From Obstacle to Opportunity:

How acid rain emissions trading is delivering cleaner air

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Environmental Defense

finding the ways that work

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Environmental Defense, a leading national, New York-based nonprofit organization, represents 300,000 members. Environmental Defense links science, economics, and law to create innovative, equitable and economically viable solutions to today's environmental problems.

This report was prepared by the following staff members in the Global and Regional Atmosphere Program at Environmental Defense: Andrew Aulisi, Daniel Dudek, Joseph Goffman, Michael Oppenheimer, Annie Petsonk, and Sarah Wade. It updates and expands a report issued in November 1997 entitled “More Clean Air for the Buck: Lessons from the U.S. Acid Rain Emissions Trading Program,” which included contributions from Deborah Salon.

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A Note to Readers

This report has two related subjects. The first four parts of the report focus on the emissions performance and economic results of the acid rain emissions trading program—a system in the United States to reduce sulfur dioxide pollution from electricity plants. Our hope is that these sections will inform the public of our assessment of the program and influence a broad range of policy makers and stakeholders, particularly with regard to issues involved in the design of successful “cap and trade” mechanisms to reduce air pollution. The fifth part discusses specific design issues relevant to the Kyoto Protocol on climate change, which is presently under deliberation by international negotiators who are seeking to develop rules for greenhouse gas emissions reductions. This part will be of particular interest to readers concerned with the successful implementation of the international framework to mitigate climate change. The conclusion of the report enumerates a set of policy challenges characterized by the imperative of achieving substantial reductions in air pollution quickly and inexpensively. The report invites policy makers to assess the design and results of the sulfur dioxide program as they move forward with their own initiatives.

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Preface

The battle against acid deposition in the United States is far from over. The current federal program to reduce the major precursors of acid rain, namely emissions of sulfur dioxide (SO_2) and nitrogen oxides (NOx), is only just beginning its second phase. Mounting evidence suggests that even more reductions in these pollutants, beyond those called for under the current law, will be necessary.

At least, however, the battle has begun.

This report presents the results of the first five years of the federal program to reduce the SO_2 emissions that are precursors of acid deposition. It also includes observations about these results and the lessons they can teach policy makers and other stakeholders as they grapple with the continuing, wide-ranging threats to human health and the environment posed by air pollution.

Advancing this kind of learning is critical if we are to find solutions to complex environmental problems. The problem discussed in this report—acid deposition—and the method used to address it—emissions trading—have been of special concern to Environmental Defense (formerly Environmental Defense Fund, or EDF) for almost 20 years.

Throughout the 1980s, EDF devoted extensive research and advocacy resources to the effort to solve the acid rain problem. EDF scientists engaged in a variety of research and public education activities, and, together with EDF economists and lawyers, worked energetically to promote the use of "market mechanisms" as the most effective way to achieve large reductions in SO_2 and NOx emissions. In 1989 and 1990, EDF was widely credited for advancing the "cap and trade" proposal to reduce acid rain emissions embraced by the Bush administration and then enacted by Congress as part of the Clean Air Act Amendments of 1990.

Throughout the 1990s, EDF waged active campaigns to persuade policy makers on every level to use the "cap and trade" model of the SO_2 program in the battle against pollutants ranging from ozone smog precursors, to stratospheric ozone depleters, to greenhouse gases. Many of the critical elements of this approach are now reflected in regional NOx programs in the United States and even in the Kyoto Protocol, to which Environmental Defense continues to devote considerable resources both in the United States and abroad.

This report, then, is part of an ongoing effort begun nearly 20 years ago. Although the results of the first phase of the SO_2 program are very promising, the struggle to protect human health and natural resources from the ravages of air pollution continues.

Thus this report is intended to offer useful material both to those looking backward and those looking forward across the horizon of environmental policy.

Executive summary

Since 1995, the United States has been conducting what ten years ago was widely regarded as a novel "experiment." In 1990, President George Bush and the United States Congress enacted legislation that required all power plants in the continental United States to reduce and cap their total annual emissions of sulfur dioxide (SO_2), a precursor of acid rain. The legislation introduced the additional innovation of allowing the power plants to meet this requirement through the optional use of emissions trading. At the time, a pollution control program that made polluters explicitly liable as a matter of law for limiting their total emissions to a specified level while permitting them to use emissions trading was simply unprecedented.

From 1995 to 1999, or the period known as "Phase I," the program yielded impressive environmental and economic results. Figure 1 summarizes one set: Phase I power plants reduced their SO_2 emissions far below the level that was legally allowable under all of the provisions of the program. Furthermore, in response to the economic dynamics created by the "cap and trade" design of the program, these plants released substantially less pollution relative to the more stringent level of "base" allowable emissions established by Congress. At the same time, the SO_2 emissions trading market has done what markets do best: drive down costs.

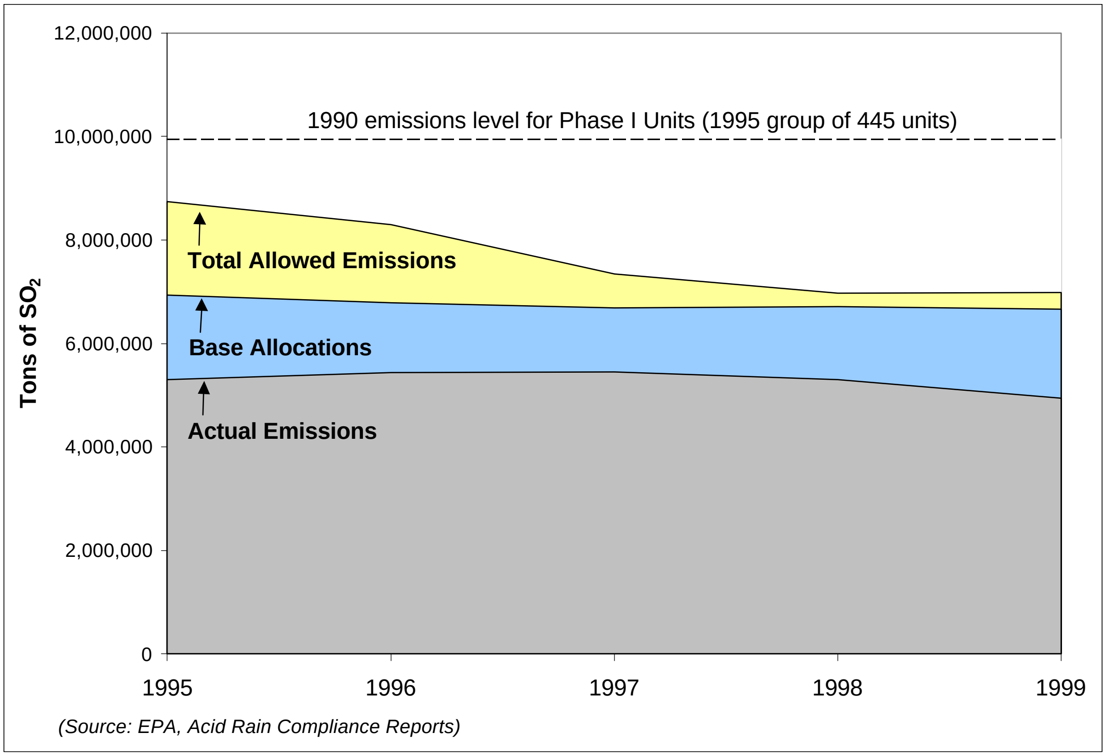

Figure 1: Phase I emissions performance: actual emissions vs. base allocations vs. total allowances

These results are especially critical now, since they can inform the actions of current policy makers—those who must respond to growing evidence that further reductions in SO_2 and NOx emissions are needed to solve the problem of acid rain and protect public health. In addition, the reaction of polluters to this market-based program bears important lessons for those who are grappling with the control of greenhouse gases (GHGs) to protect the climate.

Largely through a series of graphs and illustrations, this report details the successful and encouraging results of the acid rain emissions trading program:

- While achieving *100% program compliance* during Phase I, power plants reduced SO_2 emissions 22% *below* the levels required as compared to the restricted number of "base" allowance allocations initially allotted to them by Congress, resulting in 7.3 million tons of *extra emissions reductions*.

- When taking into account *all* Phase I emissions allowances allocated under the program, such as "extension allowances" for certain technologies and allowances available through a statutory auction, actual emissions were 30% lower than the level that was legally permitted, resulting in *11.6 million* unused allowances.

- The *extra reductions* in emissions were distributed across 22 of the 24 states whose power plants have participated in Phase I, and many sources in the highest-emitting states—such as those in Ohio, Indiana, Georgia, Pennsylvania, West Virginia, and Missouri—have made the greatest number of cuts in emissions.

- The extra reductions, which represent a concrete economic asset because of the banking and trading provisions of the program, have occurred in the absence of any federal or state action to restrict the saving or transfer of allowances.

- The cost of SO_2 reductions, as reflected indirectly in the price of traded SO_2 emissions allowances, is far below the cost predicted during the initial debates on the program.

- Despite the rapid fall in SO_2 emissions over the past five years, both electricity generation and the United States economy experienced strong growth during the same period. Thus the results of the program offer more evidence to disprove the supposed link between economic growth and emissions growth.

- Reductions in sulfate deposition have been observed in geographic areas affected by atmospheric transport of sulfur.

The superior environmental and economic results of Phase I of the SO_2 program are precisely what should have been expected of a program that matched an explicit emissions limit with a market that turned pollution reductions into marketable assets.

Despite these achievements, air pollution continues to pose serious threats to human health and the environment. Mounting evidence suggests that if the acid rain problem is to be solved, even more emissions reductions are needed in SO_2 and, in particular, NOx, which is not under the same regulatory limit on emissions as that specified for SO_2. In addition, these pollutants contribute to the formation of ground level ozone and fine-particle smog. Human health is also menaced by the release of mercury from power plants, while global emissions of GHGs from a variety of sectors and sources threaten damaging changes to the world's climate system.

The results of Phase I of the SO_2 program are so promising, however, as to create a clear imperative for stakeholders and decision makers—people facing the pollution-control challenges now looming on the political horizon—to test the potential performance of their own strategies and initiatives against the results of the SO_2 program.

This obligation applies to federal and state policy makers in the United States who are grappling with regional pollution issues and potential changes in the control requirements for the nation's electricity plants across the spectrum of four major pollutants: SO_2, NOx, mercury and carbon dioxide.

This obligation also applies to international negotiators who are seeking to develop rules to bring forward the Kyoto Protocol on climate change. Accordingly, with particular emphasis on the dual objective of ensuring both the integrity of the emissions reductions mandates of the Protocol and the effectiveness of the international emissions trading market created by the Protocol, this report includes a discussion of certain issues currently facing the international negotiators. It offers a number of recommendations and lessons derived from the design of the SO_2 program:

- Clear, consistent rules that emphasize transparency, fungibility, and market performance have been the key factors in creating the investor certainty that has brought about the program's success.

- To foster extra, early reductions during the first compliance period of the Kyoto Protocol (2008-2012), nations should advocate "banking" of allowable emissions and establish, before 2008, their limits for GHG emissions for the second compliance period.

- To promote compliance, the Protocol framework should incorporate a key feature found in the SO_2 program: automatic deduction of excess emissions from a noncomplying party's subsequent "assigned amount."

- In view of the limited set of enforcement tools available to an international regime, nations should adopt a limited but effective form of "buyer liability" to create incentives in favor of compliance and to ensure that the environment is made whole.

- In weighing "compliance funds," nations should ensure that any such programs adopted provide sufficiently high penalties to preserve the environmental and economic integrity of the GHG emissions reduction trading system. Parties and firms must be permitted "no exit" from their obligations to reduce GHG emissions.

I. Introduction and background

The program implemented in the United States to reduce SO_2 emissions, a major cause of acid rain, demonstrated dramatic success between 1995 and 1999, the Phase I period. With the advent of Phase II in January 2000 and the requirement for more reductions from more sources, the program took another important step forward in tackling what was once a seemingly intractable environmental problem.

Establishment of the SO_2 program

Throughout the 1970s, both lay and scientific observers noted the occurrence of acidified lakes and streams located across large areas of the eastern United States. Many of these waterways exhibited a startling decline in animal life. Anecdotal and scientific evidence also pointed to declines in some forests in roughly the same areas. Based on years of research at the Hubbard Brook Experimental Forest in New Hampshire, Dr. Gene Likens identified the cause as related to air pollutants, and popularized the term "acid rain" to describe the phenomenon.[1] In 1981, the National Academy of Sciences issued a broad report supporting the view that atmospheric emissions of SO_2 and NOx result in acidic deposition (through rain, snow, and fog) that, in turn, caused this environmental damage.[2] The Academy's report also urged a "prompt tightening of restrictions on atmospheric emissions from fossil fuels and other large sources."[3]

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[1] Extensive research outside the United States, particularly Scandinavia, also demonstrated the connection between air pollution and acid deposition. Dr. Likens is the President and Director of the Institute of Ecosystem Studies in Millbrook, NY.

[2] Committee on the Atmosphere and the Biosphere, National Research Council, National Academy of Sciences, *Atmosphere-Biosphere Interactions: Toward a Better Understanding of the Ecological Consequences of Fossil Fuel Combustion* (Washington, DC: National Academy Press, 1981).

[3] Ibid., 7.

The ensuing scientific and policy debate about the link among air pollution, acid deposition, and adverse effects on ecosystems consumed the rest of the decade. It was fueled by bitter political and economic controversy among industrial and regional stakeholders over the cost of reducing SO_2 emissions and the perceived inequitable distribution of both those costs and the claimed benefits. Specifically, as shown in Figure 2, the vast bulk of SO_2 emissions were from electric utilities, particularly coal-burning plants in the Midwest and Southeast—a trend that continues to this day.[4] These companies and regions would bear the cost of the reductions, as would that part of the coal industry that produced high-sulfur coal. The benefits would be gained by "downwind" regions, such as the Northeast (where acid deposition was having a strong effect) and by providers of low-sulfur fuel.

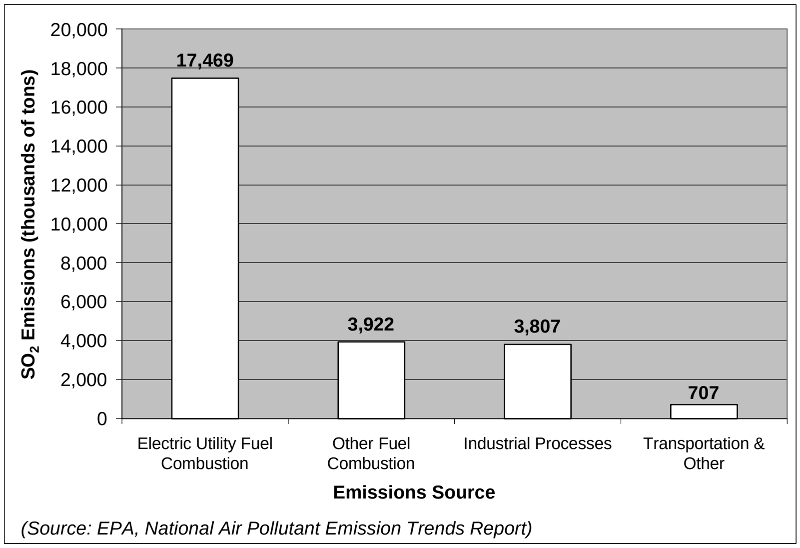

Figure 2: SO_2 emissions in the United States, 1980

These disputes stalled legislation until the Bush administration, with the ultimate support of a Democrat-led Congress, brought forward a plan to lower SO_2 emissions, cap them at the reduced levels, and allow sources to use emissions trading to lower costs. This approach enabled the deadlocked policy makers to defer to the emissions trading market itself as the forum in which a host of competing economic interests would be balanced. In 1990, Congress finally enacted the multifaceted Clean Air Act Amendments, which included a nearly 50% reduction requirement for SO_2 emissions from electric utilities (Title IV of the amendments).

Design of the SO_2 program

The reduction was implemented as an annual SO_2 emissions budget—literally a "cap" on total SO_2 emissions from power plants at levels substantially lower than those of the 1980s. This approach was unprecedented, as existing air pollution regulation relied on specific technical or operational requirements on sources, usually resulting in a restriction on the *rate* of emissions discharge but not on *total* discharges. Although such requirements were based on projections of actual emissions reductions, fixed levels of total reductions were never explicitly mandated. Consequently, as long as sources met their operational requirements, they were not held responsible if the projected levels of emissions reductions were not met.

Under the SO_2 program, however, the Environmental Protection Agency (EPA) distributes to each power plant a fixed number of emissions "allowances," each of which gives the owner the authorization to emit one ton of SO_2 at any time. A plant may then sell the allowances to another plant (or to any interested buyer, including environmental groups and speculators) provided that at the end of the year it surrenders to the EPA enough allowances to cover its emissions for that year. Allowances that are not used to cover emissions in one year may be saved for use in later years, which is known as "banking." The law requires each power plant to install continuous emissions monitors and to report the results on a quarterly basis to the EPA. The EPA is required, in turn, to operate an emissions and allowance tracking system, which has ensured the transparency and sound record-keeping needed to make the program successful.

[4] Office of Air Quality Planning and Standards, Environmental Protection Agency, *National Air Pollutant Emission Trends: 1900-1998*, EPA 454/R-00-002 (Washington, DC: Environmental Protection Agency, 2000), A-19.

Also critical to the character and success of the program is the fact that the aggregate number of allowances circulated every year is fixed, or capped. As a result of this design, power companies must plan for economic growth and change while operating against a limit on their total SO_2 emissions. This "cap and trade" regime gives utilities a direct financial incentive to reduce emissions below required levels. Extra reductions, in the form of unused allowances, give companies flexibility to offset increases in emissions in one location with reductions in another. In addition, utilities can optimize control by reducing emissions when it is least expensive to do so and then banking the allowances for future use or sale. Consequently, extra reductions give power plants the flexibility needed to respond to economic demands and opportunities while meeting their compliance obligations under the cap. Where extra reductions are achieved, the environment benefits from less pollution at an earlier time than required by law.

Furthermore, through emissions trading, power companies have the incentive to find the lowest-cost means of achieving compliance and to reap financial rewards for developing those means. Under this program, each power plant can choose between various compliance alternatives, for example, using low-sulfur fuel, investing in energy efficient technologies, chemically removing sulfur from smokestack emissions, or acquiring allowances from other utilities that can make reductions more cost-effectively. As a result, the different compliance alternatives have been forced to compete with one another. The expected result has occurred: compliance costs have been driven steadily downward.

Phase I of the acid rain program mandated participation by the largest emitters of SO_2—specifically, 263 sources at mostly coal-burning electricity plants (located primarily in eastern and midwestern states). They were joined by additional sources that voluntarily chose to participate in Phase I rather than wait until Phase II, as allowed under certain provisions of the legislation. The total program budget, or cap, for 1995 included 8.7 million tons worth of allowances, as shown in Table 1. By 1999, the budget gradually decreased to roughly 7 million tons due to the phase-out of provisions designed to promote certain control options and investments.

Table 1: Annual Allowance Budgets

Phase	Year	Number of Mandatory Units	Number of Voluntary Units	Total Number of Units	Total Allowance Budget (tons SO_2)
I	1995	263	182	445	8,744,081
	1996	263	168	431	8,296,548
	1997	263	160	423	7,147,464
	1998	263	145	408	6,969,165
	1999	263	135	398	6,990,132
II	2000	> 2000	--	> 2000	9,200,000
	2010	> 2000	--	> 2000	8,950,000

Source: EPA, Acid Rain Program Compliance Reports

Phase II, which began in January 2000, imposed more stringent emissions limits on the units participating in Phase I. In addition, Phase II established caps on SO_2 emissions for virtually every other power plant in the continental United States (any with output capacity of greater than 25 megawatts) as well as all new utility units, thus bringing the total universe of regulated units to more than 2,000. The annual budget for these sources was set at 9.2 million tons. It will continue at that level until 2010 when the cap drops to a permanent level of 8.95 million tons, a level roughly equal to 50% of electric utility emissions in 1980.

Pollution in the atmosphere and emissions trading

Policy makers chose to focus the design of the SO_2 program on total *cumulative* emissions reductions and on *unrestricted* emissions trading and banking because of the atmospheric characteristics of SO_2 emissions. In the atmosphere, SO_2 reacts with other pollutants, including the various elements of "smog," to form acidic particles and droplets. These are what constitute acid deposition. Various components of this "soup" of pollutants have been traced traveling over long distances, after being mixed from widely dispersed groups of sources.

In the United States, one common wind pattern moves air from the midwestern region to the northeastern region of the country. These winds mix and carry SO_2 and sulfate (a chemical derived from SO_3), as well as other pollutants involved in the formation of acid deposition. Figure 3 depicts the average trajectories of winds arriving at a monitoring station in central Pennsylvania during precipitation. The arrows represent the average trajectories for a six year period and the numbers represent the median sulfate concentrations in precipitation (expressed as milligrams per liter) associated with those trajectory directions. One should note that the highest concentrations occurred with air travelling over the midwestern region (the red arrow).

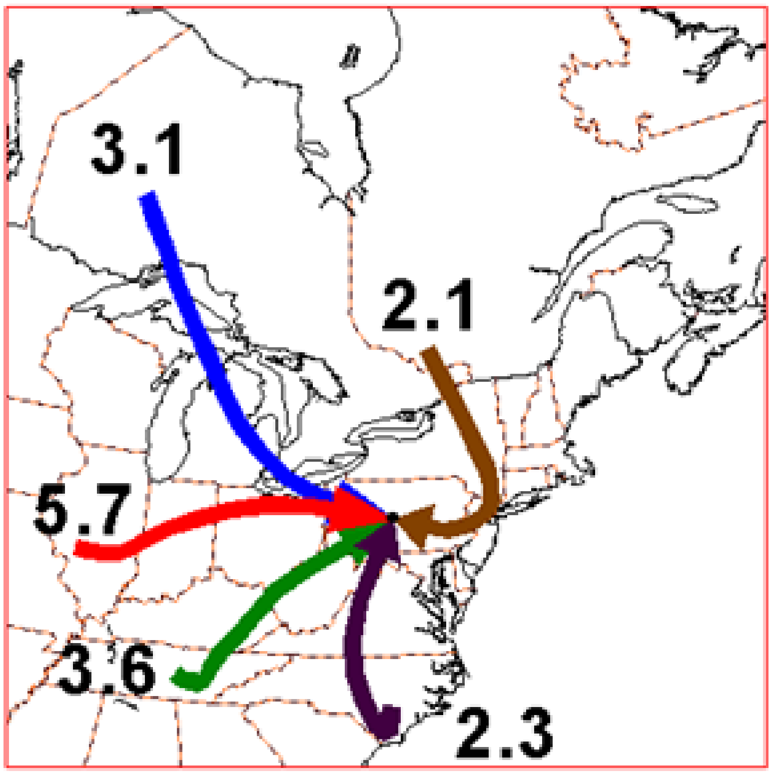

Figure 3: Typical wind trajectories and sulfate concentrations in precipitation at a site in central Pennsylvania[5]

Figure 4 shows the location and magnitude of SO_2 emissions in 1990 from *all* sources in the continental United States—roughly 23.7 million tons in total.[6] The power plants covered by Phase I of the acid rain program released a total of 10 million tons of SO_2 in 1990—or 42% of total SO_2 emissions nationwide. Phase I sources are considered to be the major contributors of sulfur in acid rain.

[5] The trajectory analysis and sulfate concentrations were contributed by Environment Canada from measurements at a site near State College, Pennsylvania. Environment Canada generously provided Figure 3 for inclusion in this report. The figure may also be viewed on the Environment Canada web site at http://airquality.tor.ec.gc.ca/natchem.

[6] EPA, *National Air Pollutant Emission Trends*, A-19.

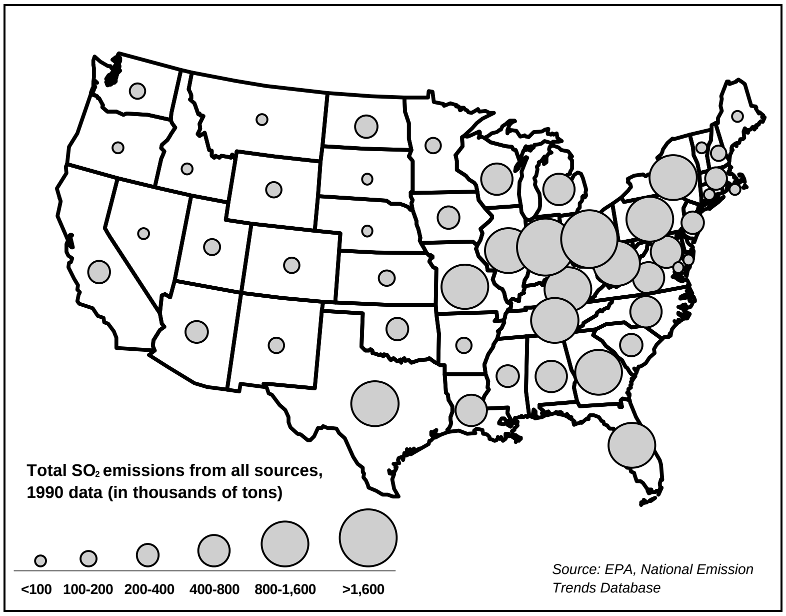

Figure 4: Total SO_2 emissions by state, 1990

Considering Figures 3 and 4 together supports the conclusion that general wind patterns prevailing over the eastern half of the United States capture the large amount of SO_2 emissions in the Midwest and South. Once the emissions are captured, they are dispersed widely over those parts of the country as well as over the Mid-Atlantic and the Northeast, where acid rain has had a severe local effect.

Wind captures SO_2 emissions in the Midwest and South and disperses them widely over those parts of the country as well as over the Mid-Atlantic and the Northeast.

In view of this, Congress focused on reducing and capping the overall level of SO_2 emissions instead of trying to control local, source-by-source variables. Since it is the total accumulation of acid deposition that principally determines its effect on the environment, the reduction in total emissions of acid precursors (rather than reductions from any one source) appeared to be most critical. Consequently, Congress concluded that it was acceptable to allow emissions trading to occur *without restrictions*. As long as overall reductions were achieved, the emissions levels of individual sources could be permitted to adjust to market forces through trading.

The program's provisions that permit sources to bank allowances for future use also stemmed from the commitment of Congress to both the environmental and the economic performance of the program. Through banking, sources would enjoy much greater flexibility in operating under their SO_2 emissions constraints. In fact, banking could play a critical role in the formation of the overall SO_2 emissions trading market. Equally important, the opportunity to bank extra allowances could yield more and earlier reductions than Congress otherwise could mandate.

At the time the program was proposed, a formal analysis of alternative policy designs was undertaken by Environmental Defense. The study strongly suggested that the very large quantity of SO_2 emissions in the Midwest and parts of the South would allow those regions and their sources to tap economies of scale in making SO_2 reductions.[7] Because of their large inventory of emissions, power plants in those parts of the country would exploit opportunities to make substantial reductions relatively easily and inexpensively. The resulting lower marginal cost of an incremental ton of reduction would make it economically attractive for those sources to "over-

[7] Daniel Dudek, "Emissions Trading: Environmental Perestroika or Flimflam?" *Electricity Journal* 2 (1989): 32-43.

control" their emissions—so that they could either sell their extra reductions to other sources or bank those reductions for use in offsetting future emissions. Consequently, the likely economic dynamics of an emissions trading and banking market favored making both mandatory and extra reductions at the high-emitting sources.

The banking component of this dynamic was particularly important. Even for those sources that were uncertain about the short-term economic value of creating extra reductions for the purpose of selling the unused allowances, the prospect of banking those extra reductions was likely to be appealing. While the market demand for extra reductions might not materialize in the short-term, sources knew that they would have to operate against a permanent cap on their emissions. The certainty of the cap and the expectation of economic growth over time would mean that the opportunity to bank extra reductions for future use all but guaranteed that those reductions would be economically valuable. Furthermore, with Congress taking a phased approach to control, both the banking provisions and the provisions that allowed Phase II sources to "substitute in" offered the opportunity to design system-wide control optimization.

At the same time, the common understanding of the adverse ecological effects of acid deposition strongly suggested both that reducing cumulative SO_2 emissions should be the goal of the program, and that early reductions were of significant environmental value. The earlier the reductions, the sooner the ecosystems affected by acid deposition could begin to recover their acid-neutralizing capacity. As a result, the economic dynamic created by an emissions cap with banking favored the environmental benefit of early, extra emissions reductions. Indeed, as shown in forthcoming sections, the cap and trade program for SO_2 emissions has provided immediate and significant reductions in emissions beyond the legal mandate.

Finally, Congress' latitude in permitting unlimited emissions banking and trading, albeit in the implementation of a large mandatory cap and reduction requirement, was augmented by other existing provisions of the Clean Air Act. Beginning with its enactment in 1970, the Act has required the EPA and the states to regulate the release of SO_2 from sources whose emissions had local effects on public health. In fact, in the legislation establishing the SO_2 cap and trade program, Congress explicitly barred sources subject to SO_2 emissions limits under the local health-effects program from using SO_2 emissions allowances to meet their local limitations. As a result, plants subject to SO_2 emissions limits imposed for purposes of protecting local air quality cannot exceed these limits no matter how many SO_2 allowances they hold.[8]

[8] The legislation establishing the SO_2 program explicitly preserved the existing Clean Air Act authorities of Congress and the EPA to impose additional restrictions on SO_2. In addition to calls for Congress to require further reductions in annual SO_2 emissions beyond those mandated for Phase II, the EPA has issued new standards for fine particle emissions (these regulations are currently in litigation). Depending on how the implementation programs for these standards are designed, power plants may face either one of, or a combination of, additional reductions in the SO_2 emissions cap and/or additional source-specific reduction requirements.

More Reductions and a Cap: Environmental Victory Through Emissions Trading

The notion of using emissions trading as part of the implementation of national SO_2 emissions reductions was formally unveiled in June 1989 in a speech by President George Bush, introducing his administration's overall proposals for amending the Clean Air Act. At the time, emissions trading was highly controversial among both environmental advocates and the public at large.

That controversy was sparked because the initial focus of the ensuing debate revolved around emissions trading as a "market mechanism" and as a method for reducing compliance costs. To many, these were but shorthand for "industry loophole."

In 1989 and 1990, the issue of cost remained the pivotal point of the political debate. In the end, however, the link between emissions trading and cost savings played to the environment's advantage. Initially, the Bush administration's economic analysts were leaning toward supporting a reduction target of only 8 million tons. Moreover, legislation introduced in early 1989 and in previous Congresses had mandated an annual reduction in SO_2 emissions of only 8 million tons. It was the promise of cost savings through emissions trading that persuaded the Bush administration to propose in its Clean Air legislation that the SO_2 program stipulate an annual reduction of *10 million tons*.[9] With a Republican president sending a 10 million-ton bill to a Democrat-led Congress, the enactment of the more stringent target was all but ensured. Thanks to the anticipated cost savings of emissions trading, the final legislation required the additional 2 million tons of annual SO_2 reductions.

Perhaps even more important, the inclusion of emissions trading led to another environmental victory. Throughout the 1980s, the environmental community and some of its congressional champions had sought to craft acid rain legislation that both reduced SO_2 emissions and *capped* total emissions at the reduced levels. None of these efforts succeeded. In legislation sent to Capitol Hill in July 1989, however, the Bush administration included the critical elements of just such a cap, which was made possible only by the operational flexibility offered to companies by emissions trading. In the ensuing legislative process, the Senate Committee on Environmental and Public Works (and subsequently the full Senate and the House of Representatives) used the allowance allocation system to construct a truly comprehensive emissions cap.

[9] Tom Wicker, "Who'll Stop the Rain?" *New York Times*, 16 June 1989, A27.

II. Market development and extra emissions reductions

One early concern about the “cap and trade” aspect of the acid rain program was that markets for allowances would not develop or would not function like conventional markets. The results of Phase I tell a different story. Although the SO_2 program experienced some of the characteristics of any startup exchange, it is growing into a full-fledged commodities market. Liquidity has increased dramatically, as shown in Figure 5, which charts the total number of allowance transfers recorded by the EPA’s Allowance Tracking System. The year 1999 witnessed a 460% increase in the total number of private transfers compared with 1995 (the first year of the program). This trend of increasing liquidity is continuing through the year 2000, with 2,223 transfers already recorded by mid-year.[10]

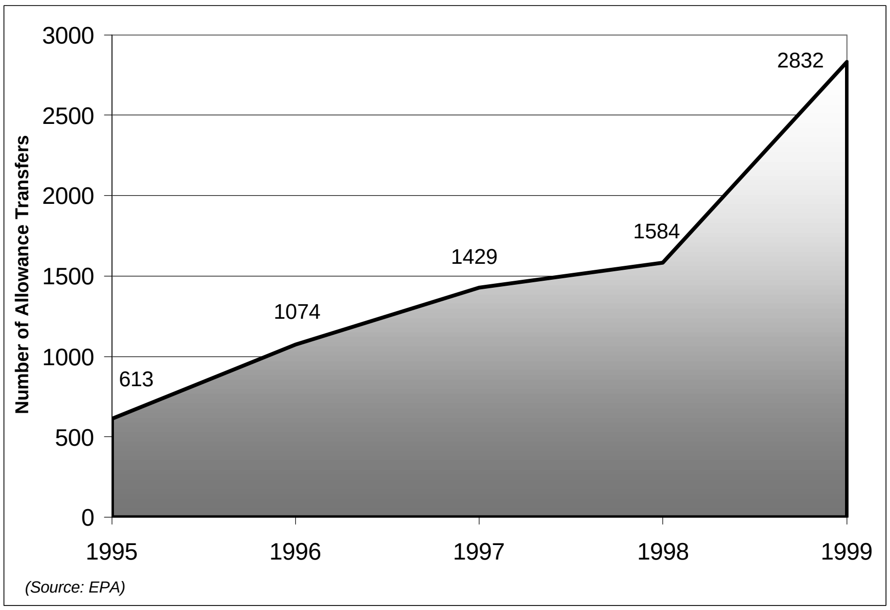

Figure 5: Total private transfer activity

It is notable that the majority of these transfers took place between individual boiler units within single operating systems. (An individual boiler unit is the level at which an emission source is legally defined and the level at which compliance is evaluated; there can be many boiler units within an operating system, and many such systems cross over state borders.) In other words, many of the transfers consisted of reallocations within a company. This type of transaction is sometimes referred to as “internal optimization.” When given the flexibility to determine the best means of reducing total emissions, a company will review the operations of its entire plant system. It will then phase in control measures at different locations, at times and of magnitudes that make economic sense within the constraints of the environmental program.

Inter-company transfers are also significant. In terms of tons of SO_2 allowances, Figure 6 indicates the variety and distribution of the types of allowance transactions that occurred in Phase I. In 1995, the high percentage of reallocations may be attributed to firms adjusting to the program and balancing their initial allocations among units. In 1999, reallocation activity may be attributed to firms preparing for the onset of Phase II reduction obligations.

[10] See EPA statistics at http://www.epa.gov/acidrain/ats/cumchart.html.

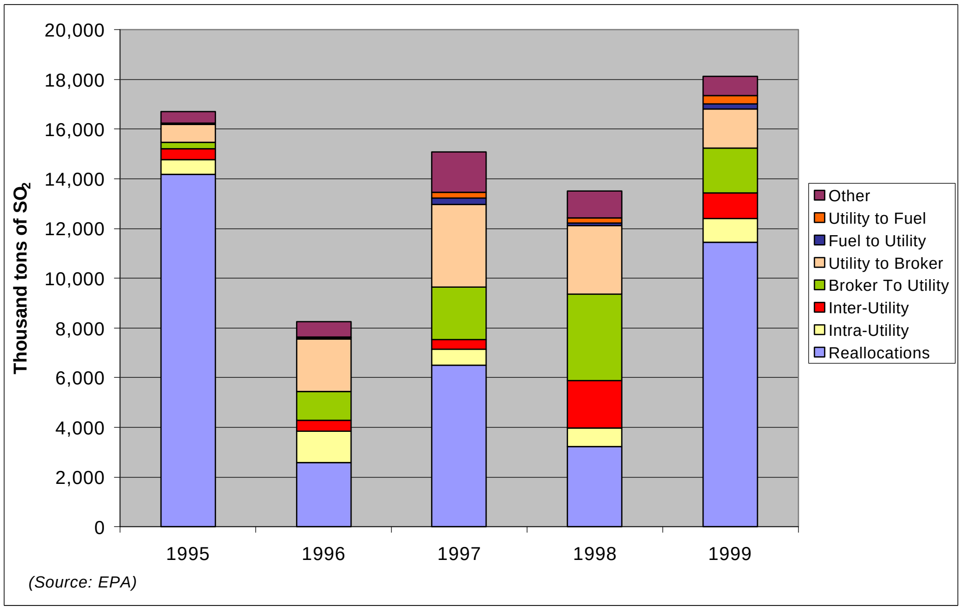

Figure 6: Type and quantity of SO_2 transfers, 1995-1999

In retrospect, the results of this trading activity should have been predictable. The value for SO_2 allowances created by a market in which unused allowances can be sold or saved forced sources to treat emissions, in effect, as a variable operating cost. As a result, utilities had to do what is sometimes called a "make or buy" analysis about the costs involved in reducing emissions. Many companies decided to "make" emissions reductions rather than buy them.

An important factor in the "make or buy" analysis for every plant operator was the limited amount of allowances that each plant received on an annual basis. This initial allotment, referred to as the "base allocation," was allocated by the EPA according to an explicit statutory formula. When a plant emits less SO_2 than its base allocation, the plant is "over-controlling" and making extra emissions reductions, which, in turn, creates a bank of unused allowances. One indication of the remarkable success of the SO_2 program may be seen in Figure 7. In 22 of 24 states, power plants emitted less SO_2 than their aggregate number of base allocations.[11] Further, many high-emitting states/sources achieved the highest level of over-control, including Ohio, Indiana, Georgia, Pennsylvania, and West Virginia. Because of the financial value of SO_2 reductions, the "make or buy" analyses conducted by utilities led overwhelmingly to direct and indirect investment in reducing emissions. Only units in Illinois and Kentucky released more SO_2 than their aggregate base allocation, as indicated by a negative value in Figure 7—and these amounts are relatively small. This is not to imply noncompliance, however, since these emissions could be legally covered by a number of means, including purchasing allowances on the market or through the EPA auction. In fact, when utilities were required to reconcile their allowance holdings with their actual emissions, 100% compliance was achieved.

[11] Only 24 states are represented because the program is phased in. Phase I required only the largest-emitting plants to make reductions, whereas all plants across the United States come under the program in the year 2000.

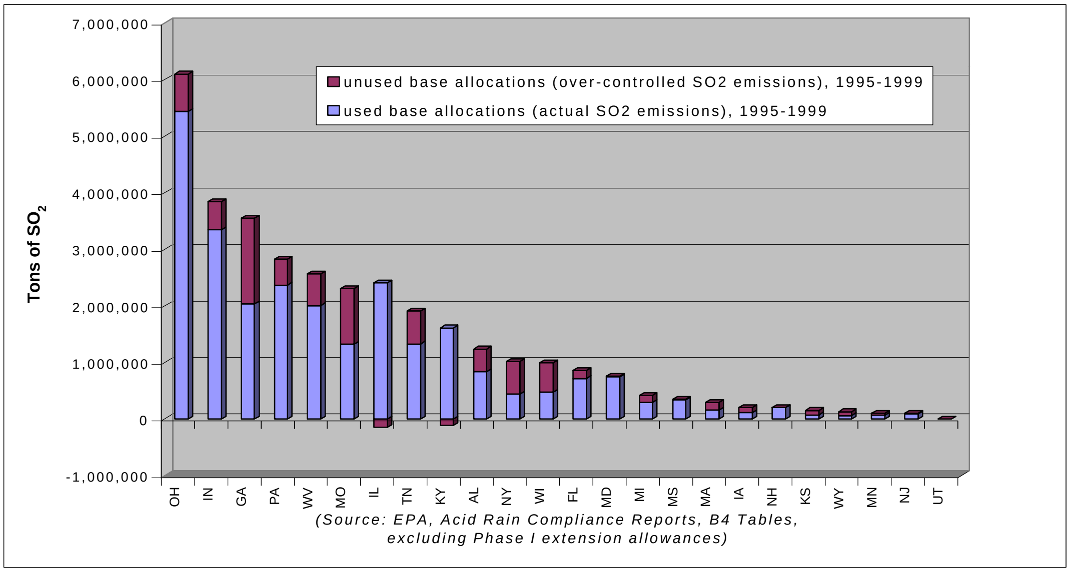

Figure 7: Cumulative over-control of emissions by state

The analysis underlying Figure 7 is conservative—it compares actual emissions to base allocations *only*. This comparison excludes bonus allowances made available by Congress as incentives for specific actions. In fact, an additional 3.3 million tons of "extension allowances" were distributed to plants that employed certain "scrubbing" technologies for achieving deep cuts in air pollution. The reason for excluding the extension allowances from the analysis is that their effect on the "make or buy" dynamics of the program is ambiguous.

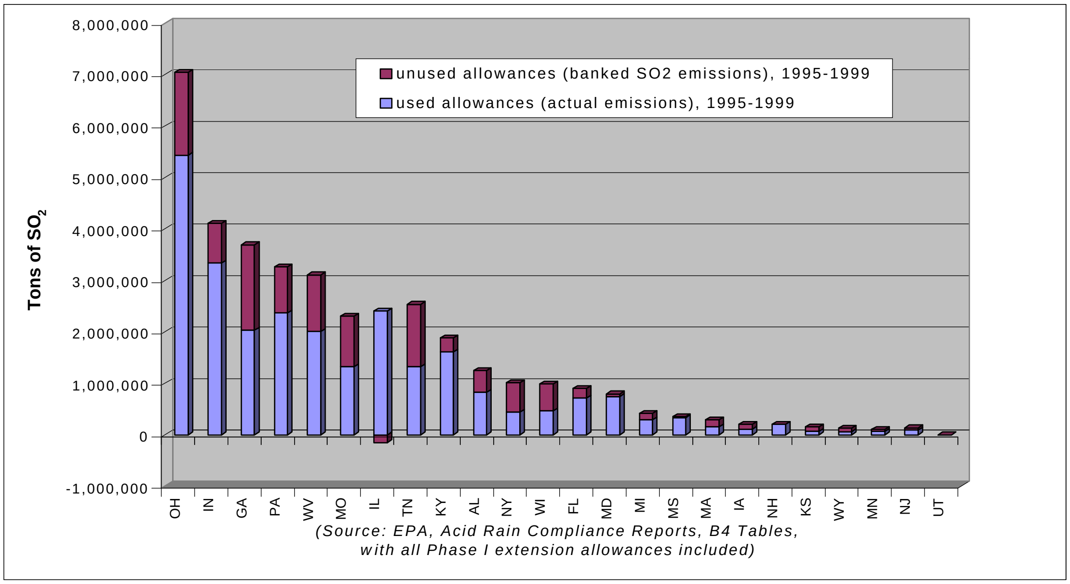

Figure 8: Emissions vs. base allocations and extension allowances (combined) by state

Figure 7 reflects the behavior of the regulated community in relation to stricter constraints on emissions, represented by the base allocations. In contrast, Figure 8 considers both the base allocations and the extension allowances, which were conditional incentives.[12] The availability of these additional allowances gave sources using "scrubbers" an extra two years to meet their Phase I emissions limitations. At the same time, however, under the extension provision sources could forego the time extension and operate their scrubbers to reduce pollution earlier (and to much lower levels) than required. In view of that, the comparison in Figure 8 may be significant. Sources doing this, however, would have saved or banked *both* an extension allowance *and* a base allowance for at least a portion of each ton over-controlled. Thus the comparison represented in Figure 8 may quantitatively overstate the extent of over-control that was achieved. What Figure 8 clearly shows, however, is that relative to the broader pool of allowances allocated—and the total allowable emissions "budget"—a significant level of banking occurred during Phase I.[13]

Environmental Regulatory Reform

In 1989, the rhetoric surrounding SO_2 emissions trading emphasized "market mechanisms," "economic incentives," and "cost-savings." Less apparent, but equally significant, is that in the process of establishing the SO_2 program, Congress ended up creating a new paradigm for pollution policy. That paradigm managed to overthrow the traditional discretionary powers of environmental regulators even while making it more certain that the full measure of promised emissions reductions would be delivered to the public and the environment.

Between 1970, when the "modern" Clean Air Act was first adopted, and 1990, programs to control air pollution were characterized by requirements focusing on *how* sources of emissions operated. State and federal regulators were empowered and called on to assess the cost, feasibility, and effectiveness of various technologies, methods, and processes for reducing emissions from the operations of various classes of sources.

On the basis of those assessments, regulators would impose either specific technology requirements or operational parameters such as emissions rates. Compliance was defined in terms of meeting those operational parameters, not in terms of meeting specified emissions reduction targets. Often, plants were subject to detailed operating permits, and enforcement resources went toward ensuring that plants developed and submitted compliance plans and met the operational milestones delineated in the plans, rather than focusing on actual emissions performance. To a significant extent the approach worked. According to many key indicators, air quality in the United States improved substantially.

continued on next page:

[12] Figure 8 does not include the 750,000 allowances that were available through the EPA public auction, which was mandated by Congress as part of the program.
[13] For example, Figure 7 shows that sources in Kentucky had actual emissions that exceeded base allocations. When the extension allowances are added in, as shown in Figure 8, sources in Kentucky had actual emissions that were below the level that was legally permitted by the sum of base and extension allowances. Further discussion of this issue can be found at Figures 16 and 17.

. . . Environmental Regulatory Reform (continued)

By 1990, however, the performance of the traditional approach was often burdened by a broad range of flaws. In many cases, the full increment of pollution reductions that had been promised, predicted, or assumed when operational requirements were adopted had not been achieved. Because compliance was defined simply in terms of technologies or operating parameters, however, nobody, including the polluters themselves, was legally accountable for the failure to achieve the expected levels of total reductions. With fewer than the expected and needed pollution reductions achieved, key ambient air-quality standards were often not attained. Specifying technologies or operating parameters was not enough to limit total emissions discharges.

At the same time, the costs of these programs were high. The regulatory community's resources often were inadequate for collecting and processing the range of information needed to formulate operational requirements for whole classes of sources. Of course, once the requirements and implementing permits were put in place, the capacity to absorb new information and respond to inevitable and ongoing economic and other operational changes was virtually nonexistent. Because the characteristics of sources varied, while requirements tended to be uniform, many sources were subject to expenses that could have been avoided in more flexible systems. Other sources could have adopted more effective or innovative control technologies, but had no incentive to do so. At the same time, regulators, mindful of the need to control costs, compromised the stringency of requirements either in setting the standards or in negotiating individual permits and "variances" to permits, all at the cost of total emissions reductions achieved.

In contrast, the SO_2 program replaced the regulator with the polluter itself as the pivotal actor in compliance, overthrew the traditional paradigm, and replaced it with a new one. Under the SO_2 program, the pollution sources are legally accountable for achieving a specified level of emissions reductions and for little else save continually monitoring and reporting their actual emissions. The only job that regulators have to do is ensure that each source meets its monitoring and reporting requirements and that its actual annual emissions equal the number of allowances the source holds.

How power plants reduce their SO_2 emissions has been left completely to the discretion of the plant operators themselves. As a result, it is up to them to manage the continually changing economic, technical, and other circumstances in which they are operating and to integrate their basic business activities with their obligation to meet their emissions cap. The burden and the opportunity of lowering costs are placed squarely on the power plants operators. In place of variances and other cost-relieving methods that entail compromise of standards and forego actual emissions reductions, plant operators under a cap and trade system must turn to emissions banking and trading for cost control. Because of the built-in cap-based structure of the program, cost savings through emissions trading in no way lessens the amount of total emissions reductions or their environmental benefit.

Today, the EPA proudly embraces the very coup that, at least as far as SO_2 is concerned, stripped it of much of the scope of its traditional regulatory power. Noting that the acid rain program embodies the highest ratio of tons of pollution reduced to administrative resources expended, the agency reports approvingly that the program produced 100% compliance—all while giving regulators far less authority to exert direct control over the methods of compliance.

III. Economic performance and innovation

One of the foremost news stories of the 1990s was the strength of the overall U.S. economy, including the longest peacetime economic expansion in history and record growth in capital markets. From 1990 through 1999, the gross domestic product grew at an average annual rate of 5.4%.[14] Likewise, demand for electricity increased throughout the decade. As shown in Figure 9, electricity generation by U.S. utilities grew in each of the first four years of the acid rain program, with significant growth relative to 1985. Despite early claims to the contrary by opponents of acid rain legislation, U.S. utilities were able to provide more electricity while reducing SO_2 emissions. At the same time that overall generation increased, so, too, did the amount of production fueled by coal—specifically a 6.8% increase from 1995 to 1999. Comparing this with total generation by utilities during the same period, the use of coal actually outpaced that of other fuel sources despite its higher sulfur content.

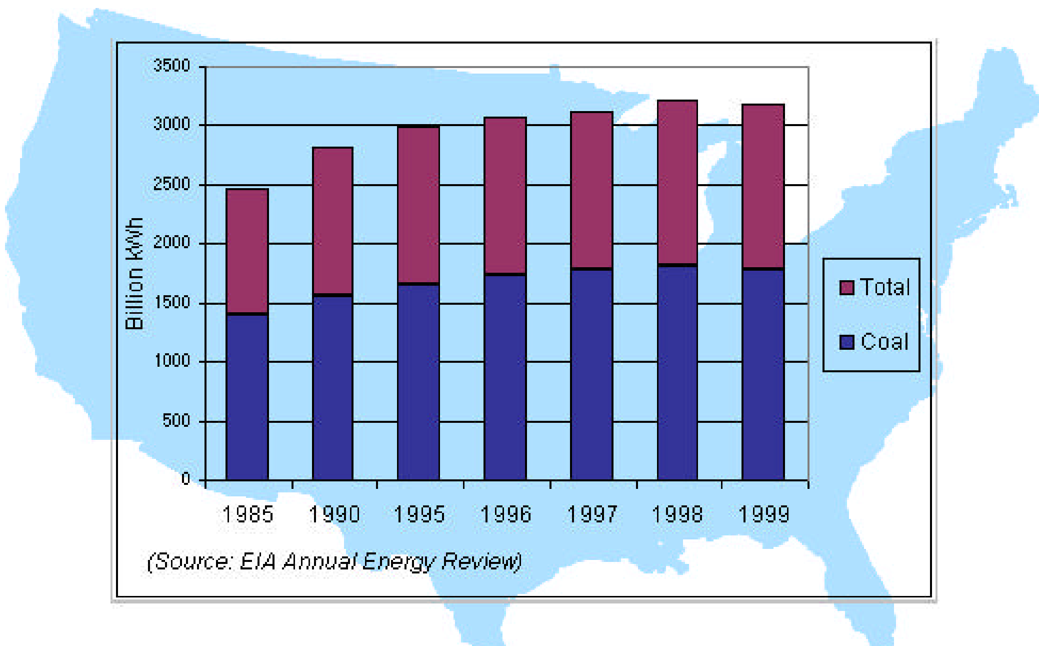

Figure 9: Net electricity generation by utilities in the United States, Total vs. Coal

Figure 10 depicts the regional breakdown of electricity generation in 1990, compared with that of 1995 through 1998. It is important to note that provisions of the acid rain allowance trading program prevent Phase I power plants from simply appearing to reduce SO_2 emissions by shifting electricity production to other plants not controlled during Phase I. All electric utilities are required to regularly report SO_2 emissions to the EPA. Consequently, the anticipated maneuver of generation-shifting could not possibly account for the continued growth of electricity generation while substantial SO_2 reductions are being achieved. Moreover, the obligation to control SO_2 emissions has not prevented those regions most affected by the regulations from expanding the production of electricity.

[14] See Dept. of Commerce, Bureau of Economic Analysis statistics at http://www.bea.doc.gov/bea/dn/gdppch.htm.

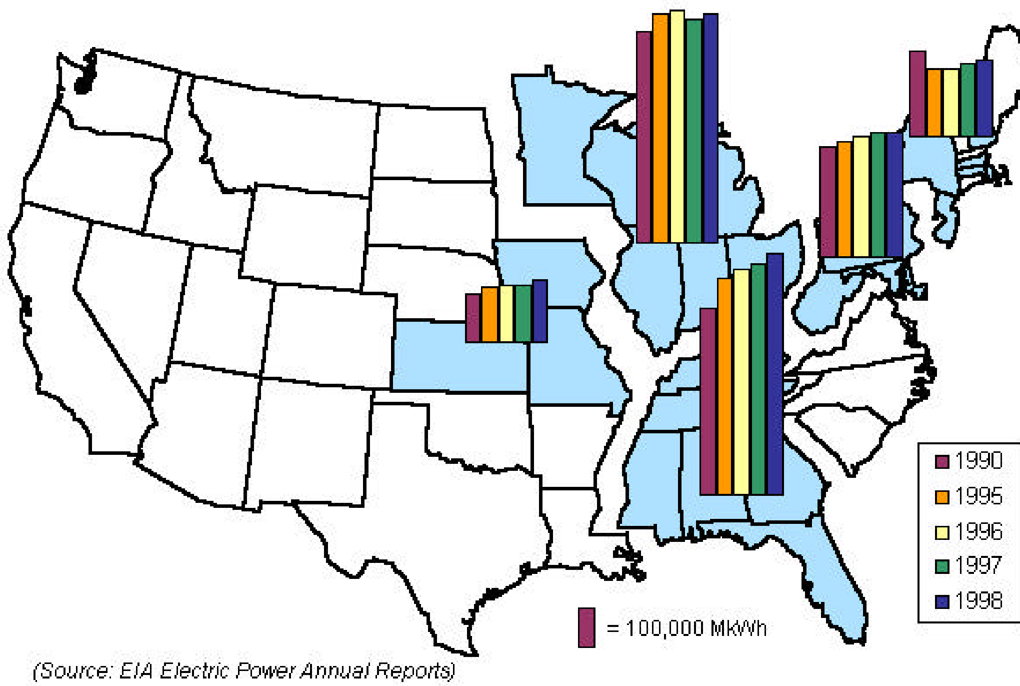

Figure 10: Regional net electricity generation by utilities in Phase I States, 1990 vs. 1995-1998

Thus during Phase I, electricity generation both increased and maintained relative regional distribution patterns despite the differential impact of controls. Furthermore, although demand increased, the price of electricity remained stable throughout the 1990s. As shown in Table 2, a cleaner national power supply was produced at no additional cost to consumers.

Table 2: Average Retail Prices of Electricity Sold by Electric Utilities in the United States (cents per kilowatt-hour)

Year	Residential	Commercial	Industrial	Other	Total
1991	8.04	7.53	4.83	6.51	6.75
1992	8.21	7.66	4.83	6.74	6.82
1993	8.32	7.74	4.85	6.88	6.93
1994	8.38	7.73	4.77	6.84	6.91
1995	8.40	7.69	4.66	6.88	6.89
1996	8.36	7.64	4.60	6.91	6.86
1997	8.43	7.59	4.53	6.91	6.85
1998	8.26	7.41	4.48	6.63	6.74
1999	8.14	7.18	4.40	6.55	6.60

Source: Department of Energy, Energy Information Administration

The experience in the United States in the latter half of the 1990s belies the initial claims of opponents of the SO_2 emissions cap that it would preclude economic growth. Through emissions trading, electric utilities and the overall economy were able to integrate large reductions in emissions with economic activity and growth in electricity production. In Figure 11, the two upper lines chart continued growth in U.S. gross domestic product and electricity generation, respectively, versus reductions in SO_2 emissions (the lowest line).

Through emissions trading, electric utilities and the overall economy were able to integrate large emissions reductions with economic activity and growth in electricity production.

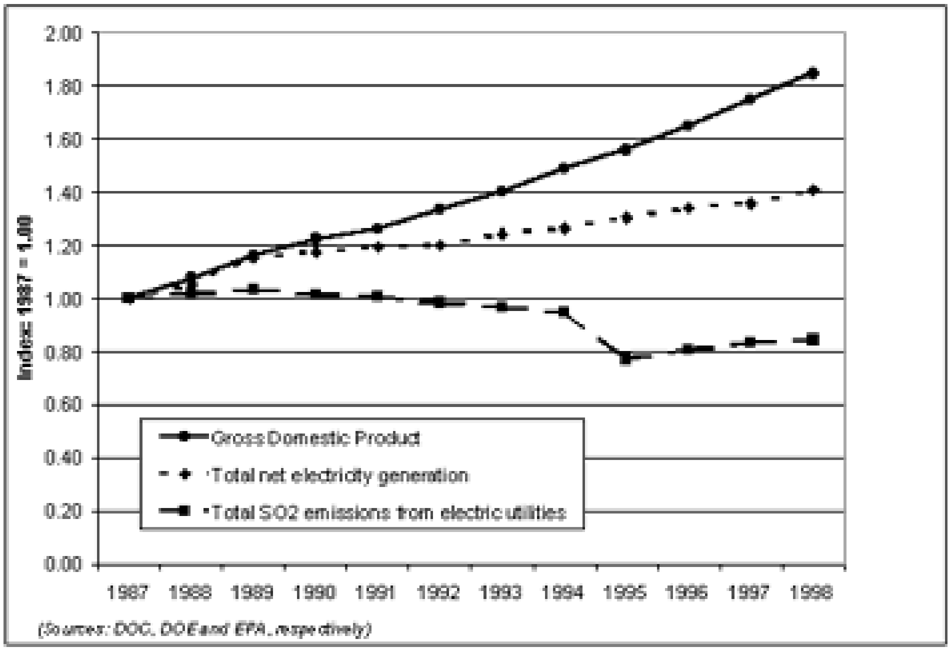

Figure 11: U.S. economic growth indicators vs. SO_2 emissions

That emissions trading is instrumental to this economic response is suggested by the path that allowance prices have followed since active trading began, first in anticipation of the program and then continuing into the present. At the time the legislation was enacted, predictions of marginal compliance costs and allowance prices were in the range of $300 to $1,000 per ton.[15] However, allowances have traded at much lower levels, with prices between $69 and $212 per ton.[16] These dramatically low prices correlate with the intensification of competition between and among the various compliance options (in addition to trading) available to power plants—competition that is uniquely created through the emissions trading market. Figure 12 tracks the prices paid for SO_2 allowances since 1994. Even at its peak, the price of SO_2 tons has been a fraction of the ominous estimates prior to program implementation.

[15] Robert W. Hahn and Carol A. May, "The Behavior of the Allowance Market: Theory and Evidence" *Electricity Journal* 7 (1994): 28-33.
[16] Cantor Fitzgerald Environmental Brokerage Services market data.

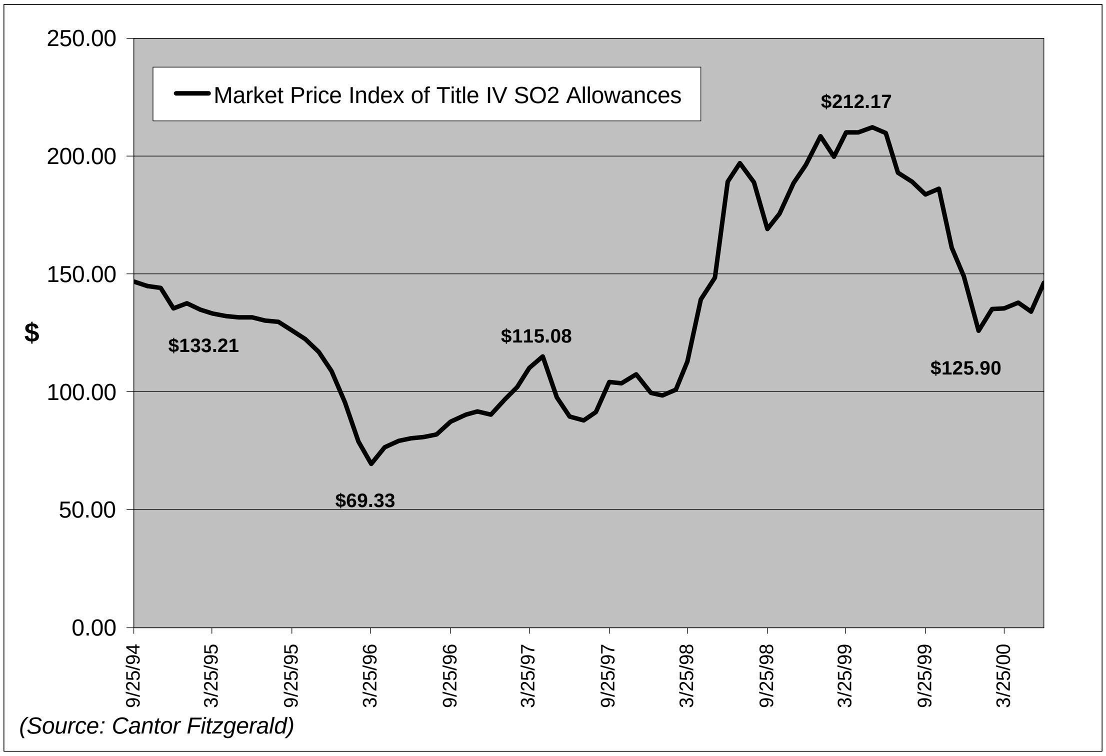

Figure 12: Market price index of SO_2 allowances

"As the final Clean Air Act Amendments neared passage in 1990, just how much money the new rules would cost was a matter of sharp debate. At the high end, some lobbyists, columnists, and industry advertisements were touting vaguely documented figures of '$3 billion to $7 billion per year, with the price tag rising to $7 billion to $25 billion by the year 2000.' …After the first two years of the Phase I limits, [emissions reductions] were done at a cost of about $0.8 billion per year, according to two independent estimates. …Phase I was expected to be cheaper than later reductions, but estimates of the long-term costs through 2010 have also been dropping. By 1995, [the ICF Consulting firm's] estimate for the EPA had dropped to $2.5 billion per year. [The Electric Power Research Institute's] 1997 estimate was down to $1.6 billion to $1.8 billion per year, and [Resources for the Future's] 1998 estimate is $1.0 billion—a far cry from many early estimates and below the EPA's early projections."

Richard A. Kerr, "Acid Rain Control: Success on the Cheap" *Science*, 6 November 1998, 1024-27.

Proponents of emissions trading point to its value in stimulating innovation. Because the emissions trading market transforms emissions reductions into economic assets that can be bought and sold, those utilities that can find the best ways to make the most reductions at the lowest costs stand to gain the greatest reward. Furthermore, those companies that develop new control strategies have a ready market for their ideas or technologies. The results of Phase I seem to bear this out, while casting light on some of the more subtle features of the complex process of innovation.

During Phase I, innovation took its most obvious form in the development of low-cost "scrubbers." Scrubbers are technologies that physically remove pollutants from the gases that escape through a plant's smokestack. Under a separate program stipulated in the Clean Air Act, scrubbers were included in the operations of new and refurbished power plants throughout the United States. This program required individual sources to meet specific operational mandates. Neither specific limits on the total tonnage of emissions nor emissions trading was included in that program, which had been in effect since 1970. As of 1992, no significant progress in scrubber technology had been observed, a result attributed to the meager incentives for innovation in existing programs.[17]

Since the enactment of the SO_2 emissions trading program, the level of innovation in scrubber technology has changed dramatically enough to prompt a major study to state that "the striking contrast between technological stagnation in scrubber technology before 1992, under a regulatory regime of direct emission controls, and technological progress since then, under a regulatory regime with tradable permits is hard to ignore."[18] This progress has taken the form of both improved technical performance and cost decreases—hardly surprising since the driving force behind almost all innovation is cost savings. For example, scrubber manufacturers have been marketing scrubbers for Phase II at about half the cost of Phase I scrubbers.[19]

At the same time, the connection between cost and innovation is illustrated by other ways in which the flexibility of the SO_2 program has enabled utilities to choose among various means of compliance. In contrast to regulatory programs that rely on specific operational mandates, the cap and trade structure of the SO_2 program fundamentally changes the decision making process for power plant operators as they weigh compliance options. As a result, all forms of compliance—scrubbing, fuel-switching, investments in energy-efficient technologies, using non-sulfur energy sources, and changing the order in which electricity plants are dispatched—must compete with one another to succeed in the "compliance market." That competition is intensified by emissions trading: because plant operators can buy reductions from other plants, they can evaluate these different options not just as applied to their own facilities, but as they might operate on others from which the reductions can be purchased. Not only does this competition lower costs, but the flexibility of the program, together with the drive for cost reduction, allows operators and other investors to use a combination of compliance options in innovative ways.

"The striking contrast between technological stagnation in scrubber technology before 1992, under a regulatory regime of direct emission controls, and technological progress since then, under a regulatory regime with tradable permits is hard to ignore."[18]

Before the enactment of the SO_2 program, for example, most observers assumed that expensive changes to the combustion technology of existing plants would be required for those plants to use lower-sulfur coal. From that perspective, low-sulfur coal was assumed to be an expensive option, making scrubbing appear more attractive, even at high cost. Instead, power plant operators and investors in the fuel and engineering industries, motivated by competition in the compliance market, have developed alternative means involving fuel-blending and new fuel-blending technologies to use low-sulfur coal at much lower costs.[20] Thus Denny Ellerman and his colleagues observe: "The high degree of innovation in adapting boilers built for bituminous coals has been one of the major surprises in Phase I."[21]

Some have asserted that the "only" reason for the emissions reductions and cost savings during Phase I was the modernization of rail transport. Specifically, improvements in loading equipment and tracking reduced the cost to deliver low-sulfur coal from the Midwest (particularly the Powder River Basin in Montana and Wyoming)

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[17] A. Denny Ellerman, Richard Schmalensee, Elizabeth M. Bailey, Paul L. Joskow, and Juan-Pablo Montero, *Markets of Clean Air: The U.S. Acid Rain Program* (New York: Cambridge University Press, 2000), pp. 241.
[18] Ibid., 242.
[19] Ibid., 240.
[20] Byron Swift, "The Acid Rain Test" *Environmental Forum* 14 (1997): 19.
[21] Ellerman et al., *Markets of Clean Air: The U.S. Acid Rain Program*, 243-44.

to utilities in the eastern United States. Some claim that the decreases in transportation costs would have produced the same results—lower emissions—even in the absence of the SO_2 program. In fact, under a more traditional "command-and-control" program, especially one that prescribes specific combustion technologies, the option to use this low-sulfur coal would have triggered significant capital investments. Thus the low cost of compliance during Phase I was the result of the flexibility it afforded to plant operators, particularly to choose and blend fuels. Together with advances in low-cost scrubbers, this led to reductions in SO_2 emissions that were "significant and clearly attributable to Title IV [the SO_2 program]."[22]

[22] A. Denny Ellerman, Richard Schmalensee, Paul L. Joskow, Juan-Pablo Montero and Elizabeth M. Bailey, "Emissions Trading Under the U.S. Acid Rain Program: Evaluation of Compliance Costs and Allowance Market Performance" (Cambridge, MA: MIT Center for Energy and Environmental Policy Research, 1997), 5, 20.

IV. Environmental performance

The first five years of experience with the SO_2 program demonstrate the success of an emissions budget and trading program in delivering substantial and early emissions reductions and significant cost savings. Equally striking is the possible effect of the decline in emissions on the physical environment they are intended to protect. Figure 13 shows the sharp drop in SO_2 emissions in various multistate regions with Phase I units. Comparing emissions in 1999 with those in 1990, the North Central, Southeast, and Mid-Atlantic regions, whose plants contribute the bulk of sulfur in acid deposition, achieved reductions of 49%, 48%, and 43%, respectively.

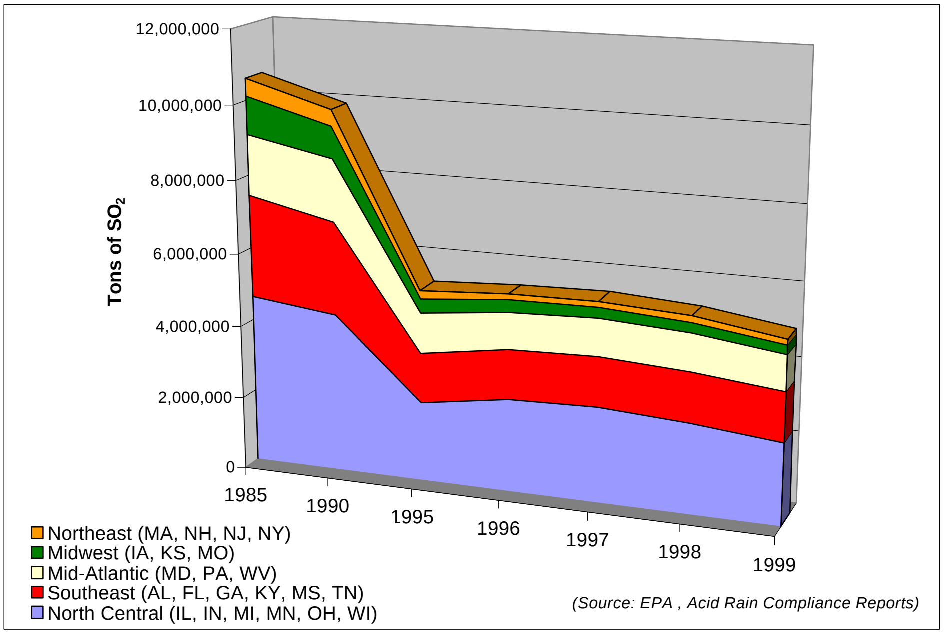

Figure 13: Regional SO_2 emissions, historic vs. Phase I levels

In addition to realizing substantial reductions relative to historic emission levels, Phase I facilities over-controlled SO_2 emissions every year relative to their initial, base allocation, and in so doing added to a significant bank of allowances, as shown in Table 3.

Table 3: Total Phase I Performance - Base Allocations

Year	SO_2 Emissions	Base Allocation*	Tons Over-Controlled	% Over-Controlled
1995	5,298,429	6,936,618	1,638,189	24
1996	5,433,351	6,784,631	1,351,280	20
1997	5,474,440	6,686,718	1,212,278	18
1998	5,298,498	6,705,460	1,406,962	21
1999	4,944,666	6,669,460	1,724,794	26
Cumulative:	26,449,384	33,782,887	7,333,503	22

Source: EPA, Acid Rain Program Compliance Reports, B4 Tables
*(*figures exclude Phase I extension allowances)*

Has the decrease in SO_2 emissions resulting from the acid rain program begun to alleviate the problems caused by acid deposition? The short answer is that it is too early to tell and more research is required. So far, preliminary findings show that while the reductions in SO_2 emissions have lessened some of the burden on ecosystems, recovery is still slow or nonexistent in some areas, demanding further measures. According to Gene Likens and his colleagues, “Major declines in emissions of SO_2 …have been correlated with significant decreases in [sulfate] concentrations in precipitation. Deposition, however, is the key variable ecologically as sensitive ecosystems respond primarily to deposition of acidifying substances, rather than to emissions directly. Unfortunately, many sensitive ecosystems have not yet shown improvement in response to decreased emissions of SO_2. Clearly, inputs of other chemicals, such as nitric acid and base cations, must be considered. …[In addition], meteorological variability may contribute to significant changes in the long-term record of precipitation sulfur chemistry and may obscure (or exceed), at least on an annual basis, changes due to reductions in SO_2 emissions."[23] Thus while both SO_2 emissions and sulfate concentrations in precipitation have declined significantly, the role of other chemicals and variations in rain and snow can affect the short-term measurements of acid deposition.

Despite this complexity, important observations have been ongoing during the relevant time period. From 1989 to 1998, the total deposition of sulfur decreased by 26% in the eastern United States.[24] This marked decline is illustrated in Figure 14. In addition, in the Adirondack Mountains of northern New York, an analysis of a representative sample of lakes showed that sulfates declined in 92% of the lakes during the period from 1992 to 1999.[25]

> "In 1995, ... we saw the largest one-year drop in SO_2 emissions since 1970. The 110 power plants required to be in this first phase of the program reduced emissions by more than 50% below their levels in 1980 and 40% below the levels required by law. In 1996, these impressive results were nearly repeated with emissions 35% below required levels. These emissions reductions resulted in a decrease of 10 to 25% in wet sulfur deposition over large areas of the eastern U.S. in 1995. Ambient concentrations of sulfur dioxide also declined by 17% between 1994 and 1995. By the year 2010, the reduction in fine sulfate particulate matter is expected to provide health benefits of $12 to 40 billion per year and visibility benefits of $3.5 billion per year."
>
> Mary Nichols, Assistant Administrator, Air and Radiation, EPA, before the Congressional Joint Economic Committee, 9 July 1997.

Figure 15, which illustrates wet *nitrate* deposition in the eastern United States in the periods from 1983-94 and 1995-98, offers an interesting comparison. The federal acid rain program legally required aggressive reductions in SO_2 emissions. In contrast, the same program, relying on a largely conventional "command-and-control" design, called for only minor decreases in uncapped NOx emissions. As a comparison of Figures 14 and 15 shows, while wet sulfate deposition declined, wet nitrate deposition remained approximately constant or even rose in much of the Phase I and "downwind" regions.

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[23] Gene E. Likens, Thomas J. Butler and Donald C. Buso, "Long- and short-term changes in sulfate deposition: Effects of The 1990 Clean Air Act Amendments" *Biogeochemistry* (in press). Quoted with permission from the primary author.

[24] General Accounting Office, *Acid Rain: Emissions Trends and Effects in the Eastern United States*, GAO/RCED-00-47 (Washington, DC: General Accounting Office, 2000), 10.

[25] Ibid., 16.

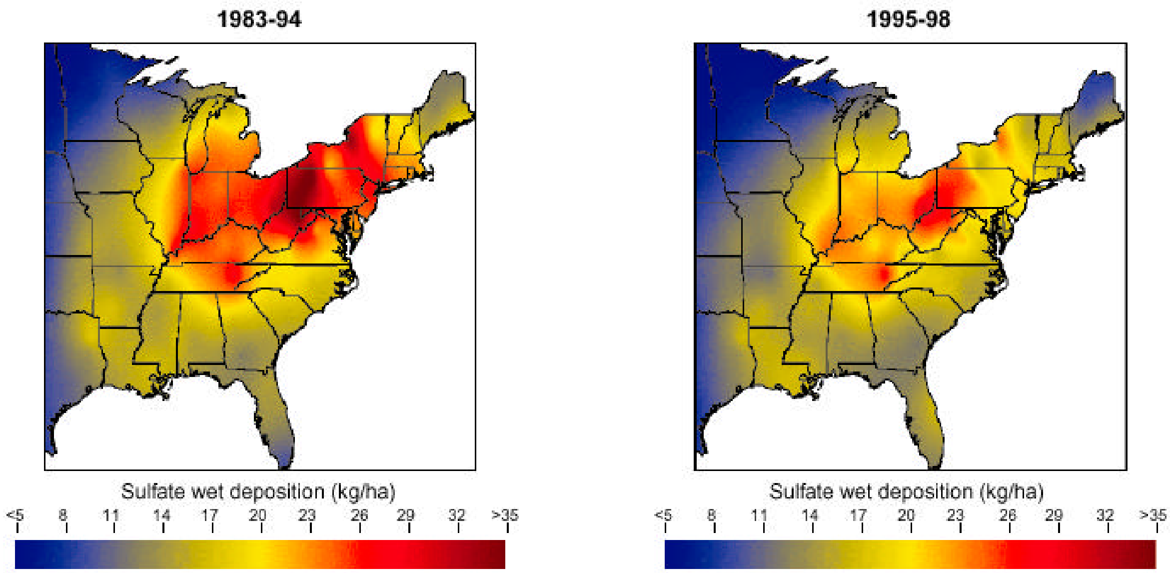

Figure 14: Wet sulfate deposition in the eastern United States, 1983-94 and 1995-98 [26]

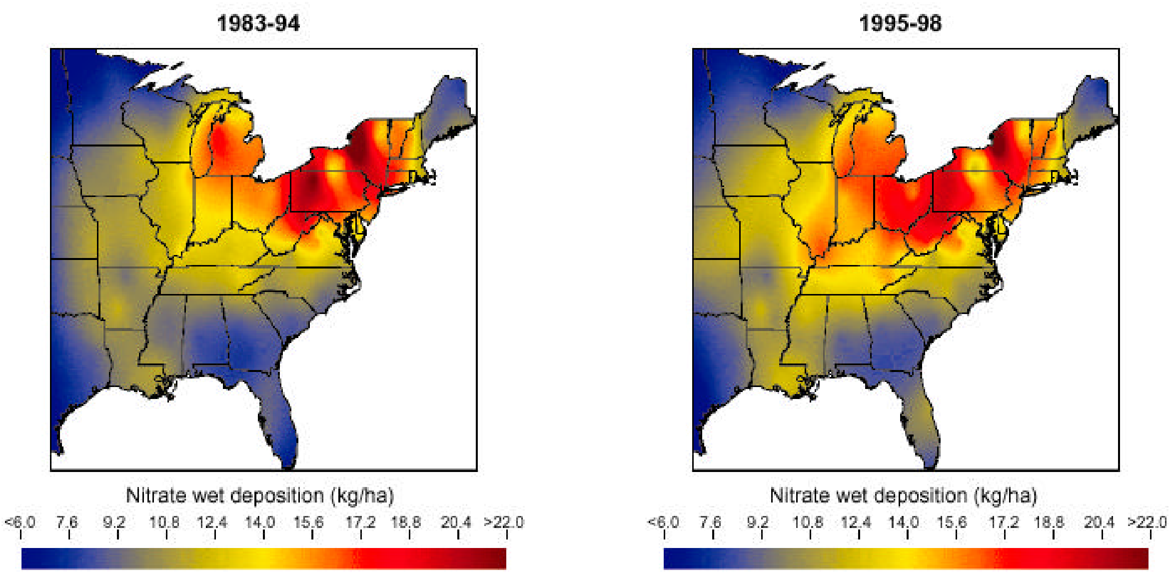

Figure 15: Wet nitrate deposition in the eastern United States, 1983-94 and 1995-98

[26] Figures 14 and 15 are reproduced as published in ibid, which credits the original source: J.A. Lynch, V.C. Bowersox and J.W. Grimm, "Changes in Sulfate Deposition in the Eastern U.S.A. Following Enactment of Title IV of the Clean Air Act Amendments of 1990" *Atmospheric Environment* 34 (2000): 1665-68. Graphs are reproduced here with permission from the primary author.

When the acid rain program was implemented, one concern was that emissions trading would allow utilities that emitted large amounts of SO_2 to purchase allowances and continue to release SO_2 at high levels, leading to so-called hot spots of sulfur deposition. This consideration played to regional fears, in particular that utilities in the Northeast would sell allowances to large emitters in the Midwest and Southeast, whose continued high levels of emissions would, in turn, exacerbate the acid deposition problem in the Northeast. The experience of Phase I does not support this concern: "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 inter-regional 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."[27]

> "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 suggest a cap-and-trade program may help to even out pollution levels."
>
> Byron Swift, Director, Energy and Innovation Center of the Environmental Law Institute, Washington, D.C., "Allowance Trading and SO_2 Hot Spots: Good News from the Acid Rain Program," *BNA Environment Reporter*, 12 May 2000, O-2.

An analysis of inter-regional allowance trading shows that the high-emitting sources that participated in Phase I generally made reductions before purchasing allowances in the market. Looking at midwestern utilities in particular (because they had the highest combined emissions), Phase I units in 11 midwestern states relied on their direct allocations for 81% of their emissions compliance between 1995 and 1998.[28] During that period, midwestern states imported a total of 2.68 million tons of allowances, 20% of which originated in the Northeast and Mid-Atlantic regions (where acid deposition is most severe), and 80% of which originated in the Southeast and West.[29] Midwestern states *exported* 2.12 million tons of allowances, for a net import of 560,000 tons.[30]

From 1995 to 1998, the 11 midwestern states had a base allocation of 16.4 million tons. In comparison, their net import of allowances was only 3.4% of this amount. More important, the *actual emissions* from these states during the period were 13.9 million tons[31]—15% lower than their initial allotment. In other words, sources in these states banked roughly 2.5 million tons of extra reductions, far exceeding the 560,000 tons of net imports. As Figure 16 shows, many of the states that were net importers of allowances also achieved substantial reductions in SO_2 emissions below their base allocations.

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[27] Byron Swift, "Allowance Trading and SO_2 Hot Spots: Good News from the Acid Rain Program" *BNA Environment Reporter*, 12 May 2000, O-1.
[28] GAO, *Acid Rain: Emissions Trends and Effects in the Eastern United States,* 21. The states considered here are: Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Ohio, West Virginia, and Wisconsin.
[29] Ibid., 22.
[30] Ibid., 29.
[31] Ibid., 27.

Following Figure 7 above, the analysis of over-control in Figure 16 uses a conservative formulation by comparing actual emissions to base allocations only. As discussed in Section II, this conservative formulation could be viewed as *understating* the extent of emissions over-control achieved in Phase I. Specifically, 3.1 million extension allowances were issued between 1995 and 1998 pursuant to the intent of Congress to provide incentives for the use of certain scrubber technologies. Although the unused portion of these extension allowances may correspond, to some extent, to extra emissions reductions, they do not do so on a strictly ton-for-ton basis. Limiting the comparison to actual emissions and base allocations may provide a clearer distillation of the environmental performance of the program, especially with respect to the over-control of emissions.

At the same time, the presence of the more than 3 million additional extension allowances may obscure the broader issue of whether *emissions trading* itself resulted in higher emitting sources' continuing to release large quantities of SO_2 rather than making reductions. In contrast to Figure 16, Figure 17 presents Phase I sources' actual emissions in comparison to the sum of their base allocations and extension allowance allocations. As Figure 17 shows, this comparison reveals, for example, that the actual emissions of sources in Kentucky fell *below* their total allowable level and that sources in other states generated even more unused allowances than suggested by Figure 16. The comparison of the two figures suggests that it was not *emissions trading* that contributed to the lessening of the difference between actual emissions and even base allocations, and to Kentucky sources' emitting more SO_2 than their base allocation.[32] Rather, this outcome appears to be the result of the wholly unrelated decision of Congress to use the allocation of additional allowances—which could be used to delay emissions reductions for up to two years—to favor a specific technological means of compliance.[33]

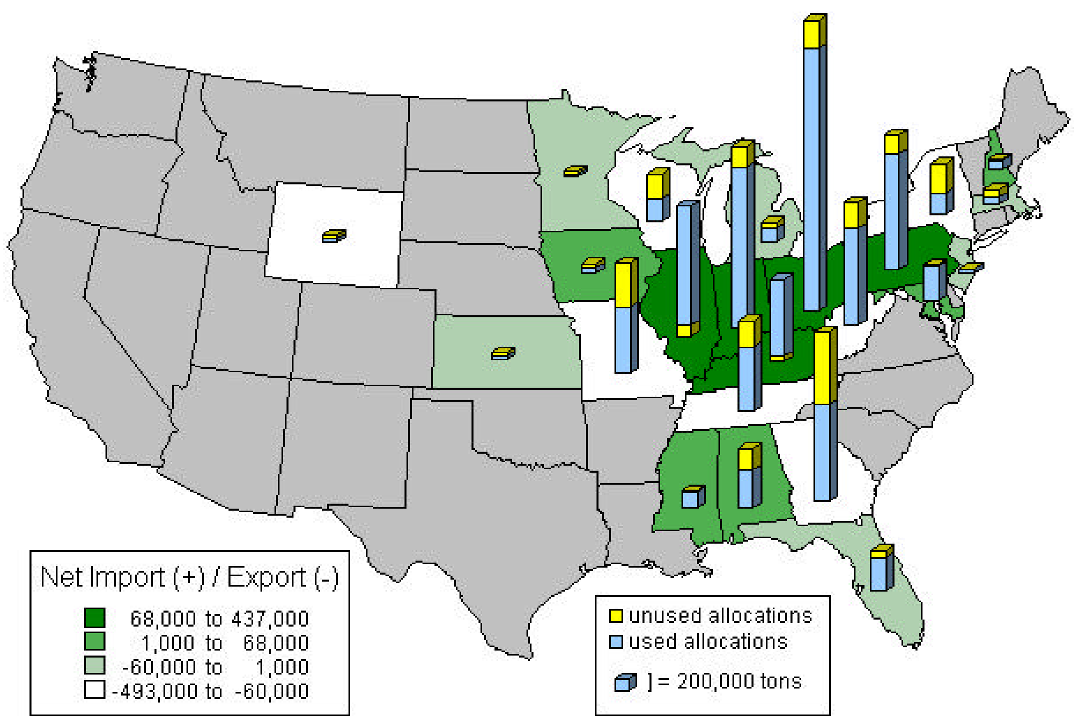

Figure 16: Interstate allowance flows (in tons) and over-control by state, 1995-1998

[32] For both Figures 16 and 17, interstate allowance transfer data is from GAO, *Acid Rain: Emissions Trends and Effects in the Eastern United States*, Appendix III; and allowance data is from EPA, Acid Rain Compliance Reports (1995-1998), B4 tables, with adjustments for extension allowances. In states where the bar colors are inverted (blue over yellow), the aggregate emissions of units in the state exceeded the aggregate base allocation (Figure 16) or the combination of aggregate base allocation + aggregate extension allowances (Figure 17).

[33] Congress believed that these additional allocations would not result in additional *cumulative* emissions since the legislation it enacted required emissions reductions to begin one year earlier than the Bush administration's bill.

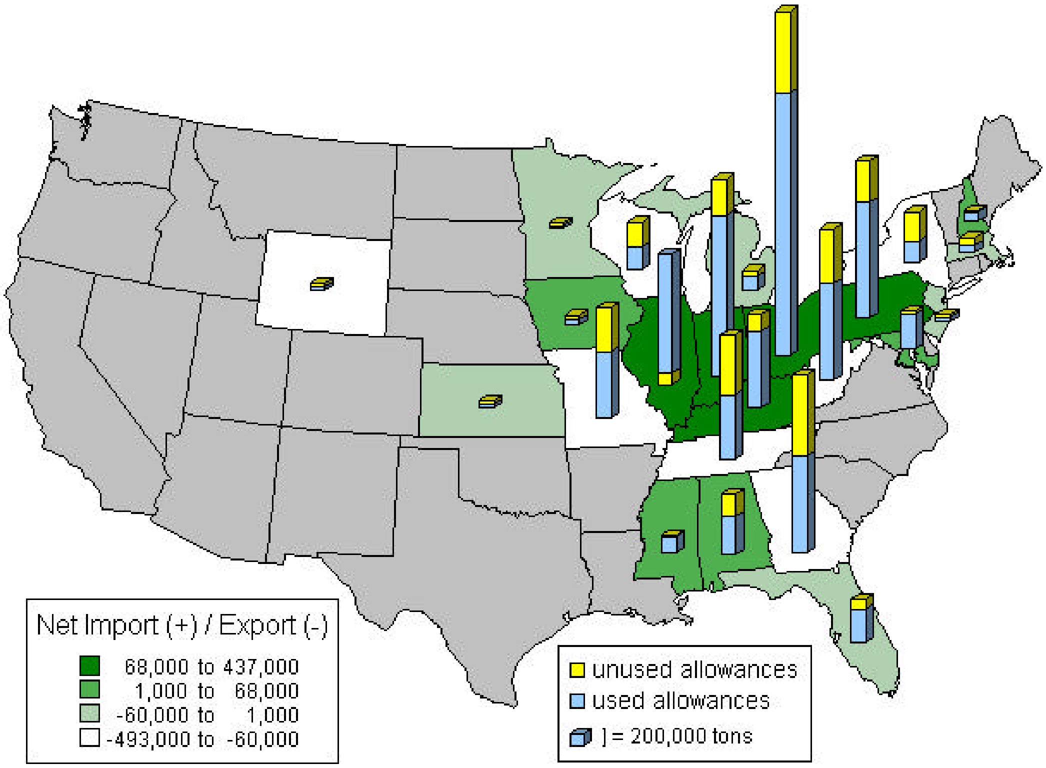

Figure 17: Interstate allowance flows (in tons) and aggregated base allocations + extension allowances by state, 1995-1998

Banked Tons and Environmental Protection

Relative to the total cumulative budget for Phase I, the EPA estimates that a bank of 11.6 million tons worth of unused allowances accrued from 1995 to 1999. This bank includes both unused bonus allowances, such as "extension" allowances, as well as unused base allocations. Looking specifically at *base allocations*, the environment saw 7.3 million tons of *extra reductions* in SO_2 emissions—beyond the base reduction levels. As a result, geographic areas afflicted with high levels of sulfate deposition had a better chance of beginning the recovery process because plants made *early* cuts in emissions rather than delaying those obligations until the year 2000 or later. The reason for these early reductions is that they could be saved for Phase II, when limits would be tighter and compliance would be potentially more expensive.

In Phase II, there is a chance that many utilities seeking low-cost compliance with the more stringent limits in fact will turn to the current bank of unused Phase I allowances. If so, then annual emissions during the first few years of Phase II may be higher than the annual budget of 9.2 million tons established in the Clean Air Act.

That outcome would be perfectly legal under the Act, which explicitly permits power plants to keep unused Phase I allowances to cover emissions in Phase II. That outcome would be part of a trade-off deliberately made by Congress, which saw the environmental problems caused by sulfuric deposition as linked to *cumulative* emissions. Again, the remarkable emissions reduction performance of Phase I almost certainly would not have occurred without this trade-off. Thus the risk that SO_2 emissions during Phase II may be higher than the annual budget of 9.2 million tons is the exchange for the 7.3 million tons of extra SO_2 reductions that occurred between 1995 and 1999. Unfortunately, this risk is aggravated by the fact that the 7.3 million tons of over-control are essentially a subset of the total cumulative bank—specifically, 11.6 million unused allowances, which include more than 3 million extension allowances for scrubbers. This added risk is as much a function of the independent decision by Congress to favor scrubbing technology through the additional allocation as it is of banking—and thus would seem to be far less justified, if at all, environmentally.

Will all the saved allowances be used and, if so, over what period? The answer could become clear in early 2001, when the first year of Phase II is completed. One outcome that seems unlikely is that all of those allowances will be used without being replaced by ongoing emissions over-control. As long as that is true, then the program will always be creating, or at least maintaining, more cumulative SO_2 reductions than required.

Fortunately for the environment, the logic of maintaining a substantial SO_2 allowance bank will persist indefinitely for power plant operators. That is because at any given time, the option of drawing from a bank of emissions reductions functions as a kind of insurance policy against costs of compliance becoming too high—at any time in the future. That insurance policy gives utilities flexibility as they continually respond to economic change and growth while operating against an emissions cap. Of course, if a surplus is to be maintained in the bank, then it is necessary for legislators and regulators to continue to honor those assets under any future regulatory changes.

V. The SO_2 program and the Kyoto Protocol: A matter of design

Since 1992, the parties to the United Nations Framework Convention on Climate Change have been working to design a global system to reduce emissions of greenhouse gases (GHGs). In particular, they are currently negotiating rules for market mechanisms that were put forward in the 1997 Kyoto Protocol on climate change. It is logical that the SO_2 program in the United States has been invoked countless times as an important precedent for the structure of the Kyoto Protocol. Although the differences between the SO_2 program and the Protocol are numerous, the environmental and economic results of Phase I are likely to command some attention among the international negotiators. Perhaps even more important, the results themselves—full compliance, dramatic levels of early, extra emissions reductions, and low costs—will reaffirm the negotiators' commitment to the fundamental cap and trade framework of the Protocol.

This section of the report examines some of the design choices that Congress made in developing the SO_2 program—choices that might parallel those available to the Kyoto Protocol negotiators. In that way, the design of the SO_2 program may shed light on pressing issues involved in global control of greenhouse gases—such as the timely achievement of significant GHG reductions, compliance, cost containment, and "compliance funds."

Extra and early reductions

The Kyoto Protocol has the potential to deliver emissions performance similar to that seen during Phase I of the SO_2 program—that is, the achievement of *more* GHG reductions than are required in the first compliance period. Realizing that promise, however, may depend on the willingness of the Conference of the Parties (COP) to negotiate a *second* compliance period, specifically before 2008 (the beginning of the first compliance period).

Article 3.13 of the Protocol parallels the provisions in the SO_2 legislation that permit the banking and saving of allowances. The article specifies that parties that do not use all of their "assigned amounts" of GHG emissions during the compliance period may add the unused assigned amounts in later compliance periods.

The results of Phase I of the SO_2 program indicate that the bank-and-save feature has been critical to stimulating power plants to make significantly more reductions in emissions than mandated in the Clean Air Act. Those extra reductions may be attributable to the acid rain program's more stringent emissions requirements in Phase II, which imparted financial value upon banked allowances.[34] The assessment of that value logically depended, in turn, on the clear understanding among power plant operators of their Phase II obligations. Those obligations were spelled out both in the legislation and in regulations issued by the EPA two years before the start of Phase I (and seven years before the start of Phase II). As a result, electricity companies and other investors were able to calculate with some precision the potential costs of meeting a specific set of more stringent reduction requirements before making their initial compliance decisions and investments. Based on those cost calculations, they were also able to see the value in achieving extra reductions in Phase I. Again, the result in the United States has been the achievement of SO_2 emissions levels that are 30% below those required by law.

Because of the cumulative effects of acid deposition, those extra, early SO_2 reductions offer better hope for the ultimate environmental efficacy of the program. Likewise, the atmospheric build-up of GHGs presents a similar situation. Because of the persistence and effect of these gases in the atmosphere, the current rapid increase and accumulation of emissions of GHGs are increasing the likelihood that global warming will occur at a faster rate and to a greater extent that will be environmentally and socially sustainable. That prospect puts a very high premium on achieving reductions in GHG emissions as soon as possible.

[34] Ellerman et al., *Markets of Clean Air: The U.S. Acid Rain Program*, 264.

Article 3.13 of the Kyoto Protocol offers an incentive pathway for achieving such early reductions, and involves more than just "flexibility" for countries that must manage their assigned amounts. Article 3.13 offers these countries (known as "Annex B parties" in the parlance of the Kyoto Protocol) an opportunity and a rationale for achieving reductions in GHGs sufficient to bring them *below* their cap. As in the case of power plants in the United States, Annex B nations looking forward to continued economic growth in concert with a GHG emissions limit may value the future flexibility offered by assigned amounts that are saved from the first budget period. If so, they will seek early on to make more reductions in GHG emissions, presumably at a lower cost.

As currently negotiated, however, the Protocol does not fully sustain this logic. It includes specified total-emissions limits for Annex B parties only for the first compliance period. Although the Protocol has provisions that assume the establishment of an ongoing series of compliance periods and assigned amounts, these subsequent assigned amounts are not specified. Neither policy makers nor private investors can apply the kind of calculus available to power plant operators under Phase I of the SO_2 program. As a result, their investment calculus during the first compliance period is less likely to spur early reductions in GHG emissions, which the environment greatly needs.

However, the COP can take steps to change this omission simply by agreeing before 2008 to adopt targets for the second compliance period. With both their first and second compliance period obligations in place, public and private-sector decision makers would be forced to follow GHG reduction strategies with a longer-term scope. In the case of long-lived capital investments common to energy-intensive processes and industries, this time perspective would allow more choices for control in the context of long-term financial planning. To the extent that incentives based on temporal flexibility can drive governments and firms to reduce GHG emissions quickly, as well as through the coming decades, then the Protocol would have that much better a chance of serving its ultimate environmental objective—limiting global GHG emissions to a level that will forestall or avoid dangerous changes in the global climate.

As in the case of power plants in the United States, Annex B nations looking forward to continued economic growth in concert with a GHG emissions limit may value the future flexibility offered by assigned amounts that are saved from the first budget period.

Compliance

Despite the many differences between the SO_2 program and the Kyoto Protocol, at least one crucial design feature of the SO_2 program should also be adopted by the COP: if a party releases excess emissions in the first compliance period, then there should be an automatic deduction of emissions from subsequent compliance periods. Further, the contrast between the SO_2 program and the Protocol highlights the need for the Protocol to use a modest "buyer liability" device to reinforce the parties' incentives to comply with their GHG obligations.

At first glance, international negotiators might assume that the approach of the SO_2 program to compliance and cost containment has little to offer in the way of solutions to international problems in the implementation of the Kyoto Protocol. After all, the U.S. Congress had the relatively easy task of establishing a compliance system that affected only domestic legal entities. Protocol negotiators, in contrast, must devise a system that governs the compliance of sovereign nations. Nevertheless, both the SO_2 program and the Kyoto Protocol rely on an emissions trading market as a primary means for delivering compliance with a fixed emissions limit. For that reason, it may be useful to examine the design choices that Congress made in the areas of compliance and cost containment in order to ensure both the environmental integrity of the program and the economic efficiency of the emissions trading market.

Transparency and Record-Keeping

The operational linchpin of the SO_2 emissions trading program has been the EPA's Allowance Tracking System (ATS) and Emissions Tracking System (ETS). Most observers agree that the ATS/ETS has been essential for ensuring compliance, vouchsafing environmental integrity, and facilitating investment and trading. The ATS/ETS provides the ultimate transactional "ledger"—a *publicly accessible* electronic database that records each source's actual SO_2 emissions as reported by its emissions monitoring system (ETS) and each source's allowance holdings (ATS). The ATS reflects all allowance transfer and banking activities. In the ATS, allowances are deducted from transferors' accounts and added to acquiring source accounts whenever both parties report that a transaction has taken place. The parties report their transactions for compliance purposes, that is, for ensuring that they have sufficient allowances in their accounts to cover their actual emissions. At the end of each year, the EPA deducts, from each source's account the allowances equal to the party's reported actual emissions for the year. Unused allowances are automatically carried forward to the account for the next year.

The demands on the Kyoto Protocol's implementation system for a reliable compliance structure, environmental integrity, and a record of ultimate "ownership" of AAUs/ERUs/CERs are the same as those placed upon the compliance and reporting system of the SO_2 program. That is why it is critical that the Protocol's implementation rules establish a publicly available double-entry "ledger" system for all Annex B parties and for CDM participants. Under such a system transfers would be recorded through the appropriate deductions and additions to parties' accounts. Deductions for actual GHG emissions would be similarly made, along with additions of unused portions of a parties' assigned amount. Additional features for such a system may be necessary depending on the particular compliance and liability ruled adopted. At the same time, the Protocol's reporting system must function as a public and transparent ledger accurately reflecting each party's emissions performance and its transactions under the flexibility mechanisms.

Both the SO_2 program and Article 3 of the Protocol codify a primary system of "seller liability." Under the acid rain program, power plants that sell allowances must reduce their emissions to an amount equal to or less than the remaining balance in their allowance accounts. The effect of Articles 3.10 and 3.11 in the Protocol is identical. These articles require Annex B parties to deduct from their assigned amounts those "assigned amount units" (AAUs) transferred under Article 17 (on emissions trading) and those AAUs/emissions reduction units transferred under Article 6 (on joint implementation). As a result of these provisions, Parties must limit their GHG emissions to their assigned amount *net* of these deductions in order to be in compliance.

Under the SO_2 program, Congress determined that only "sellers" are liable if their SO_2 emissions exceed the number of allowances remaining after transfers. This choice seems inevitable since it was built into the fundamental measure of compliance—matching annual SO_2 emissions to the number of allowances held for a given year. In addition, Congress relied on a stringent compliance regime that rested on two critical pillars. First, when the SO_2 emissions of a power plant exceed its allowances, the EPA must automatically deduct allowances from the plant's next annual allocation in an amount equal to the excess emissions. This creates an ongoing legal obligation for noncomplying power plants to "make the atmosphere whole" by restoring the reductions in emissions that were lost through noncompliance.

Second, the program provides for an *automatic* penalty of $2,000 per ton of excess SO_2.[35] (This penalty burden is augmented through enforcement provisions under the Clean Air Act that impose steep judicial fines on noncomplying sources.) Even taking into account the predictions of high compliance costs advanced by the utility industry during the public and legislative debates about the program, Congress determined that this penalty would represent a cost at least twice as high as, and likely three or four times higher than, the marginal reduction cost. Current SO_2 allowance prices, which are selling in the range of about $160 per ton, certainly validate this determination. Congress' strategy was to ensure that it would be irrational for a power plant operator to opt for suffering the penalty price in lieu of achieving compliance, particularly given the availability of diverse compliance options and unrestricted allowance trading.

As Congress did in the SO_2 program, the negotiators must ensure the environmental and legal integrity of the Protocol by automatically deducting assigned amounts in the second compliance period equal to a party's excess emissions in the first period. Only in this way will the Protocol create full-fledged, truly binding obligations on parties to limit their total GHG emissions. At the same time, the rules will ensure that the atmosphere is "made whole"—that the GHG reductions lost as a result of a Party's initial non-compliance are recovered eventually when the Party comes into compliance with its more stringent assigned amount. The integrity of this provision would be weakened, however, if parties were able to delay negotiation of their obligations in the second compliance period until after the first period began. This is another reason for the COP to adopt assigned amounts for the second compliance period before 2008.

Of course, the efficacy of an automatic deduction depends on the sovereign party's willingness to participate in the Kyoto regime as well as the establishment of a second budget period. It remains to be seen whether a future international consensus about the urgency of reducing GHG emissions will sustain support for automatic penalties for noncompliance. Until that time, negotiators must look to other strategies to prompt Annex B parties to meet their assigned amount obligations.

Because the Protocol is the artifact of the willing participation of sovereigns, negotiators must resort to a substantially different approach from the reliance on financial penalties used by the Congress in the SO_2 program. While the Protocol cannot impose the stark economic calculus created by the SO_2 program's steep monetary fines, it can take advantage of the economic incentives potentially created by the GHG emissions trading market fostered by Articles 17 and 6. Through the judicious application of a supplemental "buyer liability" rule, the COP can tap those incentives.

Specifically, a "dynamic balance" rule[36] for assigning liability to buyers, as well as sellers in some

The negotiators must ensure the environmental and legal integrity of the Protocol by automatically deducting assigned amounts in the second compliance period equal to a party's excess emissions in the first period.

[35] The penalty is adjusted for inflation. As of July 2000, the penalty stood at $2,682 per ton.

[36] The proposed dynamic balance rule is intended to identify the continually changing point at which a Party's actual emissions and assigned amounts are sufficiently out of balance that a buyer (by purchasing AAUs from the Party in question) demonstrably adds to the risk that the Party will be out of compliance at the end of the compliance period. In that circumstance, the rule would impose a share of the seller's ultimate liability under Article 3 on the buyer as well. To define this point of imbalance, the rule asks three questions: How many AAUs does the Party have remaining in its account for the commitment period?; How many emissions is the Party likely to have during the remaining commitment period?; and, How do those two numbers compare? If those numbers were out of balance beyond a certain threshold, any AAUs transferred at that point would be subject to a discount in their emissions-offset value if the selling Party ended the compliance period with excess emissions. By establishing a threshold of liability between buyers and sellers, the dynamic balance rule uses market forces to deter noncompliance without placing undue burden on the GHG emissions trading market.

circumstances, would create additional incentives favoring compliance. Under such a rule, buyers of AAUs, in specified circumstances, would know that they would share liability with sellers if the sellers ended the compliance period with excess emissions. As a result, buyers would place greater value on AAUs marketed by parties more likely to be in ultimate compliance. Those parties, in turn, would be more richly rewarded by the emissions trading market when they sold their AAUs. Thus, the emissions trading market itself would play a role in building incentives for compliance—or at least in steering participants away from parties whose transfer of AAUs contributed to their noncompliance.

Cost containment

Perhaps the issue that looms largest over the Kyoto Protocol is that of cost. The same was true for policy makers in the United States throughout the acid rain debate. In the end, Congress rejected every temptation to reach for a "quick fix," such as a price ceiling, to limit costs. Instead, it designed a program to take full advantage of market mechanisms to allow the market itself to act as the bulwark against unacceptably high compliance costs. This commitment was key both to the environmental integrity and economic performance of the program. No lesson may be more important for international negotiators confronting the challenge of limiting GHG emissions, especially because the size and diversity of the potential GHG emissions trading market imparts the critical mass and strength that allows all successful markets to do what markets do best: lower cost. That promise could be jeopardized, however, if negotiators create distortions in the market—distortions that would inevitably result from attempts to inject explicit limits on costs.

Congress constructed the SO_2 program with a firm cap and gave power plants a variety of compliance options, including emissions trading. In addition, an important element of this construct was an automatic penalty of $2,000 per ton of excess emissions. The amount, so much greater than the actual cost of achieving an incremental ton of reduction, compelled all sources to achieve or acquire through trading the reductions necessary to be in compliance. "Paying to pollute" is simply not a rational option under the SO_2 program.

Congress did include some provisions aimed at addressing concerns about dependence on the emissions trading market as a low-cost compliance option. These provisions were designed, however, to favor direct emissions reduction and emissions trading for compliance. Specifically, the EPA is required to withhold from the annual budget approximately 2.8% of the total number of allowances. About half of these are auctioned annually through the Chicago Board of Trade. Neither a floor nor a ceiling price is set for these allowances. As a result, participants must bid at or above a market-clearing price to obtain allowances. In effect, the auction is simply a segment of the overall market for emissions allowances.

The remainder of the withholding must be offered for "direct sale" at a price specified in the legislation—$1,500 per ton. Congress selected this price precisely because it was *50% higher* than the highest per-ton compliance cost estimates offered during the legislative debate. By setting the direct sale price at this level, Congress deliberately created a stark disincentive to participating in the direct sale option in lieu of purchasing allowances in the emissions trading market. The design was so successful that the EPA, by regulation, suspended the direct sale account simply because of lack of participation.

The most obvious benefit of this "no exit" strategy of the SO_2 program is that it guarantees the environmental integrity of the program. Even if both the auction and the direct sale program were fully subscribed, total emissions would not exceed, even by a single ton, the program cap. This is because every allowance transferred through these provisions is deducted from the total amount allocated. These mechanisms are but emissions trading—under the cap—by other means. The "no exit" approach may also be key to the economic success of the program, as demonstrated by its lower-than-predicted costs. Not only are allowances available through the auction and direct sale deducted from the total budget, but both the automatic penalty and the direct sale price are set so high above expected (and actual) market prices for allowances as to be economically intolerable. Consequently, the resources of the power plants and of other investors are directed exclusively at finding the *lowest cost methods of achieving actual reductions.*

One of the most striking aspects of the 7.3 million tons of over-control achieved during Phase I is that those reductions represent the willingness of power plant operators and other investors to expend present-day capital. In return, they are creating or receiving assets (the saved allowances) whose value will emerge only in the future, when, according to their assessments, compliance costs would be high enough, and operational flexibility needs great enough, to make a bank of these allowances valuable. At the same time, these early, low-cost reductions are integral to the success of an emissions trading market in driving down costs. Early investment in low-cost reductions produces a supply of relatively cheap allowances, which, in turn, ignites greater market demand and thus stimulates fundamental, cyclical market forces.

The most obvious benefit of the "no exit" strategy is that it guarantees the environmental integrity of the program, and it may be the key to economic success.

A prescribed ceiling price on trading, or "cost cap," at so-called "reasonable" levels would likely deter the cycle of early investment in a supply of low-cost reductions. If power plants in the SO_2 program could have counted on their costs being capped at a "reasonable" level, their incentive for making investments in early, bankable, low-cost reductions would have been greatly reduced. In the absence of robust investment in early low-cost reductions, the market and the attendant cost-reducing dynamic would have been slower in forming. A slowly forming market, in turn, would have signaled to firms to place their reliance in the future cost cap and to delay or eschew the search for, and purchase of, near-term low-cost reductions. With the investment in low-cost reductions not being made the market's cost-reducing capacity would dwindle. Furthermore, any cap on costs arbitrarily set by a political process introduces unaccountable uncertainty into any investment process, further dimming the interest in over-control. Thus, ironically, a cost cap could have made the SO_2 program *more* expensive than the actual outcome that emerged in an emissions trading market free of regulatory price distortions.

Compliance fund

In the ongoing effort by negotiators to formulate rules for compliance under the Kyoto Protocol, some have offered proposals to levy fees on noncomplying parties, and to use the fees to purchase GHG reductions that would offset the excess emissions. The details of the proposals vary; some would specify in advance the amount of the penalty, while others would calculate the penalty by levying a tax on GHG reductions transferred in the global emissions trading market. Such "compliance fund" proposals have been advanced for possible adoption at the global level, at national levels, and at regional levels among groups of nations. For evaluating these proposals, the design and initial success of the acid rain program offer a point of comparison that suggests these conclusions:

- The fees paid into any compliance fund should be high enough to ensure that parties and private firms have a strong incentive to invest in and achieve sufficient low-cost reductions (including through flexible market mechanisms), before subscribing, either voluntarily or involuntarily by dint of noncompliance, to one or more official, non-private compliance funds.

- The fees should be high enough to ensure that the compliance fund mechanism has more than adequate resources to invest in and acquire the full amount of additional GHG emissions reductions needed to offset all excess GHG emissions. The fees would also have to cover administration expenses for managing the fund, with all expenses recorded in a transparent manner.

- The rules that govern the compliance fund mechanism should be integrated into those that govern the other flexible mechanisms of the Protocol in order to ensure that the reductions acquired by the fund represent true, additional GHG reductions that offset excess emissions and achieve the goal of avoiding dangerous anthropogenic interference with the climate system.

The Kyoto Protocol already provides for a variety of distinct "flexibility mechanisms" that represent the pillars of a potential international emissions trading system. Those mechanisms and the market they purport to create will be the most likely sources of compliance for nations that choose not to achieve the full measure of emissions reductions domestically. Furthermore, the creative energy engendered by this market will produce the affordable and effective solutions needed to permanently address the global warming problem. From this perspective, a Protocol-sanctioned compliance fund may be viewed as wholly superfluous, if not compromising of the environmental effectiveness of the Protocol. Still, the notion of a compliance fund mechanism may find support among Parties committed to fulfilling their obligations, but uncertain about their own ability to take full advantage of the flexibility mechanisms. Thus the impetus to provide those Parties with an additional voluntary pathway in the form of a compliance fund may prevail. Lest fears of crippling costs and infeasibility become the reality, however, a compliance fund should not be allowed to curtail the potential of the market itself to meet the demand for low-cost reductions.

Regardless of the choices made by the COP, what is critical in assessing designs for a compliance fund is that the COP adopt a "no exit" strategy similar to that in the SO_2 program. Such an approach ensures that no matter how high the level of participation in the compliance fund, the full measure of GHG reductions mandated under Article 3 and Annex B will be achieved. At the same time, the mechanism likely would reinforce incentives to use the primary means of compliance—policies to reduce GHG emissions, direct investment in such reductions, and participation in the emissions trading system—which make up the Protocol's flexibility mechanisms. The more those means are used, the greater the likelihood that the Protocol will produce full compliance, and do so at the lowest possible cost. Conversely, the less these means are used by governments and firms, whose resources would be diverted simply to paying compliance fund fees rather than directing their resources to the creation of low-cost reductions, the greater the risk that the Protocol would either fail to meet its environmental goal or create unnecessarily high costs – or both.

The COP should ensure that a compliance fund does not become,* de facto, *a path by which Parties can simply "pay to pollute."

Accordingly, the COP should ensure that a compliance fund does not become, *de facto*, a path by which Parties can simply "pay to pollute." In that case, the Protocol would simply fail to achieve the full measure of GHG reductions mandated in Article 3. In addition, the key economic and environmental functions of the flexibility mechanisms and the overall global GHG emissions trading market—the stimulation of successful investment in low-cost reductions—would be frustrated. The paradoxical effect would not only be to make all compliance unnecessarily expensive, but also to leave even the fund managers with reduced options for finding an affordable supply of GHG reductions adequate to offset excess emissions. In the end, no compliance fund should function in a way that makes it a competitor to the primary compliance options that foster low-cost compliance.

The key, then, for an effective compliance fund mechanism is that the fee for noncompliance, or voluntary participation, must be set at a *high* level. First, and foremost, this would ensure that the fund had adequate resources to acquire all of the GHG reductions necessary to offset the excess emissions generated by Parties opting to use the fund in lieu of complying by other means. At the same time, through the use of a high fee, a compliance fund would be able to serve what would perhaps be its most important function: steering governments and firms toward their own active pursuit of low-cost reductions. That, in turn, would ensure that a compliance fund truly reinforced the critical function of the global GHG emissions trading system itself: driving public and private energy and investment directly toward the ongoing harvest of sufficient and affordable GHG reductions. After all, it is the bounty of that harvest that will determine whether the Protocol meets both its environmental and economic objectives.

Finally, during 1989 and 1990, Congress weighed a variety of arguments from stakeholders that the emissions trading market would not deliver an adequate supply of low-cost SO_2 reductions. In addition, some power companies asserted that participating in an SO_2 emissions trading market was outside of their core business capacities. In the end, Congress rejected all compliance mechanisms that would directly compete with, and divert investment and energy from, the SO_2 emissions trading market itself. It concluded that if the program was based on a "no exit" structure, then even if concerns about participation in the market proved valid, the emissions trading market itself would generate solutions. The results of Phase I strongly suggest that the market has performed precisely this task with respect to the achievement of low-cost emissions reductions. At the same time, during Phase I, the market succeeded in prompting several private firms to establish brokerages and other mechanisms to aid power plants and reduce transactions costs that otherwise might stymie participation in emissions trading and other means of compliance.

This experience, too, should inform the deliberations of the COP if and when it focuses on the question of establishing a compliance fund. Perhaps the COP, too, will conclude that in a market as potentially diverse and deep as an international GHG market, Parties and firms will devise *their own* compliance fund mechanisms. These could range from insurance instruments created by private legal entities to mutual assistance agreements among parties with existing political and economic affinities and parallel interests. Indeed, it is hard to imagine that such tools will not be established, and they are likely to be more robust if the COP refrains from devising its own compliance fund that competes directly with the proposed flexibility mechanisms.

Conclusion

Despite decades of real progress, air pollution continues to threaten both natural resources and human health. Policy makers at all levels who wish to meet the growing public demand for protection of people and the environment from the threats posed by ozone smog, fine particulates, acid rain and global climate change will be forced to require additional large-scale reductions of a range of air pollutants, such as NOx, SO_2 and GHGs. Growing evidence suggests that mercury and other airborne toxins pose a serious threat to human health as well, and their release into the environment will have to be reduced.

Since 1990, a variety of pollution-control programs have been developed that closely resemble the "cap and trade" model of the SO_2 program.[37] At the same time, policy makers in both the United States and other nations are faced with still more pollution-control challenges to which the approach taken by the SO_2 program might suggest a solution:

- In 22 eastern states, air regulators and, in some cases, legislators must develop state plans for complying with federal requirements to reduce summertime NOx emissions. The EPA has put forward a "model" cap and trade rule that any of the states may voluntarily choose to adopt.

- Ongoing scientific analysis suggests that in the absence of substantial additional reductions in annual NOx emissions and another increment of SO_2 reductions, critical natural resources will continue to be plagued by acid deposition.

- At a time when the electricity industry in the United States is undergoing a period of dramatic economic change, necessitating substantial new investment and new business strategies, both the public and some in the industry itself are looking to the EPA and Congress to formulate a definitive set of comprehensive pollution control requirements for NOx, SO_2, carbon dioxide and mercury.

- In November 2000 and in subsequent years, international negotiators will be called on to elaborate the implementing rules of the system of emissions trading authorized by the Kyoto Protocol on climate change, which also imposes explicit limits on the total GHG emissions of industrialized nations. In addition, government policy makers in those nations, anticipating participation in the Protocol, will be developing domestic greenhouse gas reduction policies. A number of nations—including the United Kingdom, Germany, Norway, Denmark, and France—have developed or are considering domestic GHG trading programs.

For those intent on achieving large-scale reductions in air pollutants, the results of Phase I are extremely promising, even compelling. They are so much so as to create a great temptation to extrapolate a set of "lessons" for stakeholders and policy makers who are grappling with the present and future challenges of controlling air pollution. Fortunately, stakeholders and policy makers will have the benefit not only of any "lessons" they wish to draw from these results, but also of a much wider range of continuously unfolding knowledge and understanding of the challenges they face.

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[37] These include: (1) the "NOx Budget" Program of the Ozone Transport Commissions of the northeastern states seeking to limit summertime emissions of NOx as groundlevel ozone precursors; (2) the "model rule" propounded by the EPA through which a group of Eastern states can meet their federal requirement to limit summertime NOx emissions transport as it affects groundlevel ozone formation; (3) the "RECLAIM" program established in Southern California to limit SO_2 and NOx emissions in connection with their local health effects; (4) the program developed by the state of Illinois to limit stationary source emissions of volatile organic compounds, as precursors of groundlevel ozone in the Chicago metropolitan area; and (5) the Kyoto Protocol negotiated by the third COP, which limits the total GHGs of specified industrialized countries while permitting those countries and their "legal entities" to engage in emissions trading. In addition, "cap and trade" legislation has been introduced in the United States Congress for further reducing annual SO_2 and NOx emissions to deal more aggressively with continuing environmental problems associated with acid deposition. Finally, in March, 2000 the European Commission issued a "green paper" outlining ways in which the European Union could apply a marketable permit, or "cap and trade," system for limiting greenhouse gas emissions in the EU.

At the same time, however, to deal with the ongoing problems of acid rain, the long-range transport of ground-level ozone precursors, climate change, and perhaps the release of fine particles and mercury into the atmosphere, policy makers will find that their immediate problem is to achieve large-scale reductions in pollutants like SO_2, NOx and greenhouse gases as quickly and as inexpensively as possible. In pluralistic societies that pursue environmental protection, prosperity, and other social goals simultaneously, it will behoove those policy makers to consider the outstanding environmental and economic performance of the SO_2 program when weighing the programs they themselves are developing. Otherwise, their constituents would have every right to ask: How can we accept alternative approaches if they do not deliver the critical pollution reductions as assuredly and as cost-effectively as the SO_2 program has in Phase I?

> **"Allowance Trading:** This unique aspect of Title IV has been successful both in terms of the volume of trades and in its effectiveness in keeping compliance costs down. Economic analysis shows the market of SO_2 emission allowances is functioning, liquid, and effective and can serve as a model for other air pollution control programs."
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> National Science and Technology Council, Committee on Environment and Natural Resources, National Acid Precipitation Assessment Program, *Biennial Report to Congress: An Integrated Assessment* (Silver Spring, MD: National Acid Precipitation Assessment Program, 1998), Executive Summary.

Does Trading Have to Be Regulated or Restricted?

The best answer to the question of whether or not trading must be regulated (including geographic or temporal restrictions) may be that it depends on the environmental and public health problem being addressed, including issues of environmental justice.

The results of Phase I suggest that restricting trades and banking may come at both an environmental and an economic cost. This notion stems from the 7.3 million tons of extra SO_2 reductions achieved between 1995 and 1999. Thanks to the banking and trading system established under the acid rain program, power plants were given a direct economic rationale for making these reductions. The extra reductions represented an economic asset in that they could have been sold during Phase I or banked for later use or sale in Phase II. To the extent that none of those options was restricted temporally or geographically or was subject to regulatory approval, the potential usefulness, and therefore economic value, of the extra reductions was that much greater. To the extent that the volume of extra reductions achieved was directly related to the power plant operators' calculation of the size of their economic value, *then regulatory constraints restricting their value might have diminished the total number of extra reductions achieved*. Consequently, policy makers should use a high level of care when considering restrictions of any kind on banking and trading or on individual sources.

The legislative history of the Clean Air Act Amendments of 1990 shows that Congress discarded provisions requiring the EPA to create geographically distinct "trading zones." Given that Congress believed that the sheer volume of SO_2 reductions was critical to curbing acid deposition, it appears that it also believed that the cumulative reductions mandated would be sufficient to swamp the effects of any geographic pattern of trades. Moreover, the legislative history also suggested that Congress anticipated that in any emissions trading market, economies of scale would encourage high-emitters in the "upwind" regions to control their emissions, rather than buy allowances from elsewhere. The results of Phase I bear this out.

In the case of the Ozone Transport Commission's (OTC) NOx Emissions Budget Program, the OTC chose to include a feature that limited the use of banked emissions reductions. The OTC cap and trade program is intended to limit NOx as a precursor of ground level ozone, whose health effects are chronic and not cumulative. The OTC concluded that extra emissions reductions in one year did not fully offset emissions in later years. At the same time, the Commission believed that banking yielded both economic benefits and environmental benefits in the form of early over-control of NOx emissions. Accordingly, rather than precluding or directly limiting banking per se, the OTC program includes a modest discount on the use of already banked allowances. The discount is applied in certain limited circumstances suggesting that the use of banked allowances would create an unacceptable environmental risk. The EPA's "model rule" of implementing NOx trading through State Implementation Plans follows a similar approach.

Perhaps the most challenging design problem for banking and trading arises in the context of pollutants that threaten human health and/or raise the issue of environmental justice. Recent studies suggest, for example, that SO_2 emissions and, perhaps, mercury emissions in part directly affect people within short distances of the sources of these emissions and in part are transported long distances to threaten human health and natural resources much farther away. Even leaving aside the issue of cost, if emissions trading and banking systems can help accelerate the achievement of greater levels of emissions reductions, policy makers will have to consider whether and how to use emissions trading in future programs.

If they decide to do so, should they restrict trading by limiting trades to prescribed geographic areas? Alternatively, programs may be designed to impose certain emissions limitation requirements on a strict source-by-source basis while requiring additional increments of reductions that may be achieved through emissions trading. Without far more scientific investigation and analysis, it may still be impossible to reach the threshold conclusion that some form of trading is permissible. However, there are clearly a variety of ways that trading programs can be limited to ensure environmental justice and public-health protection without compromising their capacity to create incentives for achieving early and extra reductions.

References and suggested reading

Dudek, Daniel (1989) "Emissions Trading: Environmental Perestroika or Flimflam?" *Electricity Journal*. Vol. 2, No. 9 (November).

Ellerman, A. Denny, Richard Schmalensee, Elizabeth M. Bailey, Paul L. Joskow, and Juan-Pablo Montero (2000) *Markets of Clean Air: The U.S. Acid Rain Program*, Cambridge University Press, New York.

Ellerman, A. Denny, Richard Schmalensee, Paul L. Joskow, Juan-Pablo Montero, and Elizabeth M. Bailey (1997) "Emissions Trading Under the U.S. Acid Rain Program: Evaluation of Compliance Costs and Allowance Market Performance" MIT Center for Energy and Environmental Policy Research, Cambridge, MA.

Environmental Defense (2000) *The Kyoto Protocol: Maintaining The Dynamic Balance (a working paper)*, Environmental Defense, New York.

Environmental Defense (1998) *Cooperative Mechanisms Under the Kyoto Protocol: The Path Forward*, Environmental Defense, New York.

Hahn, Robert W. and Carol A. May (1994) "The Behavior of the Allowance Market: Theory and Evidence" Electricity Journal, Vol. 7, No. 2 (March).

Kerr, Richard A. (1998) "Acid Rain Control: Success on the Cheap" *Science*, Vol. 282 (November 6).

Kosobud, R.F., W.A. Testa, and D.A. Hanson (eds.), (1997) *Market-Based Approaches to Environmental Policy*, University of Illinois Press, Champaign, IL.

Likens, Gene E., Thomas J. Butler, and Donald C. Buso (2000) "Long- and short-term changes in sulfate deposition: Effects of The 1990 Clean Air Act Amendments." *Biogeochemistry* (in press).

Lynch, J.A., V.C. Bowersox, and J.W. Grimm (2000) "Changes in Sulfate Deposition in the Eastern U.S.A. Following Enactment of Title IV of the Clean Air Act Amendments of 1990" *Atmospheric Environment*, Vol. 34.

National Academy of Sciences (1981) *Atmosphere-Biosphere Interactions: Toward a Better Understanding of the Ecological Consequences of Fossil Fuel Combustion.* Committee on the Atmosphere and the Biosphere, National Research Council. National Academy Press, Washington, DC.

National Acid Precipitation Assessment Program (1998) *Biennial Report to Congress: An Integrated Assessment*, National Science and Technology Council, Committee on Environment and Natural Resources, National Acid Precipitation Assessment Program, Silver Spring, MD.

Swift, Byron (2000) "Allowance Trading and SO_2 Hot Spots: Good News from the Acid Rain Program." *BNA Environment Reporter*, No. 19 (May 12).

Swift, Byron (1997) "The Acid Rain Test." *Environmental Forum*. Vol. 14, No. 3.

United States Environmental Protection Agency (2000) *National Air Pollutant Emission Trends: 1900-1998*, EPA 454/R-00-002, Office of Air Quality Planning and Standards, Washington, DC.

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

Wicker, Tom (1989) "Who'll Stop the Rain?" *New York Times* (June 16).

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