



**CEEPR**

**Center for Energy and Environmental Policy Research**

**Electric Utility Response to Allowances: From Autarkic to  
Market-Based Compliance**

by

**A. Denny Ellerman**

**98-009 WP**

**July 1998**

**A Joint Center of the Department of Economics, Laboratory for Energy  
and the Environment, and Sloan School of Management**

# **Electric Utility Response to Allowances: From Autarkic to Market-Based Compliance**

A. Denny Ellerman<sup>1</sup>  
Center for Energy and Environmental Policy Research  
Massachusetts Institute of Technology

## **I. INTRODUCTION**

Allowances are a central feature of Title IV; and, from the time Title IV was enacted, there has been concern about how rate-regulated electric utilities would make use of this novel instrument for achieving environmental goals. In particular, many questioned whether utilities would use allowances in a manner that would achieve the cost savings associated with emissions trading. There is, in fact, no requirement to trade allowances. If they wished to do so, utilities could treat allowances simply as non-tradable permits and reduce emissions to match the allocation to each unit. That utilities have not done so is one of the most important facts about electric utility use of allowances in Phase I.

Still, the way that electric utilities have made use of allowances has changed significantly from the early years of Phase I compliance planning to the present. The central feature of this change is the relation of internal compliance decisions to the external allowance market; and that change can be characterized as a movement from autarkic to market-based compliance. Like all attempts to categorize human activity, there are exceptions and the change is uneven, but the main outlines persist. This evolution in electric utilities' use of allowances helps to explain what are otherwise puzzling phenomena in Phase I, and it also reveals what may be viewed as one of the most attractive features of allowances, the ability to mitigate the cost of mistakes.

---

<sup>1</sup> Executive Director, Center for Energy and Environmental Policy Research, and Senior Lecturer, Sloan School of Management. This paper was presented at the Workshop on Market-based Approaches to Environmental Policy at the University of Illinois at Chicago on June 19, 1998. As always, I have benefited greatly from continuing discussions and insights from my colleagues, Richard Schmalensee, Paul Joskow, Juan Pablo Montero, and

The year 1995 was a pivotal one in the evolution of the electric utility use of allowances. It was of course the first year in which emissions had to be covered by an allowance, but it was also a year of surprise dominated by the fact that the market price for allowances, which was believed already too low, fell even lower. The experience contributed to a change in utility attitudes towards the allowance market, and it led to an integration of the market price for allowances into compliance decisions. Accordingly, the evolution of electric utility use of allowances can be described in three phases: the pre-1995 years of compliance planning in which autarkic compliance prevailed, the 1995 revelation of over-investment in compliance, and the post-1995 embrace of market-based compliance.

## II. AUTARKIC COMPLIANCE

Autarky denotes a self-sufficient disregard for the benefits of trade. In this context, the word describes the distinct tendency of utilities to plan for compliance in Phase I without much regard to emissions trading possibilities outside of the utility. It does not imply that utilities ignored emissions trading possibilities within the utility. To the contrary, utilities have shown little hesitation in trading internally, both in space and through time; and there can be little doubt that internal trading has yielded significant cost savings. In planning for Phase I compliance, utilities acted as if they faced a utility-specific cap, within which they created their own implicit market for allowances. What made the planning autarkic was that the price implicit in this internal market bore little relation to the outside, market price for allowances.

The results of early compliance planning became evident in 1995 as the planned Phase I emission reductions were implemented. Two basic patterns in the use of allowances can be observed. A frequent pattern was to reduce emissions more than required at one or a few units and to use a portion of that over-compliance to avoid reductions at other units. TVA is a good example of this pattern. Over 90% of the emission reduction effected by TVA in 1995 was accomplished at the two scrubbed units at the Cumberland plant, while half of TVA's 26 affected units required allowances from the two units to cover 1995 emissions. It's evident that TVA and

other utilities were not taking allowance allocations at the unit level as given, and that they were trading within the utility to avoid abatement cost at units where emissions exceeded the allowance allocation.

The other pattern was to reduce emissions at almost all units but by far more than required. The Southern Company provides a particularly good illustration of this pattern. The reduction of emissions is not as concentrated at a few units as was the case for TVA: the two units making the largest emission reductions account for only 27% of the total. Moreover, only 4 of Southern's 50 affected units needed allowances from other units to cover 1995 emissions; the other 46 units banked allowances. Perhaps most surprising, but also revealing of compliance planning, the Southern Company received more allowances in 1995 than would have been needed to cover emissions in the non-Title-IV counterfactual.<sup>2</sup> Nevertheless, SO<sub>2</sub> emissions were reduced by 40%. There is no other explanation for this utility's compliance behavior in 1995 than purposeful over-compliance in order to bank allowances for later use in Phase II.

These two examples are repeated and mixed at a number of other utilities. A total of 203 units were constrained by the allowance allocation in 1995, but 95 of these benefited from allowance transfers from other units to achieve compliance. These 95 units were operated by 27 different utilities, about three-quarters of the 37 utilities with multiple affected units and at least one unit constrained by the allowance allocation, in other words, by those who had to reduce emissions and who could trade internally.<sup>3</sup>

It is also evident that utilities engaged in purposeful over-compliance. The 24 utilities that faced a binding utility-level cap in 1995 were constrained to reduce emissions by only 1.5 million tons, but they reduced emissions by 3.2 million tons, more than twice what was required. Further evidence of purposeful banking can be observed in the 33 utilities that were not constrained by the utility cap. These utilities received 0.85 million allowances in excess of the counterfactual emissions, but they made further reductions totaling 0.77 million tons to bank a total of 1.62 million allowances for Phase II.

---

<sup>2</sup> In keeping with Ellerman et. al. (1997), counterfactual emissions are estimated as 1996 heat input times the 1993 emission rate.

<sup>3</sup> For 13 utilities, every affected unit in 1995 received more allowances than the estimate of counterfactual emissions. Another 7 utilities had only a single affected unit, and therefore no opportunity to trade internally in the current year.

Although autarkic compliance characterized Phase I planning for most utilities, a few did take advantage of the allowance market. The most well-known instances are Carolina Power and Light and Illinois Power. Carolina Power and Light did not have any Phase I units, but it swept the 1993 allowance auction, obviously for use in Phase II. Illinois Power initially planned to retrofit two Phase I units at its Baldwin plant with scrubbers, but it later cancelled those plans in favor of a heavy reliance on allowance purchases on the open market. In addition to Illinois Power, five other utilities acquired small amounts of allowances from the open market to cover emissions in excess of the 1995 allocation to these entities.

Autarkic compliance implies higher cost for a given amount of aggregate national abatement, but it is hard to imagine an alternative. The lead times for many compliance decisions required action sooner rather than later, and the market for allowances was nascent at best in 1993 and early 1994, when many of these decisions were being made. An executive needed little imagination to realize that more serious consequences would result from failing to have enough allowances to cover emissions in Phase I, out of a mistaken faith in the development of an allowance market, than from spending a little more (and reducing emissions more). Moreover, the recovery of costs for environmentally mandated expenditures was virtually assured. It is not surprising then that most utilities planned to go it alone.

### **III. OVER-INVESTMENT IN PHASE I COMPLIANCE**

The year 1995 was a revealing year, probably inevitably so. Allowances had an operational reality that they did not possess before. No one doubted the requirement to cover emissions with an allowance. Moreover, open market trading in allowances had risen steadily in volume from virtually nothing in 1993 to about 5 million allowances in 1995.<sup>4</sup> As a result, the external price of an allowance was readily discernible. Immediate, real time comparisons could be made between allowance prices and the cost of using more or less sulfur in operational decisions such as spot purchases of coal.

---

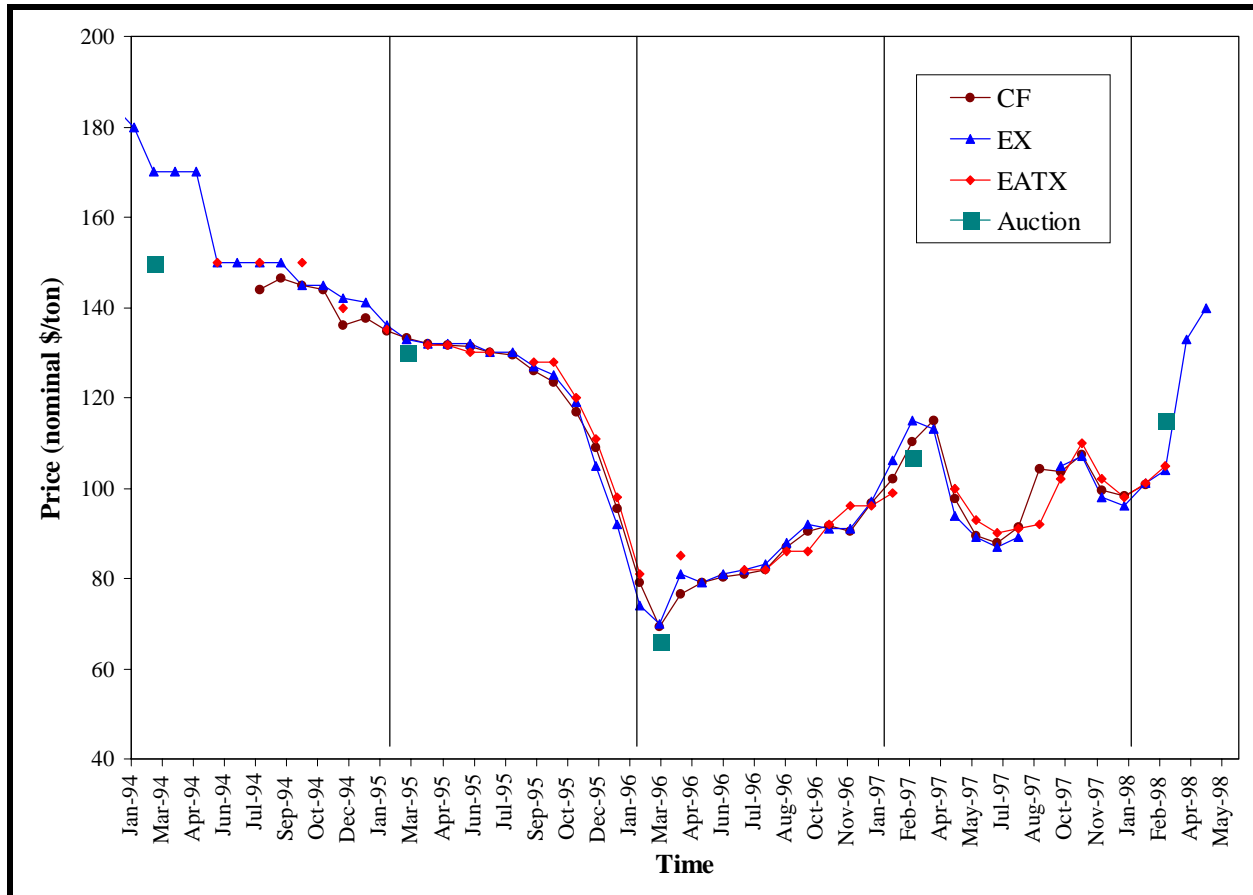
<sup>4</sup> Ellerman et. al., p. 28.

The year 1995 also marked a significant revision of expectations concerning allowance prices. Although the nascent allowance market of 1993 and early 1994 indicated values from \$130 to \$150, experts were almost unanimous in affirming that the market price of allowances was “too low” and that allowances would be worth more once Title IV got under way. According to this argument, prices were low because utilities were not buying as a result of utility conservatism and public utility commission regulation. Moreover, it was argued that defects in the design of EPA’s mandatory auction led to a downward bias in the clearing price.<sup>5</sup> More realistic prices would appear in 1995 when allowances would have to be surrendered and actual compliance costs would be compared with open market prices. As shown in **Figure 1**, allowance prices did not rise with the start of Phase I. They remained steady at about \$130 for the first half the year and then fell precipitously in the latter half of the year to reach an all-time low of \$67 in early 1996.

The first sign that things were not what they were expected to be in 1995 was the collapse of the low sulfur coal premium in Central Appalachia in early 1995. This region is the largest coal producing area in the U.S. and a principal supplier of low sulfur coal. In **Figure 2**, the top two lines are the prices of low and mid-sulfur coals and the bottom line is the difference, or the low sulfur premium. All coal prices declined in early 1995, but low sulfur coal prices declined more than mid-sulfur prices. This was not what had been expected: Title IV was supposed to result in higher premiums of low sulfur coal. In fact, the pre-1995 premium of \$4 a ton of coal—approximately equal to \$200 an allowance—incorporated the expectation that allowance prices would rise when Title IV became effective in 1995. When allowance prices did not increase, the coal premium had to fall, the start of Title IV notwithstanding. It fell because utility coal buyers were making comparisons between coal premiums and open market allowance prices and purchasing the higher sulfur product, even though fewer allowances would be banked.

---

<sup>5</sup> See Cason (1993), Cason (1995), Cason and Plott (1995) for the argument and Joskow et. al. (1998) and Ellerman et. al. (pp. 17-33) for the counter-argument.

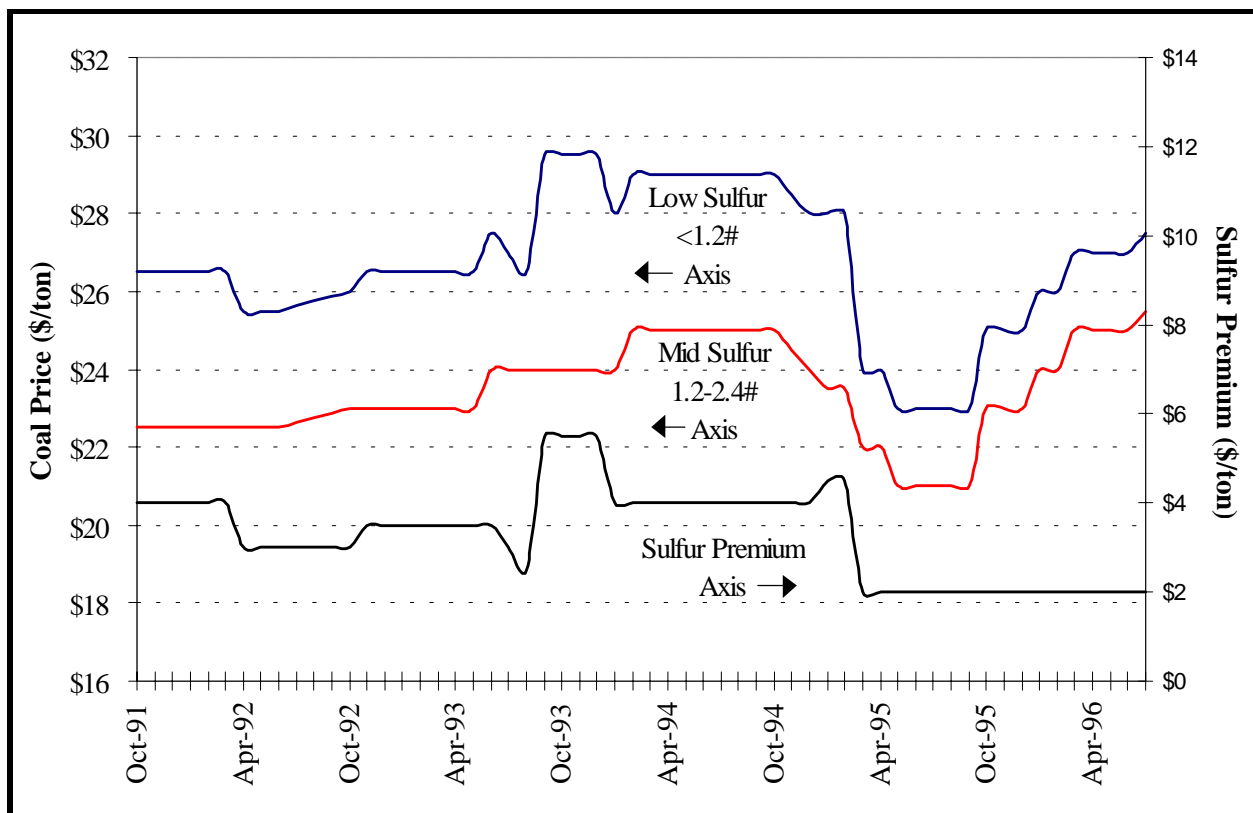
**Figure 1** Allowance Prices, 1992-98 (1995 or Current Vintage)

The second indication that earlier expectations were mistaken appeared with the release of the quarterly CEMS reports, which revealed actual emissions at all Phase I affected units.<sup>6</sup> Consultants and other analysts were able thereby to determine the number of allowances required to cover emissions at affected units, to calculate the difference from the allowances allocated to these units, and to sum the differences. It took only a little extrapolation to project the year, and predictions of a cumulative Phase I bank of 12 million tons or more appeared in the fall of 1995.<sup>7</sup> This was much more than had been previously predicted, and a little more than will likely occur, but the point was made: the number of allowances required to cover emissions was less than had

<sup>6</sup> CEMS stands for Continuous Emissions Monitoring System. All utilities are required to install a CEMS on each stack and to report the readings to EPA which publishes the results quarterly. I am indebted to Brian McLean who first suggested to me that the release of this information could be related to the subsequent fall in allowance prices.

been expected. There would be no utility scramble for allowances and low sulfur coal. The implications for allowance prices were obvious, and it was at this time that allowance prices began the sharp, downward adjustment that marked the latter half of 1995.

**Figure 2** Central Appalachian Coal Prices (12,500 Btu/lb, spot)



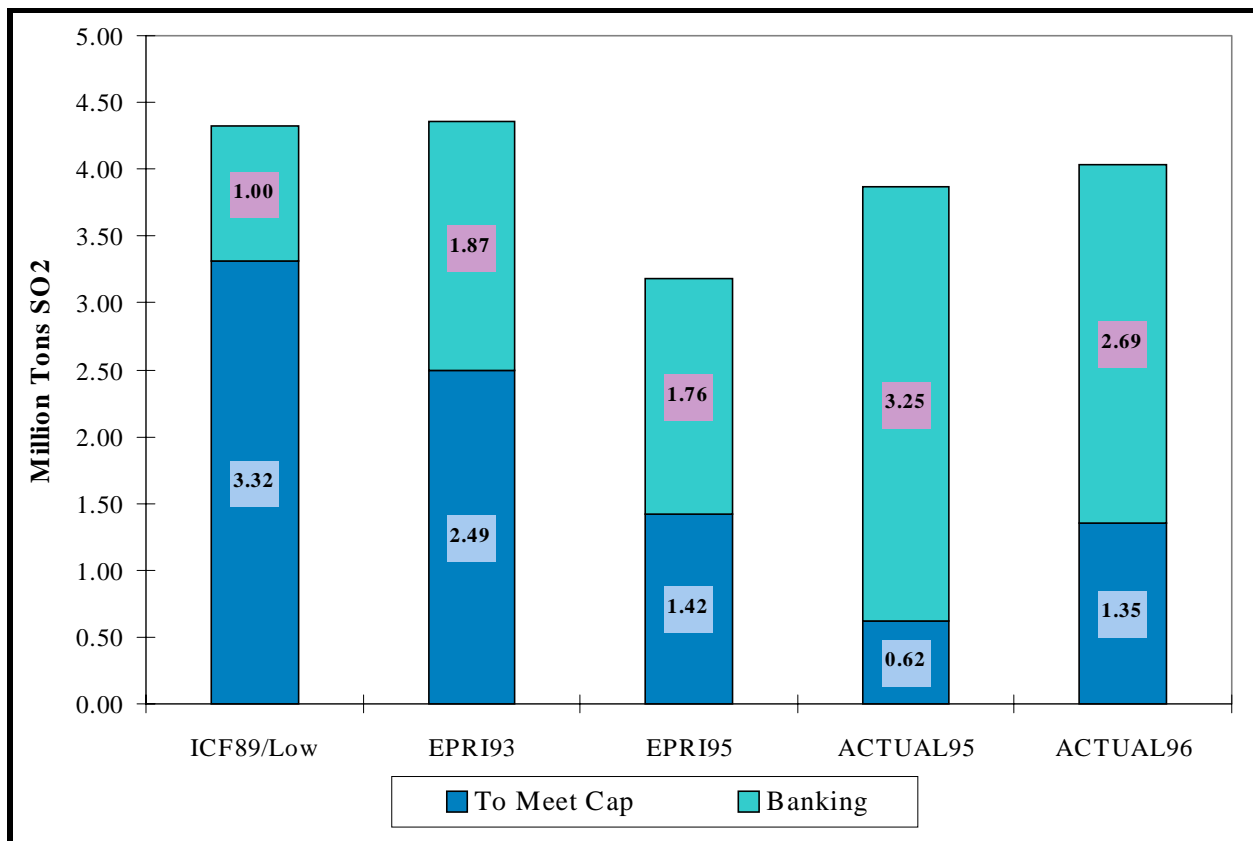
In retrospect, the situation is clear. Compared to expectation, far less abatement was required in the aggregate to get below the 1995 cap; and far more allowances were banked for use in Phase II. **Figure 3** presents a comparison of earlier predictions of compliance in early Phase I by ICF and EPRI with the MIT estimate of what actually happened in 1995 and 1996.<sup>8</sup> The height of the columns indicates the reduction of emissions attributable to Title IV, which is then split into two parts: that required to reduce emissions to the aggregate cap and the extra amount attributable to banking. From the very beginning, it was expected that allowances would

<sup>7</sup> See for instance Myers and Custode (1995).



be banked. As early as 1989, ICF's estimate for low electricity growth (which is what happened) was a 3.3 million-ton reduction of emissions to meet the cap and an additional 1.0 million tons banked. EPRI's later and more informed studies in 1993 and late 1994 predicted more banking, 1.8 million tons in both, but less of a required reduction to meet the cap: 2.5 million tons in 1993 and then 1.4 million tons in the later study. In reality, the aggregate reduction required to meet the cap was only 0.6 million tons in 1995 and 1.3 million tons in 1996. Instead of 1.8 million tons annually, an average of 3 million allowances were banked in each of these first two years of Phase I. It is evident from these estimates that expectations about the amount of emission reduction required to meet the cap were being revised as Phase I approached. Still, the amount actually required in 1995 and the amount banked appears to have been a surprise.

**Figure 3**  
Mandatory Reduction and Banking Components of 1995 Title IV Abatement



<sup>8</sup> See ICF (1989), EPRI (1993), EPRI (1995) and Ellerman et. al. (1997).

Everything indicates over-investment in compliance in Phase I, if you wish, too much compliance.<sup>9</sup> This over-investment resulted from the expectation of higher allowance prices in Phase I and the underlying failure to appreciate the extent to which aggregate abatement requirements had become less over time. The compliance actions taken in 1995 were for the most part decided earlier. They did depend on allowance price assumptions, and some of the most significant actions were irreversible for some period of time. As a result, these compliance actions continued impervious to changes in the current price of allowances. Scrubbers and multi-year contracts for low sulfur coal are two salient examples.

Scrubbers are complicated pieces of equipment that require several years from construction contract to operation. The decision to retrofit a scrubber depended on many considerations, some site-specific, others regulatory, but a very important factor was the expected value of allowances. Whether the utility was considering the one-time bonus allowances associated with most scrubbers or the ongoing stream of unused allowances generated by the scrubber's over-compliance, higher allowance values translated into a greater offset of the capital and operating costs of the scrubber. Thus, higher expected allowance prices led to more investment in scrubbers and more irreversible Phase I compliance. Since the ongoing operating cost of a scrubber is much lower than the total cost, these devices continued to operate even with lower allowance prices.

Multi-year coal supply contracts need not have such long lead times, and they are irreversible only for the length of the contract. Nevertheless, any utility planning to switch to low sulfur coal to meet Title IV requirements faced the decision of whether to contract early for Phase I supplies and for what duration. The alternative was to depend on the spot market for low sulfur coal during Phase I. Expectations of higher allowance prices and higher premiums for low sulfur coal prompted many utilities to sign multi-year contracts for low sulfur coal in 1993 and 1994, some for the entirety of Phase I, based on the price expectations prevailing in those years. Since the whole purpose of the contract is to insulate the purchase and sale from the vagaries of the market, the compliance so determined will not respond to current allowance prices for the duration of the contract.

---

<sup>9</sup> See Ellerman et. al. (1997), pp. 18-53, for a more extensive presentation of this argument.

In retrospect, it is evident that the pre-1995 argument for higher allowance prices was badly flawed. The argument was lent some credibility by the novelty of allowances, the thinness of the early allowance market, and the internal costs observed by many utilities planning for more or less autarkic compliance. Nevertheless, the nascent allowance market, including the mandatory EPA auction, was providing a more accurate signal of what was to come.

Some utilities did cancel decisions about scrubbers in response to these very early prices.<sup>10</sup> As previously noted, others, such as Carolina Power & Light or Illinois Power, did not let arguments about the defects of the early allowance market dissuade them from taking advantage of the opportunity presented. Why more did not pay attention to these early price signals, and whether compliance decisions could have been changed, may be an enduring topic of academic discussion about Title IV. There should be little debate, however, about the consequences of over-investment in Phase I compliance.

A one-time adjustment in allowance prices occurred as new and increasingly irrefutable information appeared about the abatement required and the abatement already committed. Elements of irreversibility in compliance decisions meant that the planned reductions would occur anyway, and that the error would be banked.

#### **IV. MARKET-BASED COMPLIANCE**

The dominant feature of compliance decisions after 1995 is adjustment to the over-investment that was revealed in that year. The response took two forms. One was the short-term adjustment to the really low allowance prices after mid-1995, and the second was the long-term adjustment of Phase II compliance plans.

Lower allowance prices imply less current abatement. The convergence of the Central Appalachian low sulfur coal premium to the allowance price in early 1995 indicated that coal buyers were prepared to use more allowances and to buy higher-sulfur coal to reduce compliance

---

<sup>10</sup> The amount of retrofitted scrubber capacity, 13 GW<sup>e</sup>, is less than initially predicted. Also, a number of respondents to the MIT/CEEPR survey of Phase I compliance cost indicated deferrals and cancellations as a result of lower allowance prices. See the footnote on p. 50 in Ellerman et. al. (1997).

costs. Further evidence of this short-term adjustment is provided by the comparison of 1996 compliance with 1995.<sup>11</sup> A number of utilities were taking advantage of the significantly lower allowance prices in late 1995 and in 1996 to shift to higher sulfur coals. For the 386 non-scrubbed units that were subject to Phase I in both 1995 and 1996, the average SO<sub>2</sub> emission rate increased by 4.6%, from 1.85 to 1.94 #/mmBtu.

This switching back to higher sulfur coal, and the concomitant use of more allowances, provides clear evidence that utilities were making compliance decisions based on the external allowance market. Utilities that continued to adhere to an autarkic compliance plan, without regard to outside prices, would not have increased emissions in the second year of Phase I, if anything they would reduced emissions even more as Phase II approached. Not all utilities responded to lower allowance prices in this manner. Some probably were keeping to previous autarkic plans, but such behavior can equally be explained by irreversible coal contracts.

The more important adjustment to over-investment in compliance during Phase I is the long-term response. Banked allowances permit the deferral of compliance with the Phase II emission limits, and the extent of the deferral depends on the amount of banking. If the pre-1995 expectations for banking had been correct, the cumulative bank at the end of Phase I would have been about 6 million allowances.<sup>12</sup> As a result of over-investment in Phase I compliance, current estimates for the Phase I bank lie in the range of 10-12 million tons. Obviously, costs that would have been incurred in say 2003, when the smaller bank ran out, can now be put off for a few more years.

If electric utilities are arbitraging between current Phase I and future Phase II compliance costs, then a deferral of the time when the bank runs out will affect current allowance prices.<sup>13</sup> The value of an allowance not used today will be the present value or the discounted cost of future abatement. Thus, if the time of the future abatement is pushed off several years, because of an unexpected access of allowances for instance, the present value will fall, not because the expected expenditure is any less, but because it is later.

---

<sup>11</sup> See Ellerman, Schmalensee and Joskow (1997) for a more complete discussion of compliance in 1996.

<sup>12</sup> This number is based on an extrapolation of the estimate in EPRI (1995) of 1.8 million allowances banked in each of 1995 and 1996, assuming a million fewer allowances per year for the last three years of Phase I.

<sup>13</sup> See Bailey (1998) for evidence concerning effective arbitrage and Schennach (1998) for a discussion and illustration of the theory of banking.

The same considerations that required the one-time downward adjustment in allowance prices also defined the floor for that adjustment and the new equilibrium price path. Utilities participating in the market would begin to purchase allowances for Phase II compliance when the current price is less than the present value of the marginal cost expected to be incurred when the utility's bank runs out. Moreover, those autarkic utilities, not yet participating in the market, would be increasingly tempted to do so when faced with the same comparison. Once that floor has been found, allowance prices could be expected to increase as the future expenditure approaches and the discounted value rises.

The behavior of allowance prices since mid-1995 is consistent with arbitrage between Phase I and Phase II costs. The price of allowances did fall as the over-investment in Phase I compliance was revealed; a floor was established; and prices have risen steadily, if irregularly, since. Such a pattern would not have emerged if utilities had kept to earlier autarkic compliance plans. The evolution of allowance prices suggests that utilities have been willing to participate in the external allowance market as appropriate opportunities arose and to adjust compliance, both currently in Phase I and prospectively in Phase II, as market values indicated.

## **V. CONCLUSION**

The post-1995 adjustment to over-investment in Phase I compliance reveals a new dimension of the cost-saving characteristics of allowance trading: the ability to reduce the cost of mistakes. The word "mistake" is used here not pejoratively, but only as recognition of the reality of decision-making in an uncertain world. Mistakes will inevitably be made; the issue is always what is learned and how subsequent behavior is changed. The opportunity to mitigate the cost of error is an attribute that is not indicated by the usual analyses of emissions trading which assume perfect foresight, nor is it an attribute shared by regulatory mechanisms that operate by other means than the use of allowances.

In the case of Title IV, pre-1995 compliance planning was characterized by what turned out to be erroneous expectations of allowance prices and a tendency to disregard allowance market signals, such as they were in these early years. When combined with lead times and

irreversibility, utilities invested too heavily in Phase I compliance. The result is higher cost of compliance in Phase I than would have been incurred if, magically, there had been better foresight. But the story does not end here—as it would if the regulatory mechanism were command-and-control, or even a credit-based form of emissions trading. Utilities who were not committed by irreversible decisions in early Phase I found themselves in the pleasant situation of facing lower current compliance costs than they had expected. And the ability to bank the unused allowances meant that future abatement expenditure could be deferred for a few more years with consequent, further cost savings. These savings partially offset the higher Phase I cost associated with over-investment.

More fundamentally, allowances make learning possible, and with it, the cost-reducing responses to the inevitable mistakes of decision-making in an uncertain world. The market in allowances transmits the true value of current and future abatement to agents and allows them adapt to the extent that they can. Perhaps, most importantly, the ability to bank makes the rigidities of investment and contract less irreversible. Not surprisingly, given the opportunity to benefit from learning, electric utilities are abandoning autarkic compliance and they are basing compliance decisions increasingly on the external allowance market. This ability to learn and to act on what is learned is one of the most important attributes of the use of allowances for meeting environmental goals.

## REFERENCES

Bailey, Elizabeth M., "Intertemporal Pricing of Sulfur Dioxide Allowances," M.I.T. Center for Energy and Environmental Policy Research Working Paper 98-006, March 1998.

Cason, T.N., "Seller Incentive Properties of EPA's Emissions Trading Auction," Journal of Environmental Economics and Management, September 1993, 25, 177-195.

Cason, T.N., "An Experimental Investigation of the Seller Incentives in EPA's Emissions Trading Auction," American Economic Review, September 1995, 85, 905-922.

Cason, T.N., and Charles R. Plott, "EPA's New Emissions Trading Mechanism: A Laboratory Evaluation," Journal of Environmental Economics and Management, March 1996, 30, 133-160.

Ellerman, A. Denny, Richard Schmalensee and Paul L. Joskow, "1996 Update on Compliance and Emissions Trading under the U.S. Acid Rain Program," M.I.T. Center for Energy and Environmental Policy Research Working Paper 97-005, November 1997.

Ellerman, A. Denny, Richard Schmalensee, Paul L. Joskow, Juan Pablo Montero and Elizabeth M. Bailey, Emissions Trading under the U.S. Acid Rain Program: Evaluation of Compliance Costs and Allowance Market Performance, M.I.T. Center for Energy and Environmental Policy Research Special Report (October 1997).

Electric Power Research Institute, Integrated analysis of fuel, technology and emission allowance markets: electric utility responses to the Clean Air Act Amendments of 1990," EPRI TR-102510, Palo Alto, CA.

Electric Power Research Institute, The emission allowance market and electric utility SO<sub>2</sub> compliance in a competitive and uncertain future," EPRI TR-105490s, Palo Alto, CA.

ICF Resources Incorporated, "Economic Analysis of Title IV (Acid Rain Provisions) of the Administration's Proposed Clean Air Act Amendments, H.R. 3030/S. 1490," Washington, D.C., September 1989.

Joskow, Paul L., Richard Schmalensee, and Elizabeth M. Bailey, "The Development of the Sulfur Dioxide Emissions Market," American Economic Review, (1998, forthcoming).

Myers, Todd A. and Pamela Custode, "CAAA Phase I Performance: Overcompliance," Coal, October 1995, 100:10, pp. 25-26, Intertec Publishing (Chicago).

Schennach, Susanne M., "The Economics of Pollution Permit Banking in the Context of Title IV of the 1990 Clean Air Act Amendments," M.I.T. Center for Energy and Environmental Policy Research Working Paper 98-007, May 1998.