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Curbing Acid Rain:
Cost, Budget, and Coal-Market Effects
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ERRATA

On page 160, Options IV-1 through IV-3 were mistakenly captioned Options VI. The page should have appeared as below.

Option III-2C: A 10 million ton rollback of SO_2 emissions that requires the 50 highest emitting plants to install scrubbers, and that includes a 90 percent capital subsidy for all retrofit scrubbers provided by a temporary tax on electricity generation fired by fossil fuels.

Option IV-1: Imposes a tax on SO_2 emissions of $600 per ton, to achieve a total SO_2 rollback of 9.2 million tons.

Option IV-2: Imposes a tax on SO_2 emissions of $600 per ton, and includes a 90 percent capital subsidy for retrofit scrubbers. Achieves a total SO_2 rollback of 9.5 million tons.

Option IV-3: Imposes a tax on SO_2 emissions of $600 per ton, and includes a 90 percent capital subsidy and a 50 percent O&M subsidy for retrofit scrubbers. Achieves a total SO_2 rollback of 9.6 million tons.

Option V-1: Imposes a tax on each ton of coal sold, computed at $0.50 per pound of sulfur contained in each ton (to the extent that sulfur content exceeds 10 pounds per ton). Grants a 90 percent capital subsidy on retrofit scrubbers as well as a $0.50 per pound subsidy for any sulfur removed by a scrubber. Achieves a total SO_2 rollback of 8.9 million tons.

Option V-1: Imposes a tax on each ton of coal sold, computed at $0.50 per pound of sulfur contained per million Btus (to the extent that sulfur content exceeds 0.4 pounds per million Btus). Grants a 90 percent capital subsidy on retrofit scrubbers as well as a $0.50 per pound subsidy for any sulfur removed by a scrubber. Achieves a total SO_2 rollback of 8.9 million tons.

Option VI-1: A polluter pays rollback of SO_2 emissions based on utilities' achieving a statewide average emission rate of 1.2 pounds of SO_2 emitted per million Btus of fuel burned. Achieves a total SO_2 rollback of 9.1 million tons.

Option VI-2: A polluter pays rollback of SO_2 emissions based on utilities' achieving a plant-by-plant emission rate of 1.2 pounds of SO_2 emitted per million Btus of fuel burned. Achieves a total SO_2 rollback of 9.9 million tons.

Option VI-3: A polluter pays rollback of SO_2 emissions based on utilities' achieving a plant-by-plant emission rate of 0.7 pounds of SO_2 emitted per million Btus of fuel burned. Achieves a total SO_2 rollback of 12.3 million tons.

CURBING ACID RAIN:

COST, BUDGET, AND COAL-MARKET EFFECTS

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NOTE

All costs are in 1985 dollars unless otherwise noted.

PREFACE

Throughout the 1980s, acid rain has grown into a prominent environmental concern. Although questions remain on the chemistry and mechanisms of damage from acid rain, both the 98th and 99th Congress have considered proposals to stem this form of pollution. These proposals call for significant reductions in the amount of sulfur dioxide discharged by electric utilities, usually by placing additional controls on older power plants that are principally located in the Midwest and Appalachia and burn coal with a high sulfur content. Such approaches raise complex regional issues of who would pay the sizable abatement costs and which states might suffer substantial losses in coal production and mining jobs. At the request of the Senate Committee on Environment and Public Works, this study examines the key elements of legislative proposals introduced over the last several years, including two recent bills now under consideration in the Congress. In keeping with the Congressional Budget Office's (CBO) mandate to provide objective analysis, this report makes no recommendations.

This paper was written by Marc Chupka and John Thomasian of CBO's Natural Resources and Commerce Division, under the supervision of Everett M. Ehrlich and John Thomasian. The authors wish to express special thanks to William Orchard-Hays and Melinda Hobbs of the Department of Energy for their time and expert knowledge. Lois Trojan, Caryna Baker-Fox, Dolly Riegert, and Tom Young provided valuable research assistance. The authors are also grateful to the many individuals who provided valuable comments on earlier drafts, including Robert Friedman, Rob Brenner, and Paul Portney. Patricia H. Johnston edited the manuscript, and Patricia Joy prepared the report for publication.

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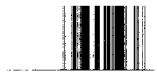


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SUMMARY

Over the past several years, the Congress has considered various methods to control "acid rain." Acid rain is a type of air pollution in which acidic compounds in the atmosphere (usually sulfates and nitrates) fall to the earth's surface through the action of rain and gravity. The particles that comprise acid rain can damage structures, ecosystems, and--through respiratory exposure--possibly human health.

The causes of acid rain are generally understood; man-made emissions of sulfur dioxide and nitrogen oxides, often discharged far from the areas they ultimately affect, are the primary culprits. Yet, the extent of the problem and its control remain subjects of debate. A number of Congressional proposals would lower sulfur dioxide (SO_2) emissions from the nation's power plants by between 45 percent and 70 percent from levels reported in 1980, perhaps the year of highest SO_2 discharges in this decade. Sulfur dioxide emissions from electric utilities have been targeted because they represent the pollutant and source most amenable to significant reduction through available techniques. But the high cost of such emission reductions (at least $3.2 billion annually for about a 60 percent national reduction from 1980 levels) and their potentially adverse effect on mining employment in the high-sulfur coal regions of the Midwest and Appalachia have spurred a search for alternative abatement programs.

This paper examines the different types of programs that the Congress has considered to diminish SO_2 emissions. Some control options would place no restrictions on the type of coal used or abatement method chosen; some would restrict switching from high-sulfur to low-sulfur coal; and others would tax either electricity production, sulfur dioxide emissions, or the sulfur content of coal to finance partially the utilities' costs of installing flue gas desulfurization equipment ("scrubbers") as an alternative to burning low-sulfur coal. While this analysis calculates the costs and coal-market effects of various SO_2 reduction alternatives, it does not estimate the benefits of the emission reductions. Such estimates lie beyond the scope of this study.

THE NATURE OF THE PROBLEM

Man-made emissions of SO_2 totaled about 27 million tons nationwide in 1985, of which about 15.8 million tons came from electric utilities. Under

current policy, SO_2 emissions from electric utilities are expected to grow to approximately 18.5 million tons per year by 1995. Although new power plants will produce some of this growth, older plants--built before the first federal emission regulations were issued in 1971--will still account for over 90 percent of total utility SO_2 discharges in 1995. The chief federal emission law affecting electric power plants--called the New Source Performance Standard (NSPS)--limits the discharge of SO_2 and other pollutants from new utility boilers. (This regulation was revised and standards tightened in 1978.) Although power plants built before the first NSPS still must meet other requirements of the federal Clean Air Act, their emission limits are generally set by the states and are usually more lenient than the federal NSPS.

The SO_2 emitted from these older sources (as well as from newer, but cleaner plants) is an important primary pollutant in the formation of acid rain. As the SO_2 is carried away from its source--it can travel well over 300 miles--it can be transformed in the atmosphere to sulfate, perhaps the most commonly studied constituent of acid rain. Sulfate compounds and other acid rain pollutants can return to earth in rain, snow, fog, dew, or as dry particles and gases. Upon entering bodies of water, these compounds can threaten aquatic life by raising the acidity of a lake or stream beyond acceptable levels for some fish species. Acid rain has also been linked to crop and tree damage, although airborne pollution may be only one of several explanations for these effects. Finally, some researchers--amid much disagreement--believe that acid rain poses a health risk, primarily among people with preexisting cardiac or respiratory problems.

Proposals to lower the amount of SO_2 discharged from electric utilities typically have called for a reduction of between 8 million tons and 10 million tons annually as measured from 1980 levels. (The year 1980 is a commonly used baseline, since it tends to capture the emissions of the older plants which are most often chosen for control.) Most programs would assign reductions to the individual states through an "excess emissions" formula that targets those states with the most power plants emitting SO_2 in excess of a specified amount. 1/ Under the traditional regulatory approach, each state would be required to meet its overall reduction level by placing new emission limits on the power plants it now regulates; states would be

1. Typically, the benchmark used is 1.2 pounds of SO_2 emitted per million British thermal units (Btu) of fuel used, which is the same standard as set by the first utility NSPS of 1971. The excess emissions are defined as the total amount of SO_2 emitted annually by each plant in excess of 1.2 pounds per million Btu. National allocation schemes are subsequently derived by dividing each state's share of excess emissions by the national total of excess emissions and then multiplying this fraction by the appropriate reduction target (for example, either 8 million tons or 10 million tons).

allowed to set the new limits for each power plant. Usually, the states and utilities would be given about 10 years to comply. For this analysis, 1995 is used as the illustrative deadline.

A major issue in all proposals is the relative cost burden that would fall on specific areas of the country. Because of their reliance on older, coal-burning power plants, the states of Missouri, Illinois, Indiana, Ohio, and Pennsylvania account for over 40 percent of annual utility SO_2 emissions. These same states would, therefore, bear the greatest responsibility for lowering SO_2 emissions under most plans.

Coal-Market Issues

Reducing SO_2 emissions nationwide would have varying effects on coal production in different regions of the country, chiefly because the sulfur content of coal differs among the three major coal-producing areas. The Appalachian states contain both high- and low-sulfur coal, which is predominantly mined through expensive underground methods. The Midwest, primarily in the Illinois coal basin, produces mostly high-sulfur coal, which is close to the surface and usually can be mined through less expensive "strip mining" methods. The western states of Wyoming, Montana, and Colorado, contain an abundance of low-sulfur coal which is often closer to the surface than in the Midwest, making it the cheapest coal to mine.

When an existing plant is required to lower SO_2 emissions, it can either switch to a lower-sulfur coal, which costs more, or install scrubbers and continue to use less expensive high-sulfur coal. If given the choice when faced with tighter SO_2 limits, most existing plants would switch coals, since the real annual cost of using a low-sulfur coal is often less than that of building and operating a scrubber for most levels of SO_2 reductions. Because 80 percent of all coal mined is used by utilities, a large-scale switch to low-sulfur coal could lower mining output in the states producing high-sulfur coal--chiefly Illinois, Indiana, Ohio, and Pennsylvania.

STRATEGIES TO REDUCE SO_2 EMISSIONS

This paper presents several types of programs to reduce SO_2 emissions, based in part on current and past legislative proposals (see box). The basic characteristics and effects of the options developed from these program types are contained in Summary Table 1, with the roman numeral in each option indicating the chapter in which it is discussed. The simplest program

TYPES OF PROGRAMS EXAMINED

The Polluter Pays Approach with No Fuel-Switching Restrictions.. This policy is the most traditional method for reducing SO_2 emissions. One example is to set emission reduction goals for each state (using the excess emission formula) and then require each state to set individual power plant emission limits in order to reach the statewide goal. This report examines two such cases in Chapter II: Option II-1A would require an 8 million ton SO_2 reduction from 1980 emission levels, and Option II-2A would require a 10 million ton SO_2 reduction. In contrast, the polluter pays approach could simply establish emission limits for individual power plants, and allow the states to permit either statewide averaging or compliance on a plant-by-plant basis. This method is exemplified by three SO_2 emission reduction options (between 9 million and 12 million tons) in Chapter VI. Options VI-1, VI-2, and VI-3 reflect various provisions of two recent Congressional proposals. In all cases, power plants could meet the assigned reductions by installing scrubbers or by switching to low-sulfur coal.

The Polluter Pays Approach with Fuel-Switching Restrictions. In addition to mandatory statewide emission reductions, these options would also restrict the amount of low-sulfur coal that could be substituted for high-sulfur coal. In this analysis, coal-market restrictions were simulated by requiring that 80 percent of coal purchases made in 1985 (as measured by sulfur content and coal rank) continue through 1995. This prescriptive approach for preserving current coal-market patterns is examined in Options II-1B and II-2B.

Electricity Taxes with Scrubber Subsidies. This type of option would provide financial incentives for installing scrubbers by partially subsidizing either their capital costs or their capital and operating costs. To pay for the subsidies, funds would be collected through a tax on electricity produced from fossil fuels. These alternatives are examined in Options III-1A, III-1B, III-2A, III-2B, and III-2C. In this last option, many high emitting power plants would be required to install scrubbers to meet the reduction goals.

Emissions Taxes with Scrubber Subsidies. These options would not establish specific emission reduction targets, but would provide financial incentives to lower SO_2 emissions by taxing the emissions themselves and, in some cases, by providing subsidies for scrubber installation. These scenarios are described in Options IV-1, IV-2, and IV-3.

Sulfur-in-Fuel Taxes with Scrubber Subsidies. This approach also would not mandate specific emission reduction targets, but instead would encourage SO_2 rollbacks by charging a tax on the sulfur content of coal burned by utilities while providing a rebate for each pound of sulfur removed through scrubbing. Options V-1 and V-2 explore these proposals.