Factors Critical to the Success of an Emissions Trading Program

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Emissions trading is a type of environmental control. It permits individual sources to comply with emissions limits by reducing their own discharges or by paying to reduce those of other sources. Because regulated sources have the flexibility to choose among a wide range of control options, compliance can be achieved at lower cost.

Emissions trading has met with varying degrees of success in different circumstances. Our review of U.S. experience with trading programs identified factors critical to program success. While the relative importance of these factors varies somewhat with the nature and objectives of each program, the factors apply to emissions trading programs generally.

Emissions trading programs are likely to become increasingly common for the pollutants associated with fossil-fired generation of electricity. With such programs, electricity conservation becomes more cost-effective and therefore a more attractive component of a utility's environmental compliance strategy. For example, trading programs for SO_2 and CO_2 could increase the value of energy efficiency programs to an electric utility by 25 to 50% from current levels.

What is Emissions Trading?

Traditional environmental regulations mandate pollution control devices directly or indirectly.[1] Emissions trading programs, in contrast, allow individual sources to meet emissions limits by implementing cost-effective control measures or by purchasing emissions permits from sources that have reduced emissions beyond the required level. The key features of an emissions trading program are:

- An overall limit on the emissions of the specified pollutant that is apportioned among the regulated sources;[2]
- A requirement that each regulated source accurately monitor and report its emissions;[3] and
- The flexibility for a source to comply with its emissions limit by reducing its own emissions or by paying another source for its reduced emissions.

A trading mechanism is implemented to facilitate transactions among regulated sources. Sources that can reduce their emissions at relatively low cost will implement control measures. If they reduce emissions by more than the amount needed to achieve compliance, they can sell the remaining emissions credits. Sources that face expensive control options can purchase emissions credits from other sources at lower cost than reducing their own emissions. The seller is able to sell the excess emissions credits at a profit, while the emissions credits are the lowest cost option for the buyer. Because both parties gain from the transaction, compliance is achieved at a lower overall cost.

There are two common misconceptions about emission trading. First, emissions trading is often portrayed as an alternative to environmental regulation. This is incorrect; regulations are still needed to establish overall emissions limits, to regulate trades in emissions credits, and to monitor and enforce compliance. Rather, emissions trading complements environmental regulation by reducing the cost of regulatory compliance. Second, emissions trading is sometimes portrayed as a license to pollute--a right to emit any amount of pollution if the price is paid. While this may appear to be true for an individual source, it is not true for affected sources in the aggregate. There is an overall limit on emissions, so supply of emissions credits is restricted to a level consistent with the environmental goal.

Application of emissions trading to pollutants associated with energy production, such as sulfur oxides (SO_x), nitrogen oxides (NO_x), and carbon dioxide (CO_2), is already under way. Emissions trading will provide an economic incentive for energy efficiency because of the supply-side emissions reductions associated with demand-side management (DSM). If emissions trading is to be used to control pollutants associated with electricity production, then lessons from past experience should be incorporated into new program design to ensure success and to facilitate cost-effective implementation of increased demand-side management.

Dozens of emissions trading programs have been implemented in the United States since the late 1970s. Emissions credits have been defined in two fundamentally different ways; as quantities (e.g., one ton of SO_2) and as flows (e.g., one ton of NO_x per year in perpetuity).[4] Emissions permits have also been defined in fundamentally different ways. In most programs a source must demonstrate that emissions have been reduced below permitted levels. Emissions permits equal to the difference are issued. These can be sold to sources whose actual emissions exceed specified levels. Other programs issue permits equal to the total emissions target for the period to regulated sources based on an agreed formula. Each source must remit permits equal to its actual emissions for the period to the regulatory agency.

Despite variations in successful emissions trading program design, experience suggests a number of features that are generally necessary for success. For example, regulators must have a comprehensive permit system in place. Regulators must be able to verify actual emissions by regulated sources and to track the ownership of emissions credits used for regulatory compliance. There must be a credible enforcement threat. Sources must face a range of marginal control costs. There must be a viable emissions market, and participants must represent enough of the emissions program that together they can achieve air quality goals.

Overall, emissions trading programs, carefully designed, can provide an efficient and effective means of achieving air quality goals. They provide economic incentive for environmentally responsible behavior and, in so doing, provide incentive for pursuing environmentally beneficial activities such as cost-effective demand-side management.

Experience with Emissions Trading

While the attention paid to emissions trading is a recent phenomenon, emissions trading is not new. Emissions trading experience is limited to the United States and, to date, consists of some 30 emissions reduction credit programs for criteria pollutants under the Clean Air Act, lead credit trading, and more recently, chlorofluorocarbon (CFC) permit trading.

Emissions Reduction Credit Programs

The 1977 Clean Air Act Amendments established ambient air quality standards for nitrogen oxides (NO_x), sulfur oxides (SO_x), total suspended particulates (TSP), carbon monoxide (CO), and hydrocarbons. The Act specifies a variety of control technologies for existing, modified, and new sources. The stringency of the control technologies and the minimum size of the regulated sources depend on whether or not the area has attained the ambient air quality standard. The Act also severely restricts the ability of large, new sources of a pollutant to locate in a nonattainment area for that pollutant.

A variety of trading mechanisms--offsets, netting, bubbles, and banking--has been developed to accommodate economic growth and to facilitate cost-effective compliance with the air quality standards in nonattainment areas. The "currency" of trades is the emissions reduction credit (ERC). An ERC is a real, surplus, quantifiable, enforceable, permanent reduction of emissions by an existing source that is certified by the regulatory authority. An ERC gives the purchaser the right to emit a specified quantity of a pollutant annually for an indefinite period.

Offset trades allow a new or modified source to operate in a nonattainment area by purchasing ERCs for at least the amount of its emissions from existing sources in the same area.[5] Netting trades allow emissions reductions achieved at a plant to offset the emissions due to expansion of the facility and so avoid triggering the stringent new-source review process for the expansion. Bubbles involve trades among or within existing facilities to meet a combined emissions requirement for those sources. Banking allows existing sources to store ERCs for future sale or use.

Federal policy allows states and regions to employ emissions trading as part of their air quality attainment strategies, but the ERC trading programs and markets are regional. Each nonattainment area develops its own compliance strategy and its own ERC trading programs. As a result the programs vary in the stringency of rules governing the creation, ownership, and trading of ERCs. Approximately 30 regional programs have been implemented nationwide.

Comprehensive data on ERC trades are not readily available, so it is difficult to directly estimate the monetary savings realized by affected sources. However a study of trading programs through 1986 estimated the savings at between \$1 and \$13 billion.[6] A more recent review estimates that 7,000 to 12,000 trades took place through 1989, resulting in cost savings in excess of $10 billion.[7]

Credits for Lead in Gasoline

Under the authority of the Clean Air Act, the United States Environmental Protection Agency (EPA) regulates the content of lead in gasoline. Until 1982, the EPA enforced requirements on a refiner-by-refiner basis. In 1982, it amended the rules to allow for trading of lead credits among refiners. Each refiner was allocated credits for a specified quantity of lead. The credits could be used or sold to other refiners. Credits expired at the end of the quarter if unused. It is estimated that up to 20% of lead credits were traded by 1985.[8]

In 1985, lead standards became considerably more stringent, and the total amount of lead used in gasoline had to be reduced significantly. The EPA developed a schedule for reducing lead use and established a bank for reductions accomplished ahead of schedule. The existence of the trading program meant that requirements for production of unleaded gasoline could be adopted without waiting until all refineries had been modified. Some 10.6 billion grams of lead were banked, with an estimated cost savings to refiners of $226 million.[9] The program was terminated in 1988 because the EPA was concerned that further reductions in lead levels would damage older engines.

Tradable Permits for CFCs

The EPA has instituted a system of tradeable permits for chlorofluorocarbons (CFCs) as part of its implementation of the Montreal Protocol.[10] Permits are allocated to CFC producers and importers on the basis of historic use. Each permit covers a specified quantity of CFCs during a particular calendar year. Annual allocations decline over time to comply with the protocol's timetable for phased reduction of CFCs. Permits can be freely traded, but there is a ban on the use of CFCs for "nonessential" purposes, such as aerosol propellants. There is no provision for banking allowances, because such a provision might not be consistent with the phasing out of CFC emissions. Information on potential buyers and sellers is readily available, as the EPA monitors CFC production and imports and has the ability to track trades. To date, trading of CFC allowances has been limited because producers have reduced use faster than required by the phase-out schedule. Recently an accelerated phase-out schedule was approved, which may stimulate trading activity.[11]

Emissions Trading Programs that will Affect Electric Utilities

Electric utilities will be increasingly affected by emissions trading. The Clean Air Act Amendments of 1990 established a national allowance trading scheme for SO_2 emissions targeted specifically at electric utilities. This program may be extended to include nitrogen oxides (NO_x). The South Coast Air Quality Management District (SCAQMD) has proposed that utilities be among the existing stationary sources included in a trading program for reactive organic gases (ROG) and nitrogen oxides (NO_x). The possibility of developing an emissions offset program for utilities has been discussed in Massachusetts as a means to better incorporate environmental externalities into utility decision making. Many proposals for controlling emissions of greenhouse gases feature tradable emissions credit components.

Sulfur Dioxide Allowance Trading

Title IV of the 1990 Clean Air Act Amendments establishes a system of tradable allowances for sulfur dioxide to help achieve the goals of reducing SO_2 emissions by 10 million tons from 1980 levels by the year 2000 and maintaining emissions at that level from 2000 onward.[12] Allowances permit the holder to emit one ton of SO_2 in or after a given calendar year. To achieve the desired level of emissions, the EPA will reduce the number of allowances available to the target levels.[13] EPA will not impose geographic restrictions on allowance trades within the continental U.S.[14]

The program will be implemented in two phases. Phase I, which begins in 1995, will affect the 110 largest, highest emitting utility plants. Phase II, which becomes effective in 2000, will impose emissions limitations on nearly all utility plants of 25 MW or more in the contiguous 48 states. Allowances are specifically allocated in the Act for Phase I; for Phase II, allowances will be determined by formula, largely based on historic emissions. Allowances are allocated to regulated sources free of charge.

Regulated sources will have to install approved monitoring equipment and report their SO_2 emissions to the EPA. Allowances equal to actual emissions will have to be remitted to the EPA. Any measure that reduces SO_2 emissions directly (such as scrubbers or low- sulfur coal), or indirectly (such as reduced demand for electricity), will help achieve compliance. Thus the avoided cost of electrical efficiency measures will rise by the value of the SO_2 allowances for the electricity saved.

NO_x and ROG Emissions Trading in the SCAQMD

Utilities in the South Coast Air Quality Management District are part of the Regional Clean Air Incentives Market (RECLAIM), a new regional emissions control scheme proposed for the district's largest emitters of NO_x and ROG.[15] RECLAIM would involve bubbling stationary sources at the facility level, limiting total emissions from the facility, and requiring each facility to meet annual emissions targets. Emissions trading would be one option for compliance. SCAQMD recommends that sources with annual emissions of four tons or more be included in the program. Electric utilities are among the source categories included. The program may also be expanded to include SO_x.

Under RECLAIM each facility would be required to reduce ROG emissions by 5% annually from a calculated baseline until the year 2000, and NO_x emissions by 8% annually until 2005 to help achieve the ambient air quality goals for the area. Sources would have to install emissions monitoring equipment linked to the SCAQMD computer network. Trades would be subject to geographic and seasonal restrictions. The SCAQMD estimates that by 1997, NO_x emission credits could be selling for $2,800 per ton and hydrocarbon credits for $40,900 per ton. If the RECLAIM program is approved, implementation will begin in 1994.

Emissions Offsets and Environmental Externalities

Over the past few years, utility regulatory commissions have paid increasing attention to environmental externalities--the environmental effects resulting from the residual emissions after compliance with existing regulations. Amid much controversy, state commissions are increasingly requiring utilities to consider externalities in their new resource selection decisions. The expected long-term result is a mix of "cleaner" generation facilities and more widespread use of demand-side management. The current requirements have unintended negative effects, including a bias toward keeping older, "dirtier" plants on line; market inefficiencies from inconsistent consideration of externalities across jurisdictions; and inequities due to application of externalities solely to regulated sources in the electric utility industry.

Emissions trading within an overall emissions cap provides an alternative mechanism for addressing these externalities. If a utility is required to obtain a permit for each unit of pollutant emitted, then the cost of the permit "internalizes" the environmental effects of the emissions. The issue of offsets as a means to address the environmental externalities of utility emissions came up in recent proceedings on externalities in Massachusetts.[16] Participants offered general support for the idea, although potential implementation difficulties were also raised.

Emissions Trading for Greenhouse Gases

The United Nations Conference on Trade and Development (UNCTAD) has proposed a system of tradable entitlements for carbon dioxide.[17] Under the proposed system, participating countries would together issue entitlements that would permit the holders to emit specific quantities of particular emissions into the atmosphere. To control global climate change, an emissions cap on the total emissions authorized through the entitlements would be imposed. The UNCTAD recommends starting with a smaller group of nations, expanding to include more nations as time goes on. If the United States were to agree to participate in such a trading scheme, electric utilities with fossil-fired generation would be affected.

Factors Critical to a Trading Program's Success

Emissions trading has met with varying degrees of success in different circumstances. EPA's lead credit trading program was a tremendous success; it enabled leaded gasoline to be phased out faster and at lower cost than would have been possible using conventional refinery-specific regulations. ERC trading programs have enjoyed mixed success; some have been consistently active while others have lain dormant for years.

We recently compared the characteristics of various emissions trading programs to identify the factors critical to success.[18] The success factors and the reasons for their importance are discussed below. The more of these factors that are present is a particular program, the more likely that the program will be successful.

Clearly Defined Goals

A clear statement of the goals of the emissions program is important for measuring the program's success. For example, the ERC trading programs of the 1977 Clean Air Act were generally designed to accommodate economic growth while *maintaining* air quality. A source could establish or expand in a non-attainment area if its emissions were offset by reductions at existing sources in the area.[19] *Improving* in air quality to attain the ambient air quality standards was to be achieved through implementation of the specified control technologies. Although many ERC trading programs enjoyed only limited success, they are often unfairly faulted for not improving air quality--a role for which they were not designed.

Ideally, the statement of goals for an emissions program should establish the relative importance of cost savings in program performance. For example, the SO_2 allowance trading program is being designed in accordance with clear direction from Congress to let the market accomplish maximum cost savings. At the same time, environmental goals are limited to reducing SO_2 emissions to a set level and enforcing monitoring and compliance requirements. The SCAQMD's RECLAIM program, in contrast, is placing environmental goals above market performance by including geographical and seasonal trading restrictions, as well as a program design that allocates emissions credits only in response to actual emission reductions.

A Quality Emissions Inventory

The emissions inventory should include accurate data on emissions by all sources. Based on accurate data, the trading program can be designed to achieve the specified goal. The sources to be included in the program and the reductions expected from those sources must offer a realistic prospect of achieving the air quality goal after allowing for the effect of emissions from exempt sources.

A Comprehensive Permit System

A permit system provides regulators a way to bring sources into the trading system. To secure a permit, a source must gain advance approval for its emissions before construction, modification, or operation begins. This provides the regulator the opportunity to specify monitoring requirements, total emissions limits, offset requirements, and other matters important to the administration of the trading program. Failure to comply with the requirements should result in permit revocation, fines, or other sanctions.

The permit system should be designed to interact smoothly with emissions trading requirements. For example, the permit system could incorporate automated permit amendments so that engaging in trades does not create additional transaction costs due to permit amendment delays and fees.

A Credible Enforcement Threat

For an emissions trading program to be successful, a source should find that the cost of compliance with its emissions limits is smaller than the risk and penalty resulting from noncompliance. The penalty for noncompliance with offset provisions in the SCAQMD is as much as $25,000 per violation per day, along with the possibility of permit revocation and both civil and criminal penalties against the operator. The new SO_2 allowance trading program imposes a noncompliance penalty of $2,000 per ton in addition to the cost of acquiring the allowances necessary to cover the excess emissions.

Participation Proportional to Pollution

It is important that sources participate in an emissions trading program in proportion to their contribution to the air quality problem. For example, some ERC trading programs have faltered because of the large percentage of emissions from exempt sources. The emissions thresholds that trigger the need for new or modified sources to secure offsets under these programs have often been set too high. One study found that between 1976 and 1986, more than 80% of the reactive organic gas (ROG) emission increases in the South Coast Air Quality Management District (SCAQMD) were exempt from offset requirements because the sources of these ROG increases had emissions below the offset threshold.[20] The SCAQMD and others have since dropped their threshold levels to zero in an effort to include previously exempt sources.

Of course, there are inherent tradeoffs in determining what sources to include in a trading program. The theoretical ideal of 100% participation needs to be balanced with the costs to the sources of installing the necessary monitoring equipment and the costs to the regulatory agency of auditing, verifying, and enforcing requirements. Thus mobile, area, and small-point sources are often excluded due to their relatively high monitoring and regulatory costs.

Efficient and Predictable Administration

Straightforward rules, consistent decisions, and predictable time requirements contribute to the success of an emissions trading program. Some parties claim that administrative uncertainty has hindered the ERC trading program in the SCAQMD. Since 1976, its emissions trading rules have gone through at least six significant modifications. In addition, ERC applications can take up to a year to process. Inefficient administration and changing rules can significantly add to the transaction costs associated with market participation.

An Effective Emissions Bank

An emissions bank is an administrative mechanism that allows sources to store emissions credits for later sale or use. An emissions bank can provide an incentive for a source to implement emissions reductions by giving them a value for later use. An emissions bank also facilitates emissions trades, because it provides buyers a way to identify credits that are unmistakably valid and quickly available. An effective emissions bank should provide a long shelf-life for credits and protection from confiscation by rules promulgated after the credit has been deposited.

However, an emissions bank may not be desirable in all situations. Banking stores credits for use in future years, leading to increased pollution when the credits are used. Discounting banked emissions can address this concern, but it makes banking less attractive from a financial perspective. For this reason an emissions bank was not incorporated into the CFC allowance program.

The value of an emissions bank is exemplified by the operation of the ERC trading program in the San Joaquin County Air Pollution Control District (SJCAPCD). Prior to the creation of the emissions bank in 1987, no offset trades had been implemented and few sources had voluntarily reduced emissions. After 1987, 1,549 tons of ERCs were sold through 12 offset trades.

Enough Players

A successful emissions trading program must have enough participants facing different marginal costs of compliance to create a viable market in emissions credits. The lead credit trading program was successful because it applied to a large number of refiners and importers. There were no geographic restrictions on trades and up to 20% of lead emissions credits were traded.[21] New Jersey's ERC trading program, in contrast, enjoyed limited success because slow economic growth and high thresholds meant few sources needed to purchase ERCs, although the emissions bank contained thousands of tons of ERCs.

A trading program must be structured so that a few large sources are not able to dominate the market for emissions permits. As with any commodity, if the market is dominated by a few buyers or sellers, they may be able to use their market power to earn excess profits. If emissions trading is limited to an airshed that is smaller than a utility's service territory, the utility might be able to dominate the market for emissions permits.

In general, the larger the number of participants, the greater the variation in marginal control costs. Thus, the economic gains from emissions trading stem from these differences in marginal control costs. The greater the number and diversity of sources, the larger the potential economic benefits of emissions trading.

Trading Activity

The benefits of emissions trading can only be realized through trading. A program structured to promote trading is likely to be more successful. The ERC trading programs depend on new and expanding sources with emissions above threshold levels to create the demand for ERCs. Low economic growth and high thresholds reduce demand for ERCs and so limit the success of the program. The lead credit program, the CFC permits, and the new SO_2 allowance trading program stimulate trading because each source receives fewer credits over time. Thus, each source has an incentive either to reduce its own emissions and possibly sell surplus credits, or to purchase the additional credits it needs.

Sources are more likely to use an emissions trading program if the market functions well. In order for the market to function well, participants need information on prices and on potential buyers and sellers. Mandatory auctions of a portion of the permits or market makers can meet these information needs. In addition, transactions costs must be small relative to potential benefits. Regulatory authorities should attempt to minimize transactions costs when designing the trading system.

Minimal Regulatory Interference

The economic benefits of emissions trading stem from the flexibility accorded individual sources in complying with specified emissions limits. Regulations that limit the choice of compliance options reduce the potential economic benefits of trading. Some states have adopted, or are considering, laws and regulations that will limit the options of utilities in those jurisdictions in complying with their SO_2 emissions limits. Most of these initiatives are intended to protect the local coal mining industry. The result is likely to be higher compliance costs for the utilities affected, lower costs for utilities in other states, and lower overall savings due to emissions trading.

In the case of utilities, regulation can also reduce the incentive to trade. Trading yields economic gains for both parties. If a utility is regulated so that economic gains accrue entirely to the customers, the motivation to trade will be minimal. State utility regulators are beginning to address the question of how the economic benefits of emissions trading should be shared between customers and shareholders.

Self-Supporting

It is helpful to program success if an emissions trading program is self-supporting, as long as the fees involved are not overly burdensome. A program should levy appropriate fees on those wishing to create, use, or trade emissions credits, and the collected fees should be earmarked for program administration. The importance of a program being self-supporting is demonstrated by comparing the ERC programs in the SJCAQMD and the SCAQMD. The SJCAPCD supported its staff through fees for processing ERC applications and administered the program efficiently, while the ill-funded staff at the SCAQMD was pulled off administration of the ERC program and assigned to other regulatory tasks, causing the operation of the trading program to suffer. Trading programs in other states have failed to get off the ground at all because of inadequate funding.

Regulatory Champion

A successful emissions trading program generally needs champions both within and outside the implementing agency. An emissions trading program is generally a departure from the status quo of command and control regulation. A successful program needs a champion during the developmental phase, to recognize the inefficiencies of traditional regulatory strategies and to advocate emissions trading as an improvement. The champion needs to have a vision of how to achieve program goals and determine the tradeoffs between environmental and economic goals. A champion is also needed once the program is approved, to ensure that it is administered well and adequately supported. Much of the success of the emissions trading program in the SJCAPCD is attributed to the individual who championed the program, who made a difference in the agency's willingness to work with industry and the public to develop effective emissions trading program rules.

Effective Input from Stakeholders

A successful emissions trading program must have the support of the affected parties. For example, the proposed rules for EPA's sulfur dioxide (SO_2) allowance trading program have been drafted with the input of interested parties. Stakeholders include legislators, regulators, industry participants, and the public. Failure to gain this support will likely result in a system that is ill-funded, unused, fails to accomplish its goals, or does not effectively serve its intended users. However, control of the input process must also be maintained, and stakeholders need to reach consensus early on as to what the standards of fairness are in attempting to formulate an optimal solution.

Implications for Energy Efficiency in Buildings

Emissions trading programs will provide utilities with an increased incentive to pursue electrical energy efficiency. In 1990, the residential sector consumed 10.24 quads of energy and the commercial sector used 6.70 quads, for a total of 16.94 quads.[22] Electricity demand was 928 billion kWh in the residential sector and 839 billion kWh in the commercial sector. Electricity use in buildings amounted to about 65% of total electricity consumption. Because energy efficiency reduces emissions, and because the opportunities for cost-effective efficiency improvements in buildings are large, emissions trading programs that affect electric utilities will provide a stimulus for increased energy efficiency in buildings.

Consider the following example. Typically, avoided costs for electric utilities are about 6¢ per kWh. Electric utilities that offer demand-side management (DSM) programs must design their programs so that program administration, delivery, and evaluation costs are less than their avoided costs. Administration and other overhead costs often amount to over one-third of the total cost; thus electrical efficiency measures must often cost less than 4¢ per kWh net of overhead costs.[23]

Now consider the impact of emissions trading for sulfur dioxide (SO_2) and carbon dioxide (CO_2). A coal plant that meets new source performance standards emits 1.2 lbs of SO_2 per million British thermal unit (Btu) and 209 lbs of CO_2 per million Btu.[24] Although there is a wide range of estimates of the future value for SO_2 allowances, $500 per ton is a reasonable median value for the purposes of this illustration. The costs of sequestering CO_2 through reforestation are estimated to be in the range of $20 per ton.[25] Using these values for tradeable allowances and a heat rate of 10,000 Btu per kWh, a utility would add 2.54¢ per kWh to value electrical efficiency at the generating station. Since electrical efficiency is delivered at the customer's meter, the avoided transmission and distribution losses raise its value to about 2.7¢ per kWh.

The impact of emissions trading on avoided costs depends, obviously, on the proportion of fossil-fired generation in the system and the emissions rates for marginal units. Given the existing generation mix, tradable allowances for SO_2 and CO_2 with the above values would probably add between 1¢ and 2¢ per kWh to the value of energy efficiency in buildings. This represents an increase of 25 to

50% from the current values, which should make appreciably more measures cost-effective.

Southern California Edison (SCE) has already demonstrated that emissions trading can yield environmental benefits as well as economic benefits for the utility and its clients. SCE contacted industrial customers to persuade them to convert combustion engines to electric motors and to promote other electrotechnologies as a means to offset the environmental impacts of its proposed merger with San Diego Gas and Electric. Although the merger did not proceed, SCE earned ERCs for the emissions reductions associated with the electrotechnologies promotion. These ERCs are "in the bank" to serve future needs. SCE continues to promote electrotechnologies to assist customers with energy efficiency and environmental compliance.

Conclusion

Emissions trading is increasingly proposed as a way to achieve environmental goals. While the attention paid to emissions trading is new, emissions trading programs are not. Programs have been implemented across the nation with varying degrees of success. Both the successes and the failures have provided lessons for successfully designing and implementing emissions trading programs as alternative means to achieving environmental goals.

Regulators and other stakeholders are learning from past experience with emissions trading programs and are becoming more confident of their ability to design successful programs. Successful emissions trading programs permit a wider range of compliance options and so reduce the cost of achieving a given environmental objective. In the case of electric utilities, one of the compliance options available under an emissions trading program is increased electrical energy efficiency. Trading programs for SO_2 and CO_2 could increase the value of electrical energy efficiency to a utility by 25 to 5% from current levels.

A large portion of the energy used in buildings is electricity, and the potential for increased energy efficiency in buildings is significant. The added value of electrical efficiency under emissions trading programs will provide economic stimulus for enhanced building energy efficiency.

Endnotes

1. Regulated sources are often required to install Best Available Control Technology (BACT), or the control technology that produces the Lowest Achievable Emissions Rate (LAER), or to keep emissions below specified emission rates, which are typically based on the performance of control technologies.

2. For nonuniformly distributed pollutants this can be considerably more complex. Modeling or trading ratios or matrices may be used to ensure that individual receptors are not negatively impacted.

3. Market-based systems generally require maintaining a more accurate and current emissions inventory than under command and control.

4. The term "emissions credit" will be used to apply to either (or both) a quantity or a flow. Emission reduction credits (ERCs) are flows; SO_2 allowances, lead credits, and CFC permits are quantities.

5. Typically, new or expanded sources are required to purchase ERCs that exceed their emissions; although the ratios vary, offsets of 120% are common. The ratio often rises with the distance of the existing source from the new source.

6. R. W. Hahn and G. L. Hester. 1989. "Marketable Permits: Lessons from Theory and Practice," *Ecology Law Quarterly* 16:361–406.

7. T. H. Tietenberg. 1990. "Economic Instruments for Environmental Regulation," *Oxford Review of Economic Policy* 6(1):24.

8. Hahn and Hester, 1989.

9. Hahn and Hester, 1989.

10. Office of Technology Assessment. *Changing By Degrees*. Washington, D.C.: U.S. Government Printing Office, pp. 67–68.

11. Estimates of compliance cost savings are not available, but the savings are probably small due to the lack of trading activity.

12. U.S. Congress, *Public Low 101-549*, "An Act to Amend the Clean Air Act." Washington, D.C., U.S. Government Printing Office, November 15, 1990.

13. The number of allowances available for compliance will increase during Phase II, although the amount allocated to Phase I units will be reduced from the Phase I allocation levels.

14. Some states have passed legislation or adopted regulations that will restrict the compliance options utilities

may adopt, thus restricting potential trades and reducing commensurate economic benefits.

15. South Coast Air Quality Management District. Spring 1992. *Regional Clean Air Incentives Market (RECLAIM)*, Summary Report.

16. Proceedings DPU 91-131, Massachusetts Department of Public Utilities.

17. "UN Study Proposes a Global Trade in Emission Entitlements." 1992. *Energy, Economics, and Climate Change* (Cutter Information Corp.) 2 (2):14–15. Others have also proposed tradable permits for greenhouse gases, for example, E. F. Haites (1991), "Tradeable Allowances and Carbon Taxes: Cost Effective Policy Responses to Global Warming," *Energy Studies Review* (1):1–19; and Committee on Science, Engineering and Public Policy (1991), "Policy Implications of Greenhouse Warming--Synthesis Panel," *Policy Implications of Greenhouse Warming*, National Academy Press, Washington, D.C. 1991.

18. Barakat & Chamberlin. 1991. "Study of Atmospheric Emission Trading Programs in the United States." Prepared for the Canadian Council of Ministers of the Environment, Winnipeg.

19. Many of the programs include features, (such as requiring offsets greater than the maximum allowable emissions of the new source), that help improve air quality when trades occur.

20. California Air Resources Board. 1988. *Systems and New Source Review Programs: A Report to the Legislature*. California Air Pollution Control Officer's Association, AB2162 Technical Review Group.

21. R. W. Hahn and G. L. Hester. 1989. "Marketable Permits: Lessons from Theory and Practice," *Ecology Law Quarterly* 16: 361–406.

22. Energy Information Administration, *1991 Annual Energy Outlook With Projections to 2010*, DOE/EIA-0383(91), Washington, D.C., Department of Energy, March, 1991, Reference Case, Tables A11 (p. 55), A12 (p. 56) and A4 (p. 48). A Quad is 10^{15} Btu.

23. P.O. Joskow and D.B. Marron. 1991. "What Does a Negawatt Really Cost?" working Paper No. 596, Department of Economics, Massachusetts Institute of Technology. Table 1 (p. 18) shows the weighted average retail price of electricity for selected utilities as 6.9¢/kWh. Administrative costs are discussed (pp. 29–31) and found to represent 30 to 50% of utility costs for energy efficiency programs. Committee on Science Engineering and Public Policy. 1991. "Policy Implications of Greenhouse Warming--Mitigation Panel," *Report of the Mitigation Panel*, National Academy Press, Washington, D.C. Appendix B reports the 1989 average price of electricity to buildings as 7.5¢/kWh, the all-sector average price of electricity as 6.4¢/kWh, and the typical operating cost for an existing U.S. power plant of 3.5¢/kWh. The appendix also contains a graph of the cost of conserved electricity for buildings; the graph estimates 689 GWh of savings (about 40% of total electricity in the sector) at a cost of less than 4¢/kWh.

24. R. L. Ottinger et al. 1989. *Environmental Costs of Electricity*. New York, Oceana Publications, Inc., Table 1, p. 351.

25. Other estimates of the cost of CO_2 control are much higher.