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The 1990 Clean Air Act Amendments: Failing the Acid Test

by Curtis A. Moore

> I must tell you that we have heard much of this before in less sophisticated form. We heard it in 1970 and again in 1977. We heard it repeatedly in the 1980s. It is the same message today and it boils down to this: Impose the cost of pollution on people who breathe, so the people who pollute can avoid the cost of control. I think that is backwards. What must life be like for that asthmatic child when the very air can make her a shut-in and even threaten her life? What does it cost the rest of us to turn our backs on that child when the solution to her problem is known?
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> The late Sen. Edmund S. Muskie (D–Me.)
> Author of the Clean Air and Water Acts
> November 14, 1995

The acid rain trading program embodied in Title IV of the Clean Air Act (CAA) Amendments of 1990 has been widely applauded, but on few occasions, if any, has it been critically analyzed to determine its true impacts on cost, innovation, and, most especially, the achievement of its stated objectives. That is the purpose of this examination.

The acid rain trading program requires electricity-generating facilities in the United States to gradually reduce emissions of sulfur dioxide (SO_2) using what is often referred to as a "cap-and-trade" approach. The law establishes a "cap," or national limit on aggregate utility emissions of SO_2. This is at a level said, incorrectly, to be 10 million tons below 1980 emissions.[1]

The law also imposes source-by-source emission limits conferring on the polluter the "right" to these allocations, or "allowances." The limits decline with time, thus reducing aggregate emissions gradually, finally reaching full effect in 2010. As allocations shrink, a source can choose to reduce its actual emissions by, for example, burning lower sulfur coal, or instead buy the allocation assigned to another source, which must, in turn, either reduce its emissions or acquire an allocation. Thus, a given reduction in emissions may be initially assigned to a power plant in, say, Ohio, but actually occur in, for example, Georgia in much the same way that a share of stock in IBM might initially be issued to a Pennsylvanian but ultimately be traded to a Vermonter.

The principal advantage of "cap-and-trade" programs is said to be cost savings, and some assessments, such as that of *Fortune* magazine, are almost giddy in their praise:

> SO_2 emissions have fallen faster, further, and at less cost than anyone dared expect, and the system has been extended to more than 2,000 power plants. Even as the economy has grown, SO_2 emissions are on track to fall to half their 1980 levels by 2010 . . . . The cost to industry is about $1 billion a year; the EPA figures the benefits, just in terms of less sickness and fewer premature deaths, will reach $50 billion by 2010.[2]

Is such enthusiasm warranted? Has trading really reduced aggregate costs, and if so, at what nonmonetary price? What has been its impact on innovation? This Article examines the acid rain trading program in an effort to answer these questions, and its conclusions differ markedly from those of other reviews.

SO_2 emissions are reduced in two phases. Phase I ran for five years, from 1995 through 1999. Phase II started in the year 2000 and will be fully implemented in 2010. (However, the U.S. Environmental Protection Agency (EPA) issues allocations 30 years into the future, so pollution that will not be emitted until the 2030s is now available for trading.)

The first question is to ask what progress has been made toward restoring and protecting the pristine lakes, streams, and forests from Maine to Georgia, as well as in the upper Midwest and elsewhere, whose plight was the principal reason for enacting Title IV of the CAA Amendments of 1990. Emissions of SO_2 in 2001 were, according to EPA, 10.6 million tons,[3] 1.65 million tons above the emissions cap of 8.95 million tons. It is unlikely that significant environmental improvements beyond those already realized will occur in the near future, so what we see today is very likely to be what we will see in the near future, and perhaps, the distant one as well.

Indeed, the acid rain program has resulted in slight, if any, environmental improvement, whether the focus is lakes, streams, forests, soils, or human health.

The principal reason, by far, for enactment of the acid rain provisions was to restore the thousands of lakes and stream miles that had been damaged or left devoid of aquatic life because of air pollution, principally from coal-fired power plants. Yet, more than a decade after enactment, there have been, by some measures, no discernable improvements. By other measures, improvements have been slight.

One measure, for example, of the ability of lakes and streams to fend off the damage of acid rain is acid neutraliz-

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Curtis Moore, coeditor and publisher of the HEALTH & CLEAN AIR NEWSLETTER (http://healthandcleanair.org), was Republican counsel to the U.S. Senate Committee on Environment and Public Works from 1978-1989, where he worked on a wide range of environmental laws and issues. He is also the coauthor, with Alan Miller, of GREEN GOLD: JAPAN, GERMANY, THE UNITED STATES, AND THE RACE FOR ENVIRONMENTAL TECHNOLOGY (1994), as well as numerous articles in periodicals ranging from *Ambio* to the *New York Times*. As a consultant on international environmental policies and technologies, his clients have included Tokyo Electric Power, the California Air Resources Board, and Greenpeace.

1. *See*, *e.g.*, Statement of Sen. Max Baucus (D-Mont.) that the law "will reduce [SO_2] emissions by 10 million tons below 1980 levels and cap it at these levels by the year 2000." 135 CONG. REC. S17234 (daily ed. Oct. 26, 1990).

2. Cait Murphy, *Hog Wild for Pollution Trading*, FORTUNE, Sept. 2, 2002.

3. U.S. EPA, THE EPA ACID RAIN PROGRAM: 2001 PROGRESS REPORT (2002), *available at* http://www.epa.gov/airmarkets/cmprpt/arp01/index.html [hereinafter PROGRESS REPORT].

ing capacity (ANC) which, in turn, is increased by the presence in soils of cations. If acid rain, snow, and fog are not neutralized, they leach from the soil metals such as aluminum and lead, that are toxic to fish and trees. According to EPA in its 2001 report on program progress: "Recovery, as shown by increasing . . . ANC is occurring, especially in the Adirondacks and Pennsylvania . . . . However, *levels of base cations, including calcium, magnesium, and potassium, are not increasing; in fact, they are decreasing.*"[4]

According to the Hubbard Brook Research Foundation, which operates the longest on-going program of acid rain study in the United States, dating to the 1960s:

> Only modest improvements in ANC, an important measure of water quality, have occurred in New England. No significant improvement in ANC has been measured in the Adirondack or Catskill Mountains of New York. Elevated concentrations of aluminum have been measured in surface waters throughout the Northeast and it has improved, but only slightly and in only some areas. There is no improvement in the Adirondacks and Catskills.

The end result, according to EPA, is that

> [i]n spite of declining sulfate concentrations, some lakes and streams have been slow to recover. Their recovery is slowed by continuing acid deposition, the presence of nitrate in surface waters, the loss of soil's ability to neutralize excess acidity, the contribution of naturally occurring acid sources, and a lengthy lag time between deposition reduction and ecosystem recovery.[5]

In short, 14 years after enactment, 41% of lakes in the Adirondacks and nearly 15% of New England lakes remain acidic, and their recovery is hampered by the acidic anions slowly leaching from the soils.[6]

Widespread forest damage due to acid rain, especially along the spine of the Appalachian Mountains from Maine to Georgia, had been documented in 1990, and was a major reason for enactment of the CAA Amendments. The loss of calcium and magnesium nutrients from the soil and foliage weakens trees and makes them more susceptible to freezing temperatures and insect infestation. In addition, aluminum released from the soil is in a form that is highly toxic to trees and aquatic life. Red spruce at higher elevations in the Northeast have declined 25 to 50% since the 1960s. Sugar maple trees in western Pennsylvania have stunted growth and high mortality rates.

Twelve years later, EPA reported that there is "less stress on forest ecosystems compared to what it would have been without the Acid Rain Program." Actual recovery of these forests, however, is a different matter entirely: "The time frame for full recovery, however, is uncertain. Leached nutrients must first be restored through weathering of the bedrock, and soilwater aluminum concentrations must be reduced. *"Even after soil chemistry is restored, full recovery of sensitive forests is not expected to occur for decades."*"[7]

As SO_2 and oxides of nitrogen (NO_x) linger in the atmosphere, they are converted to sulfates and nitrates that reduce visibility. With substantial reductions in emissions, it should be possible to see farther and more clearly, but that hasn't happened, certainly not to a significant degree. According to EPA, in the West, visibility impairment for the worst days remained relatively unchanged over the 1990s, with the mean visual range for 1999 of 80 kilometers (km) nearly the same as the 1990 level of 86 km.[8] This would be consistent with the acid rain program, because it allows emissions in the West to actually increase, on the premise that these states were so clean that additional pollution growth should be allowed there. Over the 1992–1998 period, the magnitude of aerosol extinction due to sulfates, increased, most notably between 1997 and 1998.[9] "This corresponds," EPA noted in its 1998 *National Air Quality and Emissions Trends Report*, to an "increase in sulfate aerosols and summertime increase in regional SO_2 emissions."[10] Other data collected by EPA show that during the 1990s visibility in the parks, national monuments, and other pristine areas of the United States failed to improve, whether the measure was "best" days, "worst," or "mid-range."[11]

Before the acid rain provisions were enacted, they were described as essential not only to protect lakes, streams, and forests that are sensitive, but to protect public health as well. As Sen. George Mitchell (D–Me.), then the Majority Leader of the U.S. Senate and a leading advocate of acid rain controls, explained: "[S]ulfate exposure can overwhelm our respiratory system and may cause as many as 50,000 premature deaths annually."[12] Twelve years later, EPA reported that "[w]hen fully implemented by the year 2010, the public health benefits of the Acid Rain Program are estimated to be valued at $50 billion annually, due to decreased mortality, hospital admissions, and emergency room visits."[13] In the meantime, people continue to die unnecessarily.

Indeed, the acid rain trading program itself is adding to these needless, avoidable deaths. According to one report, because the cap-and-trade program allows some power plants to increase emissions by buying credits from low-emitting facilities, higher emissions have led to thousands of premature deaths.[14] The report *Particulate-Related Health Impacts of Emissions in 2001 From 41 Major U.S. Power Plants* concluded that of the 600 power plants that emit SO_2, 252, or 42%, actually *increased* their emissions, resulting in between 4,800 and 5,600 premature deaths in 2001. Although SO_2 emissions decreased about five million tons nationwide, they actually rose in 16 states.[15]

Supporters of trading argue that left free to choose among competing options for reducing air pollution—as opposed

4. *Id*. at 37 (emphasis added).
5. *Id*.
6. Charles Driscoll et al., *Acidic Deposition in the Northeastern United States: Sources and Inputs, Ecosystem Effects, and Management Strategies*, 51 BioScience 180 (2001).
7. Progress Report, *supra* note 3, at 37 (emphasis added).
8. U.S. EPA, National Air Quality 2001 Status and Trends (2002), *available at* http://www.epa.gov/air/aqtrnd01/visible.html. [hereinafter 2001 Status and Trends].
9. U.S. EPA, National Air Quality and Emissions Trends Report (1998), *available at* http://www.epa.gov/oar/aqtrnd98/ [hereinafter 1998 Report].
10. *Id*.
11. 2001 Status and Trends, *supra* note 8 (chart "Visibility Trends for Eastern U.S. Class I Areas, 1992–1999").
12. Statement of Sen. George Mitchell (D-Me.), 135 Cong. Rec. S16903 (daily ed. Oct. 27, 1990).
13. U.S. EPA, Effects of Acid Rain: Human Health (2003), *available at* http://www.epa.gov/airmarkets/acidrain/effects/health.html.
14. Abt Associates, Inc., Particulate-Related Impacts of Emissions in 2001 From 41 Major U.S. Power Plants (2002), *available at* http://www.rffund.org/eip/docs/PMHealthImpact2001.pdf [hereinafter Abt Associates].
15. *Id*.

to being constrained by explicit, technology-based or technology-forcing emissions limits—some polluters will opt to employ advanced technologies that will reduce emissions more than necessary, thus producing emission credits that can be sold for a profit. Therefore, they argue, trading will stimulate the development and deployment of environmentally advanced technologies.

That was not the experience in either the leaded gasoline or Regional Clean Air Incentives Market (RECLAIM) trading programs, nor has it been with acid rain. In fact, trading has had precisely the opposite effect, stifling innovation in newer, cleaner generating technologies. Integrated gasification-combined cycle (IGCC), for example, can reduce emissions of SO_2, NO_x, carbon dioxide (CO_2), and mercury by up to 99%, but the only two generating plants built since 1990 have been federally subsidized. One IGCC plant, Tampa Electric's new Polk Station, does not participate in the acid rain program at all.[16] The second, a repowering of Unit 1 of the Wabash River Plant in West Terra Haute, Indiana, participates, but it was proposed before enactment of the acid rain program, so it could not have been stimulated by the new law. Essentially the same is true with respect to deployment of wind power and other renewable sources of energy, as well as conservation.

This is not to say that there was no innovation, for there was. However, innovation is of two kinds:

> There is innovation that leads to the development of environmentally superior technologies like IGCC, wind turbines, and conservation regimes that can many pollutants simultaneously. That has not happened under the trading program.
>
> Then, there is innovation of a different sort, concerned not so much with environmental improvement as saving money in the reduction of a specific pollutant, SO_2, by an exact amount: namely, the allocation for that particular source.

In trading schemes like acid rain, RECLAIM, and leaded gasoline, the innovation that is stimulated, and which prevails in the marketplace, is of the second type. In the acid rain program, the innovation it stimulated was in new railroad tracks, on- and off-loading systems, and other ways of bringing lower sulfur coal from the Powder River Basin to market. These improvements added nothing extra to the environment benefits. In other words, the "magic" that the market brings to bear, happens only on the cost side—the environmental benefits, after all are capped, so there are reductions in only one pollutant and only by so much. The flexibility inherent in trading is in cost.

What the advocates of trading fail to understand is that technologies can only win in the market if they deliver same environmental benefit at less cost. The market places no value on IGCC's ability to reduce not only SO_2 by an order of magnitude, but also NO_x, carbon monoxide (CO), volatile organic compounds (VOCs), and heavy metals such as mercury. The polluter is interested in one—and only one—outcome: reducing emissions of SO_2 to its allocated level of pollution, no more, at the lowest possible price.

This rigidity is perhaps the greatest single practical flaw in trading. Under a technology-forcing regime, the multiple benefits of specific technologies or practices can be seized. To be sure, buying coal shipped by rail from the Powder River Basin is a cheaper way of reducing SO_2 emissions than replacing a 1950s vintage power plant with IGCC. However, if IGCC reductions in NO_x, CO, CO_2, VOCs, mercury, and other pollutants are taken into account, it is almost certain to be less expensive than the aggregation of pollutant-specific technologies, such as scrubbers, selective catalytic reduction (SCR), and carbon absorption, that would be required.

Moreover, what money has been saved if after 14 years it is necessary to reduce emissions even further, as was the case with both RECLAIM and leaded gasoline and as it almost certainly will be with acid rain as well? Years have been lost and with them, thousands of lakes, acres of lakes, and miles of streams, as well as human lives.

Worse, trading is now being advanced as a reason for repealing the technology-forcing provisions of the CAA, mandates that new sources install best available control technology (BACT), in pristine areas or meet the lowest achievable emission rate (LAER), in areas where the air fails to comply with the law's health-based standards. It is these mandates that have resulted in the installation of SCR, a technology not unlike the catalytic converters found on cars, that destroys NO_x, as well as so-called scrubbers that remove SO_2. The BACT and LAER mandates have been a major stimulus in efforts to develop newer, cleaner ways to burn natural gas and coal. Trading is now being advanced as a reason for their effective repeal.

BACT and LAER are triggered when polluters seek to build new or substantially modified power plants or factories. The Bush Administration, arguing that trading eliminates the need for new source review, is seeking its repeal in favor of a trading-based "Clear Skies Initiative." That would, in turn, effectively eliminate LAER and BACT and, with them, the two provisions of the law that are explicitly aimed at forcing the development of new, environmentally superior technologies.

Thus, the Bush Administration is forcing the U.S. Congress to confront one of the two fundamental questions that lie at the heart of this debate: what is most important? That a program be really cheap? Or that it encourage innovation?

The critical question is not whether control costs under Title IV of the CAA Amendments are lower than they otherwise might have been, but whether savings, if any, should be attributed to trading or some other aspect of the program—specifically, the cap. However, if any element of the program saved money, it was almost certainly the cap, not trading. To put it at its simplest, it costs less to do less, whether the mechanism employed is trading, regulations, or something else entirely such as taxes.

But the focus on costs raises a second, fundamental question that lies at the heart of this debate: what is the measure of success, environmental protection or saving money?

Even if trading does reduce cost compared to command-and-control—and this analysis failed to find evidence demonstrating this to be the case, those supposed savings may be illusory. The trading program will not be fully implemented until 2010, so it will be at least six years, if ever, before projected savings in final emission controls can be compared to true costs. At roughly this same stage in the implementation of RECLAIM it, too, appeared to be a money saver, though ultimate its effects were just the opposite.

16. Personal Communication with Ross Bannister, Senior Coordinator, Media Relations, Tampa Electric Power Company (Sept. 12, 2002).

Some have asserted that the cap-and-trade program has not only saved as much as predicted prior to its enactment, but much more. Notwithstanding these claims, current costs are consistent with some, though not all, analyses conducted in the late 1980s.

Inherent in all trading programs, including acid rain, are other failings. It requires reliance on a bureaucracy for effective administrations, making it almost impossible for citizens to know in advance how much pollution will actually be emitted from a given power plant. Pollution credits are routinely traded months after SO_2 was emitted, so "hot spots" can come and go with neighbors of power plants being none the wiser. The same lack of transparency make trading programs a ripe target for cheating. While there is no evidence that this has happened in acid rain, it clearly did with leaded gasoline and has been alleged with RECLAIM.

Finally, and perhaps most importantly, trading in air pollution removes the stigma that is, and should be, associated with releasing into the environment a substance, that by definition, is a threat to human health. SO_2 can kill people, and it has. Calling a commodity that is being traded for what it is "pollution" or "poison" creates a moral suasion that presses polluters in the direction of eliminating their pollution. This is neutralized when terms such as "allocations" are introduced and the purpose of the program is shifted from protecting people to moving units from one side of a state, or the country, to the other. What is lost is the linkage between government action and some test of environmental or public health integrity.

The CAA Amendments of 1990

An Observation

The 1990 Amendments are less than they seem. This means that no single provision can be taken at face value. Instead, each must be held up to the light and scrutinized carefully. Among the first words in the acid rain Title IV, for example, is the following:

> The purpose of this title is to reduce the adverse effects of acid deposition through reductions in annual emissions of [SO_2] of [10] million tons from 1980 emission levels, and, in combination with other provisions of this Act, of [NO_x] emissions of approximately [2] million tons from 1980 emission levels, in the [48] contiguous states and the District of Columbia.[17]

Examined carefully, however, the title will reduce annual emissions of SO_2 by nine million tons, if that; and reduce NO_x, perhaps not at all.

Total U.S. emissions of SO_2 in 1980 were estimated to be about 26.6 million tons. Electricity-generating facilities (which at the time were virtually all utilities, but many of which have since been deregulated and operate as independent power producers) accounted for about 17.4 million tons.[18] However, acid ran was of greatest concern principally in the 31 states east of or bordering the Mississippi River, where utility emissions of SO_2 were about 16.2 million tons.

The goal of the acid rain provisions is to cap average annual SO_2 emissions of electric utilities at 8.95 million tons, which is roughly one-half of the estimated 1980 level of 17.378 million tons. This is to be achieved in two phases.

> In Phase I, which began in 1995, each of the 110 dirtiest power plants (which have 263 generating units) were allocated allowances sufficient for an emission rate of 2.5 pounds (lbs.) of SO_2 per million British thermal units (mmBtus) of heat input.[19]
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> In Phase II, which began in the year 2000, all fossil-fueled power plants larger than 25 megawatts (MW) are annually allocated allowances sufficient for an emission rate of 1.2 lbs. of SO_2/mmBtus of heat input.[20] The largest polluters were within this region. In addition, roughly 25% of the land area contains soils and bedrock that allow acidity through a watershed to lakes and streams. Roughly 17,000 lakes and 112,000 miles of streams were in these sensitive areas.[21] This was the resource that, first and foremost, the acid rain provisions of the 1990 Amendments were aimed at protecting—or were they?

Impacts on Health and the Environment

Oddly, the reported reductions in emissions of SO_2 do not seem to be mirrored in environmental improvements. Sulfate levels, created when SO_2 is oxidized in the atmosphere, should be falling sharply, and this should be reflected in increases in visibility, but it isn't. Similarly, in proportion to emission reductions, sulfate concentrations in rain, snow, and other forms of deposition should be falling, and with them, the aggregate amount of the pollutant found on surfaces, but that isn't happening either.

Visibility Trends Generally

Without the effects of pollution, the natural visual range in the United States is roughly 75 to 150 km (45 to 90 miles) in the East and 200 to 300 km (120 to 180 miles) in the West.[22] Because of air pollution, however, visibility ranges in the United States are substantially less than what they should be. In the East, sulfate is clearly the largest contributor to visibility impairment, ranging from an average 75–79% of each year's during the haziest days. In the eastern United States, reduced visibility is mainly attributable to secondarily formed sulfates.[23] Sulfates are also the principal cause of visibility degradation, though other pollutants also play a role.

For most rural eastern sites, sulfates account for more than 60% of annual average light extinction on the best days and for more than 75% on the haziest days. Sulfate

17. 42 U.S.C. §7651. *See also* National Acid Precipitation Assessment Program, Biennial Report to Congress: An Integrated Assessment, Implementation and Costs of Title IV (1990), *available at* http://www.nnic.noaa.gov/CENR/NAPAP/.

18. Office of Technology Assessment, U.S. EPA, Acid Rain and Transported Pollutants: Implications for Public Policy 149–51 (1984) [hereinafter Implications for Public Policy].

19. Firms can voluntarily enroll additional generating units ("compensation and substitution" units) in Phase I, subject to the constraint that the average emission rate of all units does not increase.

20. In both phases, heat input is based on the 1985–1987 reference period.

21. Implications for Public Policy, *supra* note 18, at 10-13.

22. 2001 Status and Trends, *supra* note 8.

23. *Id.*

plays a particularly significant role in the humid summer months, due to its nature to attract and dissolve in water vapor, most notably in the Appalachian, Northeast, and mid-South regions.[24]

EPA has reported a 24% decrease in emissions of SO_2 from 1992 to 2001.[25] Yet these reductions are not being manifested by visibility improvements. In the West, visibility impairment for the worst days remained relatively unchanged over the 1990s, with the mean visual range for 1999 of 80 km nearly the same as the 1990 level of 86 km.[26] According to EPA, over the 1992–1998 period, the magnitude of aerosol extinction due to sulfates, increased, most notably between 1997 and 1998.[27] "This corresponds," EPA noted in its 1998 *National Air Quality and Emissions Trends Report*, to an "increase in sulfate aerosols and summertime increase in regional SO_2 emissions."[28]

Data collected by EPA show that during the 1990s visibility in the parks, national monuments, and other pristine areas of the United States failed to improve, whether the measure was "best" days, "worst," or "mid-range."[29]

Sulfates and nitrates become more efficient at scattering light with increasing humidity.[30] Thus, a given amount of pollution will reduce visibility more in the humid East than in the arid West.

EPA concluded in its 1998 report that "overall, essentially no change in visibility is noted between 1989 and 1998," adding that "a 4[%] *degradation* has occurred since 1992."[31]

National Parks

Air masses passing over the Ohio River Valley are most likely to contribute to extreme sulfur contributions at Shenandoah National Park, while Detroit and Chicago are second most likely to contribute sulfur-laden air to the park.[32]

Coal-fired power plants in the New York-Philadelphia area contribute about 15% of the sulfur at Acadia National Park, while power plants in northern New York account for about 24%. Sources in the Midwest, especially Michigan, contribute another 20% to sulfur measured at Acadia.[33]

Roughly 30% of the sulfur measured at Shenandoah National Park is from coal-fired power plants in the Pittsburgh-Cleveland area, while those in the Columbus-Dayton-Cincinnati region account for another 12%. The Piedmont-northern Tennessee area contributes 16% of the ambient sulfur, while the Southeast accounts for another 23%.[34]

At the Great Smoky Mountains National Park, roughly 35% of the sulfur is blown in from the Ohio River Valley, while the Tennessee Valley Authority (TVA) and Memphis areas contribute about 17% and the Gulf Coast more than 10%.[35]

Measures of acidity at three of the eastern U.S. major National Parks, Acadia in Maine, Shenandoah in Virginia, and Great Smoky in North Carolina, show relatively little change—indeed, a few instances, actual acidity increases—during the 1990s. For example, at the Big Meadows monitoring station in the Shenandoah National Park, the annual average deposition of sulfate (adjusted to take into account the amount of rain, snow, and other precipitation) was 1.38 milligrams per liter (mg/*l*), a decrease of only .02 mg/*l*, or about 1.4%, from 1994 to 2001. The annual deposition sulfate at Big Meadows did decline, falling about 20% from 19.29 kilograms per hectare (kg/ha) to 15.39 kg/ha. However, sulfate deposition in the summer growing and reproductive season increased, rising from 7.14 kg/ha to 7.25 kg/ha, or 1.5%.[36]

The monitor at Elkmont in the Great Smoky Mountains National Park showed a similar mix of modest declines and slight increases. In that case, the annual concentration of sulfate in deposition rose slightly, from 1.17 mg/*l* in 1994 to 1.18 mg/*l* in 2001, with a decline in deposition from 22.38 kg/ha to 16.40 kg/ha, or a drop of about 27%. This was reversed for summer, however, with concentrations rising from 1.35 mg/*l* to 1.53 mg/*l*, an increase of 13%; and deposition declining from 7.43 kg/ha to 7.26 kg/ha, a fall of 2%.[37]

As early as 1982 scientists testified that saving these pristine lakes and streams would require very large reductions in emissions. Testifying before the Senate Committee on Environment and Public Works, Dr. Orie Loucks said that

> [t]he Phase II report of the United States/Canada Assessment of Effects From Transboundary Air Pollution estimates that a "no effects level" of acidic deposition is

24. 1998 Report, *supra* note 9.
25. 2001 Status and Trends, *supra* note 8.
26. *Id.*
27. 1998 Report, *supra* note 9.
28. *Id.*
29. 2001 Status and Trends, *supra* note 8 (chart "Visibility Trends for Eastern U.S. Class I Areas, 1992–1999").
30. 1998 Report, *supra* note 9.
31. *Id.* (emphasis added).
32. William C. Malm, Introduction to Visibility 48 (Cooperative Institute for Research in the Atmosphere, Colorado State University 1999).
33. *Id.* at 51.
34. *Id.*
35. *Id.*
36. National Acid Deposition Program (NADP), Annual Data Summary for Site: VA28 (Shenandoah National Park-Big Meadows) (2002), *available at* http://nadp.sws.uiuc.edu/sites/siteinfo.asp?id=VA28&net=NADP. Sample handling procedures for monitoring sites in the NADP changed substantially on Jan. 11, 1994, so samples before and after that date are "different and not comparable." *See* NADP, *Notification of Important Change in NADP/NTN Procedures on January 11, 1994*, *at* http://nadp.sws.uiuc.edu/documentation/advisory.html.
37. NADP, Annual Data Summary for Site: TN11 (Great Smoky Mts. National Park-Elkmont) (2002), *available at* http://nadp.sws.uiuc.edu/nadpdata/ads.asp?site=TN11. Alone among the three parks, Acadia has shown a significant decline, though virtually all of this was in the 2000–2001 period. From 1994, annual average sulfate concentration at Acadia's McFarland Hill monitoring station increased from 1.10 mg/*l* in 1994 to 1.22 in 2000. Annual average deposition fell slightly, from 15.94 kg/ha to 15.74, a decline of 1%.
    In 2000–2001, however, deposition dropped dramatically, from an annual level of 15.74 kg/ha to 6.38, a decline of 9.36, or 59.4% The annual sulfate concentration also declined, dropping from 1.22 mg/*l* to 1.01, or 17.2 %.
    A similar sudden decline in 2000–2001 occurred at the nation's oldest acid rain monitoring site in Hubbard Brook, New Hampshire. There, annual average sulfate concentrations and deposition had declined from 1.59 mg/*l* and 16.85 kg/ha in 1994 to 1.30 and 16.04, respectively, in 2001. These amounted to decreases of 18.2% and 4.8% over the six-year period. Yet in the one year that followed, annual sulfate concentration and deposition fell to 1.13 mg/*l* and 10.24 kg/ha, or declines of 13.1% and 36.2%.
    What could account for such sudden and substantial declines at Acadia is unclear. One possible explanation is decreased emissions from smelters in Sudbury, Canada, which account for 29% of the deposition in Acadia. Between 1990 and 1997, the INCO and Falconbridge smelters cut sulfur emissions by 63%.

> probably close to 25[%] of present acidic inputs in the most heavily impacted areas. This estimate is in general agreement with the recent National Academy of Sciences' report. Even with a 75[%] reduction, the remaining acidic input would be roughly 200 to 400[%] above our historic atmospheric sulfate. Thus, for purposes of defining the need, we should talk about a possible maximum 75[%] decrease in deposition.[38]

Put simply, this advice called for reaching and maintaining an SO_2 emissions level in the East of about 4.0 million tons, compared to the Title IV levels of 8.9 million tons.[39]

Not surprisingly, despite the emission reductions that have resulted from the 1990 Amendments, acid rain continues to plague the Northeast and, more recently, the Southeast as well. At Hubbard Brook Research Station in New Hampshire, where scientists have been studying acid rain since the experimental forest was established there in 1955. Researchers result that acid rain has leached roughly one-half of the calcium from forest soils, while sharply increasing levels of sulfur, nitrogen, and a toxin, aluminum. Declines in red spruce, sugar maple, and likely other forest species as well are linked to acid deposition.[40]

In North and South Carolina, Tennessee, and other states in the Southeast researchers have found circumstances mirroring those in the Northeast. Streams are acidified in both the Shenandoah and Great Smoky Mountains National Parks. The loss of the capacity to neutralize acids in Shenandoah is said to be "ubiquitous." Trout embryo survival has fallen and, in one stream, fish survivorship dropped from 80 to 0% as acid neutralizing capacity fell.[41]

Death and Illness

In addition to SO_2 and NO_x, coal-fired power also emits large quantities of fine particles, some small enough for 40 or more to fit on the width of a human hair. In addition, SO_2 and NO_X are converted into fine particles by reactions in the air. Together, these and other fine particles blanket virtually the entire eastern United States, causing death and illness.

Visibility measurements from airport and other sites reflect concentrations of fine particles. On maps in which dense haze is shown in deepening shades of orange, that color has spread from a small, roughly circular area covering northern Ohio and bordering areas of Pennsylvania and Michigan in 1960 to a blanket over virtually every square mile east of the Mississippi River in 1990. In a few locations—southern California is the most notable—fine particle levels have fallen. With the enactment of Title IV, levels of fine particles should have fallen in the eastern United States as well, but that may not be the case.

According to the National Acid Precipitation Assessment Program, concentrations of fine particle sulfur in the summer, when most people would be outside, continued to increase in the early 1990s in the Shenandoah and Great Smoky Mountains, even though reduced emissions of SO_2 were being reported.[42]

The increases have also occurred in the vicinity of specific plants, according to one study, resulting in increased mortality. The report said that because the cap-and-trade approach allows some power plants to increase emissions by buying credits from low-emitting facilities, higher emissions have led to thousands of premature deaths.[43]

The report, *Particulate-Related Health Impacts of Emissions in 2001 From 41 Major U.S. Power Plants*, prepared by Abt Associates, examined 41 power plants that either increased their emissions of SO_2 between 1990 and 2001 or saw emission decreases of less than 15%. It concluded that of the 600 power plants that emit SO_2, 252, or 42%, actually increased their emissions. This was because rather than reducing their emissions to meet their cap, they bought credits from other facilities. The result is the uneven distribution of pollution reduction benefits, the report said.[44]

"Abt Associates estimates that between 4,800 and 5,600 premature deaths in 2001 were associated with the emissions from these 41 plants," the study said. During this period, SO_2 emissions decreased about five million tons nationwide, but actually rose in 16 states, the report said. Other states saw only marginal improvement.[45]

Three power plants in western Pennsylvania increased their combined emissions from 408,000 tons in 1990 to 483,000 in 2001, the report said. Further, in areas where increases from power plants occurred, studies indicated higher mortality rates as well as more cases of asthma and other respiratory diseases, the Abt study said.[46]

Effects on Innovation

The title also states:

> It is also the purpose of this title to encourage energy conservation, use of renewable and clean alternative technologies, and pollution prevention as a long-range strategy, consistent with the provisions of this title, for reducing air pollution and other adverse impacts of energy production and use.[47]

Indeed, supporters of trading argue that industries left free to choose among competing options for reducing air pollution—as opposed to being constrained by explicit, technology-based emissions limits—will opt to employ advanced technologies that will overcontrol, thus producing emission credits that can be sold in the market. Obviously, there is some inconsistency between this argument and the claims that trading will reduce costs, for if the value of pollution credits falls, so does the potential financial gain—and incentive to employ it—from new technology.

38. *Acid Rain: A Technical Inquiry, Hearing Before the Comm. on Env't and Public Works*, 97th Cong. 399 (1982) (statement of Orie L. Loucks).

39. 42 U.S.C. §7651b.

40. Hubbard Brook Research Foundation, Acid Rain Revisited (2001), *available at* http://www.hubbardbrook.org/education/Glossary/AcidRain.pdf.

41. National Park Service, Acid Deposition Impacts on Aquatic and Terrestrial Ecosystems, Technical Information in Support of the Department of the Interior's Request for a Rule to Restore and Protect Air Quality-Related Values (undated), *available at* http://www.aqd.nps.gov/ard/epa/.

42. National Science and Technology Council, Committee on Environment and Natural Resources, National Acid Precipitation Assessment Program Biennial Report to Congress: An Integrated Assessment, Changes in Emissions, Concentrations, and Deposition (1998), *available at* http://www.nnic.noaa.gov/CENR/NAPAP/.

43. Abt Associates, *supra* note 14.

44. *Id.*

45. *Id.*

46. *Id.*

47. 42 U.S.C. §7651.

Abstract economic theory aside, however, the experience with the acid rain trading program makes it clear beyond any credible dispute that if innovation is stimulated, it is not that which encourages "use of renewable and clean alternative technologies, and pollution prevention as a long-range strategy, consistent with the provisions of this title, for reducing air pollution and other adverse impacts of energy production and use." The sad state of conservation and renewable energy programs in the United States is a case in point.

To encourage adoption of renewable energy and conservation, Title IV sets aside 300,000 "bonus" allowances that can be given to utilities that implement such programs. Of these 300,000, only 47,493 had actually been allocated by November 2002, and most of those were to power companies in the western United States, not in the South or Midwest, where the bulk of the pollution is generated. (See Appendix A for a list of companies that have received allocations and for what purposes.)

Indeed, data suggest that enactment of the trading program is one of the largest single obstacles confronting those seeking to deploy new technologies. Acid rain trading has not been a boon to these entrepreneurs, but a burden. Consider, for example, one of the most advanced ways of utilizing coal, IGCC.

IGCC: A Technology Left Behind by Trading

If ever there were an innovative yet demonstrably feasible technology whose adoption should have been accelerated by the trading programs of the 1990 Amendments, it was Cool Water IGCC. It was clearly technologically feasible, as tests in California on a wide range of fuels had made clear. The component manufacturers included two of America's oldest and most technologically competent firms, Texaco and General Electric Company. They had partnered with the research arm of the electric utility industry, the Electric Power Research Institute (EPRI), as well as the U.S. Department of Energy (DOE). Cool Water IGCC would reduce not only SO_2 emissions, but those of NO_x as well, producing saleable byproducts. The only potential obstacle was cost, but that was dropping rapidly.

High-sulfur, poor-quality fuels such as coal or petroleum coke can be converted into a high quality synthesis gas, or syngas, that can then be burned with only a small fraction of the air pollution that would otherwise be generated. Gas made from coal was first used in 1798 as a fuel for lamps. By the 1890s, it was so widely used that it lent its name to an entire period of time, the "gaslight era." The advent of electricity, especially its transport over long distances by wires, and the development of a natural gas pipeline system ended these widespread but small-scale generation of gas from coal. With the successful demonstration in 1984 of large scale gasification to provide fuel for electricity-generating turbines, the potential for exploiting the energy in coal in vastly less polluting ways was revived.

That demonstration, the 1984 Cool Water Project, was at the site of the former Cool Water Ranch in the Mojave Desert near Barstow, California, supported by a number of governments and companies. Called IGCC because it produces coal gases that are burned in a gas turbine, heat is extracted from the hot exhaust gases and used to run a steam turbine. Thus, it integrates gasification with two combined, or linked, generating cycles—thermal and steam. Basically, the coal is prepared and fed into a reactor, or gasifier, where it is partly oxidized with steam under pressure. By simultaneously reducing the presence of oxygen in the gasifier, the carbon in the coal is converted into a gas that is 85% CO and hydrogen, with smaller portions of CO_2 and methane. The process allows sulfur to be removed from the gasified coal and sold in its elemental form, or as sulfuric acid. Inorganic materials such as ash and metals drop out as slag, which is typically used for construction materials. The plant may provide process or heating steam as well.

All of these plants rely on heavy-duty gas turbines that General Electric in Schenectady, New York, has been modifying for IGCC service since the Cool Water Project. At Cool Water, the IGCC technology generated electricity at a cost of $2,000 per kilowatt (kw). Since then, the cost of IGCC-generated electricity has dropped to less than $1,000 per kw.[48] Using wastes can reduce costs further: the Schwarze Pumpe plant in Spreewitz, Germany, for example, gasifies junked railroad ties and telephone poles, sewage sludge, old tires, and household garbage. These materials are ground up, pelletized, mixed with coal, and sent into four solid-bed gasifiers.[49] Wastes from refining and related facilities are especially suited to use as IGCC fuels.[50]

Indeed, the world's largest IGCC plant is at the Saras Oil Refinery in Sarroch, the second largest European refinery. It generates 551 MW of electricity, 285 metric tons of process steam for the refinery, as well as 20 million standard cubic feet a day of hydrogen uses in the refining operations. The Sarlux IGCC gasifies petroleum coke, a tar-like residue from refining gasoline, diesel, and other lighter fuels. Pumped into the gasifier, the coke is enriched with oxygen, which creates hydrogen used by the refinery and other synthetic gases that are burned to generate electricity.[51]

Following enactment of the CAA Amendments, in January 1996, an IGCC began operating in Florida. It was commercial electric utility application at the 250-MW size using an entrained-flow, oxygen-blown, gasifier with full heat recovery, conventional cold-gas cleanup, and an advanced gas turbine with nitrogen injection for power augmentation and control of emissions of NO_x. Sited near the town of Mulberry in Polk County Florida, the gasifier had by 2001 operated over 21,000 hours since its startup in July of 1996. The power station had produced more than six million megawatt hours (MWh) of electricity and, for the six-month period ending in March 2000, had a combined-cycle availability of 94%. Participants in the project included Tampa Electric Company, Texaco, General Electric, Air Products & Chemicals, Monsanto Enviro-Chem Systems, TECO Power Services Corporation, and Bechtel Power Corporation. Trouble is, this project had no connection to the acid rain program. It was built with $120 million from DOE.[52] Its developers had applied for funding in August 1989 as a Clean Coal 3 demonstration project, well before enactment of the 1990 Amendments.[53] The only other IGCC utility project operating in the United States, the Wabash River Coal Gasification

48. Michael Valenti, *Trash and Burn*, MECHANICAL ENG'G, Nov. 2000.

49. *Id.*

50. *Id.*

51. *Id.*

52. *See* http://environment.tampaelectric.com/EPPolk.html.

53. TAMPA ELECTRIC CO., ANNUAL REPORT JANUARY–DECEMBER 1992 (1993), *available at* http://www.lanl.gov/projects/cctc/resources/pdfs/tampa/000000DD.pdf.

Repowering Project, is also funded by DOE through the Clean Coal Program. Again, the decisions to construct it is unlikely to have been influenced by the prospect of generating emission credits.[54]

Certainly better than any other utility power plant in the United States, and perhaps in the world, Wabash illustrates the tremendous potential of the IGCC technology to simultaneously reduce a full range of air pollutants, thus decreasing the impacts not only of acid rain, but also ground-level ozone, fine particles, and global warming. Consider the following operating experience at Wabash:

> Emissions of SO_2, the primary cause of acid rain as well as fine particle sulfates, were cut by 99%, reaching levels that were roughly 70% below the new source performance standard (NSPS).
>
> Emissions of NO_x, the major cause of ground-level ozone, as well as a significant contributor to both acid rain and fine particle pollution, reduced to the level of the NSPS.
>
> Plant efficiency was boosted from 33%, producing 90 MW, to 40% with an output of 262 MW. This represents a reduction in emissions of CO_2 per unit of electricity of roughly 21%.
>
> The sulfur removed from the coal was in the form of 99.99% pure sulfur, a highly valued byproduct.
>
> Coal ash was converted to a low-carbon vitreous slag, impervious to leaching and valued as an aggregate in construction or as grit for abrasives and roofing materials; and trace metals from petroleum coke were also encased in an inert vitreous slag.

Thus, a 1950s vintage pulverized coal-fired plant was transformed into what is certainly one of the world's cleanest coal-fired power plants.[55]

Despite these truly remarkable achievements, Polk and Wabash are the only two plants in the United States that generate electricity for sale utilizing the IGCC technology. When Dale Simbeck of the firm SFA Pacific, Inc., which compiles data on IGCC for DOE, electric utilities and a wide range of other customers, was asked why there are only two such plants in the United States, he replied: "[L]ife extension of the big dirties."[56]

According to Simbeck, there are IGCC facilities generating electricity in the United States, but these are at refineries. Even though an IGCC-generating plant may cost as little as $1,000 per kw to construct and remove pollutants ranging from SO_2 to mercury, life extensions cost even less "as long as you don't trip new source review," he explained.

Simbeck's firm conducted the first World Gasification Survey, supported by DOE and member companies of the Gasification Technologies Council in Arlington, Virginia. The survey identified 160 commercial gasification plants operating, being built, or planned in 28 countries. The effect of stringent emission regulations in encouraging the deployment of IGCC to generate electricity can clearly be seen in the results of this survey. Although the United States is home to General Electric, Texaco, and many of the other market leaders in the technology, it is not the leading nation in deployment of IGCC for electricity generation. That place belongs to Italy, with 1,484 installed MW, followed by Spain with 1,224, with the United States in third place at 1,156.[57]

54. The project was selected for funding by DOE on Sept. 12, 1991. *See* http://www.lanl.gov/projects/cctc/factsheets/wabsh/wabsh_timeline.html.

55. According to DOE, before repowering, the Wabash River plant was a nominally 33% efficient, 90-MW unit. Afterwards, it was a nominally 40% efficient, 262-MW (net) unit. Cinergy, PSI's parent company, dispatches power from the project, with a demonstrated heat rate of 8,910 Btu/kwh. The SO_2 capture efficiency was greater than 99%, keeping SO_2 emissions consistently below 0.1 lb/10^6 Btu and reaching as low as 0.03 lbs./10^6 Btu; and SO_2 was transformed into 99.99% pure sulfur, a highly valued byproduct. The NO_X emissions were controlled by steam injection down to 0.15 lbs./10^6 Btu. Coal ash was converted to a low-carbon vitreous slag, impervious to leaching and valued as an aggregate in construction or as grit for abrasives and roofing materials; and trace metals from petroleum coke were also encased in an inert vitreous slag. *See* http://www.lanl.gov/projects/cctc/factsheets/wabsh/wabashrdemo.html.

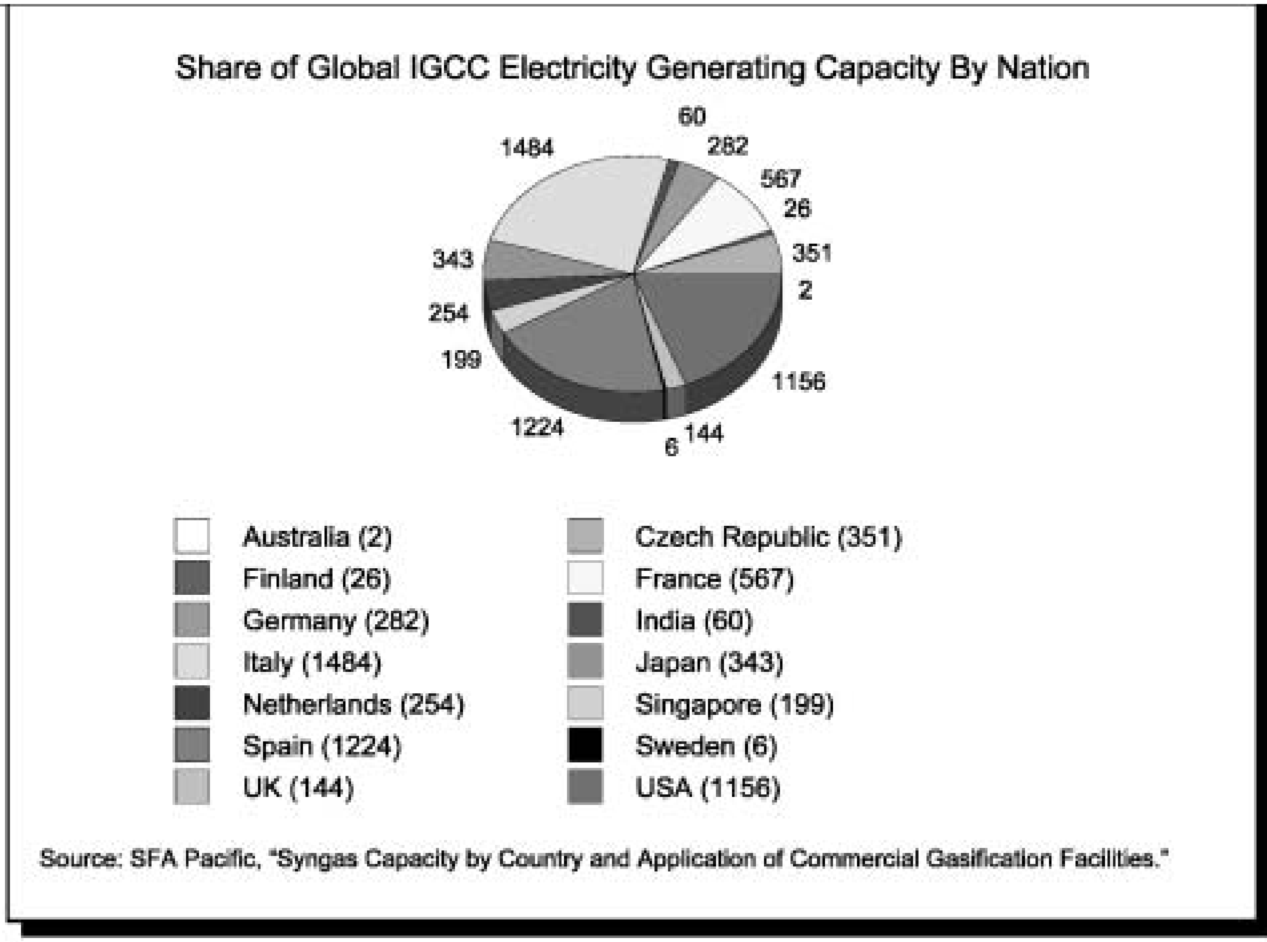
56. Personal Communication with Dale Simbeck, SFA Pacific, Inc. (Sept. 11, 2002).

57.

IGCC Projects: Global Summary

Country	"Real" Projects		Electricity	Total Equivalent MW	Planned HR.	MW
	Chemicals/FT Liquids	Gaseous Fuels				
Australia	1	–	1	62	–	–
Brazil	1	–	–	246	–	–
China	19	2	–	2,594	3[a]	–
Czech Republic	1	–	1	620	1[b]	400
Dominican Republic	–	1	–	107	–	–
Egypt	1	–	–	58	–	–
Finland	1	3	1	92	–	–
Former Yugoslavia	2	–	–	124	–	–
France	4	1	1	712	–	–
Germany	14	3	3	3,087	–	–
India	10	–	1	1,430	1[b]	397
Italy	2	–	4	1,622	2[b]	605
Japan	5	–	1	600	2[b]	476

[a] chemical
[b] electricity
[c] 1 chemical @157 MW; 4 Power @1,823 MW
[d] 1 chemical @546 MW; 1 Power @546 MW



Country	"Real" Projects		Electricity	Total Equivalent MW	Planned HR.	MW
	Chemicals/FT Liquids	Gaseous Fuels				
Malaysia	1	–	–	564	–	–
The Netherlands	1	1	1	648	1[b]	26
Poland	–	–	–	–	1[b]	504
Portugal	2	1	–	232	–	–
Russia	1	–	–	5	–	–
Singapore	1	–	1	319	–	–
South Africa	4	–	–	5,618	–	–
South Korea	3	–	–	111	–	–
Spain	2	–	2	1,239	–	–
Sweden	1	1	1	33	–	–
Taiwan	1	–	–	160	–	–
Ukraine	–	1	–	243	–	–
United Kingdom	1	1	2	273	2[b]	421
United States	14	1	7	3,796	5[c]	2,039
Unspecified Asian Nation	–	–	–	546	1[a]	546
Unspecified European Nation	–	–	–	–	2[d]	1,092
Zambia	1	–	–	65	–	–

[a] chemical
[b] electricity
[c] 1 chemical @157 MW; 4 Power @1,823 MW
[d] 1 chemical @546 MW; 1 Power @546 MW

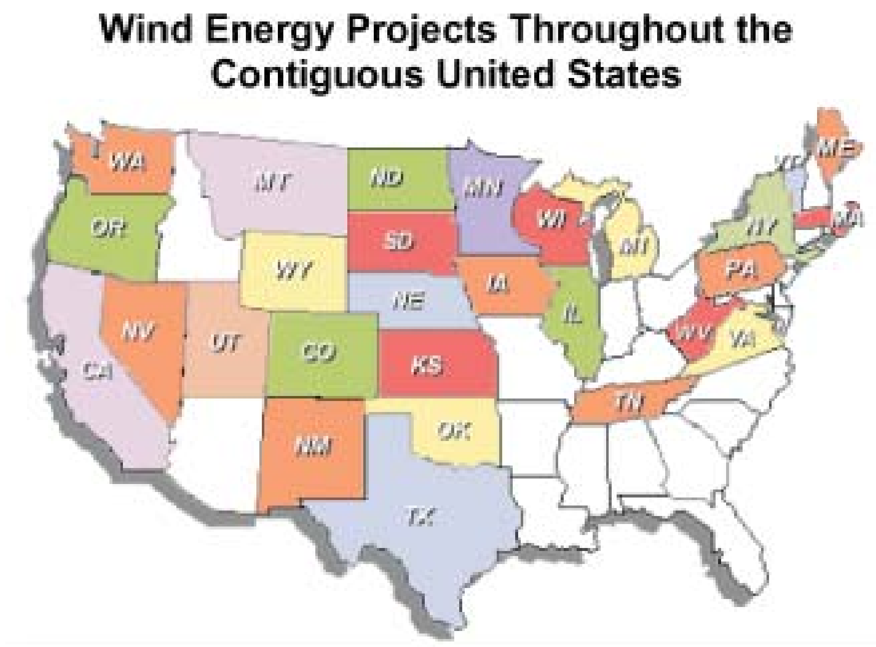
Source: SFA Pacific, Inc., Syngas Capacity by Country and Application of Commercial Gasification Facilities.

The IGCC "Cool Water" technology is clearly sweeping the world, as would be expected. Its emission benefits are truly extraordinary, even when utilizing high-sulfur coal, petroleum coke, and some of the other most heavily polluted fuels available.[58] Yet in the United States not a single IGCC plant has been built due to the acid rain trading program.

Taking the Wind Out of Wind Power's Sails

Just as trading eliminated the market for what is arguably the best technology available for using coal, so, too, did it deal a body blow to hopes of generating electricity with renewable sources of energy. There is no evidence trading has encouraged the installation of even one wind turbine or solar array, or caused the adoption of a conservation program. There is, however, ample evidence that since 1990 the market for these and other technologies has shrunk in the United States or, where it has grown, has done so despite the chilling effect of the acid rain title. The effect has been especially grave for wind energy.

Wind turbines are perhaps the most rapidly evolving of the many renewable energy technologies. Fundamentally, the windmills of the 20th century, like their 18th century forebears, use the wind's energy to turn blades that supply energy for some other purpose, such as pumping water. But current versions rely on sophisticated electronics and space age materials to squeeze more and more energy from breezes, and then turn it into electricity. Usually, the power is fed into the grid.



58.

Performance of Two U.S. IGCC Plants[1]

	Fuel	Emissions	Performance	Cost
Tampa Electric (Polk)	Illinois #6, Pittsburgh #8, Kentucky #11, and Kentucky #9 coal. These bituminous coals have: **sulfur** 3.1-3.9%, **ash** 6.2-9.9%, **moisture** 6.0-18.3%, **carbon** 73.8-79.5%	**Sulfur capture** 97% emissions held below .15 lbs./mmBtu (.0014 lbs./kwh) by an amine sulfur extraction system which is capable of greater than 98% capture. **NO_x** less than .27 lbs./mmBtu (.0026 lbs./kwh) **Particulate** near zero **CO_2** ~ 208 lbs./mmBtu (1.97 lbs./kwh)	**Heat rate (Btu/kwh) & Efficiency:** 8,600-9,350 heat rate (40-36% efficiency).[2] **State of the art** is about 8,320 (41%). **Future:** With continued research & development (R&D), heat rates of 6,335 (60%) or greater are possible.	Cost to build a commercial IGCC plant has generally been estimated at between $1,000-1,250/kw
Wabash	**Illinois Basin Bituminous: sulfur** 1.9%, **ash** 12%, **moisture** 15%. **Petcoke: sulfur** 5.2%, **ash** 0.3%, **moisture** 7%	**Sulfur capture** greater than 99%, .1-.03 lbs./mmBtu (.0009 and .0003 lbs./kwh) **NO_x** 0.15 lbs./mmBtu (.0013 lbs./kwh) **Particulate** near zero **CO** .05 lbs./mmBtu (.0004 lbs./kwh) **CO_2** 208 lbs./mmBtu (1.77 lbs./kwh	**Heat rate (Btu/kwh) & Efficiency:** 8,530 heat rate (40% efficiency). **State of the art** is about 8,320 (41%). **Future:** With continued R&D, heat rates of 6,335 (60%) or greater are possible.	Cost to build a commercial IGCC plant has generally been estimated at between $1,000-1,250/kw

1. Source: Letter from Secretary of Energy, Spencer Abraham, Sept. 12, 2001, to Sen. James M. Jeffords (I-Vt.).

Both the technology and the cost of electricity generation from wind have improved remarkably over the past decade. The technology related to grid-connected wind turbines is mature and commercially available. The most successful commercial wind turbines have installed capacities of over 600 kwh, which is roughly enough electricity for 120 homes. Within the past four years, however, new generations of machines—first in the one MW range and recently even larger—have been developed and are being installed throughout much of Europe. While the United States was an early leader in developing wind technology, companies in Europe have surpassed the United States since 1990 in both research and development and deployment. The potential for wind turbines in the United States is immense. The wind resources in states like Maine, Minnesota, Montana, Vermont, and Wyoming are tremendous. Yet little of that potential is being realized.

A wind farm with a capacity of 10 MW would generate approximately 30,700 MWh of electricity each year (assuming a 35% capacity factor). Based on national average emission rates, this would displace some 80 tons of NO_X and 123 tons of SO_2. Replacing 10% of current electricity production with wind generated power would reduce annual emissions by roughly 875,000 tons of NO_X and 1.3 million tons of SO_2. Researchers have estimated that 10% of 1993 U.S. electricity demand could be met by developing only 1.8% of the wind resource in the lower 48 states.

Unlike many fossil fuels, wind farms leave 97% of the land they require available for conventional agricultural uses, such as farming and grazing. Landowners receive either a one-time payment for wind rights or a royalty for electricity produced by turbines on their land. Optimally sited new wind turbines are now generating electricity at under $.04 per kwh in Europe and the United States. In Minnesota, for example, state law requires the purchase of renewable energy. Wind electricity is currently being generated at a cost of $.04-.05 per kwh, and the some bids for new wind generation were close to $.03 per kwh. Wind turbines can be purchased from any of several major manufacturers. The most advanced machines are European.

The Minnesota state legislature has required the state's largest utility, Northern States Power, to build a total of 425 MW of wind power and Iowa has a comparable requirement. Its Alternative Energy Production statute requires utilities to purchase electricity at a fixed price of $.06 per kwh. Alternative energy includes power generated from solar, wind, small hydro, refuse-derived fuel, agricultural crops or residues, and wood-burning facilities.

Despite the ready availability of both wind and the machines with which to economically extract energy from it, the technology is spreading slowly in the United States and only in a few places. The acid rain trading program seems to have provided no development stimulus whatsoever. In the states with the largest sulfur emissions, and hence the largest reduction requirements, the number of wind turbines is virtually zero. According to the American Wind Energy Association, there are currently no wind energy projects in the following states: Alabama, Arkansas, Delaware, Connecticut, Florida, Georgia, Indiana, Kentucky, Louisiana, Maryland, Mississippi, New Hampshire, New Jersey, North Carolina, Ohio, and South Carolina.[59]

The Costs of Control: Doing Less Costs Less

Fundamentally, there are three options for reducing emissions of a fuel-bound contaminant such as sulfur: switch to a technology that removes the pollutant before or during combustion, e.g., IGCC; install a device that removes the pollutant after combustion, e.g., scrubbers; or, switch to a fuel that contains less of the pollutant. In the case of the acid rain program, only the second and third options, scrubbing and fuel-switching, came into play. In both of these, the cost of

59. In other major emitting states east of the Mississippi River, the projects are:

State/Project	Location	Status	MW Capacity	On Line By
Massachusetts				
Princeton	Muni Light	On Line 1984	0.32	N/A
Hull	Town of Hull	Dec. 2001	0.66	N/A
AllEnergy	Hancock	Proposed	7.2	2002
DisGen	Hancock	Proposed	5.3	2002
Cape Wind	Nr. Nantucket	Proposed	420	TBD
New York				
PG&E	Madison County	Sept. 2000	11.55	N/A
CHI Energy	Wyoming County	Oct. 2000	6.8	N/A
CHI Energy	Fenner Project	Dec. 2001	30.0	
Atlantic Renewable	Flat Rock	Proposed	50.0	2003
Long Island PA	Shelter Island	Proposed	0.05	2002
NYSERDA	Unk.	Proposed	0.15	2002
Atlantic Renewable	East Central NY	Speculative	10.0	Dec. 2003
Pennsylvania				
Energy Unlimited	Hazelton	Dec. 1999	0.13	N/A
West Virginia				
Atlantic Renewable	Tucker County	Permitted	65.0	Mid 2002
Mega-Energy	Preston County	Proposed	10.0	Dec. 2002
U.S. Windforce	Grant County	Proposed	150.0	Late 2002

control is largely a function of how much air pollution must be reduced.

This is obviously the case with fuel-switching, since the price of control varies directly with the amount of the fuel burned (unless, of course, the lower sulfur coal also sells for less than higher sulfur fuel, which was sometimes the case with acid rain controls).

It is also the case with scrubbers, though this may be less obvious. In the case of add-on control systems such as scrubbers, 90% of the fixed cost is due to the installation of technology, and the variable costs are minimal. The cost of running the device depends principally on the volume of flue gas that is being treated, not the concentration of the pollutant.

In other words, the only way to save money when add-on technology is the control option is to install less of it. In a single plant with multiple boilers, which is the case with the vast majority of U.S. generating facilities, this means running one or more boilers with no equipment while operating another equipped with scrubbers running at 95% removal. This results in roughly 50% removal by doing nothing in one case and operating at maximum efficiency in the other. Thus, costs are cut in half—but only if the aggregate reduction requirement is modest. Of course, the reduction requirement must by definition be modest in a trading program, because if it is not there is no excess pollution available. If, in contrast, the reduction requirement is on the order of 90%, every unit must be controlled in some fashion.

The remaining question is whether in a modest reduction program, like that for controlling acid rain in the United States, trading saves money compared to conventional regulations. This is an impossible question to answer with absolute certainty. However, experts at the University of Karlsruhe in Germany attempted to answer it.

Asked by the German government to examine the potential saving from trading, researchers at the university examined 30 boilers in one of the German states, Baden-Württemberg, and many more in Austria, Denmark, the Netherlands, and other nations. Their conclusion was that "a reasonably designed Ordinance is as cheap as (trading) alternatives, but it guarantees emission reduction."[60]

Still, economists, who had for years urged policymakers to adopt market mechanisms to control pollution, say that, in the words of one, "trading has contributed to significant cost reductions, compared to original forecasts of cost."[61] This statement is, quite simply, unsupported by the facts.

First, it is essential to bear in mind that commentators are not comparing projected costs to actual costs. They are comparing cost *estimates* in the 1980s to cost *estimates* today. Further, not all estimates from the 1980s are being examined. Instead, to justify claims that trading has saved money, commentators most often cite one specific 1990 estimate:

> [F]or evaluation of the program compared to prior expectations, the most useful study is ICF (1990), which was done for the EPA and available prior to enactment of the legislation. This study captured more accurately the ultimate design of the regulation, and projected marginal costs of $579–760 (1995 dollars) for full compliance under the program.[62]

Completely ignored by these commentators is an ICF Consulting Group, Inc. analysis done in 1987 of Senate Bill S. 316, which was virtually identical to the acid rain control program ultimately enacted. Introduced by Sens. William Proxmire (D-Wis.) and Alan Simpson (R-Wyo.), the bill would have reduced emissions in two stages, as did Title IV. It called for SO_2 emission reductions of 5.0 to 5.8 million tons by 1995, the same order of magnitude as Title IV; and of 9.1 to 9.3 million tons by its endpoint (the year 2000 for S. 316, 2010 for Title IV), also the same as Title IV. In addition, S. 316 allowed trading on a holding company basis, which is essentially what has occurred under Title IV.[63]

"Costs" Compared—And They're Where Predicted

	ICF 1990 (1990 Amendments)[1]	ICF 1987 (S. 361)[2]	Current Estimates (NAPAP)[3]
Million Tons Removed (1995)	2	5.6	3.89
Annual Cost	$2.3-$5.9 billion	$1.08-$2.15 billion	$0.73
Cost per ton of sulfur removed (1995)	$299-$457	$190-$430	$284

1. Dallas Burtraw, Cost Savings, Market Performance, and Economic Benefits of the U.S. Acid Rain Program (Resources for the Future, Washington, D.C., 1998).
2. Undated ICF, Inc. memo updating an April 2, 1987 analysis of S. 316, which provided for SO_2 emission reductions of 9.1 to 9.3 million tons per annum, with trading.
3. National Acid Precipitation Assessment Program, *Biennial Report to Congress: An Integrated Assessment*, "Implementation and Costs of Title IV," *at* http://www.nnic.noaa.gov/CENR/NAPAP/implementation.pdf.

ICF's 1987 estimate of S. 316's annual costs ranged from $0.8 to $1.4 billion in 1995, rising to $2.6 to $3.7 in 2000 (mid-1987 dollars).[64] Expressed in 1995 dollars, the S. 316 projections of annual costs are $1.08 to $2.15 billion in 1995[65], which is very close to the range being projected today. (Because S. 361 and Title IV had different full compliance dates, the years 2000 and 2010, respectively, estimates for final costs should not be compared.) Roughly two years later, when the 1990 Amendments were being crafted, ICF's projected annual costs had jumped sharply, to a range of $2.3 to $5.9 billion, with a marginal cost per ton of SO_2 removed of $579–760 and an average cost per ton of $299–$457 (expressed in 1995 dollars).[66]

60. Personal Communication with Prof. Otto Rentz, Institut für Industriebetriebslehre und Industrielle Produktion Deutsch-Französisches Institut für Umweltforschung Universität Karlsruhe (TH) (Dec. 4, 2002).
61. Dallas Burtraw, Innovation Under the Tradable Sulfur Dioxide Emission Permits Program in the U.S. Electricity Sector (Resources for the Future 2000) [hereinafter Innovation].
62. Dallas Burtraw, Cost Savings, Market Performance, and Economic Benefits of the U.S. Acid Rain Program (Resources for the Future 1998) [hereinafter Cost Savings].
63. Memorandum from ICF, updating an April 2, 1987 analysis of S. 316, which provided for SO_2 emission reductions of 9.1 to 9.3 million tons per annum, with trading (undated). Unlike Title IV, emissions trading was not allowed between holding companies or across state lines.
64. *Id.*
65. John J. McCusker, *Inflation Conversion Factors for Dollars 1665 to Estimated 2012*, *at* http://www.orst.edu/Dept/pol_sci/fac/sahr/sahr.htm.
66. In both phases, heat input is based on the 1985–1987 reference period.

Comparing Phase I Costs to Phase II Projections

An equally serious and misleading habit of commentators is to compare the estimated costs of Phase I compliance with the projected costs for Phase II. The acid rain control program is currently at its midpoint, not endpoint. It will be 2010 before the final reductions actually occur. In that respect, Title IV is now where the RECLAIM program was in the late 1990s, and at that stage it was also being touted as a great success, only to ultimately fail spectacularly. Time will tell whether the same will happen with the acid rain program.

While it would be an overstatement to say that these models results bear no relationship to the actual costs of control, it is important to bear in mind that what companies have, in fact, spent, whether on lower sulfur coal or on scrubbers, is closely held information. It is not available to the public. The premise of many of these models is that because sulfur allowances are bought and sold on the open market, the sales prices reflects the costs of control.[67] Then again, they might not. As any American who was heavily invested in Enron, Global Crossing, WorldCom, Tyco, or any of hundreds of other firms can personally attest, the price paid on the floor of an exchange, whether in New York for stock or in Chicago for sulfur allowances, does not necessarily reflect either value or cost.

Perhaps most importantly, the estimate of "cost" is based on a snapshot taken in time. In this case, the costs of operating the utility industry in 1990 is being compared to operating the industry in, say, 2000. This ignores what happened outside that time frame, presenting a potentially distorted, inaccurate picture. For example, the costs of reducing SO_2 emissions in the 1990–2000 time frame are being assigned entirely to acid rain controls, even though some of the reductions should have been compelled under preexisting law.

Similarly, the snapshot ignores what may happen in the future. It is clear that there is growing momentum in Congress and the executive branch for further reductions in emissions of SO_2, as well as other pollutants. The reductions of the 1990 Amendments could be met through the easiest and least expedient method: namely, switching to lower sulfur coal from the Powder River Basin in Montana and Wyoming. Further reductions will likely require repowering or replacement of power plants, which can be much more costly. In other words, doing less almost always costs less than doing more, in the same way that buying a rail ticket from New York to St. Louis costs less than buying one to Seattle. But it doesn't save money in the long run if the ultimate destination is Seattle.

Recognizing that for all these and other reasons, the issue of costs must be treated gingerly, it is nevertheless essential to do so because that is the single most powerful argument advanced in favor of trading: it saves money compared to command-and-control.

Comparing Estimates *of Cost*

When commentators and government officials assert that trading has saved money, they justify the conclusion by comparing the cost *estimates* made in 1990 or earlier with cost *estimates* made since enactment. In the words of one leading commentator:

> While most of the studies in Table I rely on engineering-based *models of compliance options and their costs*, Carlson et al. uses a *simulation model* based on marginal abatement cost function derived from an econometrically estimated long-run total cost function for electricity generation for a sample of over 800 generating units over the period 1985–1994.[68]

Measuring "cost" is not as straightforward as it might initially seem, for the following reasons:

> To measure the costs of a specific program—in this case, Title IV of the CAA Amendments—they must be distinguished from the costs of other programs affecting the same pollutants. For example, if emissions of SO_2 were to be reduced by mandates adopted at the state level by, for example, Minnesota, New York, and Wisconsin, should the cost of complying those requirements be attributed to Title IV?
>
> Similarly, to measure the costs of a specific program, it must be certain that they were required solely to respond to the mandates of that program. For example, had tall stacks been prohibited as required by both the 1970 and 1977 Amendments, emissions of SO_2 assuredly would have been required in order to attain the ambient standards in the neighborhoods of the power plants.
>
> In addition, to measure the costs of Title IV, the amount of pollution that is reduced must be known with great confidence—indeed, if possible, with certainty. Yet pre-1990 emissions of SO_2 are estimates, and perhaps not very good ones, because emissions were not actually monitored and measured.
>
> Moreover, to assign costs or cost savings to one specific aspect of Title IV—in this case, trading—it must be clear that the credit does not actually belong to other provisions of the law or other regulatory actions. The cost of scrubbers was reduced by roughly one-third by eliminating the requirement that a spare module be installed to assure low emissions in cases of outages.
>
> Similarly, it must be clear that reductions in costs, even when they are real, can be properly attributed to trading. In the case of SO_2 emissions, for example, the bulk of the reductions have been due to the burning of lower sulfur coal, the price of which fell due to decreased rail costs.
>
> "Savings" are measures of money not being spent, determined by comparing estimated future costs to actual costs. If the projected costs are exaggerated, which was certainly the case with some industry and government projections of acid rain controls, then the "savings" are unreal.

From the outset, estimates of the costs of acid rain controls have varied wildly. Within Congress, estimates were provided principally by the U.S. Office of Technology As-

67. One of the earliest studies of the cost under an allowance trading system was Elman et al. (1990), who estimated the marginal cost of compliance and inferred that this would be the value of emission allowances. COST SAVINGS, *supra* note 62.

68. COST SAVINGS, *supra* note 62.

sessment (OTA) and, later, the Congressional Budget Office. Outside Congress, most were provided by ICF, Inc., a Washington, D.C.-based consulting firm with a proprietary computer model. It conducted model runs for a wide variety of clients, ranging from not only EPA but also to the National Wildlife Federation, using different assumptions. Because ICF is a for-profit company, its cost projections could be altered by client instructions regarding assumptions, e.g., on cost of capital, plant lifetimes, etc. Other estimates were provided by individual companies or industry associations, also using different assumptions. Among the highest projections was that of American Electric Power Company (AEP), which estimated in 1981 that the cost of installing scrubbers would be as much as $500 per ton of SO_2 removed in 1980 dollars. The estimate of the publicly owned TVA, however, was $155 per ton, or less than one-third that of AEP. The DOE estimated a potential cost range of $153 to $273, while the OTA estimates ranged from $116 to $313. Most assumed that companies would reduce emissions principally by installing scrubbers, because utilities said lower sulfur coal from the Powder River Basin would be unavailable.

Accepting the proposition that control costs have, in fact, declined, the question remains whether trading accounts for the reductions.

If Costs Fell, Why?

It is quite clear that if control costs have fallen, at least some of the reasons are tangentially related to trading, at best. Commentators uniformly agree that the reasons for costs that are lower than original projections are due to factors that include the following:

> Penetration of western lower sulfur coal into eastern markets, combined with lower rail shipping costs.
>
> Lower scrubber costs due to elimination of the requirement for redundancy.
>
> Reductions in SO_2 emissions due to demographic shifts in electricity demands.

Unfortunately, these are rarely discussed by advocates of trading. In a 1999 presentation to state legislators, for example, a representative of EPA's Acid Rain Division asked and answered his own question: "Why Have Costs Been So Low?" He explained that markets "reveal true costs" and "provide continuous incentives for innovation," while banking "provides timing flexibility," while there was also "competition across all emission reduction options." There was no mention of nontrading factors, including the lowered cost of rail transport or the elimination of scrubber redundancy.[69]

SO_2 Reductions Predating the 1990 Amendments

Emissions from facilities affected by Phase I totaled 9.3 million tons in 1985, and allowance allocations to these facilities for Phase I (beginning in 1995) totaled 6.9 million tons. But by 1993, emissions had already fallen to 7.5 million tons. This decline was due to a demographic shift in electricity demand toward areas closer to lower sulfur coal, coupled with its increased availability. Between 1989 and 1993, emission rates (lbs. of SO_2/mmBtus) for SO_2 fell sharply. Because less SO_2 was being emitted, the amount by which it had to be reduced further to meet the 8.95-million-ton cap dropped by about 2 million tons. This, in turn, lowered projected compliance costs for the program.[70]

Lower Priced Coal

In the 1980s rail rates fell 35%, yet profits went up because of, some believe, increased flexibility in tariffs and increased incentives to reduce costs. Whatever the explanation, railroads invested in new technologies such as increased size of car fleets and unit trains, AC motors, the laying of double and triple tracks, increased numbers of locomotives, use of aluminum cars, and increased dump speed. These allowed more Powder River Basin coal to be shipped to the East and Midwest faster and at lower cost. Most importantly, lower sulfur coal became cheaper than other coals, so utilities switched to save money. Consumption was increased even further than innovations in fuel-blending. In the late 1980s, the rate at which it was thought that low-sulfur sub-bituminous coals could be blended with high-sulfur coal was less than 5%. By the year 2000, coals were being blended at rates of 30 to 40%. As one expert wrote, "blending has provided significant cost savings . . . mixing high- with low-sulfur coals to reduce average SO_2 emissions."[71]

Fewer Scrubbers

A major factor explaining the changes in estimated annual costs is the assumption by EPA in 1990 that a greater number of scrubbers (37) would be built than were actually constructed (28). In addition, before the 1990 Amendments, scrubber systems usually included a spare module to maintain low emission rates if and when a module failed. Because a spare was not required in the acid rain program, capital costs for scrubbing were reduced by perhaps one-third with a spare module. In addition, because retrofit scrubbers burn higher sulfur coal the number of tons eliminated is larger. This, in turn, lowers the cost per ton of removed sulfur because some costs, such as the price of a loan, are fixed, regardless of the hours of operation or tons of removal.[72]

At the time that acid rain proposals were first seriously considered in Congress in the 1981–1982 time frame, a wide variety of companies, associations, and institutions prepared estimates of costs. Virtually all focused on "scrubbing," or flue gas desulfurization, because it was expected to be the most costly alternative. It also was widely accepted that because low-sulfur western coal would be unavailable, this add-on technology would be the principal means of compliance. In fact, western coal is not only now widely available, but is the principal means of reducing sulfur emissions.

Some of these estimates wildly exaggerated probable costs. For every variable—the interest on loans, for example—AEP adopted the most costly alternative and reached a projected cost for scrubbing of $500 per kw.[73] That was 3.25

69. Brian McLean, The SO_2 Allowance Trading Experience (National Conference of State Legislators 1999).

70. Innovation, *supra* note 61.

71. *Id.*

72. *Id.*

73. *See supra* note 38, at 723.

times the TVA's projection of $155 and 4.3 times the OTA's low-end estimate of $116.

Comparison of Projected Scrubber Retrofit Costs[74] (1981 dollars per kw)

Study	Cost	Average
Utility Companies		
American Electric Power Company	$300-500	$295
Indianapolis Power & Light Company	$240	
New England Electric System	a	
New York Power Pool	$250-450	
Ohio Edison	$378-403	
Public Services, Indiana	$193-200	
Southern Company Services, Inc.	$179-388	
Union Electric Company	$193-200	
Tennessee Valley Authority	$155[b]	$155
ICF	$239-266	$226
DOE	$153-273	
OTA	$116-313	

[a] no scrubbers used in analysis
[b] 1982 dollars

Trading has, in fact, played a rather minor role so far in the reduction of SO_2 emissions. Although EPA reports that 81.5 million sulfur allowances were traded during Phase I, most of these were internal reallocations within a single holding company. Inter-firm trading for compliance comprised only 577,583 allowances, or 2% of total emissions. Only three firms emitted more allowances than they were allocated, requiring their use of 577,583 allowances, as noted in Figure 2-5. A slightly higher number is reached if one adds the 130,789 allowances used by other firms that exceeded their allowance allocation for only one or two years.

The History That Led to Acid Rain Trading

A key question that must be asked in evaluating the acid rain provisions enacted in 1990 is whether they were needed at all. That is, was it failings in the existing law that resulted in the "acid rain" that killed lakes, forests, and humans alike? Or was it, instead, the failings of successive generations of political appointees to enforce the law as it had been plainly written by Congress? A persuasive—some would say compelling—case can be made that those who failed were the political appointees responsible for enforcing the law, not those who wrote it. Indeed, some have suggested that it was President Richard M. Nixon and his first Administrator of EPA, William D. Ruckelshaus, who effectively created acid rain (and, with it, fine particle sulfate and nitrate pollution) by allowing power plants to dilute their air pollution with so-called tall stacks rather than eliminate it through scrubbers and other devices.

Answering this question is not impossible. Doing so starts with an examination of the 1970 CAA, as it was strengthened in 1977, as well as the events that led up to the 1990 Amendments.

The specific provisions of the 1970 CAA relevant to this examination are explained in greater detail below. For present purposes, it is sufficient to say that the law's drafters, knowing that SO_2, the principal cause of acid rain, was a serious threat to human health and the environment, crafted a series of provisions that they believed would be as effective in dealing with coal-fired power plants as those aimed at cars proved to be. To the extent that these members of Congress erred, it was in believing that political appointees within the executive branch would conscientiously implement the law that they wrote.

The Myth of "Grandfathered" Power Plants

It is frequently said that the 1970 CAA "grandfathered," or exempted from regulation, power plants that were in existence in 1970.[75] This is untrue. If there is evidence to support the assertion it cannot be found in a thorough review of the transcripts of hearings and meetings, or in the reports of the committees or in the floor debate or the explanations of conference committee or in the subsequent discussions. Saying that these plants were grandfathered does serve another purpose, however: it implies that the blame for acid rain, fine particle sulfates, and ozone lies with the Congress instead of the electricity generation industry, where is where it properly belongs.

Control Techniques

Clearly, Congress intended that major sources of air pollution, including power plants, be required to actually reduce emissions and to do so promptly, because it said so: control techniques are those that "result in elimination or significant reduction of emissions." Congress was mandating actual reductions in emissions, not merely decreases in concentrations of pollutants, which could be achieved through dilution. In the case of cars, members of Congress were comfortable enough with their own understanding of the technology to calculate for themselves how much emissions needed to be reduced, so they simply wrote the numbers and dates into the law ("vehicles and engines manufactured during or after model year 1975 shall (achieve) require a reduction of at least 90 percentum from emissions of [CO] and hy-

74. Larry Parker, Summary and Analysis of Technical Hearings on Costs of Acid Rain Bills (1982).

75. The "Citizen's Call for a National Solution to Power Plant Pollution," for example, explains:

> Old dirty power plants emit at as much as [10] times more pollution than modern facilities. They were exempted from modern pollution controls nearly 25 years ago because it was expected that they would be retired and replaced with new clean plants. However, most of these old dirty plants have not retired. There must be some reasonable limit on the grandfather loophole. All power plants on their thirtieth birthday should be required to meet modern emission standards.

See http://www.seedcoalition.org/act.national.ppp.htm.

drocarbons").[76] There was no need for an EPA-issued control technique, because Congress wrote its own.

Uncertain, however, of how to do the same with respect to the many different technologies employed not only to generate electricity, but also in the steel, smelting, refining, cement, and many other industries, Congress left the task of developing counterparts to the auto mandate to the Administrator of EPA. The first Administrator was Ruckelshaus, who also served a second time. In implementing this and others provisions, however, Administrator Ruckelshaus made critical decisions both in his first tenure as Administrator from 1970 to 1973 and his second from 1983 to 1985 that sidestepped the law and allowed both the electricity-generating and coal industries to continue with business as usual. His decisions, in effect, created not only acid rain, but much of the nation's fine particle pollution and, with them, the consequent deaths of lakes, forests, and humans. Those decisions also, together with two decades of intransigence on the part of the coal and electricity-generating industries, laid the groundwork for the 1990 Amendments and its trading program.

Evading the Law Through Tall Stacks

Electric utility companies responded in the 1970s to the mandates of the CAA and the increasingly stringent controls being adopted by state and local governments by building tall smoke stacks that would project plumes into the upper atmosphere, sending pollution over long distances. Had the pollutants, principally SO_2 and NO_x, stayed at ground level or close to it, they would have remained in their initial forms. Achieving the ambient standards would have required actual reductions in emissions. Injecting into the upper atmosphere not only allowed them to be transported, but also to be transformed. They, in effect, metamorphosed into much more dangerous—indeed, lethal—chemicals.

Creating New Pollutants

Hanging in the air for days at a time, exposed to sunlight and other chemicals in the air, SO_2 and NO_x, are oxidized in the air to form extremely fine particle sulfates, nitrates, and acids. These can fall to earth in either dry or wet forms and, if wet, as either fog, rain, or snow, resulting in acid rain, snow, or fog.[77] They can also be inhaled and, because they are so fine, can reach the deepest reaches of the lung. There, in ways that are incompletely understood, they can result in death. The environmental impacts were comparable, for these pollutants could kill not only humans, but lakes, streams, and forests as well.[78] Had tall stacks never been allowed by Ruckelshaus, had he instead required the actual reductions Congress had expected and enacted, in all likelihood most Americans would never have heard of acid rain, forest death, or fine particle mortality. Yet the Agency said dispersion was a legally acceptable means of complying with the law,[79] that became an omelet almost impossible to unscramble.

Ruckelshaus Reversed by the Courts

Ultimately, the Ruckelshaus policy was reversed by decisions in the U.S. Court of Appeals for the Fifth Circuit,[80] the U.S. Court of Appeals for the Sixth Circuit,[81] and the U.S. Court of Appeals for the Ninth Circuit,[82] but not before the damage had been done. The Fifth Circuit, for example, held in *Natural Resources Defense Council, Inc. v. U.S. Environmental Protection Agency*[83] that "allowing tall stack dispersion enhancement as an alternative to emission limitation programs must be disapproved since the Act requires that emission limitations be the primary mode of compliance, and permits dispersion enhancement in addition to but not in lieu of such action."[84] Despite these decisions, more than 175 stacks higher than 500 feet were constructed after the 1970 Amendments.[85] Congress responded in 1977 by enacting §123 to deal specifically with tall stacks. The Senate floor manager and chair of the Subcommittee on Environment Pollution observed that

> [t]here is increasing evidence of the long-range transport of pollutants that become sulfates, acid rain, and other phenomenon affecting human health, vegetation, and soils, but leaving no definable plume that is traceable back to its source . . . . These derivative pollutants are thought to be more toxic forms than the oxides of sulfur and nitrogen that are actually permitted at the smokestack and are measured in the vicinity of the source.[86]

The new law did not prohibit tall stacks per se. Instead, it required that emissions from tall stacks built after the effective date of the 1970 CAA to be computer modeled as if they were only as tall as warranted by good engineering practice.[87] In the words of one court, this dealt with tall stacks by

76. Pub. L. No. 91-604, §202(b)(1)(A).

77. Implications for Public Policy, *supra* note 18, at 274.

78. *See, e.g.*, Robert H. Boyle, *An American Tragedy*, Sports Illustrated, Sept. 21, 1981, at 68, 70.

79. The CAA Amendments were enacted on December 31, 1970. Exactly 120 days later, on April 30, 1971, EPA promulgated the national ambient standards for the six criteria pollutants. *See* 40 C.F.R. §50. On August 14, 1971, the Administrator adopted regulations to guide the states in the formulation and submission of their implementations plans. Requirements for the Preparation, Adoption, and Submittal of Implementation Plans, 40 C.F.R. §51. Implementation plans were due nine months from the date of the promulgation of the ambient standards, on January 31, 1972. Forty states met the deadline; the other states all filed their plans within a short time thereafter. The Administrator announced his actions on the various plans May 31, 1972. 37 Fed. Reg. 10842 (May 31, 1972). Georgia was one of the 40 states to meet the January 31, 1972, deadline. The Administrator announced his action on the Georgia plan in the regulations published May 31, 1972. The Administrator disapproved the plan in two respects not material here and approved all other portions of the plan. 37 Fed. Reg. at 10859 (promulgating 40 C.F.R. §52.572-4).

80. Natural Resources Defense Council v. EPA, 489 F.2d 390, 4 ELR 20204 (5th Cir. 1974), *rev'd on other grounds sub nom.* Train v. Natural Resources Defense Council, 421 U.S. 60, 5 ELR 20264 (1975).

81. Big Rivers Elec. Corp. v. EPA, 523 F.2d 16, 5 ELR 20532 (6th Cir. 1975), *cert. denied,* 425 U.S. 934 (1976).

82. Kennecott Copper Corp. v. Train, 526 F.2d 1149, 6 ELR 20102 (9th Cir. 1975), *cert. denied,* 425 U.S. 935 (1976).

83. 489 F.2d 390, 4 ELR 20204 (5th Cir. 1974), *rev'd on other grounds sub nom.* Train v. Natural Resources Defense Council, 421 U.S. 60, 5 ELR 20264 (1975).

84. *Id.* at 394.

85. Robert V. Percival et al., Environmental Regulation: Law, Science, and Policy 590 (3d ed. 2000).

86. 123 Cong. Rec. S9174–9175 (daily ed. June 8, 1977) (statement of Sen. Muskie); *see also* Senate Comm. on Env't and Public Works, Congressional Research Service, Library of Congress, A Legislative History of the Clean Air Act Amendments of 1977, vol. 3, at 739 (1978).

87. *See* Alabama Power Co. v. Costle, 636 F.2d 323, 10 ELR 20001 (D.C. Cir. 1979).

"removing all existing regulatory incentives for constructing them."[88]

While this denied a source credit for the dilution of its pollution in determining whether the implementation plan submitted by an area—say, Cleveland or Birmingham—was adequate, it left the pollution exactly where the utility had put it: namely, at the height of the Empire State Building.

In the words of one commentator: "This practice was terminated by the 1977 Amendments, but not before utility companies had constructed the 111 'big dirties' that are the primary sources of acid rain in the eastern United States."[89]

Opening the "Modification" Loophole

The implied prohibition on tall stacks contained in the 1970 Amendments and the express rejection of them in 1977 were by no means the only provisions enacted by Congress—and evaded by the utility industry, with the complicity of the executive branch—to compel emission reductions from coal-fired power plants. Knowing that all machinery must sooner or later be repaired in order to continue operating, Congress required in §111(a)(4) of the 1970 Amendments that whenever a source was "modified" ("any physical change in, or change in the method of operation of, a stationary source which increases the amount of any air pollutant emitted by such source or which results in the emission of any air pollutant not previously emitted")[90] it must comply with NSPS. Thus, after 1970 a source seeking to replace, say, a boiler would be required to comply with the NSPS. It was not, however, required to have a permit.

In 1977, new types of performance standards—BACT and LAER—were added to the law based on whether the facility was located in an area where the air was clean (BACT) or dirty (LAER). The 1977 Amendments also added a requirement for preconstruction permitting. The triggering of new source standards for any modified source was retained unchanged, however. Thus, after 1977, a coal-fired utility seeking to replace a boiler would be required to first obtain a permit and, by its terms, comply with the relevant technology mandate.

From almost literally the day the CAA of 1970 was enacted, this requirement was honored by the electric utility industry as well as state and federal air pollution control agencies principally in its breach. Evidence of this is that in the 32 years since the 1970 Amendments were adopted not even so little as one "modification" has been made to a power plant.

A major reason for this was, once again, the implementation of the statutory requirement by EPA. The 1970 Amendments define a modification as "*any* physical change in, or change in the method of operation of, a stationary source which increases the amount of *any* air pollutant emitted by such source or which results in the emission of *any* air pollutant not previously emitted." Clearly from the repeated use of the expansive word "any" Congress intended that modification be viewed inclusive, not exclusive.

Yet in subsequent regulations defining the term, the Agency defined modification as a physical or operational change that resulted in any increase in the maximum hourly emission *rate*—as opposed to the law's increase prohibition of "increases." The Agency said modification review would be triggered only by increases in a controlled air pollutant—but law prohibited rises in "any air pollutant."[91] Thus a source could increase the total emissions of a criteria pollutant, or increase emissions of noncriteria pollutants, without triggering new source review. Moreover, the Agency went further: the regulations stated that a source could spend up to 50% of the fixed capital costs of building a new facility without being it being considered a modification—but law proscribed "any physical change" or "any . . . change in the method of operation."[92]

The effect of the Agency's regulation was to create exclusions as large as the coverage itself. In effect, the hole became the doughnut.

1977 Amendments

When new source permitting and review were adopted by the 1977 Amendments, the Agency's earlier definition of a modification had to be revised to determine when the BACT and LAER requirements would be triggered. A "significant" increase in emissions triggering new source review was defined as 40 tons per year (TPY) for SO_2 and NO_x. As a practical matter, life extensions, which can keep a facility operating for an extra 10 to 20 years typically involve no increase in emissions, and the cost is far less than 50% of the asset value.

The Agency also adopted several exclusions from the "physical or operational change" component of the definition. Among the activities excluded were: (1) routine maintenance, repair, and replacement; and (2) changes in hours of operation or in the production rate.[93]

A source that could avoid triggering new source review by escaping the definition of a modification could save money, and lots of it. For example, one utility expert estimated in the mid-1980s that the capital cost of a life extension would be on the order of $150 to $300 per kw, compared to $1,400 per kw for a new plant.[94] He then went on to observe that

> a major factor affecting the decision to extend the operating life of a unit is whether more stringent environmental controls will be required. For new plants, environmental controls typically constitute 30-40[%] of total plant capital and operating costs, half of which is the FGD system (while) a retrofit FGD system alone can cost over $200/kw.[95]

The "Bubble": EPA's First Attempt at Trading

In 1975, the Agency attempted to loosen the definition even further, promulgating amendments to allow "bubbles." The new regulations would have classified an entire plant as a

88. *Id.* at 388–91.

89. *See* Percival et al., *supra* note 85.

90. 42 U.S.C. §7411(a)(4).

91. *See* 36 Fed. Reg. 24877 (1971), *codified at* 40 C.F.R. §§60.2(d), (h) (1975).

92. *Id.*

93. *See, e.g.*, 40 C.F.R. §§52.21(b)(2)(iii), 52.24(f)(5)(iii), 51.165(a)(1)(v)(C)(1), 51.166(b)(2)(iii).

94. J. Edward Cichanowicz, Environmental Controls for Plant Life Extension, in Proceedings, *Life Extension and Assessment of Fossil Power Plants*, June 2–4, 1986, Washington, D.C. (Electric Power Research Inst.) [hereinafter Proceedings].

95. *Id.*

single stationary source by embellishing the statutory definition of a stationary source as follows:

> "Stationary source" means any building, structure, facility, or installation which emits or may emit any air pollutant *and which contains any one or combination of the following:*
> *(1) Affected facilities.*
> *(2) Existing facilities.*
> *(3) Facilities of the type for which no standards have been promulgated in this part.*

The italicized language is not included in the statutory definition of "stationary source" ("any building, structure, facility, or installation which emits or may emit any air pollutant"), nor was it included in the prior regulations. The regulations also provided that "[a] modification shall not be deemed to occur" unless the change in an existing facility results in a net increase in the emission of a pollutant from the whole "source."

The purpose of these changes was to effectively exempt large industrial complexes with multiple individual sources, such as smelters or power plants, from the "modification" definition. A source that increased its emissions at one point could avoid application of the NSPS by decreasing emissions at another point in the plant. This was frequently described as placing a "bubble" over the entire plant, and was the earliest form of trading.

The Agency's proposals were rejected by the U.S. Court of Appeals for the District of Columbia Circuit using reasoning that could easily be applied to the trading program established 12 years later:

> [T]he goal of the [CAA] is to *enhance* air quality and not merely to *maintain* it. Section 111's provisions mandating [NSPS] were passed because Congress feared that the system of state plans designed to keep air pollution below nationally determined levels was insufficient by itself to achieve the goal of protecting and *improving* air quality . . . . The bubble concept in the challenged regulations would undercut [§]111 by allowing operators to avoid installing the best pollution control technology on an altered facility as long as the emissions from the entire plant do not increase. For example, under the bubble concept an operator who alters one of its facilities so that its emission of some pollutant increases might avoid application of the NSPS by simultaneously equipping other plant facilities with additional, but inferior, pollution control technology or merely reducing their production. Applying the bubble concept thus postpones the time when the best technology must be employed and at best maintains the present level of emissions.[96]

Methusala Power Plants

By the mid-1980s, industry disregard of the law's requirements had become so flagrant that the EPRI organized a three-day conference at the L'Enfant Plaza Hotel in Washington, D.C. (roughly one mile from EPA headquarters) to examine ways of keeping power plants in service beyond their design lifetimes of 30 years to "50 to 60 years or longer."[97] One presentation described how the life of Unit 3 of Cincinnati Gas & Electric's W.C. Beckjord Station, originally placed in service in 1954, was extended for 25 years through a combination of 49 different measures.

Industry and Agency disregard of the law began to attract attention. For example, in 1985 the Congressional Research Service reported that

> [o]ver the last five years, it has become apparent that the actual life-span of power plants is not set, but relatively elastic. With new power plants costing over $1,000 [per kw] to construct, utilities have powerful incentives to avoid construction and to rehabilitate older facilities instead. This incentive is partially reinforced by environmental regulations which permit facilities to be rehabilitated up to 50[%] of their assessed value without being required to install NSPS (i.e., scrubbers). With such rehabilitation estimated at about $500 [per kw] (although that number can vary substantially), operating existing facilities for upwards of 60 years seems to be a developing trend.[98]

EPA did attempt briefly in the late 1980s to enforce this provision of the law, igniting a firestorm of criticism. Wisconsin Electric Power Co. (WEPCO) proposed extensive, life-extension renovations for several 35- to 50-year-old coal-fired electric utility boilers. The Agency reasoned that because modernized units would be more reliable and less costly, WEPCO would run them more, thus increasing their emissions. It determined in a 1988 decision that the changes would constitute a modification, thus requiring compliance with the CAA prevention of significant deterioration requirements. In a 1992 ruling, however, the U.S. Court of Appeals for the Seventh Circuit rejected this interpretation, saying that the renovations were a "like-kind replacement" in which old steam drums and other major components were being replaced by new versions of identical design and function.[99] In its revised regulations, often called the WEPCO rule, the Agency established an "actual-to-future-actual" test in which emissions during a baseline period are compared to estimated future-actual emissions.[100] At the time the 1990 Amendments were under consideration, however, the industry challenge to EPA's decision was still in litigation.

Sacrificing Asthmatics: Failure to Adopt a Short-Term SO_2 Standard

SO_2, an invisible gas emitted when the sulfur in coal, diesel, or other fuels is burned, is among the most common of air pollutants. Roughly 70% of total U.S. emissions are from coal-fired power plants, so any regulation of this pollutant will directly impact both the coal and electricity-generating industries, although other sources include refineries, sugar beet mills, and some factories, which account for another 13%.[101]

Exposure to SO_2 is linked to an increase in hospitalizations and deaths from respiratory and cardiovascular causes, especially among asthmatics and those with preexisting re-

96. ASARCO, Inc. v. EPA, 578 F.2d 319, 8 ELR 20164 (D.C. Cir. 1978).

97. Proceedings, *supra* note 94.

98. *The Clean Air Act and Proposed Acid Rain Legislation: Can We Get There From Here?*, Cong. Research Serv. 46 (Feb. 21, 1985).

99. Wisconsin Elec. Power Co. v. Reilly, 893 F.2d 901, 20 ELR 20414 (7th Cir. 1990).

100. 57 Fed. Reg. 32314 (July 21, 1992).

101. U.S. EPA, National Air Pollutant Emission Trends, 1900–1992, at 3-15 (1993).

spiratory diseases.[102] The severity of these effects increases with rising SO_2 levels, and exercise enhances the severity by increasing the volume of SO_2 inhaled and allowing SO_2 to penetrate deeper into the respiratory tract.[103]

In addition to steady-state emissions, SO_2 can be emitted "bursts," or sudden, unannounced surges. Electric utilities account for between 17 and 37% of exposures to bursts. Other significant sources include refineries, pulp and paper mills, copper smelters, primary lead smelters, sulfuric acid plants, and steel mills.[104] In addition, SO_2 undergoes a chemical reaction in the atmosphere to form two other pollutants, sulfates (SO_4 compounds) and sulfuric acid (H_2SO_4). Both are uniquely dangerous, although disentangling their effects is challenging.

The devastating impacts of SO_2 and its successor pollutants are clear. In Japan, the damage to human health from SO_2 pollution was so severe that by 1988, the government designated over 90,000 residents as official SO_2 "victims." (In that year, polluters forced the curtailment of the program.) These unfortunates cough blood, wheeze, and gasp for air because of attacks due to permanent, crippling diseases. They receive government payments for disability, as well as medical and funeral expenses funded by a dedicated tax on SO_2 emissions. Asthmatics, particularly children, are highly vulnerable to SO_2.[105]

Asthma, which is the leading cause of chronic illness in children,[106] renders its victims especially sensitive to pollution. An asthmatic child or adult exposed to SO_2 can be doubled over gasping for breath within minutes.[107] Between 4% and 5% of the American population is asthmatic, and incidence of the disease is climbing sharply, both in the United States and globally.

Physiologically, SO_2 triggers a sudden swelling in airway tissue that chokes off breathing. Some SO_2 is scrubbed from the air by nasal passages, but an exercising asthmatic—one climbing as few as three flights of stairs—or one with a cold or the flu, tends to breathe through the mouth, bypassing this line of defense and increasing susceptibility to pollution-triggered attacks.[108] Attacks may be triggered in older, severe asthmatics even while resting.[109, 110]

EPA has set an air quality standard of 0.03 parts per million (ppm) for long-term, one-year average concentrations of SO_2. Short-term, 24-hour air concentrations should not exceed 0.14 ppm more than once a year. However, Agency administrators have repeatedly refused to adopt a standard for bursts, even though "exercising"—again, this can be merely climbing a flight of stairs—asthmatics are sensitive to concentrations as low as 0.25 ppm.[111]

Had Ruckelshaus adopted a short-term standard, or if succeeding administrators (including himself) not followed his precedent, acid rain would have been a much lesser threat. Outside groups have urged the adoption of such a standard, and even some internal ones as well. For example, the committee created for the exact purpose of advising the administrator on matters of science, the Clean Air Scientific Advisory Committee (CASAC) recommended adoption of a short-term standard in 1987, saying that "in view of the significance of the effects reported in these clinical studies, there is strong, but not unanimous support for the recommendation that the Administrator consider establishing a new [one]-hour standard for SO_2 exposures."[112]

Had an administrator adopted a one-hour standard, the SO_2 emission reductions would have been substantial. A regulatory impact analysis prepared by the Agency examined two different one-hour standards: 0.25 and 0.5 ppm. It concludes that 0.5 ppm standard would have reduced emissions by 6.4 million TPY (4.4. million tons from utilities), while a 0.25 ppm standard would have resulted in an 11.2 million ton annual reduction (9.0 million from utilities).[113]

Failure to adopt a short-term standard was only one of many options that could have—*should have*—prevented acid rain from ever becoming a threat to America's lakes, stream, forests, and people. But every opportunity officials, under intense pressure from industry, chose to manage air pollution rather than eliminate it, though the contrary intent of Congress on this was manifest.

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102. A. Peters et al., *Acute Effects of Exposure to High Levels of Air Pollution in Eastern Europe*, 144 AM. J. EPIDEMIOLOGY, 570, 578–80 (1996); J. Sunyer et al., *Air Pollution and Mortality in Barcelona*, J. EPIDEMIOLOGY & COMMUNITY HEALTH, Apr. 1996, at S76; M. Vigotti et al., *Short-Term Effects of Urban Air Pollution on Respiratory Health in Milan, Italy, 1980–1989*, J. EPIDEMIOLOGY & COMMUNITY HEALTH, Apr. 1996, at S71; G. Touloumi et al., *Daily Mortality and "Winter Type" Air Pollution in Athens, Greece: A Time Series Analysis Within the APHEA Project*, J. EPIDEMIOLOGY & COMMUNITY HEALTH, Apr. 1996, at S47.

103. WORLD HEALTH ORGANIZATION (WHO), UPDATE AND REVISION OF THE AIR QUALITY GUIDELINES FOR EUROPE 11 (WHO Regional Office for Europe 1994).

104. OFFICE OF AIR QUALITY PLANNING AND STANDARDS, U.S. EPA, REVIEW OF THE NATIONAL AMBIENT AIR QUALITY STANDARDS FOR SULFUR OXIDES: UPDATED ASSESSMENT OF SCIENTIFIC AND TECHNICAL INFORMATION, SUPPLEMENT TO THE 1986 OAQPS STAFF PAPER ADDENDUM (1994).

105. M.J. Jaeger et al., *Effect of 0.5 PPM Sulfur Dioxide on the Respiratory Function of Normal and Asthmatic Subjects*, 156 LUNG 119-27 (1979); J.Q. Koenig et al., *Acute Effects of Inhaled SO_2 Plus NaCl Droplet Aerosol on Pulmonary Function in Asthmatic Adolescents*, 22 ENVTL. RESEARCH 145-53 (1980); D. Sheppard et al., *Lower Threshold and Greater Bronchomotor Responsiveness of Asthmatic Subjects to Sulfur Dioxide*, 122 AM. REV. RESPIRATORY DISEASE 873 (1980); D. Sheppard et al., *Exercise Increases Sulfur Dioxide-Induced Bronchoconstriction in Asthmatic Subjects*, 123 AM. REV. RESPIRATORY DISEASE 486-91 (1981).

106. MAYO FOUNDATION FOR MEDICAL EDUCATION AND RESEARCH, MAYO CLINIC FAMILY HEALTH BOOK 466 (1990).

107. Jaeger et al., *supra* note 105; Michael Weisskopf, *Legal Pollution That Makes Students Sick: Sulfur Dioxide Standards Don't Protect the Particularly Sensitive*, WASH. POST, June 6, 1989, at A1.

108. U.S. EPA, REVIEW OF THE NATIONAL AMBIENT AIR QUALITY STANDARDS FOR SULFUR OXIDES; W.S. Linn et al., *Respiratory Effects of Sulfur Dioxide in Heavily Exercising Asthmatics*, 127 AM. REV. RESPIRATORY DISEASE 278 (1983); R.A. Bethel et al., *Effects of Exercise Rate and Route of Inhalation on Sulfur Dioxide-Induced Bronchoconstriction in Asthmatic Subjects*, 128 AM. REV. RESPIRATORY DISEASE 592 (1983); D. Horstman et al., *Airway Sensitivity of Asthmatics to Sulfur Dioxide*, 2 TOXICOLOGY & INDUSTRIAL HEALTH 289 (1986); M.D. Kirkpatrick et al., *Effect of the Oronasal Breathing Route on Sulfur Dioxide-Induced Bronchoconstriction in Exercising Asthmatic Subjects*, 125 AM. REV. RESPIRATORY DISEASE 627 (1982).

109. REVIEW OF THE NATIONAL AMBIENT AIR QUALITY STANDARDS FOR SULFUR OXIDES, *supra* note 108.

110. *See* sources cited *supra* note 105.

111. Agency for Toxic Substances and Disease Registry, *Public Health Statement for Sulfur Dioxide*, *at* http://www.atsdr.cdc.gov/toxprofiles/phs116.html.

112. Clean Air Scientific Advisory Committee, Summary of the Major Scientific Issues and CASAC Conclusions on the 1986 Draft Addendum to the 1982 Sulfur Oxides Staff Paper, at 2 (SAB-CASAC-87-0).

113. U.S. EPA, Regulatory Impact of the National Ambient Air Quality Standards for Sulfur Oxides (Sulfur Dioxide) (draft May 1987).

1981–1989: The Years of Quiet Resistance

It is often said that the CAA Amendments were the culmination of a 10-year struggle to enact an acid rain control program. In fact, for the first eight years it was precisely the opposite: those favoring tougher air pollution controls sought to maintain a delicate balance of advancing interest in acid rain and its control, but avoiding the risk of losing the CAA altogether.

When Ronald Reagan was elected president in 1980, he entered office intent on rolling back social and environmental legislation. Chief among his targets was the CAA, widely regarded as the flagship environmental law. With a Senate controlled by largely conservative, antiregulation Republicans and a U.S. House of Representatives by largely compliant Democrats—especially Rep. John Dingell (Mich.), a long-standing foe of the law—effective repeal of the law was a constant threat.

The Need for Strengthening the Law

During these eight years, the damages attributable to power plant pollution had became undeniable as researchers accumulated an overwhelming body of evidence demonstrating impacts ranging from the death of mountain lakes and forests to the illness of small children. Because ozone and acid deposition were frequently both present at the same time and in the same place—and because it was difficult to differentiate the effects of one from the other—discussions of impacts tended to lump acid deposition, ozone, and the precursors of the two together.

The Need for Strengthening the Law: Emissions

Emissions of SO_2 had risen sharply from 1940 to 1980, as had those of NO_x and VOCs, the principal causes of ozone.

Year	**SO_2**[a,b]	**NO_x**[a,b]	**Hydrocarbons**[a]
1940	19.1	7.2	15.3
1950	18.1-21.6	7.4-10.3	19.3
1955	17.7	8.5	—
1960	21.2-22.2	11.5-14.0	23.8
1965	26.7	14.2	—
1970	28.7-30.8	17.7-20.4	29.8
1975	27.3-28.2	19.3-21.6	25.1
1980	25.2-26.1	21.0-22.8	24.0-28.3[c]

a U.S. EPA, National Air Pollution Emission Estimates, 1940-1980 (1982) (EPA 450-4-82-001).
b G. Gschwandtner et al., Historic Emissions of Sulfur and Nitrogen Oxides in the United States From 1900 to 1980 (1980) (draft reports to EPA from Pacific Environmental Service, Inc.).
c Emissions, Costs, and Engineering Assessment, Work Group 3B, United States-Canada Memorandum of Intent on Transboundary Air Pollution (June 15, 1982).

Emissions of the three pollutants had been 19.1, 7.2, 15.3 million tons, respectively, in 1940, rising to 25.2, 21.0, and 24.0 in 1980. The CAA of 1970 had resulted in modest reductions—on the order of 10%. However, what the future might hold was uncertain because utilities had increasingly begun to satisfy electricity demand through keeping existing power plants in service, rather retiring them and building newer, cleaner replacements.

Appendix A

Conservation and Renewable Energy Reserve					Page 1
Allowances by Group					
Total Number of Utilities as of 2/02			39		
Total Number of Allowances Distributed as of 2/02			47,493		
Total Number of Energy Efficiency Allowances Awarded - 2/02			36,360		
Total Number of Renewable Energy Allowances Awarded - 2/02			11,133		
Award Distributions by Group					
Group Number	Date Awarded	Utility Name	Total Allowances	Energy Efficiency	Renewable Energy
Group I	Nov-93	ESI Energy	109	0	109
		Portland General Electric	57	57	0
		New England Electric System	103	83	20
		City of Austin	18	18	0
		Puget Sound Power and Light	245	245	0
Total, Group I		5	532	403	129
Group II	Apr-94	Connecticut Light and Power	173	173	0
		Narragansett Electric	27	21	6
		Niagara Mohawk Power	177	177	0
		Cleveland Electric	2	2	0
		Dayton Power and Light	4	4	0
		Minnesota Power and Light	8	8	0
		Toledo Edison	4	4	0
		Wisconsin Public Power	3	3	0
Total, Group II		8	398	392	6

Conservation and Renewable Energy Reserve					Page 1
Award Distributions by Group					
Group Number	Date Awarded	Utility Name	Total Allowances	Energy Efficiency	Renewable Energy
Group III	Sept-94	Sierra Pacific Power	835	0	835
		Puget Sound Power and Light	757	757	0
		Portland General Electric	220	220	0
		Otter Tail Power Co.	42	0	42
		PSI Energy	41	41	0
		Rochester Gas and Electric	7	7	0
Total, Group III		6	1,902	1,025	877
Group IV	Sept-95	City of Austin	79	79	0
		NY State Electric and Gas	142	142	0
		Orange and Rockland	46	46	0
		Western Massachusetts Electric	30	30	0
		United Illuminating	47	47	0
		Cincinnati Gas and Electric	11	11	0
		Massachusetts Electric	339	312	27
		Granite State Electric	18	17	1
		Narragansett Electric	102	94	8
		Long Island Lighting Co.	535	535	0
Total, Group IV		10	1,349	1,313	36

Appendix A (cont.)

Conservation and Renewable Energy Reserve					Page 2
Award Distributions by Group					
Group Number	Date Awarded	Utility Name	Total Allowances	Energy Efficiency	Renewable Energy
Group V	Dec-95	Consolidated Edison	1,854	1,854	0
		ESI Energy	154	0	154
		Minnesota Power and Light	63	63	0
		Niagara Mohawk Power	717	717	0
		Ohio Edison	131	131	0
		Otter Tail Power Co.	90	14	76
		Portland General Electric	506	506	0
		Puget Sound Power and Light	1,208	1,208	0
		Sierra Pacific Power	661	0	661
		Southern California Edison	3,251	3,251	0
Total, Group V		10	8,635	7,744	891
Group VI	Oct-96	ESI Energy	143	0	143
		Pacific Gas and Electric	3,814	3,814	0
		San Diego Gas and Electric	1,027	1,027	0
		Sierra Pacific Power	666	0	666
		Wisconsin Public Power	37	37	0
Total, Group VI		5	5,687	4,878	809
Group VII	May-97	Consolidated Edison	2,290	2,290	0
		Detroit Edison	445	0	445
		Long Island Lighting Co.	481	481	0
		United Illuminating	398	387	11
		New England Electric System	847	800	47
		Otter Tail Power Co.	198	60	138
		WEPCO	2,141	2,141	0
		Central Hudson	182	182	0
		Cinergy (CG&E)	84	84	0
		Northern States Power	75	0	75
Total, Group VII		10	7,141	6,425	716

Conservation and Renewable Energy Reserve					Page 2
Award Distributions by Group					
Group Number	Date Awarded	Utility Name	Total Allowances	Energy Efficiency	Renewable Energy
Group VIII	Dec-97	Sierra Pacific Power	645	0	645
		ESI Energy	130	0	130
		Central Hudson	169	169	0
		Minnesota Power and Light	160	160	0
		PSI Energy	755	755	0
		Central Maine Power Co.	2,100	0	2,100
		Portland General Electric	734	734	0
Total, Group VIII		7	4,693	1,818	2,875

Conservation and Renewable Energy Reserve					Page 3
Award Distributions by Group					
Group Number	Date Awarded	Utility Name	Total Allowances	Energy Efficiency	Renewable Energy
Group IX	Nov-98	Sierra Pacific Power	623	0	623
		ESI Energy	135	0	135
		New York State Electric and Gas	1,375	1,375	0
		City of Austin	1,099	958	141
		Cambridge Electric Light Co.	12	12	0
		Commonwealth Electric	90	90	0
		Portland General Electric	955	955	0
		Jacksonville Electric Authority	12	12	0
Total, Group IX		8	4,301	3,402	899
Group X	Oct-00	Portland General Electric	2,713	2,713	0
		ESI Energy	437	0	437
		Sierra Pacific Power	1,027	0	1,027
		Pacific Gas and Electric	3,335	3,335	0
		Central Maine Power Co.	1,537	0	1,537
		Otter Tail Power Co.	278	153	125
Total, Group X		6	9,327	6,201	3,126

Appendix A (cont.)

Conservation and Renewable Energy Reserve					Page 3
Award Distributions by Group					
Group Number	Date Awarded	Utility Name	Total Allowances	Energy Efficiency	Renewable Energy
Group XI	Oct-00	Portland General Electric	1,816	1,614	202
		Portland General Electric	227	227	0
		ESI Energy	174	0	174
		Jacksonville Electric Authority	107	0	107
		City of Austin	474	396	78
		City of Austin	506	422	84
		Otter Tail Power Co.	224	100	124
Total, Group XI		5	3,528	2,759	769

	Conservation and Renewable Energy Reserve	
	Bonus Allowance Recipients as of February 2002	
	Name of Recipient	Number of Allowances Awarded
1	Cambridge Electric Light Co.	12
2	Central Hudson	351
3	Central Maine Power Co.	3,637
4	Cincinnati Gas and Electric	11
5	Cinergy (CG&E)	84
6	City of Austin	2,176
7	Cleveland Electric	2
8	Commonwealth Electric	90
9	Connecticut Light and Power	173
10	Consolidated Edison	4,144
11	Dayton Power and Light	4
12	Detroit Edison	445
13	ESI Energy (Florida Power and Light)	1,282
14	Granite State Electric	18
15	Jacksonville Electric Authority	119
16	Long Island Lighting Co.	1,016
17	Massachusetts Electric	339
18	Minnesota Power and Light	231
19	Narragansett Electric	129
20	New England Electric System	950
21	New York State Electric and Gas	1,517
22	Niagara Mohawk Power	894
23	Northern States Power	75
24	Ohio Edison	131
25	Orange and Rockland	46
26	Otter Tail Power Co.	832
27	Pacific Gas and Electric	7,149
28	Portland General Electric	7,228
29	Rochester Gas and Electric	7
30	PSI Energy	796
31	Puget Sound Power and Light	2,210
32	San Diego Gas and Electric	1,027
33	Sierra Pacific Power	4,457
34	Southern California Edison	3,251
35	Toledo Edison	4
36	United Illuminating	445
37	Western Massachusetts Electric	30
38	Wisconsin Electric Power Co.	2,141
39	Wisconsin Public Power	40
	TOTAL ALLOWANCES AWARDED	47,493