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The United States Experience With Economic Incentives To Control Environmental Pollution

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THE UNITED STATES EXPERIENCE WITH ECONOMIC INCENTIVES TO CONTROL ENVIRONMENTAL POLLUTION

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ADMINISTRATOR'S PREFACE

Since its creation two decades ago, EPA has made great strides in protecting the environment. For the most part, these environmental improvements were made through the use of command-and-control regulation; that is, promulgation of uniform, source-specific emission or effluent limits.

It is becoming increasingly clear that reliance on the command-and-control approach to environmental regulation will not, by itself, allow EPA to achieve its mission. A number of persistent, seemingly intractable problems remain. Whereas in the past we focused mainly on controlling pollution from large, readily identified industrial sources, we are now confronted by environmental concerns that stem from a diverse range of products, sources, and activities. Some of these new problems are global in scope, such as stratospheric ozone depletion and global climate change. Others are local in nature but require that many people take similar actions individually. These kinds of problems typically are less amenable to traditional command-and-control approaches than are large, industrial sources.

To maintain momentum in meeting our environmental goals, we must move beyond prescriptive approaches by increasing our use of innovative policy instruments such as economic incentives. Properly employed, economic incentives can be a powerful force for environmental improvement.

Economic incentives work by providing pollution sources greater flexibility to meet their environmental responsibilities. Economic incentives harness powerful marketplace forces to cut environmental pollution, and can significantly lower the cost of environmental programs. When properly designed, economic incentives can stimulate both consumers and businesses to take actions in their own economic interests that also advance environmental protection goals.

Consideration of economic incentives could not be more timely. Another EPA report[1] makes clear that the proportion of U.S. Gross National Product devoted to environmental protection is projected to grow significantly—from 1.9 percent in 1990 to about 2.7 percent by the year 2000. Most of these costs will be borne by the private sector.

This projected growth in expenditures raises important issues for maintaining U.S. competitiveness in the global economy. I do not for a moment believe that we should pull back from our environmental commitments. After all, the benefits of environmental protection are substantial. Yet, I am equally convinced that as we pursue our environmental goals, we must do so in the most cost-effective manner possible. Today, economic incentives offer an historic opportunity to help reconcile the nation's economic and environmental aspirations.

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[1] U.S. EPA (1990).

EPA has promoted economic incentives for a number of years. Our emissions trading policy and our program to phase down the use of lead in gasoline are two prime examples. The potential advantages of using appropriate economic incentives has also been recognized by President Bush and by Congress. The Clean Air Act of 1990 includes numerous economic incentives relating to many aspects of air pollution. A leading example is the market--based acid rain program that will allow utilities to buy and sell emission "allowances" to achieve compliance at reduced cost.

Mindful of the advantages of economic incentives, when I first arrived at EPA, I asked the staff to identify new ways economic incentives could be used to improve environmental protection. The resulting report[2] developed and evaluated a broad array of proposals. This new report is a companion document to the earlier report in that it reviews not what could be, but what is (or soon will be). It also looks at the effectiveness of current efforts in controlling pollution. I hope that this review will prove useful to all levels of government and the private sector as economic incentives are more widely applied to reduce pollution.

I want to stress that this report does not endorse nor does it dismiss any particular economic incentive. Rather, the report is intended to stimulate a continuing dialogue among policy makers on the uses and usefulness of economic incentives in environmental policy. The author and I welcome your comments.

William K. Reilly
Administrator
July, 1992

[2] U.S. EPA (1991).

In the past few years, economic incentives have moved from relative obscurity to a significant role as a tool for managing the environment. Nowhere is this attention to incentives more explicit than in the 1990 Clean Air Act Amendments. That legislation authorizes incentive-based mechanisms for the control of acid rain, for the development of cleaner burning gasoline and less polluting vehicles, for states to use in controlling urban ozone and carbon monoxide, and to facilitate the reduction of toxic air emissions.

Other key environmental statutes, the Clean Water Act and the Resource Conservation and Recovery Act, are now up for reauthorization. Incentive mechanisms promise to be actively debated as these and other environmental legislative proposals make their way through Congress. EPA is currently preparing analyses of numerous possible incentives to support this debate. At the state level, some incentive programs have been implemented, and many other proposals are currently under active consideration.

With current high levels of interest in incentive mechanisms for environmental management, it is useful to examine the record to date. Over the past 20 years, federal, state, and local authorities have enacted a diverse array of environmental incentive mechanisms. How well have these mechanisms performed? What can be learned from the record that will assist in the formulation of new mechanisms? How economically efficient have these mechanisms been in achieving their objectives?

This report examines that record, highlighting applications of emission and effluent fees, charges for solid waste disposal, marketable permit systems for air and water pollution, deposit-refund systems, and information and liability mechanisms. All satisfy the basic requirement that an incentive provide a continuous signal to pollution generators to be aware of and act on opportunities to reduce releases of pollution to the environment.

The report first reviews the available information on the economic efficiency and environmental effects of economic incentives in general. The literature uniformly finds that economic incentives should be much more economically efficient in controlling pollution than the traditional command-and-control approaches. Some studies, however, indicate that the cost savings actually realized have fallen short of those predicted by these studies. Economic incentives should be particularly efficient when diverse sources of pollution are involved which are most efficiently controlled using little-known technology. In addition, incentives provide a stimulus to innovation and technical change. The evidence on the environmental effects of economic incentives, while much less extensive than that on economic efficiency, suggests that incentives mechanisms are fully compatible with environmental objectives.

The historic record concerning individual incentive programs suggests that although there have been a number of important successes, in some cases incentive programs have failed to live up to their full theoretical promise. This appears to be the result of the particular design features of the programs tried, however, rather than the theoretical promise of the approach. In most cases, fees and charges have been designed primarily to raise government revenue, and have thus been set too low to have significant incentive effects. Trading systems have often been constrained by complicated regulations, but some new ones which have not as yet been fully implemented hold out considerable promise for being both effective and efficient in reducing pollution. Beverage container deposits appear to have greatly reduced litter, but there is only limited knowledge of the impact of other deposit-refund systems and virtually no analysis of the costs and benefits of any of the deposit-refund mechanisms. Some programs providing information appear to be having great impact among fully implemented incentives considered in this report and are likely to be economically efficient as well, but have not been examined with the detailed scrutiny necessary for a fair evaluation of performance. Liability mechanisms can and do act as effective incentives, but structuring liability rules to accurately internalize the costs of pollution has proved difficult.

Finally, a review of the use of economic incentives outside the United States suggests a preference for a somewhat different mix of incentive mechanisms but somewhat similar conclusions as to their effectiveness and efficiency as in the United States. The United States uses many more marketable permit systems than European countries, but much less environmental labelling. Although charges and fees are used more widely in Europe, they also tend to be revenue-raising instruments with few incentive impacts, as in the United States. The lack of incentive impact of charges is due primarily to their low magnitude and because a number of the charges are not closely linked to waste generation or product consumption. As in the United States, official interest in economic incentives appears to be increasing in Europe.

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FOREWORD

Many people both inside and outside of EPA have made major contributions to this report. Inside EPA, Betsy David, Barry Elman, Richard Kashmanian, Barry Korb, Albert McGartland, and Dan Mussatti of the EPA Office of Policy, Planning and Evaluation made a number of useful comments on earlier drafts of this report. Three EPA employees outside OPPE provided valuable and detailed comments: Mark Luttner of the Office of Water, and Dr. Leland Deck and Karen Martin of the Office of Air Quality Planning and Standards. Outside EPA, Dr. Randy Lyon of the Office of Management and Budget made useful comments. Dr. Robert C. Anderson contributed both his time and expertise generously.

Particular thanks are due to Bob Anderson, Leland Deck, and Barry Elman for continuing and unusually useful inputs.

1. INTRODUCTION

In the past few years, economic incentives have moved from relative obscurity to the fore as tools for managing the environment. Nowhere is this attention to incentives more explicit than in the 1990 Clean Air Act Amendments. That legislation authorizes incentive-based mechanisms for the control of acid rain, for the development of cleaner burning gasoline and less polluting vehicles, for states to use in controlling urban ozone and carbon monoxide, and to facilitate the reduction of toxic air emissions.

Other key environmental statutes, the Clean Water Act and the Resource Conserva-tion and Recovery Act, are currently up for reauthorization. Incentive mechanisms promise to be actively debated as these and other environmental legislative proposals make their way through Congress. At the state level, incentive proposals also are being actively debated and in some cases have already been adopted.

1.1. PURPOSE OF REPORT

With current high levels of interest in incentive mechanisms for environmental management, it is useful to examine the record to date. Over the past 20 years, governments at the federal, state and local levels have implemented a variety of incentive systems for managing the environment. Many European nations also have implemented incentive mechanisms to supplement traditional approaches for managing the environment. How well have these mechanisms performed? What can be learned from the record that will assist in the formulation of new mechanisms? How economically efficient have these mechanisms been in achieving their objectives? What have been their environmental effects?

Focusing primarily on results in the United States, this report examines the record to the extent permitted by available information. Particular attention is paid, where information is available, to the effectiveness of each incentive in achieving the desired environmental objective and the economic efficiency with which it is accomplished. Unfortunately, much less information is available, particularly on the environmental effects, than would be desirable.

1.2. DEFINITIONS

In order to bound the subject, economic incentives for the purposes of this report only will be defined broadly as instruments that provide continuous inducements, financial or otherwise, for sources to make reductions in the environmental pollution they release. That is, sources view each unit of pollution as having a cost. For maximum efficiency, the cost per unit of pollution faced by different sources should be comparable, except as adjusted to reflect differences in harm caused at different geographical locations or at different times.

This definition excludes certain mechanisms that sometimes are referred to as incentives. Although such mechanisms may have many admirable characteristics and some of the attributes of economic incentives as the term is often used, they will not be discussed in this report. This class of mechanisms prices (explicitly or implicitly) activities that have pollution as a byproduct. Ride sharing, bike paths, high occupancy vehicle lanes, and parking surcharges provide examples of this type of mechanism. While these mechanisms may lead to a reduction in pollution, the mechanisms place neither an explicit nor an implicit price on incremental units of pollution. Exclusion of these mechanisms carries no implications for whether future EPA actions will or will not consider them to be economic incentives. Rather, their exclusion is primarily for the purpose of limiting the subject of this report to something manageable.

Payments per unit of pollution are the clearest example of an incentive, as the term is used in this report. Market-based systems in pollution reduction credits also qualify, for sources earn a credit that can be sold if they reduce pollutants below permitted amounts. Finally, indirect financial incentives for continuous effort at pollution abatement are created when sources must report publicly the quantities of specified substances they release and thus risk the loss of market share or a lower demand for their products. All of these incentive mechanisms operate through the ingenuity and actions of individual sources, who have an incentive to be on the alert for opportunities to make reductions in their pollution.

The contrast between incentive mechanisms and traditional “command-and-control” approaches is that the latter do not provide incentives to reduce the quantity of releases below permitted levels or to improve the quality of the releases of pollutants beyond permitted levels, as illustrated in Table 1-1. Under pure command-and-control approaches, sources view all releases below permitted quantities or above permitted quality as costless. To have gains in environmental quality, the burden is solely on regulators to tighten requirements imposed on individual sources. Sources operating within the limits of existing regulations (the shaded area in Table 1-1) have no economic reason to act until new regulations are issued.

Unfortunately, there are a wide variety of definitions of economic incentives in common use as well as a variety of related concepts. One of these related concepts is “market mechanisms.” Generally, this term is used for a somewhat narrower concept than economic incentives involving only those economic incentives which are implemented through mechanisms having direct effects on economic markets. Thus providing risk information could be an economic incentive but not a market mechanism while pollution fees would be both. Risk information can have an indirect effect on economic markets by shifting either the demand function or the supply function (either through appealing to profit-motivated market share considerations or liablilty-aversion), but does not directly change prices.

Table 1-1: INCENTIVES FACED BY SOURCES UNDER THE COMMAND-AND-CONTROL APPROACH

		Quantity of Pollution Released→	
		Within Regulatory Limits	Excess above Those Allowed by Regulations
↑ Tox-icity of Pol-lution Rel-eased	Excess above Those Allowed by Regulations	Fines and Penalties	for Exceeding Regulations
	Within Regulatory Limits	No Incentives for Reducing Pollution	if Caught and Successfully Prosecuted

It must be emphasized that although this report makes a careful distinction between command-and-control and economic incentive approaches, these distinctions are often difficult to apply in practice. In other words, there is a continuous distribution of pollution control measures ranging from the "pure" command-and-control to the "pure" market mechanism. Expressed still another way, the dividing line between command- and-control and economic incentives can be drawn at any number of places; although the definition used above is based on what is probably the most important economic distinction between the two approaches, a case can be made for a number of other definitions.

Another important definition is what is meant by the economic efficiency of economic incentives. Theoretically, the most economically efficient incentive is one which requires the polluter to pay exactly the price for pollution that he imposes in terms of damages on others. The polluter will then in theory reduce his pollution to the point that the cost of further reductions exactly equals the damages caused to others by the pollution. An economically efficient incentive will therefore be defined as one that either imposes an incentive that meets this criterion or that encourages polluters to act as if it had been imposed.

1.3. ORGANIZATION OF REPORT

After reviewing the economic efficiency and environmental effects of using economic incentive systems in general to control pollution (Section 2), Sections 3 through 8 discuss a broad spectrum of economic incentives, in descending order of how closely they fit the classification of market mechanisms and how far along they are toward actual use. Thus Section 3 discusses pollution fees that are already in use, which represent the purest form of

Table 1-2: TYPES OF ECONOMIC INCENTIVES

Incentive Type	Time Incentive Becomes Effective		
	Prior to Time of Pollution	At Time of or as a Direct Result of Pollution	Long after Pollution Occurred or Might Have Occurred
Payments to Government for Pollution (Section 3)		Pollution fees	
Deposit-refund Systems (Sec. 4)	Deposits		Refunds
Trading of Pollution Permits (Sec. 5)	Allowance Trading Systems		Credit Trading Systems
Payments from Government for Pollution Control (Sec. 6.1)	Subsidies for Installing Pollution Control Equipment		Tax Advantages in Return for Reduced Pollution
Payments to Damaged Parties under Liability Law (Sec. 6.2)			Tort Law for Private Damages Natural Resource Damages to Public Resources
Information on Pollution (Sec. 6.3)	Manufacturer-Provided Warnings		Disclosure of Past Emissions

economic incentive. Section 8, at the other end of the spectrum, summarizes some additional incentives that have been suggested but not yet implemented. Section 9 briefly summarizes foreign experience for the purpose of providing some perspective on the US experience. Section 10 summarizes the conclusions reached in the report. Finally, Appendix A provides a bibliography of the references used in each section and Appendix B highlights key incentive mechanisms created or authorized by the Clean Air Act Amendments of 1990.

1.4. TYPES OF ECONOMIC INCENTIVES DISCUSSED IN THE REPORT

The nation's environmental laws control pollution through a mix of strategies, most of which involve direct regulation of the quantity of pollution allowed by individual sources or the control technology sources must use. This direct regulatory approach to pollution control often is termed “command-and-control.”

In a limited number of applications, incentive systems create rewards for preventing or controlling and penalties for increasing one's emissions, effluents, or wastes. Incentive mechanisms can establish a system of rewards and penalties through a variety of specific mechanisms. Table 1-2 shows the mechanisms discussed in this report classified according to the time the incentive becomes effective in relation to the time the pollution occurs. A case can be made for including liability for damages to publicly-owned or managed natural resources within the first category since payments are made to a government agency. It appears easier, however, to group them with other liablility approaches.

Some incentive mechanisms, generally shown in the last line of Table 1-2, establish prices indirectly through market transactions. Within this group are information reporting requirements such as Title III of the Superfund Amendments and Reauthorization Act and California's Proposition 65. Others, such as pollution fees and various trading systems, including EPA's air emission trading program, transferable development rights, and marketable effluent discharge credits, work by directly affecting market prices.

More specifically, the economic incentives discussed in this report have been separated into the following categories:

Pollution fees, charges, and taxes (Section 3) are payments by polluters based on the quantity of pollutants emitted.

Deposit-refund systems (Section 4) involve payments by potential polluters at the time a potentially polluting product is purchased, which are refunded if the product is disposed of or recycled in specified ways.

Pollution trading (Section 5) is the transfer of pollution credits and allowances for in-kind or financial compensation.

Subsidies and tax concessions (Section 6.1) provide financial payments to polluters and tax advantages based on changes in pollution or in return for future pollution control actions.

Liability approaches (Section 6.2) provide for future payment by polluters based on the damages caused by their emissions.

Information approaches (Section 6.3) provide for the release of information related to companies' products or activities, such as data on their emissions or compliance status.

New systems that have reached an advanced proposal status but have not yet been adopted (Section 7).

Other systems that have been suggested (Section 8).

1.5. SCOPE OF REPORT

This report makes no pretense of being exhaustive. The literature on economic incentives is immense. Many levels of government have adopted such programs or are considering their use. Rather, an attempt has been made to pick out those efforts that seem most likely to have the greatest long-run significance. In doing so, many important efforts have undoubtedly been omitted either through lack of information or the need to make this project manageable. For example, economic mechanisms for allocating water use are not discussed (even though they may have some implications for environmental pollution control) since pollution control is not their primary purpose.

2. THE ECONOMIC EFFICIENCY AND ENVIRONMENTAL EFFECTS OF INCENTIVE SYSTEMS

Before reviewing the actual experience with using particular economic incentives, it is worthwhile to briefly review the available literature on the economic efficiency and the environmental effects of incentive systems in general. With respect to economic efficiency, incentive mechanisms have several properties that could make them especially well suited to environmental problems the nation faces now and into the future. First, relative to traditional forms of direct regulation, incentive approaches offer the prospect of more effectively dealing with pollution from diverse sources, an increasingly important problem. Second, incentive mechanisms are inherently more economically efficient; that is, they achieve environmental goals at lower cost than direct regulation. Third, incentive mechanisms provide a greater stimulus for innovation and technical change in pollution control than does a direct regulatory approach. These properties are discussed in the first three subsections. The last subsection summarizes what is known concerning the environmental effects of incentive systems.

2.1. DIVERSE SOURCES AND LITTLE-KNOWN CONTROL TECHNOLOGY

Direct regulatory approaches generally are most effective when all the affected sources of pollution have similar emission characteristics, environmental impacts, and pollution control possibilities and when the regulators have as good a knowledge of the available abatement opportunities. These conditions do not apply to many of current environmental problems since the “easy” pollution sources have already been controlled. Many heterogeneous smaller sources discharge effluents into the nation's streams and rivers. Emissions from small dispersed area and mobile sources contribute over one-half of the precursors of ozone in most nonattainment areas. Millions of motorists change their oil and release used motor oil into the environment in a variety of places and ways. Shortages of capacity and the difficulty of siting new solid waste facilities in communities across the nation have stimulated interest in ways to reduce the generation of solid waste by households. For these and similar environmental problems, direct regulatory action may be much more expensive and less effective than economic incentives.

Particularly for such diverse sources, individual firms or households are more likely than regulators or legislators to have the knowledge to choose the most effective pollution control techniques for their particular situation. Acting on their own knowledge or with information provided by vendors of equipment or government agencies, individuals and firms are most likely to be aware of the full range of options available—from process changes to input changes to behavioral changes to specific control technologies, and their costs and effectiveness. Regulatory bodies are not likely to have access to this range of knowledge. Regulatory approaches further fail to provide an incentive to adopt pollution controls other than those specified by regulators, even if they would be more effective.

2.2. GREATER EFFICIENCY

Evaluations of incentive systems that have been implemented typically find savings in control costs, improvements in environmental quality, or both relative to a command and control approach. Several of these systems will be described subsequently. Theoretical modeling of pollution control costs consistently demonstrates that incentive systems outperform command-and-control approaches in terms of efficiency.

Economists have long suggested that the traditional approach to environmental pollution control, which is predominantly command-and-control in nature, results in control costs that are higher than necessary to achieve a given level of environmental protection. They have suggested that costs could be substantially reduced if economic incentives were used in place of command-and-control regulations. Costs could be reduced because sources having the lowest costs of additional control would have an economic incentive to control more and those sources having the highest incremental control costs could control less rather than all polluters of a given type controlling to the same extent, as is now usually the case. Many of the quantitative studies done by these economists are summarized in Table 2-1. The ratio shown for most of the studies in the last column is the ratio of command-and--control costs to the lowest cost of meeting the same objective using economic incentives. A ratio of 1.0 suggests that the command-and-control approach is equal in cost to the economic incentive approach, so that the savings are zero. A ratio greater than 1.0 means that there are positive potential savings from using economic incentives. Since all the ratios shown are greater than 1.0, they support the assertion above that economic incentive approaches are more cost-effective than other approaches. Some additional studies are listed for which ratios have not been worked out. A review of these studies suggests that they also support the above assertion, however. The studies listed alphabetically under Section 2 of Appendix A of this report constitute the bulk of the quantitative studies done for the United States. No studies are known to exist for the United States that reach the opposite conclusion.

In particular, three studies of particulate control in the St. Louis area showed that the current approach costs from three to five times as much as a marketable permit system.[1] However more modest potential efficiency gains were reported for the control of six air pollutants in the St. Louis area.[2] A potential fourteen-fold decrease in control expenditures was estimated for nitrogen dioxide (NO_2) in the Chicago area through a permit system.[3] Command-and-control regulations were estimated to be 50 percent more costly than a permit system for the control of sulfur dioxide (SO_2) in Cleveland.[4] Potential savings also were noted for a marketable permit system for the control of phosphorous effluent in Lake Michigan;[5] and for a marketable permit system for SO_2 in Los Angeles.[6] Both emission taxes and marketable permits could reduce the cost of controlling noise at Boston's Logan airport.[7] Cost savings could be obtained from a marketable permit system to restrict chlorofluorocarbons.[8] The efficiency of emission
charges for the control of benzene emissions was demonstrated in another study.[9]

Table 2-1: QUANTITATIVE STUDIES OF ECONOMIC INCENTIVE SAVINGS

Pollutants Con-trolled	Study, Year, and Source	Geographic Area	Command-and-control Approach	Ratio of CAC Cost to Least Cost
AIR				
Criteria Air Pollutants				
Hydrocar-bons	Maloney & Yandle (1984) T	Domestic Du-pont Plants	Uniform Percent-age Reduction	4.15[a]
Lead in Gasoline	U.S. EPA (1985) A	United States	Uniform standard for lead in gasoline	See footnote for $ savings[b]
Nitrogen Dioxide (NO_2)	Seskin *et al*. (-1983) T	Chicago	Proposed RACT Regulations	14.4
NO_2	Krupnick (1986) O	Baltimore	Proposed RACT Regulations	5.9
Particu-lates (TSP)	Atkinson & Lewis (1974) T	St. Louis	SIP Regulation	6.00[c]
TSP	McGartland (1984) T	Baltimore	SIP Regulations	4.18
TSP	Spofford (1984) T	Lower Dela-ware Valley	Uniform Percent-age Reduction	22.0
TSP	Oates *et al.* (1989) O	Baltimore	Equal Proportional Treatment	4.0 at 90 $\mu g/m^3$
Reactive Organic Gases / NO_2	SCAQMD (Spring 1992) O	Southern Cali-fornia	Best Available Control Technolo-gy	1.5 in 1994
Sulfur Di-oxide	Roach *et al.* (1981) T	Four Corners Area	SIP Regulation	4.25
Sulfur Di-oxide	Atkinson (1983) A	Cleveland		About 1.5

Pollutants Con-trolled	Study, Year, and Source	Geographic Area	Command-and-control Approach	Ratio of CAC Cost to Least Cost
Sulfur Di-oxide	Spofford (1984) T	Lower Dela-ware Valley	Uniform Percent-age Reduction	1.78
Sulfur Di-oxide	ICF Resourc-es (1989) O	United States	Uniform Emission Limit	5.0
Sulfates	Hahn & Noll (1982) T	Los Angeles	California Emis-sion Standards	1.07[d]
Six Air Pollutants	Kohn (1978) A	St. Louis		
Other				
Benzene	Nichols *et al.* (1983) A	United States		
Chloro-fluorocar-bons	Palmer *et al.* (1980); Sha-piro & Warhit (1983) T	United States	Proposed Emis-sion Standards	1.96
Airport Noise	Harrison (1983) T	United States	Mandatory Ret-rofit	1.72[e]
WATER				
Biochemi-cal Oxy-gen De-mand (BOD)	Johnson (1967) T	Delaware Estuary	Equal Proportional Treatment	3.13 at 2mg/l DO; 1.62 @ 3m-g/l; 1.43 @ 4mg/l
BOD	O'Neil (1980) T	Lower Fox River, Wis-consin	Equal Proportional Treatment	2.29 at 2mg/l DO; 1.71 @ 4mg-/l; 1.45 @ 6.2 mg/l
BOD	Eheart *et al.* (-1983) T	Willamette River, OR	Equal Proportional Treatment	1.12 at 4.8 mg/l; 1.19 @ 7.5 mg/l
BOD	Eheart *et al.* (1983) T	Delaware Estuary in PA, DL, & NJ	Equal Proportional Treatment	3.00 at 3 mg/l DO; 2.92 @ 3.6 mg/l

Pollutants Controlled	Study, Year, and Source	Geographic Area	Command-and-control Approach	Ratio of CAC Cost to Least Cost
BOD	Eheart *et al.* (1983) T	Upper Hudson River in NY	Equal Proportional Treatment	1.54 at 5.1 mg/l; 1.62 @ 5.9 mg/l
BOD	Eheart *et al.* (1983) T	Mohawk River in NY	Equal Proportional Treatment	1.22 at 6.8 mg/l
Heavy Metals	Opaluch & Kashmanian (1985) O	Rhode Island Jewelry Industry	Technology-based Standards	1.8
Phosphorus	David *et al.* (1977) A	Lake Michigan		

Footnotes for Table 2-1

a. Based on 85 percent reduction of emissions from all sources.

b. The trading of lead credits reduced the cost to refiners of the lead phasedown by about $225 million.

c. Ratio based on 40 g/m^3 at worst receptor, as given in Tietenberg (1985), Table 4.

d. Ratio based on a short-term, one-hour average of 250 g/m^3.

e. Because it is a benefit-cost study instead of a cost-effectiveness study, the Harrison comparison of the CA approach with the least-cost allocation involves different benefit levels. Specifically, the benefit levels associated with the least-cost allocation are only 82 percent of those associated with the CA allocation. To produce cost estimates based on more comparable benefits, as a first approximation the least-cost allocation was divided by 0.82 and the resulting number compared with the CA cost.

Acronyms Used: CAC—Command-and-control, the traditional regulatory approach. DO—Dissolved oxygen; higher DO targets indicate higher water quality. RACT—Reasonably available control technologies. SIP—State implementation plan.

Sources: A stands for Anderson *et al.* (1989); they did not compute the ratio or provide the other information left blank in this table. O stands for original reference. T stands for Tietenberg (1985), Table 5. See Appendix A for all references.

It is important to note, however, that one recent review of retrospective analyses of emission and effluent trading systems concluded that realized cost savings fall well short of these projections.[10] Trades have been fewer and cost savings smaller, according to this analysis, than indicated by economic modeling. A number of explanations have been offered about why the full savings have not always been realized.[11] Regulatory and legal requirements of the actual programs may limit the trading opportunities to a greater extent than portrayed in the models, especially where the incentive programs is in addition to existing command-and-control programs. Various models have not fully reflected aspects of real regulatory programs, including the transaction costs, number of buyers and sellers, trading rules, monitoring and reporting requirements, and the administrative burden placed on both emission sources and regulatory agencies.

Even if the cost savings are less than predicted, the actual savings are still impressive. In the appropriate circumstances, the wider use of incentive programs that are feasible in an actual policy setting will result in substantial costs savings while achieving equivalent environmental goals. In other circumstances, the cost differences between an incentive program and a well designed command-and-control program will be less,[12] although the incentive program will provide a stronger stimulus for innovation and technical change.

2.3. STIMULUS TO INNOVATION AND TECHNICAL CHANGE

Because most economic incentive programs base the incentive on the quantity of emissions, they are more likely to provide incentives for innovation and technical change than command-and-control approaches. When emissions are used as the basis for determining either incentives or compliance with a command-and-control approach, polluters have incentives to innovate and introduce technical changes to reduce emissions to the point where the marginal cost of further reductions equals the magnitude of the incentive, or to the required levels in the case of command-and-control. When some other basis is used, particularly a technology standard, polluters usually have less of an incentive to innovate. In the case of a technology standard, pollution sources could have a negative incentive since if they use improved technology, the regulators may use that as the basis for requiring even tighter control in the future since it has then been "proven." So although emission-based command-and-control approaches can be used that provide incentives for innovation, they may be less effective than an economic incentives approach since they only provide incentives to bring emissions down to the standard rather than to zero. This may be considerably less technically challenging.

With this in mind, it is not surprising that studies that have examined the incentives for technological change and innovation under alternative pollution control regimes have concluded that emission taxes provide greater stimulus to innovation than direct controls, with marketable permits providing an intermediate level of stimulus.[13]

Long run changes in behavior, technology, and investment are among the most difficult economic effects to document. For that reason, relatively little is known of such effects that take place as a result of different pollution control systems. Yet these effects are thought to be very important; the rate of technological change in pollution control is "the single most important criterion on which to judge environmental policies," according to some analysts.[14] Others term innovation in pollution control "the key to an effective solution" of environmental problems.[15]

What evidence is available suggests that existing environmental policies give only a mild stimulus for technical change and innovation.[16] Outlays for research and development in pollution control are between two and three percent of total pollution control expenditures. This percentage is about average for all sectors of manufacturing, but far below that of drug, electronics, and information processing.[17] Pollution control is a newer and growing industry; a low rate of investment in research and development is unexpected other than in the context of regulation through direct controls.

2.4. ENVIRONMENTAL EFFECTS OF INCENTIVE APPROACHES

To get a full understanding of the effectiveness and economic efficiency of incentive programs in achieving environmental objectives, it is necessary to have information on not only the relative costs of incentive-based versus command-and-control programs, but also the actual environmental benefits realized by both types of programs. The literature focuses almost exclusively on the relative cost side of the comparison, while providing very little information or analysis of the environmental benefit side of the comparison. Thus, while this report attempts to summarize the available information, it is important to recognize that a complete analysis of incentive-based approaches would require additional research on the relative environmental benefits that have been realized by such programs.

Generally, incentive mechanisms based on trading are designed to produce environmental effects that to a first order of approximation are equivalent to a command-and-control alternative. Trading-based approaches often require trading ratios in excess of one. That is, more than one unit of pollution is eliminated for every extra unit allowed. If faithfully executed, this should result in at least modest decreases in total pollution where such ratios are used. Fee-based incentive mechanisms implemented to date in the United States and elsewhere typically are used to raise revenue to support pollution control objectives and management authorities. Because their environmental objectives are more modest than command-and-control alternatives, the environmental effects are not strictly comparable. Deposit systems appear to produce environmental effects significantly greater than could be achieved through command-and-control methods, although there appears to be a threshold of deposit size needed in order to induce people to achieve the environmental objective[18]

Comparisons of environmental effects of alternative pollution control mechanisms need to be made carefully. It is not safe to assume that the effects of command-and-control and incentive systems are always comparable. Oates *et al.* (1989) show, for example, that a command-and-control approach often results in "overcontrol" beyond a pollution control standard, whereas many of the incentive approaches analyzed in the literature would just achieve the standard. At least for the example they studied, particulate matter control in the Baltimore area, the relative attractiveness of the command-and-control compared to an incentive approach is much closer when measured in terms of net benefits. For that reason, when comparing the two approaches, it is important to examine not only differences in costs, but also in environmental effects.

Endnotes for Section 2

1. Atkinson and Lewis (1974 and 1976) and Atkinson and Tietenberg (1982).

2. Kohn (1978).

3. Seskin *et al.* (1983).

4. Atkinson (1983).

5. David *et al.* (1977).

6. Hahn and Noll (1982).

7. Harrison (1983).

8. Palmer *et al.* (1981).

9. Nichols (1983).

10. Atkinson and Tietenberg (1991).

11. See Atkinson & Tietenberg (1991), Dudek & Palmisano (1988), Hahn (1989), Hahn & Hester (1989), Liroff (1986), and Tietenberg (1985 and 1990).

12. Oates *et al*. (1989).

13. Zerbe (1970), Wenders (1975), Downing and White (1986), and Milliman and Prince (1989).

14. Kneese and Schulze (1978).

15. Orr (1976).

16. Cramer *et al.* (1990).

17. U.S. Department of Commerce. Articles entitled "Pollution Abatement and Control Expenditures," published periodically in the *Survey of Current Business.*

18. See, for example, the Swedish and Norwegian experience with automobile deposits in Section 9.2.

3. FEES, CHARGES, AND TAXES

This Section concerns economic incentives involving payments to government for pollution. These usually take the form of fees, charges, or taxes set by government. The academic literature has extensive discussions of auction systems, but they have not been widely used in practice to set prices.

In the last few years, a number of fee or tax-based incentives have appeared at the federal level. The charges on production of ozone-depleting chemicals provide one example; charges on “excess” production of hydrocarbons in certain ozone nonattainment areas provide another example.

In contrast, pollution fees have been more common at the state and local level. State and local pollution fees typically are set at levels to recover the administrative costs of state and local pollution control agencies. However, fees such as those set by publicly-owned treatment plants and those charged for disposal of industrial solid and hazardous waste are set to recover the cost of disposing of wastes, which may not always reflect the full social costs of pollution.

In order to be an economic incentive, pollution fees must vary according to the pollution produced; in other words, they must have a unit cost pricing attribute. Many analysts have argued that noncompliance penalties are an economic incentive. Noncompliance penalties rise with increasing levels of pollution, and are used to remove any economic benefit polluters obtain from command-and-control regulations. They do do not, however, fully satisfy the definition of an incentive mechanism used in this report since penalties are imposed only on firms that are not in compliance. Penalties are zero for firms in compliance with regulations.

As discussed in Section 1.2, pollution fees can also be more or less economically efficient. To be fully efficient, they must reflect the damages caused by the pollution; in other words, they must reflect the full social costs of pollution. Those that do are said to reflect the full social costs of pollution. Those that largely do not are often referred to as “revenue raisers” since their chief purpose is usually to increase government revenues rather than to have a strong incentive effect on polluters. They have some incentive effect, but nothing close to that required by economic efficiency.

Thus, although all the incentives discussed in this section will involve unit cost pricing, none will involve full social cost pricing. These are described in textbooks but have yet to be implemented as pollution control measures. It should be noted, however, that some states (*e.g.*, New York) currently are investigating the feasibility of social cost pricing for electricity.

Pollution fees, charges, and taxes have not proved as popular as trading in the United States, in part because they increase the total financial outlays by polluters above the cost of pollution abatement since all potential pollution, both controlled and uncontrolled must be paid for. Economists, on the other hand, point out that fees, charges, and taxes provide incentives for pollution control while raising revenue for the government. Since some revenue has to be raised anyway, they argue, it may be better to do it in a less economically distorting manner than most current taxation programs do, such as through charges for pollution.

3.1. NPDES PERMIT FEES

The Federal Water Pollution Control Act of 1972 provides for the regulation of discharges of pollutants from point sources through a system of national effluent standards promulgated by EPA. Point sources such as industrial plants, municipal sewage treatment facilities and feedlots must obtain permits in order to discharge effluent. Without a permit, discharging effluent is illegal.

EPA has delegated responsibility for issuing National Pollution Discharge Elimination System (NPDES) permits to the majority of states. Several of these states impose charges for NPDES permits based on factors such as volume and toxicity of the effluent. For example, New York divides effluents into three categories and imposes a separate schedule of volume-based fees in each category. California uses a fee schedule that is based on the type and volume of discharge. Many other states, however, impose set fees for NPDES permits and do not differentiate by volume or toxicity.

Whether current fee levels in some states are sufficiently high to affect the volume of discharges in unknown. To date there exists no comprehensive examination of the impacts of volume and toxicity based NPDES fees.

3.2. PUBLICLY OWNED SEWAGE TREATMENT PLANT USER FEES

Publicly Owned Treatment Works (POTWs) impose charges on industrial facilities and households discharging into their systems. The charge for industrial sources may be based on effluent volume or the types and amounts of pollutants present. Due to high monitoring costs, pollutant-based charges generally are limited to large users. Others industrial users and households are billed based on effluent volume times a rate specific to the individual sector. Sims (1977) found that pollutant-based charges provided an incentive for large industrial facilities to reduce effluents. Purely volume-based charges did not appear to have such an effect, possibly because such charges typically appear as part of a user's water consumption bill and water prices often reflect lower historical average costs rather than long-run marginal costs.

3.3. MUNICIPAL SOLID WASTE DISPOSAL CHARGES

Throughout the nation, most communities levy fixed fees for the collection of household solid waste or include the costs in property taxes. Fees may be set at a fixed price per month or effectively “hidden” altogether as part of residential property taxes. Under such as approach, incremental charges are zero despite the fact that incremental costs to the disposal authority are positive.

In a growing number of jurisdictions, about 100 at present, charges for solid waste collection are based on the volume generated by the household. One of two pricing systems may be used: charges based on subscriptions for a certain number of containers and charges for stickers that must be placed on each bag left for curbside pickup. Under the subscription syistem, households pay to have the right to dispose of a set number of containers each week. If the containers nare not filled, the household pays for the unused capacity. The available evidence suggests that such incremental pricing can have a significant effect on the volume of wastes produced, particularly when marginal pricing is coupled with recycling programs.[1]

In cities where solid waste collection charges are volume-based, the evidence points to a significant impact on the quantity of waste that is generated. High Bridge, New Jersey implemented a pay-per-bag program in January, 1988. Since that date the tonnage of trash collected has decreased by 25 percent. A pay-per-bag system in Perkasie, Pennsylvania has resulted in a 50 percent decrease in the tonnage of solid waste collected and an increase of about 30 percent in recycling. Seattle's Solid Waste Authority estimates that the tonnage of solid waste generated fell by about 20 percent once its pricing and recycling programs were fully implemented.

3.4. AIR EMISSION FEES

3.4.1. State Permit Fees

The equivalent of air emission fees appear in some states in the form of annual permit fees that are based on emissions of air pollutants. Generally fee levels are set to recover administrative costs of state air quality programs. For example, the Texas Air Control Board set fees at $3 per ton of regulated pollutants for fiscal 1992 and $5 per ton in fiscal 1993 to finance certain agency activities. This is an example of a fee that may generate revenue but is unlikely to have much incentive effect to reduce emissions.

Air emission permit fees in California's South Coast Air Quality Management District (SCAQMD) have greatly increased since first implemented under the Lewis Air Quality Management Act of 1976 and are presently the highest in the nation. Amendments in June 7, 1991 set fee levels for the largest source category (over 75 tons per year) at $596 per ton for organic gases, $343 per ton for nitrogen oxides, $413 per ton sulfur oxides and $456 per ton for particulate matter. Smaller sources face a fee schedule about one-third lower in cost per ton.

Annual permit fees for the largest sources can amount to $2 million or more per year. From a financial point of view fees of this magnitude are likely to gain the attention and concern of plant managers. While SCAQMD permit fees create a financial incentive to reduce emissions, firms are limited in their ability to respond because incremental control costs for most sources in the region are considerably higher.

3.4.2. Federal Nonattainment Area Fees

The 1990 Clean Air Act Amendments provide for a variety of new incentive measures. One of these is a charge of $25 per ton for permits for regulated pollutants, a fee designed to recover administrative costs of the permit program. Another is a fee on “excess” emissions of Volatile Organic Compounds (VOCs) in certain ozone nonattainment areas. Severe ozone nonattainment areas, defined as those with design values between 0.18 and 0.28 ppm ozone, are given 15 to 17 years to attain the ozone National Ambient Air Quality Standard (NAAQS); more specifically, they have 15 years for areas with design values between 0.18 and 0.19 ppm, and 17 years for areas with design values between 0.19 and 0.28 ppm. Extreme ozone nonattainment areas (currently just California's South Coast Air Quality Management District), which have design values above 0.28, are given 20 years to reach attainment. Failure of an area to attain by these schedules will subject major stationary sources to annual fees on VOC emissions. Fees are set by statute at $5,000 per ton (adjusted for inflation) for each ton of VOC emitted that exceeds 80 percent of a baseline quantity. Emission fees are also specifically authorized under Economic Incentive Program rules (Section 182(g)(4)). Fees are allowed for highway tolls (Section 108) to reduce pollution and congestion, for consumer products (Section 183), and generally in Sections 110 and 172 as a part of a State's available tools for designing State Implementation Plans.

3.5. INDUSTRIAL SOLID AND HAZARDOUS WASTE CHARGES

In contrast to flat fee schedules (with incremental charges equal to zero) typically faced by households, commercial and industrial generators of solid waste generally face costs that rise with increases in volume (positive marginal charges). Charges are based on the number of containers emptied and the substances contained. Across regions, charges can vary several fold for the identical volumes of a particular substance.

The pollution control literature contains no reports of generator responses to varying disposal charges for hazardous waste. Waste disposal firms may have some knowledge of these relationships.[2]

3.6. PRODUCT CHARGES

This subsection reviews briefly several product charges that are widely used at the state level. While the incentive effects of product taxes on pollution is likely to be weak, such taxes do raise revenues that can be used to finance pollution control activities.

3.6.1. Fertilizer Taxes

According the Fertilizer Institute, 46 states had imposed taxes on fertilizer sales by 1988 to help pay for programs of environmental protection and environmental research. Tax rates ranged from $0.10 per ton to $1.70 per ton and raised a total of about $14 million annually. With fertilizer prices in the range of $60 to $200 per ton, taxes are no more than 2.5 percent of value and much less than that in most instances. Incentive effects, to the extent they exist, would be to dampen overall demand for fertilizer. Input taxes such as fertilizer taxes are likely to have minimal impact on the manner in which the product is used and, hence, have minimal impact on pollution. Environmental protection and research funded trough such taxes may, of course, have a beneficial impact on pollution.

3.6.2. Automobile Tire Taxes

Many states and/or counties impose special taxes on the sale of automobile tires, with revenues earmarked for used tire disposal. Fees typically are in the range of $1 to $3 per tire.

3.6.3. Motor Oil Taxes

In 1989 Rhode Island imposed a fee of five cents per quart on motor oil, the proceeds of which are earmarked for used oil collection costs, including hauling fees.[3] Of the state's 39 municipalities, 28 now have collection sites where residents may deposit up to five gallons of used oil per quarter free of charge. The state has contracted with a hauler to pick up used oil at these collection facilities for a fee of $.25 per gallon.

3.6.4. Superfund Feedstock Taxes

The federal superfund (described in section 6.2.1) is financed with a combination of taxes on domestic crude oil production (8.2 cents per barrel), crude oil and petroleum product imports (11.7 cents per barrel), petrochemical feedstocks (varying rates), gross business profits (0.12 percent of amounts over $2 million), and general revenues. The oil and petrochemical taxes may be characterized as product charges; however, the intent as with most product charges appears to be to raise revenue for a specific purpose and not to deter pollution.

3.6.5. Chlorofluorocarbon Taxes

The Budget Reconciliation Act of 1989 imposed taxes on the production of chlorofluorocarbons, with the intent to aid in the development of substitutes and speed reduction in use of ozone-depleting chemicals. Taxes are calculated as a base amount per pound multiplied by an ozone-depletion factor. The taxes went into effect January 1, 1990, with the rate increasing over time.[4]

3.7. WETLAND COMPENSATION FEES

Maryland[5] and New Jersey[6] allow compensation for wetland loss caused by development activities in situations where on-site mitigation is not feasible. The State of Louisiana is currently considering such a system. The funds collected in the New Jersey and Maryland programs are available for use by state agencies for wetland enhancement and restoration.

In New Jersey, state agencies have yet to ask for compensation payments as they debate whether they want long-term responsibility for wetlands that they enhance or restore. In Maryland, the state appears ready to assume long-term management responsibilities when it restores or enhances wetlands. In Maryland, fees range from $11,500 to $15,750 per acre in Category A (inland) counties and from $50,800 to $58,000 per acre in Category B (coastal) counties. The fees are structured to include design, construction, and monitoring costs of $10,000 and $50,000 per acre for inland and coastal counties, respectively, plus an additional fee for land acquisition.

Endnotes for Section 3

1. Anderson *et al.* (1989)

2. Information obtained in telephone conversations with Jack Hornberger, Sr. Vice president of Rollins Environmental Service, Inc., Wilmington DE and Robert Reineke of Chemical Waste Management, Oak Brook, IL.

3. Andrew Lohof (1991), pp. 100-101.

4. Internal Revenue Code, sections 4681 and 4682.

5. In Maryland Code (COMAR) 08.05.04.18.

6. In its 1988 Freshwater Protection Act

Deposit-refund systems differ from pollution fees because part or all of the fee is refunded if the person paying the fee takes certain actions—usually returning a product for recycling or proper disposal.

4.1. BEVERAGE CONTAINER DEPOSITS

In 1972 Oregon became the first state to require mandatory deposits on soft drink and beer containers. Nine additional states have since enacted similar legislation.[1] Meanwhile several other states have failed to adopt proposed deposit legislation. Although state legislation governing container deposits is of relatively recent origin, beverage manufacturers had long used deposit-refund mechanisms. These private systems fell out of favor in the 1960s with the introduction of cheaper “disposable” containers.

Deposits address two costs that usually are external to beverage manufacturers, distributors and consumers—namely the costs of disposal and littering. Deposits provide a disincentive to specified types of litter and an incentive to collect such litter, and reduce the volume of solid waste. One important outcome of mandatory deposit legislation is a reduction in litter. Oregon reported a 75 to 85 percent reduction in roadside litter just two years after enacting deposit legislation. Valuing a reduction in litter is fraught with problems. While litter pickup costs are readily quantified at about one-fourth of a cent per container, the amenity costs of litter are largely unknown.

While some states have reported great success with beverage container deposit laws in terms of reducing litter, such systems involve additional costs to consumers and retailers.[2] In particular, it is difficult to quantify the value of consumers' time expended to comply with deposit laws. Because key cost and benefit elements of beverage container deposit laws are known only within very broad ranges, it is not possible at this time to demonstrate the clear superiority of beverage container deposit laws in terms of their economic efficiency.

4.2. BATTERY DEPOSITS

In the past three years approximately ten states have implemented deposit systems for lead batteries.[3] Each state requires a $5 or $10 deposit at the point of sale. Deposits are refundable if the old battery is returned within seven or 30 days, depending on the state. In nine of the ten states, unclaimed deposits are retained by the retailer. In addition, many retailers in other states such as Maryland and Virginia include deposits in their retail prices and offer comparable rebates when a used battery is returned. These activities are not required by state laws, but may help the retailers comply with provisions of the Resource Conservation and Recovery Act.

4.3. PESTICIDE CONTAINER DEPOSITS

Maine requires deposits on pesticide containers, primarily those destined for commercial use. The law requires triple rinsing and through a deposit provides an incentive for the return of rinsed containers. Deposit fees are five dollars per container of less than 30 gallon capacity and ten dollars for larger containers. Approximately 13,000 containers are returned under this program each year.

Endnotes for Section 4

1. California, Connecticut, Delaware, Iowa, Maine, Massachusetts, Michigan, New York, and Vermont.

2. Porter (1978).

3. Specifically, the states (and effective dates) are: Arizona (September, 1990), Arkansas (July, 1992), Connecticut (October, 1990), Idaho (July, 1991), Maine (October, 1989), Minnesota (October, 1989), New York (January, 1991), Rhode Island (January 1989), South Carolina (date unknown), and Washington (July, 1989). The only state where the retailer does not retain all unclaimed deposits is Rhode Island, where 80 percent is retained by the state and 20 percent by the retailer. Based on information provided by Saskia Mooney of Weinberg, Bergson, and Neuman, Washington, D.C.

5. TRADING SYSTEMS

Relative to fee or charge-based systems, trading systems generally cost polluters less[1] since under existing practice for allocating pollution rights, the maximum cost to polluters is the pollution control cost incurred in meeting the regulations or standards; fee or charge-based systems, on the other hand, require outlays to control pollution as well as fees or charges on all units of pollution that are not controlled. In addition, trading systems provide more certainty regarding total quantities of pollution than do fee-based systems unless auction approaches are used. For these and other reasons, trading systems have proved more popular in the United States.

5.1. SOME ATTRIBUTES OF TRADING SYSTEMS

Trading systems can be characterized in terms of a number of important attributes, including scope of coverage, degree of government intervention, the technical basis for the trading, and the geograpic limits for the trading. Table 5-1 provides a list of the trading systems that will be discussed in this Section and shows the attributes of each.

5.1.1. Industrial Scope

Trading programs can be applied to either inter-firm (or inter-polluter trades), intra-firm trades between product lines, and intra-firm trades between locations (which will be referred to as inter-plant trades).

5.1.2. Credits Versus Allowances

A trading program can involve either credits or allowances. A credit is created by a source emitting less than its allowable limit. To obtain the credit, a polluter is required to show that its actual emissions, plus or minus any traded credits, is less than its allowable limit. In a credit program, the agency or a designated authority must certify the creation of the credit as well as record trades.

In an allowance system, on the other hand, trading involves future pollution. Once the environmental protection agency sets an allowable limit for a source, the source can add to its allowable limit or reduce it by trading in allowances. The agency should, at a minimum, record trades, but it need not certify each and every allowance that is traded. The certification of allowances for each source takes place prior to trading and may be revised whenever a source changes its pollution control equipment.

Until the past few years, most trading programs were credit programs, but allowance programs are now being more widely used.

Table 5-1: ATTRIBUTES OF TRADING SYSTEMS DISCUSSED

Report Section	Program Name	Scope of Cov-erage	Govern-ment In-terven-tion	Cred-it / Al-low-ance	Emis-sion Lim-its	Geo-graphic Locat-ion
5.2.1	Acid Rain Allowance Trad-ing	Ir-F	Min	Al	Mass	Natl
5.2.2	Oxygenated Gasoline Credit Program	Ir-F	Min	Cr	Av	Oz NA
5.2.3	Low Emission Vehicle Credit Program	Ir-F	Min	Cr	Av	Oz NA
5.2.4	Chlorofluorocarbon Produc-tion Allowance Trading	Ir-F	Min	Al	Mass	Natl
5.2.5	Lead Trading	Ir-F	Min	Cr	Av	Natl
5.2.6	Transferable Development Rights	Ir-F	Min	Cr	Total	Locl
5.2.6.1	Montgomery County, Maryland	Ir-F	Min	Cr	Total	Locl
5.2.6.2	Talbot County, Maryland	Ir-F	Min	Cr	Total	Locl
5.2.6.3	The Pinelands, New Jersey	Ir-F	Min	Cr	Total	Locl
5.2.7	Fireplace and Wood Stove Permit Trading	Ir-F	Min	Cr	Total	Locl
5.3.1	Trading of Air Emissions Rights	Var-ies	Ap	Cr	Mass	Locl
5.3.1.1	Bubbles	Ir-F	Ap	Cr	Mass or Av	Locl
5.3.1.2	Offsets	Ir-F	Ap	Cr	Mass or Av	Locl
5.3.1.3	Banking	Ir-F	Ap	Cr	Mass or Av	Locl
5.3.1.4	Netting	Ia-P	Ap	Cr	Mass or Av	Locl
5.3.2	Effluent Reduction Trading	Ir-F	Ap	Cr	Mass	Locl

Report Section	Program Name	Scope of Cov-erage	Govern-ment In-terven-tion	Cred-it / Al-low-ance	Emis-sion Lim-its	Geo-graphic Locat-ion
5.3.2.1	Wisconsin	Ir-F	Ap	Cr	Mass	Locl
5.3.2.2	Dillon Reservoir, Colorado	Ir-F	Ap	Cr	Mass	Locl
5.3.2.3	Cherry Creek Reservoir, Colorado	Ir-F	Ap	Cr	Mass	Locl
5.3.2.4	Tar-Pamlico Basin, North Carolina	Ir-F	Ap	Cr	Mass	Locl
5.3.2.5	Steel Industry Effluent Bubble	Ia-P	Ap	Cr	Mass	Locl
5.3.3	Wetland Mitigation Banking	Ir-F	Ap	Cr	Av	Locl
5.4.1	Reasonably Available Control Technology Requirements.	Ia-F	Ap	Cr	Mass	Locl
5.4.2	Heavy Duty Truck Engine Emissions	Ia-F	Min	Cr	Av	Natl
5.4.3	California Motor Fuel Characteristics	Ia-F	Min	Cr	Av	Locl
5.4.4	Hazardous Air Pollutant Early Reduction Program	Ia-F	Ap	Cr	Mass	Locl
7.1	RECLAIM	Ir-F	Min	Cr	Mass	Locl
7.2	Scrapping Older Vehicles	Ir-F	Ap	Cr	Mass	Locl

Footnotes for Table 5-1

Abreviations Used:

Industrial Scope: Ia-F for Intra-firm; Ir-F for Inter-firm; Ia-P for Intra-plant
Government Intervention: Ap for Approval; Min for Minimal or non-approval
Emission Limits: Av for Average
Credit / Allowance: Al for Allowance; Cr for Credit
Geographic Location: Locl for Local; Natl for National; Oz NA for Ozone Nonattainment Areas.

5.1.3. Degree of Government Intervention

Although all trading requires some involvement of a pollution control agency, there is substantial variation in the extent of that involvement. In some cases this involvement is nothing more than recording trades; in others, it involves specific approval of each and every trade. In the case of credit programs it requires monitoring the creation of the credits. The major variable between programs is whether the pollution control agency must also approve each trade. Although all programs involve trade recording (the function does not necessarily have to be carried out by government), not all require government approval for a trade to occur. The necessity for approval depends on what is being traded. Agency approval is more likely to be required when trades involve different pollutants, pollutants that have differing locational impacts, and pollutants with different measurement and other characteristics.

5.1.4. Emission Limits

Another distinction concerns whether a trading program involves mass emission limits or not. Mass emission limits prescribe the total emissions that a polluter may have over a designated period of time. Other programs do not prescribe total emissions, but rather the rate at which they occur. Within firm trading can be used to meet both a mass emission limit target as well as a rate-based emission target.

Most of the command-and-control emission regulations limit the rate of emissions, not the total amount (for example, Federal automobile tailpipe standards). This distinction is very important, and has important implications for trading systems. A trading system can be designed either with or without mass limits. Limits are a crucial distinction because mass emission limits are a significantly different regulatory burden placed on sources. Many of the most difficult problems associated with a trading program come from the limits, not from allowing sources to adjust their limit (in a marketable allowance program) or meet their limit via trading (in an emission reduction program). Issues including baselines, accurate emission monitoring, and make-up or other penalty provisions all are limit-related, not trading related.

For other than air and water pollution, the concept of mass emission limits is more reasonably interpreted as total emission limits.

5.1.5. Geographic Area

The geographic area over which trades are permitted is largely determined by the type of pollutant. If the pollutant spreads widely and has adverse effects at the low concentrations found at distant points, the geographic area is likely to be very large. An example would be chlorofluorocarbons which can damage the ozone layer regardless of where on earth they may be released. On the other hand, many pollutants have adverse effects primarily on a small local or regional area. An example is carbon monoxide, which has no short-term adverse effects outside the metropolitan area where it is initially released.

5.1.6. Section Organization

The choice of the organization for the remainder of this section is essentially the choice of what to highlight among these various attributes. Although a case can be made for many combinations of the attributes discussed earlier in this subsection, the following list of subsections represents one useful way to break the programs down into a manageable number of categories and will be the one used:

5.2. Inter-firm non-approval trading involves pollution reduction credits that, once issued, can be relatively freely traded without major intervention by pollution control agencies;

5.3. Inter-firm approval trading involves pollution reduction credits that can be used or traded by a polluter with significant intervention of pollution control agencies, usually because the pollution involved does not have identical environmental impacts; and

5.4. Intra-firm approval trading involves pollution credits that are tradable only within a firm, to be used to meet firm standards.

Inter-firm and intra-firm approval trading have in the past been the most common form of economic incentive used in the United States; with the passage of the Clean Air Act Amendments of 1990, however, inter-firm non-approval trading is assuming more importance. Appendix B contains a general overview of the economic incentive provisions of the 1990 Amendments.

5.2. INTER-FIRM NON-APPROVAL TRADING

5.2.1. Acid Rain Allowance Trading

Title IV of the Clean Air Act Amendments of 1990 directs the Environmental Protection Agency to establish a program to reduce acid rain. Acid rain is the term used to describe the phenomenon associated with emissions of fossil fuel combustion, the transport of these emissions in the atmosphere, and the deposition of their transformation products.

The Clean Air Act Amendments set a national cap of 8.95 million tons per year on SO_2 emissions from electric utilities, to be accomplished in two phases. Phase I, beginning in 1995, requires the 110 largest, highest emitting utility plants to reduce emissions to levels reflecting an intermediate emission limit of 2.5 lbs. of SO_2 per million Btu. In phase II, beginning in the year 2000, existing utility plants greater than 25 megawatts and all new units must reduce emissions to levels reflecting emission limits of 1.2 lbs. per million Btu.

Through this program total SO_2 emissions will be reduced by 10 million tons relative to 1980 baseline emissions.

The most important feature of the acid rain control program is a trading system of marketable allowances. EPA issued proposed rules in late 1991 that govern the operation of the allowance trading system.[2] Under the proposed rules, existing utility sources subject to the program are granted allowances based on historic fuel use and emission rates set in the 1990 amendments. Each allowance is for one ton of emissions. Utilities may meet their emission limits by using their allowances or by acquiring allowances from utilities that control emissions more than is required. Beginning in 1993, a relatively modest number of emission allowances will be auctioned each year by the EPA. To assure that each utility source is in compliance, sources must install a system to continuously monitor the flow and concentration of emissions.

At a later date, EPA will promulgate regulations permitting sources not explicitly affected by the acid rain program the opportunity to participate in the allowance market through an “opt in” provision.

Because it encourages cost-effective emissions control, the acid rain allowance trading system has the potential to save affected utility sources billions of dollars in compliance costs. EPA estimates that savings from the acid rain trading program will range from $0.7 to $1.0 billion per year.[3] Whether the full potential savings are achieved depends on several factors including state public utility regulation and the willingness of utilities to participate.

5.2.2. Oxygenated Gasoline Credit Program

Title II of the Clean Air Act Amendments of 1990 tightens mobile source tailpipe emission standards and provides for the development of new and reformulated fuels. One of the incentive mechanisms appears as marketable credits for fuel characteristics in cities where reformulated fuels are required. Fuel credits would be earned by refiners, blenders or importers who certify that their gasoline or blend has an oxygen content equal to or greater than 2.0 percent by weight. Credits would be fully marketable; gasoline containing more than 2.0 percent oxygen by weight would earn a credit that could be transferred to refiners or importers having a gasoline oxygen content below the required limit. Proposed guidelines implementing the oxygenated gasoline credit program were issued by EPA in early 1992.[4] The guidelines specify a 2.0 percent minimum oxygen content by weight during the control period, an averaging period equal to the control period, and enforcement through an “attest engagement” in place of audits. EPA declined to provide for banking of oxygen credits for use in subsequent periods.

Although authorized by the 1990 amendments, EPA has decided not to promulgate trading provisions for the benzene content of gasoline at this time, but may do so at a later date.[5]

5.2.3. Low Emission Vehicle Credit Program

Section 249 of Title II of the Clean Air Act Amendments of 1990 concerns a California pilot test program for clean-fuel vehicles and clean alternative fuels. The language of section 249 closely follows provisions of the California Air Resources Board (CARB) Low Emission Vehicle (LEV) program that dates from 1984. Section 249(d)(1) authorizes the State to offer marketable credits to manufacturers who sell more clean-fuel vehicles than is required. Manufacturers who sell fewer vehicles than required may make up the deficiency by purchasing credits. EPA proposed rules in 1991 governing LEV credit trading that follows earlier CARB guidance.[6]

5.2.4. Chlorofluorocarbon Production Allowance Trading

In 1988 the United States ratified the Montreal Protocol on Substances that Deplete the Ozone Layer. The Montreal Protocol called for a cap on production of chlorofluorocarbons at 1986 levels, with further reductions in 1993 and 1998. EPA issued regulations implementing the Montreal Protocol in 1988.

Title VI of the Clean Air Act Amendments of 1990 calls for additional restrictions on chlorofluorocarbon production. In late 1991 EPA issued a temporary final rule that (1) apportions baseline allowances, (2) provides for gradual reductions in allowances, and (3) permits the transfer of allowances among firms.[7] Transfers of production allowances are limited only in that the transferor's remaining allowances are reduced by the amount transferred plus one percent of the amount transferred.

5.2.5. Lead Trading

Since the 1920s tetra-ethyl lead has been added to gasoline to raise its octane and reduce knocking in engines. Because of concerns over adverse health effects from airborne lead, the EPA required that unleaded gasoline be made available by July 1974 and restricted the lead content of leaded gasoline to 1.7 grams per gallon after January 1, 1975.[8] The schedule for lead phase down had five stages. The final stage, which occurred after January 1, 1979, limited the average lead content for individual refiners to 0.5 grams per gallon, averaged across the lead content of leaded and unleaded gasolines. Similar requirements applied to importers of gasoline.

During the early 1980s, the demand for leaded gasoline decreased steadily, becoming a small fraction of the total gasoline consumption. Consequently, limits on the average lead content of all gasolines ceased to have much impact on the lead content of leaded gasoline. Meanwhile, concern over adverse health effects from airborne lead continued to grow.

EPA established a limit of 1.1 grams per gallon for the content of leaded gasoline beginning on July 1, 1985 and announced its intent to further reduce lead in gasoline to 0.5 grams per gallon after July 1, 1985, and 0.1 grams per gallon after Jan. 1, 1986.[9] This aggressive schedule of lead reduction was facilitated by a program EPA established to allow trading in lead credits among refiners. Without trading in lead credits, two alternatives were likely: (1) the phase down would have taken longer or (2) there would have been a short-term contraction in the supply of gasoline and possible supply disruptions in some areas.

5.2.5.1. The Lead Trading Program

Starting July 1, 1983 EPA allowed refiners and importers of gasoline to trade lead reduction credits to meet the limit for the average lead content of gasoline.[10] Refiners and importers that reduced the average lead content of their gasoline below the EPA limit generated credits that could be sold to refiners or importers that exceeded the limit. Reporting was on a quarterly basis; all credits generated in a quarter had to be used within that quarter.

Once the limit for the average content of leaded gasoline reached 0.1 grams per gallon, trading would not be allowed because of concern that gasoline with less than 0.1 grams of lead per gallon could cause excessive valve seat wear in older vehicles.

In 1985 EPA allowed refiners to bank lead credits for subsequent use anytime until the end of 1987.[11] Banking effectively extended the life of credits from the quarter they were generated to the end of 1987.

5.2.5.2. Administration and Enforcement

Refiners and importers were required to report on a quarterly basis all trades, banking deposits, withdrawals and balances, along with gasoline volumes. Reporting forms for refiners and importers were simple. They consisted of brief summary information for each refiner or importer along with two lists: (1) the names of entities with which the refiner or importer traded and the quantities traded; and (2) a list of physical transfers of lead additives to or from entities other than lead additive manufacturers. The second list contained not only physical transfers of lead additives, but also any sales of gasoline components or unfinished gasolines to which lead had been added. Together, this data provided enough information to match individual purchases and sales of lead credits and to verify that total sales of lead rights equalled total purchases. Any discrepancies in totals could trigger further investigation and enforcement action.

5.2.5.3. Effects of Lead Trading on Gasoline Markets

There is very limited data on the actual transaction prices of lead credits under the trading program. Although there was an active market with several hundred participants, actual transaction prices were known only to the market participants. No price reporting was made to EPA, only volumes traded. Further, intermediaries played only a limited role in this market. Consequently, only anecdotal evidence is available concerning the price of lead credits; that evidence indicates that lead rights traded in the range of 3/4 to over four cents per gallon.[12]

The large volume of lead rights traded and banked suggests that the total savings could have been substantial. EPA estimated that about 9.1 billion grams of lead would be banked and that banking alone would save refiners $226 million. The actual amount banked was very close to this estimate: just over 10 billion grams, for an average saving of 2.5 cents per gram that was banked.[13]

5.2.5.4. Environmental Effects of Lead Trading

The lead trading program likely had a beneficial effect in terms of reducing the total amount of lead used in gasoline, at least as rapidly as would have been the case if a command-and-control approach had been used. It seems likely that the banking provisons allowed more reductions to occur in the early years than would have occurred otherwise.

5.2.6. Transferable Development Rights

A number of jurisdictions have adopted systems of transferable development rights (TDRs) to manage land use and for other reasons. Although these are not strictly pollution rights, they are closely related since development normally leads to at least increased water pollution and often air pollution and solid waste. Three such programs are considered here.

5.2.6.1. Montgomery County, Maryland

Montgomery County is a prosperous county bordering Washington, DC with a population of about 750,000. The portions closest to the District have become urbanized and there was a tendency in this direction for even the more distant rural and agricultural areas. To preserve the character of the agricultural areas, the county, in 1980 and 1981, downzoned approximately 90,000 acres from one dwelling per five acres to one per 25 acres. To compensate land owners for the loss in value and to avoid the “takings” prohibition of the Constitution, valuable transferable development rights were distributed to the affected land owners on the basis of one TDR per five acres (minus one TDR per existing dwelling).[14] About 18,000 TDRs were thus created.

On subsequent occasions, the county has designated other areas, known as receiving areas, where the TDRs can be used.[15] In all receiving areas, development without TDRs is permitted up to a base zoning density. In addition, a higher optional density up to a specified maximum is available to developers who apply TDRs. Units above the base density require TDRs on a one for one basis. To date, the county has created about 12,000 units of receiving capacity, the difference between optional and base density over all receiving areas.

A limited market exists where TDRs are sold, directly or indirectly, by farm land owners to developers.[16] Prices initially fell from about $6,000 to below $3,000, recovered to about $7,000, and are now in the range of $4,500 to $5,000 each. Approximately 5,300 TDRs have been used to date.

The program is regarded by the county and others as having achieved its objective of preventing the further conversion of farms to subdivisions.

5.2.6.2. Talbot County, Maryland

Talbot County has two TDR programs.[17] The first program, created in 1989, is intended to protect environmental amenities, principally the shoreline of the Chesapeake Bay and certain interior lands. The receiving area for the program is the critical zone within a thousand feet of the Bay. If a property is eroding at least two feet per year and the developer takes steps to prevent further erosion, then, with the application of TDRs, the property can be developed at a density up to one dwelling per five acres versus the base density of one per twenty acres. One TDR is required for each optional unit.

The sending area for TDRs is an interior area where it is desired to protect plant and wildlife, drainage and park sites. TDRs were distributed in this area at the rate of one per twenty acres which is also the area's zoning density. When a TDR is sent from this area, the sending parcel can no longer be developed although it may be used for agricultural purposes.

To date, three units have been built with TDRs. Those TDRs were reportedly purchased for $40,000 to $50,000 each. The substantial price reflects the high value of a shoreline lot whose creation they permit.

The second program was created in June, 1991. TDRs were distributed in the five election districts in the Rural Agricultural Conservation Zone at the rate of one per ten acres which is the base zoning density throughout the Zone. A TDR is required for any dwelling built and the maximum density has been raised to one per five acres. However, the fixed number of TDRs limits overall development to one per ten acres. The intent is to concentrate development in some areas and to leave others undeveloped as farms. TDRs cannot be transferred across election districts.

5.2.6.3. The Pinelands, New Jersey

The Pinelands is an area of about a million acres in southeastern New Jersey recognized in federal and state statutes as containing a significant ecosystem of forests, wetlands and endangered species habitats.[18] To implement the policy of channelling development to selected growth sites, TDRs known as Pineland Development Credits (PDCs) were created in 1981. Each PDC permits development of four units above the base zoning density in the growth areas. The PDCs were distributed to landowners in the preservation and agricultural production portions of the Pinelands in return for limiting development on their lands. Two PDCs were issued per 39 acres of farmland in the agricultural production and preservation areas, one per 39 acres of nonfarmland uplands in the preservation area and 0.2 per 39 acres of wetlands in the preservation area.

A Pinelands Development Credit Bank was also established. In the early years of the program, it was a purchaser of last resort of PDCs at a statutory price $10,000. In May, 1990, it auctioned off its inventory at a price of $20,200 per PDC.

To date, approximately 100 PDCs have been used by developers.

5.2.7. Fireplace and Wood Stove Permit Trading

Many mountain communities in Colorado have historically experienced undesirable levels of particulate air pollution in the winter months because of the use of wood stove fireplaces. Increased winter populations due to resort development have worsened the problem in some of these communities.

Telluride, Colorado, one such alpine resort community, is located in a box canyon at an altitude of 9,000 feet. The local geography and meteorology produce severe inver-sions. In 1977, Telluride passed an ordinance limiting new construction to one wood stove or fireplace per unit, but air pollution from wood stoves only grew worse. In 1987, Telluride initiated a program to reduce the use of wood-burning fireplaces and stoves. Existing wood stove and fireplace users were granted an operating permit, but were asked to meet new operating standards of six grams of particulate matter and 200 grams of carbon monoxide per hour within three years. During the first two years of the three year period, fireplace and wood stove owners could earn a rebate of $750 for conversion to natural gas. An integral component of the program banned the use of wood stoves and fireplaces in new construction, unless the developer acquired two permits surrendered by existing users.

The combined effects of performance standards for existing users and a system of marketable permits to accommodate growth has yielded a 50 percent reduction in wood stoves and fireplaces in use. Offers to sell wood stove permits are advertized regularly in local papers, with current asking prices in the $2,000 range. Since the program was implemented, Telluride has not violated the 24-hour or annual particulate matter standards.

Aspen, Colorado has a rule similar to that in Telluride that limits the number of wood-burning stoves and fireplaces in each building. Anyone who wishes to exceed the limit in a building has to buy fireplace or stove rights from existing rights owners. The number of rights required depends on the geographical area where the new units are to be installed.[19]

Related programs currently operate in Vail, Crested Butte, and other alpine resort communities in Colorado.

5.3. INTER-FIRM APPROVAL TRADING

As mentioned at the beginning of this section, trading programs described in this section are characterized by the property that credits or allowances are less freely tradable. Permission of one or more governmental agencies is needed for each trade. To secure necessary permission, environmental modeling may be required and trade ratios other than unity may be set by governmental agencies. Trades may be restricted in time as well as in space.

5.3.1. Trading of Air Emissions Rights

The air emissions trading program consists of four separate activities: bubbles, offsets, banking, and netting. The components of EPA's air emission trading program were developed through regulations and policy statements issued by EPA. The various programs began independently in the mid- to late-1970s and were revised several times.[20] EPA's Final Emissions Trading Policy Statement, issued in 1986, addresses trading of criteria pollutants such as sulfur dioxide, nitrogen oxides, particulate matter and chemicals that contribute to the formation of ground-level ozone.[21] The policy responded to public comments that earlier policies could cause potential environmental damage unless new protective features were added. Such procedures, including redefining the emissions baseline and other accounting procedures, are included in the final policy.

5.3.1.1. Bubbles

The bubble program, first established in 1979, allows existing sources flexibility in meeting required emission limits by treating multiple emission points as if they face a single, aggregated emission limit. The bubble can include more than one facility owned by a firm or facilities owned by different firms, but all the affected emission points must be within the same attainment or non-attainment area.

Bubbles must be approved as a revision to an applicable State Implementation Plan (SIP). Prior to the 1986 final policy, EPA approved or proposed to approve approximately 50 source specific bubbles. In addition, 34 bubbles were approved by states under EPA authorized generic bubble rules. As of March, 1989, EPA approved or proposed to approve a number of additional bubbles[22] under the revised policy.

The pre-1986 bubbles were estimated to save $300 million over conventional control costs, with an additional $135 million saving from the state generic bubbles.[23] Estimates of the additional cost savings from the post-1986 bubbles are not available.

5.3.1.2. Offsets

The offset program was developed in 1976 to lessen the conflict between economic growth and progress towards air quality goals in areas that did not meet EPA's ambient air quality standards, referred to as nonattainment areas.[24] Without the offset policy, there was little or no opportunity to locate a major new plant or expand significantly a major existing plant ("major" generally was defined as plants emitting over 100 tons per year of one or more criteria pollutants) in areas that did not meet air quality standards. Under the offset policy, major new or modified existing sources are allowed to operate in nonattainment areas provided that they obtain offsetting emission reduction credits from existing sources. States implementing this policy have usually required new or modified existing sources to offset emissions by a factor greater than one. Under the 1990 Clean Air Act Amendments, higher offset ratios are mandated in ozone non-attainment areas.

Some 2,500 offset trades have occurred, about 10 percent of which were between firms and the rest within firms.[25] About 90 percent of all offset transactions have taken place in California, since California has applied offset requirements to smaller sources than mandated under federal law.

Some states have devised innovative offset programs. On May 8, 1991 the Albuquerque/Bernalillo County Air Quality Board adopted Regulation No. 38, which governs trading of hydrocarbon emissions between stationary sources and a variety of other sources, including gasoline vapor pressure, Stage II vapor recovery systems, and scrapped vehicles that were designed to be fueled with leaded gasoline. In Salinas, California, owners of the O'Brien cogeneration facility reached an agreement with state air quality regulators to offset the plant's emissions by buying and scrapping older vehicles registered in the Salinas-Monterrey area.

5.3.1.3. Banking

EPA's initial offset policy did not allow the banking of emission reduction credits for future use or sale. Banking was added by the offset provisions of the 1977 Clean Air Act Amendments.[26] Although the EPA has approved several banks, there has been only limited use of the provision. One report suggests that the relatively limited use of banking stems from a concern that banked emission reduction credits may be appropriated by states that need emission reductions to attain air quality goals.[27]

5.3.1.4. Netting

Netting, which dates from 1980, allows sources undergoing modification to avoid new source review if they can show that plant-wide emissions do not increase significantly.[28] Netting is the most widely used emission trading activity. Detailed information is available only for 1984. In that year, approximately 900 sources used the netting provision. One source extrapolates from this one year of data to estimate that between 5,000 and 12,000 sources have used netting since 1974.[29]

The total savings in control costs resulting from the use of netting is difficult to estimate because the number of transactions is not known precisely and the savings in individual transactions are quite variable. The savings to firms using netting arise from three sources. First, netting may allow a firm to avoid being classified as a major source, under which it would be subject to more stringent emission limits. Reductions in control costs in such a case would depend in part on the control costs and emissions limits to which the firm must adhere after netting. One source estimates that netting typically results in savings between $100,000 and $1 million per source.[30] Based on the previous estimate of the number of netting transactions, control cost savings would range from $500 million to $12 billion. Second, savings result from avoiding the cost of going through the major source permitting process. These savings could add an additional $25 million to $300 million to the estimate of total savings from netting. Third, additional savings can result from avoided construction delays due to disruptions caused by the permitting process.

Netting is designed to have no adverse effect on environmental quality. EPA regulations establish thresholds below which emission increases do not trigger new source review. Consequently, the impact of netting on air quality for individual transactions is insignificant. To the extent that large numbers of modified sources use netting in an area, there could be modest adverse impacts on local air quality.[31]

5.3.1.5. Evaluation of Air Emissions Trading Program

Quantitative estimates have consistently found air emissions trading has the potential to substantially reduce industry's cost of complying with air pollution control programs. Cost savings have been commonly estimated to be 50 percent of traditional command-and-control costs, and up to 95 percent in one study.[32] Unfortunately, as discussed in Section 2.2, the full potential cost savings predicted by the quantitative estimates have not always been realized. Nevertheless, savings from trading under the air emissions trading program probably range from $5.5 to over $12.5 billion since 1975.

The overall impact of emissions trading on air quality is likely to have been neutral. In theory, the offset ratio of greater than 1:1 ensures some reduction in pollution; however, netting may allow small increases in pollution.

5.3.2. Water Effluent Reduction Trading

At least three states, Wisconsin, Colorado and North Carolina, have established programs for trading credits for reducing water effluents.[33] The Wisconsin program, which allows point sources to trade water effluent reduction credits, has been in effect since 1981. Colorado has two programs to trade credits for rights to further reductions of phosphorus discharge into reservoirs in the Denver area: Dillon and Cherry Creek. More recently, North Carolina implemented a program that will permit trading in further reductions of nutrients released into the Tar-Pamlico Basin.

5.3.2.1. Wisconsin

The Wisconsin program was created to provide flexibility for point sources such as paper mills and municipal wastewater treatment plants to meet state water quality standards throughout the State. Sources that reduce discharges containing biological oxygen demand below permitted amounts are allowed to sell the excess reductions to other sources. The pulp and paper mill effluent guidelines suggested that substantial costs would be incurred to meet the stringent limits required to meet the water quality standards because of the large numbers of dischargers concentrated in a few miles of the state streams. Analysis showed a potential cost savings from trading of about $7 million.[34] In fact, the effuent guidelines far overstated the needed expenditures. Costs in addition to those needed to meet the national point source requirements were not incurred and with one limited exception on the Fox River no trades have yet occurred.

5.3.2.2. Dillon Reservoir, Colorado

Dillon Reservoir is the source of one half of Denver's water supply. Surrounding the Dillon Reservoir is a recreational community that grew during the 1970s and early 1980s. Four municipal treatment plants, sixteen small treatment plants, one industrial plant and numerous nonpoint sources all discharge wastes into the reservoir. All of the point sources were subject to strict discharge limits. According to analysis prepared for the EPA, the municipal treatment plants had a nutrient loading allocation that could be limiting in the near future. The municipal wastewater treatment facilities faced incremental control costs for phosphorous that were many times that of nonpoint sources, providing a rationale for trading.

In 1984 Summit County, Colorado instituted a point / nonpoint source trading program that allowed the four POTWs to meet their discharge limits by maintaining their advanced levels of control and earning additional phosphorous reduction credits for controlling phosphorous loadings from existing nonpoint sources. The system used a trading ratio between point and nonpoint sources of 2:1 to provide a margin for new growth. Recently, there have been a few trades proposed between non-point sources, something not anticipated when the program was established. Because of a slowdown in growth in the region and substantially improved point source removal efficiencies, point sources have not yet faced a significant need to trade with nonpoint sources.

5.3.2.3. Cherry Creek Reservoir, Colorado

Cherry Creek Reservoir is an important recreation area near Denver that until recently was experiencing strong development pressure and rapid population growth. In the mid-1980s, the Denver Regional Council of Governments developed a management plan to prevent eutrophication in the reservoir. The plan identified phosphorous as the critical effluent, projecting that by 1990 loadings would have to be limited in order to maintain water quality standards established by the Colorado Water Quality Commission.

The Cherry Creek trading program allows POTWs discharging into the Reservoir to earn phosphorous reduction credits through the control of nonpoint source phosphorous discharges.[35] The program requires that nonpoint sources reduce their loading by 50 percent on their own before point sources can earn credits for any reductions. Because growth has slowed, phosphorous loadings remain below established limits and trading has not materialized yet.

5.3.2.4. Tar-Pamlico Basin, North Carolina

North Carolina has designated certain areas as "nutrient sensitive waters" of the State for which management strategies will be developed. The North Carolina Department of Environmental Health and Natural Resources created what in effect is a basin-wide bubble for the Tar-Pamlico Basin. The Department gave the Tar-Pamlico Basin Association, which consists of about a dozen POTWs and one industrial discharger, an overall limit for nitrogen and phosphorus effluent. If the Association fails to meet the effluent targets in 1992 through 1995, charges will be imposed.

Upon completion of watershed modeling, the Department will establish new and probably much lower aggregate effluent limits that will have to be met by the Association. In this stage, the Association will be able to arrange for control of nonpoint effluents in lieu of controlling its own effluents further.[36] The Association members are currently creating a fund to pay for these nonpoint controls.

5.3.2.5. Steel Industry Effluent Bubble

In 1982 the U.S. Environmental Protection Agency issued point source effluent guidelines for iron and steel manufacturers.[37] One provision of the guidelines allows iron and steel plants to provide central treatment facilities for effluents originating at multiple outfalls rather than treating each effluent stream separately.

Alternative effluent limitations for individual pollutants treated under this bubbling approach are calculated by adding the total mass limits at multiple outfalls and then subtracting a net reduction amount. In the case of total suspended solids, the minimum net reduction amount is approximately 15 percent; for all other traded pollutants the minimum net reduction is approximately 10 percent.[38]

5.3.3. Wetland Mitigation Banking

Federal and state laws require developments in wetlands to minimize adverse effects on the environment. Section 404 of the Clean Water Act is the principal federal statute governing such activity. As implemented by the U.S. Army Corps of Engineers (33 CFR 320.4(r)), “mitigation is an important aspect of the review and balancing process....” Many states also impose mitigation requirements, some of which are more stringent than federal requirements. Florida's “Mitigation Rule” is illustrative. The State will accept as mitigation alternatives the creation of new marshes or the enhancement of existing marshes. Specific requirements include in-kind mitigation, monitoring for 25 years, and a replacement ratio of 2:1 for marshes that are destroyed by development.

Mitigation “banking,” a concept developed in 1981 by the U.S. Fish and Wildlife Service (FWS), attempts to simultaneously reduce the cost and increase the effectiveness of mitigation actions. Wetland mitigation banking closely parallels emission banking as developed by the U.S. Environmental Protection Agency. A mitigation bank can involve the enhancement of an already deteriorated wetland area or the creation of new wetlands through the diversion of water into an upland area. Mitigation credits (usually defined in terms of habitat units or acres) are earned by the bank and available for sale to developers to meet state-imposed mitigation requirements.

Mitigation banking is driven by four objectives: (1) availability of cost information at the beginning of the permit application process; (2) lower costs per unit of habitat improvement due to economies of scale; (3) environmental benefits from large scale preservation or enhancement efforts; and (4) greater certainty regarding the success of mitigation actions. More than 35 wetland mitigation banks currently function in at least 10 states: California, Florida, Idaho, Louisiana, Minnesota, New Jersey, North Carolina, North Dakota, Oregon, and Virginia. Several of the contending legislative proposals for reauthorization of the Clean Water Act contain provisions for wetland mitigation banking. If enacted, these proposals would extend the availability of wetland mitigation banking to the entire nation.

5.4. EMISSIONS AVERAGING

Emissions averaging to meet a standard is equivalent to emissions trading in which all trades are required to be internal to a plant or firm. Emission averaging is permitted under the emissions trading policy to meet industry-specific Reasonably Available Control Technology (RACT) standards. Perhaps the best known example of emissions averaging is the fleet averaging approach to controlling motor vehicle pollution from heavy duty truck engines. A similar proposal for averaging automobile emissions, included in the Administration's 1989 Clean Air Act reauthorization, failed to win congressional approval.

Fuel characteristics will be averaged as California implements its plan for reformulating gasoline.

5.4.1. Reasonably Available Control Technology Requirements

For years EPA has allowed RACT requirements to be met through emission averaging. In 1980, EPA allowed can coating operators to compute daily weighted average VOC emissions in conjunction with a plant-wide emission limitation for satisfying RACT requirements.[39] This so-called “cross line averaging” is available under the Agency's Emissions Trading Policy to other industrial sectors.

5.4.2. Heavy Duty Truck Engine Emissions

Title II of the Clean Air Act called for an emissions standard for nitrogen oxides that represented the maximum degree of reduction achievable, with a goal of attaining a reduction of 75 percent in the “average of actually measured emissions” from heavy duty gasoline engines. The emissions standard for particulates was to be set in a similar fashion. While vehicles and engines had to be certified on an individual engine basis, section 206(g) allowed manufacturers to comply through the payment of a nonconformance penalty sufficient to remove whatever competitive advantage they obtained from making high emitting engines. EPA's implementation of these requirements allows manufacturers to comply by averaging together the emissions performance of all heavy duty truck engines they produce.

5.4.3. California Motor Fuel Characteristics

California's program for reformulating gasoline is being implemented in two phases. Phase I, which went into effect on January 1, 1992, specifies a reduction of Reid vapor pressure to 7.8 pounds per square inch during the summer months, the complete elimination of lead, and the addition of deposit control additives. Phase II, which is to be implemented in 1996, contains specifications on the content of sulfur, benzene, olefins, oxygen, and aromatics, as well as lower vapor pressure limits.

California's implementation program allows refiners three options. Under option 1, all gasoline produced by the refiner must meet the specified limits. Under option 2, a refiner may average across batches but the average must comply with standards more strict than in option 1. Under option 3, a refiner who can demonstrate that the recipe has lower emission characteristics than the California standards can comply with a relaxed set of limits.

5.4.4. Hazardous Air Pollutant Early Reduction Program

Title III of the Clean Air Act Amendments of 1990 substantially revises existing authorities to regulate hazardous air pollutants. Section 112(i) allows firms six-year waivers of emission limits for hazardous emissions set under section 112(d). Firms must voluntarily reduce toxic air emissions by 90 percent (95 percent in the case of toxic particulates) ahead of the Act's schedule in order to qualify for the waiver. The 90 percent reduction is determined by averaging reductions across participating sources within a facility. In essence, firms are given the option of making early voluntary reductions in exchange for somewhat higher emissions, on a termporary basis, in later periods. This process can be described as emissions averaging over time. For most participating firms, average emissions will be lower under the program than without it, yet many firms are expected to participate and experience reduced control costs. To qualify, firms must commit to making the stated reduction before Maximum Achievable Control Technology (MACT) standards are proposed. Regulations implementing this provision were proposed by EPA in June 1991.[40]

The first industrial segment to benefit from this provision will be synthetic organic chemicals. MACT standards for that sector are expected to require an overall 95 percent reduction, suggesting that early voluntary efforts will be an attractive option.

Endnotes for Section 5

1. Shapiro and Warhit (1983).

2. 56 Federal Register (FR) 63002-351, December 3, 1991.

3. *Ibid*., p. 63097.

4. 57 FR 4413-48, February 5, 1992.

5. While authorized by the 1990 amendments, EPA has decided not to offer a credit program for the aromatic content of gasoline on the basis that the relevant section of the 1990 Amendments (section 211(k)) does not contain a specific numerical limit, only a performance standard for emissions (56 FR 31176, July 9, 1991).

6. 56 FR 48614, September 25, 1991.

7. 56 FR 49548-580, September 30, 1991 and 56 FR 67368, December 30, 1991.

8. U.S. EPA (1973).

9. U.S. EPA (1982), (1984), and (1985).

10. U.S. EPA (1982).

11. U.S. EPA (1985a).

12. Anderson *et al*. (1989).

13. U.S. EPA (1985a).

14. The motivation for and history of TDRs is drawn from Maryland-National Capital Park and Planning Commission (1980).

15. The designation of receiving areas is discussed in Maryland National Capital Park and Planning Commission (1990).

16. Data on prices and uses of TDRs are drawn from Montgomery County Planning Department (1991).

17. The material in this section is drawn from a telephone conversation of September 3, 1991 with Barry Griffith of the Talbot County Planning Commission.

18. The material for this section is drawn from Tripp and Dudek (1989) and from telephone conversations with Norma Milner and Lois Cristorelli of the Pinelands Commission.

19. Aspen / Pitkin Environmental Health Department.

20. See, for example, U.S. EPA (December 11, 1979; April 7, 1982; July 29, 1982; and August 31, 1983)

21. U.S. EPA (December 4, 1986).

22. Creekmore (1989).

23. Dudek & Palmisano (1988).

24. U.S. EPA (1976).

25. Dudek and Palmisano (1988).

26. U.S. EPA (1979).

27. Hahn and Hester (1989).

28. U.S. EPA (1980).

29. Hahn and Hester (1989).

30. Hahn and Hester (1989).

31. Hahn and Hester (1989).

32. Atkinson & Tietenberg (1991) and Krupnick (1986).

33. Apogee Research, Inc. (1991).

34. O'Neil *et al.* (1983).

35. Apogee Research, Inc. (1991).

36. Based on information from Glen Anderson of the Environmental Defense Fund and from Tar-Pamlico Basin Association (1991).

37. 47 FR 23284, May 27, 1982, amended at 47 FR 41739, September 22, 1982.

38. Code of Federal Regulations (CFR) section 420.03.

39. U.S. EPA (December 8, 1980).

40. 56 FR 27338-74.

6. OTHER INCENTIVES

Three other incentives that do not fit easily into the earlier sections will be discussed in this section, namely:

6.1. Subsidies and tax concessions;

6.2. Liability approaches; and

6.3. Information programs.

6.1. SUBSIDIES AND TAX CONCESSIONS

Subsidies and tax concessions provide financial payments to polluters and tax advantages based on changes in previous pollution emissions or in return for future pollution control actions. Two such programs will be described here: federal grants to municipalities for the construction of sewage treatment plants and state subsidies to businesses to encourage them to locate in a state. In Louisiana, the latter are being tied to a firm's environmental record.

6.1.1. Municipal Sewage Treatment Plant Construction Grants

The construction grant program for municipal sewage treatment plants has been in operation since 1956. Since that time, the federal government (through EPA since 1970) has awarded grants of 75 percent toward the cost of constructing municipal sewage treatment facilities. The program was funded by special congressional appropriations until the most recent reauthorization of the Clean Water Act in 1987. At that time funding for the program was changed substantially, with monies to come from a newly created (and much smaller) State Revolving Fund.

A good case can be made that although municipal sewage treatment plant construction grants involve financial payments that are likely to reduce effluents in future years, they do not meet the definition of an economic incentive provided in Section 1 because they are usually granted only to build plants in areas that do not meet water quality standards and only to bring such areas into compliance with water quality standards and requirements. On the other hand, it seems likely that through oversight or miscalculation, some plants have been built which would otherwise not have been built and which have been operated in such a way as to reduce pollution below standards and requirements.[1] The program is included despite these doubts as to whether it meets the definition of economic incentives because of its size and prominence.

6.1.2. Louisiana Tax Concessions

In December 1990, Louisiana enacted a new tax rule that ties the amount of business property taxes a firm pays to its environmental record. For the past 65 years, an important part of the State's policy for attracting industry was to exempt from local property taxes new equipment and capital expenditures for a ten year period. Under the new policy, a firm applying for an exemption or seeking a renewal of an exemption is rated on a scale according to the number of environmental violations it has received, the volume of chemicals it releases into the environment and other, related factors. The better a firm's record, the higher the score and the larger its tax exemption.[2]

Several other states have tried in recent years to use tax policy to further environmental objectives. For example, New York and New Hampshire reduce property taxes for wetlands that are protected from development. Minnesota exempts some wetlands from property taxes altogether if they are preserved from development. A case can be made that all of these efforts are really pollution control subsidies where the taxes reduced represent the actual costs of governmental services provided.

6.2. LIABILITY APPROACHES

Liability approaches provide for future payment by polluters based on the damages caused by their emissions. Liability approaches to environmental pollution control are found in a wide variety of places, ranging from tort law to a number of specific statutes.

6.2.1. Superfund

The best known of these is the Comprehensive Environmental Restoration, Compensation and Liability Act of 1980 (CERCLA), otherwise known as Superfund. This includes a number of liability provisions.

The best known provision of CERCLA creates retroactive liability for generators, haulers and disposal facility operators for the cleanup of hazardous wastes that pose a threat to human health and the environment. Another provision that is attracting increasing attention concerns liability for injury to natural resources caused by the release of hazardous substances.

6.2.1.1. Hazardous Waste Cleanup Liability

Congress passed CERCLA to address problems posed by abandoned hazardous waste sites, principally landfills. The objectives of CERCLA were to obtain rapid and effective cleanup of those sites that posed serious threats to health and the environment. Note that CERCLA cleanup liability is not intended to influence future waste disposal practices, though it could have some impact. The statute created a fund otherwise known as the Superfund financed by a combination of taxes on petroleum, petrochemical feedstocks, and general government revenues. Congress gave EPA the right to bring damage actions against potentially responsible parties to recover damage costs.

The EPA sought and won in court the right to assign strict, joint and several liability to any entity that it identified as a potentially responsible party. Thus, firms and individuals that made minimal contributions to the overall problems at a site could have liability for the entire cleanup. Firms and individuals that are identified as PRPs have the right to bring action against other entities that also contributed wastes to the site.

6.2.1.2. Natural Resource Damage Liabilities

Under provisions of CERCLA, the Department of the Interior issued rules governing assessments for natural resources damaged by spills of oil and hazardous materials. The Oil Pollution Act of 1990 directs the National Oceanic and Atmospheric Administration to promulgate separate rules for oil spills that occur after 1990. Both rules will require compensation for restoration costs plus the value of lost use.

Liability law such as CERCLA and the Oil Pollution Act of 1990 provide incentives for individuals transporting, storing and otherwise responsible for the care of a wide variety of substances to avoid accidental releases. Unlike many of the other incentives described in this paper, however, liability law generally does not result in predictable costs per unit of pollution. Nevertheless, the costs imposed may be very large. For example, liability for natural resource damages amounted to $17 per gallon in the 1990 Exxon Bayway incident, $23 per gallon in the 1989 Shell Martinez release, and about $82 per gallon in the 1989 Exxon Valdez grounding. Petroleum and chemical companies have responded in a variety of ways, including changes in tanker design and operating procedures and creation of the Marine Spill Response Corporation for rapid response to oil spills (at a projected five year cost of $900 million to the industry).

6.2.2. Other Statutes Providing for Environmental Liability

Many of the federal pollution control statutes make certain polluting activities subject to prosecution as a civil offense. Civil and criminal penalties for disregard of statutory obligations can include fines and imprisonment of responsible individuals. To the extent that such penalties are proportional to the emissions for which they are imposed, they can be regarded as economic incentives.

State legislatures have been active in creating liability for certain polluting activities. Many states have superfund statutes similar in structure to the federal program. Several states have enacted provisions for compensation to the state as trustee for injuries to natural resources caused by releases of hazardous substances. Most, if not all, states also have established penalties for individuals caught littering.

6.2.3. Tort Law

In principle, tort law is designed to identify the cause of harm, identify who was responsible for the harm and quantify how much harm was caused to particular victims. Through the payment of monetary compensation, those responsible for causing harm should bear the full costs of their actions. For a variety of reasons, however, tort law for environmental harm does not and probably cannot approach these objectives.

Under tort law, plaintiffs alleging injuries from pollution must establish that the defendant's actions were more likely than not the cause of the harm. Plaintiffs may receive full compensation if they can establish the probability is over 50 percent that the defendant caused their harm, yet they receive nothing if the probability is under 50 percent that they were harmed by the defendant. Because most harms caused by pollutants in the environment have more than one possible origin, and often have long lags between the polluting activity and the onset of any disease, satisfying the more likely than not test normally is difficult. Nonetheless, in some jurisdictions plaintiffs have received large awards through tort litigation.

6.2.4. Effectiveness of Liability Approaches

In practice, CERCLA liability has resulted in the rapid and effective cleanup of far fewer sites than originally envisioned. Largely this is attributable to extensive litigation by the private sector over the apportionment of liability and the proper cleanup remedy. Further adding to the overall costs of the program are extensive subsidiary cost recovery actions by responsible parties against their insurers. Since cleanup liability focuses largely on past activities, which may have been perfectly legal at the time, it is debatable whether it has any prospective incentive effect. In other words, how likely is it that CERCLA causes the current level of care in hazardous waste disposal to exceed what presently is required by law?

The uneven and unpredictable nature of tort awards, along with high transactions costs and long lags between polluting activities and subsequent litigation, suggest that tort law does not provide the correct price signals concerning the damage caused by pollution.[3]

6.3. INFORMATION PROGRAMS

Information approaches provide for publicly available data on emissions or exposures furnished by polluters. Two significant programs whose disclosure requirements are designed to provide incentives for firms to reduce human exposure to toxic substances are described here: California's Proposition 65 and Title III of the Superfund Amendments and Reauthorization Act.

6.3.1. Proposition 65

California adopted Proposition 65, known formally as the Safe Drinking Water and Toxic Enforcement Act of 1986, by initiative in the November 1986 election. The Act's approach to the regulation of toxic chemicals is fundamentally different from that of other state or federal law. Rather than the traditional approach of setting standards to which the regulated community must adhere, the Act shifts the burden of determining what is acceptable to that community.[4]

Once a chemical is listed by the Governor as a carcinogen, firms may not expose any individual to these chemicals without providing a clear and reasonable warning. Warnings are displayed on alcoholic beverages and tobacco and industry is quietly coming into compliance on other products. Firms also must comply with the Act's prohibition on discharge of the listed chemicals into drinking water sources. A landmark “bounty hunter” provision allows citizens to bring enforcement actions and receive 25 percent of any fines assessed against violators.

6.3.2. SARA Title III

Users and producers of hazardous chemicals have long been required by federal law to comply with applicable regulations aimed at protecting human health and the environment. The 1986 Emergency Planning and Community Right-to-Know Act (SARA Title III) added new requirements for emergency planning and for disclosure of information on the use and release of hazardous chemicals. The disclosure requirements were viewed by Congress as a powerful stimulus, through their effect on public attitudes, shaping company behavior.[5]

At the time SARA Title III requirements were enacted, there was little hard evidence as to how companies would respond to information disclosure requirements—other than disclosing the required data on production and use of specified chemicals. A retrospective study of eight firms, conducted by The Center for Environmental Management at Tufts University[6] found that for that sample SARA Title III disclosure requirements provided a powerful incentive for companies to identify and act upon opportunities for reducing accidental and routine releases of hazardous chemicals.

Endnotes for Section 6

1. The Congressional Budget Office (1985 and 1988), among others, offers critical re-views of the wastewater treatment program.

2. The Louisiana program is summarized by Glenn (1992). The program was terminated by Governor Edwards in 1992.

3. A good summary of this can be found in Menell (1991).

4. See Draper and Johnson (1989) and Larson *et al*. (1992) for more details.
5. Ramonas (1989).
6. Baram *et al*. (1990).

7. NEW INCENTIVE SYSTEMS PROPOSED BUT NOT YET ADOPTED

This section describes two incentive mechanisms that are likely to be implemented: one is very close to being implemented in the South Coast Air Basin of California; the second was recently proposed by the Administration.

7.1. SOUTH COAST AIR BASIN MARKETABLE PERMITS PROPOSAL

Although numerous urban areas in the United States currently exceed the federal ozone limit, California's South Coast Air Basin has the country's highest ozone level. Under the Clean Air Act Amendments of 1990, the Basin has until 2010 to reduce its current peak concentration of over 0.28 parts per million to the federal ozone standard of 0.12 ppm. As regulations imposed to reduce ozone pollution have become more onerous to more sources, the need for cost-effective methods of improving air quality has become more pressing. Title I of the 1990 Amendments encourages states to develop marketable air emissions permit schemes as a cost-effective mechanism for improving urban air quality.

The South Coast Air Quality Management District (SCAQMD or District) recently proposed a marketable air emissions permits program for sources emitting the ozone precursors NO_x and Reactive Organic Gases (ROG).[1] The District is considering adding sulfur dioxide emissions to the trading proposal. Sources will be allowed to satisfy emission reduction requirements by one of three means: additional emission controls, the use of reformulated products, or acquiring excess emission credits from other sources. Emission reduction requirements will be expressed as mass emission limits, not equipment or process specific concentration limits. Mass emission limits will decline over time for all emission sources.

Termed RECLAIM, for Regional Clean Air Incentives Market, the program will begin with ROG and NO_x emissions from stationary sources that hold permits for greater than or equal to four tons annually. The ROG market will encompass about 2,000 sources with about 85 percent of permitted emissions and the NO_x market approximately 700 sources with 95 percent of permitted emissions. Air toxics will not be included in the plan and trading between ROG and NO_x will not be allowed.

The proposal contains several exemptions. Some facilities such as dry cleaners, restaurants and service stations would be controlled through command-and-control rules. The District intends to evaluate the feasibility of including in the market sources that emit less than four tons per year in a second phase. When it appears to be more cost-effective to regulate small sources through source specific rules, small sources may be exempted from the market.

The initial baseline for emission reduction is important and several alternatives are being evaluated. ROG sources will have to reduce emissions approximately five percent per year from the initial baseline. For the years 2000 to 2010, a second annual rate of reduction will be determined by the SCAQMD. NO_x sources will have to reduce their emissions by approximately eight percent per year relative to their initial baseline.

Facilities operating under the RECLAIM program will have a facility-wide permit that identifies all sources at the facility. Each facility will be given a mass emissions limit for each of the next ten years covering the collective emissions from all facility sources (*i.e.*, each facility will have a facility-wide "bubble" permit). The facility permit will be amended whenever a facility engages in an external trade.

RECLAIM contains provisions to assure compliance as well as procedures for monitoring emissions. While the District does not intend to specify the structure of the market in which trading will take place, it will record all transactions in credits and disseminate information to participants. Trade in credits will be constrained by geography and season, but final details of such rules have yet to be developed.

Significant cost savings are anticipated through RECLAIM relative to a command-and-control approach. Compliance costs for the air quality management plan that otherwise would be in place are estimated at $660 million for 1994. In comparison, RECLAIM is expected to require compliance costs of $223 million in that same year, or a saving of $437 million.

7.2. SCRAPPING OLDER VEHICLES

In March 1992, the Administration unveiled plans to reduce pollution control costs by increasing the scrapping of old, high-polluting vehicles. While details of the program have yet to be fully worked out, the plan would grant pollution reduction credits to companies that bought and scrapped older automobiles. The credits could be applied toward pollution reductions that the sources would otherwise have to make. In terms of the classifications used in Section 5, the program would create a system of approval credits.

Certain design features remain to be resolved.[2] One issue concerns the years of remaining life and the extent of future use of the vehicle that should be assumed in the credit calculation. A second design issue is what should be assumed as the pollution per mile of use. Is it the same for all older vehicles (if so, what), or does it vary from vehicle to vehicle based on some observable characteristics? A third design issue is how to control the migration of older vehicles into an area where above-market prices are offered.

In 1990, the Unocal Corporation bought and scrapped 8,400 pre-1971 vehicles operating in the Los Angeles area.[3] According to Unocal estimates, the cost per ton for removing hydrocarbons was approximately $7,000. Such an expenditure is cost effective in Los Angeles and other areas where the incremental costs of pollution control already are high.

Endnotes for Section 7

1. South Coast Air Quality Management District (1992).

2. Schoeer (1991).

3. Unocal (1991).

8. SOME OTHER INCENTIVES THAT HAVE BEEN SUGGESTED

There have been a wide variety of other incentives suggested over the years. Many of them have been proposed in the form of bills introduced into the United States Congress.[1] In addition, two recent reports include particularly comprehensive sets of possible incentives. They will be summarized in this section.

8.1. EPA ECONOMIC INCENTIVES REPORT

At the request of EPA administrator Reilly in early 1989, the Economic Incentives Task Force began an investigation of new ways incentives could be used to improve environmental protection. The March 1991 Task Force report entitled *Economic Incentives: Options for Environmental Protection*[2] identified four broad areas where economic incentives might be applied: municipal solid waste management, global climate change, water resource management, and multi-media concerns.

Within the area of municipal solid waste management, the report noted volume-based pricing of municipal waste collection, fees on new tire sales to fund collection and tire recycling programs, deposit-refund systems for lead-acid batteries, a credit system of a deposit-refund system for used oil, beverage container deposit systems, incentives for yard waste composting, and a recycled content standard for newsprint. Under the topic of global climate change incentives, the report mentioned a carbon fee, international trading of greenhouse gas emission rights, demand side bidding and least-cost planning in the provision of electricity, and a fee on gas guzzling automobiles with rebates for gas sippers. Among possible water resource incentives the report discussed the marginal cost pricing of water, a deposit system for pesticide containers, and reduction in federal subsidies for coastal development. The report reviewed several potential multi-media incentives: fees on VOC emissions from major stationary sources, fees on VOC emitting consumer products, a deposit system for chlorinated solvents, labeling for "environmentally responsible" products, marketable permit or surcharge systems for lead, fees on releases reported under SARA Title III, a reduction in federal subsidies that encourage virgin material use, and changes in federal procurement policy.

8.2. THE PROJECT 88 REPORT

Sponsored by Senators Heinz of Pennsylvania and Wirth of Colorado, a group of public policy scholars prepared a report identifying thirty-six proposals for "innovative solutions to major environmental and natural resource problems."[3] Several of these proposals would rely on economic incentive mechanisms, including:

A national market for CO_2 offsets;
Internationally marketable permits for greenhouse gases;
Marketable permits for potential ozone depleters;
Marketable permits for stationary sources of primary air pollutants;

Emission charges for mobile sources of air pollution;
Marketable permits for SO_2 and NO_x;
Taxes on low fuel economy vehicles with rebates for fuel efficient vehicles;
Marketable permits for point and nonpoint sources of water pollution;
Taxes on certain pesticides; and
A deposit-refund system for containerizable hazardous wastes.

Round II of the Project 88 Report[4] evaluates in detail implementation issues regarding three broad areas where incentives might be applied: global climate change, solid and hazardous waste management, and natural resource management.

Endnotes for Section 8

1. For a summary of current pending bills introduced in the 102nd Congress, see U.S. EPA (November 1991).

2. U.S. EPA (March 1991).

3. Wirth and Heinz (1988).

4. Wirth and Heinz (1991).

9. FOREIGN EXPERIENCE WITH INCENTIVE SYSTEMS

A number of economic incentives have been implemented to control pollution in foreign countries. It is beyond the scope of this report to provide a detailed description of each of these incentives, but this section contains an overview of charges, deposit-refund systems, subsidies, product labelling schemes, and marketable permit systems used as environmental policy instruments outside the United States for the purpose of providing perspective on the U.S. experience. Although this section in general does not include economic instruments that have been proposed but not adopted, it does describe a few proposals whose acceptance appears imminent. The incentives are under the same general headings as in earlier sections.

9.1. FEES, CHARGES, AND TAXES

An effluent charge is a fee based on the quantity and / or quality of pollutants discharged into the environment. A user charge is a fee paid in exchange for collection or disposal of pollutants. The terms “charge,” “fee,” and “tax” are used interchangeably throughout this section on foreign experiences with incentives.

9.1.1. Waste

Almost all industrialized countries impose charges on the disposal of waste, but since most of these charges are relatively low and / or independent of the quantity of waste generated, they are intended not to influence waste generators' behavior but to finance waste handling.

Belgium and Denmark have levied charges on solid waste disposal. The magnitude of the Belgian charge depends on the type of waste and the manner in which it is treated.[1] Denmark recently raised its charge from 40 DK ($6) to 130 DK ($19) per metric ton.[2] Until 1988, the Netherlands levied charges on companies that stored, treated, or disposed of chemical waste. However, these and other charges were replaced in 1988 by the Netherlands' general product charge on fuel.[3]

In 1989, Austria introduced a charge on the disposal and export of hazardous and non-hazardous wastes. The magnitude of the charge is 40 S ($3.2) per metric ton for non-hazardous waste and 200 S ($16) per metric ton for hazardous waste.[4] It is not known whether this charge has a significant incentive effect. Numerous German states have imposed charges on the generation, collection, or disposal of hazardous or non-hazardous wastes. As is the case in Austria, it is unclear whether the waste taxes have influenced generators' behavior. However, the German state of Baden-Württemberg's tax on hazardous waste generation of 50 DM ($29) to 150 DM ($87) per metric ton appears to be high enough to encourage waste reduction. Baden-Württemberg plans to double this tax in 1993.[5]

In 1987, the Netherlands imposed a charge on the disposal of manure in an effort to reduce acid and phosphate pollution caused by manure. Individuals are permitted to dump the manure equivalent of 125 kg of phosphate per hectare per year free of charge. Those who dispose of 125 kg to 200 kg of manure per hectare per year must pay a charge of 0.25 f ($0.13) for every kg over 125 kg. Quantities above 200 kg per hectare per year are subject to a fee of 0.5 f ($0.25) per kg.[6]

9.1.2. Air

In France, emissions of hydrochloric acid, sulfur-containing compounds, and nitrogen oxide-containing compounds are taxed at 150 francs ($25) per metric ton. Combustion facilities with a maximum thermal power of at least 20 megawatts, burning sites for household garbage with a capacity of at least three metric tons per hour, and installations that emit more than 150 metric tons per year of sulfur-containing compounds, nitrogen oxide-containing compounds, hydrochloric acid, non-methane hydrocarbons, solvents or other volatile organic compounds are subject to the fees.[7]

Sweden plans to impose taxes on sulfur and nitrogen dioxide emissions. The sulfur tax is imposed on sulfur in oil, coal, and peat. Strictly speaking, this tax is a product charge on sulfur in fuel, but since facilities can receive refunds of the tax by using emissions control equipment, the tax is in effect imposed on emissions. Nitrogen dioxide emissions will be subject to a tax of 40 SEK ($6.3) per kg by January 1992. Only furnaces with an annual production of 50 GWh (gigawatt-hours) or more will be subject to the nitrogen dioxide tax.[8]

Like Sweden, Portugal taxes sulfur dioxide and nitrogen oxide emissions. It also taxes emissions of volatile organic compounds. Japan taxes sulfur oxide emissions.[9]

9.1.3. Water

Water effluent charges have been levied in Australia, Belgium, France, Germany, Italy, the Netherlands, Spain, and the United Kingdom.[10] In addition, almost all industrialized countries levy water user charges.[11] Water effluent and user charges are primarily used to fund water policy measures rather than to discourage water pollution or use.

9.1.4. Noise

France, Germany, Japan, the Netherlands, Sweden, Switzerland, and the United Kingdom have levied fees on noise emissions from aircraft. The Netherlands began imposing fees on noise emissions from industrial sources in 1983, but these and other fees were replaced by a general fuel charge in 1988.[12] An OECD report notes that most of these charges have little incentive effect and are intended to raise revenue to finance noise abatement measures. According to this report, noise pollution is one of the few areas of environmental policy in which the use of economic incentives is declining. However, noise fees remain in effect at approximately 30 European airports and at most civil airports in Japan.[13] Moreover, Germany intends to modify its tax on cars so that this tax is positively related to noise emissions.[14]

9.1.5. Product Charges

Product charges, fees or taxes imposed either on a product or some characteristic of that product, have been levied in several industrialized countries. Although some of these product charges may discourage consumption, many of them are intended to finance the proper disposal of the products after their use. Charges have been imposed on various products, including batteries, beverage containers, building materials, chlorofluorocarbons, fertilizer, lead, lubricating oil, pesticides, plastic bags, sulfur, and tires.

Product charges have been imposed on batteries in Italy, Norway, Sweden, Switzerland, and the Canadian province of British Columbia. In Italy, for example, vehicle batteries are subject to a charge of 1,900 lire ($1.5) and other batteries to a charge of one percent of their price. The revenue funds the collection of used batteries.[15]

Various types of beverage containers have been taxed in Denmark, Finland, Germany, Italy, Norway, Sweden, and Taiwan. In several of these countries, charges on one-way beverage containers are intended to promote container deposit systems. As described below, some of these charges, such as the plastic container charge in Italy and the bottle charge in Taiwan, are used to fund the recycling of used containers.

Denmark levies a fee of 5 kroner ($0.75) per cubic meter on gravel and sand. The purpose of this charge is to encourage recycling of building materials.[16] Denmark also imposes product charges on chlorofluorocarbons (ozone-depleting chemicals), disposable tableware, and light bulbs.[17]

Product charges have been imposed on fertilizer in Austria, Finland, Norway, and Sweden. Austria's charge, which was introduced in 1986, is regarded as low, but it has resulted in a 20 percent decrease in fertilizer use.[18]

New Zealand levies on fee of NZ$0.066 ($0.039) per gram on lead added to gasoline.[19] The effect of such a fee is similar to that of preferential taxation of unleaded gasoline described below.

Lubricating oil is subject to product charges in Finland, France, Italy, and Spain. Finland, for example, levies a fee on lubricants of 0.25 FIM ($0.06) per kg.[20] This and other product charges on lubricants have little incentive effect, but they provide funds for used oil collection.

Fees have been levied on pesticides in Denmark, Finland, Norway, and Sweden. In Denmark, for example, pesticides sold in small containers are subject to a 20 percent product charge.[21]

Italy levies a tax of 100 lire ($0.077) on plastic bags that are less than 90 percent biodegradable. An OECD report notes that since this tax is about five times as high as the cost of manufacturing taxable plastic bags, it is likely to have a significant incentive impact.[22]

Norway imposes a fee on the sulfur content of oil.[23] Sweden has a similar sulfur charge, but since refunds of the charge are available if emissions are controlled, this charge is regarded as an emissions tax and is discussed above.

Product charges have been imposed on tires in Taiwan and in the Canadian provinces of British Columbia and Ontario. These charges fund tire collection projects.[24]

Finland, the Netherlands, Norway, and Sweden have imposed carbon taxes, product charges on fossil fuels based on their carbon content. For example, Finland imposed a fuel tax of FIM 24,5 ($5.8) per metric ton of carbon.[25] Denmark, Germany, and Japan also plan to introduce carbon taxes. The purpose of these taxes is to reduce the buildup of carbon dioxide in the atmosphere.

Another form of product charge adopted in several countries is preferential taxation. Canada, Singapore, and most European countries tax leaded gasoline at a higher rate than unleaded gasoline. In Austria, Denmark, Finland, Germany, Greece, Japan, the Netherlands, and Norway, motor vehicles are taxed according to their air pollution characteristics. “Cleaner” vehicles receive preferential taxation. Germany's tax on cars is also positively related to cars' noise emissions.[26] Japan grants preferential taxation not only to cleaner cars but also to various pollution abatement facilities and low polluting products.[27] According to an OECD report, the fact that sales of clean cars have exceeded expectations in some countries could be attributed to preferential taxation.[28]

9.2. DEPOSIT-REFUND SYSTEMS

Perhaps the most common application of deposit-refund systems is the management of beverage containers, which are subject to refundable deposits in a number of countries. Some beverage container deposits are levied voluntarily by industry. The types of containers and beverages for which deposits are used vary from country to country. Deposits have been used for glass and plastic containers and for beverages such as beer, soft drinks, milk, liquor, and wine. The percentage of containers returned for reuse is approximately 90 percent in Finland, 70-90 percent in Norway, 80 percent in the Netherlands, and 90 percent in Sweden. Although deposit payments on soft drink and beer containers are lower than deposits on other containers, the percentage of containers returned is higher for soft drinks and beer. This suggests that the magnitude of the deposit relative to the retail price of the beverage could be a more important determinant of incentive effect than the absolute magnitude of the deposit.[29]

Sweden's refundable deposit on aluminum beverage cans provides evidence of the incentive effect of deposits. After a deposit of ECU 0.04 ($0.048)[30] was imposed on cans in 1983, the percentage of cans returned was 60-70 percent. After the magnitude of the deposit was doubled in 1987, the percentage of cans returned increased to over 80 percent.

Norway and Sweden impose deposits on car hulks. In both countries, the initial deposit is lower than the refund. In Norway, where the deposit was ECU 130 ($156) in 1988, over 90 percent of cars are returned. In Sweden, where the deposit was ECU 35 ($42) and the refund ECU 42 ($50), the percentage of cars returned was under 50 percent. According to an OECD report, a large number of Swedish motorists did not return their cars because their spare parts and scrap were worth more than the refund. To encourage more motorists to return their vehicles, the government recently raised the deposit and the refund.[31]

Deposits have been considered for a number of other goods, but few of these have been implemented. However, Austria recently introduced a deposit system for certain types of lamps.[32]

9.3. TRADING SYSTEMS

The use of marketable permits in environmental protection is more common in the United States than in other industrialized countries. Marketable permit systems have been studied in Europe, but few have been implemented. However, Germany has a marketable permit system for air emissions. The establishment of new sources of air emissions is in most cases prohibited in areas where air quality is especially poor, but firms may build new facilities if air pollution from nearby existing sources is reduced so that combined emissions in the area are lower after the construction of the new facility. Under the system, firms emitting air pollutants can negotiate to determine who will reduce emissions. Under another marketable permit scheme in Germany, a firm seeking to renovate a facility can receive an exemption from the requirement to obtain a renovation license if it and nearby polluters can achieve a significant reduction in combined emissions.[33]

9.4. OTHER INCENTIVES

9.4.1. Subsidies

Various industrialized countries subsidize activities that are thought to protect the environment. Such subsidies, which include grants, soft loans, and tax allowances, are often financed by charges such as those described above. For example, Italy's aforementioned product charges on batteries, plastic beverage containers, and lubricating oil are used to fund the otherwise unprofitable activities of collecting used batteries, plastic containers, and oil. The difference between the cost of collecting these used products and their reuse value is covered by product charge revenue.[34] Several other countries, including Finland, France, and Spain, use product charges on lubricants to fund used oil collection.[35] Taiwan uses taxes on bottles and tires to fund the collection and reuse of these products.[36]

The United Kingdom uses subsidies to encourage farming practices that minimize nitrate pollution of water. In ten areas with high concentrations of nitrate in water, farmers who alter their use of land and fertilizer qualify for payments of 55-95 pounds ($32-56) per hectare per year. The payment farmers receive depends on the earnings they forgo to adopt the environmentally friendly land and fertilizer use practices suggested by the government. Those who take arable land out of production qualify for additional compensation, the magnitude of which depends on factors such as the amount and location of the land. Farmers are not required to participate in this scheme, but most have chosen to do so.[37]

Another economic incentive that could be considered a subsidy is preferential taxation. Examples of preferential taxation are presented above in the section on product charges.

9.4.2. Product Labelling

The role of product labelling in environmental policy is to inform consumers of the influence of products on the environment. Products that are believed to have environmental advantages could bear labels indicating that they are environmentally friendly. Products that are thought to be harmful to the environment could bear labels indicating that they are environmentally unfriendly.

Canada, Finland, France, Germany, Japan, Norway, and Sweden practice environmental product labelling. These labelling systems vary in extent and in criteria used to determine products' environmental friendliness. Austria, the Netherlands, and New Zealand are developing environmental labelling systems.[38] Under Germany's Blue Angel labelling system, which was started in 1978, about 3,500 products, including non-CFC spray cans and retread tires, have received an environmental label of approval.[39] Under France's labelling system, which was introduced in 1991, products are being evaluated based on energy use, waste generation, and pollution during their entire life cycle. The first products to be considered for labelling are batteries, paints, varnishes, insulation, and plastic garbage bags.[40]

9.5. CONCLUSIONS

A few general observations can be made on the use of economic incentives in environmental management outside the United States:

Charges tend to be revenue-raising instruments with little incentive impact. The lack of incentive impact of charges is due primarily to their low magnitude. Another reason is that some charges are not closely linked to waste generation or product consumption. However, a number of the charges described above appear to have significant incentive effects.

The United States to some extent differs from other countries in its mix of economic instruments. For example, the United States uses many more marketable permit systems than other countries, but it uses much less environmental labelling.

Official interest in economic instruments appears to be increasing both in the United States and in other countries. Six countries have official task forces studying the feasibility of economic instruments, and a number of countries have stated that they plan to increase their use of economic instruments.[41]

Endnotes for Section 9

1. Organization for Economic Cooperation and Development (hereafter referred to as OECD) (1989), p. 45.

2. OECD (1991), p. 7. Unless otherwise stated, national currencies are converted into U.S. dollars at the exchange rates of August 23, 1991, as listed on page C-17 of the *Wall Street Journal* of August 26, 1991.

3. OECD (1989), p. 45.

4. OECD (1991), p. 5.

5. *Landesabfallabgabengesetz*, Article 4.

6. *International Environment Reporter* (hereafter referred to as *IER*), Vol. 14, June 19, 1991, p. 350.

7. Decree 90-389, May 11, 1990; *Arrêté du 11 mai 1990 relatif à la taxe parafiscale sur la pollution atmosphérique*.

8. OECD (1991), pp. 18-19.

9. de Savornin Lohman (1991), Annex Table 3.

10. OECD (1991).

11. OECD (1989), p. 51.

12. *Ibid*., pp. 47-49.

13. OECD (1991a), pp. 33-35.

14. OECD (1991), p. 11.

15. *IER*, Vol. 14, February 13, 1991, p. 71.

16. OECD (1991), p. 7.

17. de Savornin Lohman (1991), Annex Table 6.

18. *Ibid*., p. 5.

19. *Ibid*., p. 15.

20. Lohof (1991), p. 38.

21. OECD (1991), p. 7.

22. OECD (1989), p. 58.

23. OECD (1991), p. 16.

24. *IER*, Vol. 13, January 1990, p. 5; *IER*, Vol. 14, January, 16, 1991, p. 32.

25. OECD (1991), p. 8.

26. *Ibid*., p. 11.

27. *Ibid*., p. 13.

28. OECD (1989), p. 116.

29. *Ibid*., p. 87.

30. The magnitude of this deposit is expressed in ECU (European Currency Units) because the source of this information, OECD (1989) expresses monetary values in this currency. All monetary values in this report expressed in ECU were taken from this report. The ECU rate of exchange used in this report, $1.2 per ECU, is that of August 26, 1991.

31. OECD (1989), pp. 82-87.

32. OECD (1991), p. 5.

33. OECD (1989), pp. 97-98.

34. *IER*, Vol. 14, February 13, 1991, p. 71.

35. Lohof (1991), p. viii.

36. *IER*, Vol. 13, January 1990, p. 5.

37. *IER*, Vol. 14, June 19, 1991, pp. 346-347.

38. *IER*, Vol. 14, June 19, 1991, p. 332.

39. U.S. EPA (1991), pp. 5.23-5.24.

40. *IER*, Vol. 14, February 27, 1991, p. 112.

41. de Savornin Lohman (1991), p. 7

10. CONCLUSIONS

At least 40 different economic incentive mechanisms are currently being used in the United States. They are being used at many levels of government from individual towns to the Federal Government. Some of them have multiple applications in different states or cities. Although it would be desirable to to be able to summarize the cost savings from their use, the financial consequences to individual economic sectors, and the environmental effects of each of these mechanisms, the available evidence provides significant information only on the cost savings.

Over 20 quantitative comparative studies have been done, all of which indicate that economic incentives should be much more economically efficient than command-and-control approaches for controlling environmental pollution. The differences in efficiency are quite large, but it must be kept in mind that some studies have concluded that the cost savings actually realized fall well short of the potential indicated by these comparisons. There is very little evidence available on the environmental effects of economic incentives. Although incentives are being increasingly used, they have not always been implemented in the ways advocated by economists. Not surprisingly, therefore, the results have sometimes fallen short of what economists hoped for. A review of the principal types of incentives suggest several reasons for this result.

Revenue goals have been the principal driving force behind many of the charge-based incentive mechanisms. Fees and charges, with few exceptions, have not been set equal to marginal treatment cost, let alone the theoretically more defensible and generally higher values determined by the marginal damages the pollution causes. In other words, fees and charges generally have been too low to have a true incentive effect. In situations where fees and charges approximate marginal treatment cost, surprisingly little analysis exists concerning their impact. Areas where such analysis could be productive include (1) the impact of state effluent discharge permit fees that vary by toxicity and volume, (2) the impact of POTW user fees on industrial users' discharge, (3) the impact of existing pricing mechanisms for commercial and industrial generators of solid and hazardous waste, and (4) further studies on per-can pricing of household waste.[1]

Among the market-based trading systems with which there is experience, only the lead phase down example can be termed a full success. Other emission and effluent trading systems are subject to severe regulatory constraints that have raised barriers to trading. With the exception of lead trading, actual cost savings have fallen far short of originally projected amounts. If, as seems likely, the United States will rely heavily in the near future on market-based trading of pollution reduction credits or allowances, this suggests the importance of assuring that unnecessary constraints are not imposed in future applications.

Deposit-refund systems are used for several products at the state level and in Europe. Beverage container deposits appear to be effective in reducing litter. With the exception of beverage container deposits, however, there is only limited knowledge of impact and virtually no analysis of costs and benefits.

Several programs that act solely to provide information appear to be having great impact. Many firms have made public announcements of a corporate commitment to reduce pollution voluntarily in response to reports filed under SARA Title III. One attractive feature of information requirements is that response is highly flexible; corporations are free to do nothing or to seek pollution reductions as they see fit. Where pollution reduction can be achieved at reasonable cost, many corporations see it in their self interest to make those efforts.

Liability mechanisms can and do act as incentives. Structuring liability rules to internalize the cost of pollution, without deviating from this objective by a wide margin, may be difficult to accomplish, if the experience with natural resource damage assessment is any guide.

Finally, a review of the use of economic incentives outside the United States suggests a somewhat different mix of incentive mechanisms but somewhat similar conclusions as to their effectiveness and efficiency as in the United States. The United States uses many more marketable permit systems than European countries, but much less environmental labelling. Although charges and fees are used more widely in Europe, they also tend to be revenue-raising instruments with few incentive impacts, as in the United States. The lack of incentive impact of charges is due primarily to their low magnitude and because a number of the charges are not closely linked to waste generation or product consumption. As in the United States, however, official interest in economic incentives appears to be increasing in Europe.

Endnotes for Section 10

1. It should be noted that the EPA Office of Water is examining effluent fees and various pollutant trading systems to support the Clean Water Act reauthorization process.

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APPENDIX B. ECONOMIC INCENTIVE ASPECTS OF THE CLEAN AIR ACT AMENDMENTS OF 1990

The Clean Air Act Amendments of 1990 include provisions in all major air quality programs. This Appendix will briefly summarize these provisions by Title,[1] with emphasis on those not discussed in the text of the report; where they are discussed in the text, references will be given to the sections involved.

Title I of the Amendments concerns the attainment of National Ambient Air Quality Standards (NAAQSs) for criteria pollutants. Incentive mechanisms appear in several places within this Title. First, sections 110(a)(2) and 172(c)(6) provide general authorization for states to use economic incentives as part of their air quality plans.

Second, section 182(g)(4) mandates the use of incentive-based programs in extreme ozone and serious carbon monoxide nonattainment areas that fail to meet applicable air quality milestones or certain other requirements. Incentive programs are optional in other areas. In developing its guidance under section 182(g)(4), EPA intends to define incentive programs very broadly—to include permits, subsidies, public awareness and education programs, and transportation control measures. Further, in addition to addressing situations where the use of incentive programs is mandated, this guidance will encourage the discretionary use of incentive programs by states as an integral part of their air quality plans. The South Coast Basin Marketable Permits Proposal (described in Section 7.1 of this report), is one of many discretionary economic incentive programs currently being developed around the country.

Third, section 183 of Title I gives EPA explicit authority to consider the use of economic incentives, including marketable permits and auctions of emission rights, as one of its regulatory options for reducing emissions from consumer and commercial products. EPA is currently exploring this option.

Finally, section 185 of Title I pertains to the use of emission fees in severe and extreme ozone nonattainment areas that do not meet attainment deadlines. Severe ozone nonattainment areas are given 15 to 17 years to attain the ozone NAAQS; extreme areas (currently just California's South Coast Air Quality Management District) are given 20 years. Failure to attain by these schedules will subject major stationary sources in these areas to fees on VOC emissions. These fees are set by statute at $5,000 (as adjusted for inflation) for each ton of VOC emitted that exceeds 80 percent of a baseline quantity. (A more detailed discussion of this provision can be found in Section 3.4.2 of this report).

Title II tightens mobile source tailpipe emission standards and provides for the development of new and reformulated fuels. Incentive mechanisms appear as marketable credits for fuel characteristics (described in Section 5.2.2 of this report) and a California pilot program for clean fuel vehicles and clean alternative fuels which allows credits for companies that exceed their requirements (described in Section 5.2.3). Title II also includes a marketable credit program for certain vehicle fleet operators who exceed requirements for the use of clean fuel vehicles.

Title III substantially revises existing authorities to regulate hazardous air pollutants. Section 112(i) allows firms to obtain six-year waivers of emission limits for hazardous emissions set under section 112(d). (For a more detailed discussion, see Section 5.4.4 of this report.) Section 112(g) concerns hazardous air pollutant sources that undergo modifications that result in increased hazardous air pollutant emissions. Such sources may avoid new source review and its tighter standards by offsetting these emissions "by an equal or greater decrease in a more hazardous pollutant."

Title IV establishes a market-based acid rain control program, under which coal-fired electric power plants will greatly reduce their sulfur dioxide emissions (see Section 5.2.1. of this report).

Title V mandates that requirements of the Act be listed in state-issued permits specific to individual sources. Permits will cost at least $25 per ton, providing some incentive effect. Additionally, the identification of Clean Air Act requirements in individual permits will facilitate permit review and make possible greater use of other incentive mechanisms.

Finally, Title VI provides for the transfer of production allowances for chlorofluorocarbons (see Section 5.2.4 of this report).

Endnotes for Appendix B

1. For a more complete description of the economic incentives under the Act, see Elman (1992). For a description of the Agency's strategy for implementation of these incentives, see U.S. EPA (1991).