BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	)	
	)	
PROPOSED NEW 35 ILL.ADM.CODE PART 225	)	**PCB R06-25**
CONTROL OF EMISSIONS FROM	)	**Rulemaking - Air**
LARGE COMBUSTION SOURCES	)	

NOTICE OF FILING

To:

Dorothy Gunn, Clerk
Illinois Pollution Control Board
James R. Thompson Center
Suite 11-500
100 West Randolph
Chicago, Illinois 60601

Persons included on the
ATTACHED SERVICE LIST

PLEASE TAKE NOTICE that we have today filed with the Office of the Clerk of the Pollution Control Board **MIDWEST GENERATION'S POST-HEARING COMMENTS: ADDITIONAL INFORMATION.**

/s/ *Kathleen C. Bassi*
Kathleen C. Bassi

Dated: September 15, 2006

Sheldon A. Zabel
Kathleen C. Bassi
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BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	)	
	)	
PROPOSED NEW 35 ILL.ADM.CODE PART 225	)	**PCB R06-25**
CONTROL OF EMISSIONS FROM	)	
LARGE COMBUSTION SOURCES	)	

MIDWEST GENERATION'S POST-HEARING COMMENTS: ADDITIONAL INFORMATION

NOW COMES Participant MIDWEST GENERATION, LLC, by and through its attorneys, SCHIFF HARDIN, LLP, pursuant to 35 Ill.Adm.Code § 102.108, and offers the following information as requested at hearing as comments for the Record of the above-captioned proposed rule:

1. Mr. William DePriest was asked to provide information specific to Illinois regarding the number of upgrade projects for electrostatic precipitators ("ESPs") involving Sargent & Lundy as further response to pre-filed Question 29 from the Illinois Environmental Protection Agency ("Agency"). Chicago Transcript ("C Tr."), p. 1216 (August 18, 2006, a.m.) Mr. DePriest reports that Sargent & Lundy has been involved in 21 retrofits of whole precipitators to existing units, 20 precipitator performance improvement projects, and five structural examinations and modifications at Illinois companies.

2. Mr. James Marchetti was asked to provide a breakdown of the categories included in his conclusion that the Illinois mercury rule would cost companies $200 million per year, annualized costs as further response to Question 7 of the pre-filed questions submitted by the

Agency. C Tr., p. 1302 (August 18, 2006, p.m.) Appended hereto as Attachment 1 is a table breaking down those costs.

3. Mr. Marchetti has also provided additional information relative to Exhibits 119 and 120, appended hereto as Attachments 2 and 3, respectively.

4. Dr. Peter Chapman was asked for the internet address of the Metropolitan Water Reclamation District's information that served as the basis for his calculations of the amounts of mercury in stormwater runoff as further response to the Agency's pre-filed Question 5. C Tr., p. 27 (August 22, 2006, a.m.) That address is <www.mwrd.org/RD/iepa_reports.htm#Water Quality Data Reports>.

5. Dr. Gail Charnley was asked to provide articles regarding emissions trading. C Tr., p. 1679 (August 22, 2006, p.m.) Appended hereto as Attachment 4 is Byron Swift, *Emissions Trading and Hot Spots: A Review of the Major Programs*, BNA (May 7, 2004). Appended hereto as Attachment 5 is Byron Swift, *Command Without Control: Why Cap-and-Trade Should Replace Rate Standards for Regional Pollutants*, 31 ELR 10330.

6. Mr. Ayres asked Mr. Krish Vijayaraghavan to provide a calculation of a 90 percentile confidence levels for the point estimates. *See* C Tr., pp. 1500-1502. Mr. Vijayaraghavan indicated that he would have to look into whether that could be done. C Tr., p. 1502. Mr. Vijayaraghavan has examined that question further and determined that the type of analysis that Mr. Ayres appears to have requested is not applicable to the type of information that

Mr. Vijayaraghavan provided at hearing. Therefore, we have no additional information on this point.

Respectfully submitted,

MIDWEST GENERATION, LLC

by:

Kathleen C. Bassi

One of Its Attorneys

Dated: September 15, 2006

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Attachment 1

Follow-Up Information for Question 7 Posed to Mr. Marchetti

FOLLOW-UP INFORMATION ON QUESTION 7

CUMULATIVE ANNUALIZED COMPLIANCE COSTS FOR SO2, NOx AND MERCURY BY COST COMPONENTS: 2009 - 2018
(billions of 2006 $)

Rule	Ann Cap_Tech	Ann_Fuel	Ann_fixed	Ann_var	Allow Pur	Allow Sales	Total Cost
CAIR							
SO2	1.03	-0.06	0.12	0.25	0.77	-0.20	1.91
NOx	0.38	0.00	0.01	0.17	0.30	-0.21	0.65
CAMR	0.05	0.00	0.01	0.11	0.41	-0.04	0.54
TOTAL	1.46	-0.06	0.14	0.53	1.48	-0.45	3.10
IL-CAIR							
SO2	1.01	-0.03	0.12	0.25	0.73	-0.22	1.85
NOx	0.36	0.00	0.01	0.16	0.30	-0.21	0.62
IL-Hg	2.08	0.00	0.11	0.44	0	0	2.63
TOTAL	3.45	-0.03	0.24	0.85	1.03	-0.43	5.10

Attachment 2

Additional details for Exhibit 119

CAIR-CAMR Tech (Ex - 119)

Lookup	SYSTEM	UNIT_NAME	so2_tech	so2_tech_year	nox_tech	nox_tech_year	hg_tech	hg_tech_year	Namplate
384#7	Midwest Generations EME LLC	JOLIET 7					ACI	2011	660
384#8	Midwest Generations EME LLC	JOLIET 8					ACI	2010	660
6016#1	Ameren Energy Resources Generating Co	DUCK CREEK 1			S7MO	2009			441
6017#1	Ameren Energy Generating Co	NEWTON 1	DFGD	2010			ACI	2010	617.4
856#1	Ameren Energy Resources Generating Co	ED EDWARDS 1			SNCR	2009			136
856#2	Ameren Energy Resources Generating Co	ED EDWARDS 2			SNCR	2009			280.5
856#3	Ameren Energy Resources Generating Co	ED EDWARDS 3			S7MO	2009			363.8
861#1	Ameren Energy Generating Co	COFFEEN 1	WFGD/FS	2010	S7MO	2009			388.9
861#2	Ameren Energy Generating Co	COFFEEN 2	WFGD/FS	2010	S7MO	2009			616.5
864#3	Ameren Energy Generating Co	MEREDOSIA 3			SNCR	2009	ACI	2010	239.3
867#8	Midwest Generations EME LLC	CRAWFORD 8			SNCR	2010			358.1
876#1	Kincaid (Dominion)	KINCAID 1			S7MO	2009			659.5
876#2	Kincaid (Dominion)	KINCAID 2			S7MO	2009			659.5
879#5	Midwest Generations EME LLC	POWERTON 5			SCR	2009			892.8
879#6	Midwest Generations EME LLC	POWERTON 6			SCR	2009	HACI	2017	892.8
883#8	Midwest Generations EME LLC	WAUKEGAN 8			SNCR	2009			355.3
884#4	Midwest Generations EME LLC	WILL COUNTY 4			SNCR	2010			598.4
889#3	Dynegy Midwest Generation Inc	BALDWIN 3					ACI	2016	634.5
891#6	Dynegy Midwest Generation Inc	HAVANA 6					HACI	2010	488
898#5	Dynegy Midwest Generation Inc	WOOD RIVER (IL) 5			SNCR	2009			387.6
963#1	Springfield City of	DALLMAN 1			S7MO	2009			90
963#2	Springfield City of	DALLMAN 2			S7MO	2009			90
963#3	Springfield City of	DALLMAN 3			S7MO	2009			207
976#4	Southern Illinois Power Coop	MARION (IL) 4			S7MO	2009			173

Note: 1. The Newton 1 and Coffeen 1 & 2 FGD systems are planned for CAIR compliance and are not projected by our modeling, but their compliance costs have been included in our CAIR costs, as well as their emissions.

2. Baldwin 1 - 3 and Havana 6 DFGD systems have been included in our modeling of emissions, but no CAIR costs have been assigned because they are a result of Dynegy's co decree. These four FGD ystesms will be installed between 2009 and 2012. The 3 existing SCRs at Baldwin 1 & 2 and Havana 6 are to operate year-round due to the consent They have been included in our modeling of emissions but no CAIR costs have been assigned.

3. The existing FGDs at Duck Creek, Marion 4 and Dallman 1-3 are not listed above but have been included in our modeling of emissions.

Attachment 3

Additional Information for Exhibit 120

CAIR-IL Rule Tech (Ex - 120)

Lookup	SYSTEM	UNIT_NAME	so2_tech	so2_tech_year	nox_tech	nox_tech_year	hg_tech	hg_tech_year	Namplate
384#7	Midwest Generations EME LLC	JOLIET 7					COHP	2009	660
384#8	Midwest Generations EME LLC	JOLIET 8					COHP	2009	660
6016#1	Ameren Energy Resources Generating Co.	DUCK CREEK 1			S7MO	2009			441
6017#1	Ameren Energy Generating Co	NEWTON 1	DFGD	2010			HACI	2009	617.4
6017#2	Ameren Energy Generating Co	NEWTON 2					HCOHP	2009	617.4
856#1	Ameren Energy Resources Generating Co.	ED EDWARDS 1			SNCR	2009	HCOHP	2009	136
856#2	Ameren Energy Resources Generating Co.	ED EDWARDS 2			SNCR	2009	HCOHP	2009	280.5
856#3	Ameren Energy Resources Generating Co.	ED EDWARDS 3			S7MO	2009	HCOHP	2009	363.8
861#1	Ameren Energy Generating Co	COFFEEN 1	WFGD/FS	2010	S7MO	2009	COHP	2009	388.9
861#2	Ameren Energy Generating Co	COFFEEN 2	WFGD/FS	2010	S7MO	2009	FF	2009	616.5
863#3	Ameren Energy Generating Co	HUTSONVILLE 3					HCOHP	2009	75
863#4	Ameren Energy Generating Co	HUTSONVILLE 4					HCOHP	2009	75
864#1	Ameren Energy Generating Co	MEREDOSIA 1					HCOHP	2009	57.5
864#2	Ameren Energy Generating Co	MEREDOSIA 2					FF	2009	57.5
864#3	Ameren Energy Generating Co	MEREDOSIA 3			SNCR	2009	HCOHP	2009	239.3
867#7	Midwest Generations EME LLC	CRAWFORD 7					HACI	2009	239.3
867#8	Midwest Generations EME LLC	CRAWFORD 8					HCOHP	2009	358.1
874#6	Midwest Generations EME LLC	JOLIET 6					COHP	2009	360.4
876#1	Kincaid (Dominion)	KINCAID 1			S7MO	2009	HACI	2009	659.5
876#2	Kincaid (Dominion)	KINCAID 2			S7MO	2009	HCOHP	2009	659.5
879#5	Midwest Generations EME LLC	POWERTON 5			SCR	2009	FF	2009	892.8
879#6	Midwest Generations EME LLC	POWERTON 6			SCR	2009	COHP	2009	892.8
883#6	Midwest Generations EME LLC	WAUKEGAN 6					HACI	2009	121
883#7	Midwest Generations EME LLC	WAUKEGAN 7					HACI	2009	326.4
883#8	Midwest Generations EME LLC	WAUKEGAN 8			SNCR	2009	HCOHP	2009	355.3
884#1	Midwest Generations EME LLC	WILL COUNTY 1					HACI	2009	187.5
884#2	Midwest Generations EME LLC	WILL COUNTY 2					HACI	2009	183.7
884#3	Midwest Generations EME LLC	WILL COUNTY 3					HCOHP	2009	299.2
884#4	Midwest Generations EME LLC	WILL COUNTY 4					HCOHP	2009	598.4
886#19	Midwest Generations EME LLC	FISK 19					COHP	2009	374
887#1	EEI	JOPPA 1					HCOHP	2009	183.3
887#2	EEI	JOPPA 2					HCOHP	2009	183.3
887#3	EEI	JOPPA 3					HCOHP	2009	183.3
887#4	EEI	JOPPA 4					HCOHP	2009	183.3
887#5	EEI	JOPPA 5					HCOHP	2009	183.3
887#6	EEI	JOPPA 6					HCOHP	2009	183.3
889#3	Dynegy Midwest Generation Inc	BALDWIN 3					HACI	2009	634.5
891#6	Dynegy Midwest Generation Inc	HAVANA 6					HACI	2009	488
892#1	Dynegy Midwest Generation Inc	HENNEPIN 1					HACI	2009	75
892#2	Dynegy Midwest Generation Inc	HENNEPIN 2					HCOHP	2009	231.3
897#2	Dynegy Midwest Generation Inc	VERMILION 2					HACI	2013	108.8
897#ST1	Dynegy Midwest Generation Inc	VERMILION 1					HACI	2013	75
898#4	Dynegy Midwest Generation Inc	WOOD RIVER (IL) 4					ACI	2009	112.5

CAIR-IL Rule Tech (Ex - 120)

Lookup	SYSTEM	UNIT_NAME	so2_tech	so2_tech_year	nox_tech	nox_tech_year	hg_tech	hg_tech_year	Namplate
898#5	Dynegy Midwest Generation Inc	WOOD RIVER (IL) 5			SNCR	2009	COHP	2009	387.6
963#1	Springfield City of	DALLMAN 1			S7MO	2009			90.2
963#2	Springfield City of	DALLMAN 2			S7MO	2009			90.2
963#3	Springfield City of	DALLMAN 3			S7MO	2009			207.3
976#4	Southern Illinois Power Coop	MARION (IL) 4			S7MO	2009			173

Note: 1. The Newton 1 and Coffeen 1 & 2 FGD systems are planned for CAIR compliance and are not projected by our modeling, but their compliance costs have been included in our CAIR costs, as well as their emissions.

2. Baldwin 1 - 3 and Havana 6 DFGD systems have been included in our modeling of emissions, but no CAIR costs have been assigned because they are a result of Dynegy's consent decree. These four FGD ystesms will be installed between 2009 and 2012. The 3 existing SCRs at Baldwin 1 & 2 and Havana 6 are to operate year-round due to the consent decree. They have been included in our modeling of emissions but no CAIR costs have been assigned.

3. The existing FGDs at Duck Creek, Marion 4 and Dallman 1-3 are not listed above but have been included in our modeling of emissions.

Attachment 4

Emissions Trading and Hot Spots: A Review of the Major Programs

BNA, INC.

ENVIRONMENT REPORTER

BNA Employee-Owned Since 1947

AIR POLLUTION

EMISSIONS TRADING

This report examines whether the major U.S. emissions trading programs for air pollutants have contributed to elevated emissions concentrations in specific geographic areas, or pollution "hot spots." Assessment of the actual performance of these programs shows that none has resulted in a regional shift of emissions, and all trading programs examined have led to proportionately greater emissions reductions from the larger sources. Overall, the data from the programs reviewed indicate that trading has not created geographic hot spots and, in promoting reductions at the largest plants, has smoothed out pollutant emissions instead of concentrating them.

Emissions Trading and Hot Spots: A Review of the Major Programs

BY BYRON SWIFT

I. Introduction

This report examines whether the major U.S. emissions trading programs for air pollutants have contributed to elevated emissions concentrations in specific areas, also known as pollution "hot spots." Environmentalists have been concerned about the potential for emissions trading programs to create such concentrations or hot spots, as have advocates of environmental justice, who have voiced such concerns as a basis for opposing emissions trading programs.[1]

This report is the first to comprehensively examine the actual emissions data from the major emissions

[1] See, e.g., Moore, Curtis, *Marketing Failure: The Experience with Air Pollution Trading in the United States* 34 ELR 10,281 (March 2004); Johnson, Stephen: *Economics vs. Equity: Do Market-based Environmental Reforms Exacerbate Environmental Justice?* 56 Wash. & Lee L. Rev. 111 (1999).

 ISSN 0013-9211

trading programs, which primarily affect emissions of sulfur dioxide and nitrogen oxides from power plants:

- Phase I of the SO_2 Acid Rain Program (1995-1999);
- Phase II of the SO_2 Acid Rain Program (starting in 2000); and
- Ozone Transport Commission (OTC) NOx Budget Program (1999-2002).

In addition to these three major emissions cap and allowance trading programs, we also examine NOx credit trading programs in several states.

This report first examines the hot spot issue from a regional perspective, addressing the chief concern voiced at the initiation of the acid rain SO_2 trading program: whether the increased flexibility allowed by trading would result in disproportionately greater emissions from Midwestern sources, affecting sensitive ecosystems in downwind areas to the east. For the OTC NOx program we examine the data by state to determine whether there were in fact regional shifts of emissions with trading.

Secondly, we attempt to determine the effects of trading on a more local level by examining plant-level data to see whether the trading programs caused reductions homogeneously with regard to plant size, or caused disproportionate emissions reductions at plants with relatively high or low emissions.

The objective evaluation of the hot spot issue is important because emissions trading programs create the opportunity to attain pollution reduction goals at lower cost through a market-based implementation mechanism.[2] The cap-and-trade programs combine a stringent environmental standard—the cap—with a very high-integrity trading system that increases compliance options. This creates efficiency, and the major cap-and-trade programs have been credited with substantially lowering compliance costs in comparison to traditional rate-based standards.[3] By lowering costs, the programs can benefit the environment by allowing politicians to set standards that achieve even greater reductions. In addition, some authors assert that emissions cap-and-trade programs create a fundamentally better regulatory system for regional pollutants that promotes innovation, creates continuous drivers for cleaner production, and are easily enforced.[4] These benefits could be lost if inaccurate perceptions about trading systems discourage their use where appropriate.

II. Emissions Trading Systems

Emissions trading programs provide flexibility to regulated sources that must meet a common environmental standard. Trading systems allow sources that emit pollution below an allocation level or an environmental standard to sell or transfer their reductions to other sources, which may then emit above the level or standard. The flexibility afforded by trading reduces compliance costs by allowing sources that can reduce emissions more cheaply to transfer allowances or credits to other sources facing higher costs.[5] This article assesses the impact of such spatial[6] trading systems with regards to emissions concentrations or hot spots.

No assessment of emissions trading can be done without understanding its three fundamentally different forms—emissions cap and allowance trading (cap-and-trade) programs, emissions averaging programs, and project-based emissions credit programs.[7] Most of our analysis deals with the major cap-and-trade systems, which both reduce emissions and create a fundamentally different compliance system for sources than traditional technology-based rate standards. They also have a very high-integrity allowance trading system that, because of the cap, assures a decline in total emissions from affected sources. Averaging and credit systems, however, are grafted onto existing compliance systems and differ from cap-and-trade programs in many ways. These three programs differ so significantly in their environmental and economic effects that they should be considered distinct types of regulatory programs and not lumped together as trading programs.

A. Emissions Cap and Allowance Trading Programs

Most of our analysis concerns the Acid Rain Program and the Northeastern OTC NOx Program, both cap-and-trade programs. Under this approach, an overall emissions cap is established over a large region, creating a strict regulatory standard that permanently reduces emissions. All affected sources are then allocated allowances,[8] which represent their share of the total cap, and can trade allowances with each other for compliance purposes. New sources are typically not pro-

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[2] See, e.g., Tietenberg, T.H., *Emissions Trading: An Exercise in Reforming Pollution Policy* (Resources for the Future, Washington, D.C., 1985); Harrison, David, *Tradable Permits for Air Pollution Control*, in International Yearbook of Environmental and Resource Economics 2001 (2001).

[3] See, A. Denny Ellerman et al., Markets for Clean Air: The U.S. Acid Rain Program (2000); Curtis Carlson, Dallas Burtraw, Maureen Cropper, and Karen L. Palmer, *Sulfur Dioxide Control by Electric Utilities: What Are the Gains from Trade?*108 Journal of Political Economy 1292 (2000).

[4] Authors point out that cap-and-trade programs guarantee emissions reductions, permanently cap emissions, create zero growth in emissions from new sources, allow greater scope for compliance through cleaner fuels and clean production technologies, increase compliance levels to virtually 100 percent, and greatly lower compliance costs. See generally, Ellerman, Denny, Paul Joskow and David Harrison, *Emissions Trading in the U.S.: Experience, Lessons, and Considerations for Greenhouse Gases*, Pew Center on Global Climate Change, Arlington, Va. (May, 2003) [available at http://www.pewclimate.org]; Swift, Byron, *How Environmental Laws Work: An Analysis of the Utility Sector's Response to Regulation of Nitrogen Oxides and Sulfur Dioxide Under the Clean Air Act*, 14 Tulane Envtl. L.J. 309 (Summer 2001) [available at http://www.epa.gov/airmarkets/articles/index.html].

[5] See generally, U.S. EPA, *Clearing the Air: The Truth About Capping and Trading Emissions*. EPA 430F-02-009 (May 2002); Ellerman, A. Denny, David Harrison, *Emissions Trading in the U.S.: Experience, Lessons, and Considerations for Greenhouse Gases*. Pew Center for Global Climate Change (Arlington, Va., May 2003); Haites, Erik, *An Emerging Market for the Environment: A Guide to Emissions Trading* (U.N. Environment Program, 2002) [see http://www.uccee.org/ETguide/GuideEmissionsTrading.pdf].

[6] This article refers to trading in this spatial sense of a transfer of emissions tons between different sources and examines its effects with regards to emissions concentrations. The spatial trading of allowances or credits is to be distinguished from temporal trading, such as banking, which has the effect of moving a ton of emissions from one year to another.

[7] See generally, EPA, *Three Forms of Emissions Trading*. Clean Air Markets Update, Winter 2002.

[8] Each allowance typically represents one ton of a pollutant that may be emitted in a given year.

vided with any allowances, but must obtain them from existing sources, leading to essentially a zero new source standard.[9]

The cap-and-trade approach fundamentally changes the regulatory system away from traditional end-of-pipe rate-based standards and into an overall performance system.[11] These programs have been shown to reduce the costs of compliance to half or less of the cost of traditional rate-based standards. They can also transform business compliance behavior towards a pollution prevention response and away from installing end-of-pipe controls, broaden and strengthen the context for innovation, greatly reduce administrative costs, and create almost 100 percent compliance.[10] Cap-and-trade programs also establish an extremely credible form of allowance trading based on rigorous monitoring that has high integrity because the cap prevents trading from ever leading to excess emissions.

B. Emissions Credit Trading Programs

At the other end of the spectrum are credit trading programs, which are grafted onto existing regulatory programs, such as traditional emissions rate regulations under the Clean Air Act. These are voluntary programs in which sources undertake projects that create quantifiable pollution reductions over and above their existing permitted levels or past emissions levels. The sources receive credits for these reductions, which they may then sell or transfer to other sources for compliance purposes.

Credit trading programs generally generate fewer economic and environmental benefits when compared to other trading programs. Some of the reasons are that there is no change in the underlying compliance system, fewer tons are available to be traded, and more regulatory procedures are needed, generating fewer economic gains. Also, because credit programs are used with existing permitting programs that typically do not require continuous emission monitors, they also have less reliable reporting and monitoring of emissions than cap-and-trade programs since firms can select which projects to present, credit trading systems have an inherent weakness in allowing firms to derive credit for projects that they might have done anyway, potentially increasing overall emissions. However, credit trading systems may be useful when system-wide approaches, such as cap-and-trade or averaging, are infeasible. A recent analysis provides best practices for credit programs, while noting they have lower integrity than cap-and-trade programs.[12]

C. Emissions Averaging Programs

In between these two systems are emissions averaging programs, in which a rate-based "average," or standard, is established for a group of sources. Individual sources that emit below the average emissions rate can earn credits that can then be sold or transferred to sources that emit above the average rate. Averaging systems can be used either with a uniform rate standard or technology-based rate standards, although the use of a uniform standard may promote cleaner technologies.[13]

Averaging systems allow trading to take place automatically between covered sources, which allows for greater trading and thus economic gains. Although total emissions may grow over time, unlike cap-and-trade programs, all sources are included in the program, which eliminates the danger of "gaming" the system through self-selection of projects that exists with credit trading programs. Also, credits in averaging systems are generated through standard protocols that do not require government approval of individual projects, greatly reducing transaction costs and hence enhancing economic gains.

III. Limitations and Context of an Evaluation of Emissions Concentrations, or Hot Spots

This paper reviews the effect of existing emissions trading programs to determine if they have increased or decreased the concentration of pollution emissions. Such a study essentially evaluates and compares trading programs with other possible regulatory approaches that achieve equivalent reductions over the same sources, and as such has a number of limitations, discussed below. In particular, such a review should not be confused with one of the stringency of regulation, nor of differing needs of national versus local regulatory programs.

A. Assessing Regulatory Stringency vs. Method

The first caveat to our study is that it does not deal with the level of stringency of regulation, which is typically legislatively determined. Emissions concentrations or hot spots originate in real-world situations, such as the siting of coal-fired power plants or the use of motor vehicles, that concentrate emissions in certain areas. Only if programs are sufficiently stringent in re-

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[9] Note that several states in the OTC program did allocate a small portion of allowances to new sources.

[11] Traditional environmental regulations under the Clean Air Act have been established as technology-based rate standards measuring the concentration or percentage of a pollutant in end-of-pipe emissions. See, for example, air standards such as Reasonably Available Control Technology (RACT) for existing sources, Best Available Control Technology (BACT) for new sources, and Maximum Achievable Control Technology (MACT) for hazardous pollutants. 42 U.S.C. §§ 7502(c)(1), 7475(a)(4), 7412(g)(2)(A) (1994). Rate standards have been shown to be poor performance standards because they significantly restrict the range of technology choices available for compliance, provided limited incentives for innovation and improvement, do not encourage shifts to cleaner technology and tend to freeze innovation. See, EPA, Pub. No. EPA-101/N-91/001, PERMITTING AND COMPLIANCE POLICY: BARRIERS TO U.S. ENVIRONMENTAL TECHNOLOGY INNOVATION 39 (1991); Swift, Byron, Environmental Law Institute, *How Environmental Laws Work: An Analysis of the Utility Sector's Response to Regulation of Nitrogen Oxides and Sulfur Dioxide Under the Clean Air Act*, 14 Tulane Envtl. L.J. 309 (Summer 2001) [available at http://www.epa.gov/airmarkets/articles/index.html].

[10] For evaluations of the SO_2 program, see supra notes 3 and 4.

[12] See Environmental Law Institute, *Emission Reduction Credit Trading Systems: An Overview of Recent Results and an Assessment of Best Practices*, Environmental Law Institute (October 2002); see also Dudek, Daniel & John Palmisano, *Emissions Trading: Why Is This Thoroughbred Hobbled?*, 13 Colum. J. Envtl. L. 217 (1988).

[13] Uniform standards do so because they allow firms to meet the standard by using a cleaner technology. Technology-based rate standards on the other hand require controls regardless of how clean the technology is and so provide no incentives to install cleaner technologies. An example of a uniform standard is the fuel-neutral New Source Performance Standard for NOx. 40 C.F.R. § 60.44b.

quiring adequate pollutant reductions will emission levels in such areas actually decline.

A good example is the case of SO_2, as the building of power plants in the Midwest to use the relatively high-sulfur coals of the region led to elevated emissions levels in that region and also affected downwind (Eastern) states. Initial efforts to regulate these plants under Title I of the Clean Air Act[14] resulted primarily in the dispersion of pollution through tall stacks;[15] SO_2 emissions barely declined, falling from 17 million to 16 million tons between 1970 and 1990.[16]

The Acid Rain Program was passed in 1990 to address this situation and mandates a 50 percent reduction in SO_2 emissions from 1980 baseline levels to approximately 9 million tons.[17] While EPA data shows that the Acid Rain Program has significantly reduced sulfur deposition and sulfate concentrations in the atmosphere, it also indicates that additional reductions in sulfate deposition are still needed to assure the recovery of acidic waters and forest soils, and enhance health benefits.[18] These findings have led to the introduction of bills in Congress, as well as a proposal by EPA, that call for major additional reductions in SO_2 emissions to the 2 million to 3 million ton level.[19]

Our examination instead is of the regulatory method, in an inquiry as to whether, at a given level of stringency, the use of the emissions trading method has led to disproportional increases or decreases in emissions in certain areas that cause or exacerbate emissions concentrations.

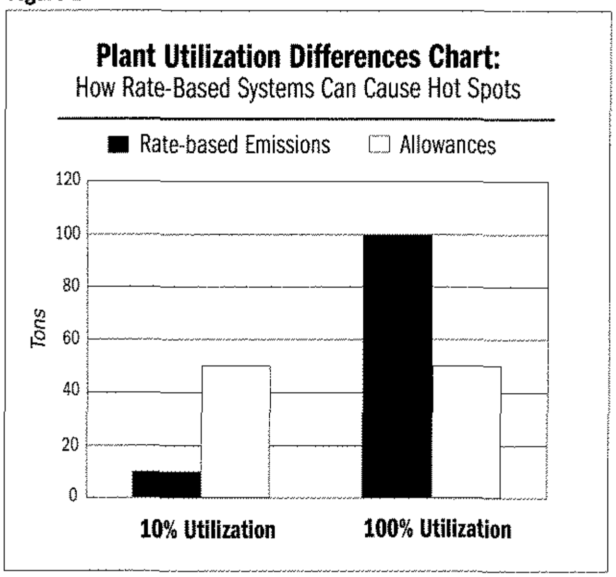
In the SO_2 example above, the issue would not be whether the reductions mandated in the Acid Rain Program were enough, but whether the program led to an uneven allocation of the tons of reduction in a way that exacerbated areas of concentration, such as the Midwest. The point is simply that we must differentiate an analysis of the effects of regulatory method—trading—from the issue of stringency and assess whether the method itself led to pollutant concentrations.

B. All Regulatory Systems Create Differentiated Emissions Levels in Plants

It is important to understand that all regulatory systems will create variable emissions responses at plants. At similar levels of overall reductions, regional or national source-specific rate standards or other regulations do not meaningfully address local emissions levels any better than trading systems. A principal reason is that rate-based regulations do not control the overall amount of pollution, which depends on plant siting, plant size, and utilization—whether a plant is operated 100 percent, 50 percent or 1 percent of the time. Therefore rate systems do not guarantee per-plant reductions. In addition, rate-based standards allow emissions to increase due to economic growth, and so over time may lead to greater overall emissions than cap-and-trade systems.

For many plants, the cap-and-trade approach, which allocates a given number of allowances to the plant, may be more likely to lead to consistent pollutant reductions than the rate-based approach. Figure 1 shows how rate-based systems can lead to greatly increased pollution at the plant level with differences in plant utilization, comparing a plant utilized at a 10 percent level to one utilized at a 100 percent level. Although the allowance allocation does not change, a rate-based regulatory system allows pollution emissions to increase greatly as plant utilization increases.

Figure 1



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C. Context of Existing Regulatory Standards

A further limitation of this study is that trading programs for NOx and SO_2 exist simultaneously with other regulatory programs for criteria pollutants. Although important, these standards would not be expected to

[14] The federal Clean Air Act of 1970 established the first National Ambient Air Quality Standards, designed to protect health and welfare, and required states to develop "state implementation plans" (SIPs) to achieve these standards. 42 U.S.C. § 7401 et seq.

[15] For SO_2, for example, an unintended consequence of these new ambient standards was the dispersion of SO_2 through tall stacks. The EPA permitted over a dozen states to adopt SIPs allowing sources to meet the new standard by building tall stacks to disperse the SO_2 instead of reducing emissions. This practice injected SO_2 into the higher atmosphere where it remained longer, facilitating the chemical reactions that produce sulfuric acid and aggravating acid precipitation. See Vickie L. Patton, *The New Air Quality Standards, Regional Haze, and Interstate Air Pollution Transport*, 28 Envtl. L. Rep. 10,155 (1998).

[16] EPA, National Air Quality and Emissions Trends Report, 1999 EPA-454/R-01-004 (March 2001).

[17] 42 U.S.C. § 7651 et seq. (imposing a 8.95 million ton cap to be achieved by 2010).

[18] U.S. Environmental Protection Agency, Acid Rain Program: 2002 Progress Report at pp. 7-11. EPA-430-R-03-011 (November 2003). See also, U.S. Environmental Protection Agency, Acid Rain Program: 2001 Progress Report at pp. 35-37. EPA-430-R-02-009 (November 2002).

[19] Congress has acted to advance several cap-and-trade proposals for electric utilities, such as the Clear Skies Act (H.R. 999) introduced by Reps. Joe Barton (R-Texas) and Billy Tauzin (R-La.); the Clean Power Act (S. 366) introduced by Sen. Jim Jeffords (I-Vt.); and the Clean Air Planning Act of 2003 (S. 843) introduced by Sens. Tom Carper (D-Del.), Lincoln Chafee (R-R.I.), and Judd Gregg (R-N.H.). EPA announced the signing of proposed rules to reduce SO_2 emissions in a 28-state region to 2.7 million tons by 2015. U.S. EPA, *Air Quality Proposal to Deeply Cut Power Plant Emissions is Signed*, EPA Press Release (Dec. 17, 2003; 34 ER 2742, 12/19/03).

   ISSN 0013-9211

significantly affect compliance behavior in response to the cap-and-trade programs evaluated in this report.

1. State Regulation of Sources to Attain NAAQS

Prior to passage of the Acid Rain Program in Title IV, existing power plants were primarily affected by Title I of the Clean Air Act. Under this law, states develop "state implementation plans" (SIPs)[20] to attain federally-established National Ambient Air Quality Standards (NAAQS) designed to protect human health and welfare.[21] States are authorized to adopt Reasonably Achievable Control Technology (RACT) requirements on existing stationary sources to supplement more stringent federal new source standards. These standards affected plants differently for SO_2 and NOx emissions, as described below.

For SO_2, the first National Ambient Air Quality Standards were developed soon after passage of the Clean Air Act in 1970,[22] and states subsequently acted to require plants to reduce local SO_2 emissions levels. Although plants did so, many states allowed them to simply disperse the pollution through use of tall stacks, which aggravated acid precipitation, until Congress banned the practice in 1977.[23] Today, few areas are in nonattainment for SO_2,[24] and the above actions occurred well before the baseline years considered in our analysis of the SO_2 Acid Rain Program.[25] However, it is important to note that these ambient standards still exist and protect against plants emitting SO_2 at levels that would cause local air quality to exceed NAAQS.

For NOx, the first major requirement faced by plants in the OTC states was to meet RACT standards that involved the installation of low-NOx burners by 1995. Collectively, this action reduced these plants' NOx emissions by 40 percent from 1990 levels.[26] These OTC standards were roughly equivalent to the national requirement for NOx reductions for coal-burning plants imposed by the Acid Rain Program in 1996,[27] but both standards took effect before the initiation of OTC cap-and-trade program in 1999.

The cap-and-trade programs examined in this paper are in part a response to the failure of the above Title I rate-based standards to achieve significant pollutant reductions in SO_2 and NOx from power plants whose national SO_2 emissions only declined from 17 million tons to 16 million tons between 1970 and 1990, and NOx emissions only declined from 7 million to 6 million tons from 1980 to 1998.[28] The need for further overall reductions led to the imposition of cap-and-trade programs to guarantee major reductions: the Title IV SO_2 program in 1995, and the OTC NOx budget program in 1999.

2. New Source Standards

In addition to the above standards faced by existing plants, stringent federal new source standards apply to new power plants or major modifications of existing plants. These standards include New Source Performance Standards (NSPS)[29] and New Source Review standards that require the use of Best Available Control Technology (BACT) in attainment areas and Lowest Achievable Emissions Reduction (LAER) technology plus emission offsets in nonattainment areas.[30] Both BACT and LAER are stringent rate standards that are

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[20] 42 U.S.C. § 7410.

[21] The federal Clean Air Act of 1970 established the first national ambient air quality standards for SO_2, which were designed to protect health and welfare, and required states to develop "state implementation plans" (SIPs) to achieve these standards. 42 U.S.C. § 7410; 40 C.F.R. § 50.2(b). The primary air quality standards are ones "the attainment and maintenance of which . . . are requisite to protect human health," and secondary air quality standards "to protect the public welfare from any known or anticipated adverse effects." 42 U.S.C. § 7409(b). The primary standard for SO_2 was set at 0.030 parts per million (ppm), to be achieved on a calendar-year basis, and the secondary standard was 0.5 ppm, set on a three-hour basis. 40 C.F.R. §§ 50.4, 50.5. The national primary and secondary ambient air quality standard for NOx is 0.053 ppm on an annual basis, 40 C.F.R. § 50.11. However, further SO_2 and NOx reductions may be needed to meet the new primary and secondary ambient air quality standards for fine particulate matter, 40 C.F.R. § 50.7, and for ozone at 0.08 ppm. 40 C.F.R. § 50.10.

[22] 40 C.F.R. § 50.2(b) (2000). See other SO_2 standards in the note above.

[23] The EPA permitted over a dozen states to adopt SIPs allowing sources to meet the new standard by building tall stacks to disperse the SO_2 instead of reducing emissions; this practice injected SO_2 into the higher atmosphere where it facilitated the chemical reactions that produce sulfuric acid and aggravating acid precipitation. See Patton, supra note 14, at 10,162; Richard L. Revesz, *Federalism and Interstate Environmental Externalities*, 144 U. Pa. L. Rev. 2341, 2351-52 (1996); see generally, James L. Regens & Robert Rycroft, The Acid Rain Controversy 35-58 (1989) (discussing history of efforts to control acid rain). In the 1977 Clean Air Act Amendments Congress subsequently prohibited the use of tall stacks or any other dispersion technique to achieve ambient standards. 42 U.S.C. § 7423.

[24] Nonattainment areas for SO_2 only affect 24 counties and about 1 percent of the population (3.67 million people). U.S. EPA, *Sulfur Dioxide Nonattainment Areas as of June 23, 2003*. See http://www.epa.gov/oar/oaqps/greenbk/sntc.html for SO_2 nonattainment areas since Jan. 6, 2004.

[25] The baseline year used in considering the reductions achieved by the Acid Rain Program is 1980, but the data used by EPA to calculate the 1980 baseline was gathered in 1985-1987, 42 U.S.C. § 7651a(4), well after any compliance action by plants to comply with these initial Title I requirements imposed in the 1970s.

[26] See Memorandum of Understanding Among the States of the Ozone Transport Commission on Development of a Regional Strategy Concerning the Control of Stationary Source Nitrogen Oxide Emissions (Sept. 27, 1994). EPA estimates that this action reduced NOx emissions by approximately 40 percent, from a 1990 baseline level of 473,000 tons to 290,000 tons in 1995. U.S. EPA, NOx Budget Program: 1999-2002 Progress Report at 4 (2003).

[27] Nationwide rate standards based on the use of low-NOx boiler technology were imposed on coal-fired power plants in 1996 under the Acid Rain Program in Title IV of the Clean Air Act, 42 U.S.C. § 7651f.

[28] EPA, National Air Quality and Emissions Trends Report, 1999, EPA-454/R-01-004 (March 2001).

[29] 42 U.S.C. § 7411.

[30] New Source Review standards apply to new sources or major modifications of existing sources built after Aug. 7, 1977. Sources built in areas that have attained the federal ambient ozone standard set by EPA must prevent significant deterioration of air quality and install the Best Available Control Technology (BACT) for the type of plant proposed considering "energy, environmental, and economic impacts and other costs." 42 U.S.C. §§ 7475(a)(4), 7479(3). New plants in nonattainment areas must meet the even more stringent Lowest Achievable Emissions Rate (LAER) standard, which excludes considerations of cost. 42 U.S.C. § 7503(a)(2). The New Source Review standards, BACT, and LAER specify the older New Source Performance Standards only as a floor. See, e.g., 42 U.S.C. § 7479(3) (BACT), and § 7501(3) (LAER).

set on a case-by-case basis.[31] These standards have principally affected new sources and have had relatively little effect on compliance behavior of existing power plants in the programs studied.[32]

D. National/Regional vs. Local Regulation

A final caveat is that our study largely concerns programs designed to achieve national or regional levels of reductions, and not local levels. The choice between trading systems and rate-based standards is distinct from a choice between national and local regulation. Regardless of the type of regulation used to achieve national reductions, only local regulation can achieve local pollution reductions over and above national standards.

Our inquiry as to the method of regulation is however relevant to both the national or local level, as trading programs may be used to achieve these local goals as well. For example in Houston, a local cap-and-trade program was initiated in 2002 that will ultimately achieve a 90 percent reduction in NOx in the Houston-Galveston area.[33] Clearly, a national program aimed at achieving a 50 percent reduction will only partially assist Houston in this effort and added local regulation is needed. However, our study would be relevant to both situations, in clarifying whether trading would be expected to lead to emissions concentrations within whatever area is defined as the area subject to regulation.

IV. Results of Trading Programs

This paper now examines the actual emission data from four major emissions trading programs to determine whether they resulted in shifts in emissions among regions or plants that led to concentrating local emissions levels. We evaluate four major programs:

- Phase I of the SO_2 Acid Rain Program (1995-1999);
- Phase II of the SO_2 Acid Rain Program (2000 and 2001);
- Ozone Transport Commission NOx Budget Program (1999-2002); and
- NOx Discrete Emission Reduction credit trading programs in several states.

V. SO_2 Acid Rain Program

The nation's largest emissions cap and allowance trading program is the SO_2 cap-and-trade program under Title IV of the Clean Air Act.[34] The program was designed to reduce SO_2 emissions from electric utilities by 10 million tons from 1980 levels. Its passage in 1990 broke a 10-year legislative impasse to address the primary cause of acid rain.[35] The program combines an SO_2 emissions cap set to reach 8.95 million tons by 2010 with a flexible implementation mechanism that lets sources trade emissions allowances to achieve efficiency in reaching the cap.

This program has been implemented in two phases. Phase I commenced in 1995 and required the 265 largest, highest-emitting power units to make significant initial emissions reductions.[36] Starting in 2000, Phase II requires all plants above 25 megawatts in capacity (2,300 units in all) to comply with a nationwide emissions cap set at 8.95 million tons of SO_2.[37] These reduction levels were achieved, although the opportunity for banking allowances meant that many sources achieved early reductions by emitting below their allocated levels during Phase I, and have used the stored allowances to emit slightly above their allocated levels during the initial years of Phase II (see Figure 2).

The Title IV program has been called one of the most effective emissions reduction programs, principally because it achieves significant and permanent reductions at very low compliance costs. Compliance costs for full Phase II implementation are estimated at $1.2 billion per year, well below initial estimates that ranged from $3 billion to 7 billion.[38] The low cost is attributed to the flexibility afforded by both the cap approach and trading mechanism. However, the program has achieved a number of other notable results as well: virtually 100 percent compliance; high monitoring quality; low transaction cost to business; and very low administrative costs to government.[39]

A. Lack of Regional Emissions Shifts

Possibly the most important concern in the hot spot debate has been whether trading programs would lead to regional shifts in emissions. This concern was especially acute for the SO_2 Acid Rain Program, where it

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[31] New Source Review establishes an emissions rate standard set by regulators on a case-by-case basis based on the specific plant and power-generation technology. 42 U.S.C. § 7479.

[32] After 1978, new source standards for SO_2 essentially requires scrubbing, (see 40 C.F.R. § 60.43a and the standards in notes 29 & 30, supra), but only 35 units (other than new units) installed scrubbers from 1978 to 1994, when plants started to install scrubbers for compliance with the Title IV cap-and-trade program. U.S. Energy Information Agency, Pub. No. EIA-0348(99)12. Flue Gas Desulfurization (FGD) Capacity in Operation at U.S. Electric Utility Plants as of December 1999, 2 Elec. Power Annual, table 30 (October 2000). This failure of existing sources to reduce pollution promoted a series of lawsuits by states and EPA in 1999 against a number of major utility companies, only some of which have been settled.

[33] The Mass Emissions Cap and Trade Program (MECTP) has been established by the Texas Commission on Environmental Quality for certain stationary sources of nitrogen oxides (NOx) emissions in the Houston-Galveston nonattainment area (HGA). The initial cap was implemented Jan. 1, 2002, with mandatory reductions increasing over time until achieving the final cap by Jan. 1, 2007. 30 Tex. Admin. Code § 101.351. See http://www.emissionstrading.com/tx_facts.htm on the World Wide Web.

[34] This title was promulgated in the Clean Air Act Amendments of 1990, 42 U.S.C. § 7651 et seq. See generally A. Denny Ellerman et al., Markets for Clean Air: The U.S. Acid Rain Program (2000) and Byron Swift, Environmental Law Institute, *How Environmental Laws Work: An Analysis of the Utility Sector's Response to Regulation of Nitrogen Oxides and Sulfur Dioxide Under the Clean Air Act*, 14 Tulane Envtl. L.J. 309 (Summer 2001) [available at http://www.epa.gov/airmarkets/articles/index.html on the Web].

[35] Richard Cohen, Washington at Work, Back Rooms and Clean Air (1990) (discussing congressional debates); Ian M. Torrens et al., *The 1990 Clean Air Act Amendments: Overview, Utility Industry Responses, and Strategic Implications*, 17 Ann. Rev. Energy & Env't 211, 213 (1992).

[36] 42 U.S.C. § 7651c.

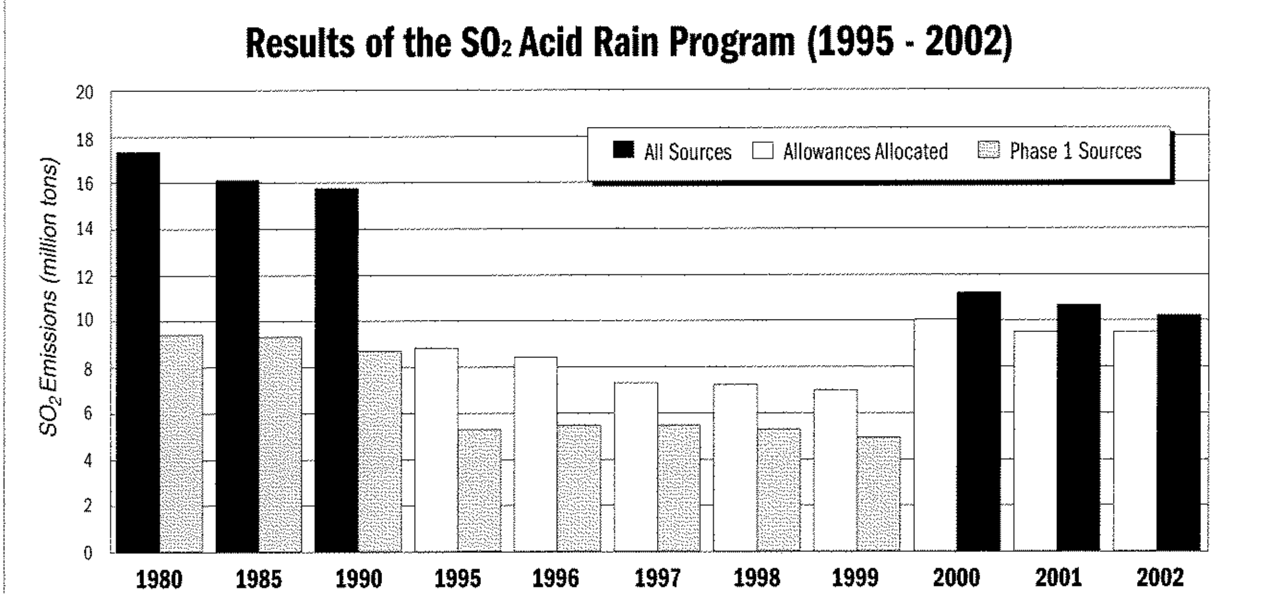
[37] 42 U.S.C. § 7651d.

[38] Ellerman, Denny, *Lessons from Phase 2 Compliance with the U.S. Acid Rain Program*, MIT CEEPR Working Paper WP-2003-009 at 4 (Cambridge, MA, May 2003) [see http://mit.edu/ceepr/www/workingpapers.htm on the Web].

[39] See EPA, Acid Rain Program Compliance Reports 1995-2002; references in note 34, supra; Brian Mclean, *Evolution of Marketable Permits: The U.S. Experience with Sulfur Dioxide Allowance Trading*, 8 Int'l J. Envtl. & Pollution 19 (1997).

   ISSN 0013-9211

Figure 2



Source: EPA, Acid Rain Program: Compliance Reports [1995-2002]; and EPA, Acid Rain Program: Emissions Scorecard [1995-2002]. Both series are available at http://www.epa.gov/airmarkets/emissions/index.html#reports on the Web. A BNA Graphic/en425g02

was feared that trading could increase emissions from Midwestern sources, whose emissions had traditionally caused significant harm in sensitive ecosystems in the Northeast states and Canada.[40] This section examines the data to see whether regional shifts have in fact occurred.

1. Results of Phase I of the Acid Rain Program

Figure 3 shows the actual results from Phase I of the Acid Rain Program by region, for all units that participated in all five years of Phase I.[41] Three numbers are illustrated for each region: the first bar shows 1980 baseline emissions levels;[42] the second, the allowances allocated on an annualized basis; and the last, actual emissions on an annualized basis. The regions are composed of the Midwest (8 states), Southeast (8 states), and Northeast (14 states).[43] The data show that during Phase I, sources collectively emitted well below the baseline levels, as required by the cap, but also below their allocation levels.

Note that there are two ways of determining the effect of the cap-and-trade program on shifts in emissions levels. The most important is the comparison of baseline emissions levels (the left bar) with actual emissions levels during the program (the right bar). This incorporates both elements of a cap-and-trade program—the reductions caused by the cap itself and any changes caused by the trading program. A second view of only the effect of trading would compare the allowance allocation (the middle bar) with actual emissions. However, it is important to view cap-and-trade systems as a complete system, as the imposition of the cap also strongly affects emissions results.

a. Greatest Reduction in the Midwest. The most important finding in this Phase I data is extremely good news: by far the greatest reductions from baseline emissions in terms of both tonnage and percentage reductions took place in the Midwest, the region with the highest emissions. Midwestern sources reduced SO_2 emissions by 55 percent from baseline levels, compared to only 45 percent in other regions (see Figure 4).

Two factors may help to explain this result. The first is that the formula for allocating allowances was itself a

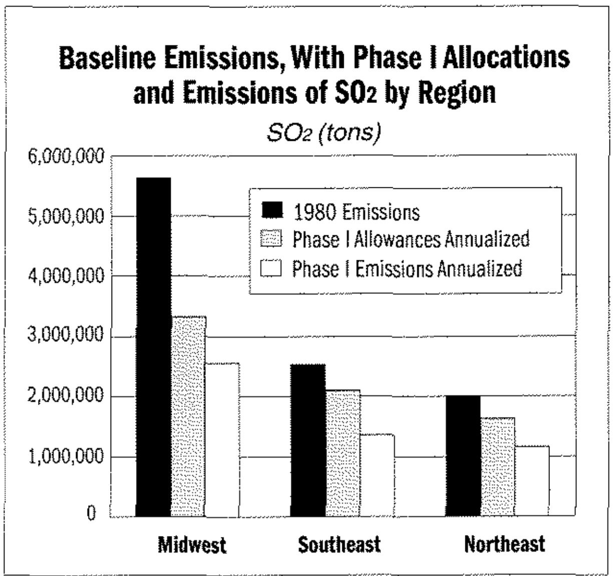
[40] Acid precipitation damage has been most pronounced in the northern tier and northeastern United States and Canada because the forests and lakes in these areas are more sensitive to acidic deposition. NATIONAL ACID PRECIPITATION ASSESSMENT PROGRAM, 1990 INTEGRATED ASSESSMENT REPORT (1991); see also JAMES L. REGENS & ROBERT RYCROFT, THE ACID RAIN CONTROVERSY 35-58 (1989).

[41] These units included the 265 "big and dirty" units that were required by Congress to participate in Phase I (Table A plants) and those other units, called substitution and compensation units, that participated in all five years of Phase I. Title IV allowed firms to select which plants would participate in Phase I as substitution units each year, and so the data does not include emissions for those substitution units that participated in fewer than 5 years.

[42] The intent of Congress in creating Title IV was to effect a 10-million-ton reduction in SO_2 from 1980 levels. However, monitoring data in 1980 was not adequate to fairly judge the actual emissions of each source, and so individual source monitoring data was used from the years 1985-1987, and then scaled to equal 1980 emissions.

[43] The Midwestern states are Illinois, Ohio, Indiana, Iowa, Michigan, Minnesota, Missouri, and Wisconsin; the Southeastern states are Alabama, Kentucky, Georgia, Florida, Mississippi, North Carolina, South Carolina and Tennessee; and the Northeastern states are Connecticut, the District of Columbia, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, and West Virginia. All sources participating in Phase I are covered within these regions except for one unit in Kansas.

Figure 3



Source: EPA, Acid Rain Program: Compliance Reports [1995-1999]; and EPA, Acid Rain Program: Emissions Scorecard [1995-1999]. Both series are available at http://www.epa.gov/airmarkets/emissions/index.html#reports on the Web.

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Figure 4

Title IV Phase I Emissions Reductions From 1980 Baseline*

Region	Total Tons Reduced	Percent Change From Baseline
Midwest	3,079,034	-55%
Southeast	1,168,720	-46%
Northeast	854,173	-43%
Total	**5,101,927**	**-50%**

*Units participating all five years only.

A BNA Graphic/en425g04

The data exclude 2 units in Kansas that were the only western units in Phase I. The tons of reduction show only those tons allocated to units (including bonus allowances).

Source: EPA, Acid Rain Program: Compliance Reports [1995-1999]; and EPA, Acid Rain Program: Emissions Scorecard [1995-1999]. Both series are available at http://www.epa.gov/airmarkets/emissions/index.html#reports on the Web.

factor in reducing emissions concentrations proportionately greater in high emissions areas such as the Midwest. In Phase I, allowances were allocated to units on the basis of 2.5 lb. SO_2 per million Btu (mmBtu) multiplied by their 1980 baseline *utilization*. This meant that the dirtier plants with high baseline emissions rates had to reduce emissions significantly more to reach their allowance allocation than cleaner sources did. The allocation method disproportionately affected sources burning the high-sulfur coals in the Midwest, leading to greater incentives to reduce emissions in this region. The second reason is that large plants reduced emissions the most,[44] which also led to greater reductions in the Midwest, as that region has relatively more large plants. The result is that by far the greatest reduction occurred in the region with the greatest emissions, thereby contributing to cooling rather than creating hot spots.

b. Consistency Among Regions in the Use of Trading. The second evident feature of the Phase I data is that the three major regions are quite similar in terms of the use of trading mechanisms: sources in each region reduced emissions by a roughly similar percent below allocations and banked most of these saved allowances.[45]

Since emissions in each region were consistently below the total amount allocated, there is also little to no discernible effect regarding the spatial shift of emissions due to trading. The only thing that can be said is that sources in the Southeast banked slightly more allowances than other regions (35 percent, as opposed to 29 percent in the Northeast and 23 percent in the Midwest). A contributing factor to this result was the "BUBA" strategy of the major utility in the region, the Southern Company, to "Bank, Use and Buy Allowances;" the company banked almost 2 million tons of allowances.[46] However, an examination of the Phase II results shows that the extra allowances banked in the Southeast were not traded to other regions, but primarily were used to allow sources in the Southeast to emit slightly above their allowance allocations in Phase II.

2. Results of Phase II of the Acid Rain Program

Phase II of the Acid Rain Program commenced in 2000 and covers all 2,300 units above 25 MW, not just the "big dirty" plants included in Phase I. In Phase II, allowance allocations were lowered to reach the final cap level of 8.95 million tons.[47] Figure 5 shows the results for 2001, the second year of implementation of Phase II.[48] The regions comprise the Midwest (8 states), Southeast (10 states), Northeast (14 states), and West (17 states).[49] Note that sources are emitting slightly

[44] See Part IV.B infra.

[45] Banking refers to emitting below allowance allocations in order to save allowances to use in future years. As shown, most firms in Phase I chose to bank allowances to use in Phase II, when they would face a much lower emissions cap. In all, nearly three-quarters of the allowances freed up for emissions trading in the first three years of Phase I were banked for later use. Ellerman 2000 at Section 6.6. Although the banked allowances are expected to be used in the future, banking causes early reductions, which has positive environmental consequences in reducing sulfur deposition earlier.

[46] See Gary R. Hart, *Southern Company's BUBA Strategy in the SO_2 Allowance Market*, in EMISSIONS TRADING 204, 205 (Richard F. Kosobud ed., 2000); see generally, Swift, 2001 at 335 and Fig. 2-5.

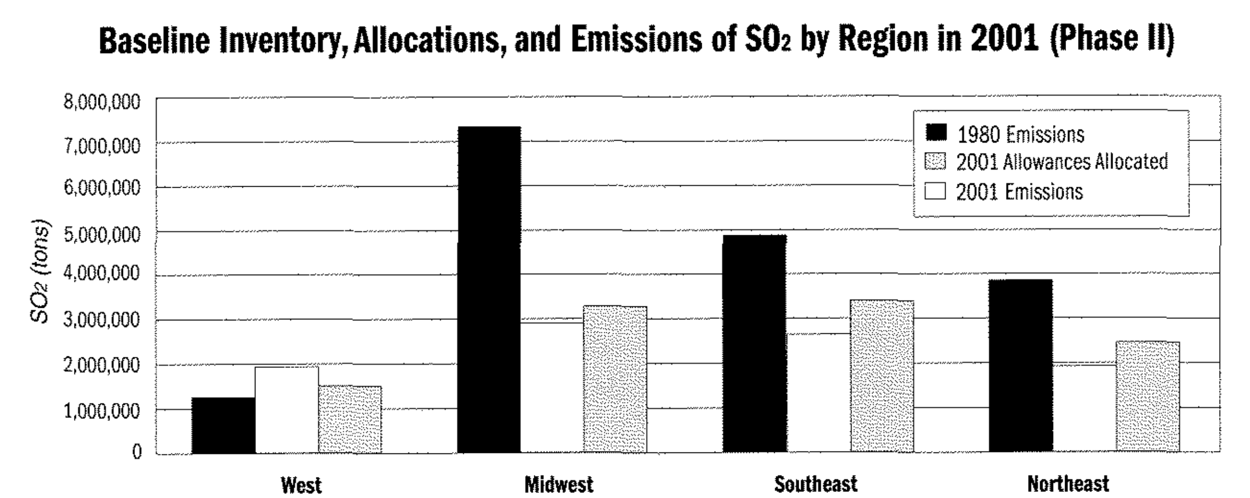
[47] 42 U.S.C. § 7651d.

[48] 2001 was selected because it is the intermediate year of implementation of Phase II (all three years of which are very similar in their emissions characteristics), and also lacked the 400,000 bonus allowances allocated in 2000.

[49] The Midwestern states are Illinois, Ohio, Indiana, Iowa, Michigan, Minnesota, Missouri, and Wisconsin; the Southeastern states are Alabama, Arkansas, Kentucky, Georgia, Florida, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee; the Northeastern states are Connecticut, the District of Columbia, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, and West Virginia; and the Western

above their allocation levels as they use up the bank of allowances saved through early reductions in Phase I.

Figure 5



Source: EPA, The EPA Acid Rain Program 2001 Progress Report, Pub. No. EPA-430/R-02-009 (November 2002); EPA, Acid Rain Program: 2001 Emissions Scorecard (2002). A BNA Graphic/en425g05

greater emissions in Phase II in the Southeast therefore reflect banking behavior by these same sources, and not any spatial flow of allowances to or from other regions.

Again, the news for hot spots is very good. In Phase II, as in Phase I, by far the greatest reductions occurred in the Midwest, the most polluted region, and all three major regions—Midwest, Southeast, and Northeast—behaved similarly in the use of trading.

Note that the relatively few plants in the West behaved quite differently from eastern plants. Western plants tend to be newer and cleaner than Eastern plants, with ready access to low-sulfur Powder River Basin coal, and so had low baseline emissions levels. As a consequence, the allowance allocation to Western plants was actually above their baseline emission levels. Their actual emissions in 2001 were slightly below their allocation level, but above their baseline level.[50]

a. Consistency Among Regions in Use of Trading. The first major point with regard to hot spots is that all three major regions achieved similar results in the use of trading mechanisms, if one compares the level of 2001 allowance allocations with the level of 2001 emissions. However, because sources are using up the bank of allowances accumulated by early reductions made in Phase I, sources in each of these regions emitted slightly over their allocated level in 2001 (although well below their baseline emissions level).

Again, the only slight difference in regions is in the Southeast, where sources had slightly more emissions in Phase II in comparison to their allocation level than the other regions. However, this is simply the converse of their behavior in Phase I, when Southeast sources had the greatest amount of early reductions (see Figure 3). The slightly greater reduction in Phase I and slightly

b. Significantly Greater Total Reductions Occurred in the Midwest. The second point relevant to hot spots is very significant: if one looks at the environmental result, in comparing 1980 baseline levels with 2001 emissions, considerably greater reductions occurred in the Midwest than in other regions. Sources in the eight-state Midwest region achieved a 55 percent reduction from baseline levels and contributed 60 percent of the total tons of abatement, far exceeding other regions, as shown in Figure 6.

The reasons for the greater reductions in the Midwest appear to be the same as in Phase I. A significant cause is that disproportionately large emissions reductions are made at the largest plants, as described in part B below. Many Midwestern plants are among the dirtiest sources (those with the highest baseline emissions), including 10 out of the highest 17 plants and 15 out of the next 34 highest plants. This over-representation of large plants accounts for 47 percent of the greater than average reductions in the Midwest.[51]

states are all those west of and including the Great Plains, except Texas.

[50] Since the allocation methodology assigned plants allowances based on baseline emissions of 1.2 lb SO_2 per million Btu (mmBtu), very low-emitting plants such as many in the West received more allowances than baseline emissions, leading to the emissions characteristics shown in Figure 5.

[51] The discussion in subpart B shows that higher-polluting plants tend to reduce emissions more than others in the SO_2 trading program, which would help to explain the greater reductions in the Midwest, as many Midwestern plants are over-represented in the third and fourth quartiles, the plants with the highest baseline emissions shown in Figure 9. A detailed analysis shows that Midwestern plants constitute 42 percent of total baseline emissions, but constitute 59 percent of the largest plants in the fourth quartile (10 out of the 17 largest plants, representing 2,574,681 out of the 4,394,151 tons of 1980 baseline emissions in this quartile), and 44 percent of the third quartile (15 of the next largest 34 plants, representing 1,911,019 out of 4,359,691 tons of 1980 baseline emissions in the next quartile); however Midwestern plants are under-represented in the smaller plants, making up only 37 percent of the third quartile and 29 percent of the quartile with the lowest emitters. If Midwestern sources were to have behaved according to the national average, their baseline emissions of

Figure 6

Phase II SO2 Emissions Reductions From Baseline Levels, by Region in 2001

Region	Total Tons Reduced	Percent Change From Baseline
West (17 states)	(+239,430)	+23%
Midwest (8 states)	4,046,904	-55%
Southeast (10 states)	1,466,343	-30%
Northeast (13 states)	1,404,920	-37%
Total	**6,678,737**	**-39%**

Source: EPA, The EPA Acid Rain Program 2001 Progress Report (Pub. No. EPA-430/R-02-009 (November 2002); EPA, Acid Rain Program: 2001 Emissions Scorecard (2002). A BNA Graphic/en425g06

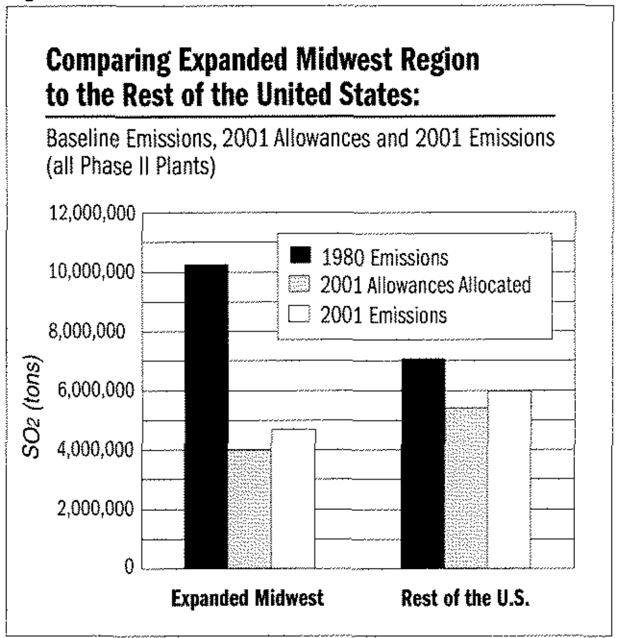
A second factor is that Title IV's allowance allocation method disproportionately reduced allowance allocations to the dirtiest sources—shown by the difference between baseline emissions and allocation levels in Figure 5. Both of these factors indicate that the large reduction made in the Midwest is not a coincidence, but a predictable aspect of the SO^2 allowance trading program.

c. Reductions Even Greater in an Expanded Midwest Region. The finding of a disproportionately large amount of emissions reduction in the Midwest is reinforced if one slightly expands the Midwest to include Kentucky, Tennessee, and West Virginia. These states behaved quite similarly to Midwestern ones and altogether achieved a 54 percent reduction—compared to only a 16 percent reduction in the rest of the United States. Together, the 11 states in this expanded Midwest region constitute 60 percent of baseline emissions, but contributed a very high 80 percent of all tons of abatement from 1980 emissions levels. Again, this is extremely good news for hot spots—a disproportionately high portion of reductions came from the most polluted region (see Figure 7).

d. Counterfactual Emissions Also Show Greater Midwestern Reductions. In the above analysis, we compare actual Phase II emissions with baseline emissions to determine the contribution of Midwestern sources. We note that a similar conclusion is reached if one compares baseline emissions to an estimate of the "counterfactual emissions" that would have occurred in 2001 without Title IV. The Center for Energy and Environmental Policy Research of the Massachusetts Institute of Technology (MIT) calculated such counterfactual emissions and determined that the great majority, 77

7,326,537 tons should have been reduced by only 44 percent to 4.1 million tons; this over-representation among large sources alone would predict that Midwest sources should reduce emissions to approximately 3.7 million tons. Actually, Midwestern sources emitted 3.28 million tons in 2001, so the over-representation of large sources explains almost half (47 percent) of this difference between predicted (4.1 million) and actual (3.28 million) emissions. The lower allowance allocation likely also played a causative role.

Figure 7



Source: EPA, The EPA Acid Rain Program 2001 Progress Report [Pub. No. EPA-430/R-02-009 (November 2002); EPA, Acid Rain Program: 2001 Emissions Scorecard (2002). A BNA Graphic/en425g07

percent, of abatement has been achieved at the older, high-emitting plants located in Midwestern states.[52]

We conclude therefore that the Phase II cap-and-trade program led to emissions reduction exactly where they are needed most to address health and environmental problems—in the Midwest—where sources achieved three times the reductions from 1980 baseline emissions as sources in the rest of the country.

B. Analysis of Plant-Level Emissions

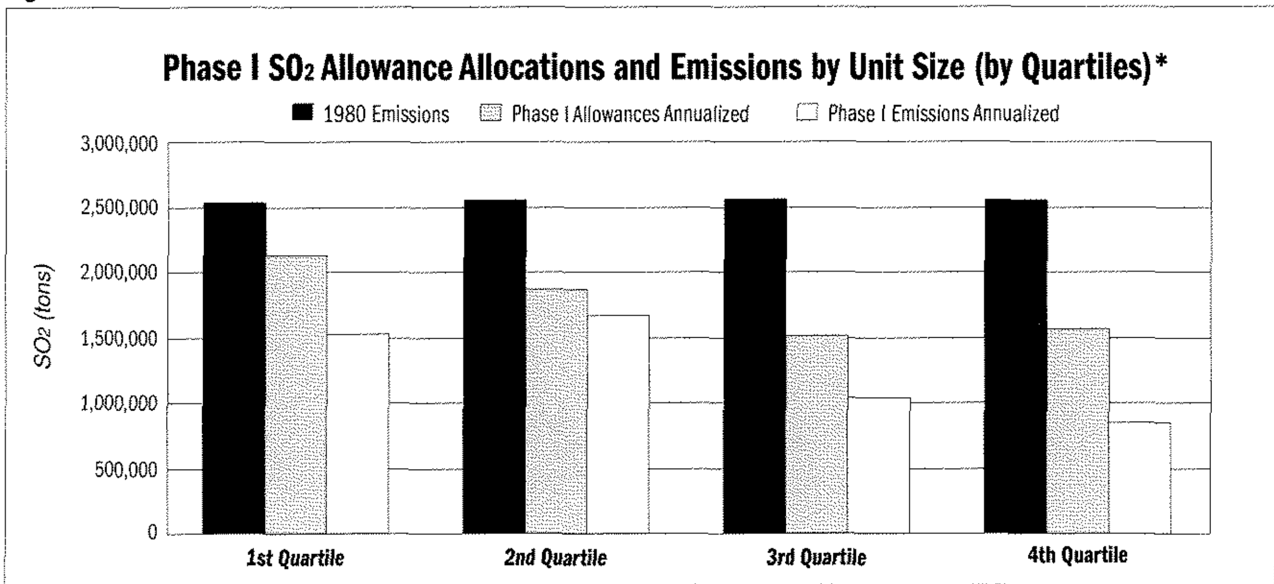
A different way to evaluate the environmental consequences of a cap-and-trade approach is to assess where emissions reductions have taken place on a plant level. Did cap-and-trade programs reduce emissions evenly across plants, or were there disproportionate reductions in plants with relatively high or low emissions levels? Reductions at higher-emitting plants would have a beneficial tendency to cool, and not create, hot spots.

The results from all the examined trading programs show strongly that disproportionately greater reductions were made at the higher-emitting plants. A plant-level analysis therefore shows that trading programs result in the dispersion, not the concentration of emissions.

Figures 8 and 9 show emission data by size of the source (unit or plant) for Phases I and II of the Acid Rain Program. Sources are grouped into four quartiles according to plant size, with each quartile representing sources with 25 percent of baseline emissions. The fourth quartile on the right side represents a few large (highest-emitting) sources, whereas the first quartile on the far left represents a large number of small

[52] Ellerman, Denny, *Lessons from Phase II Compliance with the Acid Rain Program* at 4. MIT CEEPR Working Paper 2003-009 (Cambridge, MA 2003) [available at http://web.mit.edu/ceepr/www/2003-009.pdf on the Web].

Figure 8

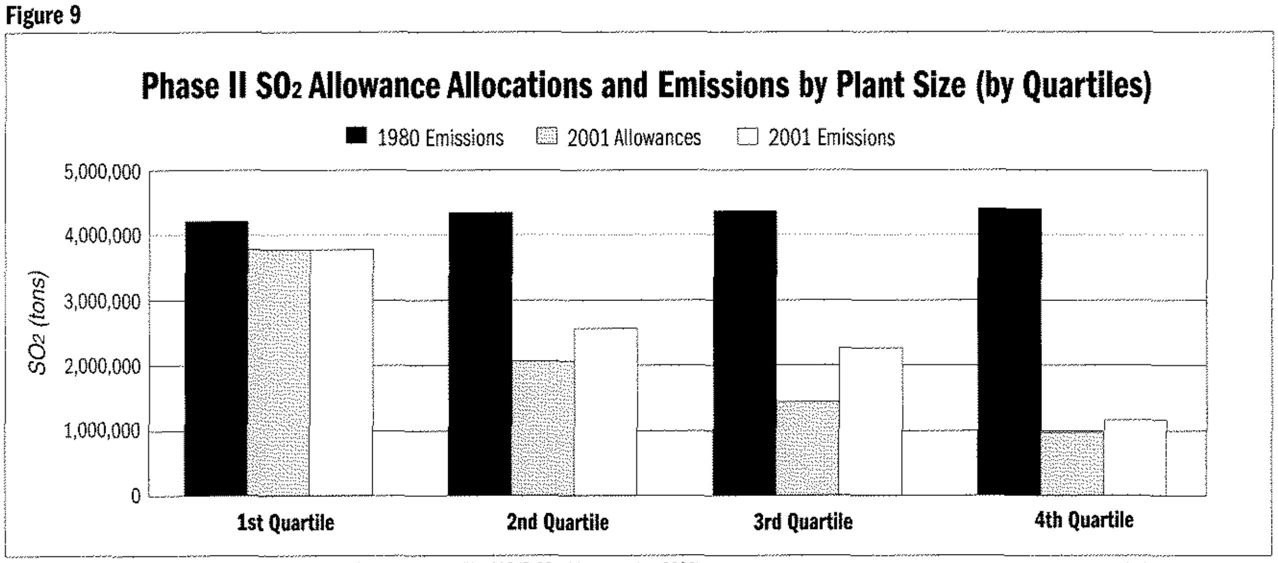


*This table was sorted by units based on the amount of their baseline emissions; with each quartile representing sources responsible for approximately 2.5 million tons of SO_2 in 1980. The 24 units (at approximately 11 plants) with the largest baseline emissions comprise the "large dirty" units in the fourth quartile; the next largest 42 units comprise the third quartile; there are 69 units in the third quartile; and the remaining 235 units are in the fourth quartile representing the units with the smallest baseline emissions level.

A BNA Graphic/en425g08

Source: EPA, Acid Rain Program: Compliance Reports [1995-1999]; and EPA, Acid Rain Program: Emissions Scorecard [1995-1999]. Both series are available at *http://www.epa.gov/airmarkets/emissions/index.html#reports on the Web.*

Figure 9



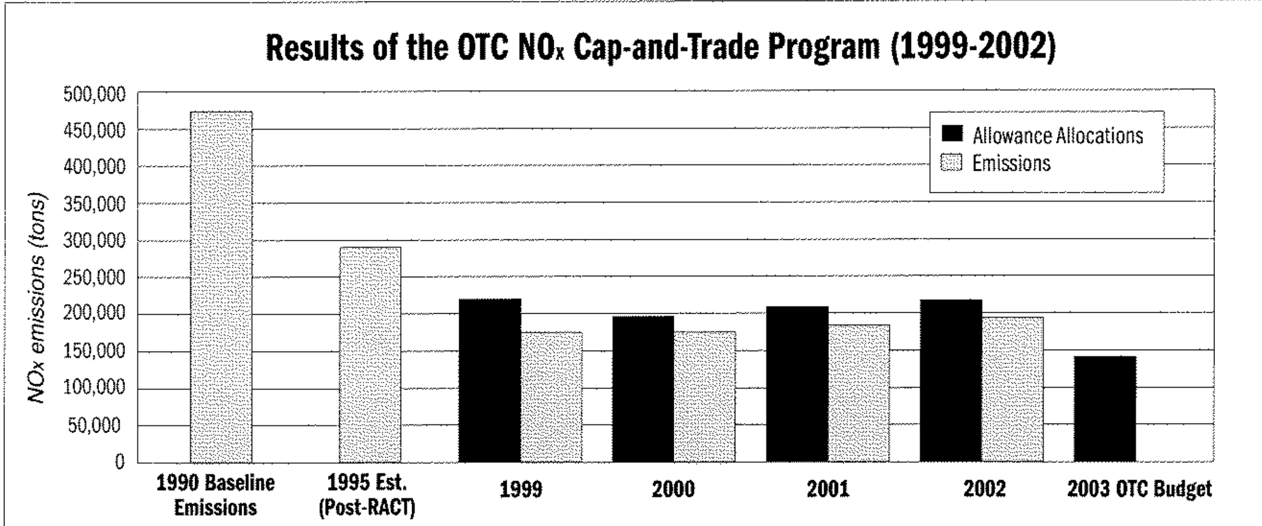
Source: EPA, The EPA Acid Rain Program 2001 Progress Report. Pub. No. EPA-430/R-02-009 (November 2002); EPA, Acid Rain Program: 2001 Emissions Scorecard (2002).

A BNA Graphic/en425g09

sources.[53] The data reveals that the larger sources achieved significantly greater emissions reductions in both Phase I and II, and especially in Phase II.

[53] We choose to sort by size of baseline emissions (as opposed to another factor such as capacity) because the most significant environmental goal is the total reduction of pollution from baseline emissions to present emissions. The quartiles sort sources by size into four groups with roughly equivalent total baseline emissions, such that the relatively "large dirty" sources (with the highest baseline emissions levels) make up the fourth quartile, the next largest in terms of their baseline emissions make up the third quartile, and many sources with relatively low baseline emissions levels comprise the first quartile. This allows us to determine whether reductions are made at the few "large dirty" source in the fourth quartile, or the

Figure 10



Source: EPA, OTC NOx Budget Program Compliance Reports [1999 - 2002]; available at http://www.epa.gov/airmarkets/cmprpt/index.html on the Web. A BNA Graphic/en425g10

For Phase I, Figure 8 shows that the largest units in the fourth quartile reduced emissions the most, by 67 percent below 1980 baseline levels, compared to 59 percent for the third quartile, 35 percent for the second, and 40 percent for the fourth quartile containing the smallest sources.

The finding of disproportionately greater reductions from the largest sources is even more striking in Phase II, as shown in Figure 9. The data show that significantly greater reductions have been achieved as average plant size grows larger. The fourth quartile, representing the 17 Phase II plants with the highest baseline emissions, reduced their emissions by 73 percent from baseline levels, compared to a 48 percent reduction by the next 34 plants in the second quartile, 41 percent from 71 plants in the third, and only 10 percent from the remaining 887 smallest plants.[54]

These data confirm a general prediction about cap-and-trade programs, which is that they will tend to create incentives for the dirtiest plants to clean up the most, where the economies of scale are the greatest. Capital investment in the form of process equipment or control equipment, such as scrubbers, would be predicted to be made at large plants where the most reductions can be achieve for the investment, and where the per-ton cost of reductions will be cheapest. The actual evidence confirms this theory, and shows convincingly that, if anything, trading may be expected to cool hot spots and not create them.

VI. OTC NOx Budget Program

The second major U.S. cap-and-trade program has been implemented by the Ozone Transport Commission, a coalition of 12 Northeastern states with a unified program to reduce NOx emissions from electricity generators and industrial sources during the summer ozone season.[55] Phase I commenced in 1994 and imposed rate-based standards similar to the NOx rate standards imposed under Title IV.[56] Phase II of the program imposed a seasonal emissions cap and allowance trading program for NOx to achieve additional reductions, which covered nine of the 12 states from 1999 to 2002. In 2003, Phase III reduced the emissions cap level further, as the OTC program becomes part of a larger NOx "SIP call" trading program for Eastern states.[57]

Although the OTC budget program is a cap-and-trade program similar to the Title IV SO_2 program, it has a number of different features. Instead of allocating allowances to each source, it allocated allowances to each state in accordance with that state's share of the regional budget. The states in-turn allocated the allowances to sources within the state. Another feature was that the OTC states established an Inner, Outer, and Northern zone for the purpose of setting reduction targets, but because trading was allowed on a 1:1 basis between all zones, roughly equivalent emissions reductions were achieved in all zones.[58] Although banking is allowed, a mechanism called flow control potentially reduces the amount of banked allowances that can be used in future years.[59]

progressively larger number of smaller sources in the following quartiles.

[54] Note that the analysis for Phase I is for units, and that for Phase II is for plants (which may contain several units), although the findings are expected to be similar in either case. Since Phase II has many more sources, we show data at the plant level, as we find the most environmentally relevant concern is the level of emissions at the site or plant level.

[55] See Memorandum of Understanding Among the States of the Ozone Transport Commission on Development of a Regional Strategy Concerning the Control of Stationary Source Nitrogen Oxide Emissions (Sept. 27, 1994), available at http://www.otcair.org on the Web.

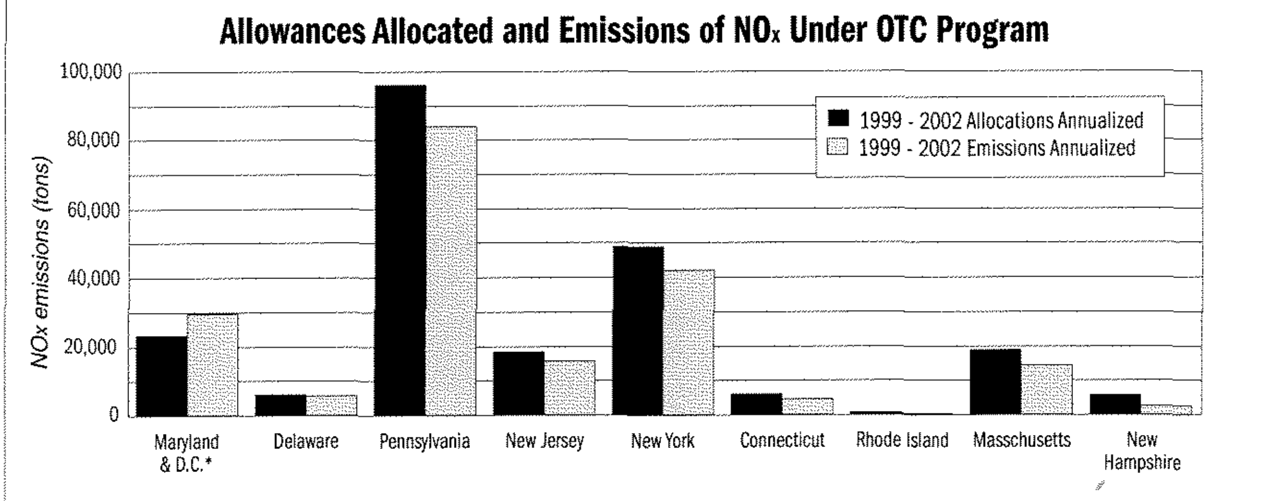
[56] In Phase I of the OTC program, states required sources to install Reasonably Available Control Technology (RACT) by 1994, a standard roughly equivalent to the Title IV NOx standards based on low-NOx burner technology, 42 U.S.C. § 7651f, but applying almost one year earlier.

[57] EPA, NOx Budget Program: 1999-2002 Progress Report at 4-5 (2003), available at http://www.epa.gov/airmarkets/otc/otcreport.pdf on the Web.

[58] Id. at 7.

[59] See generally EPA, OTC NOx Budget Program: 2002 Compliance Report 2 (2003), available at http://www.epa.gov/airmarkets/cmprpt/otc02/index.html on the Web.

Figure 11



*Note that most Maryland and DC sources did not participate in the program until 2001, and all sources did not fully participate until 2002, due to a law suit. The data in the table show only 2002 allocations and emissions.

A BNA Graphic/en425g11

Source: EPA OTC Budget Program Compliance Reports; (Maryland data for 2002 only).

The OTC NOx cap-and-trade program, which reduced emissions by 60 percent from 1990 baseline levels, and by 35 percent from estimated RACT levels achieved under Phase I.[60] Surprisingly, sources have lowered overall emissions by more than the allowance allocation in each of the four ozone seasons (1999-2002), as shown in Figure 10. Also, as discussed below, emissions were below allowance allocation levels in all states but Maryland, whose entry into the program was delayed due to a lawsuit. Also, analyses by EPA and independent researchers show that the cap-and-trade program has been effective in reducing both average and peak emissions levels by a similar proportion, alleviating a concern that the OTC program might not reduce short-term peak NOx emissions.[61]

We examine the emissions data to determine the effect of trading on emissions concentrations in two different ways. First, we look at the data by state to determine if shifts in emissions occurred regionally, and then by Inner and Outer zones to see if there were any east-to-west emissions shifts. As with the SO_2 program, the data show very little regional shifting of emissions.

A. Analysis of Emissions Shifting by State

Viewed on a state-by-state basis, very little emissions shifting can be observed, as emissions reductions in most states, especially the large ones, were quite consistent, averaging 11 percent below their allocated levels. However, slightly greater than average emissions reductions occurred in New England (due in part to an unplanned outage of a New Hampshire unit) and slightly less than average in Maryland. The result in Maryland, however, was affected by a lawsuit that delayed the entry of most sources, which created uncertainty and may have allowed sources to take advantage of the lower-than-expected price of allowances. This situation, though anomalous, created a small emissions shift equivalent to about 3 percent to 4 percent of total allocations.[62] However, this shift was small and in a climatically neutral north-to-south direction, and so should not affect transport or hot spots (see Figure 11).

B. Viewing Emissions by Inner and Outer Zones

Another way to judge whether spatial emission shifts occurred under the OTC NOx program is to view whether there were "wrong-way" shifts in emissions that moved emissions upwind, or in an east-to-west direction. This can be readily determined because the OTC program was divided into an Inner Zone comprising the heavily populated corridor from Washington, D.C., to Boston, almost all of which is classified as an ozone nonattainment area, and a more westerly Outer Zone.[63]

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[60] EPA, NOx BUDGET PROGRAM: 1999-2002 PROGRESS REPORT at 6-7 (2003). Sources received allowance allocations representing either a 55 percent or 65 percent reduction from 1990 baseline levels, depending on whether they were located in the Outer or Inner zones. In addition, 24,635 bonus allowances were provided, which slightly increased allocations.

[61] Id. at 8. See also Farrell, Alexander E., *Temporal Hotspots in Emissions Trading Programs: Evidence from the Ozone Transport Commission NOx Budget*. Presented at an EPA conference, *Market Mechanisms and Incentives: Applications to Environmental Policy* (Washington, D.C., May 1-2, 2003).

[62] Due to the lawsuit, Maryland sources did not participate fully in the program until 2002, when they emitted 6,290 tons over their allocation level. In contrast, sources in New England emitted an average of 9,000 tons below their allocated levels. Data from EPA, *2002 NOx Budget Program Compliance Report* at 2 (June 25, 2003). Therefore, if one compares the lower emissions in New England and the higher emissions in Maryland to the average emissions rate achieved in all states, the result is that 7,500 tons of emissions were "shifted" annually from New England states to Maryland due to the flexibility allowed by trading. Note however that a portion of these net reductions will never be emitted, due to flow control that reduces the value of banked tons.

[63] See Ozone Transport Commission, *NOx Budget Program: 1999-2002 Progress Report* at 5 (EPA, Washington, D.C., 2003) [available at http://www.epa.gov/airmarkets/otc/

The data show that from implementation of the program resulted in comparable reductions in both zones—a 59 percent reduction in the Outer Zone and a 58 percent reduction in the Inner Zone (see Figure 12).[64] Although the reduction levels were almost identical to the extent there was a one-percent shift in emissions, in terms of wind direction it was a "right-way" shift in emissions from western to eastern sources, reducing transport of NOx. A contrary view is that reductions in nonattainment areas are 1 percent less than reduction in more westerly attainment areas, which is not desirable. Either way, the shift in emissions was slight, showing again that trading programs have achieved consistency in emissions results.

C. Daily Emissions Levels

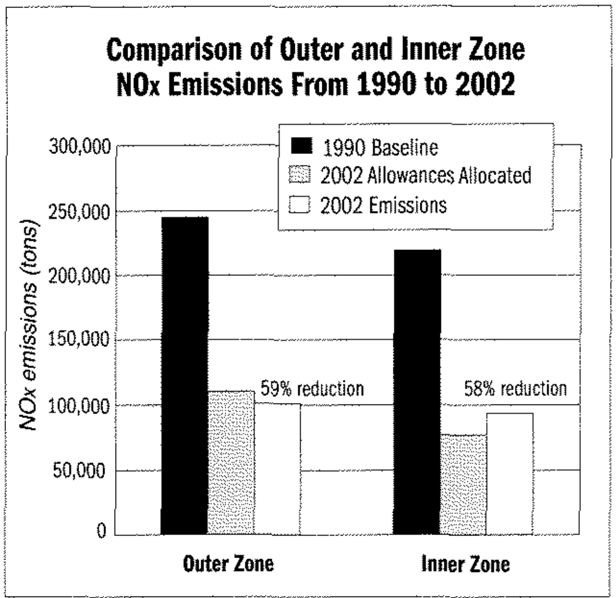
An even more unusual finding concerns the lack of *temporal* shifting of emissions, even on a daily basis, in the OTC NOx cap-and-trade program. The regulation of NOx presents a problem for any regulatory system because NOx formation is episodic and occurs principally on hot summer days. More power is also generated on hot days due to increased demand, potentially causing the most pollution on precisely the worst days. However, it is hard to regulate daily pollutant releases, either through a cap-and-trade program that caps total seasonal tons, or via rate standards, which allow more pollution to occur whenever generation increases.

Notwithstanding these issues, the NOx cap-and-trade program resulted in lowering tons of NOx emissions both in total and on high.-emissions days. Both average and peak emissions during the ozone season declined by roughly the same amount after imposition of the Phase II cap.[65] EPA noted that this finding "shows that the seasonal budget is reducing daily emissions, even on the days with the highest emissions."[66] This finding suggests that cap-and-trade programs are possibly more effective than rate-based standards in consistently reducing emissions regardless of short-term changes.

VII. Discrete Emission Reduction Credit Trading

The oldest form of emissions trading is credit trading programs. EPA has allowed market-incentive policies, including open-market emissions or credit trading programs, to be used for criteria pollutants[67] under the Clean Air Act in order to reduce the costs of compliance without sacrificing air quality.[68] Offset programs were established in 1977, and discrete emission reductions

Figure 12



Source: EPA, NOx Budget Program: 1999 - 2002 Progress Report (2003)

A BNA Graphic/en425g12

(DER) credit trading programs have been adopted in six states since 1995. DER programs provide flexibility for sources complying with federal emissions standards that do not involve new sources or hazardous pollutants (such as "reasonably achievable control technology" or RACT standards) and with sources complying with state emissions standards.

These "open-market" systems are established through a certification process in which sources carry out specific projects to create emissions reductions, and then obtain regulatory approval of the tons of reductions created, which can then be traded in the form of emission credits. Although offset programs are frequently used, the DER credit trading programs have resulted in relatively few trades, due in part to the transaction costs involved and regulatory uncertainty.[69]

A. Largest Plants Reduced the Most

A review of the results of six state DER programs and the state procedures involved was recently published by

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otcreport.pdf on the Web]; there was also a Northern Zone, but this had little relevance during Phase II, as Maine and Vermont did not participate, and New York and New Hampshire included their northern areas in the Phase II program.

[64] Note that equivalent emissions reductions were made in both zones despite differing allocation of allowances. Sources in the Inner Zone received allowances representing a 65 percent reduction from 1990 levels, whereas Outer Zone sources receive allowances representing only a 55 percent reduction. The states debated whether or nor to impose ratio restrictions on trading between the zones, but eventually decided to allow inter-zonal trading on a one-to-one basis. Id. at 7.

[65] Id. at 8.

[66] Id.

[67] Criteria pollutants are carbon monoxide, lead, NOx, SO_2, volatile organic compounds, and particulate matter.

[68] EPA has established guidelines for the use of such programs as economic incentive mechanisms. See EPA, IMPROVING AIR QUALITY WITH ECONOMIC INCENTIVE PROGRAMS: FINAL GUIDANCE, EPA-452/R-01-001 (January 2001); U.S. EPA, Final Economic Incentive Rules: 59 Fed. Reg. 16,690 (April 7, 1994); U.S. Environmental Protection Agency, Proposed Model Open Market Trading Rule for Ozone Smog Precursors, 60 Fed. Reg. 39,668 (Aug. 3, 1995); EPA, Emissions Trading Policy Statement, 51 Fed. Reg. 43,814 (Dec. 4, 1986) (pt. I).

[69] These programs are reviewed in Environmental Law Institute, *Emission Reduction Credit Trading Systems: An Overview of Recent Results and an Assessment of Best Practices*. Environmental Law Institute (October 2002), available at http://www.elistore.org/reports_detail.asp?ID=10694 on the Web. In general, open market credit trading programs have not generated significant trading opportunities or cost reductions. See generally, Dudek, Daniel & John Palmisano, *Emissions Trading: Why Is This Thoroughbred Hobbled?*, 13 Colum. J. Envtl. L. 217 (1988); Hahn, Robert & Gordon Hester, *Where Did All the Markets Go? An Analysis of EPA's Emissions Trading Program*, 6 Yale J. on Reg. 109 (1989).

Figure 13

New Jersey B Generation and Use of NOx DERs by County Ozone Attainment Status (1992-2000)

	Severe (18)	Moderate (2)	Marginal (1)
DERs Generated	32,908 (99%)	295 (1%)	0
DERs Used	1,056 (72%)	403 (28%)	0

Sources: New Jersey OMET Registry for DER credit generation and use by county (July 2001); EPA Air Data B Net Count Report (July 17, 2001) for county 1999 NOx emissions data. A BNA Graphic/en425g13

the Environmental Law Institute.[70] The most concrete conclusion that can be made about emission shifting in DER credit trading programs for NOx is that the generation of credits (equivalent to emission reductions) occurred at the largest plants. The study found that in four of the six states, over 90 percent of credits were generated by fewer than five sources that were typically the largest emitters in the state: 94 percent in Texas, 96 percent in New Jersey and Massachusetts, and 99 percent in New Hampshire. On the other hand, actual credit use, while much less than credit generation, was dispersed among a large number of smaller sources, with typically 10-30 tons being used by a source in one year.

These data confirm a general expectation about trading programs—that they will lead to emission reductions at the largest sources, where the capital cost of pollution abatement strategies or controls can be spread over the largest number of tons and hence lower the per-ton cost of generating a credit.

B. Emissions Shifting at the Area Level

The available regional data for DER programs only allow a limited assessment of emission shifting at the area level for NOx. County-level emissions trading data can be examined in two states, New Jersey and Texas, which give some indication of where emissions were generated and used, and hence allows some assessment of emission shifts.[71] Figures 13 and 14 show that DER programs have tended to reduce emissions in the most polluted counties. To the extent they have shifted emissions at all, the shift has been towards less polluted counties. This pattern indicates that DER programs have cooled hot spots to a limited extent, and led to more evenly dispersed pollution in both states.

New Jersey. Figure 13 shows that 99 percent of DERs in New Jersey were generated in counties with "severe" status for ozone attainment, but 28 percent of the modest DER use was in counties with "moderate" status. This represents a small but slightly beneficial shift of emissions from heavily polluted counties to less polluted counties, reducing rather than increasing emissions concentrations.

Another indication in New Jersey that credit trading did not contribute to hot spots was the simple element of dispersion. Ninety-eight percent of credits were generated in two counties with severe nonattainment status—Hudson and Mercer—whereas credits were used in 10 counties, none of which used more than 28 percent of the total credits used.[72]

Figure 14

Texas B Generation and Use of NOx DERs by County Ozone Attainment Status

	Severe (8 counties)	Serious (5 counties)	Moderate (3 counties)
DERs Generated	38,527 (95%)	0	2,241 (5%)
DERs Used	368 (50%)	368 (50%)	0

Sources: DER credit generation data by county from 1997-2000: Texas DER Registry (version of Oct. 20, 2000); credit use data from Texas Natural Resources Conservation Commission, *Discrete Emissions Credit Banking and Trading Program Audit* (draft, Austin, Texas 2001); county 1999 NOx emissions data from EPA Air Data Net Count Report (July 17, 2001). A BNA Graphic/en425g14

Texas. In Texas, while 38,527 DER credits were generated from 1997 to 2000, only 736 credits were used, making any conclusions tentative. Again, DER generation, equivalent to emissions reductions, is disproportionately higher in severe nonattainment counties where the environmental benefits are greatest; the limited use occurred in both severe and moderate nonattainment counties. Again, DER trading appears to have slightly reduced emissions disproportionately more in severely polluted regions than in less polluted ones (see Figure 14).

VIII. Conclusions

A review of the actual performance of trading programs shows that none of the programs evaluated has resulted in regional shifts of emissions, and all trading programs led to proportionately greater reductions from the larger sources. Overall, the data from the programs reviewed in this report indicate that the effects of trading have been slight but beneficial with regards to geographic hot spots, in the sense of smoothing out emissions concentrations instead of concentrating them, and cooling and not creating hot spots.

A. Trading Has Not Led to Regional Concentrations

At the area level, the principal conclusion that emerges from a review of the data is that trading programs have generally led to consistent behavior in the use of trading mechanisms among regions. In the SO_2 program, the three large regions (Midwest, Northeast and Southeast) behaved very similarly in both phases of

[70] Environmental Law Institute, *Emission Reduction Credit Trading Systems (2002)*, supra note 69.
[71] Analysis derived from id. at 15-18.

[72] Id.

the program, with sources banking allowances to a roughly equal extent during Phase I and emitting slightly over their allowance allocation in the initial years of Phase II. There was also a high degree of consistency among states in the OTC NOx program, even though some states have only a handful of major sources.

In particular, the concern that trading in the SO_2 program could result in "upwind" sources in the Midwestern region, disproportionately increasing emissions that affect "downwind" areas in the Northeast, did not occur. In fact, due to the number of large plants in the Midwest as well as Title IV's allocation method, there was a disproportionate decrease in emissions in the Midwest, as Midwest sources contributed a disproportionate 60 percent to 80 percent of emissions reductions.[73] The working of the trading program helped to actually reduce emissions in this region with historically high SO_2 levels.

An appropriate conclusion seems to be that in the power sector, any significant group of sources would be expected to behave similarly in a cap-and-trade program, and so negate the idea that there will be emissions shifting. Further research is needed on how many sources need to be included in a trading program in order for it to exhibit such consistency; the evidence from the OTC program at a state level suggests that even a few sources may be enough.

B. Allocation Systems May Help Cut Concentrations

The disproportionate SO_2 emissions reductions in the Midwest appear to be caused largely by the disproportionate reductions at larger plants, but also in part by the method by which allowances were allocated. The SO_2 program allocated allowances to sources based on their past utilization (in Phase II, baseline mmBtu multiplied by 1.2 pounds of SO_2). This method results in dirty plants receiving far fewer allowances in comparison to their past emissions than cleaner plants of a similar size, since allowances are allocated based on past heat input and not on past emissions. This method, therefore, provides a positive incentive for plants with the highest baseline emissions (i.e. those using high-sulfur Midwestern coal) to reduce pollution in areas where it is most needed.[74]

C. In Trading Programs, Largest Sources Reduce Emissions Most

Another striking finding of the results is that emissions trading programs have consistently led to significantly greater emissions reductions at the highest-emitting plants.

In the SO_2 program's Phase II, the largest plants reduced emissions by 73 percent from baseline levels, compared to a 48 percent reduction by the next largest quartile, 41 percent from the third quartile, and only 10 percent from the smallest plants. This is because the economics of installing capital equipment for process changes or controls provides the greatest financial returns when installed in the largest sources, leading to disproportionate emissions reductions at those sources. This attribute of cap-and-trade programs is significant in dispersing and not concentrating emissions, or cooling and not creating hot spots.

D. Summary

Although trading programs do not guarantee reductions at each source, the above data show that they have achieved consistent results between regions, and have also led to proportionately greater reductions at higher-emitting plants. The SO_2 trading program in particular significantly reduced existing hot spots by causing disproportionate reductions in the Midwest. This finding is attributable both to the allocation method used in Title IV and for the tendency in trading programs for the largest sources to reduce emission the most. These findings indicate that cap-and-trade programs similar to those evaluated would not be expected to lead to emissions concentrations or hot spots.

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[73] Sources in the eight state Midwestern region (see Figure 6) constituted 42 percent of baseline emissions, but contributed 60 percent of emissions reductions in Phase II; in an expanded 11-state Midwest region (Figure 8), sources comprised 60 percent of baseline emissions and contributed 80 percent of all reductions.

[74] Note, however, that a 10 percent difference in allocation levels to plants in the Inner and Outer zones of the OTC NOx program did not result in any difference in resulting emissions levels. This is in accord with the general trading theory—in perfectly fluid markets, allocations should not make a difference, as emissions reductions should be made where it is most cost-effective to do so. A possible explanation for the discrepancy between the two programs is that the disparity in allocated amounts was simply greater in the SO_2 program, leading to a positive, albeit modest, response. Midwestern sources received 20 percent fewer allowances than those in other states (a 60 percent versus a 40 percent reduction from baseline emissions), twice the difference than in the OTC program. Another possible factor that requires further research is that, given the autarkic response of firms to regulation, allowance allocation systems that differentiate the allocation to sources by region may affect emissions results more if the trading regions segregate firm territories instead of split them. Therefore, allocation systems that split a state in two like the OTC program's Inner and Outer zones may make little difference in firm behavior, as power companies that have plants throughout the state would tend to create a system-wide compliance strategy that would not depend on the allowance allocations to particular sources. Given that firms behave autarkicly, we might expect a more pronounced difference in emissions result if trading programs make different allocations to different states or regions that include all of a firms territory, such as occurred in the SO_2 program.

   ISSN 0013-9211

   ISSN 0013-9211

Attachment 5

Command Without Control: Why Cap-and-Trade Should Replace Rate Standards for Regional Pollutants

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Command Without Control: Why Cap-and-Trade Should Replace Rate Standards for Regional Pollutants

Byron Swift

Byron Swift is a Senior Attorney and Director of the Energy and Innovation Center at the Environmental Law Institute. His work addresses issues in designing environmental law to achieve high environmental quality while promoting innovation and lowering costs. He can be contacted by e-mail at swift@eli.org. An overview of nitrogen oxides and sulfur dioxide regulation of power plants in the 1990s will be published in 14 TUL. ENVTL. L.J. 1 (2000). Background research for this Article was supported in part by The Joyce Foundation and A.W. Mellon Foundation. The author thanks these foundations, and the many others who generously provided advice and data, with particular thanks to the Clean Air Markets Division of the U.S. Environmental Protection Agency, Joel Bluestein, Dallas Burtraw, Denny Ellerman, and Debra Knopman. The views expressed are of the author, and not necessarily those of the Environmental Law Institute, The Joyce Foundation, or the A.W. Mellon Foundation.

[31 ELR 10330]

I. Introduction

While current environmental laws provide us with an adequate environmental protection system, they must be reformed if we hope to achieve an excellent one. This Dialogue examines regulation of nitrogen oxides (NO_x) and sulfur dioxide (SO_2) in the power sector over the past years, and provides a direct comparison of the rate-based methods used in both the Title IV and new source review (NSR) programs of the Clean Air Act (CAA)[1] with cap-and-trade programs that have been established for both pollutants. This examination reveals the need to move away from the use of end-of-pipe rate standards and the old source/new source distinction in order to create an efficient and effective regulatory system that embraces the principles of pollution prevention and sustainable development.

II. An Overview of SO_2 and NO_x Regulation in the Power Generation Sector

A. Regulation of Existing Sources: Title IV and Ozone Transport Commission (OTC) Standards

Emissions of NO_x and SO_2 from most existing power generation sources are regulated under Title IV of the CAA established in the CAA Amendments of 1990.[2] Title IV creates two very different systems to achieve major reductions in SO_2 and NO_x emission from utility sources: a national emissions cap and allowance trading approach for SO_2, and rate-based standards for NO_x. Northeastern states comprising the Ozone Transportation Region also initiated NO_x regulation in 1995 and instituted an emissions cap and allowance trading system for NO_x in 1999. The results of these programs are described below.

1. Emissions Cap and Allowance Trading Program for SO_2

Electric utilities are responsible for 60% of national SO_2 emissions,[3] and Title IV imposes a permanent cap on utility SO_2 emissions at 8.95 million tons, roughly one-half the 1980 baseline.[4] Title IV, unlike traditional regulation that imposes source-specific rate limits, implements an industrywide mass standard known as an emissions cap. The emissions cap and allowance trading program for the SO_2 program is divided in two phases. Phase I began in 1995 and required the 263 dirtiest coal-fired electric-generating units (referred to as Table A units) to reduce their emissions to a base level of 5.7 million tons of SO_2.[5] Phase II implements a stricter standard in the year 2000, and requires all generating units larger than 25 megawatts to reduce their emissions to the final cap amount.[6]

To implement the cap, allowances equivalent to a ton of SO_2 are assigned to each affected generating unit based on their generation rates from the historic base period of 1985-1987, scaled down so that the aggregate emissions equaled the target emissions cap.[7] Although the annual and the bonus allowances are allocated without charge to existing sources, a limited number of allowances also are available for purchase through an annual U.S. Environmental Protection Agency (EPA) auction.[8] Title IV, therefore, implements a zero new source standard, as any new generating source must purchase all its needed allowances.[9] In another **[31 ELR 10331]** departure from traditional regulation, Title IV allows individual sources to trade their unused allowances to other sources or bank them for future use.[10]

Finally, Title IV incorporates an extremely strict monitoring and compliance system. Monitoring is required by continuous emissions monitoring devices (CEMS) that collect data every 15 minutes, with consolidated data reported hourly.[11] The monitors must also regularly transmit data that indicates that the monitor is functioning properly. CEMS are expensive, costing almost $ 1 million per stack.[12] Compliance procedures are also strict and include an automatic $ 2,000 fine per ton and forfeiture of an additional ton of reductions.[13]

Utilities responded to the Title IV program by reducing SO_2 emissions by eight million tons, almost 50% below their 1990 emissions level and30% below the cap in Phase I.[14] The most significant use of the flexibility mechanisms of Title IV was banking, or emitting below the standards and saving the allowances for later use. About 75% of total allowances created were banked,[15] as a more stringent cap on all units would be imposed in 2000. Another major use of a flexibility provision was trading, which was used by 30 of the 51 firms for intra-firm averaging.[16] Although trading volume increased throughout the program[17] as firms became more comfortable with trading and some began to trade for arbitrage purposes, only 3 of the 51 firms used inter-firm trading to emit over their allowance allocation.[18]

Figure 1:1990-1999 SO_2 Allocated Allowances and Emissions[19]

[SEE ILLUSTRATION IN ORIGINAL]

[31 ELR 10332]

A major story of Phase I compliance under the SO_2 program was the low cost of compliance. This was due to the flexibility of Title IV, derived primarily from the cap approach, which allows greater flexibility than the rate-based standards, and also the ability to trade allowances.[20] Initial expectations by industry in 1991 were for allowance prices of $ 300 to $ 1,000 during Phase I.[21] In 1992 and 1993, the earliest signals began to show that prices would be substantially lower,[22] and EPA's first auction of allowances in March 1993, revealed prices at $ 131. Allowance prices then continued in the $ 100 range until they began to climb toward $ 200 as Phase II approached.[23]

The lower cost of compliance was driven by cost reductions and innovation in both of the principal means of compliance—the use of low-sulfur coal and scrubbing. The widespread use of low-sulfur coal has been a major component of compliance strategy for Phase I, resulting in over seven million tons of net reductions (over one-half of net reductions).[24] This use was catalyzed by the flexibility afforded by Title IV, which allowed low-sulfur coal to compete with scrubbing as a compliance method. This led to experimentation and innovation in fuel blending techniques that allowed greater than expected use of low-sulfur western coals, and greater incentives to use eastern low- and medium-sulfur coals. These innovations, together with reduction in rail costs due to competition among railroads, lowered the cost premium for low-sulfur coal and dramatically increased their use, which has been a major driving force in lowering the cost of compliance in Phase I of Title IV.[25]

Scrubbing was the second principal strategy to reduce SO_2 in Phase I, and accounts for 3.5 million tons of emissions reductions (rising to 5.5 million tons if bonus allowances allocated to scrubbed units are counted).[26] Scrubbers were installed for 27 Table A units,[27] promoted in part by the bonus allowances, although several firms canceled scrubber contracts when the low prices for low-sulfur coal became apparent in the early 1990s. The cost of scrubbing also fell significantly during the compliance period, due to innovation in design and materials as well as the significantly lower need for redundancy to comply with Title IV's annual standard, in comparison to previous scrubbers that had been built to meet the new source standard.

Although the Phase I cap required only a moderate SO_2 reduction of around 30%,[28] the cap-and-trade approach exerted continuous pressure to innovate and create lower cost reductions. The cap has prompted continuing innovation in fuel blending techniques and rail infrastructure relating to low-sulfur coal, and also in scrubbing, the cost of which has declined steadily since competition was created with low-sulfur coal.[29] The ability to trade allowances has led to a fully integrated cost of sulfur in the coal market, integrating an environmental parameter into the price of coal. Finally, the monetization of environmental costs and benefits under the cap-and-trade approach has allowed the fuller integration of environmental considerations into the regular financially based decisionmaking throughout a company.

Overall, the shift in Title IV away from scrubber use and toward low-sulfur coal had economic, environmental, and political consequences. The investment in rail infrastructure, innovation in fuel blending and rail transport, and competition among railroads led to low compliance costs that benefitted both the industry and ratepayers. The principal environmental benefit is the reduction and permanent cap on SO_2 emissions, together with the greater political possibility of further reductions given the low cost of compliance. Other environmental benefits of the move to cleaner fuels include the benefits of pollution prevention, in avoiding the direct 1.5% energy loss and significant resource use and waste disposal consequences of scrubbing. Political consequences were also significant, and include the move from unionized coal-mining jobs in midwestern states with high-sulfur coal to western and Appalachian states with low-sulfur coal. Notwithstanding these shifts, the success of the Title IV SO_2 cap-and-trade program in overachieving a strict standard at low cost has led some to include it among the most successful programs under the CAA.[30]

2. Title IV's Rate-Based Standards for NO_x

Title IV was also designed to reduce NO_x emissions from utility boilers by two million tons below 1980 levels by the year 2000.[31] Title IV established the first regulation of NO_x faced by many existing power plants, as previously only certain states had established NO_x standards for older sources in order to meet ambient standards established under Title I of the CAA.[32] However, instead of using an emissions **[31 ELR 10333]** cap and allowance trading system, Congress required EPA to establish annual average emission limits in pounds per million British thermal unit (lb/mmBtu) for coal-fired electric utility units based on the use of "low NO_x burner technology."[33] The law further contained flexibility provisions, including an annualized emissions rate period and the ability of firms to average the emissions rates of units under their control.[34]

Phase I ofthe NO_x program applied to the 265 wall-fired and tangentially fired boilers included in Table A or substitution units active on January 1, 1995, and lasted from 1996 to 1999.[35] Phase II of the program started in 2000, and includes all other affected units.[36] The chart below shows the emissions limits applicable to different boiler types in Phase I and Phase II of the program. For wall-fired and tangentially fired boilers, the Phase I limits represent reductions from their respective uncontrolled emissions levels of 0.95 and 0.65 lb/mmBtu.[37]

*5*Table 1. Title IV NO_x Standards by Boiler Type (lb/mmBtu)[38]

Boiler Type	*2*Phase I		*2*Phase II	
	# Units	Standard	# Units	Standard
Tangentially fired	135	0.45	308	0.40
Dry Bottom Wall-fired	130	0.50	299	0.46
Cell burners			36	0.63
Cyclones (>155 MW)			55	0.86
Vertically fired			28	0.84
Wet-bottom (>65 MW)			26	0.84

Following a lawsuit on the meaning of "low-NO_x burner technology" that delayed implementation for one year,[39] the NO_x program proceeded smoothly with all 265 of the coal-fired units affected under Phase I meeting the legal requirements in each year.[40] Most of the units—178 of 265—met the emissions rate limits specified in the regulations through the installation of low-NO_x burners, which, for many sources, was the least-cost method of meeting the standards.[41] However, 10 units were granted less stringent alternative emissions limits because they could not meet the emissions rate standard even after installing low-NO_x burners.[42] Of the remainder, 23 met the emissions limit without the need for burner modifications, and the rest of the units continue to emit above the standards and were able to comply through the law's averaging provisions.[43] Overall, the flexibility provisions in the law, including the annual rate standard and the ability to average emissions among a firm's units, allowed a relatively low cost economic compliance, with NO_x reductions averaging $ 412 per ton in Phase I.[44]

The reductions resulting from Phase I are shown graphically below. Overall, units lowered their average NO_x emissions rates to 0.40 lb/mmBtu during Phase I, 43% below the 1990 average of 0.70 lb/mmBtu.[45] This has resulted in NO_x reductions of approximately 400,000 tons per year or 32% below 1990 levels, with reductions projected to rise to 2,060,000 tons per year during Phase II that starts in 2000.[46] There is less of a reduction in tons than in rates because economic growth leading to higher fuel use by both Table A and substitution units. Unlike the capped SO_2 program, NO_x emissions would be expected to rise with increased utilization.[47]

[31 ELR 10334]

Figure 2. Title IV NO_x Emission Rates for Phase I Units (1990-1999)[48]

[SEE ILLUSTRATION IN ORIGINAL]

Compliance with the NO_x program can be characterized in several ways. First, the program led primarily to the simple retrofit of a known technology onto most boilers. Innovation led to cost reductions in low-NO_x burner technology for two kinds of boilers, but not a third, and did not lead to continuous drivers for improvement beyond the compliance date. Second, firms made heavy use of the flexibility provisions, especially averaging—204 of the 265 affected units were included in an averaging plan.[49] A third characteristic was slight overcompliance with the standard, as Table A firms emitted 11% below the standard to ensure a margin of safety.[50]

3. OTC Cap-and-Trade in 1999 Forced Further Reductions at Existing Plants

In the 12 northeastern and Mid-Atlantic states,[51] NO_x emissions from large power plants have been controlled not by Title IV, but by more stringent state regulations coordinated under the OTC. The OTC was created under the CAA Amendments of 1990 to coordinate planning at a regional level to facilitate each state's efforts to reduce NO_x in order to attain the national ambient air quality standard for ground level ozone. In September 1994, every northeastern and Mid-Atlantic state, except Virginia, adopted a memorandum of understanding to achieve regional reductions of NO_x from power generators in three phases starting in 1995.[52]

In Phase I of the OTC program, states required sources to install reasonably available control technology (RACT), a standard roughly equivalent to the Title IV standards but applying one year earlier.[53] Pennsylvania required sources to install low-NO_x burners with separate overfire air, and other states, such as New York and New Jersey, defined rate standards that were slightly more stringent than the Title IV standards.[54] Most states also allowed averaging among a firm's facilities, creating standards slightly more stringent than but similar to Title IV. In response, most sources added combustion controls such as low NO_x burners and/or overfire air to their units.

[31 ELR 10335]

Phase II of the OTC program started in 1999, and nine OTC states established a NO_x Budget Program involving an emissions cap and allowance trading system similar to EPA's SO_2 Acid Rain Program.[55] The emissions cap required 912 electricity-generating units to reduce emissions by 55-65% from their 1990 baseline of 417,444 tons.[56] Despite the stringency of the standard, sources overcomplied by reducing emissions 20% below the cap level.[57] Compliance levels were also very high, with only one source failing to meet its standard by one ton and, therefore, subjecting itself to an automatic fine and two-ton penalty.[58]

Despite initial expectations that many sources would need to use expensive end-of-pipe controls such as selective catalytic reduction (SCR) to achieve these deep reductions, the flexibility afforded by the cap-and-trade approach led to unexpected results. One such result was that 126 of the 142 affected coal-fired units achieved NO_x reductions up to 30% through operational changes alone, without significant capital additions.[59] The cap approach allowed compliance through a number of technologies, including gas reburn and selective noncatalytic reduction, and not only SCR. As a consequence, allowance prices, after initial volatility at the start of the program in which prices ranged from $ 3,000 to $ 7,000 per ton, have settled down to less than the $ 500 to $ 1,000 range, significantly lower than estimated.[60]

B. New Source Standards

New plants or significant modification of existing plants are subject to a stringent federal NSR process, which requires at a minimum compliance with new source performance standards (NSPS).[61] Traditional NSPS establish emissions rate standards for each power generation technology, such that more lenient standards are applied to dirtier technologies. NSPS for NO_x allow coal-fired boilers to emit twice the NO_x as oil-fired ones, and three times that of gas-fired ones.[62] In 1998, EPA established a new, fuel-neutral NSPS of 0.15 lb/mmBtu for major modifications of existing sources, and 1.6 lb/megawatt hour (MWh) of electricity generated for new sources, the latter an innovative output-based standard that provides a benefit to efficient producers.[63] However, this fuel-neutral NSPS rarely applies, as the case-by-case oriented NSR process is more stringent and, therefore, controls new plant standards.

Under the NSR process, regulators establish an emissions rate standard on a case-by-case basis, again based on the power generation technology, such that more lenient standards are applied to dirtier technologies. The standard also varies geographically: sources built in areas that have attained the ambient ozone standard set by EPA must prevent significant deterioration of air quality, and install the best available control technology (BACT) for the type of plant proposed considering "energy, environmental, and economic impacts and other costs."[64] New plants in nonattainment areas must meet the even more stringent lowest achievable emissions reduction (LAER) standard, which excludes consideration of cost.[65] These strict standards are motivated both as a means to achieve ambient standards, and as a mechanism to spur the development and application of new technologies.

1. New Source Standards for SO_2

The 1970 CAA also established a stringent NSPS for new plants, limiting SO_2 emission rates to 1.2 lb/mmBtu for coal-fired plants.[66] This had a dramatic effect on the industry, as emission rates from older plants were far higher, and electric utilities began to focus research and operational efforts to extending the operating life of the old "grandfathered" facilities. In the CAA Amendments of 1977, Congress created stricter NSPS by requiring new sources to meet both the 1.2 pound standard *and* remove either 90% of SO_2 emissions from high-sulfur coal or 70% of the SO_2 emissions from low-sulfur coal.[67] This new standard requires utilities to install scrubbers at all new generating units, removing much of the incentive to use low-sulfur coal and favoring political interests in using eastern high-sulfur coal. However, by increasing the cost of new coal-fired plants, this requirement added to the incentives to extend the life of the older and dirtier plants, and may have further aggravated the conditions that led to acid precipitation.

There are several aspects of the NSPS for SO_2 that significantly restrict technology use and increase costs. First, it requires sources to make a percentage reduction in potential emissions of SO_2 precluding compliance through switching to low-sulfur fuel, as no matter how low the sulfur, the standard requires a further 70-90% reduction, necessitating the **[31 ELR 10336]** use of an end-of-pipe technology such as scrubbing.[68] Second, the standard significantly increases the cost of the scrubber, which must be overbuilt to achieve a 90% (or 70%) reduction on a continuous basis. As a consequence, the cost of an NSPS scrubber is far higher than needed to reduce sulfur, requiring significant redundancy and typically a backup scrubber module in case the first one fails.

Ironically, the environment also does not benefit from the inflexible NSPS standard. Despite the costs imposed by the NSPS standard, it creates no net environmental benefits as total emissions are now governed by the emissions cap under Title IV. Nor are there significant local benefits, as sources must already comply with SO_2 standards pursuant to Title I of the CAA that protect against local ambient concentrations. The continued use of the inflexible rate-based methodology under the SO_2 NSPS therefore makes little sense today when there is a national emissions cap on SO_2.

2. New Source Rate Standards for NO_x Have Created an Uneven Regulatory Framework and Differential Business Drivers

A major problem with NO_x new source standards is that by differentiating between old and new plants, they create a significant bias toward old sources that only need to meet a relatively weak standard, while new clean sources face a very stringent one. This problem is exacerbated in the power sector due to long capital life and the great differences in generating technologies. Older largely coal-fired plants emit NO_x at levels of 100 to over 1,000 parts per million (ppm) of exhaust volume, even though some could reduce NO_x at prices as low as $ 300 a ton.[69] However, new plants are virtually all gas-fired[70] and far cleaner than coal plants, and the stringent NSR standards require them to reduce their already low NO_x emissions to 9 ppm, or in some states 2 ppm.[71] This requires investments in end-of-pipe controls that cost from $ 2,500 to over $ 10,000 per ton of NO_x reductions and that can discourage investment in newer clean technologies.[72]

As shown in the table below, NO_x regulation of power plants in the 1990s created a highly uneven regulatory framework. Because rate standards were set at differing levels for the different base technologies, they create a perverse situation in which the greater the amount of NO_x emitted by a power technology, the more lenient the rate standard. The table also reveals the great disparity between the standards for old and new sources, and also how technology-by-technology standards have imposed the highest costs on the cleanest sources.

*4*Table 2. Differential Effects of Current Law on NO_x Reductions From
*4*Generating Technologies (1996-1999)[73]
*4*Differential Standards for NO_x Reductions From Generating
*4*Technologies (1996-1999):

	*3*Old Sources (Title IV RACT)		
	Cyclone Coal	Wall-Fired Coal	T-Fired Coal
Uncontrolled NO_x (lb/mmBtu)	1.50	0.95	0.65
Legal Standard (lb/mmBtu)	none	0.50	0.45
Cost Per Ton	none	$ 150	$ 400

*4*Table 2. Differential Effects of Current Law on NO_x Reductions From
*4*Generating Technologies (1996-1999)[73]
*4*Differential Standards for NO_x Reductions From Generating
*4*Technologies (1996-1999):

	*3*New Sources (BACT/LAER)		
	New Coal	New Gas Large	New Gas Small
Uncontrolled NO_x (lb/mmBtu)	0.50	0.05	0.10
Legal Standard (lb/mmBtu)	0.10	0.02 +	0.02 +

Cost Per Ton	$ 565 (SCR)	$ 2,500	$ 10,000 +

[31 ELR 10337]

NSR also applies when plants undergo significant modifications, and EPA has filed lawsuits against eight companies asserting that their older plants should be subject to NSR because they have made major modifications. However, even if a source has undergone NSR, years or decades may elapse before the plant is subject to the standards again, during which time there is no incentive to improve. Another problem is that these standards divert research attention away from identifying and developing new, cleaner power sources, to how to achieve pollutant reductions and extend the life of older sources without triggering NSR. This leads to a fundamental lack of alignment of the objectives promoted by CAA and objectives of a sound clean energy policy.

III. Findings

A. Problems With the Methodology of Using Rate Standards

There are several key problems with the rate standards for NO_x and SO_2 used under Title IV and new source standards.These problems preclude their efficient or effective operation and are especially pronounced in sectors, such as power generation, with long capital life.

1. Emissions Rate Standards Do Not Force a Move Toward Cleaner Technologies

One of the chief problems with emissions rate standards for NO_x under both Title IV and new source standard is that they are individually set for each specific generation technology. Different standards are set depending on the kind of fuel used, and specific boiler or turbine technology used. Therefore, Title IV's Phase I NO_x standards were 0.50 lb/mmBtu for wall-fired boilers, 0.45 lb/mmBtu for tangentially fired boilers, and various other boilers were completely exempt; under Phase II NO_x standards vary from 0.86 to 0.40 lb/mmBtu.[74] Under NSR, new gas technologies face standards at or lower than 0.05 lb/mmBtu, an order of magnitude lower than the standards for old coal plants.[75] Such standards create no incentive to move from dirtier to cleaner technologies. Yet in the power sector, the fundamental answer to solving pollution problems is precisely to move to cleaner, less polluting technologies.

2. Rate Standards Apply Only at a Discrete Point in Time, Limiting Compliance Methods

Another key problem with the current rate standard approach is that they require reductions only once: for new plants, at the time the plant is built or undergoes a major modification, and for existing plants, at the date Title IV applied.[76] This limits compliance options to those capital or process equipment choices made at the time the plant is built or modified, and eliminates the possibility of compliance through changes in management practices, fuels, or any other operational decisions after a plant is built. This harkens back to an older view of pollution, that there is a single known technology "fix" that can be implemented once. The reality is that technology is ever-evolving, and there are numerous technologies and management practices that can reduce pollution; a good regulatory system needs to provide firms with the incentives to implement them.

There are three major negative consequences of applying a rate standard at only one time, such as when a plant is built or at a certain date. The first is that such a standard provides firms with no incentive to take advantage of future technology advances. A firm does not have to implement anything more after the date it is permitted, even if a technological breakthrough means that it could inexpensively reduce pollution an additional amount. This is precisely what has happened with cyclone boilers, as after the regulatory standard was issued, the industry discovered how to cheaply reduce NO_x emissions in cyclones far below the standard. However, firms had no incentive to do so, thereby allowing high-emittingboilers to continue to pour pollution into the air.

The second negative consequence is that the CAA's new source standards only promote compliance through decisions about capital equipment, and not through ongoing operational or management decisions. Many NO_x reduction technologies, such as gas reburn and overfire air, are incremental, and can be adjusted to achieve various rates of NO_x control depending on the cost of inputs and other parameters. Indeed, the first year of application of the OTC cap-and-trade for NO_x in northeastern states revealed that once a market incentive was created to reduce NO_x

emissions, firms found ways to lower NO_x by up to 30% *at existing units*, and without significant capital additions.[77] Achieving NO_x reductions through operational changes can be highly effective, and may be essential in order to reduce NO_x to very low levels. Promoting such changes requires that regulatory systems move beyond the current rate-based approach, which provide no incentives to go beyond initially established limits.

A third major but longer term consequence of requiring compliance only through periodic changes in rates is its chilling effect on research and development. Since the rate standard creates no continuous driver to lower emissions, firms do not invest continuously in research and development to enhance environmental quality, because there is no compliance benefit in doing so. Instead, the periodic effort to lower the rate standards becomes a political issue, with industry battling through its lawyers to make sure the rate standard is as lenient as possible, and then to use existing technologies for compliance. As demonstrated best by the cyclone boiler situation,[78] when the rate standard is then announced, **[31 ELR 10338]** there is a flurry of research activity on how to reach the standard at least cost, after which the research effort subsides again.

3. Emissions Rate Standards Restrict Compliance Technologies and Promote End-of-Pipe Solutions Instead of Pollution Prevention and Cleaner Processes

A fundamental problem with rate standards is that by focusing on end-of-pipe rate reductions, they may restrict technology choice, and inherently favor compliance practices through end-of-pipe pollution controls instead of the other two compliance methods—cleaner inputs or fuels and cleaner processes. Both of the latter are more aligned with pollution prevention principles.

The following table compares the technologies permitted under various SO_2 standards, and the estimates of compliance cost using those standards. It shows that for identical pollutant reductions, more inflexible regulatory standards can significantly increase costs. A technology prescription, such as one mandating that scrubbers gain a 10 million ton reduction, is the least flexible and was estimated to cost $ 7 million.[79] Equally inflexible was the 1978 NSPS because it required a rate reduction in potential emissions of 70-90%, which meant that one had to scrub no matter how clean the coal.[80] Somewhat more flexible was the 1971 NSPS, with a percentage concentration rate standard that allowed the use of either a scrubber or compliance coal.[81] Title IV's cap-and-trade program—passed in 1990—allows any compliance method.

*4*Table 3. Technologies Permitted Under Different SO_2

*4*Regulatory Systems[82]

Regulatory Method	Technology Prescription	Emissions Limit Using Percentage Reduction	Emissions Limit Using Percentage Concentration
Technologies Permitted	. scrubbers	. scrubbers	. scrubbers . limited use low-sulfur coal
Estimated Compliance Cost in Billions Per Year	$ 7	$ 4.5	-

*3*Table 3. Technologies Permitted Under Different SO_2

*3*Regulatory Systems[82]

Regulatory Method	Emissions Cap Without Trading	Emissions Cap With Trading
Technologies Permitted	. scrubbers . major use low-	. scrubbers . major use low-

	sulfur coal . fuel blending . no backup necessary . demand side management	sulfur coal . fuel blending . no backup necessary . demand side management . power shifting . trading
Estimated Compliance Cost in Billions Per Year	$ 2.5	$ 1.2

[31 ELR 10339]

The regulatory agency applying a rate standard may add to the inflexibility inherent in rate standards by favoring pollutant reductions gains through end-of-pipe controls over those achieved through pollution prevention. Over the past decade, major technological advances in natural gas turbines have reduced their uncontrolled NO_x emissions from over 100 ppm to the very low 9-15 ppm range.[83] This has achieved a 90% pollution reduction, yet this may not count when a regulatory body applies a standard like BACT or LAER. Some states applying these standards only recognize a 90% reduction achieved though end-of-pipe control equipment such as SCRs, and do not count what has been achieved through pollution prevention or process change.[84]

4. Emissions Rate Standards Create High Transaction Costs and a Culture of Conflict Between Regulators and the Regulated Industry

Typical permitting processes applying new source rate-based standards under the CAA typically takes one and one-half years or longer, creating high administrative costs to governments and major opportunity costs for firms that may be siting new clean plants. Under this process, a government regulator must make a specific determination of what specific technology meets the regulatory standards or is the "best available," pitting regulators against the applicant in a series of factual issues.[85] Title IV's NO_x standards resulted in litigation that delayed the program one year due to a conflict between industry and regulators on the applicable technology, and the NSR process is time- and resource-intensive. However, the gain to the environment may be zero or slight if the plant is a modern gas plant, as NO_x and SO_2 emissions are minimal, and they would be expected to create benefits by displacing power from dirtier sources. In addition, in nonattainment areas, any resulting emissions must be offset anyway, creating no net environmental benefit from these lengthy procedures.

Regulations do not have to be this way. Major environmental benefits can be achieved without transaction costs under technology-neutral approaches such as the emissions cap and allowance trading system. Both the Acid Rain Program's SO_2 cap and the OTC NO_x cap create major emissions reductions and a zero new source standard without any lengthy permitting procedures (transactions take less than 24 hours) or conflict between regulator and regulated. These approaches redirect business efforts away from contesting regulatory authority toward competing in the marketplace.

B. Problems Relating to the Disparity in Standards Between Old and New Plants

A fundamental strategy in our CAA has been to impose strict standards on new plants, while old plants are exempted or subject to lenient requirements. These new source standards are designed both to reduce ambient pollution levels, on the assumption it will be cheaper to achieve reductions at new plants instead of old plants, and as a technology-forcing mechanism to encourage the development of cleaner processes. The effectiveness of these standards is assessed below for NO_x reductions, as the lack of construction of new coal plants means there are few new SO_2 sources.

1. New Source Standards Have Failed to Efficiently Reduce Ambient Pollution Levels

A basic assumption behind new source standards is that it will be less expensive to attain the emissions reductions needed to achieve ambient levels through new source standards. This assumption appears fundamentally flawed in the NO_x case, and based on a static concept of technology change. Due to fundamental technology changes in power generation, the disparity in rate standards between old and new plants now results in perverse incentives for attaining clean energy. Today, virtually all new power plants use gas-fired turbine technology[86] and are both more efficient and far cleaner than coal-fired units—even without controls. Modern gas combined cycle plants emit virtually no SO_2, particulates or air toxics, and NO_x emission levels are around 0.05 lb/mmBtu, well below the NSPS and 10 to 40 times lower than that of coal units.[87] Therefore, as shown in the above Figure 3, there is actually an inverse relationship between the age and cleanliness of plants and the costs of added NO_x reductions. Contrary to the initial supposition that it would be cheaper to achieve significant reductions at new plants versus older ones, technology change has meant that significant reductions are available only at old plants and are also far cheaper there.

2. New Source Standards Force Only Limited Kinds of Innovation

The record of new source standard and forcing innovation is more complex. New source standards have led to development of new technologies, including improvements in SCR technology and innovative control technologies, such as SCONOX[88] **[31 ELR 10340]** and XONON.[89] They have also contributed to a collaborative federal-industry effort to develop cleaner and more efficient gas turbines, to which federal research also played a large role.[90] However, it has also suppressed innovation. The distinction between old and new plants has led firms to continue to use highly polluting old plants, and has restrained upgrades or efficiency investments because they might trigger NSR. As a consequence, virtually all research funds spent by the principle utility research coalition, EPRI (formerly the Electric Power Research Institute), is to improve the performance of existing units, whereas most federal research funds are to develop new and cleaner technologies.[91] Secondly, the process of governmental approval of specific firm technology choices has led to a situation that has virtually eliminated venture capital from the environmental technology field.[92]

3. NSR Creates No Net Benefits in Nonattainment Areas or Under an Emissions Cap Approach

A final irony is that in a cap-and-trade situation, or in nonattainment areas where the CAA requires any new source to fully offset its emissions with matching reductions from existing sources, there are no actual environmental benefits as there are no net NO_x reductions even after the very high costs imposed by NSR.[93]

C. Cap-and-Trade Programs Achieve a Results-Oriented Approach

Fortunately, there are solutions for each of the significant problems created by NO_x and SO_2 rate regulations. The best and most comprehensive solution would be to replace existing standards with a stringent emission cap and allowance trading system, created on a national or regional basis, that includes all sources.[94] This solution would not only be extremely effective environmentally, but also would eliminate virtually all of the problems mentioned above that are caused by the use of rate standards, because cap-and-trade programs:

* create a consistent standard applicable to both old and new plants;
* do not discriminate by creating different standards for different technologies;
* create continuous drivers for improvement and innovation;
* allow business flexibility to choose differing compliance approaches;
* have effective monitoring of emissions;
* achieve high levels or 100% compliance; and
* minimize transaction costs and conflict.

Steps are being taken to implement cap-and-trade approaches, including existing programs such as the Acid Rain Program, the OTC NO_x cap-and-trade system in the Northeast, and the pending EPA state implementation plan call that would extend an NO_x cap-and-trade system to at least 19 eastern states.[95] In addition, "4-pollutant" bills proposed in Congress would establish stringent national cap-and-trade standards for SO_2, NO_x, and carbon dioxide, and address mercury reductions.[96] These would eliminate the grandfathering problem and create a uniform standard applied to all covered units, while promoting compliance through pollution prevention.

The major benefits of a good cap-and-trade system are that it enacts a stringent and permanent limit, which serves society's interest in pollution reductions, while allowing the widest possible breadth of compliance options, hence reducing costs. It removes government from case-by-case decisionmaking about technologies, freeing business to experiment without liability. Cap-and-trade systems eliminate all discrimination between old and new plants and between technologies because all face equal incentives to reduce.[97] It performs far better than a rate-based system in regards to **[31 ELR 10341]** both cost and innovation, principally because government no longer needs to predict where innovation may occur as they do in a rate system. The cap-and-trade system places this burden on the regulated entities.

A cap-and-trade approach also encourages greater innovation for several reasons. Perhaps the most important is that the uniform standard exerts pressure on all to innovate, as all sources are equally covered under the standard. There are no exceptions, waivers, or lower standards for certain technologies that characterize most rate systems, such as the Title IV NO_x program, in contrast to the SO_2 program. This maximizes the breadth of innovation and allows unexpected innovation. Second, the pressure to innovate is continuous, driven both by the lack of growth in the cap and the opportunity to market allowances. Both give firms reasons to continuously seek lower emissions, unlike rate systems where there is no incentive to go beyond the rate limit. Third, the opportunity to use allowances softens the risk of failure in experimentation, while the cap assures achievement of environmental goals.

Another key benefit of cap-and-trade programs is their record of effective monitoring and near 100% compliance. In five years, the Acid Rain Program for SO_2 has achieved 100% compliance every year, and in the first year of the OTC NO_x cap-and-trade program, there was only one exceedance of one ton, leading to a swift and automatic penalty.[98]

Yet another benefit is that cap-and-trade programs minimize transaction costs. Instead of a protracted dispute between firms and government about what technology is most appropriate, firms must simply comply and be able to show the government that at year-end they have enough allowances to cover emissions. The government role changes appropriately and dramatically from choosing technologies to assuring compliance. The environmental integrity of the program is assured by the reductions made through the emissions cap, which never grows.

A negative aspect that some believe may occur with cap-and-trade programs is that the trading may shift the locus of emissions, potentially causing areas of higher localized pollution levels. In reality, it is difficult to see why cap-and-trade systems should have any greater effect in this regard than rate standards, which themselves allow great local variability as they do not control plant size, siting, or utilization. In particular, this should not be of concern with a regional pollutant, or if the total reductions are sufficiently great that everyone benefits. In addition, an analysis of the first four years of the Acid Rain Program's SO_2 cap-and-trade program showed that regional movements of allowances were minimal (3% of all allowances used), and that trading may even have helped cool hot spots.[99]

IV. Conclusion

Experience with rate-based approaches for NO_x and SO_2 regulation in the power generation sector reveals inflexibility in their application that does not help to reach environmental benefits. Key problems include the disparities created for different technologies and between old and new plants, which creates strong economic incentives to use dirtier technologies and against the installation of new plants; their restriction of technology choice; and tendency to limit innovation to end-of-pipe controls. Emissions cap and allowance trading systems now in place for both SO_2 and NO_x have been able to effect a strict environmental standard while avoiding the inflexibility of rate standards, and are more aligned with pollution prevention goals. Moving from rates standards toward cap-and-trade programs appears essential to meet the goals of a clean energy policy and to attaining the multipollutant reductions benefits from switching to cleaner new power sources.

1. 42 U.S.C. §§ 7401-7671q. ELR STAT. CAA §§ 101-618.

2. Title IV of the CAA Amendments of 1990, Pub. L. No. 101-549, tit. IV, 104 Stat. 2399 (codified at 42 U.S.C. §§

7651-7651o, ELR STAT. CAA §§ 401-416), was designed to address the problem of acidification of lands and water bodies caused by acid deposition from emissions of SO_2 and NO_x. Emissions of these substances also cause significant health problems in the formation of fine particulates and urban ozone, which although recognized at the time of passage of the 1990 Amendments were not emphasized.

3. U.S. EPA, NATIONAL AIR POLLUTANT EMISSION TRENDS 1990-1998 3-10 (1999) [hereinafter EMISSION TRENDS].

4. U.S. EPA, 1999 COMPLIANCE REPORT. ACID RAIN PROGRAM 5 (2000) (EPA-430-R-00-007) [hereinafter EPA 1999 COMPLIANCE REPORT]; EMISSION TRENDS, *supra* note 3, at 3-12 (utility SO_2 emissions recorded at 17.5 million tons in 1980).

5. The level of the Phase I cap was reached by multiplying an emission rate of 2.5 pounds of SO_2 per million British thermal unit (lb/mmBtu) times utilization in the baseline years.

6. The level of the Phase II cap of 8.95 million tons was reached by multiplying an emissions rate of 1.2 lb/mmBtu SO_2 times baseline utilization. The 1.2 lb/mmBtu emission rate has historical significance, as it is the rate standard that has been required for new coal-fired power plants since 1970. Because bonus allowances of 530,000 tons per year will be issued from 2000 to 2009, the cap in those years will equal 9.48 million tons.

7. In addition to these basic allowance allocations, Title IV also allocates 3.5 million bonus allowances over the first years of the program to encourage the use of scrubbers, and 300,000 bonus allowances to reward efforts to develop alternative energy sources. 42 U.S.C. § 7651c(g), ELR STAT. CAA § 404(g).

8. *Id.* § 7651, ELR STAT. CAA § 401.

9. *Id.* § 7651b(e), ELR STAT. CAA § 403(e).

10. *Id.*

11. EPA 1999 COMPLIANCE REPORT, *supra* note 4, at 17-18; *see also* 40 C.F.R. pt. 75 (2000).

12. A. DENNY ELLERMAN ET AL., MARKETS FOR CLEAN AIR: THE U.S. ACID RAIN PROGRAM 250 (2000) [hereinafter ELLERMAN 2000].

13. 42 U.S.C. § 7651j, ELR STAT. CAA § 411.

14. EPA 1999 COMPLIANCE REPORT, *supra* note 4. In addition to the actual reductions of almost 8 million tons, 3.5 million extension allowances were allocated as bonus allowances, which together with other bonus programs created an 11.6 million allowance bank at the end of 1999. *Id.*

15. ENVIRONMENTAL LAW INST., ANALYSIS OF EPA 1995-1999 COMPLIANCE REPORTS (on file with author) [hereinafter ELI 1995-1999 COMPLIANCE REPORT ANALYSIS].

16. *Id.*

17. EPA 1999 COMPLIANCE REPORT, *supra* note 4, at 11.

18. ELI 1995-1999 COMPLIANCE REPORT ANALYSIS, *supra* note 15.

19. U.S. EPA. ACID RAIN COMPLIANCE REPORTS 1995-1997; EPA 1999 COMPLIANCE REPORT, *supra* note 4.

20. ELLERMAN 2000, *supra* note 12; Dallas Burtraw & Byron Swift, *A New Standard of Performance: An Analysis of the Clean Air Act's Acid Rain Program*, 26 ELR 10411 (Aug. 1996).

21. An industry poll showed widespread expectations of allowance prices on the order of $ 300 to $ 735 for Phase I and $ 500 to $ 1,000 for Phase II in June-July 1991, falling to $ 200 to $ 550 for Phase I and $ 300 to $ 700 for Phase II by

October-November 1991. Ian M. Torrens et al., *The 1990 Clean Air Act Amendments: Overview, Utility Industry Responses, and Strategic Implications*, 17 ANNUAL REV. OF ENERGY & THE ENV'T 220 (1992); *see also* ELLERMAN 2000, *supra* note 12, at 232.

22. The first was a trade of 10,000 allowances from Wisconsin Power & Light to the Tennessee Valley Authority at $ 265. Matthew L. Wald, *T.V.A. Buys Allowance to Emit a Chemical in Acid Rain*, N.Y. TIMES, May 12, 1992,at A1; Frank Edward Allen, *Tennessee Valley Authority Is Buying Pollution Rights From Wisconsin Power*, WALL ST. J., May 11, 1992. The second was a trade of 25,000 allowances from ALCOA to Ohio Edison for $ 300 per allowance. Joan E. Rigdon, *ALCOA Unit Arranges $ 7.5 Million Sale of Pollution Allowances to Ohio Edison*, WALL ST. J., July 1, 1992.

23. EPA 1999 COMPLIANCE REPORT, *supra* note 4, at 10.

24. ELI 1995-1999 COMPLIANCE REPORT ANALYSIS, *supra* note 15.

25. ELLERMAN 2000, *supra* note 12.

26. ELI 1995-1999 COMPLIANCE REPORT ANALYSIS, *supra* note 15.

27. U.S. DOE, ENERGY INFORMATION ADMIN., ELECTRIC POWER ANNUAL vol. II, tbl. 30 (detailing flue gas desulfurization capacity in operation at U.S. electric utility plants as of December 1999).

28. The 1985-1987 baseline level of Phase I units is about 10 million tons, and the average Phase I cap was approximately 6.8 million tons (not counting bonus allowances), for a 33% reduction. EPA 1999 COMPLIANCE REPORT, *supra* note 4, at 7.

29. ELI 1995-1999 COMPLIANCE REPORT ANALYSIS, *supra* note 15.

30. *Id.*; Burtraw & Swift, *supra* note 20.

31. Acid Rain Program; Nitrogen Oxides Emission Reduction Program—Phase II Final Rule, 61 Fed. Reg. 67111 (Dec. 19, 1996) [hereinafter Phase II Final Rule].

32. Although some states established these as early as 1972, most states did not emphasize NO_x reductions until scientific evidence began to indicate reducing NO_x would be the most effective way to reduce urban ozone. NATIONAL RESEARCH COUNCIL, RETHINKING THE OZONE PROBLEM IN URBAN AND REGIONAL AIR POLLUTION (1991).

33. 42 U.S.C. § 7651, ELR STAT. CAA § 401.

34. *Id.* § 7651f, ELR STAT. CAA § 407.

35. These units, known as Group 2 boilers, include cell, cyclone, and wet-bottom boilers. *Id.*

36. Phase II includes both wall-fired and tangentially fired (Group 1) boilers not covered in Phase I and other types of boilers (Group 2 boilers). *See* Phase II Final Rule, *supra* note 31. Since the units included in Phase I have already made their boiler modifications, they are permanently grandfathered at the lower Phase I standards and not the more stringent Phase II standards. 42 U.S.C. § 7651f, ELR STAT. CAA § 407.

37. U.S. EPA, COMPILATION OF AIR POLLUTANT EMISSION FACTORS AP-42 (1990).

38. 42 U.S.C. § 7651f, ELR STAT. CAA § 407.

39. Alabama Power Co. v. EPA, 40 F.3d 450, 25 ELR 20166 (D.C. Cir. 1994) (vacating Phase I NO_x final rule).

40. EPA1999 COMPLIANCE REPORT, *supra* note 4, at 10.

41. ELI 1995-1999 COMPLIANCE REPORT ANALYSIS, *supra* note 15.

42. EPA 1999 COMPLIANCE REPORT, *supra* note 4, at 10. The process for approving these alternative emissions limits is still not complete for any unit.

43. ELI 1995-1999 COMPLIANCE REPORT ANALYSIS, *supra* note 15.

44. *See* Phase II Final Rule, *supra* note 31.

45. EPA 1999 COMPLIANCE REPORT, *supra* note 4, at app. C-2. The range of emissions rates for the affected boilers has also been reduced, from 1990 baseline emissions ranging from 0.26 to 1.21 lb/mmBtu to a range from 0.13 to 0.81 lb/mmBtu in 1999. *Id.*

46. *Id.* at 13.

47. *Id.* at 13-15.

48. ELI 1995-1999 COMPLIANCE REPORT ANALYSIS, *supra* note 15.

49. EPA 1999 COMPLIANCE REPORT, *supra* note 4, at app. C-1.

50. *Id.* at 14. For Table A units, average emissions were 0.43 lb/mmBtu during the 4 years of the program, 11% below the average limitation of 0.49 lb per mmBtu. Emissions rates of Table A units gradually moved lower during the Phase I, from 0.45 lb/mmBtu in 1996, to 0.42 lb/mmBtu in 1999. *Id.*

51. The OTC comprises the states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont; the northern counties of Virginia; and the District of Columbia.

52. Memorandum of Understanding Among the States of the Ozone Transport Commission on Development of a Regional Strategy Concerning the Control of Stationary Source Nitrogen Oxide Emission (signed Sept. 27, 1994), *available at* http://www.sso.org/otc [hereinafter OTC MEMORANDUM OF UNDERSTANDING]. Phase I included the installation of reasonably available control technology (RACT).

53. *Id.*

54. Pennsylvania law defines RACT for large coal-fired units as "the installation of low NO_x burners with separate overfire air." 25 PA. CODE § 129.93 (b)(1) (2000). New Jersey requires utility boilers to meet the following standards: tangentially fired: .38 lb/mmBtu; wall-fired; .45 lb/mmBtu; and cyclone .55 lb/mmBtu. 7 N.J. ADMIN. CODE § 27-19.4 (2000). New York State RACT regulations set standards for wet-bottom coal-fired tangential plants at 0.42 lbs./mmBtu, and for wall-fired at 0.45 lbs./mmBtu. N.Y. COMP. CODES R. & REGS. tit. 6, § 227-2.4 (2000).

55. OTC Memorandum of Understanding, *supra* note 52. Under this program, budget sources were allocated allowances by their state government. Each allowance permits a source to emit one ton of NO_x during the summer period (May through September). Allowances may be bought, sold, or banked. Any person may acquire allowances and participate in the trading system. Each budget source must comply with the program by demonstrating at the end of each control period that actual emissions do not exceed the amount of allowances held for that period. However, regardless of the number of allowances a source holds, it cannot emit at levels that would violate other federal or state limits, e.g., new source performance standards (NSPS), Title IV, or NO_x RACT.

56. U.S. EPA, 1999 OTC NO_x BUDGET PROGRAM COMPLIANCE REPORT (Mar. 27, 2000).

57. *Id.*

58. *Id.*

59. Joel Bluestein, Energy and Environmental Analysis, Inc., OTR NO_x Market: Lessons Learned (1999) (unpublished report presented at Emissions Marketing Associates in October 1999) (on file with author); GAS RESEARCH INST.,

LOW COST OPTIONS FOR ACHIEVING DEEP NO_x REDUCTIONS (2000), *available at* http://www.gri.org.

60. Alternative technologies are described in the Gas Research Institute's report on *Low Cost Options for Achieving Deep NO_x Reductions. See* GAS RESEARCH INST. *supra* note 59. Compliance cost is described in U.S. EPA, 1999 OTC NO_x BUDGET PROGRAM COMPLIANCE REPORT, *supra* note 56.

61. 42 U.S.C. § 7479(3), ELR STAT. CAA § 169.

62. The initial NSPS for power plant boilers established NO_x emissions limits of 0.50 to 0.80 lb/mmBtu for coal-fired boilers, 0.30 lb/mmBtu for oil-fired boilers, and 0.20 lb/mmBtu for gas-fired boilers. 40 C.F.R. pts. 60.44, 60.44a (2000).

63. *Id.* pt. 60.44a(d); Revision of Standards of Performance for Nitrogen Oxide Emissions From New Fossil-Fuel Fired Steam Generating Units; Revisions to Reporting Requirements for Standards of Performance for New Fossil-Fuel Fired Steam Generating Units, 61 Fed. Reg. 49442 (Sept. 16, 1998) (final rule).

64. 42 U.S.C. §§ 7475, 7479(3), ELR STAT. CAA §§ 165, 166(3).

65. *Id.* § 7503(a)(2), ELR STAT. CAA § 173(a)(2).

66. 40 C.F.R. pt. 60.44 (2000).

67. *Id.* pt. 60.44a.

68. In Sierra Club v. Costle, 657 F.2d 298, 11 ELR 20455 (D.C. Cir. 1981), the court affirmed that a utility could not use low-sulfur coal to create equivalent reductions. It interpreted the rate-based standard and held that:

> In no instance, however, can a plant reduce emissions by less than 70 percent of potential uncontrolled emissions. . . . There is no dispute that the 70 percent floor in the standard necessarily means that, given the present state of pollution control technology, utilities will have to employ some form of flue gas desulfurization ("FGD" or "scrubbing") technology.

Id. at 316 & n.38, 11 ELR Digest at 20455.

69. *See* Table 2 *infra*.

70. U.S. DOE, ANNUAL ENERGY OUTLOOK 2000 (1999) [hereinafter DOE ANNUAL ENERGY OUTLOOK 2000].

71. U.S. EPA, RACT/BACT/LAER CLEARINGHOUSE ANNUAL REPORT FOR 1998: A COMPILATION OF CONTROL TECHNOLOGY DETERMINATIONS (June 1998) (EPA 456/R-98-004) [hereinafter U.S. EPA CLEARINGHOUSE REPORT FOR 1998].

72. *See* Table 2 *infra*.

73. U.S. EPA, COMPILATION OF AIR POLLUTANT EMISSION FACTORS AP-42 (1998); Phase II Final Rule, *supra* note 31; Joel Chalfin, General Electric Power Plant Systems, Gas Turbine Emissions (1999) (unpublished presentation) (notes on file with author); Leslie Witherspoon & Ken Smith, NO_x Control Technology Options and Development Activity for Mid-Range Natural Gas Fired Turbines (1999) (unpublished presentation) (notes on file with author).

74. 40 C.F.R. pts. 76.5-76.7 (2000).

75. U.S. EPA CLEARINGHOUSE REPORT FOR 1998, *supra* note 71.

76. Title IV required sources affected by Phase I to make reductions by January 1, 1995, and for all other sources must make reductions by January 1, 2000. 42 U.S.C. §§ 7651c(a), 7651d(a), ELR STAT. CAA §§ 404(a), 405(a). NSR

applies when a plant is built or undergoes a major modification. *Id.* § 7479(1)-(2), ELR STAT. CAA § 169(1)-(2).

77. GAS RESEARCH INST., *supra* note 59; Bluestein, *supra* note 59.

78. *See* Dave O'Connor et al., Electric Power Research Inst., The State of the Art in Cyclone Boiler NO_x Reduction (1999) (unpublished presentation at EPRI-EPA-DOE Combined Utility Air Pollutant Control Symposium in Atlanta) (notes on file with author); ELECTRIC POWER RESEARCH INSTITUTE, FIRST DEMONSTRATION OF OVERFIRE AIR ON CYCLONE STEAM GENERATOR REDUCES COSTS OF NO_x COMPLIANCE (1998). "The results have clearly demonstrated the technical and operational feasibility of overfire air as a commercially viable NO_x control approach for cyclones. The application of the technology on five cyclone furnaces . . . . showed no substantial impacts from slagging, fouling, or corrosion of waterwall tubes when fueled by western coal." ELECTRIC POWER RESEARCH INST., NO_x CONTROL FIELD TEST RESULTS ON COAL-FIRED CYCLONE BOILERS—CNCIG PROGRAMS (1999), *available at* http://www.epri.com (EPR Report No. TR-113643).

79. H.R. 3400, 98th Cong. (1983). H.R. 3400, which was known as the Waxman-Sikorski Bill and which was cosponsored by over 80 House members, would have mandated scrubbing on the 50 largest utility plants, and was estimated to cost as much as $ 7 billion annually. Paul R. Portney, *Economics and the Clean Air Act*, 4 J. ECON. PERSP. 173-81 (1990). *See generally* Dallas Burtraw, *Appraisal of the SO_2 Cap-and-Trade Market, in* EMISSIONS TRADING 133-89 (Richard F. Kosobud ed., 2000).

80. If the law requires a percentage rate reduction in potential emissions, cleaner fuels cannot be used for compliance, as the standard requires an additional percent reduction via end-of-pipe control devices no matter how clean the fuel. *See* note 68 *supra*. This perversely may even lead businesses to use dirtier fuels, as it may be cheaper to reduce pollution by the given percentage with a dirtier fuel compared to the cleaner fuel.

81. A standard such as the 1.2 lb/mmBtu rate standard enacted in the 1971 NSPS would have permitted the use of compliance coal within this defined sulfur limit as an alternative to scrubbing, but would not have prompted the experimentation with fuel blending that led to the significantly increased use of western and mid-sulfur coals that was observed under Title IV.

82. Byron Swift, *Barriers to Environmental Technology Innovation and Use*, 28 ELR 10202 (Apr. 1998); Burtraw & Swift, *supra* note 20; ICF RESOURCES, COMPARISON OF THE ECONOMIC IMPACTS OF THE ACID RAIN PROVISIONS OF THE SENATE BILL (S. 1630) AND THE HOUSE BILL (S. 1630 [sic]) (1990); U.S. GENERAL ACCOUNTING OFFICE, AIR POLLUTION: ALLOWANCE TRADING OFFERS AN OPPORTUNITY TO REDUCE EMISSIONS AT LESS COST (1994).

83. Marvin Schorr & Joel Chalfin, General Electric Power Systems, Gas Turbine NO_x Emissions Approaching Zero—Is It Worth the Price? (1999) (unpublished presentation at Air & Waste Management Association's 92d Annual Meeting, June 1999, St. Louis, Mo.) (notes on file with author); STATE & TERRITORIAL AIR POLLUTION PROGRAM ADMINISTRATORS & ASS'N OF LOCAL AIR POLLUTION OFFICIALS (STAPPA/ALAPCO), CONTROLLING NITROGEN OXIDES UNDER THE CLEAN AIR ACT: A MENU OF OPTIONS (1994).

84. MASS. REGS. CODE tit. 310, §§ 7.00, 7.02 (1999); *see* MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL REGULATION, CONDITIONAL COMPREHENSIVE PLAN APPROVAL OF MYSTIC STATION (2000) (requiring end-of-pipe SCR technology to reach 2 ppm in addition to dry low-NO_x burner). EPA has recognized this problem and proposed a guideline that would presume BACT requirements are met if a source adopts very clean gas turbine technology without using SCR. Notice of Availability for Draft Guidance on BACT for NO_x Control at Combined Cycle Turbines, 65 Fed. Reg. 50202 (Aug. 17, 2000).

85. U.S. EPA CLEARINGHOUSE REPORT FOR 1998, *supra* note 71.

86. Modern gas plants are cheaper to build than coal plants, and achieve 55% efficiency instead of the 34% average for coal plants. This offsets the relatively more expensive fuel cost for natural gas, and the U.S. Department of Energy (DOE) estimates that 90% of new generation between 2000 and 2020 will be gas-fired. DOE ANNUAL ENERGY OUTLOOK 2000, *supra* note 70, at 65, 67.

87. Because they are more efficient than coal plants, they also emit roughly one-half the carbon dioxide (CO_2). *See generally* STATE & TERRITORIAL AIR POLLUTION PROGRAM ADMINISTRATORS & ASS'N OF LOCAL AIR POLLUTION OFFICIALS, REDUCING GREENHOUSE GASES AND AIR POLLUTION: A MENU OF HARMONIZED OPTIONS 49 (1999).

88. SCONOX is available for use with gas-fired turbines, and uses post-combustion catalysts to remove both NO_x and CO from the turbine exhaust, and reduces particulates as well. SCONOX is more expensive than SCR, and entails the loss of about 1% of plant efficiency. For large units, the combined capital and operating costs add about 2 mills (0.2 cents) to the cost of a kilowatt hour, twice that of SCR. For small industrial 7 MW gas turbines, the capital cost of a SCONOX unit at over $ 2 million may exceed the cost of the turbine itself, and annual costs are $ 310,000. Together these yield an annualized cost of $ 590,000 to reduce 25 tons of NO_x emissions to 2 tons, or $ 25,000 a ton (note the cost of reducing the marginal 1 ton from SCR is $ 1 million).

89. XONON is a system that combusts fuel through a chemical process that prevents the formation of NO_x.

90. DOE's Advanced Turbine Systems program has the objective of developing ultra high-efficiency gas turbine systems for utilities, with an appropriation of approximately $ 30million in recent years. U.S. DOE, ENERGY INFORMATION ADMINISTRATION, FEDERAL ENERGY MARKET INTERVENTIONS: PRIMARY ENERGY 33, app. B (1999) (Report #SR/OIAF/1999-03).

91. ELECTRIC POWER RESEARCH INST., 1999 ANNUAL REPORT (2000); U.S. DOE, FISCAL YEAR 2000 BUDGET, *at* http://www.doe.gov.

92. According to Environmental Business International, private venture funding, which reached $ 200 million in 1990, has now sunk to less than $ 60 million in an era of major technology funding. *See* PROGRESSIVE POLICY INST., HOW ENVIRONMENTAL LAWS CAN DISCOURAGE POLLUTION PREVENTION: CASE STUDIES OF BARRIERS TO INNOVATION 3-4 (2000), *available at* http://www.dlcppi.org; *see also* ENVIRONMENTAL LAW INST., BARRIERS TO ENVIRONMENTAL TECHNOLOGY INNOVATION 9 (1998) (reasons include the double approval barrier to environmental technologies—governmental and firm—and the fractioning of market size into individual permitting jurisdictions).

93. This is particularly true for CO_2, the principal greenhouse gas. Since CO_2 is a long-lived gas that lasts for centuries once emitted, it is critical to achieve major carbon reductions in the next decade or two. The only practical way to do so is to invest heavily in efficiency and in modern gas-fired generation, which is needed to substitute for the older coal-fired power plants. Yet our NO_x policies make such new investment considerably more difficult, especially for smaller units that are precisely the ones that are used for co-generation at industrial sites or to convert methane gas to power, and are counted on to achieve efficiency gains and major greenhouse gas reductions.

94. Although a system of pollution charges or fees may also provide similar benefits if the charges are set high enough, such systems have rarely been implemented in the United States.

95. Finding of Significant Contribution and Rulemaking for Certain States in the Ozone Transport Assessment Group Region for Purposes of Reducing Regional Transport of Ozone; Final Rule, 63 Fed. Reg. 57356 (Oct. 27, 1998) (covering 22 states and achieving similar reductions as a 0.15 lb/mmBtu rate standard). Although initially proposed for a group of 22 states, challenges to EPA's authority resulted in court orders that restricted application of the final rule to 19 states. Appalachian Power Co. v EPA, 208 F.3d 1015, 30 ELR 20560 (D.C. Cir. 2000) (limiting application to 19 states) (deadline for states to file state implementation plans extended to Oct. 31, 2000).

96. *See, e.g.*, H.R. 25, 106th Cong. (1999) (sponsored by Rep. Sherwood Boehlert (R-N.Y.)); H.R. 2569, 106th Cong. (1999) (sponsored by Rep. Frank Pallone (D-N.J.)); and S. 1369, 106th Cong. (1999) (sponsored by Sen. James Jeffords (R-Vt.)).

97. A related aspect is that cap-and-trade systems allow for efficient and smooth reductions in pollutant levels. Title IV provides a good example, as the allowable limit was lowered between Phase I and Phase II of both programs. However, under the rate-based approach for NO_x, all boilers that had complied with Phase I limits were grandfathered without

having to meet the Phase II limits, whereas in the cap-and-trade approach for SO_2, the cap was simply lowered, requiring all units to comply.

98. EPA 1999 COMPLIANCE REPORT, *supra* note 4; U.S. EPA, 1999 OTC NO_x BUDGET PROGRAM COMPLIANCE REPORT, *supra* note 56.

99. U.S. GENERAL ACCOUNTING OFFICE, ACID RAIN: EMISSIONS TRENDS AND EFFECTS IN THE EASTERN UNITED STATES (Mar. 2000) (GAO/RCED-00-47); Byron Swift, *Allowance Trading and SO_2 Hot Spots—Good News From the Acid Rain Program*, 31 Env't Rep. (BNA) 954 (May 12, 2000), *available at* http://www.epa.gov/acidrain/papers.

CERTIFICATE OF SERVICE

I, the undersigned, certify that on this 15th day of September, 2006, I have served electronically the attached **MIDWEST GENERATION'S POST-HEARING COMMENTS: ADDITIONAL INFORMATION** upon the following persons:

Dorothy Gunn, Clerk
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and electronically and by first-class mail with postage thereon fully prepaid and affixed to the persons listed on the **ATTACHED SERVICE LIST**.

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