OZONE TRANSPORT COMMISSION

NO_X BUDGET PROGRAM

1999-2002 Progress Report

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

OZONE TRANSPORT COMMISSION

Introduction to the OTC NO_x Budget Program

Ground-level ozone (or smog) is formed when nitrogen oxides (NO_x) and volatile organic compound (VOC) gases react with sunlight, particularly in the warm summer months. Once formed, ozone targets the respiratory system, aggravating asthma, increasing susceptibility to respiratory illnesses like pneumonia and bronchitis, and contributing to permanent lung damage. It can also damage forests, reduce the productivity of agricultural crops, and lead to the decay of monuments and buildings.

The Ozone Transport Commission (OTC) was established under the Clean Air Act Amendments of 1990 to help states in the Northeast and Mid-Atlantic region meet the National Ambient Air Quality Standard (NAAQS) for ground-level ozone. Historically, ozone control strategies have focused on VOC emissions. In recognition of the important role of NO_x in ozone formation and transport, the OTC has focused much of its efforts on regional NO_x reduction strategies.

The OTC developed an unprecedented, multi-state cap and trade program to control NO_x emissions and address regional transport of ozone. This market-based program, called the NO_x Budget Program, sets a regional "budget" (or cap) on NO_x emissions from power plants and other large combustion sources during the "ozone season" (from May 1st through September 30th). To meet the budget, sources are required to reduce emissions significantly below 1990 baseline levels and may use emissions trading to achieve the most cost-effective reductions possible.

The OTC NO_x Budget Program has significantly reduced NO_x emissions in the Northeast and Mid-Atlantic region. Through the trading program and earlier Reasonably Available Control Technology (RACT) requirements, NO_x Budget sources have reduced their ozone season emissions approximately 60 percent below 1990 baseline levels, well under target levels. Deep reductions have occurred in all states across the region. Daily peak emissions have also declined. In addition, the market-based approach has proven to be cost-effective, and a viable trading market has emerged. These measures indicate that the OTC NO_x Budget Program is functioning well and achieving its goal of significantly and cost-effectively decreasing NO_x emissions from large combustion facilities.

Overview of the OTC NO_x Budget Program

Transport Plays a Critical Role in the Ozone Problem

The Clean Air Act requires EPA to set a NAAQS for ozone. This standard is intended to limit ozone exposure to levels that will protect public health and the environment. Initially, Clean Air Act implementation emphasized state planning and local solutions to attain the ozone NAAQS first set in 1971. However, despite the implementation of significant, local control strategies in the decades that followed, states still have had difficulty meeting the ozone standard.

Based on numerous studies and analyses, EPA and others determined that ozone and its precursors are capable of being transported over large distances. In particular, atmospheric modeling during the past decade has demonstrated that long-range transport of emissions from upwind areas contributes significantly to persistent ozone nonattainment in the Northeast and Mid-Atlantic United States (see Figure 1).

Transport Winds and Ozone Patterns on High Ozone Days

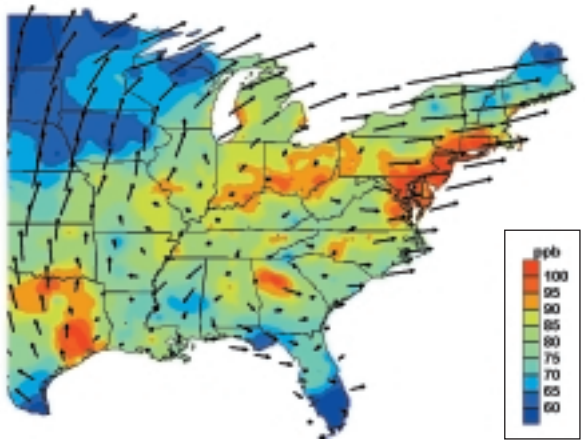


Figure 1
High ozone levels in the Northeast are typically associated with persistent transport from west to east. (Data represent high 90th percentile ozone conditions.)

Source: Ozone Transport Assessment Group.

As the scientific and policy communities came to realize the importance of ozone transport, Congress saw a need for coordinated regional efforts to address this problem and established the OTC through the 1990 Clean Air Act Amendments. The OTC consists of representatives from the Northeast and Mid-Atlantic states, including Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and Virginia.

Regional Cap and Trade Program Formed to Address the Transport Problem

Initially, the OTC states agreed to implement year-round, regionwide emission limits based on RACT for the major stationary source category of NO_x emissions—large fossil fuel combustion sources. Next, in 1994, all of the OTC states except Virginia signed a Memorandum of Understanding (MOU) to create a market-based emissions trading program to reduce and cap regional NO_x emissions substantially below levels required by RACT. The NO_x Budget Program applies to more than 1,000 large combustion facilities (budget sources) in signatory states, including over 900 electric generating units (EGUs) and over 100 industrial units, such as steam boilers and process heaters.

The NO_x Budget Program requires that these budget sources collectively meet a regionwide emissions budget each ozone season (total NO_x mass emissions from May through September) based on reductions from 1990 baseline emissions. Under the program's cap and trade provisions, each state allocates emission allowances to their budget sources in accordance with the state's portion of the regional budget. Each allowance permits a source to emit one ton of NO_x during the ozone season and is associated with a "vintage" year (the year in which a source can first use the allowance for compliance). Budget sources must demonstrate that their actual ozone season emissions do not exceed the amount of allowances held for that period to remain in compliance. Unused allowances may be sold or saved for use in a subsequent ozone season ("banked"). Regardless of the number of allowances a source holds, it cannot emit at levels that would violate RACT or other emission limit requirements.

Budget sources can devise their own strategies to comply with NO_x emission restrictions. The ability to trade allowances places a value on emission reductions and encourages sources to develop the most cost-effective emission reduction strategies to achieve the overall emission reduction target. For example, owners can control emissions at a unit with low control costs to levels below the unit's allowance allocation and then use the extra allowances at other units with higher control costs or sell the allowances to other entities. This approach allows the OTC states to achieve greater reductions than they could under a traditional regulatory approach for the same overall cost.

For further information on the OTC program, see:
www.epa.gov/airmarkets/otc
and
www.sso.org/otc

The NO_x Budget Program, while based in large part on the successful implementation of EPA's national cap and trade Acid Rain Program for controlling sulfur dioxide (SO_2), represents the first example of a group of states coming

together to form a multi-jurisdictional emissions trading program. The OTC states, in cooperation with EPA and stakeholders, identified key elements that should be consistent among the regulations in all participating states so that an integrated interstate emissions trading program could be created. These elements included: program applicability, control period, NO_x emissions rates, emissions monitoring, record keeping of emissions and allowances, and electronic reporting requirements. Each state was then responsible for developing and adopting state rules with these consistent elements.

Under this collaborative state/federal partnership, the states established the program requirements and emission budgets in accordance with the MOU requirements and then allocated allowances to each affected unit. EPA administers the data systems used to manage the program and provides technical assistance to the OTC states and to affected sources, such as tracking allowance transfers, maintaining unit and account information, assisting with monitoring issues, and preparing end-of-season compliance reports.

Accurate monitoring of all emissions and timely reporting ensure that a ton of NO_x emitted from one budget source is equal to a ton from any other source, that the integrity of the budget is maintained, and that the states have accurate and comprehensive compliance information. All emissions and allowance data from budget sources are publicly available on the EPA Web site, providing complete transparency. To date, budget sources have achieved a very high rate of compliance.

Reductions Achieved in Phases

The OTC states established three separate phases for reducing NO_x emissions from large combustion sources (see Figure 2). Phase I involved year-round RACT controls. Phases II and III comprised the OTC NO_x Budget Program: Phase II had an initial ozone season budget beginning in 1999, with the

OTC NO_x Reduction Strategy Overview

Phase	Geographic Distinctions	Emissions Reduction Target	Ozone Season Emission Levels
1990 Baseline	Not applicable	Not applicable	473,000 tons (approx. baseline level)
Phase I: RACT requirements beginning May 1, 1995	All areas	Approximate 40% reduction	290,000 tons (approx., no budget applies)
Phase II: Trading program beginning May 1, 1999	Inner Zone	65% or 0.20 lb/mmBtu (based on 1990 heat input)	219,000 tons (budget level)
	Outer Zone	55% or 0.20 lb/mmBtu (based on 1990 heat input)	
Phase III: Trading program beginning May 1, 2003, but...	Inner & Outer Zones	75% or 0.15 lb/mmBtu (based on 1990 heat input)	143,000 tons (budget level)
	Northern Zone	55% or 0.20 lb/mmBtu (based on 1990 heat input)	
Phase III replaced by NO_x SIP Call Trading Program on May 1, 2003	No zones, but excludes ME, NH, and VT	0.15 lb/mmBtu (based on 1995 or 1996 baseline heat input with growth factor)	141,000 tons (budget level)

Figure 2

Source: OTC and EPA.

lower, Phase III budget set to begin in 2003. The OTC's Phase III reductions have been merged into a broader regional cap and trade program under EPA's "NO_X SIP Call." The NO_X SIP Call will affect 21 eastern states and the District of Columbia, including all of the OTC states in the trading program except New Hampshire. The emission reduction targets under the NO_X SIP Call trading program are comparable to the OTC Phase III reduction targets— about 70 percent from 1990 baseline levels. This approach, utilizing a firm budget that decreases in stages, is known as a declining cap.

In developing their NO_X Budget Program, the OTC states establish three zones—"Inner," "Outer," and "Northern"—and required different emission rates for Phases II and III in the different zones (see Figure 3). In contrast, the NO_X SIP Call uses the same emissions rate throughout the affected region to establish the emissions budgets.

OTC Zones for NO_X Control

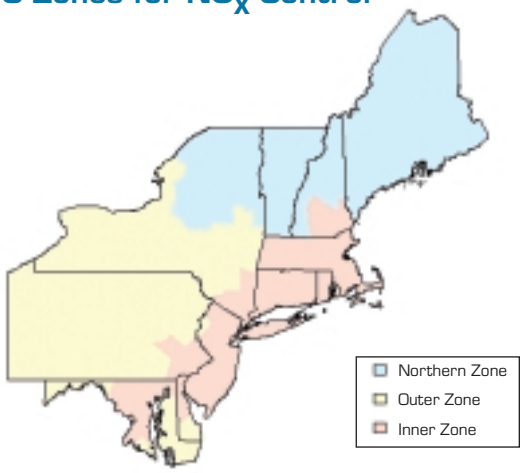


Figure 3
The OTC states that signed the MOU split the region into Inner, Outer, and Northern Zones, and planned for different reduction targets in each zone.

Source: OTC and EPA.

The OTC's Inner Zone generally comprised the contiguous ozone nonattainment areas along the heavily populated corridor from the Washington, D.C., metropolitan area to southern New Hampshire. The OTC set the most stringent reduction targets for this zone. The Northern Zone contained all of Maine and Vermont, northeastern New York, and all but southern New Hampshire, and had the least stringent reduction target. The Outer Zone contained the rest of the OTC region.

The use of a separate Northern Zone has had little effect on the OTC NO_X Budget Program. Maine and Vermont have not participated in Phase II of the program and are not affected under the NO_X SIP Call. Maine will meet the OTC MOU requirements for 2003 through unit-specific emission limits, with provisions for intra-source emissions averaging. Vermont has only a single affected source that has already met the 2003 emission reduction target, with 2001 emissions of 4 tons, well below the 1990 baseline of 27 tons. While portions of New Hampshire and New York also were in the Northern Zone, they included those portions beginning in 1999 as part of the OTC NO_X Budget Program.

Emission Reductions

The OTC NO_X Budget Program has produced emission reductions well below required levels. Moreover, these significant reductions have occurred throughout the region, and the seasonal reduction strategy appears to have successfully reduced daily peak emission levels.

Emissions Reduced by 60 Percent from 1990 Levels

OTC NO_X Budget Program sources successfully reduced their regional ozone season NO_X emissions in 2002 by nearly 280,000 tons, or about 60 percent, from 1990 baseline levels. Emissions have been lower than the regional budget in each of the four ozone seasons (1999-2002), in which participants have been able to "bank" unused allowances for use in the future. The use of banking (in combination with progressive flow control—see page 15) did not result in any single season peaks above budget levels.

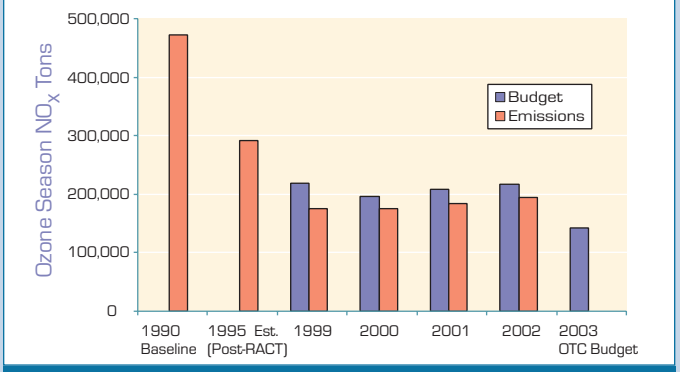


Figure 4
NO_X Budget Program units reduced ozone season emissions by 60 percent from 1990 levels, achieving greater reductions than required each year of the program.

Source: OTC and EPA.

The decrease in the budget from 1999 to 2000 reflects the allocation of credits for reducing emissions prior to the start of the trading program in 1999 only. The slight increases in the 2001 and 2002 budgets and emissions resulted from the delayed entry of the District of Columbia and Maryland into the program. For 1999, Figure 4 includes no data for Maryland or the District. The year 2000 data also do not include the District, but include about 1,800 allowances and 2,300 NO_X tons for the small number of sources in Maryland that participated in 2000. The regional budget increased by about 12,500 tons in 2001 and 9,000 tons in 2002 as the District and additional Maryland sources joined the program. At the same time, emissions increased by about 15,500 and 12,000 tons, respectively.

Reductions Achieved through RACT and Subsequent Budget Requirements

The first large, regional NO_X reductions in the OTC were achieved in the summer of 1995 when Phase I RACT rules went into effect for existing sources. These rules are comparable to, and in some states more stringent than, the NO_X rules that EPA has enacted nationwide for existing coal-fired boilers under the Acid Rain Program.

The RACT requirements ensure that existing units employ reasonably available controls (primarily combustion modification techniques) to reduce their emission rates on a year-round basis. After achieving substantial NO_X reductions through RACT, OTC states then employed the NO_X Budget Program so that deeper, more costly reductions during the ozone season could be achieved as cost-effectively as possible. The reductions achieved under the OTC NO_X Budget Program reflect about a 35 percent reduction from estimated RACT levels during the ozone season.

Inner and Outer OTC Zones Achieved Similar Reductions

The OTC states developed different zones in the NO_X Budget Program in order to achieve deeper emissions reductions in areas with the most significant ozone nonattainment problems. The states debated whether or not to impose ratio restrictions on trading between the zones but eventually decided to permit interzonal trading on a one-for-one basis. The effect of this decision was that both zones reduced ozone season NO_X emissions by a similar amount from baseline levels (see Figure 5). Because trading was allowed freely between the zones, all areas achieved comparable reductions.

Comparison of Outer and Inner Zone NO_X Emissions from 1990 to 2002

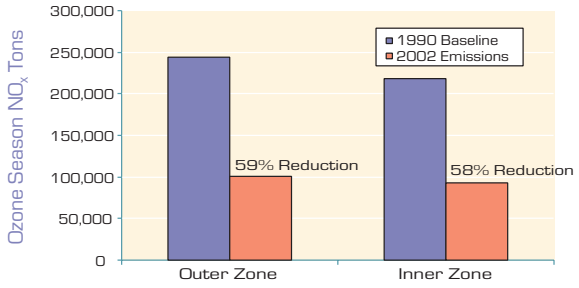
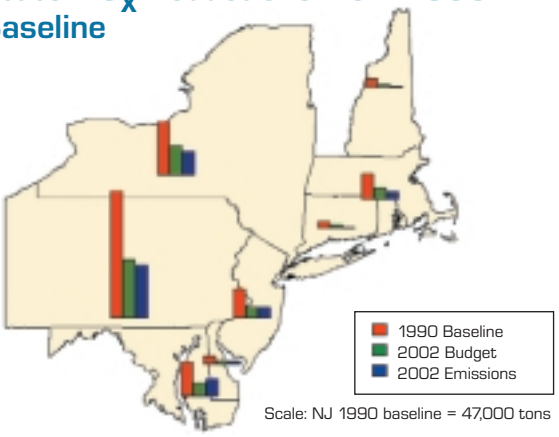


Figure 5
Inner and Outer Zones of the OTC region have achieved comparable percent reductions.

Source: EPA.

State NO_X Reductions from 1990 Baseline



Note: Results for the District of Columbia and Rhode Island do not appear on the map because of their small scale. The 2002 seasonal emissions are below 700 tons in each jurisdiction.

Figure 6
Reductions from 1990 levels have occurred across the NO_X Budget Program states.

Source: EPA.

States Across the Region Achieved Reductions

A state-by-state comparison shows that, in 2002, all NO_X Budget Program states (except the District of Columbia) achieved significant reductions from 1990 ozone season NO_X baseline levels (see Figure 6). Moreover, all of the states, except Maryland and the District of Columbia, had 2002 emissions below state budget levels. The anomalous results in Maryland stem from litigation and a subsequent consent order that delayed the participation of several sources in the trading program. The District of Columbia began participation in 2001 and had emissions below baseline and budget levels. In 2002, NO_X emissions in the District were above baseline and budget levels. All of the units in the District are relatively low-emitting oil and gas fired units, and the total expected reduction from 1990 baseline levels was less than 100 tons per season (only about a 17 percent reduction). The District is likely to have some year-to-year variability given this mix of units, the small degree of reduction required, and the overall small emissions budget.

By its nature, a broad regional trading program is designed to achieve significant regional reductions, but ozone season emission reductions from NO_x Budget sources also resulted in important county-level reductions throughout the region. Regionwide, almost all counties with existing NO_x Budget sources have reduced their ozone season NO_x emissions from 1990 levels. Many counties achieved substantial declines in NO_x emissions, including all of the counties with the highest 1990 baseline emissions. In comparison, only a few counties did not decrease their emissions from 1990 levels. In some cases, new sources located in the counties after 1990. In other cases, there may have been very low operating levels for existing units in the counties during the 1990 baseline year. Such minimal increases are not expected to produce localized peaks of ozone, given the nature of ozone and the major NO_x emissions reductions regionally.

Daily Peak Emissions Appear to Have Declined

Epidemiological studies indicate that many of the health effects associated with ozone are attributable to short, peak exposures, and the ozone NAAQS was developed to protect against such short-term exposures. The NO_x Budget Program, however, is a seasonal program that ensures significant average NO_x reductions in the ozone season but does not necessarily ensure that emission reductions are achieved on a short-term basis. There have been concerns that a seasonal cap would not ensure the reduction of short-term, peak NO_x emissions that may occur on hot, high electricity demand days, when ozone formation often is a concern.

An analysis of daily emissions from NO_x Budget units that are affected under the Acid Rain Program, however, shows that average and peak daily emissions from these units have declined during the ozone season (see Figure 7). These Acid Rain units account for the vast majority of budget source emissions in the region. Ozone season average daily NO_x emissions from these units declined nearly 30 percent between 1997 and 2002. Also, the ozone season days with the highest total emissions from Acid Rain units for each year of the trading program had emissions significantly lower than the corresponding values prior to implementing the program. It appears that the seasonal program design of the NO_x Budget Program does, in fact, provide NO_x reductions from affected sources on high electricity demand days. Reducing peak daily NO_x emissions during the ozone season remains an important concern, and EPA and the OTC states will continue to examine trends in peak emissions and their relationship to high ozone days.

Daily Ozone Season Emissions Trends (OTC Acid Rain Units Only)

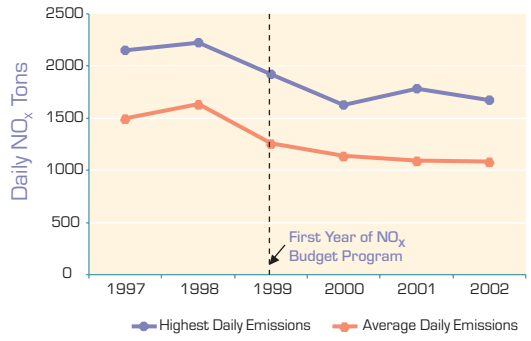


Figure 7
Data for Acid Rain Program units from before and after the NO_x Budget Program show that the seasonal budget is reducing daily emissions, even on the days with the highest emissions.

Source: EPA.

Industrial Units Responded Similarly to Electric Generating Units

The Acid Rain Program's SO_2 trading system applies only to electric generating units (EGUs), which are responsible for the large majority of NO_x emissions from combustion of fossil fuels. Industrial boilers, turbines, and process heaters, however, also contribute a significant amount of NO_x emissions, and the OTC states decided to include these additional industrial units in the NO_x Budget Program.

The industrial units in the NO_x Budget Program have consistently emitted below budget levels during the program, and thus have achieved significant reductions from baseline levels. The ozone season emissions from the affected industrial units on average have been more than 10 percent below their allowance allocations. These results are comparable to the results for the electric generating sector and indicate that industrial combustion units can be effectively integrated into a cap and trade program.

Compliance Strategies Do Not Appear to Have Shifted Emissions to Upwind States

Under the NO_x Budget Program, sources can use means other than add-on controls to meet the emissions budget. One method is to reduce utilization of high-emitting units and shift production to lower-emitting units within the program or to sources that are outside the budget. If production shifts to upwind, unaffected units with higher emission rates, the effectiveness of the NO_x Budget Program would be reduced because pollution could be transported back into the region.

Shifting of emissions to unaffected, upwind units has been an ongoing concern for the OTC states and EPA, and there are some reports that sources are purchasing off-peak power from outside the OTC region to reduce total seasonal emissions as part of their compliance strategy.

Changes in Ozone Season Regional Generation and Sales

Category	1997 and 1998 2-Year Average MWh	2000 and 2001 2-Year Average MWh[1]	Change in 2-Year Average MWh
Nuclear Net Generation	59,132,000	77,787,000	18,655,000
Acid Rain Unit Gross Generation[2]	119,525,000	119,019,000	-506,000
Utility Sales	213,085,000	224,355,000	11,270,000

[1] 1999 excluded from analysis because Energy Information Administration (EIA) reports that 1999 data on utility sales have likely errors (Pennsylvania data are low).

[2] Plant demand (e.g., for pollution control systems) can require part of a unit's gross load, so the use of reported gross generation for Acid Rain Program units may overstate the decline in generation available to the electric grid.

Source: EPA and EIA.

Figure 8
Increases in OTC nuclear generation appear to offset increases in regional demand and account for much of the decrease in fossil generation.

Moreover, data from 1997 through 2001 show that ozone season generation from large, Acid Rain Program units responsible for most of the fossil fuel generation in the OTC region, has declined as a percent of regional utility electric sales (a measure of demand). The ratio of Acid Rain Program unit generation to regional utility sales averaged 56 percent in 1997 and 1998, the two years prior to the start of the NO_X Budget Program, and declined to 53 percent in 2000 and 2001. These results, at first, suggest a potential shifting of emissions to unaffected, upwind units.

The decline in OTC fossil plant utilization as a percent of utility retail electricity sales, however, was more than offset by an increase in the OTC region's nuclear generation over the same period. The ratio of nuclear generation to utility retail electricity sales averaged 28 percent in 1997 and 1998, and increased to an average of 35 percent in 2000 and 2001. (See Figure 8.)

These data do not identify where power generated in the region is distributed but do show that the increase in nuclear generation in the OTC region is large enough to offset the combined effect of the decrease in fossil generation from Acid Rain Program units and the increase in utility retail electricity sales. So, although some companies participating in the program may have purchased electricity from upwind fossil plants in non-OTC states to comply with NO_X requirements and shifted emissions out of the region, this preliminary analysis indicates that the three percent decline in fossil fuel generation as a percent of regional utility electric sales in the OTC region cannot necessarily be attributed to shifting of electricity production out of the region. Rather, the significant increases in nuclear generation indicate that fossil fuel generation is more likely to have shifted to the nuclear sector.

In addition, the difference in emission rates between OTC units and units in neighboring states has declined since 1997, in large part because of reductions from EPA NO_X requirements under the Acid Rain Program (see Figure 9). The reduced gap between emission rates in the two areas lessens the air quality impacts from shifting generation to upwind sources, although the average emission rates in upwind states remain nearly twice the level of rates in the OTC. EPA expects that NO_X SIP Call reduction requirements in these non-OTC states will decrease the gap in emission rates even further beginning in 2004. While these future actions should reduce concerns of emissions shifting to sources upwind of the OTC region, EPA and the OTC states continue to examine this important issue, especially with the ongoing electric power industry restructuring in the region and possible changes in federal energy policy.

NO_X Budget Program Ozone Season Emission Rates Compared to Neighboring States (Acid Rain Units)

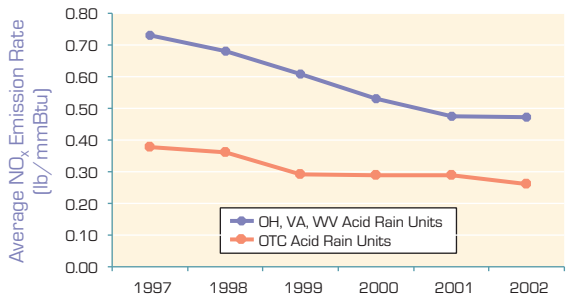


Figure 9
Potential for shifting generation remains a concern as the ozone season NO_X emission rates for Acid Rain Program units in neighboring upwind states remain higher than the OTC emission rates, although the gap is declining.

Source: EPA.

Ambient Trends and Future Emission Reduction Needs

The Northeast Continues to Face Ozone Problems

Despite the work that the OTC states have done to achieve NO_x emission reductions from large combustion facilities, much of the Northeast urban corridor still has not attained the 1-hour ozone NAAQS, though state plans are now in place to achieve this 1-hour goal (Figure 10 shows all nonattainment counties in this region as of January 2003). In 1997, a new, more stringent 8-hour ozone standard was finalized based on scientific evidence that longer-term exposures, at levels lower than under the previous standard, can cause significant health effects. Additional areas in the Northeast and Mid-Atlantic region are expected to be designated as nonattainment under this new standard.

Ozone conditions generally are evaluated on a 1-hour basis or 8-hour basis to match the averaging time of the ozone NAAQS. To measure ozone trends, EPA uses the second highest maximum 1-hour value (for the 1-hour NAAQS) and the fourth highest maximum 8-hour value (for the 8-hour NAAQS).

From 1990 through 2001, average ambient ozone conditions in the OTC states remained relatively constant (see Figure 11). Figure 11 does show a spike in ambient ozone levels in 2002 associated with poor weather conditions during that summer. The figure provides data from two EPA data sources: the Aerometric Information Retrieval Information System (AIRS), which has data from ambient ozone monitoring stations (generally located in urban and suburban areas) that are used to evaluate attainment, and the Clean Air Status and Trends Network (CASTNet), a predominantly rural monitoring network designed primarily to collect dry deposition data that also provides ozone data (Figure 11 includes CASTNet data through

Ozone Attainment Classification in the OTC States (1-Hour Standard)

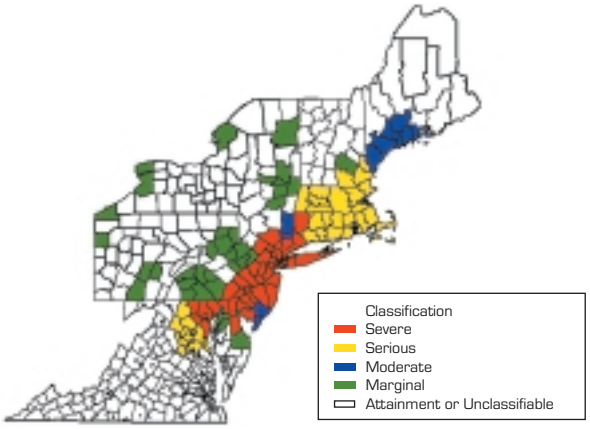


Figure 10
Many of the areas in the OTC region still do not meet the 1-hour ozone standard (as of January 2003).

Source: EPA.

1-Hour Standard (initially set in 1971): Daily maximum 1-hour concentration shall not exceed 0.120 parts per million (ppm) more than once per year on 3-year average basis.

8-Hour Standard (promulgated in 1997): Daily maximum 8-hour concentration shall not exceed 0.08 ppm based on 3-year average of the annual 4th highest daily maximum 8-hour value.

Ozone Classifications: Areas are classified based on the degree to which the daily maximum ozone levels exceed the ozone standard on a ppm basis. For example, if the 4th highest value over a 3-year period was 0.170 ppm, an area would be a "serious area" under the 1-hour standard because the value is greater than 0.160 ppm but less than 0.180 ppm.

2001 only). The trends in rural areas, which generally have limited local ground-level generation of ozone, tend to serve as a strong barometer of trends in ozone transport.

At this point, the data do not show an obvious year-to-year downward trend in ozone conditions. This is not surprising because the substantial reductions in NO_X achieved by the NO_X Budget Program have been partially offset by simultaneous increases in NO_X emissions from some types of mobile sources in the region and by long-range transport of ozone into the region from states upwind of the OTC. In addition, the strong influence of weather differences from year to year make it difficult to detect trends in ozone. EPA and states intend to continue examining ozone trends as more years of data become available.

While the efforts of the OTC states have not necessarily resulted in a decline in ozone levels yet, the NO_X Budget Program has been critically important in keeping total NO_X emissions from increasing in the region and in holding ambient ozone levels in check, despite increases in emissions of some types of mobile sources and long range transport into the region.

Future Mobile Source Emission Reductions Are Part of the Solution

While NO_X Budget Program sources have reduced annual emissions significantly, they are not the only NO_X sources in the region. Even though NO_X Budget sources reduced their annual emissions over 40 percent since 1990, annual emissions data from the National Emissions Inventory (NEI) show that total annual NO_X emissions in the region between 1990 and 1999 declined by only 10 percent. This is because, since 1990, emissions from other sources in the region, particularly mobile sources, have increased or stayed the same (see Figure 12).

Mobile source NO_X emissions in the OTC region are starting to decline. EPA projects that, by 2020, EPA and states will reduce mobile source NO_X emissions to only about one-third of year 2000 emissions through measures such as the National Low Emission Vehicle (NLEV) Program. The goal of improving ambient ozone conditions through NO_X reduction strategies will take the combined effort of stationary source measures, like the OTC NO_X Budget Program, and these mobile source programs.

Average OTC Region Ozone Trends (Northern Virginia Sites Not Included)

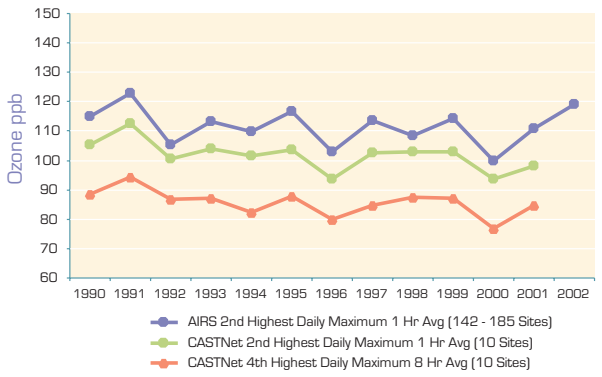


Figure 11
Average data from monitoring sites across the OTC region do not show any significant regional downward trend in ambient levels between 1990 and 2002.

Source: EPA and CASTNet.

Comparison of Annual NO_X Emissions from Mobile Sources and Industrial Fossil Fuel Combustion in OTC States

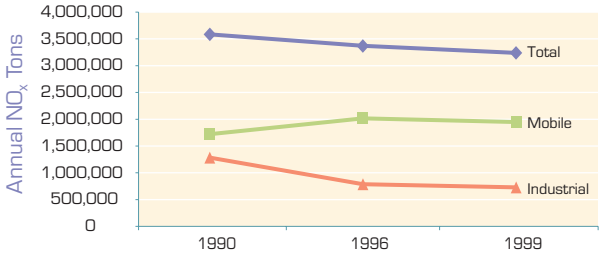


Figure 12
During the 1990s, NO_X emissions from the mobile source category reduced the gains from stationary source NO_X emission reductions.

Source: EPA.

Expanding the OTC Approach Also Will Help Address Ozone

Even after considering the reductions that would be achieved in Phase III of the OTC NO_X Program, the OTC states determined that further regional reductions would be necessary for them to attain the ozone standard and that these reductions would have to come from a much larger region than the OTC. EPA modeling also has shown that emission reductions in the OTC alone would not be sufficient to attain the ozone NAAQS. Many of the OTC states petitioned EPA under section 126 of the Clean Air Act to require reductions in upwind states.

At the same time, EPA's NO_X SIP Call requires upwind states to develop control strategies to reduce their significant contribution to nonattainment in downwind states. Based on the success of the NO_X Budget Program and the Acid Rain Program, EPA has developed under the NO_X SIP Call a regional NO_X cap and trade program. EPA designed the SIP Call trading program structure and procedures to resemble closely the OTC NO_X Budget Program and gave the SIP Call states the option to be part of the trading program to take advantage of the cost savings of achieving emissions reductions through trading.

OTC and SIP Call Trading Programs

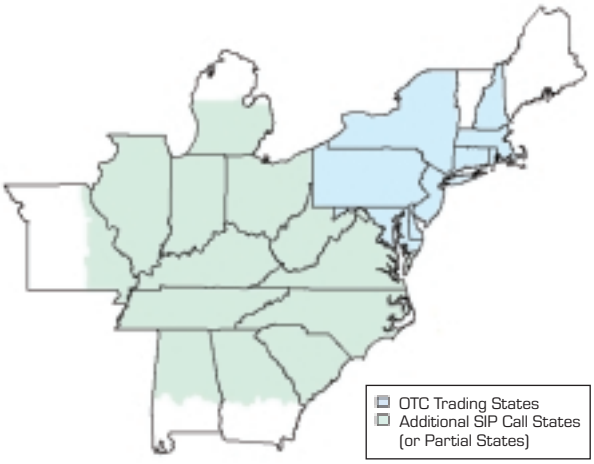


Figure 13
Beginning in May 2004, the NO_X SIP Call trading program will extend the NO_X Budget Program cap and trade program concept to additional states in the eastern United States.

Source: EPA.

The OTC states are poised to begin implementing the SIP Call (in place of Phase III of the OTC program) on May 1, 2003. Other states in the expanded region that are contributing to regional transport of ozone also have chosen to join the program. These states will initiate monitoring in 2003 and require compliance with their respective budgets beginning in May 2004 (see Figure 13). In addition, OTC states plan to achieve additional NO_X reductions by requiring controls on stationary sources other than budget sources, by promoting energy efficiency, and through state programs for multi-pollutant reductions. EPA anticipates that implementation of the NO_X SIP Call, along with additional ozone attainment efforts by the OTC and other SIP Call states, will lead to improved ambient ozone levels across the entire region.

Market Activity, Banking, and Compliance Costs

A Healthy Allowance Market Has Emerged

Allowance transfer activity can involve three main components: transfers from or to the state as part of allocating or surrendering allowances; transfers within a company or between related entities (holding company transfers to a small operating subsidiary, for example); and transfers between separate economic entities. The latter category of transfers are categorized broadly as "economically significant trades."

Economically significant trades represent about half of the total trades so far. These transactions provide the strongest indicator of true market activity because they represent an actual exchange of assets between unaffiliated participants. The volume of economically significant trades generally has been increasing from year to year, which indicates a maturing market (see Figure 14). These trades include only Phase II allowances (vintage years 1999-2002), and the trading volume remained high even in 2002, the final year of Phase II.

Volume of Economically Significant Trades (1998-2002)

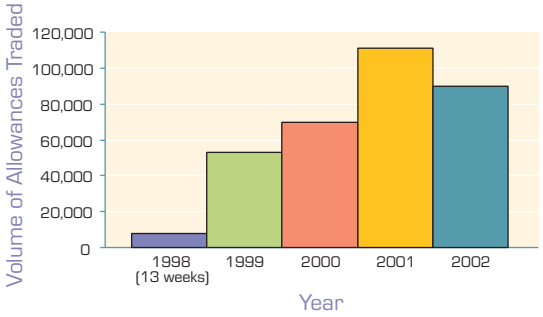


Figure 14
Trading volume of Phase II allowances (vintage years 1999-2002) between separate economic entities generally increased during Phase II of the OTC NO_x Program.

Source: EPA.

Industrial sources, although representing a smaller portion of the affected sources than electric generating units, have been active in allowance trading, with transfers to and from electric generating units, brokers, and other market participants.

OTC Allowance Prices Stabilized Well Below Initial Expectations

Another indicator of a maturing market is pricing activity. An analysis of market prices from the program's inception indicates that the early trading prices for NO_x allowance credits for vintage 1999 allowances ranged from $1,500 to $3,000. Then, just prior to the beginning of the 1999 ozone season, prices for vintage 1999 allowances spiked at over $7,000 per ton because of initial fears that there would be a shortage of allowances. By the end of 1999, prices for both vintage 1999 and 2000 allowances had fallen to less than $1,000 per ton as fears of a shortage were allayed. From April 1999 through December 2002, the price for vintage 1999, 2000, 2001, and 2002 allowances generally converged to a level of less than $750 per ton (see Figure 15).

Market Participants Have Created a Bank of Allowances

Finally, another sign of a maturing market is the development of an allowance bank to provide a pool of allowances available to address unexpected events or smooth the transition into deeper reductions. The NO_X allowance bank has increased steadily over the first four years of the NO_X Budget Program.

The ability to bank allowances also encourages early reductions below budget levels, which provides an environmental benefit as well. In fact, as the OTC states make the transition to a broader trading program under EPA's NO_X SIP Call in 2003, only a portion of the banked allowances are being carried forward to future years, so the benefit of the early reductions will be permanent. As part of the NO_X SIP Call, EPA made available a pool of allowances that states could use to reward early reductions (or to allow for delayed implementation if sources faced hardship in meeting the initial compliance deadline). Most of the OTC states have established a process to provide SIP Call allowances from this "compliance supplement pool" in exchange for banked OTC allowances held by units in the applicable states. The total compliance supplement pool for all of the OTC states is less than 25,000 allowances, while there are over 90,000 NO_X Budget Program banked allowances (based on preliminary 2002 data). Because the total allowances in the OTC states' share of the compliance supplement pool is far less than the total banked allowances, many of the early reductions that those banked OTC allowances represent will be permanent upon transition to the NO_X SIP Call.

Growth in Banked Allowances

1999:	43,585
2000:	60,589
2001:	78,746
2002:	91,000

(Note: 2002 figure is approximation based on preliminary data.)

Nominal OTC NO_X Allowance Prices

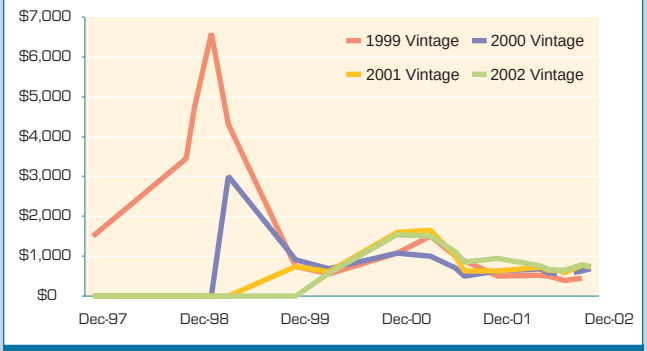


Figure 15
After an initial price spike, allowance prices have dropped well below expectations.

Source: Natsource LLC and Cantor Environmental Brokerage.

The use of banked allowances, however, could allow emissions to exceed the emissions budget in a particular year. To address this potential concern, the OTC NO_X Budget Program has allowance deduction provisions (referred to as "flow control") that provide sources a financial incentive to avoid using a high volume of banked allowances for compliance in a single ozone season. Flow control applies if the bank holds allowances equal to more than 10 percent of the total budget. If an owner uses banked allowances for compliance when flow control applies, only a portion of the source's banked allowances can be surrendered on the customary 1:1 basis (one allowance for each ton of emissions). If additional banked

allowances must be withdrawn for compliance, the allowances are used on a 2:1 basis (two banked allowances for each ton of emissions). The portion of banked allowances subject to the 2:1 requirement is set for each ozone season based on the amount by which the total bank exceeds the 10 percent threshold.

Because of the size of the allowance bank, the flow control provisions have been in effect since 2000, and emissions in the first four compliance seasons have not exceeded budget levels. These results indicate that flow control may help to avoid exceedances of the NO_X budgets. Because the NO_X SIP Call trading program has similar flow control provisions, EPA and the OTC states will be able to continue monitoring the effects of this incentive mechanism.

The Program Has Been Highly Cost-Effective

Cost-effectiveness is a common measure for comparing the costs of reducing a ton of emissions under different regulatory programs. For NO_X, since 1990, EPA has used $2,000 per ton of reduction ($2,600 in 2000 dollars) as an upper limit for evaluating highly cost-effective NO_X control strategies. While it is difficult to determine the actual cost of Phase II of the OTC NO_X Program, there are indications that costs are significantly below EPA's highly cost-effective cut-off of $2,600 per ton.

Before the OTC NO_X Budget Program, a study conducted for EPA (Estimated Effects of Alternative NO_X Cap and Trading Schemes in the Northeast Ozone Transport Region, September 1995) projected that the compliance costs for Phase II of the OTC NO_X Program (i.e., from 1999-2002) would result in an approximately $60 million total annualized cost, approximately $38 million for add-on control equipment and $22 million for operating costs (all figures have been updated to year 2000 dollars based on the Producer Price Index). This study projected that the average cost per ton of NO_X reduction would be approximately $1,200 per ton.

The 1995 EPA study acknowledged that it probably underestimated projected costs for several reasons. The study excluded industrial units and did not model electric generating units in parts of western Pennsylvania and certain other areas within the OTC. The study also did not address the impact of keeping emissions from new units within the budget — the study indicated these costs would add approximately $10 million to the annual cost projections. Notably, the study showed that the compliance costs under the trading program would be far lower than a "no trading "scenario, where total annual costs of installing add-on control equipment were projected to be over $130 million (2000 dollars).

In calculating the actual costs of the NO_x Budget Program, it is difficult to separate totally the actions sources may have taken as they anticipated and planned for future needed NO_x reductions (under Phase III of the OTC NO_x Program or under the NO_x SIP Call program). The costs of installation of control equipment, while expected to be similar to EPA's 1995 projections, cannot be considered representative of the true cost of the OTC Phase II NO_x Program because these costs were, at least partly, incurred in response to more stringent future requirements.

Another indicator of the cost of the program is the price of allowances. Since a source can choose to buy allowances instead of reducing NO_x emissions, the price of an allowance should indicate the highest cost (the marginal cost) that a source would have to pay to reduce an additional ton of NO_x. Once the OTC NO_x Budget Program established itself by the end of 1999, allowance prices have ranged between $600 and $1,700 per ton and have generally been less than $1,000 per ton. Assuming these allowance prices represent the marginal cost of the program, the average cost of a ton of NO_x reduction under the program would appear to be lower. Given that allowance prices for the program after 1999 have been well under $2,600 per ton, it appears that, once the OTC NO_x Budget Program was established, it was highly cost-effective and was certainly less costly than a "no trading" program would have been.

There are several additional factors that may have helped keep the cost of NO_x reductions under the NO_x Budget Program lower than projected. There was an unforeseen increased use of nuclear power in the region, which decreased the need for reliance on fossil generation. In addition, the combustion modifications that had been installed under the RACT requirements appear to have been optimized for greater effectiveness, resulting in additional NO_x reductions.

Conclusion

The OTC was formed to address the regionwide problem of ozone nonattainment in the Northeast and Mid-Atlantic states, and the NO_x Budget Program is one of the states' key initiatives in this regional effort. The state/federal partnership has ensured a high quality interstate emissions trading program with consistent monitoring and reporting requirements. A viable trading market has emerged, and sources have achieved a high rate of compliance. In addition, the program has successfully reduced NO_x emissions from budget sources throughout the region, while ozone conditions have not deteriorated since 1990, despite increases in NO_x emissions from mobile sources and continued transport of pollutants into the region from states downwind of the OTC states.

However, ambient ozone conditions remain a serious problem in the region, and further emission reduction efforts both within and upwind of the OTC region will be necessary to achieve the ozone standard. The OTC states will achieve further reductions through a reduced emissions budget for the affected sources beginning in 2003, and they have been developing regional NO_x emission reduction programs for additional sources. In addition, the success of the OTC NO_x Budget Program in achieving NO_x reductions has laid the groundwork for a significant reduction in emissions throughout the eastern United States through a broader trading program. State and local programs as well as EPA mobile source programs also will be essential to the overall ozone attainment strategy.

EPA projections indicate that these combined efforts to reduce NO_x emissions will contribute to improved ambient ozone conditions. In particular, EPA's benefits assessment for the NO_x SIP Call predicts significant public health benefits as a result of full implementation of regional NO_x reductions. Broad NO_x emission reductions also will aid efforts to reduce exposure to particulate matter, reduce nitrogen deposition, and improve visibility.

While EPA and the states will have to monitor the long-term air quality trends to ensure that these environmental goals are met, the NO_x Budget Program has been an important step in efforts to reduce ambient ozone levels and achieve these other environmental goals. Moreover, the ability of the OTC states to achieve NO_x reductions in the context of a firm, declining emissions cap across multiple industrial sectors, on schedule, cost-effectively, and without significant geographic disparities, provides further support for the use of cap and trade emission reduction programs to address regional air pollution problems.

For Further Information

There are a number of information sources relevant to the OTC NO_x Budget Program and the issues discussed in this report, including the following:

General Background Information on the OTC NOx Budget Program. See www.epa.gov/airmarkets/otc for access to OTC compliance reports, an overview of the program, and access to emissions and allowance data. See www.sso.org/otc for the OTC's main Web site, including access to program documents, formal actions such as OTC Memoranda of Understanding, and links to the Web sites of the individual states.

1990 OTC NOx Baseline Emission Inventory, July 1995 (EPA-454/R-95-013). This report provides a detailed explanation and listing of the data used to identify the baseline emissions for the OTC NO_x Budget Program.

Emissions Data. EPA receives quarterly reports with NO_x mass emissions data for sources subject to the NO_x Budget Program. These data are used in a variety of the findings in this report. At this time, EPA is still finalizing 2002 data as part of completing allowance true-up activities for 2002 compliance, and thus the 2002 data in this report are considered preliminary. To access the emissions data, see www.epa.gov/airmarkets/emissions/prelimotc/index.html. You can also conduct queries on emissions data for these units at cfpub.epa.gov/gdm.

Allowance Data. EPA also maintains the OTC allowance data in the NO_x Allowance Tracking System (NATS). To access NO_x allowance data, see www.epa.gov/airmarkets/tracking.

Ambient Ozone Data. Various data sources are available to identify ambient ozone results and trends. This report relies on Air Quality System (AQS) data (see AQS Summary Data Tables at www.epa.gov/aqspubl1/select.html) and data from U.S. EPA's Clean Air Status and Trends Network (CASTNet) at www.epa.gov/castnet.

Control Cost Information. For information on what assumptions EPA uses to assess the costs of various control technologies in modeling control strategies for electric generating units, see Documentation of EPA Modeling Applications (V.2.1) Using the Integrated Planning Model, March 2002 (EPA 430/R-02-004). The 1995 study of potential compliance cost impacts for the OTC NO_x Budget Program used an earlier version of the same modeling application (see Estimated Effects of Alternative Cap and Trading Schemes in the Northeast Ozone Transport Region, ICF Resources, September 1995).

Electric Generation Data. An analysis of shifts in electric generation requires access to generation data. EPA's Emissions and Generation Resource Integrated Database (E-GRID) is one source of data (see www.epa.gov/airmarkets/egrid). E-GRID combines data from EPA and Energy Information Administration (EIA) databases. You may also want to review EIA reports and databases (see www.eia.doe.gov). This report used data from the EIA 759, 826, and 906 Electricity Databases, as well as EIA Electric Power Monthly Reports.

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