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THE UNITED STATES EXPERIENCE WITH ECONOMIC INCENTIVES IN ENVIRONMENTAL POLLUTION CONTROL POLICY

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EXECUTIVE SUMMARY

In the past several years, economic incentives have assumed a prominent position among the tools for environmental management. Nowhere is this role 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.

As other key environmental statutes such as the Clean Water Act and the Resource Conservation and Recovery Act come up for reauthorization, potential applications of incentive mechanisms may be actively debated. EPA is currently evaluating a variety of incentives to support these debates as well as working to implement other mechanisms under existing statutory authority. At the state level, a wide variety of incentive programs have been implemented, and many other proposals are currently under active consideration. Outside the United States a diverse group of nations are extending the frontiers for applying incentives.

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 as well as many foreign nations 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 updates and extends a 1992 EPA review[1] of 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. The mechanisms described in this report all satisfy the basic requirement that a continuous signal be provided 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 or yet-to-

[1] EPA (July 1992).

be developed technologies. 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 labeling. Also, a wider range of commodities are subject to deposit systems outside the United States. 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, Australia, South Korea, Chile, many parts of the former Soviet Union and elsewhere.

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FOREWORD

This report was prepared by Robert C. Anderson and Andrew Q. Lohof of Resource Consulting Associates under a subcontract to the Environmental Law Institute as part of cooperative agreement CR822795-01 between ELI and the U.S. Environmental Protection Agency. Alan Carlin, EPA's Project Officer, provided substantial assistance and helped to format the report for publication on EPA's World Wide Web Site.

Many individuals provided valuable assistance during the course of this research. Literally hundreds of individuals in the U.S. and abroad offered details as to the design and performance of individual market-based approaches used to manage pollution. As the work progressed, other individuals offered their technical comments and reviews. In particular the authors would like to thank Tom Gillis and Michael Podolsky of the EPA Economy and Environment Division, and Byron Swift, the Environmental Law Institute's project manager.

1. INTRODUCTION

In recent years, economic instruments have achieved a prominent place among tools for managing the environment. Once mainly an academic proposition, or a revenue-raising adjunct to command and control mechanisms, market-based economic incentives are now being used as the *principal* instrument of control for a number of environmental issues. Nowhere is this fact more evident than in the 1990 Clean Air Act Amendments, which created many programs underpinned by market-based mechanisms. The Clean Water Act Amendments of 1992, the Safe Drinking Water Act, and a host of state and local initiatives also contain important new incentive-based initiatives. For example, solid waste disposal currently is priced on a per unit basis in more than 2,000 communities throughout the United States.

The reliance on economic instruments is growing, not only here, but in many other nations as well. Quite possibly nowhere else is interest in these mechanisms higher than in the former Soviet Union, where newly-independent nations are moving quickly from central planning to market-based approaches to improve the environment and overall economic conditions. The pace of change toward market-based mechanisms also has been rapid throughout Western Europe and other areas such as Australia, Korea, and Chile.

1.1. PURPOSE OF REPORT

A 1992 EPA report documented the use of economic instruments to manage the environment in the United States and also characterized many of the foreign experiences; its title: *The United States Experience With Economic Incentives To Control Environmental Pollution*. In the five years since that report was issued, many new instruments have been implemented and existing instruments subjected to evaluation by academics and government agencies, making it not only timely for an update but also a good opportunity for offering new insights and perspectives. While the basic conclusions of the 1992 report are not changed greatly, the number of instruments that are reviewed has grown substantially. A number of subtle and not so subtle differences in perspective also may be evident to the reader.

This report attempts to go well beyond simply enumerating existing market-based mechanisms for managing the environment by examining key issues. How well have these instruments performed? What can be learned from the record that will assist in the formulation of new mechanisms? How economically efficient or cost-effective are these mechanisms in achieving the goals of environmental management? What have been their environmental effects? Why is it that the theoretical gains from economic instruments seldom are observed in practice and what can be done to improve this record?

1.2. DEFINITIONS

In order to bound the subject, economic incentives for the purposes of this report will be defined broadly as instruments that provide continuous inducements, financial or otherwise, for sources to make reductions in their releases of pollutants or to make their products less polluting. In essence, with incentives sources view each unit of pollution as having a cost, whereas under more traditional regulatory approaches pollution may be free or nearly so once regulations have been satisfied. To achieve maximum cost-effectiveness, the cost per unit of pollution faced by different sources should be comparable. In this fashion, pollution control costs are minimized for a given level of pollution. To achieve efficiency, the per unit costs of pollution faced by each source should be equated to the marginal damage to health and the environment caused by that pollution. This latter objective is much more difficult to achieve, so much so that it is of interest primarily as an academic or theoretical exercise and does not have great regulatory significance.

This definition excludes mechanisms that use explicit or implicit price signals for activities that have pollution as a by-product. While sometimes termed environmental incentives, programs to provide ride sharing, bike paths, high occupancy vehicle lanes and parking surcharges and the like are beyond the scope of this report, except for a brief discussion of congestion pricing which addresses an externality not unlike (and quite likely linked directly to) pollution. While of interest because they may lead to a reduction in pollution, these mechanisms provide neither an explicit nor an implicit price on units of pollution. Excluding these mechanisms carries no implications for whether future EPA actions will consider them as economic incentives. Rather their exclusion is primarily for the purpose of drawing boundaries around the scope of this report and making it manageable.

Payments per unit of pollution are perhaps the clearest example of an incentive, as the term is used in this report. Market-based systems in pollution reduction credits and allowances also provide direct price signals, since sources receive a paper chit that can be sold and used by another source if they reduce pollution below permitted amounts. Subsidies for pollution control and deposit-refund systems also create continuous financial incentives. Finally, indirect financial incentives for continuous effort at pollution abatement are created through reporting requirements, liability rules, and voluntary programs. All of these incentive mechanisms provide a continuous prod to sources to take actions to reduce their emissions and to make their products more environmentally friendly.

The contrast between incentive mechanisms and traditional “command and control” approaches is that the latter do not provide incentives to reduce releases below permitted levels, or to make their products less harmful to the environment once regulatory requirements are satisfied. Under pure command and control approaches, sources are tempted to view releases within permitted amounts as costless and products with environmental performance better than required levels as having no incremental value because of that attribute. To achieve improvements in environmental quality, regulators must tighten requirements on individual sources and products. Sources operating within the limits of existing regulations have little reason to act until new regulations are issued. In fact, if firms reduce pollution below permitted amounts or produce products with superior environmental performance, they may trigger actions by regulators to impose new requirements equivalent to these improved levels on all activities of the firm. Thus, under command and control type regulations there may be perverse incentives not to innovate and not to improve the technology of pollution control.

It should be emphasized that although this report attempts to make a careful distinction between command-and-control and market-based approaches, these distinctions are often blurred in practice. A range of pollution control measures exists, spanning the spectrum from such purely regulatory measures as technology requirements to such purely market-oriented measures as deposit-refund systems or pay-per-bag methods for financing municipal waste disposal. Between there exists a broad range of instruments, with no clear dividing line between command-and-control approaches and methods based on economic incentives. Many approaches to environmental management embody some features of incentive mechanisms along with a heavy dose of direct regulatory action. Most of the best known examples of economic incentive approaches, such as the acid rain trading program and the gasoline lead credit trading program, also have some distinctively command and control type features.

1.3. ORGANIZATION OF REPORT

This report is organized into ten additional sections which are summarized briefly below.

<u>Section 2</u> examines US government policies regarding incentive mechanisms. Since its early days in office the Clinton Administration has urged greater reliance on economic incentives for environmental management. The 1995 report "Reinventing Environmental Regulation," the 1996 *Economic Report of the President*, and the 1996 report of the President's Council on Sustainable Development all support greater use of economic instruments for dealing with environmental issues.

In the first years of the Environmental Protection Agency in the mid-1970s, incentive-based programs for environmental management were largely ignored. Early environmental legislation and agency action dealt primarily with easily identified problems at point sources using command and control approaches. As these problems were resolved, the emphasis in law and in Administration actions has shifted toward incentive-based mechanisms. Nowhere is this more evident than in the 1990 Clean Air Act Amendments with its highly successful market-based approach for controlling acid rain.

Section 3 reviews the efficiency and environmental effects of economic incentives to control pollution. The criterion of economic efficiency requires that environmental improvement be sought until the incremental benefits of further controls are just equal to the incremental costs of those controls. Neither economic incentives nor command and control mechanisms can guarantee this result; however, several incentive-based approaches lead to least cost means of accomplishing a given environmental goal. Such a result generally does not obtain with command and control approaches. In fact, a very large number of studies point to the conclusion that incentive-based approaches can save anywhere from 10% to 90% of the cost of controlling pollution under traditional command and control approaches.

Analysts agree that an important determinant of the long run success of an environmental management strategy is whether it stimulates technical change and innovation in pollution control. On this ground, pure command and control strategies score poorly. Well-designed incentive-based mechanisms, on the other hand offer a continuous inducement for sources of pollution to find better and cheaper ways to control their pollution and improve the environmental performance of their products.

Section 4 treats fee, charge and tax systems in place in the United States. From an economic perspective, fees, charges and taxes are largely interchangeable in terms of their effects, but to governments there may be important distinctions such as which committees and agencies have jurisdiction, how the receipts may be spent and so forth. There are far fewer of these instruments actually labeled taxes than called fees. Environmental taxes are found on landfill operations, and the disposal of hazardous wastes.

Pollution-based fees are imposed on the quantity and/or quality of emissions released to the environment. Some examples include air emission permit fees in California, Texas and other states; effluent permit fees in Washington, New Jersey, Wisconsin and other states; and per can solid waste disposal fees found in over 2,000 communities across the nation. User fees are levied for use of a resource, with examples including grazing fees and water use and sewage fees.

From the perspective of environmental management, most fee and tax systems impose rates that are far too low to have significant impacts on pollution. The reason is that if tax or fee rates were set at the economically efficient level (equal to marginal damages) or a level high enough to accomplish environmental goals, polluters typically would have to make large payments to government agencies. While such payments are not real resource costs, they are important to the sources of pollution, might affect product prices and demand for their output, and could affect their competitive position in internationally traded goods. With few exceptions, fee and tax rates have been set at levels far below what efficiency or the satisfaction of environmental goals would dictate. In those exceptional cases with high fees, a mechanism exists by which the payments for pollutants are rebated to the sources in proportion to output of useful goods, so that the polluting sector experiences almost no net payment to the government (e.g., Swedish NOx charge).

Product charges are sometimes levied on products believed to have environmentally harmful effects. Some examples of product charges include chlorofluorocarbon taxes, the gas guzzler tax, state taxes on fertilizer, motor oil, packaging and other materials. Other fees may be charged on activities that are potentially damaging to the environment; examples include wetland development fees and storm water runoff fees.

Section 5 considers deposit-refund systems, which may be characterized as a product charge used in conjunction with a recycling subsidy. In the United States, deposit systems have seen the most extensive application for lead-acid batteries but also are used in some jurisdictions for a number of other products such as beverage containers, pesticide containers, and tires. When used products are valuable, as is currently the case for lead-acid batteries and in years past was true of beverage containers, the private sector may create and manage a disposal system.

Deposit-refund systems appear to be most appropriate for discrete, solid commodities such as containers, batteries, and car bodies that would cause environmental harm through improper disposal. Government mandated deposit systems for substances such as water and air pollutants have not been attempted but might be feasible. There certainly are examples in industry where valuable substances in pollution streams are captured and sold.

One of the main difficulties with deposit systems are their often high transactions costs. The administrative costs of running these programs can be large and additional transactions costs imposed on those who collect and return the commodities for credit.

Section 6 covers trading systems. Trading programs can come in many forms; two of the best known involve credits for pollution reductions that have been achieved and emissions cap and allowance trading programs which provide allowances for future releases of pollution. Credits and allowances may be exchanged for cash payments. Most of the markets where these items are traded are informal, but organized auctions also take place periodically.

Beyond the best known examples of trading such as the acid rain allowance program and RECLAIM, are a wide variety of other programs that feature some form of trading in rights to release pollutants. Some of the high mountain communities in Colorado require permits to operate wood-burning appliances. Developers who wish to instal such a device are required to retire two existing permits, a rule that has resulted in pollution reduction and fostered an active market in permits. Certain classes of heavy duty engines are subject to emissions averaging, in effect intra-firm trading. The rights to burn grass are subject to trading in Spokane County, Washington. Land development rights are subject to trading in a few jurisdictions in Maryland, New Jersey and Florida. Wetland mitigation credits can be created, banked and sold to offset the adverse effects of development activities on wetlands.

Trading programs have certain features that have made them increasingly popular in the United States. Conceptually, they can achieve much of the same efficiency of a tax approach but have the advantages of protecting the assets of existing firms and providing more certainty about the magnitude of environmental improvement. A number of drawbacks are also observed, though, including high transactions costs and inactive markets. The long-term effects of trading programs on innovation and technical change are variable among programs. Some, such as the acid rain program, have spurred considerable innovation, while others have not due to high transactions costs. At worst, trading programs are neutral in their effects on costs and the environment. Sources will not engage in trades that worsen their financial situation. Also, pollution increases generally are not allowed with trading. As an escape valve to burdensome command and control regulations, trading programs can offer relief.

Section 7 discusses subsidy systems. Generally looked upon with disfavor by economists because they encourage more of an activity than would occur under a polluter pays approach, subsidies nonetheless are a commonly-used instrument of government environmental policy. The subsidies reviewed in this report include grants, low-interest loans, favorable tax treatment, and preferential procurement policies for products believed to be environmentally friendly.

The following broad areas of application are reviewed: pollution prevention and control, the cleanup of contaminated industrial sites, farming and land preservation, consumer product waste management, citizen monitoring of environmental regulations, alternative fuels and low emitting vehicles, and municipal wastewater treatment.

Section 8 deals with liability as an incentive. The Clean Water Act requires cleanup of oil and petroleum product spills into the nation's waters. The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the Oil Pollution Act (OPA) create liability for harm to the environment caused by releases of hazardous substances and petroleum, respectively. The incentive effect is clear as environmental costs become part of the overall cost of doing business. Awards and settlements for damages to natural resources under these and related state statutes total over $700 million, with a number of large cases involving a similar sum still in varying states of litigation. Cleanup costs, while not documented as fully, certainly have involved even larger sums.

Many of the federal environmental statutes provide for civil and criminal liability for failure to comply with the law and with implementing regulations. The incentive effect of this form of liability is to encourage individuals to comply with what are largely command and control regulations. While civil and criminal provisions of environmental laws are reviewed briefly in this report, such incentives are qualitatively different from those that price services of the environment and for the most part not within the scope of this report.

<u>Section 9</u> scrutinizes the potential incentive effects of information reporting requirements of two laws, the Emergency Planning and Community Right-To-Know Act (EPCRA) and California's Safe Drinking Water and Toxic Enforcement Act, commonly referred to as Proposition 65. The Toxic Release Inventory reporting requirements of EPCRA have led to a large reduction in releases of the listed substances, even though no reductions are actually required by the law. Merely requiring that public reports be filed seems to provide a strong encouragement for sources to reduce their releases.

Other forms of information reporting are also reviewed in this Section, including environmental impact assessment reporting, product labeling, environmental performance awards, Securities and Exchange environmental reporting requirements, and lead paint and radon disclosure requirements. Information approaches used outside the United States are discussed in Section 11.

<u>Section 10</u> looks at programs under which EPA asks companies to voluntarily participate in activities to protect the environment. Such programs have become increasingly popular in the 1990s; a recent EPA publication *Partnerships in Preventing Pollution* describes 28 such measures. One incentive for firms to participate in these programs is favorable public relations, which could help product sales and lessen regulatory pressures. Another reason some firms participate is technical assistance that may be offered by the regulatory agency. Voluntary programs may also reduce possibly adversarial relations with residents living near a facility and with the environmental community.

Voluntary programs are criticized for their lack of teeth, for the fact that firms with already-good environmental records tend to participate but bad actors do not, and for the general lack of accountability. While positive results are observed for certain programs, it is difficult to document significant changes in environmental performance as a consequence of many of the voluntary programs.

<u>Section 11</u> provides an overview of foreign experiences with economic instruments for managing the environment. A broad array of economic instruments exists outside the United States. While the United States has relatively more experience with trading mechanisms, information reporting requirements and, possibly, voluntary programs, the rest of the world has relatively more experience with sophisticated pollution tax systems,

a broader array of deposit-refund systems, and the use of environmental funds.

1.4. SCOPE OF REPORT

Though a great many incentive programs are reviewed herein, 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 than being exhaustive, an attempt has been made to identify those mechanisms that are most likely to have long-run significance In doing so, many important initiatives have undoubtedly been omitted either through lack of information or the need to draw limits and make this project manageable. For example, economic mechanisms for allocating water are noted only briefly, despite their potential linkages to the environment, because pollution control is not their primary objective. Likewise, the brief discussion of highway pricing and congestion charges merely serves to introduce this important application of incentives, since the environmental effects of such charges, though potentially significant, have yet to be documented.

Readers of this report who are aware of interesting applications of incentive mechanisms that they believe should be included in subsequent revisions of the report are encouraged to send that information to Robert Anderson at the following Email address: boba@erols.com.

2. GOVERNMENT POLICIES ON ECONOMIC INCENTIVES

Since its first days in office, the Clinton Administration has expressed strong support for greater reliance on economic incentives in environmental management. Having witnessed the success of the acid rain control program, policy makers are convinced that similar approaches can work in other environmental policy areas.

As discussed in Section 6, experiences with the acid rain control program are very positive to date, showing that environmental protection can be achieved at less cost than previously believed. Not only have pollution abatement costs been much less than expected, the magnitude of emissions reductions has significantly exceeded requirements to date. Moreover, recent scientific evidence indicates that the health benefits are far greater than originally forecast.

2.1. SOME RECENT POLICY DEVELOPMENTS

2.1.1. Reinventing Environmental Regulation

Released on March 16, 1995 by the Clinton Administration, "Reinventing Environmental Regulation" outlines major policy initiatives designed to improve environmental regulation so that the nation achieves a better environment at lower cost.[1] Two of the "10 Principles for Reinventing Environmental Protection" are that environmental regulation must be "performance-based," allowing flexibility while requiring accountability in attaining goals and that "market incentives should be used to achieve environmental goals, whenever appropriate." Open-market air emissions trading and effluent trading in watersheds are two of the "25 High Priority Actions" described in the document. Some of the actions seeking to improve compliance, accountability, and enforcement are coordinated through the Environmental Leadership Program described in section 10 of this report. These include incentives for auditing, disclosure, and correction. Project XL (another voluntary program discussed in section 10) is described as one of the "Building Blocks for a New System" of environmental regulation.

2.1.2. Economic Report of the President

Under the terms of the Employment Act of 1946, the President's Council of Economic Advisors prepares annually an *Economic Report of the President*. Among the topics discussed in the 1996 report is regulatory reform and its application to environmental policy.

The report offers several ideas for "reinventing regulation," which it defines as "taking a new look at regulation and the regulatory process to ensure that regulations meet legitimate social needs, and where necessary changing both content and process to improve efficiency and effectiveness." Regulatory reinvention efforts take several forms, including "better targeting of regulatory efforts to where the need is greatest," "a shift in emphasis from prescribing methods of compliance to specifying desired outcomes," and "harnessing economic incentives through market-based regulatory mechanisms."

A significant portion of the report is devoted to reinventing regulation of the environment and natural resources. "The Administration is improving the way we protect the environment," states the report, "making government a partner rather than an overseer." The report cites "cooperation with States and localities, partnerships with the private sector that engender creative solutions as well as set standards, and careful assessment of the advantages and disadvantages of alternative government action" as means by which "environmental protection can be achieved at an affordable cost."

Stating that environmental rules should impose the least possible burden and that their benefits should justify their costs, the report discusses a number of incentive approaches that have been or could be used to protect natural resources. The section entitled "Creating Cost-Effective Policies: Economic Incentives for Environmental Protection" includes liability for environmental damages, fees and charges, trading systems, conservation easements, and the provision of information. Trading systems for water and air pollution and for fishing quotas are discussed at length. On the subject of water pollution, the report contains Administration estimates that annual compliance cost savings of several hundred million to several billion dollars could be achieved through expanded use of effluent trading.

2.1.3. Council on Sustainable Development

Appointed by President Clinton in May 1993, the Council on Sustainable Development is composed of representatives from the Cabinet, industry, and environmental groups. The President assigned the Council the task of developing a strategy to achieve long-term economic growth without harming natural resources.

In its report released in March 1996, the Council recommended the use of performance targets in lieu of technology standards, commending Project XL for allowing companies to develop innovative pollution control methods. It also recommended the adoption of incentives and elimination of disincentives for environmental protection in a number of areas as well as more cooperation between industry and government in controlling pollution. One example of cooperation endorsed by the report is the Common Sense Initiative, under which industry and environmental groups are working with EPA to study ways to improve environmental regulations affecting six specified industries.

(report site: www.whitehouse.gov/WH/EOP/pcsd/#council_report)

2.1.4. Vice-Presidential National Performance Review

Vice President Gore's National Performance Review released a report in 1993 entitled *Creating a Government That Works Better & Costs Less*. Focused on reinventing government, the report included a number of recommendations for improved environmental protection, some of which advocated the use of economic incentives. It suggested that EPA work with Congress to encourage incentive approaches to reduce water pollution, including wastewater discharge fees. Another recommendation was the modification of the conditions of access to federal resources for activities such as grazing and mining to ensure that the government obtains a fair return on its land and to provide incentives for appropriate land management.

2.1.5. Executive Order 12866 and Related OMB Guidance

The central idea of President Clinton's Executive Order (EO) 12866 of September 30, 1993 is that regulations should be imposed only if their benefits justify their costs. (This EO replaced President Reagan's EO 12291 described below.) Agencies are required to conduct cost-benefit analysis for any "significant regulatory action." Actions deemed "significant" are those that "have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities" or that meet certain other criteria.

EO 12866 also requires that agencies consider the possibility of using incentive-based approaches for any significant regulatory action. Two specific "Principles of Regulation" in EO 12866 refer to incentive-based approaches:

> 1b3: "Each agency shall identify and assess available alternatives to direct regulation, including providing economic incentives to encourage the desired behavior, such as user fees or marketable permits, or providing information upon which choices can be made by the public."
>
> 1b8: "Each agency shall identify and assess alternative forms of regulation and shall, to the extent feasible, specify performance objectives, rather than specifying the behavior or manner of compliance that regulated entities must adopt."

In January 1996, an interagency group convened by the Office of Management and Budget (OMB) issued guidelines for economic analysis of proposed federal regulations under EO 12866. Among the topics discussed in these guidelines were the importance of performance-based standards, alternative compliance methods, information approaches, and economic incentives.[2]

On the first of these topics, the guidelines state, "Performance standards are generally to be preferred to engineering or design standards because performance standards provide the regulated parties the flexibility to achieve the regulatory objective in a more cost-effective way." "Performance standards," the guidelines continue, "should be applied with a scope appropriate to the problem the regulation seeks to address. For example, to create the greatest opportunities for the regulated parties to achieve cost savings while meeting the regulatory objective, compliance with air emission standards can be allowed on a plant-wide, firm-wide, or region-wide basis rather than vent by vent, provided this does not produce unacceptable air quality outcomes (such as 'hot spots' from local pollution concentration)."

On the subject of ensuring compliance, the guidelines state, "When alternative monitoring and reporting methods vary in their costs and benefits, promising alternatives should be considered in identifying the regulatory alternative that maximizes net benefits."

The guidelines mention various "informational measures," including "government establishment of a standardized testing and rating system (the use of which could be made mandatory or left voluntary), mandatory disclosure requirements (e.g., by advertising, labeling, or enclosures), and government provision of information (e.g., by government publications, telephone hotlines, or public interest broadcast announcements.)"

The guidelines also call for consideration of economic incentives: "In general, alternatives that provide for more market-oriented approaches, with the use of economic incentives replacing command-and-control requirements, are more cost-effective and should be explored." Incentives "that may be considered include fees, subsidies, penalties, marketable permits or offsets, changes in liabilities or property rights (including policies that alter the incentive of insurers and insured parties), and required bonds, insurance or warranties."

2.2. SOME SIGNIFICANT EARLIER POLICY DEVELOPMENTS

2.2.1. Economic Incentives: Options for Environmental Protection

A 1991 report by the EPA Economic Incentives Task Force, *Economic Incentives: Options for Environmental Protection*, studied existing and potential incentive mechanisms for the purpose of stimulating discussion on the role of such mechanisms in environmental policy. The report focused on four areas where incentives might be applied: municipal solid waste management, global climate change, water resource management, and multimedia concerns. In the preface to the report, the EPA Administrator stated, "To maintain progress toward our environmental goals, we must move beyond a prescriptive approach by adding innovative policy instruments such as economic incentives. Properly employed, economic incentives can be a powerful force for environmental improvement."

2.2.2. 1990 Clean Air Act Amendments

With the passage of the 1990 Clean Air Act Amendments, the legislative branch of government showed a strong interest in economic incentives and a major shift in approach away from command-and-control requirements that previously had dominated air pollution control policy. Among the incentive mechanisms included in the Amendments are the acid rain control program, provisions for offsets and other trading programs in ozone non-attainment areas, offset provisions for hazardous pollutants, fees based on pollutant emissions, marketable credits for certain fuel constituents, marketable production allowances for ozone-depleting substances, and labeling of ozone-depleting substances. These incentives are discussed in Appendix B and in relevant sections of this report.[3]

2.2.3. The Project 88 Report

Sponsored by Senators Heinz and Wirth, a group of public policy scholars prepared a report identifying 36 proposals for "innovative solutions to major environmental and natural resource problems." Among the economic incentives included in these proposals were:

- a national market for CO_2 offsets;
- internationally marketable permits for greenhouse gases;
- marketable permits for potential ozone-depleting substances, SO_2, NO_x, and point and nonpoint sources of water pollution;
- a deposit-refund system for containerizable hazardous wastes;
- taxes on fuel-inefficient vehicles with rebates for fuel-efficient vehicles;
- taxes on certain pesticides;
- air emissions charges for mobile sources.

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

2.2.4. Executive Order 12291 and EPA Guidelines for Performing Regulatory Impact Analysis

President Reagan's EO 12291 of February 17, 1981 required a Regulatory Impact Analysis (RIA) for proposed "major rules." (The definition of "major rule" was similar to that of "significant regulatory action" in EO 12866. EO 12866 replaced EO 12291.) Each RIA was required to contain a "description of alternative approaches that could substantially achieve the same regulatory goal at lower cost, together with an analysis of this potential benefit and costs and a brief explanation of the legal reasons why such alternatives, if proposed, could not be adopted."

After EO 12291 was adopted, EPA developed guidelines for conducting RIAs, according to which "each RIA should calculate the benefits and costs of a proposed regulation's full range of effects and should compare them with those of other regulatory and nonregulatory approaches." In "Considering Alternative Approaches," the guidelines call for consideration of "market-oriented regulatory alternatives (whether or not they are explicitly authorized in the Agency's legislative mandate)." Such alternatives "include using information or labeling to enable consumers or workers to evaluate hazards themselves and using economic incentives, such as fees or charges, marketable permits or offsets, changes in insurance provisions, or changes in property rights." EPA must submit all RIAs and proposed regulations to OMB for review. Although EPA's RIA guidelines could lead to increased use of incentive mechanisms in environmental regulation, no study appears to have addressed the extent to which the over 100 RIAs prepared to date have considered incentive-based alternatives.

EO 12291 builds on a number of earlier Executive Orders and regulations dating back to President Nixon's "Quality of Life" reviews requiring an assessment of alternatives and cost comparisons for proposed regulations. President Ford's EO 11821 of 1974 and EO 11949 of 1976 required inflation impact statements for major regulations. President Carter's EO 12044 of 1978 required Regulatory Analyses of the economic consequences of proposed regulations and alternatives under consideration and instructed agencies to select the "least burdensome" alternative.[4]

2.3. CONCLUSIONS

In short, government policy, as well as industry and the environmental community, appears to have embraced the following beliefs:

1. Environmental protection should be achieved in such a way as to limit regulatory burden. Regulation should stress performance targets rather than prescribed compliance methods.

2. Industry and government should act as partners rather than adversaries in environmental protection.

3. The use of economic incentives in environmental protection should be increased.

These beliefs have important implications for the incentive mechanisms described in the rest of this report.

3. THE ECONOMIC EFFICIENCY AND ENVIRONMENTAL EFFECTS OF INCENTIVE SYSTEMS

3.1. BACKGROUND

This Section compares various incentive-based strategies for managing the environment with traditional command and control approaches. The goal of environmental management is the control of pollution, or externalities in the terminology of economists. Pollution is an output that occurs outside of normal market transactions. It has no cost to the source but may impose costs on other economic actors. How best to get sources to control their pollution is an issue that has been studied closely by economists and policy analysts.

One means of control is to rely on private negotiations between those who bear the costs of pollution and the sources of pollution. Under the assumptions of costless transactions and no strategic behavior, such negotiations can lead to an optimal level of pollution control in which the full costs of pollution are taken into account in the decision process of the source (Coase). While the assumption of no strategic behavior may be reasonable in many cases, costless transactions, which are necessary for the victims of pollution to negotiate successfully with sources, may never be a realistic assumption. The more victims there are, and the more geographically disperse are the victims, the higher transactions costs are likely to be.

Because negotiations between victims and sources of pollution cannot be relied upon as a means of control, environmental legislation dictates other mechanisms for internalizing pollution externalities. In one approach the pollution control authority specifies in considerable detail requirements for different source categories. The regulations may impose discharge limits or much more, such as the technology that must be used, the inputs that must be used, or characteristics of the outputs that are produced. This regulatory approach is termed “command and control.” Market-based or incentive approaches, by contrast, provide rewards for reducing pollution (and conversely penalties for releasing pollution). The rewards may be of a financial nature, but need not be. In contrast to the command and control approach, an incentive-based regulatory strategy gives sources great flexibility in selecting both the type and magnitude of response.

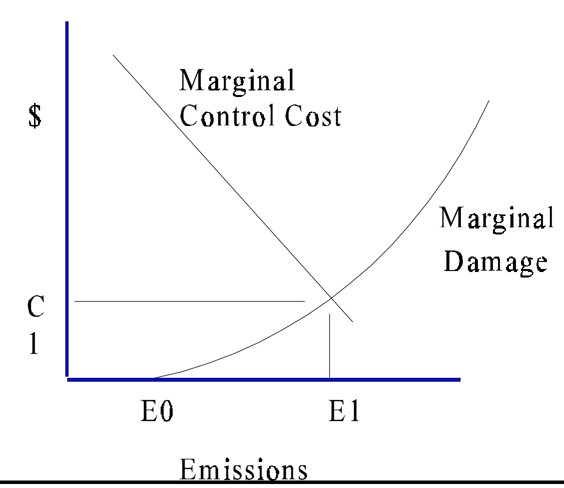
The basic reference point is Figure 3-1, a stylized depiction of the incremental damage of increased levels of pollution and the incremental costs of controlling pollution. The economically efficient level of control limits pollution to E_1. Up to that level of pollution the incremental damage from successive units of pollution are less than the incremental costs of control. Beyond E_1, incremental damage exceeds incremental control cost. Net benefits of pollution control are maximized at E_1.

If cost and damage functions are as well-behaved as depicted in Figure 3-1, traditional command and control approaches generally will not perform as well as incentive-based mechanisms such as pollution taxes, marketable permits, and liability in yielding the efficient level of pollution control. Several factors affect the economic efficiency of different tools for environmental management. As will be shown, market-based instruments offer a number of distinct advantages over traditional command and control approaches. Which instrument performs best, though, depends upon the specific characteristics of the problem. Consequently, a case-by-case approach probably is advisable in selecting the most appropriate instrument from among those potentially available.

Consider first, the sources of pollution. Are the costs of control known with certainty? If not, how great is the uncertainty? Is the technology of pollution control static, or is it likely to change over time? Can the quantity of pollution from each source be measured (or approximated) easily? How many sources are there for each pollutant? Are incremental control costs similar for different sources, or is there considerable variation?

On the damage side, does a unit of pollution from each source have the same impact on health and the environment, regardless of where it is released? Are the impacts on health and the environment known with certainty? If not, how great is the uncertainty? At which juncture do major uncertainties arise: imprecise knowledge of the effect of pollution on environmental quality, exposures, physical effects, or economic valuation of effects? How many parties are experiencing pollution damage? Is it critical to control pollution within narrow limits to achieve environmental goals, or are damage functions such that there is a continuum of effects from less serious to more serious, with no obvious unacceptable level of pollution?

Figure 3-1: INCREMENTAL DAMAGES AND COSTS OF CONTROLLING POLLUTION



Depending upon these parameters, some tools of environmental management are likely to perform better than others. Of course, performance can be measured in a number of ways. While economists would place the emphasis on economic efficiency, other criteria such as fairness, political acceptability, stimulus for innovation and technical improvement, enforceability and consistency with religious and moral precepts also could be used in place of or in conjunction with efficiency. Cost-effectiveness is a compromise criterion that takes both economics and the political and legal structure into account by finding the least cost means of achieving a stated environmental goal. Alternatively under this criterion, one could identify the pollution control measure that maximized environmental gains within a given cost budget.

The following sections describe alternative means for managing the environment, pointing out circumstances under which one mechanism is likely to perform better than others.

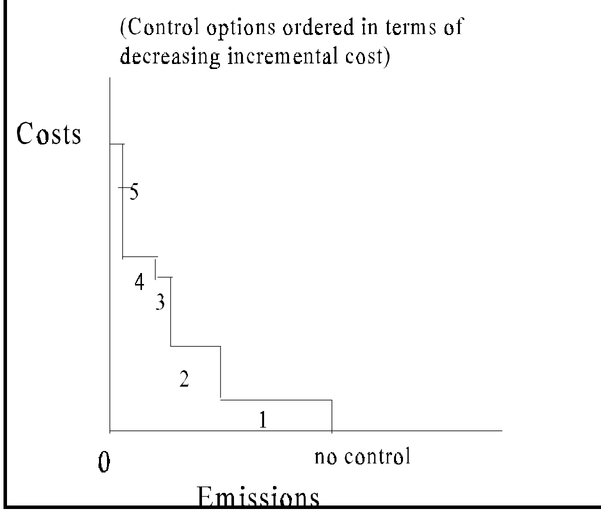
3.2. COMMAND AND CONTROL

Command and control mechanisms normally operate through one of three means: ambient standards, source-specific emission limits, or technology requirements. A brief description of each means illustrates both the strengths and weaknesses of command and control. Ambient standards specify a minimum level of environmental quality (e.g., a maximum concentration of pollutants in the atmosphere, or minimum levels of dissolved oxygen in water) to be achieved through limits on sources, products, and other sources of pollution. Ambient standards at first blush are unambiguous, though how they are set and the means by which they are to be achieved clearly is open to debate. Upon closer inspection, the means by which environmental quality is measured (e.g., the number and location of monitoring stations, the number of excursions allowed above the standard) also provides ample room for disagreement.

In principle, ambient standards could be established with reference to incremental control costs and incremental pollution damage. Environmental laws rarely give EPA this discretion. The Clean Air Act requires that national ambient air quality standards be set to protect human health with an adequate margin of safety (below the threshold of effects E_0 in Figure 1). Cost is not supposed to enter the decision process as a criterion. Similarly, water quality standards such as fishable, swimmable, or drinkable are selected by states for each body of water. EPA sets effluent limitation standards for different industrial sectors on the basis of technologies already adopted by cleaner facilities. Cost enters the standard-setting process only to the extent that large segments of industry must not be driven to bankruptcy.

Unless costs can be taken into account explicitly in setting standards, the ambient standards approach may lead to unsatisfactory outcomes from an efficiency perspective. The ambient standards approach under the Clean Air Act is built on the twin concepts of thresholds below which effects cannot be observed and margins of safety above thresholds for protecting health with a margin of safety. This approach is giving EPA increasing difficulties because even small amounts of some air pollutants are likely to have measurable effects on health or the environment. The lowest levels where effects can be detected have moved steadily lower as scientific techniques improve and as effects on sensitive subgroups are studied. Referring to Figure 3-1, the ambient standards approach built on the assumption of thresholds, eventually would set the maximum permissible emissions below E_0 where effects are first detected. But this results in the control of emissions from E_0 to E_1 whose marginal costs of control exceed marginal damage. By focusing only on environmental improvement, ambient standards are likely to be set at too ambitious a level; large costs may be incurred to achieve incremental improvements in environmental quality that are worth far less than they cost.

Figure 3-2: CONTROL OPTIONS FOR A SOURCE



Emission (or effluent) limits are applied to individual sources as a means of achieving health or environment-based ambient standards. Referring to Figure 3-1, the pollution control authority might attempt to limit total pollutant releases to E_1, E_0 or some other level by setting emissions standards for individual sources, such that total emissions just equaled those amounts. If pollution rights are "grandfathered" to existing sources, new entrants and expanding existing sources are disadvantaged unless existing sources can transfer some of their pollution rights. Other pollution allocation formulas could be used, such as a set number of pounds of pollution per unit of output, that do not disadvantage new sources.

Unless the pollution control authority is able to identify which sources have the lowest incremental control costs and insist that those sources implement controls first, the incremental cost of controlling emissions to E_1 will be higher than C_1. As Figure 3-2 depicts, each source generally will have a number of options for controlling emissions. The least cost option (1) will control some emissions.

Other successively more expensive measures may be implemented until all emissions are controlled. It is very difficult in practice to identify the least cost strategy for the total emissions from several sources (the incremental cost curve of Figure 3-1). If all control measures and their costs are known, linear programming could be used to find the marginal cost curve. Generally all control measures are not known, and even if they are, pollution control laws do not permit an agency to impose control measures for different sources on this basis. Sources would argue that it is not fair. Consequently, emission or effluent limits are likely to be inefficient.

From a dynamic perspective, identifying the strategies that should be implemented to achieve least cost control is more problematic. Technology is not static. Over time, the number of possible options increases, most of which offer improvements over previous technologies, either in terms of cost or environmental performance. A command and control strategy to identify and mandate least cost controls would lock firms into technologies that become progressively less attractive over time.

Technology requirements specify the techniques or equipment that sources must use to control pollution. Some examples of technology-based standards include the ban on lead in gasoline and the requirement that automobiles be equipped with catalytic converters. Some standards that are nominally performance-based demand a level of emission control that can be met only with one technology and there fore are best classified as technology standards (e.g., new source performance standards for SO_2 emissions at coal-fired electric power plants require a 90% reduction relative to uncontrolled emissions, a degree of control that can be met only by scrubbing). Technology standards are likely to be less efficient than emission or effluent standards; the latter give sources the freedom to choose the least costly method of compliance. Further, technology standards tend to lock firms into one accepted method of compliance, discouraging technical change and innovation. When emissions cannot be measured, and / or there are concerns about the feasibility of enforcing tax or trading systems, technology standards provide an objective indicator that something is being done about pollution. For that reason, if no other, technology standards remain popular despite their lack of efficiency.

3.3. INCENTIVE-BASED MECHANISMS

While incentive-based systems have existed in some form for decades as tools of environmental management, the federal government has aggressively sought their implementation for only the past 10 to 15 years. Economic incentives rely on decentralized decision-making by hundreds or thousands of economic agents, all acting in their own self interest, to protect the environment. In contrast, traditional command and control approaches for environmental management depend upon regulatory commands by a central authority (the EPA) to limit the amount of pollution. While actual compliance is accomplished by firms and individuals subject to the regulations, the flexibility sources have to choose technology, as well as the extent of pollution control, tend to be quite limited under a command and control approach. Economic incentive methods generally allow sources to select both the amount of control and the technology.

3.3.1. Pollution Taxes, Fees, and Charges:

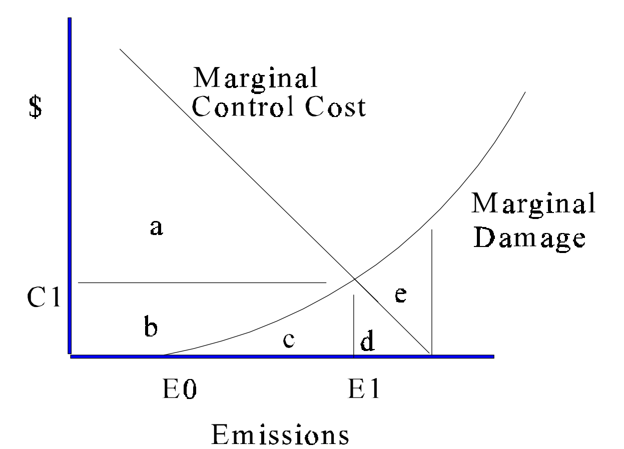
The feasibility of imposing emission fees, taxes and charges depends on a number of parameters, one of which is whether one can measure emissions. From an economic perspective, these instruments are interchangeable, though from a legislative and legal perspective there are some differences. Proposed taxes must be reviewed by the House Ways and Means Committee, since tax revenues are a part of general federal revenues. Perhaps for that reason, there are few environmental taxes labeled as such (one notable exception being the CFC tax). Fees and charges, in contrast, are designed to recover some or all of agency administrative costs and need only be reviewed by environment committees and subcommittees. Fees and charges can arise in two ways: (1) the activity subject to fees and charges may be specified by an environmental statute, and (2) Section 6501 of the Omnibus Budget Reconciliation Act of 1990 authorizes EPA to assess and collect fees and charges for services carried out under the nation's environmental laws.

Long ago economists pointed out that an emission tax provides the pollution control agency with limited control over the physical quantity of emissions. If the magnitude of emissions is very important, as could be the case with important health exposure thresholds, an emission tax may be viewed as an inadequate control over actual emissions. Environmentalists sometimes oppose emissions fees because they seem to sanction polluting activities; emission fees become a "license to pollute."

In the remainder of this discussion, the simple analytics of fees, charges and taxes (the terms are used interchangeably) will be described from an economic perspective. Refer to Figure 3-3 in which a tax per unit of emissions is imposed. A cost-minimizing polluter faced with an emissions tax controls those emissions for which control costs are less than the tax and releases the remainder, paying the tax on each of those units of pollution. For example, if an emissions tax just equal to C_1 were imposed, cost-minimizing polluters would reduce total emissions to E_1. If the tax were less than C_1, emissions would be greater than E_1.

Emission fees set at C_1 per unit of emissions cause cost-minimizing polluters to pay for all emissions up to E_1, an amount equal to areas b+c in Figure 3-3. They spend an amount equal to area d to control emissions beyond E_1 and reduce environmental damage by an amount d+e. Emission fees set at levels to materially change behavior typically would result in large revenue transfers to the government. That is, area b+c tends to be large relative to area d. For this reason, polluters usually oppose pollution charges, taxes and fees that would be high enough to have an incentive effect. Legislation

Figure 3-3: MARGINAL DAMAGES AND COSTS FOR TAX PER UNIT OF EMISSIONS APPROACH TO POLLUTION CONTROL



authorizing pollution fees, taxes and charges typically limits their magnitude to what is necessary to recover the costs of administering the program in question or related programs. Worldwide, the vast majority of emission tax, fee, and charge systems collect revenues that at the margin are only a few percent of marginal control costs.

Two exceptions that are described in more detail later in this report are worth noting: (1) U.S. chlorofluorocarbon taxes that were designed to remove a windfall that would otherwise accrue to producers while the quantities of CFCs allowed in commerce were being reduced by government regulation; and (2) the Swedish NO_x charge, which is set at a high level with the objective of changing behavior, then rebated to affected power plants in proportion to their energy output to avoid the large revenue transfers that otherwise would occur. Relatively "clean" facilities receive rebates in excess of payments while relatively "dirty" facilities pay more than they receive in rebates.

The pollution damage function depicted in Figures 3-1 and 3-3 is idealized. In many situations, the function is not well known, so the ability of an agency to set charges to equate marginal control costs and marginal damages is questionable. Moreover, the damage function may differ from one localized area to another depending upon the population at risk, prevailing winds, sunshine, temperature, and other factors. If marginal control costs or marginal damages differ from one region to another, a single charge level may be inappropriate; regionally differentiated charges may be required to attain efficient pollution control.

3.3.2. Subsidies

Subsidies are the mirror image of emission taxes. Rather than taxes to encourage firms to reduce emissions, the subsidy approach offers cash payments to firms for reducing emissions. Polluters who release emissions forgo the cash payment. Under a subsidy system, polluters have an incentive to control all units of pollution whose marginal control cost is less than the subsidy. Subsidy systems for pollution control are especially popular in two sectors: farming and municipal government.

Economists point out a major drawback of subsidy systems. While existing firms, farmers and the like have an incentive to reduce their pollution, new entrants may be attracted by the higher profits earned as a result of subsidies. In some extreme situations this could have the perverse effect of increasing total pollution.

3.3.3. Trading Systems

Two main forms of trading systems are observed: emission (or effluent) reduction credits (ERC), and tradable allowances for future pollution. ERCs are earned by releasing less pollution than authorized in a facility's permit. With either form of trading, sources with high marginal control costs will try to find sources with low marginal control costs. Trading ERCs or allowances in such a situation is mutually beneficial.

For trading systems to function well, a number of requirements must be satisfied. There should be several potential participants in trades to create a functioning market. Exactly how small a universe of potential participants there can be and still have a functioning market is difficult to say, but simulation experiments suggest that 8-10 is a reasonable estimate. If sources are dispersed geographically, trading ratios other than one to one might have to be imposed to assure no degradation in environmental quality. This could dampen interest in trading. Trading requires that pollution control agencies have the ability to monitor emissions (or measure a surrogate) reasonable well. The commodity to be traded needs to be well-defined. Generally a well defined commodity requires a baseline from which to calculate the emission reduction credits (or allowances) that may be traded. Establishing baselines is likely to require good historic data on emissions, input use, etc.

Price versus Quantity Instruments

The economics literature makes an important distinction between price and quantity instruments in a setting of uncertainty over control cost and damage functions (Weitzman). Quantity instruments, such as marketable permits and credit trading within caps, provide the pollution control authority strict control over the quantity of emissions. Price instruments, such as pollution taxes and fees, provide strict limits on how much a firm must spend to control pollution but do not limit the release of emissions.

With uncertainty, the regulatory authority would not have good information concerning the costs of a quantity-based approach, or the environmental consequences of a price-based approach. Which type of uncertainty is more serious? If there are important environmental threshold effects, a quantity approach would be preferred. But few pollutants have that characteristic; most exhibit stable dose-response relationships. Rather, the important discontinuities are likely to lie in the cost function, as different technologies must be used to achieve progressively greater control over emissions. Though he declines to

Trading systems tend to be more popular than tax systems with pollution sources because the sources generally do not have to pay for their rights to pollute up to permitted amounts. In fact those rights become the commodity that is traded and hence immediately have a value once a trading system is created.

The literature cited later in this Section predicts large potential savings from trading systems, yet available evidence points to relatively modest savings. In searching for reasons for the wide gap between the potential and what actually is accomplished, Stavins identifies transactions costs as the primary culprit. With transactions costs as a barrier to trading, sources tend not to venture far from their initial allocation of pollution rights. As transactions costs rise, the prices that sellers receive for pollution rights fall and the prices that buyers must pay rise, making transactions less likely. Transactions costs were especially high in EPS's early Emissions Trading Program, described later in this report, with the result that fewer than one percent of the emissions potentially available for trading actually were traded (Hahn, 1989). Transactions costs were lower for programs such as lead credit trading, resulting in a far higher proportion of available credits actually being traded. Transactions costs also feature prominently in the choice between making trades internally within a firm and externally between firms. For all of the trading programs that have been studied, firms exhibit a strong preference for internal trading when that is feasible, often even when larger cost savings are available externally. (Burtraw, Kerr)

3.3.4. Deposit-Refund Systems

A deposit-refund system operates like a tax system on the original purchase with a subsidy system for returning a used item to a designated collection site. The purpose of the subsidy or refund it to encourage individuals and firms to dispose of items in an environmentally acceptable manner. The tax or deposit is made on the original purchase and yields sufficient revenue to pay future refunds. Some or all of the unclaimed deposits may be used to subsidize collection facilities.

Though most deposit-refund systems are created by legislation, deposit-refund systems occasionally are developed by the private sector when the used product has economic value. Thus, private sector deposit-refund systems for beverage containers were widespread in the early part of the twentieth century before cheaper, non-returnable containers appeared. Mandatory deposit legislation for lead-acid automotive batteries has been enacted in about a dozen states; the private sector has created deposit systems for lead-acid batteries in every other state, largely because of the economic value of used batteries. Ten states have enacted beverage container deposit-refund systems. Deposit systems exist for car bodies in four European nations, and for a wide variety of containers through most European nations. In a few nations of Europe, deposit systems help assure the recycling of used motor oil.

Administrative costs may be important for deposit systems and potentially outweigh their other attractive features. Ackerman at al. (1995) estimate that these costs average about 2.3 cents per container (over $300 per ton for steel containers, $1,300 per ton for aluminum cans) in states with traditional bottle deposit legislation. These costs may be compared with disposal costs which average nearer to $100 per ton. Also potentially important are the costs imposed on consumers, who must store used containers and return them for redemption. Deposit-refund systems appear best suited for products whose disposal is difficult to monitor and potentially harmful to the environment. When the used product has economic value, the private sector may initiate the program.

3.3.5. Information Programs

By information programs, this report refers to mandatory disclosure requirements, such as those associated with Title III of the Superfund Amendments and Reauthorization Act of 1986 and California's Proposition 65. At the time these statutes were enacted there was little evidence as to how companies would respond to information disclosure rules, other than that they strenuously objected to such requirements.

A retrospective study of eight firms, conducted by the Center for Environmental Management at Tufts University found that SARA Title III requirements gave a strong incentive for those firms to identify and act upon opportunities for reducing accidental and routine releases of hazardous substances. Information reporting requirements caused firms to behave as if all emissions were costly. Emissions that could be controlled relatively cheaply were reduced.

3.3.6. Liability for Health and Environmental Harm

One approach for resolving environmental issues is to make polluters liable for damage they cause. The purpose is twofold: first to get polluters to make more careful decisions and second to compensate victims of pollution. Liability operates to control pollution through the decentralized decisions of polluters.

Refer again to Figure 3-1. If polluters are liable (and must pay) for the damage they cause, they will control pollution to the optimal level where marginal pollution damage equals the marginal costs of control. At this point their total payments for controlling pollution and compensating victims are minimized.

Liability can take two forms: civil and common law. Civil liability is expressly written into law. For example, many of the environmental statutes, worldwide, have liability provisions. In the US, the most important ones are the Comprehensive Environmental Response, Liability and Compensation Act (CERCLA) and the Oil Pollution Act (OPA), which hold responsible parties liable for cleanup costs and for damage to natural resources caused by releases of hazardous substances and petroleum, respectively. Liability under CERCLA applies to historic as well as contemporary releases. The form of liability is strict, joint and several, meaning that one contributor out of many can be held responsible for all of the damage. Further, since liability is retroactive, an individual can be held liable for actions that were perfectly legal at the time they occurred. The incentive effect of retroactive liability is open to question. Does it enhance efficiency? Will it affect future behavior in the desired manner? CERCLA is apparently the only statute (worldwide) with retroactive liability for actions that were legal at the time they were done. While the statute has withstood numerous legal challenges, it clearly lies well outside the mainstream of ordinary civil liability.

Harm to individuals and their properties caused by pollution is actionable under various doctrines of common law such as nuisance, trespass, and negligence. Whether these approaches are effective in dealing with pollution is an open question. In selected applications, liability can be a strong deterrent, but a number of considerations limit the effectiveness of this approach as a general solution to pollution-related problems. One limiting factor is the time limit within which cases can be filed, the statute of limitations. In most jurisdictions, a case must be filed within two or three years of discovering a harm. In a few jurisdictions, a case must be filed within a two or three year period of when the harm occurred. This distinction is very important for cancer and other diseases of long latency that result from contact with toxic substances, since observable effects may arise many years or even decades following the exposure.

A second limiting factor is the burden of proof required by law. Typically, a defendant will be judged either guilty or innocent of causing the harm. The burden of proof required for a guilty verdict is usually the standard of "more likely than not," usually interpreted as greater than 50 percent probability. Epidemiological studies may suggest that exposure to a particular toxic substance is but one of many factors that could have caused a disease. Satisfying the more likely than not criterion can be difficult. Even if a substance is implicated, it may be difficult to determine the polluter responsible for the harm. For example, an auto mechanics' mesothelioma may be attributed to inhaling dust from brake linings, but assigning responsibility to a particular manufacturer may be impossible. A minority of jurisdictions allow the assignment of proportional responsibility for both the harm-causing substance and for the determination of who is responsible.

A final limiting factor for liability systems are the transactions costs of pursuing a claim. These costs include the legal costs of obtaining evidence, agreeing among plaintiffs how to pursue a case, presenting the case, and following up if the case is appealed. Liability works best when there is one party on each side of the case and an easily demonstrated harm. When the harm is large in magnitude, liability systems may perform reasonably well with transactions costs small in proportion to the amounts awarded, if there are few defendants and clear causation, even if the number of plaintiffs is large.

3.4. RELATIVE ECONOMIC EFFICIENCY

Economic theory and common sense argue that incentive mechanisms should enhance the efficiency of pollution control relative to traditional command and control approaches. The reasons for this conclusion are several. First, some incentive-based mechanisms explicitly allow trading of pollution reduction obligations. With trading, sources with high incremental costs of control can have their obligations satisfied by sources with low incremental costs of control. Other incentive-based mechanisms levy a charge or tax on each unit of pollution. Under such an approach sources would control pollution only to the point at which the incremental cost of control equaled the charge or tax. In an idealized world without transactions costs and competitive markets, both permit/credit trading and pollution charge approaches should result in the marginal cost of controlling pollution being the same at each source. At every level of pollution, control costs should be lower than (or at worst the same as) costs associated with a command and control approach.

A number of other incentive-based mechanisms, such as information reporting requirements, liability, and voluntary programs, rely on implicit charges for pollution. The efficiency consequences of such mechanisms are more difficult to predict because sources are reducing pollution for reasons that have only an indirect financial consequence. And sometimes that financial link is very tenuous. The motives for participating in voluntary programs are largely one of improving corporate image to customers, to employees, and to regulators, though management concern for the environment certainly could be a factor. While the motives for controlling pollution are very real, the benefit to the firm of reducing emissions is difficult to express in financial terms. Perhaps the best that could be done is to examine what firms actually spend as part of such programs to generate a willingness to pay for pollution reduction. One might find that forms respond in a systematic fashion to various of the indirect incentives. For example across a sample of firms, liability might generate higher willingness to pay for a unit of pollution reduction than does an information reporting requirement, which in turn might exceed the willingness to pay for strictly voluntary activities.

The following tables summarize results of theoretical studies that compare incentive mechanisms with command and control approaches for managing the environment. One observes that in every case the command and control approach would be more costly than the market-based approach, sometimes much more costly. Of course, these are merely theoretical studies of *potential* savings. Actual savings could be much less if sources face high transactions costs with trading regimes that are the basis for comparison in most of the studies.

Table 3-1: QUANTITATIVE STUDIES OF POTENTIAL SAVINGS FROM USING ECONOMIC INCENTIVES TO CONTROL AIR POLLUTION

Pollutant Controlled	Study Year, Source	Geographic Area	Command and Control Approach	Ratio of CAC to Market-Based Approach
Hydrocarbons	Maloney & Yandle (1984) T	DuPont facilities in U.S.	Uniform percent reduction	4.15
Nitrogen dioxide	Seskin *at al.* (1983) T	Chicago	Proposed RACT regulations	14.4
Nitrogen dioxide	Krupnick (1986) O	Baltimore	Proposed RACT regulations	5.9
Particulates (TSP)	Atkinson & Lewis (1974) T	St. Louis	SIP regulation	6.0
Particulates (TSP)	McGartland (1984) T	Baltimore	SIP regulations	4.18
Particulates (TSP)	Spofford (1984) T	Lower Delaware Valley	Uniform percent reduction	22.0
Particulates (TSP)	Oates *et al.* (1989) O	Baltimore	Equal proportional treatment	4.0 at 90 ug/m^3
Reactive organic gases and NO_2	SCAQMD (1992) O	Southern California	Best Available Control Technology	1.5 in 1994 1.3 in 1997
Sulfur dioxide	Roach *et al.* (1981) T	Four Corners Area	SIP regulation	4.25
Sulfur dioxide	Atkinson (1983) A	Cleveland		
Sulfur dioxide	Spofford (1984) T	Lower Delaware Valley	Uniform percent reduction	1.78

Pollutant Controlled	Study Year, Source	Geographic Area	Command and Control Approach	Ratio of CAC to Market-Based Approach
Sulfur dioxide	ICF Resources (1989) O	United States	Uniform emission limit	5.0
Sulfates	Hahn and Noll (1982) T	Los Angeles	California emission standards	1.07
Six air pollutants	Kohn (1978) A	St. Louis		
Benzene	Nichols *et al.* (1983) A	United States		
Chlorofluorocarbons	Palmer *et al.* (1980); Shapiro and Warhit (1983) T	United States	Proposed emission standards	1.96
All?	Toman *et al.* (1994) O	Poland	EC and German standards	1.1 to 1.2
Sulfur dioxide	Haklos (1994) O	Europe	Uniform percent reduction	1.42
Ozone	Hahn (1995) O	United States	Vehicle mandate in CA and Northeast	1.3 (NE only) 2.0 (CA + NE)

Table 3-2: QUANTITATIVE STUDIES OF POTENTIAL SAVINGS FROM USING ECONOMIC INCENTIVES TO CONTROL WATER POLLUTION

Substance Controlled	Source Year, Source	Geographic Area	Command and Control Approach	Ratio of CAC to Least Cost Approach
Biochemical Oxygen Demand (BOD)	Johnson (1967) T	Delaware Estuary	Equal proportional treatment	3.13 at 2 mg/l 1.62 at 3 mg/l 1.43 at 4 mg/l
BOD	O'Neil (1980) T	Lower Fox River, WI	Equal proportional treatment	2.29 at 2 mg/l 1.71 at 4 mg/l 1.45 at 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 at 7.5 mg/l
BOD	Eheart, et al. (1983) T	Delaware Estuary	Equal proportional treatment	3.00 at 3 mg/l 2.92 at 3.6 mg/l
BOD	Eheart et al. (1983) T	Upper Hudson River, NY	Equal proportional treatment	1.54 at 5.1 mg/l 1.62 at 5.9 mg/l
BOD	Eheart et al. (1983) T	Mohawk River, 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		
Selenium	EDF (1994) O	Central Valley, CA	Best management practices	1.2

Table 3-3: QUANTITATIVE STUDIES OF POTENTIAL SAVINGS FROM USING ECONOMIC INCENTIVES TO REDUCE SOLID WASTE

Substance Controlled	Study Year, Source	Geographic Area	Command and Control Approach	Ratio of CAC to Least Cost Approach
Municipal solid waste	Palmer, et al. (1995) O	United States	Uniform percent reduction of 10%	2.0

Table 3-4: QUANTITATIVE STUDIES OF POTENTIAL SAVINGS FROM USING ECONOMIC INCENTIVES FROM OTHER POLLUTION-RELATED ACTIONS

Substance Controlled	Study Year, Source	Geographic Area	Command and Control Approach	Ratio of CAC to Least Cost Approach
Fuel efficiency	Charles River Associates (1991) O	United States	CAFE standards	4.5
Agricultural chemicals	Rendleman *et al.* (1995) O	United States	Uniform percent reduction	1.1
Traffic congestion	Hau (1990) O	Hong Kong	Car ownership restraint	2.5

Footnotes for Tables 3-1 to 3-4

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.

In many of these studies, a distinction was not drawn as to the precise nature of the market-based mechanism that would be used. Rather, the assumption was made that either pollution taxes or marketable permits would yield the least cost outcome identified through linear programming. Examining the performance of trading systems in particular, one finds that existing applications fail to achieve anywhere near their theoretical potential cost savings.[5] 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 predicted savings are not realized.[6] 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, restrictive trading rules, monitoring and reporting requirements, and the administrative burden placed on both emission sources and regulatory agencies.

In addition to limitations imposed by the regulatory structure, potential participants in trading systems may be reluctant to trade paper credits, preferring instead the greater certainty of installing pollution control equipment at their facilities. Moreover, pollution credits have a limited life whereas engineering controls in principle last for the life of a facility. In most trading systems, the vast majority of trades that take place occur within firms, not between firms. Further, markets in rights available for sale tend to be thin (Hahn) and it may be difficult to locate potential sellers of rights.

For tax, charge and fee systems, with a couple of exceptions in Sweden, the principal limitation to achieving the theoretical efficiency gains has been the generally low level of charge relative to what would be required to have a significant impact on pollution. Charges typically are set to recover administrative costs for a program, not to impact pollution.

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,[7] although the incentive program will provide a stronger stimulus for innovation and technical change.

3.5. ECONOMIC INSTRUMENTS AND TECHNOLOGICAL CHANGE

Market-based instruments should have significant advantages over command and control mechanisms in terms of stimulating technical change and innovation in pollution control. The reason is that each and every unit of pollution is costly to the firm. In contrast, under a command and control approach, once a source has satisfied the emission limits, all pollution within those limits is costless. Why spend valuable resources instituting further controls when there is no reward? In fact, the incentives may be negative, for a firm that controls to less than permitted amounts may be inviting reductions in what is permitted. In many parts of the nation pollution control agencies are constantly struggling to find ways of meeting ambient environmental quality goals. Firms that demonstrate the possibility of making emission reductions below permitted amounts offer an easy target for obtaining some of the necessary emission reductions. These same innovative firms may supply the catalyst for regulations that require other firms in the same industry to undertake what has been demonstrated as possible.

Figure 3-4: COSTS FOR EMISSIONS CONTROL FOR FIRMS UNDER EMISSIONS TAX AND COMMAND AND CONTROL APPROACHES

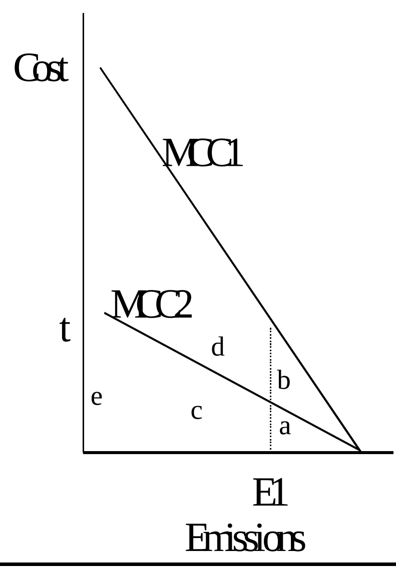


Figure 3-4 depicts graphically the difference in incentives for innovation between an emissions tax and a command and control policy. With marginal control costs of MCC1, a firm controls emissions to E1 with an emission standard set at that level, incurring costs equal to area (a+b). With an emissions tax set at t, the firm also would control emissions to E1, incurring costs equal to (a+b+c+d+e).

The incentive to the firm to find improved methods of pollution control are much stronger under the emissions tax, since total pollution control outlays are so much higher. If the firm finds a new pollution control technology with marginal control costs equal to MCC2, total abatement costs under the emissions standard approach would fall by an amount equal to area b. Under the emissions tax approach, total pollution control outlays would decline by an amount equal to area (b+c).

It should not be surprising that the theoretical and empirical literature concludes that emission taxes provide the greatest stimulus for technical change and innovation, with marketable permits offering a lesser stimulus and command and control the least. Among command and control approaches, it is safe to say that performance-based standards should provide a greater incentive to innovate than would pure technology requirements.

Long-run changes in behavior and technology are among the most difficult economic effects to document. For that reason, relatively little is known of the effects that take place as a consequence of different pollution control policies. Yet these effects are thought to be very important. One author said the rate of technological change in pollution control is "the single most important criterion on which to judge environmental policies." Another analyst termed innovation "the key to an effective solution" of environmental problems.

The available evidence suggests that existing environmental policies give only a mild stimulus for technical change and innovation, though there are important exceptions such as the U.S. acid rain control program where control costs have fallen dramatically due to major technical and behavioral changes. Outlays for research and development in pollution control are between two and three percent of total pollution control expenditures. This is about the same as the average R&D expenditure in all of U.S. manufacturing, but far lower than one might expect in a new and rapidly changing industry. A more apt comparison might be provided by drugs, electronics and information processing where R&D runs between 6 and 10 percent of expenditures. Research and development in pollution control appears to lag behind largely because of the command and control framework that has been chosen, not because of any other inherent limitation. Pollution control based more heavily on economic instruments would be expected to stimulate greater R&D and in turn reduce over the long run the costs of improving the environment.

3.6. IMPACTS ON ENVIRONMENTAL QUALITY

A full understanding of the effectiveness and economic efficiency of incentive programs requires information on the realized environmental benefits. The literature focuses almost exclusively on the cost side because of the presumption that the same environmental goals are being sought. In comparing incentive-based policies with command and control approaches, or among different incentive-based policies, there may be impacts on environmental quality that would be of interest to regulators and other parties.

Generally, incentive mechanisms based on trading are designed to produce environmental effects that closely approximate what would be achieved through a command and control approach. Some distinctions still apply, however, in that a "cap and trade" policy is likely to give greater control over total emissions than is an "open market" trading approach. Open market approaches do not provide a limit on total emissions; credits may be generated as sources see fit. If there is to be a control on total emissions, it would have to come from a companion command and control regime. In contrast, under a capped trading program, total emissions are limited. Either type of trading will reduce total emissions if trading ratios of greater than 1:1 are required. Some trading program described in this report have that feature (e.g., fireplace permit trading) but others do not (e.g., acid rain allowances).

Emission tax systems typically have not been designed to have an environmental impact. Rather, modest revenue raising has been the principal goal. However, in the few examples for which emission fees have been set at a level intended to have environmental impacts, the benefits were greater than forecast (Swedish NOx and SO2 charges, and United States CFC taxes).

Deposit systems appear to produce environmental effects greater than would be expected through a command and control method; however, there appears to be a threshold of deposit size needed in order to induce people to achieve the desired environmental objective. For example, deposits on automobile bodies function well in assuring the proper disposal of car hulks when set at a high enough level (see the section on international experiences). In contrast, thousands of abandoned car hulks are removed at city expense in New York each year despite regulations prohibiting that type of disposal.

Variations in environmental effects can be important in evaluating the overall desirability of different approaches. Often it is not correct to simply assume various approaches yield the same result. Oates et al. (1989) describe an example of particulate matter control in the Baltimore region in which "over control" in some areas required under a command and control approach yields environmental improvements that lessen the relative attractiveness of an incentive-based policy that produces more uniform pollutant concentrations.

3.7. FINDING THE RIGHT INSTRUMENT FOR THE PROBLEM

This section has described a wide range of instruments from the perspectives of economic efficiency, distributional consequences, environmental effects, and incentives to develop new technologies to deal with pollution. The evidence accumulated from literally hundreds of applications of economic that is reviewed in the following sections suggests that the set of instruments that can deal successfully with individual classes of environmental problems is fairly narrow. Table 3-5 identifies the types of incentive-based instruments that have been applied to a variety of environmental problems. The relative effectiveness of the different mechanisms is also characterized. The interested reader is referred to Field and Dower for other perspectives on selecting the correct economic instrument for individual environmental problems.

Table 3-5: USES OF ECONOMIC INSTRUMENTS

Instrument	Types of Applications	Examples	Pros & Cons
Pollution Charges & Taxes	* damage function has little slope * monitoring data available	Emission charges Effluent charges Solid waste charges Sewage charges	Pro: stimulates new technology; effective if the charge is high Con: potentially large distributional effects; uncertain environmental effects
Input or Output Taxes & Charges	* numerous sources * no monitoring data * damage function has little slope * some link between environment and use of input or output	Leaded gasoline tax Carbon tax Fertilizer tax Pesticide tax Virgin material tax Water user charges CFC taxes	Pro: administratively simple; raises revenue Con: often weak link to pollution; uncertain environmental effects
Subsidies	* politically or economically infeasible to tax activity * unlikely to stimulate new sources to enter * monitoring is feasible	Municipal sewage plants Land use by farmers Industrial pollution	Pro: politically popular Con: budgetary cost; may stimulate too much of activity; uncertain effects
Deposit-Refund Systems	* reusable or recyclable * damage function has little slope	Lead-acid batteries Beverage containers Automobile bodies	Pro: deters littering; stimulates recycling Con: potentially high transactions costs
Marketable Permits	* damage function has steep slope * strict control over pollution important * marginal control costs vary across sources	Emissions Effluents Fisheries access	Pro: control over activity; stimulus to technical change Con: potentially high transactions costs;
Reporting Requirements	* damage function unknown or of low slope * strict control over pollution unimportant	Proposition 65 SARA Title III	Pro: flexible, low cost Con: impacts may be hard to predict
Liability	* links between pollution and harm are clear * harms not life threatening	Natural resource damage assessment Nuisance, trespass	Pro: strong incentive where applied Con: assessment and litigation costs can be high; burden of proof large; few applications
Voluntary Programs	* damage functions unknown * seeking control beyond what is required by law	Project XL 33/50 Greenlights	Pro: low cost; many possible applications Con: uncertain and perhaps low effectiveness

Endnotes for Section 3

1. A text of "Reinventing Environmental Regulation" can be found in *DEN*, March 17, 1995, p. E1.

2. The guidelines draw a distinction between "informational measures" and "market-oriented approaches." This report, however, considers information approaches as a type of economic incentive. Information approaches are described in Section 9.

3. For further information on economic incentive provisions in the 1990 Clean Air Act Amendments, see Appendix B of the previous version of this report: EPA (July 1992), *The United States Experience with Economic Incentives to Control Pollution*.

4. For a discussion of the evolution of benefit-cost analysis requirements, see Rusin et al (June 1996).

5. Atkinson and Tietenberg (1991).

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

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

4. FEES, CHARGES, AND TAXES

4.1. INTRODUCTION

A pollution charge is a fee based on the quantity and/or content of pollutants discharged into the environment. A user charge is a fee paid in exchange for use of natural resources or collection or disposal of pollutants. Product charges are imposed on products that are believed to have environmentally harmful effects. Although the terms "fee,""charge," and "tax" are used interchangeably in this Section, they do not all convey the same connotation. Under federal law, a tax is a purely revenue-raising instrument, whereas charges or fees are intended to offset costs to government. Although the different types of fees, charges, and taxes discussed in this Section could be classified in various ways, they may be summarized as follows:

Table 4-1: OVERVIEW OF FEES, CHARGES, AND TAXES IN ENVIRONMENTAL POLICY

Instrument	Description	Examples
Pollution fee	Charge based on the quantity and/or content of pollutants released into the environment	1. Air emissions permit fees in California, Maine, other states 2. Effluent permit fees in Louisiana, California, Wisconsin, other states 3. Solid waste disposal fees
User fee	Fee for the use of resources	1. Water use fees 2. Road congestion fees 3. Grazing fees
Product charge	Charge on a product believed to have environmentally harmful effects	1. Gas guzzler tax 2. CFC tax 3. State taxes on fertilizers 4. State advance disposal fees on tires, motor oil, packaging, other goods
Other fees on environmentally damaging activities	Various mechanisms	1. Wetland development fees 2. Stormwater runoff fees

As discussed in Section 3, most environmental taxes are intended primarily to raise revenue, often to fund environmental protection activities. The economic rationale behind such taxes is that those who cause pollution should bear the costs. Such costs include both damage to the environment and the administrative costs incurred by authorities in regulating polluters. To be economically efficient, environmental taxes should reflect these costs.

Although some charges, especially product charges, have been imposed on the federal level, the majority of them have been introduced on the state or local level. In the case of air and water pollution, the federal government has provided policy guidance on charges, but the states have developed and implemented charges as they have seen fit.

Given the multiplicity of environmental taxes imposed at various levels of government and the frequency with which they are adopted or modified, this Section does not attempt to provide a comprehensive description of all environmental taxes in place in the United States. Its purpose is rather to describe some of the more important taxes to stimulate discussion.

4.2. WATER FEES

Water fees take various forms, including user fees (for groundwater, surface water, or for drinking water supplied by waterworks) and fees for direct or indirect water discharges. Indirect discharges are sent to treatment works. The rationale for water user fees is that water is not a free good but rather a scarce resource that should be priced to avoid inefficient use that can cause environmental problems.[1] The rationale for discharge fees follows from the polluter pays principle as described above. Most water fees are intended primarily to raise revenue, but user fees based on consumption and discharge fees based on volume or toxicity may have some incentive effect.

4.2.1. Indirect Discharge and User Fees

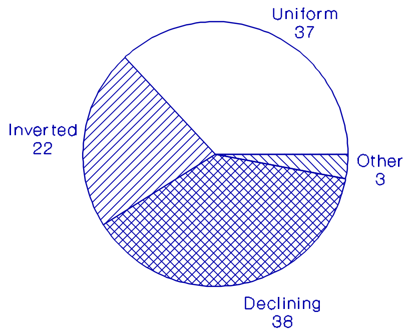
Fees are imposed on households and businesses for discharges into Publicly Owned Treatment Works (POTWs). Some larger businesses' fees are based not only on water use but also on discharge toxicity. To the extent that discharge fees are included in water consumption bills, they can be difficult to distinguish from water user fees.

As shown in Figure 4-1, periodic surveys of selected water utilities indicate that water fees are almost always based at least in part on water consumption. The declining block rate structure is becoming less common, the main reason for the shift being the desire to promote water conservation.

Figure 4-2 indicates that water and wastewater fees have risen significantly during every 2 year period since 1986. These price rises have exceeded inflation.

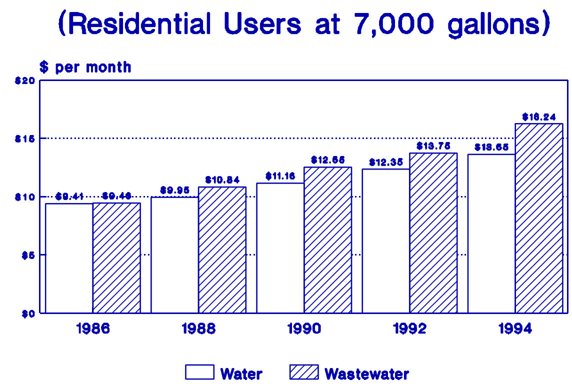
In addition to water and wastewater charges, stormwater charges have been imposed in a number of areas. Ernst and Young found that the number of utilities with such charges increased significantly from 1992 to 1994. Their use varies significantly across regions: They are used by over half of all utilities surveyed in the West but by none surveyed in the Northeast. In some areas, reduced stormwater fees are assessed in return

Figure 4-1: 1994 WATER CHARGE STRUCTURES



Source: Ernst and Young 1994 National Water & Wastewater Rate Survey, p. 7

Figure 4-2: MONTHLY WATER AND WASTEWATER CHARGES



Source: Ernst & Young 1994 National Water & Wastewater Rate Survey, p. 3

for measures to promote stormwater management.[2]

In some states, water user fees generate revenues for drinking water programs. New Jersey, for example, raises $2.8 million annually (out of a total drinking water program budget of $5 million) from a water use tax of $0.01 per 1,000 gallons.[3]

Sims (1977) found that pollutant-based charges provided an incentive for large industrial facilities to reduce discharges. Some studies have found that household water demand elasticity is low in winter but significant in summer, and others have found industrial and agricultural water demand to be sensitive to price.[4] Two European studies cited in Section 9 found residential water demand inelastic, between -0.05 and -0.30.

4.2.2. Direct Discharge Fees

The Federal Water Pollution Control Act of 1972 provides for the regulation of point source discharges through a system of national effluent standards promulgated by EPA. All point sources must obtain National Pollution Discharge Elimination System (NPDES) permits in order to discharge effluent. EPA has authorized 40 states to issue NPDES permits. In the other ten states, EPA regional offices issue the permits. As of July 1995, about 59,000 municipal and industrial facilities in the United States had received NPDES permits.[5]

As shown in Table 4-2, 39 states assessed NPDES permit fees as of December 1993. In 18 of these states, fees varied according to discharge volume, and in an additional 10, fees varied according to discharge volume and toxicity.[6] Other criteria sometimes used in setting fees include the purpose of the water use, the receiving water, and the type of discharger. Some states use point or class systems with various criteria to determine different dischargers' fee levels. Fees for POTWs are sometimes based on the size of the population presumed to be connected to the local sewage system.

Table 4-2: STATE EFFLUENT FEES AS OF DECEMBER 1993

States with effluent fees that are flat or vary only according to industry or size of permittee.	Alabama, Alaska, Delaware, Hawaii, Kentucky, Maine, Massachusetts, Pennsylvania, Rhode Island, Utah, Virginia
States with effluent fees varying according to discharge volume	Arizona, Arkansas, Colorado, Connecticut, Florida, Kansas, Minnesota, Missouri, Nevada, New York, North Carolina, Ohio, Oregon, South Carolina, South Dakota, Tennessee, Vermont, Washington
States with effluent fees varying according to discharge volume and toxicity	California, Indiana, Louisiana, Maryland, Montana, New Jersey, Oklahoma, Texas, West Virginia, Wisconsin

Source: Duhl, p. 10.

4.2.3. Examples of State Effluent Fees: Louisiana, California, and Wisconsin

Although it is beyond the scope of this report to describe all state water effluent fees, examples from Louisiana, California, and Wisconsin should illustrate their characteristics. Louisiana uses water permit fees to fund not only the state permit program but also the activities of the Office of Water Resources of the Department of Environmental Quality. (The legislature no longer provides general revenues to the Office.) The annual permit fee is determined by a worksheet assigning points on the basis of 1) facility complexity, 2) flow volume and type, 3) pollutants released, 4) heat load, 5) potential public health threat, and 6) major/minor facility designation. The points are multiplied by a rate factor of $97.50 per point for municipal facilities and $170.63 per point for industrial facilities to determine total annual fees. The minimum annual fee is $227.50, and the maximum annual fee is $90,000. In addition to annual fees, Louisiana imposes application fees for new, modified, or reissued permits. In most cases, these fees are 20% of the annual fee.

In California, NPDES annual fees are based on the threat to water quality and the complexity of the permit. There are three categories for each characteristic: I, II, and III for water quality threat and a, b, and c for permit complexity. Permittees with a I-a rating, with the greatest threat to water quality and the most complex permits, pay the highest fees, $10,000 a year. III-c permittees pay the lowest fees, $400 a year. These fees fund State Water Board programs.

In addition to the NPDES permit fees, California charges Bay Protection and Toxic Cleanup fees. This fee structure is similar to that of the NPDES permits except that it is also applied to other sources such as storm drains, boat construction and repair facilities, marinas, dredging operations, and beach replenishment activities. Another difference is that its revenues fund the Bay Protection and Toxic Cleanup Program designed to identify hot spots, develop a water quality database, and help coordinate water policy. Bay Protection and Toxic Cleanup fees range from $300 for III-c permittees to $11,000 for I-a permittees. Dredging operations are charged an annual fee of up to $15,000.[7]

(Bay Protection and Toxic Cleanup fee schedule: www.swrch.ca.gov/pub/FEES/feebptc.zip)

The Wisconsin effluent fee system is believed to have potential incentive effects. Since the fee rate per pound of pollutant is inversely related to the permit limit for the pollutant, the most harmful pollutants are taxed at the highest rate. Pollutant loadings are calculated on the basis of flow and concentration information contained in wastewater monitoring reports. Polluters are thereby encouraged to reduce both the quantity and the toxicity of pollutant releases.

The primary purpose of NPDES permit fees is to raise revenue, especially for the permitting program, which explains why fees are often based on permit complexity. In a number of states, fees are set to attain revenue targets.

A secondary purpose is to discourage water pollution. Although the incentive effect of water effluent fees in the United States has not been comprehensively studied, several factors limit the likelihood of a strong impact. In some cases, fees are based not on actual discharge characteristics but rather on proxies for discharge data. Moreover, some fee structures place dischargers into classes for the purposes of discharge volume and/or toxicity and charge the same fees for all volume and toxicity levels within given classes. In such cases, polluters have no incentive to limit discharges unless they can move from one class to another. Finally, the charges are often modest relative to control costs. As of 1993, the largest effluent fees in the United States, paid by two facilities in New Jersey, amounted to $702,812, and most states had maximum fee levels of less than $100,000. For large facilities, annual effluent control costs typically exceed $5 million.

4.2.4. Stormwater Runoff Fees

It is common practice for counties to impose fees on real estate developments based on surface area runoff (paved areas and areas under roof). Fee revenues are used for stormwater management in stream valleys. These fees differ from the utility stormwater fees described above in that they apply to runoff into surface water.

4.3. AIR FEES

As is the case with water pollution, there are no national air emissions fees. However, the Clean Air Act Amendments of 1990 provided for permit fees and for mandatory excess VOC fees in ozone non-attainment areas.

4.3.1. Permit Fees

The 1990 Clean Air Act Amendments require states to impose permit fees to recover the administrative costs of their EPA-approved operating permit programs. The Amendments set the minimum presumptive level for such fees at $25 per ton of emissions of criteria air pollutants (excluding carbon monoxide) and air toxics and specified that this amount should be adjusted for inflation. Each state is required to set fees to completely cover operating permit program costs. If the fees are greater than or equal to $25 per ton adjusted for inflation (currently about $30 per ton), EPA assumes that they are adequately high. States with lower fees must present detailed evidence that fee revenues are sufficient to cover their operating permit program costs. Several state permit programs have been denied EPA full approval because insufficient information was submitted on fee adequacy. These states have received interim approval pending submission of evidence of fee adequacy.

Although states can meet the revenue-raising requirement through flat or other types of fees, most have chosen incremental fees of approximately $20-30 per ton. Some states base fees on the pollutant's potential harm to the environment. New Mexico, for example, charges fees of $150 per ton for air toxics but only $10 per ton for criteria pollutants[8]. Fee structures in Maine and Southern California are discussed here for illustrative purposes.

4.3.1.1. Air Emission Permit Fees in Maine

In November 1993, Maine raised its air emission permit fees from $2 to $5 per ton for emissions up to 1,000 tons, from $4 to $10 per ton for emissions between 1,001 and 4,000 tons, and from $8 to $15 per ton for emissions in excess of 4,000 tons. The minimum charge rose from $100 to $250, and the maximum charge rose from $100,000 to $150,000. The fees cover sulfur oxides, NO_x, VOCs, and particulate matter. Having since been adjusted for inflation, their current levels are shown in Table 4-3. The fees apply to all permit holders, of which there are currently 517.

Maine has also imposed an air quality surcharge based on toxicity of emissions. The magnitude of the surcharge is determined on the basis of several criteria. Approximately 85 facilities are subject to the tax, which is capped at $50,000. Before the adoption of the surcharge, the Director of Maine's Air Quality Bureau said it would give polluters an incentive to identify methods of reducing their emissions of the most toxic substances. An Air Quality Bureau official says that surcharge revenues have fallen and that the surcharge has had a slight incentive effect, but the impact is difficult to isolate from other potential factors such as the Toxic Release Inventory. Annual revenues are approximately

$1.8 million from permit fees and $0.6 million from toxicity surcharges. Revenues are used for the air permit program and other air quality activities

Table 4-3: AIR EMISSIONS PERMIT FEES IN MAINE
(in dollars per ton)

Amount emitted	Fee
up to 1,000 tons	5.28
1,000-4,000 tons	10.57
more than 4,000 tons	15.85

Source: Limouze, Maine Air Quality Bureau

.[9]

4.3.1.2. Air Emission Permit Fees in the South Coast Air Quality Management District

The South Coast Air Quality Management District (SCAQMD, located in Southern California) levies the highest unit air emissions fees in the United States. The fees shown in Tables 4-4 and 4-5 are adjusted for inflation every May.[10]

Facilities that temporarily exceed their allowable emissions levels must pay excess emissions fees. For most pollutants, the excess emissions fees are about the same as the regular fees. For carbon monoxide, however, they are approximately twice as high. In addition, SCAQMD imposes fees for visible emissions and various administrative procedures[11].

(www.aqmd.gov/rules/html/r303.html)

Given the presence of command-and-control regulations and other factors that might influence air pollutant emissions, the incentive effect of the SCAQMD emissions fees would be difficult to determine. In most cases, these fees are lower than marginal pollution abatement costs. The main purpose of the fees is to recover the administrative costs of SCAQMD's activities.

Table 4-4: EMISSION FEES IN SCAQMD
($ per ton)

Annual Emissions	Organic Gases	Specific Organics[12]	Nitrogen Oxides	Sulfur Oxides	Particulate Matter
4-25 tons	$274.47	$49.16	$156.70	$190.49	$209.95
25-75 tons	$445.50	$77.83	$255.01	$308.27	$340.01
>75 tons	$666.72	$116.75	$384.05	$461.89	$509.00

Source: SCAQMD Rule 301 (www.aqmd.gov/rules/html/r301.html)

Table 4-5: AIR TOXICS AND OZONE-DEPLETING CHEMICALS FEES IN SCAQMD
($ per pound)

Pollutant	FY96-97	FY97-98
Asbestos, cadmium	$2.17	$3.00
Benzene, carbon tetrachloride, ethylene dibromide, ethylene dichloride, ethylene oxide	$0.90	$1.00
Methylene chloride	$0.05	$0.05
Hexavalent chromium	$2.67	$4.00
Chlorinated dioxins and dibenzofurans	$3.17	$5.00
Nickel	$1.67	$2.00
1,3-Butadiene, inorganic arsenic, beryllium, polynuclear aromatic hydrocarbons (PAH)	$1.50	$3.00
Lead, vinyl chloride	$0.50	$1.00
1,4-Dioxane	$0.11	$0.21
Formaldehyde, perchloroethylene	$0.21	$0.21
Chlorofluorocarbons	$0.18	$0.18
1,1,1-trichloroethane	$0.038	$0.40

Source: SCAQMD Rule 301 (www.aqmd.gov/rules/html/r301.html)

4.3.1.3. California "Hot Spots" Fees

The California Air Toxics "Hot Spots" Information and Assessment Act (AB 2588) requires facilities to report the type and quantity of certain substances they release into the air. The program is administered by the California Air Resources Board (CARB). The law also requires CARB to develop and adopt fees to cover administrative costs of the program incurred by CARB and local air districts. Districts can either set their own fees or request that CARB set fees for them. Each district is responsible for billing and collecting the fees and remitting the district's share of state costs to CARB. The information component of this law is discussed in Section 9. The fees are discussed here.

(CARB Hot Spots description: arbis.arb.ca.gov/toxics/ab2588/2588summ.txt)

CARB's Hot Spots fee structure, which is used in 12 of California's 34 air pollution control districts, is no longer based on tonnage of emissions. However, at least two of the 22 districts setting their own fees base them on amounts and toxicity of pollutants and one bases its fees on amount but not toxicity[13]. The toxicity-based fee structure of the Bay Area Air Quality Management District (BAAQMD) is described here.

BAAQMD bases fees on Unit Risk Values (URVs) for carcinogen emissions and Acceptable Exposure Levels (AELs) for other emissions. Fee amounts depend on quantities of weighted emissions. For carcinogens, weighted emissions are determined by multiplying the amount of each substance by 100,000 times its URV (in m^3/microgram). For other toxics, weighted emissions are determined by multiplying the amount of each substance by the reciprocal of its AEL (in m_3/microgram). The sum of the weighted emissions of all toxics is multiplied by a coefficient to calculate each source's fees. The coefficient varies from year to year depending on the costs incurred by CARB and BAAQMD in managing the Hot Spots program.

Facilities with fewer than 50 weighted pounds pay no fees, and facilities with weighted emissions between 50 and 1,000 pounds pay a fee of $125. For gasoline dispensing facilities, the fee is simply $5 for each dispensing nozzle. For small businesses, which are defined as having no more than 50 employees and $5 million in annual receipts, fees are capped at $5,000. Government facilities are also subject to the fees. Although there is no maximum for larger businesses, no source has paid more than $60,000 in annual fees. In 1992, about 1,200 facilities paid $1.16 million in fees.

A total of 81 toxics are subject to the fees. Emissions usually are not measured but rather estimated on the basis of toxics use data and emissions factors that depend on the abatement equipment.[14]

Although fee amounts appear relatively small for larger businesses, BAAQMD officials believe that the fees have contributed to a decrease in toxic emissions. Facilities have lowered emissions in various ways, including process changes and toxics use reduction. When toxicity-based fees were adopted in 1992, for example, hospitals and metal plating facilities emitted relatively large amounts of ethylene oxide and hexavalent chromium. Since these substances have high URVs, emitting facilities faced high fees. Most of these facilities installed Best Available Control Technology soon after the structure was adopted.[15]

However, it is difficult to isolate the effects of the fees from other factors that could influence toxic emissions, including the information and reductions planning components of the Hot Spots program and federal TRI requirements. In addition, refineries have made large investments to comply with reformulated fuel and fugitive emissions standards.[16]

4.3.2. Ozone Non-Attainment Area Fees

The 1990 Clean Air Act Amendments also provide for excess VOC emissions fees in areas with dangerously high levels of ozone. To give these areas time to reduce their ozone levels, the fees will not enter into effect until the next century. Areas with ozone design values of 0.18 to 0.19 ppm have 15 years to comply with ozone standards; areas with values of 0.19 to 0.28 ppm have 17 years; and areas with values over 0.28 ppm, referred to as extreme ozone non-attainment areas, have 20 years. (California's South Coast Air Quality Management District is currently the only extreme non-attainment area.) Failure to attain specified levels by the deadlines will subject major stationary sources to VOC emissions fees of $5,000 (adjusted for inflation) for each ton emitted in excess of 80% of a baseline quantity.[17]

4.4. WASTE FEES

This subsection briefly discusses variable rate programs (a relatively new trend in household waste collection), landfill taxes, and hazardous waste disposal taxes. As discussed below, such taxes can reduce waste generation, but they also create incentives to dispose of waste illegally or in other locations where disposal is cheaper.

4.4.1. Variable Pricing Programs

Communities throughout the United States have traditionally levied fixed collection fees for household waste or included the collection costs in property taxes. Such pricing practices are inefficient in that the marginal price for the household is zero, whereas the marginal collection cost is positive.

However, a growing number of communities are now charging for solid waste collection based on the volume generated by the household. Such variable rate (or "pay-as-you-throw") programs have been implemented in over 3,400 communities in 37 states, reaching an estimated 11% of the U.S. population. Four states have mandated the use of variable rate programs in some or all of their municipalities. Washington's law applies mostly to private collectors operating in unincorporated areas of the state, but virtually all municipalities in the state use variable rates. Iowa and Wisconsin require variable rates only in communities that fail to attain a 25% waste recycling / diversion goal by certain deadlines. In Minnesota, variable rates are required in all communities.[18] EPA is also encouraging variable rates and has held a series of workshops to explain their advantages and disadvantages and provide information on how to implement them. The report inventory on the EPA Economy and Environment World Wide Web site includes several of the documents cited in this subsection on variable rates.[19]

(Economy and Environment doc site: www.epa.gov/docs/oppe/eaed/eedhmpg.htm)

Variable rate programs can take several forms. Pre-paid garbage bags or stickers to affix to bags can be required for collection, or collection fees can be based on the number and/or size of cans. Some areas have weight-based systems. Others have mixed systems combining a fixed rate up to a certain amount of garbage and incremental rates for amounts in excess of the minimum covered by the flat rate. Such mixed systems are becoming increasingly common, perhaps because they are relatively easy and inexpensive to implement, provide a stable source of revenue for collection services, have the potential to reduce illegal dumping, and offer a minimum level of free service to many customers[20]. According to one source, collection systems that require periodic billing of customers are likely to be administratively more expensive than bag or sticker systems[21]. One disadvantage of bags is that they can tear, especially if handled improperly or penetrated by animals. Table 4-6 shows variable rate structures in various U.S. communities.

Table 4-6: VARIABLE RATE STRUCTURES IN SELECTED COMMUNITIES

Community	Fee structure
Glendale, CA	65-gallon cart: $6.45/month, 2¢/gallon 100-gallon cart: $10.10/month, 2¢/gallon
Pasadena, CA	60-gallon cart: $10.41/month, 4¢/gallon 100-gallon cart: $16.23/month, 4¢/gallon 2 60g carts: $19.01/month, 4¢/gallon 60g & 100g cart: $22.40/month, 4¢/gallon 2 100g carts: $28.62/month, 3¢/gallon
San Jose, CA	32-gallon cart: $13.95/month, 10¢/gallon 64-gallon cart: $24.95/month, 10¢/gallon 96-gallon cart: $37.50/month, 10¢/gallon 128-gallon cart: $55.80/month, 10¢/gallon
Santa Monica, CA	40-gallon cart: $14.85/month, 9¢/gallon 68-gallon cart: $17.76/month, 7¢/gallon 95-gallon cart: $21.07/month, 6¢/gallon 68g & 95g cart: $37.28/month, 5¢/gallon
Oakland, CA	20-gallon can: $10.08/month, 13¢/gallon 1st 32-gallon can: $13.74/month, 11¢/gallon Each extra 32g can: $16.49/month, 13¢/g

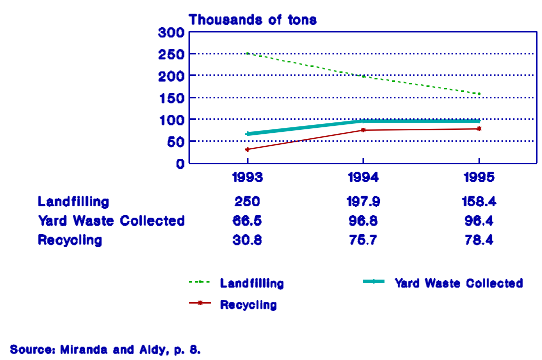
Community	Fee structure
Portland, OR	20 gallon can: $14.60 / month, 18¢ / gallon 32 gallon can: $17.60 / month, 14¢ / gallon 35 gallon cart: $19.30 / month, 14¢ / gallon 60 gallon cart: $24.05 / month, 10¢ / gallon 90 gallon cart: $27.10 / month, 8¢ / gallon
Tacoma, WA	60 gallon can: $17 / month, 7¢ / gallon 90 gallon can: $25.50 / month, 7¢ / gallon
Spokane, WA	20 gallon can: $8.56 / month, 11¢ / gallon 1st 30 gallon can: $11.07 / month, 9¢ / gallon Each extra 30g can: $6.01 / month, 5¢ / gallon
Colorado Springs, CO[22]	1 34g can + 1 30g bag: $9.50 / month, 4¢ / g 2 cans and 2 bags: $11 / month, 2¢ / gallon 3 cans and 3 bags: $13 / month, 2¢ / gallon
Downers Grove, IL	30-gallon bag: $1.50, 5¢ / gallon
Grand Rapids, MI (City)	30-gallon bag: $0.85, 3¢ / gallon 30-gallon can: $44.20 / year, 3¢ / gallon
Grand Rapids, MI (Waste Management)	64-gallon cart: $15 / month, 6¢ / gallon 104-gallon cart: $17 / month, 4¢ / gallon
Grand Rapids, MI (Able)	90-gallon cart: $17.35 / month, 5¢ / gallon
Hoffman Estates, IL	30-gallon bag: $1.45, 5¢ / gallon
Lansing, MI (City)	30-gallon bag: $1.50, 5¢ / gallon
Lansing, MI (Waste Management)	63-gallon cart: $12 / month, 5¢ / gallon 104-gallon cart: $15 / month, 4¢ / gallon
Lansing, MI (Granger)	60g cart: $11 / month, 5¢ / gallon 90g cart + 3 30g bags: $13.40 / month, 2¢ / g
Woodstock, IL	30-gallon bag: $1.56, 5¢ / gallon

Sources: Miranda and Aldy; Bauer and Miranda

Table 4-6 shows that communities vary as to whether the city and / or private haulers collect waste. Waste collection systems can be open systems or exclusive franchises. In open systems, the city may provide optional waste collection (e.g., Grand Rapids, Lansing) or it may leave collection completely in the hands of private firms (e.g., Colorado Springs). In exclusive franchises, collection can be done either by the city (e.g., Spokane, Tacoma) or by one or more contracted haulers (e.g., Oakland). In both open and franchise systems, communities can set rules regarding collection fees. In St. Paul, Minnesota, for example, the city operates no collection program but requires that collectors charge variable rates, and Portland's open system has no city program but sets collection fees charged by private haulers.

Many communities with variable rates implement public education, curbside recycling, yard waste, white goods, and holiday greenery programs as well. Education has been found to be an important element in the success of variable rate programs. The collection frequency, fees, materials collected, and participation requirements for curbside recycling, yard waste, white goods, and holiday greenery collection programs vary across communities. These complementary activities can have an important impact on the success of variable rate programs.

Figure 4-3: HOUSEHOLD WASTE LANDFILLING AND RECYCLING IN SAN JOSE



San Jose, California began its variable rate program in 1993. The city has contracted its waste collection and curbside recycling services to two different firms, one serving the approximately 80,000 single-family households in the northern half of the city as well as all multi-family housing and another serving about 105,000 single-family households in the southern half of the city. A combination cart/sticker system is used to price household waste collection. Residents subscribe to specific cart sizes and pay the fees shown in Table 4-6 for weekly collection of the waste in these carts. When they have too much garbage for their cart sizes, they can put the excess garbage in 32-gallon plastic bags provided the bags each bear a sticker sold for $3.50 at local libraries, supermarkets, and convenience stores. Multi-family dwellings pay flat fees. One potential advantage of the stickers is that they give households the flexibility to exceed planned waste generation rates on occasion. San Jose also offers free curbside collection of recyclables since 1987 and yard waste and collects white goods for a separate fee of $18 for up to three items. Figure 4-3 suggests that the variable rate program has significantly reduced the amount of waste landfilled and increased the amount recycled. The amount of yard waste set aside for collection and subsequent composting also increased.

The variable rate systems described thus far base prices on waste volumes. Another, less common price basis is weight. Communities that have implemented waste-based pricing include Seattle, Milwaukee, Minneapolis, Durham (NC), Columbia (SC), and Farmington (MN). Such systems could have a stronger incentive effect by charging for every additional unit of weight and discourage consumers from compacting trash into containers. Seattle's weight-based scheme lowered the weight of garbage collected by 15%. One disadvantage of weight-based systems is that they tend to be more complicated, requiring more equipment and increasing the time needed to collect waste. Seattle, for example, found that collection times were extended by 10% under its weight-based system. But increased implementation costs could be offset by decreases in the weight of garbage collected.[23]

In most areas where variable rate programs have been introduced, amounts of waste collected have decreased significantly. A 1992 survey of 14 cities with variable rate programs found that the amount of waste destined for disposal decreased by an average of 44%.[24] A study in Maine found that municipalities with variable rate systems disposed of less than half as much waste per capita as municipalities without such systems.[25] Surveys in Tompkins County, New York and Dover, New Hampshire found that variable rates led consumers to think of ways to reduce waste generation, including altering their purchasing habits. A 1996 study of four communities in California and five in the Midwest found that they achieved reductions in waste disposal of 6% to 50% after introducing variable rate systems. The higher the unit prices, the greater the reductions. Moreover, reductions were greater in those communities with relatively small minimum container sizes. (Some variable rate structures are more variable than others.) If the minimum container size is too large, consumers often have little incentive to alter their behavior.[26]

As shown in Table 4-7, another study found reductions in tons of waste landfilled ranging from 17% to 74% following the adoption of variable rates in 21 northern cities. The study found the magnitude of the unit prices to be positively correlated with the change in the amount of waste recycled and negatively correlated with the change in the amount of waste landfilled.

The recycling increases shown in Table 4-7 were achieved in areas that did not simultaneously implement recycling programs. In places where the adoption of variable rate programs has coincided with new public recycling activities, however, it may be difficult to determine how much of the decline in waste disposal is due to the variable rates and how much is due to the new recycling alternatives. The Dover survey found that curbside recycling programs alone encouraged recycling but that variable rates provided additional incentive.[27] Another study estimates that a variable rate program will increase the percentage of waste diverted under existing recycling programs by 4-13%.[28]

Table 4-7: CHANGES IN WASTE DISPOSAL IN RESPONSE TO VARIABLE RATE PRICING PROGRAMS[29]

Municipality	% Reduction in tons of waste landfilled	% Increase in tons of waste recycled
Antigo, WI	50	145
Charlemont, MA	37	N/A
Downers Grove, IL	52	N/A
Grundy Center, IA	32	N/A
Hancock, VT	33	N/A
Hartford, VT	17	29
Harvard, IL	33	113
High Bridge, NJ	18	N/A
Huntingburg, IN	74	N/A
Illion, NY	51	141
Ithaca, NY	31	63
Lisle, IL	53	N/A
Mt. Pleasant, IA	49	N/A
Mt. Pleasant, MI	44	141
Perkasie, PA	54	157
Plains, PA	49	88
Quincy, IL	41	45
River Forest, IL	19	N/A
St. Charles, IL	41	456
Weathersfield, VT	36	150
Woodstock, IL	31	N/A

Source: Miranda, reprinted in Arner and Davis, p. 4.

Despite the evidence cited above, variable rate programs are not without problems. Data on decreases in collection can be misleading if the programs result in significant illegal disposal or diversion to cheaper disposal services. Illegal dumping includes direct discharge to the environment as well as placing waste in someone else's container or donating unrepairable items to charitable organizations. Direct discharge to the environment is likely to be of more concern than other types of illegal disposal. The Maine study found that an increase in backyard burning and a slight increase in roadside dumping and illegal disposal in commercial containers coincided with variable rate systems. Of the cities surveyed in the 14-city study mentioned above, "six cities reported no problem with dumping, four reported minor problems, and four reported notable problems." Among the measures cited to limit illegal disposal are creation of viable recycling alternatives, public education, the locking of commercial dumpsters, high dumping fines, and minimum flat collection fees.[30]

Other problems that need to be addressed in designing and managing variable rate programs are that they can be difficult to implement in multi-family housing such as apartments and that they can have a regressive effect on the poor and large families. In addition, the programs can lead to significant decreases in revenue for municipal waste collectors. The magnitude of these decreases can be difficult to predict.[31]

Variable rate programs may not be appropriate for all communities. Analysts assert that variable rate pricing is unlikely to be successful in areas with affordable and environmentally acceptable landfill disposal options, lack of nearby recycling possibilities, nearby open spaces for easy illegal dumping, and lack of consumer willingness to pay variable rates[32]. In some areas, however, they appear to be beneficial. According to a World Resources Institute (WRI) study, "Where landfill costs are high, disposal charges would generate net economic savings of $0.17 for every dollar of revenue collected, even after the gross costs of curbside recycling programs were paid."[33]

4.4.2. Landfill Taxes

According to the National Recycling Coalition, surcharges on waste delivered to landfills have been imposed in over 20 states.[34] If operators are capable of passing on such taxes to their customers in their tipping fees, landfill taxes could have effects similar to variable rate programs.

New Jersey levies three different landfill taxes: a Solid Waste Services Tax of $1.05 per ton, a Landfill Closure and Contingency Tax of $0.50 per ton, and a Solid Waste Recycling Tax of $1.50 per ton. For waste in liquid form, the rates are 0.002 cents per gallon for the Solid Waste Services Tax and the Landfill Closure and Contingency Tax and 0.00225 cents per gallon for the Solid Waste Recycling Tax.[35]

In Pennsylvania, counties are required to create trust funds to finance the costs associated with closing landfills. The amount paid into the fund is a tonnage fee depending on the estimated cost of closing the landfill and the weight of the garbage to be disposed of at the landfill before it is closed.

Texas levies a fee of $1.50 per ton on all municipal solid waste disposal. Fee revenues are used to fund state solid waste control activities and to provide grants to local governments and other organizations for resource recovery, waste minimization, and waste facility efficiency enhancement programs.[36]

It is unclear whether these fees have produced a significant incentive effect. However, the District of Columbia's experiences with its nearby Lorton, Virginia landfill illustrate one of the drawbacks of increasing waste disposal fees. Of the $64.39 per ton tipping fee at Lorton, $28.39 per ton was reserved for the District's residential recycling program. Private trash haulers have reportedly trucked waste to landfills elsewhere in Virginia and southern Pennsylvania, where tipping fees are lower. The resulting loss in tipping fee revenue led the District to suspend its recycling program in 1995. It subsequently re-established the program but with reduced service. Because of the instability of tipping fee revenues, the District now relies on general revenues to fund the recycling program[37]. As is the case with variable rate programs, other measures that increase incremental waste disposal prices create incentives to use alternative disposal options.

4.4.3. Hazardous Waste Taxes

A number of states, 31 as of 1990, impose taxes on the generation or management of hazardous wastes. Some of these have higher tax rates for land filling than for incineration, and several states impose no tax on incineration. In some states, taxes vary according to the type of waste and/or whether the waste was generated outside the state. In addition, on-site disposal is exempt in some states. In 1990, Vermont and California each had taxes of over $100 per ton for land disposal, and six other states had taxes of over $50 per ton. The mean tax level for all states, including those with no tax, was $21 per ton. To put these taxes into perspective, a middle-of-the-range estimate of hazardous waste disposal costs in the late 1980s was $132 per ton.

As shown in table 4-8, for example, hazardous waste disposal fees range up to $220 per ton in California.[38] Table 4-9 shows the generation fees in effect in the state, which are fixed within a given generation range.

Table 4-8: HAZARDOUS WASTE LAND DISPOSAL FEES IN CALIFORNIA, FY 1996

Waste Category	Rate ($/ton)
Non-RCRA cleanup wastes	7.50
Other non-RCRA wastes	17.94
Ores and minerals	14.30
Extremely hazardous waste	220.00
Restricted hazardous waste	220.00
Hazardous waste (RCRA)	44.44

Source: California Department of Toxic Substances

Table 4-9: HAZARDOUS WASTE GENERATION FEES IN CALIFORNIA, CY 1996

Generator Size (tons / year)	Fee ($)	$ / ton (mid-range)
less than 5	0	0
5 to 25	169	11.3
25 to 50	1,348	35.9
50 to 250	3,371	22.5
250 to 500	16,855	44.9
500 to 1,000	33,710	44.9
1,000 to 2,000	50,565	33.7
more than 2,000	67,240	<33.7

Source: California Department of Toxic Substances

According to the California Department of Toxic Substances Control, the fees above are intended to raise revenue and to encourage waste minimization. Tonnage has declined in the last ten years, but it is difficult to determine to what extent this decline is due to the fees, as many other factors could influence generation and disposal practices.

Hazardous waste is also subject to numerous other administrative fees in California. Efforts are currently being made to simplify the existing fee structure, which is widely viewed as too complicated.[39]

The findings of several studies suggest that hazardous waste taxes have a impact on disposal. In the 1980s, two engineering studies, one by CBO and one by EPA, concluded that such taxes significantly reduced land disposal. By 1987, ten states had taxes exceeding the level at which EPA predicts a 60% reduction in land disposal. Another study examined empirical evidence on the effects of a two-fold rise in hazardous waste taxes in New York in 1985 and found that the quantity of hazardous waste disposed of in the state decreased significantly. Because taxes on incineration remained constant in this case, the amount of waste incinerated rose but not as much as the amount of waste landfilled fell.

Sigman (1996) studied the impact of landfilling and incineration taxes on the generation of four types of chlorinated solvent wastes from metal cleaning. Using data from the 1987-1990 Toxic Release Inventories, the study includes a cross-section analysis of generation across states, using a number of independent variables, including disposal taxes in the state of generation and in neighboring states. It also studied the impact of disposal taxes and other factors on the choice of disposal method. The study found that elasticities of waste generation with respect to taxes on incineration were in the range of -7 to -22 and that the taxes encouraged generators to choose incineration or other treatment over landfilling as their waste management method. However, the impact of the taxes was estimated to be minor because they were small relative to total waste management costs.

Although "[s]tates' experience suggests that taxes may provide an alternative to the standard-based policies now used for most hazardous waste regulation," Sigman found, the design and implementation of such taxes pose several potential problems, including the determination of tax levels. Taxes should reflect the social cost of hazardous waste generation, but this cost depends on the type of waste, method of disposal, geographic location, and various other factors that are difficult to assess and incorporate into tax structures. Moreover, if taxes are too high, they could encourage illegal dumping, of which even a small amount could cause enough environmental damage to offset the increased efficiency achieved by taxes. "In the presence of illegal dumping," the study states, "a deposit/refund program may be substantially less costly than a waste-end tax."

Another problem is that current federal regulations impose high management costs that may already provide sufficient incentives to reduce hazardous waste. If existing (command-and-control) incentives are sufficient, taxes could raise waste disposal costs to a level that is higher than socially desirable.

4.5. PRODUCT CHARGES

Product charges are imposed either on a product or some characteristic of that product. Products that are believed to have environmental disadvantages are taxed to reflect the added social costs they impose. Although some product charges may have a significant effect on behavior, most of them are intended primarily to raise revenue. Some product charges take the form of advance disposal fees (ADFs), or taxes on a product to fund its proper disposal after its use.

4.5.1. Federal Product Charges

Unlike water, air, and waste fees, a number of product charges have been imposed on the national level. Subject to these taxes are fuels, transportation, transport equipment, and chemicals. Most of these taxes are intended to raise revenue; they have minimal incentive effect.[40] The following paragraphs discuss the Superfund taxes as well as taxes on fuel-inefficient automobiles and chlorofluorocarbons.

4.5.1.1. Superfund Taxes

Used to fund the cleanup of inactive hazardous waste disposal sites, the federal Superfund was until the end of 1995 financed by taxes on crude oil (9.7 cents per barrel), chemicals ($0.22-$4.87 per ton), and gross business profits (0.12% of amounts over $2 million).[41] The oil and chemical taxes could be regarded as product charges, but their purpose is to raise revenue rather than prevent pollution.

4.5.1.2. Taxes on Fuel-Inefficient Automobiles

Introduced in 1978, the gas guzzler tax applies to all automobiles with a fuel efficiency of less than 22.5 miles per gallon. The magnitude of the tax ranges from $1,000 to $7,700 per automobile, depending on fuel efficiency. Revenues, which amounted to $144.2 million in 1992, contribute to the Highway Trust Fund.[42] According to EPA, most gas guzzler tax payments have been for foreign luxury cars.[43]

Two measures that could have effects similar to gas guzzler taxes are fines for failure to meet corporate average fuel efficiency (CAFE) standards and luxury car taxes. CAFE fines, which could be regarded as non-compliance fees, are based on the extent to which an automaker violates CAFE standards. Luxury taxes are set at 10% of the sales price of a car in excess of a base level (originally $30,000 and currently $34,000). Since many luxury cars are relatively fuel-inefficient, luxury taxes could encourage the use of fuel-efficient vehicles.

4.5.1.3. Ozone-depleting Chemicals

In accordance with the terms of the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer and subsequent amendments, production of ozone-depleting chemicals such as chlorofluorocarbons (CFCs) for most uses in the United States was phased out by January 1, 1996.[44] To facilitate the phaseout, the United States imposed a tax on selected CFCs on January 1, 1990 and expanded the tax to other CFCs the following year. The magnitude of the tax was determined by multiplying a base rate per pound by an ozone depletion factor that varied according to the type of chemical. Initially set at $1.37 per pound, the base tax amount increased to $3.35 in 1993, $4.35 per pound in 1994, and $5.35 in 1995. The ozone depletion factors, which are intended to indicate each chemical's damage to the ozone layer, were set by the Montreal Protocol. For example, methyl chloroform had a factor of 0.1, whereas Halon-1301 had a factor of 10.0. The tax was imposed on the production and importation of these chemicals as well as the importation of products which contained them or used them in their production processes.[45]

Unlike most product charges, this tax is widely credited with a significant incentive impact. CFC consumption (expressed in CFC-11 equivalents) fell from 318,000 metric tons in 1989 to 200,000 metric tons in 1990, the year the tax was introduced[46]. A Congressional Research Service (CRS) study concluded, "the CFC tax has clearly accelerated the rate at which CFC uses are being substituted for and the rate at which CFCs are being recovered for reuse." CRS adds that the tax was also intended to raise revenue for the federal government and to capture CFC producers' windfall revenues resulting from a tightening supply situation.[47]

According to the World Resources Institute (WRI), the tax raised $2.9 billion in its first five years. WRI adds that the phaseout cost less than EPA's original projection. In 1988, EPA predicted that the average cost of halving CFC use would be $3.50 per kg. In 1992, the predicted cost was only $2.45 per kilogram.[48]

Although the tax is believed to have contributed significantly to the reduction in CFC use, other factors also had an impact, including a CFC trading system (described in Section VI), well-publicized CFC phaseout intentions, and EPA's work with the private sector on CFC recycling and substitutes. As a result of the multiplicity of policy measures, it is difficult to isolate the effects of the CFC tax.

4.5.2. State Product Charges

States have imposed charges on a number of products, including beverage containers, fertilizers, furniture, motor oil, pesticides, refrigerators, solvents, and tires. Many of these have taken the form of advance disposal fees (ADFs). This subsection describes charges that have been imposed on different products.

4.5.2.1. Tire Charges

Fees have been imposed on automobile tires in 34 states. The fees generally range from $0.25 to $2.00, but Texas has a fee of $3.50 on truck tires. Some of the fees are assessed as a percentage of sales price.[49] Fee revenue is typically used to finance the disposal of used tires, which may include the cleanup of tire disposal sites. Given the low magnitude of the charge levels relative to the price of tires and the lack of substitutes for tires, the incentive effect of state tire charges is likely to be minimal. As shown in Table 4-7, the Federal Government also imposes product charges on tires ranging from $0.15 to $0.50 per pound, but revenues from these charges are allocated to the Highway Trust Fund.[50]

4.5.2.2. Fertilizer Charges

Product charges have been imposed on fertilizers in 46 states. Nebraska's fee of $4 per ton is one of the highest; most are below $1 per ton. Assuming fertilizer prices of $150-$200 per ton, the charges are too low to significantly influence fertilizer use. The most common use of charge revenues is inspection of fertilizers.[51]

4.5.2.3. Rhode Island Hard-to-Dispose Material Tax

Rhode Island imposes products charges on "hard-to-dispose material": lubricating oil, antifreeze, organic solvents, and tires. The amounts are 5¢ per quart of lubricating oil, 10¢ per gallon of antifreeze, 1/4 of one cent per gallon of organic solvents, and 50¢ per tire. Although incentive effects are assumed to be minimal, the charge incorporates at least some of the disposal costs of various materials into their prices. Charge revenues are deposited in a "hard-to-dispose material account" to fund educational and technical assistance programs, grants, research, and collection centers for hard-to-dispose material.[52]

Table 4-10: PRODUCT CHARGES ON TIRES

Taxing authority	Magnitude of tax	Uses of revenues
Federal Government	Tires 40-70 lbs: $0.15 / lb x weight exceeding 40 lbs Tires 70-90 lbs: $4.50 + $0.30 x weight exceeding 70 lbs >90 lbs: $10.50 + $0.50 x weight exceeding 90 lbs	Highway Trust Fund
State Governments (34)	$0.25 to $2.00	Tire recycling, tire disposal site cleanup, other similar activities

Source: Fullerton, p. A7; *Scrap Tire News Legislative Report*, pp. 18-19.

4.5.2.4. Florida ADF

On October 1, 1993, an ADF of $0.01 went into effect on a variety of containers in Florida. Exempted from the tax were containers made of plastic, plastic-coated paper, and glass with average recycling rates of at least 50%, glass containers with a 35% recycled content and plastic containers with a 25% recycled content. Paper and plastic packaging were also subject to the ADF, with exemption possibilities similar to those for glass and plastic containers. Since the Florida Department of Environmental Protection determined that aluminum and steel cans had already fulfilled the 50% requirement, they were exempt from the tax.[53] To further encourage recycling, legislation called for the tax to be doubled in January 1995.

Despite the low fee level, manufacturers reportedly went to considerable trouble to obtain exemptions. Their efforts appear to have been due more to the public relations value of exemption than to the ADF itself.[54]

One interesting aspect of this ADF is the wide range of options that it gave manufacturers to obtain exemptions. These options included working with other firms in the same sector to raise recycling rates, increasing the recycled content of packaging, averaging recycled content over various containers, and recycling into other products equivalent amounts of previously discarded waste. In theory, the variety of options should have allowed each firm to select a relatively cost-effective way to promote recycling. Most firms sought exemption based on use of recycled content. However, at least two companies, Piper Plastics and Anheuser-Busch, have built or planned to build recycling facilities.

Both companies cited the ADF as the decisive factor in their decisions to build in Florida.[55]

One disadvantage of including various exemption possibilities into the ADF was the potential administrative burden of assessing requests for exemptions. At least one industry group criticized the ADF as deceptive, burdensome, and administratively costly. The ADF expired in October 1995.

(criticism is on http://www.gmabrands.com/news/may95/5_12_95.htm)[56]

4.5.2.5. North Carolina ADF

North Carolina imposes an ADF on "white goods," such as refrigerators and freezers. The ADF is $10 for products containing CFCs and $5 for those without CFCs. It is to be discontinued in June 1998.

Although the ADF is unlikely to have a significant incentive effect, it generates revenues to manage the disposal of white goods. With the introduction of the ADF, county landfills are required to accept old white goods for disposal free of charge. Counties receive 75% of the ADF revenue on a per capita basis to fund the removal of CFCs and programs to recycle white goods and metal products. Additional ADF revenues are available for those counties whose disposal costs exceed their per capita ADF allocations.[57]

(Information taken from http://wastenot.ehnr.state.nc.us/SWHOME/avail.htm)

4.5.2.6. Texas Clean Fuel Incentive Surcharge

In 1989, Texas introduced a 20¢ per MMBtu surcharge on boiler oil. The surcharge applies only to industrial and utility boilers capable of using natural gas, in use between April 15 and October 15 of each year, and located in ozone non-attainment areas with populations of 350,000 or more. As part of a larger State effort to encourage the use of natural gas, the surcharge specifically addresses summer ozone problems resulting from NO_x emissions. Used oil and fuels derived from hazardous waste are exempt. Surcharge receipts are deposited in the State General Revenue Fund.[58] According to one TNRCC official, the surcharge has had little if any incentive effect because few facilities used fuel oil before the introduction of the surcharge.[59]

4.6. ROAD USER FEES

Found throughout the United States, toll roads are generally used to finance road construction and are beyond the scope of this report. Of particular interest, however, are congestion pricing tolls intended to reflect some of the social costs of traffic congestion. One of these costs is increased emissions per mile traveled. One study estimated that in southern California, if the current level of vehicle miles traveled flowed smoothly, mobile source emissions would decrease by approximately 13%.[60]

On December 27, 1995, a private congestion-based 4-lane toll road opened in the median of the existing eight-lane Riverside Freeway (SR-91). The road was built and the toll system is operated by the California Private Transportation Company (CPTC), which is free to determine toll levels but is subject to a cap on the rate of return on its investment. Five different toll levels range from $0.25 to $2.50 per 10-mile trip, depending on the time of day. Toll prices are announced in advance so that motorists can plan their trips accordingly. Windshield-mounted transponders allow for motorists to pay for toll lane use without stopping at booths. High-occupancy vehicles with 3 occupants, public transit, zero-emission vehicles, and vehicles with a disabled person license plate are exempt from the tolls. CPTC can raise the allowable rate of return on its investment by raising HOV rates.

By March 1996, over 30,000 transponders were in use, a level the project had not expected to reach until late June.[61] As of May 1996, 45,000 transponders had been issued.[62] In interviews with the *Los Angeles Times*, express lane users have reported time savings of more than 30 minutes.[63] CPTC adds that the toll lanes have not only reduced travel times for their users but also diminished congestion on the adjacent freeway.[64]

As part of its Congestion Pricing Pilot Program, the Federal Highway Administration is studying the experiences of SR91 and funding nine other projects. Six of these are studies. The other three (in the San Diego area, on the San Francisco-Oakland Bay Bridge, and in Lee County, Florida) are implementation projects. The San Diego project is scheduled to be implemented in the Fall of 1996, whereas the San Francisco-Oakland project still requires legislative approval. The Lee Country project will involve peak and off-peak tolls on three bridges.[65]

France, Norway, and Singapore have adopted congestion pricing schemes. These are described in Section 11.

(See http://www.hhh.umn.edu/Centers/SLP/Conpric/short.html. Changed: need to update this link)

4.7. WETLAND COMPENSATION FEES[66]

Wetland compensation fee systems could be described as programs in which a regulatory agency collects fees in lieu of requiring a developer to compensate for wetland losses through on-site mitigation or acquiring credits generated by a mitigation bank. The fees are used in mitigation projects by an agency or non-profit organization. Thus compensation fees differ from mitigation banking (which is discussed in Section 6) in that they require a fixed payment as opposed to the purchase or generation of a mitigation credit. Like banking systems, wetland compensation fees offer the flexibility to mitigate wetland loss in a more cost-effective manner: Instead of doing on-site mitigation on its own, the developer pays a fee to another organization to perform mitigation activities in more suitable locations.

Fee-based mitigation mechanisms have been used in Arkansas, Florida, Illinois, Louisiana, Maryland, Mississippi, Texas, and Virginia. The magnitude of the fees is usually set to cover costs such as mitigation, land acquisition, project planning, and site management.

Initiated in 1986, Florida's Mitigation Park Program is the oldest fee-based wetland mitigation system in the United States. Fees paid by wetlands developers in lieu of on-site mitigation are deposited in the Florida Game and Fresh Water Fish Commission's Fish and Wildlife Habitat Trust Fund to finance the purchase and subsequent management of large, biologically defensible Mitigation Parks. These parks, which range in size from 400 to 1,500 acres, are publicly owned but may be managed by either public or private non-profit organizations.

To participate in the program, developers need approval from the regulatory agency with which they are working. Fees depend on the amount of wetlands developed, the type of habitat impacted, and the species present at the site of the development. The developer pays one fee to finance land acquisition, a second fee (15% of the first) to fund site management, and a third (7% of the sum of the first two) as state tax. Interest accrued on the second fee revenues is used to fund site management. As of 1995, the Mitigation Park Program had received over $3.8 million and purchased over 5,600 acres.

In Maryland, the mitigation fees paid by developers into the Nontidal Wetlands Compensation Fund depend on the number of acres and type of wetlands impacted and the costs of wetland restoration and construction. The mitigation ratio (the number of acres that must be enhanced, restored, or created for every acre impacted) is either 1:1, 2:1, or 3:1, depending on the type of wetland impacted. The 3:1 ratio applies to wetlands of special concern to the state. Land acquisition costs are assessed based on prevailing market prices for agriculturally zoned or low density land with little potential for development. Restoration and construction costs are assessed at $10,000 per acre in low-cost counties and $50,000 per acre in high-cost counties. Counties with a relatively large amount of farmed hydric soils, which indicates the former presence of wetlands, are placed in the low-cost category. Losses of less than 5,000 square feet do not require mitigation.[67]

In Louisiana, companies are required to offset their damage to coastal wetlands by performing a mitigation project on their own property or by contributing mitigation fees to the Louisiana Wetlands Conservation and Restoration Fund. Mitigation fees range from $1,500 to $12,000 per acre depending on the quality of the developed wetland.[68]

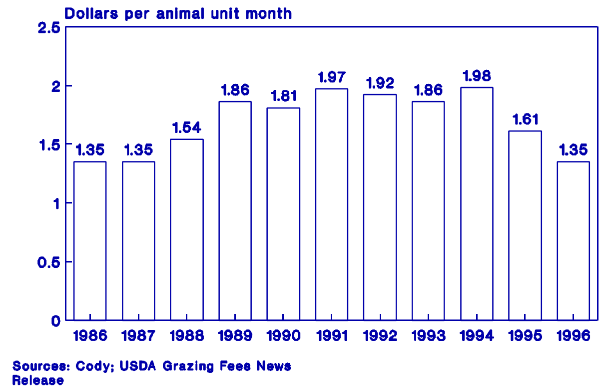
Although the costs, benefits, and incentive effects of wetlands compensation fees have not been comprehensively studied and would be difficult to determine given the various uses and sources of value of wetlands, some evidence suggests that such fees have been beneficial. Clustering individual mitigation activities into selected areas increases the viability of the wetlands. Moreover, the fact that developers have participated in fee-based schemes suggests that paying fees is more economical for them than carrying out on-site mitigation on their own.[69]

(Crookshank report: www.api.org/cat/SEC12.htm#10)

4.8. GRAZING FEES

Federal and state governments charge fees for animal grazing on public lands. Federal fees date back to 1906 and are currently charged for grazing on about 167 million acres of Bureau of Land Management land and 94 million acres of Forest Service land. Grazing on this land accounts for approximately 2% of total beef cattle feed in the 48 contiguous states and supports about 10% of livestock producers in the 16 Western states in which fees are charged based on a formula set by the 1978 Public Rangelands Improvement Act (PRIA).[70]
(CRS primer on grazing: www.cnie.org/nle/ag-5.html)

Figure 4-4: GRAZING FEES UNDER THE PUBLIC RANGELANDS IMPROVEMENT ACT



The PRIA formula is based on private grazing rates, beef cattle prices, and the cost of livestock production. The fee is expressed in animal unit months (AUM), where one AUM is the amount of forage required to sustain one cow and her calf, one horse, or five sheep or goats for a month. As shown in Figure 4-4, the 1996 fee is $1.35 per AUM. Under the terms of a 1986 Executive Order, $1.35 is the minimum fee.[71]

(http://www.fs.fed.us/forum/graznews.htm)

The theory behind such fees is that animal owners should pay fair market value for use of the land and bear the costs of the damage inflicted by their animals. However, current fee levels are widely believed to be lower than market value. To the extent that the fees are too low, they amount to a form of subsidization and are therefore included in the discussion of environmentally harmful subsidies in Section 7.

(1995 Green Scissors on grazing fees: www.essential.org/orgs/FOE/scissors95/greenpart22.html)

4.9. MINNESOTA CONTAMINATION TAX

The Minnesota Contaminated Property Tax, which entered into effect in fiscal year 1995, is levied on the "contamination value" of property, i.e. the difference in its value before and after contamination. Property owners responsible for contamination that do not have approved cleanup plans pay contamination tax at the full property tax rate. The contamination tax is halved for owners who have filed an approved cleanup plan. Owners who purchase contaminated land without notice of the contamination pay 25% of the property tax rate until a cleanup plan is filed, after which the rate decreases to 12.5%. According to a local tax official, the tax gives property owners "a strong impetus to clean up."[72]

Endnotes for Section 4

1. EPA (March 1991), p. 4-6.

2. For more information on such stormwater credits, see Reese (1996).

3. Morandi et al. (1995), p. 10.

4. EPA (March 1991), p. 4-6.

5. GAO (January 1996), pp. 1-4.

6. Unless otherwise stated, the rest of the information in this sub-section on state effluent fees is provided by Duhl (1993). This document is obtainable free of charge from the American Petroleum Institute. www.api.org/cat/SEC12.htm#12

7. The fee schedule can be found on the California Water Resources Control Board internet site: www.swrch.ca.gov/pub/FEES/feebptc.zip

8. Information in these last two paragraphs provided by Candace Carraway, Air Quality Management Division, Environmental Protection Agency, personal communication, June-July 1996.

9. All information on Maine's air pollution fees provided by *DEN*, June 22, 1993, p. B-6 and by Richard Limouze, Maine Air Quality Bureau, personal communication, 1996.

10. Information in tables 4 and 5 and on carbon monoxide fees taken from SCAQMD Rule 301 as revised on May 10, 1996. www.aqmd.gov/rules/html/r301.html

11. SCAQMD, Rule 303. www.aqmd.gov/rules/html/r303.html

12. These are defined in paragraph (b)(20) of rule 301 to include the following:
trifluoromethane (HFC-23);
chlorodifluoromethane (HCFC-22);
dichlorotrifluoroethane (HCFC-123);
tetrafluoroethane (HFC-134a);
dichlorofluoroethane (HCFC-141b);
chlorodifluoroethane (HCFC-142b);
1,1,1-trifluoroethane (HFC-143a);
1,1-difluoroethane (HFC-152a);
cyclic, branched, or linear, completely fluorinated alkanes;
cyclic, branched, or linear, completely fluorinated ethers with no unsaturations;
cyclic, branched, or linear, completely fluorinated tertiary amines with no unsaturations;
sulfur-containing perfluorocarbons with no unsaturations and with sulfur bonds

only to carbon and fluorine.

13. Carla Takemoto, California Air Resources Board, personal communication, May 1996.

14. Catherine Fortney, Bay Area Air Quality Management District, personal communication, May and June 1996.

15. Environmental Law Institute (August 1993), pp. 22-23.

16. Fortney, op cit.

17. The baseline amount is the lower of actual or allowable VOC emissions. For details, see Title I, Section 185 of Clean Air Act.

18. Skumatz (1996), p. 1.

19. The internet site for these documents is www.epa.gov/docs/oppe/eaed. For references, see Bauer and Miranda; Miranda, Bauer, and Aldy; and Miranda and Aldy in the bibliography.

20. Skumatz (1996), p. 2.

21. Miranda and Aldy (1996), p. 16.

22. The city of Colorado Springs neither collects garbage nor licenses haulers. The fees listed here are charged by Waste Management (one of the haulers operating in the city) when it supplies cans and bags. Customers supplying their own cans and bags pay other rates.

23. Miranda, Bauer, and Aldy (1995), pp. 8-9.

24. Skumatz (1993), pp. 283-284.

25. *Warmer Bulletin*, February 1996, p. 16.

26. Miranda and Aldy (1996), p. 19.

27. Skumatz (1994), p. 284.

28. Skumatz (1996), p. 4.

29. The source of the table is Marie Lynn Miranda et al., *Managing Municipal Solid Waste: The Unit-based Pricing Approach*, 1993, as reprinted in Arner and Davis (1994). An N/A in the recycling column denotes either that data were insufficient or that the municipality implemented a recycling program simultaneously with variable rate pricing.

30. Repetto et al. (1992), pp. 18-19.

31. *DEN*, pp. A5-6.

32. Skumatz (1994), p. 286.

33. Repetto et al. (1992), p. 27.

34. Miller, p. 3.

35. *DEN*, February 13, 1996, pp. B3-4. The rates for waste in liquid form were provided by Tom Lucas, New Jersey Taxation Division's Special Audit Section, personal communication, 1996.

36. GAO (February 1995), p. 23.

37. Information obtained from *DEN*, April 21, 1995, pp. A2-3 and from personal communication with Hallie Clem, DC Department of Public Works, 1996.

38. Disposal and generation fees taken from California Department of Toxic Substances Control, "Hazardous Waste Fee Summary, Effective 1996." The authors have added the last column to the second table to provide estimates of fees per ton.

39. Walt Larson, California Department of Toxic Substances Control, personal communication, May 1996.

40. For a list of federal environmental excise taxes, see Barthold (1994), p. 146.

41. Ibid, pp. 146-147.

42. Fullerton (1995), p. A7.

43. EPA (March 1991), p. 3-18.

44. Unless otherwise stated, the term "CFCs" refers throughout this section to a variety of ozone-depleting chemicals, including halons and methyl chloroform.

45. Barthold (1994), pp. 137-138.

46. Cook (1996), p. 5.

47. Congressional Research Service (1994), pp. 72-75.

48. Cook (1996), p. 5.

49. *Scrap Tire News Legislative Report*, "Scrap Tire Laws and Regulations," January 1996, pp. 18-19.

50. Fullerton (1995), p. A7.

51. Information on fertilizer taxes as of March 1994 was provided by the Fertilizer Institute.

52. Rich Girasole, Rhode Island Department of Environmental Management, personal communication, May 1996.

53. *DEN*, October 5, 1993.

54. Ackerman (1994), pp. 273-4.

55. Hoerner (1995), p. 16.

56. Grocery Manufacturers of America. Another source of information on the Florida ADF is Martin (1994).

57. North Carolina Department of Environment, Health, and Natural Resources. wastenot.ehnr.state.nc.us/SWHOME/grants.txt

58. Environmental Law Institute (August 1993), p. 24.

59. Randy Hamilton, Texas Natural Resource Conservation Commission, personal communication, June 1996.

60. Cameron (1991), p. 8.

61. Transponder figure provided by March 19, 1996 Earthlink release from Greg Brooks, California Private Transportation Company.

62. Martine Micozzi, Federal Highway Administration, personal communication, May 1996.

63. Federal Highway Administration, *Buyline$: Congestion Pricing Updates*, Spring 1996.

64. Brooks, CPTC, March 19, 1996 Earthlink release.

65. Federal Highway Administration, *Buyline$: Congestion Pricing Updates*, Spring 1996.

66. Unless otherwise stated, the information on wetland compensation fees is provided by Crookshank (1995). www.api.org/cat/SEC12.htm#10

67. Information on Mitigation Park Program and Maryland Nontidal Wetlands Compensation Fund provided by Crookshank (1995), p. 42. This document describes fee-based programs in Arkansas, Florida, Maryland, Louisiana, Mississippi, and Illinois.

68. "DNR Sets New Rules for Wetlands Mitigation," *Baton Rouge Advocate*, August 27, 1995.

69. For a discussion of the economic benefits of off-site mitigation and larger wetlands, see Anderson and Rockel (1991), pp. 50-51. www.api.org/cat/SEC12.htm#22

70. Cody (1994), p. 1. The states with federal fees calculated according to this formula are Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Utah, Washington, and Wyoming. Fees are different for eastern states and for national grasslands managed by the Forest Service.

71. U.S. Department of Agriculture Forest Service news release, "1996 Grazing Fees Announced." www.fs.fed.us/forum/graznews.htm

72. Hoerner (1995), p. 16.