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## Opportunity NOx: An Easy Way To Cleaner Air

CAN ENVIRONMENTAL PROFESSIONALS SPEAK DIFFERENT LANGUAGES?  
CAN U.S. POLICY INTEGRATE ENERGY, ECONOMICS — AND ENVIRONMENT?

COVER  
STORY

# Opportunity NOx

*The only major pollutant that has risen under the Clean Air Act is nitrogen oxides, which affects both human health and the environment. EPA is addressing the problem by controlling emissions from power plants during the summer to reduce smog. Why not abate a host of impacts by running the control equipment year-round?*

VICKIE PATTON

A common policy pronouncement is that, while we have made great strides in protecting the environment, future progress will only be achieved at an increasingly higher cost for each additional decrement — the “final 10 percent” argument. Better to invest society’s limited economic resources on different programs, the reasoning goes. But closer scrutiny reveals a number of potential measures that refute this assertion. In fact, there is one immediate opportunity to substantially lower levels of a major pollutant at modest additional expense.

Nitrogen oxides are emitted by fossil fuel combustion from mobile and stationary sources, helping to form smog and particulates, which impact human health, and contributing to haze and acid deposition, which affect the environment in a variety of ways. EPA has launched a program under the Clean Air Act to control smog by reducing NOx emissions from power plants during the summer months, when the conditions are right for formation of ground-level ozone. Which raises the intriguing possibility of requiring the plants to run the control equipment year-round — “annualizing” the program — further reducing emissions at very little marginal cost.

The agency is requiring 19 eastern states to cut summertime NOx emissions by about 1 million tons. The program has been dubbed the “NOx SIP Call” because EPA has declared the state implementation plans for the covered states inadequate, and “called” for the states to revise their air quality management strategies by lowering NOx emissions each year between May 1 and September 30. Most of the required reductions will come from power plants.

The federal program provides for lower NOx emissions in these five summer months

because the technical and legal basis of EPA’s action is reducing ozone — which is formed by volatile organic compounds reacting with NOx in hot weather. Originally, the program was developed to advance compliance with both the new 8-hour ozone national ambient air quality standard adopted in 1997 and the pre-existing 1-hour standard. The 8-hour standard became somewhat famous when the U.S. Court of Appeals for the District of Columbia Circuit remanded it to the agency in the *American Trucking Associations* case. Before the Supreme Court reversed that decision earlier this year, EPA revised the basis of the SIP Call program to focus on attainment of the 1-hour standard. Enforcement of the program begins in May 2004. But on October 1 of that year, power plant operators can turn the new equipment off till the next spring.

Which is unfortunate, because NOx contributes to a suite of pollution problems that are not confined to the summer. Particulates, which come from NOx and other sources, are also regulated under the Clean Air Act because of their serious public health impacts, which include premature death as well as hospitalization. Haze from particulates is regulated because of its visibility impacts. And NOx itself, along with sulfur dioxide, is also regulated as a principal cause of acid deposition, which affects a number of terrestrial and aquatic ecosystems, including the forests and lakes of the Adirondacks and the Great Smokies. Because nitrogen is a fertilizer, NOx deposition also leads to eutrophication of premier coastal water bodies, such as the Chesapeake and Delaware bays and Long Island Sound. The public health impacts are year round, and the environmental effects either are worse in the winter season or are the result of cumulative pollution loadings that occur throughout the year. Further,



high ozone concentrations occur at times other than May through September, particularly in the southern latitudes. For example, last year, unhealthy ozone concentrations were recorded as early as March in Great Smoky Mountains National Park. Clearly, the NOx SIP Call program falls short.

**E**conomic analyses show that power plants could readily reduce NOx emissions year-round at only modest additional cost, principally because most of the expenses are capital equipment costs. The Northeast States for Coordinated Air Use Management and Mid-Atlantic Regional Air Management Association generally examined the cost of NOx reductions for coal-fired power plants operating selective catalytic reduction, a commonly used NOx removal technology, both seasonally and year-round. The analysis found that running the control equipment throughout the year was only slightly more expensive. At the same time, the year-round removal of NOx emissions resulted in a dramatically greater overall reduction of NOx. When measured according to the amount of reduction achieved per dollar invested, for society as a whole it is considerably more cost-effective to lower NOx emissions year-round.

Economists at Resources for the Future have specifically examined the cost-effectiveness of annualizing the SIP Call program. RFF found that both the average and marginal cost-effectiveness of NOx cuts in the region subject to EPA's program fell considerably under a year-round program. It estimates that the average cost under the seasonal program is \$2,163 per ton but only \$1,147 per ton under an annual program — a dramatic savings for society as a whole. The analysis estimates that annualizing EPA's NOx program would decrease yearly utility emissions in the affected region by 2.4 million tons from a projected baseline of 3.4 million tons. In other words, by running the equipment year-round, utilities would lower their annual

NOx emissions by approximately 70 percent instead of the 30-percent cut that would result from the 1-million-ton reduction required by the SIP Call program.

Of course, running the control equipment year-round adds to the costs. RFF estimates that the additional compliance costs of annualizing would be \$580 million regionwide each year, which is an increase of about 27 percent over the summer program. The additional benefits to society in improved public health, however, add up to more than \$1 billion per year just for particulates. And that's before adding the environmental benefits that would result from reduced pollution.

There are two principal opportunities for policymakers to expand the federal administrative NOx control program: through national legislation or state initiative. While the debate in Congress over multi-pollutant reductions from power plants provides a venue

to optimally enhance NOx abatement requirements — proposed legislation attacks NOx pollution by placing the first cap on emissions; SO<sub>2</sub> was capped under the 1990 amendments' acid rain emissions trading program — it is unclear whether the legislation will advance into law.

Multi-pollutant legislation that encompasses NOx by requiring cuts year-round and nationwide is well-founded. Unlike the other major criteria pollutants, all of which have decreased, NOx emissions have *increased* since the advent of the modern Clean Air Act, rising by more than 4 million tons annually. About one-

fourth of the 25.4 million tons of NOx released each year across the country comes from power plants, and they are responsible for nearly 20 percent of the substantial rise in NOx emissions since 1970.

One of the major multi-pollutant power plant bills has been introduced by James Jeffords, chair of the Senate Committee on Environment and Public Works. Senate Bill 556 would reduce power plant emissions of NOx, SO<sub>2</sub>, mercury, and carbon dioxide. The NOx reductions would be achieved through an emissions allowance cap-and-trade program patterned after the SO<sub>2</sub> acid rain pro-

***By running control equipment year-round, utilities would lower their annual NOx emissions by 70 percent instead of the 30-percent cut required in the EPA program***

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gram. However, the national legislative debate over multi-pollution cuts from power plants is highly unpredictable and fractious.

In light of the uncertainty in the national legislative arena, the states are well-positioned to lead. Since the debate over regulatory reform in the mid-1990s and the corresponding advent of the Environmental Council of the States, state environmental officials have claimed an expansive leadership role in protecting the nation's environment. Annualizing the NOx SIP Call program provides a premier opportunity for states to demonstrate environmental leadership by developing a year-round NOx abatement program under state law. With foresight, states can readily build on the federal seasonal program and achieve large benefits at relatively low cost. The rationale for a state year-round program is robust. It could include mitigating the serious health impacts associated with fine particles, clearing haze in parks and urban areas, addressing acid rain, and combatting eutrophication of coastal waters.

Whether a result of federal or state initiative, expeditious action by policymakers will help clarify compliance planning responsibilities for the regulated community. A more comprehensive approach to NOx will enable the electric utility sector to optimize its investments in NOx pollution controls and more efficiently plan for other pollution reduction obligations.

Environmentally and economically, opportunity NOx.

**T**he development of the SIP Call program reflects the somewhat belated recognition of the role of NOx in the high summertime ozone concentrations across the eastern United States. While scientists have long understood that volatile organic compounds

and NOx react in the presence of sunlight to form ozone, much of the nation's air quality policy had emphasized curtailing VOCs, which are emitted from a wide variety of industrial chemicals and consumer products.

The policy focus on NOx sharpened substantially in 1991 when the National Research Council issued its report *Rethinking the Ozone Problem in Urban and Regional Air Pollution*,

which fundamentally reassessed ozone control strategies. The report recommended that ozone abatement strategies give increased attention to lowering NOx levels, finding that "state-of-the-art air-quality models and improved knowledge of ambient concentrations of VOCs and NOx indicate that NOx control is necessary for effective reduction of ozone in many areas of the United States."

Leading scientists continue to investigate the complex chemistry of ground-level ozone formation. Accordingly, the technical understanding continues to evolve and inform policy strategies. The North American Research Strategy for Tropospheric Ozone issued a report in 2000 that found that a "combined VOC- and NOx-based reduction strategy likely will be required" to abate peak ozone levels.

As mentioned, NOx is the only criteria pollutant regulated under the Clean Air Act whose annual emissions have increased since the law was passed in 1970, up by approximately 20 percent to a total of 25.4 million tons in 1999. By contrast, emissions of VOCs have fallen by more than 40 percent, carbon monoxide by 25 percent, and lead by 98 percent. The transportation sector generates about one-half of the NOx total. Recently, EPA has established rigorous new NOx emission standards for both light- and heavy-duty onroad vehicles, which together account for about one-third of national NOx. These controls, of course, operate year round.

The 1990 acid rain program was the first major Clean Air Act program to lower utility NOx emissions. While the program cuts NOx from electric generating units year-round and nationwide, the program has several design flaws. It establishes different emission rates for different boiler technologies, allowing greater emissions from more polluting technologies. The standards also are relatively weak. Consequently, coal-fired plants complying with these standards still emit considerably more NOx than do modern gas-fired power plants. Further, the legislation's reliance on emission rates instead of emission caps means that some of the projected NOx reductions have been offset by increased utilization at power plants in response to demand growth.

In the mid-1990s, the northeastern and mid-Atlantic states developed a NOx reduction initiative that expanded upon the cuts required under the acid rain program. Spurred by the compelling scientific research on ozone formation pointing to the need for

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cuts in NO<sub>x</sub> and the public health imperative to tackle its far-reaching interstate ozone pollution problems, the states adopted a regional program under the ambit of the Northeast Ozone Transport Commission. The first phase of the program established year-round cuts, but subsequent phases further lowered emissions only during the May through September period.

Concerned that unilateral NO<sub>x</sub> cuts would be inadequate to achieve healthy ozone levels in the region, and recognizing that elevated ozone concentrations were occurring across the Midwest and Southeast, officials from states ranging from Illinois to New York to Virginia came together to examine the NO<sub>x</sub> contribution to broader regional ozone concentrations in a process termed the Ozone Transport Assessment Group. The resulting analyses informed the development of EPA's NO<sub>x</sub> SIP Call.

**T**he EPA program is critical to combating the adverse public health effects of ozone pollution. At the same time, there is a body of research on the additional health and environmental impacts of NO<sub>x</sub> emissions that underlines the need for a more far-ranging approach. These effects result either from cumulative NO<sub>x</sub> emissions loadings or emissions in non-summer seasons.

NO<sub>x</sub> emissions contribute to the unhealthy fine particle concentrations in the eastern United States. These particulates are composed of airborne contaminants emitted directly as fine particles and as gases that transform in the atmosphere into fine particles. Sulfur dioxide and NO<sub>x</sub> are two of the principal gases that form into fine particles, becoming sulfates and nitrates. Epidemiological studies associate exposure to fine particles at contemporary pollution concentrations observed in urban airsheds with premature death, exacerbation of chronic disease, and increased hospital admissions. Further, these effects occur at levels below the pre-existing national ambient air quality standards for particulate matter, which is why EPA in 1997 established a more stringent standard for fine particles that are 2.5 micrometers or smaller in size. (This was the other standard remanded by the D.C. Circuit in *American Trucking* but restored by the Supreme Court in February.) The agency estimated that its new fine particle health standards would prevent about 15,000 premature deaths each year.

Recently, a concerted research program has been undertaken to advance the understanding of fine particle health effects. Research has confirmed the core findings of the epidemiological studies underlying the EPA's 2.5-micrometer standard. An independent reanalysis validated epidemiological studies associating fine particle concentrations with premature mortality. A study of the 90 largest U.S. cities found strong evidence linking daily increases in particulate pollution at contemporary levels to increases in daily death rates and in hospital admissions of the elderly. New studies also show that chronic exposure to particulate pollution shortens lives by one to three years. In short, lowering fine particle concentrations is one of the nation's most pressing air pollution problems.

The same fine particles that have deleterious health effects also obscure scenic vistas in national parks, wilderness areas, and urban airsheds. Currently, the long-term monitoring of haze air pollution in national parks, carried out by the National Park Service, EPA, and the states, is the best available information about the contribution of nitrates to fine particle problems in a given area. While EPA and the states are in the process of collecting data from a recently developed national fine particle monitoring network that will provide more extensive information, especially for urban areas, existing data highlight areas affected by NO<sub>x</sub> air pollution. The National Park Service visibility monitoring network shows that nitrates are a significant contributor to fine particle aerosol concentrations in the East, especially in the winter, ranging from 11-17 percent at locations in Arkansas, Kentucky, Mississippi, New Jersey, and Washington, D.C., and three sites in New England.

A year round NO<sub>x</sub> program would also reduce the effects of acid deposition, which includes acid rain and other forms of pollution inputs to ecosystems. While the harmful effects of acid deposition are being observed throughout the East, the Adirondacks in upstate New York have been particularly impacted.

The Hubbard Brook Research Foundation recently issued a report, *Acid Rain Revisited: Advances in Scientific Understanding Since the*

**... The additional benefits in public health, however, add up to more than \$1 billion per year just for particulates. And that's before adding the environmental benefits**

*Passage of the 1970 and 1990 Clean Air Act Amendments*, that examines the current effects of acid deposition in the Adirondacks and other northeastern ecosystems. The report documents that “acid rain is still a problem and has had a greater environmental impact than previously projected.” Half of the large canopy red spruce in the Adirondacks and the Green Mountains in Vermont have died since the 1960s from acid deposition, according to the report, and 41 percent of lakes in the Adirondack mountain region exhibit worrisome signs of acidification.

Scientific inquiry has increasingly shed light on the need for further reductions in both NO<sub>x</sub> and SO<sub>2</sub> to spur ecosystem recovery. A report released last year by the General Accounting Office, *Acid Rain: Emissions Trends and Effects in the Eastern United States*, firmly shifted the policy debate by documenting the need to further lower NO<sub>x</sub> levels as part of any comprehensive strategy to protect eastern ecosystems. For example, the report documented that wet sulfate deposition in a representative sample of lakes in the Adirondacks had decreased significantly as a result of the Clean Air Act’s acid deposition control program. At the same time, nitrate levels in almost half of the lakes had increased. Total sulfur deposition in the eastern United States dropped 26 percent from 1989 to 1998, while deposition of nitrogen decreased by only 2 percent.

The nitrogen-related acidification of the Adirondacks and other eastern ecosystems also has a strong seasonal dimension called episodic acidification. Nitrogen accumulates in the winter snowpack and is released as a pulse during the spring thaw. According to the GAO report, this pulse enters sensitive lakes and streams “at about the same time as fish and other aquatic species lay their eggs or hatch their offspring, and these eggs and offspring are more vulnerable to the acidity than are the adults.” Consequently, wintertime NO<sub>x</sub> emissions contribute to acute ecosystem effects.

Similarly, the Great Smokies experience some of the highest acid deposition rates in North America. In the Great Smoky Mountains National Park, fish kills have been documented after acidic rainfall harmed the streams feeding hatcheries.

Elevated NO<sub>x</sub> emissions also are implicated in southeastern ecosystem effects. Nitrate deposition in the southern Blue Ridge Mountains increased more than 10 percent from the mid-1980s to the mid-1990s. The southeastern United States is home to 7 of the 15 states with the highest NO<sub>x</sub> pollution levels in the country, Alabama, Florida, Georgia, Louisiana, Kentucky, North Carolina, and Tennessee. Collectively, more than 5 million tons of NO<sub>x</sub> are emitted each year from these states — almost a fifth of the national total.

The Hubbard Brook report estimated that an 80-percent reduction in SO<sub>2</sub> emissions from power plants over the cuts required under the acid deposition control program adopted in 1990 would hasten ecosystem restoration and recovery to a 25- to 50-year timeframe. At the same time, the GAO report observed the importance of addressing NO<sub>x</sub> in any further policy solutions. The trends of increased nitrate levels in lakes in places like the Adirondacks “highlight the significance of nitrogen oxide emissions and the resulting nitrogen deposition, which may not have been fully appreciated when the 1990 amendments were being drafted. Because those amendments require relatively little reduction in nitrogen oxide emissions, the prospects are uncertain for the recovery of already acidified lakes and for preventing further acidification.”

**L**owering airborne NO<sub>x</sub> contaminants year-round will also curtail the nitrogen deposited into coastal waters, which include vital spawning grounds and other habitat. Estuaries along the East Coast are harmed by the cumulative atmospheric deposition of nitrogen and other nutrients. Nitrogen is a nutrient essential to the production of plant and animal tissue. But at the high levels found in premier coastal waters, like the Chesapeake Bay, it becomes a pollutant.

The changes brought about by overenrichment of nutrients form a cascade of harmful effects to ecosystems. In the Chesapeake, for example, nutrient overenrichment promotes algal blooms that cloud the water and deprive submerged aquatic vegetation, such as bay grasses, of the light necessary for them to grow. These bay grasses in turn provide habitat for waterfowl, fish, and shellfish, including the American oyster and the bay’s famous blue crab.

**Year-round controls would help achieve the new national air quality standard for fine particles, which EPA estimates will save 15,000 lives a year ...**



The downward spiral continues as the nutrient-fed algal blooms kill bay grasses, the loss of which harms the oyster population. The reduction of both the grasses and the oyster population slows the filtering of the already cloudy waters, thereby compounding the damage already done. Even after they die, the nutrient-fed algae continue to harm the bay, because the decomposition of their bodies consumes oxygen that the living plants and animals need to survive.

Scientists have only recently understood the extensive contribution of atmospheric deposition to harmful nitrogen loadings in coastal waters. In *Clean Coastal Waters: Understanding and Reducing the Effects of Nutrient Pollution*, a report by the National Research Council released last year, scientists suggest that atmospheric deposition of nitrogen is the dominant source of nitrogen from nonpoint sources in the Chesapeake Bay's major tributaries. By contrast, when the historic Chesapeake Bay Agreement was forged in 1983, the restoration program did not even address mitigation of airborne nitrogen. The report concluded that the atmospheric component of the nitrogen load to estuaries had previously been underestimated, and it recommended that policies under the Clean Air Act explicitly consider the need to minimize coastal eutrophication.

The adverse effects of nutrient overenrichment are not limited to the Chesapeake Bay. Important coastal waters like Long Island Sound and the Delaware Bay also are impacted. In the eastern watersheds of North Carolina, airborne NO<sub>x</sub> contaminants, along with ammonia from hog farms and other sources of nitrogen, are responsible for overloading watersheds such as the Tar-Pamlico and Neuse River estuaries. In a review of coastal areas in the United States, the National Oceanographic and Atmospheric Administration found that 44 of 139 coastal areas studied demonstrated symptoms of severe eutrophication.

Lowering NO<sub>x</sub> levels year-round is essential to protecting these critical ecosystems.

**I**n the on-going debate over environmental federalism, state officials have expounded on the ability of states to lead the way in protecting the environment, and suggested a corresponding diminution of federal management. Annualizing the federal summertime

ozone control program provides a quintessential opportunity for state leadership. State action can be carried out with relative administrative ease. The states implementing their obligations under the NO<sub>x</sub> SIP Call have already developed the technical foundation and regulatory infrastructure to curtail NO<sub>x</sub> emissions from power plants. Translating the seasonal pollution cuts into a year-round program should be facilitated by building from the existing program, augmented as necessary under state authorities to protect the health of their citizens and their environment.

Recognizing the year-round impacts of NO<sub>x</sub> emissions from power plants and the corresponding benefits of annualizing seasonal programs, a few states already have moved in this direction. Massachusetts has adopted year-round NO<sub>x</sub> pollution abatement requirements for its power plants. The Illinois legislature has directed the state's environmental agency to examine the need for lower year-round emissions of NO<sub>x</sub> and other power plant pollutants. And, New York recently circulated a draft proposal that would annualize its program under the NO<sub>x</sub> SIP Call.

One potential obstacle to leadership by the states is . . . other states — those that lag behind in carrying out the SIP Call. EPA has identified a number of states with programs that are, to varying degrees, deficient in implementing the federally required seasonal NO<sub>x</sub> reductions. With initiative, or federal incentive, these states can transform this liability for the environment into forward progress. The affected states that seize the opportunity to achieve year-round cuts in NO<sub>x</sub> can sensibly streamline the administrative processes necessary to address the deficiencies in their response to the SIP Call and an initiative to expand the reductions to every month.

Given the unlikelihood of new federal legislation, particularly as the Congress focuses on anti-terrorism measures, the war effort, and the economy, leadership from the nation's capital on this issue is unlikely any time soon. With existing regional approaches on ozone already under way among the states, they are well-positioned to respond to the opportunity of year round NO<sub>x</sub>. •

**... Lowering annual NO<sub>x</sub> also would reduce acid rain, helping to restore forests, streams, and lakes, and limit eutrophication of coastal waterbodies**

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