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The First Year of the NO_X Budget*

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One of the largest and most innovative emissions trading programs yet was started up last year, the northeast's NO_X Budget. Designed to address the region's chronic problem of summertime ozone (or smog) problem, it controls emissions of nitrogen oxides (NO_X) from large stationary sources, most of which are power plants. It is important to understand the NO_X Budget for several reasons. First, controlling power plant NO_X may be on the horizon in many places, especially the Midwest. Second, the NO_X Budget has several unique features which might be useful in other proposed emissions trading programs. Third, it shows how restructuring helps make market-based environmental regulation work better.

1 Description

1.1 Basics

The NO_X Budget is similar to other cap-and-trade programs such as the Acid Rain Program for SO_2 and California's RECLAIM program.[1] Regulated firms are allocated a fixed number of allowances and are required to redeem one allowance for every ton of pollution emitted. The allocations are smaller than previous emissions, so regulated firms have four basic options: 1) control emissions to exactly match their allocation, 2) buy allowances to meet this redemption requirement, 3) "overcontrol," and bank allowances for use in future years (when fewer allowances will be allocated), or, 4) overcontrol and then sell their excess.

The NO_X Budget applies to electrical generating units that are rated at 15 MW or larger (although plants below 25MW have less restrictive requirements than those described below) and similar-sized industrial facilities (such as process boilers and refineries), and it covers emissions from May through September in eight northeastern states. There are over 470 individual sources in the program, owned by 112 distinct organizations (mostly firms but some government bodies). The NO_X Budget follows previous command-and-control efforts to reduce NO_X emissions under Title I (NO_X RACT) and Title IV of the Clean Air Act. The program has three phases, the first was essentially a re-labeling of the NO_X RACT program that the states were required to implement anyway. The second and third phases, use a cap-and-trade emission allowance program to reduce total emissions by 55%-65% (compared to uncontrolled sources) for 1999-2002 and by at least 65%-75% starting in 2003. The final Phase III standard is approximately equivalent to 0.15 lb./mmBtu.

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1.2 Multi-lateral Development

Most importantly, the NO_X Budget was not imposed by the Federal Government, it was jointly developed and implemented by several states. The NO_X Budget is best seen as a single cap-and-trade program implemented by individual states who cooperated through two multi-state groups to develop a model rule for all to follow.[2]

Nonetheless, the federal government had a strong influence on the development of the NO_X Budget. The multi-lateral creation of the NO_X Budget is partly due to the fact that the U.S. Environmental Protection Agency (EPA) does not have the statutory authority to implement a centralized emissions program, market-based or otherwise, under Title I of the Act, which is the statutory basis for controlling ozone. Instead, the EPA is required to work with state environmental agencies in creating individual State Implementation Plans. In contrast, Title IV of the Act clearly gave the EPA the authority to implement a national SO_2 program to deal with acidifying deposition. However, the EPA did fund several studies of the proposed regulations and operates systems to track NO_X allowances and monitor NO_X emissions.

Moreover, the states had great incentive to act together, having been grouped together into a special Ozone Transport Region by Section 184 of the Clean Air Act Amendments of 1990. This section also created the Ozone Transport Commission (OTC).[3] The OTC was charged with "developing recommendations for additional control measures to be applied within all or part of such transport region if the commission determines such measures are necessary." After several years of work it was the OTC that initiated the NO_X Budget by signing a Memorandum of Understanding (MOU) on September 27, 1994 that committed the states to emissions reductions as stated above through command and control regulation, but it also provided for the development of a "region-wide trading mechanism". The states worked to develop such a program, including a demonstration project, and by the end of 1996 all of the fundamentals of the NO_X Budget were clear, although it was not yet legally enacted.[4]

Not all the states in the OTC have joined the NO_X Budget program. Vermont and Maine decided to operate traditional permit-based programs, because the small number of sources involved (less than three in each state) and their regulatory status did not justify the administrative burden of developing an emissions trading program. Maryland's program was delayed for a year by a lawsuit from a power company. Finally, Virginia did not join the NO_X Budget and has not taken any other action to regulate the sources that would have been part of the program.

1.3 Controlled Banking

When the NO_X Budget program was being designed, environmental regulators were very concerned that many allowances would be banked, especially if several cool summers occurred in a row, reducing air conditioning load. If so, they feared that power companies would use their banked allowances in a subsequent year, resulting in a "NO_X spike" of higher-than-anticipated emissions. To prevent this from happening, "progressive flow control" (PFC) was introduced. In contrast, banking in the SO_2 program is unregulated, while banking is not allowed in the RECLAIM program.[5]

If the total number of allowances carried over is greater than 10% of the annual allocation for that year, the PFC rule imposes a discount factor of 50% (i.e. two banked allowances would have to be redeemed for each ton of NO_X emitted) for *some* allowances carried over from previous years. The proportion of discounted allowances grows with the size of the bank. This rule creates a strong disincentive to use any discounted allowances. The PFC rule will be especially critical in the first year of Phase 3, 2003, when the total allocation will drop significantly. Unfortunately, this is just when banked allowances might be most valuable to smooth the transition.

Moreover, the structure of the PFC requirement creates a paradox of sorts, a firm would be better off the aggregate number of allowances was small (to avoid invoking PFC) but its own was large (to ease the effect of the PFC rule). Thus, the question of how many allowances to hold is much more difficult in the NO_X Budget than in other emissions trading programs because their value (in terms of emissions) in the future is uncertain, as well as their price.

1.4 Compliance without attainment ?

There are more fundamental difficulties, however. The first is the temporal mismatch between the NO_X Budget and ozone accumulation in the northeast. The NO_X Budget regulates *seasonal* emissions, firms are responsible for redeeming allowances for their total emissions from May through September. But the environmental goal is one of controlling peak ozone concentrations that occur during a relatively small number of *episodes* in the Northeast, typically during the hottest days of summer. Unfortunately, these are also the days when electricity demand is greatest (due to air conditioning load). If power prices rise sufficiently, operators may choose to adjust plant operation for maximum output and make up for any extra NO_X emissions during off-peak periods. This temporal mismatch creates the potential for short-term NO_X spikes and sets up a potential problem, compliance with the NO_X Budget without attainment of the ozone standard.[6] Of course, attaining the standard will require significant emissions reductions in other sectors (particularly in transportation), and we are still several years away from complete phase-in of the NO_X Budget, but this problem will bear further analysis.

The second problem is that ozone is neither a wholly regional nor a wholly localized phenomenon and the photochemistry of ozone is non-linear, so that differences in the locations of sources trading emissions allowances can lead to differences in the effect on ozone concentrations (i.e. "directionality and distance" effects). Generally, however, studies of the overall impact of these effects on actual or proposed emissions trading programs suggests these effects are minimal, although the RECLAIM program limits trading between coastal and inland regions to address this problem.[7]

The OTC understood these problems when it was designing the NO_X Budget. The directionality and distance effects were partially addressed by allocating the fewest allowances (per mmBtu) to sources in an Inner Zone (the Portsmouth, NH-Washington, DC corridor), more to sources in the Outer Zone, and the most to sources in the Northern Zone (The Adirondack region and northern New Hampshire). Several ideas to control emissions during peak demand days were considered, but none was considered feasible.

1.5 Technical differences

A few technical issues made the NO_X Budget particularly challenging. First, there does not appear to be a near-zero cost method to meet NO_X control requirements, as switching low-sulfur coal turned out to be for SO_2 requirements in some cases. Second, the emissions reductions required by the NO_X Budget are deeper than those required by other programs. With a tighter standard, it is tougher to create excess allowances for sale on the market, thus limiting supply. Some firms have voiced concern that the very tight standard imposed in Phase 3 is so low that it will be virtually impossible to overcontrol, eliminating the supply of excess allowances. Thus, NO_X Budget may be more like the lead trading program of the 1980s, which existed only for a short while as the gasoline additive was phased out. Even so, the flexibility in the timing and type of emissions control strategies allowed by the NO_X Budget provides significant improvements in efficiency compared to command-and-control regulations.[8]

But it is by no means clear that an exceptionally tight supply of allowances will develop, several feasible developments could make many allowances available on the market. First,

switching away from coal would free up many allowances. This could happen by switching boiler fuel to natural gas, or by replacing steam boilers with gas-fired combustion turbines, or even fuel cells. However this option is often quite expensive. Second, extremely efficient emissions control technologies are beginning to be commercialized, lowering the floor of cost-effective emissions from coal-fired boilers.[9]

2 Early Outcomes

With the first season of the NO_X Budget in the past and most of the trading for compliance in 1999 completed, it is already possible to take an early look at the outcome of the program. The data come from multiple sources. The EPA reports the size and names of the parties for all transactions. Price information is self-reported by brokers and market participants, but since there is no single clearinghouse for NO_X allowance prices, multiple prices are sometimes reported for the same period. For the data reported here (through the end of November), multiple sources have been compared for consistency, and, where possible, survey data (i.e. independent telephone surveys of several brokers) is used.

2.1 Phase-in was hurried and awkward

The appropriate state laws and regulations needed to implement the NO_X Budget were slow in coming, and a few were the subject of industry lawsuits, adding further to the delay. In some states the implementing legislation and rules were still unclear only six months before the program was scheduled to begin. This was partly due to the reluctance of some state legislatures to accept the model rule, which they had not helped develop. The OTC is made up almost entirely of gubernatorial appointees, and some legislators see it as an inappropriate effort to create an unelected regional government, largely at their expense.

The states faced significant challenges in developing their individual rules, one of the most difficult being the allocation of allowances to the regulated firms, since this involved dividing up a limited number of valuable assets to competing firms. One problem was that different industries have very different regulatory histories and measure their NO_X emissions with different scales, so devising an allocation scheme that was considered fair was both a technical and a political decision. In some states, this decision was made by legislators, in others, by regulators. In either case, the ability of each state to determine how to allocate its allowances was an important factor in gaining sufficient political support to implement the NO_X Budget.

Below, Table 1 shows the allocation of vintage 1999 allowances (i.e. allowances that can be redeemed in 1999 or later) by state. The total allocation was 220,127 – about 25% below 1998 emissions and equivalent to 0.35-0.40 lb./mmBtu.[10] These initial allocation figures were known within a few percent well before the start of 1999, but the number and distribution of Early Reduction Credits was not clear until the beginning of the summer.

Phase-in was also poor by the regulated firms. Although main features of the NO_X Budget program had been known since 1996, many regulated firms did not prepare for its implementation until the last minute. This is partly explained by the fact that firms are unwilling to incur environmental expenses that may turn out to be unnecessary, especially in a competitive environment. In addition, preparing proposed for environmental regulations weakens the position of a firm arguing that such regulations are unneeded or excessive. Further, the incentives to reduce emissions early were poor and uncertain. Finally, the power sector was intensely focused on restructuring during the years just prior to the NO_X Budget.

The most important outcome is that reliable prices were not readily available until very shortly before the program started, too late for firms to respond. Although a few emissions trades were announced as early as January 1998, the NATS system was not on line until September and trading did not begin in earnest until the beginning of 1999. This was a much

shorter phase-in than had occurred in other emissions trading programs, and much less time than power companies prefer to have when planning new equipment installations. This added to the uncertainty in the market and helped cause the steep run-up in allowance prices in the early spring. Inefficient decisions on control technology investment and allowance trading could have been avoided with more information earlier.[11]

Table 1: NO_X Budget Allowance Allocation (1999 vintage)

State	Initial Allocation	Early Reduction and Other Credits	Total	Percent of Total
CT	5,866	446	6,312	3%
DE	6,142		6,142	3%
MD*	(22,881)			
MA	18,145	2,981	21,126	10%
NH	5,119	1,669	6,788	3%
NJ	17,340	3,952	21,292	10%
NY	46,959	7,260	54,219	25%
PA	93,895	9,773	103,668	46%
RI	580		580	<1%
TOTAL	194,046	26,081	**220,127**	100%

*Maryland's program was stayed and these allowances did not enter the market; they are shown for illustration only

2.2 Market participation was broad

Many different firms, and various types of firms were active participants in the NO_X Budget market. Over 110 distinct firms and organizations received initial allocations of allowances and over 50 other firms are listed as market participants on the NATS system (although some of these are new subsidiaries of holding companies). Table 2 presents the names and allocations (initial plus early reduction credits) for the 25 largest firms by allocation. Power companies received the largest share of allowances (over 90%) and were also the largest participants in the market, participating in over 98% of all trades.

The next largest group of participants were brokers, although the line between brokers and the marketing arms of the large power companies is blurring due to restructuring. One of the largest group of participants, in terms of number of firms, were cogeneration projects, many of which are partnerships of larger firms. In addition, refineries and manufacturing firms actively participated in the NOx allowance market, even relatively small companies.

The supply side of the NO_X market is somewhat concentrated, with the 25 largest allocations accounting for 90% of the market. Moreover, restructuring may tend to increase market concentration since some of the largest firms in the NO_X market have begun to sell off their generation assets, while others have started to acquire power plants (see the right-hand columns of Table 2). Firms in the selling category include GPU, PP&L, ConEd, and Conectiv, which account for over 40% of the 1999 NO_X allocation. In addition, the entry of merchant power plants might exacerbate this trend, since they would probably have to buy allowances.[12] Due to concerns that competitive pressures in the electricity market might make it hard for these firms to find sellers, some states have set aside a small number of allowances just for new sources.

Table 2: Top NO_X allowance 25 allocations (by firm)

	Firm	Individual Allocation		Cumulative Allocation		Generation assets	
						Selling	Buying
1	GPU	24,973	12%	12%		y	
2	PP&L	22,711	11%	22%			y
3	Allegheny Electric	21,633	10%	32%		y	
4	FirstEnergy	13,541	6%	39%		y	y
5	Edison Mission Energy	12,450	6%	45%			y
6	PSEG	12,067	6%	50%			
7	ConEd	10,924	5%	55%		y	
8	Northeast Utilities	9,754	5%	60%			y
9	PG&E Generating	8,763	4%	64%		y	
10	KeySpan Energy	8,656	4%	68%			y
11	Southern Energy	7,219	3%	72%			y
12	Conectiv	7,091	3%	75%		y	
13	NRG	5,601	3%	77%			y
14	Duquesne Light	4,629	2%	80%		y	
15	Sithe Energies	4,308	2%	82%			y
16	Central Hudson Gas & Electric	3,600	2%	83%		y	
17	Eastman Kodak	3,547	2%	85%			
18	PECO	3,226	2%	87%			
19	Dunkirk Power	2,641	1%	88%			
20	Niagara Mohawk Power	1,234	1%	88%			
21	New York Power Authority	1,208	1%	89%			
22	Motiva Enterprises	1,060	0.5%	89%			
23	WISVEST – Connecticut	897	0.4%	90%			
24	Rochester Gas & Electric	886	0.4%	90%			
25	Medical Area Energy Plant	776	0.4%	91%			

2.3 The market developed quickly

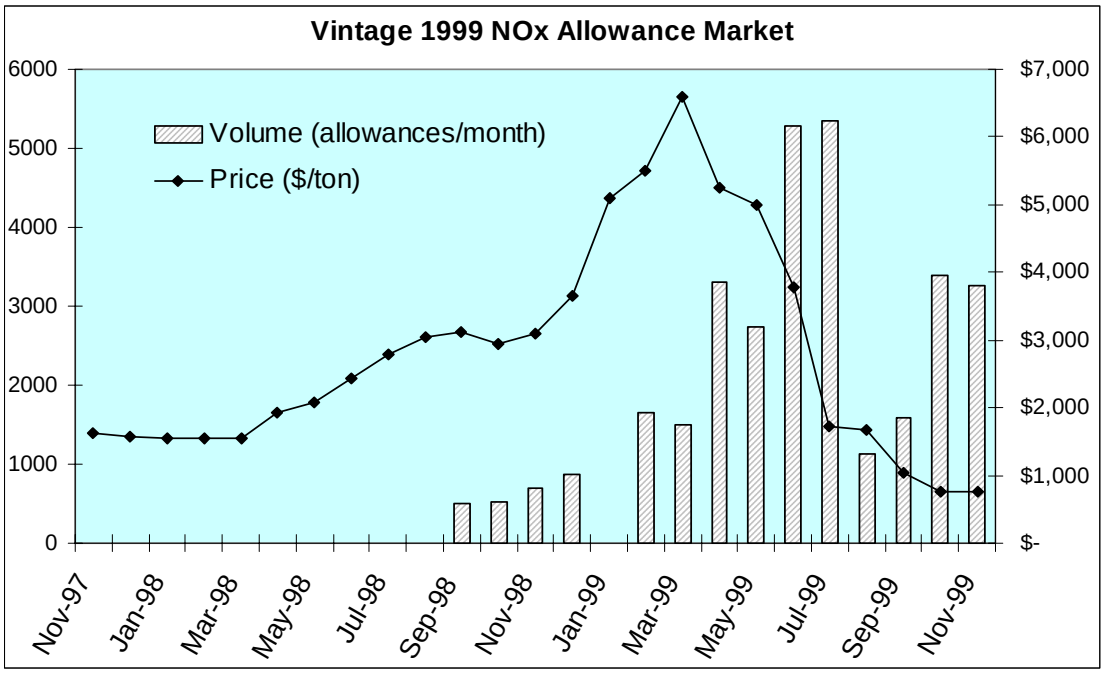
Once it got started, the NO_X emissions market matured very quickly and is now quite sophisticated. Firms were willing to enter the market even before all the details were finalized. Much of this sophistication is located in marketing and brokerage firms who participate in power, emissions, fuel, and other markets simultaneously, and to whom generating companies are increasingly turning to for risk management.[13] Compared to the SO_2 market, greater use of derivative products (e.g. options) is reported in the NO_X market, due to greater volatility. And derivatives were being traded in the first year of the NO_X Budget market, whereas it took several years for options in SO_2 allowances to appear.

2.4 The market was active

Almost 32,000 vintage 1999 NO_X allowances were traded by economically distinct entities in 643 transactions through the end of November, as shown in Figure 2. This is about 15% of all allowances allocated. The effects of restructuring are clear in the NO_X market; sales of generation assets account for nearly a third of all allowance trades, while California- and Texas-based firms are major participants, both as marketers and as owners of regulated generation assets. Even more allowances, almost 42,000, were moved within firms but this largely reflects corporate reorganization in response to restructuring.

The market trades represent a total value of about $100 - $120 million. (A precise number cannot be determined because individual trades remain confidential.) This estimate is obtained by matching the dates of trades reported on the NATS with prices reported for the same period. Unfortunately, there is considerable uncertainty about delays between when two firms agree to trade and set a price, when they report the trade to the EPA, and when it actually appears on the NATS. Estimates obtained by assuming no delay in reporting trades, a one-month delay, and a two-month delay all fall in the range given above.

Figure 2



The most striking thing about this market was the rise in price in the winter and spring, when some trades occurred above $7,000 per ton. Forecasts of marginal control costs (and thus for allowance prices) for Phase II of the NO_X Budget (or similar programs) range from $500/ton to about $2,500/ton, and except for a very few cases in a small class of boilers, marginal costs for NO_X control for all sources in the NO_X Budget are below $5,000/ton.[14] Notably, prices for later vintage allowances (not shown) did not rise above $3000/ton, except briefly in May.

The rise in price occurred as many participants in the market began to realize that there really would be a NO_X Budget program in 1999, and that the market looked "short." That is, the regulated firms suddenly realized they might not have installed enough emissions control equipment in aggregate to meet the cap. By the time this realization occurred, near the end of 1998, there was insufficient time to install control equipment for the upcoming ozone season. It also seems that some participants in the NO_X market were surprised to find that the experience of the SO_2 market (low prices and an abundant supply of allowances) was not repeated. Lastly, through the end of May none of the promised early reduction credits had been definitively allocated by the states. These factors added up to a short ("tight") market, with an insufficient supply of allowances given the expected demand, so allowance prices naturally rose. There is some evidence that power and fuel markets also responded to high allowance prices. Most importantly, firms responded to these challenges through the marketplace, not the courts.

Prices stayed high through the spring, after which new forces on both the supply and demand side of the market emerged. First, early reduction allowances began to enter the

market, starting with New Hampshire's in early April, followed soon after by New York and New Jersey's very large distributions. This dramatically expanded allowance supply.

Second, several firms found that when push came to shove, they *could* install emissions control equipment in time. Unexpected and much faster-than-normal installations of controls on plants in Massachusetts, New Hampshire, New Jersey, and Pennsylvania reduced demand. Third, the Maryland lawsuit reduced demand further, since power plants there were expected to be net buyers of allowances. Fourth, power plant operators began to consider the implicit higher-than-expected cost of NO_X emissions into generation decisions and power pricing, and began making adjustments in plant operation in response. New electronic operating systems, ogten using adaptive neural networks, enabled many plants to reduce emissions fairly easily, and some even switched fuels to reduce emissions. This further reduced demand for allowances. Finally, power purchases from outside the control region seem to have increased, further reducing demand for NO_X allowances.[15]

By July, the price for 1999 vintage allowances fell below the price for 2000 and later allowances for the first time, and a consistent differential of several hundred dollars has been maintained since. This reversal of relative prices is due to the recognition that the emissions rates in the first two months of the program suggested that enough allowances would be banked to invoke the PFC rule in the 2000 ozone season.

2.5 Emissions have decreased

Emissions from the power plants in the NO_X Budget program have clearly decreased, preliminary summary figures released by the USEPA shows total seasonal emissions of 174,505 tons.[16] This is a decrease of 64% from the 490,000 tons emitted in 1990, however some of this decrease is due to the pre-existing NO_X RACT requirements. The 1999 emissions represent about a 25% decrease from 1998 emissions, which may be a better way to judge the magnitude of the change. The actual emissions rate in 1999 was 0.30-0.35 lb./mmBtu.

However, due to the temporal mismatch discussed above, it is not clear just what effect the program has had on ozone levels. Only when detailed, final emissions and air quality monitoring data are published and analyzed can this question be resolved.

3 Early Lessons

Overall, the first year of the NO_X Budget proves that states can develop and implement regional emissions trading programs that reduce emissions, provide flexibility to firms, send price signals to stimulate innovation, and are suited to the conditions in each state. It is possible to draw more specific lessons from the program, even though it is still in its early stages.

3.1 Cap-and-trade programs reduce emissions cost-effectively.

The NO_X Budget program shows again that cap-and-trade programs are effective in reducing emissions, and do so efficiently. Like other such programs, greater reductions in emission occurred in the first year of the NO_X Budget than were required by law, building up a bank for later use. In addition, there is little evidence of any problems related to directionality and distance. However, it is still too early to say how well the program achieved its environmental goals until the necessary monitoring data and modeling studies are available.

3.2 Multi-lateral emissions trading is possible, but may be limited.

The NO_X Budget is the first effective multi-state emissions trading program and shows that it is possible for state governments to work across their borders to develop cooperative regulatory programs. However, it should be noted that the interests of the eight states that

participated in the 1999 program were all quite similar, especially in agreeing that NO_X emissions needed to be reduced and in having a history of coordinated on air quality management. Cases in which similar conditions do not exist will not be as conducive to cooperative action.

3.3 Phase-in is important.

It is costly to introduce new regulations; uncertainty and short phase-in periods make the problem worse. However, the record in 1999 clearly shows that markets can adjust fairly quickly, and that they provide incentives for innovation which helps smooth transitions.

3.4 Restructuring allowed responsiveness and sophistication

Despite the delays and confusion in the beginning of 1999, firms used the NO_X, power, and fuel markets to manage these difficulties. Notable achievements are the current low price of allowances, the lack of recourse to the courts, and essentially no impact on reliability. The rapid development and sophistication of the NO_X market may be partly explained by the restructuring of the power sector; firms do not have to worry about having their compliance decisions approved by state utility commissions and competitive pressures focus firms on reducing costs. The ability of power companies to effectively respond to the NO_X Budget and use sophisticated tools for risk management is early evidence of success in restructuring the electric industry.

3.5 Evidence of leakage exists.

A chief concern among the Northeast states is that the NO_X Budget program may encourage leakage of electricity generation to "upwind" states, yielding increased costs but no environmental benefit. The experience to date suggests that there is some basis for these concerns, although it is not clear if the amount of leakage observed so far is significant.

4 Looking Forward

4.1 Future NO_X Budget markets

The 2000 NO_X Budget market will probably look quite different from the 1999 market. Most importantly, volatility will be reduced because supply and demand are better balanced (and better understood), because there may be little need for further installations of emissions controls, and because a considerable bank of allowances has been built up. It is doubtful the 2000 NO_X market will ever look nearly as tight as the 1999 market did in early April. However, some factors suggest allowance prices could still rise. These include potentially higher prices for oil and gas, and the possibility of an expansion of the program to other states (including Maryland), and the possibility of new sources increasing demand for allowances.

The most difficult question is how the large bank and the PFC rule will affect the market. Approximately 46,000 vintage 1999 allowances have been banked, over 20% of the total 1999 allocation. With several more years to go in Phase II, it is entirely conceivable that a bank equal to the entire allocation in 2003 could be built up, presumably making *all* of them subject to a 50% discount. For the industry as a whole, this is an issue of tens of millions of dollars. Managing NO_X allowance accounts in the face the uncertainty created by the PFC rule may become a significant challenge.

4.2 NO_X SIP Call

The NO_X Budget is proposed as the model for a solution to the long-running controversy about emissions from Midwest coal-fired power plants. In the NO_X SIP Call, the EPA has set individual caps on NO_X emissions for 22 eastern states, and recommends that they use an emissions trading program for power plants to implement these caps.[17] A single market would be easier to implement and provide for greater efficiency and flexibility, but significant questions have been raised.

First, although many Midwestern states and power companies recognize that they need to control NOX emissions, they disagree that the same tough standard should apply to them and to sources in the Northeast. Similarly, "directionality and distance" may be a bigger problem for the 22-state region for the relatively small OTC states. Both of these problems could be solved by using multiple zones with different levels of control, similar to those in the NO_X Budget and RECLAIM programs.

Second, entry into a multi-state emissions trading program might be hard to reconcile with the existing state-by-state air quality planning requirements of Title I. Sections 176 and 184 of the Clean Air Act, under which the OTC was created, allows for expansion, so states that wanted to join the NO_X Budget could simply join the OTC. However, it is not clear states would want all that goes along with membership in the OTC, especially the delegation of some authority to it. This could turn out to be the overriding concern and may need to be addressed by more flexible rules for entry into the emissions trading program only.

Third, some states may find it necessary to reduce NO_X emissions from specific sources in order to deal with local conditions. This problems have been dealt with successfully in other programs. The SO_2 program allows for emissions trading but leaves in place enforceable provisions for individual sources to protect local air quality, while the RECLAIM places geographic restrictions on trading.

Finally, the concerns about an inability to overcontrol relative to the tight caps of the NO_X SIP Call, just as they have with Phase III of the NO_X Budget. But as indicated above, this view underestimates the power of price signals and innovation – firms in emissions trading programs have routinely found new ways to cut emissions deeper and cheaper than previously thought.

5 Endnotes

[1] For a more complete description of the NO_X Budget, *see* A. Farrell, R. Carter, and R. Raufer, *The NO_X Budget: Costs, Emissions, and Implementation Issues*, 21 RESOURCE & ENERGY ECON., 103-124 (1999); The Acid Rain and RECLAIM programs are discussed in J. Lents and P. Leyden, *RECLAIM: Los Angeles' New Market-Based Smog Cleanup Program*, 46 J. AIR & WASTE MGT. ASSOC., 195-206 (1996); D. Bohi and D. Burtraw, *SO_2 allowance trading: How do expectations and experience measure up?*, 10 ELEC. J., 67-75 (1997). B. McLean, *Evolution of marketable permits: The US experience with sulfur dioxide allowance trading*, 8 INTL. J. ENVR. POLLUTION, 19-36 (1997); and T. Klier, R. Mattoon and M. Prager, *A Mixed Bag: Assessment of Market Performance and Firm Trading Behavior in the NOx RECLAIM Program*, 40 J. ENVR. PLAN. AND MGMT., 751-774 (1997). For a description of other forms of emissions trading, see R. Ayres, *Developing a Market in Emission Credits Incrementally: An 'Open Market' Paradigm for Market-Based Pollution Control*, 25 BNA ENVR. REPORTER at 1526 (1994). See also the EPA's Clean Air Markets Division homepage, http//www.epa.gov/acidrain/otc/otcmain.html.

[2] These groups are the Northeast States for Coordinated Air Use Management (NESCAUM, see http://www.nescaum.org/) and the Mid-Atlantic Regional Air Management Association (MARAMA, see http://www.marama.org/). L. Carlson, NESCAUM/MARAMA NO_X BUDGET MODEL RULE (NESCAUM January 1996).

[3] The states in the OTC include Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia and the District of Columbia. The only part of Virginia that is covered by the OTC rules are the counties in the Washington, DC metropolitan area.

[4] However, there is some disagreement about just how clear the details of a regulatory program can really be before the legislative, rule-making, and adjudication processes are complete. Regulated firms have complex roles regulatory development; they can gain substantially by delaying and weakening the final requirements, but doing so (through lobbying and litigation) contributes to regulatory uncertainty. OZONE TRANSPORT COMMISSION, MEMORANDUM OF UNDERSTANDING AMONG THE STATES OF THE OZONE TRANSPORT COMMISSION ON DEVELOPMENT OF A REGIONAL STRATEGY CONCERNING THE CONTROL OF STATIONARY SOURCE NITROGEN OXIDE EMISSIONS (OTC September 1994) s*ee* http://www.sso.org/otc/. NORTHEAST STATES FOR COORDINATED AIR USE MANAGEMENT AND MID-ATLANTIC REGIONAL AIR MANAGEMENT ASSOCIATION, NESCAUM/MARAMA EMISSIONS TRADING DEMONSTRATION PROJECT (NESCAUM 1996).

[5] The need for something like PFC in the NO_X Budget, when no such need exists in the SO_2 program arises partly due to differences in the underlying law, Titles I and IV of the Act. Title I is far more restrictive and was not drafted with emissions trading in mind. Individual exceedances of the ozone standard (as might happen during a "NO_X spike") could put areas into the dreaded non-attainment status. In contrast, Title IV simply seeks a reduction in average annual SO_2 emissions regardless of year-to-year variations, something a cap-and-trade program is ideally suited for.

[6] See Farrell, et al. *supra*. note 1.

[7] ICF RESOURCES, ESTIMATED EFFECTS OF ALTERNATIVE NO_X CAP AND TRADING SCHEMES IN THE NORTHEAST OZONE TRANSPORT REGION (OTC Aug 1995); P. Mueller, *An Analysis of the First Year of the RECLAIM Program*. AIR & WASTE MGMT. ASSOC. ANN. MTG. (A&WMA 1995); ICF-KAISER, OTAG TRADING ANALYSIS WITH EPA/IPM, (EPA Apr 1996); A. KRUPNICK AND V. MCCONNELL, COST-EFFECTIVE NOX CONTROL IN THE EASTERN U.S., (Resources For the Future 1999).

[8] Stated another way, the dynamic efficiency gains of emissions trading may be more important than the static efficiency gains in some cases.

[9] Anonymous, *Ozone seeks a place in NOx reduction efforts*, 143 POWER 15 (March/April 1999). Various, *Symposium offers latest in air emissions control*, 143 POWER, 67-76 (November/December 1999).

[10] This allocation includes *all* vintage 1999 allowances, as calculated from the data on the NOx Allowance Tracking System on December 15, 1999. Stated another way, the total allocation for 1999 would allow an average emissions rate of about 0.60 tons/GWhr.

[11] Other emission trading programs have largely avoided this problem. The SO_2 program had a lengthy period between legislative enactment (1990) and implementation (1995). Moreover, by including early auctions of emissions allowances, which though imperfect and ultimately a small part of the market, provided important early price signals to market participants. B. Solomon and K. Rose *Making a Market for SO_2 Emissions Trading*, 5 ELEC. J., 58-66 (Jul 1992). P. Joskow, R. Schmalensee, et al. *The Market for Sulfur Dioxide*, 88 AM. ECON. REV., 669-685 (1998). In addition, SO_2 program's bonus allowance provisions was designed to give power companies sufficient incentives to invest early in emissions controls early, which they did. E. Markey, and C. Moorhead, *The Clean Air Act and Bonus Allowances*, 3 ELEC. J., at 30 (1990). R. Schmalensee, P. Joskow, et al. *An Interim Evaluation of Sulfur Dioxide Emission Trading*, 12 J ECON. PERSP., 53-68 (1998). The RECLAIM program avoided this problem (possibly inadvertently) by allocating too large a budget for the first several years, so that firms were able to get used to the program before it really grew "teeth". T. Klier, (1998). *Emissions Trading - Lessons from experience*, CHI. FED LTR. (Nov 1998).

[12] A. Chambers, *Merchant Fever Rising*, PWR. ENG., 36-38 (Aug 1999). R. Swanekamp, *Rise of the merchant class*, PWR., 48-58 (Sept/Oct 1999).

[13] C. Harder and M. Golden, *Pollution Rights Fetch Premium at EPA Sale - Fewer Bid On Allowances To Emit Sulfur Dioxide As Brokers Gain Role*, WALL ST. J., B7D (March 27, 1998).

[14] STATE AND TERRITORIAL AIR POLLUTION PROGRAM ADMINISTRATORS AND ASSOCIATION OF LOCAL AIR POLLUTION CONTROL OFFICIALS , CONTROLLING NITROGEN OXIDES UNDER THE CLEAN AIR ACT: A MENU OF OPTIONS (STAPPA/ALAPCO, 1994). OZONE TRANSPORT ASSESSMENT GROUP, OTAG TECHNICAL SUPPORTING DOCUMENT (EPA 1997) see http://www.epa.gov/ttn/rto/otag/finalrpt/. ENVIRONMENTAL PROTECTION AGENCY, REGULATORY IMPACT ANALYSIS FOR THE NOX SIP CALL, FIP, AND SECTION 126 PETITIONS (1998). NORTHEAST STATES FOR COORDINATED AIR USE MANAGEMENT, STATUS REPORT ON NOX: CONTROL TECHNOLOGIES AND COST EFFECTIVENESS FOR UTILITY BOILERS (1998). Farrell, et al. *supra*. note 1. NESCAUM/MARAMA *supra*. note 4. ICF Resources *supra*. note 7.

[15] Business Editors, *KeySpan Forecasts Cleaner Power Plants from New Emissions Trading*, BUS. WIRE (June 2, 1999). C. Seiple and R. LaCount, *NOx Emissions Trading: Changing Generator Behavior?*, PUB UTL. FORT., 8-9 (July 15, 999).

[16] See the EPA's Clean Air Markets Division homepage, http//www.epa.gov/acidrain/otc/otcmain.html

[17] The EPA can only recommend an emissions trading program in this case due to the language of Title I, but this proposal would be approximately equivalent to a 0.15lb./mmBtu standard. U.S. Environmental Protection Agency, *Proposed Rule for Reducing Regional Transport of Ground-Level Ozone (Smog)*, 62 FED. REG., 60317 (October 10, 1997).