

***Allowance Markets Assessment:
A Closer Look at the Two Biggest Price Changes in the
Federal SO₂ and NO_x Allowance Markets***

**White Paper
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Cap and trade programs in the United States have garnered many accolades for achieving significant emission reduction goals at the lowest cost possible to the public. As these programs continue to gain attention and momentum builds toward broader global application, one concern voiced by some outside observers is unexpected price volatility in the allowance markets that underpin these programs. In order to investigate and help address this concern, EPA examined two particular time periods in two different cap and trade programs where prices increased most significantly: the SO₂ market in late 2005/early 2006 and the NO_x market in early 2003. In both of these cases, allowance prices have temporarily risen to levels beyond those projected by EPA-based market fundamentals before self-correcting.

To best understand the dynamics of these situations, EPA sought input from the major power companies, brokers and traders most active in the allowance markets during these periods and also researched our own records and resources, which are all publicly available through the Clean Air Markets web site at www.epa.gov/airmarkets.¹ This paper shares the findings from this research.

The price of an allowance in a cap and trade program can be expected to reflect the marginal cost of compliance, or the cost of reducing the next incremental ton of emissions. When there are real or perceived changes in market fundamentals that impact this cost, there are subsequent adjustments in allowance prices. These adjustments can stem from market forces, including the price of coal and natural gas, the demand for electricity related to weather and other factors, and the availability and reliability of technology. They can also stem from regulatory forces, which can impact the overall supply and demand of the market. EPA finds that it is regulatory forces in the form of transitions to significantly more aggressive emission caps that have been the primary impetus behind the most significant price adjustments studied in this paper. EPA also finds that, overall, the allowance markets are generally relatively stable.

¹ EPA primarily utilized the Data and Maps internet application, which provides an easy to use, interactive, and intuitive Web-based interface to view unit, facility, emissions, and allowance data collected as part of EPA's emissions trading programs. Note that when characterizing allowance market activity, it is important that users differentiate between economically distinct transactions and those within organizations in order to get the best sense of true market activity.

The SO₂ Market

Acid Rain Program: Consistently throughout the early years of the Acid Rain Program, allowance prices were significantly lower than projected. Market observers attribute the low cost of allowances to two primary factors: first, the choice of many sources to fuel switch to low cost, lower sulfur coal sourced from parts of Appalachia and the Illinois Basin as well as the newly developed Powder River Basin in Wyoming; and second, to technological innovation, which reduced the expected marginal costs of scrubbers by over 40 percent from original estimates.² Just prior to the beginning of the program in 1995, SO₂ allowance prices on the spot market were close to \$150/ton. The cost of allowances was initially projected to be between \$250 and \$500 per ton during Phase I (1995 to 1999) and \$500 to \$1,000 per ton in Phase II (beyond 2000). Actual allowance prices in Phase I were in the \$100 to \$200 range, with a low of \$65 in 1996. Allowance prices did display some variability (as would commodities in any market), but it was within this very limited range and tended to be concentrated around times of regulatory change or uncertainty, such as the beginning of Phase I in 1995 and the transition to Phase II in 2000. Even as the more stringent Phase II requirements became effective in 2000, however, prices remained generally below the \$200 mark until they started to rise at the end of 2003 with the proposal of the Clean Air Interstate Rule.

EPA worked with consultants to analyze the volatility of SO₂ prices from August 1994 to December 2003 to capture market behavior in the absence of major regulatory adjustments (while the onset of Phase II in 2000 was marked by a tighter limit affecting more sources, it had been anticipated since the passage of the Clean Air Act Amendments in 1990). These findings suggest that the volatility of SO₂ allowance prices in the study period is very comparable to the volatility of other energy related prices, if not generally lower, for the time period considered.³

Transition to the Clean Air Interstate Rule: Once the Clean Air Interstate Rule (CAIR) was proposed in late 2003, the considerable additional SO₂ reductions required in the power sector beginning in 2010 started to influence spot market allowance prices. After CAIR was finalized in March 2005, allowance prices continued to trend upward. CAIR requires significant additional reductions in SO₂ and NO_x emissions from the power sector in the eastern US, on the order of more than a 70 percent and 60 percent from 2003 levels, respectively. Soon after its promulgation, affected sources began responding to

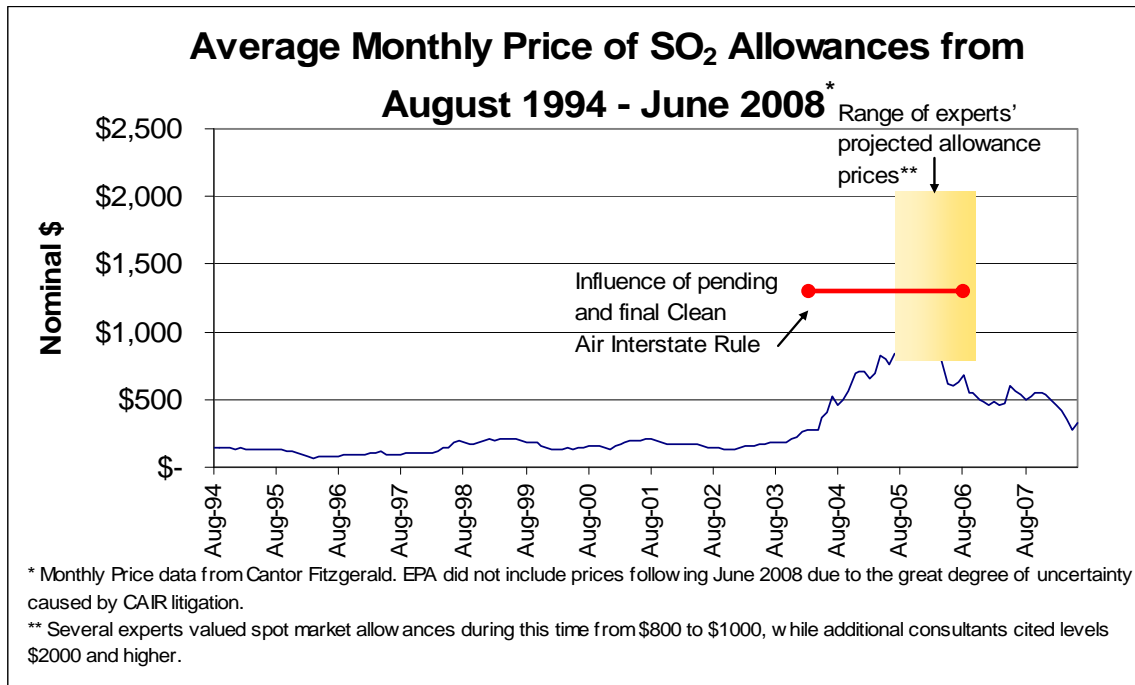
² See Ellerman, A.D., P. Joskow, R. Schmalensee, J. Montero, and E. Bailey, *Markets for Clean Air, The U.S. Acid Rain Program*. Massachusetts: MIT Center for Energy and Environmental Policy Research, Cambridge University Press, 2000. See also Kosobud, Richard F, ed. 2000. *Emissions Trading Environmental Policy's New Approach*. John Wiley & Sons, Inc., New York.

³ "Assessing Allowance Price Volatilities in Cap-And-Trade Programs", memo from ICF Consulting to EPA Clean Air Markets Division, February 22, 2008 and "Initial Comments on Helfand Paper", memo from ICF Consulting to EPA Clean Air Markets Division, January 11, 2008. To make the comparison more consistent, the analysis used companies within the energy industry with similar market capitalization as the SO₂ allowance market (because volatility is likely to be related to size). The analysis used price data to calculate the average and standard deviation and then calculated a volatility measure by dividing the standard deviation by the average. The result was a volatility measure of SO₂ allowance prices of 0.27, lower than those of the energy sector companies in the analysis, which ranged from 0.32 to 0.75.

this future, more stringent cap and new compliance deadline with revised compliance strategies. These strategies included both earmarking capital dollars for new investments in scrubber technology retrofits and the continued use of allowances to transition to this era of necessarily greater reliance upon control technology (scrubbers) for compliance.

CAIR – with its accompanying new requirements and regulatory uncertainties – was the first and most significant driver of the price adjustment that began in 2004 and culminated with prices in the \$1,600 range for a short time in December 2005. See Figure 1. The Acid Rain SO₂ market essentially became the CAIR SO₂ market: SO₂ allowance prices factored in the marginal cost of future compliance with CAIR and the increased future value of current banked allowances in the new program. (While 2010 and later vintage allowances would be discounted under CAIR, pre-2010 vintages could be used 1:1 for CAIR compliance.)

Figure 1. A Long History of Relatively Stable Prices in the National SO₂ Market with the Exception of the Transition to CAIR’s Aggressive New Emission Caps



Note that prices are monthly averages, as reported by most emissions brokers. Prices can also be averaged on a daily or weekly basis and display greater variation but this distracts from the longer term trends that help define the market and shape the participants' choices.

EPA’s CAIR modeling projected that pre-2010 vintage allowances would be worth \$736 per ton in 2010 (\$2007) and allowance prices ended 2004 in the \$700 range. EPA’s conversations with the most active participants in the market at the time of the highest SO₂ prices led to an interesting realization: a number of the most respected and reputable consulting firms thought that spot market allowances should be valued more along the lines of \$800 to \$1000 under the new control program CAIR set in place. Several experts

placed appropriate price levels in this range⁴, and some additional authorities cited levels as high as \$2000 and potentially exceeding even the penalty price.⁵ The range of estimates we came across is included in Figure 1 for reference (except for the penalty price, somewhat of an outlier in the estimates). Several major participants in the market at that time indicated that these estimates of higher allowance prices due to CAIR influenced significant market actors, increasing their willingness to purchase allowances at these prices. A major portion of the US power sector (close to 70 percent of total capacity) continues to be highly cost-regulated and hence relies heavily upon outside opinions to justify “prudent” decision making when seeking cost recovery from state public utility commissions.

Most of the price increase at the outset appears to be purely based on the changing market fundamentals as they were assessed by experts that power companies and traders relied on in evaluating the impacts of the more restrictive new CAIR regulations. A major change in the SO₂ reduction program induced most of the change, as would be expected. (Notably, some traders noted that prior to the CAIR-induced higher allowance prices, SO₂ allowances were undervalued in the market). However, there were also some other factors that applied some upward pressure on allowance prices late in 2005.

Other Market Factors: The power sector is generally very cautious, a characteristic more notable in times of uncertainty or regulatory change. Major power companies with substantial coal-fired generation assets wanted to be very sure they had enough allowances to cover future obligations rather than have allowances serve as an operating constraint in meeting future power market demands, even if that meant paying somewhat higher prices (especially when their purchases were backed by expert opinions and in most cases costs simply passed on to consumers as with changing fuel costs). EPA’s conversations with major market participants reinforced that notion. It is important to keep in mind that the main compliance alternatives to buying allowances were primarily installing scrubbers or switching to natural gas at some locations. With natural gas prices peaking in the fall of 2005, and a minimum lead time of two to three years to install scrubbers, significant allowance holders were inclined to sit on or “bank” (save) their holdings.

As allowance prices increased towards December 2005, compliance deadlines with the Acid Rain Program loomed just a few short months away (February 28th is the annual

⁴ EPA had three sources for this data: 1) CERA: SO₂ Market Commentary: Prices Fall, but Market Remains Tight, February 27, 2006 Insight; 2) PIRA Energy Group: Hot Summer, Hot Markets, August 2005; and 3) Power and Energy Analytic Resources: The NO_x-SO_xMeter, Volume OS-06 v. 1, January 31, 2006.

⁵ Congress established a Title IV penalty price of \$2,000 per ton in 1990, adjusted annually for inflation. The penalty price for the 2008 compliance year was \$3,337. EPA had two sources for this data: 1) Gary Payne, Dominion Energy Clearinghouse: NO_x and SO₂: Balancing Environmental Compliance and Economics, American Coal Council, 2005 Issue 2; and 2) Merrill Lynch: SO₂ Emissions: Scarcity on the Horizon, December 19, 2005 (prices in the report represent a pre-Appeals Court ruling price level).

deadline by which sources must hold sufficient allowances to cover the previous year's emissions). For companies short of allowances, there was still good reason to participate in the market. Larger companies continued to buy since prices were still significantly below EPA penalty levels, in line with some expert forecasts, and in many cases still below the per ton cost to install a scrubber. Furthermore, for the more than 700 facilities (nearly 2,300 units) in the program with less than 100 tons of annual SO₂ emissions, high prices were not much of a deterrent in meeting their relatively small allowance buying needs for compliance.

Weather also played a unique role: Hurricane Katrina struck the Gulf Coast on August 29 and Hurricane Rita struck Texas on September 24, 2005. Aside from the far-reaching toll on human life and local economies, these hurricanes had a marked impact on the SO₂ allowance market. The prevailing conclusion was that the natural gas supplies would be dramatically disrupted following these weather events. When the costs of inputs or alternatives change, the economics of compliance change – i.e., a coal burning facility is willing to pay more for allowances to keep burning coal when the cost of switching to natural gas is comparatively much higher or if there is a feared scarcity of allowances. Additionally, with gas prices above fuel oil prices, there could also have been an incentive for steam units with dual-fired capacity to switch to oil, resulting in higher emissions and thus higher demand for allowances and higher prices. It was within a month of these hurricanes that SO₂ allowance prices began increasing at significant rates. At least one consultant directly attributed the price increase to \$1,600 after CAIR promulgation to the soaring gas prices following the hurricanes. Even though the disruption was ultimately less than originally anticipated, perception plays a key role in any market, and the allowance markets are no exception.

EPA's research does not conclude that limited liquidity played a role in the price increase. While the allowance markets certainly cannot compare to the liquidity of financial markets since there are far fewer participants, the SO₂ market is nonetheless a large and diverse one, including 3,500 regulated units as well as numerous entities – from brokers and traders to nonprofits – that are involved for purposes other than compliance. There was also a fairly large bank of allowances (6.2 million by the end of 2005), sufficient to cover compliance needs for several years. EPA found no marked decrease in the volume of allowances transferred that might have indicated a drop in participation around this time.

Interestingly, however, EPA did find that 70 percent of the volume between unrelated companies (as opposed to trading among their own electric generating units) pivoted around the buying and selling of just four companies, including both large power companies and financial firms. This activity represents the participation of a far larger sample of the market, since the traders at financial firms likely act as agents for other customers and all four of these parties were likely buying and selling on behalf of dozens of others.

The substantial activity by financial firms is indicative of market evolution. The early SO₂ market generally saw trading only among power plants, often supported by emissions

brokers, who have played an important role in facilitating market activity. As the program continued, some power companies grew more sophisticated, running their own trading operations. Separately, firms operating specialized trading operations entered the market to seek arbitrage opportunities. These firms help increase trading activity and efficiency. However, the vast majority of allowances are held and traded among the power companies, either directly or through brokers or traders in the investment community. As prices rose, some participants made money as a result of allowance sales, but EPA believes the main drivers were the changes in the fundamental market situation (e.g., the introduction of CAIR followed by the gas supply disruption), and the penchant for caution displayed by major power companies whenever a new program begins.

Following the market highs in late December 2005 and January 2006, prices dropped substantially in response to a number of factors. High prices encouraged some allowance holders to start selling their holdings (in some cases, quite large amounts), which immediately began to allay fears of allowance shortages. Additionally, after December highs, gas prices began to fall in a trend that would continue throughout most of the rest of the year. Further, market players became increasingly aware that scrubbers needed to achieve the additional reductions required by CAIR were in fact being installed. Others in the market gained a sense that over time, with scrubbers coming on line (and other factors also contributing to downward price pressure,) the prices of allowances should be much lower. With this awareness, power companies (the most substantial participants in the market) and others saw that fundamentals in a new CAIR trading program priced allowance values for the long term well under \$1,000 per ton, and the prices dropped to this level.

The NO_x Market

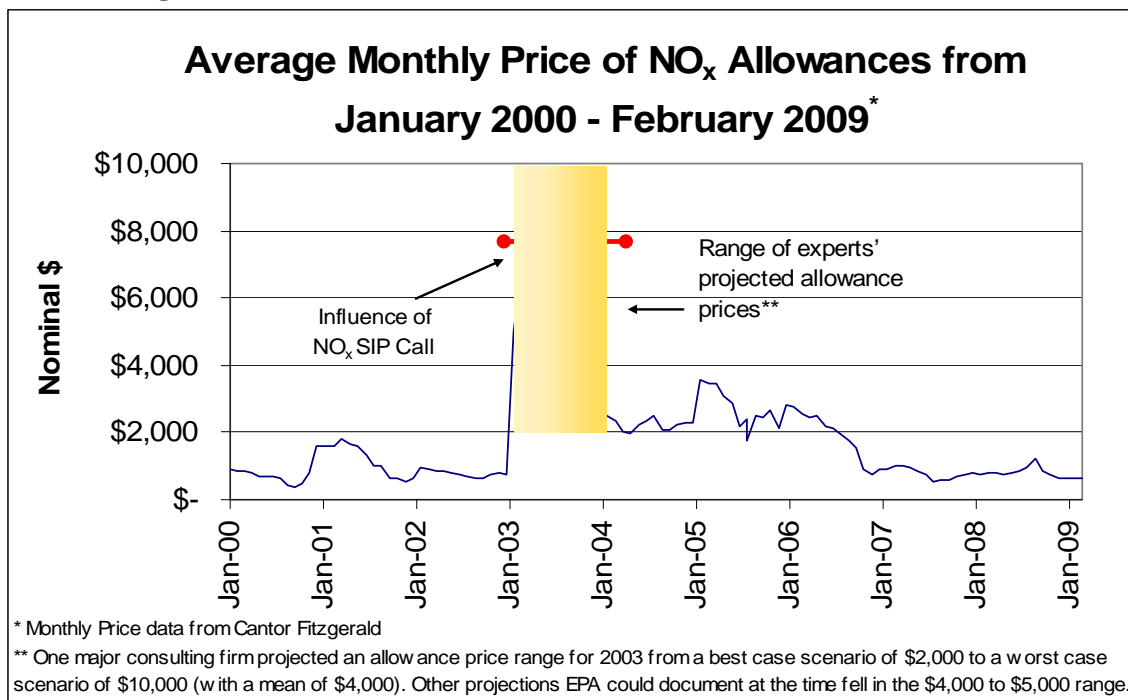
Ozone Transport Commission: The NO_x allowance market first began in 1999 when the Ozone Transport Commission implemented a multi-state cap and trade program to control NO_x emissions in the Northeast and address regional transport of ozone. After initial price increases beginning just prior to the 1999 ozone season (largely because of the uncertain participation of one state), prices fell throughout the rest of 1999 and generally settled within an expected range.

Transition to NO_x Budget Trading Program: Beginning in 2003, the Ozone Transport Commission Program was replaced by the federal NO_x Budget Trading Program (NBP) under the NO_x SIP call. The NBP is a seasonal cap and trade program for large electric generating units and large industrial boilers, turbines, and combined cycle units designed to achieve most of the substantial reductions required by the NO_x SIP call (based on ozone season NO_x emission rates of 0.15 lb/mmBtu). EPA reported in 2004 that the combined capacity of the add-on control installations to meet NBP requirements was nearly 50,000 megawatts.

As shown in Figure 2, the onset of the new program coincided with an increase in allowance prices beginning in January 2003 and peaking in April before self-correcting. As with the SO₂ case, EPA believes this increase is largely due to the necessary price

adjustment as the market participants prepare to meet new, tougher requirements and adjust accordingly to new fundamentals governing expected marginal costs of abatement, as well as other factors. The temporarily higher prices reflect market uncertainties as companies evaluated information on control installations, energy demand and other external factors that would affect compliance decisions and overall cost of control under the NBP.

Figure 2. The Slightly More Variable History of the Regional Seasonal NO_x Market, Generally Decreasing Over Time with the Exception of Transition to the NO_x SIP Call's Stringent New Limits



EPA talked to affected sources and some outside organizations that advise them on market fundamentals and compliance decisions, and found the range of projected prices for NO_x allowances in 2003 depicted in Figure 2, based on various assumptions regarding gas prices, performance of control technologies and electricity sales, among other things. Among the three companies from which EPA received projections, mean scenarios fell in the \$4,000 to \$5,000 range, but the full range of best and worst case scenarios spanned from \$2,000 to \$10,000.⁶ Interestingly, natural gas prices in 2003 averaged \$5.61, slightly above the \$5.50/mmbtu referenced in one firm's worst case scenario.

EPA's conversations with several affected sources also found genuine concerns whether SCRs could be installed in time for compliance. This concern arose in part due to litigation that threw the SIP call into doubt for some time after its promulgation in 1998,

⁶ EPA had three sources for this data: 1) ICF Consulting, NO_x Emission Market Outlook for 2003. 2) Energy Ventures Analysis Fuelcast Long Term Outlook 2003, and 3) Power & Energy Analytic Resources Long Term Outlook Ozone Season 2001, Chapter IV Mid-Term Scenarios 2003-2004.

causing some affected sources to hold off on control technology installations or stall those that had been initiated. Soon after the D.C. Circuit largely upheld the SIP call in 2000, there was a tangible sense of urgency in the regulated community to start new construction projects or finish stagnant installations to achieve required reductions on time.

Like the SO₂ market, the NO_x market consists of thousands of regulated units (approximately 2,500), as well as numerous brokers, traders and other participants. EPA's conversations with significant market actors as well as our own research lead us to conclude that the price increase was largely the result of the transition to the stringent new program and its associated uncertainties in a cautious environment. As with any market, though, there are a host of other contributing factors taken into account with varying degrees of importance by different market participants.

Other Market Factors: Many stakeholders cited high natural gas prices that were rising through fall 2002 and into spring 2003, and uncertainty regarding these prices, as conditions contributing to temporarily higher prices. As noted previously, gas prices for 2003 were in the neighborhood of one firm's worst-case price scenarios.

Another important factor in all markets is information. In a perfect market, theoretically, there is predictability, liquidity, and complete information. While EPA has worked diligently to make our cap and trade programs and the data systems that support them extraordinarily accessible, there are always different interpretations. For example, note two combating headlines early in the 2003 ozone season: Air Daily posted a reassuring headline "NO_x Allowances, Controls Should Be Adequate For 2003"⁷ in early May 2003, while the very next month Business Wire proclaimed "U.S. NO_x Credit Price Surge Expected to Persist Due to Insufficient Compliance."⁸

Whatever the perceptions, prices dropped through the first ozone season under the federal program. Certainly some of this is attributable to the manifestation of new market fundamentals, increasingly clear as more SCRs came on line and performed as well or better than expected. Additionally, the summer of 2003 was unseasonably cool and natural gas prices decreased as well.

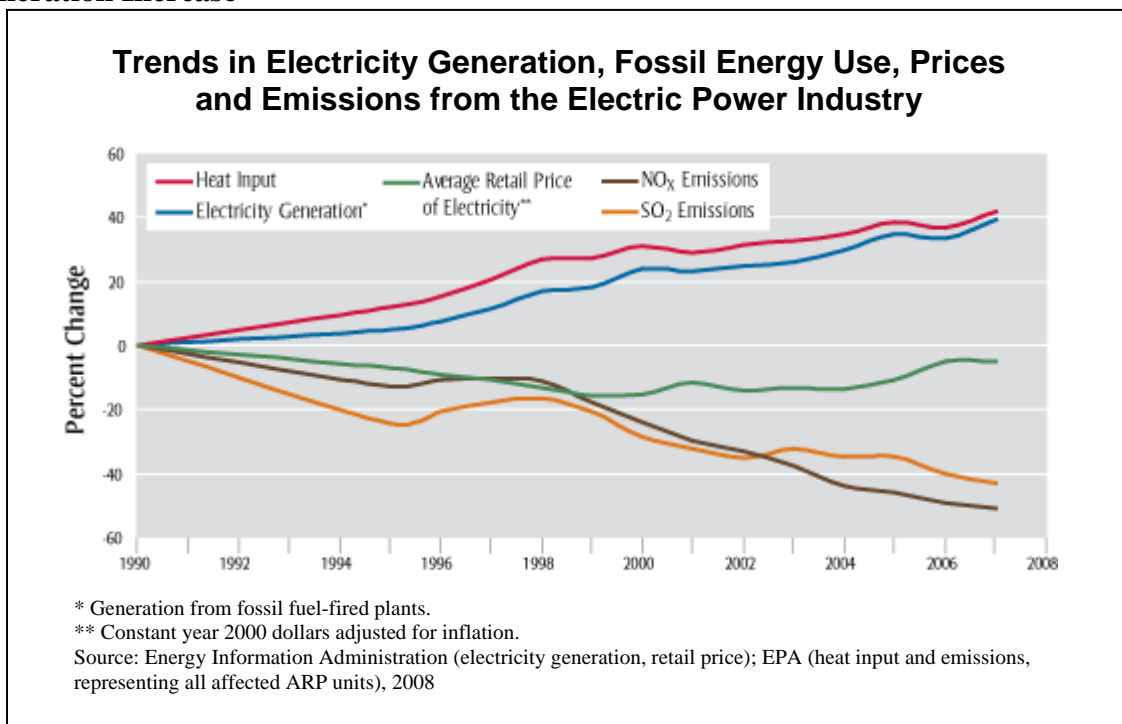
⁷ "NO_x Allowances, Controls Should Be Adequate For 2003" Air Daily, Volume 10, Number 083, May 5, 2003.

⁸ "U.S. NO_x Credit Price Surge Expected to Persist Due to Insufficient Compliance", Business Wire, June 3, 2003, at <http://www.allbusiness.com/energy-utilities/utilities-industry-electric-power/5723609-1.html>

Concluding Thoughts

While EPA's focus in this paper is the allowance market, it is important to keep these observations in context. Regardless of market activity or movements in allowance prices, the core purpose of the cap and trade mechanism is to achieve emissions reductions. Figure 3 shows that irrespective of what occurred in the allowance market, SO₂ emissions have decreased markedly under the Acid Rain Program while the combustion of fossil fuels, measured as "heat input," for electricity generation has increased significantly. These are the core results of the program. Notably, electricity prices have fallen due to restructuring and decreasing fuel prices while these reductions were occurring. Despite a few large increases in allowance prices for short periods of time, we have not seen electricity price jumps, and therefore, consumers have not been hurt by these changes.

Figure 3: Significant Drops in Emissions as Fossil Fuel Combustion and Electricity Generation Increase



The principal driver behind the temporary periods of higher prices in the federal SO₂ and NO_x markets examined in this paper is the advent of aggressive new control programs. Stringent new policies require a market adjustment to account for the new, higher allowance values that more appropriately reflect new, higher costs of compliance. There have been a wide range of allowance cost estimates that market participants have to consider while they learn to adapt to the market situation. As caps shift downward and marginal costs of control increase, market participants use their best judgments about future control costs and market dynamics to make informed decisions. The initial uncertainty about allowance availability and the cautious nature of the regulated entities potentially exacerbate any normally expected increase. Many other factors including fuel

markets, weather, and technology availability and performance can also potentially apply pressure on allowance prices during these periods, as they do continually in other markets.

Market observers should not confuse temporary high prices in the transition to new market dynamics as volatility. We have demonstrated in both programs that a relatively large portion of the increase is a natural adjustment to a new control level, while some portion is related to early market jitters and tends to self-correct relatively quickly. (Notably, the market jitter issue should be reduced by EPA and other sources providing good market information when cap and trade programs begin, or change substantially. Also, a gradual phase in of new programs to lower emissions should reduce price jumps as well.) We have also explained how the concerns of undue volatility in the SO₂ allowance market are misplaced outside of a transition to aggressive new regulations: EPA found that generally speaking, allowance market volatility is no more or less than volatilities of other related energy prices and stock prices of energy-related companies. Further, even in periods of higher prices due to more temporary market influences, there are always options for regulated sources to pursue outside of the allowance market, including switching fuel grades or types and installing controls.

Cap and trade markets have a reputation for delivering cost effective environmental results almost from the beginning, and the achievement of the desired emissions reductions are not affected by changes in the markets. However, EPA strives to make these markets as efficient, effective and transparent as possible to realize the greatest reductions at lowest cost. One way we do so is by continually improving access to information, as we have worked to do since the beginning of the Acid Rain Program. Within the rigid but transparent framework of a cap and trade program, the market is able to assess information and circumstances and adjust in real time to what participants expect to be the costs of meeting environmental goals. Thus far, market history and experience suggest that, once emissions cap and trade programs are established, there is long term, relatively stable emissions allowance market performance with gradually declining prices as significant emission reductions are achieved.