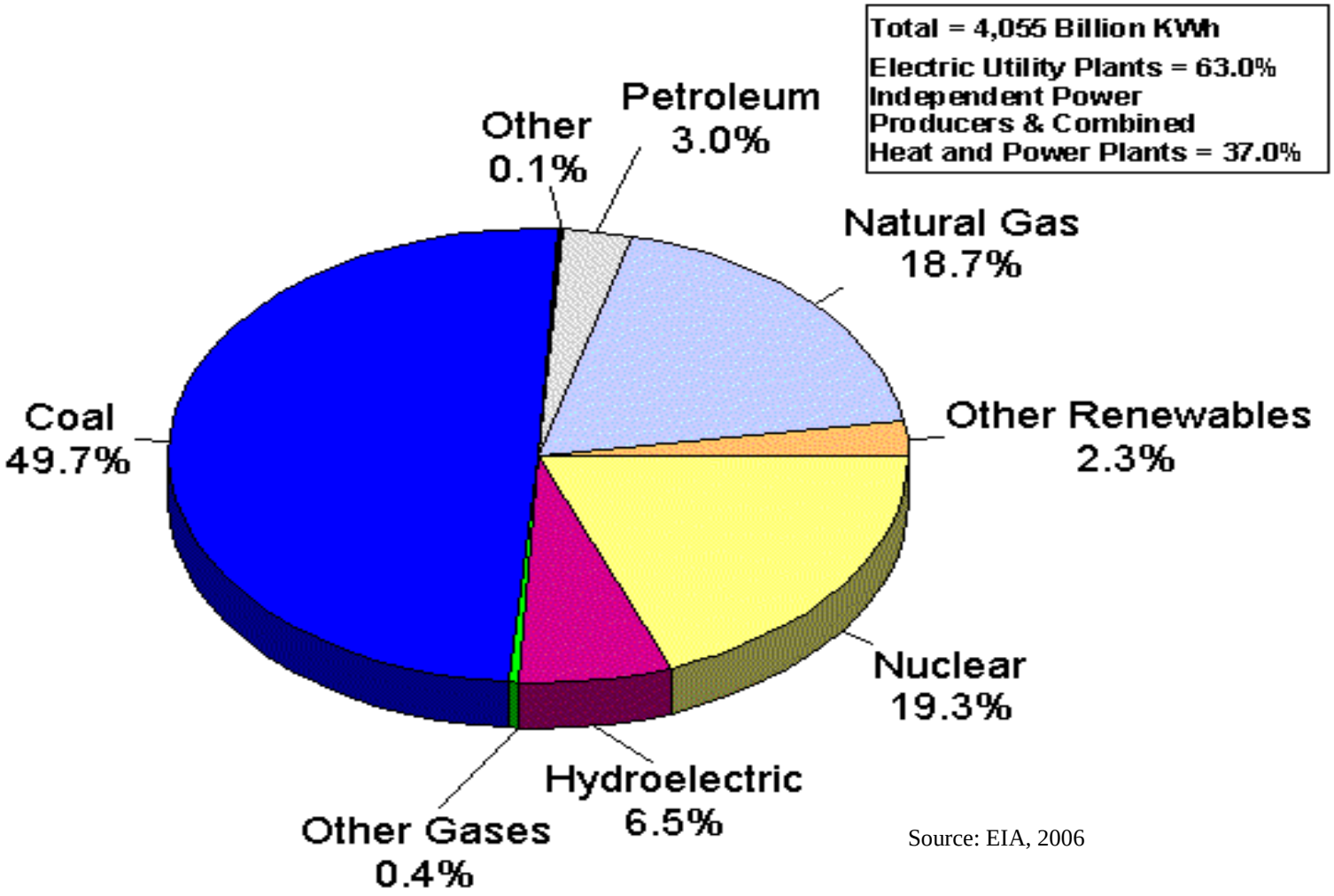
Estimated Volumes of Economically Significant Trades under the NO_X Budget Trading Program, 2003–2005



Note: As part of compiling this information for the 2005 report, EPA has reexamined all allowance transfer data from 2003 and 2004, and has revised the numbers for 2003 and 2004 presented in previous reports. Generally, EPA's estimate of economically significant trade volume in those years has decreased based on further analysis of outside data sources (such as company Web sites and Securities and Exchange Commission filings) to identify corporate relationships and ownership interests in units. The 2003 data also have been adjusted to correct a computational error. Because trades are not reported by market participants with respect to whether they are economically significant, EPA presents these data as a general estimate only.

Source: EPA

Power Generation by Fuel Type in 2005



Source: EIA, 2006