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Ex Post Evaluation of the RECLAIM Emissions Trading Program for the Los Angeles Air Basin

by

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EX POST EVALUATION OF THE RECLAIM EMISSIONS TRADING PROGRAMS FOR THE LOS ANGELES AIR BASIN[1]

I. INTRODUCTION AND OVERVIEW

The emissions trading program developed for the Los Angeles air basin—the Regional Clean Air Incentives Market ("RECLAIM")—provides perhaps the most complex experience thus far of any established emissions trading programs. Begun in 1994 after a three-year development effort, the RECLAIM cap-and-trade programs for nitrogen oxides ("NO_X") and sulfur dioxide ("SO_2") include participants from numerous sectors (in contrast to most other existing trading programs, which focus on a single sector). Several project-based programs that provide credits for reductions from mobile and area sources supplement the cap-and-trade programs. Indeed, this basic structure is similar to that envisioned for other emissions trading programs including those for greenhouse gas ("GHG") emissions, in which trading under national or regional caps would be supplemented by project-based programs (Joint Implementation and Clean Development Mechanism). Notwithstanding important differences

[1] Parts of this draft draw heavily upon a joint paper with Denny Ellerman and Paul Joskow on experience and lessons from emissions trading programs and implications for greenhouse gas trading that was prepared for the Pew Center on Global Climate Change (Ellerman et al., forthcoming). I am indebted to both co-authors for their insights on RECLAIM as well as to Paul Joskow for his detailed and insightful analyses of the linkages between California's electricity markets and RECLAIM (Joskow 2001 and Joskow and Kahn 2002). Warren Herold and James Patchett of NERA provided very helpful research assistance. In the past, I have served as a consultant regarding RECLAIM to the South Coast Air Quality Management District, the California Council for Environmental and Economic Balance, and the Regulatory Flexibility Group. Despite these debts and affiliations, all views expressed by are mine and I alone am responsible for any errors or omissions this paper might contain.

between RECLAIM and other potential programs, the experience with RECLAIM promises to provide some insights into how other more extensive trading programs might function.

The NO_X RECLAIM program has had a tempestuous history in recent years. The significant developments include:

- In 2000, the prices for NO_X Reclaim Trading Credits ("RTCs," the basic unit of trade) increased dramatically. From a range of about $1,000-$4,000 per ton in 1994-99, the average RTC price increased to more than $45,000 in 2000 (with individual trades reported for more than $100,000 per ton).

- The pressure of price increases may have lead to improper dealings by a prominent RTC broker. The SCAQMD has issued a violation notice against one of the major RTC brokers for alleged violations of the emissions credit trading regulations; the notice follows lawsuits charging ACE with not providing RTCs that were paid for by their clients.

- This increase in RECLAIM NO_X prices both was a reflection of the "California electricity crisis" of 2000—which involved dramatic increases in wholesale electricity spot prices—and was itself a significant contributing factor to the higher wholesale electricity spot prices.

- As a result of the high NO_X prices and the electricity circumstances, NO_X emissions exceeded the RECLAIM cap for 2000 by about 6 percent (after taking advantage of limited banking/borrowing options). RECLAIM provisions call for these excess emissions to be reflected in reduced future RTC allocations.

- In May 2001, the agency responsible for RECLAIM, the South Coast Air Quality Management District ("SCAQMD") passed major changes to RECLAIM that have in effect suspended participation in it by electric generators and returned the control of their emissions at least temporarily to a command-and-control program. Generators submit compliance plans for the installation of best available retrofit control technology (BARCT) and pay a mitigation fee of $15,000 for excess emissions that is used by the SCAQMD to fund project-based emission reductions; generators also receive reduced future RTC allocations for any shortfall in emissions reductions.

- Electricity generators have complied with the May 2001 requirements by submitting compliance plans and paying mitigation fees for excess emissions in 2000 and 2001. The SCAQMD has contracted for emission reductions from marine and other sources.

- RTC prices have reduced considerably since their peaks in 2001, so that by the end of 2002, RTC NO_X prices for 2003 RTCs are in the neighborhood of $6,000 per ton.

These experiences can suggest lessons for how emissions trading works "in practice," particularly with regard the treatment of price volatility and the interaction of emissions trading and restructuring of electricity markets. In considering such lessons, however, it is important to compare RECLAIM's performance not only to an "ideal" emissions trading program but also to the alternative "command-and-control" program that otherwise would exist.

The key conclusions regarding the recent RECLAIM performance are the following:

1. *With regard to environmental performance, RECLAIM has generally been successful in achieving its emission goals; even for 2000, the net effect of the dramatic shifts in RTC prices was to shift a relatively small percentage (6 percent) of NO_X emission reductions from 2000 to future years*. Moreover, there is no reason to believe that a command-and-control alternative would have performed better under the circumstances. Indeed, since emission *rates* would have been regulated—rather than overall emissions—the command-and-control alternative would likely have resulted in the same or greater emissions increases without the compensating measures taken as a result of exceeding the NO_X RECLAIM cap.

2. *With regard to cost savings, the large number of RTC transactions suggests that trading has reduced the overall cost of meeting emissions targets; indeed, even in 2000, the RECLAIM market behaved as a market should.* As the demand for NO_X RTCs increased and their supply decreased in 2000, NO_X prices increased as they should have. Moreover, the prices of an important product "using" NO_X RTCs, wholesale electricity, also increased. This should have provided signals to affected sources to invest in emissions controls as well as signals to consumers to reduce consumption of electricity.

3. *The major "problems" of RECLAIM were due primarily to flaws in California's newly deregulated electricity markets rather than to serious flaws in the RECLAIM program itself.* Had the structure of California's electricity industry remained composed of regulated monopolies, or if the transition to new competitive market structures had been done more competently and with greater sensitivity to the interactions between NO_X RTC prices and spot electricity prices, the impact of higher NO_X RTC prices on the average price of electricity would have been much more modest. And if the electricity crisis had not occurred, electricity generators likely would not have been removed—at least temporarily—from the NO_X RECLAIM program.

4. *RECLAIM could be improved by providing more tools to manage extreme price volatility effectively.* The experience of RECLAIM in 2000 in 2001 shows that short-term and unexpected fluctuations in demand can lead to significant volatility in allowance prices, which can in turn lead to significant volatility in prices of goods whose production involves significant "use" of emissions allowances. The major tool used in other programs to reduce price volatility—banking of excess emissions reductions—is largely unavailable under RECLAIM. Other options include expanding

the range of emission-reduction alternatives in RECLAIM—beyond the relatively few additional emission reduction alternatives made available from project-based credits or voluntary opt-ins thus far—and maintaining the mitigation fee or developing a "safety valve" that would directly limit the maximum price.

II. OVERVIEW OF RECLAIM AND INITIAL EXPERIENCE

A. Development of the RECLAIM Program

Regulators in the Los Angeles air basin were developing RECLAIM in the early 1990s at the same time that the national Acid Rain Program was being developed for electricity generations. RECLAIM was significant both in some of its provisions and as the first major example of a tradable permit program developed by a local jurisdiction, rather than a federal authority.

The SCAQMD approved the RECLAIM program in October 1993 after a three-year development program, and the program began operation in January 1994 (South Coast Air Quality Management District 1993). RECLAIM was developed as an alternative and less expensive means of achieving the emission reductions of nitrogen oxides (NO_x) and SO_2 called for by a set of command-and-control measures designed to bring the Los Angeles Basin into compliance with National Ambient Air Quality Standards. The Los Angeles Basin consists of a 6,600 square mile area with a combined population of about 13 million inhabitants in 1990. The SCAQMD had struggled with the task of complying with federal air quality mandates for many years. At the time that efforts began to develop an emissions trading program, air emissions were governed by the 1989 Air Quality Management Plan (AQMP). The 1989 AQMD was a massive plan—consisting of 130 individual control measures affecting every sector in the region—that was designed to bring the area into compliance with federal air quality standards by 2010. The cost of the control strategy was enormous, estimated to be about $13 billion (1988 dollars) per year, or about $2,200 annually for every household in the region (Harrison 1988).

Interest in emissions trading was due in large part to the need to develop an expensive means to achieve air quality targets and avoid driving businesses out of the region. The SCAQMD developed workshops, produced many documents including a full-scale feasibility

study, and set up an Advisory Committee to assist in the development of details for the program that became RECLAIM.[2] Studies done at the time indicated that RECLAIM could reduce the costs of meeting emission targets by about 40 percent relative to the command-and-control alternatives in the AQMP (Harrison and Nichols 1993, Johnson and Pekelney 1996).

B. Key Features of RECLAIM

The major elements of RECLAIM were cap-and-trade programs for major stationary source emitters of nitrogen oxides (NO_X) and sulfur dioxide (SO_2). (The SCAQMD had considered developing a cap-and-trade program for volatile organic compounds ("VOCs"), but decided not to do so.[3]) Sources subject to the cap—which were issued RECLAIM Trading Credits ("RTCs")—included those emitting more than 4 tons per year, although there are provisions for additional sources to opt-in to the program. RECLAIM also allowed sources to gain additional RTCs from reductions in emissions from mobile sources, primarily through scrapping existing vehicles.

Under RECLAIM, the caps for both NO_x and SO_2 were set higher than expected emissions in the initial years—which reflected in part the effects of a recession in the Los Angeles region—but the overall caps were reduced steadily over time so that by 2003, emissions from the covered sources would be reduced by about 50 percent below early-1990s emission levels and about 80 percent below allowable emissions. From 2003 on, the caps remain constant. The final caps were equivalent to the levels of emissions expected under the set of command-and-control regulations that would otherwise have applied to these sources.

Several features of the RECLAIM program distinguish it from other emissions trading programs. First, the program covers a heterogeneous group of participants including power plants, refineries, cement factories, and other industrial sources. Second, the RECLAIM

[2] The author was a member of the RECLAIM Advisory Committee.

[3] VOCs were not included in RECLAIM because of concerns among environmental groups that toxics exposure might be affected and because of concerns among industry groups that cost saving would be relatively modest and not justify the setting of a cap on overall emissions. See Harrison 1999b.

program distinguishes between emissions in two geographic zones.[4] Since emissions in the Los Angeles Basin generally drift inland from the coast, sources located in the inland zone were allowed to use RTCs issued for facilities in either the inland or coastal zones, but sources located in the coastal zone could use only RTCs issued for facilities in the coastal zone. A third distinctive feature of the RECLAIM program is that it does not allow banking because of concerns that use of banked emissions might lead to substantial increases in some future year, and thus delay compliance with ambient air quality standards. RECLAIM does provide limited temporal flexibility, however, by grouping sources into two 12-month reporting periods, one from January through December and the other from July through June, and by allowing trading between sources in overlapping periods. This provision effectively allowed participants to bank or borrow RTCs six months before or after a given compliance period.

The initial allocation of RTCs was the most contentious part of the planning process, although eventually an allocation plan acceptable to the wide range of affected facilities was developed (Harrison 1999a). As was the case with the Acid Rain Program, RTCs were allocated free to incumbents and distributed many years prior to when they could be used for compliance.[5] The final set of formulas for allocating RTCs departed considerably from the simple formula initially proposed by the SCAQMD, and it was the result of literally dozens of proposals, many of which were exhaustively studied by the SCAQMD (and no doubt by the affected firms as well). Despite threats by several firms and sectors to oppose the program if their formulas were not chosen, the final result was an administratively feasible and politically salable cap-and-trade program.

C. Initial Experience with RECLAIM

The experience with RECLAIM over the first six years, from 1994 to 1999, was relatively uneventful and positive—emissions caps were not exceeded, brokerage and other

[4] The original RECLAIM proposal included 38 separate trading regions, corresponding to the regions used for the offset program. This detailed geographic division was abandoned as a result of the plausible fear that the trading markets would be too thin. See Harrison (1999b).

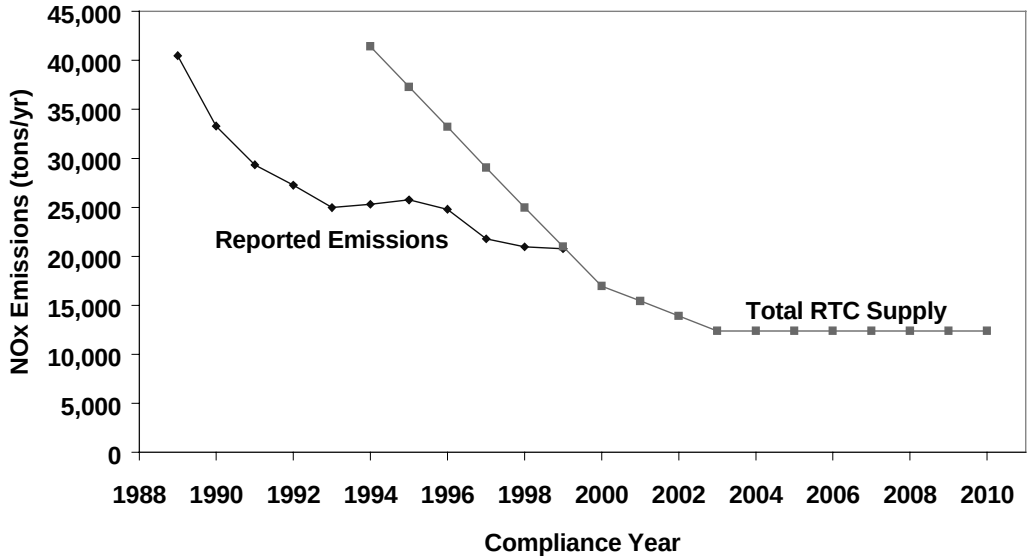
[5] SO_2 allowances in the Acid Rain Program are distributed for thirty years forward on a rolling basis, while RTCs are distributed indefinitely into the future.

institutions developed to facilitate trades, some initial monitoring difficulties were worked out, and large volumes of RTCs were traded. There were, however, anticipations of future difficulties.

1. Emissions and Caps

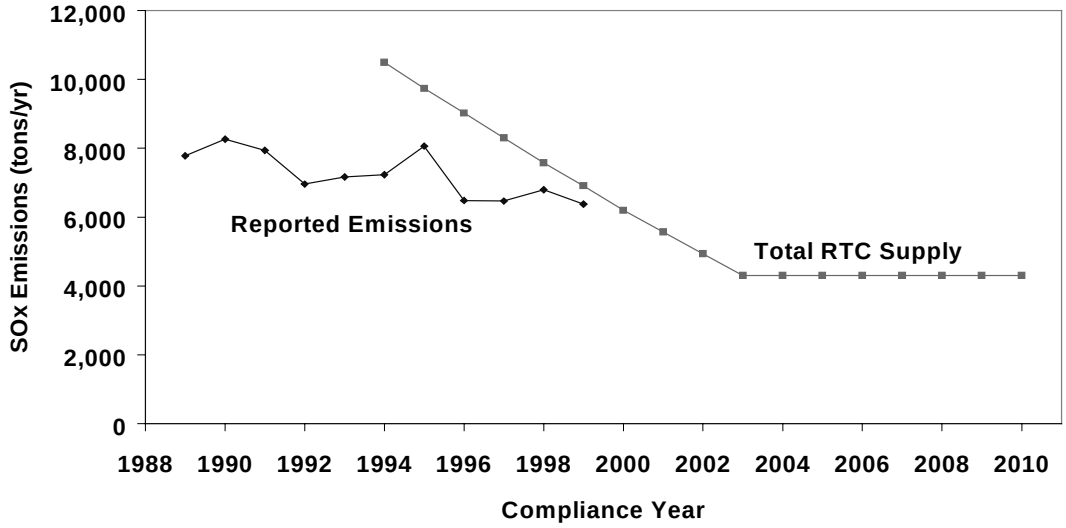
Emissions for both NO_X and SO_2 RECLAIM sources were below the annual caps throughout the period from 1994 to 1999, although the 1999 NO_X emissions were virtually equal to the cap. Figures 1 and 2 show emissions and the annual caps for NO_X and SO_2, respectively.

Figure 1. NO_X Emissions and Available RTCs (1994-1999)



Source: South Coast Air Quality Management District (2001c).

Figure 2. SO_X Emissions and Available RTCs (1994-1999)



Source: South Coast Air Quality Management District (2001c).

These figures also suggest that the relatively lenient caps in the early years of RECLAIM did not result in emissions increases. Some critics of RECLAIM have complained about the lax early caps, although it important to remember that many of the command-and-control regulations that RECLAIM replaced had not gone into force when RECLAIM begun. Indeed, the emphasis in the 1989 AQMP was on compliance with ozone requirements in 2003, which explains why the final cap levels were set for 2003. The number of sources changed somewhat over time, although the charges in RTCs were relatively modest. Table 1 shows inclusions, exclusions and shutdowns over the period from 1994 to 1999. Shutdowns do not affect the RTC cap.

Table 1. RECLAIM Universe Changes (1994-1999)

	NO_X Facilities	SOx Facilities	Total Facilities
Start of Program	392	41	394
Inclusions—1994-1999	79	5	79
Exclusions—1994-1999	62[a]	4	63[a]
Shutdowns—1994-1999	55	6	56
End of Compliance Year 1999	354	36	354

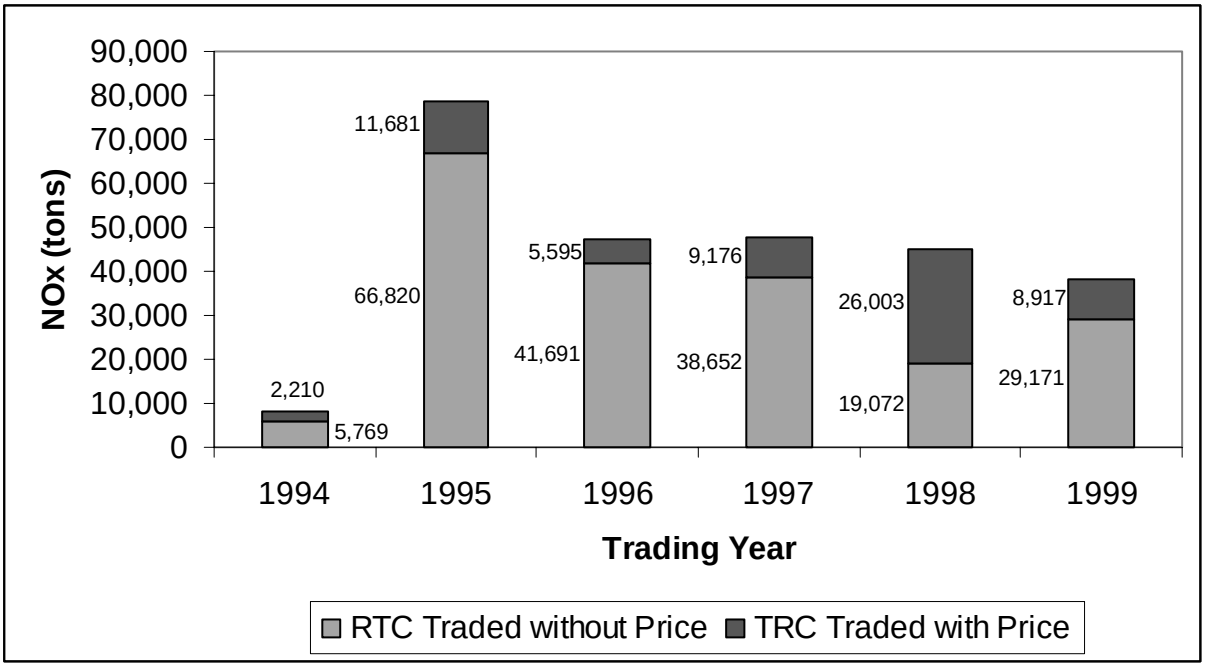
Note: [a] Consolidation of two pairs of adjacent facilities into two facilities. No equipment shutdown or removed from the RECLAIM Universe

Source: South Coast Air Quality Management District (2002a).

2. Trading Volumes and Compliance Costs

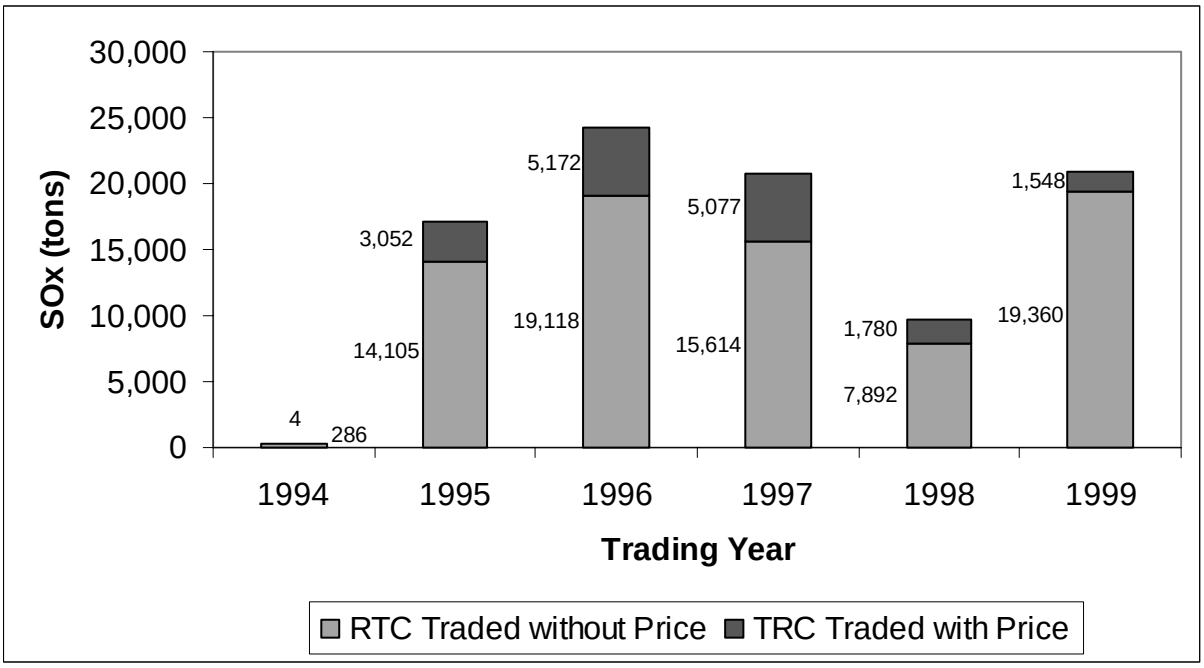
Figures 3 and 4 show the volumes of trading in SO_2 and NO_x RTCs, respectively, over the first six years of RECLAIM. The figures are reported separately for RTCs without a price—which includes transfers from sellers to brokers, transfers within facilities with common ownership, and transfers as part of other transactions (e.g., sale of a facility including its RTCs)—as well as the number of RTCs traded between firms at various prices.

Figure 3. Total Tons of NO_X RTCs Traded (1994-1999)



Source: South Coast Air Quality Management District (2002a).

Figure 4. Total Tons of SO_X RTCs Traded (1994-1999)



Source: South Coast Air Quality Management District (2002a).

The figures show the total numbers of RTCs of all vintages "traded" in each calendar year; because the figures are not reported for individual vintages, it is not possible to compare total volumes of trades with total RTCs for the current compliance year. The fact that the volume of trade in a given trading year typically exceeds the current compliance year RTCs of course implies that firms were trading various vintages. As of the end of 1999, RTC permits for about 265,000 tons of NO_x and about 93,000 tons of SO_2 had been traded. Since the aggregate NO_x and SO_2 caps were non-binding and because the volumes traded in virtually every year exceed that year's cap (often by several multiples), the presumption is that most of these trades are in future vintages. Moreover, the trend of less trading over time, especially for NO_x, suggests that future vintages were bought, sold, and transferred ahead of time, in keeping with plans to install the required abatement equipment to meet the final cap in 2003 and thereafter.

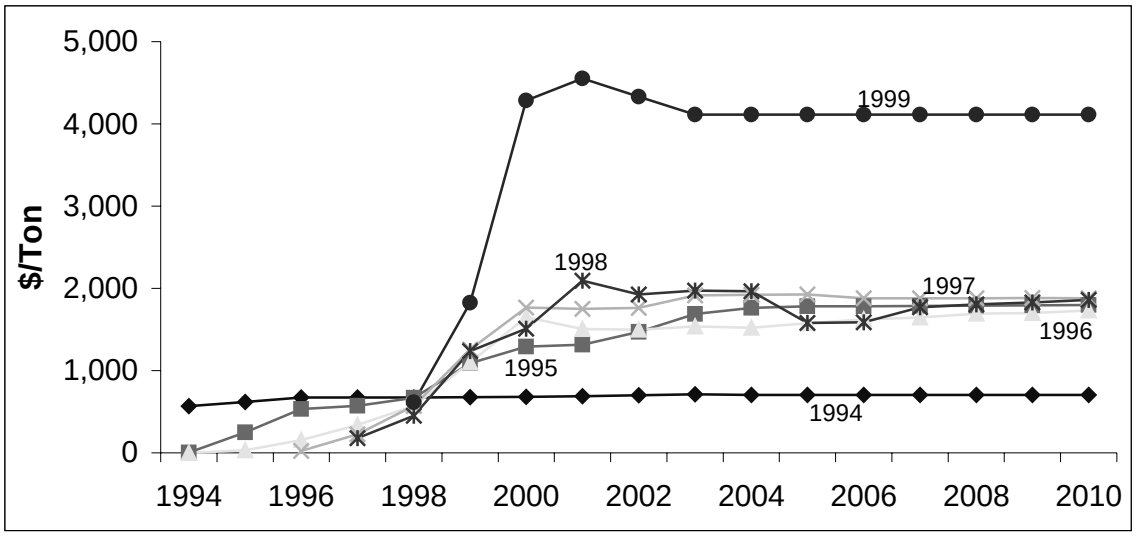
These conclusions regarding the volume of RTC transactions must, however, be tempered by complexities in the reporting of RTC trades. As Burnside and Eichenbaum (1996)

point out in an early review of RECLAIM, there is considerable double counting of trades because RTCs are recorded as sold for a zero price when they are transferred to a broker for possible sale, and recorded again when they are sold or returned to the seller if no buyer is found.

3. RTC Prices

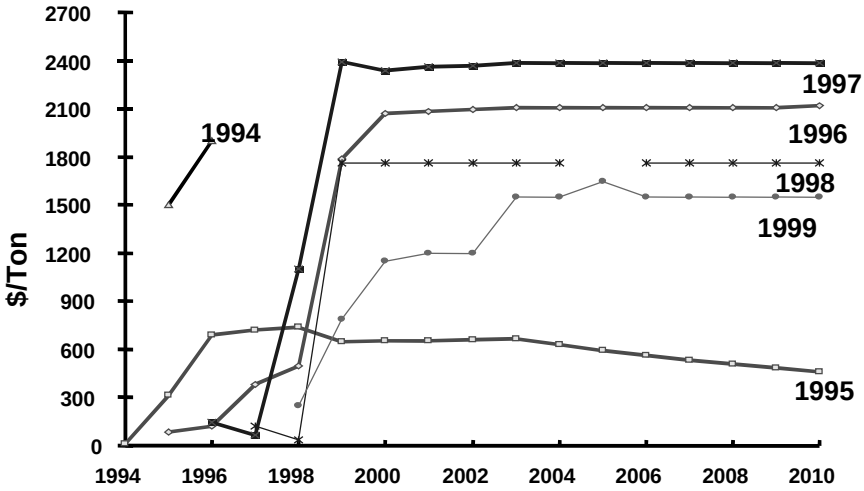
The average prices for RTCs over the six-year period from 1994 to 1999 are provided in Figure 5 and 6 for NO_X and SO_2, respectively. The graphs are complicated because they summarize prices for different vintage RTCs in the various calendar years. The horizontal axis in Figure 5 represents the vintage, i.e., the year in which the RTC can be used, and the lines in the graph show the average prices for current and future vintages in successive calendar years. The curve labeled 1999, for example, shows the average price for transactions in calendar year 1999. This curve shows that the price of the current year vintage (1999 vintage year) was substantially lower than the prices of future vintages (2000, 2001, 2002, etc.), which are about equal. In addition, between 1994 and 1998, the prices of all NO_x RTC vintages remained relatively stable, ranging from $1,500 to $3,000 per ton.

Figure 5. Yearly Average Prices for NO_X RTCs (1994-1999)



Source: South Coast Air Quality Management District (2000).

Figure 6. Yearly Average Prices for SO_X RTCs (1994-1999)



Source: South Coast Air Quality Management District (2000).

Prices for SO_2 RTCs are generally substantially lower than for NO_X RTCs and show a different pattern. Prices generally have fallen over time, presumably in line with expectations about the likely marginal costs of reducing SO_2 emissions from RECLAIM sources. Note, however, that the prices for SO_2 RTCs are substantially lower than for national SO_2 allowances under the acid rain trading program, which have generally been in the range of $100-$200 per ton. This difference presumably reflects the more costly controls required to comply with the SO_2 cap in RECLAIM compared to the SO_2 cap in the acid rain trading program.

4. Transaction and Monitoring Costs

Numerous brokers and other intermediaries have emerged to facilitate these trades and to provide other services to participants, such as pricing information and some derivatives to manage price risk. The current RECLAIM website lists more than 100 individuals who have registered to engage in RTC sales, many of whom are affiliated with brokerage firms rather than RECLAIM facilities. Transaction costs for RTCs appear to have been relatively low and there can be no doubt that RECLAIM markets have been active.

Like the SO_2 cap-and-trade program, RECLAIM required that largest sources use CEMS to verify their emissions as a means of providing assurance that the data were valid. Table 2 summarizes the monitoring requirements for RECLAIM sources. When the program

first was implemented, there were technical difficulties with some of the CEMS, and some facilities could not rely upon CEMS data for all of their submissions (South Coast Air Quality Management District 1998). (The early problems with CEMS occurred because of technical malfunctions of the CEMS equipment; see Burnside and Eichenbaum 1996.) These difficulties prompted requests that the large sources be allowed to use the less expensive monitoring options allowed for smaller sources, a request that was denied by the SCAQMD. Eventually the technical difficulties with these CEMS were overcome and virtually all of the emissions data from large sources now are based upon the CEMS information.

Table 2. Monitoring Requirements for RECLAIM Sources

Source Category	Major Sources (NOx and SOx)	Large Sources (NOx only)	Process Units and Rule 219 Equipment (NOx and SOx)
Monitoring Method	Continuous Emission Monitoring System (CEMS)	Fuel Meter or Continuous Process Monitoring System (CPMS)	Fuel Meter and/or Timer
Reporting Frequency	Daily	Monthly	Quarterly

Source: South Coast Air Quality Management District (2002a).

III. RECENT EXPERIENCE WITH RECLAIM

The difficulties experienced by the RECLAIM program began in the summer of 2000 as an implication of restructuring of California's electricity sector and culminated in May 2001 in significant changes in RECLAIM, including at least a temporary severing of electricity generators from RECLAIM and introduction of command-and-control requirements.

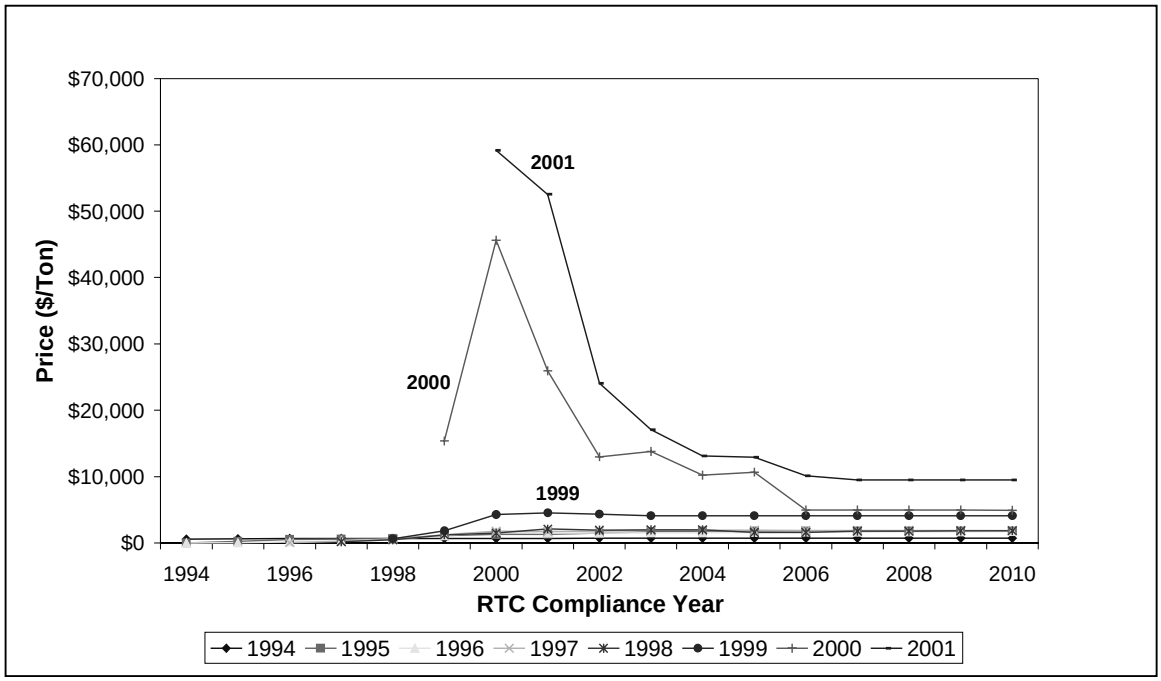
A. RECLAIM Price Spikes

Price volatility manifested itself most visibly in the dramatic spikes in 2000 in the prices of NO_x RTCs for 2000 vintages and those surrounding it. This trend continued into 2001, until the electricity generators were removed (at least temporarily) from RECLAIM.

Figure 6 shows average NO_X prices for various vintages over the history of the program from 1994 to 2001. In 2000, the prices for all "near term" vintages of allowances

jumped significantly (the points on the top line labeled "2000" in the figure), with the largest price increase exhibited for the 2000 vintage allowances, tapering off quickly for later vintages. (Note that the price for the 1999 vintage allowance also increased, because RTCs from the 1999 July cycle could be traded used to cover emissions through June 2000.) The price for 2000 NO_x RTCs increased from an average of about $4,300 per ton for trades in 1999 to almost $45,000 per ton for trades in 2000, a ten-fold increase. The average monthly price of 2000 vintage NO_x RTCs reached in the peak month in 2000 was more than $70,000 per ton, with the highest single price reported equal to more than $100,000 per ton. The price increases—in 2000, relative to 1999—for 2001 and later vintage allowances (the points on the top line) were smaller and taper off for farther-out vintages. The increase in NO_X RTC prices continued into 2001, with the same pattern as 2000 regarding the much larger increases for near-term (2000-2002) vintages relative to later vintages, whose prices would be limited by the costs of emission reduction alternatives.

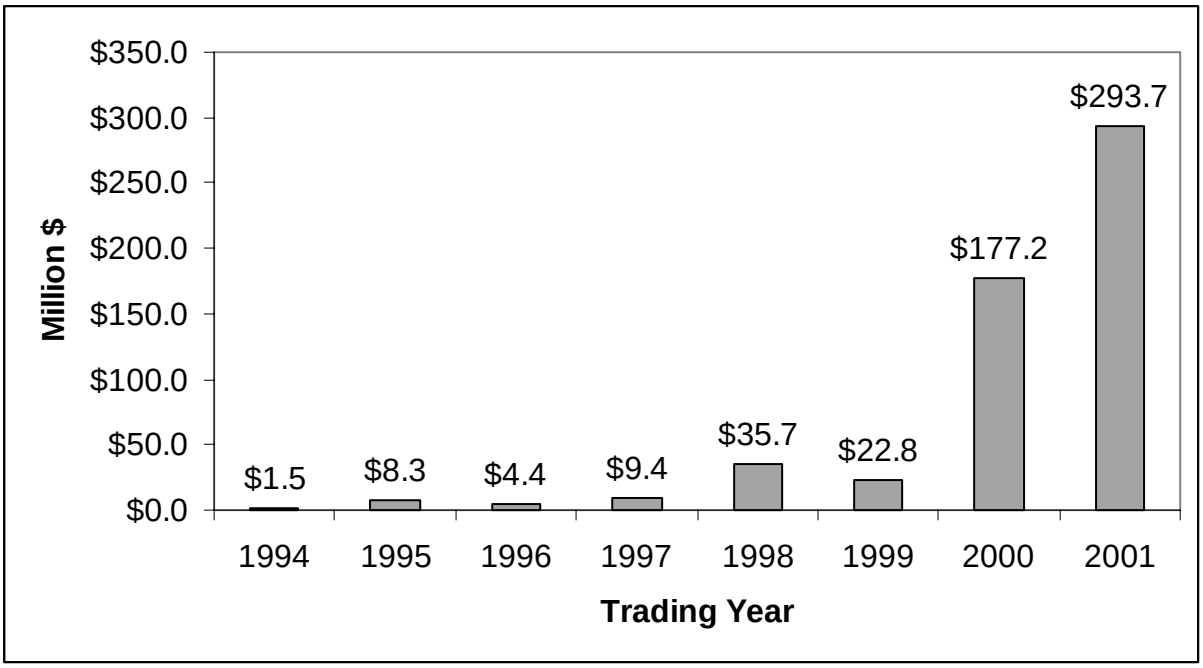
Figure 6. Yearly Average Prices for NO_X RTCs (1994-2001)



Source: South Coast Air Quality Management District (2002a).

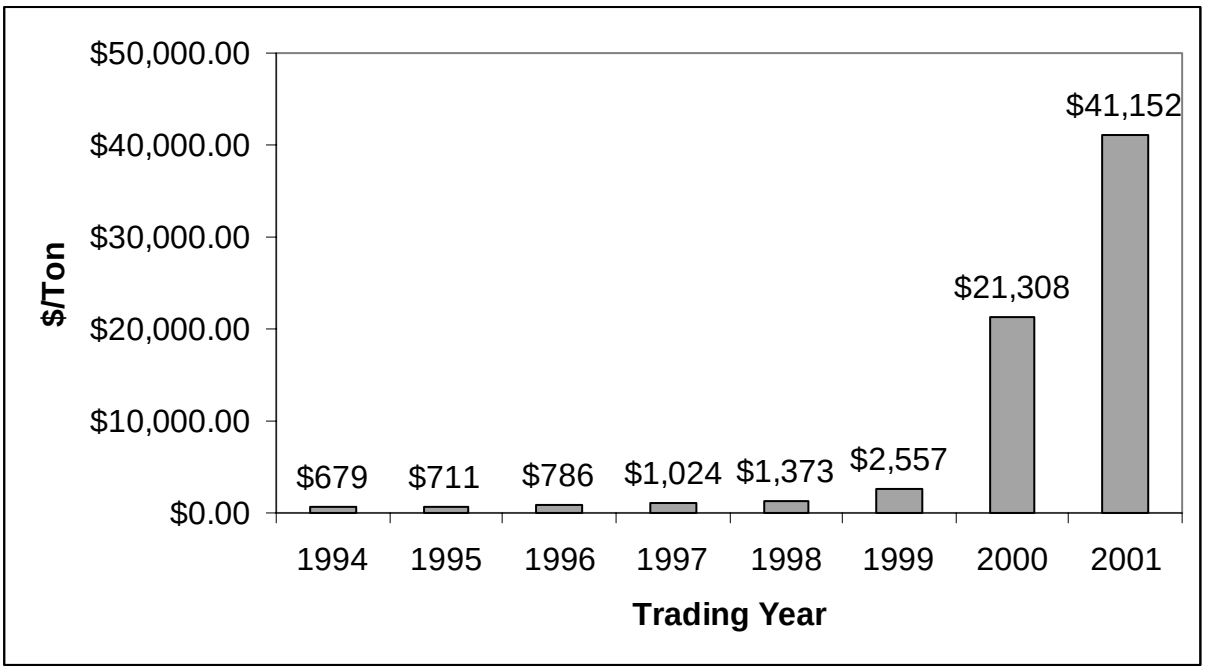
The dramatic increase in NO_X RTC prices in 2000 and 2001 was reflected in the overall dollar of trading volume and the average value for NO_X RTCs. Figure 7 shows the total value for NO_X RTC trades by trading (calendar) year. The total volume of NO_X RTC transactions increased from a high of $35.7 million in the 1994-99 period, to $177.2 million in 2000 and $293.7 million in 2001. The average value per ton for NO_X RTCs ranged from around $1,00-$2,500 in the 1994-99 period, to more than $21,000 in 2000 and more than $41,000 in 2001. (Note that these average values reflect transactions for all RTC vintages.)

Figure 7. Total Value of NO_X RTC Trades (1994-2001)



Source: South Coast Air Quality Management District (2002a).

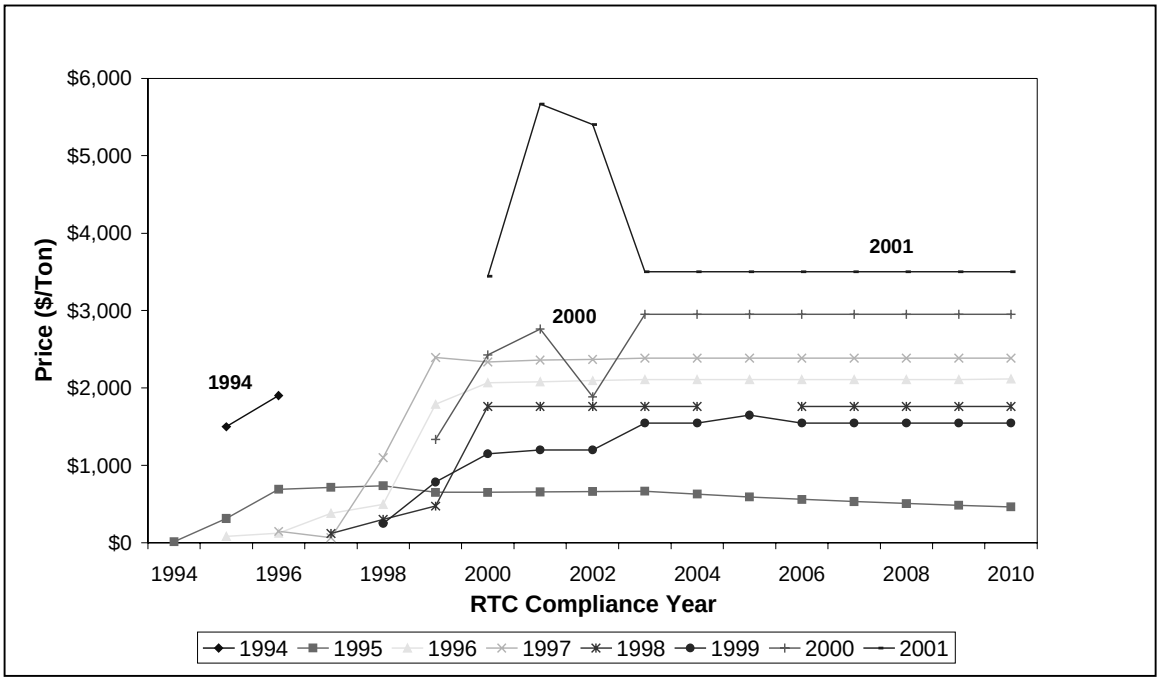
Figure 8. Average Price per Ton for NO_X RTC Trades (All Vintages) (1994-2001)



Source: South Coast Air Quality Management District (2002a).

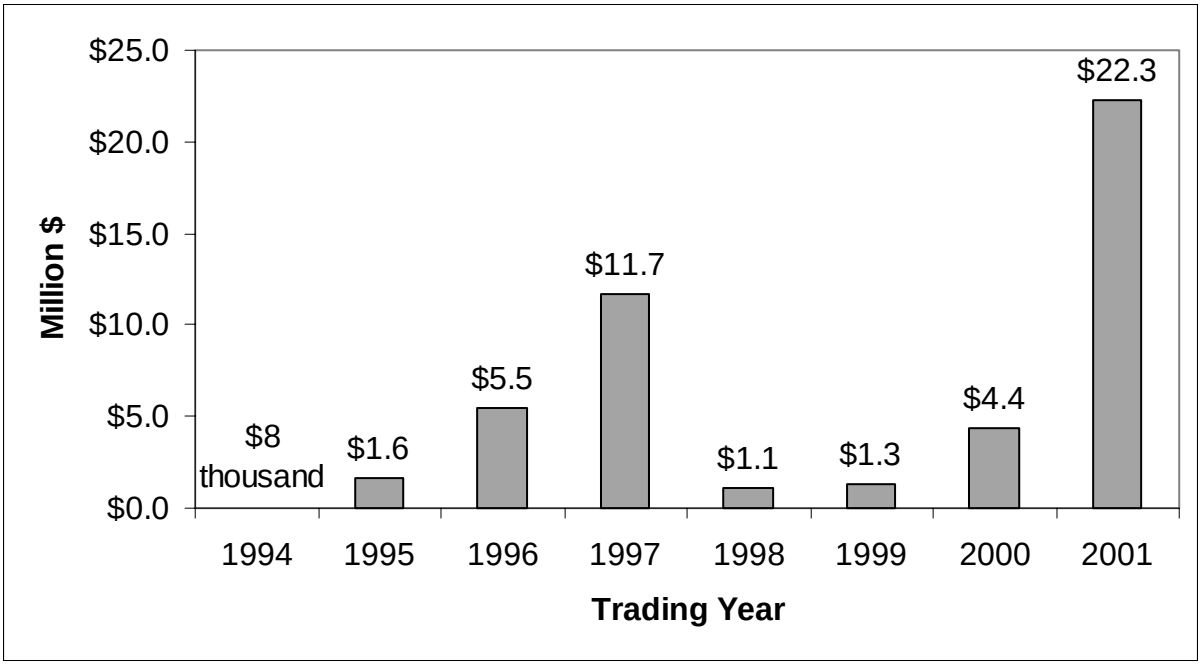
The increases were much less pronounced for SO_2 RTCs than for NO_X RTCs. Figure 9 shows the price history for SO_2 RTCs. Prices increased substantially, particularly in 2001, although the increases were much smaller than for NO_X RTCs. Indeed, as Figures 10 and 11 indicate, the total value of SO_2 trades and the average price per SO_2 RTC actually both were greater in 1997 than in 2000, although the values were greatest in 2001.

Figure 9. Yearly Average Prices for SO_X RTCs (all vintages) (1994-2001)



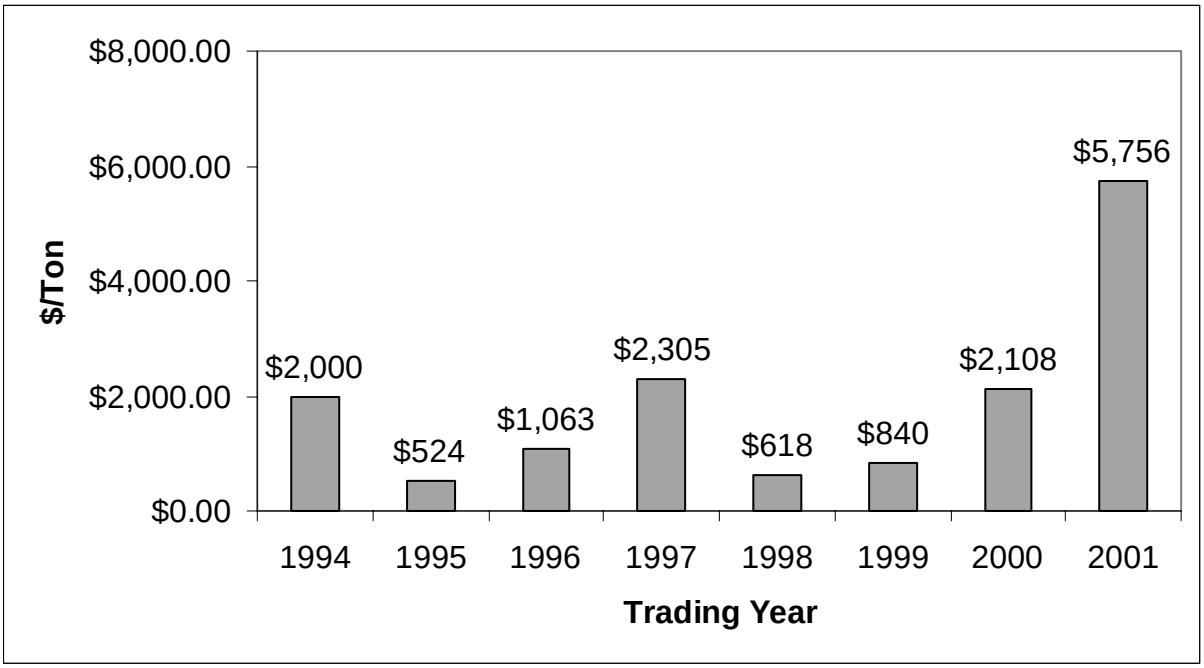
Source: South Coast Air Quality Management District (2002a).

Figure 10. Total Value of SO_X RTC Trades (all vintages) (1994-2001)



Source: South Coast Air Quality Management District (2002a).

Figure 11. Average Value of SO_X RTC Trades (all vintages) (1994-2001)



Source: South Coast Air Quality Management District (2002a).

B. Interactions Between RECLAIM Market and California Wholesale Electricity Market

The dramatic increase in the cost of NO_x RTCs in the summer of 2000 was caused by a substantial increase in the demand for RTCs on the part of electric generators. The demand for electricity soared in California during the summer of 2000 while the availability of imported power from other states declined (Joskow 2001). The increased demand had to be met by running the large fleet of old in-state gas-fired generating units more intensively than in the recent past. Few of these old plants had yet installed NO_x emissions controls and no new plants were completed until the summer of 2001. As a result, the demand for NO_x RTCs and their prices increased significantly during summer 2000 as generation from the in-state gas fired power plants increased to balance supply and demand.

The high price for NO_x RTCs was one of several factors leading to the high wholesale electricity prices in California during 2000 (see Joskow and Kahn 2002 and Borenstein et al. 2002). The generating units subject to NOx RECLAIM requirements became the marginal units for a significant number of hours, thus setting prices for wholesale electricity throughout

California. Moreover, a large fraction of electricity demand under California's new wholesale market institutions was supplied through the spot market, where demand was effectively insensitive to prices, rather than through long-term contracts. As a result, the huge spikes in spot market prices for electricity, caused in part by the spike in NOx RTC prices, became an enormous financial burden on distribution utilities, consumers, and the state of California.

There has been speculation that unregulated electricity suppliers manipulated the NOx RTC credit market as well as electricity and (possibly) natural gas markets. Indeed, there is some preliminary evidence that electricity generators used the NO_X RTC credit market to earn greater profits in the electricity market (Kolstad 2002) and there is currently substantial litigation regarding the behavior of electricity and natural gas traders during this period. It seems too early to develop clear conclusions on these issues of market power and market manipulation.

What does seem clear, however, is that the inadequacies of the California electricity restructuring contributed substantially—perhaps definitely—to the dramatic increase in NO_X RTC prices (see Joskow 2002). Had the structure of California's electricity industry remained composed of regulated monopolies, or if the transition to new competitive market structures had been done more competently and with greater sensitivity to the interactions between NO_X RTC prices and spot electricity prices, the impact of higher NO_X RTC prices on the average price of electricity would have been much more modest.

This is the case because regulated prices would have been based on the average costs of generating electricity, including the average costs of NO_x RTC credits rather than the marginal cost of the generating units with the highest marginal spot fuel and RTC costs that cleared the spot electricity market. In addition further price increases resulting from unregulated generators exercising market power (Joskow and Kahn 2002, Borenstein, Bushnell and Wolak 2002) would not have occurred under regulation. Finally, as Joskow (2001) points out, the disruptions caused by divestiture, the hasty movement to a set of complex new wholesale market institutions, inelastic short-term electricity demand, and the excessive amount of electricity demand supplied out of the spot market, probably undermined rational forward contracting and investments in NO_x controls by the new owners of most of the fossil-fired power plants in

California and shifted the burden of short-term price volatility to economic agents (distribution utilities and retail consumers) who did not have the ability to manage it.

C. RECLAIM NO_X Emissions

The dramatic increases in demand for NO_X RTCs—leading to price spikes in 2000—also were reflected in emissions above the NO_X cap set for 2000. The excess emissions were due to excess emissions both from power facilities and non-power facilities. Table 3 summarizes NO_X emissions and allocations for Compliance Year 2000, the last year for which information is available. Overall, compliance year 2000 emissions were in excess of compliance year 2000 allocations by about 3,300 tons, or about 19 percent of the compliance year 2000 allocation. (Figure 12 shows these results graphically.)

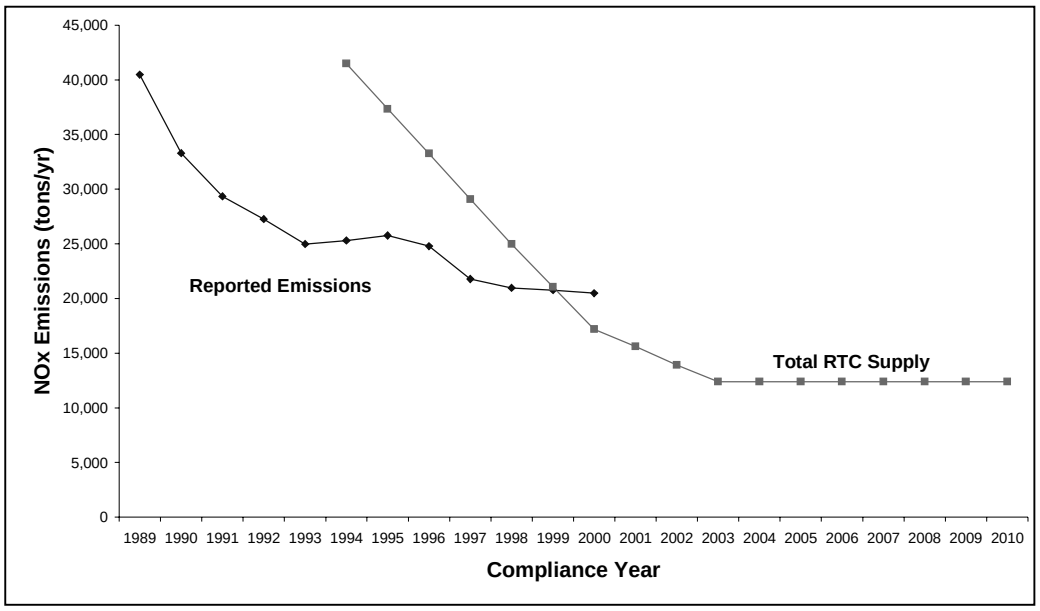
The role of power plant demand on the overall demand for NO_X RTCs is clear—emissions from power facilities were almost 6,800 tons, almost 300 percent of their initial allocation. Although power facilities purchased more than 2,500 tons of NO_X RTCs, these purchases were not sufficient to put them into compliance, leading to a noncompliance excess of more than 1,900 tons. Indeed, as a group, non-power facilities sold more NO_X RTCs than they were allocated, yielding a noncompliance excess of more than 1,300 tons.

Table 3. Impact of NO_X Emissions from Power Producing Facilities on the Overall NO_X Allocations for Compliance Year 2000

	Non-Power Producing Facilities (a)		**Power Producing Facilities (b)**		**All Facilities (a) + (b)**
	RTCs Held in CY 2000	Initial Allocations	RTCs Held in CY 2000	Initial Allocations	
Allocations (tons)	12,345	14,895	4,852	2,302	17,197
Emissions (tons)	13,703		6,788		20,491
Difference (Exceedance)	(1,358)	1,192	(1,936)	(4,486)	(3,294)

Source: South Coast Air Quality Management District (2002a).

Figure 12. NO_X Emissions and Available RTCs



Source: South Coast Air Quality Management District (2002a).

The temporal flexibility provided in RECLAIM—limited though it was—did, however, result in a substantial reduction in the actual excess emissions from the 19 percent level reported in Table 3. The data in Table 3 compares emissions in compliance year 2000 only to allocations issued by compliance year 2000. But RECLAIM has two overlapping 12-month cycles. This structure creates overlapping six-month periods so that RTCs from different compliance years can be used to offset emissions. In the case of 2000, sources could use RTCs from compliance years 1999 and 2001 as well as 2000.

Based upon the emissions monitoring and compliance reports that were submitted by RECLAIM sources, the amount of excess emissions totaled 1,089 tons, only about 6 percent above the compliance year 2000 allocation (South Coast Air Quality Management District 2002). Thus, as a result of the limited temporal flexibility in RECLAIM, the excess emissions were reduced by more than a factor of three—from about 19 percent to 6 percent.

Although the effect on emissions appears to be modest, the high NO_X RTC prices may have lead to improper activity on the part of a prominent RTC brokerage firm. The SQAQMD has issued a violation notice against one of the major RTC brokers for alleged violations of the

emissions credit trading regulations (South Coast Air Quality Management District 2002b). The notice follows lawsuits charging the broker, Automated Credit Exchange ("ACE"), and its president with not providing RTCs that were paid for by their clients (Jacobs 2002). The SCAQMD notes, however, that these alleged problems have not compromised the environmental performance of the RECLAIM program.

D. RECLAIM Modifications in May 2001

The high NO_X RTC prices triggered a backstop provision in RECLAIM that requires the Executive Officer of SCAQMD to submit an evaluation and review within six months of the determination that the average RTC price has exceeded $15,000 per ton. The Executive Officer also is required to propose that the Governing Board amend the program as appropriate to address specific problems. On January 11, 2001, the SCAQMD released a White Paper evaluating the increases in NO_X RTC prices and presenting near-term and long-term options to stabilize NO_X RTC prices (South Coast Air Quality Management District 2001a). This document reflected public input from an Advisory Committee. The staff concluded that increased demand by electric generation sources was the major cause of the abrupt change in NO_X RTC prices. The authors of the White Paper concluded that substantial lower-cost control alternatives were available for RECLAIM sources, but that these controls would take some time to be put in place. The staff recommended various changes to the RECLAIM program, most of which were adopted by the governing board.

The governing board of the SCAQMD on May 11, 2001 approved the following changes to RECLAIM (South Coast Air Quality Management District 2001b):

- Power plants are separated temporarily from the rest of RECLAIM until at least 2003;
- Power plants must submit by September 1, 2001, compliance plans that involve installation of pollution control equipment (equal to "Best Available Retrofit Control Technology" or BARCT) over the next two to three years;
- Power plants are allowed to pay into a mitigation fund for any excess emissions at the rate of $7.50 per pound ($15,000 per ton), with the SCAQMD using the mitigation fees to reduce pollution from other sources (e.g., diesel trucks and equipment at the port);

- Non-power facilities with emissions greater than 50 tons per year must submit by September 2001 plans either to demonstrate compliance with their NO_X allocations for years 2001 to 2005 based upon their 2000 production rate or to comply with BARCT by January 1, 2003.

- Temporary credit programs will be established, including an Air Quality Investment Program for mobile and area source credits that can be used by new power plants and other buyers.

- Additional and more timely information will be required on RTC trades, including a requirement that trades be reported jointly by the buyer and seller within five days of the trading transaction; and

- The SCAQMD will study the merits of a centralized trading market to replace the decentralized system involving individual RECLAIM companies, brokers or agents, and auctions.

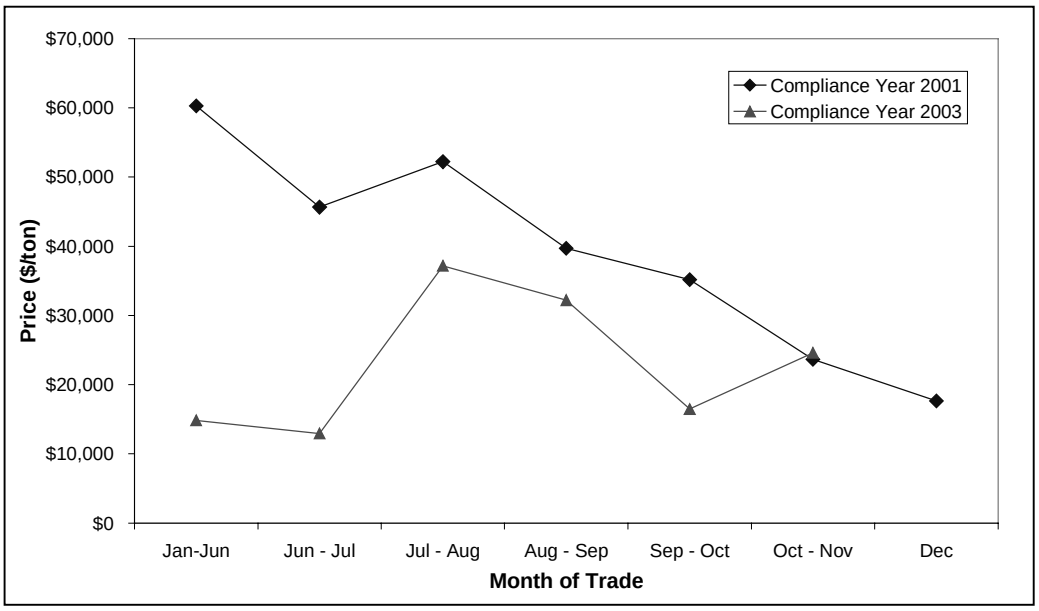
E. Experience After May 2001 Changes

Since the May 2001 changes were put in place, the RECLAIM market has been much less eventful—prices have declined and emission targets have been achieved, albeit at least temporarily due in part to a command-and-control regime. Moreover, the crisis in the California electricity market that largely precipitated the extreme price RTC price volatility has subsided (see Joskow 2002).

1. RTC Prices

The May 2001 changes—particularly the bifurcation of power facilities from the RECLAIM program—appear to have resulted in substantial reductions in RTC prices for the remainder of 2001. Figure 13 shows monthly average RTC NO_X prices for the first half of 2001 (January-June) compared to monthly average prices for the last six months of 2001. Prices are shown for two vintages, 2001 and 2003. Prices for 2001 vintage NO_X RTCs dropped substantially over the last six months of 2001, from more than $60,000 per ton in the first six months of 2001 to less than $20,000 per ton by December 2001.

Figure 13. Changes in Average Prices for NO_X RTCs in Calendar Year 2001



Source: South Coast Air Quality Management District (2002a).

Prices for NO_X RTCs have continued to fall in 2002 and 2003, presumably reflecting the introduction of emission control equipment and the lack of demand from power generators. Information from Canter-Fitzgerald indicates that prices for 2003 NO_X RTCs were about 6,000 per ton at the end of 2002 and the beginning of 2003 (Canter-Fitzgerald 2003).

2. Compliance Plans

The compliance plans required by the May 2001 RECLAIM changes represent at least a temporary shift to a command-and-control regime intended "to ensure timely installation of emission controls." (South Coast Air Quality Management District 2001) All power facilities were required to submit a plan by September 1, 2001 to demonstrate plans to install NO_X Best Available Retrofit Control Technology (BARCT). Deadlines for compliance with BARCT were set for January 1, 2004 for turbines used as peaking units and by January 1, 2003 for all other units. Non-power facilities still in RECLAIM emitting more than 50 tons per year also were required to submit a plan by September 1, 2001 to either demonstrate compliance with their NO_X allocations between years 2001 and 2005 (based on 2000 production rates) or comply with BARCT by January 1, 2003. Together, the facilities required to submit

compliance plans accounted for about 90 percent of RECLAIM NO_X emissions in compliance year 2000.

The required compliance plans—14 by power producers and 42 by non-power producing facilities—were submitted by the due date of September 1, 2001. Table 4 shows the projected emissions reductions from the compliance plans, and Table 5 shows comparisons of projected emissions for the power producing facilities based upon the compliance plans with their RTCs, and the resulting emissions reductions necessary from the mitigation fees program. Based upon the compliance plans, power facilities are projected to have NO_X emissions below their RTC allocations by compliance year 2003. Moreover, SCAQMD staff have recommended emission reductions beyond those called for in the compliance plans; according to the SCAQMD, these changes would yield additional NO_X emission reductions of 460 tons, 291 tons and 195 tons in compliance years 2003, 2004 and 2005, respectively.

Table 4. Projected Emission Reductions from RECLAIM Compliance Plans

Facility Category	Compliance Year				
	2001	2002	2003	2004	2005
Emission Reductions from Power Producing Facilities (tons)	2,559	3,414	4,896	5,373	5,494
Emission Reductions from RECLAIM Facilities with annual emissions greater than 50 tons of NOx emissions (tons)	6,855	6,949	7,539	8,122	8,147
Total (tons)	9,414	10,363	12,435	13,495	13,641

Source: South Coast Air Quality Management District (2002a).

Table 5. Comparison of Projected Emissions and Available RTCs at Power Producing Facilities

Compliance Year	Projected NO_X Emissions in Tons	RTCs Available in Tons	Emission Reductions Necessary from Mitigation Fees Program
2001	4,010	2,735	1,275
2002	3,155	2,371	784
2003	1,673	2,037	None
2004	1,196	2,165	None
2005	1,075	2,156	None

Source: South Coast Air Quality Management District (2001d).

3. Mitigation Fees and RTC Credits

The net result of the compliance plans and the SCAQMD projections is that SCAQMD expects emissions to be below RTC levels for all future compliance years. As reported by the SCAQMD, emissions in 2001 are lower than originally expected because of lower than expected electricity demand during the second half of calendar 2001. Thus, the SCAQMD projects little need for RTC credits to be generated from the mitigation fee payments.

Table 6 shows SCAQMD records regarding the RTCs that were added as a result of conversion from mobile and area sources over the history of RECLAIM, from 1994 to 2002. Over the entire period, a total of 598 NO_X RTC tons were added. This total is a small percentage of the average annual NO_X RTCs over the period. These figures indicate that project-based credits had a relatively small effect on the RTC market, and did not provide much of a "cushion" to absorb the increase in demand that occurred in 2000 and 2001.

Table 6. NO_X RTCs Converted from Mobile and Area Source Credits, 1994-2002

Year	Amount (tons)	Source of Credits*
1994	33	Rule 1610
1995	36	Rule 1610
1996	36	Rule 1610
1997	4	Rule 1610
1999	50	Rule 1612
2000	150	Rule 1612
2000	68	Rule 2506
2000	13	Rule 1620
2001	72	Rule 1612
2001	68	Rule 2506
2002	68	Rule 2506

*Rule 1610 – Old Vehicle Scrapping
Rule 1612 – Credit for Clean On-Road Vehicles
Rule 2506 – Area Source Credits for NO_X and SO_2
Source: Lieu, Dabirian, and Dawson (2001).

The SCAQMD has developed several projects to generate emission reductions to offset excess power plant emissions. In 2001, the SCAQMD contracted to reduce NO_X emissions from marine vessels by 175 tons per year over the four-year period from 2002 to 2005.

Table 7 summarizes the SCAQMD's most recent estimates of the likely market conditions for NO_X RTCs in various future compliance years, taking into account emissions from power plant (Rule 2009), non-power plants required to submit compliance plans or show compliance (Rule 2009.1), and other RECLAIM facilities. According to these projections, the NO_X RTC market would achieve a surplus (excess of RTCs over emissions) after the 2003 compliance year.

Table 7. Projected Emissions and Available NO_X RTCs for all RECLAIM Facilities

Compliance Year	Projected NO_X Emissions (Tons)					Available RTC (Tons)	Excess RTCs (Tons)
	Rule 2009	Rule 2009.1 Option 1	Rule 2009.1 Option 2	Other Facilities#	Total		
2001	4,010	7,633	1,269	2,509	15,421	15,266	0 – (195)
2002	3,155	7,539	1,269	2,509	14,472	13,833	0 – (639)
2003	1,673	6,949	1,269	2,509	12,400	12,396	0 – (4)
2004	1,196	6,366	1,269	2,509	11,340	12,396	1,056
2005	1,075	6,341	1,269	2,509	11,194	12,396	1,202

Source: South Coast Air Quality Management District (2001d).

IV. CONCLUSIONS REGARDING RECLAIM EXPERIENCE

The nine-year experience with RECLAIM—including its relatively uneventful early years, its tumultuous years of 2000 and 2001 and its recent return to normalcy—provides a basis for tentative conclusions regarding its economic and environmental performance.

A. Cost Savings Relative to Command-and-Control

When the program was being developed, cost savings were estimated to be about 40 percent compared to the cost of achieving the same emission levels using the traditional command-and-control approach (see Harrison and Nichols 1992 and Johnson and Pekelney 1996). No *ex post* estimates of cost savings have been made. It is possible, however, to speculate on the cost savings under RECLAIM.

1. Volume of RTC Trades

The high volume of trading in the RECLAIM program implies significant cost savings relative to the command-and-control alternative that it replaced. Although there is some double counting of trades—because of the RECLAIM accounting rules—it is clear that substantial cost-reducing RTC trades have taken place over the nine years the program has been in place.

2. Use of Mobile and Area Source Reduction Credits

The use of mobile and area source reduction credits in theory should add to the cost savings, because it introduces the possibility of lower-cost control options. In practice, however, these credits have accounted for a very small share of overall emissions allowances. Indeed, some criticize EPA for not approving mobile and area source credit rules and advocate expanding these alternatives to increase potential cost savings (see Wyman 2002).

3. Compliance Plans for Electricity Generators

The May 2001 requirements for electricity generators to adopt BARCT controls reflected a concern that RECLAIM participants had not taken proper measures to reduce their emissions, relying too much on the market to purchase RTCs. This logic disregards the unusual circumstances that precipitated the dramatically increased demand for RTCs in 2000 and 2001.

Whether the required compliance plans have led to cost-effective emission reductions that should have been adopted or instead represent excessively costly controls has not been studied.

B. Environmental Performance

The environmental performance of RECLAIM can be measured along several dimensions, including the ability of the program to meet the increasingly-stringent cap, the likely comparison with the command-and-control alternative, and the accuracy (and cost-effectiveness) of monitoring information.

1. Emissions Relative to Caps

Notwithstanding the relatively lenient early caps and the extreme pressure of prices that increased ten-fold in the course of a few months of 2000, RECLAIM has been successful in achieving the caps that were set in 1993 when the program was passed. Based upon compliance annual compliance audits for 1994 to 2000, the cap was exceeded only in 2000 for NO_X. Moreover, when the effects of the limited banking/borrowing that is allowed are taken into account, the excess emissions in 2000 represent only a six percent increase. In addition, because this excess is reflected in fewer RTC allowances in future years, the emissions increases will be "made up" in the future; in essence, the 2000 excess represents a borrowing of emissions allowances rather than a net increase in overall program emissions.

2. Comparisons to Command-and-Control Alternatives

There is no reason to believe that a command-and-control alternative would have performed better than RECLAIM did under the circumstances. Indeed, since command-and-control mandates typically regulate emission *rates*—rather than overall emissions—a command-and-control alternative would likely have resulted in the same emissions increases but without the compensating measures taken as a result of exceeding the NO_X RECLAIM cap. Put another way, the command-and-control alternative does not have a natural mechanism to provide for borrowing (or banking) of emissions reductions.

3. Accuracy of Emissions Monitoring

Assessments of the environmental performance of RECLAIM depend in part on assessments of the accuracy of the monitoring data. Under RECLAIM, the largest emission sources were required to install expensive CEMs in order to provide credible and accurate emissions data. The early experience with CEMs was problematic; many of the initial data could not be used because of CEM malfunctions. But these technical issues were resolved, and the CEMs data currently provide reliable emissions values. It is possible, however, that similarly reliable data could be obtained with less expensive monitoring (although perhaps with less public acceptability).

C. Other Considerations

The RECLAIM experience suggests several additional considerations beyond the likely effects on emissions and costs.

1. Links Between Emissions and Electricity Markets

Perhaps the most important lesson from the 2000 experience with RECLAIM is that the "problems" were due primarily to flaws in California's newly deregulated electricity markets rather than to serious flaws in the RECLAIM program itself. RECLAIM behaved largely as it should have. Demand for NO_x RTCs increased, their supply decreased and their prices increased as they should have, and the prices of an important product, electricity, that required NO_x credits also increased. This should have provided signals to affected sources to invest in emissions controls, as well as signals to consumers to reduce consumption of electricity. Had the structure of California's electricity industry remained composed of regulated monopolies, or if the transition to new competitive market structures had been done more competently and with greater sensitivity to the interactions between NO_X RTC prices and spot electricity prices, the impact of higher NO_X RTC prices on the average price of electricity would have been much more modest. And if the electricity crisis had not occurred, electricity generators likely would not have been removed—at least temporarily—from the NO_X RECLAIM program.

2. Administrative Costs and Broker Activity

Administrative costs under RECLAIM appear to be relatively modest, contributing to the overall cost savings. Developing the regulatory program was costly, but in all likelihood substantially less costly (and time consuming) than developing all of the command-and-control regulations that RECLAIM supplanted. Moreover, the ongoing administrative costs of RECLAIM are almost certainly less than those for the command-and-control alternatives, which require ongoing assessments of technical alternatives.

Brokers have participated actively in RECLAIM and no doubt have helped to promote active markets in RTCs. Moreover, there is no evidence that a recent scandal involving a prominent RTC broker—which involves allegations of substantial misconduct—has had an effect on either the economic or environmental performance of RECLAIM.

3. Means of Addressing Price Volatility

Despite the general solid performance of RECLAIM, its experience in 2000 and 2001 make it clear that short-term fluctuations in emissions levels can lead to significant volatility in allowance prices. Allowance price volatility in turn can lead to significant short-term volatility in prices of goods whose production involves significant "use" of emissions allowances. Accordingly, the recent experience with RECLAIM suggests that it is important to give emissions market participants the necessary tools to manage extreme price volatility effectively. Assuming the use of a marketable permits program—rather than an emissions tax approach—several mechanisms could remedy price volatility problems (Ellerman 2001). These include expanding the ability to bank/borrow RTCs, expanding the range of sources participating in the program, and providing a mitigation fee or (if damages roughly linearly related to emissions) a "safety valve" that would cap RTC prices.

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