The NO_x Budget Trading Program: 2008 Emission, Compliance, and Market Analyses

The NO_x Budget Trading Program (NBP) was a market-based cap and trade program created to reduce the regional transport of emissions of nitrogen oxides (NO_x) from power plants and other large combustion sources that contribute to ozone nonattainment in the eastern United States. NO_x is a major precursor to the formation of ground-level ozone, a pervasive air pollution problem in many areas in the East. The NBP was designed to reduce NO_x emissions during the warm summer months, referred to as the ozone season, when ground-level ozone concentrations are highest. In 2009, the NBP was replaced by the Clean Air Interstate Rule (CAIR) NO_x ozone season program, which started requiring emission reductions from affected sources in an expanded geographic area on May 1, 2009.

Over the next few months, the U.S. EPA will release several reports summarizing progress under the NBP. The first report in this four-part series, released in May, presented 2008 data on emission reductions, compliance results, and NO_x allowance prices. This is the second report in the series, and it further evaluates progress under the NBP in 2008 by analyzing emission reductions, reviewing compliance results, investigating factors affecting market price, and exploring control options used by sources. For more information on the NBP, please visit: <http://www.epa.gov/airmarkets/progsregs/nox/sip.html>. Detailed emission results and other facility and allowance data are also publicly available on EPA's Data and Maps Web site at <http://camddataandmaps.epa.gov/gdm>. To view emission and other facility information in an interactive file format using Google Earth or a similar three-dimensional platform, go to <http://www.epa.gov/airmarkets/progress/interactivemapping.html>.

At a Glance: NBP Results in 2008

Ozone Season Emissions: 481,420 tons

- 9% below 2008 cap
- 62% lower than in 2000 (before implementation of the NBP)
- 75% lower than in 1990 (before implementation of the 1990 Clean Air Act Amendments)

Compliance: Nearly 100%

- Only 2 units out of a total 2,568 units were out of compliance by a total of 63 tons
- Continues trend of near-perfect compliance since start of program in 2003

Controls: 70% of NBP units have NO_x controls

- Emission rates for all units have dropped by 45% since 2003
- Emission rates for units without controls have dropped by over 50% since 2003

Allowances: Prices and activity are down but there is still a substantial bank and an active market

- 28% price decline in 2008, from an average price of $825/ton in January to $592/ton in November
- 275,367 unused NBP allowances transferred for future use under the Clean Air Interstate Rule (CAIR)

Overview of the NO_x Budget Trading Program: Market-based Emission Reductions

The NO_x State Implementation Plan (SIP) Call, promulgated in 1998, was designed to address the problem of ozone transport across the eastern United States. It required states to reduce ozone season NO_x emissions that contribute to ozone nonattainment in other states. EPA created a cap and trade program, the NBP, as a cost-effective alternative to achieve the required reductions. All 20 affected states and the District of Columbia (DC) chose to meet mandatory NO_x SIP Call reductions primarily through participation in the NBP.

Over the past six ozone seasons, the NBP significantly lowered NO_x emissions from affected sources, contributing to improvements in regional air quality across the Midwest, Northeast, and Mid-Atlantic.

Cap and trade programs such as the NBP and the Acid Rain Program (ARP) set a cap on overall regional emissions and allocate allowances to each affected source. Each allow-

Key Components of the NBP

The NBP was an ozone season (May 1 to September 30) cap and trade program for electric generating units (EGUs) and large industrial combustion sources, primarily boilers and turbines. The program had several important features:

- **Regionwide Cap:** The sum of state emission budgets that EPA established under the NO_x SIP Call to help states meet their air quality goals to protect human health and the environment.
- **Limited Allowances:** Authorizations to emit, known as allowances, were allocated to affected sources based on state trading budgets. The NO_x allowance market enabled sources to trade (buy and sell) allowances throughout the year.
- **Compliance Alternatives:** Sources could choose among several options to reduce NO_x emissions, such as adding emission controls, replacing existing controls with more advanced technologies, optimizing existing controls, or switching fuels.
- **Stringent, Complete Monitoring:** To accurately monitor and report emissions, sources used continuous emission monitoring systems (CEMS) or other approved monitoring methods under EPA's stringent monitoring requirements (40 CFR, Part 75).
- **Compliance Determination:** At the end of every ozone season, each source had to surrender sufficient allowances to cover its ozone season NO_x emissions (each allowance represents one ton of NO_x emissions). This process is called annual reconciliation.
- **Automatic Penalties:** If a source did not have enough allowances to cover its emissions, EPA automatically deducted allowances from the following year's allocation at a 3:1 ratio. Units out of compliance in 2008 had to surrender 2009 CAIR NO_x ozone season allowances.
- **Allowance Market and Banking:** If a source had excess allowances because it reduced emissions beyond required levels, it could sell the unused allowances or bank (save) them for use in a future ozone season. On January 1, 2009, EPA transferred NBP banked allowances for use under the CAIR NO_x ozone season program.

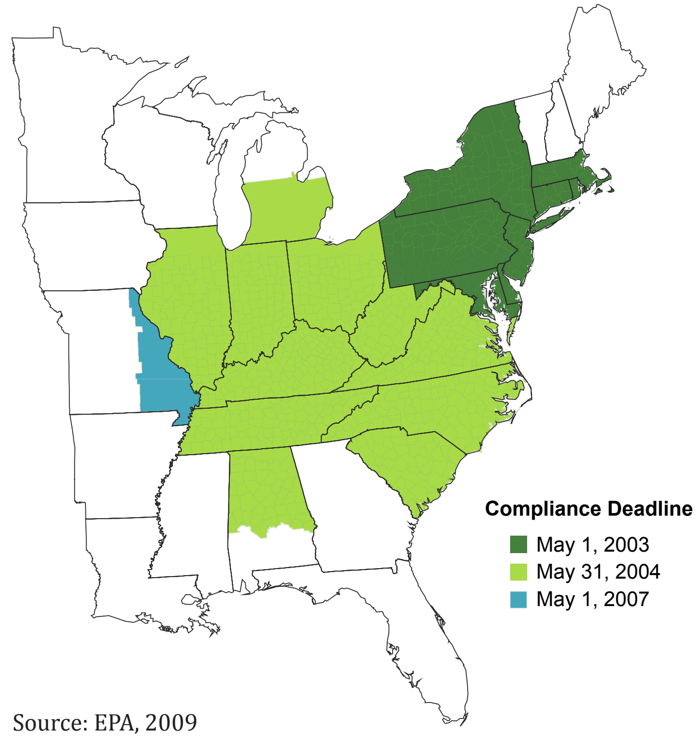
ance authorizes a certain number of emissions – in this case, one ton. This approach provides individual sources with flexibility in complying with emission limits. Sources may sell or bank (save) excess allowances if they reduce emissions and have more allowances than they need, or purchase allowances if they are unable to keep emissions within their allocated budget. As a group, the participating sources cannot exceed the cap. The cap level is intended to protect public health and the environment and to sustain that protection into the future, regardless of growth in the affected sector. The cap also lends stability and predictability to the allowance trading market and provides regulatory certainty to affected sources. Cap and trade programs like the NBP and the ARP have proven highly effective in reducing emissions from multiple sources, while meeting environmental goals, and improving human health.

Affected States and Compliance Dates

Compliance with the NO_x SIP Call was scheduled to begin on May 1, 2003, for the full ozone season. However, litigation delayed implementation for 12 states not previously in the Ozone Transport Commission's (OTC) NO_x Budget Program. The eight states previously in the OTC adopted the original compliance date of May 1, 2003, in transitioning to the NO_x SIP Call (see Figure 1). These OTC states included Connecticut, Delaware, Maryland, Massachusetts, New Jersey, New York, Pennsylvania, and Rhode Island, as well as the District of Columbia.

Eleven states not previously in the OTC NO_x Budget Program began compliance on May 31, 2004, one month into the normal ozone season. These states were Alabama, Illinois, Indiana, Kentucky, Michigan, North Carolina, Ohio, South Carolina, Tennessee, Virginia, and West Virginia. Finally, Missouri began compliance with the program on May 1, 2007.

Figure 1: NO_x SIP Call Program Implementation



Source: EPA, 2009

Only portions of Alabama, Michigan, and Missouri were affected by the program. In addition, Georgia was originally slated to begin compliance with the NBP in 2007 along with Missouri. However, on April 16, 2008, EPA finalized a rule to remove the requirements of the NO_x SIP Call for Georgia in response to a petition, and Georgia never participated in the NBP.

Affected Units

There were 2,568 affected units under the NBP in 2008, including some units that may not have operated nor had emissions during the 2008 ozone season. For example, some units provide electricity only on peak demand days, and may not operate every year.

Most of the units in the NBP were electric generating units (EGUs), which are large boilers, turbines, and combined cycle units used to generate electricity for sale. Figure 2 shows that EGUs constituted 88 percent of all regulated NBP units. The program also applied to large industrial units that produce electricity or steam primarily for internal use. Examples of these units were boilers and turbines at heavy manufacturing facilities, such as paper mills, petroleum refineries, and iron and steel production facilities. These units also included steam plants at institutional settings, such as large universities or hospitals. Additionally, some states included other categories of units, such as petroleum refinery process heaters and cement kilns.

States could also choose to allow individual sources that were not affected by the NBP to opt in to the trading program. Opt-ins were limited to fossil fuel combustion devices that vent all emissions through a stack and that met EPA's stringent Part 75 emission monitoring requirements. Potential opt-in sources had to apply for a state NBP opt-in permit. If approved, these sources were issued opt-in allowances, which were in addition to the state's base budget. In 2008, there were three states with five total opt-in units under the program.

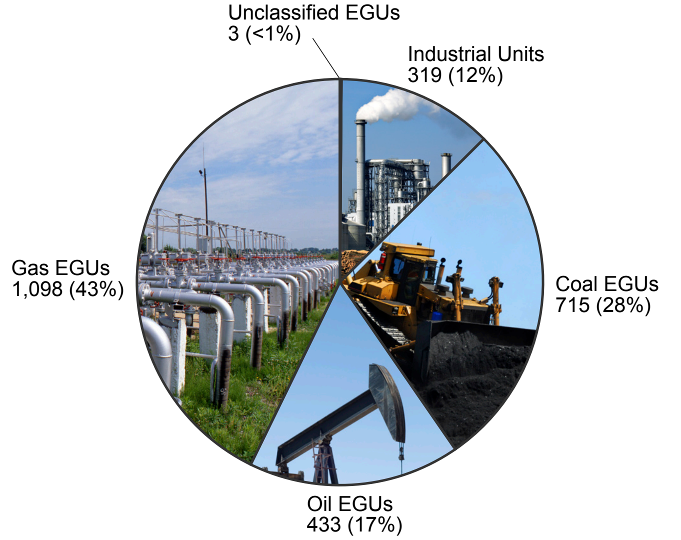
Emission Reductions

EPA uses two baseline years for measuring progress under the program:

1990: This baseline represents emission levels before the implementation of the 1990 Clean Air Act Amendments.

2000: This baseline represents emission levels after the implementation of NO_x regulatory programs under the 1990 Clean Air Act Amendments but before implementation of the NBP.

Figure 2: Number of Units in the NBP by Type in 2008

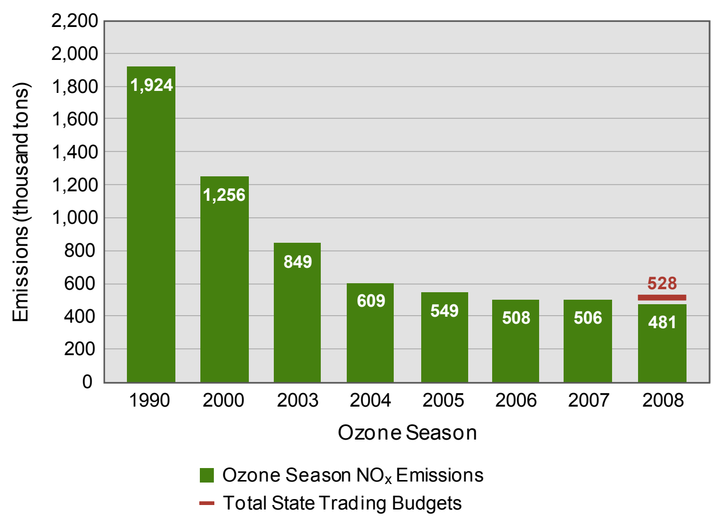


Notes:

- The three "unclassified" units represent units in long-term shutdown or other non-operating status that remained identified as affected units under the NBP and that had not retired prior to the 2008 ozone season.
- Percentages add up to more than 100 due to rounding.

Source: EPA, 2009

Figure 3: Ozone Season NO_x Emissions from All NBP Sources



Notes:

- Data reflect full ozone season emissions in all years for all states. The year 2000 baseline value has been adjusted to correct a misprint in Figure 5 of the 2007 NBP report.
- The 2008 total state trading budgets include opt-in allowances, where applicable (New York, Ohio, and West Virginia).

Source: EPA, 2009

Ozone Season NO_x Reductions

In 2008, NBP sources emitted 481,420 tons of NO_x during the summer ozone season, an overall decrease of 24,880 tons from 2007. Emissions in 2008 were 62 percent below 2000 levels, 75 percent below 1990 levels, and 9 percent below the 2008 cap. Figure 3 (on previous page) shows the total ozone season NO_x emissions for all affected sources in the NBP region in 2008 compared to pre-NBP baseline years (1990 and 2000) and prior NBP compliance years (2003 through 2007). It also presents the allowances allocated for 2008, which constituted the cap (the sum of the state budgets) for the program (528,453 tons). Note that all data for 2003–2008 in this section were gathered from EPA's data systems as of April 1, 2009.

Many of the NO_x reductions since 1990 are a result of other programs implemented under the Clean Air Act, such as the Acid Rain NO_x reduction program and other state, local, and federal programs. The significant decrease in NO_x emissions after 2000 largely reflects reductions achieved by the OTC NO_x Budget Program, which operated between 1999 and 2002, and the NBP, which began in 2003. The large drop in emissions between 2003 and 2004 was a result of the entry of the non-OTC states into the NBP. The majority of states subject to the NO_x SIP Call started to participate in the NBP on May 31, 2004.

Although Missouri did not participate in the NBP until 2007, its emissions are included for all years in Figure 3 to more effectively capture and express trends due to the program. For more detailed information on state budgets and emissions subject to compliance, see Appendix A and Figure 6 on page 7.

Ozone season NO_x emissions decreased substantially, by 43 percent, between 2003 and 2008, while heat input remained relatively flat over the same period. As Table 1 shows, total heat input increased by approximately two

What Is Heat Input?

Heat input, often expressed in million British thermal units (mmBtu), is a measure of the energy content of fuel. It is standardized across fuel sources to allow comparisons among them. For example, a cubic foot of natural gas releases a different amount of energy than a gallon of oil when burned. Heat input also offers an indication of energy demand. For example, high electricity consumption for air conditioning on a hot day will be reflected in high heat input levels at EGUs.

What Is Emission Rate?

Emission rate is the measure of how much pollutant (NO_x) is emitted from a combustion unit compared to the amount of energy (heat input) used. In this report, emission rate is expressed as pounds of NO_x emitted per mmBtu of heat input. Emission rates enable comparison of a combustion unit's environmental efficiency given its fuel type and usage. A lower emission rate represents a cleaner operating unit—one that is emitting fewer pounds of NO_x per unit of fuel consumed.

Table 1: Comparison of Ozone Season NO_x Emissions, Heat Input, and NO_x Emission Rates for All NBP Sources, 2003–2008

Units by Fuel Type	Ozone Season NO_x Mass Emissions (thousand tons)						Ozone Season Heat Input (billion mmBtu)						Ozone Season NO_x Emission Rate (lb/mmBtu)					
	2003	2004	2005	2006	2007	2008	2003	2004	2005	2006	2007	2008	2003	2004	2005	2006	2007	2008
Coal	800	564	494	475	475	456	4.91	4.91	5.10	5.06	5.15	4.93	0.32	0.23	0.19	0.19	0.18	0.18
Oil	26	25	32	14	13	9	0.27	0.25	0.31	0.17	0.17	0.13	0.19	0.20	0.20	0.16	0.15	0.14
Gas	24	20	23	19	19	16	0.59	0.70	0.85	0.87	0.99	0.85	0.08	0.06	0.05	0.04	0.04	0.04
Total	849	609	549	508	506	481	5.77	5.86	6.27	6.10	6.30	5.91	0.29	0.21	0.18	0.17	0.16	0.16

Notes:

- Tons are rounded to the nearest 1,000, and the heat input values are rounded to the nearest 10 million mmBtus. Totals in final row may not equal the sum of individual rows due to rounding.
- The average emission rate is based on dividing total reported ozone season NO_x emissions for each fuel category by the total ozone season heat input reported for that category, and then rounding the emission rate to the nearest 0.01 lb/mmBtu. The average emission rate expressed for the total uses total NO_x mass divided by total heat input to represent the heat input-weighted average for the three fuel categories.
- Fuel type, as shown here, is based on the monitoring plan primary fuel designation submitted to EPA; however, many units burn multiple fuels. Also, one primary wood-fired boiler is classified with the coal-fired units based on its secondary fuel.

Source: EPA, 2009

percent from 2003 to 2008, with gas-fired units primarily responsible for this growth in heat input. Furthermore, the average NO_x emission rate for all units remained stable between 2007 and 2008, maintaining the 45 percent overall drop in emission rate since the program began in 2003. Because heat input has not significantly changed since the start of the program, other factors, such as fuel choice and added NO_x controls, have contributed to this improvement.

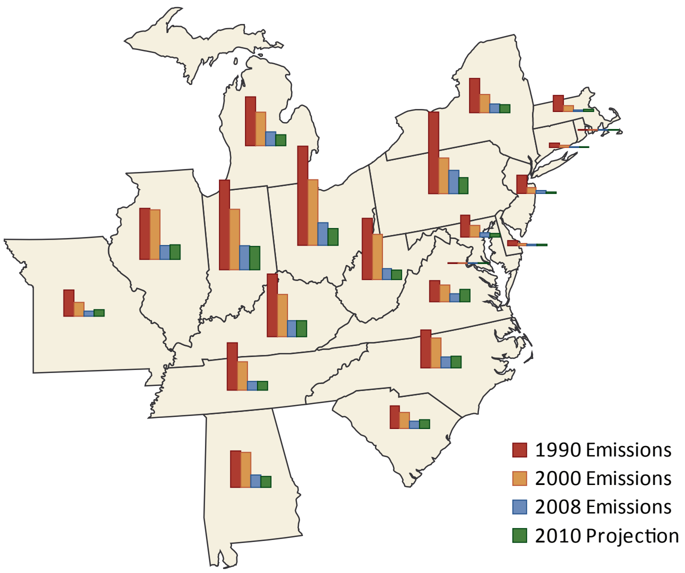
Table 1 shows that between 2007 and 2008, ozone season emissions decreased for all fuel types, primarily reflecting a six percent decline in 2008 ozone season heat input.

State-by-State NO_x Reductions

Ozone season NO_x emissions decreased from levels in the baseline years in all states that participated in the NBP. EPA projects that the CAIR NO_x ozone program, which started in 2009, will bring a continued decline in emissions in states across the region (see Figure 4).

In the 2008 ozone season, the total emissions from NBP sources were 47,033 tons (9 percent) below the regional emission cap. Fourteen states and the District of Columbia had emissions below their allowance budgets, collectively by 70,960 tons. Another six states (Alabama, Indiana, Kentucky, Michigan, Ohio, and Pennsylvania) exceeded their 2008 budgets by a total of 23,927 tons, indicating that some sources within those states covered a portion of their emissions with allowances banked from earlier years or purchased from the market.

Figure 4: State-level Ozone Season NO_x Emissions from NBP to CAIR, 1990–2010



Scale: Largest bar equals 241,000 tons of NO_x emissions in Ohio, 1990.

Note: Projected emissions in 2010 represent estimated reductions due to the implementation of CAIR.

Source: EPA, 2009

In any given year, emission control programs experience variation in emissions from individual units due to a wide range of conditions, including weather, electricity demand, transmission constraints, fuel costs, and compliance strategy. As Appendix B shows, 17 states had lower NBP ozone season emissions in 2008 compared to 2007, while only three states and the District of Columbia had increased emissions. The drop in emissions between 2007 and 2008 was primarily the result of lower electricity demand, with regionwide heat input declining six percent from 2007 levels. Only one state (Maryland) experienced a relatively sharp decline in NO_x emissions that coincided with a decline in NO_x emission rate, with the average rate for NBP units falling from 0.23 lb/mmBtu to 0.16 lb/mmBtu. Other states saw only subtle differences in their NO_x emission rate (changes of 0.02 lb/mmBtu or less). The District of Columbia saw an increase of 0.06 lb/mmBtu, reflecting the year-to-year variability in emission rate given the District's small set of affected units.

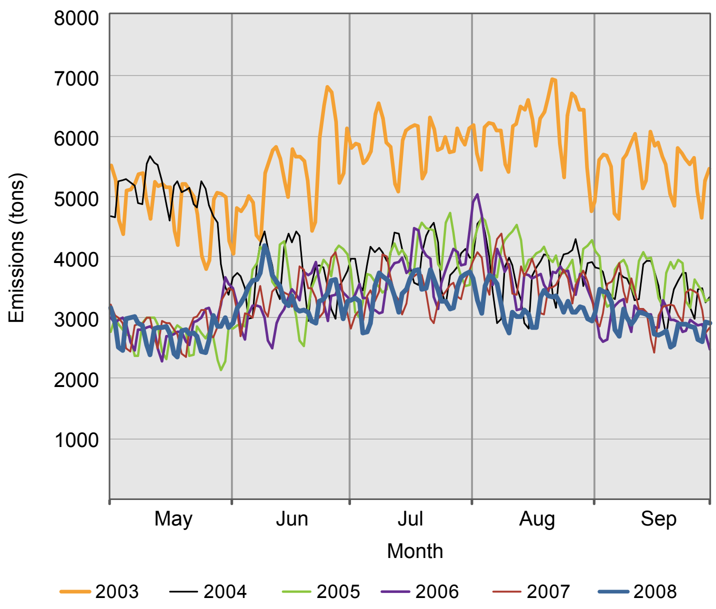
In total, sources in all states reduced NO_x emissions dramatically since the start of the program, despite a slight increase in heat input. Detailed unit-level data are available in Appendix 1, online at <http://www.epa.gov/airmarkets/progress/progress-reports.html>.

High Electric Demand Days

Since the inception of the NBP in 2003, overall seasonal NO_x emissions decreased each year through 2008 as NBP emission reduction requirements led EGUs to install pollution control equipment. Even with these seasonal reductions, periods of hot weather and related high electricity demand often elevate peak NO_x emissions on a given day. High demand for electricity is heavily tied to weather and is driven primarily by the use of air conditioning on hot days. It is significant that during the 2008 ozone season, emission levels on peak demand days were lower than those seen in previous years. For example, Figure 5 shows that in contrast to past years' peak NO_x levels (early August 2007, late July/early August 2006, late July 2005, and mid-July 2004) daily emissions peaked in early June 2008 at a lower level (4,203 tons) than all prior NBP years.

Further EPA analysis found that the average NO_x emission rate for the 10 highest electric demand days (as measured by megawatt hours of generation) consistently fell every year of the NBP, from 0.277 lb/mmBtu in 2003 to 0.156 lb/

Figure 5: Comparison of Ozone Season Daily NO_x Emissions for All NBP Units, 2003–2008



Note: The relatively high May 2004 daily emissions represent the delayed May 31st compliance date that year for non-OTC states.

Source: EPA, 2009

mmBtu in 2008. This 44 percent drop occurred despite a slight increase in electricity demand for 2008 compared to 2003.

High electric demand days often coincide with National Ambient Air Quality Standards (NAAQS) exceedances. Because of continued nonattainment in some portions of the NBP region, EPA, states, and others are investigating additional programs and policies that could provide further emission reductions from targeted sources on these days. With the promulgation of a new, tighter ozone NAAQS in March 2008, stakeholders will likely continue to focus on these types of targeted measures, such as demand-side strategies (e.g., energy efficiency, demand response, clean distributed energy sources), fuel switching, selective non-catalytic reduction (SNCR), water injection, and smarter trading. Smarter trading is a potential market design strategy that uses weather and atmospheric chemistry forecasts to vary the price of NO_X allowances to more finely control the impacts of NO_X emissions on ozone formation.

In addition, stakeholders are also pursuing NO_X reduction strategies for the mobile source sector, such as commuter car taxes in major metropolitan areas.

Compliance Results

Annual Reconciliation

Under the NBP, affected sources had to hold sufficient allowances to cover their ozone season NO_X emissions each year. Sources could maintain the allowances in compliance accounts (established for each unit) or in an overdraft account (established for each facility with more than one unit). Sources could buy or sell allowances throughout the year, but had only two months at the end of the ozone season to complete their transactions to ensure their emissions did not exceed allowances held. After the two-month period, EPA froze activity in compliance and overdraft accounts and reconciled emissions with allowance holdings to determine program compliance.

There were 2,568 units affected under the NBP in 2008. Of those units, only two units at separate facilities failed to hold sufficient allowances to cover their emissions (63 tons total). One gas-fired combined cycle unit was out of compliance by only one ton while the second unit, at an industrial cogeneration facility, was out of compliance by 62 tons. Affected facilities transitioned to the

Table 2: NO_x Allowance Reconciliation Summary for the NBP in 2008

Total Allowances Held for Reconciliation (2003 through 2008 Vintages)	755,684
Allowances Held in Compliance or Overdraft Accounts	673,336
Allowances Held in Other Accounts*	82,348
Allowances Deducted in 2008	482,476
Allowances Deducted for Actual Emissions	481,147
Additional Allowances Deducted under Progressive Flow Control (PFC)	1,329
Banked Allowances (Carried into 2009 CAIR NO_X Ozone Season Program)	273,208
Allowances Held in Compliance or Overdraft Accounts	188,003
Allowances Held in Other Accounts**	85,205
Penalty Allowances Deducted*** (from 2009 CAIR NO_X Ozone Season Program Allocations)	189

Notes:

* "Other Accounts" refers to general accounts in the NO_X Allowance Tracking System (NATS) that can be held by any source, individual, or other organization, as well as state accounts.

** Total includes 2,857 unused new unit allowances returned to state holding accounts.

*** These penalty deductions are taken from 2009 vintage year CAIR NO_X ozone season allowances, not 2008 allowances.

Source: EPA, 2009

As of April 1, 2009, the reported 2008 ozone season NO_x emissions by NBP sources totaled 481,420 tons. Because of variation in rounding conventions, changes due to resubmissions by sources, and allowance compliance issues at two units, this number is higher than the number of emissions used for reconciliation purposes shown in Table 2 (481,147 tons). Therefore, the total number of allowances deducted for actual emissions in Table 2 differs from the number of emissions shown elsewhere in this report.

Reported emissions (tons):	481,420
Rounding and report resubmission adjustments (tons):	-210
Emissions not covered by allowances (tons):	-63
Total allowances deducted for emissions:	481,147

CAIR NO_x ozone season program on May 1, 2009. Accordingly, the two units out of compliance automatically surrendered first year (2009) CAIR NO_x ozone season program allowances on a 3:1 basis, or 189 allowances total. Table 2 (on page 6) summarizes the allowance reconciliation process for 2008, and the textbox on this page provides details on how reported emissions for the 2008 ozone season translated into allowances deducted for those emissions.

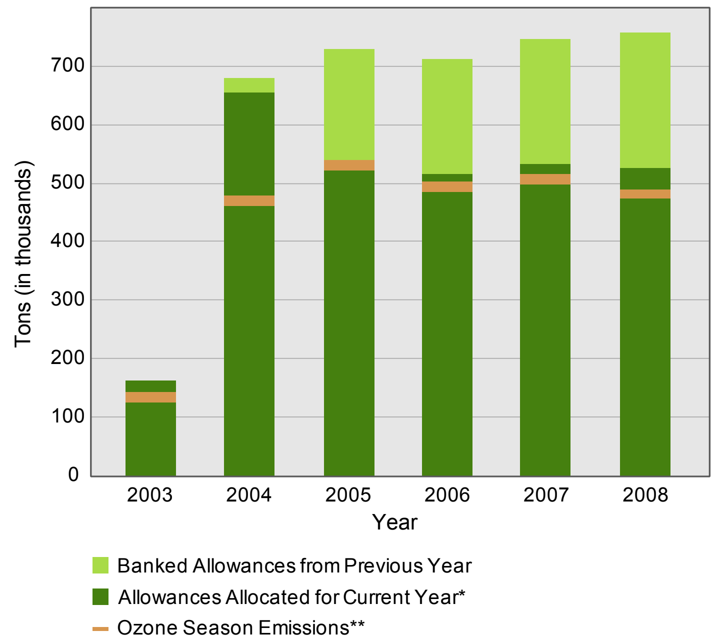
Banking in 2008

In general, under cap and trade programs, banking allows sources that decrease emissions below the number of allowances they are allocated to save the unused allowances for future use. Banking can produce environmental and health benefits earlier than required and provides an available pool of allowances that could be used to address unexpected events or smooth the transition into deeper emission reductions in future years. Figure 6 shows the allowances allocated each year, the allowances banked from the previous year, and the total ozone season emissions subject to allowance holding requirements for NBP sources from 2003 to 2008. With emissions well below the regional budget in 2008, the bank grew to 273,208 allowances by the end of the 2008 ozone season. Additionally, 2008 marked the fifth of six compliance years in which sources achieved more reductions than required under the NBP and were able to bank allowances for use in future years.

On May 1, 2009, the NBP transitioned to the CAIR NO_x ozone season program. As part of this process, EPA transferred the bank of NBP allowances to CAIR NO_x ozone season accounts for use under CAIR in 2009 and beyond. In addition, EPA transferred some allowances from the primary reserve accounts of two states. These 2,159 allowances were not counted in Table 2 because they were allocated by the state after reconciliation was completed. In total, EPA transferred 275,367 allowances from the NBP to the CAIR NO_x ozone season program.

The NBP included progressive flow control provisions, designed to discourage extensive use of banked allowances in a particular ozone season. Flow control was triggered when the total number of allowances banked for all sources exceeded 10 percent of the total regional budget for the next year. When this occurred, EPA calculated the flow control

Figure 6: NO_x Allowance Allocations and the Allowance Bank, 2003–2008



Notes:

* Allowances allocated may include those issued by states from base budget, compliance supplement pool (CSP) (available only for the first two years of compliance), and opt-in allowances. Not all budgeted allowances were necessarily issued by the states each year.

** This graph represents only those emissions from states that were subject to compliance each year. Thus, the 2003 total ozone season emissions includes emissions only from OTC states. The 2004 total represents emissions from non-OTC states in the NBP (except Missouri) during a shortened control period (May 31 to September 30) and OTC states during the full control period (May 1 to September 30). The 2005 and 2006 emissions represent the full ozone season for all participating NBP states, except Missouri. The 2007 data is the first year in which the ozone season emissions represent all NBP states, including Missouri.

Source: EPA, 2009

ratio by dividing 10 percent of the total regional NO_x trading budget by the number of banked allowances (a larger bank thus resulted in a lower flow control ratio). The flow control ratio established the percentage of banked allowances that could be deducted from a source's account on a 1:1 ratio of one allowance per ton of emissions. The remaining banked allowances, if used, had to be deducted at a 2:1 ratio of two allowances per one ton of emissions. In 2008, the flow control ratio was 0.22, and 1,329 additional allowances were deducted from the allowance bank under the flow control provisions.

Flow control, however, will no longer apply in 2009 and beyond with the transition to CAIR. Thus, the transferred NBP allowances may be used under CAIR with no restrictions or time limits on a straight 1:1 basis.

Continuous Emission Monitoring Systems

Accurate and consistent emissions monitoring is the foundation of a cap and trade system. EPA has developed detailed procedures (40 CFR Part 75) to ensure that sources monitor and report emissions with a high degree of precision, accuracy, reliability, and consistency. Sources use continuous emission monitoring systems (CEMS) or other approved methods. Part 75 requires sources to conduct stringent quality assurance tests of their monitoring systems, such as daily and quarterly calibration tests and a semiannual or annual relative accuracy test audit. These tests ensure that sources report accurate data and provide assurance to market participants that a ton of emissions measured at one facility is equivalent to a ton measured at a different facility.

While many NBP units with low levels of emissions did not have to use CEMS, the vast majority—over 99 percent—of the NO_x emissions under the NBP were measured by CEMS. Coal-fired units were required to use CEMS for NO_x concentration and stack gas flow rate (and if needed, a diluent carbon dioxide or oxygen gas monitor and stack gas moisture measurement) to calculate and record their NO_x mass emissions. Oil-fired and gas-fired units could use a NO_x CEMS in conjunction with a fuel flowmeter to determine NO_x mass emissions. Alternatively, for oil-fired and gas-fired units that either operated infrequently or had very low NO_x emissions, Part 75 provided low-cost alternatives for NBP sources to conservatively estimate NO_x mass emissions.

In all, about 70 percent of NBP units used CEMS in 2008, including 100 percent of coal-fired units, 66 percent of gas-fired units, and 28 percent of oil-fired units. The relatively low percentage for oil-fired units was consistent with the decline in oil-fired heat input, as most of these units were used infrequently and qualified for reduced monitoring.

Compliance Options

Sources could select from a variety of compliance options to meet the emission reduction targets of the NBP in ways that best fit their own circumstances. Compliance options included:

- Installing NO_x combustion controls, such as low NO_x burners;
- Installing add-on emission controls, such as Selective Catalytic Reduction (SCR) or Selective Non-Catalytic Reduction (SNCR);
- Using banked allowances or purchasing additional allowances from other market participants that reduced emissions below their allocations;
- Decreasing or stopping generation from units with high NO_x emission rates, or shifting to lower emitting units, during the ozone season; and
- Using combinations of the above options.

How Controls Work

- Combustion Controls — Low-NO_x burners and overfire air ports are combustion controls that change the proportion of air to fuel in the combustion zone. This causes combustion to occur in stages, lowering the flame temperature and promoting complete combustion. With a lower flame temperature, less of the nitrogen (N_2) from air is converted to NO_x. Minimizing the time of N_2 exposure to high combustion zone temperatures also minimizes NO_x formation.
- SCR — Selective Catalytic Reduction (SCR) is an add-on post-combustion control that converts NO_x, created during the combustion process, back to N_2. Ammonia (NH_3) is injected into flue gas before it travels through a fixed bed of catalyst material. The catalyst promotes a reaction between NO_x and NH_3 to form water vapor and nitrogen. SCR can be applied to a wider range of sources than SNCR (see below) and delivers higher NO_x removal rates.
- SNCR — Selective Non-Catalytic Reduction (SNCR) is an add-on control that is used in boilers to convert NO_x back to N_2. It involves injecting a reagent (ammonia or urea) into the furnace just after the combustion zone. In this high temperature zone, a non-catalytic reaction takes place, converting NO_x to N_2 and water vapor (and carbon dioxide if urea is used).

NO_x Controls in 2008

Of the 2,563 units that operated in 2008 (out of a total of 2,568 affected units), approximately 30 percent were non-controlled (see Table 3), a share that has remained stable since the start of the program in 2003. As Figure 7 shows, however, the average ozone season NO_x emission rate for all non-controlled units dropped dramatically, by over 50 percent, from 0.425 lb/mmBtu in 2003 to 0.211 lb/mmBtu in 2008. The following section presents results from an EPA examination of this striking drop in emission rate among non-controlled units.

The group of non-controlled units in the NBP included coal-, oil-, and gas-fired units. While the overall number of units did not change significantly from 2003 to 2008, the fuel mix shifted, primarily from coal to gas. Figure 7 illustrates this trend as the number of non-controlled coal-fired units dropped by 34 percent, from 182 units in 2003 to 120 in 2008, while gas units increased by 17 percent, from 261 to 306.

Further evidence of this shift can be seen in the trends in heat input, a measure of fuel consumption indicating how intensely various units are operating. As Figure 7 indicates, ozone season heat input for non-controlled coal units decreased significantly since the start of the program. In 2003, coal made up 68 percent of non-controlled heat input; by 2008 that share had dropped below 50 percent. During this same period, oil usage also fell by over 50 percent. The drop in utilization of coal and oil units was made up by gas, which experienced a 65 percent increase in heat input between 2003 and 2008, with gas accounting for nearly 40 percent of the non-controlled heat input in 2008. Because the NO_x emission rate of gas units without any controls is considerably lower than coal or oil, this fuel switching accounts for much of the improvement (lower emission rate) in the non-controlled units as a group.

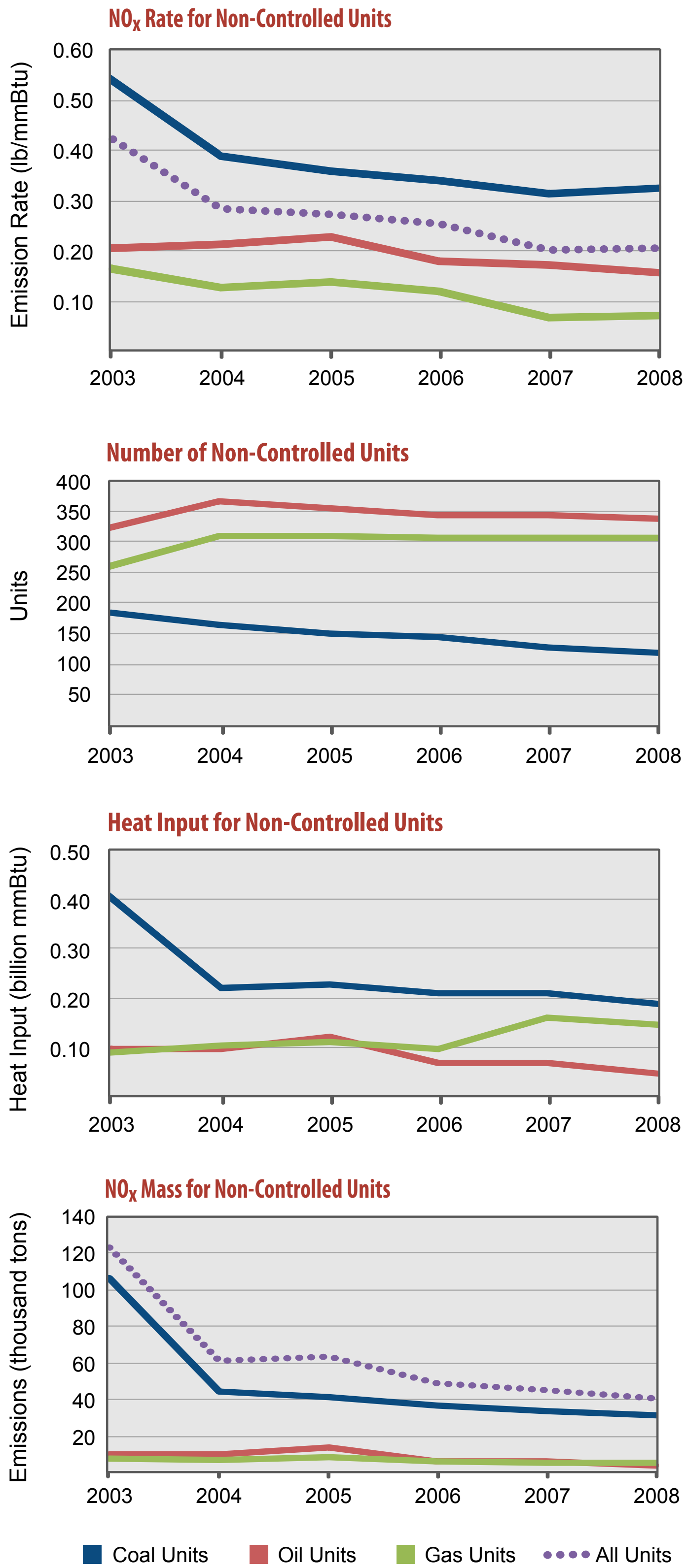
Fuel switching, however, does not entirely explain the drop, given that the improvement in NO_x emission rate holds across all three fuel types (see Figure 7). One of the as-

Table 3: NBP Operating Units by Control Type in 2008

Control Type	Number of Units	Percent of Total
Non-controlled	762	30%
Combustion	803	31%
SCR	435	17%
SNCR	101	4%
Other Control	462	18%

Source: EPA, 2009

Figure 7: Summary Ozone Season Data, 2003–2008



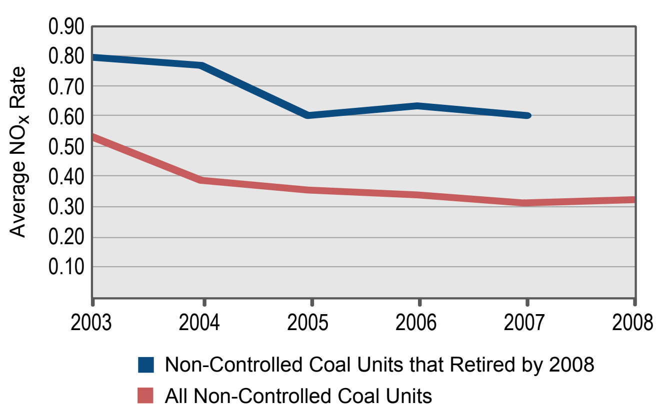
Source: EPA, 2009

sumptions that underlies cap and trade programs is that the "dirtiest" units are more likely to either be retired, used less often, or be retrofitted with controls. Out of the 132 NBP units that retired since 2003, 91 were non-controlled, and 33 of those were coal-fired boilers with decades of service stretching as far back as the end of World War II. EPA examined whether the assumption about the dirtiest units holds true for the NBP by comparing the performance of the 33 retired, non-controlled, coal-fired units to similar units that stayed in service.

The 2003 ozone season NO_x rate for the 33 coal-fired units that retired was 0.797 lb/mmBtu. These units were dirtier than average, and had a considerably higher emission rate compared with the average 2003 emission rate of 0.538 lb/mmBtu for the group of all 182 non-controlled, coal-fired units (see Figure 8). Also, by the end of the NBP, not only had 33 of the coal-fired units retired, an additional 41 units were retrofitted with NO_x controls. After ranking the non-controlled, coal-fired units by their 2003 NO_x emission rates, EPA found that nine of the top ten least efficient units either retired or added controls by 2008. With the less efficient units taken out of service each year and the addition of controls on many of the remaining units, the NO_x emission rate for this group of units fell 40 percent from 2003 to 2008.

In conclusion, sources in a cap and trade program may take a variety of measures to meet compliance obligations, including fuel switching, retiring less efficient units, and adding controls. This examination of non-controlled units demonstrates that all three strategies were at work in the NBP.

Figure 8: Comparison of Ozone Season NO_x Emission Rate for Retired versus Active Non-Controlled Coal Units, 2003–2008



Note: Non-controlled coal units that retired by 2008 did not report emissions in 2008.

Source: EPA, 2009

Market Activity

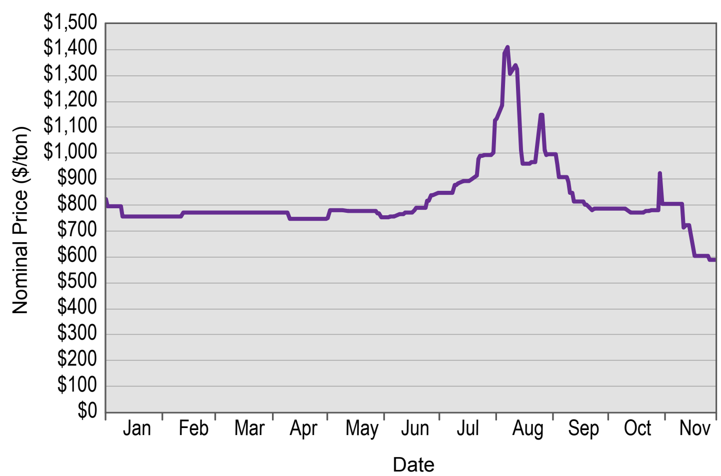
NO_x Allowance Prices

The 2008 NO_x allowance market experienced a 28 percent price decline—beginning the year at $825 per ton in January and climbing as high as $1,413 during the middle of the year before falling to a period-end closing price in November of $592 per ton (see Figure 9).

In 2008, the final year of the NBP before CAIR went into effect, NBP emissions were 5 percent below 2007 levels. Not surprisingly, the downward tendency of allowance prices that occurred from 2003 to 2007 continued into 2008 (although there was a sharp price spike in August following the court decision to vacate CAIR). During the ozone season, NBP sources emitted 47,033 tons fewer than their overall budget, and the allowance bank increased to 273,208. This increase contributed to the lower allowance prices. These banked allowances have been converted to CAIR NO_x ozone season allowances as of January 1, 2009 and will be available for compliance purposes under CAIR.

In a cap and trade program, sources may purchase allowances as part of their compliance strategy. Because abatement costs are not the same for all sources, the flexibility offered by cap and trade programs (e.g., choice of controls, efficiency, buy/sell/bank allowances) allows sources to achieve emission targets at a lower cost than through a command and control program. By allowing sources to buy, sell, and bank allowances in order to comply with the

Figure 9: NO_x Allowance Spot Price (Prompt Vintage), January 2008–November 2008



Note: Prompt vintage is the vintage for the "current" compliance year. For example, 2008 vintage allowances were considered the prompt vintage until the true-up period closed at the end of November 2008.

Source: CantorCO2e's Market Price Indicator (MPI), 2009; see <www.emissionstrading.com>

program's emission reduction requirements, a market for emission allowances can emerge, and the allowance price should ultimately reflect the marginal cost of emission reductions. Emission control decisions can then be made based on the cost of control options relative to the market price of allowances. The allowance price motivates those who can reduce their facility's emissions at a relatively low cost to make those investments and then sell their surplus allowances to those with higher marginal reduction costs.

Looking ahead to the CAIR NO_x allowance markets (ozone season and annual), it is EPA's expectation that the CAIR NO_x annual cap will absorb most of the capital costs of controls (i.e., SCRs). These capital costs will most likely be reflected in allowance prices in the CAIR NO_x annual market, while the NO_x ozone season allowance prices will primarily be driven by the operating costs of controls. The final 2008 NBP NO_x allowance price was below the total expected control cost, and continued to reflect the variable costs of SCR operation. Therefore, EPA sees the SCR operating cost acting as a surrogate price floor for the CAIR NO_x ozone season allowance price—at least until EPA promulgates a new rule to replace CAIR.

On July 11, 2008, the U.S. Court of Appeals for the D.C. Circuit issued a ruling vacating CAIR in its entirety. EPA and other parties requested a rehearing, and on December 23, 2008, the Court revised its decision and remanded CAIR to EPA without vacatur. This ruling leaves CAIR and the CAIR Federal Implementation Plans (FIPs)—including the CAIR trading programs—in place until EPA issues new rules to replace CAIR. EPA estimates that development and finalization of a replacement rule could take about two years.

As currently written, the CAIR NO_x ozone season program includes six additional eastern states (Arkansas, Florida, Iowa, Louisiana, Mississippi, and Wisconsin) and full state coverage in Alabama, Missouri, and Michigan. The 2009 CAIR NO_x ozone season cap is 580,000 tons.

Transaction Types and Volumes

NO_x allowance transfer activity includes two types of transfers: EPA transfers to accounts and private transactions. EPA transfers to accounts include the initial allocation of allowances by states or EPA, as well as transfers into accounts related to special set-asides. This category does not include EPA transfers used to retire allowances. Private transactions include all transfers initiated by authorized account representatives for any compliance or general account purposes.

As Figure 10 shows, trends in market activity continue to show an active market based on a look at overall NO_x allowance transfer activity. Although the overall volume was lower in 2008 than in previous years, the market remains active.

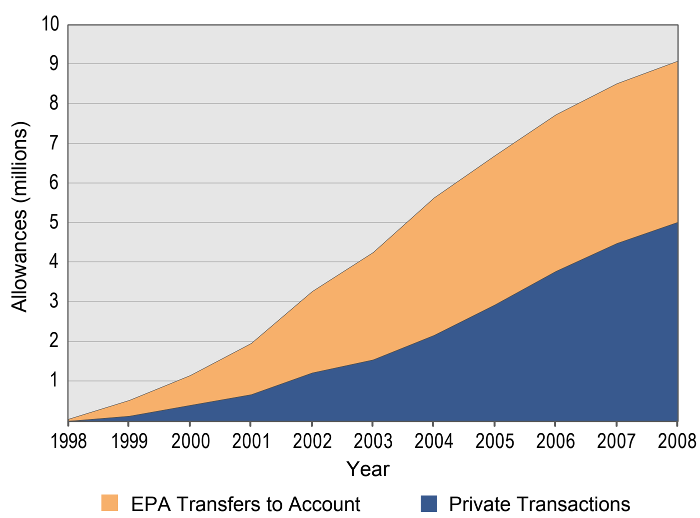
> **What Is the Difference between Marginal Cost, Operating Cost, and Capital Cost?**
>
> In the context of the NBP allowance market, marginal cost is the cost to reduce one additional ton of NO_x emissions. Operating costs are the day-to-day costs of operating and maintaining an emission control technology. Capital costs are the one-time setup cost of installing a control technology, after which there will only be recurring operating costs.

To help better understand the trends in market performance and transfer history, EPA classifies private transfers of allowance transactions into two categories:

- Transfers between separate and distinct economic entities, which may include companies with contractual relationships such as power purchase agreements, but excludes parent-subsidy types of relationships. These transfers are categorized broadly as "economically significant trades."
- Transfers within a company or between related entities (e.g., holding company transfers between a unit compliance account and any account held by a company with an ownership interest in the unit).

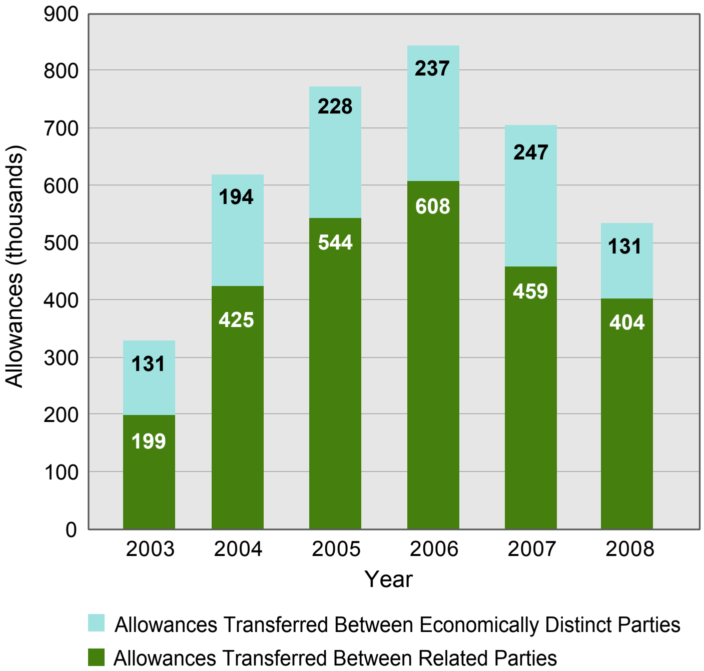
While all transactions are important to proper market operation, EPA follows trends in the economically significant transaction category with particular interest because these transactions represent an actual exchange of assets between unaffiliated participants.

Figure 10: Cumulative NO_x Allowances Transferred, 1998–2008



Source: EPA, 2009

Figure 11: Breakdown of Private NO_x Allowance Transfers, 2003–2008



Source: EPA, 2009

As mentioned, there was a noticeable drop in trading activity in 2008 compared to previous years. In 2008, economically significant trades represented only about 25 percent of the total private trades (down from 35 percent in 2007). The volume of economically significant trades also decreased in 2008, falling from approximately 247,000 trades in 2007 to 131,000 in 2008 (see Figure 11).

Industrial sources continued to participate in the allowance market, accounting for just over 10 percent of the economically significant trade volume, an increase from 2007 levels. In 2008, as in prior years, industrial sources transferred far more allowances to others than they received. Most of these trades were between industrial sources and electric generating companies or brokers, with very few trades involving an industrial source as both buyer and seller.

It is worth noting that more facilities found themselves at or below current cap levels as they reduced NO_x emissions in anticipation of CAIR and thus shifted fewer allowances among their units. It is the drop in economically significant trading by nearly half, however, that is most striking because it signifies a dramatic turnaround from the growth in trading in recent years. This decline in trading is, in large part, a result of uncertainty regarding the value of allowances due to the litigation surrounding CAIR.

Role of Brokers and Their Fees

Brokers play an important role in the emissions allowance markets. They primarily facilitate and conduct trades between willing buyers and sellers, undertaking the direct costs of identifying trading partners and transacting sales at a price acceptable to both parties. In the allowance trading market, the fees charged by brokerage firms are often considered to be transaction costs. These fees are the direct costs associated with buying and selling allowances.

Costs for services are fairly standardized and are generally low compared to the value of allowances—usually within the 1 to 2 percent range of allowance values typically quoted in the economics literature.[1] There is sufficient competition amongst the brokerage houses that any attempt at charging fees in excess of market standards would likely be bid down through existing competition and entry of more businesses able to provide brokerage services. In many instances, larger clients can negotiate fees even lower than market averages. In addition, if a company needs some expert analysis or opinions to maximize the value of its allowances, it may agree to pay additional fees unrelated to the actual execution of the trades. For example, brokers may collect and provide historic and current price information for a cost.

While the majority of transactions are conducted through brokers, emission allowances and derivatives (i.e., futures contracts) may also be traded on exchanges such as the New York Mercantile Exchange (NYMEX) and the Chicago Climate Exchange. The fees charged for conducting business on exchanges appear to be markedly lower than the fees charged by brokerage firms. On a per ton basis, these exchange fees as applied to CAIR NO_x allowances translate to less than $1.00 per ton for seasonal NO_x and up to $2.50 per ton for annual NO_x. These fees are both below the broker fees charged for transactions between two parties.

[1] Personal communication with Gary Hart, ICAP-United, June 25, 2007 as quoted in Napolitano, S., J. Schreifels, G. Stevens, M. Witt, M. LaCount, R. Forte, & K. Smith. 2007. "The U.S. Acid Rain Program: Key Insights from the Design, Operation, and Assessment of a Cap-and-Trade Program." *Electricity Journal*. Aug./Sept. 2007, Vol. 20, Issue 7.

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Appendix A: State Trading Budgets, 2003–2008

STATE	2003	2004	2005	2006	2007	2008
AL	0	34,459	25,497	25,497	25,497	25,497
CT	4,950	4,477	4,477	4,477	4,477	4,477
DC	233	233	233	233	233	233
DE	5,395	5,227	5,227	5,227	5,227	5,227
IL	0	53,245	35,557	35,557	35,557	35,557
IN	0	75,644	55,729	55,729	55,729	55,729
KY	0	49,744	36,224	36,224	36,109	36,109
MA	13,334	12,861	12,861	12,861	12,861	12,861
MD	19,306	15,466	15,466	15,466	15,466	15,466
MI	0	41,154	31,247	31,247	31,247	31,247
MO	0	0	0	0	19,089	13,459
NC	0	42,184	41,547	34,632	34,713	34,703
NJ	9,750	13,022	13,022	13,022	13,022	13,022
NY	44,161	41,388	41,380	41,397	41,397	41,385
OH	0	72,366	49,975	49,978	49,974	49,842
PA	66,606	50,843	50,843	50,843	50,843	50,843
RI	936	936	936	936	936	936
SC	0	25,022	19,678	19,678	19,678	19,678
TN	0	42,045	31,480	31,480	31,480	31,480
VA	0	26,699	21,195	21,195	21,195	21,195
WV	0	46,215	29,501	29,507	29,507	29,507
Totals:	164,671	653,230	522,075	515,186	534,237	528,453

Note: Totals include base budget, compliance supplement pool, and opt-in allowances, as applicable, for a given year and state. Some states may not issue all budget allowances, and so the total budgets presented in this file may be higher than the total allowances allocated as presented in report tables and graphics that depict allowance allocations and allowance bank totals (see, e.g., Figure 6).

Source: EPA, 2009

Appendix B: Ozone Season NO_x Emissions (Tons) from NBP Sources, 1990–2008, and 2008 State Trading Budgets

State	1990	2000	2003	2004	2005	2006	2007	2008	2008 Budget
AL	89,758	84,560	50,895	40,564	33,632	27,812	28,744	30,221	25,497
CT	11,203	4,697	2,070	2,191	3,022	2,514	2,152	1,721	4,477
DC	576	134	72	35	279	115	76	133	233
DE	13,180	5,256	5,414	5,068	6,538	4,763	5,454	4,285	5,227
IL	124,006	119,460	48,917	40,976	37,843	36,343	35,630	34,126	35,557
IN	218,333	145,722	100,772	68,375	57,249	55,510	56,374	57,838	55,729
KY	153,179	101,601	63,057	40,394	36,730	37,461	40,210	39,386	36,109
MA	40,367	14,324	9,265	7,481	8,269	5,464	3,666	3,230	12,861
MD	54,375	28,954	19,257	19,944	20,989	18,480	16,521	10,667	15,466
MI	120,132	80,425	45,614	39,848	42,157	40,353	34,354	34,358	31,247
MO	64,272	34,058	29,407	16,190	18,809	15,917	12,961	12,777	13,459
NC	92,059	73,082	51,943	39,821	32,888	30,387	28,390	27,105	34,703
NJ	44,359	14,630	11,003	10,807	11,277	8,692	7,773	7,139	13,022
NY	84,485	43,583	34,815	34,157	36,633	26,339	24,728	20,934	41,385
OH	240,768	159,578	133,043	67,304	54,335	52,817	57,862	54,644	49,842
PA	199,137	87,329	51,530	52,140	51,125	52,806	57,615	56,747	50,843
RI	1,099	288	209	177	253	181	187	161	936
SC	56,153	39,674	34,624	25,377	18,193	18,376	18,418	17,552	19,678
TN	115,348	69,641	55,376	31,399	25,718	23,930	23,261	21,711	31,480
VA	51,866	40,043	32,766	25,448	22,309	20,491	22,957	19,596	21,195
WV	149,176	109,198	69,171	41,333	30,401	28,852	28,967	27,089	29,507
All NBP States	1,923,831	1,256,237	849,220	609,029	548,649	507,603	506,300	481,420	528,453

Notes:

- Emissions for Alabama, Michigan, and Missouri are for units in the portion of the state that became subject to the NBP in 2004 (Alabama and Michigan) and 2007 (Missouri).
- The 2008 state budget values include opt-in allowances, where applicable (New York, Ohio, and West Virginia).
- Emissions for prior years reflect emission resubmissions as of April 1, 2009, and may differ slightly from numbers that appear in previous progress reports.

Source: EPA, 2009