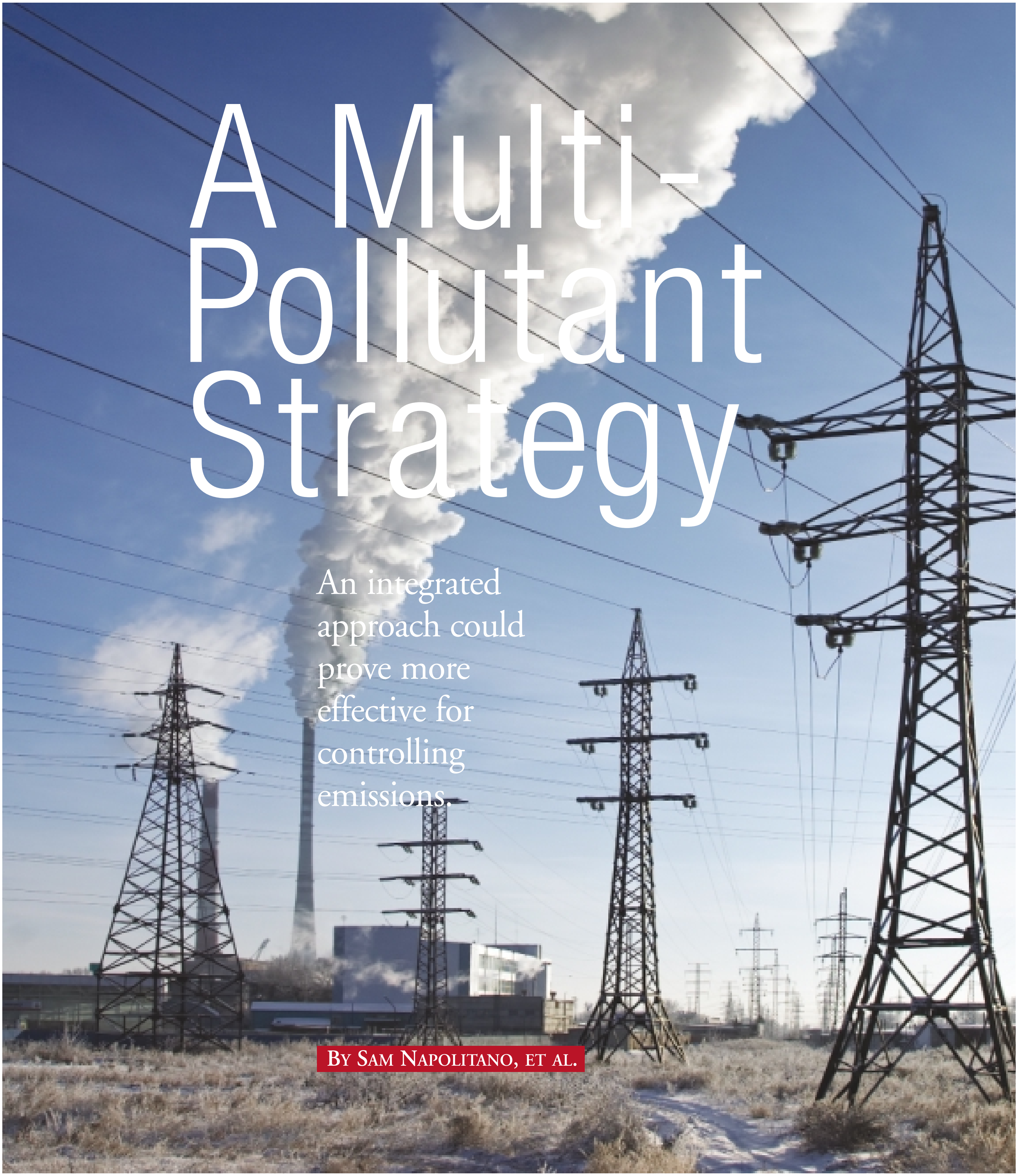


A Multi-Pollutant Strategy

An integrated approach could prove more effective for controlling emissions.

By Sam Napolitano, et al.

At this juncture, it is no longer clear exactly what requirements are going to govern further major emission reductions in the electric power sector. EPA promulgated the Clean Air Interstate Rule (CAIR), Clean Air Mercury Rule (CAMR) and Clean Air Visibility Rule (CAVR) in the first half of 2005. The years leading up to these regulations were marked by interplay between two major control paradigms: the traditional, problem-oriented one-issue-at-a-time approach and the more holistic sector-based, multi-pollutant approach. EPA effectively has been on both tracks for the last fourteen years, pursuing problem-oriented solutions while applying lessons learned to broader efforts. With the passage of the CAIR/CAMR/CAVR, EPA was able to achieve a significant first: coordinated multi-pollutant regulations. However, the first two of these rules were derailed when the United States Court of Appeals for the District of Columbia Circuit vacated both CAIR and CAMR earlier this year, throwing the immediate future of power-sector emission reductions into question.

What is not in question is that further emission reductions of SO_2 and NOx, as well as reductions of mercury and possibly carbon dioxide (CO_2), must occur in the power sector to address health and environmental impacts of air pollution as required by the Clean Air Act (CAA) and that power-sector reductions can be cost effective. There is a legitimate sense of urgency to clarify the outlook for further emission reductions. A look at related efforts over the last 14 years provides perspective on the enduring allure of integrating requirements into a market-based multi-pollutant control strategy, and perhaps some insights into two persistent questions: Why hasn't a deal been reached yet? And why keep trying?

The latest data indicate that 141 million people in the United States live in counties that do not meet the national standards for fine particles and ozone.[1] Electric power generation remains a significant source of nationwide SO_2, NOx and mercury emissions, and related widespread human health and environmental impacts, including premature mortality, heart attacks, hospitalizations and neurological damage in fetuses and young children. In 2007, power generation was responsible for 71 percent of all SO_2 emissions, 22 percent of NOx emissions, and 44 percent of anthropogenic mercury emissions. The power sector also was responsible for 39 percent of anthropogenic CO_2 emissions (*see Figure 1).*

In the last eleven years, EPA has enacted two rounds of National Ambient Air Quality Standards (NAAQS) revisions for fine particles and ozone to keep pace with emerging science. These efforts commonly found the electric power sector to be both a major contributor of emissions and the source of some of the most cost-effective controls to reduce emissions. EPA obtained similar findings in the related regional haze efforts. Further, the *Mercury Report to Congress* in December 1997 (and subsequent updates) identified coal-fired utility boilers as the largest remaining identified source of mercury emissions.[2] Subsequent analysis showed that although there were issues related to how well mercury controls would work across the fleet of coal-fired generation units, these controls were not likely to be inordinately expensive. Most recently, EPA provided Congress with analysis of climate-change legislation in 2007 and 2008, including the Lieberman-Warner Climate Security Act of 2008 (S.2191) and the Bingaman-Specter Low Carbon Economy Act of 2007 (S.1766).[3] These analyses found the power sector to be the greatest source of emission reductions to achieve the goals of economy-wide CO_2 reduction requirements.

There remains enormous promise in the benefits of a meaningful market-based multi-pollutant control strategy.

Multi-Pollutant Control Efforts

The Clean Air Power Initiative: The Clean Air Power Initiative (CAPI), a stakeholder process initiated in 1995, was the first concerted effort to pursue an integrated regulatory strategy to address electric power generators' emissions of SO_2, NOx, and mercury over a 15-year planning horizon. The effort recognized that CO_2 reductions also were important, but too premature to include at this juncture.

In a 1996 paper, EPA expressed its interest in "reinventing its regulatory approach to reduce the number, administrative complexity and cost of its requirements while improving the likelihood of achieving environmental results."[4] CAPI arose from the intersection of the increasing number of regulations the power sector could face under the CAA and the corresponding transition towards more competitive power markets.

CAPI brought together stakeholders from industry, states and environmental groups. EPA analyzed emission reductions and costs resulting from six different national cap-and-trade scenarios to reduce SO_2 and NOx, and also did some limited analysis of mercury controls. Scenarios set caps beginning nine years out from 1996, with the tightest SO_2 cap at 50 percent below Title IV, and a summer NOx cap based on 0.15 to 0.25 lbs/MMBtu (56 to 69 percent below 2000 summertime NOx emissions).[5] (Alternative scenarios analyzed SO_2 caps five years later at 50 to 60 percent below Title IV.) The analyses found reductions in 2010 on the order of 54-67 percent from base-case levels for summer NO_x and 27-41 percent for annual SO_2. Costs ranged from $1.7 billion to $3.8 billion in 2005 and $3.8 billion to $6.5 billion in 2010 (all dollar values are expressed in 2007 dollars for comparability).[6] EPA also analyzed a traditional command-and-control approach for these pollutants, finding costs to be nearly twice that of the cap-and-trade scenario.

CAPI modeling showed that national trading and banking approaches for annual SO_2 and seasonal NO_x could provide significant reductions throughout the country, with the greatest reductions generally occurring in areas of highest emissions.[7] However, without a regulatory driver for additional controls in 1996, the process wound down.

In a novel turn of events, in 1998 EPA entered into a settlement agreement that required additional multi-pollutant analysis regarding the mercury listing determination. EPA produced a report in March 1999 entitled "Analysis of Emission Reduction Options for the Electric Power Industry" that examined a number of hypothetical options for further SO_2, mercury, and CO_2 emission reductions in conjunction with the NO_x reduction that EPA recently had promulgated in the NO_x SIP Call.

EPA took that analysis and engaged in a dialogue with representatives of the power and mining industries that the Edison Electric Institute helped to organize. Analysis performed by the Energy Information Administration and others also played into the dialogue, along with increased interest in considering meaningful control levels and removing or reducing CAA requirements deemed duplicative or less effective.

In support of the dialogue, EPA staff put forth a hypothetical option in May 1999 to reduce SO_2, NO_x, mercury and CO_2 over a 10- to 15-year timeframe. The proposal extended cap and trade for SO_2 and NO_x, created a new cap-and-trade program for CO_2 and established mercury maximum achievable control technology (MACT) standards. Specifically, it proposed discussion caps six to eight years out from 1999 with an interim SO_2 cap as a step-down to a 50-65 percent reduction beyond Title IV by 2010; additional 50 percent non-ozone season NO_x reductions in the East and year round in the West; a mercury MACT requiring a 65 to 90 percent reduction in mercury content in flue gas; and a CO_2 cap at 7 percent below 1990 levels with 5-year budget.[8] Further, it would have revised New Source Review to complement the new approach.

With the failure of Clear Skies and various bills in Congress, the void of a multi-pollutant program remains unfilled.

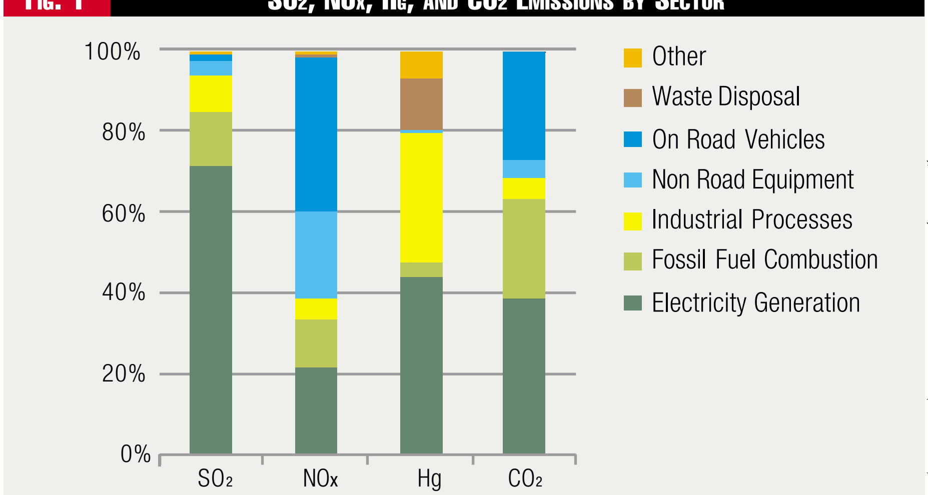
In this effort, there were more clear drivers in play: 1) the 1997 NAAQS revisions and related looming due dates for PM2.5 (particulate matter) and regional haze state implementation plans (SIPs); 2) the 1997 adoption of the Kyoto Protocol; and 3) increasingly advanced knowledge of the mercury problem. However, the initial appellate court decision in 1999 that remanded the 1997 NAAQS for ozone and fine particles led to an end of this particular dialogue.

Congress Joins the Game

Also in 1999, Senators Moynihan and Schumer, both of New York, introduced S.172, the Acid Deposition and Ozone Control Act. The bill would have cut annual SO_2 emissions by an additional 50 percent from Title IV levels six years out, beginning in 2005, and created a new cap-and-trade program for NO_x to reduce power-sector emissions nationwide by approximately 60 percent below levels projected to result from Title IV (with provisions to encourage reductions in summer months). The bill also included mercury monitoring and reporting provisions.

In July 2000, EPA provided an analysis of the environmental impacts, costs, and benefits of S.172. The analysis found annualized monetized human health benefits from reductions in PM2.5 of close to $75 billion and visibility benefits of $1.5 billion annually as compared to a compliance cost of $6 billion in 2010. This analysis found the NO_x and SO_2 reductions cost

FIG. 1 SO_2, NO_x, Hg, AND CO_2 EMISSIONS BY SECTOR



Source: EPA's 2002 National Emissions Inventory; EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks (EPA 430-R-08-005)

$1,220 and $830 per ton, respectively.[9] As found in the CAPI analysis, emissions of both pollutants were reduced significantly across the country, with the greatest reductions in areas with the highest baseline emissions of both pollutants.

A series of bills arose to require multi-pollutant emission reductions by the power sector in the first half of this decade. The Bush administration introduced Clear Skies in February 2002. Several other members of Congress proposed competing legislation with a few fundamental differences, but also a good deal of common ground, including reliance on emission caps and trading. The impetus was provided by now-familiar facts, with a growing sense of urgency. Forty percent of the U.S. population was living in counties with air quality concentrations above the NAAQS, and the power sector was contributing a significant amount to the problem. There were many possible ways to implement the Clean Air Act and the power industry already was dealing with restructuring challenges.

FIG. 2 — POWER SECTOR SO_2 EMISSIONS AND PROPOSED CAPS (2007)

Due to banking in trading programs actual emissions are higher in the years caps go into effect.
*** 2007 SO2 Emissions from EPA's Continuous Emissions Monitoring System;**
**** 50% Below Title IV discussed in CAPI, EPA/EEI Effort, and Moynihan/Schumer; 60% Below Title IV discussed in CAPI; 65% Below Title IV discussed in EPA/EEI Effort.**

The president's Clear Skies proposal used cap-and-trade programs to phase in mandatory reductions of SO_2, NOx, and mercury. At full implementation, these caps would achieve a 73 percent reduction of SO_2 from 2000 levels (equivalent to a 68 percent reduction from Title IV levels), 67 percent reduction of NOx from 2000 levels, and a 69 percent reduction of mercury from 1999 levels. (The administration also proposed a separate, voluntary program to improve the carbon efficiency of the economy.) EPA projected Clear Skies would deliver $138 billion in annual health and environmental benefits by 2020 at a cost of $8 billion.[10]

Clear Skies was billed as a simpler and more certain path allowing for strategic planning and co-benefits from control technologies (*i.e.*, mercury removal). But even with increasing, broad-based support for an integrated strategy, the legislation failed. It did generate a great deal of debate, but its progress was hindered primarily by disagreements over the failure to include CO_2 (as several competing bills did), the timing and level of the mercury cap, as well as reliance on mercury trading, and provisions that streamlined the existing Clean Air Act.

In October 2005, EPA released its analysis of the costs and benefits of Clear Skies and alternative approaches, including EPA's CAIR/CAMR/CAVR, Senator Carper's (D-Del.) Clean Air Planning Act (CAPA), and Senator Jeffords' (I-Vt.) Clean Power Act (CPA). It demonstrates how the SO_2 reductions from these (and previous) approaches stack up relative to each other and to 2007 emissions (*see Figure 2*). The differences are not as significant as one would expect. Comparing reductions for NOx is less straightforward given seasonal and geographic variations, but the overall relative picture is similar to SO_2. The differences are more apparent in the case of mercury (particularly the extent of trading) and CO_2 (whether or not it is regulated).

Senator Carper's CAPA of 2003 would have set a nationwide, three-stage, declining cap for SO_2 emissions, with caps implemented in 2009, 2013, and 2016, resulting in a 76 percent decrease in SO_2 emissions from Title IV levels at full implementation. Additionally, CAPA would have reduced NOx and Hg emissions by implementing nationwide caps in 2009 and 2013. The NOx caps ultimately would achieve the same emission reductions as the Clear Skies NOx program, but in a shorter timeframe, while the final mercury cap would reduce mercury emissions 33 percent beyond Clear Skies (the mercury caps were supplemented with unit-specific limits). CAPA also would have established caps on CO_2 emissions in 2009 at 2006 emissions levels and in 2013 at 2001 emissions levels. Of the legislation analyzed by EPA in the 2005 Multi-Pollutant Analysis, CAPA was predicted to have the second highest annual benefits and costs with full implementation benefits of $197 billion and costs of $11.6 billion.[11]

The only effort assessed that resulted in greater benefits and costs was Senator Jeffords' CPA, introduced in January 2005.

CPA would have reduced power-sector emissions from all four pollutants by implementing caps on each five years out, in 2010 only. The caps would have lowered SO_2 emissions by 76 percent from Title IV levels, NOx by 11 percent beyond Clear Skies, and mercury by 67 percent beyond Clear Skies (with no mercury trading). Additionally, CPA would have implemented a CO_2 cap, reducing CO_2 emissions by 16 percent from 2000 levels. These steep emissions reductions resulted in estimated annual benefits of $258 billion and an estimated annual cost of $62 billion in 2020.[11]

A ton of SO_2 emissions reduced from electric power generation delivers seven times the benefit of a ton of NOx.

EPA Moves on Regulations

Starting in 2003, EPA began working to develop three regulations that worked in concert as a multi-pollutant program. EPA's CAIR/CAMR/CAVR endeavor had many similarities to the Administration's Clear Skies legislative efforts. The primary differences among CAIR/CAMR/CAVR and Clear Skies were that: CAIR/CAMR/CAVR was regulatory as opposed to legislative; the regulations did not alter the Clean Air Act in any way; and CAIR adopted an eastern domain (28 eastern states and D.C.) to cap emissions of SO_2 and NOx from the power sector, whereas Clear Skies would have implemented a national program. CAIR and CAMR were announced in March 2005 with CAVR following in June. At full implementation, CAIR was predicted to reduce power sector SO_2 and NOx emissions in the east by 73 percent and 61 percent, respectively, from 2003 levels, thereby helping states achieve the PM2.5 and ground-level ozone NAAQS. Meanwhile, CAMR was predicted to reduce power-sector emissions of mercury by nearly 70 percent and CAVR would ensure SO_2 and NOx emission reductions from facilities affecting visibility in Class 1 National Parks. CAMR was notable as the world's first rule to begin to reduce the emissions of mercury from existing coal-fired power plants. As such, it could have influenced other countries to enact controls, providing further benefits to the United States because of the global transport of mercury emissions.

EPA's assessment of CAIR/CAMR/CAVR in 2020 predicted annual human health and welfare benefits of $171 billion at an annual cost of $7.5 billion.[11] The marginal cost per ton of SO_2 and NOx reductions, respectively, were projected to be at $860 and $1,600 in 2010 and $1,700 and $2,000 in 2020.[12]

Most of these benefits in the near term currently are left on the table as only CAVR remains in effect. With the failure of Clear Skies, various multi-pollutant bills in Congress, and the court's recent vacatur of CAIR and CAMR, the void of a U.S. multi-pollutant emission reduction program for the power sector remains unfilled.

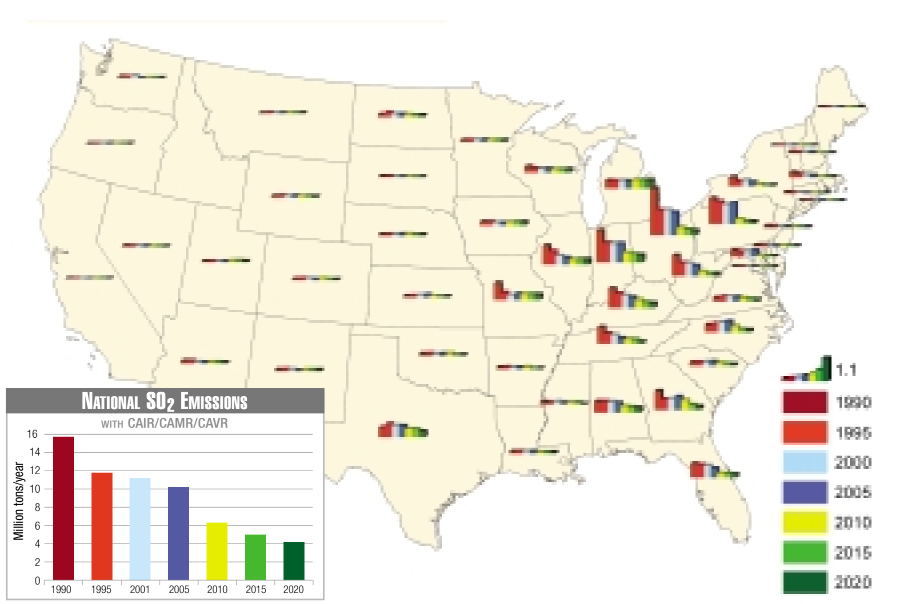
The Current Landscape

In response to the Court's decision on CAIR, EPA is pursuing action through all three branches of government—judicial, legislative, and regulatory. Whatever the forum, EPA is committed to working expeditiously with states and other stakeholders to get back on track towards efficient, effective means to reduce power-sector emissions and achieve the health and environmental goals of the Clean Air Act. Some of the major lessons gleaned from our experiences can help efforts progress.

Lesson 1: There is great value in a multi-pollutant control strategy, but significant challenges remain to reach agreement. Although we have noted the many advantages and the broad

FIG. 3 POWER INDUSTRY SO_2 EMISSIONS

Source: EPA



For a sense of scale of state emissions over time recognize that 1990 Ohio emissions are 2.2 million tons. Pre-2010 data from EPA's Acid Rain Program emissions reporting under Title IV; 2010, 2015, and 2020 data is based on IPM projections with CAIR/CAMR/CAVR.

general support afforded the integrated concept, parochial issues of different groups hinder efforts toward a Congressional and/or regulatory solution. Persistent areas of contention encountered to date are: Whether CO_2 belongs in a multi-pollutant control program (at least, now); whether mercury should be traded; and whether certain provisions of the current CAA should be streamlined in response to large emission reductions provided by emission caps?

With that in mind, stakeholders should not let the perfect be the enemy of the very good. All the SO_2 and NO_x emissions under the alternative proposals are much lower than current levels, and resolution of these differences is not insurmountable.

Lesson 2: Coal-fired generation is very resilient. When it comes to controlling SO_2, NO_x and mercury, EPA repeatedly has found that coal-fired generation can achieve significant reductions and still compete effectively, given its relatively low operating costs compared to generation from other fossil fuels, nuclear and renewables.[13] Until fairly recently, when significant CO_2 reductions were added to the mix, the dynamic changed and coal-fired generation became less attractive.[14] However, more recent analyses have suggested that clean-coal technologies, including IGCC and carbon capture and sequestration, could allow coal-fired generation to remain competitive even with significant CO_2 reductions.[15] As capital costs for new generation technologies continue to increase, efficient existing coal also remains cost competitive depending upon the stringency of required CO_2 reductions.

Lesson 3: SO_2 reductions deliver the biggest bang for the buck. Most of EPA's benefits analysis have focused on PM2.5 and ground-level ozone benefits due to SO_2 and NO_x emission reductions, with only limited attention to the benefits for mercury and CO_2 reductions (due to the complexities of quantifying CO_2 and mercury benefits). As part of EPA's 2005 assessment of CAIR and related multi-pollutant legislative proposals, the agency found that with respect to reducing PM2.5, a ton of SO_2 emissions reduced from electric power generation has over seven times the benefit of a ton of NO_x emissions reduced.[16] According to additional analysis, 87 percent of the total PM2.5 benefits can be attributed to reductions in SO_2 emissions. Further, the average health benefit associated with each ton of SO_2 reduced is nearly $12,000 per ton.[17] Notably, the benefits for reducing emissions affecting highly populated urban areas are greater, and smaller for less populated areas.

Lesson 4: Co-benefits from pollution controls can be very meaningful for mercury reductions. Multi-pollutant analyses have demonstrated that proper placement of particulate controls, flue gas desulfurization (FGD) for SO_2, and selective catalytic reduction (SCR) for NO_x dramatically could lower mercury emissions from generation units using coal, especially bituminous coals. There is a substantial mercury co-benefit to be derived from the application of this set of advanced control technologies.

Lesson 5: Cap and trade can work, but it is not the only regulatory tool. The Acid Rain Program and NO_x Budget Program have reduced SO_2 and NO_x emissions faster and at far lower costs than anticipated, yielding wide-ranging health and environmental improvements. Four benefits of cap-and-trade programs in particular stand out as we consider future applications:

- **Certainty**: A cap-and-trade program can deliver regulatory certainty for the power sector coupled with environmental certainty that reductions will be achieved and sustained. Litigation has disrupted this certainty for CAIR (note that litigation often disrupts reductions under conventional command-and-control regulations). The clear requirements and incentives for early reductions under CAIR led many companies to comply early and many state regulators to rely on it for improving air quality. In 2007, SO_2 emissions in the CAIR states had been reduced nearly 1.2 million tons from 2005 levels to 8.17 million tons (below emission levels required by the Title IV cap). Additionally, EPA estimates that approximately $3.8 billion worth of SO_2 controls and nearly $1 billion of NO_x controls were installed in CAIR states in 2006 and 2007.[18]
- **Reduced costs**: Cap-and-trade programs have demonstrated that control with cap and trade costs a good deal less than more prescriptive command-and-control regulations. EPA demonstrated this with CAPI and it since has become an accepted attribute of the cap-and-trade approach. Many other researchers have come to similar conclusions.[19]
- **Innovation**: Since trading places a direct economic value on emission reductions, it provides a reward for innovations that result in more efficient pollution-reducing technologies. Acid Rain Program implementation has been accompanied by reduced costs, improved performance of pollution-control technologies (including improved FGD), and greater fuel flexibility (seen in increased utilization of low sulfur coal and more recently, low NO_x producing coals), which has led to lower than expected overall program compliance costs.
- **Broad distribution of large emissions reductions**: Implementation of the Acid Rain and NO_x Budget Programs has demonstrated that large emission reductions under cap-and-trade programs are spread over a broad area. Further, the greatest reductions tend to occur in areas of greatest emissions, where reductions are most needed. This can be seen in the two trading programs covering SO_2 emissions (*see Figure 3*). This pattern of reduction repeatedly has appeared in all the analysis EPA and others have performed for various sets of pollutants over the last 14 years.

Despite these advantages, it is important to remember that emissions trading is only one tool of several provided by the Clean Air Act to pursue air quality goals. In cases where local concentrations of emissions do raise concerns, local governments have authority under the CAA's local protections (source-specific limits) to ensure adequate local controls to supplement regional reductions from trading.

The Road Ahead

These lessons might prove useful to stakeholders in working with EPA, States and Congress towards a widely acceptable multi-pollutant strategy. Past proposals were not as far apart as one would expect in core program elements, including significant emission reductions and utilization of some degree of emissions trading. This suggests that the time has come to recognize these commonalities and bridge the gaps on the remaining issues. There remains enormous promise in the benefits of a meaningful market-based multi-pollutant control strategy.

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ENDNOTES

1. Calculated from Greenbook *(www.epa.gov/oar/oaqps/greenbook/qncl3.html)*. The 2000 Census is the source of the population data. Areas included in the estimate are those that are nonattainment for either 8-hour ozone or PM2.5 as of Aug. 15, 2008 (the most recently available status update).
2. *Mercury Study Report to Congress*, U.S. Environmental Protection Agency, December 1997, EPA-452/R-97-003. *(http://www.epa.gov/mercury/report.htm)*.
3. Analyses available at *http://www.epa.gov/climatechange/economics/economicanalyses.html*.
4. *EPA's Clean Air Power Initiative*, Office of Air and Radiation, U.S. Environmental Protection Agency, October 1996.
5. Using 2005 monitoring data, CAPI's rate-based NO_x cap would have capped summertime NO_x emissions between 0.99 and 0.7 million tons.
6. *Better Approaches to Cleaner Air from Electricity Generation*, Presentation on EPA's Clean Air Power Initiative by Office of Air and Radiation, U.S. EPA, April 1997, 5th US-Dutch Symposium on Air Pollution in the 21st Century.
7. *Better Approaches to Cleaner Air from Electricity Generation*, Sam Napolitano, Brian McLean, John Bachmann and Linda Reidt Critchfield for the 5th U.S. Dutch International Symposium, Air Pollution in the 21st Century, April 1997.
8. *A Potential Integrated Approach to Emissions Reductions from the Electricity Power Industry*, Staff Hypothetical Option Presentation, U.S. Environmental Protection Agency, May 18, 1999.
9. *Analysis of the Acid Deposition and Ozone Control Act (S. 172)*, Clean Air Markets Division, Office of Air and Radiation, U.S. Environmental Protection Agency, July 2000 Draft. This benefits calculation arises from EPA's primary benefits methodology (value of a statistical life or VSL approach). An alternative, age-adjusted approach (value of a statistical life year or VSLY approach) results in monetized benefits of $46.7 billion in 2010.
10. *EPA Clear Skies: Health and Environmental Benefits (www.epa.gov/air/clearskies/benefits.html)*; values are expressed in terms of 2007$, inflated from 1999$ using the GDP deflator.
11. Emissions, benefits, and costs are available from the *2005 Multi-Pollutant Analysis (http://www.epa.gov/airmarkets/progsregs/cair/multi.html)*. Values are expressed in terms of 2007$, inflated from 1999$ using the GDP deflator.
12. *Regulatory Impact Analysis for the Final Clean Air Interstate Rule*, U.S. Environmental Protection Agency, Office of Air and Radiation, EPA-452/R-05-002. *(http://www.epa.gov/cair/pdfs/finaltech08.pdf)*.
13. Sources include: *EPA's Clean Air Power Initiative*, Office of Air and Radiation, U.S. Environmental Protection Agency, October 1996; *Analysis of Emissions Reduction Options for the Electric Power Industry*, Office of Air and Radiation, U.S. Environmental Protection Agency, March 1999; *2002 and 2003 Technical Support Packages for Clear Skies (http://www.epa.gov/air/clearskies/technical.html)*; *EPA's 2005 Multi-Pollutant Legislative Analysis (http://www.epa.gov/airmarkets/progsregs/cair/multi.html); Regulatory Impact Analysis for the Final Clean Air Interstate Rule (http://www.epa.gov/cair/pdfs/finaltech08.pdf)*.
14. See *http://www.epa.gov/airmarkets/progsregs/cair/dcos/jeffords.pdf*.
15. See *http://www.epa.gov/climatechange/economics/economicanalyses.html*.
16. Declaration of William Harnett, Director of the Air Quality Policy Division, U.S. EPA, to U.S. Court of Appeals for the District of Columbia Circuit, *State of North Carolina, et al, Petitioners v. United States Environmental Protection Agency*, Respondent, Sept. 19, 2008.
17. Based on apportioning analysis of the "Fresh Look" analysis (cited below). 87 percent of the PM2.5 benefits were apportioned to SO_2 reductions then divided by tons of SO_2 reduced. Lauraine G. Chestnut, David M. Mills, "A Fresh Look at the Benefits and Costs of the U.S. Acid Rain Program," *Journal of Environmental Management*, November 2005, pp. 252-266.
18. Declaration of Brian J. McLean, Director, Office of Atmospheric Programs, U.S. EPA, to U.S. Court of Appeals for the District of Columbia Circuit, *State of North Carolina, et al, Petitioners v. United States Environmental Protection Agency*, Respondent, Sept. 20, 2008.
19. Teitenberg, T.H. 2006. *Emissions Trading Principles and Practice*, Washington, D.C.: RFF Press.