Analysis&Perspective

AIR POLLUTION

ACID RAIN

The Acid Rain Program enacted as part of the Clean Air Act Amendments of 1990 has been remarkably successful at both reducing emissions of sulfur dioxide from power plants and in reducing the costs of compliance. However, its trading mechanism has been the subject of contention. Early criticism of the program questioned the ethical basis of trading, and linked trading to a right to pollute. Some commentators also believed trading might have negative environmental consequences, as it may lead some plants to emit greater quantities of pollution and create "hot spots" of pollution.

This article examines data from the first four years of the Acid Rain Program as to the effects of trading on localized pollution levels. These indicate that the effects of trading have been minimal in regards to such hot spots, and likely even positive. On a regional level, no significant trends can be discerned in the flow of traded allowances, and net interregional trades of allowances constitute only 3 percent of all allowances used. On a source-by-source basis, the opportunity to trade has led many of the largest emitters of pollution to clean up the most, such that trading has had an effect of cooling potential hot spots, not creating them. Finally, the article points out that differences in regulatory methods, including trading, have far less relation to localized pollution levels than factors such as plant location, size, and utilization.

Allowance Trading and SO_2 Hot Spots—Good News From the Acid Rain Program

BY BYRON SWIFT *

It is important to assess whether an emission cap and allowance trading program has the potential to create sulfur dioxide "hot spots" because it is a fundamentally better way to reduce regional pollution than traditional rate-based standards. A cap-and-trade program allows greater scope for compliance through cleaner fuels and clean production technologies, promotes innovation among a broader set of compliance alternatives, and greatly lowers compliance costs, which ultimately allow the political system to set tighter standards as needed. These benefits are jeopardized if concerns about trading bring a return to traditional rate-based regulation.

* *Byron Swift directs the Energy and Innovation Center of the Environmental Law Institute in Washington, D.C.* *The author thanks the A.W. Mellon Foundation for supporting research on which this article was based, EPA's Clean Air Markets Division for its generous provision of data, and Beverly Grossman for her assistance on this article.*

I. The Acid Rain Program

The Acid Rain Program implements an innovative emission cap and allowance trading program to reduce SO_2 emissions that is quite different from traditional rate regulations. While traditional regulations set individual rate standards for each source, the Acid Rain Program sets an overall cap of 8.95 million tons, half of historic levels, on industrywide SO_2 emissions. The 8.95 million tons were then allocated in the form of allowances to each combustion unit based on their historic emissions as well as performance parameters. In a sec-

  ER ISSN 0013-9211

ond innovation, individual sources were allowed to trade their allowances or bank them for future use. This allows individual units to either meet the limit, over-comply and trade or bank the saved allowances, or emit above the limit and acquire allowances to make up the difference.

Phase I of the Acid Rain Program, in effect from 1995 to 2000, required the dirtiest 263 units to reduce their SO_2 emissions to 5.7 million tons a year. All affected plants complied individually for each year, and collectively reduced emissions to an average of 4.6 million tons a year, well below the limit. The total cost of these reductions during Phase I were significantly below estimates, and the market price of an allowance averaged $150, far below the $250-$700 most analysts predicted at the start of the program. The flexibility offered by the cap approach, combined with the ability to trade allowances, is widely credited with allowing such low-cost compliance (EPA 1999; Ellerman 1997; Burtraw 1999).

Environmentally, the Acid Rain Program has also been a success. Even though the 8.95 million ton cap only takes effect in 2000, Phase I already has been achieving a 25 percent reduction in acid deposition in Eastern states (Lynch et al. 1999; NAPAP 1998).

II. Trading and its Relation to Hot Spots.

The innovative allowance trading mechanism that is part of the Acid Rain Program has, however, attracted criticism from environmental advocates because of its perceived ability to create hot spots, or localized areas of high pollution. This article examines this issue, first generally and then by examining the data on allowance trading from the first four years of the program.

In practice, trading may be expected to have little relation to hot spots in the first place, for several reasons. First, the potential for hot spots must be evaluated in the total regulatory context of the pollutant: for SO_2 this includes both the existing ambient limits on SO_2 emissions and the major added reductions made under the Acid Rain Program. The second consideration is the relative importance of trading in relation to other factors of an economic, circumstantial, and operational nature that are likely to have far greater influence on local pollution levels than the operation of a regulatory program. The third set of issues involves the nature of the regulatory program, where it is does not appear that a cap-and-trade program has a greater tendency to cause elevated local pollution levels than a more traditional rate-based approach. In fact, the evidence suggests a cap-and-trade program may help to even out pollution levels.

Overall Regulatory Context. The first issue is to determine the meaning of hot spots, which requires that the total regulatory context for a pollutant be viewed. For SO_2, entirely apart from the Acid Rain Program, there *is a set of ambient and source-specific pollutant standards* enforced under the Clean Air Act, state regulation, and occupational health and safety laws. Their objective is to limit sulfur emissions to levels that would not endanger human health in the vicinity of a plant. All reductions made under the Acid Rain Program are over and above these localized standards, which were inadequate to solve long-range and ecosystem effects. Therefore, there is a strong argument that no amount of trading under the Acid Rain Program could create a hot spot that would cause emissions to exceed limits necessary to protect human health.

In addition, the Acid Rain Program makes a major 50 percent reduction in SO_2, so concerns about trading are only about relative degrees of benefit, since all are better off. Also, the program has achieved reductions in a way that minimizes compliance costs. This increases the possibility our political system can consider additional reductions, given the low costs. Concerns about trading may ignore these total (not local) benefits.

Other relevant factors. Second, if one considers hot spots to be localized levels of higher-than-average pollution, these are caused almost entirely by other factors, notably plant location, size, and utilization, and not the regulatory system. Location is the most important. Because far more coal-fired power plants are located in Midwest states such as Ohio and Indiana, per capita emissions of sulfur dioxide in those states are many times the national average (See figure 1). Siting is also important—if three plants are located near each other, there is more local pollution. It also matters if a plant is located in a densely populated area, or is distant from population centers. Plant size and utilization are other major determinants of pollution levels. These attributes, dictated by economic factors or by proximity to high-sulfur coal fields, are likely to determine over 90 percent of localized pollution levels, not the regulatory system for pollutant reduction.

Comparison of Regulatory Systems. Even considering the regulatory system, it is not obvious that traditional pollutant reduction standards based on emission rates help to prevent hot spots any better than the cap-and-trade approach used in the Acid Rain Program. A principal reason is that rate-based regulations do not control the overall amount of pollution, which depends on plant utilization—whether a plant is operated 100 percent, 50 percent, or 1 percent of the time. At least the allowance trading approach is based on overall annual pollutant caps, and may be more likely to lead to consistent total pollutant reductions than the rate-based approach. However, as stressed earlier, any difference in local pollutant levels due to differences in regulatory approaches will be minor compared to the relative pollutant loading caused by plant location, size, and operational decisions.

Finally, trading could be expected to be random, as the motive to trade is economic; therefore, flows of allowances from one area to another would be expected to cancel each other out, with little or no environmental significance. In fact, the only principle at issue might be a slight tendency for the larger sources to reduce emissions the most, as they might be expected to have the cheapest per-unit reductions. The data below confirm both the lack of directionality, as very little net regional flow of allowances can be discerned, and also that the major sources do tend to reduce emissions slightly more than average, with an effect to cool and not create hot spots.

III. Effects of Trading Under the Acid Rain Program

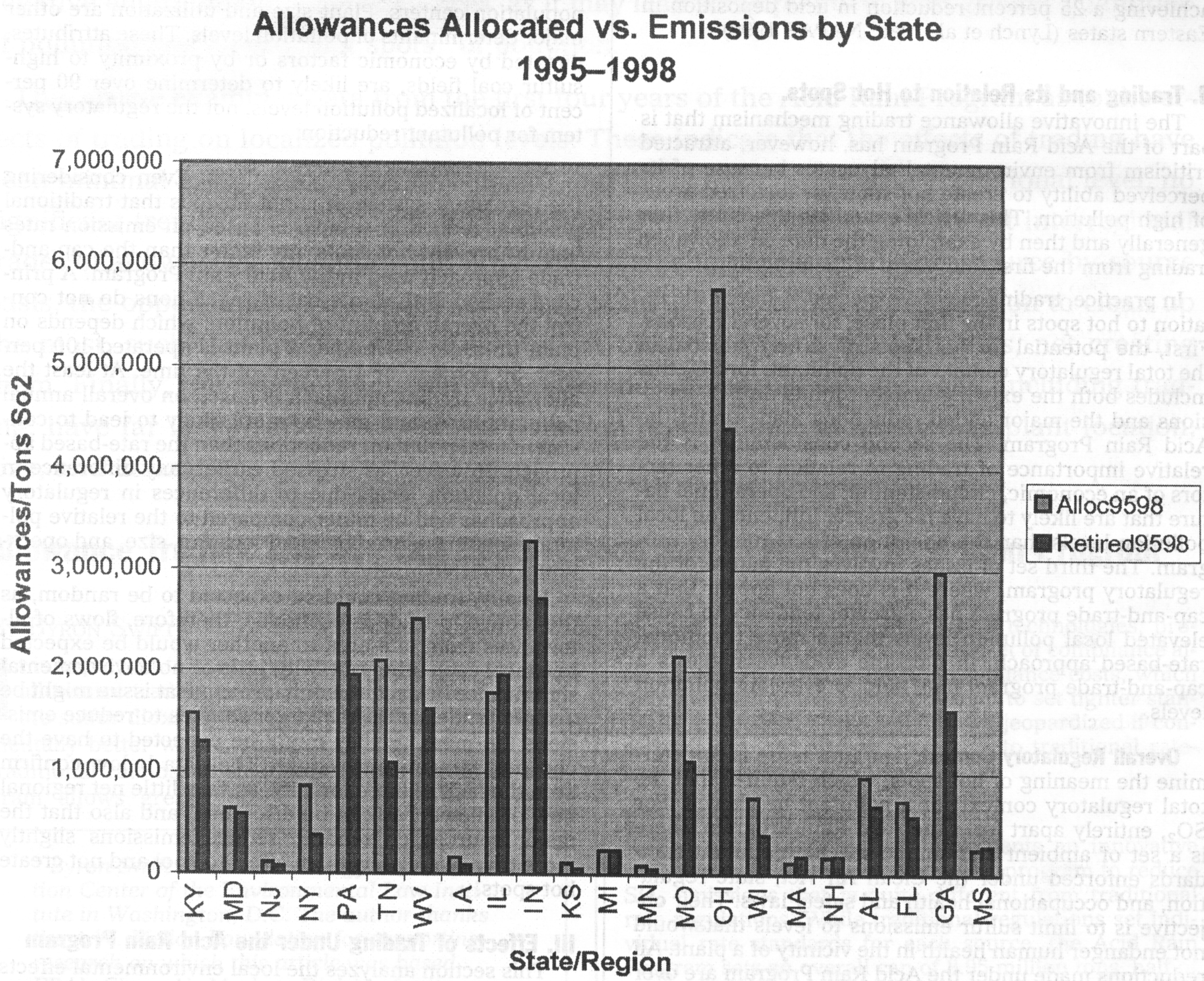
This section analyzes the local environmental effects of trading, here defined as trading between different spatial units, under the Acid Rain Program. This analysis is made difficult by the overwhelming use of banking, or saving of allowances, during Phase I. The Program allows sources that create allowances by over-compliance to either trade them, or bank them for later use. Because Phase II of the program that started in 2000 imposes a significantly lower cap, most firms affected by Phase I have banked their excess allowances for later use in Phase II. 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 Sec. 6.6). The extensive use of banking itself has some environmental significance. Although the banked allowances are expected to be used in the future, banking results in early reductions, which has positive environmental consequences in reducing sulfur deposition earlier. Overall, banking makes it difficult to assess the local impacts of trading, as most firms have lowered emissions well below authorized levels, and comparison can only be made as to the relative extent of their over-compliance.

Notwithstanding the analytical problems caused by the use of banking, it is still possible to assess the local environmental effect of emissions trading in three ways, shown below. These respectively examine where emission reductions have taken place on a state level, a regional level, and a plant level in an attempt to define any role of trading in redistributing local environmental effects.

A. Comparison of Emissions Reductions by State

The most direct way to examine any differential effects of trading is to review total SO_2 emissions by state, and compare the total to the number of allowances issued to that state. This reveals the extent to which emissions in each state are above or below the states allotted amount. However, the ability to bank allowances has meant that the emissions of virtually all states are below their allocated allowance levels, as revealed in the following figure.

Figure 1. Allocation of Allowances and Emissions from 1995-1998 by State



Broader flows of allowance transfers can be more readily observed on a regional basis. The three major regions are quite consistent in terms of emissions versus allowances issued, each with a major use of banking and with total emissions between 64 and 77 percent of allowances allocated. Since emissions in each major region are well below the total allowed, it can only be said that in the Midwest, sources banked slightly fewer allowances than other regions, and hence there were fewer early reductions.

Figure 2. Allocation of Allowances and Emissions by Region in 1995-1998

	Allocation	Emissions (%)
Mid Atlantic	10,418,878	6,973,564(67%)
Midwest	14,335,420	11,012,164(77%)
Southeast	4,922,155	3,150,761(64%)
Other	427,603	418,009(97%)
Total	30,104,056	21,554,498(72%)

The above data clearly show the emphasis on banking, and the relative consistency of reductions among states and regions, making it difficult to ascribe any effects to inter-spatial trading.

B. Analysis of Regional Flows in Trading

A more direct way to examine the effects of trading on local emissions is to examine the actual net flows of the allowances used to offset emissions. The data show that 81 percent of allowances used to offset actual emissions come from the same state as the emitting source, a high level that indicates a relative lack of emissions-shifting through trading. Interestingly, 80 percent of the averaging plans for NOx sources regulated under Title IV of the Act are also limited to one state, showing similar home-state compliance under the more traditional rate-based regulatory regime used for NOx.

Figure 3. Source of Retired Allowances by Region

	Emissions	Same state source of retired allowances
Mid Atlantic	6,973,564	5,142,005(74%)
Midwest	11,012,164	9,140,255(83%)
Southeast	3,150,761	2,835,101(90%)
Other	418,009	352,967(84%)
Total	21,554,498	17,470,318(81%)

Secondly, the data below reveal extraordinarily little net allowance flow between regions. Of the total emissions of 21,544,498 tons between 1995 and 1999, only 663,795 tons, or 3 percent, represent net inter-regional transfers. There is little directionality revealed in Figure 4—even the largest transfer, from the Middle Atlantic to the Midwest, consists mostly of transfer from Tennessee and West Virginia to neighboring Illinois and Indiana. The data on allowance origin show that traded allowances have made little or no difference in the spatial location of emissions due to trading.

C. Analysis Shows Trading May Cool Hot Spots

Another way to identify the environmental consequences of a cap-and-trade approach is to assess where emissions reductions have taken place on a plant level. The reductions made, however, will indicate banking strategy as much as it will trading strategy.

The data shows that the plants with the largest emissions have cleaned up the most. Figures 5 and 6 show data for the largest plants in Phase I, and for all Table I plants sorted by size. The data for the large plants show that virtually all emitted at low levels, and for most well below the overall average. The major exception is Baldwin, but that plant also has recently made a major 90 percent reduction in SO_2 by shifting to low-sulphur coal in order to meet the more stringent Phase II requirements starting in 2000. Figure 6 shows allowances issued and emissions by all Table I plants, and also reveals a general trend for the larger plants to achieve slightly greater reductions. Plants are arranged according to their size by quartiles, and the data show emissions are 24 percent below allowance levels for the largest plants, declining gradually to 6 percent below for the smallest.

These data confirm a general prediction about cap and trade programs, that they will tend to create incentives for the dirtiest plants to clean up the most, as the per-ton cost of emissions reductions may be expected to be the least (as the capital cost is spread over a larger return). These data show that, if anything, trading may be expected to cool hot spots and not create them.

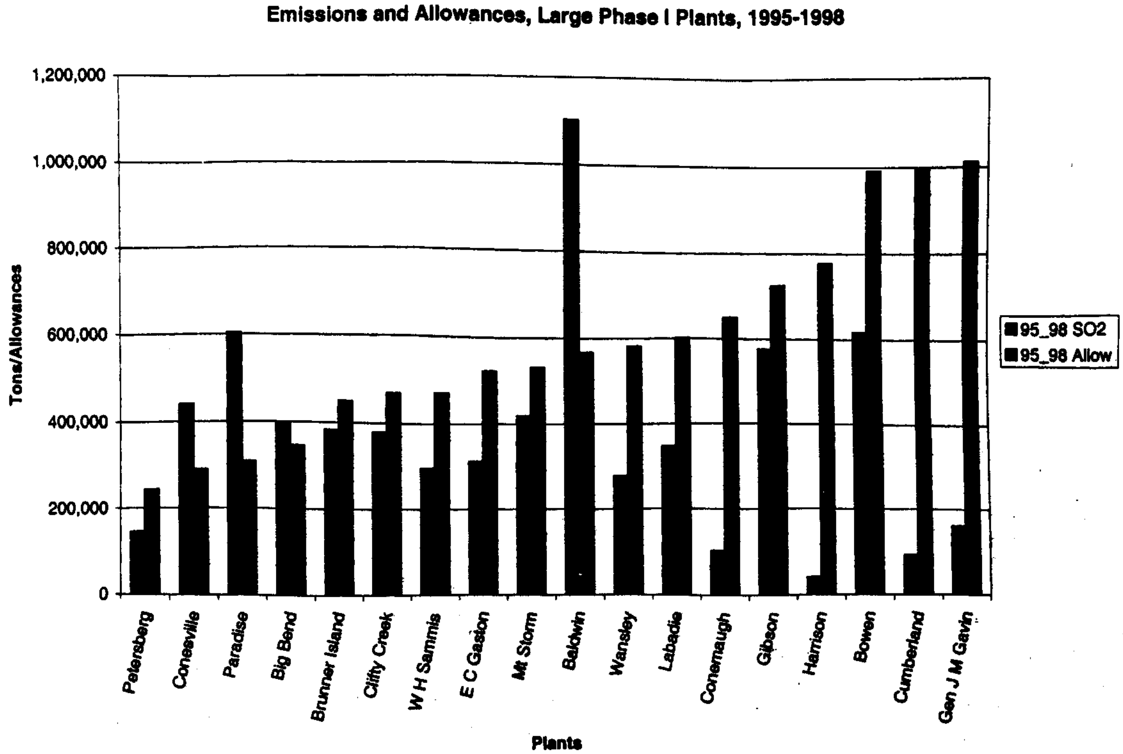
Figure 4. Net flows of allowances transferred between regions from 1995-1998

Region	Mid Atlantic	Midwest	Northeast	Southeast	West	(total emissions)
Middle Atlantic		–413,984	–12,683	54,228	13,273	6,973,564
Midwest	413,984		16,838	97,625	45,955	11,012,164
Northeast	12,683	–16,838		2,416	134	357,624
Southeast	–54,228	–97,625	–2,416		6,659	3,150,761
West	–13,273	–45,955	–134	–6,659		60,385

Source: EPA Allowance Tracking System

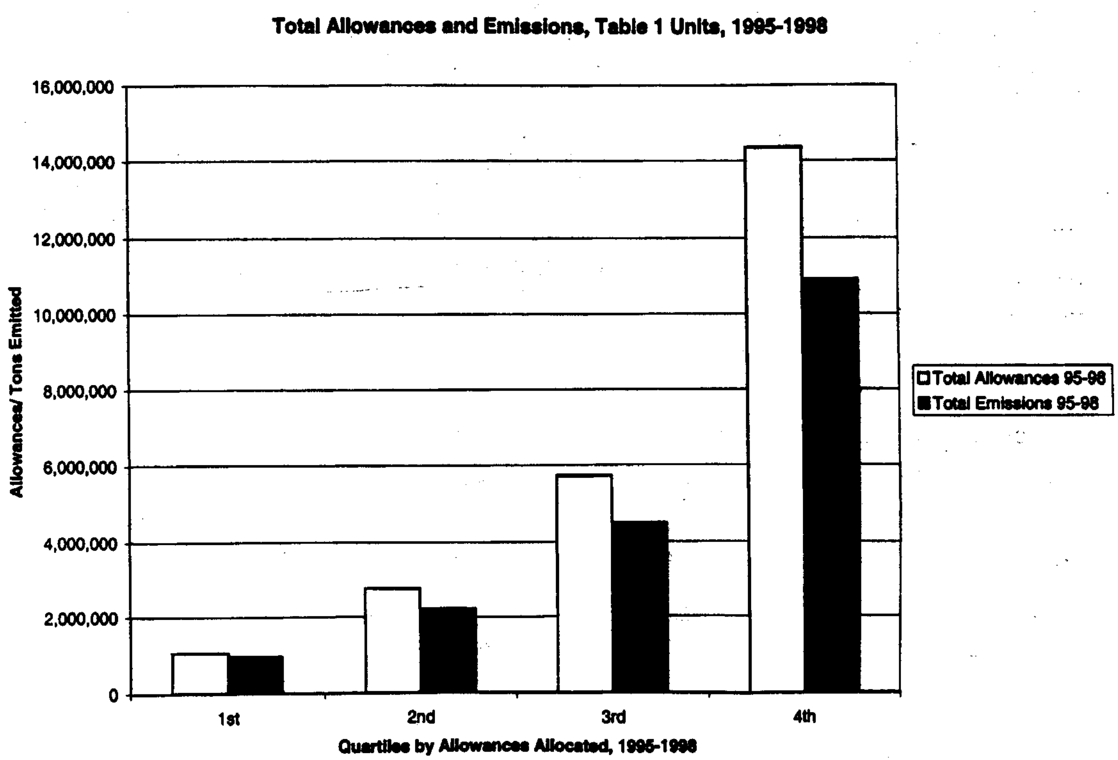
Note: for each region in left column, + indicates net inflow, – indicates net outflow

Figure 5. Allowances Issued and Emissions of 20 Largest Phase I Plants (1995-1998)



Source: EPA 1999

Figure 6. Allowances Issued and Emissions According to Plant Size, Table I Units (1995-1998)



Source: EPA 1999

ER ISSN 0013-9211

Sources

Burtraw, D., 1999. Cost savings, market performance and economic benefits of the U.S. Acid Rain Program. In Sorrell, S. & J. Skea, Pollution for Sale: Emissions trading and Joint Implementation. (Elgar Publishing, Northampton, MA).

Burtraw, D. & B. Swift, 1996. A New Standard of Performance: An Analysis of the Clean Air Acts Acid Rain Program. 26 Envir. Law Rep. 10411 (August). Ellerman, A.D. P. L. Joskow, R. Schmalensee, J-P. Montero, and E.M. Bailey, 2000. Markets for Clean Air: The U.S. Acid Rain Program. (Cambridge University Press, New York).

Ellerman, A.D., R. Schmalensee, P.L. Joskow, J-P. Montero, and E.M. Bailey (1997). Emissions Trading under the U.S. Acid Rain Program: Evaluation of Compliance Costs and Allowance Market Performance. (M.I.T. Center for Energy and Environmental Policy Research, Cambridge, MA).

Lynch, J.A., Bowersox, V.C. and Grimm, J.W., 1999. Changes in Sulfate Deposition in Eastern USA Following Implementation of Phase I of Title IV of the Clean Air Act Amendments of 1990. Atmospheric Environment (in press).

National Acid Precipitation Assessment Program (NAPAP), 1998. Biennial Report to Congress: an Integrated Assessment. (May).

United States Environmental Protection Agency, 1999. 1998 Compliance Report: Acid Rain Program. (EPA-430-R-99-010) (July). [Also 1997, 1996 and 1995 Compliance Reports.]

United States Energy Information Agency, 1997. The Effects of Title IV of the Clean Air Act Amendments of 1990 on Electric Utilities: An Update. (DOE/EIA 0582-97) (March).

United States General Accounting Office, 2000 Acid Rain Emissions Trends and Effects in the Eastern United States, GAO/RCED-00-47 (March).